Prepared for:
Regional Municipality of Halton

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Drainage and Stormwater Management Report

Norval West Bypass Transportation Corridor Improvements, Municipal Class Environmental Assessment Study, Highway 7 to 10 Side Road (Regional Road 10), Town of Halton Hills

November 2025

SIGN OFF SHEET

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Prepared by 
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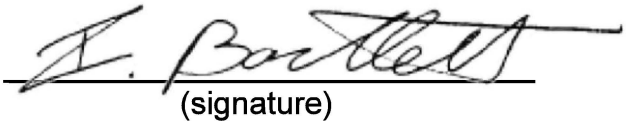
Nathan Yokich, P.Eng, CAN-CISEC

Approved by 
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Isaac Bartlett, P.Eng., ENV SP

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1.0 Introduction

Stantec Consulting Ltd. (Stantec) was retained by the Region of Halton to undertake a Municipal Class Environmental Assessment (MCEA) for the Norval West Bypass Transportation Corridor Improvements, Highway 7 to 10 Side Road (Regional Road 10). The study assesses the need for a new Norval West Bypass between Highway 7 and 10 Side Road, as well as improvements to 10 Side Road between Tenth Line and Adamson Street/Winston Churchill Boulevard (the Project). The study provided herein is the Drainage and Stormwater Management (SWM) assessment which is part of the MCEA.

It should be noted that the Southeast Georgetown Secondary Plan Study has been completed by the Town of Halton Hills in parallel to this MCEA Study. The southern portions of the proposed Norval West Bypass and 10 Side Road are generally surrounded by the Southeast Georgetown Secondary Plan area, which has informed this proposed stormwater management strategy. The strategy developed for the Norval West Bypass MCEA study is for the road only and does not include the development of the Southeast Georgetown Secondary Plan lands as that is being considered through a separate process. However, recognizing that development is proceeding, this strategy is in alignment with the strategy for the Southeast Georgetown Secondary Plan area. It is anticipated that the SWM plan will continue to be refined through detailed design to coordinate and align with development in the Southeast Georgetown Secondary Plan area.

Overview

The study area is located in Halton Region, within the Credit River Watershed and is under the jurisdiction of the Credit Valley Conservation Authority (CVC). Levi's Creek, Silver Creek and the Norval to Port Credit subwatershed boundaries intersect within the project limits. Refer to Figure 1 for the study area map.

The proposed Norval West Bypass is a new road and along with the improvements to 10 Side Road and the addition of the Highway 7 roundabout, the increase in impervious areas will result in an increase of runoff to drainage outlets, requiring SWM controls. This report has been written to document the drainage and SWM design strategy and criteria for the Norval West Bypass MCEA Study.

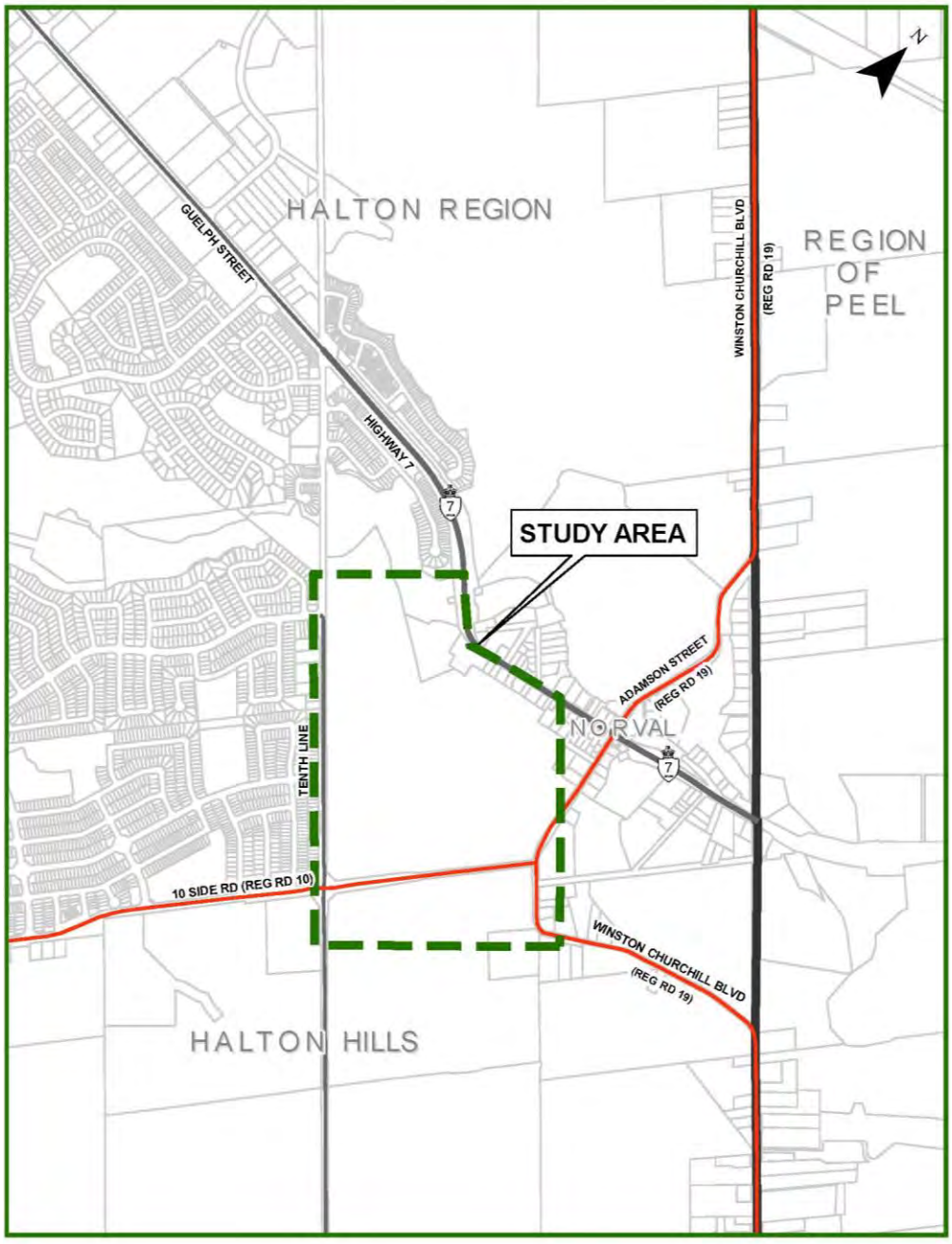

Figure 1: Study Area – Norval West Bypass

Background

The following background and technical documents have been referenced during preparation of this report:

- Credit Valley Conservation (CVC), Stormwater Management Criteria, 2012.
- Erosion and Sediment Control Guide for Urban Construction, Toronto and Region Conservation Authority (TRCA), 2019.
- GeoPro Consulting Limited, Geotechnical and Hydrogeological Desktop Review, 2021.
- Low Impact Development Planning and Design Guideline, Credit Valley Conservation Authority and Toronto and Region Conservation Authority, 2010.
- MTO Highway Drainage Design Standards (HDDS), Ministry of Transportation, 2024.
- MTO Drainage Management Manual, Ontario Ministry of Transportation, 1997.
- Provincial Planning Statement (PPS), Ontario Ministry of Municipal Affairs and Housing, 2024.
- Silver Creek Subwatershed Study, Credit Valley Conservation Authority; Schroeter & Associates; Environmental Water Resources Group; Aquafor Beech Limited; Jacques Whitford Environmental Limited; Waterloo Hydrogeologic Inc., 2003.
- Southeast Georgetown Scoped Subwatershed Study (SWS) - Phase 4: Implementation and Secondary Plan Policies, WSP, 2024.
- Stormwater Management Planning and Design Manual (SWMPD Manual), Ontario Ministry of the Environment, March 2003.
- Town of Halton Hills Subdivision Manual, 1999.
- Town of Halton Hills Official Plan, 2019.
- Urban Services Guidelines, Halton Region, 2020.
- W.G. Clarke, Winston Churchill Boulevard (5 Side Road/Embleton Road to 17 Side Road/Mayfield Road) Municipal Class Environmental Assessment Study, Drainage and Stormwater Management Report, 2004.
- 10 Side Road (Trafalgar Road to Winston Churchill Boulevard) Municipal Class Environmental Assessment Study Report, Town of Halton Hills, 1995.

2.0 Design Criteria

The following Drainage and SWM design criteria were retrieved from the CVC Stormwater Management Criteria guidelines (CVC, 2012).

For areas draining to Silver Creek:

- Water Quantity – Control post-development flow rates to pre-development levels for storm events up to and including the 100-year event (i.e., 2, 5, 10, 25, 50, & 100 year-return period event).
- Water Quality – 80% TSS (Total Suspended Solids) removal.
- Erosion – 5 mm retention on site or 25 mm – 48 hour detention, or if a site drains to a sensitive creek, or an Environmental Implementation Report is required, then the proponent must complete a geomorphologic assessment study to determine the site appropriate erosion threshold.

For areas draining to the Credit River:

- Water Quantity – no control required.
- Water Quality – 80% TSS removal.
- Erosion – 5 mm retention on site or 25 mm – 48 hour detention.

For areas draining to Levi's Creek:

- Water Quantity – Control post-development flow rates to pre-development levels for all storm events (i.e., 2, 5, 10, 25, 50, & 100 year-return period events and the Regional Storm.
- Water Quality – 80% TSS removal.
- Erosion – 5 mm retention on site or 25 mm – 48 hour detention, or if a site drains to a sensitive creek, or an Environmental Implementation Report is required, then the proponent must complete a geomorphologic assessment study to determine the site appropriate erosion threshold.

A treatment train approach using source, conveyance, and end-of-pipe facilities, in combination with low impact development practices, should be considered to meet the design criteria associated with water quantity, quality, erosion, and water balance.

Through background review and consultation with CVC, it was determined that Silver Creek is considered a sensitive watercourse, while Levi's Creek is not considered to be

sensitive. Therefore, an erosion threshold analysis is recommended to be completed at the Silver Creek outlet during detailed design to identify target release rates. CVC also noted that the existing Headwater Drainage Features within the study area may need to consider Scour Assessment Requirements. The Scour Assessment Requirements are to be confirmed during detailed design.

The watercourse crossings downstream of the Norval West Bypass are not anticipated to be impacted, however a hydraulic analysis may be required during detailed design to ensure that there are no flooding nor erosion hazard risks. In addition, road improvements or reconstruction at a minimum should maintain existing depth of flooding on the road or improve the road such that it is flood free under Regional Storm Conditions.

CVC has endorsed a new Erosion and Sediment Control Guide for Urban Construction, 2019. The Erosion and Sediment Control Plans are expected to coincide with this document.

3.0 Existing Drainage Conditions

3.1 Topography and Surface Drainage

The study area is bounded by the Silver Creek valley to the north, adjacent to Levi Creek to the south, and the Credit River valley slope, along Highway 7, to the northeast. The majority of the study area is cultivated lands with developed areas around the perimeter and a steep valley slope to the northeast. Rural properties and associated buildings are located near the center of the study area. The site generally drains from west to east and is comprised of flat plateau table land and the Credit River and Silver Creek valley slope. Elevations in the south portion of the site vary from approximately 230 masl to 225 masl. Elevations from the top to the bottom of the valley slope vary from approximately 225 masl to 205 masl, respectively. Headwater Drainage Features and ephemeral channels traverse the site drainage area and outlet to Silver Creek, Levi Creek or the Credit River. Existing development west of Tenth Line drains north to Silver Creek or south to an existing SWM facility.

3.2 Geotechnical Information

Surficial geology for the study area was retrieved from the Ontario Geologic Survey database (OGS, 2021). The site contains Paleozoic bedrock, older and modern alluvial deposits, and fine-coarse glaciolacustrine deposits. Site soil data was determined based Soil Survey Mapping for the area provided by the Ontario Ministry of Natural Resources and Forestry (Soil Map – Halton County Ontario – Soil Survey Report No. 43, 1971). Site soils can generally be described as clay loam. For the purposes of this investigation, the site soils were characterized as Hydrologic Soil Group C.

The site is located in an area with a Highly Vulnerable Aquifer (HVA) (GeoPro, 2021). No wellhead Protection areas (WHPA) or Intake Protection Zones (IPZ) are within the site vicinity.

4.0 Hydrologic Modeling

The hydrologic analysis was completed to determine the surface drainage characteristics of the study area. Existing and proposed models were created to evaluate the performance of the drainage system and provide recommendations based on the proposed Norval West Bypass improvements and contributing drainage features. Hydrologic event modeling was used to quantify flow rates at various points of interest. For the hydrologic model, Visual OTTHYMO (VO) version 6.2 software was used.

ARCMAP GIS software was used to determine the drainage areas contributing to each culvert. Ontario Ministry of Natural Resource and Forestry Mapping and aerial photography was used to assess the validity of the generated catchments, and manual adjustments were made accordingly. It was determined that no significant external areas drain into the study area. Time of concentration was calculated using the airport method and a minimum time of concentration of 10 minutes was implemented.

4.1 Precipitation

To assess the drainage system, the area was modelled using Town of Halton Hills precipitation parameters (3-hour Chicago Storm), the MTO Intensity Duration Frequency (IDF) curve lookup tool for the site location (24-hour Soil Conservation Service (SCS) Type II storm distribution) and the Regional Storm (48-hour Hurricane Hazel event). The hydrologic models were simulated with the 3-hour Chicago and 24-hour SCS Type II storm distributions to determine the most conservative design event. Table 1 illustrates the rainfall volumes used for 24-hour SCS Type II distribution for each return period. Town of Halton Hills precipitation data and the MTO IDF look-up parameters are included in Appendix A for reference.

Table 1: Rainfall Parameters

Return Period	Rainfall Amount (mm) (24-hour)
2-year	60.0
5-year	76.8
10-year	88.8
25-year	105.8
50-year	115.2
100-year	127.2
Regional Storm	285.0

4.2 Existing Conditions

As mentioned above, the existing land use is primarily cultivated lands with a rural dwelling and associated agriculture buildings near the centroid of the site limits. Guelph Street (Highway 7), Adamson Street South, 10 Side Road and 10th Line rights-of-way (ROW) generally confine the drainage for the site with minimal contributing external flows. Under existing conditions, the site drainage has three outlets including Silver Creek, Levi's Creek and the existing drainage infrastructure within Norval which subsequently drains to the Credit River (Norval to Credit River). Hydrologic analysis was completed to determine existing flows to each outlet within the study limits. The major outlets from the study area are illustrated on Figure 2 and summarized below:

- **Silver Creek** – **Catchment 100** - The northwestern portion of the study area drains north down the valley slope to Silver Creek. This area does not cross any municipal infrastructure before reaching the creek.
- **Norval and Credit River** – **Catchments 105 and 110** - the north and east portions of the study area drain to the Credit River. This area drains though Norval and will use minor and major drainage systems to pass through the community.
- **Levi's Creek** – **Catchment 115** - the south portions of the study area drain across 10 Side Road to the south and subsequently drains to Levi's Creek through a residential property southeast of the site.

The existing conditions catchment parameters and hydrologic model files are included in Appendix B for reference. Table 2 below summarizes peak flows for the existing catchments.

Table 2: Existing Peak Flows

Parameter	2-year Rainfall	5-year Rainfall	10-year Rainfall	25-year Rainfall	50-year Rainfall	100-year Rainfall	48-hour Regional Storm
3-hour Chicago Storm Peak Flows (m^3/s)							
Catchment 100	0.40	0.78	1.07	1.45	1.78	2.09	
Catchment 105	0.20	0.31	0.38	0.56	0.73	0.92	
Catchment 110	0.24	0.45	0.62	0.83	1.01	1.18	
Catchment 115	0.30	0.56	0.77	1.03	1.25	1.46	
24-hour SCS Storm Peak Flows (m^3/s)							
Catchment 100	0.80	1.21	1.53	1.99	2.26	2.60	2.90
Catchment 105	0.25	0.42	0.57	0.83	0.96	1.13	1.01
Catchment 110	0.46	0.69	0.86	1.11	1.26	1.45	1.86
Catchment 115	0.57	0.85	1.07	1.37	1.55	1.78	2.53

Stantec

Legend
- Study Area
- Property Boundary
- Watercourse (Permanent)
- Contour (100 m Interval)
- Contour (10 m Interval)
- Contour (5 m Interval)
- Waterbody
- Surface Water Flow Direction
- Surface Water Catchment

0 0.3 km

1:5,500 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2020.
3. Orthoimagery © First Base Solutions, 2024, imagery date 2023.

Project Location
Halton Region

165010598 REV4
Prepared by JSa on 2024-06-25
Technical Review by ABC on yyyy-mm-dd
Independent Review by ABC on yyyy-mm-dd

Client/Project
HALTON REGION
NORVAL WEST BYPASS - CLASS EA

Figure No.
2

Title
Surface Water Drainage

4.3 Proposed Conditions

The proposed Norval West Bypass is a new road which increases the net impervious area from existing conditions. Implementation of the Bypass would result in increased flows and runoff from the roadway to downstream receivers. The proposed Norval West Bypass cross section includes 4 travel lanes for traffic, multi-use paths on either side of the road, a boulevard and a raised center median (curb and gutter).

A roundabout located southeast of the existing 10 Side Road alignment is proposed to connect 10 Side Road, Norval West Bypass, Adamson St. S. and Winston Churchill Blvd.10 Side Road is proposed to be realigned and widened from 2 to 4 lanes from 10th Line to Winston Churchill Boulevard. 10 Side Road will be a semi-urban section similar to the Norval West Bypass, with multi-use pathways.

Generally, the proposed Norval West Bypass crosses through the study area from NW to SE while 10 Side Road generally follows a SW to NE alignment. As the Bypass transects the drainage areas to the corresponding outlets, the contributing drainage areas to each outlet are altered within the study area. Levi's Creek and Silver Creek outlets will have additional contributing drainage area while contributing drainage area to the Credit River is reduced. Table 3 shows the existing and proposed contributing drainage area to each outlet.

Table 3: Norval West Bypass and 10 Side Road Contributing Drainage Areas

Outlet	Existing Drainage Area (ha)	Proposed Drainage Area with Bypass (ha)	Percent Change (%)
Silver Creek	23.5	28.1	19.6
Levi's Creek	23.8	29.0	21.7
Credit River via Hamlet of Norval	24.5	14.7	-39.8

The existing agricultural area within the study limits is zoned as future residential / mixed use area in the Town of Halton Hills Official Plan (Halton Hills, 2019). The Southeast Georgetown Town Secondary Plan Study has been completed by the Town of Halton Hills in parallel to this MCEA Study. The Norval West Bypass crosses through the Southeast Georgetown Secondary Plan area. A Scoped Subwatershed Study (SWS) has been completed as part of the Southeast Georgetown Secondary Plan Study in the following three (3) stage process:

- Phase 1: Background and Characterization.
- Phase 2/3: Impact Assessment and Management Plan.

- Phase 4: Implementation and Secondary Plan Policies.

The purpose of the studies undertaken in support of the Southeast Georgetown Secondary Plan was to provide a framework for the surrounding development and to assess the impacts of the surrounding watersheds as it relates to the Southeast Georgetown Secondary Plan. A preferred land use concept of the surrounding developments was provided in Appendix E of the Phase 4 SWS Report (WSP, 2024). This preferred land use concept has informed the Norval West Bypass MCEA Study, including this Drainage and Stormwater Management Report which was completed for the MCEA Study. It is recognized that development of these lands is ongoing and further coordination and alignment will be required during the detailed design of the Norval West Bypass.

5.0 Stormwater Management (SWM)

5.1 Stormwater Management Strategy

A Stormwater Management (SWM) Strategy was considered as a method to minimize/mitigate environmental impacts due to the proposed Norval West Bypass and 10 Side Road improvements. A range of SWM controls are available on any given site and an evaluation of site conditions and physical constraints is required to determine which options are most appropriate. Physical constraints include topography, soils, bedrock elevation, groundwater elevation, and drainage area. The feasibility of traditional SWM controls is limited due to the linear constraints of the corridor. Various design alternatives were considered for the overall SWM strategy including:

- **Distributed or Lot Level Controls**: Lot level controls include most Low Impact Development (LID) measures such as bio-retention areas (bio-swales), tree pits, vegetated conveyance systems such as grassed swales, vegetated buffer strips, and filter strips which provide passive water quality treatment for adjacent roads, primarily filtering sediments and heavy metals prior to out-letting. Additional treatment can also be provided with the use of enhanced grass swales which utilize permanent rock check dams used to reduce in-channel flow velocities to allow finer sediment to settle. Distributed infiltration measures such as infiltration trenches, porous pavements, and sand filters provide water quantity benefits while also contributing to groundwater recharge. Oil and Grit Separators (OGSs) and other Manufactured Treatment Devices (MTD) can also provide water quality treatment where space is limited.

- **End-of-Pipe Controls**: End-of-Pipe storage facilities such as wet ponds, dry ponds, constructed wetlands, and infiltration basins can be effective control measures, providing both water quality and quantity control measures. Underground storage can be effective at providing quantity controls where available property is limited.

Technical analysis for the Southeast Georgetown Secondary Plan included the study of how stormwater should be managed on the subject lands. A more detailed review of stormwater management for this site in the context of the proposed development is being undertaken by the applicant through the development review process. This work is separate from the Norval West Bypass MCEA Study and is anticipated to accommodate a portion of the drainage from the Norval West Bypass improvements. The stormwater management analysis undertaken through both the Southeast Georgetown Secondary Plan and the analysis being undertaken through the development review process are separate processes with which the Norval West Bypass MCEA is aligning. However, the stormwater management plan developed for

the Norval West Bypass MCEA Study is for the Norval West Bypass transportation corridor improvements only.

5.2 Stormwater Management/LID Evaluation

The SWM strategy for the Norval West Bypass improvements was designed to meet SWM design guidelines and policies outlined by previous watercourse studies and reviewing agencies. Water quality, water quantity, and erosion controls are required for any proposed road improvements. In addition, 5 mm of retention or 25mm, 48 hr. detention is required for road runoff (CVC, 2012). A treatment train approach using source, conveyance, and end-of-pipe facilities, in combination with LID practices, should be considered to enhance the water quantity, water quality, water balance, and erosion mitigation potential. Table 4 provides an evaluation of SWM and LID measures considered to meet the design objectives for the proposed Norval West Bypass and improvements to 10 Side Road from 10th Line to Winston Churchill Boulevard.

Table 4: Evaluation of SWM/LID Controls for Norval West Bypass and 10 Side Road

SWM/LID Control	Design Criteria: Water Quality Control Effectiveness	Design Criteria: Water Quantity and Erosion control Effectiveness	Location and Considerations: Drainage Area to Silver Creek Outlet	Location and Considerations: Drainage Area to Levi's Creek Outlet
Oil-Grit Separator	Pre-treatment Only - Provides an estimated maximum of 60% TSS Removal	N/A	Recommended at each storm sewer outlet. Frequent Maintenance required.	Recommended at each storm sewer outlet. Frequent Maintenance required.
Superpipes	N/A	Flow Attenuation, Low - Moderate Storage Potential	Low storage potential with the steep slopes. Not feasible for the storage required.	Limited feasibility due to potential clearance, outlet configuration and high capital costs.
Enhanced Grass Swales	Moderate Pollutant Removal	Flow Attenuation	Recommended with for use in roadside drainage ditch. Check dams to be used for reduced channel velocities.	Recommended with for use in roadside drainage ditch as pre-treatment and flow attenuation. However, this would not apply to the urban cross-section abutting adjacent development.
Vegetative filter Strips	Pre-treatment Only - Moderate Pollutant Removal	N/A	Not Feasible due to steep slopes and limited landscaped area.	Not Feasible due to limited landscaped area.
Underground Storage (Infiltration chambers)	Moderate – Effective Pollutant Removal	Flow Attenuation and Storage Potential	Limited space in urban cross section. Steep slopes limit infiltration potential.	Limited space in urban cross section. Potential groundwater constraints (1m separation from high groundwater level). Road runoff implications to groundwater quality with road salt application. Potential for use under multi-use pathway.
Porous Pavement	Potential for effective pollutant removal	Flow Attenuation	Recommended for use along multi-use pathway. De-icing constituents can contaminate infiltration	Recommended for use along multi-use pathway. De-icing constituents can contaminate infiltration
Bio-Retention	Effective Pollutant Removal	Flow Attenuation and storage potential	Not applicable with urban cross-section and limited space within center median.	Not applicable with urban cross-section and limited space within center median.
SWM Facility (Wet Pond, Dry Pond, Wetland)	Effective Pollutant Removal	High Flow Attenuation and Storage Potential	Achieves the minimum water quantity, quality and erosion control criteria for Silver Creek. Feasible location is within the greenlands land use area, adjacent to Silver creek. Disadvantages include the large footprint required outside the ROW, high cost and maintenance.	Achieves the minimum water quantity, quality and erosion control criteria for Levi's Creek. Potential to integrate with the proposed SWM pond location at the Bypass and 10 Side Road intersection as per the preferred land use plan in Southeast Georgetown Secondary Plan area. Disadvantages include the large footprint required outside the ROW, high cost and maintenance.

The feasibility of each option was screened based on the following criteria:

- Ability to meet stormwater management water quantity, quality and erosion control criteria.
- Spatial constraints within the road ROW and downstream watercourses.
- Integration with the proposed road cross-section.
- Suitable connection with the minor conveyance infrastructure and outlet.
- Cost-effectiveness including operation and maintenance.

5.3 Preferred Alternative

5.3.1 Proposed Stormwater Management/LID Strategy

5.3.1.1 Silver Creek Outlet (Northwest)

The portion of the proposed Norval West Bypass draining northwest to Silver Creek will be relatively steep (approximately 5% slope) with minimum space in the urban cross-section to accommodate stormwater storage. In addition, the Norval West Bypass will be cut below the surrounding original ground elevations and will be too low to drain to SWM facilities in future adjacent developments. Based on the evaluation above, the following SWM/LID features for the northwest draining portion of the Norval West Bypass and Highway 7 roundabout are recommended:

- Considering the increase in drainage area and impervious area that drains to Silver Creek, a SWM pond (SWM Pond 3) is the most feasible water quantity, quality and erosion control/extended detention measure for the north outlet of the Bypass.
- Water quantity / water quality / water balance may be supported through the use of enhanced grass swales and to promote pollutant settling and flow attenuation. Check dams can be implemented along the ditch slope to reduce channel velocities and increase infiltration potential with ponding water.
- Oil-grit-separators as pre-treatment for storm sewer outlets.

For both the northwest and southeast Bypass segments, additional LID measures may include pre-treatment measures such as catchbasin inserts (CB Shields, Envirobasin) or pervious/porous pavement integrated in the multi-use pathways. Location specific infiltration testing and confirmation of groundwater levels will determine the efficacy and

viability of infiltration specific LIDs. The feasibility of each recommended LID feature will be explored during detailed design.

5.3.1.2 Levi's Creek Outlet (Southeast)

The southern portions of the proposed Norval West Bypass and 10 Side Road are generally surrounded by the Southeast Georgetown Secondary Plan area, which has informed the proposed strategy. The recommended SWM/LID features based on the evaluation are as follows:

- Two SWM ponds (SWM Pond 1 and SWM Pond 2) are recommended to control storm events from the 2-year up to and including the regional storm and circumvent the impact of the increased drainage area to Levi's Creek while providing water quality, quantity and erosion control.
    - One SWM pond (SWM Pond 1), as identified through the Southeast Georgetown Secondary Plan, is to accommodate a portion of the drainage from the Norval West Bypass, along with the Southeast Georgetown Secondary Plan area (for the purposes of this report, the design of the SWM Pond 1 is for the Norval West Bypass improvements only).
    - One SWM pond (SWM Pond 2) for the proposed roundabout, new 10 Side Road alignment and Adamson St S. and Winston Churchill Blvd. extensions drainage.
- Enhanced grass swales within the roadside ditching will be beneficial for meeting water quantity, quality and water balance objectives. Under future conditions, the proposed development may replace the roadside ditching on the south segment of the Bypass. However, Enhanced grass swales can be used as a temporary treatment measure.
- Opportunity for implementing linear underground retention under the multi-use pathways to collect a portion of the storm sewer runoff to satisfy the erosion control retention criteria and reduce storage volume required for Levi's Creek outlet.
- Oil-grit-separators as pre-treatment for storm sewer outlets.

As mentioned, additional LID measures may include pre-treatment measures such as catchbasin inserts (CB Shields, Envirobasin) or pervious/porous pavement integrated in the multi-use pathways. Location specific infiltration testing and confirmation of groundwater levels will determine the efficacy and viability of infiltration specific LIDs. It is anticipated that the SWM plan will continue to be refined through detailed design to coordinate and align with development in the Southeast Georgetown Secondary Plan area.

5.3.2 Proposed Drainage Plan

Conveyance systems for the proposed Norval West Bypass and improvements to 10 Side Road from 10th Line to Winston Churchill Boulevard are required to route runoff to the respective outlets. Table 5 summarizes the proposed minor and major system conveyance systems for the proposed roadway's corridors only assuming existing conditions and does not consider the development of the Southeast Georgetown Secondary Plan area which is subject to a separate stormwater management plan.

Table 5: Norval West Bypass and 10 Side Road Proposed Conveyance Systems

Location	Minor System	Major System
North Segment of Norval West Bypass and Highway 7 Roundabout	• Minor flows are conveyed via urban curb and gutter, catchbasin and storm sewers. • Storm sewers will discharge into the proposed SWM pond (SWM Pond 3).	• Major flows are directed to the roadside ditches (enhanced grass swales). • Flows subsequently discharge overland to the proposed SWM pond (SWM Pond 3) or via ditch inlet catch basins and storm sewers under the road.
South Segment of Norval West Bypass	• Minor flows are conveyed via urban curb and gutter, catchbasin and storm sewers. • Storm sewers will discharge into the proposed SWM pond (SWM Pond 1).	• Under future conditions with Southeast Georgetown Secondary Plan development, major flows would be conveyed through the right-of-way and storm sewers to SWM Pond 1 would need to be sized for major flows.
Proposed Roundabout, new 10 Side Road Alignment and Adamson St S. and Winston Churchill Blvd. Extensions	• Minor flows are conveyed via urban curb and gutter, catchbasin and storm sewers. • Storm sewers will discharge into the proposed SWM pond (SWM Pond 2).	• Major flows are directed to the roadside ditches (enhanced grass swales). • Flows subsequently discharge overland to the proposed SWM pond (SWM Pond 2).

5.3.3 Stormwater Management Pond Location Evaluation

Through the SWM and LID evaluation, it was determined that there is potential for SWM ponds to provide end-of-pipe control for the preferred design. The location of the

potential SWM ponds for the preferred design was evaluated based on several criteria including integration with the adjacent Southeast Georgetown Secondary Plan.

For the SWM ponds proposed at Highway 7 and at 10 Side Road, an analysis was undertaken to determine the best approximate location (east of west of the Bypass), as shown in Tables 6 and 7.

The location of the SWM pond (SWM Pond 2) for the new 10 Side Road alignment, 10 Side Road roundabout and Adamson St S. and Winston Churchill Blvd. extensions drainage was recommended based on the proximity to the outlet. Therefore, a SWM pond (SWM Pond 2) location evaluation was not completed for the roundabout, new 10 Side Road alignment, Adamson St S. and Winston Churchill Blvd. extensions contributing drainage. Table 6 and Table 7 include the SWM Pond (SWM Pond 1 and SWM Pond 3) location evaluation for the Silver Creek and Levi's Creek outlets for the Norval West Bypass, respectively.

Table 6: Silver Creek Outlet (Northwest) Stormwater Management Pond (SWM Pond 3) Location Evaluation

Criteria	Option 1 – West of Norval West Bypass	Option 2 – East of Norval West Bypass
Policy • Potential to impact Greenbelt Policy Area • Potential be placed within Credit Valley Conservation (CVC) Regulation Limits	• Stormwater management pond would be fully located within the Greenbelt Policy Area. • Stormwater management pond would be located within CVC Regulation Limits.	• Stormwater management pond would be partially located within the Greenbelt Policy Area. • Stormwater management pond would be located within CVC Regulation Limits
Natural Environment • Potential to impact wildlife and wildlife habitat • Potential to impact vegetation	• High potential to impact breeding bird habitat and bat maternity roost trees. • High potential to impact large area of forest and woodland communities along the Silver Creek Valley. • Located within the Provincially Significant Valleyland Area. • Stormwater management (SWM) facilities, including ponds, are permitted within Provincially Significant Valleylands and Natural Heritage Systems. This is contingent upon meeting specific environmental protection criteria outlined in the Provincial Planning Statement (PPS, 2024). These criteria ensure that the integration of SWM facilities does not compromise the ecological integrity of these sensitive areas, supporting sustainable development while preserving natural heritage values.	• High potential to impact breeding bird habitat and bat maternity roost trees. • Less potential to impact large area of forest and woodland communities. Area is located further away from Silver Creek Valley. • Located within the Provincially Significant Valleyland Area. • Stormwater management (SWM) facilities, including ponds, are permitted within Provincially Significant Valleylands and Natural Heritage Systems. This is contingent upon meeting specific environmental protection criteria outlined in the Provincial Planning Statement (PPS, 2024). These criteria ensure that the integration of SWM facilities does not compromise the ecological integrity of these sensitive areas, supporting sustainable development while preserving natural heritage values.
Grading / Land Impact • Ability to accommodate grading	• Stormwater pond would be located on much steeper area of land, surrounded by woodland area with a larger grading footprint.	• Stormwater management pond would be located on less steep area of land, with woodland area surrounding the southern side of the pond with a small grading area footprint.
Cultural Environment • Potential to impact archaeological resources • Potential to impact cultural heritage resources	• Stage 2 Archaeological Assessment required for a portion of the area. • No anticipated impacts to cultural heritage resources.	• Stage 2 Archaeological Assessment required for a portion of the area. • Potential for indirect temporary impacts to identified cultural heritage resources during construction.
Drainage Feature Impacts • Potential to impact existing drainage features • Potential to accommodate future drainage requirements • Potential to accommodate future expansion	• No floodplain mapping is available at the Silver Creek Crossing through Highway 7. • Stormwater management pond would likely conflict with floodplain boundary and erosion hazard limit. • Limited space between roundabout and Silver Creek.	• Area is flat and partially cleared. • Requires the outlet to be conveyed through the Norval West Bypass to Silver Creek. • Online with existing tributary through valley.
Constructability • Potential for design challenges	• High potential for design challenges with steep grading at this location, and proximity to Silver Creek.	• Low potential for design challenges as the grading at this location is more level.
Cost • Estimated costs associated with construction and maintenance	• Higher construction costs	• Lower construction costs

Summary	Option 1 has greater potential to impact the natural environment, is located within a steep slope, and will cost more to construct. Option 2 has less potential to impact the natural environment, is better suited topographically for a SWM pond, with lower construction costs. Provided the property can be acquired, Option 2 would be preferred location.	Option 1 has greater potential to impact the natural environment, is located within a steep slope, and will cost more to construct. Option 2 has less potential to impact the natural environment, is better suited topographically for a SWM pond, with lower construction costs. Provided the property can be acquired, Option 2 would be preferred location.

Table 7: Levi's Creek Outlet (Southeast) Stormwater Management Pond (SWM Pond 1) Location Evaluation

Criteria	Option A – West of Norval West Bypass	Option B – East of Norval West Bypass
Natural Environment • Potential to impact wildlife and wildlife habitat • Potential to impact vegetation	• No anticipated impacts to wildlife/wildlife habitat or vegetation.	• No anticipated impacts to wildlife/wildlife habitat or vegetation.
Grading / Land Impact • Ability to accommodate grading	• Stormwater management pond can be accommodated to match existing grading.	• Stormwater pond can be accommodated to match existing grading.
Land Uses • Potential to impact planned future land uses	• Does not align with the preferred land use concept of the Southeast Georgetown Secondary Plan.	• Aligns with the preferred land use concept from the Southeast Georgetown Secondary Plan.
Cultural Environment • Potential to impact archaeological resources • Potential to impact cultural heritage resources	• No potential to impact archaeological resources. • No potential to impact cultural heritage resources.	• No potential to impact archaeological resources. • No potential to impact cultural heritage resources.
Drainage Feature Impacts • Potential to impact existing drainage features • Potential to accommodate future drainage requirements • Potential to accommodate future expansion	• Conveyance through existing 10 Side Road west of the Bypass. • Routed through 10 Side Road ditching to Levi's Creek.	• Online with existing Levi's Creek Headwaters • Conveyance through existing 10 Side Road east of the Bypass. • Routed through 10 Side Road ditching to Levi Creek.
Constructability • Potential for design challenges	• More road crossings required to convey water to the existing tributary to Levi's creek. • More spatial constraints in mixed-use zone.	• Less road crossings required to convey water to the existing tributary to Levi's creek. • Less spatial constraints in parkland.
Cost • Estimated costs associated with construction and maintenance	• Costs are anticipated to be similar when comparing the two locations.	• Costs are anticipated to be similar when comparing the two locations.
Summary	Both options are similar in their impacts. Based on the stormwater conveyance purposes and the preferred land use concept, Option B would be recommended.	Both options are similar in their impacts. Based on the stormwater conveyance purposes and the preferred land use concept, Option B would be recommended.

5.3.4 Storage Requirements

Under proposed conditions, the proposed Norval West Bypass, Highway 7 roundabout, 10 Side Road alignment, 10 Side Road roundabout and Adamson St S. and Winston Churchill Blvd. extensions increases flows to Silver Creek and Levi's Creek outlets. To satisfy the water quantity objectives for the downstream outlets, stormwater storage is requisite. As mentioned in Section 2, the water quantity criteria for Silver Creek and Levi's Creek are as follows:

- Silver Creek: Control post-development flow rates to pre-development levels for storm events up to and including the 100-year event.
- Levi's Creek: Control post-development flow rates to pre-development levels for all storm events including the regional storm.

A proposed hydrologic model of the study limits was created in Visual OTTHYMO 6.2 to determine the approximate storage volume required to achieve the water quantity control for each outlet. The storage volume of each SWM pond was iteratively adjusted until the proposed peak flow rates were less than or equal to the existing conditions peak flow rates for each storm event, at each outlet. The SCS Type II distribution was used to determine the requisite storage. Proposed catchments and preferred storage SWM pond locations (not to scale) are illustrated on Figure 3 and summarized below. Proposed conditions catchment parameters and hydrologic model files are included in Appendix B for reference.

Catchment 200 – The northwestern portion of the study area drains north down the valley slope, directly to Silver Creek.

Catchment 201 – Portion of valley slope and Norval residential properties draining overland to the recommended location of the north SWM pond (SWM Pond 3).

Catchment 202 – North segment of the proposed Norval West Bypass. Minors are conveyed via storm sewers and majors are conveyed via ditching to the north SWM pond (SWM Pond 3).

Catchment 203 – Land use consists primarily of the approximate location of the south SWM pond (SWM pond 1) and corresponding grading.

Catchment 204 - South segment of the proposed Norval West Bypass. Minors are conveyed via storm sewers and majors are conveyed via ditching to the south SWM pond (SWM Pond 1).

Stantec

Legend

- Watercourse (Permanent)
- Contour 1m
- Surface Water Flow Direction
- New Construction - Grading Limits
- New Construction - Road
- Study Area
- Property Boundary
- Waterbody
- Proposed Catchments
- Proposed Stormwater Management Pond (SWM)

0 100 200 300 Metres

1:5,500 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2020.
3. Orthoimagery © First Base Solutions, 2023, imagery date 2023.
4. Contours derived from Ontario Digital Terrain Model (Lidar-Derived) GTA 2014-18 Project.

Project Location
Halton Region

165010598 REV4
Prepared by JSa on 2024-06-25
Technical Review by ABC on yyyy-mm-dd
Independent Review by ABC on yyyy-mm-dd

Client/Project
HALTON REGION
NORVAL WEST BYPASS - CLASS EA

Figure No.
3

Title
Proposed Drainage

Catchment 205/210 – Includes the north and east portions of the study area, ultimately draining to the Credit River. This area drains though Norval and will use minor and major drainage systems to pass through the Village.

Catchment 215 – Includes the southwest portion of the study area draining to the south SWM pond (SWM Pond 1).

Catchment 220 - Proposed 10 Side Road alignment, 10 Side Road roundabout and Adamson St S. and Winston Churchill Blvd. extensions and a portion of the undeveloped drainage area south of the existing 10 Side Road alignment draining to the south SWM pond (SWM Pond 2).

Catchment 225 – Portion of the undeveloped drainage area south of the existing 10 Side Road alignment draining directly to Levi's Creek.

Several assumptions were made in the preparation of the proposed model as follows:

- Peak flows from the prospective development, adjacent to the Norval West Bypass, will be controlled to pre-development conditions. Therefore, the proposed model parameters for areas surrounding the Bypass are akin to the existing conditions model.
- The allowable release rates from the SWM ponds equates to the 2- to 100-year and regional storm peak flow rates required to achieve post- to pre-development peak flow attenuation for all design storm events at Silver Creek and Levi's Creek outlets, respectively.

- As the urban boundary ends along the existing 10 Side Road alignment, two SWM ponds were included in the proposed model to separate the drainage from the future development and 10 Side Road improvements which both outlet to Levi's Creek. The proposed storage reservoirs draining to Levi's Creek were simulated per the following:
    - Catchments 203, 204 and 215 are drained to SWM Pond 1 to account for a portion of the surrounding prospective development drainage and interception of the existing Levi's Creek headwater flow path:
        - The modeled storage required in SWM Pond 1 assumes that catchments 215, 220 and 225 are controlled to existing conditions. The modeled storage required in SWM Pond 1 does not consider the storage in SWM Pond 2, such that the required storage for the proposed Bypass is independent of the new roundabout, 10 Side Road alignment and Adamson St S. and Winston Churchill Blvd. extensions.
    - SWM Pond 1 and SWM Pond 2 discharge in parallel to the Levi's Creek outlet. Catchment 220 is drained to SWM Pond 2 to account for the new roundabout, 10 Side Road alignment and Adamson St S. and Winston Churchill Blvd. extensions:
        - To determine the storage required in SWM Pond 2, the proposed model was revised to account for catchment 220's proposed conditions catchment parameters. The storage volume in SWM Pond 2 was then iteratively adjusted until peak flow attenuation was achieved at Levi's Creek outlet, assuming the predetermined storage-discharge curve in SWM Pond 1 remained.

Table 8 and 9 summarizes the model output and storage requirements for the Silver Creek and Levi's Creek Outlets, respectively. The total proposed peak flow rate to Levi's Creek in Table 9 includes the outflow from SWM Ponds 1 and 2 as well as the uncontrolled runoff from catchment 225.

Table 8: Silver Creek Outlet (SWM Pond 3) Visual OTTHYMO Model Output

Parameter	2-year Storm	5-year Storm	10-year Storm	25-year Storm	50-year Storm	100-year Storm
Existing Peak Flow Rate to Silver Creek (m^3/s)	0.80	1.21	1.53	1.99	2.26	2.60
Catchment 200 Proposed Peak Flow Rate to Silver Creek (m^3/s)	0.76	1.15	1.45	1.88	2.14	2.47
Allowable Release Rate from SWM Pond 3 (Bypass Drainage) (m^3/s)	0.04	0.06	0.08	0.10	0.12	0.13
Total Proposed Peak Flow Rate to Silver Creek (m^3/s)	0.79	1.19	1.50	1.95	2.22	2.56
Storage Required in SWM Pond 3 (m^3)[1]	1208	1775	2218	2824	3268	3659

[1] corresponds to active storage volume (permanent pool volume requirements not included)

Table 9: Levi's Creek Outlet (SWM Ponds 1 and 2) Visual OTTHYMO Model Output

Parameter	2-year Storm	5-year Storm	10-year Storm	25-year Storm	50-year Storm	100-year Storm	Regional Storm
Existing Peak Flow Rate to Levi's Creek (m^3/s)	0.57	0.85	1.07	1.37	1.55	1.78	2.53
Allowable Release Rate from SWM Pond 1 (m^3/s)	0.26	0.39	0.49	0.63	0.71	0.81	1.40
Allowable Release Rate from SWM Pond 2 (m^3/s)	0.25	0.37	0.46	0.58	0.66	0.76	0.78
Total Proposed Peak Flow Rate to Levi's Creek (m^3/s)	0.50	0.72	0.90	1.16	1.32	1.49	2.35
Storage Required in SWM Pond 1 (m^3)[1]	1915	2841	3532	4543	5156	5920	11938
Storage Required in SWM Pond 2 (m^3)[1]	498	690	831	1038	1165	1377	1229

[1] corresponds to active storage volume (permanent pool volume requirements not included)

5.3.5 Preliminary Stormwater Management Pond Footprint

A preliminary SWM pond footprint analysis was completed to determine the extent of land required based on the volume required for the three SWM ponds. The estimated required permanent pool volume was added to the active storage volume (section 5.3.4) based on the enhanced water quality control criteria as per the Stormwater Management and Design Manual (MECP, 2003). The following assumptions were made in the preliminary pond footprint analysis:

- The 3 SWM ponds are classified as Wet Ponds.
- The volume was calculated using the Truncated Rectangular Pyramid formula.
- 3m of total depth in the pond with additional 0.3m of freeboard is provided.
- Length x Width Ratio is 2:1 with 5:1 side slopes throughout.

- A 30% contingency was added to the area for grading purposes.

Table 10 summarizes the results from the preliminary footprint calculations. The preliminary stormwater management pond footprint and permanent pool calculations are included in Appendix C for reference.

Table 10: Preliminary Norval West Bypass and 10 Side Road SWM Pond Footprint Analysis

SWM Pond Characteristics	SWM Pond 1	SWM Pond 2	SWM Pond 3
Active Storage Required (m^3)	11938	1377	3659
Permanent Pool Storage Required (m^3)	772	658	674
Estimated Pond Footprint Required (ha)	0.90	0.24	0.40

The storage required and consequently the footprint required for SWM Pond 1 is significantly larger than SWM Pond 2 to account for a portion of the undeveloped Southeast Georgetown Secondary Plan area draining to SWM Pond 1. For analysis purposes only, under proposed conditions for the Norval West Bypass MCEA, the SWM ponds are modeled assuming the Southeast Georgetown Secondary Plan area is undeveloped. Under future conditions, runoff from the southeast portion of Bypass will be conveyed to the Southeast Georgetown Secondary Plan SWM pond. The storage/footprint requirements for SWM Pond 1 identified for this MCEA study were determined to inform the future development SWM Pond design which will be refined as development plans progress.

6.0 Storm Sewers

The minor system storm event for the proposed Norval West Bypass will be conveyed via storm sewers. The configuration of the urban cross-section stipulates storm sewer inlets on both north-bound and south-bound lanes, abutting the outside curbs that oppose the center median. Existing storm sewers are located along Guelph Street, in the Village of Norval. No storm sewers currently exist along 10 Side Road at the Norval West Bypass intersection. Storm sewers are proposed with the new 10 Side Road improvements. The Norval West Bypass sewers are not expected connect to the storm sewer networks at the intersections of Guelph St. or 10 Side Road.

Based on the proposed Norval West Bypass profile, two branches of storm sewers are recommended to divide the minor system runoff to the north and south segments at the highpoint in the roadway. Both north and south storm sewer branches will outlet to the proposed SWM pond inlets (SWM Pond 1 and SWM Pond 3). For the purpose of this report, the proposed Norval West Bypass will be classified as an Arterial Road thus, the minor system design flow is defined as the 10-year return period.

Under future conditions, the proposed development may replace the roadside ditching on the south segment of the Bypass. As a result, the storm sewers proposed along the south segment of the Bypass would be required to convey the major storm (100-year return period) flow to SWM Pond 1. Inlet capacity and flow spread analyses should be completed during detailed design to ensure safe vehicular travel. The ultimate configuration of the proposed storm sewer system will be confirmed during detailed design.

7.0 Roadside Ditching

Roadside ditching will be implemented into the proposed Norval West Bypass cross-section to accommodate the flows from major storm events, where required. For example, at the north end, ditching will be provided along the cut area and would be retained either at the toe of the slope or at the base of any future retaining walls.

Where ditching is practical and feasible, the proposed cross-section will include ditching adjacent to the multi-use pathway on both northbound and southbound lanes. It is anticipated that the SWM plan will continue to be refined through detailed design in coordination with development in the Southeast Georgetown Secondary Plan area.

A preliminary hydraulic capacity analysis was completed using FlowMaster to determine the required configuration of the roadside ditching. The criteria for the roadside ditch design are based on the Highway Drainage Design Standards (MTO, 2024). Due to the spatial constraints under ultimate conditions, a V-ditch is proposed on both sides of the Bypass. The Roadside Ditching design criteria is provided in Table 11.

Table 11: Norval West Bypass Roadside Ditching Design Parameters (for analysis purposes only)

Parameter	Minor System	Major System
Maximum Velocity	1.5 m/s for grass-lined ditching	1.5 m/s for grass-lined ditching
Flow Depth	1.0m	Must be contained within ditching
Minimum Freeboard	0.3m to Sub-grade	N/A
Minimum Depth	0.5m 0.3m to road Sub-grade	0.5m 0.3m to road Sub-grade
Maximum Side Slopes	2:1	2:1

Based on the design parameters, a concept section was modeled in FlowMaster to determine the flow characteristics at the North and South segments of the Bypass. The following assumptions were made for the FlowMaster input:

- To account for the crossfall at the median, flow is assumed to be 50% of regional storm peak flow for catchments 202 for the north segment at 5% longitudinal grade (See section 5.3.4 for catchment details).

- To account for the crossfall at the median, flow is assumed to be 50% of regional storm output for catchment 204 for the south segment at 1% longitudinal grade (See section 5.3.4 for catchment details).
- Ditch section is a symmetrical V-ditch with 2:1 side slopes.
- Manning's n for the north is 0.055 for vegetative channel with rock check dams.
- Manning's n for south is 0.035 for vegetative channel.

The FlowMaster results are summarized in Table 12. FlowMaster output is provided in Appendix D.

Table 12: Norval West Bypass Ditching FlowMaster Results

Section	50% Flow (m^3/s) (Regional Storm)	Flow Depth (m)	Velocity (m/s)	Top Width at Water Level (m)
North Bypass	0.524	0.44	1.37	1.75
South Bypass (for analysis purposes only)	0.229	0.37	0.85	1.46

Therefore, it is recommended that the roadside ditching should be a minimum depth of 0.5m to control the regional storm event. The final configuration of the roadside ditching will be confirmed during the detailed design stage.

8.0 Culverts

8.1 Existing Culverts

The Norval West Bypass is a new road thus, no culverts currently exist within the proposed alignment. However, the implementation of the Proposed Norval West Bypass will have a direct impact to existing culverts located at 10 Side Road (Levi Creek) and Guelph St. / Highway 7 (Silver Creek), downstream of the study area.

10 Side Road

The proposed 10 Side Road alignment is offset from the existing 10 Side Road alignment. It is unknown at this stage if the existing 10 Side Road alignment will be retained and abandoned or removed and repurposed. The Drainage and Stormwater Management report (Clarke, 2004) indicated that the culverts between 10th Side Road and Levi Creek will be abandoned when new storm sewers and ditch inlets are installed. Per the Region of Peel AutoCAD Civil 3d Existing base drawing, the existing 10 Side Road Culvert is a 300 mm diameter CSP.

The hydraulic capacity and condition of the existing 10 Side Road culvert should be confirmed during detailed design. Should the existing 10 Side Road alignment be retained, it is recommended that the 10 Side Road culvert be replaced and relocated to accommodate the Norval West Bypass alignment and convey drainage from the adjacent development lands.

Highway 7

It was discovered through correspondence with CVC, that floodplain mapping is not currently available for the reach of Silver Creek that crosses Highway 7. A hydraulic model was completed for the Silver Creek Subwatershed Study (CVC Et al., 2002) in HEC 2 software. The HEC 2 model provided flood elevations upstream of Highway 7 at Silver Creek Bridge for existing, interim and ultimate land use scenarios. Through review of the hydraulic output, the regional storm elevation for the ultimate condition scenario at the section upstream of Highway 7 is 206.56m. From the Norval West Bypass concept alignment, the low point of the proposed Norval West Bypass road profile is approximately 210.00 masl. Therefore, as no modifications are proposed to the Silver Creek Bridge, it is not anticipated that the Bypass will impact the flood elevations in Silver Creek at Highway 7 nor conveyance through the Silver Creek Culvert. It is recommended that additional hydraulic modeling of Silver Creek at Highway 7 be completed during detailed design to confirm the results from the existing Silver Creek Subwatershed Study.

8.2 Proposed Culverts

In order to identify the suitable locations for proposed culverts crossings along the proposed Norval West Bypass, Highway 7 roundabout, new 10 Side Road alignment, 10 Side Road roundabout and Adamson St S. and Winston Churchill Blvd. extensions, an evaluation of the future development SWM plan will be required. . For the purposes of this MCEA, a preliminary culvert placement analysis was completed to determine suitable locations based on the following factors:

- Proposed road and ditching profile (low points).
- Proposed conveyance pathways.
- Natural drainage pattern connectivity.

Six (6) new culverts are recommended with the implementation Norval West Bypass and adjoining roadways. Table 13 summarizes the recommended culvert locations. Figure 4 illustrates the proposed culvert locations.

Figure 4: Proposed Culvert Locations

Table 13: Norval West Bypass and 10 Side Road Proposed Culvert Details

Culvert ID	Roadway	Ditching / Watercourse	Downstream Outlet	Flow Direction
CLVT_1	Norval West Bypass	Tributary to Silver Creek	Silver Creek	West
CLVT_2	Norval West Bypass	Levi's Creek Headwater Feature	Levi's Creek	Northeast
CLVT_3	Existing 10 Side Road	SWM Pond 1 Outlet	Levi's Creek	Southeast
CLVT_4	Norval West Bypass	10 Side Road Ditching	Levi's Creek	Northeast
CLVT_5	Adamson St. S. Extension	Adamson St. S. Ditching	Levi's Creek	Southeast
CLVT_6	Winston Churchill Blvd. Extension	SWM Pond 2 Outlet	Levi's Creek	Southeast

The hydraulic openings of the proposed culverts will be designed in accordance with the Highway Drainage Design Standards (MTO, 2024). Following confirmation of the proposed road profiles, a detailed investigation of the new culverts should be completed to determine hydraulic capacity and structural requirements.

9.0 Conclusions and Recommendations

The preceding report summarizes the Drainage and Stormwater Management objectives for the Norval West Bypass Municipal Class Environmental Assessment (MCEA) Study. The following is concluded/recommended based on the proposed drainage analysis for the study corridor:

- Norval West Bypass will bisect the study area and increase the drainage areas to Levi's Creek and Silver Creek watersheds by 21.7% and 19.6%, respectively.
- The urban cross-section proposed for the Norval West Bypass will result in increased flows and pollutant runoff from the roadway.
- Contributing drainage area to the Silver Creek outlet requires SWM Pond 3 to have an active storage volume of 3,659 m^3 to control the 24 hr. SCS Type II, 100-year storm event.
- Contributing drainage area (excluding the proposed 10 Side Road roundabout, new 10 Side Road alignment and Adamson St S. and Winston Churchill Blvd. extensions) to the Levi's Creek outlet requires SWM Pond 1 to have an active storage volume of 11,938 m^3 to control the 2-year up to and including the 48-hour regional storm event.
    - Including the contributing drainage area of the proposed 10 Side Road roundabout, new 10 Side Road alignment and Adamson St S. and Winston Churchill Blvd extensions, the Levi's Creek outlet requires SWM Pond 2 to have an active storage volume of 1377 m^3 to control the 2-year up to and including the 48-hour regional storm event.
- Water Quality, Quantity and Erosion control can be achieved through 3 SWM Ponds:
    - Estimated land area required for the SWM Pond 1 is 0.90 ha (note; SWM Pond 1 is to be implemented in coordination with the Southeast Georgetown Secondary Plan and is to accommodate this drainage).
    - Estimated land area required for the SWM Pond 2 is 0.24 ha.
    - Estimated land area required for SWM Pond 3 is 0.40 ha.
- Additional LIDs and MTBs recommended to enhance water quality and erosion control objectives include Oil Grit Separators, enhanced grass swales, permanent rock check dams, catchbasin inserts or porous pavement.

- Online underground storage / infiltration facilities for the portion of the Norval West Bypass and the proposed 10 Side Road roundabout, new 10 Side Road alignment and Adamson St S. and Winston Churchill Blvd extensions draining to Levi's Creek are recommended to be investigated during detailed design:
    - Potential to satisfy the erosion control criteria and reduce the storage volume required for the SWM ponds.
- Minor storm events will be conveyed via curb and gutter system and storm sewers.
- Beyond the Southeast Georgetown Secondary Plan area, major storm events will be conveyed via roadside ditches with, with 2:1 side slopes and minimum 0.5 m depth:
    - Ditch inlets should be installed where required.
- Six new culverts are recommended with the implementation of the Norval West Bypass, Highway 7 roundabout, new 10 Side Road alignment, 10 Side Road roundabout and Adamson St S. and Winston Churchill Blvd. extensions.
- An erosion threshold analysis is recommended to be completed at the Silver Creek outlet during detailed design to identify target release rates.
- Scour Assessment Requirements for the existing Headwater Drainage Features within the study area are to be confirmed during detailed design.
- The stormwater management plan for the Norval West Bypass improvements will continue to be refined through detailed design to coordinate and align with development in the Southeast Georgetown Secondary Plan area.