Wildfield Village Secondary Plan
Caledon
Local Subwatershed Study (LSS)
Phase 1 Report
Subwatershed Characterization and Integration

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Submitted by:

SCS Consulting Group Ltd
30 Centurian Drive, Suite 100
Markham, ON L3R 8B8

GEI Consultants Inc.
330 Trillium Drive, Unit D
Kitchener, ON N2E 3J2

Project Number: 2630

Table of Contents

List of Appendices

List of Figures

List of Tables

Section 4 - **Tables Within Body of Report**

1.0 Introduction

Wildfield Village is located within the Region of Peel, in the Town of Caledon, within the Region's Urban Boundary. The lands are designated as 2051 New Urban Area in the Region of Peel Official Plan (April 2022). Through the Region's Settlement Area Boundary Expansion (SABE) Study, Community Lands, of which Wildfield Village is included, have been identified to be developed for residential purposes including associated roads, infrastructure, utilities, institutions, retail, parks and open space.

1.1 Purpose

This Local Subwatershed Study (LSS) has been prepared by SCS Consulting Group Ltd. and GEI in support of the Secondary Plan for Wildfield Village. Per Town of Caledon correspondence (Cassie Schembri, Town of Caledon, March 28, 2024), the intent of the LSS is to "develop a sustainable development plan for the subject growth area in Caledon by protecting and enhancing the natural and human environments through the implementation of the direction, targets, criteria and guidance of the Region of Peel Scoped Subwatershed Study (SWS) prepared by Wood (2022). The LSS will confirm, refine and implement a Natural Heritage System (NHS) and the water resource management approach that will protect, rehabilitate, and enhance the natural and water-based environments within the Secondary Plan area, and the surrounding lands in the subwatershed."

The LSS has been prepared in accordance with the approved Terms of Reference dated August 23, 2024 (refer to **Appendix A1**). The LSS will address a range of environmental and servicing matters associated with the Wildfield Village Secondary Plan (WVSP) area, including the protection and management of surface water, groundwater, fluvial geomorphology, and terrestrial and aquatic resources. The LSS will also identify the NHS and municipal servicing needs, including stormwater management, sanitary and water servicing and site grading requirements.

The LSS serves to:

- Address the relevant natural features and functions identified in the Provincial Planning Statement (PPS; MMAH 2024), Region of Peel Official Plan, and Town of Caledon Official Plan. Specifically, to ensure that the LSS aligns with the Town of Caledon's requirements which are consistent with Section 4.2 of the PPS, which emphasizes the importance of watershed studies—of which the LSS is an extension of—for large and rapidly growing municipalities to inform infrastructure planning and the protection and enhancement of water resources;

- Provide the foundation for the layout of the Secondary Plan by defining and delineating elements such as the NHS, transportation and servicing networks, and the location of stormwater management (SWM) facilities;
- Follow the direction and guidance of the Region of Peel Scoped SWS (Wood., 2022) confirming targets and criteria based on site specific data obtained through the Secondary Plan level study; and,
- Define measures to protect and/or enhance the NHS.

The LSS will be completed in three phases as follows:

- Phase 1 – Characterization of Existing Conditions and Baseline Inventory
- Phase 2 - Analysis, Impact Assessment, Mitigation and Recommendations
- Phase 3 - Implementation, Monitoring and Adaptive Management

This report fulfills the requirements of the Phase 1 LSS. The purpose of the Phase 1 report is to characterize the existing conditions and develop a baseline inventory of the natural heritage features, flood and erosion hazards, and, groundwater and surface water resources for the WVSP area.

1.2 Study Area

The WVSP area is approximately 389.7 hectares (ha) in size, and is located in the Town of Caledon, and the Region of Peel. The WVSP area is bound by Centreville Creek Road to the west, Mayfield Road to the south, the planned Highway 413 Transportation Corridor to the north and the West Humber River to the east. Refer to **Figure 1.1** in **Appendix A2** for the location of the Secondary Plan area. **Figure 1.2** (**Appendix A2**) shows the ownership for the WVPS area with approximately 57% of the lands owned by parties participating in the LSS and the Secondary Plan process.

The WVSP area is dominated by active agricultural lands, with a woodland, scattered wetlands and headwater drainage features (HDFs) occurring on the tableland. The West Humber River and its associated valley occur north and east of the WVSP area, within the Greenbelt Plan (2017) area. The valley consists of woodland and wetland habitat. Residential homes front onto portions of the roads bordering the WVPS area.

The WVSP area will be the study area basis for the LSS; however, there are several study components that will have study areas that will go beyond the WVSP limits as follows.

1.2.1 Natural Heritage Study Area

The Natural Heritage Study Area (NHSA) will consist of the WVSP area plus the 120 m adjacent lands to study and assess natural heritage features.

1.2.2 Geomorphic Study Area

The geomorphic assessment will be undertaken for watercourses within the WVSP area, as well as receiving watercourses for a distance of approximately 250 m downstream of the WVSP area. Recognizing that some reaches flow on lands that are not participating in the current study, where appropriate, these geomorphic assessments will be completed within the road right-of-way, or through desktop-based methods.

1.2.3 Hydrologic Study Area

The WVSP is located within the upper reaches of the Humber River watershed and is identified as being in the West Humber subwatershed. The hydrologic modelling will encompass the WVSP area, in addition to external drainage from lands upstream that flow through the WVSP area. It should be noted that the hydrologic study area is approximately 358.1 ha which is less than the WVSP area of 389.7 ha. The difference is attributed to the fact that the Secondary Plan includes a portion of the future Highway 413 corridor whereas the hydrologic study area does not, although it is considered as an external drainage area.

The hydrologic analysis will also include flow nodes downstream of the WVSP area to Lake Ontario in accordance with the Final Report Humber River Hydrology Update (Toronto and Region Conservation Authority, 2018). Background Information

1.3 Background Information

1.3.1 Reports

In preparation of the LSS, the following reports have been reviewed and referenced:

- Humber River Watershed Characterization Report (TRCA, 2023);
- Region of Peel Settlement Area Boundary Expansion Study (SABE), (2022);
- Scoped Subwatershed Study (SWS), Part A: Existing Conditions and Characterization (Final Report) Settlement Area Boundary Expansion, Region of Peel (Wood., 2022);
- Scoped Subwatershed Study (SWS), Part B: Detailed Studies and Impact Assessment (Final Report), Settlement Area Boundary Expansion, Region of Peel, (Wood., 2022);
- Scoped Subwatershed Study (SWS), Part C: Implementation Plan (Final Report), Settlement Area Boundary Expansion, Region of Peel (Wood., 2022).
- Approved Assessment Report: Toronto and Region Source Protection Area (CTC Source Protection Committee, 2022);
- Region of Peel Water and Wastewater Master Plan (2020);

- Technical Memorandum, Peel Scoped Subwatershed Study (SWS) – Groundwater "Areas of Concern" mapping (Oak Ridges Moraine Groundwater Programs (ORMGP), 2020);
- Final Report Humber River Hydrology Update (TRCA, 2018);
- Mayfield Road Improvements, Airport Road to Coleraine Drive – Class Environmental Assessment, Environmental Study Report (Stantec and the Region of Peel, April 2015)
- Humber River State of the Watershed Reports (TRCA, 2008);
- Humber River Watershed Plan (TRCA, 2008);
- Humber River Watershed Scenario Modelling and Analysis Report (TRCA, 2008);
- Listen to Your River: A Report Card on the Health of the Humber River Watershed (TRCA, 2007);
- Groundwater Modelling of the Oak Ridges Moraine Area (Kassenaar, J.D.C. and Wexler, E.J., 2006); and,
- The Physiography of Southern Ontario (Chapman and Putnam, 1984).

1.3.2 Policies, Guidelines and Legislation

The following policies, guidelines, and legislation have been reviewed with respect to preparing the LSS:

- Town of Caledon Official Plan (2024);
- Future Caledon Official Plan (2024);
- Ontario Regulation 41/24: Prohibited Activities, Exemptions and Permits (2024);
- Draft Town of Caledon Growth Management Phasing Plan and Financial Impact Assessment Presentation (2023);
- Municipal Consolidated Linear Infrastructure Environmental Compliance Approvals, Ministry of Environment, Conservation and Parks (MECP), (June 2023);
- Region of Peel Official Plan (2022);
- Approved CTC Source Protection Plan (CTC Source Protection Committee, 2022);
- A Place to Grow; Growth Plan for the Greater Golden Horseshoe (2020);
- Development Standards Manual, Town of Caledon, Version 5 (2019);
- Erosion and Sediment Control Guide for Urban Construction (TRCA, 2019);
- Technical Guidelines for Flood Hazard Mapping (TRCA and other Conservation Authorities, 2017);
- Wetland Water Balance Risk Evaluation (TRCA, 2017);
- Geotechnical Engineering Design and Submission Requirements (TRCA November 2017);

- Greenbelt Plan (May 2017);
- Wetland Water Balance Monitoring Protocol (TRCA, 2016);
- Crossings Guideline for Valley and Stream Corridors (TRCA, 2015);
- TRCA Master Environmental and Servicing Plan Guideline (TRCA, 2015);
- Evaluation, Classification, and Management of Headwater Drainage Features (HDF) Guidelines (CVC & TRCA, 2014);
- Hydrogeological Assessment Submissions- Conservation Authority Guidelines to Support Development Applications (Conservation Ontario 2013);
- Ministry of Municipal Affairs and Housing (MMAH) Supplementary Guidelines SG-6, Percolation Time and Soil Descriptions, (MMAH 2012)
- Stormwater Management Criteria, Toronto and Region Conservation Authority Version 1.0 (August 2012);
- Ministry of Natural Resources: Natural Heritage Reference Manual: Second Edition (OMNR 2010);
- TRCA/CVC Low Impact Development Stormwater Management Planning and Design Guide (2010);
- https://wiki.sustainabletechnologies.ca/wiki/Main_Page
- Peel Region Storm and Sanitary Sewer Use By-Law 53-2010 (Peel Region, 2010)
- Humber River Watershed Plan Implementation Guide (TRCA, 2008);
- Species at Risk in Ontario (SARO) List, regulation to the Endangered Species Act (ESA 2007);
- Channel Modification Design and Submission Requirements (TRCA, 2007);
- Belt Width Delineation Procedures (TRCA, 2004);
- Ministry of Environment (MOE) Stormwater Management Planning and Design Manual (March 2003);
- Technical Guide for River & Stream Systems: Erosion Hazard Limit (MNRF, 2002);
- The Living City Policies for Planning and Development in the Watersheds of the Toronto and Region Conservation Authority (TRCA, November 28, 2014).
- Ministry of Transportation (MTO) Drainage Management Manual (1997).

1.3.3 Base Mapping

The following data sets have been utilized in preparing the mapping utilized in the LSS:

- LiDAR 1.0 m Contours from Geohub, 2024
- Topographic Survey prepared by R-PE Surveying Ltd, October 2023
- Roads and Lot Fabric, Region of Peel
- Digital Imagery, First Base Solutions, 2002, 2013 and 2022.
- Watercourses, TRCA 2018
- TRCA Regulatory Mapping, 2024
- Humber River Hydrologic Catchments, Civica 2018
- Humber River Floodplain Mapping, Cole Engineering, May 2018
- Gao, C., Shirota, J., Kelly, R. I., Brunton, F.R., van Haaften, S. 2006. Bedrock topography and overburden thickness mapping, southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 207.
- Aerial photographs from 1960, 1976, and 1988, National Air Photo Library
- Digital imagery from 1954, University of Toronto Aerial Imagery Database (University of Toronto, 2024)
- Ministry of Environment, Conservation and Parks (MECP). Water Well Information System, Data Catalogue. Retrieved from: https://data.ontario.ca/dataset/well-records
- Ontario Geological Survey 2011. 1:250,000 scale bedrock geology of Ontario. Ontario Geological Survey. Miscellaneous Release---Data 126-Revision 1.
- Ontario Geological Survey. 2010. Surficial geology of Southern Ontario. Ontario Geological Survey. Miscellaneous Release--Data 128-Revised.
- Ontario Geological Survey. 2000. Quaternary geology, seamless coverage of the Province of Ontario. Ontario Geological Survey. Data Set 14---Revised.
- Ontario Ministry of the Environment, Conservation and Parks. 2021. Source Protection Information Atlas. Retrieved from: https://www.lioapplications.lrc.gov.on.ca/SourceWaterProtection/index.html?viewer=SourceWaterProtection.SWPViewer&locale=en-CA
- Ontario Ministry of Natural Resources. 2024. Ontario Watershed Information Tool. Retrieved from: https://www.lioapplications.lrc.gov.on.ca/OWIT/index.html?viewer=OWIT.OWIT&locale=en-CA
- Gao, C., Shirota, J., Kelly, R. I., Brunton, F.R., van Haaften, S. 2006. Bedrock topography and overburden thickness mapping, southern Ontario. Ontario Geological Survey. Miscellaneous Release--Data 207.
- Armstrong, D.K. and Dodge, J.E.P. 2007. Paleozoic Geology Map of Southern Ontario. Ontario Geological Survey. Miscellaneous Release--Data 219.

1.3.4 Models

The following models have been utilized in the technical analysis completed as part of the LSS:

- Humber River Visual Otthymo Hydrologic Model (TRCA, 2018)
- Humber River Zone 2 HEC-RAS Hydraulic Model (TRCA, 2018)

The following reports contain the methodology and results for regional groundwater modelling, including the WVSP area, and have been referenced as part of the LSS:

- York Tier 3, results summarized in "Tier 3 Water Budget – Water Quantity Risk Level Assignment Study, Regional Municipality of York, Phase 1 Model Development Report," by Earthfx, dated February 2013.
- TRCA 2008 PRMS, results summarized in "Humber River Watershed, Scenario Modelling and Analysis Report," by TRCA, 2008.

1.3.5 Natural Heritage Resources

The following resources were reviewed for information relating to natural heritage features and species that may be found in the NHSA:

- The Ministry of Natural Resources and Forestry (MNRF) Land Information Ontario (LIO) database (2024);
- The Ministry of Natural Resources and Forestry (MNRF) Natural Heritage Information Centre (NHIC) database (MNRF 2024);
- Bird Studies Canada's Atlas of Breeding Birds of Ontario (BSC et al. 2006);
- Ontario Nature's Reptile and Amphibian Atlas (2020);
- Toronto Entomologists' Association's (TEA) Ontario Butterfly and Moth Atlases (2023, 2020);
- DFO Aquatic Species at Risk Mapping (2023); and,
- Other sources (e.g. watershed management plans, fisheries management plans).

The results of these background reviews are discussed in the following sections. This information assisted in defining the search effort and target species for studies on and immediately adjacent to the NHSA.

1.3.5.1 Land Information Ontario Natural Features Summary

Based on the MNRF Land Information Ontario (LIO) geographic database, no provincially significant wetlands or earth science areas occur on or within 120 m of the NHSA.

However, the Gooseville Moraine Candidate Earth Science ANSI is located immediately north of the NHSA (north of Healey Road).

1.3.5.2 Natural Heritage Information Centre

The NHIC database (MNRF, 2024) was searched for records of provincially significant plants, vegetation communities and wildlife on, and in the vicinity of, the NHSA. The database provides occurrence database 1 km^2 area squares, with nine squares overlapping at least a portion of the NHSA.

Within these squares, the search revealed six records of species listed as threatened or endangered on the SARO list or Species of Conservation Concern (i.e., listed as Special Concern on the SARO list, or identified as an S1-S3 species):

Species listed as threatened or endangered on the SARO list:

- Eastern Meadowlark (*Sturnella magna*) – Threatened;
- Bobolink (*Dolichonyx oryzivorus)* – Threatened; and,
- Redside Dace (*Clinostomus elongatus*) – Endangered.

Species listed as Special Concern on the SARO list or identified as an S1-S3 species:

- Wood Thrush (*Hylocichla mustelina*) – Special Concern;
- Eastern Wood- Pewee (*Contopus virens*) – Special Concern; and,
- American Brook Lamprey (*Lethenteron appendix*) – S3.

1.3.5.3 Ontario Breeding Bird Atlas

The Ontario Breeding Bird Atlas contains detailed information on the population and distribution status of Ontario birds (BSC et al. 2006). The data is presented on 100 km^2 area squares with two squares overlapping a portion of the NHSA (17PJ05 and 17NJ95). It should be noted that the NHSA may be a small component of the overall bird atlas squares, and therefore it is unlikely that all bird species are found within the NHSA. Habitat type, availability and size are all contributing factors in bird species presence and use.

A total of 122 species were recorded in the atlas squares that overlap with the NHSA. The following species of interest are noted:

Species listed as Threatened or Endangered on the SARO list:

- Acadian Flycatcher (*Empidonax virescens*) – Endangered;
- Prothonotary Warbler (*Protonotaria citrea*) – Endangered;
- Red-headed Woodpecker (*Melanerpes erythrocephalus*)--Endangered;
- Whip-poor-will (*Antrostomus vociferus*) – Threatened;

- Chimney Swift (*Chaetura pelagica*) – Threatened
- Bank Swallow (*Riparia riparia*) – Threatened;
- Eastern Meadowlark – Threatened and,
- Bobolink – Threatened.

Species of Conservation Concern (i.e., listed as Special Concern on the SARO list, or identified as an S1-S3 species):

- Eastern Wood-Pewee – Special Concern;
- Wood Thrush – Special Concern;
- Common Nighthawk (*Chordeiles minor*) – Special Concern;
- Barn Swallow (*Hirundo rustica*)- Special Concern;
- Golden-winged Warbler (*Vermivora chrysoptera*) – Special Concern;
- Grasshopper Sparrow (*Ammodramus savannarum*) – Special Concern;
- Upland Sandpiper (*Bartramia longicauda*)-S2B; and
- Purple Martin (*Progne subis*) – S3B.

1.3.5.4 Ontario Nature's Reptile and Amphibian Atlas

The Ontario Reptile and Amphibian Atlas contains detailed information on the population and distribution status of Ontario herpetofauna (Ontario Nature 2020). The data is presented on 100 km2 area squares with two squares overlapping the NHSA (17PJ05 and 17NJ95). It should be noted that the NHSA are a small component of the overall atlas squares, and therefore it is unlikely that all herpetofauna species are found within the NHSA. Habitat type, availability and size are all contributing factors in herpetofauna species presence and use.

A total of 18 species were recorded in the atlas square that overlaps with the NHSA, of which three are salamander and lizard species, nine are frog and toad species, two are turtle species and four are snake species. Of these species, the following species of interest were noted:

Species of Conservation Concern (i.e., listed as Special Concern on the SARO List or identified as an S1–S3 species):

- Eastern Ribbonsnake (*Thamnophis saurita*) - Special Concern; and,
- Snapping Turtle (*Chelydra serpentina*) – Special Concern.

1.3.5.5 Ontario Butterfly and Moth Atlases

The Ontario Butterfly and Moth Atlases (Toronto Entomologists' Association 2020, 2023) contain detailed information on the population and distribution status of Ontario butterflies and moths. The data is presented on 100 km^2 area squares with two squares overlapping a portion of the NHSA (17PJ05 and 17NJ95). It should be noted that the NHSA is a small component of the overall atlas squares, and therefore it is unlikely that all butterfly and moth species are found within the NHSA. Habitat type, availability and size are all contributing factors in butterfly and moth species presence and use.

A total of 64 species were recorded in the atlas square that overlaps with the NHSA, of which 46 are butterfly species and 18 are moth species. Of these species, one Species of Conservation Concern (i.e., listed as Special Concern on the SARO list, or identified as an S1-S3 species) was noted: Monarch (*Danaus plexippus*)- Special Concern.

1.3.5.6 Aquatic Species at Risk Distribution Mapping

Aquatic species at risk distribution mapping (DFO 2024) was reviewed to identify any known occurrences of aquatic SAR, including fish and mussels, within the subwatershed where the NHSA is located. One aquatic species at risk (Redside Dace) is present within the NHSA, located in the West Humber River east of the WVSP area but within the 120m adjacent lands. The West Humber River is expected to be considered occupied Redside Dace habitat.

1.3.5.7 West Humber River Fish Community

The Humber River Fisheries Management Plan (FMP; MNR and TRCA 2005) states that the West Humber River subwatershed is dominated by agricultural land-uses within a highly impermeable clay soil. The West Humber River subwatershed contains the least amount of riparian vegetation out of the entire Humber River watershed. Historically the West Humber River supported species such as American Brook Lamprey (Lethenteron appendix), Brassy Minnow (*Hydognathus hankinsoni*), Brook Trout (*Salvelinus fontinalis*), Mottled Scuplin (*Cottus bairdii*), Redside Dace (*Clinostomus elongatus*), Smallmouth Bass (*Micropterus dolomieu*), Stonecat (*Noturus flavus*) and Yellow Perch (*Perca flavescens*).

As of 2001, only 17 fish species were found within the watershed, with the fish community dominated by warmwater species. The FMP notes there is potential for the above noted species to still persist within the subwatershed. As illustrated on Figure 2 of the FMP (Stream Order for the Humber River Watershed), first and fourth order streams are found on the NHSA. No instream barriers are illustrated within the vicinity of the NHSA on Figure 10 (Instream Barriers in the Humber River Watershed) of the FMP.

Figure 22 of the FMP (Locations of the Aquatic Habitat Categories in the Humber River Watershed) of the FMP illustrates the portion of the West Humber River in the NHSA as intermediate riverine warmwater habitat. Small riverine warmwater habitat was also identified in reaches within the NHSA. The FMP notes that small riverine warmwater habitats have poor infiltration rates and minimal groundwater inputs, causing many of the reaches to dry up during the summer months or are reduced to standing pools of water.

1.3.5.8 Humber River Watershed Characterization Report

The Humber River Watershed Characterization Report (TRCA; 2023) Map 6 Watercourse and Headwater Drainage Feature Hydrology Function Classification identifies the West Humber River in the NHSA as having Important hydrologic functions, while the majority of other reaches in the NHSA are shown as having Valued/Contributing hydrologic functions. A small number of reaches in the NHSA are identified as having Limited/Recharge hydrologic functions.
The SABE (2022) classified drainage features within the NHSA as watercourses or HDFs, with HDFs categorized as swales or having a defined channel. However, the SABE recommended that management recommendations be identified through future studies.

1.3.5.9 Citizen Science Database

The iNaturalist (2024) database is a large citizen science-based identification and data collection app. It allows any citizen to submit observations to be reviewed and identified by other naturalists and scientists to help provide accurate species observations. As the observations can be submitted by anyone, and the records are not officially vetted, the data obtained from this tool should not be used as a clear indicator of species presence, and species may be filtered out based on habitat and target survey efforts.

This online database was examined to identify observations made within the NHSA that were research grade. The following species of interest are noted:

- Species listed as Threatened or Endangered on the SARO list:
    - Rapids Clubtail (*Phanogomphus quadricolor*) – Endangered
- Species of Conservation Concern (i.e., listed as Special Concern on the SARO list, or identified as an S1-S3 species):
    - Snapping Turtle (*Chelydra serpentina*) – Special Concern; and,
    - Barn Swallow – Special Concern

Four observations of Rapids Clubtail were noted east of the NHSA. Coordinates for Endangered species are obscured in iNaturalist; however, the observations are generally within 2 km of the NHSA. One observation of Barn Swallow was noted generally within 1 km southwest of the NHSA. One Snapping Turtle was observed nesting 2 km southwest of the NHSA along Goreway Drive.

The eBird (2024) database is a large citizen science-based project with a goal to gather bird diversity information in the form of checklists of birds, archive it, and share it to power new data-driven approaches to science, conservation and education. As the observations can be submitted by anyone, and the records are not officially vetted, the data obtained from this tool should not be used as a clear indicator of species presence, and species may be filtered out based on habitat and target survey efforts. This online database was examined to identify observations made within and adjacent to the NHSA. However, no significant species were found within the WVSP area or the NHSA.

1.3.5.10 Species at Risk Assessment Tool

Mapped natural heritage features on the landscape were cross-referenced with species-specific habitat requirements through GEI's Species at Risk Assessment Tool (SARAT) to determine potential Species at Risk (SAR) habitat in the NHSA. The SARAT includes all potential and known habitats for every species at risk listed under the ESA, and municipalities where these species are known to occur, where indicated in individual species assessment and/or recovery strategy reports.

1.3.6 Additional Data

Additional data is still required to supplement background information presented in the sections above. This includes both groundwater monitoring and surface water chemistry sampling. Monitoring of groundwater within the monitoring wells installed in the WVSP area will continue until summer of 2025. This will provide two years of monitoring across most of the participating lands, and one year of monitoring at Parcels 5 and 9 (refer to **Figure 2.1, Appendix A2**) that joined the study in the summer of 2024. The last round of surface water chemistry sampling will occur in the fall of 2025 for a wet and dry event. Flow monitoring will also continue into the fall of 2025.

2.0 Natural Heritage Features and Hazards

2.1 Planning and Policy Context

An assessment of the quality and extent of natural heritage features found on and adjacent to the NHSA was completed. Ecological opportunities and constraints to development were evaluated in the context of the requirements of the following regulatory agencies, local and regional municipalities, and/or legislation:

- Town of Caledon Official Plan (2024);
- Future Caledon Official Plan (2024);
- Peel Region Official Plan (2022);
- Greenbelt Plan (2017);
- Toronto Region Conservation Authority (TRCA);
- Provincial Planning Statement (MMAH; 2024);
- Provincial Endangered Species Act (ESA; 2007; as amended June 2025);
- Migratory Birds Convention Act (2017); and,
- Federal Fisheries Act (2019).

The relevant portions of each of these, as they apply to the NHSA and the development potential, are discussed in the following sections.

2.1.1 Town of Caledon Official Plan (2024 Consolidation)

Parts of the NHSA are designated as “Prime Agricultural Area” on Schedule A of the Caledon Official Plan (OP). The West Humber River and its valley, as well as a tributary and headwater drainage feature, in the WVSP area are designated “Environmental Policy Area” on Schedule A (**Figure 2.1, Appendix B1**).

“Environmental Policy Area” encompasses “Natural Core Areas” and “Natural Corridors” within the Town of Caledon OP. Section 5.7.3.1.1 of the Caledon OP states that major development and site alteration is not permitted within lands designated “Environmental Policy Area”. Minor refinements to the limits of an “Environmental Policy Area” may be made through environmental studies without the need for an OP Amendment. Major modifications to an “Environmental Policy Area” require an OP Amendment. Natural Core Areas and Natural Corridors are defined within Table 3.1 of the OP as including the following features:

Natural Core Areas:

- All Woodland Core Areas;
- All Wetland Core Areas;
- All Niagara Escarpment Natural Areas;
- All Life Science Area of Natural and Scientific Interest;

- All Environmentally Significant Areas (ESAs);
- All Significant Habitat of Threatened and Endangered Species; and,
- All Greenbelt and Oak Ridges Moraine Key Natural Heritage Features and Key Hydrological Features.

Natural Corridors:

- All Core Fishery Resource Areas; and,
- All Valley and Stream Corridors.

These components are subject to detailed land use policies for Environmental Protection Areas in Section 5.7 of the Caledon OP.

Supportive Natural Systems and Natural Linkages play a crucial role in supporting and enhancing the form, function and integrity of Natural Core Areas and Natural Corridors. These both include:

- Other Woodlands;
- Other Wetlands and Wetland Adjacent Lands;
- All Niagara Escarpment (NEC) Protection Areas;
- All Earth Science ANSI's;
- Potential ESAs; and
- All Other Fishery Resource Areas

Supportive Natural Systems also include:

- All Other Habitats of Threatened and Endangered Species;
- All Other Wildlife Habitat;
- Bedrock Aquifers, Surficial Aquifers, Recharge Areas and Discharge Areas;
- Productive Soils;

Natural Linkages also include:

- Recharge Areas and Discharge Areas;
- Erosion Prone Soils; and
- Natural Slopes >15 %.

2.1.2 Future Caledon Official Plan (2024)

The Town of Caledon's Future Caledon OP (2024) was adopted by Council on March 26, 2024. This OP is not yet in force and effect as it must still be approved by the Ministry of Municipal Affairs and Housing. On Schedule B2 of the Future Caledon OP, the WVSP area is noted as part of the "New Urban Area 2051". Schedule B4 denotes proposed Land Uses for the New Urban Area; the WVSP area includes “New Community Area” and “Natural Features and Areas”.

It is anticipated that through the WVSP Official Plan Amendment (OPA) process, with the support of this LSS, that final detailed land uses designations will be determined and will facilitate future site-specific land development applications by individual landowners.

The Future Caledon OP refers to the Region of Peel Scoped SWS (Wood., 2022) in Section 13.9 in reference to the delineation of a preliminary Natural Environment System for New Community Areas and New Employment Areas. This Section outlines the requirements for a local SWS to be completed for each secondary plan area within these “New Urban Areas” in Section 13.9.1. The “Natural Features and Areas” outlined in Schedule B4 for the New Urban Areas have been preliminarily defined through the SABE (see below for more details on the SABE reports); however, it is assumed that these areas will be further refined and updated based on more targeted desktop and field investigations through this LSS.

In general, the LSS should provide recommendations for updated “Natural Environment System” that includes “Natural Features and Areas” including:

- Provincially Significant Wetlands (PSW);
- Woodlands meeting one or more of the criteria for Core Area woodland on Table 1 of the Region of Peel Official Plan;
- Significant Valleylands;
- Environmentally Sensitive or Significant Areas;
- Provincial Life Science Areas of Natural and Scientific Interest (ANSIs);
- Escarpment Natural Area designation of the Niagara Escarpment Plan; and,
- Valley and stream corridors meeting one or more of the criteria for Core Area valley and stream corridors in Table 2 of the Region of Peel OP.

As well as “Supporting Features and Areas” inclusive of:

- Evaluated non-provincially significant wetlands;
- Unevaluated wetlands;
- Woodlands meeting one or more of the criteria for a natural areas and corridors woodland in Table 1 of the Region of Peel OP;
- Cultural woodlands and cultural savannahs within the urban system meeting one or more of the criteria for a potential natural area and corridor woodland in Table 1 of the Region of Peel OP;
- Any other woodland greater than 0.5 hectares that does not meet the criteria for a natural areas and corridors (NAC) woodland in Table 1 of the Region of Peel OP;

- Significant Wildlife Habitat (SWH) meeting one or more of the criteria in the Ministry of Natural Resources and Forestry significant wildlife habitat technical guide, but located outside of an applicable provincial plan area;
- Fish habitat;
- Habitat of aquatic SAR;
- Habitat of endangered species and threatened species;
- Enhancement Areas; and
- Linkages.

Appropriate minimum buffers for natural heritage features are to be established based on the LSS assessments.

The Future Caledon OP (2024) also brings in additional climate change considerations. In 2010, the Town of Caledon created its first Community Climate Change Action Plan (CCCAP), furthering their climate action efforts in 2017 by signing on to the Global Covenant of Mayors for Climate and Energy (GCOM). The Town created a Future Climate Projections Report (2018) to better understand anticipated trends and impacts of climate change on the community. The climate change objectives and policy directions outlined in Chapter 5 of the Future Caledon OP aim to support the corporate goals, actions, and strategies identified in the newest version of the Resilient Caledon CCCAP, released in 2021. The Resilient Caledon Plan combines adaptation and mitigation actions to reduce GHG emissions and help the community prepare for climate change. The Future Caledon – Our Official Plan (2024), highlights the need to address climate change through a series of objectives and policy decisions that support the corporate goals, actions, and strategies in the Resilient CCCAP.

2.1.3 Peel Region Official Plan (2022)

As of July 1, 2024, the Region of Peel Official Plan (Peel OP) constitutes an official plan of Peel's lower-tier municipalities. As such, the Town of Caledon is now responsible for the interpretation and implementation of the Peel OP.

The Peel OP (2022) identifies the WVSP area as part of the Urban System, overlayed with the 2052 New Urban Area as shown on Schedule E-1 ("Regional Structure"). The West Humber River corridor is identified within the Greenlands System containing Core Areas (Schedules C-1; "Greenlands System", and C-2 "Core Areas of the Greenlands System in Peel") (**Figure 2.1, Appendix B1**). In addition, several Natural Areas and Corridors (NAC) and Potential Natural Areas and Corridors (PNAC) are identified within and adjacent to the WVSP area shown on Figure 7 ("Regional Greenlands System- Core Areas Natural Areas and Corridors and Potential Natural Areas and Corridors") of the Peel OP (2022).

The Peel OP (2022) defines Core Areas of the Greenlands System as:

- Significant Wetlands;
- Significant Coastal Wetlands;
- Woodlands meeting one or more of the criteria for Core Area woodland in Table 1 of the Peel OP;
- Environmentally Sensitive or Significant Areas;
- Provincial Life Science Areas of Natural and Scientific Interest;
- Escarpment Natural Areas of the Niagara Escarpment Plan; and
- Valley and Stream Corridors that meet criteria outlined in Table 2 of the ROP.

NAC are defined as:

- Evaluated non-provincially significant wetlands and coastal wetlands;
- Woodlands meeting one or more of the criteria for NAC woodland in Table 1 of the Peel OP;
- Significant wildlife habitat;
- Fish habitat;
- Habitat of aquatic species at risk;
- Habitat of endangered and threatened species;
- regionally significant life science Areas of Natural and Scientific Interest;
- Provincially significant earth science Areas of Natural and Scientific Interest;
- Escarpment Protection Areas of the Niagara Escarpment Plan;
- The Lake Ontario shoreline and littoral zone and other natural lakes and their shorelines;
- Any other valley and stream corridors that have not been defined as part of the Core Areas;
- Sensitive headwater areas and sensitive ground water discharge areas; and,
- Any other natural features and functional areas interpreted as part of the Greenlands System Natural Areas and Corridors.

PNAC are defined as:

- Unevaluated wetlands and coastal wetlands;
- Cultural woodlands and cultural savannahs within the Urban System meeting one or more of the criteria for PNAC woodland in Table 1 of the Peel OP (2022);
- Regionally significant earth science Areas of Natural and Scientific Interest;
- Sensitive ground water recharge areas;
- Portions of Historic shorelines;
- Open space portions of the Parkway Belt West Plan Area;
- Enhancement areas, buffers and linkages; and,
- Any other natural features and functional areas interpreted as part of the Greenlands System Potential Natural Areas and Corridors.

The Official Plan review (Peel 2051) also identified the need for a Community Energy and Emissions Reduction Plan (CEERP) and Climate Adaptation Plan (CAP) to be completed for each new secondary plan area. The CEERP aims to address the feasibility, planning and implementation requirements around energy matters such as net zero annual energy usage, alternative and renewable energy systems, and electric vehicle charging infrastructure. A CAP should address risk and vulnerability related matters for the built and natural environment, public health and water resource systems and provide direction to implement recommendations to reduce community and environmental vulnerability to changing climate conditions and extreme weather events.

As part of the review of the Region of Peel's Official Plan review (Peel Official Plan review (Peel 2051+) the Region conducted a SABE Study including a technical study on climate change entitle Opportunities for Climate Change Mitigation, Energy and Emissions Reductions, which establishes a vision for the SABE area to be a low carbon community with the ultimate goal of transitioning to net zero over time. The Town of Caledon has incorporated this policy direction in its Future Official Plan (2024), including policies that prioritize climate change at the forefront of land use planning decisions. Goal 2.4.1(a) in the Town's Future Official Plan update is to achieve a built form and system of infrastructure that mitigates the Town's contribution to climate change and enhances resiliency to its impacts.

The main purpose of the SABE was to summarize findings of technical studies for a broad area in southern part of the Town of Caledon and to assess the most appropriate location for new urban lands and appropriate settlement growth. As part of the Peel Region SABE Study, a scoped SWS was conducted to inform recommendations for the natural environment and provide base level guidelines for future, detailed subwatershed studies completed as part of the OPA process. The details of the studies undertaken are described in the subsequent section.

2.1.4 Settlement Area Boundary Expansion (SABE) Environmental Screening Report & Scoped SWS

To better understand the environmental conditions, impacts, and management opportunities, an Environmental Screening Report (Wood, 2020) was prepared for the Region of Peel, and followed by the Scoped SWS (Parts A, B & C; Wood, 2022). The WVSP area falls within the SABE boundary, and thus the desktop data presented in the Environmental Screening Report (Wood et al., 2020) and the SABE Scoped SWS (Part A, B, & C; Wood et. al., 2022) were used to inform this LSS.

In order to define the preliminary NHS for the SABE, the following feature classes were identified and integrated into the NHS.

Key Features: features and areas that are recommended to be protected as part of a connected NHS and include:

- Woodlands;
- Wetlands;
- Valleylands;
- Environmentally Sensitive/Significant Areas;
- Significant Wildlife Habitat;
- Fish Habitat;
- Provincially significant Life Science and Earth Science ANSIs;
- Regionally significant Life Science ANSIs;
- Habitat for Endangered and Threatened Species;
- HDFs identified as Protection or Conservation;
- Key Natural Heritage Features as defined in the Greenbelt Plan and the Growth Plan;
- Key Hydrologic Features as defined in the Greenbelt Plan and the Growth Plan; and,
- Sand Barrens, Savannahs, and Grasslands (as per Provincial Plans or ELC classifications).

Supporting Features: features and areas that are not identified as Key Features but meet criteria as Supporting Features and require further assessment as part of a local SWS to determine if they meet Key Feature criteria or to evaluate their functions, interactions and contributions to the NHS in order to determine how they are managed. These include:

- Woodlands;
- Wetlands;
- Valleylands;
- Regionally significant Earth Science ANSIs;
- HDFs identified as Mitigation;
- Successional habitats; and,
- Open aquatic habitats.

Other Features: those features and areas that are not Key or Supporting features but meet criteria as 'Other Features'. This category may include small and/or isolated features, features or areas requiring further assessment to determine their status as potential key or supporting features. These include:

- Woodlands;
- Wetlands;
- Successional habitats; and,
- Open aquatic habitats.

The Scoped SWS (Wood, 2022) also outlines recommended targets for the NHS within the SABE area. These targets are recommendations that should be explored through the LSS to support the identification and planning of the NHS. Targets for feature types are as follows:

- Natural cover: no net loss;
- Wetlands: no net loss of wetland cover; increase total wetland cover through NHS enhancements;
- Valley and Stream corridors: no net loss of ecological and hydrological functions; increase natural cover within these corridors through enhancements;
- Successional/Open Habitats: Maintain important existing successional / open habitats contiguous to other features and areas of the NHS; increase representation and quality of open country habitats across the landscape through NHS enhancement opportunities; strive to create at least one habitat area with a minimum size threshold of 5 ha;
- Aquatic: achieve 75% naturally vegetated watercourse length through protection, enhancement or restoration;
- Sand Barrens, Savannahs, Grasslands: protect these where they occur; and,
- NHS Enhancements: identify and distribute enhancement opportunities across the NHS to support a robust and sustainable system; increase natural cover by 30%.

These targets will be further assessed as part of the Phase 2 LSS in the context of proposed land use changes.

2.1.5 The Greenbelt Plan

The Greenbelt Plan (2017) works to permanently protect environmentally sensitive areas due to their ecological value within the Golden Horseshoe. It is intended to enhance the natural landscapes by working to facilitate the connection of environmentally significant areas and reduce fragmentation of the landscape. Protection is offered also to permanent agricultural areas ensuring the permanency and sustainability of natural resources.
The Greenbelt Plan Area is located northeast and east of the WVSP area and contains the NHS. As described within Section 3.2 of the Greenbelt Plan (2017), the Protected Countryside contains a Natural System component of a NHS and a Water Resource System (WRS). The NHS includes core and linkage areas of the Protected Countryside with the highest concentration of sensitive and significant natural features and functions, while the WRS is made up of both ground and surface water features, areas and their associated functions.

The NHS protects natural heritage, hydrologic and/or landform features (key hydrologic areas, key hydrologic features and key natural heritage features) that contribute to conserving Ontario's biodiversity and the ecological integrity of the Greenbelt itself. As described within Section 3.2.2 of the Greenbelt Plan (2017), new developments and/or site alterations must show that there are no negative impacts on the key natural heritage features or key hydrologic features of their functions.

2.1.6 Bill 23 and Ontario Regulation 41/24

Effective January 1, 2023, following the implementation of Bill 23, the role of Conservation Authorities in reviewing development applications has changed. Previously, the TRCA reviewed planning application submissions associated with future development of properties within its jurisdictional boundaries. In addition, the TRCA provided planning and technical advice to planning authorities to assist them in fulfilling their responsibilities regarding natural hazards, natural heritage, and other relevant policy areas pursuant to the Planning Act, as both a watershed-based resource management agency and through planning advisory services, in addition to their regulatory responsibilities. With the changes associated with Bill 23, the commenting role Conservation Authorities will play in Planning Act applications may vary from municipality to municipality.

Effective April 1, 2024, Ontario Regulation (O. Reg.) 41/24: Prohibited Activities, Exemptions and Permits has come into force, replacing the former O. Reg. 166/06: Toronto and Region Conservation Authority: Development, Interference with Wetlands, Alterations to Shorelines and Watercourses Regulation. O. Reg. 41/24 allows Conservation Authorities to implement Section 28 Conservation Authorities Act, 1990 (amended 2024), which states under Section 28(1) that:

"28 (1) No person shall carry on the following activities, or permit another person to carry on the following activities, in the area of jurisdiction of an authority:

a) Activities to straighten, change, divert or interfere in any way with the existing channel of a river, creek, stream or watercourse or to change or interfere in any way with a wetland.
b) Development activities in areas that are within the authority's area of jurisdiction and are,
    i) hazardous lands,
    ii) wetlands,
    iii) river or stream valleys the limits of which shall be determined in accordance with the regulations,
    iv) areas that are adjacent or close to the shoreline of the Great Lakes-St. Lawrence River System or to an inland lake and that may be affected by

flooding, erosion or dynamic beach hazards, such areas to be further determined or specified in accordance with the regulations, or

v) other areas in which development should be prohibited or regulated, as may be determined by the regulations. 2017, c. 23, Sched. 4, s. 25.”

As of April 1, 2024, the official definition of a watercourse under Ontario Regulation 41/24, made under the Conservation Authorities Act is: “a defined channel, having a bed and banks or sides, in which a flow of water regularly or continuously occurs.”

Pursuant to O. Reg. 41/24, any interference with or development in or on areas stated in the Conservation Authorities Act (e.g., hazardous lands, wetlands, river or stream valleys) requires permission from the Conservation Authority. The Conservation Authority may issue permits under Section 28.1 and may attach conditions on the permits per Section 9(1) of the Regulation. A review of TRCA’s Regulation mapping shows that the NHSA includes regulated areas including a watercourse, HDFs and unevaluated wetlands. **Figure 2.6** (**Appendix B1**) displays all mapped TRCA regulated features.

The TRCA’s Living Cities Policies (2014) document contains the principles, goals, objectives and policies approved by the TRCA for their planning and development approvals process. This document outlines policies related to the determination of the Natural System and recommends buffer widths for natural heritage features such as woodlands, wetlands, and valley and stream corridors.

2.1.7 Provincial Planning Statement (PPS)

The PPS (MMAH, 2024) provides direction on matters of provincial interest related to land use planning and development. It “…supports a comprehensive, integrated and long-term approach to planning…”. The PPS is to be read in its entirety and land use planners and decision-makers need to consider all relevant policies and how they work together.

This report addresses those policies that are specific to Natural Heritage (section 2.1 of the PPS) with some reference to other policies with relevance to Natural Heritage and impact assessment considerations and areas of overlap (e.g., Sewage, Water and Stormwater, section 3.6; Water, section 4.2; Natural Hazards, section 5.2).

Eight types of significant natural heritage features are defined in the PPS, as follows:

- Significant wetlands;
- Significant coastal wetlands;
- Significant woodlands;
- Significant valleylands;
- Significant wildlife habitat (SWH);

- Fish habitat;
- Habitat of endangered and threatened species; and,
- Significant areas of natural and scientific interest (ANSIs).

Development and site alteration shall not be permitted in significant wetlands, or in significant coastal wetlands. Development and site alteration shall not be permitted in significant woodlands, significant valleylands, SWH or significant ANSIs, unless it is demonstrated that there will be no negative impacts on the natural features or their ecological functions.
Development and site alteration shall not be permitted in the habitat of endangered and threatened species or in fish habitat, except in accordance with provincial and federal requirements. Development and site alteration may be permitted on lands adjacent to fish habitat provided it has been demonstrated that there will be no negative impacts on the natural feature or their ecological functions.

2.1.8 Ontario Endangered Species Act (ESA)

The provincial ESA (2007; as amended June 2025) was developed to:

- Identify Species at Risk (SAR), based upon best available science;
- Protect SAR and their habitats and to promote the recovery of SAR; and,
- Promote stewardship activities that would support those protection and recovery efforts.

The ESA, 2007 protects all threatened, endangered and extirpated species listed on the Species at Risk in Ontario (SARO) list. These species are protected from harm, and their habitats are protected from damage or destruction, as defined under the Act.
On April 17, 2025, the Government of Ontario introduced Bill 5, the Protect Ontario by Unleashing our Economy Act, 2025. On June 5, 2025, Bill 5 received Royal Assent, and is set to modify and eventually replace the ESA at a date yet to be determined. Upon enactment, the ESA and its associated regulations will be repealed.

The Species Conservation Act, 2025, will replace the Endangered Species Act and is expected to retain many of the same protections for Species at Risk (SAR), with several notable changes, including:

- A revised definition of “habitat” and the removal of “contributing habitat”;
- Removal of “harass” from the list of prohibited activities;
- Introduction of an online project registration system; and
- Expanded eligibility for project registration.

2.1.9 Migratory Birds Convention Act

This federal legislation protects the nests and offspring of listed migratory bird species from destruction or disturbance. In its application, it requires that best management practices be implemented to detect and avoid disturbance to active nests during development activities.

2.1.10 Federal Fisheries Act

The Department of Fisheries and Oceans Canada (DFO) administers the federal Fisheries Act, which defines fish habitat as “spawning grounds and 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” [subsection (2)1]. The Fisheries Act prohibits the death of fish by means other than fishing [subsection 34.4 (1)] and the harmful alteration, disruption or destruction of fish habitat [HADD; subsection 35. (1)]. A HADD is defined as “any temporary or permanent change to fish habitat that directly or indirectly impairs the habitat’s capacity to support one or more life processes” (DFO 2019).

Some projects may be eligible for exemption from the DFO review process, as specified under Step 3 of the DFO Fish and Fish Habitat Protection Program review process (DFO 2019b; e.g., clear-span bridges and bridge maintenance projects where DFO mitigation measures are applied, artificial waterbodies with no hydrological connection to occupied fish habitat, and projects that follow the Standards and Codes of Practice defined by DFO). All other projects or activities that have the potential to impact fish or fish habitat should be submitted to DFO through the “Request for Review” process. DFO will review the proposed project to determine whether there is potential to (1) impact an aquatic species at risk, (2) cause the death of fish or (3) result in HADD of fish habitat. The death of fish by means other than fishing or a HADD of fish habitat can be authorized by DFO under paragraphs 34.4(2)(b) or 35(2)(b) of the Fisheries Act. Authorizations require the preparation and submission of an application package identifying the impacts on fish and fish habitat as well as the avoidance, mitigation and offsetting measures that will be implemented as well as any monitoring that is proposed.

2.2 Natural Heritage

2.2.1 Reach Delineation

Reaches are defined as sections of river along which boundary conditions are sufficiently uniform such that the river maintains a near consistent structure (Brierley and Fryirs,

2005). Reaches are typically delineated based on changes in channel planform, gradient, valley form, physiography, land cover, flow inputs, channel disturbances, and past channel modifications. Due to spatial variability in the modifying and controlling influences of channel form, two reaches situated immediately upstream or downstream of each other could show a marked difference in planform (TRCA 2004). Reaches delineated as part of the SABE SWS were maintained for the most part, and refined as needed. A reach map, showing delineated and modified reaches from the SABE, as well as corresponding labels adopted by GEI, is provided in **Figure 2.6** (**Appendix B1**).
Two headwater drainage features collect water in the WVSP area's central agricultural fields before conveying flow towards Tributary H5S1/S2/S3 (previously scoped as an HDF named reach WHT2-4 in the SABE) in the southeastern corner. Reach H5S4A (WHT2-5 in the SABE) and H5S4 (a continuation of WHT2-4 in the SABE) originate as HDFs upstream of the Subject Lands boundary. The HDF portion of H5S4, named reach H5S4-2, stretches a short distance before becoming defined within a hedgerow, at which point it is also considered a watercourse, named H5S4-1. H5S4-1 flows as a watercourse until it joins with H5S4A, where Reach H5S3 begins. Reach H5S3 flows to the east before exiting the extent of the agricultural field and entering a grassy area, and which point a reach break marking the beginning of reach H5S2 was placed. Reach H5S2 continued to flow through the grassy area adjacent to the agricultural field before becoming more entrenched and sinuous. As such, a reach break was placed before this change in planform and definition, delineating reach H5S1. Reach H5S1 extended to the crossing at The Gore Road.

In addition to features within the participating properties of the WVSP Area, features traversing non-participating properties were also analysed via desktop and / or windshield assessment. A tributary of the West Humber River, reach WHT2(1)1-1 flows from north to south, flowing into a higher-order branch shortly upstream of Mayfield Road. A smaller, lower-order feature, named reach WHT2(1)2-1, flows into reach WHT2(1)1-1 from the agricultural fields to the east, within the WVSP Area.
The reach delineation was subsequently verified during the field investigation.

2.2.2 Terrestrial Connectivity

The NHSA is situated in the West – Main Branch Humber River secondary subwatershed unit (TRCA 2008) which is characterized as containing little habitat with small, fragmented patches that are mostly constrained to valley corridors and tableland forests (TRCA 2008). Figure 3-11 (Terrestrial System – Existing Conditions Landscape Analysis) of the Humber River Watershed Plan (TRCA 2008) displays the habitat patch quality of the identified natural heritage features within the NHSA as a mix of fair and poor.

The West – Main Branch Humber River secondary subwatershed is dominated by agriculture in the north and urbanized in the south. As such, the West Humber River valley is expected to serve as a primary wildlife corridor and linkage for terrestrial, semi-aquatic and aquatic species. North of Healey Road, the West Humber River corridor extends beyond King Street, where it reaches the Main Humber River subwatershed. Here, the Main Humber River is generally surrounded by large woodlands and wetlands and includes several conservation areas such as the Bolton Resource Management Tract, the Nashville Conservation Reserve, the Cold Creek Conservation Area and the Albion Hills Conservation Park, allowing species to move north, south, east and west across the landscape. Contiguous forest cover protects wildlife while they are foraging, migrating, mating and/or overwintering. South of Mayfield Road, the West Humber River is surrounded by residential developments before converging with the Lower Humber River at Claireville Conservation Area.

The existing road network surrounding the NHSA serves as a significant barrier to wildlife movement and includes busy roads. Specifically, Mayfield Road is a major arterial roadway for Caledon and Brampton. With increased population projected for the Town of Caledon, it is anticipated that Humber Station Road and Healey Road will be widened and become busier and will pose an increased risk to wildlife movement. Wildlife passage opportunities are recommended to be assessed during Phase 2 of the LSS.

2.2.3 Natural Heritage Field Investigations

Ecological field investigations were completed for the NHSA from 2021 through 2024, as detailed in **Table 2.1** (**Appendix B2**). The field program was designed with consideration of data collected during the background NHIC and wildlife atlas searches, preliminary SAR screening, and aerial photo interpretation. The following ecological surveys were completed for the participating ownerships within the NHSA:

- Botanical Inventory and Ecological Land Classification (ELC);
- Wetland Evaluations;
- Amphibian Call Count Surveys;
- Snake Visual Encounter Surveys;
- Turtle Basking Surveys;
- Breeding Bird Surveys;
- Bat Habitat Assessment;
- Bat Acoustic Monitoring;
- Drone Imagery Analysis;
- Stem Density Plot;
- Aquatic Habitat Assessment;
- Headwater Drainage Feature Assessment; and
- Fish Community Sampling.

Ecological survey methodology is found in **Appendix B3**.

2.2.4 Species at Risk

GEI's SARAT was utilized to assess the NHSA for SAR. The self-screening results showed that the NHSA has potential suitable habitat for thirteen (13) SAR. Refer to **Table 2.2 (Appendix B2)** for a detailed list of potential SAR in the NHSA.

2.2.5 Ecological Land Classification

The NHSA is dominated by active agricultural lands with some natural vegetation communities including scattered small and isolated marsh wetlands and a deciduous swamp and cultural woodland located in the south-central area. There are also small cultural woodlands and thickets, as well as linear systems of marshes and wet meadows along some of the tributaries and drainages.

ELC mapping of the NHSA is shown on **Figure 2.2** (**Appendix B1**). All non-participating ownerships were assessed using air photo interpretation. A description of each ELC type is provided in **Table 2.3** (**Appendix B2**). No provincially rare vegetation communities were present on the NHSA (NHIC, 2024).

2.2.6 Botanical Inventory

Botanical inventories completed in the NHSA recorded a total of 228 species (i.e., taxa, inclusive of subspecies, varieties, and hybrids). Of these, 54% are native to Ontario and 46% are exotic. A complete list of species documented from the NHSA is provided in **Table 2.4** (**Appendix B2**).

The majority of the native plants (89%) are ranked S5 (secure in Ontario). Twelve species (10%) are ranked S4 (apparently secure in Ontario), while none are ranked S1-S3. Eleven locally rare species were observed, as per the Peel Region rarity rankings (Varga et al. 2005). None of the locally rare species are considered rare in Ontario, and none had a co-efficient of conservatism value of 9 or 10.

Black Ash is a Species at Risk plant listed as being endangered in Ontario. Black Ash was identified within the NHSA. Multiple specimens were observed at one location, within the Silver Maple Mineral Deciduous Swamp in the south-central portion of the NHSA.

Local plant rarity is based on the number of population occurrences for a given area. For Peel Region, a plant is considered rare if it has ten (10) or fewer known occurrences, the data of which is derived primarily from historical checklists, MNRF reports, site records, and herbaria records (Varga et al. 2005). Overall, eleven (11) locally rare plants were observed in the NHSA. These were:

- Tall Beggarticks (*Bidens vulgata; R1*)
    - Rare in MAM2-10 and MAM2-2 communities.
- Pennsylvania Smartweed (Persicaria pensylvanica; R3)
    - Rare in MAS2-1 and MAM2-2 communities.
- Common Bedstraw (*Galium aparine; R4*)
    - Rare in MAM2-2 communities.
- Peach-Leaved Willow (*Salix amygdaloides; R6*)
    - Rare in MAS2-1, MAM2-10, MAM2-2 and SWD3-3 communities.
- Sandbar Willow (*Salix interior; R5*)
    - Rare in MAM2-10 community.
- White Spruce (Picea glauca; R3)
    - Rare in CUT1 community.
- Star Duckweed (Lemna trisulca; R4)
    - Abundant in SAF1-3 community.
- Necklace Sedge (*Carex projecta; R4*)
    - Rare in CUT1 community.
- Short-Awned Foxtail (Alopecurus aequalis var. aequalis; R3)
    - Rare along the margins of agricultural fields.
- Eastern Mannagrass (Glyceria septentrionalis var. septentrionalis; R2)
    - Occasional in MAS2-1 communities.
- Strict Blue-Eyed Grass (*Sisyrinchium montanum*; R5)
    - Rare in agricultural pasture

2.2.7 Drone Imagery Analysis

Ecological Land Classification practices subdivide the vertical structure of vegetation into four categories: canopy, subcanopy, understory, and ground cover. Woodlands within the Town are recognized as having >25% tree canopy cover (in part). Traditional survey methods require the surveyor to visually estimate canopy cover percent, which can be a difficult task to complete accurately. Surveyors must determine the height range of woody cover that constitutes the canopy and estimate percent-cover while excluding lower woody strata, such as the subcanopy and understory. This task can be simple in mature, full canopy forests but becomes complex in communities that vary in structure and size.

Recognizing the subjectivity associated with visual estimates of canopy cover in culturally influenced natural features, GEI developed an objective approach to quantifying the canopy cover, used in conjunction with standard ELC surveys. The approach is to generate a 3D model of the feature, identify pixels representing a specified elevation and then quantify those pixels relative to the ELC polygon.

The drone flight path was prepared using Drone Deploy software, the results of which provided 595 overlapping images. A 3D model of the WVSP area was then prepared in Drone Deploy using a process known as Structure from Motion. This data served as the Digital Surface Model (DSM), representing the heights of natural and artificial objects on the landscape.

To calculate height values, a Digital Terrain Model (DTM) of the WVSP area was obtained from the MNRF, which provided baseline terrain elevation values. Feature heights were calculated by subtracting the DSM from the DTM.

In order to calculate canopy cover percent, the minimum canopy height was determined to start at 12m – the value of which was used for subsequent cover calculations. This height was chosen because it most accurately accounts for the transition from upper subcanopy to lower canopy within this feature. Many of the tall shrubs – particularly European Buckthorn (*Rhamnus cathartica*) were quite mature, reaching heights of approximately 8m to 12m at their tallest, which should not be factored into woodland canopy calculations.

The results of this analysis are illustrated on **Figure 2.3** (**Appendix B1**), which shows all areas of the overall feature having live tree canopy greater than 12m in height. The outcome of this analysis resulted in refinements to the ELC mapping – most notably adjustments to the boundaries of the buckthorn shrub thickets, as well as the addition of a cultural woodland unit (**Figure 2.2, Appendix B1**).

These results show that the cultural woodland community (CUW1) has 56% canopy cover, the deciduous swamp (SWD3-2) has 40% canopy cover, and each of the buckthorn thickets (THDM2-6) have no more than 22% canopy cover. Further details are provided in **Table 2.5** (**Appendix B2**).

Results of the tree canopy cover mapping as well as the calculated values were reviewed on site and appeared to appropriately reflect existing conditions. These results were used and applied for ELC purposes. It is recognized that the Town defines European Buckthorn as a “tree” and therefore requires the buckthorn thickets to be treated as part of the contiguous woodland, provided they don’t meet the Town’s exemption criteria for areas dominated by Buckthorn. In contrast, ELC guidelines explicitly exclude European Buckthorn from the definition of “tree”.

2.2.8 Stem Density Plots

Recognizing that stem density is often another consideration when identifying woodlands, a stem density assessment was completed in the two buckthorn thickets and one cultural woodland to determine if the features satisfy the Forestry Act (1990) definition of woodland, which differs from the ELC definition. As part of this analysis, tall shrubs / small trees were included in this calculation (e.g., Hawthorn and Apple species). The results of the stem density analysis show that the larger of the two buckthorn thickets as well as the cultural woodland satisfy the Forestry Act definition of woodland, whereas the smaller of the buckthorn thickets did not (**Table 2.6**, **Appendix B2**). The larger buckthorn thicket met one of the four stem density thresholds (1000 trees, of any size, per hectare); the majority of those stems were young Green Ash seedlings that were below DBH height. These results exclude European Buckthorn.
When applying language from the Town’s Official Plan (i.e., treating European Buckthorn as a tree and including it in the stem density analysis; analysis of exemption criteria (which GEI found the thickets did not meet – **Appendix B2**)), both of the Buckthorn thickets meet the Town’s definition of woodland.
The Town defines “woodland” as:

a) a tree crown cover of over 60 percent of the ground, determinable from aerial photography, or
b) a tree crown cover of over 25 percent of the ground, determinable from aerial photography, together with on-ground stem density requirements.

GEI understands that the Town has included the Buckthorn thickets as part of the Natural Features and Areas layer of the Wildfield Village Land Use Plan. As per the OPA Policy #34.10.3 e), “The Natural Features and Areas designation boundaries shown conceptually on Schedule H34 are subject to change without requiring an amendment to this Secondary Plan and will be finalized through approval of the Local Subwatershed Study and/or site-specific Environmental Impact Studies by the Town and applicable agencies.”

Therefore, limits of the Natural Features and Areas may continue to be refined as part of the LSS. GEI maintains the recommendation that Buckthorn thickets be excluded from any woodland and NHS mapping due to their highly invasive nature and, as they are considered a noxious weed by the Province under Ontario’s Week Control Act (1990). Buckthorn thickets are therefore not carried forward to the Significant Woodland analysis section and are not shown as part of the NHS.

2.2.9 Feature Staking

The limits of wetlands and driplines were staked by TRCA, the Town of Caledon, and GEI on November 7, 2023, as identified on **Figure 2.2** (**Appendix B1**). Due to the late season, TRCA requested to revisit the SWD3-2 staking in 2024 during the appropriate growing season. This staking occurred on September 20, 2024.

2.2.10 Wetland Evaluation

Wetland communities on participating lands (**Figure 1.2, Appendix A2**) were assessed under the Ontario Wetland Evaluation System (OWES;2022). Wetland units smaller than 2 ha were evaluated if there was rationale to warrant a full evaluation. If rationale did not exist, the wetlands were not evaluated and treated as non-significant. Overall, 15 wetlands were assessed. Thirteen of these wetlands did not have sufficient rationale to warrant a full evaluation. Two of the wetlands did have sufficient rationale and were evaluated, of which only the Silver Maple Mineral Deciduous Swamp (SWD3-2) met the criteria to be considered provincially significant. This wetland had a score of 231 under the Special Features component, which was influenced by the presence of terrestrial crayfish, Wood Thrush, and Black Ash – all of which are provincially significant species. The Significant Wetland is illustrated on **Figure 2.2** (**Appendix B1**). As required under the OWES process, a copy of the two wetland evaluations and screening tables have been submitted under separate cover.

2.2.11 Calling Amphibians Survey

A total of five amphibian species were heard calling within the WVSP area during the three rounds of call count surveys (**Table 2.7**, **Appendix B2**). Station locations are illustrated on **Figure 2.4** (**Appendix B1**). The species heard calling were the American Toad (*Anaxyrus americanus*), Western Chorus Frog (*Pseudacris tristeriata*), Gray Treefrog (*Hyla versicolor*), Green Fog (*Lithobates clamitans*), and Wood Frog (*Lithobates sylcaticus*). All of these species are provincially ranked S5 (common and secure) or S4 (apparently common and secure).

2.2.12 Reptile Surveys

2.2.12.1 Snake Visual Encounter Survey

Snake visual encounter surveys were conducted in the agricultural (AG) and fallow lands, along the edges of a shrub thicket (THDM) and deciduous swamp (SWD) and within farm and residential properties in 2021 (**Figure 2.4**, **Appendix B1**). These surveys revealed there is no suitable habitat within the NHSA as there were no rocks, logs or debris located below the frost line. In 2024, Parcels 5 and 9 (**Figure 1.2, Appendix A2**) became participating ownerships and three rounds of surveys were conducted looking under rocks, logs and debris. No snake species were observed during the surveys (**Table 2.8**, **Appendix B2**). No suitable hibernacula locations were identified during the surveys.

2.2.12.2 Turtle Basking Survey

One turtle species was observed within the NHSA. Seven Midland Painted Turtles (*Chrysemys picta marginata*) were observed at station BS1 in a Cattail Mineral Shallow Marsh (MAS2-1; Wetland 34) during round 1 of surveys (**Figure 2.4**, **Appendix B1**). Two Midland Painted Turtles were also observed incidentally during the summer round of botanical inventory surveys at station BS2 in in a Cattail Mineral Shallow Marsh (MAS2-1; Wetland 3). This species is provincially ranked as S4 (apparently common and secure). All species observed in the NHSA are listed in **Table 2.9** (**Appendix B2**).

2.2.13 Breeding Bird Surveys

A total of fifty-two (52) bird species were observed within the NHSA in 2022. Of this total, eleven (11) species are confirmed, twenty-two (22) are probable, and fourteen (14) are possible breeders on the WVSP area. The remaining five (5) bird species are considered non-breeders, flyovers, or migrants. Seven additional species were observed only on surrounding lands within 120 m. The observed breeding bird species are discussed in the sections below. All species observed on the WVSP area are listed in **Table 2.10A** and **Table 2.10B** (**Appendix B2**).

A total of forty-six (46) (98%) of the confirmed, probable or possible breeders are provincially ranked S5 (common and secure), S4 (apparently common and secure) or SNA (species not native to Ontario). One bird species is considered provincially rare (S1-S3; NHIC 2024) and is discussed in the sections below.

- **Upland Sandpiper** (*Bartramia longicauda*) (S2B); a pair was observed in fallow fields on May 31, 2022 near Point Count (PC) 5 and PC 2. Suitable breeding habitat was present as the species prefers short vegetation combined with bare soil in continuous patches greater than 30 ha (pers.obs. P.Burke). These fields had been ploughed last in 2021 or early spring of 2022 and left fallow. No further breeding evidence was observed on this date however their secretive behaviour suggested nesting activity. During the second round of surveys, the fields were observed to have been recently ploughed and had become unsuitable. A singing male Upland Sandpiper was observed approximately 150 m to the west on the bordering agricultural lands on this visit.

The following Species at Risk were observed on, or adjacent to (within 120 m), the NHSA. Survey stations are illustrated on **Figure 2.4** (**Appendix B1**):

- **Bobolink: Threatened in Ontario;** 11 individuals were detected during round one and seven were detected during round two, on non-participating hayfields within the NHSA east of The Gore Road. Probable breeding was observed in these hayfields east of PC 10 that provided suitable breeding habitat. One individual was observed flying over the NHSA at PC 10 however no suitable habitat was observed in this location.
- **Eastern Meadowlark: Threatened in Ontario;** Three individuals were observed during round one and four during round two within the hayfields located east of The Gore Road. This provided probable breeding evidence in suitable breeding habitat.
- **Wood Thrush: Special Concern in Ontario;** one male was detected on both surveys in the Mineral Swamp Deciduous Swamp (SWD3-2) at PC22. This provided probable breeding evidence in suitable breeding habitat.
- **Barn Swallow: Special Concern in Ontario;** foraging individuals were noted over the WVSP area during both rounds of surveys. An outbuilding shed on a non-participating property west of PC25 contained at least one nesting pair. No other breeding evidence or suitable structures were observed.

A total of twenty-eight (28) bird species were observed within the two new participating ownerships (Parcels 5 and 9, **Figure 1.2, Appendix A2**) in 2024. Of this total, seven (7) species are confirmed, six (6) are probable, and seven (7) are possible breeders. The remaining eight (8) bird species are considered non-breeders, flyovers, or migrants. Three additional species were observed only on surrounding lands within 120 m. The observed breeding bird species are discussed in the sections below. All species observed on Parcels 5 and 9 (**Figure 1.2, Appendix A2**) are listed in **Table 2.10B** (**Appendix B2**).

A total of eleven (11) (73%) of the confirmed, probable, or possible breeders are provincially ranked S5 (common and secure), S4 (apparently common and secure) or SNA (species not native to Ontario). Four (4) bird species are considered provincially rare (S1-S3; NHIC 2024) and are discussed in the sections below.

The following Species at Risk and rare species were observed during the 2024 surveys:

- Bobolink: Threatened in Ontario;

    - At Parcel 5, during round one a Bobolink was observed singing at PC 5-4 in an alfalfa field that had been recently harvested. The monoculture alfalfa had been planted within the last three years and did not provide any thatch or grasses with which a Bobolink could build a nest and provide proper shelter. The habitat here is unsuitable breeding habitat, and it is expected that the Bobolink had visited from more suitable habitat in fields to the south-east of Centreville Creek Road.

- A second Bobolink was heard during round one at PC 5-6, calling from an alfalfa hayfield on a non-participating property to the south-east. By round two, the alfalfa had been removed and the field seeded with soy. No Bobolinks were observed during rounds 2 or 3 at Parcel 5.
- In Parcel 9, eight male Bobolink were observed singing from within, or just outside of PC 9-2 during round one. By the time of the round two survey, the fallow field and the small, low-quality hayfield at Parcel 9 had been tilled and re-planted in soy, in accordance with Section 4.1 of Ontario Regulation 242/08 under the Endangered Species Act (2007). As a result, Bobolink was not subsequently detected and there is no suitable habitat present on Parcel 9.

- **Eastern Meadowlark: Threatened in Ontario;** During round 1 there was an Eastern Meadowlark heard and observed calling at PC 5-2 in a small field of mature Rye that had been planted the previous year. While the Rye remained in the southern portion of PC 5-2, it had already been harvested in the northern portion and the ground remained with only stubble. By round two, the northern portion had been seeded with sorghum. No Eastern Meadowlarks were observed in rounds 2 or 3 as the rye, sorghum, soy in the field adjacent to the north, and corn in the adjacent field to the south did not provide suitable habitat for this species.
- **Barn Swallow: Special Concern in Ontario;** Barn Swallows were observed foraging over parcels 5 and 9 during both rounds 1 and 2 of breeding bird surveys. Two rounds of targeted Barn Swallow Nest Surveys were undertaken on both parcels during breeding bird surveys. Five active nests were confirmed in suitable structures at Parcel 5, while no nests were observed at Parcel 9.
- **Upland Sandpiper (S3B);** During round 2, one Upland Sandpiper was heard vocalizing at PC 5-2 from a narrow, approximately 4-5m wide, strip of long grass border between the field access lane and the seeded corn field to the south. This grass border was mostly occupied by 1 to 2 rows of plastic-wrapped round hay bales as "baleage". No suitable habitat occurs on Parcel 5, and none of the adjacent fields provide vegetation cover suitable for this species to nest and forage. There appear to be small Meadow Marsh communities off-property, within the soy field to the north-east of parcel 5 that may provide suitable habitat for this species.

2.2.14 Bat Habitat and Bat Acoustic Monitoring Surveys

2.2.14.1 Bat Habitat Assessment

With respect to maternity colony SWH, vegetation communities including Mineral Cultural Woodlands (CUW1) and Silver Maple Mineral Deciduous Swamp (SWD3-2) surveyed in the NHSA meet the minimum density criteria for significance (>10 suitable roosting trees/ha). Suitable snags were not identified within the Swamp Maple Mineral Deciduous Swamp (SWD3-3) community. Although the CUW1 communities meets the minimum density criteria it does not meet the ecosite criteria to be considered bat maternity colony SWH.

With respect to SAR bats, the Mineral Cultural Woodlands (CUW1), Silver Maple Mineral Deciduous Swamp (SWD3-2) and Swamp Maple Mineral Deciduous Swamp (SWD3-3) contain features that may be used by SAR bats. Several barn structures and a residence within Parcel 5 and a residence at Parcel 9 were identified as providing potential bat habitat.
The results of the bat habitat assessment are presented in **Table 2.11** (**Appendix B2**).

2.2.14.2 Bat Acoustic Monitoring

Bat recorder stations were located within the SWD3-2 (WILD2) and immediately adjacent CUW1 (WLD3), as well as a southern CUW1 (WILD1).

Four (4) bat species were confirmed to be present within the woodlands: Big Brown Bat *(Eptesicus fuscus),* Silver-haired Bat *(Lasionycteris noctivagans),* Hoary Bat *(Lasiurus cinereus*) and Eastern Red Bat (*Lasiurus borealis*). During 40 detector evenings of acoustic surveys 528 calls were recorded and identifiable to species.

Of the 465 calls that were identifiable to species, 122 were Big Brown Bat, 217 were Silver-haired Bat, 125 were Hoary Bat, and one was Eastern Red Bat **(Table 2.12, Appendix B2)**.

CUW1 is not considered an appropriate ELC ecosite as per the MNRF's Significant Wildlife Habitat Criteria Schedules For Ecoregion 6E and 7E. However, it is acknowledged that due to the results of the survey, and proximity of features, the SWD3-2/CUW1 complex (WILD2/WILD3) as a whole can be treated as SWH. The southern CUW1 (WILD1) did not record a sufficient number of calls to be considered SWH.

2.2.15 Aquatic Habitat Assessment

An aquatic habitat assessment for a small tributary of the West Humber River situated in the southeast portion of the NHSA (Reaches H5S1/S2/S3; **Figure 2.2, Appendix B1**) was conducted. The tributary is fed by two features that initiate in the south-central portion of the NHSA. Reach H5S3 was delineated immediately downstream of the confluence, flowing into reach H5S2 after approximately 50m. H5S2 continues flowing through an agricultural field before becoming more sinuous and entrenched, marking the beginning of reach H5S1. Reach H5S1 flows a short distance through a shrub thicket before flowing under The Gore Road, offsite. The aquatic assessment for the feature is characterized as follows.

As reach H5S3 is limited in length, and very similar to H5S2, they were treated as one reach. The feature was observed to have intermittent flow with natural stream morphology. The channel's morphology displayed a low degree of meandering and a moderate gradient.

The feature consisted mostly of runs, with some deeper pockets containing standing water. The riparian vegetation was limited to terrestrial grass and small shrubs. Short grasses were also present in the channel, lining the bed between sequential pools.
The mean bankfull width was measured to be 3.0 m with a mean depth of about 0.5 m. The wetted width and depth were variable throughout the reach due to the intermittent nature of the flow. Bank material consisted mostly of silt and sand. Pool substrate consisted of sand and silt, while some larger cobbles and gravel particles were observed throughout some runs. No fish were observed in the reach during the aquatic habitat assessment. Water temperature was warm (>20 degrees Celsius), and the entirety of the reach was unshaded.

Reach H5S1 became much more entrenched and sinuous downstream of reach H5S2. The feature was observed to have perennial flow in a natural stream morphology. The channel's morphology displayed a high degree of meandering and a moderate gradient. The feature consisted of pools and riffles, with variable flow velocity. A knickpoint was observed at the midpoint of the reach. Several portions along the channel were severely degraded, evident in slumping occurring along undercut meander bends as well as a suspended armour layer observed at the undercuts. Riparian vegetation consisted of tall grasses, shrubs, and scattered trees.

The mean bankfull width was measured to be 1.8 m with a mean depth of about 1.0 m. The wetted width was approximately 0.7 m throughout the reach, while the average depth of flowing water was measured at 0.15 m. Bank material consisted mostly of silt and sand. Pool substrate consisted of sand and silt, while riffles consisted of gravel and some larger cobbles. No fish were observed in the reach during the aquatic habitat assessment. Water temperature was warm (>20 degrees Celsius), and approximately 50% of the reach was shaded by trees.

2.2.16 Headwater Drainage Feature (HDF) Assessment

The NHSA supports a number of headwater drainage features (HDFs; **Figure 2.2**, **Appendix B1**) that feed the West Humber River and its tributaries. TRCA policies require regulated HDFs to be identified and managed in accordance with their Evaluation, Classification and Management of Headwater Drainage Features Guideline (CVC and TRCA 2014). Additionally, the Town of Caledon also requires the completion of a HDF assessment in their natural heritage review role.

Headwater drainage features as per the HDF Guidelines are defined as a non-permanent (intermittent or ephemeral) drainage feature that may lack a defined bed or banks. These features include first-order and zero-order channels, swales, and connected headwater wetlands, but exclude rills and furrows. As such, the selection of the appropriate management recommendations is required to adequately protect or mitigate the feature and its ecological functions from any proposed development.
As per the HDF guidelines, GEI completed three rounds of surveys between 2021 (Round 1-March 24), 2022 (Round 2-May 18; Round 3- August 3) and 2024 (Round 1-April 10; Round 2-May 31; Round 3-August 14). The Town of Caledon commented on the appropriateness of the timing of the spring surveys, to which GEI responded on April 8, 2025 in a letter report included here as **Appendix B4**. It was confirmed through subsequent meetings and correspondence with the Town that the initial surveys were appropriate as indicated in the email from Michael Hoy to George Buckton dated April 23, 2025 (**Appendix B4**).

The HDF Assessments identified 14 HDFs in the NHSA (**Figure 2.2**, **Appendix B1**). All features identified in the SABE SWS (Wood 2022) and by TRCA's regulation mapping on participating lands were reviewed in the field. GEI observed some of these features to not be present, as detailed in the Watercourse and Drainage Feature Letter Report (**Appendix B5**) on Figures 1 and 2 and discussed in Section 4 of that report.

The HDFs on non-participating lands were reviewed via windshield and/or desktop (LiDAR) assessments, however, a fulsome HDFA with formal field surveys was not performed due to access issues.
The West Humber River is located immediately northeast and east of the NHSA and is fed by HDFs within the east portion of the NHSA. The western HDFs flowing under Centreville Creek Road feed a smaller west tributary of the West Humber River located west of the NHSA. The west and east tributaries of the West Humber River merge approximately 2.7 km south of the NHSA.

2.2.16.1 Classification

GEI utilized the guidance provided in Part Two of the HDF Guidelines (CVC and TRCA 2014), which addresses the approach for the assessment and classification of the HDFs. By design, the HDF Guidelines are focused on the classification of ephemeral and intermittent headwater drainage features and are not intended to characterize those features that are watercourses.

2.2.16.2 Management Recommendations

Management recommendations for all HDFs were decided upon utilizing Part Three of the HDF Guidelines (CVC and TRCA 2014). This section of the Guidelines provides guidance in linking the habitat classification information with the proposed management approach for each HDF. The guidelines and information collected from the surveys were utilized to determine management recommendations. All HDF reaches and their management recommendations are depicted on **Figure 2.2** (**Appendix B1**).
It is important to acknowledge that as with any guidelines, the HDF Guidelines are intended to have flexibility to best reflect additional considerations regarding the site-specific nature of features, such as historical straightening for agricultural purposes, impairment related to surrounding agricultural or residential land use, and compatibility with land uses. As such, there are situations where recommendations are made for an alternative management recommendation based on site specific understanding of these additional factors.

The application of the HDF Guidelines to existing site conditions results in recommendation for protection, conservation, mitigation, or no management. Strict application of the HDF Guidelines to certain HDFs that are wetlands or have upstream wetlands would result in management recommendations of Protection.
The HDFs in the NHSA have been negatively impacted by agricultural and residential land uses, including straightening and impairment (i.e., siltation due to ploughing through, or up to, the edge of the feature, and pollution resulting from fertilizers), as well as reduction of riparian habitat. However, it is acknowledged that eliminating the agricultural impacts is not the sole rationale for their proposed removal and replication.

Some HDFs are connected to small wetlands that are isolated with limited species diversity. In general, the HDFs and associated wetlands are low-functioning features and are proposed for removal with replication of their functions (which includes flow, limited sediment transport, and allochthonous contributions) through wetland compensation and alluvium deposits, as identified conceptually on **Figure 2.5** (**Appendix B1**). The proposed creation of wetland habitat in the NHS will be fed clean water which will provide baseflow to downstream habitat.

Headwater drainage features located on non-participating lands will require further study before a HDF management recommendation is provided. Should the non-participating disturbed area at the upstream end of H11S1 (**Figure 2.2, Appendix B1**) be considered for development, consultation with authorities responsible for wetlands will be undertaken by that property owner.

Management recommendations are provided in **Table 2.13** (**Appendix B2**).

2.2.16.3 Implementation Techniques

The HDF Guidelines suggest implementation techniques for each of the 'Protection', 'Conservation', 'Mitigation' and 'No management required' recommendations. The HDF Guideline recommendation for implementation techniques is provided below.
All of the Mitigation management recommendations are made for reaches on the tableland within agricultural or residential lands. Here, they are generally ephemeral and intermittent swales that convey flow during the freshet but are otherwise dry, with many reaches being ploughed through and planted in row crops. The primary functions of these features may include water conveyance, sediment transport (albeit very limited), and allochthonous inputs (e.g., organic matter) to downstream reaches. The existing sediment contributions from HDFs in active agricultural fields consists of fine silts and clays and likely has a negative impact on downstream fish habitat. All reaches within participating lands have a Management Recommendation of Mitigation, based on the anticipated ability to replicate HDF functions through the provision of baseflow, alluvium deposits, and on-site compensation of wetland habitat (which provides allochthonous inputs to downstream habitat) as conceptually shown on **Figure 2.5** (**Appendix B1**).

One exception is HDF H12A1, which is proposed to be piped and will convey flow from the MAS2-1 feature to the existing downstream outlet at Mayfield Road. The HDF's functions of seasonal fish habitat, and limited sediment transport and supply of allochthonous material will be replicated at Compensation Area 2, located approximately 400m east of H12A1, but ultimately connected to the same tributary system (i.e. West Humber River). The receiving watercourse/HDF downstream of H12A1 (south of Mayfield Rd) is well vegetated and the proposed loss of allochthonous input from agricultural plantings is not anticipated to negatively impact the downstream habitat. Sediment transport from this ploughed-through feature is likely having a negative impact on downstream habitat through the release of fine silts and clay and piping it will not negatively impact downstream habitat.

As noted in the HDF Guidelines, Mitigation management allows for the replication of the function of the HDF to:

- Replicate or enhance functions through enhanced lot level conveyance measures, such as well-vegetated swales (herbaceous, shrub and tree material) to mimic online wet vegetation pockets, or replicate through constructed wetland features connected to downstream;
- Replicate on-site flow and outlet flows at the top end of system to maintain feature functions with vegetated swales, bioswales, etc. If catchment drainage has been previously removed due to diversion of stormwater flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage); and
- Replicate functions by lot level conveyance measures (e.g. vegetated swales) connected to the natural heritage system, as feasible and/or Low Impact Development (LID) stormwater options.

As discussed with TRCA (June 18, June 24, and July 9, 2025), proposed mitigation through traditional storm sewers may also be considered acceptable provided that flows for drainage features will be maintained to the appropriate downstream receiving watercourses/HDFs.

2.2.17 Fish Community Sampling

Fish community sampling was completed in June 2022 and May 2024 within the small tributary of the West Humber River (Reaches H5S1/S2/S3), headwater drainage features (H1S1, H2S1, H3S1/S1A, H5S4-2/S4A), as well as downstream culverts (HDF4, HDF5, HDF12) at the surrounding road crossings. Fish sampling locations are illustrated on **Figure 2.4 (Appendix B1)**.

No fish were captured within any of the sampling reaches in 2022. Fathead Minnow (*Pimephales promelas)* and Brook Stickleback (*Culaea inconstans*) were caught in 2024 at one culvert at The Gore Road and one culvert at Mayfield Road at the downstream extents of HDF4 and HDF5. One Brook Stickleback was also observed incidentally within H12A1 during HDFA Round 1 in April 2024. The results of the fish community sampling can be found in **Table 2.14** (**Appendix B2**). These fish species are provincially ranked S5 (common and secure) and are identified as warm water species.

GEI conducted groundwater and surface water monitoring, as further detailed in **Section 3.4** below. The results indicate that the participating HDFs, tributary and wetlands are primarily surface water driven features, although there is potential for seasonal interflow (shallow subsurface lateral flow) during the spring. Exceptions include HDF H3S1A/H5S4-2 located at the south end of the NHSA, as well as two small (<0.10 ha) and isolated Cattail Mineral Shallow Marsh communities located in the north end of the NHSA, that were found to be fed by groundwater.

2.2.18 Staking of Natural Heritage Features

The limits of wetlands and driplines were staked by TRCA, the Town of Caledon, and GEI on November 7, 2023, as identified on **Figure 2.2** (**Appendix B1**). Due to the late season, TRCA requested to revisit the SWD3-2 staking in 2024 during the appropriate growing season. This staking occurred on September 20, 2024.

2.3 Natural Hazards

2.3.1 Meander Belt Assessment

Tributary H5S1/S2/S3 (Reach WHT2-4) crosses the WVSP area, which eventually feeds into the West Humber River (**Figure 2.6, Appendix B1**). The Humber River watershed is situated in the TRCA's jurisdiction, spanning 900 km^2 of land that includes portions of local municipalities of Caledon, King, Brampton, Mississauga, and Toronto (TRCA 2023).

Geomorphic investigations and assessments have been completed to identify erosion hazards including:

- Reviewing historic and recent aerial imagery, particularly with respect to deriving stream corridor dynamics such as meander belt, 100-year erosion risk;
- Reviewing existing geomorphic mapping from the Scoped SWS (Wood, 2022) and refining based on site specific investigations;
- Conducting reach delineations, rapid assessments and detailed geomorphic field assessments within watercourses; and,
- Completing meander belt width assessments for higher order streams.

Climate and geology play an important role to influence the form and processes of the watercourse. Geological influences on patterns and rates of river change include landscape configuration, material availability, and erodibility of the substrate. Climatic fluctuations influence water balance and vegetation patterns, which impact flow regimes and the production, supply, and transport of sediment. The following sections provide an understanding of the physical setting of the Humber River tributary and provide context to the active fluvial geomorphological processes in the WVSP area.

Precipitation was calculated from climate normals (1981-2010) recorded at the Woodbridge (Environment Canada Climate ID 6150103), approximately 11 km east of the study area. Precipitation averaged 58 mm in the winter (November to February, inclusive) and 76 mm in summer (June to August, inclusive; Environment Canada 2023). For most streams in Southern Ontario, the highest instream flows typically occur during the spring freshet due to snowmelt, as well as rain-on-snow events. Convective thunderstorms are likely to be the cause of higher amounts of precipitation in the summer. Typically, these events do not result in extreme flow events, unless when sustained intense rainstorms occur.

The WVSP area lies within the South Slope physiographic region (Chapman & Putnam 2007). This is a sloping plain that extends from the boundary with the Oak Ridges Moraine, southwards, and is underlain by glacial till. Bedrock in this region consists of shale, limestone, dolostone, and siltstone. The soil types in this physiographic region are predominantly clay with some clay loam, and loam. The topography is relatively smooth, and infiltration is low due to the clay content. As a result, runoff rates are high. Surficial geology consists of clay to silt-textured till (OGS, 2010). Refer to **Section 3.1** below for additional information on the geology of the WVSP area.

2.3.1.1 Historical Assessment

Historical aerial photographs of the watercourse in the vicinity of the WVSP area were reviewed to determine changes to the channel and surrounding land use and land cover. Historic analyses provide insight into how past channel adjustments and modifications have contributed to current channel form and processes.

Aerial photographs from 1960, 1976, and 1988, obtained from the National Air Photo Library, were compared with digital imagery from 1954, obtained from the University of Toronto Aerial Imagery Database (University of Toronto, 2024) and from 2002, 2013 and 2022, obtained from First Base Solutions (refer to **Appendix B6**). When possible, the average annual migration rate for the feature in the southeast of the Subject Lands (reach H5S1 / H5S2 / H5S3, or reach WHT2-4 in the SABE) was identified by measuring the distance between each year's respective watercourse location. The analysis for reaches H5S2 and H5S3 was combined, due to the relatively short length of H5S3.

In 1954, the surrounding land use was mainly agricultural. Properties, separated by hedgerows, consisted of agricultural fields, small wood lots, and residential dwellings. The West Humber River traverses the property to the northeast of the WVSP area, and small drainage features conveying flow from the agricultural fields were observed. The exact location of the channel could not be identified due to the lower resolution of the imagery. There are existing residences located along Centreville Creek Road, and The Gore Road within the WVSP area.

Apart from some new additional residences being constructed along The Gore Road, no significant changes were noted between 1954 and 1960. By 1976, a portion of the WVSP area at the corner of Mayfield Road and Centreville Creek Road had been partially developed, and a new residential property had been constructed along Mayfield Road. Additionally, the intersection at The Gore Road and Mayfield Road had been realigned.

No significant changes, apart from the construction of small new properties in the vicinity of the WVSP area, were noted between 1976 and 1988. The location of the channel could not be identified due to the low resolution of the imagery.

By 2002, the properties lining the WVSP area had continued to expand, with small roads leading into the interior of the WVSP area. No notable changes were observed between 2002 and 2013.

By 2022, the property to the southeast of the WVSP area had been changed significantly. Previously an empty field, the entire lot had been filled with over 200 townhouses. The southeast corner of the WVSP area was expanded slightly. A parking lot had closed the distance between the watercourse and the property. Construction was also initiated within the previous decade, and silt fencing was put up along the southern floodplain.

The average migration rate for this reach over the period under consideration, was calculated to be approximately 3 m.

2.3.1.2 Field Investigation

A field investigation was completed for reaches H5S4-1, H5S3, H5S2, and H5S1 (WHT2-4) within the West Humber River tributary on May 24, 2023, and consisted of a Rapid Geomorphic Assessment (RGA), a modified Rapid Stream Assessment Technique (RSAT) and classification of the reach using the Downs Method (Thorne et al., 1997). It should be noted that bankfull width measurements may differ from those performed as part of the Aquatic Habitat Assessments, as the assessments were performed on different days, and along different sections of each reach.

The RGA (MOE, 2003) documents observed indicators of channel instability. Observations made during the field investigation are quantified using an index that identifies channel sensitivity based on evidence of aggradation, degradation, channel widening, and planform adjustment. The index produces values that indicate whether the channel is stable/in regime (score <0.20), stressed/transitional (score 0.21-0.40), or adjusting (score >0.41).

The RSAT (Galli, 1996) provides an assessment of the channel by also considering the ecological function of the stream. Observations under the modified RSAT include channel stability, channel scouring/sediment deposition, physical instream habitat, water quality, and riparian habitat condition. The RSAT scores rank the channel as maintaining a poor (<13), fair (13-24), good (25-34), or excellent (35-42) degree of stream health.

The Downs Method, as outlined in Thorne et al. (1997), was developed based on adjustment processes and trends of channel change and links these processes and trends to the fluvial and sediment processes responsible for driving channel change. This system classifies streams as stable, depositional, laterally migrating, enlarging, compound, recovering, or undercutting.

Generally, only the southern portion of the features were observed to be watercourses. Reaches H5S1, H5S2, H5S3 all displayed defined bed and banks, in which water was flowing. Additionally, reach H5S4-1, a small feature flowing into H5S3, was deemed to be a watercourse by the TRCA. Reaches H5S4-2 and H5S4A join at the upstream extent of reaches H5S4-1 and H5S3 respectively. Reach H5S4-2 was observed to be an HDF, matching the classification from the SABE (Peel Region 2022), while reach H5S4A was classified as both an HDF and a watercourse by the TRCA.

The upstream extent of H5S4-1 forms in a hedgerow, downstream of H5S4-2. At this point, the watercourse shows minimal definition, existing as a shallow-flowing channel with emergent, grassy vegetation and some trees in the riparian zone. The riparian buffer extended greater than 5 channel widths in dimension on either side, though the buffer does include agricultural land. Although distinct pools and runs could not be discerned, some point bars, coarse material deposits, and silt deposits were observed, suggesting that active sediment transport occurs within the watercourse during some flow regimes. The dominant habitat type consisted of runs. Where defined, bankfull widths ranged between 1.0 – 1.6 m, while bankfull depths ranged between 0.40 – 1.20 m. Bed substrate was mostly composed of sand, silt, and clay, with some pockets of coarser material. Bank angles were moderately steep, ranging between 30 and 60°, and erosion was noted on approximately 5 to 30% of banks.

The RGA produced a score of 0.13, which indicated that the reach was in regime. The dominant process observed in the channel was aggradation. The RSAT score of 18 indicated that this reach was in a fair state of ecological health. Riparian and instream habitat conditions were noted to be the main limiting factor, evident by the embedded riffle substrate and lobate bar formation, as well as a lack of mature riparian vegetation. The Downs Method (Thorne et al., 1997) classified this reach as M – lateral migration, which is characterized by erosion on one bank and deposition on the other.

The upstream extent of H5S3 forms at the confluence of two headwater drainage features, which convey flow from the central agricultural fields towards the eastern corner of the WVSP area. At this point, the watercourse shows minimal definition, existing as a shallow-flowing channel with little to no riparian or instream vegetation. In areas where instream vegetation was present it existed as immature, short grass. The riparian buffer extended greater than 5 channel widths in dimension on either side. Although distinct pools and runs could not be discerned, some point bars, coarse material deposits, and silt deposits were observed, suggesting that active sediment transport occurs within the watercourse during some flow regimes. The dominant habitat type consisted of runs. Where defined, bankfull widths ranged between 2.0 – 4.5

m, while bankfull depths ranged between 0.25 – 1.0 m. Bed substrate was mostly composed of sand, silt, and clay, with some pockets of coarser material. Bank angles were shallow, ranging between 0 to 30°, and erosion was noted on approximately 5 to 30% of banks.

The RGA produced a score of 0.13, which indicated that the reach was in regime. The dominant process observed in the channel was aggradation. The RSAT score of 18 indicated that this reach was in a fair state of ecological health. Riparian and instream habitat conditions were noted to be the main limiting factor, evident by the embedded riffle substrate and lobate bar formation, as well as a lack of mature riparian vegetation. The Downs Method (Thorne et al., 1997) classified this reach as M – lateral migration, which is characterized by erosion on one bank and deposition on the other.

No geomorphic differences were observed between reach H5S3 and reach H5S2. As such, they were considered one reach during the field investigation. Instead of flowing through an agricultural field in reach H5S3, reach H5S2 flows through a grassy meadow. Reach H5S1 is established at the beginning of a heavily eroded stretch of channel, directly downstream of reach H5S2. This portion of the feature showed significant entrenchment / basal scour throughout the reach, resulting in steep banks and an incised bed. Plant roots, visible due to undercutting, were observed along the first half of reach H5S1. Point bars are slightly more established and vegetated with taller grasses than in the previous reaches. Past the steep banks, riparian vegetation exists as grasses, shrubs, and in the downstream half of the reach, trees. The riparian buffer extended greater than 5 channel widths in dimension on either side. Distinct pools and riffles, as well as some point bars, coarse material deposits, and silt deposits were observed, suggesting that active sediment transport occurs within the watercourse during some flow regimes. The dominant habitat type consisted of runs. Where defined, bankfull widths ranged between 1.5 to 2.5 m, while bankfull depths ranged between 1.0 to 2.0 m. Bed substrate was mostly composed of sand, silt, and clay, with some pockets of coarser material. Some coarse material deposits were associated with a knickpoint. An armour layer was visible in the bank's substrate, indicating that the channel had incised through a previously present bed layer. Bank angles were steep, ranging between 60 to 90°, and erosion was noted on approximately 30 to 60% of banks.

The RGA produced a score of 0.33, which indicated that the reach was in transition / stressed. The dominant process observed in the channel was degradation. The RSAT score of 24 indicated that this reach was in a fair state of ecological health. Channel stability was noted to be the main limiting factor, evident by the basal scour, undercutting, and general symptoms of erosion throughout the channel. The Downs Method classified this reach as E – enlarging which is characterized by erosion on one bank and deposition on the other.

In addition to features within participating properties of the WVSP, some features traversed the WVSP through non-participating properties. While a fulsome field assessment was not possible, as the properties were non-participating properties, desktop and windshield assessments were performed.

Reach WHT2(1)1-1 traverses non-participating properties within the WVSP, to the east of The Gore Road, flowing from north to south for approximately 1,500 m. The feature appears to exist within an unconfined valley setting, according to LiDAR-derived topography. The feature flows through agricultural and residential land with a riparian buffer extending 1 – 5 channel widths beyond each bank. An online pond exists shortly downstream of the feature's upstream terminus. Bankfull widths and depths ranged between 6.0 - 13.6 m and 0.31 - 0.52 m, respectively. An RGA, RSAT, and Down's analysis could not be performed due to a lack of access.

Reach WHT2(1)1-1b spans approximately 300 m between the southern boundary of the WVSP's participating property and reach WHT2(1)1-1, into which it flows. The feature appears to exist within an unconfined valley setting, according to LiDAR-derived topography. The feature flows through agricultural land with a riparian buffer extending 1 – 5 channel widths beyond each bank. The feature flows through a small culvert underneath a small farm crossing. Bankfull widths and depths ranged between 2.2 - 7.7 m and 0.20 - 0.35 m, respectively. An RGA, RSAT, and Down's analysis could not be performed due to a lack of access.

Rapid assessment results are summarized in **Table 2.16** (**Appendix B2**). A photographic record of existing conditions is provided in **Appendix B6**.

2.3.1.3 Meander Belt Delineation

2.3.1.3.1 Meander Belt Delineation Policy

Streams and rivers are dynamic features on the landscape, and their configuration and position on the floodplain changes as part of meander evolution, development and migration processes. When development or other activities are contemplated near a watercourse, it is desirable to designate a corridor that is intended to contain the complete natural meander and migration tendencies of the channel.

Ontario Regulation 41/24 outlines the definition of watercourse limits as follows:

1. Where the river or stream valley is apparent and has stable slopes, the valley extends from the stable top of the bank, plus 15 meters, to a similar point on the opposite side
2. Where the river or stream valley is apparent and has unstable slopes, the valley extends from the predicted long term stable slope projected from the existing stable slope or, if the toe of the slope is unstable, from the

predicted location of the toe of the slope as a result of stream erosion over a projected 100-year period, plus 15 meters, to a similar point on the opposite side.

3. Where the river or stream valley is not apparent, the valley extends,
    a. to the furthest of the following distances
        i. the distance from a point outside the edge of the maximum extent of the flood plain under the applicable flood event standard to a similar point on the opposite side, and
        ii. the distance from the predicted meander belt of a watercourse, expanded as required to convey the flood flows under the applicable flood event standard to a similar point on the opposite side, and
    b. an additional 15-metre allowance on each side, except in areas within the jurisdiction of the Niagara Peninsula Conservation Authority.

The space that a meandering watercourse occupies on its floodplain, and in which all these natural processes occur, is referred to as the meander belt (TRCA, 2004), as per definition 3.a.ii in the aforementioned regulation. In the case of unconfined systems, the erosion hazard allowance consists of the meander belt and an access allowance. In the case of confined systems, the erosion hazard allowance consists of the stable slope allowance and toe erosion allowance, in addition to the access allowance (MNR 2002).

2.3.1.3.2 Meander Belt Delineation Results

As Tributary H5S1/S2/S3 within the WVSP area is situated in an unconfined valley, a meander belt width was delineated for reaches H5S1, H5S2, and H5S3. Due to geomorphic similarities, the meander belt delineation was combined for reaches H5S2 and H5S3. The TRCA's *Belt Width Delineation Procedures* (2004) document was created to recommend a protocol for delineation of meander belt for river systems within the TRCA's jurisdiction but is accepted by Conservation Authorities throughout Ontario as a primary method for delineating the belt width. The method involves drawing lines tangential to the outside meander bends of the planform, including the historical position of the watercourse. The perpendicular distance between these two lines represents the meander belt width. A factor of safety, calculated using the historical migration rates of the channel, is added to the preliminary meander belt.

An average 100-year watercourse migration, determined through the historical assessment, was calculated to be approximately 3 m. Using a preliminary belt of 8 m, and an average bankfull width of approximately 3 m, the final meander belt was calculated using Equation 5 from the TRCA's *Belt Width Delineation Procedures* (2004):

$$Final\ Belt\ Width = (1.05 * Preliminary\ Belt\ Width) + 100\ Year\ Migration$$

The final belt width was found to be 15 m for H5S1, H5S2, and H5S3. The limits of the meander belt are shown in **Figure 2.7** in **Appendix B1**.

2.3.2 Slope Stability Hazards

The WVSP area is in the Humber River Watershed, which is within the jurisdiction of Toronto and Region Conservation Authority (TRCA). The West Humber River within the Greenbelt Plan Area is located east of The Gore Road and east of the WVSP area. Two tributaries of West Humber River are located south of Mayfield Road, denoted as Reaches WHT2-2 and WHT2-3. This is shown on **Figure 2.8** in **Appendix B1**. Online Regulation Mapping from TRCA shows that West Humber River is a Regulated Area, and therefore the methodology to determine long-term development setbacks associated with slope stability must comply with TRCA policy guidelines.

The West Humber River and some of its tributaries are part of a confined valley system, which typically consists of a watercourse, floodplain, and slope. It is noted that other surface water features on or near the WVSP area are likely unconfined valley systems and therefore are not subject to slope stability setbacks and are not included in the scope of this slope stability and erosion hazard assessment. The West Humber River also flows to the north of the northern WVSP area boundary where it crosses The Gore Road. This stretch of the river was not included in the preliminary slope stability assessment because the planned Highway 413 Transportation Corridor will separate the river and WVSP area. The slope area included in the assessment is shown on **Figure 2.8** in **Appendix B1**.

To support preliminary constraints and opportunities mapping, as further detailed in **Section 2.5.2**, a preliminary slope stability assessment was conducted which included:

- Review of the high-level top of bank linework publicly available from the TRCA.
- Creating four (4) cross-sections through the confined valley system based on topographic LiDAR data available for the WVSP area.
- Determining conservative estimates for the toe erosion allowance and stable slope allowance used to estimate the Long-Term Stable Top of Slope (LTSTOS).
- Plan and profile views of the LTSTOS and overall Erosion Hazard Limit.

At the time of this report, it was not possible to access the confined valley system of West Humber River to the east or south of the WVSP area. No on-site visual inspections were conducted, nor were site specific boreholes advanced to determine soil and groundwater conditions. The findings presented in this assessment are based exclusively on publicly available information. As such, the Erosion Hazard Limit is considered highly conservative and is likely to be a maximum extent of the constraint. Visual slope inspections, physical top of bank staking, subsurface drilling investigations, refined topographical information, site-specific detailed slope stability analysis, etc. will refine the setbacks shown, if conducted.

2.3.2.1 Slope Stability Setbacks and Policy

TRCA provides policy requirements and technical guidance for developments within slope and erosion hazard zones based on the following documents:

- "The Living City Policies for Planning and Development in the Watersheds of the Toronto and Region Conservation Authority," by TRCA, dated November 28, 2014.
- "Technical Guide on River and Stream Systems: Erosion Hazard Limit," by the Ministry of Natural Resources (MNR), dated 2002.

The above noted guidelines are consistent with discussion on slope stability policies and guidelines within the Scoped SWS reports.

The West Humber River is within a TRCA Regulated Area and is subject to these policy guidelines. Included in these policy guidelines are setbacks in which all new development must be set behind. The following allowances are applicable for the confined valley system at the Study Area:

- **Toe Erosion Allowance:** This setback is an estimate of the distance the toe of slope will move over the next 100 years. This can be based on a site-specific fluvial geomorphology study, average annual recession rate based on 25 years of data or based on set values provided by the MNRF depending on the soil type encountered. If the watercourse is greater than 15 m away from the slope toe, no toe erosion allowance is typically required.
- **Stable Slope Allowance:** This setback is associated with determining the inclination of the slope that achieves a minimum factor of safety of 1.5. In some cases, the existing slope inclination may meet this minimum requirement. In lieu of detailed geotechnical engineering analysis, a conservative estimate for the stable slope inclination of 3H:1V can typically be applied, as per the *Technical Guide on River and Stream Systems: Erosion Hazard Limit* (MNR 2002).
- **Erosion Access Allowance:** An additional 10 m setback (for development, new buildings) is applied to allow for emergency access, routine maintenance of the slope and potential erosion areas, and to create an additional buffer between the development and the potential erosion hazard.

The toe erosion allowance and stable slope allowance combine to form the Long-Term Stable Top of Slope (LTSTOS). When the LTSTOS is combined with the Erosion Access Allowance, this total setback line is the Erosion Hazard Limit from which all new development or redevelopment must be set behind, per TRCA guidelines. The above setbacks are applicable to sites where there is a confined valley system only. These policies are not applicable for unconfined systems, where the Erosion Hazard Limit is defined by the meander belt allowance or flooding hazard limit, plus an additional allowance (beyond the scope of work of the slope stability assessment).

2.3.2.2 Scoped SWS Overview

In the Scoped SWS: Part A report, (Wood, 2022) a desktop level assessment was completed to estimate the potential for instability for slopes identified in the SABE boundary. The ranking system followed the MNR Slope Rating Chart methodology to estimate if the slopes have a low, slight, or moderate risk for instability. The report summarized the risks as follows:

- **Low risk** for slope instability means the slopes are likely stable and would only require a site inspection and letter report to confirm the slope is stable.
- **Slight risk** for slope instability means the slopes are typically stable but require a site inspection and conservative slopes stability analysis to verify if the existing slope is stable.
- **Moderate risk** for slope instability means the slopes may or may not be stable in their current form, and a geotechnical subsurface investigation is required. The stable top of slope may not coincide with the current top of slope.

On-site visual slope inspections were not completed by Wood (2022), so some assumptions were required in their assessment. They also used a digital elevation model, surficial geology mapping, and aerial imagery. Wood (2022) notes that future studies are required to confirm the rating and investigation requirements. Figure No. G-C3 within the Part A SABE report shows mapping with the risk evaluation for West Humber River watershed, and it includes the WVSP area. The West Humber River flowing south along the eastern side of the WVSP area was identified as having low to slight risk for slope instability. Figure No. G-C3 within the Scoped SWS: Part A report (Wood, 2022) also shows a small tributary in the northwestern corner of the WVSP area as having a low risk for instability; however, based on GEI's visual inspection on site, that feature is unconfined and does not require a slope stability assessment. A photograph of the unconfined feature is provided in **Appendix B7**.

The Scoped SWS: Part A report, (Wood, 2022) also provides commentary on the policy requirements related to slope and erosion hazards, along with high-level discussion on the toe erosion allowance, stable slope allowance, and erosion access allowance. Scoped SWS: Part B report, (Wood, 2022) contains similar geotechnical information and the assessment for slope risk in the WVSP area remains the same. Figure D-2 in the Part B SABE report shows low to slight risk for instability along the main West Humber River tributary within the Study Area.

2.3.2.3 Preliminary Slope Stability Assessment

The preliminary slope stability assessment for the confined valley system of the West Humber River to the east and south of the WVSP area is discussed below. The slope geometry for the analysis was determined by creating a total of four (4) cross sections through the West Humber River confined valley using a LiDAR DEM, which included 0.5 m contour spacing. The cross-sections are included as **Figures 2.9A to 2.9D** and the locations are shown on **Figure 2.8** (refer to **Appendix B1**). The cross-sections were created in locations appearing to represent the worst-case conditions, such as where the watercourse is close to the slope toe and/or where the slope is steeper. Additional cross-sections with closer spacing would be required when the slope stability setbacks are refined during more detailed studies.

The confined valley system is outside of the participating lands, so physical top of bank staking was not possible. The top of bank location shown on **Figure 2.8** (**Appendix B1**) is taken from publicly available TRCA linework for the area which shows the estimated top of bank (typically established from LiDAR data). Field staking for the top of bank will be required if/when there is permission to enter the tableland and valley locations. The edge of the watercourse for starting the toe erosion allowance was also taken from TRCA linework.

The preliminary analysis below was completed using highly conservative assumptions. The confined valley system is not within participating lands, so visual slope inspections and field investigations could not be completed at this time. More detailed analysis will be required if/when permission to enter the area is granted, and a detailed field investigation can be completed, to further refine the setbacks.

2.3.2.3.1 Toe Erosion Allowance

The toe erosion allowance is a horizontal distance typically measured out from the bankfull width of a watercourse, existing water level of the watercourse, or bottom of the watercourse channel as deemed appropriate based on the site-specific conditions. The toe erosion allowance applied is based on numerous considerations such as: proximity of the watercourse to the slope toe, the presence of existing erosion, average and peak velocity within the watercourse, susceptibility of the soils at the slope toe to erosion, extent of vegetation, fluvial geomorphological processes, etc. Due to the varied and complex nature of determining toe erosion, multiple simplified methods are available for determining this toe erosion allowance, including:

A conservative toe erosion allowance of 15 m was selected as limited data was available as part of this study. This toe erosional allowance can be refined per **Table 2.17 (Appendix B2)** in the future if more detailed fluvial geomorphology studies, visual slope inspections, or location-specific borehole investigations are completed using the MNR table below (MNR, 2002).

2.3.2.3.2 Stable Slope Allowance

MNR guidelines allow a factor of safety (FOS) between 1.3 to 1.5 for active land use (e.g. habitable structures, commercial buildings, storage/warehousing, etc.) when determining the stable slope inclination. TRCA guidelines require a minimum FOS of 1.5. **Table 2.18 (Appendix B2)** is taken from the MNR provincial guideline (MNR 2002). Based on these guidelines and TRCA guidelines, a minimum FOS of 1.5 is required to determine the stable slope inclination.

For this preliminary assessment, detailed stability analysis has not been completed. As such, a stable slope inclination of 3H:1V is applied across the WVSP area which is considered to be a stable slope inclination when limited data is available. The stable slope inclination can be refined through additional analysis after a location-specific subsurface investigation is completed. Based on the nearby boreholes advanced within the WVSP area west of the valley, the valley slopes might consist of stiff to hard or dense to very dense glacial till deposits, which would achieve an FOS of 1.5 or greater at an inclination of 3H:1V.

2.3.2.3.3 Long-Term Stable Top of Slope (LTSTOS)

The LTSTOS combines the toe erosion allowance with the stable slope allowance. The LTSTOS position is shown in plan view on **Figure 2.8 (Appendix B1)**, and in profile view on the cross-sections on **Figures 2.9A to 2.9D (Appendix B1)**. An LTSTOS model is shown on **Figure 2.10 (Appendix B1)**. The LTSTOS position ranges from being set back 13.8 to 26.3 m from the TRCA top of slope for the West Humber River at the cross-section locations. The LTSTOS setback estimations are summarized in **Table 2.19 (Appendix B2)**. The LTSTOS position between and beyond the specific cross-section locations, as shown on **Figure 2.8 (Appendix B1)**, was estimated using the specific setback distances from each cross-section location, and based on review of the slope height, inclination, and location of the watercourse within the valley.

2.3.2.3.4 Erosion Hazard Limit and Total Slope Setbacks

The TRCA policy guidelines require an additional setback of 10 m from the LTSTOS position for the Erosion Access Allowance. The Erosion Access Allowance is applied beyond the LTSTOS to allow for emergency access, routine maintenance of the slope and potential erosion areas, and to create an additional buffer between the development and the potential erosion hazard. This allowance forms the total setback distance related to slope and erosion hazards, called the Erosion Hazard Limit. The 10 m Erosion Access Allowance is shown in plan view on **Figure 2.8 (Appendix B1)**, with the green line on the figure representing the Erosion Hazard Limit. The Erosion Hazard Limit is also shown on the cross-sections on **Figures 2.9A to 2.9D (Appendix B1)**. The overall Erosion Hazard Limit shown is for preliminary constraints mapping and to identify areas where future detailed studies could occur to refine the setbacks. Additional commentary is below.

2.3.2.4 Commentary on Future Slope Stability Studies

As discussed in **Section 2.3.3**, it was not possible to access the confined valley system of West Humber River to the east or south of the WVSP area. No on-site visual inspections were conducted, nor were site specific boreholes advanced to determine soil and groundwater conditions.

Future slope stability studies should consider the following details:

- Visual slope inspections, physical top of bank staking, subsurface drilling investigations, obtaining refined topographical information, and completing site-specific detailed slope stability analysis can be used to refine the setbacks.
- Based on the preliminary analysis conducted, it can be confirmed that further slope stability analysis and review will be required from the intersection of Mayfield Road and The Gore Road to 1,000 m north of the intersection, and 300 m east to 300 m west of this intersection. Beyond this (i.e. farther than 1,000 m north of the intersection of Mayfield Road and The Gore Road), the watercourse is sufficiently setback from the WVSP area that further detailed studies are not specifically recommended, unless the study area changes in the future.
- The LTSTOS cuts into Mayfield Road in two locations and into The Gore Road in two locations. Three of these locations appear to correspond with culverts crossing below the roadways. There is an inherent expectation that municipal infrastructure and the roadways will be maintained in the long-term. Discussion with the TRCA and other governing bodies could define the roadways at the LTSTOS separately from the results of any slope stability analysis based on this.
- For the tributaries south of Mayfield Road (Reaches WHT2-2 and WHT2-3), a 15 m toe erosion allowance from the watercourse and a 3H:1V stable slope allowance were similarly used to determine the LTSTOS. It is possible that some of these features could be unconfined systems, but this could be determined through future field investigations.

- The slope stability setbacks identified in this preliminary assessment serve as critical components for the constraints and opportunities mapping in the WVSP area. These setbacks, based on conservative estimates using publicly available data, delineate areas that may require further geotechnical investigation to refine development constraints accurately. While these preliminary setbacks help in identifying potential limitations for development, they are not definitive boundaries but rather guidelines that highlight zones where additional detailed studies are necessary to align fully with the TRCA policy guidelines.

2.3.3 Flood Hazards

2.3.3.1 Floodplain Mapping

The West Humber River is located to the east of The Gore Road and the WVSP area. Through the TRCA Flood Plain Mapping Program, the regulatory floodlines have been delineated for the West Humber River adjacent to the WVSP area. Refer to Map Sheets 137 and 138 in **Appendix B8** for the floodplain mapping. Map Sheet 137 also shows the floodline for the East Tributary to the West Humber River that enters the WVSP area east of The Gore Road, approximately 500 m north of Mayfield Road.

The floodline and associated 10 m development setback for both the West Humber River and the East Tributary are shown on **Figure 2.11 (Appendix B1**). As both the West Humber River and the East Tributary are located on non-participating properties, updates to the floodplain mapping have not been completed as part of this LSS. Should development of these lands proceed, updated floodplain mapping based on detailed topographic mapping will be required for both the West Humber River and East Tributary, as part of future development applications.

A recent update to the TRCA Flood Plain Mapping Program has extended the floodplain mapping and produced Regional Storm floodlines for six (6) drainage features located within the WVSP area. Refer to the TRCA Flood Plain Map Sheets 251, 252 and 253 provided in **Appendix B8**. These drainage features consist of both HDFs and watercourses as identified through the aquatic habitat and HDF assessments provided above in Sections 2.2.15 and 2.2.16, respectively. As established through several meetings with TRCA and confirmed via email communication from Mr. Dilnesaw Chekol dated June 16, 2025 (**Appendix B8**), HDFs within the WVSP area will not be subject to regulation by TRCA under current floodplain management policies.

Where the features have been identified as a watercourse, there is an associated floodplain that is regulated by TRCA. This includes Reaches H5S1/S2/S3, the southern portion of Reach H5S4 within the hedgerow and the northern portion of Reach WHT2(1)1-1 east of The Gore Road (refer to **Figure 2.2, Appendix B1**). Reach WHT2(1)1-

1 is located on non-participating lands and is thus subject to future study to confirm that it is a watercourse and delineate the regulatory floodplain, as required. The remaining reaches, Reach H5S1/S2/S3 and H5S4 are located on a participating property and as such, regulatory floodlines have been further delineated as part of this LSS as follows.

The estimated HEC-RAS hydraulic modelling files for the West Humber River were provided by the TRCA. The peak flows utilized in the hydraulic model were first confirmed to be correct for the purposes of establishing Regional storm flood elevations for the watercourses within the WVSP area. River Stations 1386.26 to 393.62 on River WH5A TribD, Reach 1 within the estimated hydraulic model were then updated based on the topographic information prepared by R-PE Surveying Ltd., dated February 1, 2024. The update also included updating the information in the model for Culvert #11 at The Gore Road north of Mayfield Road. The updated Regional storm (Hurricane Hazel) floodline elevations were then mapped against the topographic survey as illustrated on **Figure 2.11 (Appendix B1)**. Refer to **Appendix B8** for the updated existing conditions hydraulic modelling outputs along with a link to the digital modelling files.

2.3.3.2 Flood Vulnerable Areas

There is one existing Flood Vulnerable Area (FVA) located downstream of the WVSP, the Albion Road Flood Vulnerable Cluster as identified in the Humber River Watershed Characterization Report (TRCA, 2023), that has been assessed in this LSS (refer to **Appendix B8** for Map 26). This FVA, located at the confluence of the West Humber and Lower Main Humber branches in northern Etobicoke, includes sixty-six (66) flood vulnerable structures including residential and institutional buildings (Region of Peel Scoped SWS, Wood, 2022).

Region of Peel Scoped SWS (Wood., 2022) evaluated this FVA based on updates to the Humber River hydrologic modelling (TRCA, 2018) to consider full build-out of the Whitebelt lands including the development of the WVSP area. The FVA was evaluated with respect to the hydraulic performance based on potential increases in flood elevations and the width of floodplain, as well as analysing the potential increase in flood damages within the FVA by evaluating the flood damage cost. The conclusion of the analysis was that unmitigated development within the Whitebelt lands upstream of the Albion Road FVA would result in increases in the risk and frequency of flooding (Wood., 2022). As such, all future development within those lands, including the WVSP area, require stormwater management (SWM) to mitigate the impacts to the FVA during the 2 through 100 year, and Regional (Hurricane Hazel) storm events. Further characterization of the FVA is provided in the Region of Peel Scoped SWS (Wood., 2022).

2.4 Natural Heritage System Evaluation

Eight types of natural features are identified in the PPS (MMAH 2024):

- Significant wetlands;

- Significant coastal wetlands;
- Significant woodlands;
- Significant valleylands;
- Significant wildlife habitat;
- Fish habitat;
- Habitat of endangered and threatened species; and
- Significant areas of natural and scientific interest.

The presence/absence of these natural features within the WVSP area are discussed in the subsequent sections below. The Natural Heritage Reference Manual (MNR 2010), Town of Caledon's OP (2024), Peel Region's OP (2022) and O. Reg. 41/24 were referenced to assess the potential significance of other natural features, and their associated forms and functions on the landscape.

Based on a desktop review of background information as well as municipal, regional and provincial policy documents, the following environmental constraints have been identified and have informed the development potential for the NHSA. These features and their associated preliminary minimum buffers are identified on **Figure 2.5 (Appendix B1)**.

2.4.1 Significant Wetlands

GEI assessed the provincial significance of wetlands using current Ontario Wetland Evaluation System (OWES) protocol (MNRF 2022), and determined which wetlands meet the criteria for significance. The Silver Maple Mineral Deciduous Swamp (SWD3-2) meets the criteria to be considered provincially significant and is illustrated on **Figure 2.2 (Appendix B1)**. All other wetland communities are either too small (<2 ha) to meet the OWES size criteria or were evaluated as non-significant.
The Silver Maple Mineral Deciduous Swamp (SWD3-2) is associated with a Mineral Cultural Woodland (CUW1) and Buckthorn Deciduous Shrub Thickets (THDM2-6) surrounded by agricultural fields. The OWES report identified four locally rare plants species, one endangered species (Black Ash- *Fraxinus nigra*) and species of Special Concern (Wood Thrush and Terrestrial Crayfish).
The OWES evaluation report will be submitted under separate cover.

2.4.2 Significant Woodlands

Significant woodlands are identified by the planning authority in consideration of criteria established by the MNRF. Under the Natural Heritage Reference Manual (MHRM; 2010), woodlands are defined as:

"…treed areas that provide environmental and economic benefits to both the private landowner and the general public, such as erosion prevention, hydrological and nutrient cycling, provision of clean air and the long-term storage of carbon, provision of wildlife habitat, outdoor recreational opportunities, and the sustainable harvest of a wide range of woodland products. Woodlands include treed areas, woodlots or forested areas and vary in their level of significance at the local, regional and provincial levels."

Woodlands, as defined by the Peel OP, include woodlots, cultural woodlands, cultural savannahs, plantations and forested areas and may also contain remnant of old growth forests. They further define woodlands as any area greater than 0.5 ha that has:

a) A tree crown cover of over 60% of ground, determinable from aerial photography, or;
b) A tree crown cover of over 25% of the ground, determinable from aerial photography, together with on-ground stem estimates of at least:
    i. 1,000 trees of any size per hectare;
    ii. 750 trees measuring over five centimeters in diameter at breast height (1.37m), per hectare;
    iii. 500 trees measuring over 12 centimeters in diameter at breast height (1.37m), per hectare; or
    iv. 250 trees measuring over 20 centimeters in diameter at breast height (1.37m), per hectare (densities based on the Forestry Act of Ontario 1998); and, which have a minimum average width of 40 meters or more measured to crown edges.

Based on this definition, the CUW1/SWD3-2 complex is considered a woodland and will be further assessed for significance.

Further to this, The Peel OP (2022) further evaluates woodlands as being Core Area, NAC, PNAC. The requirements for this classification are derived from Table 1 (Criteria and Thresholds for the Identification of Core Areas, Natural Areas and Corridors (NAC) and Potential Areas and Corridors (PNAC) Woodlands of the Peel OP. The Region of Peel considers NAC and Core woodlands to be significant. In the Future Caledon OP, similarly, a Core Area Woodland is any woodland that meets one or more of the criteria for Core and Natural Areas and Corridors Woodlands in Table 1 of the Region of Peel Official Plan. A summary of the assessment based on the Peel OP and Future Caledon OP is provided below.

Mineral Cultural Woodland (CUW1)/Silver Maple Deciduous Swamp (SWD3-2): This feature meets the NAC size criteria of being >0.5 ha and having Significant Species and Communities (Wood Thrush [Special Concern]). As such, this feature also meets the Town's Woodland Core criteria.

Forest (FO)/ Cultural Woodland (CUW) (East of The Gore Road and associated with the West Humber River valley): This feature meets the Region's Core Woodland size criteria of being >4 ha. As such, this feature also meets the Town's Woodland Core criteria.

The woodlands within the NHSA were assessed using the above Region OP and Future Caledon OP criteria and were found to be Core Area and NAC woodlands; they are therefore considered to be Significant Woodlands (**Figure 2.2**, **Appendix B1**).

2.4.3 Candidate Significant Valleylands

Significant valleylands should be defined and designated by the planning authority. General guidelines for determining significance of these features are presented in the NHRM (MNR 2010) for Policy 2.1 of the PPS. Recommended criteria for designating significant valleylands include prominence as a distinctive landform, degree of naturalness, and importance of its ecological functions, restoration potential, and historical and cultural values.

A well-defined valley surrounding the West Humber River occurs along the east end of the NHSA. The valley merits consideration for significance due to its landform prominence (well-defined valley morphology with steep slopes and meander belt) and is considered a candidate significant valleyland.

2.4.4 Significant Wildlife Habitat

Significant wildlife habitat (SWH) is one of the more complex natural heritage features to identify and evaluate. There are several provincial documents that discuss identifying and evaluating SWH including the NHRM (MNR 2010), the Significant Wildlife Habitat Technical Guide (MNR 2000), and the SWH Eco-Region Criterion Schedules (MNRF 2015a and MNRF 2015b). As discussed previously, the NHSA is located in two Eco-Regions: 6E and 7E. Therefore, the NHSA was assessed using both 6E and 7E Criterion Schedules) MNRF 2015a and MNRF 2015b). Refer to **Table 2.15 (Appendix B2)** for a summary of the SWH assessment completed for the WVSP area.

There are four general types of SWH:

- Seasonal concentration areas;
- Rare and specialized habitats;
- Habitat for species of special concern; and
- Animal movement corridors.

2.4.4.1 Seasonal Concentration Areas

Seasonal Concentration areas are those sites where large numbers of a species gather together at one time of the year, or where several species congregate. Seasonal concentration areas include deer yards; wintering sites for snakes, bats, raptors, and turtles; waterfowl staging and molting areas, bird nesting colonies, shorebird staging areas, and migratory stopover areas for passerines or butterflies. Only the best examples of these concentration areas are usually designated as significant wildlife habitat. Areas that support Special Concern species or provincially vulnerable to imperiled species (S1-S3), or if a large proportion of the population may be lost if the habitat is destroyed, are examples of seasonal concentration areas which should be designated as significant.

With respect to bat maternity colonies SWH, bat recorder stations were located within the SWD3-2 and adjacent CUW1. Both stations recorded the presence of Big Brown Bats and Silver-haired Bats. However, calls are not indicative of individuals, and therefore at an average of around 10 calls a night, there is no clear evidence that the criteria has been exceeded (>10 Big Brown Bats and >5 Adult Female Silverhaired Bats). Additionally, CUW1 is not considered an appropriate ELC ecosite as per the MNRF's Significant Wildlife Habitat Criteria Schedules For Ecoregion 6E and 7E. However, it is acknowledged that due to the results of the survey and the proximity of the woodland features, the SWD3-2/CUW1 complex as a whole can be treated as SWH.

2.4.4.2 Rare or Specialized Habitats

Rare and specialized habitat are two separate components. Rare habitats are those vegetation communities that are considered rare in the province. S-Ranks are rarity rankings applied to species at the ‘state’, or in Canada at the provincial level, and are part of a system developed under the auspices of the Natural Conservancy (Arlington, VA). Generally, community types with S-Ranks of S1 to S3 (extremely rare to rare-uncommon in Ontario), as defined by the NHIC (MNRF 2023), could qualify. It is to be assumed that these habitats are at risk and that they are also likely to support additional wildlife species that are considered significant. Specialized habitats are microhabitats that are critical to some wildlife species. The NHRM (MNR 2010) defines specialized habitats as those that provide for species with highly specific habitat requirements; areas with exceptionally high species diversity or highly specialized habitat requirements; areas with exceptionally high species diversity or community diversity; and areas that provide habitat that greatly enhances species survival.

2.4.4.3 Habitat for Species of Conservation Concern

Species of conservation concern include those that are provincially rare (S1 to S3), provincially historic records (SH) and Special Concern species. Several specialized wildlife habitats are also included in this SWH category, i.e., terrestrial crayfish habitat and significant breeding bird habitats for marsh, open country and early successional bird species.

Habitats of species of conservation concern do not include habitats of endangered or threatened species as identified by the ESA (2007). Endangered and threatened species are discussed in **Section 2.4.6** below.

With respect to Terrestrial Crayfish, GEI is suggesting a minor variation on the recommended criteria of any wetland containing at least one or more crayfish or their burrows being considered significant. The SWH EcoRegion Criteria Schedules acknowledges that "the information within these schedules will require periodic updating to keep pace with changes to wildlife species status in the Species at Risk in Ontario (SARO) list, or as new scientific information pertaining to wildlife habitats becomes available". Given that it has been 10 years since these guidelines were published, the understanding of the distribution of terrestrial crayfish within southern Ontario has greatly improved since that time, warranting this reconsideration. This is further detailed below.

GEI has completed a detailed literature review and review to the MiST (SWH Mitigation Support Tool; MNRF 2014) and SWHTG (Significant Wildlife Habitat Technical Guide; MNR 2000 Technical Guide) and maintains the opinion that the two small wetlands with low numbers of crayfish (3 and 10 chimney observations at wetlands 3 and 14) do not warrant SWH status, and that the larger wetland (SWD3-2) with a high number of crayfish chimneys (>80) warrants the SWH designation.

Within the SWH Ecoregion Criteria Schedule, MNR references Guiasu (2007) as the source for the designation of a wetland containing at least 1 terrestrial crayfish as being the threshold for significance. Guiasu (2007) states that "crayfish is restricted to only a few isolated patches of suitable wetland habitat in southern Ontario". GEI infers from this statement that identification of terrestrial crayfish was restricted to a limited number of suitable wetlands in the entirety of southern Ontario, resulting in MNR concluding that any wetland containing terrestrial crayfish is therefore significant.

With the inclusion of terrestrial crayfish in the SWH Ecoregion Criteria Schedules, there has been a significant increase in the amount of effort expended by the development industry in looking for this species. The results of these studies have clearly demonstrated that the distribution of these species in southern Ontario is not restricted to only a few patches of suitable wetland habitat.

Specifically, GEI has completed crayfish surveys at proposed development sites throughout the Greater Toronto Area (GTA) and have documented several instances where hundreds of chimneys are present in a single colony (at sites in Milton, Mississauga and Brampton to name a few), including in wetlands of relatively limited ecological quality (such as newly established marshes along drainage channels in agricultural fields).

Given the small proportion of the land base within the GTA that GEI has assessed, it is reasonable to conclude that terrestrial crayfish are much more common and widely distributed than was known at the time of preparation of the SWH Ecoregion Criteria Schedules and the supporting paper by Guiasu (2007).

As a result, GEI has concluded that due to the low number of chimney observations at small wetlands, in comparison to higher chimneys observed at the larger SWD3-2, and considering the small size and isolated nature of the wetlands surrounded by active agricultural land use, a designation of SWH is not reasonably warranted for Wetlands 3 and 14, however it is warranted for wetland 8 (SWD3-2).

This determination would also be consistent with the requirements of the SWHTG. The Ecoregion Criteria Schedules (ECS) are prepared as guidance for interpretation of the SWHTG, but do not replace the SWHTG. As such we must consider the requirements of the SWHTG as it comes to identification of significant wildlife habitat for species of conservation concern. Section 8.6 of the SWHTG states "Habitats [of species of conservation concern] that support large populations of a species of concern should be considered significant." Designating habitats with low numbers of species of concern would not be consistent with this direction given the apparent prevalence of terrestrial crayfish documented throughout southern Ontario.

2.4.4.4 Animal Movement Corridors

Animal movement corridors are areas that are traditionally used by wildlife to move from one habitat to another. This is usually in response to different seasonal habitat requirements, including areas used by amphibians between breeding and summer/over-wintering habitats called amphibian movement corridors.

Table 14 (Appendix B2) assesses all types of SWH relevant to the NHSA considering the ecological data collected by GEI.

As detailed in the tables, the following SWH types are present on the NHSA. The confirmed SWH is shown on **Figure 2.2 (Appendix B1)**:

- Seasonal Concentration Areas of Animals
  - Bat Maternity Colonies (SWD3-2/CUW1);
  - Turtle Overwintering Area within a Cattail Shallow Mineral Marsh (MAS2-1).
- Species of Conservation Concern
  - Terrestrial Crayfish within a Silver Maple Mineral Deciduous Swamp (SWD3-2));
  - Wood Thrush (Special Concern) within the SWD3-2/CUW1 located at the south-central portion of the NHSA; and
  - Barn Swallow (Special Concern) habitat within barn structures on Parcel 5, along Centreville Creek Road

The following Candidate SWH types have potential to occur in the adjacent West Humber River valley located north and east of The Gore Road:

- Seasonal Concentration Areas of Animals:
  - Candidate Bat Maternity Colonies
- Specialized Wildlife Habitat:
  - Candidate Bald Eagle and Osprey Nesting, Foraging and Perching Habitat (West Humber River corridor)
  - Candidate Seeps and Springs
- Species of Conservation Concern:
  - Candidate Marsh Bird Breeding Habitat.
  - Candidate Terrestrial Crayfish, Wood Thrush, and Eastern Wood-Pewee Habitat.

The following Candidate SWH types have potential to occur within non-participating lands in the NHSA:

- Candidate Barn Swallow Habitat;
- Candidate Overwintering Turtle Habitat; and
- Candidate Terrestrial Crayfish Habitat.

2.4.5 Fish Habitat

Fish habitat, as defined in the federal Fisheries Act, C.F-14, means “spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes.” Fish, as defined in S.2 of the Fisheries Act, C.F-14, includes “parts of fish, shellfish, crustaceans, marine animals and eggs, sperm, larvae, spat and juvenile stages of fish, crustaceans and marine animals” (DFO 2019).

The TRCA’s Humber River Fisheries Management Plan (2005) identifies on Figure 22 the portion of the West Humber River in the NHSA as Intermediate Riverine Warmwater habitat. Therefore, the West Humber River is identified as providing direct fish habitat.

Several small riverine warmwater habitat were also identified in reaches within the NHSA as per Figure 22. As detailed in **Section 2.2.16**, GEI conducted fish community sampling within the NHSA in 2022 and 2024, targeting wet reaches (H1S1, H2S1, H3S1/S2, H5S1/S2/S3/S4/S4A) and downstream culverts (HDF4, HDF5, HDF12). Several reaches were dry at the time of sampling (H4S1/S2/H3, H8S1, H14S1, H15S1/S2, H12A1/S1/S2). No fish were captured within the reaches on participating ownerships within the WVSP area. Therefore, these features are identified as providing indirect fish habitat. However, Brook Stickleback and Fathead Minnow were captured at downstream culverts (HDF4 and HDF5) along The Gore Road and Mayfield Road. As a result, the downstream extents of HDF4 and HDF5, outside of the WVSP area, are identified as providing direct fish habitat. In addition, due to the connection to HDF4, candidate fish habitat is also identified within the tributary of the West Humber River east of The Gore Road. One Brook Stickleback was observed in April 2024 during HDFA surveys in a small and isolated pool along HDF H12A1, approximately 130 m upstream of Mayfield Road. The pool was in an agricultural field and the HDF had been ploughed through and planted with wheat, representing very low-quality fish habitat. Fish community sampling in 2024 was attempted within this feature and the downstream culvert but it had dried out by May. Therefore, HDF H12A1 is identified as providing direct seasonal fish habitat.

2.4.6 Habitat of Endangered and Threatened Species

Species designated as Threatened or Endangered in Ontario are afforded both individual and habitat protection under ESA (2007). In order to identify the presence of any Threatened or Endangered species a background information review and detailed field investigations were completed within the NHSA.

The background review identified that a number of SAR could potentially be present within the NHSA. To assess habitat suitability and species presence/absence a number of targeted surveys were undertaken. A discussion of the potential for endangered and threatened SAR and their habitat within the NHSA is provided in **Table 2.2** (**Appendix B2**).

Redside Dace occupied habitat occurs in the West Humber River located in the south-east corner of the NHSA. This habitat is within the Greenbelt Plan Area and will be protected from development.

GEI prepared a Redside Dace contributing habitat assessment dated April 11, 2025. MECP provided written confirmation that Redside Dace contributing habitat is absent from the NHSA on April 25, 2025 (**Appendix B9**). Further, GEI understands that under the amended Endangered Species Act (2025), the definition of Redside Dace habitat has changed and no longer includes Contributing Habitat. The new definition of habitat for SAR fish in streams and rivers—including Redside Dace—focuses on ‘dwelling places,’ which include spawning areas, nursery and early rearing areas, wintering areas, and staging areas (for migratory species), along with the immediate surrounding area essential to maintaining the conditions necessary for breeding, rearing, and overwintering. As a result, contributing features are no longer considered part of Redside Dace habitat under the updated legislation.

Eastern Meadowlark and Bobolink were observed in suitable habitat (hayfields) located within the NHSA east of The Gore Road. No suitable habitat for these species occurs on participating lands in the NHSA.

Rapids Clubtail was identified through background review and may be present along the West Humber River. This species prefers large streams and rivers with wooded shorelines and riffle and pool features.

No bat SAR were identified with the NHSA participating ownerships during the acoustic monitoring. Habitat for bat SAR may be present within the well forested West Humber River valley along the east end of the NHSA.

Species at Risk will be addressed with MECP through their Information Gathering Form at the Draft Plan of Subdivision stage. The Phase 2 LSS will provide a more comprehensive understanding of potential impacts to SAR building on the habitat identification completed in this Phase 1 LSS.

2.4.7 Other Features

Other wetlands (non-significant) have been identified throughout the NHSA as mineral meadow marsh, mineral shallow marsh, and deciduous swamp communities (**Figure 2.2**, **Appendix B1**). The wetland communities are small in size, ranging from 1.8 ha to 0.02 ha, with the SWD and MAM2 communities the largest in size.

The Caledon OP states that:

> "New development will not be permitted in Other Wetlands unless it can be demonstrated that such development will not result in the degradation of ecosystem integrity, to the satisfaction of the Town, the Conservation Authority, the Ministry of Natural Resources and Forestry, or other delegated authority".

One other woodland (non-significant) has been identified as a small (0.5 ha) cultural woodland located southwest of the corner of Mayfield Road and the Gore Road, within 120m of the WVSP area (**Figure 2.2**, **Appendix B1**).

The Caledon OP states that:

> "New development will not be permitted in Other Woodlands unless it can be demonstrated that such development will not result in the degradation of ecosystem integrity, to the satisfaction of the Town and Ministry of Natural Resources and Forestry, or other delegated approval authority."

Areas of Natural and Scientific Interest (ANSI) must also be considered. Gooseville Moraine is a Candidate Earth Science ANSI and is immediately north of the WVSP area (**Figure 2.1**, **Appendix B1**).

2.4.8 Natural Heritage Features on Non-participant Lands

Based on GEI's air photo review and field studies on adjacent and/or nearby participating properties, natural heritage features on non-participant lands within the NHSA are small and scattered within an active agricultural setting and are likely comprised of common and secure vegetation communities and flora and fauna. These features are anticipated to be removed as properties participate in the development process and are not anticipated to be part of the NHS long-term.
Until these lands participate, and features can be studied in the field, they are designated as “Non-participant Natural Heritage Features and Buffers - For Further Study” on **Figure 2.5** (**Appendix B1**).

2.4.9 Key Ecological Features and Functions

An analysis of existing natural heritage features in the NHSA was completed, followed by an evaluation of their significance against criteria in the Significant Wildlife Technical Guide and Eco-region 6E and 7E Criteria Schedules (MNRF 2015a and 2015b), as well as under criteria recommended in the Peel Region OP (2022) and NHRM (MNR 2010).

These analyses identified the following key natural heritage features and natural hazards as present, within the NHSA:

- Significant Wetland;
- Unevaluated and Other Wetlands;
- Significant Woodlands;
- Other Woodlands;
- Candidate Significant Valleyland;
- Fish Habitat
  - Direct Fish Habitat (West Humber River, downstream extent of HDF4 at The Gore Road culvert and downstream extent of HDF5 at the Mayfield Road culvert);
  - Direct Seasonal Fish Habitat (H12A1);
  - Indirect Fish Habitat (H1S1, H2S1, H3S1/S1A, H4S1/S2/S3, H5S1/S2/S3/S4/S4A, H7S1, H8S1, H14S1, H15S1/S2)
  - Candidate Fish Habitat (WHT2(1)1-1, east of The Gore Road)
- Habitat of endangered and threatened species (Redside Dace, Bobolink, Eastern Meadowlark); and,

- Significant Wildlife Habitat including:
    - Seasonal Concentration Areas of Animals (Confirmed and Candidate Turtle Overwintering Area and Confirmed and Candidate Bat Maternity Colonies)
    - Specialized Wildlife Habitat (Candidate Bald Eagle and Osprey Habitat and Candidate Seeps and Springs).
    - Species of Conservation Concern (Candidate Marsh Bird Breeding Habitat, Confirmed and Candidate Barn Swallow Habitat, Confirmed and Candidate Wood Thrush Habitat, Candidate Eastern Wood-Pewee Habitat and Confirmed and Candidate Terrestrial Crayfish Habitat)
- Floodplain (as estimated by the TRCA);
- Meanderbelt; and
- Long-term Stable Top of Slope.

2.5 Preliminary Natural Heritage System

The preliminary NHS (**Figure 2.5**, **Appendix B1**) is founded upon a sound technical understanding of the extent and quality of natural heritage features and functions, and natural hazards that meet the definition of NHS components as described in the Town of Caledon OP and Peel OP.

The constraints and opportunity analysis serves to:

a) Identify significant and sensitive biophysical features and functions that could potentially constrain how the NHSA is developed; and,
b) Identify potential opportunities for enhancement of the natural features and ecological functions in association with the future development.

The existing conditions are representative of a system of natural features and functions, including valley and stream corridors, wetlands, woodlands, significant wildlife habitat of endangered and threatened species, fish habitat, and their preliminary minimum Vegetation Protection Zones/buffers. Phase 2 of the LSS will look at proposed land use changes and will recommend a final, interconnected natural heritage system.

The proposed stormwater management strategy, as to be detailed in Phase 2 of this LSS, will include Low Impact Development (LID) techniques to support existing watercourses and wetlands, as well as the HDF and wetland compensation areas, with the goal of achieving a net ecological gain compared to existing conditions. Wetlands removed will be compensated as per TRCA's ecological offsetting guidelines, which is one to one compensation for non woody wetlands.

2.5.1 Vegetation Protection Zones (VPZs) and Setbacks

Minimum VPZs are to be established in accordance with municipal, regional and provincial policies. All natural heritage features (significant and non-significant) will require VPZs to ensure the protection of their form and function over the long-term. Final VPZs cannot be confirmed within the LSS process until detailed investigations (e.g., final feature-based water balance assessments) have been completed.

It is recognized that buffers play an important role in mitigation where development is proposed adjacent; however, vegetated buffers can provide further benefits than simply protection to the NHS. Table 13-1 of the NHRM (2010) identifies several functions and benefits of buffers including reduction of light and noise, space for tree-fall, protection of root zones, enhancement of woodland interior, attenuation of runoff, etc. Setbacks are established to preserve natural hazards from potential development pressures.

The VPZs and setbacks are based on the following policy guidance:

- TRCA's Living City Policies (2014);
- Town of Caledon's OP (2024 Consolidation);
- Peel OP (2022);
- The Greenbelt Plan (2017); and
- Section 29 of O. Reg. 831/21 (Habitat).

The SABE Scoped SWS includes a preliminary NHS with a 30 m VPZ buffer. However, it notes that these may be refined through the LSS.

For the purposes of the Secondary Plan, alternative preliminary minimum VPZs based on policy and best practices have been reviewed within this Phase 1 LSS. However, these preliminary minimum VPZs will be further evaluated in the Phase 2 LSS as part of the impact assessment to determine final minimum VPZs based on sensitivity and adjacent land use changes (as per 13.9.4,13.9.5, and 13.9.6 of the Caledon OP) and based on the buffer design recommendations within the SABE. It is anticipated that final VPZs will be established through site specific Environmental Impact Studies (EIS).

2.5.1.1 TRCA Review

Within Section 7.3.1.4 of the Living City Policies (2014), the following buffers are prescribed for natural hazards:

- 10 m buffer from the greater of long-term stable top of slope/bank, stable toe of slope, regulatory flood plain and/or meander belt; and
- 30 m buffer from Significant Wetlands or a 10 m buffer for all other wetlands. Other natural heritage buffers provided within the Living City Policies are not

included since the Conservation Authority no longer provides commentary on natural heritage considerations (refer to **Section 2.1.6**).

2.5.1.2 Town OP Review

The current in-force Caledon OP (2024 Consolidation) has no defined buffer/setback width requirements for natural heritage features; instead, it outlines that Secondary Plans require a SWS to include "confirmation of the boundaries and appropriate buffers for protection, restoration and enhancement of the Natural Environment System" (Section 5.5.9).

Section 13.9.5 of the Future Caledon OP (2024) states that "minimum buffer widths will be established in local subwatershed or equivalent studies prepared to the satisfaction of the Town". Section 13.9.6 further states that "final buffer width(s) within New Community Areas and New Employment Areas will be determined through an environmental impact study, prepared to the satisfaction of the Town". As a result, minimum buffer widths presented within Section 13.8 of the Official Plan do not apply.

An additional 5 m buffer is applied to significant valleylands in accordance with the Town's requirements within existing settlement areas outside of Provincial Plan areas. This is also a consistent setback requirement within other jurisdictions for significant valleylands (e.g., Halton Region).

2.5.1.3 Region OP Review

The Region does not provide buffer/setback requirements; rather, it defers to the Greenbelt Plan (2017) or the Town's requirements.

2.5.1.4 Greenbelt Plan Review

In accordance with Section 3.2.5 of the Greenbelt Plan (2017), a minimum VPZ of 30 m is required for wetlands, seepage areas and springs, fish habitat, permanent and intermittent streams, lakes and significant woodlands. All other KNHFs and KHFs (e.g., valleylands) require a VPZ which "is of sufficient width to protect the key natural heritage feature or key hydrologic feature and its functions form the impacts of the proposed change and associated activities".

2.5.1.5 Species at Risk Requirements

No setbacks are prescribed for noted SAR observed in the NHSA.

Section 29 of O. Reg. 831/21 defines the limits of occupied (regulated) Redside Dace habitat as 30 m from meander belt width.

Candidate SAR bat habitat was identified within the Greenbelt Plan (2017) Area and is expected to be retained. There are no setback requirements prescribed by MECP for SAR bats; however, suitable woodlands may be prescribed protection in accordance with Woodland policies.

Eastern Meadowlark and Bobolink habitat may only be removed in accordance with Part 4 of O. Reg. 830/21.

2.5.2 WVSP Preliminary Natural Heritage System

In accordance with Section 3.2.5.1 of the Greenbelt Plan (2017), wetlands, seepage areas and springs, fish habitat, permanent and intermittent streams, lakes and significant woodlands will have a minimum of a 30 m VPZ applied. Valleylands and other features/hazards located outside of the Greenbelt Plan Area and within the WVSP area will have the following preliminary minimum VPZs and setbacks:

- 30 m from Significant Wetlands or 10 m from non-significant wetlands (using the staked wetland boundary);
- 10 m from woodlands (using the staked dripline boundary);
- 15 m from significant valleylands or 10 m from non-significant valleylands (using the greater of long-term stable top of slope or staked top of bank boundary for confined systems; or the greater of meander belt or floodline boundary for unconfined systems); and
- 15 m from warmwater baitfish habitat.

The preliminary NHS limits are the ‘greater of’ the various natural heritage feature preliminary minimum buffers as noted above, including the conceptual HDF and wetland compensation areas as described in **Section 2.2.13.2.**

The preliminary NHS limits are shown on **Figure 2.5** (**Appendix B1**).

3.0 Groundwater

To characterize the geotechnical and hydrogeological conditions on site, a subsurface investigation consisting of a borehole drilling and monitoring well installation program was conducted. GEI is continuing monthly groundwater within the monitoring wells installed in the WVSP area until the summer of 2025. This will provide two years of monitoring across most of the participating lands, and one year of monitoring at Parcels 5 and 9 that joined the study in the summer of 2024. Surface water chemistry sampling was completed in 2024 and 2025 to characterize surface water quality in spring, summer and fall under both wet and dry conditions.

The WVSP area is shown on **Figure 3.1 (Appendix C1)**, a site location plan is provided as **Figure 3.2**, Surface elevation contours are shown on **Figures 3.3A and 3.3B (Appendix C1)**, a borehole location plan for the overall area is shown on **Figure 3.4 (Appendix C1)**, and the borehole locations overlaid onto an aerial image with observed natural features is provided as Figures **3.5A and 3.5B (Appendix C1)**.

3.1 Geological and Hydrogeological Setting

3.1.1 Source Water Protection

The WVSP area is in the Toronto Source Protection Area, the CTC Source Protection Region, and as noted, is in the jurisdiction of the TRCA. The following documents shall be used in determination of the regulatory requirements when it comes to maintaining hydrogeological function within the WVSP area:

- Approved CTC Source Protection Plan, CTC Source Protection Committee, February 23, 2022.
- Approved Assessment Report: Toronto and Region Source Protection Area, CTC Source Protection Committee, February 23, 2022.

Based on Source Water Protection online mapping, the following is noted:

- Wellhead Protection Area (WHPA): The WVSP area <u>is not</u> located within a WHPA Zone, Q1 or Q2 (**Figure 3.6, Appendix C1**).
- Intake Protection Zone (IPZ): The study area <u>is not</u> located within IPZ (**Figure 3.7, Appendix C1**).
- Highly Vulnerable Aquifer (HVA): The north portion, central and southeastern portion of the WVSP area <u>is</u> partially located within an HVA of vulnerability score 6 (**Figure 3.8, Appendix C1**).
- Significant Groundwater Recharge Area (SGRA): The WVSP area <u>is not</u> located within an SGRA (**Figure 3.9, Appendix C1**).
    - This is noted to be different from the concept of Ecologically Significant Groundwater Recharge Area, which is discussed later in Section 3.1.5.

- The WVSP area is not located within the Oak Ridges Moraine or Niagara Escarpment.

It is noted the north, central and southeastern portion of the WVSP area is located within an HVA. HVAs are determined through desktop studies and are mapped based on how shallow the water table is, depth to the aquifer and the coarseness of the material. HVAs are determined from large scale mapping used in supporting Well Head Protection Areas. Study area specific information helps to provide actual stratigraphic and hydrogeological conditions.

The HVA designation identifies an aquifer that has the potential for increased risk to contamination due to its proximity to the ground surface or the presence of surrounding geological materials with high permeability. For instance, clay layers provide a natural barrier due to their low permeability, offering protection to underlying aquifers, whereas materials like sand and fractured bedrock are highly permeable and lack such protective properties. The faster the water is able to flow through the ground to an aquifer, the more vulnerable the area is to contamination.

Typically, within the WVSP area the groundwater level is near surface and this contributes to portions of the WSVP area being classified as HVAs. Within the WVSP area, the general stratigraphy in the north, central and southeastern portions is clay and silt to sandy silt glacial till (Halton Till) which is considered relatively low permeability material and represents an aquitard setting. Consequently, the study area specific information indicates that the area would not qualify as an HVA.

Regardless of whether the study area qualifies as an HVA or not, the potential for contamination as a result of development activities are being considered as part of subsequent phases of development studies. For example, the risk associated with activities such as the application of handling and storage of road salt, fuel and snow will be evaluated in Phases 2 and 3 of this LSS.

3.1.2 Regional Physiography and Geology

From a regional perspective the WVSP area is located primarily within the physiographic region known as the South Slope per Chapman and Putnam (1984) (**Figure 3.10, Appendix C1**)**.** The South Slope is noted to be present at the southern flank of the Oak Ridges Moraine, and glacial till is typically encountered (soil types are mostly clay to loam). Runoff tends to be higher and infiltration tends to be lower in the South Slope as the terrain is not hummocky like the Oak Ridges Moraine (TRCA, 2008) and the finer-grained soils restrict infiltration. The physiographic landform mapping shows that the northern and central part of the WVSP area within the South Slope consist of Till Plains (Drumlinized) (**Figure 3.11, Appendix C1**)**.**

The southernmost part of the WSVP area near Mayfield Road is located within the physiographic region called the Peel Plain (Chapman and Putnam, 1984). The Peel Plain is characterized by flat to undulating topography. Soils in this region tend to be low-permeability clays, deposited when glacial meltwater ponded over a layer of low permeability deposits. The landform in this area consists of beveled till plains. Infiltration also tends to be low in the Peel Plains (TRCA, 2008).

Ontario Geological Survey surficial geological mapping (OGS, 2010) indicates the site and surrounding area is surfaced predominantly by either glaciolacustrine deposits comprising of clay to silt-textured till (generally in the northern and central part of the WVSP area) or by fine-textured glaciolacustrine deposits of mainly clays and silts (generally in the southern third of the WVSP area) (**Figure 3.12, Appendix C1**). Modern alluvial deposits of clay, silt, sand or gravel may exist along the West Humber River east of The Gore Road.

The bedrock in the WVSP area corresponds to the Georgian Bay Formation (OGS, 2011), consisting of shale and limestone (**Figure 3.13, Appendix C1**). Bedrock topography mapping (Gao et al, 2006) shows bedrock sloping from near an elevation of 240 m in the northwestern corner of the Study Area, down to near 192 to 205 m along the West Humber River to the east of the WVSP area (**Figure 3.14, Appendix C1**). The topography also shows bedrock sloping down to near elevation 215 m in the southwestern corner of the WVSP area. In terms of thickness of overburden, the mapping of drift thickness data provided by Ontario Geological Survey (Gao et al, 2006) is shown on **Figure 3.15, Appendix C1** and indicates that drift is thickest in the northwestern part of the Study Area where it approaches 60 m whereas elsewhere in the WVSP it is moderate to thin, typically between 6 and 20 m.

3.1.3 Regional Stratigraphic Units and Cross-sections

"Humber River Watershed, Scenario Modelling and Analysis Report" (TRCA, 2008), *"Technical Memorandum, Peel Scoped Subwatershed Study (SWS) – Groundwater "Areas of Concern" mapping"* (ORMGP, 2020), and the Scoped SWS: Part A (Wood, 2022) provide regional cross-sections and summaries of the main stratigraphic units below the Region of Peel and Humber River Watershed.

ORMGP (2020) contains a north-south cross section along Airport Road, about 2.5 km west of the WVSP area. In the area between Old School Road and Mayfield Road (which corresponds to the area in which WVSP lies), this cross-section shows Halton Till (~10 m thick) at the surface across the area. In the north near Old School Road, the Halton Till is underlain by Oak Ridges Moraine Aquifer Complex (up to 5 m thick) while in the south the Halton Till is underlain by Newmarket Till (up to 5 m thick). The Newmarket Till may also be present in a thin layer between ORAC and bedrock where ORAC is present. A copy of this cross-section is provided in **Appendix C2**.

"Humber River Watershed, Scenario Modelling and Analysis Report" TRCA (2008) shows a generalized cross-section along the West Humber River, cut north-to-south. The section shows Mayfield Road being underlain by recent sediments at grade, then a thick deposit of Halton Till, then ORAC above the bedrock surface. A copy of this cross-section is also included in **Appendix C2**.

Drawing GW-6A from Wood (2022) shows a stratigraphic cross-section along Mayfield Road, including the intersection with West Humber River just east of the WVSP area. The cross-section shows the WVSP area is likely underlain by a thick zone of Halton Till at grade, then potentially a zone of Newmarket Till above the bedrock surface. A local zone of ORAC is shown at / east of the West Humber River lying between the Halton and Newmarket Till deposits, potentially near elevation 210 to 215 m.

Drawing GW-6J from the Scoped SWS: Part A (Wood, 2022) shows another stratigraphic cross-section along The Gore Road, including the crossing with West Humber River which is immediately north of the WVSP area. Drawing GW-6J indicates that south of the West Humber River crossing of Mayfield Road, the Halton Till then Newmarket Till is expected above the bedrock. Bedrock is shown to undulate near an elevation of 200 m. A local zone of potential ORAC is shown near the right bank of the West Humber River at an elevation of 220 m between the Halton and Newmarket Till deposits, though further south (i.e., adjacent to the east side of WVSP) this cross-section indicates ORAC is absent.

Halton Till, Oak Ridges Deposits and Newmarket Till are part of the Late Wisconsin Glacial Complex, deposited approximately 13,000 to 20,000 years ago.

Halton Till varies in composition but is known to generally consist of sandy silt to clayey silt till interbedded with silt, clay, sand and gravel (Kassenaar and Wexler, 2006). Figure B126 from Kassenaar and Wexler (2006) estimates the thickness of Halton Till could be on the order of 5 to 10 m thick or greater in the Study Area. This forms the Halton Aquitard hydrostratigraphic unit. The map is included in **Appendix C2.**

The Oak Ridges Moraine (ORM) sediments consist of interbedded fine sands and silts, locally with coarse, diffusely-bedded sands, heterogenous gravels, and clay laminae (Kassenaar and Wexler, 2006). Kassenaar and Wexler (2006) state the following:

> "There remains considerable uncertainty about the origin and nature of sand and gravel deposits identified on the flanks of the moraine. The borehole and water well record database show the presence of significant sand bodies lying either within a single till unit or sandwiched between two different till units, particularly in the low-lying areas south of the moraine. These deposits may be associated with the sedimentological processes that created the moraine and therefore lie on top of the Newmarket Till or, alternatively, they may be isolated sand bodies

> within the Newmarket Till. If they do correspond to Oak Ridges deposition, then there is a greater probability that they are hydraulically connected to the ORM. Alternatively, if they are an element of the Newmarket Till, they would more likely be hydraulically isolated from the ORM."

Figure B125 from Kassenaar and Wexler (2006) indicates there could be localized zones of ORM sediments near the WVSP area, on the order of approximately 1 to 5 m thick. North of the WVSP area, the ORM sediments could be thicker and more continuous. The ORM sediments form the ORAC hydrostratigraphic unit. Sand deposits located below surficial glacial tills along the flanks of the ORM deposits are included in the ORAC, but in areas remote from the ORM, the sands are locally discontinuous and typically less than 10 m thick (TRCA, 2008). The WVSP area is south of the ORM in the South Slope and Peel Plain physiographic regions, and there could be locally discontinuous areas of the ORAC (where encountered). The map is included in **Appendix C2**.

Figure B124 from Kassenaar and Wexler (2006) indicates there could be some local zones of Newmarket Till below the Halton Till, on the order of about 5 m thick. Newmarket Till is generally a massive and over consolidated deposit with a matrix consisting primarily of silty sand to sandy silt with gravel. It can contain thin interbeds of sand and silt, rarely contain clay laminae, and can contain discontinuous sand interbeds about 1 to 2 m thick (Kassenaar and Wexler, 2006). This forms the Newmarket Aquitard hydrostratigraphic unit. The map is included in **Appendix C2**.

3.1.4 Hydrostratigraphy

The regional hydrostratigraphic units are summarized above in **Section 3.1.3**. **Table 3.1** (**Appendix C3**) summarizes the units that could be encountered within the WVSP area in accordance with the Scoped SWS (Wood, 2022).

Additionally, Section 2.3.1.3 of Peel Region's Scoped SWS: Part A (Wood, 2022), included a hydrostratigraphic interpretation of the Halton Till, further breaking it down into four (4) distinct units, including the:

- Upper Fractured Till Unit at the top, which was described as massive and generally weathered with vertical fracturing that extended up to 5 mbgs;
- Middle Till Complex that consisted of massive till layers with interbeds of staggered silt to sand and gravel with components exhibiting varying degrees of weathering;
- underlain by Glaciolacustrine Deposits of layers of fine-grained glaciolacustrine clayey silts and silty clays of varying thicknesses; and,
- over Lower Till Complex with similar characteristics to the Middle Till Complex, but not as variable.

Of particular importance in the WVSP area is the Upper Fractured Till Unit which can be a relatively active groundwater flow zone as it can exhibit a significantly higher relative conductivity, approximately 2 to 3 orders of magnitude higher than the underlying till materials (albeit still considered to be relatively low conductivity). The flow in this unit is considered to be primarily lateral towards surrounding depressional features (wetlands, streams, etc.). Predominant water movement can be laterally through this unit or overland, depending on the groundwater level and the relative locations of depressional features.

Additionally, where stream reaches have incised far enough into or through the till, groundwater discharge (seeps) may be observed. If the stream reaches have incised entirely through the till into the underlying Oak Ridges Moraine Deposits, more substantial groundwater discharge may be observed (springs).

These conditions were investigated for features within the participating lands of the WVSP Area, with the findings discussed below in Section 3.1.7. The lands along the West Humber River (east of the WVSP area) could not be assessed in detail at this time, because permission to enter the lands has not been granted.

3.1.5 Groundwater Areas of Concern

ORMGP (2020) authored a Technical Memorandum, "Peel Scoped Subwatershed (SWS) Study – Groundwater Areas of Concern Mapping" (August 18, 2020). The memo states the following:

> This memo has outlined the various factors that have been considered to prepare "Areas of Concern" mapping for the Region of Peel SWS study area. These areas can be used by Peel Region, the Town of Caledon and the TRCA to inform the development approval process and applicable requirements for pre- and post-development necessary regarding groundwater investigation and control.

The purpose of the above-referenced Technical Memorandum was to create Areas of Concern mapping related to certain hydrogeological settings for regions within or near Oak Ridges Moraine, to assist other public agencies to identify where more in-depth study could be considered. The two key Areas of Concern include the following:

- Where the Oak Ridges Aquifer Complex (ORAC) is 5 m thick or greater. The ORAC is typically overlain by Halton Till.
- Where groundwater levels within the ORAC are either above the ground surface (artesian) or within 4 m of the ground surface.

Figure 24 from the memo (ORMGP, 2020) shows that the majority of the WVSP area does not contain an Area of Concern as defined above. Small, localized areas are shown at the eastern and northwestern parts of the Study Area where groundwater within the

ORAC could be within 4 m of the ground surface. These locations are near the Greenbelt lands. This condition is also shown along the alignment of West Humber River, along the eastern side of the WVSP area. Figure 24 shows a potential minor isolated area in the southwestern corner where the ORAC could be 5 m thick or greater, and there may be another localized area in the northeast (near the Greenbelt lands). This condition is also shown more widely to the north of the WVSP area. The mapping is included in **Appendix C2.**

It is noted that the Areas of Concern mapping was generated as a guide, and was not based on detailed, site-specific information. The subsurface investigation carried out by GEI (discussed below) advanced boreholes at / near the Areas of Concern and did not encounter ORAC below the WVSP area. Based on this, no Areas of Concern were identified on the WVSP area. Properties at the southwestern portion of the WVSP area, and east of The Gore Road along the West Humber River, were not participating and subsurface investigations could not be completed in those areas at this time.

The Groundwater Areas of Concern map from ORMGP is also included as Drawing GW-8a in the Part A SABE (Wood, 2022).

Drawing GW-5a from Wood (2022) shows that the thickness of the Halton Till unit could be less than 3 m local to the West Humber River valley (not shown elsewhere within the WVSP area).

Apart from the areas of concern mentioned in the ORMGP (2020) memo, there are also some areas of potential hydrogeological concern that have been identified in review of the Scoped Subwatershed Study Settlement Area Boundary Expansion (SABE) report (Wood, 2022).

Specifically, the SABE provides mapping indicating groundwater recharge and discharge areas in the vicinity of WVSP and other parts of the Town of Caledon and northern Brampton. Copies of the recharge and discharge maps from the SABE are provided in **Appendix C2** for reference.

In terms of recharge, the SABE reported that, based on the results of hydrological modeling, groundwater recharge was generally estimated to be in the range of 75 mm to 125 mm/year (see groundwater recharge map in **Appendix C2**).

The SABE report also identifies some areas in the southern part of the WVSP as being Ecologically Significant Groundwater Recharge Areas (see **Appendix C2** for a copy of the map provided in the SABE). The SABE elaborates that the “ESGRAs represent areas of land where groundwater recharge occurs that may directly support groundwater dependent features such as coldwater streams, wetlands and their ecological functions.” These ESGRAs were delineated through a particle-tracking exercise to identify areas where possible groundwater recharge might ultimately discharge at those sensitive groundwater-dependent features. Discussion regarding the significance and relevance of these ESGRAs will be provided in Section 3.5.

In terms of discharge, the SABE identifies areas as being "potential discharge areas" based on mapping from ORMGP. It is noted that within the WVSP, though some areas indicate evidence of upward gradients or intersection of groundwater with ground surface, substantial groundwater discharge has not been observed. The nearest areas to WVSP which may feature substantial groundwater discharge are associated with the valley of West Humber River, located to the east of the WVSP. It is understood that the reason for this pattern of potential discharge areas is that the West Humber River is a relatively deep channel, which results in the potential occurrence of upward gradients and/or artesian conditions in underlying strata, and also due to the exposure or outcrop of thick segments of geological strata in the valley slope, which may result in the occurrence of seeps.

3.1.6 Visual Inspection of Site

Site inspections were carried out to assess the presence of surface water features. This included an inspection of surface and groundwater interactions and associated features; inspection of areas of discharge (actual or potential); inspection of any swales and drainage courses; evidence of phreatophytic vegetation, which may indicate seasonally high groundwater levels, groundwater discharge or seepage.

The topography within the study region (within 500 m of the WVSP area) slopes down from the northwest to the southeast towards West Humber River. Local to the WVSP area, the northwestern portion of the WVSP area is near elevation 249.1 m, the southeast portion is at an elevation near 221.1 m, and there is a maximum difference in elevation across the WVSP area of about 28 m, as measured at the borehole locations.

Based on visual observations and as shown on the topography mapping on **Figure 3.3A (Appendix C1)**, there appears to be a surface water divide in the northwestern WVSP area. The mapping shows an area of elevated topography forming a ridge. The land slopes to the east and west of the elevated ridge. The drainage features observed also generally flow east or west away from the elevated area.

3.1.7 Subsurface Conditions

3.1.7.1 Field Methodology and Procedures

The borehole locations were laid out in the field by GEI staff prior to commencement of drilling operations. The locations of underground utilities were coordinated with private and public locating companies.

Borehole ground surface elevations and coordinates (referencing NAD 83 geodetic datum) were surveyed by GEI with a Topcon HiPer SR GPS Survey unit. The elevations are provided on the borehole logs in **Appendix C4.** Borehole locations are shown on **Figures 3.4, 3.5A** and **3.5B (Appendix C1)**.
The fieldwork for the drilling program was carried out between April 27 and May 4, 2023. A total of forty-six (46) boreholes were drilled to a maximum depth of 8.1 m (elevation 214.7 m). At select borehole locations a deep well and a shallow well were installed to allow for nested wells to be installed as described below. Borehole logs are provided in **Appendix C4**.

The boreholes were advanced by a drilling subcontractor retained and supervised by GEI using a track-mounted drill rig, solid and hollow stem augers, and standard soil sampling equipment. Sampling was conducted using a 51 mm O.D. Split Spoon (SS) sampler. Standard Penetration Test (SPT) "N" Values (N values) were recorded for the sampled intervals as the number of blows required to drive an SS sampler 305 mm into the soil using a 63.5 kg drop hammer falling 750 mm, in accordance with ASTM D1586. In each borehole soil sampling was conducted at 0.75 m intervals for the upper 3.0 m and at 1.5 m intervals thereafter.

Thirty-three (33) monitoring wells were installed on participating lands within the WVSP area, within selected boreholes. Of these Thirty-three (33), fourteen (14) were completed as individual monitoring wells and nineteen (19) were completed as nested monitoring wells / piezometers. Locations labelled with a "D" demarks the deeper well and the "S" label demarks the shallow piezometer. The wells/piezometers were installed within WVSP area to facilitate long-term groundwater monitoring (horizontal and vertical gradients), sampling, and in-situ testing. Monitoring well construction is shown on the borehole logs in **Appendix C4.**

Nested monitoring wells were installed at key hydrologic features such as headwater drainage features (HDFs), wetlands, and other surface water features to evaluate the vertical hydraulic gradient and assess interactions between surface water and groundwater. At these locations, shallow wells were screened to capture near-surface groundwater conditions critical to understanding this interaction.

Across the broader WVSP area, monitoring well screen intervals were selected based on the subsurface stratigraphy encountered during drilling. The Halton Till unit was most commonly targeted, as it represents the zone most likely to be affected by construction activities. Additional screens were installed in the deeper Newmarket Till to monitor groundwater conditions at depth, where encountered. One weell was screened in the bedrock, and another at the bedrock–till interface to provide further insight into hydrogeological conditions in those locations.

The distinction between "shallow" and "deep" wells was made based on their relative position to the groundwater table and projected construction depths. Shallow wells targeted groundwater just below the surface to primarily support surface water–groundwater interaction assessments, while deep wells were installed to monitor groundwater levels at or below anticipated construction depths and to support the assessment of vertical gradients in the till aquitards. The GEI field staff examined and classified characteristics of the soils encountered in the boreholes, including the presence of fill materials, groundwater observations during and upon completion of the drilling, recorded observations of borehole construction, and processed the recovered samples. All recovered soil samples were logged in the field, carefully packaged, and transported to GEI's laboratory for more detailed examination and classification.

In GEI's laboratory, the samples were classified as to their visual and textural characteristics. Fifteen (15) representative samples of the major soil units from the boreholes were selected and submitted to our laboratory for grain size analysis. An additional six (6) grain sizes were conducted in conjunction with the infiltration testing scope. Grain size results are provided in **Appendix C5**.

The borehole locations are shown on **Figures 3.4, 3.5A** and **3.5B (Appendix C1)** and detailed subsurface conditions are presented on the borehole logs in **Appendix C4**. The soil conditions encountered at the borehole locations are summarized below. To illustrate the distribution of surficial materials across the Site, two cross-sections have been provided in **Figures 3.16A** (southwest to northeast) and **3.16B** (northwest to southeast) in **Appendix C1**: see **Figure 3.4 (Appendix C1)** for the alignments of the cross-sections. The stratigraphy discussed below pertains to Boreholes 1 to 41 and BH/MW101 to 105 advanced by GEI in 2023 and 2024, respectively. Boreholes were also advanced by other consultants on Parcels 5 and 9, encountering consistent soil conditions. The other borehole locations are shown on **Figures 3.4, 3.5A** and **3.5B (Appendix C1)** and the borehole logs are included in **Appendix C4**.

3.1.7.2 Stratigraphy

It should be noted that the conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the locations. The soil boundaries indicated on the borehole logs and subsurface profile are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change.

In addition, the descriptions provided in the borehole logs are inferred from a variety of factors, including: visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself (speed of drilling, shaking/grinding of the augers, etc.).

In general, the boreholes uniformly encountered Halton Till below grade. Local areas encountered cohesionless glacial till, likely the Newmarket Till unit, and bedrock was inferred to have been encountered underlying the glacial till deposits in some borehole locations as further described below.

3.1.7.2.1 Topsoil and Organics

A surficial topsoil layer was encountered at the ground surface at all of the borehole locations except for Boreholes NP-41D and NP-41S, ranging in thickness from 50 to 760 mm. The topsoil found in Borehole 12-D and 12-S was found to be mixed with peat.

Underlying the topsoil / peat in Boreholes 12-D and 12-S, a deposit of silt and organics with roots was encountered from 0.8 to 1.5 m below grade (elevation 246.0 to 245.2 m). The deposit was firm, black to grey, and moist.

3.1.7.2.2 Clay and Silt Glacial Till (Halton Till)

Below the topsoil, a deposit of clay and silt glacial till was found in all boreholes. The deposit was overlain by a section of weathered/disturbed material which is common for a farmed field. The glacial till typically contained trace to some sand, trace to no gravel, with inferred cobbles and boulders. The deposit was encountered between the surface and 0.76 m below grade (elevation 218.9 to 249.0 m). The deposit extended to depths of 2.3 m to beyond the depth of the investigation at a maximum depth of 6.6 m (elevation 217.0 to 243.3 m). The glacial till was moist with moisture contents ranging between 9 and 30%, and the colour was typically brown, turning grey with depth.

The N values in this layer ranged between 4 and 30 indicating a soft to hard (generally very stiff to stiff) consistency. It is typical for glacial till to have a competent upper crust underlain by a softer layer below, which was a trend typically observed in the boreholes.

Twenty grain size analysis tests for this layer were submitted to the lab for analysis, and the results are in **Appendix C5**. The testing shows that the glacial till typically contains 0 to 14% gravel, 2 to 20% sand, 29 to 46% silt, and 41 to 67% clay.

This relatively uniform and widespread clay and silt glacial till is interpretated to be the Halton Till unit, forming the low-permeability Halton Aquitard.

3.1.7.2.3 Cohesionless Glacial Till (Newmarket Till)

Cohesionless glacial till deposits were encountered underlying the clay and silt glacial till in Boreholes 4-D, 5, 21, 24, 26-D, 27, 36, 37, 38-D, 38-S, and 39-D at depths of 2.3 to 6.4 m below grade (elevation 241.7 m to 215.4 m). The cohesionless glacial till underlying the clay and silt glacial till typically was encountered on the northern and eastern portion of the WVSP area. The cohesionless glacial till extended to depths of 6.1

to 7.6 m (elevation 228.3 to 218.9 m) or beyond the depth of drilling at 5.0 to 8.1 m (elevation 241.3 to 214.7 m). The glacial till deposits had a cohesionless matrix consisting of silty sand, to silt, to silt and sand, containing trace to some clay, trace to some gravel, and inferred cobbles and boulders. Trace shale fragments were occasionally observed. The deposits were brown to grey and moist to wet, with measured moisture contents ranging from 8 to 21%. The N values ranged from 16 to greater than 50 blows, indicating a compact to very dense (generally very dense) relative density.

Three grain size analysis tests for these layers were submitted to the lab for analysis, and the results are in **Appendix C5.** The testing shows that the glacial till typically contains 2 to 13% gravel, 18 to 53% sand, 34 to 58% silt, and 9 to 13% clay.

Based on the regional stratigraphic units discussed previously in Section 3.1.3, it is expected that these cohesionless glacial till deposits encountered below the Halton Till and typically above the bedrock are part of the Newmarket Till unit, forming the Newmarket Aquitard.

A 1.6 m thick layer of compact, cohesionless sandy silt glacial till was encountered interbedded within the clay and silt till in Borehole 18-D. This interbedded layer is expected to be part of the Halton Till unit, where the unit locally contains less clay. These variations in the Halton Till are noted previously in Sections 3.1.3 and 3.1.4.

3.1.7.2.4 Cohesionless Sands and Silts

A sand deposit was encountered below the clay and silt glacial till in Borehole 20 at 6.4 m below grade (elevation 232.9 m). The borehole terminated in the cohesionless deposits at 6.6 m below grade (elevation 232.7 m). The sand contained trace gravel and was noted as brown and wet with a moisture content of 14%. The N values was 19 blows, indicating a compact relative density.

In Borehole 26-D, silt with some sand was encountered below the silt glacial till. The silt extended from 6.1 m to beyond the depth of drilling at 6.6 m (elevation 222.0 to 221.6 m). The silt was grey, moist, and very dense.

In Borehole 39-D, a layer of sandy silt with trace clay was interbedded between the upper cohesive and the lower cohesionless till deposits. The sandy silt was grey, moist, and very dense.

It is estimated that these local, discontinuous zones of sand or silt are part of the Halton Till or Newmarket Till units, which are known to contain these types of deposits as local interbeds.

3.1.7.2.5 Inferred Bedrock

Inferred bedrock was encountered below the glacial till in Boreholes 24, 28-D, 29, and 36 at depths of 7.6, 3.4, 3.4, and 6.2 m below grade, respectively (elevation 218.9 to 228.3 m). The bedrock extended beyond the depth of the investigation between 4.6 and 7.7 meters below grade (elevation 218.8 to 228.1 meters). The bedrock was described as weathered to highly weathered grey shale. The N values were all greater than 50 blows.

Based on the recovered split spoon samples, it is inferred that the bedrock is of the Georgian Bay Formation. Rock coring to confirm the weathering profile, type of bedrock, hard layers, quality, etc. was beyond the scope of work.

The depth and elevation of the inferred bedrock encountered in the boreholes is summarized in **Table 3.2 (Appendix C3)**.

As discussed in Section 3.1.2, bedrock topography mapping (Gao et al, 2006) shows bedrock sloping from near an elevation of 240 m in the northwestern corner of the Study Area, down to near 192 to 205 m along the West Humber River to the east of the WVSP area (**Figure 3.14, Appendix C1**). The topography also shows bedrock sloping down to near elevation 215 m in the southwestern corner of the WVSP area. In terms of thickness of overburden, the mapping of drift thickness data provided by Ontario Geological Survey (Gao et al, 2006) is shown on **Figure 3.15, Appendix C1** and indicates that drift is thickest in the northwestern part of the Study Area where it approaches

60 m whereas elsewhere in the WVSP it is moderate to thin, typically between 6 and 20 m. Boreholes 24, 28-D, 29, and 36 locally found thinner overburden and shallower bedrock, whereas the bedrock was not encountered within the depth of drilling in the remaining forty-six (46) borehole locations.

As excavations and development are not anticipated to extend into the bedrock, additional investigations, such as rock coring or the installation of monitoring wells screened in bedrock, are not considered necessary for the Phase 1 LSS. However, should future development plans indicate the need to assess bedrock conditions in greater detail, such investigations can be undertaken as part of subsequent phases, including those supporting draft plan of subdivision applications, and tailored to the specific requirements of the proposed development. This will be addressed in the Phase 2 LSS, where additional commentary and recommendations will be provided.

3.1.7.3 Rationale for Depth of Drilling Program

A total of 33 out of 46 boreholes (72%) were drilled to depths of approximately 6.6 m or greater, with the deepest borehole reaching 8.1 m below ground surface. The remaining boreholes extended to approximately 5 m or terminated at auger refusal on bedrock.

As described previously, the regional stratigraphy generally consists of Halton Till overlying Newmarket Till, underlain by shale bedrock. There is some potential for local, discontinuous zones of the Oak Ridges Aquifer Complex (ORAC) in the WVSP area, particularly between the Halton and Newmarket Till units. However, as noted by Kassenaar and Wexler (2006), these till units may also contain isolated interbeds of sand, silt, clay, and gravel that are not part of the ORAC.
Cohesive Halton Till was encountered in all boreholes. Cohesionless till (interpreted as Newmarket Till) was observed below the Halton Till in 11 boreholes (approximately 25% of locations), particularly in the northern and eastern parts of the WVSP area, at depths ranging from 2.3 to 6.4 m below grade.

The Oak Ridges Moraine (ORM) is located to the north and east of the WVSP area. If the ORAC extended into the WVSP area, it would be expected in the northern or eastern boreholes. However, a review of boreholes in these areas (e.g., Boreholes 1 to 10 in the north; Boreholes 5, 6, 14, 21, 26, 27, and 37 in the east) showed no evidence of ORAC beneath the Halton Till. Newmarket Till was encountered directly below the Halton Till in Boreholes 4, 5, 21, 26, 27, and 37 in the northern and eastern areas, with no ORAC encountered. This indicates that ORAC is generally absent in the WVSP area.

The only instance of potential ORAC within the WVSP area is indicated in MECP well record 4905181, located in the extreme northeast of the WVSP area near the crest of the West Humber River valley and which reports an apparent graded sequence of silt-sand-silt occupying the interval between 20 m and 42 mbgs. Below this graded sequence is a layer of gravel (3.7 m thick) overlying shale. Based on reference to other water well records in the WVSP area, it appears that a thin (<3 m-thick) layer of sand or gravel commonly coincides with the bedrock interface and is therefore more likely to be a deeper aquifer deposit (e.g., Thorncliffe Formation or Scarborough-equivalent) than ORAC. Furthermore, the pumping test results reported on local well records installed in this coarse (sand or gravel) layer immediately above the bedrock interface indicate significant drawdowns for modest pumping rates. This in turn indicates that the sand/gravel layer, despite being commonly encountered, may not be laterally continuous or may be of relatively low hydraulic conductivity despite the coarse material descriptions provided.

Due to the limited extent and significant depth of the potential ORAC deposits in the WVSP, as well as the relatively low hydraulic conductivity of the remaining overburden materials (i.e., Halton and Newmarket Tills), the geologic strata on site are not considered to be hydraulically connected to the ORM. This interpretation is consistent with regional mapping by Kassenaar and Wexler (2006), discussed previously.
Only two locations encountered sand or silt beneath the Halton Till, and one location encountered silt interbedded within the Newmarket till. These were interpreted as localized cohesionless interbeds within the till units:

- **BH 39-D:** Sandy silt was encountered between the Halton and Newmarket Till from 4.6 to 6.1 mbgs (Elev. 217.0 to 215.4 m). Nearby Boreholes 36 and 38-D, which extended to bedrock or Newmarket Till, did not encounter this sandy silt unit, suggesting it is discontinuous and localized.
- **BH 26-D:** Silt was encountered at 6.1 mbgs within the Newmarket Till. Nearby Boreholes 24, 25, 27, and 28-D extended into Newmarket till or bedrock. They did not encounter similar cohesionless interbedded layers, suggesting this is also a discontinuous layer.
- **BH 20:** Sand was found at 6.4 mbgs below the Halton Till. Nearby Boreholes 14-D, 15, 19, 21, 22-D, and 23 did not encounter this sand unit. Newmarket till was found below the Halton Till in nearby Borehole 21 at 6.4 mbgs.

These findings support the interpretation that these sand and silt zones are local interbeds within the till units and are not part of a laterally continuous ORAC deposit.

Given their depths below grade and limited lateral extent, these isolated units are unlikely to be intersected by the majority of site servicing or building excavations expected at this time. The current borehole data provide sufficient information to identify these areas and highlight where further investigation may be warranted at future stages. Specifically, targeted deeper drilling could be considered near Boreholes 20, 26, and 39 at the draft plan stage, once servicing layouts, grading, and basement elevations are finalized.

Based on the current land use plan, which primarily involves low-rise residential development with basements and servicing expected to extend typically only 3 to 5 m below grade, the depth and extent of investigation was considered appropriate for the Phase 1 LSS. Deeper excavation may be limited to localized areas associated with potential urban corridor development. The Phase 2 and 3 LSS reports will provide additional investigation guidance to support future design stages and assess deeper hydrogeological conditions, if required (e.g., for dewatering or deep foundations).

3.1.8 Groundwater Seepage

Characterization of the hydrology of the WVSP area requires consideration of interaction between groundwater and surface water features. Installation of wells and review of the groundwater table relative to the surface water elevation of the surface water features and wetlands provides some quantitative data to account for baseflow contributions to groundwater. However, these are limited by their fixed location. To characterize additional locations along the surface water features, data can be obtained through seepage meter testing.

As such, GEI conducted groundwater seepage meter readings within selected surface water and wetland features to quantify the amount of groundwater flux within the WVSP area. These measurements provide a more direct assessment of seepage and allow for a better understanding of mitigation measures that may be required if any reduction in baseflow will occur. This assessment is coupled with piezometer and staff gauge data to create a more fulsome understanding of the surface water and groundwater interactions for these hydrologic features.

Groundwater seepage meter testing was completed April 24 to 28, 2023, during spring freshet when temperatures were above zero degrees Celsius. To better understand baseflow seasonal variation and contribution of these features to the local hydrogeologic regime, groundwater and surface water interactions were characterized in one (1) tributary and three (3) wetlands as shown on **Figures 3.5A** and **3.5B (Appendix C1).** While all are presumed to operate in an integrated surface and groundwater hydrologic regime across the WVSP area, features are spatially separated.

Locations of the monitoring sites are marked on **Figures 3.4, 3.5A** and **3.5B (Appendix C1)**. The results of the seepage meter testing are included in **Table 3.3** in **Appendix C3**.

3.1.8.1 Groundwater Seepage Methods and Measurements

Seepage meters work through insertion into stream / wetland bed materials. Seepage meters then collect water through a segmented area for a minimum of one hour in a manner consistent with Rosenberry & LaBaugh (2008). Water that flows through the segmented area is collected in thin-walled plastic bags through a sealed opening in the seepage meter. While submergence of the seepage meter outlet is required to operate the seepage meter, full submergence of the seepage meter is the preferred method for operating.

Three different (3) groundwater seepage meter sizes were used to acquire a minimum of three (3) measures at each of four (4) locations to determine seepage rates. The smaller meter has a surface area of 594 cm^2 and the larger meters have a surface area of 2,565 and 2,642 cm^2 respectively. Seepage meters had variable length sidewalls, with smaller meters having shorter sidewalls. Seepage meters were paired to natural feature dimensions and estimated bed sediment depths, with preference given to larger meters which facilitate sampling through a larger sample area. Equilibration of the seepage meters post installation was limited to the time required to position meters and allow water flow to equilibrate between inside and outside of the meter, approximately 5-10 minutes. Only small meters were used in the rivulet. A combination of larger and smaller meters were used in wetland features. Site Photographs showing the emplaced meters during the investigation are provided in **Appendix C6**.

Temporary installation of four (4) 4' (1.28 m) drive point piezometers occurred during the first site visit, on April 24, 2023. Piezometers were 3 ft lengths of ¾" pipe, instrumented with 1 ft stainless steel fine mesh slotted screens and a stainless-steel driving tip at one end. Piezometers were hand driven into the ground such that the top of well screens were positioned approximately 15-25 cm below ground surface. Installation depths targeted the approximate depth envelopes of seepage meter sidewalls and sampled materials while providing good material seal at the top boundary of the piezometer screen. Drive points were installed local (1 to 2 m) to the proposed seepage meter replicate sites within the feature site and allowed to equilibrate for three (3) days prior to seepage metering being conducted. Point measures of hydraulic head and surface water elevations were calculated as the distance between the top of the screen and the ground surface for each piezometer, then extrapolated to the general monitoring location to quantify coarse characteristic differences in head for all seepage meters within that monitoring location. This associated data was analyzed in association with the groundwater seepage meters and staff gauges to gain a more comprehensive understanding of the near surface groundwater flow regime during the measurement period.

No multipliers were used in the reporting of collected seepage meter data. Discharge (Q) and specific discharge (q) were both calculated based on Rosenberry & LaBaugh (2008) using:

$$Q = \frac{V}{t} \quad \text{Eq. 1}$$

$$q = \frac{Q}{a} \quad \text{Eq. 2}$$

where: Q is the seepage rate (cm^3/hr)

v is the volume (cm^3)
t is the time (sec)
q is the Flux or specific discharge (cm/hr)
A is the area of the seepage meter (cm^2)

3.1.8.2 Seepage Meter Testing Discussion and Calculations

Individual groundwater seepage test results and analysis parameters are shown in **Table 3.3** in **Appendix C3**. Resultant average seepage values are summarized in **Table 3.4 (Appendix C3)**. Groundwater seepage over the study period contributed to 2.3 to 4.5 cm/day of surface water discharge during the study period. All seepage rates fall within a 'moderate' range (1 to 10 cm/day) for fine-grained soils (e.g. silt, clay) and on the low end for coarse grained soils (e.g. gravel and sand). Seepage in the benthic materials were higher relative to silt seepage rates at the WVSP area.

Staff gauge measurements were converted to surface water elevations for comparison across monitoring modalities and provide a surface water elevation baseline at each monitoring location (i.e. SG 1, SG 5, SG 12, and SG 16). For wetland features (SG 5, SG 12, SG 16), the relationship between staff gauge and piezometer measures was better related than for the low-flow rivulet. For the rivulet (SG 1) the water column appeared more as puddles and localized depressions and as such, staff gauge and piezometer water levels were less well related.

The drive point piezometer for the rivulet (DP1) exhibits no difference between water levels measured at-depth and at the surface for the seepage metering period. This indicates that no hydraulic head gradient is observed over this distance (of approximately 1.5 ft or 46 cm). Average seepage rates are however consistent with those observed at the SG 12 site, a wetland site with soft silt bed materials, where a downward (recharging) gradient of 2.3 cm/cm was observed. Where seepage from silty substrate materials was observed, individual hydraulic gradient results are somewhat inconclusive. Gradient behaviours measured at DP 1 and DP 12 may be more indicative of piezometer equilibration times in silt materials which require periods longer than employed during the current investigation. In future, a longer equilibration time is recommended in low flow river and rivulet features and where finer grained materials exist. In the near-surface piezometers DP 5 and DP 16, small but notable differences were observed between surface water level and at-depth hydraulic head values over the relatively short measuring distances and indicated discharge, which are consistent with seepage metering behaviours.

It should be noted that higher resolution mini piezometer measurements directly adjacent to seepage meters provide replicate specific hydraulic head values and may be most indicative of materials being sampled by seepage meters. However, proximal measures, while susceptible to natural variability in subsurface materials and localized flow paths, present a more practical option. Flow in hyporheic zones (stream bed zones) are known to be especially variable and dynamic, depending on the hydrologic conditions of the streambed and regional water table. Controls in the hyporheic zone include the hydraulic conductivity of layered bed materials, sediment composition, channel morphology, seasonality, and surface water flows (Reidel, 2022). Finer materials are generally considered to be less transmissive and low channel gradients and fine sediments with low interstitial flows are known to limit stream-hyporheic connectivity and dynamism (Kashara and Hill, 2007).

In this investigation seepage meters were used to account for seepage in both wetland (stable) and rivulet (flowing) surface water features. During the study period, one ephemeral wetland feature was excluded from the original field work plan due to installation limitations. While surface water levels were adequate for the investigation to take place and capture seepage flows, dense inundated organic materials prevented installation without significant destruction of the material and its hydrologic characteristics. This feature was abandoned as an object of study in favour of higher density study across those features exhibiting more favourable installation characteristics. Given the nature of observed materials and low flows observed in features across the WVSP area, coupled with the low (topographical) gradient nature of rivulet features across the WVSP area, broad generalizations may be drawn for features exhibiting similar flow and material characteristics. Seepage rates for measured features may be loosely extrapolated to the unstudied feature, however the presence of macropores in living root systems should not be discounted in groundwater / surface water flows and storage estimates.

3.1.9 Infiltration Testing

In accordance with the “Low Impact Development Stormwater Management Planning and Design Guide,” (Dated 2010, by CVC and TRCA), GEI conducted infiltration testing using a Guelph Permeameter to determine the saturated hydraulic conductivity in the vertical direction.

Measurement of the field-saturated hydraulic conductivity (Kfs) was carried out using a Guelph Permeameter apparatus (Model 2800K1) on May 19 and 26, 2023, at eight (8) locations: the coordinates for each location are provided in **Table 3.5** and **Table 3.6** (**Appendix C3**). The Guelph Permeameter testing was conducted in 60 mm diameter hand-augered boreholes completed to depths of 0.30 to 0.55 m below existing grade ensuring saturated soils were not encountered. Results of the Guelph Permeameter testing are provided in **Appendix C7** and are discussed below.

The GEI field staff examined and classified characteristics of the soils encountered in the hand-augured boreholes, including the presence of fill materials, and made groundwater observations during and upon completion of the boreholes. All recovered soil samples were logged in the field, carefully packaged and transported to the laboratory for more detailed examination and classification. In the laboratory, the samples were classified as to their visual and textural characteristics and geotechnical laboratory testing for grain size was carried out on six (6) representative samples with the results provided in **Appendix C5**.

The infiltration testing was conducted according to the requirements laid out in the *"Low Impact Development Stormwater Management Planning and Design Guide,"* (Dated 2010, by CVC and TRCA). The method used on WVSP area is summarized below:

- GEI conducted infiltration testing using a Guelph Permeameter to determine the saturated hydraulic conductivity in the vertical direction. An infiltration test was conducted in select hand-augered boreholes on WVSP area. Guelph Permeameter testing was carried out at depths of 0.30 to 0.55 m below existing grade.
- The testing did not occur during a precipitation event nor within 24 hours of a significant rainfall event, and the temperature was above freezing.
- The saturated hydraulic conductivity was converted to infiltration rate using the approximate relationships provided within Table 7.1 of Appendix C of *"Low Impact Development Stormwater Management Planning and Design Guide,"* (Dated 2010, by CVC and TRCA) and applying the appropriate factor of safety based on Table 7.2 in Appendix C of the CVC design guide.

The hand-augered boreholes encountered clay and silt glacial till throughout the depth of the boreholes. No seepage or groundwater was encountered in the hand-augured boreholes. Based on the borehole findings from the drilling investigation completed at the WVSP area, the clay and silt till typically extends to 3 m or deeper below grade. The hand auger and test locations are shown on **Figures 3.4, 3.5A** and **3.5B (Appendix C1).** The hand augered-borehole findings are summarized in the **Tables 3.5** and **3.6 (Appendix C3)**:

Measurement of the field-saturated hydraulic conductivity (K_{fs}) was carried out in eight (8) hand-augered boreholes using a Guelph Permeameter apparatus (Model 2800K1) on May 19 and 26, 2023.

The field-saturated hydraulic conductivity of the soil was calculated using the one-head method which is calculated as follows:

$$K_{fs} = \frac{C_1 Q_1}{2H_1^2 + \pi a^2 C_1 + 2\pi \frac{H_1}{a^*}}$$

Where: C_1 = shape factor

Q = flow rate (cm^3/s)

H_1 = water column height (cm)
a = well radius (cm)
α^* = alpha factor (0.01 to 0.36 cm^{-1})

Hydraulic conductivity and infiltration rate are two different concepts and conversion from one parameter to another must account for the hydraulic gradient and consequently cannot be done through unit conversion. In accordance with the CVC guidelines, the infiltration rate was determined as per the relationship with the field-saturated hydraulic conductivity provided in the CVC/TRCA guideline, which is summarized in **Table 3.7 (Appendix C3)**.

Infiltration rate is the inverse of percolation time. The approximate relationship (as provided in Figure C1 of the CVC guideline) in which the infiltration rate can be directly calculated from saturated hydraulic conductivity is as follows:

$$K_{fs} = 6 * 10^{-11}(I)^{3.7363}$$

A factor of safety is then applied to the calculated infiltration rate to account for soil variability, gradual accumulation of fine soil sediments during the lifespan of the facility, and compaction during construction. A higher factor of safety is applied if a soil with a lower infiltration rate is encountered within 1.5 m of the base of the infiltration measure. The results of the infiltration tests are included in **Appendix C7** and are summarized in **Table 3.8 (Appendix C3)**.

Appendix C of *"Low Impact Development Stormwater Management and Planning Design Guide"* (Version 1.0, 2010, by CVC and TRCA) suggests safety factors to be applied to infiltration rates. The recommended factor of safety for the clay and silt glacial till is 2.5 as the nearby boreholes show the cohesive glacial till extends an additional 1.5 m below the infiltration test elevation.

The Guelph Permeameter test at GP 5 encountered saturated soil conditions and a steady-state rate of fall was not achieved. The results showed water was entering the apparatus, possibly indicating the test was occurring below the groundwater table. Steady-state rate of fall was not achieved at GP 3 and GP 8, possibly due to the low permeability of the soil or a higher groundwater table.

Where measured, the factored infiltration rate of the clay and silt glacial till (Halton Till) was 7.3 to 10.4 mm/hr. It is noted that infiltration is impeded where groundwater levels are high and, in general, the glacial till would limit infiltration due to its low hydraulic conductivity. Design guidance from the CVC recommends that infiltration-type LID features (e.g., infiltration galleries) be constructed with their base at least 1 m above the seasonal high groundwater level. Maintaining this clearance could present a challenge due to the high groundwater table within the WSVP area. However, it is noted that even with reduced clearance above groundwater levels, LID systems may still be viable, but with reduced efficiency. Additional in-situ testing should be completed at the specific location and elevation of any proposed LID measures prior to detailed design. Further recommendations with respect to LID measures will be provided as part of Phases 2 and 3 of this LSS.

3.2 Water Balance and Groundwater Recharge

3.2.1 Water Balance Components

A water balance is an accounting of the water resources within a given area. The water balance equates the precipitation (P) over a given area to the summation of the change in groundwater storage (ΔS), evapotranspiration/evaporation (ET), surface water runoff (R) and infiltration (I) using the following equation:

$$\mathrm{P} = \Delta S + I + ET + R$$

The components of the water balance vary in space and time and depend on climatic conditions as well as the soil and land cover conditions (i.e., rainfall intensity, land slope, soil hydraulic conductivity and vegetation). For example, runoff occurs at a higher percentage during periods of snowmelt when the ground is frozen or during intense rainfall events.

Precise measurement of the water balance components is difficult, and as such, approximations and simplifications are made to characterize the water balance of a property. Field observations of the drainage conditions, land cover and soil types, groundwater levels and local climatic records are important inputs to the water balance calculations.

- **Precipitation (P):** For the purposes of approximating the annual precipitation at the WVSP area, the monthly rainfall between 1981 and 2010 was used based on Environment Canada historical weather data for the Richmond Hill, Ontario weather station (Climate ID 6157012, Latitude 43.88 N, Longitude 79.45 W, Elevation 240 metres), which is located about 19.5 km east of the WVSP area. **Change in Storage (ΔS):** Although there are water storage gains and losses on a short-term basis, for the purposes of this water balance calculation the net change in groundwater storage on a long-term basis is assumed to be zero. This is because this water balance is calculated to provide the average annual water balance over an indefinite period of time, which requires that the system be assumed to be at steady state (i.e., zero change in storage). This is a suitable assumption because for the pre-development condition, the physical environment is considered to remain more or less unchanged over the long-term.

- **Evapotranspiration/Evaporation (PET):** The evapotranspiration and evaporation components vary based on the characteristics of the land surface cover (i.e., type of vegetation, soil moisture conditions, perviousness of surfaces, etc.). Potential evapotranspiration refers to the water loss from a vegetated surface to the atmosphere under conditions of an unlimited water supply. Evaporation occurs from a hard surface (such as flat rooftops, asphalt, gravel parking areas, etc.).
- **Water Surplus (R + I):** The difference between the average annual precipitation and the average annual evapotranspiration is referred to as the water surplus. The water surplus is divided into two parts: as surface or overland runoff (R) and the infiltration into the surficial soil (I). The infiltration is comprised of two end member components: one component that moves vertically downward to underlying aquifers (referred to as percolation, deep infiltration or net recharge) and a second component that moves laterally through the near surface soil profile or shallow soils as interflow that re-emerges locally to surface (i.e., as runoff) at some short distance and time following precipitation.

3.2.2 Regional Climate

The average temperature and precipitation data was taken from Environment Canada Richmond Hill station 1981 to 2010. The annual information is presented below:

- Average Annual Precipitation: 895.2 mm
- Average Annual Temperature: 7.9°C

It is noted that the above are average values, which are representative in a regional context. The intent of the water balance calculation is to provide an estimate of average annual runoff and recharge. Seasonal and annual variations of these values are to be expected.

Climate trends were discussed in the Humber River Watershed Plan (TRCA, 2008) and were based on an analysis of climate parameters between two climate periods (1961-1990 and 1981-2010). The findings as described in the Watershed Plan are:

- Air temperature is increasing (0.7 degrees Celsius on average between the two time periods).
- Very hot days above 30 degrees Celsius and 35 degrees Celsius have increased.
- Very cold days between -10 degrees Celsius and -20 degrees Celsius have decreased.
- Total annual precipitation generally increased in the watershed by 3.3%.
- The growing season is increasing.

Fulsome discussion of the potential effects of climate change will be discussed in section 3.4 of the Phase 2 LSS report.

3.2.3 Approach and Methodology

The Thornwaithe and Mather method used to calculate the water balance involves monthly soil-moisture balance calculations to determine the pre-development infiltration volumes. The detailed water balance calculation is provided in **Appendix C8**, which is further explained in this and subsequent sections of the report.

The Thornthwaite and Mather calculation process is a standard approach to calculating water balance and involves utilization of available climate data, characterization of the site (vegetative cover, soil conditions), and reference to tables provided within the Thornthwaite and Mather water balance manual (1957).

The Thornthwaite and Mather (1957) water balance method generally operates on the following assumptions:

No moisture surplus occurs in months when soil moisture storage is below its maximum capacity.

- During wetter periods, any excess of precipitation over evapotranspiration first goes to restore soil moisture. In months where soil moisture reaches its maximum, the excess is considered to be moisture surplus, which is available to become either runoff or infiltration.
- During "dry months", changes in soil moisture are determined according to the guidance provided by Thornthwaite and Mather (1957), in which the soil moisture storage (i.e., the quantity of water that is stored in the soil) is calculated based on the accumulated potential water loss.
- In turn, the actual evapotranspiration for a given month is taken to be:
    - For cool months (temperature less than -1°C): 0 mm
    - For wet months (where there is excess precipitation over potential evapotranspiration): the difference between precipitation and potential evapotranspiration
    - For dry months (where precipitation is less than potential evapotranspiration): the sum of precipitation and the absolute value of the change in soil moisture storage.

The calculations were conducted in general accordance with the Thornthwaite and Mather (1957) method, with the following notable exceptions:

- Heat Index and Unadjusted Daily Potential Evapotranspiration were computed based on formulae given in Lorente (1961).

- The division of moisture surplus into recharge and runoff is determined based on the infiltration factors specified in the *Stormwater Management Planning and Design Manual* (MECP, 2017), which involves selection of components based on soil, topography and vegetation cover.
- Whereas Thornthwaite and Mather provides a monthly water balance, accounting for snow storage, snowmelt runoff, and other seasonal processes which re-distribute moisture surplus throughout the year, the water balance calculations provided here are annual and do not provide those distributions.
- Impervious areas were accounted for by assuming a constant evaporation rate of 15% of annual precipitation, with the remaining 85% of precipitation being considered as runoff.

As noted above, certain site conditions and material properties must be accounted for in the water balance calculation process. The following site-specific conditions and characteristics were used in these calculations:

- The maximum soil moisture storage was determined based on guidance provided by Thornthwaite and Mather (1957), which accounts for both soil type and vegetative cover.
    - Soil: Based on grain-size analyses (**Appendix C5**), the surficial Halton Till of the WVSP area is typically in excess of 40% clay with relatively low sand content. Under the Canadian Soil Classification System (Soil Classification Working Group, 1998), such soils are classified as "clay".
    - Vegetative Cover: Based on observations made during fieldwork and by review of site conditions from other photo references (e.g., Google Maps Street View), crop areas are typically planted with corn and occasionally with soybean or grain. The representative cover classification under Thornthwaite and Mather (1957) is taken to be "moderately-rooted crops" for the crop areas and "mature forest" for wooded areas.
    - Therefore, two zones of soil moisture storage have been identified and implemented in the water balance calculations:
        - Agricultural with Clay soils, corresponding to 150 mm soil moisture per Thornthwaite and Mather (1957)
        - Treed with Clay soils, corresponding to 350 mm soil moisture per Thornthwaite and Mather (1957)
- For the purposes of infiltration factor selection, the following conditions were chosen:
    - Soil factor: 0.15
        - Rationale: the surficial till soils of the Site typically contain greater than 40% clay, indicating potentially "impervious" conditions, but weathering of shallow soils indicates slightly elevated

permeability. Therefore 0.15 is a modification of the "tight impervious clay" selection of 0.1.

- Topographic Factor: 0.15
  - Rationale: the slope across the WVSP is relatively uniform, typically between 10 and 16 m/km, which indicates an intermediate value between "Rolling Land" and "Hilly Land", for which the MECP provides factors of 0.2 and 0.1, respectively.
- Vegetative Cover: 0.1 or 0.2
  - Rationale: the vast majority of the WVSP area is cultivated land (factor of 0.1) but additional calculations have been made to account for the areas that have wooded cover (factor of 0.2)

It is noted that the pre-development water balance (see **Appendix C8**) was calculated separately for each catchment within the WVSP area. This will support future impact assessment and mitigation planning in the subsequent phases of the LSS. It is also noted that the infiltration and runoff values presented in **Appendix C8** are estimates only. However, for the purposes of this LSS, the results obtained in this water balance assessment are considered suitable to support planning. Comparisons with published water balance data for the local area are made in Section 3.2.4 below and where applicable other field data are used in adapting the result for this LSS. In subsequent phases of the LSS process, the water balance calculations will be used in conjunction with available hydrogeological data to support planning for mitigation measures and the setting of infiltration targets.

3.2.4 Pre-Development Water Balance

The total WSVP Area is 358.1 ha in size. The detailed water balance calculations are included in **Appendix C8**. **Table 3.9 (Appendix C3)** summarizes the existing site condition (pre-development) water balance for the WVSP Area.

The following is a summary of the pre-development water balance calculations provided in **Appendix C8**:

- Average Annual Infiltration:
  - Total Across WVSP: 427,864 m^3/yr
  - Pervious Areas under Agricultural Cover: 126.7 mm/yr
  - Pervious Areas under Wooded/Treed Cover: 148.4 mm/yr
  - Site-Wide Average: 121.0 mm/yr
- Average Annual Runoff:
  - Total Across WVSP: 767,989 m^3/yr
  - Pervious Areas under Agricultural Cover: 190.1 mm/yr

- Pervious Areas under Wooded/Treed Cover: 148.4 mm/yr
- Impervious Areas: 760.9 mm/yr
- Site-Wide Average: 217.1 mm/yr

- Actual Evapotranspiration:
    - Total Across WVSP: 1,970,648 m^3/yr
    - Pervious Areas under Agricultural Cover: 578.4 mm/yr
    - Pervious Areas under Wooded/Treed Cover: 598.4 mm/yr
    - Impervious Areas (assumed 15% of Precipitation): 134.3 mm/yr
    - Site-Wide Average: 557.1 mm/yr

It is noted that the largest share of outgoing water is by evapotranspiration, accounting for approximately 62% of the water balance. This is an expected result because in southern Ontario evapotranspiration is typically in excess of 50% of annual precipitation and therefore takes up the majority of the water balance. Infiltration takes up the smallest proportion, 13.5%, which is also expected because the relatively low hydraulic conductivity of the soil and the relatively steep pre-development topography result in a higher tendency for water to run off rather than infiltrate.
The results of this project-specific water balance can be compared to existing water balance data published elsewhere. GEI reviewed the water balance results provided in three sources applicable to the Wildfield LSS WVSP area:

- TRCA 2008 PRMS, results summarized in "Humber River Watershed, Scenario Modelling and Analysis Report," by TRCA, 2008.
- York Tier 3, results summarized in "Tier 3 Water Budget – Water Quantity Risk Level Assignment Study, Regional Municipality of York, Phase 1 Model Development Report," by Earthfx, dated February 2013.
    - Data available online via the TRSPA Water Balance Tool
- Oak Ridges Moraine Groundwater Program Water Balance Tool (2018a) as presented in Part A of the SABE report (Wood, 2022a) for the West Humber Subwatershed.
    - It is noted that this reference does not provide a direct comparison to the Site as the available water balance data is a summary of subwatershed averages.

A comparison of the water balance components from each of these sources is provided in **Table 3.9** (**Appendix C3**)

The Thornthwaite and Mather water balance provided for the WVSP (i.e., in this report, **Appendix C8**) compares relatively well with those previously published.

The WVSP water balance utilized an annual precipitation of 895.2 mm/year, whereas the other published water balances had precipitation input ranging from 790 to 867.5 mm/year.

In terms of the outgoing components, the breakdown is summarized as follows:

- Evapotranspiration:
  - This study: 557.1 mm/year, 62.2% of precipitation
  - Prior studies: 530 mm/year to 589 mm/year, 66.3% to 68.5% of precipitation
- Infiltration/Recharge:
  - This study: 121 mm/year, 13.5 % of precipitation
  - Prior studies: 45 mm/year to 120 mm/year, 5.2% to 15.2% of precipitation
- Runoff:
  - This study: 217.1 mm/year, 24.3% of precipitation
  - Prior studies: 135 mm/year to 237.5 mm/year, 17.1% to 27.4% of precipitation.

Of particular importance for assessing hydrogeological conditions is the quantity of infiltration/recharge. The WVSP water balance provides an estimated annual infiltration that is toward the upper end of the range provided by the previous studies.

This is interpreted to be partly due to the WVSP water balance utilizing a larger precipitation input and therefore providing greater opportunity for infiltration. However, it is also likely due to the other water balances being based on models that were better able to account for stratigraphic effects of the Halton Till in differentiating between infiltration (i.e., any water that enters the subsurface) and recharge (i.e., water that reaches the groundwater table and is capable of traveling a significant lateral distance in the subsurface, such as to the watershed boundary or to discharge at a major stream): whereas the Thornthwaite and Mather model assumes that all infiltration becomes recharge, the other models appear to be capable of further partitioning infiltration quantities. For example, the TRCA (2008) used a PRMS model calibrated against recorded stream flows (total flows and baseflows) to estimate groundwater recharge within the Humber River watershed and PRMS is capable of differentiating between deep recharge, interflow, and other flow paths.

The recharge quantity reported by the water balance presented in the SABE (120 mm/year) is noted to be most similar to the WVSP water balance but it is also noted that the SABE water balance is based on an average within the West Humber subwatershed. Mapping provided in the SABE (see **Appendix C2** for copy) indicates that groundwater recharge across the vast majority of the WVSP area may be as low as 75 mm/year. Referring to the results reported by the TRCA (45 mm/year) and York Tier 3 (77 mm/year) sources, the WVSP area is noted to have annual recharge that is lower than the subwatershed average. It is therefore reasoned that the estimated infiltration provided by the Thornthwaite and Mather water balance is an overestimate of actual groundwater recharge, potentially by a factor of 2 to 3.

Recognizing the above, it is interpreted that the results from the Thornthwaite and Mather water balance calculations (see **Appendix C8**) provide an overestimate of recharge rates if all infiltration is taken to remain as recharge. However, the results can be supplemented with analysis of field data (e.g., hydraulic conductivity measurements and groundwater gradients) to guide decisions regarding impact assessment and mitigation targets in subsequent phases of the LSS. Discussion of these relevant field data is provided in Section 3.5 (see below).

3.3 Water Supply Wells

3.3.1 MECP Water Well Records and Existing Water Wells

MECP water well records were obtained within 500 metres of the WVSP area to assess the general nature of the groundwater resource in near vicinity of the WVSP area, and historical/current uses of wells in the area. One hundred and eighteen (118) well records were found, the approximate MECP well locations are shown on **Figure 3.17 (Appendix C1)** and a well records summary table is included as **Table 3.10** in **Appendix C3.**

The wells were installed for the following uses:

- Sixty-six (66) of the records indicate domestic use.
- Ten (10) of the records indicate monitoring use/test hole.
- Seven (7) of the records indicate not used.
- Twenty-Seven (27) of the records did not specify the use and are of unknown use.
- One (1) of the records indicate public supply use.
- Seven (7) of the records indicate livestock use.

The stratigraphic descriptions within the MECP monitoring well records typically lack a high level of detail due to the methodology in which they are determined (i.e., observations of cuttings in a well installation process rather than in an investigative process). There may also be inconsistencies in terminology and descriptions between different drillers. Though this is the case, an overall sense of the deep stratigraphy can be determined by looking at commonalities between most stratigraphic descriptions and where the wells were terminated in an aquifer and through comparison to other hydrogeological publications that provide regional information.

The well records in the vicinity of WVSP typically indicate silty sand or sandy silt (potentially glacial till in some locations), then clay, then sand and gravel, then shale. Bedrock was encountered in several wells at depths ranging from 11.6 to 61.3 m below existing grade. Well records for domestic and municipal uses noted installation in sand or sand and gravel units typically screened between 15.2 to 54.9 metres below existing grade. Based on the well records with available well screen information, the deeper sand and gravel units may be ORAC but, in comparing with observations from borehole drilling under this LSS, it seems likely that they correspond to an older aquifer, such as the Thorncliffe or Scarborough Formation, due to their apparent depth below the Newmarket Till. The domestic and municipal supply wells screened within the ORAC to the north appear to be outside of the Wildfield Village Secondary Plan Area. The wells screened within ORAC to the northeast and southeast appear to be within the Wildfield Village Secondary Plan Area, but not within the participating properties. A larger portion of groundwater recharge for the ORAC would most likely not come from surface water as approximately 7.6 to 57.6 m of clay and silt glacial till (Halton Till) is overlying the aquifer reducing local infiltration and recharge.

3.3.2 Private Well Survey

A door-to-door water well survey within 500 m of the Property was completed in June 2024 to ground water usage in the WVSP area. Based on the private well survey, it was concluded that sixty-one (61) sites within a 500-m radius of the Property were supplied by domestic wells. Letters were dropped off at each property. No homeowners responded to requests for information regarding their wells. A copy of the private well survey and a list of addresses visited is appended in **Appendix C9**. The location of the wells surveyed are presented in **Figure 3.17 (Appendix C1)**.

3.3.3 Groundwater Quality

To characterize the existing groundwater quality and assess the suitability for discharge of pumped groundwater to the surface or the existing storm/sanitary sewer system during potential future dewatering activities, six (6) unfiltered and six (6) filtered groundwater samples were collected from BH/MWs 5, 18D, 26D, 33D and 38D, on May 18, 2023, and BH/MW105 on August 22, 2024 and submitted under chain-of-custody protocols to a CALA-accredited laboratory (Eurofins Environmental Laboratory) for analysis.

The wells selected for sampling provide representation of two major hydrostrata on-site: Halton Till (BH/MW-18D, -33D, -105) and Newmarket Till (BH/MW-5,-26D, 38D).

Groundwater level monitoring (see discussion in Section 3.4) indicates prevalence of recharge gradients (i.e., gradients supporting downward flow), meaning that these till units mediate communication between the surface (i.e., the future development) and deeper layers. Therefore, this set of samples is considered to provide adequate characterization of the groundwater in the WVSP for the purposes of the LSS.
For select parameters (i.e., metals) the analysis was conducted on both filtered and unfiltered samples. The purpose of this was to support planning for construction dewatering. Though attempts have been made to develop the monitoring wells, it is typically difficult to achieve a sediment-free pumping condition from monitoring wells installed with slotted screens in fine-textured soils. Therefore, filtered samples allow for the assessment of the possible effects of typical erosion and sediment control techniques (e.g., filtration, sedimentation) in the management of discharge from construction dewatering activities.

Prior to collection of the samples, approximately three (3) standing well volumes of groundwater were purged from the well. The samples were collected and placed into laboratory-supplied vials and/or bottles provided with analytical test group specific preservatives, as required. Dedicated nitrile gloves were used during sample handling. The field filtered samples were run through a 75 µm filter. The samples were submitted to CALA- accredited Eurofins Environmental Laboratory for analysis.

For the assessment purposes, the analytical results were compared to Peel Region Storm and Sanitary Sewer Use Bylaw 53-2010; PWQO. The parameters were compared to both background conditions and the applicable site condition standards. O. Reg. 153/04, as amended, Table 1 is considered to be background conditions. The applicable site condition standards were determined to be Table 8. The results of the groundwater chemistry are presented in the laboratory Certificates of Analysis provided in **Appendix C10** and are summarized in **Table 3.11 (Appendix C3)**.

The unfiltered groundwater samples collected from the monitoring locations indicated some parameters in exceedance of the Peel Region Storm and Sanitary Sewer Use By-Law and PWQO. No exceedances were found when compared to O.Reg. 153/04 Table 1 and 8 all types of property uses. The filtered groundwater samples collected had fewer select samples exceed for PWQO. Based on the filtered results the filtration reduced the exceedances of the select parameters. It is expected that during construction dewatering, the pumped water is to be first discharged to a sedimentation tank and/or a silt/sediment bag, at a minimum before being discharged.

The unfiltered groundwater samples exceeded for PWQO metals and Peel Region Storm and Sanitary Sewer Use By-Law for one or more of TSS, Manganese, Cobalt, Boron, Uranium, Silver, Iron, Cadmium, Cobalt, Copper, Nickel, Zinc, Vanadium and Zirconium. In comparison, the filtered groundwater samples met the PWQO metals standards, with the exception of one (1) or more of Cobalt, Boron, Uranium and Silver.

Based on the sampling methodology for the collection of groundwater, it is common for unfiltered and turbid samples have elevated metals reported due to the acid perseverative interacting with the soil grains suspended in the sample. Unfiltered samples can be used to represent water quality in cases where the soil is disturbed and where no treatment processes are put in place to reduce TSS.

Filtered samples provide an approximation of the ambient groundwater conditions without soil disruption, or where TSS removal is applied during construction (e.g., erosion and sediment control; filtration of discharge water). The filtered results indicate that precautions beyond TSS removal may be required to permit groundwater dewatering discharge to surface water during construction activities.

However, it is noted that low-level metal concentrations (including cobalt) were also detected in surface water under low-flow conditions. This supports the likelihood that cobalt concentrations are naturally elevated in the broader area and can be attributed to background conditions (i.e., are not considered to be anthropogenic). Consequently, the occurrence of naturally elevated metals, and whether treatment is required, should be considered when developing the discharge plan.

3.4 Groundwater Monitoring

3.4.1 Groundwater Level Monitoring

Thirty-three (33) monitoring wells were installed on the site, within selected boreholes. Fourteen (14) were instrumented as monitoring wells, and nineteen (19) were instrumented as deep/shallow nested piezometers. The monitoring wells/piezometers were installed to facilitate the measurements of stabilized groundwater levels. A 50 mm diameter PVC monitoring well was installed in all monitoring wells and 25 mm diameter PVC monitoring well was installed in all nested piezometers with a 1.5 to 3.0-metre-long screen. Monitoring well and nested piezometers construction and groundwater measurements are shown on the borehole logs in **Appendix C4**. A summary of water level data is provided in **Table 3.12A, 3.12B, and 3.12C** in **Appendix C3** along with well construction details and the strata intersected by the well screen. Dataloggers were also installed in selected monitoring wells to record continuous groundwater level data. Hydrographs showing the continuous data, along with manual reading data, are in **Appendix C11**.

The hydrographs show a typical pattern of groundwater level fluctuation, varying in response to seasonal changes in weather. For example, during the latter part of the growing season, groundwater levels tend to decrease in response to the elevated evapotranspiration that persists during that period, whereas groundwater levels rise through the winter reaching annual highs in response to reduced evapotranspiration and increased moisture surplus.

Comparing groundwater levels between the shallow and deep wells in a monitoring well nest, it is noted that the vertical gradient is typically hydrostatic (i.e., negligible difference) to slightly downward (<0.3) across the study area (see **Table 3.13** in **Appendix C3** for summary of gradients). This indicates minimal tendency for seepage through the till layer to deeper strata. Coupled with the identified weathered layer at surface, it is interpreted that the bulk of infiltrated precipitation flows laterally through the weathered layer in patterns largely dictated by topography. For the purposes of this study, these lateral flows through the shallow weathered layer are considered to be interflow. Ultimately these flows are carried to depressions such as wetland areas or to headwater drainage features. As the headwater drainage features are generally dry through much of the year, these received flows are understood to either dissipate relatively quickly (i.e., in a similar timeframe as runoff from storm events) or to be low enough that they do not emerge as surface flows but rather remain in the subsurface as seepage (i.e., as hyporheic flow).

Across much of the monitoring network, annual high groundwater levels are within about 1 m of the ground surface, while annual lows are typically within 3 m of the surface.

Groundwater levels at MW5 and MW27 are noted to be relatively deep below the ground surface, which is atypical relative to the bulk of the Site area. Both of these monitoring wells are screened within a layer of sand-silt Newmarket Till underlying the Halton Till. These locations are also relatively near to the West Humber River. Based on the depth of the West Humber River valley, it is likely that the Newmarket Till is exposed along the valley, providing a drainage outlet for the Newmarket Till and allowing for the drawing down of the water levels at MW5 and MW27 relative to the rest of the WVSP area. It is noted that slug tests at MW5 and MW27 indicate low hydraulic conductivity in the Newmarket Till ($8.7x10^{-8}$ and $7.8x10^{-8}$ m/s, respectively). These findings coupled with the lower groundwater levels in turn indicate that the overlying Halton Till is of even lower hydraulic conductivity in these areas as it is not capable of supplying deep recharge at a rate sufficient to maintain higher water levels in the Newmarket Till.

The stabilized groundwater levels in the installed monitoring wells were measured to range between approximately elevation 247.7 to 219.2 m, or about 0.06 to 5.83 m below grade. Groundwater levels show seasonal fluctuations and vary in response to prevailing climate conditions, as shown on the hydrographs. The seasonal groundwater level fluctuations were measured by the data loggers installed in wells across the site. Hydrographs were created to illustrate the data. The groundwater elevation range matched with the manual measured range of 247.7 to 219.2 m asl. The surface water elevation range based on the data loggers and hydrographs ranged from 249.2 to 219.7 m asl.

It is noted in BH/MW28 Deep and Shallow nested well, artesian groundwater conditions were encountered and the groundwater table was measured to be above ground surface by about 0.16 m or more. The deep well was screened across the interface between the Halton Till and upper bedrock, whereas the shallow well was screened within the Halton Till. A specific cohesionless unit was not encountered in the borehole within the glacial till or at the till-bedrock interface. A sand seam could exist at the well screen depth. Borehole 28 was drilled in a depressed area with lower grades than the surrounding land; if a confined deposit or sand seam dips down relative to the surrounding grade, artesian conditions can develop.

An approximate groundwater contour plan is provided as **Figure 3.18 (Appendix C1)**. This groundwater contour plan is based on groundwater level measurements made at monitoring wells installed in the Halton Till and therefore constitutes the shallow groundwater table on the Site. At the available monitoring well nests, it is noted that the groundwater level is typically similar between the shallow and deep wells, indicating continuity of soil saturation (i.e., no perched water table) and therefore the groundwater levels indicated are representative of the phreatic surface of the Site. Furthermore, due to the thickness of the poorly conductive Halton Till, there is considered to be significant separation between the surface and deeper strata. Based on these conditions, it is considered unnecessary to provide a groundwater contour plan for deeper strata.

Based on the available groundwater level measurements and the interpreted groundwater contour plan, local groundwater flow on the site appears to have a general trend towards the east, southeast towards the West Humber River. On the northwestern and southwestern portion of the site the groundwater contour flow appears to be towards the southwest. It is noted that the groundwater contours were interpolated and extrapolated beyond the points of data (i.e. well locations) for the remainder of Study Area, with interpretation required for the non-participating properties where a field investigation could not be completed. Additional monitoring well locations are needed in those locations, particularly in the area east of The Gore Road, to improve the accuracy of the groundwater contour plan.

Based on the groundwater contours shown on **Figure 3.18 (Appendix C1)**, a groundwater flow divide is evident in the northwestern section of the WVSP area. A groundwater flow divide is a boundary from which flow occurs in different directions. The flow divide is generally located in an area where there is elevated topography compared to the surrounding lands, as shown on **Figure 3.3A (Appendix C1)**. The land slopes to the east and west of the elevated ridge. The groundwater flow also appears to be consistent with the surface water patterns by having a southeast flow towards the West Humber River and southwest flow towards tributaries of the West Humber River. This is a common observation in till-dominated environments, in which groundwater levels closely mimic ground elevations.

Another important aspect of groundwater levels to consider is depth to groundwater. **Figure 19** (**Appendix C1**) shows a colourized contour plot indicating the depth to the highest recorded groundwater level below existing (i.e., pre-development ground surface). A brief review of this plan indicates the prevalence of shallow groundwater levels (<1 m below ground) across the WVSP area. The two notable anomalies of MW5 and MW27 are also clearly visible in this plot, as is their proximity to the West Humber River, which lies to the east.

3.4.2 Groundwater and Surface Water Interactions

Monitoring of groundwater and surface water levels began in spring 2023 and is projected to continue to summer 2025. Additional wetland monitoring is planned for spring and summer 2026 to obtain data necessary to support feature based water balances for the retained wetlands.

Monitored wetlands and tributaries were selected based on their proximity to the area that will be affected by the proposed development of the secondary plan area. On May 15 and 16, 2023, sixteen (16) staff gauges (SG) were installed within select wetlands, tributaries, headwater drainage features, or similar surface water features on site. A total of ten (10) monitoring wells were installed within selected boreholes on WVSP area. Nested monitoring wells / piezometers were installed in eighteen (18) boreholes which allow simultaneous monitoring of deeper and shallower groundwater conditions in or near the surface water features such as wetlands and watercourses, allowing for evaluation of the vertical hydraulic gradient and groundwater-surface water interactions within the feature.

Dataloggers were placed at seven (7) of the staff gauges (SG1, SG5, SG7, SG11, SG12, SG13 and SG16) and within five (5) monitoring wells / piezometers. The dataloggers were set to record hourly water levels and temperature. Manual measurements of the groundwater and surface water levels were taken monthly from May 2023 to April 2024 and dataloggers were calibrated based on the manual groundwater elevation measurements. A barologger was also placed to record the air temperature and pressure to compensate the groundwater dataloggers for barometric pressure. Monitoring of these staff gauges and monitoring wells / piezometers and was completed in April 2024. All monitoring locations are shown on **Figures 3.4, 3.5A** and **3.5B (Appendix C1)** and hydrographs appended in **Appendix C11**.

Comparing the groundwater levels to the surface water level measurements made at nearby staff gauges, it is noted that the relationship varies from location to location and between different times of the year. A brief overview of several cases is provided here.

In some cases, the groundwater level is consistently elevated compared to the surface water level (e.g., MW39S/D versus SG2; MW22S/D versus SG8; MW28S/D versus SG6).

Part of the reason for this difference is that the monitoring wells were installed in an area of significantly higher ground than the staff gauge and the corresponding surface water feature (e.g., wetland or headwater drainage feature). The soils of low hydraulic conductivity result in the retention of water and poor drainage, resulting in higher groundwater levels being recorded only a short distance from the surface water feature. In the specific case of headwater drainage feature H5S4 (SG6 and nearby MW28S/D), the groundwater levels are occasionally artesian even relative to the ground surface at the monitoring well location. However, in all of these cases, despite the significant head difference and apparent hydraulic gradient between the monitoring wells and the features, the relatively low occurrence of surface water in the feature indicates the limited contribution of groundwater: the seepage rate is not significant enough to generate measurable surface water flows. Even in the case of H5S4, though SG6 often indicates a measurable surface water depth, this does not necessarily correspond to flows because the staff gauge is installed in a relative depression along the drainage feature, which allows the collection and retention of stagnant water.

Wetland 10_11 associated with headwater drainage feature H5S1/2 appear to indicate a similar condition, where the water levels in nearby monitoring wells indicate water levels above the surface water level at the feature. However, these features differ from the cases noted above because the underlying soil is of higher hydraulic conductivity. Slug test data from MW38D indicates that the sand silt deposit (Newmarket Till) underlying these features has hydraulic conductivity approximately two orders of magnitude higher than the overlying Halton Till. The surface water hydrograph (see **Appendix C11**, SG1) indicates that the feature is occasionally dry (i.e., surface water depth is zero, not measurable) between storm events even though during the same periods the groundwater levels in MW38S/D are persistently above the feature bottom (see April to October 2023). This indicates that though there is an apparent gradient favouring groundwater inflow to the feature, it is not sufficient to provide baseflow to the feature. However, the presence of higher hydraulic conductivity soils in the subsurface at this feature indicates a potential for greater accessibility to groundwater than at other features in the WVSP.

At SG6 and MW28S/D (near headwater drainage feature H5S4), groundwater levels are also typically elevated relative to the surface water levels. It is noted that though SG6 commonly exhibits a water level above the bottom of the feature, this does not necessarily indicate flowing water as SG6 is located in a depression along H5S4 and can retain water for long periods of time due to the soil conditions. A key difference between this location and the locations discussed above is that at MW28S/D the vertical gradient is positive (i.e., indicates potential for seepage upward) and MW28D has on a few occasions indicated artesian groundwater levels up to 0.4 m above ground surface in summer and fall 2024. Despite the artesian conditions during that period, surface water levels remained near seasonal lows (i.e., dry or stagnant) and groundwater levels in MW28S are also well below seasonal highs. This indicates that whatever upward seepage may be occurring across the Halton Till, it is relatively small compared to surface water contributions (e.g., snowmelt runoff, stormwater) which lead to the elevated surface water level readings in winter and spring.

At other locations (e.g., SG7 and MW26S/D; SG9 and MW14S/D; SG14 and MW1S/D; SG16 and MW4S/D), groundwater levels sometimes rise above the surface water level (typically during winter and spring) and at other times fall below the bottom of the drainage feature (typically during summer and fall). This indicates that during high water / wet seasons, the surface water feature may receive interflow (i.e., lateral flows through the shallow weathered stratum) whereas during dry seasons, water carried by the feature (such as runoff received during intense rainfall) has the potential to be lost to the subsurface as infiltration.

Still other locations, such as SG10 and MW17S/D show groundwater levels persistently lower than surface water levels and the bottom of the corresponding feature. This indicates a more consistent function of recharge in that any surface water accumulated in the feature has the potential to infiltrate into the subsurface due to the persistence of the downward gradients. However, it is interpreted that, due to the restriction on downward flow imposed by the Halton Till, this recharge quantity is relatively low. Therefore, changes in surface water level in these features may be largely due to runoff, evapotranspiration or interflow (i.e., infiltration and lateral seepage through the shallow weathered layer). In some cases, it may be indicative of a “flow-through” feature, where on one side of the feature groundwater levels are higher than the bottom of the feature and on the other side they are lower. This scenario may be present at SG12 and MW12S/D and at SG5 and MW30S/D, as in both of these cases the monitoring wells appear to be installed on the downgradient side of the corresponding wetland features. It may also be the case at SG11 and MW11S/D, which indicate persistent deep groundwater levels while conditions further upgradient along HDF H1S1 (i.e., SG14) indicate seasonal receipt of interflow.

In addition to the above, it is noted that the West Humber River, which is the only surface water feature in the vicinity of the WVSP that is indicated to receive appreciable groundwater discharge, receives approximately 30% of its total flow as baseflow (TRCA, 2008). This suggests that the relative significance of wet-weather flows and surface water processes over groundwater flows would be even greater for the higher elevation features (e.g., small wetlands, headwater drainage features) within the WVSP.

Based on the observed patterns of groundwater-surface water interaction noted above and to support impact assessment and mitigation tasks during later phases of the LSS, the following classifications of interaction are provided:

1. Surface Water Dependent, referring to

   a. "perched systems" where the feature is elevated well above the groundwater level throughout the year such that the flora of the community do not have access to groundwater via root depth or capillary fringe
2. Surface Water Dominant, Groundwater Supported-Aquitard, which occurs where
   a. The community has access to the groundwater table, which may be above or below ground at a depth less than the height of the capillary fringe.
   b. Soils are of low hydraulic conductivity (i.e., aquitard conditions) that allow for the retention of infiltrated water or the accumulation of runoff (e.g., as standing water).
   c. Groundwater inputs to the feature would mainly be via interflow but may not necessarily be a large proportion of the total water input.
3. Surface Water Dominant, Groundwater Supported -Aquifer
   a. The community has access to the groundwater table, which may be above or below ground at a depth less than the height of the capillary fringe.
   b. Soils are of higher hydraulic conductivity (i.e., aquifer conditions), though this may be in a relative sense in the context of the catchment area.
   c. Groundwater inputs to the feature may be substantial but may not necessarily emerge at the surface.
4. Groundwater Dependent, includes any of the following
   a. Communities that include groundwater obligate species reliant on groundwater discharge (i.e., for temperature stability)
   b. Coldwater environments
   c. Features that receive the majority of their water contributions due to extensive gravity seeps or artesian springs
   d. Communities on steep valley slopes that are dependent on seepage emerging from the valley wall and have limited access to surface water or runoff due to limited upslope catchment area and due to elevation above the associated watercourse (i.e., excludes floodplains in many cases).

A summary of interpreted hydrological classifications of each wetland area, along with relevant information about soils, gradients and water levels, is provided as **Table 3.14** in **Appendix C3**. The wetlands are also plotted according to these classifications in **Figure 20** (see **Appendix C1**), along with areas of potential groundwater discharge. However, it must be noted that groundwater discharge areas have been identified only in terms of gradients: due to low hydraulic conductivity of soils, the assessment indicates that the relative magnitude of discharge seepage is low compared to surface water inputs to these features.

Most wetland features within the study area fall into the second category (Surface Water Dominant, Groundwater Supported – Aquitard), owing to the prevalence of the

Halton Till and the widespread occurrence of shallow groundwater levels. The influence of the Halton Till is so significant that even in cases where groundwater levels indicate an apparent discharge condition, the actual amount of seepage is severely limited by the low hydraulic conductivity of the Halton Till. The bulk of groundwater available to these features is by interflow through the shallow weathered layer of Halton Till or is runoff that is retained by the Halton Till underlying the basin.

Wetland 10_11 along with off-site Wetlands 36 and 37 are classified as the third category (Surface Water Dominant, Groundwater Supported – Aquifer) due to the shallow depth or potential exposure of more conductive soils in that area.

Some features further off-site such as Wetlands 29, 30, 32, and 35 occurring along the West Humber River could not be definitively classified due to lack of site-specific data. However, based on the available topographic and stratigraphic information it is inferred that these are also likely the third category (Surface Water Dominant, Groundwater Supported – Aquifer) due to the potential exposure of soils of higher hydraulic conductivity in the valley but also due to the relative dominance of surface water flow in the West Humber River generally.

Due to the shallow depth to groundwater throughout the area, no features have been classified as solely Surface Water Dependent.

Due to the relatively low hydraulic conductivity of the subsurface materials, the general lack of observable seeps and springs, and the lack of coldwater environments and groundwater obligate species, no features in the study area have been classified as Groundwater Dependent.

3.4.3 Hydraulic Conductivity Testing

Rising head tests were completed in monitoring wells MW5, 16, 18D, 19, 26D, 27, 33D, 36 and 38 from May 16 to 18, 2023. Additional rising head tests were completed in monitoring wells BH/MW101, 103, MW4 (Pinchin) and MW8 (Pinchin) from August 21 to 22, 2024. Referring to the borehole logs and the hydrostratigraphic interpretation of the Site, these monitoring wells are mainly screened in either the Halton Till (eight monitoring wells)or Newmarket Till (five monitoring wells).

To perform the tests, water was manually purged from monitoring wells using an inertial pump. The static water level was measured prior to the start of testing, and the change in water level was monitored using an electronic level logger. The level loggers were left in the monitoring wells for up to several hours to allow for adequate recovery of the groundwater. Though most tests did not recover fully to equilibrium, the duration of the test data collected was sufficient to support analysis to determine hydraulic conductivity. Subsequent monthly groundwater level monitoring data indicated that the wells did eventually return to equilibrium but the inclusion of that data is not necessary to the analysis. The tests were completed to estimate the horizontal hydraulic conductivity (K) of the soils at the well screen depths.

Hydraulic conductivity values were calculated from the rising head test data using Hvorslev's solution (1951) where the well screen was fully saturated and Dagan's solution (1978) where the groundwater table straddled the well screen. The semi-log plots for the results are provided in **Appendix C12** and are summarized in the **Table 3.15 (Appendix C3**).

In addition to the above-noted slug test results, the hydraulic conductivity of the soils encountered on site was estimated from grain size distribution curves (as provided in **Appendix C5** and summarized in **Table 3.16, Appendix C3**) as a check.

The results indicate that the geometric mean hydraulic conductivity for each formation is as follows:

- Halton Till: 2.4×10^{-8} m/s
- Newmarket Till: 1.9×10^{-7} m/s

According to Freeze and Cherry (1979), the typical range in hydraulic conductivity is as follows:

- Glacial Till: 10^{-6} m/s to 10^{-12} m/s
- Clay 10^{-9} m/s to 10^{-12} m/s
- Silt: 10^{-5} m/s to 10^{-9} m/s
- Sand: 10^{-2} m/s to 10^{-5} m/s

The in-situ hydraulic conductivities measured in the field are within the expected ranges for the various deposits consisting of silty sand to silt glacial till, or clay and silt glacial till based on Freeze and Cherry and the estimates from the grain size data.

Based on the consistency of the hydraulic conductivity test results across the investigation area, as well as the predominance of the investigated units in governing the hydrogeological behaviour of the WVSP, it is considered that a satisfactory representation of the geological materials has been obtained.

3.5 WVSP Area Hydrogeologic Conceptual Model Summary

The overall hydrogeological conceptual model for the WVSP area is summarized below, based on the data and analysis from the previous **Sections 3.1** to **3.4**.

Both the regional geologic mapping and the boreholes advanced across the WVSP area are consistent. The mapping indicates the site is located in a Till Plain to the south of the Oak Ridges Moraine. The WVSP area is dominated by uniformly encountered Halton Till.

In some locations, a cohesionless glacial till, likely the Newmarket Till unit, was encountered at depth below the Halton Till. The till units are underlain by shale bedrock of the Georgian Bay Formation. The geologic conditions are considered to be consistent across the WVSP area.

The overburden till units are composed of low permeability, silt dominated, soils that limit infiltration and rates of groundwater migration. The till units were found to be consistent across the area with no specific areas of high infiltration (higher permeability) or groundwater migration observed.

The Halton Till is continuous across the WVSP area and largely influences the hydrogeological behaviour of the Site. At depth, the unweathered Halton Till is of low hydraulic conductivity (horizontal hydraulic conductivity on the order of 10^{-8} m/s) which creates significant hydraulic separation between the surface and deeper layers (e.g., Newmarket Till, Georgian Bay Formation shale). The upper 0.6 to 1.5 m of the Halton Till, however, has somewhat elevated hydraulic conductivity due to weathering (e.g., fissuring due to wetting-drying and freeze-thaw cycles) and disturbances from vegetation. The hydraulic conductivity contrast between the weathered and "fresh" segments of the Halton Till results in the development of a preferential lateral flow path in the weathered segment, promoting interflow to nearby depressions (e.g., wetland features, headwater drainage features).

Below the Halton Till the most frequently observed unit is the Newmarket Till, which was encountered in the eastern part of the WVSP (e.g., BH5, BH21, BH27, BH38D), typically at depths greater than 6 mbgs. The hydraulic conductivity of the Newmarket Till appears to be somewhat higher than the overlying Halton Till, based on the depressed groundwater levels observed at monitoring wells in BH5 and BH27 (which are screened in the Newmarket Till) and the results of slug testing (, which indicate an average hydraulic conductivity on the order of about 10 times that of the average in the Halton Till).

Shale of the Georgian Bay Formation was encountered in three boreholes in the southeastern part of the WVSP: at a depth of 3.4 mbgs in BH28D and BH29 and at 6.2 mbgs at BH36. The stratigraphic observations in BH28D and BH29 indicated Halton Till overlying bedrock, whereas BH36 indicated Newmarket Till between the Halton Till and bedrock. These findings indicate no presence of ORAC at these locations.

Generally, vertical gradients across the WVSP area are downward indicating potential "recharge" conditions, though the quantity of recharge is generally mitigated by the low hydraulic conductivity of the Halton Till. Estimates of vertical seepage indicate average recharge of 38 mm/year across the WVSP. This estimate was derived using Darcy's Law (flux is the product of the gradient and the hydraulic conductivity) and input parameters for average vertical gradient across all measurement events (0.10 downward, see **Table**

3.13 in **Appendix C3**) and an estimated vertical hydraulic conductivity of the Halton Till of 1.2×10^{-8} m/s, which was based on the results of *in situ* hydraulic conductivity testing (2.4×10^{-8} m/s) and an assumed ratio between horizontal and vertical hydraulic conductivity (k_h/k_v of 2) to account for the effects of bedding, particle orientation, and soil fabric. This is substantially less than the amount of infiltration estimated by the Thornthwaite and Mather water balance (121 mm/year average across the WVSP), but is in relatively close agreement with the estimated recharge provided by TRCA (2008, see **Appendix C2** for map) of approximately 45 mm/year. This result suggests that the difference is flowing laterally as interflow within the shallow weathered till zone and being expressed as runoff at nearby features (e.g., HDFs, wetlands, roadside ditches) within the WVSP.

Based on the pre-development water balance, precipitation falling within the WVSP is mostly taken up by evapotranspiration (62% of precipitation). Approximately 13.5% of precipitation is infiltrated but, based on the hydraulic conductivity of the Halton Till and average vertical gradients, only about one-third of that remains as groundwater recharge whereas the remaining two-thirds is distributed as interflow, emerging as runoff at nearby headwater drainage features or watercourses.

One monitoring well indicated occasional artesian conditions: BH28D, installed at the interface between the Halton Till and the underlying Georgian Bay Formation shale. Though this indicates potential for groundwater discharge, the hydraulic separation created by the Halton Till limits the quantities. The adjacent headwater drainage feature H5S4 is typically dry or has stagnant standing water and is dominated by surface water flows (i.e., runoff from adjacent fields).

One nest of monitoring wells, BH38S/D adjacent to headwater drainage feature H5S2, indicates subartesian conditions in the Newmarket Till. The groundwater levels in the two wells are very similar, indicating hydrostatic conditions (i.e., limited vertical flow within the Newmarket Till) and groundwater levels generally above the bottom of the channel of the adjacent H5S2 feature. Due to the depth of the channel at H5S2, the Newmarket Till may be exposed or separated from the feature by a thin layer of overlying Halton Till. Noting the elevated hydraulic conductivity of the Newmarket Till in this area, this indicates greater potential influence of groundwater on the nearby features (e.g., Wetlands 10_11). However, the hydraulic conductivity is still relatively low on the order of 10^{-6} m/s) and the feature is considered to be dominated by surface water flows.

Based on the geologic conditions, the hydrogeologic conditions in the area are also considered to be consistent across the WVSP area and include limited infiltration and rates of groundwater seepage. The bulk of drainage features within the WVSP area occur as incised channels within active agricultural fields. Groundwater flow, albeit limited, primarily occurs in the upper/shallow weathered till units and interflow. Lateral hydraulic gradients are expected to follow topography, with groundwater flow towards the southeast and the West Humber River for the majority of the WVSP area. Groundwater and surface water flows in a limited area in the northwest of the WVSP area are expected to be westerly, towards the West Tributary of the West Humber River.

Surface water features generally form parallel to dendritic drainage patterns and also indicate consistent geology over the WVSP area. Flows are expected to be predominantly surface water fed, with high variability flow (and typically higher peak flows) controlled by precipitation events due to high runoff, limited natural storm water attenuation, and limited base flow contributions. Consistent with the geology, no evidence of point source, or significant zones of groundwater discharge were encountered.

Ecologically Significant Groundwater Recharge Areas (ESGRAs) identified in the SABE report have been determined, in terms of quantity of flow and potential to reach sensitive features, to be less significant. This LSS has identified few ecological features on-site that receive substantial groundwater flows to maintain their communities. No coldwater streams or other sensitive groundwater-dependent habitats have been identified within the WVSP. Groundwater that originates by recharge on-site must travel a significant lateral distance (i.e., to areas off-site) to reach groundwater-sensitive features. However, the low hydraulic conductivity and the low vertical and horizontal gradients observed in the Halton Till make it so that groundwater is not likely to travel a significant lateral distance within the Halton Till itself: for groundwater to travel a significant lateral distance, it would generally occur by deep recharge through the Halton Till to more conductive layers below the till (e.g., the marginally more conductive Newmarket Till, or via horizontal fractures within the shale bedrock,). Such hydrostrata would collect deep recharge from a broad area and therefore, there is a diminished need to preserve particular portions of the surface for their significance in groundwater recharge. Rather it would suffice to maintain recharge generally within a catchment area upgradient of a feature that depends on groundwater discharge.

4.0 Surface Water

4.1 Hydrologic Assessment

4.1.1 Existing Drainage

As previously noted, the WVSP area is dominated by active agricultural lands, with scattered wetlands and headwater drainage features occurring on the tableland. The West Humber River and its associated valley occur north and east of the WVSP area. Existing drainage patterns for the WVSP area (358.1 ha) are shown on Figures 4.1 and 4.2 (Appendix D1).

The WVSP area is located within five (5) catchments of the West Humber River subwatershed as follows, Catchments 36.10, 36.11, 38.04, 38.05 and 38.06. Drainage from these catchments is shown on **Figure 4.1 (Appendix D1)** and can be described as follows:

Catchments 36.10 and 36.11 generally drain southerly towards existing culverts crossing under Centreville Creek Road identified as Culverts #3 through #8.

- Drainage from Catchment 38.04 is split between draining southeasterly to Mayfield Road and draining easterly towards The Gore Road. The flows from Catchment 38.04 cross Mayfield Road via Culverts #9 and #10, and cross The Gore Road via Culvert #11.
- Catchment 38.05 is located north of Mayfield Road encompassing a small drainage area on the west side of The Gore Road which drains easterly to the West Humber River via Culvert #12.
- Catchment 38.06 spans across The Gore Road. The lands on the west side of the road generally drain easterly towards existing culverts under The Gore Road, identified as Culverts #13 through #17. Lands on the east side of The Gore Road drain to a tributary of the West Humber River which flows southeasterly, parallel to the road, joining with the West Humber River approximately 500 m north of Mayfield Road.

The five (5) catchments have been further discretized into subcatchments as shown on **Figure 4.2 (Appendix D1)** and described in **Table 4.1.** This also includes external areas north of the WVSP area.

Table 4.1 Existing Conditions Drainage Area Summary

Catchment ID[1]	Sub-Catchment ID[2]	Description	Drainage Area (ha)	Outlet[3]
36.10	36.10.1	Agricultural and 8 Residential Lots fronting Centreville Creek Road	36.78	Culverts #3 and #4
	36.10.2	External Agricultural Lands (Future Highway 413 Corridor)	19.68	Catchment 36.10.1
	36.10.3	External Agricultural Lands West of Centreville Creek Road	5.27	Culverts #1 and #2
	36.10.4	External Agricultural Lands North of Healey Road	19.97	Culvert #22
36.11	36.11.1	Agricultural and 4 Estate Residential Lots fronting the east side of Centreville Creek Road	24.85	Culvert #5, Centreville Creek Road Ditch
	36.11.2	Agricultural and 3 Residential Lots fronting the east side of Centreville Creek Road	8.14	Culverts #6, #7, #8
	36.11.3	Agricultural and 5 Residential Lots fronting the east side of Centreville Creek Road	22.49	Centreville Creek Road Ditch and Culvert #5
38.04	38.04.10	Agricultural	20.62	Culvert #10
	38.04.11	Agricultural	18.75	Culvert #9
	38.04.12	Agricultural	9.24	Mayfield Road ditch and Culvert #9
	38.04.20	Agricultural	54.88	Culvert #11
38.05	38.05.10	Agricultural	5.80	Culvert #12
38.06	38.06.10	Agricultural	19.52	Culvert #13
	38.06.11	Agricultural and 4 Residential Lot fronting the west side of The Gore Road	42.12	Culvert #14
	38.06.20	Agricultural	34.73	Culvert #15

Catchment ID[1]	Sub-Catchment ID[2]	Description	Drainage Area (ha)	Outlet[3]
38.06	38.06.21	Agricultural and 1 Residential Lot fronting the west side of The Gore Road	21.92	Culvert #17
	38.06.22	Agricultural and 3 Residential Lots fronting the west side of The Gore Road	4.75	The Gore Road Ditch and Culvert #16
	38.06.30	Agricultural east of The Gore Road	26.64	Tributary to West Humber River
36.06	36.06	External Area at the Northern Limit of the WVSP adjacent to The Gore Road.	19.01	Tributary to West Humber River

[1] Refer to **Figure 4.1 (Appendix D1)** for catchment locations.
[2] Refer to **Figure 4.2 (Appendix D1)** for subcatchment locations.
[3] Refer to **Figure 4.2 (Appendix D1)** for culvert locations.

4.1.1.1 Catchment Peak Flows

The most recent hydrologic model for the Humber River watershed was obtained from the TRCA in January 2024. The 2 through 100 year, and Regional (Hurricane Hazel) Storm event pre-development peak flows were obtained for each catchment from the existing conditions scenario of the hydrologic model. Both 6 hour and 12 hour AES storm distributions were modelled in accordance with the Humber River Watershed Plan. Refer to **Appendix D2** for the hydrologic model and **Table 4.2** below for a summary of the flows.

Table 4.2 Existing Conditions Catchment Peak Flows[1] (m^3/s)

Catchment ID[2]	36.10		36.11		38.04		38.05		38.06	
Area (ha)	339.61		146.57		142.38		47.43		173.74	
	6-hr	12hr	6-hr	12hr	6-hr	12hr	6-hr	12hr	6-hr	12hr
2-year	0.233	0.326	0.109	0.152	0.121	0.165	0.090	0.115	0.134	0.185
5-year	0.450	0.573	0.212	0.267	0.232	0.290	0.174	0.202	0.259	0.325
10-year	0.621	0.764	0.294	0.357	0.320	0.386	0.240	0.270	0.357	0.434
25-year	0.861	1.025	0.408	0.480	0.443	0.517	0.333	0.362	0.495	0.582
50-year	1.055	1.232	0.500	0.578	0.542	0.621	0.408	0.435	0.606	0.699
100-year	1.257	1.449	0.597	0.680	0.645	0.729	0.485	0.512	0.723	0.823
Regional	23.674		10.904		10.896		5.139		12.867	

[1] Refer to **Appendix D2**
[2] Refer to **Figure 4.2** in **Appendix D1**.

4.1.1.2 External Subcatchment Peak Flows

As noted in Section 4.1.1, under existing conditions there are four (4) external areas to the north of the WVSP area that drain through the study area. This includes subcatchments 36.10.2, 36.10.3, 36.10.4 and 36.06 as shown on **Figure 4.2 (Appendix D1)** and described in **Table 4.1 Existing Conditions Drainage Area Summary.** The existing conditions hydrologic model outlined in **Section 4.1.1.1** has been discretized to determine the peak flows for the external areas. Time to peak calculations have been completed for the discretized external areas and input to the model. The parent catchment Curve Number and Initial Abstraction have been applied to the external areas and not recalculated, per direction from the TRCA. The resulting 2 through 100 year and Regional peak flows for the external areas are provided in **Table 4.3** below with the hydrologic modelling and time to peak calculations provided in **Appendix D2**.

Table 4.3 Existing Conditions External Subcatchment Peak Flows[1] (m^3/s)

Sub-catchment ID[2]	**36.10.2**		**36.10.3**		**36.10.4**		**36.06**	
Area (ha)	**19.68**		**5.27**		**19.97**		**173.74**	
Storm Duration	**6-hr**	**12hr**	**6-hr**	**12hr**	**6-hr**	**12hr**	**6-hr**	**12hr**
2-year	0.136	0.144	0.073	0.071	0.188	0.207	0.134	0.185
5-year	0.270	0.265	0.150	0.124	0.384	0.376	0.259	0.325
10-year	0.378	0.359	0.256	0.288	0.541	0.506	0.357	0.434
25-year	0.529	0.490	0.296	0.218	0.767	0.684	0.495	0.582
50-year	0.652	0.594	0.365	0.261	0.952	0.824	0.606	0.699
100-year	0.782	0.704	0.437	0.305	1.145	0.971	0.723	0.823
Regional	2.837		1.147		2.748		12.867	

[1] Refer to **Appendix D2**
[2] Refer to **Figure 4.2** in **Appendix D1**.

4.1.1.3 Culverts

An inventory of existing drainage culverts was undertaken based on field visits, a review of engineering drawings for The Gore Road and Mayfield Road from the Region of Peel, Culvert Inspection Reports from the Region of Peel, and topographic survey prepared by R-PE Surveying Ltd. (refer to **Appendix D3**). There were eighteen (18) culverts identified within the WVSP area (Culvert ID #1 through #17, and #24), as shown on **Figure 4.2 (Appendix D1)**. Hydraulic analysis of the existing culverts was undertaken utilizing Culvert Master to establish existing capacity for the 2 through 100 year and Regional storm events. Refer to **Appendix D4** for the summary output and **Table 4.4** below for the results. As requested by the Town, a table cross referencing the culvert ID with HEC-RAS River Station is also included in **Appendix D4**.

Table 4.4 Existing Conditions Culvert Capacity Summary

Culvert ID[1]	Culvert Size (mm dia.)	Drainage Area to Culvert[1] (ha)	Regional Flow to Culvert[2] (m^3/s)	Culvert Capacity at Spill Point[2] (m^3/s)	Design Storm for Maximum Flow Prior to Spill
1	600	5.27	0.61	0.55	100 Year
2	450	5.27	0.61	0.28	25 Year
3	1000	81.70	10.32	2.17	10 Year
5	900	47.22	5.00	0.28	2 Year
6	750	47.22	5.00	1.23	50 Year
7	600	8.14	0.97	0.61	100 Year
8	450	8.14	0.97	0.31	50 Year
9	1000	27.99	2.29	2.1	100 Year
10	950	20.62	2.40	1.51	100 Year
11	1500	55.00	5.43	6.47	No Spill
12	350	5.80	0.79	0.17	10 Year
13	650	19.52	2.17	0.83	100 Year
14	1300	42.12	4.67	3.33	100 Year
15	1000	34.73	3.94	2.58	100 Year
16	600	4.75	0.53	0.79	No Spill
17	950	21.92	2.54	2.49	100 Year
24	1100	57.52	5.67	4.42	100 Year

[1] Refer to **Figure 4.2** in **Appendix D1**.
[2] Refer to **Appendix D4**.

4.1.2 Stormwater Management Criteria

The following stormwater management criteria have been established based on the greatest requirements of each of the design guidelines and standards listed in **Section 1.3**, through discussions with agencies and review of previous studies. The stormwater management criteria are summarized below in **Table 4.5.** The Humber River unit flow target release rates are provided in **Appendix D5.**

Table 4.5 Stormwater Management Criteria

<table>
<tr><th>Criteria</th><th colspan="2">Control Measure</th></tr>
<tr><td rowspan="2">Quantity Controls</td><td>Regional Storm</td><td>• Post- to pre- development controls are required for the Regional (Hurricane Hazel) Storm event where pre-development target peak flows are to be determined by pro-rating the Catchment flows utilizing TRCA’s most recent calibrated Humber River hydrologic model on an area basis.
• Ensure no increases in peak flow at downstream nodes in existing FVAs.</td></tr>
<tr><td>2 through 100 Year Storms</td><td>Post-development peaks flows are to be controlled to the target flow rates established using the target unit release rates generated by Equation F for Sub-Basin 36 of the West Humber River as per TRCA Stormwater Management Criteria (2012). Refer to Appendix D5 for the unit rate equations.</td></tr>
<tr><td>Quality Control</td><td colspan="2">As per the SWS (Wood, 2022) and the Town of Caledon CLI-ECA, minimize or where possible, prevent increases in Contaminant loads and impacts to receiving waters.

In accordance with the Town of Caledon CLI-ECA, stormwater volumes generated from the geographically specific 90th percentile rainfall event on an annual average basis from all surfaces on the entire site are targeted for control. Control is in the following hierarchical order, with each step exhausted before proceeding to the next: 1) retention (infiltration, reuse, or evapotranspiration), 2) LID filtration, and 3) conventional Stormwater management. Step 3, conventional Stormwater management, should proceed only once Maximum Extent Possible has been attained for Steps 1 and 2 for retention and filtration.

If conventional SWM is required, then an “Enhanced” level of quality control is to be provided based on MOE Guidelines (2003) to provide 80% Total Suspended Solids (TSS) removal.</td></tr>
</table>

Criteria	Control Measure
Erosion Control	Using a calibrated continuous simulation hydrologic model complete an erosion exceedance analysis to compare pre- and post- development erosion impacts, and establish an appropriate erosion threshold and volume requirement for end-of-pipe SWM facilities. At a minimum, end-of-pipe SWM facilities must provide extended detention of the 25 mm rainfall event for 48 hours. Where conditions do not warrant an end-of-pipe SWM facility, a minimum of 5 mm of on-site retention is required.
Water Balance	In accordance with the Town of Caledon CLI-ECA, provide control as per the criteria/targets identified in the water balance assessment of this Local Subwatershed Study (LSS). Specifically, this will be implemented through the stormwater management design which will incorporate LID measures as applicable to achieve the infiltration targets specified in this LSS. These infiltration targets will be discussed alongside the post-development water balance assessment presented in the Phase 2 LSS report.

4.1.3 Regional Storm Event Quantity Control Targets

The most recent hydrologic model for the Humber River watershed was obtained from the TRCA in January 2024. The Regional (Hurricane Hazel) Storm event pre-development peak flow was obtained for each catchment from the existing conditions scenario of the hydrologic model. Per discussions with TRCA (Dilnesaw Chekol, TRCA and Andrea Keeping, SCS Consulting Group Ltd., September 23, 2024) the total existing conditions catchment peak flow was divided by the total catchment area to get a quantity control target unit rate, as summarized in **Table 4.6.**

Table 4.6 Regional Storm Quantity Control Target Unit Rates

Catchment[1]	NHYD ID[2]	Total Catchment Area[2] (ha)	Regional Storm Total Catchment Peak Flow[2] (m^3/s)	Regional Storm Quantity Control Target Unit Rate[3] ($m^3/s/ha$)
36.10	560	339.61	23.674	0.070
36.11	561	146.57	10.904	0.074
38.04	577	142.38	10.896	0.077
38.05	578	47.43	5.139	0.108
38.06	579	173.74	12.867	0.074

[1] Refer to **Figure 4.1 (Appendix D1)** for catchment locations.
[2] Per TRCA hydrologic model. Refer to **Appendix D2**.
[3] Target Unit Rate is calculated based on Total Catchment Peak Flow (TRCA model) divided by the Total Catchment Area.

To facilitate the development of quantity control targets for stormwater management (SWM) during the Regional Storm event, the TRCA catchments were discretized into subcatchments within the WVSP area, as outlined in **Section 4.1.1**. Refer to **Figure 4.2 (Appendix D1)** for an illustration of the subcatchments. The target unit rates for each catchment, per **Table 4.6**, were then applied to the subcatchment pre-development area in order to establish target flows for SWM facilities. Refer to **Table 4.7** for the quantity control target flows for the subcatchments within the WVSP area.

Table 4.7 Regional Storm Quantity Control Target Flow Rates By Subcatchment

Catchment ID[1]	Subcatchment ID[2]	Pre-Development Drainage Area[2] (ha)	Regional Storm Quantity Control Target Flow Rate[3] (m^3/s)
36.10	36.10.1	36.78	2.564
	36.10.2	19.68	1.372
36.10	36.10.3	5.27	0.367
	36.10.4	19.97	1.392
36.11	36.11.1	24.85	1.849
	36.11.2	8.14	0.606
	36.11.3	22.49	1.673
38.04	38.04.10	20.62	1.578
	38.04.11	18.75	1.435
	38.04.12	9.24	0.707
	38.04.20	54.88	4.200
38.05	38.05.10	5.80	0.628

Catchment ID[1]	Subcatchment ID[2]	Pre-Development Drainage Area[2] (ha)	Regional Storm Quantity Control Target Flow Rate[3] (m^3/s)
38.06	38.06.10	19.52	1.446
	38.06.11	42.12	3.119
	38.06.20	35.80	2.651
	38.06.21	21.92	1.623
	38.06.22	3.65	0.270
	38.06.30	26.64	1.973

[1] Refer to **Figure 4.1 (Appendix D1)** for catchment locations.
[2] Refer to **Figure 4.2 (Appendix D1)** for subcatchment locations and areas.
[3] Quantity Control Target Flow Rate is calculated based on the Target Unit Rate provided in **Table 4.6** multiplied by the subcatchment drainage area within the WVSP area.

In addition to providing post- to pre-development quantity controls for the Regional Storm event, it is required that there are no increases in peak flow in downstream FVAs (refer to **Table 4.5**). The Regional Storm event peak flows at nodes downstream of the WVSP area, including within the FVA identified in **Section 2.3.3.2**, have been summarized in **Table 4.8**. These nodal peak flows are to be utilized in Phase 2 of this LSS to confirm that the proposed SWM measures will mitigate any potential increases in peak flow downstream of the WVSP area. Refer to **Appendix D2** for the hydrologic model schematic, node location, summary output for the nodes specified and a digital link to the hydrologic modelling files.

Table 4.8 Existing Conditions Regional Storm Nodal Peak Flows

Node[1]	NHYD ID[1]	Location	Regional Storm Nodal Peak Flow[1] (m^3/s)
J7038.202	1939	Mayfield Road east of The Gore Road	178.62
J7038.112	1935	West Humber River at The Gore Road South of Countryside Drive	186.27
J42	1456	Confluence of Tributary and West Humber River	250.84
J5755.242	1776	Castlemore Road	367.59
J3477.822	1366	Upstream of Cottrelle Boulevard	369.28
J1291.942	869	Upstream of McVean Drive	369.04
O2HCO31	720	Upstream of Queen Street	708.15
J4045.633	1442	Downstream of Highway 407	954.53
J9359.973	2074	Finch Avenue and Highway 427	952.87
J7731.4112	1971	Highway 27	969.62

Node[1]	NHYD ID[1]	Location	Regional Storm Nodal Peak Flow[1] (m^3/s)
J18	1028	West of Islington Avenue and South of Albion Road	1013.55
J17	1005	South of Albion Road	1870.78
J16	975	Upstream of Eglinton Avenue, East of Scarlett Road	1919.92
CJ807.6693_1	1000	Lake Ontario	2496.74

[1] Refer to **Appendix D2** for node locations, hydrologic model schematic, summary output for the nodes specified and a digital link to the hydrologic modelling files.

4.2 Erosion Analysis

In natural systems, watercourses regularly see flows that entrain and transport sediment. This is part of the natural process that maintains natural channel form (TRCA 2012, CVC 2015). The erosion threshold represents the magnitude of flow at which bed and/or bank sediment within a reach is entrained. Specifically, the erosion threshold provides a depth, velocity, discharge, or shear stress at which sediment of a particular size (usually the median grain size) may potentially begin to move. This does not necessarily mean systemic erosion (i.e., widening or degradation of the channel); it simply indicates a flow which may potentially entrain sediment (CVC 2015).

Nine (9) outfalls are proposed to outlet to several tributaries of the West Humber River. The locations of these outfalls are presented in **Figure 4.3** (**Appendix D1**). These receiving tributaries were selected for further assessment, to assist in the development of a stormwater management plan for the WVSP area.

4.2.1 Geomorphic Assessments

Detailed geomorphic assessments were completed for the receiving tributaries of the West Humber River downstream of the WVSP area between November 12 and November 14, 2024, and consisted of the collection of a topographic survey of all accessible sites at a sufficient level of detail to allow the measurement of the longitudinal profile of the watercourse and cross-sectional geometry (refer to **Appendix B6**). Additionally, a Rapid Geomorphic Assessment (RGA) was performed on these reaches, to identify the dominant geomorphic process, to help identify whether the critical erosion threshold would be based on the bed or bank materials. Some reaches were situated within non-participating land and could not be assessed in person. As such, a LiDAR-derived digital terrain model (DTM) from the Geospatial Ontario Database (MNRF 2024) was used to extract the longitudinal profile and cross sections. This data was supplemented by visual observations from a windshield assessment.

Where possible, in-situ documentation of bankfull stage indicators was also undertaken, as well as riparian vegetation cover and general site conditions. The characteristics of bed and bank materials (e.g., composition, grain size, etc.) was also recorded. The Manning's roughness coefficient was estimated using a visual method, as outlined by Arcement & Schneider (1989). Cross-sectional measurements and bankfull dimensions, the estimate of Manning's roughness, and the gradient, were used to back-calculate bankfull hydraulics. The five surveyed cross sections were entered into FlowMaster (hydraulics software) along with the estimated Manning's roughness, to obtain the relevant bankfull hydraulics. The results from the detailed geomorphic assessment, and the method used to characterize each reach (i.e. field observations vs. LiDAR), are summarized below and in **Table 4.9.** Reach delineation established for the Scoped Subwatershed Study for the Settlement Area Boundary Expansion (Wood Environmental and Infrastructure Solutions Inc., November 2022) were maintained for this assessment.

Table 4.9 Detailed Geomorphic Assessment Results, West Humber River Tributaries

Parameter	Channel gradient (%)	Average bankfull width (m)	Average bankfull depth (m)	Maximum bankfull depth (m)	Average hydraulic radius (m)	Manning' s Roughness	Bankfull velocity (m/s)	Bankfull discharge (m3/s)	Shear stress (N/m2)
WHT2	0.2	9	1.08	1.61	1.01	0.035	1.41	14.48	38
WHT2-1-1	2.8	3.3	0.35	0.53	0.24	0.04	1.6	1.77	146
WHT2-2	4.6	2.6	0.55	0.83	0.38	0.04	2.81	3.89	370
WHT2(1)1-1c	1.1	N/A	N/A	N/A	N/A	0.04	N/A	N/A	N/A
WHT3(7)1-1	0.6	4.5	0.23	0.36	0.17	0.04	0.61	0.47	22
WHT2-4	1	2.7	0.26	0.32	0.19	0.035	0.92	0.56	32
WHT3(5)2-1	1.4	1.3	0.18	0.27	0.16	0.04	0.82	0.26	37
WHT2(1)1-1b*	1.8	5.1	0.15	0.27	0.14	0.04	0.92	0.69	49
WHT2(1)1-1a*	2.8	8.3	0.22	0.37	0.21	0.04	1.47	2.7	101
WHT2(1)2-1*	3.6	5.3	0.44	0.63	0.4	0.04	2.55	6.27	220
WHT2(1)1-1*	1.5	9.8	0.26	0.42	0.25	0.04	1.2	3.18	38
WHT2-1-2*	1.4	4	0.55	0.98	0.45	0.04	1.75	3.78	77

* Reaches were analyzed via desktop assessment (LiDAR-derived DTM instead of field assessment)

Inaccessible sites were characterized using LiDAR data, openly accessible via the Geospatial Ontario Database (MNRF 2024). The process in determining the bankfull width and depth of a feature in the desktop assessment differs slightly from the field assessment, due to the absence of certain bankfull indicators, including changes in vegetation, saturation, and substrate. Rather, this method relies on identifying changes in bank slope (i.e., inflection points) to determine bankfull. Due to the uncertainty surrounding the desktop analysis, a ground truthing exercise was performed. This ground-truthing was completed in support of gaining MECP buy-in for determining the extents of contributing habitat for Redside Dace. Bankfull width measurements taken in the field were compared to bankfull width measurements extracted from the LiDAR data, at five separate locations. The average percentage difference between the measurements produced by the two methods was found to be within 5 - 10%. It is of our opinion that the difference between the methods is similar to or less than the variability of true bankfull width throughout a given reach and therefore believe that the LiDAR method estimated the bankfull width of a feature to a similar accuracy as field measurements. For more information regarding bankfull width measurements produced by each method is shown in **Appendix D5**.

Reach WHT3(5)2-1

Overall, reach WHT3(5)2-1 had an average profile gradient of 1.4%. The channel displayed a low degree of entrenchment. Bankfull channel widths within the surveyed sections ranged between 0.9 m to 2.0 m, averaging 1.6 m. The average bankfull depth ranged between 0.03 m to 0.36 m, and averaged 0.25 m. The Manning's roughness was estimated to be 0.040. The back-calculated bankfull velocity was 1.0 m/s, which corresponded to an average bankfull discharge of 0.40 m^3/s. Based on a textural analysis, bed material in the reach was found to be represented by ordinary firm loam. Bank materials consisted of cohesive silt and clay. Riparian vegetation consisted of wetland flora.

The RGA produced a score of 0.12, which indicated that the reach was in regime. The dominant process observed in the channel was aggradation. The RSAT score of 23 indicated that this reach was in a fair state of ecological health. Instream habitat conditions were noted to be the main limiting factor, evident by the embedded riffle substrate and lobate bar formation, as well as lack of coarse material. The Downs Method (Thorne et al., 1997) classified this reach as D – depositional.

Reach WHT3(7)1-1

Overall, reach WHT3(7)1-1 had an average profile gradient of 0.60%. The channel displayed a moderate degree of entrenchment. Bankfull channel widths within the surveyed sections ranged between 3.2 m to 6.6 m, averaging 4.0 m. The average bankfull depth ranged between 0.33 m to 0.40 m, and averaged 0.24 m. The Manning's roughness was estimated to be 0.040. The back-calculated velocity was 0.67 m/s, which corresponded to an average bankfull discharge of 0.53 m^3/s. Based on a textural analysis, bed material in the reach was found to be represented by silt loam. Bank materials consisted of cohesive silt and clay. Riparian vegetation consisted of some trees and shrubs, with grasses and non-woody herbaceous species.

The RGA produced a score of 0.03, which indicated that the reach was in regime. The dominant process observed in the channel was aggradation. The RSAT score of 16 indicated that this reach was in a fair state of ecological health. Instream habitat conditions were noted to be the main limiting factor, evident by the lack of coarse substrate, channel depth. The Downs Method (Thorne et al., 1997) classified this reach as S – Stable.

Reach WHT2-1-2

As reach WHT2-1-2 flows through non-participating land, a field assessment could not be performed. Instead, a surface for the location was created using a LiDAR-derived DTM from the Geospatial Ontario Database (MNRF 2024). Overall, reach WHT2-1-2 had an average profile gradient of 1.4%. Bankfull channel widths within the surveyed sections ranged between 3.5 m to 4.9 m, averaging 4.0 m. The average bankfull depth ranged between 0.44 m to 0.68 m, and averaged 0.55 m. Via observations from the road right of way, the Manning's roughness was estimated to be 0.040. Based on a visual assessment, bed material in the reach was estimated to be represented by ordinary firm loam. Riparian vegetation consisted mainly of grasses and herbaceous species. The RGA, RSAT, and Down's analyses could not be performed for this location, as the reach was located within a non-participating property.

Reach WHT2-4

Overall, reach WHT2-4 had an average profile gradient of 1.0%. The channel displayed a low degree of entrenchment in the upstream portion of the reach, becoming highly entrenched in the downstream portion. Bankfull channel widths within the surveyed sections ranged between 1.4 m to 3.6 m, averaging 2.7 m. The average bankfull depth ranged between 0.17 m to 0.35 m, and averaged 0.26 m. The Manning's roughness was estimated to be 0.035. The back-calculated velocity was 0.91 m/s, which corresponded to an average bankfull discharge of 0.56 m^3/s. Based on a textural analysis, bed material in the reach was found to be represented by silt loam. Bank materials consisted of cohesive clay. Riparian vegetation consisted of some trees and shrubs, with grasses and non-woody herbaceous species.

The RGA produced a score of 0.33, which indicated that the reach was in transition / stressed. The dominant process observed in the channel was degradation. The RSAT score of 24 indicated that this reach was in a fair state of ecological health. Instream habitat conditions were noted to be the main limiting factor, evident by the lack of coarse substrate, channel depth. The Downs Method (Thorne et al., 1997) classified this reach as E - Enlarging.

Reach WHT2(1)2-1

As reach WHT2(1)2-1 flows through non-participating land, a field assessment could not be performed. Instead, a surface for the location was created using a LiDAR-derived DTM from the Geospatial Ontario Database (MNRF 2024). Overall, reach WHT2(1)2-1 had an average profile gradient of 3.6%. Bankfull channel widths within the surveyed sections ranged between 4.1 m to 8.1 m, averaging 5.3 m. The average bankfull depth ranged between 0.35 m to 0.56 m, and averaged 0.44 m. Via observations from the road right of way, the Manning's roughness was estimated to be 0.040. Based on a visual assessment, bed material in the reach was estimated to be represented by ordinary firm loam. Riparian vegetation consisted mainly of grasses and herbaceous species.

The RGA, RSAT, and Down's analyses could not be performed for this location, as the reach was located within a non-participating property.

Reach WHT2(1)1-1b

As reach WHT2(1)1-1b flows through non-participating land, a field assessment could not be performed. Instead, a surface for the location was created using a LiDAR-derived DTM from the Geospatial Ontario Database (MNRF 2024). Overall, reach WHT2(1)1-1b had an average profile gradient of 1.8%. Bankfull channel widths within the surveyed sections ranged between 2.2 m to 7.7 m, averaging 5.1 m. The average bankfull depth ranged between 0.10 m to 0.19 m, and averaged 0.15 m. Via observations from the road right of way, the Manning's roughness was estimated to be 0.040. Based on a visual assessment, bed material in the reach was estimated to be represented by ordinary firm loam. Riparian vegetation consisted mainly of grasses and herbaceous species.

The RGA, RSAT, and Down's analyses could not be performed for this location, as the reach was located within a non-participating property.

Reach WHT2(1)1-1c

At the time of assessment, this reach presented as a drainage feature in an agricultural field, with no defined bed or banks. Material throughout the reach consisted of loose loam. No riparian vegetation existed within the vicinity of the feature. Downstream of The Gore Road, this reach was located within non-participating lands. A surface for this location was created using a LiDAR-derived DTM from the Geospatial Ontario Database (MNRF 2024). No defined channel could be discerned through this method as well.

The RGA, RSAT, and Down's analyses were not performed for this location, as no defined channel was identified.

Reach WHT2(1)1-1a

As reach WHT2(1)1-1a flows through non-participating land, a field assessment could not be performed. Instead, a surface for the location was created using a LiDAR-derived DTM from the Geospatial Ontario Database (MNRF 2024). Overall, reach WHT2(1)1-1a had an average profile gradient of 2.8%. Bankfull channel widths within the surveyed sections ranged between 4.7 m to 13.4 m, averaging 8.3 m. The average bankfull depth ranged between 0.18 m to 0.24 m, and averaged 0.22 m. Via observations from the road right of way, the Manning's roughness was estimated to be 0.040. Based on a visual assessment, bed material in the reach was estimated to be represented by ordinary firm loam. Riparian vegetation consisted mainly of grasses and herbaceous species.

The RGA, RSAT, and Down's analyses could not be performed for this location, as the reach was located within a non-participating property.

Reach WHT2

Overall, reach WHT2 had an average profile gradient of 0.20%. The channel displayed a moderate degree of entrenchment. Bankfull channel widths within the surveyed sections ranged between 8.9 m to 10 m, averaging 9.0 m. The average bankfull depth ranged between 1.3 m to 1.7 m, and averaged 1.6 m. The Manning's roughness was estimated to be 0.035. The back-calculated velocity was 1.4 m/s, which corresponded to an average bankfull discharge of 14.5 m^3/s. Bed material in the reach was found to be in the gravel range based on the pebble counts completed in the field (sample size of 200 particles). A veneer of fine material was found to cover bed substrate throughout the reach. This deposit of fine materials did not appear to be characteristic of the reach, and is likely to be aggrading due to the effect of backwatering, such as due to large wood debris. The D_{50} (median grain size) was determined to be 5 mm due to the presence of fine material, the D_{75} mm was 51 mm, and the D_{84} was 110 mm. Bank materials consisted of cohesive silt and clay. Riparian vegetation consisted of trees, shrubs, grasses, and other herbaceous species.

The RGA produced a score of 0.23, which indicated that the reach was in transition / stressed. The dominant process observed in the channel was aggradation. The RSAT score of 35 indicated that this reach was in an excellent state of ecological health. The Downs Method (Thorne et al., 1997) classified this reach as M – Lateral Migration.

Reach WHT2-1-1

Overall, reach WHT2-1-1 had an average profile gradient of 2.8%. The channel displayed a low degree of entrenchment in the upstream portion of the reach, becoming slightly more defined as it approached the pedestrian bridge to the south. Bank full channel widths within the surveyed sections ranged between 1.0 m to 5.5 m, averaging 3.9 m. The average bank full depth ranged between 0.13 m to 0.44 m, and averaged 0.40 m. The Manning's roughness was estimated to be 0.040. The back-calculated velocity was 1.79 m/s, which corresponded to an average bank full discharge of 2.19 m^3/s. Based on a textural analysis, bed material in the reach was found to be represented by ordinary firm loam. Bank materials consisted of silty clay. Riparian vegetation consisted of some trees and shrubs, with grasses and non-woody herbaceous species.

The RGA produced a score of 0.06, which indicated that the reach was in regime. The dominant process observed in the channel was aggradation and planform adjustment. The RSAT score of 23 indicated that this reach was in a fair state of ecological health. Instream habitat conditions were noted to be the main limiting factor, evident by the lack of coarse substrate and channel depth. The Downs Method (Thorne et al., 1997) classified this reach as S - Stable.

Reach WHT2-2

Overall, reach WHT2-2 had an average profile gradient of 4.6%. The channel displayed a low degree of entrenchment in the upstream portion of the reach, becoming much more defined as it approached the culvert underneath the St. Patrick School driveway. Bank full channel widths within the surveyed sections ranged between 1.6 m to 3.7 m, averaging 2.6 m. The average bank full depth ranged between 0.39 m to 0.64 m, and averaged 0.55 m. The Manning's roughness was estimated to be 0.040. The back-calculated velocity was 2.81 m/s, which corresponded to an average bank full discharge of 3.89 m^3/s. Based on a textural analysis, bed material in the reach was found to be represented by ordinary firm loam. Bank materials consisted of silty clay. Riparian vegetation consisted of some trees and shrubs, with grasses and non-woody herbaceous species.

The RGA produced a score of 0.16, which indicated that the reach was in regime. The dominant process observed in the channel was widening. The RSAT score of 22 indicated that this reach was in a fair state of ecological health. Instream habitat conditions were noted to be the main limiting factor, evident by the lack of coarse substrate and channel depth. The Downs Method (Thorne et al., 1997) classified this reach as E - Enlarging.

Reach WHT2(1)1-1

As reach WHT2(1)1-1a flows through non-participating land, a field assessment could not be performed. Instead, a surface for the location was created using a LiDAR-derived

DTM from the Geospatial Ontario Database (MNRF 2024). Overall, reach WHT2(1)1-1a had an average profile gradient of 1.5%. Bankfull channel widths within the surveyed sections ranged between 6.0 m to 13.6 m, averaging 9.9 m. The average bankfull depth ranged between 0.21 m to 0.36 m, and averaged 0.26 m. Via observations from the road right of way, the Manning's roughness was estimated to be 0.040. Based on a visual assessment, bed material in the reach was estimated to be represented by ordinary firm loam. Riparian vegetation consisted mainly of grasses and herbaceous species. The RGA, RSAT, and Down's analyses could not be performed for this location, as the reach was located within a non-participating property.

4.2.2 Erosion Thresholds

As noted previously, erosion and deposition are natural processes that occur within watercourses. Issues arise when changes in the watershed's hydrology result in an increase or decrease in the frequency of period of erosive events. The objective, therefore, is to minimize the risk of exacerbating existing rates of erosion in the watercourse in the post-development condition.

There are several approaches that may be applied to determine the erosion threshold for a reach. These require information regarding the mean channel slope, cross-sectional dimensions, assessment of roughness, and substrate information (e.g., grain size), as obtained from the detailed geomorphic assessment. The TRCA (2012) Stormwater Management Criteria document provides a brief list of methods and resources for estimating thresholds for a range of conditions. The CVC (2015) Fluvial Geomorphic Guidelines document similarly provides a similar list of methods and resources. These methods may be based on the critical shear stress or the critical velocity. These parameters refer to the shear stress or velocity, based on the sediment size or class, at which sediment is entrained. For the shear stress approaches, when the mean shear stress in the channel exceeds the critical shear stress, sediment entrainment can be expected to occur. Similarly, for the velocity approaches, sediment entrainment occurs when the mean velocity in the channel exceeds the critical velocity. Critical shear stress or velocity for a given grain size can be calculated using empirical methods (e.g., Neill, 1967; Miller et al., 1977; Komar, 1987, etc.), or by graphical analysis, by referring to a chart (e.g., Hjulstrom, 1935; Chow, 1959). Authors such as Fischenich (2001), Julien (1998), Chang (1988), etc., provide tables of compiled permissible shear stresses and velocities for a range of sediment sizes.

Of the assessed channels where bed substrate consists of gravel, the method outlined by Komar (1987) was used. Komar presents an empirical relationship based on a function of the grain size, applicable to gravel in the 1 – 500 cm range:

$$V_{cr} = 57\ D^{0.46}$$

where V_{cr} is the critical velocity at which sediment is entrained (in cm/s), and *D* is the particle diameter to be entrained (in cm).

For the assessed channels with material finer than gravel, Julien (1998) and Fischenich (2001) provide permissible velocities that correspond to bed or bank material type (e.g. silt loam, ordinary firm loam, shale).

The reference cross-sections obtained from the detailed geomorphic assessments are used in the analysis to determine the corresponding erosion threshold, whereby the depth of flow in the cross-section is increased iteratively until the mean velocity exceeds the permissible velocity of the sediment. For each reach, this analysis was performed for all five sections surveyed, after which the results were averaged. The erosion threshold analysis and calculations are summarized below in **Table 4.10.** Erosion thresholds were determined for all receiving reaches downstream of the WVSP area.

Table 4.10 Erosion Threshold, Tributaries of the West Humber River

Parameter	Repr. Particle Size (mm)	Critical Velocity (m/s)	Maximum Water Depth** (m)	Average Water Depth** (m)	Shear Stress (N/m²)	Critical Discharge (m3/s)	Critical Fraction
WHT2	51 (D_{75})	1.21	1.23	0.89	21	8.52	0.6
WHT2-1-1	OFL*	0.76	0.13	0.1	26	0.06	0.03
WHT2-2	4.6	0.76	0.11	0.09	40	0.04	0.01
WHT2(1)1-1c	SL*	0.61	N/A	N/A	N/A	N/A	N/A
WHT3(7)1-1	SL*	0.61	0.28	0.21	13	0.36	0.7
WHT2-4	SL*	0.61	0.24	0.17	17	0.25	0.6
WHT3(5)2-1	OFL*	0.76	0.21	0.17	23	0.14	0.37
WHT2(1)1-1b	OFL*	0.76	0.2	0.12	21	0.4	0.67
WHT2(1)1-1a	OFL*	0.76	0.12	0.09	25	0.19	0.09
WHT2(1)2-1	OFL*	0.76	0.1	0.08	27	0.09	0.02
WHT2(1)1-1	OFL*	0.76	0.23	0.13	20	0.86	0.24
WHT2-1-2	OFL*	0.76	0.24	0.16	23	0.14	0.04

* SL = silt loam, OFL = ordinary firm loam, from Julien (1998).
** Under threshold conditions

Reach WHT3(5)2-1 (ETL-1)
The Rapid Geomorphic Assessment (RGA) effort had identified that the reach was in regime. Slight evidence of aggradation was observed throughout the reach. As the substrate for this reach consisted of ordinary firm loam, a permissible velocity as per Julien (1998) was chosen to establish a critical velocity for the substrate. The critical velocity for the dominant bed material in this reach, was calculated to be 0.76 m/s. The corresponding discharge in the cross section at the point that sediment is entrained is 0.14 m^3/s. This discharge represents a value that is approximately 37% of the bankfull flow. The average shear stress acting on the channel bed at this stage is approximately 23 N/m^2.

Reach WHT3(7)1-1 (ETL-3)
The Rapid Geomorphic Assessment (RGA) effort had identified that the reach was in regime, with slight evidence of aggradation. As the substrate for this reach consisted of silt loam, a permissible velocity method as per Julien (1998) was chosen to establish a critical velocity for the substrate. The critical velocity for the dominant bed material in this reach, was calculated to be 0.61 m/s. The corresponding discharge in the cross section at the point that sediment is entrained is 0.36 m^3/s. This discharge represents a value that is approximately 70% of the bankfull flow. The average shear stress acting on the channel bed at this stage is approximately 13 N/m^2.

Reach WHT2-1-2 (ETL-4)
Reach WHT2-1-2 was located on non-participating lands, and therefore, was assessed via a desktop analysis using LiDAR data. A substrate characterization was completed using a windshield assessment. The dominant substrate appeared to consist of ordinary firm loam. A permissible velocity method as per Julien (1998) was chosen to establish a critical velocity for the substrate. The critical velocity for the dominant bed material in this reach, was calculated to be 0.76 m/s. The corresponding discharge in the cross section at the point that sediment is entrained is 0.14 m^3/s. This discharge represents a value that is approximately 4% of the bankfull flow. The average shear stress acting on the channel bed at this stage is approximately 23 N/m^2.

Reach WHT2-4 (ETL-5)
The Rapid Geomorphic Assessment (RGA) effort had identified that downcutting (i.e., vertical scour) was the dominant geomorphic process. Therefore, the erosion of the bed material was considered to be the critical erosion threshold. Additionally, due to the vegetative control and compact nature of the bank materials, the erosion threshold on the banks is not likely exceeded under the threshold conditions for the bed materials.

As the substrate for this reach consisted of silt loam, a permissible velocity method as per Julien (1998) was chosen to establish a critical velocity for the substrate. The critical velocity for the dominant bed material in this reach, was calculated to be 0.61 m/s. The corresponding discharge in the cross section at the point that sediment is entrained is 0.25 m^3/s. This discharge represents a value that is approximately 60% of the bankfull flow. The average shear stress acting on the channel bed at this stage is approximately 17 N/m^2.

Reach WHT2(1)2-1 (ETL-6)
Reach WHT2(1)2-1 was located on non-participating lands, and therefore, was assessed via a desktop analysis using LiDAR data. A substrate characterization was completed using a windshield assessment. The dominant substrate appeared to consist of ordinary firm loam. A permissible velocity method as per Julien (1998) was chosen to establish a critical velocity for the substrate. The critical velocity for the dominant bed material in this reach, was calculated to be 0.76 m/s. The corresponding discharge in the cross section at the point that sediment is entrained is 0.09 m^3/s. This discharge represents a value that is approximately 2% of the bankfull flow. The average shear stress acting on the channel bed at this stage is approximately 27 N/m^2.

Reach WHT2(1)1-1b (ETL-7)
Reach WHT2(1)1-1b was located on non-participating lands, and therefore, was assessed via a desktop analysis using LiDAR data. A substrate characterization was completed using a windshield assessment. The dominant substrate appeared to consist of ordinary firm loam. A permissible velocity method as per Julien (1998) was chosen to establish a critical velocity for the substrate. The critical velocity for the dominant bed

material in this reach, was calculated to be 0.76 m/s. The corresponding discharge in the cross section at the point that sediment is entrained is 0.40 m^3/s. This discharge represents a value that is approximately 67% of the bankfull flow. The average shear stress acting on the channel bed at this stage is approximately 21 N/m^2.

Reach WHT2(1)1-1c (ETL-8)
No defined channel could be discerned for this reach within the Subject Lands, and through the LiDAR data downstream of the Subject Lands. The reach is actively farmed, lacks bed and banks, and no substrate sorting. Similarly, GEI's HDFA results characterized this reach as having a limited hydrological function. Vegetation establishment limits the potential for sediment entrainment. Therefore, this reach was deemed to not be sensitive to erosion. In lieu of a detailed erosion assessment it is recommended that the minimum on-site retention requirements outlined within the TRCA (2012) Stormwater Management Criteria document be applied to the proposed outfall on this reach.

Reach WHT2(1)1-1a (ETL-9)
Reach WHT2(1)1-1a was located on non-participating lands, and therefore, was assessed via a desktop analysis using LiDAR data. A substrate characterization was completed using a windshield assessment. The dominant substrate appeared to consist of ordinary firm loam. A permissible velocity method as per Julien (1998) was chosen to establish a critical velocity for the substrate. The critical velocity for the dominant bed material in this reach, was calculated to be 0.76 m/s. The corresponding discharge in the cross section at the point that sediment is entrained is 0.19 m^3/s. This discharge represents a value that is approximately 9% of the bankfull flow. The average shear stress acting on the channel bed at this stage is approximately 25 N/m^2.

Reach WHT2 (ETL-10)
It was noted during the field investigation that a veneer of sand and silt had been recently deposited on the surface. As this fresh deposit did not appear to be characteristic of the reach, the more representative particle size was deemed to be the coarser fraction, i.e., the D_{75} of 51 mm. The critical velocity for the bed materials in reach WHT2, based on the D_{75}, was calculated to be 1.2 m/s, using Komar's (1987) relationship. The corresponding discharge in the cross section at the point that sediment is entrained is 8.5 m^3/s. This discharge represents a value that is approximately 60% of the bankfull flow. The average shear stress acting on the channel bed at this stage is approximately 21 N/m^2. Due to the vegetative control and compact nature of the bank materials, the erosion threshold on the banks is not likely exceeded under the threshold conditions for the bed materials. Therefore, the most appropriate critical discharge for this reach was identified to be that of the bed materials (i.e., 8.5 m^3/s).

Reach WHT2-1-1

The Rapid Geomorphic Assessment (RGA) effort had identified that the reach was in regime, with a slight tendency to migrate laterally. As such, the erosion of the bank material was considered to be the critical erosion threshold. Additionally, due to the vegetative control and compact nature of the bank materials, the erosion threshold on the banks is not likely exceeded under the threshold conditions for the bed materials.

As the substrate for this reach consisted of ordinary firm loam, a permissible velocity method as per Julien (1998) was chosen to establish a critical velocity for the substrate. The critical velocity for the dominant bed material in this reach, was calculated to be 0.76 m/s. The corresponding discharge in the cross section at the point that sediment is entrained is 0.06 m^3/s. This discharge represents a value that is approximately 3% of the bankfull flow. The average shear stress acting on the channel bed at this stage is approximately 26 N/m^2.

Reach WHT2-2

The Rapid Geomorphic Assessment (RGA) effort had identified that the reach was in regime, with a slight tendency to widen. As such, the erosion of the bank material was considered to be the critical erosion threshold. Additionally, due to the vegetative control and compact nature of the bank materials, the erosion threshold on the banks is not likely exceeded under the threshold conditions for the bed materials.

As the substrate for this reach consisted of ordinary firm loam, a permissible velocity method as per Julien (1998) was chosen to establish a critical velocity for the substrate. The critical velocity for the dominant bed material in this reach, was calculated to be 0.76 m/s. The corresponding discharge in the cross section at the point that sediment is entrained is 0.04 m^3/s. This discharge represents a value that is approximately 1% of the bankfull flow. The average shear stress acting on the channel bed at this stage is approximately 40 N/m^2.

Reach WHT2(1)1-1

Reach WHT2(1)1-1 was located on non-participating lands, and therefore, was assessed via a desktop analysis using LiDAR data. A substrate characterization was completed using a windshield assessment. The dominant substrate appeared to consist of ordinary firm loam. A permissible velocity method as per Julien (1998) was chosen to establish a critical velocity for the substrate. The critical velocity for the dominant bed material in this reach, was calculated to be 0.76 m/s. The corresponding discharge in the cross section at the point that sediment is entrained is 0.23 m^3/s. This discharge represents a value that is approximately 24% of the bankfull flow. The average shear stress acting on the channel bed at this stage is approximately 20 N/m^2.

4.2.3 Erosion Exceedance Analysis

In order to understand the potential impacts of the proposed development plan on channel morphology, an impact assessment was undertaken with respect to the stormwater management plan for the site. As noted previously, in natural systems, watercourses regularly see flows that entrain and transport sediment. This is part of the natural process that maintains natural channel form (TRCA 2012, CVC 2015). The key to maintaining natural channel function is to match the frequency of exceedance or cumulative effective work in the post-development condition (TRCA 2012).

Pre- to post-development exceedance can be evaluated using several criteria. The simplest is the cumulative time of exceedance or the number of exceedances (TRCA 2012, CVC 2015). Although these provide a simple comparison, they do not provide information on the work or erosive force of flows once erosion thresholds are exceeded. To provide a more stringent assessment, an approach involving three analyses was performed, including the cumulative effective erosion index (velocity exceedance), cumulative effective discharge index, and the cumulative effective work index.

The cumulative effective velocity (*CEV*) is calculated as:

$$CEV = \sum (V - V_c)$$

The cumulative effective discharge (*CED*) is calculated as:

$$CED = \sum (Q - Q_c)$$

The cumulative effective shear stress (*CESS*) is calculated as:

$$CESS = \sum (\tau - \tau_c)$$

where V is the mean channel velocity, V_c is the critical (permissible) velocity, Q is the channel's discharge, Q_c is the critical discharge, τ is the instantaneous shear stress, and τ_c is the threshold shear stress.

The cumulative effective work index (W_i) describes the cumulative effective work or stream energy expended above the critical value. W_i is calculated as:

$$W_i = \sum (\tau - \tau_c) \mathrm{V}\, \Delta t$$

where Δt is the timestep used in the analysis.

The TRCA Stormwater Management Criteria (2012) document notes that the cumulative effective work index is the preferred method when assessing potential impacts, as the velocity will increase as flood stage increases, which means that the cumulative effective work parameter will be more sensitive to extreme floods.

To determine the potential erosion impacts associated with the proposed land use, an erosion exceedance analysis was completed. This included completing continuous simulation hydrologic modelling to establish hydrographs for existing and proposed conditions at the erosion threshold locations identified in **Section 4.2.2** and shown on **Figure 4.3 (Appendix D2)**. The event based Visual Otthymo hydrologic model created for the hydrologic assessment, as outlined in **4.1.1.1**, was utilized in continuous simulation mode for the erosion exceedance analysis. Rainfall data was provided by TRCA which included twenty-two (22) years of precipitation data from May 1986 to December 2007 from Buttonville Airport Weather Station. Refer to **Appendix D6** for the model schematic, model parameter summary and hydrographs, for both existing and proposed conditions.

For the continuous modelling simulation, soil types have been assigned to each catchment based on the Ministry of Agriculture, Food and Rural Affairs (OMAFRA) Soil Survey Complex. Similarly, the existing land cover for each catchment is noted as “Crops up to Shoulder Height” established based on aerial imagery of the WVSP area. Further to this, the land cover for each catchment in post-development conditions has been assigned as “Grass Land”, as the pervious areas in post-development conditions will consist of grassed/landscaped areas (rear yards, boulevards etc.).

The existing and proposed conditions hydrographs resulting from the continuous simulation modelling were utilized to calculate cumulative time of exceedance, cumulative effective velocity, cumulative effective discharge, and cumulative effective work.

To complete the erosion exceedance analysis, a rating curve was created based on a representative cross section (identified through the detailed geomorphic assessment and erosion threshold work). The flow in each time step of the hydrographs was then related to the representative cross section. This was then used to calculate the cumulative exceedance for each hydraulic parameter (e.g., velocity, discharge, shear stress, effective work index) in relation to the threshold condition.

Erosion exceedance analyses were only completed for reaches downstream of the WVSP area proposed to receive flows from stormwater management facilities, post-development. The cumulative exceedance analysis results for the pre-development condition are presented in **Table 4.11.** It should be noted that ETL-2 and ETL-8 were omitted from the analysis, as flows from ETL-2 are proposed to be routed to ETL-1, and

ETL-8 outlets to reach WHT2(1)1-1c, which was an undefined feature lacking bed and banks. Post development exceedance analysis will be presented in the Phase 2 LSS.

Table 4.11 Pre-Development Erosion Exceedance Analysis

Location[1]	Reach	Number of Exceedances	Duration	Cumulative Effective Velocity	Cumulative Effective Discharge	Cumulative Effective Shear Stress	Cumulative Effective Work Index
ETL-1	WHT3(5)2-1	35	84	86	24	4.10×10^3	4.38×10^6
ETL-3	WHT3(7)1-1	66	101	74	73	2.43×10^3	1.81×10^6
ETL-4	WHT2-1-2	102	178	192	55	1.48×10^4	1.87×10^7
ETL-5	WHT2-4	30	83	0	38	3.28×10^5	1.27×10^8
ETL-6	WHT2(1)2-1	109	270	284	56	2.09×10^4	2.92×10^7
ETL-7	WHT2(1)1-1b	6	8	6	5	6.18×10^2	3.22×10^5
ETL-9	WHT2(1)1-1a	259	702	726	151	4.80×10^4	8.09×10^7
ETL-10	WHT2	8	44	59	525	4.75×10^3	4.51×10^6

[1] Refer to **Figure 4.3 (Appendix D1)**.

4.3 Feature Based Water Balance

4.3.1 Wetland Screening and Water Balance Risk Assessment

In accordance with the approved LSS Terms of Reference (**Appendix A1**) wetland screening and water balance risk evaluation was completed to identify which individual wetlands (onsite and on adjacent lands) will have hydrologic changes and be at risk for negative impacts to their form and/or function based on the proposed Secondary Plan land uses.

An initial assessment of the wetland catchments and the potential impacts from the proposed land use plan was completed. Refer to **Table 4.12** for a summary of the assessment.

4.3.2 Continuous Simulation Hydrologic Modelling

The feature-based water balance assessment includes continuous simulation hydrologic modelling (including, pre-development (Phase 1), post-development without mitigation (Phase 2) and post-development with mitigation (Phase 2)) to assess suitable options to maintain pre-development wetland hydrology post-development.

As part of this Phase 1 LSS, the existing drainage areas for the wetlands were determined and the areas were modelled in continuous simulation mode to determine runoff volumes. The existing conditions catchment area was delineated for all wetlands within the WVSP area, in addition to those wetlands located outside of the WVSP area with catchment areas inside the WVSP area. Refer to **Figure 4.4** (**Appendix D1**) for the wetland ID, locations and drainage areas.

The rainfall data used in the continuous modelling was obtained from the TRCA. The data spans from May 1986 to October 2007. The time to peak was calculated for the wetlands using the Uplands Method. Refer to **Figure 4.4 (Appendix D1**) for the travel length and **Appendix D7** for the calculations. The remaining model parameters for each wetland drainage area, including Curve Number (CN), Initial Abstraction (Ia), percent imperviousness, soil types and land cover were obtained from the parent subcatchment in the erosion exceedance model.

The runoff volumes for each wetland were analyzed on an average annual, monthly and seasonal basis. Refer to **Appendix D7** for the continuous simulation hydrologic modelling for existing conditions. **Table 4.12** below, provides a summary of the existing conditions average annual runoff to wetlands within and adjacent to the WVSP area, with average monthly and seasonal runoff volumes provided in **Appendix D7**.

Table 4.12 Existing Conditions Wetland Average Annual Runoff Volume

Wetland ID[1]	Average Annual Runoff Volume[2] (ha-m)
8, 33, 34	161.2
10_11	1970.1
12	89.4
16	41.2
17	5013.3
22	20.6
23	54.1
24	7565.9
25	46.4
26A	879.8
26B	1733.1
27	2723.2
28	2509.9
31A	4423.8
31B	7693.8
36	4931.7
37	5092.3
38	2.8
39	167.9

Wetland ID[1]	Average Annual Runoff Volume[2] (ha-m)
40	86.1
41	120.9
43	2636.8

[1] Refer to **Figure 4.4 (Appendix D1)**.

Monitoring data is required for calibrating the continuous simulation hydrology model for wetlands identified as medium and high risk. Monitoring of wetlands is currently underway as further outlined below in **Section 4.4.4**; however, there is insufficient data at this time to provide a valuable calibration of the continuous simulation model. In accordance with the approved LSS Terms of Reference (**Appendix A1**), and based on the amount of field data obtained to date (1 to 2 years) the wetland continuous simulation hydrologic model has not been calibrated at this time. Per Town correspondence and TRCA SWM Criteria, Appendix D (Water Balance for Protection of Natural Features), calibration will be required as part of subsequent study prior to Draft Plan approval once a minimum of one year of monitoring data have been obtained.

4.4 Monitoring

4.4.1 Surface Water Monitoring

A baseflow and surface water level monitoring program is being carried out using nested piezometers, staff gauges and data loggers installed in or near the tributaries and wetlands to evaluate groundwater elevations and baseflow conditions in the nearby surface water features. Seepage meter testing was carried out in selected locations to provide additional quantitative data on potential baseflow. This helped to determine the groundwater base flow conditions to tributaries/wetlands, the impact that development may have on these features, and to complete a feature-based water balance. The surface monitoring data is included in **Table 3.13** in **Appendix C3** and surface water hydrographs are in **Appendix C11**. Additionally, photographs were periodically taken of surface water monitoring locations; the photos are logged in **Appendix C14**. Additional wetland monitoring is planned to begin in spring 2026 to support feature-based water balance analyses required for retained wetlands 8_9, 33 and 34.

4.4.2 Volumetric Flow Monitoring

Volumetric flow monitoring was completed at five (5) locations (SG17, SG18, SG19, SG20 and SG22), and spot volumetric flow measurements were taken at two (2) locations (SG2, SG21). Volumetric flow monitoring locations were chosen in consultation with Town of Caledon water resources staff to target downstream locations of the subwatersheds in the study area and are shown on **Figure C15-1** and **Figure C15-2, Appendix C15**.

SG2 was installed within reach H12A1 and utilized for manual surface water monitoring from May 2023 to May 2025. Though not selected as a flow monitoring location, spot volumetric flow measurements were completed in May 2024 to give an indication of the volumetric flow through this feature during spring conditions. SG2 water levels are graphed in **Appendix C11** and results of the volumetric flow monitoring are given in **Appendix C15**.

SG17 was installed within a drainage point north of reach H8S1 and SG20 was installed within a drainage point northeast of H7S2. SG17 was utilized for continuous surface water level monitoring from May 2024 to June 2025 and SG20 was utilized for continuous surface water level monitoring from May to December 2024. Both SG17 and SG20 were utilized for manual surface water monitoring from May 2024 to June 2025. Though SG17 was selected for volumetric flow monitoring at the outset of the field program, the feature was dry during all flow monitoring events (May to December 2024) except for May 30, 2024. Therefore, spot volumetric flow measurements were only completed at SG17 in May 2024. SG20 was utilized for flow monitoring from May to December 2024, dependent on the presence of flowing water at the monitoring location. SG17 and SG20 surface water level and volumetric flow monitoring results are given in **Appendix C15**.

SG18, SG19, SG21 and SG22 were installed within reaches H4S1C, H5S1, H12A1 and H1S1 respectively. SG18 and SG19 were utilized for continuous surface water level monitoring from June 2024 to May 2025, SG21 was utilized for continuous surface water level monitoring from May to December 2024, and SG22 was utilized for continuous surface water level monitoring from May 2024 to June 2025. Manual surface water level monitoring was conducted at SG18, SG19, SG21, and SG22 from May 2024 to June 2025. Though SG18 was selected as a flow monitoring location at the outset of the field program, flowing water was not present during any flow monitoring events from September through December 2024, and therefore volumetric flow monitoring was only conducted at SG18 from May to August 2024. Similarly, at SG19, flowing water was not present from June to December 2024 and therefore volumetric flow measurements were only completed in May 2024. Though not selected as a monitoring location at the outset of the field program, spot volumetric flow measurements were taken at SG21 in July 2024 to give an indication of the flow through this feature during summer conditions. Flow monitoring was conducted at SG22 from May to December 2024, dependent on the presence of surface water at the monitoring location. Results of the surface water level and volumetric flow monitoring are given in **Appendix C15**, and the surface water quality monitoring program is discussed in **Section 4.4.3** below.

Overall, surface water levels were low or absent during the monitoring program, with the exception of the spring period and following major storm events. This is consistent with the hydrogeological conceptual model of the study area, which characterizes the surface water features as largely filled by precipitation and surface water runoff. Rather than consistent water levels throughout the year provided by groundwater discharge creating baseflow in the features, sharp increases and declines in water levels were observed during and after precipitation events. Sustained surface water levels were typically only observed during the spring period, when consistent precipitation events and snow melt provided surface water runoff to the features. This is also consistent with the existing conditions water balance analysis completed for the site, which estimated infiltration to be limited by the low permeability sediments at surface; surface water pools during the spring and during precipitation events due to poor drainage conditions on site, then evaporates or runs off-site relatively soon after.

4.4.3 Surface Water Quality

In the overall Humber River watershed, surface water quality is variable, with poorest conditions often in the lower watershed. The contaminants of particular concern in the watershed are chlorides (mainly from road salts), phosphorous (fertilizers and sewage cross connections), metals (from natural and industrial sources), E. coli bacteria (sewage/animal waste).

Surface water quality testing was completed from May through December and the results are included in **Appendix C13**. A combination of laboratory testing and field measurements of surface water quality parameters were completed during spring, summer and fall to capture both dry and wet conditions each season. In order to capture surface water quality parameters during “dry” conditions, water quality monitoring was completed when rain had not occurred for at least 72 hours prior to the monitoring event. To capture “wet” conditions, one monitoring event was completed at the start of a rain event, and a second monitoring event was completed after the same rain event. Rain data from the TRCA “Tullamore” rain gauge (ID #HYO41) was used to determine rainfall amounts. Similar to the volumetric flow monitoring locations, surface water quality monitoring locations were chosen in consultation with Town of Caledon water resources staff at downstream locations of the subwatersheds in the study area. Surface water quality monitoring was completed at four (4) locations (SG18, SG19, SG21, SG22) as shown on **Figure C15-1** and **Figure C15-2, Appendix C15**. Wet and dry monitoring events were completed at SG22 in spring, summer and fall. Surface water was not present at SG18 during the fall monitoring events, and therefore only the spring and summer monitoring events were completed at SG18. Surface water was not present at SG19 during the spring wet, summer wet or fall monitoring events, and therefore only the spring and summer “dry” monitoring events were completed at SG19. Surface water was not present at SG21 during the spring wet or dry monitoring event, or the summer or fall monitoring events and therefore no chemistry monitoring could be completed at SG21.

Following the storm event in spring 2025, temperature, salinity, oxidation reduction potential and specific conductance were elevated. Following the storm event in spring 2025, pH and dissolved oxygen were elevated at SG22 but decreased at SG18. Following the storm event in summer 2025, salinity, oxidation reduction potential and conductivity were elevated while temperature and dissolved oxygen decreased. Following the storm event in summer 2024, total dissolved solids were elevated at SG22 but decreased at SG18 while turbidity and pH were elevated at SG18 and decreased at SG22. Following the storm event in fall 2024 temperature and pH were elevated and specific conductance decreased.

E.Coli exceedances occurred at SG18 during the spring and summer dry sampling events and at SG22 during all sampling events except the summer wet #1, fall dry and fall wet #1 events. At both locations, E.Coli concentrations generally appeared to decrease over time, with the highest levels detected during wet events.

Total phosphorus exceedances occurred at SG18, SG19 and SG22 during all sampling events, with highest concentrations occurring during wet events at SG18 and SG22. Total phosphorus concentrations were consistent at SG19 during all sampling events.

Total iron exceedances occurred at SG18, SG19 and SG22 during all sampling events with concentrations appearing to generally increase over time at SG18. The highest iron concentrations at SG19 were measured during the spring dry sampling event. The highest iron concentrations at SG22 generally occurred during wet events.

Total zinc exceedances occurred at SG18 during all sampling events and at SG22 during all events except the summer dry event. The highest concentrations at SG18 were recorded during the spring wet #2 and summer dry events. No clear trend occurred at SG22.

Total copper exceedances occurred at SG22 during all sampling events except the spring wet #2 event and the highest concentrations were measured during the summer wet events.

4.4.4 Wetland Surface Water Monitoring

In order to calibrate the wetland feature-based water balance hydrologic modelling, surface water levels and groundwater-surface water interactions will be monitored within the retained wetlands 8_9, 33 and 34 in Spring 2026. A topographic survey of the wetland areas will also be completed. Monitoring locations and methods have been and will continue to be coordinated between SCS and GEI in order to obtain information necessary both for the calibration of the feature-based water balance models and to fulfill ecological monitoring requirements of the retained wetlands.

5.0 Municipal Servicing

Historical municipal servicing plans and drawings have been obtained from the Region of Peel and the Town of Caledon to confirm the existing infrastructure present in the surrounding area.

Planned sanitary and water servicing improvements in the Region of Peel and Town of Caledon have been established through the Region of Peel Water and Wastewater Master Plan (2020), Region of Peel Settlement Boundary Expansion (SABE) Water and Wastewater Servicing Analysis (2022), and ongoing coordination with the Region of Peel.

Refer to **Sections 5.1** and **5.2** for further details on the existing and planned, sanitary and water servicing available for the WVSP area.

5.1 Sanitary Servicing

There are no existing sanitary sewers within the WVSP area or on the arterial roads immediately surrounding the WVSP area. An existing 1200 mm diameter sanitary sewer is located on The Gore Road approximately 615 m south of Mayfield Road. There is also an existing sanitary sewer (size to be confirmed) located on McVean Drive at the intersection with Countryside Drive approximately 1.25 km south of the WVSP area.

Draft Development Charge Project Mapping (2024) was obtained from Region of Peel staff which illustrates preliminary sanitary projects to support the full buildout of the SABE including the WVSP area. The draft mapping is provided in **Appendix E1**. The projects and construction timing shown are preliminary and subject to change.

As illustrated on the Draft Development Charge Project Mapping (2024), refer to **Appendix E1**, a 750 mm diameter sanitary sewer is proposed on The Gore Road through the WVSP area connecting to the existing 1200 mm diameter sanitary sewer approximately 615 m south of Mayfield Road. The McVean Drive sanitary sewer is proposed to be extended north of Mayfield Road on Centreville Creek Road along the frontage of the WVSP area with diameters ranging from 525 to 675 mm.

The WVSP area can be serviced by connections to either of the planned sanitary sewers with the drainage areas and populations to be confirmed in Phase 2 of this LSS.

5.2 Water Supply and Distribution

Per the Peel Water and Wastewater Master Plan (2020), the WVSP area is within Pressure Zone 6 which has a serviceable elevation of 214.5 m – 259.1 m. The WSVP is located within the East Region of Peel transmission system. The system is fed from Lake Ontario and treated at the Arthur P. Kennedy Water Treatment Plant (HLP1C, HLP2C).

Water storage and distribution for the WVSP area is provided by the Tullamore Reservoir (ES4) and Pumping Station (LLP5E, HLP6E) and the Bolton Elevated Tanks (BS6).

Existing 200 mm diameter watermains are located on Centreville Creek Road, Healey Road, and The Gore Road. Existing 300 mm (PD6), 600 mm (PD5), and 750 mm (PD6) diameter watermains are located on Mayfield Road between Centreville Creek Road and The Gore Road. The existing watermain systems are illustrated on **Figure 5.1 (Appendix E2**).

Per the Draft Region of Peel Water Development Charge Mapping (refer to **Appendix E3**), several watermains are planned to be constructed on the arterial roads surrounding the WVSP area. This includes a 600 mm diameter watermain on The Gore Road, a 400 mm diameter watermain on Healey Road, a 400 mm diameter watermain on Centreville Creek Road from Mayfield Road to the approximate middle of the WVSP area, a mid-block 400 mm diameter watermain, and a 900 mm diameter sub-transmission main on Healey Road. Refer to **Figure 5.1 (Appendix E2)** and **Appendix E3** for the location of the planned water servicing infrastructure.

The WVSP area can be serviced with water via local connections to the planned watermains located on Centreville Creek Road, The Gore Road, Mayfield Road (300 mm diameter only), and the mid-block connection.

APPENDICES

APPENDIX A

SECTION 1

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APPENDIX A1

APPROVED TERMS OF REFERENCE

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APPENDIX A2

FIGURES

APPENDIX B

SECTION 2

APPENDIX B1

FIGURES

APPENDIX B2

TABLES

APPENDIX B3

ECOLOGICAL SURVEY METHODOLOGY

APPENDIX B4

SURVEY TIMING LETTER REPORT

APPENDIX B5

WATERCOURSE AND DRAINAGE FEATURE LETTER REPORT

APPENDIX B6

GEOMORPHIC ASSESSMENTS

APPENDIX B7

UNCONFINED FEATURE PHOTOGRAPH

APPENDIX B8

FLOODPLAIN MAPPING AND HYDRAULIC MODELLING

APPENDIX B9
AGENCY CORRESPONDENCE

APPENDIX C

SECTION 2

APPENDIX C1

FIGURES

APPENDIX C2

REGIONAL CROSS-SECTIONS AND GEOLOGICAL UNIT THICKNESS MAPPING

APPENDIX C3

TABLES

APPENDIX C4

BOREHOLE LOGS

APPENDIX C5

GEOTECHNICAL LABORATORY TESTING

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GEI Consultants

APPENDIX C6

SEEPAGE METER PHOTOGRAPHS

APPENDIX C7

GUELPH PERMEAMETER INFILTRATION TESTING RESULTS

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APPENDIX C8

WATER BALANCE CALCULATIONS

APPENDIX C9

SUMMARY OF PRIVATE WELL SURVEY

APPENDIX C10

GROUNDWATER QUALITY TESTING CERTIFICATES OF ANALYSIS

APPENDIX C11

GROUNDWATER AND SURFACE WATER HYDROGRAPHS

APPENDIX C12

RISING HEAD TEST RESULTS

APPENDIX C13

SURFACE WATER QUALITY TESTING CERTIFICATES OF ANALYSIS

APPENDIX C14

SURFACE WATER MONITORING PHOTOGRAPHIC RECORD

APPENDIX C15

VOLUMETRIC FLOW MONITORING

APPENDIX D

SECTION 4

APPENDIX D1

FIGURES

APPENDIX D2

TOPOGRAPHIC INFORMATION (R-PE SURVEYING LTD.)

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APPENDIX D3

TABLES

APPENDIX D4

HUMBER RIVER DESIGN STORM UNIT RELEASE RATES

APPENDIX D5

EXISTING CONDITIONS HYDROLOGIC MODELLING (TRCA)

APPENDIX D6

EROSION EXCEEDANCE ANALYSIS

APPENDIX D7

WETLAND WATER BALANCE

APPENDIX E

SECTION 5

APPENDIX E1

WASTEWATER DEVELOPMENT CHARGES (REGION OF PEEL)

APPENDIX E2

FIGURES

APPENDIX E3

WATER DEVELOPMENT CHARGES (REGION OF PEEL)