FUNCTIONAL SERVICING REPORT ADDENDUM
GLEN WILLIAMS PHASE 2

Prepared for:
1404649 ONTARIO LIMITED

Prepared by:
MATRIX SOLUTIONS INC.

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Guelph, Ontario

Unit 7B, 650 Woodlawn Rd. W
Guelph, ON, Canada N1K 1B8
T 519.772.3777 F 226.314.1908
www.matrix-solutions.com

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Prepared for 1404649 Ontario Limited, March 2021

Alexandra Grosse, P.Eng.
Civil Engineer

reviewed by

Stephen Braun, P.Eng.
Senior Water Resources Engineer

CONTRIBUTORS

Name	Job Title	Role
Alexandra Crosse, P.Eng.	Civil Engineer	Primary author - Grading and Servicing
Shaina Blue, P.Eng.	Water Resources Engineer	Primary author - Stormwater Management
Stephen Braun, P.Eng.	Senior Water Resources Engineer	Senior Reviewer
Zoey Zimmer, P.Eng.	Water Resources Engineer	Stormwater Management Assessment
Kelly Molnar, P.Eng.	Water Resources Engineer	Hydraulic Assessment
Ziyang Zhang, M.Sc.	Water Resources Engineer-in-Training	Hydraulic Modeller
Kim Weiler	Senior Civil Designer	Civil Designer

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EXECUTIVE SUMMARY

1404649 Ontario Limited (the owner) retained Matrix Solutions Inc. to prepare an addendum to the Glen Williams Functional Servicing Report, originally dated 2015 (BCEL 2015). The following addendum indicates how servicing and stormwater management (SWM) will be completed for the Glen Williams Phase 2 Development (the site); the site includes 28 residential lots located on the proposed extension of Bishop Court between the existing Bishop Court cul-de-sac to Confederation Street. This report builds on the Stormwater Management Implementation Report (Burnside 1999) and Functional Servicing Report (BCEL 2015).

Storm Drainage

Under existing conditions, the site's land use consists of agricultural type lands, natural valley lands, a former gravel extraction pit, and a conifer plantation. Runoff from the existing site is conveyed to the valley lands of two Credit River tributaries (referred to as Reach 5 and the eastern tributary of the Credit River watercourse) that divide the site roughly in half. Proposed drainage patterns for the site will remain consistent with existing conditions.

Low impact development (LID) techniques are proposed to mimic pre-development hydrology, promote infiltration, and reduce storm runoff across the development area. These LID techniques include infiltration trenches and swales, enhanced swales, lot level soakaway pits, and raingardens. The proposed site water balance indicates a 9% increase in infiltration from existing conditions and provides a retention of the 10 mm storm, including from any areas formerly part of the conifer plantation.

In accordance with the Town of Halton Hills (the Town) engineering standards, the minor system has been designed to convey the 5-year storm, while the major system is contained within the right-of-way (ROW). Both systems are conveyed to the Phase 2 SWM facility, which consists of a dry pond with active storage for attenuation of peak flows (quantity control) and a subsurface infiltration gallery addressing erosion and quality control. The Phase 2 SWM facility outflow is combined with the outflows from an infiltration swale (which conveys uncontrolled runoff from adjacent rear yards) and conveyed to a retrofitted Phase 1 wet pond via a new outlet swale. The existing Phase 1 SWM facility will be expanded to incorporate the flows from the Phase 2 facility in accordance with Burnside (1999). Both Phases 1 and 2 SWM facilities will utilize the existing Phase 1 outlet to the eastern tributary of the Credit River.

Sanitary Servicing

The development will have private septic systems for each lot. An assessment of the potential impacts of the proposed septic beds on the freshwater habitat has been completed, in addition to a nitrate impact analysis. The individual tertiary treatment systems proposed for each lot have been determined to limit the cumulative nitrate concentration in the shallow groundwater system to less than 2.9 mg/L at the property boundary.

Water Supply

A 300 mm watermain is proposed within the Bishop Court extension. The 300 mm watermain will be extended within the Confederation Street ROW to connect to the existing 250 mm watermain at its existing intersection with Bishop Court, thereby eliminating the dead end watermain within Bishop Court. The water distribution system will be designed in full compliance with the Regional Municipality of Halton (Halton Region) standards; 25 mm diameter water service connections will be provided to each lot. Fire protection will be provided by the installation of hydrant sets in accordance with Town and Halton Region standards.

Site Grading

Final proposed site grading and lot drainage will conform to the Town standards. Proposed grades will match existing grades at the limit of development. Efforts have been made to minimize disturbance and respect existing major drainage catchments. Historically, a portion of the development area had been used for gravel extraction; therefore, significant fill has been required to achieve proposed grades. Coordination with the geotechnical consultant will be required during the detailed design phase to identify and address any areas requiring engineered fill and to determine site infiltration properties.

The road will be designed in accordance with the Town design standards for a rural estate residential road. The proposed road has a maximum grade of 6% and minimum grade of 0.5% and vertical coefficients of 15 and 15 have been used for crest and sag, respectively.

Watercourse Crossings

The extension of Bishop Court will cross Reach 5 and the smaller intermittent eastern tributary at points just upstream of their confluence. The alignment has been designed to minimize impacts at these crossings. Based on the geomorphic analysis completed (PARISH 2015), arch culverts are proposed for the Reach 5 and intermittent eastern tributary crossings, sized at 11 m and 4 m respectively. As part of the development, three existing culverts will be removed, allowing watercourses to be more closely restored to natural channel conditions. A completed post-development HEC-RAS model has been completed, which indicates that the proposed development and crossings will not adversely impact the floodplain and channel dynamics of Reach 5, the eastern tributary, or the combined Credit River tributary below the confluence of these upstream watercourses.

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1 INTRODUCTION

1404649 Ontario Limited (the owner) is seeking approval for the second phase of the Glen Williams rural residential community development in the Town of Halton Hills (the Town). The proposed development will complete a road connection from the eastern end of existing Bishop Court in Phase 1 and out to Confederation Street in support of 28 residential lots. The proposed development will also include a stormwater management (SWM) block and a number of open space blocks.

The subject site is 19.5 ha in area and includes a larger (Reach 5) and small tributary of the Credit River, which form a confluence on the site. The site is bounded by Phase 1 of the development to the south, Confederation Street (Ninth Line) to the west, agricultural lands to the north, and valley and natural lands to the east. The legal description of the lands is Part of West Half Lot 23, Concession 10, in the Town of Halton Hills. The site location is illustrated in Figure 1.

This addendum report has been prepared to address comments provided by Credit Valley Conservation (CVC), the Town, and the Regional Municipality of Halton (Halton Region) regarding the Braun Consulting Engineers Limited (BCEL) report titled *Glen Williams Phase 2, Town of Halton Hills, ON, Functional Servicing Report* dated March 2015 (the FSR; BCEL 2015). This addendum report is intended to supplement the original FSR (BCEL 2015) and therefore follows a similar format. However, the information presented in the original FSR has not been repeated in its entirety, and this addendum report includes reference to the original FSR where required.

Figure 2 illustrates the proposed development used in guiding updates to the proposed SWM strategy.

2 EXISTING CONDITIONS

The site is generally divided by two existing watercourses creating western, central, and eastern tableland portions, as well as corresponding steeper valley areas. The following sections summarize key information and relevant background studies that have been completed since the original FSR (BCEL 2015). Figures 3 and 4 indicate external drainage areas and existing site topography and features at the subject site.

2.1 Geotechnical Conditions

A number of geotechnical studies have been undertaken for the subject lands. A summary of relevant information from studies since the original FSR (BCEL 2015), which have been relied on during the preparation of this addendum, is provided below. Relevant excerpts from the studies are included in Appendix A.

- *Slope Stability Assessment Report*, Soil Engineers Ltd., February 2015 (Soil Engineers 2015a)
    - This study assessed the stability of the valley slopes, provided details regarding the approximate setbacks for the development, and provided recommendations on the construction of the proposed SWM facility per CVC comments. Note these recommendations were based on earlier versions of the proposed Phase 2 SWM facility and are not necessarily applicable to the current proposed Phase 2 SWM facility design. These will be revisited during the detailed design phase.
    - The study includes groundwater level measurements from this and previous studies in the vicinity of the proposed Phase 2 SWM facility and wetland (included in Appendix A for reference).
- *Draft Phase II Environmental Site Assessment*, AEL Environment, June 2015 (AEL 2015)
    - A soil and water quality investigation focused on the eastern portion of Phase 2 for the former industrial (quarry) lands.
    - Groundwater level measurements were recorded at 19 monitoring wells (7 in the west and 12 in the east) during five sampling events between November 2013 and April 2015. Groundwater level measurements are included in Appendix A for reference.
    - The surficial soils comprise till deposits, consisting of clay to silt textured till, derived from glaciolacustrine deposits or shale. Most of the site is a fine sandy loam, with low runoff potential and high infiltration rate, due to the sand and gravel component. The southwest end of the site is Oneida clay loam, with low infiltration rate and typically silty-loam soils.
- *A Soil Investigation for Proposed Residential Development - Bishop Court and Confederations Street,* Soil Engineers Ltd., November 2015 (Soil Engineers 2015b)
    - Five boreholes were installed within the Phase 2 area to log subsurface soil conditions: earth fill and silty clay in the western tablelands (BH1) and sandy-silt till, silt, and fine sand in the eastern tablelands (BH 4-5). Near the valley, there is earth fill and sandy-silt till underlain by shale bedrock (BH 2-3).
    - The report provides geotechnical recommendations for foundations, engineered fill, slab-on-grade, underground services, backfilling and excavating, and pavement design.
- *Response to CVC Comments, Item 6b, dated January 29, 2016*, AEL Environment, February 2017 (AEL 2017a)
    - Additional groundwater level measurements were collected on five separate occasions between March 2016 and September 2016 in response to CVC's January 29, 2016 comments (included in Appendix A for reference).

- *Letter Report re: Percolation tests at 12519 Ninth Line, Georgetown, ON (the Site)*, AEL Environment, 2017 (AEL 2017b)

  - AEL conducted percolation tests at 12 locations within the Phase 2 site area at a 20 cm depth, using an average of three readings per location.

  - The tests determined existing soils have percolation rates in the eastern tablelands greater than 25 mm/hour, in the western tablelands between 10 to 25 mm/hour, and within the valley lands less than 10 mm/hour (refer to Appendix A for reference).

- *Phase II Environmental Site Assessment, 12519 Ninth Line, Georgetown, Halton Hills, Ontario*, AEL Environment, December 2020 (AEL 2020)

  - An updated soil and water quality investigation focused on the eastern portion of Phase 2 for the former industrial (quarry) lands.

  - In addition to the monitoring reported in the 2015 Phase 2 report (AEL 2015), groundwater level measurements were recorded at 10 monitoring wells in May and June 2020. Groundwater level data and resulting contours from this sampling event are included in Appendix A for reference.

2.2 Existing Drainage and Water Features

Under existing conditions, the site consists primarily of agricultural lands, abandoned gravel extraction areas, natural areas of valley lands, and a conifer plantation. Runoff from the existing site is conveyed to the valley lands of the larger (Reach 5) and small (eastern) Credit River tributaries that divide the site. All runoff from the west section of the site is currently directed away from Confederation Street. Adjacent to the site, drainage on Confederation Street itself is achieved through roadside ditches that convey road runoff to the Credit River tributary south of the Phase 2 lands. The majority of runoff from the eastern portion of the site and the entire central portion of the site are directed to the valley lands of the tributaries. Note the existing drainage catchments were delineated as part of the hydrologic modelling and are discussed further in Section 4.2 and shown on Figure 10.

2.2.1 Site Watercourses

Within the development areas, two watercourses merge to form a single Credit River tributary. The external drainage areas are shown on Figure 3. The western watercourse (Reach 5, western tributary) has a total catchment area of 128.0 ha, of which 124.3 ha is upstream of the development area and 3.7 ha is within the development area. The eastern watercourse (eastern tributary) is intermittent in nature and has a total catchment area of 37.9 ha, of which 35.5 ha is upstream of the development area and 2.4 ha is within the development area. Further details of the watercourses are provided in the geomorphic assessment (PARISH 2015).

The external drainage areas to the two tributaries were incorporated in the hydrologic model as discussed further in Section 5. An existing conditions HEC-RAS (USACE 2016) model was prepared for the purpose of delineating the Regional floodplain for the western tributary (Reach 5). The catchment area of the eastern intermittent tributary could be considered too small to warrant delineation of a Regional floodplain; however, this tributary was included in the HEC-RAS hydraulic model for the purpose of assessing impacts of the proposed road crossing. Hydraulic modelling is discussed in further detail in Section 6. The existing condition floodplain for both the Reach 5 tributary and the smaller eastern tributary is indicated on Figure 4.

2.2.2 Existing Watercourse Crossings

There are a number of existing culverts within the Phase 2 subject site (see Figure 4). There is an existing 1,200 mm corrugated steel pipe (CSP) culvert downstream of the Reach 5 and eastern tributary confluence, which conveys the Credit River tributary flow under an existing quarry access road. There is an additional 450 mm culvert located just west of the 1,200 mm CSP, which conveys the west bank flows under the quarry access road. Upstream of the confluence, the eastern tributary flows through a 750 mm diameter CSP culvert. All three existing culverts will be removed under post-development conditions.

2.3 Existing Services

2.3.1 Storm and Wastewater Servicing

The current site is undeveloped and does not include any existing storm or sanitary sewers or septic systems.

2.3.2 Water Supply

A 300 mm diameter watermain exists within the Confederation Street right-of-way (ROW). This watermain currently terminates approximately 260 m south of the Phase 2 development site. A 250 mm diameter watermain was extended into the first phase of the development and currently terminates at the Bishop Court cul-de-sec at the east side of the site.

2.3.3 Shallow Utilities

Within the Confederation Street frontage, hydro is overhead on poles with drainage via roadside swales. A hydro corridor bisects the site running approximately parallel with the southern property boundary (Figure 4).

2.4 Development Constraints

2.4.1 Setbacks

The Phase 2 development site has a total area of 19.5 ha, of which 4.7 ha falls within the development constraint area (“Development Limit” indicated on Figure 4). The development constraint area is based on input from various team experts to identify slope stability limit plus a 5 m setback, Regulatory floodline, wetland buffer (15 m), coldwater fisheries watercourse setback (30 m), meander belt, vegetation protection zone, hamlet buffer (20 m), and restoration planting strip (10 m). The resulting limit of development, which is an integration of the various constraint lines, is identified as the outside boundary along the valley lands (Figure 4). The reader is referred to the *Glen Williams Phase II EIR: Addendum 2* (North-South 2021) for a more complete discussion of the limit of development.

2.4.2 Conifer Plantation

A portion of the Phase 2 development lands include an area of existing conifer plantation. As discussed by North-South Environmental Inc. (2021), the proposed extension of Bishop Court and development of lots 1, 2, 3, and 24 to 28 (a total of 8 residential lots) will result in the removal of approximately 1.79 ha (46%) of the conifer plantation. To minimize erosion associated with the conifer plantation removal, low impact development (LID) features have been designed to mimic the pre-development initial abstraction value of the conifer plantation. Preliminary calculations demonstrating the feasibility of this approach are provided in Section 4.3.2.

2.4.3 Outlet to Credit River Tributary

In a report by Burnside Development Services, a Division of R. J. Burnside & Associates Limited (Burnside; 1999), recommendations were made to coordinate the outflow structure designs of the Phase 1 and Phase 2 SWM facilities in order to minimize erosion within the watercourse. In addition, a detailed geomorphic study of the receiving watercourse (PARISH 2015) addresses some of the requirements for this coordination. An erosion threshold flow value for the tributary reach point just upstream of Bishop Court was estimated to be 0.16 m^3/s (PARISH 2015). An erosion assessment is provided in Section 5.2, which addresses this threshold value as well as other considerations.

2.4.4 Groundwater Elevations

Groundwater measurements have been collected across the site (per references indicated in Section 2.1) to allow prediction of seasonally high levels. To be successfully implemented, LID measures must be selected and confirmed based on a 1 m separation from the recorded seasonally high groundwater elevations. Conceptual LID-type designs, which are outlined in later sections of this report, will require confirmation during the detailed design phase.

2.4.5 Wetlands

Wetlands on the site have been identified by North-South Environmental Inc. (2021). The compensation approach for an existing wetland feature was communicated with CVC in the spring of 2018 (Matrix 2018), resulting in a permit for works being issued in March 2020. Section 8 provides details of this wetland compensation plan.

3 PROPOSED CONDITIONS

The post-development concept includes a road connection extending from existing Bishop Court in phase 1 to Confederation Street in support of 28 residential lots in Phase 2, a stormwater management block and a number of open space blocks buffering the Credit River tributaries. The following sections summarize the proposed grading and servicing details with reference to the original FSR (BCEL 2015) water supply and ROW cross-sections. The SWM strategy for the proposed development is discussed in Section 4.

3.1 Proposed Grading

As indicated in the original FSR (BCEL 2015), "site grading and drainage will conform to the Town of Halton Hills criteria. Every effort will be made to minimize disturbance and respect drainage catchments. Proposed grades will match existing grades at the Limit of Development." Historically, a portion of the development area had been used for gravel extraction; therefore, significant fill has been required to achieve proposed grades. Coordination with the geotechnical consultant will be required during the detailed design phase to ensure adequate infiltration properties of the fill. Further detail regarding grading and fill requirements on the site is provided in Soil Engineers Ltd. (Soil Engineers 2015a).

The proposed grading plan is depicted on Figures 5a and 5b for the western and eastern portions of the study area, respectively. Overall drainage patterns within the site have not been altered significantly under the proposed grading plan and no site runoff will be directed to the drainage system on Confederation Street. Accommodation has been made to provide a drainage outlet for Phase 2 lands that is integrated into the one for Phase 1 lands in accordance with the original Burnside (1999) Phase 1 recommendations. The approach is also confirmed within CVC review comments (July 24, 2015) and in the geomorphic study (PARISH 2015) and is outlined in detail in Section 4.

3.2 Proposed Services

3.2.1 Storm Servicing

3.2.1.1 Minor System

Roadway areas for the site under post-development conditions will be drained via storm sewer (minor system). The minor system will be designed and constructed in accordance with Town engineering standards to convey the 5-year design event. The development has been designed to convey minor storm runoff to the Phase 2 SWM facility, where it will be controlled by the proposed SWM system (Section 4.4).

Sufficient design has been completed to ensure that the minor system crossing of the site's two watercourses is feasible. Additional details are outlined in Section 6 of this report.

The proposed servicing plan is outlined on Figures 6a and 6b.

3.2.1.2 Major System

An overland flow path (major system) is required to convey runoff from larger rainfall events where the minor system capacity is either exceeded or otherwise blocked. The major system provides overland flow paths to safely convey large runoff events that exceed the minor system capacity. The Town requirement for major flow routes on local roads is that all flows are to be conveyed within the ROW boundaries with a maximum depth of 150 mm above road crown.

The development has been designed to convey major storm runoff to the Phase 2 SWM facility where it will be controlled by the proposed SWM system (Section 4.4). Flows exceeding the storm sewer system will proceed along the roadway and will be conveyed into the Phase 2 SWM facility.

A major flow assessment was completed to confirm the capacity of the road ROW to convey the 100-year minus the 5-year storm peak flow rate at the minimum road slope. The highest peak flows for the ROW area were extracted from the hydrologic model.

Based on the major flow assessment, Matrix Solutions Inc. recommends a concrete mountable curb with narrow gutter (Ontario Provincial Standard Drawing [OPSD] 600.100) be considered at the time of detailed design. Under this scenario, the Town standards of less than 150 mm depth at road crown and containing the Major flow within the ROW will be met. Major system flow calculations for the development are provided in Appendix B.

3.2.2 Wastewater Servicing

Please refer to Section 3.3 of the FSR (BCEL 2015) included in Appendix A.

The anticipated location of septic beds for each property have been included in the proposed site figures (Figures 6a and 6b). An assessment of the potential impacts of the proposed septic beds on the freshwater habitat has been completed by AEL. A nitrate impact analysis completed by Harden Environmental Services Ltd. (Harden 2016) concluded that the use of individual tertiary treatment systems on lots would limit the nitrate concentration in the shallow groundwater to less than 2.9 mg/L.

3.2.3 Water Supply

A 300 mm watermain is proposed within the southern edge of the proposed ROW as indicated on Figures 6a and 6b. The 300 mm watermain will be extended within the Confederation Street ROW to connect to the existing 250 mm watermain at the Bishop Court cul-de-sac. This will create a looped watermain which will eliminate the existing dead end within Bishop Court Phase 1. The water distribution system will be designed in full compliance with The Town and Halton Region standards. Water services that are 25 mm in diameter will be provided to each lot. Fire protection will be provided by the installation of hydrant sets in accordance with municipal standards.

Water distribution system analysis completed by Westhoff Engineering Resources Inc. is provided in Appendix C. The Glen Williams Phase 2 development is located within the Georgetown well supply system and would be connected to the service zone 6G6 (Westhoff 2017). The following is a summary of the water distribution analysis (Westhoff 2017):

- To complete the watermain such that the 250 mm dead end on Bishop Court in Phase 1 is removed, there by ensuring better fire flow capacity, a 300 mm diameter watermain is proposed within the Phase 2 development.
- The average daily demand analysis of the network resulted in the minimum pressure varying between 292 and 480 kPa (42 to 70 psi).
- The peak hour demand analysis of the network resulted in minimum pressure varying between 233 and 421 kPa (34 to 61 psi).
- The capacity to deliver the required fire flow (assumed 90 L/second for 2 hours) simultaneously with maximum daily demand was confirmed while the minimum modeled pressure is varying between 136 and 276 kPa (20 to 40 psi). Design parameter are met by maintaining or exceeding a system pressure of 20 psi.
- Results of the distribution modelling show that the proposed watermain is adequately sized.

3.2.4 Shallow Utilities

Details related to extending hydro, telephone, cable television, and gas services into the Phase 2 development will be confirmed with the respective utility operators during the detailed design stage of the project.

3.3 Road Alignment and Cross-section

The proposed roadway alignment has been developed and discussed through previous submissions. This section summarizes the details of the proposed road alignment and crossings. Please refer to Section 3.5 the FSR (BCEL 2015), included in Appendix A, for additional details.

The extension of Bishop Court will cross Reach 5 and the eastern tributary of the Credit River watercourse. The alignment has been designed to minimize impacts at these crossings (PARISH 2015). The proposed ROW width is 20 m and replicates the existing Bishop Court cross-section with a 6.5 m wide roadway. Figure 2 includes road dimensions and horizontal geometry of the proposed road.

The proposed road varies in elevations; 275 m at the intersection with Confederation Street, to a low of 259.8 m at the Phase 2 SWM facility, to 264.1 m at the existing Bishop Court cul-de-sac. Reach 5 has a channel bottom of 256.5 m at the road crossing. An asphalt surface with curbs, catch basins, and storm sewers will provide the most efficient cross-section to grade back to existing elevations and limit erosion concerns associated with road drainage. The proposed typical cross-section configuration is depicted in Figure 7. The hydraulic assessment for the watercourse crossings of the proposed road alignment is discussed in Section 6.

The road will be designed in accordance with the Town design standards for a rural estate residential road. The proposed road has a maximum grade of 6% and minimum grade of 0.5% and vertical coefficients of 15 and 15 have been used for crest and sag, respectively. A proposed geotechnical road structure provided by Soil Engineers (Soil Engineers 2015a) is included in Figure 7.

4 STORMWATER MANAGEMENT STRATEGY

In the stormwater servicing plan originally developed by Burnside (1999) for the Phase 1 and Phase 2 lands, a SWM facility was proposed for each of the two development phases, and it was suggested that consideration be given to a single integrated outlet to the watercourse. An integrated outlet was further reinforced as desirable in CVC review comments (July 24, 2015) on the FSR (BCEL 2015). The Burnside (1999) Phase 1 design information was used to develop the SWM strategy for Phase 2 described in this section. Additionally, impacts to watercourse erosion potential were considered in the design of the integrated Phase 1 and Phase 2 outlet in order that erosivity associated with proposed post development flow regime would not differ significantly from existing.

The following main points outline the proposed SWM plan:

- In accordance with the original Burnside (1999) SWM report that addressed both phases of development, the revised Phase 1 and new Phase 2 SWM facilities will be integrated to ensure overall compliance of stormwater objectives.

- As originally proposed, the existing Phase 1 SWM facility to the south will be cleaned out and retrofitted to provide additional quality and quantity control of runoff for Phase 1 and Phase 2 lands. It will remain a wet pond design.

- The proposed Phase 2 SWM facility will include infiltration via an underground infiltration gallery. Bioretention may be achieved through soil amendments and/or a forebay during the detailed design phase.

- The proposed Phase 2 SWM facility will also provide peak flow control of storm runoff in coordination with the Phase 1 retrofitted facility.

Matrix has completed preliminary design and modelling to determine that the proposed SWM concept presents a feasible and effective approach to storm servicing of the Phase 2 lands. The plan also provides for a cleaned-out and retrofitted Phase 1 facility that will not require maintenance until much later than it would otherwise require, thereby reducing future disturbance and providing savings to the Town.

The SWM concept for Phase 2 of the residential community incorporates several LID designs and includes:

- lot-level management of runoff via roof soakaway pits
- rear-yard rain gardens within the conifer plantation disturbance limits
- end-of-pipe SWM facility consisting of a dry pond with an underlying infiltration gallery
- infiltration swale for uncontrolled rear-yard drainage
- Phase 2 outlet swale, which conveys flows to the existing Phase 1 wet pond

    - The Phase 1 wet pond is proposed to be retrofitted to maximize treatment and attenuation capacity of the existing pond.

Approximate locations for LID measures and facilities are indicated on Figure 2, with details on Figure 8 (LID measures) and Figure 9 (SWM facilities). Exact positioning and sizing of LID measures will be confirmed during the detailed design phase.

As previously outlined, all fill material required to achieve proposed grades will be coordinated with the geotechnical consultant to ensure it is adequate to achieve the intended infiltration rate for the proposed LID measures. Suggested infiltration rates for the LID measures are discussed in further detail in Section 4.3.2.

4.1 Stormwater Management Criteria

SWM criteria are based on the Ontario Ministry of the Environment, Conservation and Parks (MECP; previously the Ontario Ministry of the Environment [MOE] *Stormwater Management Planning and Design Manual* (MOE 2003), CVC SWM Guidelines (CVC 2012), Town SWM Policy and Guidelines (Town of Halton Hills 2009), CVC and Town review comments (July 24, 2015) and the geomorphic study (PARISH 2015). Relevant SWM criteria include:

- **Quantity control:** post-development peak flow rates must not exceed pre-development levels for all storms up to and including the 100-year storm. Safe conveyance of the Regulatory storm event must also be provided.

- **Quality control:** an “enhanced” level of water quality management must be achieved in accordance with MOE 2003; i.e., 80% long-term average total suspended solids [TSS] removal.

- **Erosion potential:** post-development flow controls for the 2-year storm, such that the critical erosion threshold of 0.16 m^3/s is not exceeded in the Credit River tributary more than it is under pre-development conditions per PARISH (2015).

- **Water balance:** maintenance of pre-development infiltration/recharge amounts across site. For the proposed conifer plantation removal within the limit of grading on the western tablelands, there is to be zero post-development runoff for storms equivalent to the pre-development initial abstraction value.

In addition to the above criteria, other LID-type best management practices (BMPs) will be implemented to enhance the overall hydrologic response of the site by reducing the impacts of impervious areas and increasing infiltration. Runoff from the road ROW will be directed by storm sewer to the SWM facility for appropriate treatment.

4.2 Drainage Concept

To assess pre-development peak flows, catchment boundaries were delineated for existing drainage conditions (Figure 10) based on existing drainage patterns and previous modelling by BCEL (2015). Pre-development catchments 10 to 12 drain to the western tributary (Reach 5) and catchments 20 to 24 drain to the eastern tributary. The remaining areas (catchments 30 to 32) drains to the confluence of the two tributaries. Within the existing Phase 1 area, catchment 50 drains to the Phase 1 wet pond and catchment 51 drains uncontrolled to the tributary north of the existing Bishop Court.

To assess post-development peak flows, catchments were delineated for proposed drainage conditions (Figure 11) based on the grading concept (Figures 5a and 5b) and existing conditions on Phase 1 lands.

Runoff from the rear of lot 1 (catchment 110) and the non-driveway portion of lots 2 and 3 (catchments 120 and 900) will continue to flow uncontrolled to the site tributaries. Runoff from the rear yards of lots 24 to 28 (catchment 230) will be collected into an existing backyard swale on the western tablelands and discharge uncontrolled into the now-merged Credit River tributary. The uncontrolled discharge locations do not require quality management, as the runoff from the rear yards is considered adequately “clean”. This approach will minimize grading on each lot in order to better maintain existing conditions and protect trees and other vegetation in the area. Rain gardens are also proposed within lots 1 and 24 to 28 to provide additional water balance benefits to mimic the pre-development initial abstraction within the conifer plantation (Section 4.3.3).

Drainage from the front of lot 1 (catchment 100) and lots 17 through 28 (catchments 200 and 620 to 680), as well as the full drainage from lots 4 through 16 (catchments 500, 520, 540, 560, and 580), will be directed to the road ROW (catchments 510, 530, 550, 570, 590, 300, and 700) which will convey runoff to the Phase 2 SWM facility via storm sewer.

Runoff from the rear yards of lots 17 to 23 (catchment 610) will discharge to an infiltration swale, where it will be combined with the outflows from the Phase 2 SWM facility (catchment 800) and conveyed via the Phase 2 outlet swale to the retrofitted Phase 1 wet pond (catchment 830). Existing drainage areas to the Phase 1 wet pond are shown on Figure 11 (catchments 9000 and 9010) and have been delineated based on current topographic data and property lines.

4.3 Low Impact Development Approach

This section outlines the proposed approach to LID-type features based on the recorded groundwater elevations in the vicinity of the proposed LIDs, a screening assessment of LID techniques, and preliminary LID design considerations.

4.3.1 Low Impact Development Techniques

In an effort to better mimic pre-development hydrology, promote infiltration, and reduce storm runoff across the development area, a number of LID techniques have been considered and are summarized in Table A.

TABLE A Low Impact Development Screening Assessment

Low Impact Development Technique	Design Considerations [1]
Permeable pavement on driveways	Site topography: slope >1% and <5% Soil type: if infiltration rate <15 mm/hour perforated pipe underdrain is recommended Drainage area: impervious area <1.2 times permeable pavement area Setback from buildings: should be located downslope from building foundation; 4 m setback recommended if receiving runoff from other surfaces (other than rainfall on permeable pavement) Building envelope: appropriate building envelope required for adjacent buildings to ensure longevity of building Groundwater elevation: minimum 1 m separation from seasonal high groundwater elevation
Infiltration trenches and swales	Site topography: slope <15% Soil type: permeable soils are ideal (types A and B) Drainage area: ratio of impervious drainage area to infiltration trench should be between 5:1 and 20:1 Building envelope: minimum 4 m setback from building foundations Groundwater elevation: minimum 1 m separation from seasonal high groundwater elevation

Low Impact Development Technique	Design Considerations (1)
Enhanced grassed swales	Available space: consume about 5% to 15% of contributing area with minimum 2 m width required Site topography: slope >0.5% and <6% Drainage area: ratio of impervious drainage area to enhanced grass swale should be between 5:1 and 10:1 Building envelope: minimum 4 m setback from building foundations
Lot level soakaway pits	Available space: reserve open areas of about 10% to 20% of contributing drainage area size Site topography: slope >1% and <5% Soil type: preferred hydrologic soil group A and B Drainage area: maximum recommended contributing drainage area is 0.8 ha Setback from buildings: 4 m setback from building foundations is required if impermeable liner not used Groundwater elevation: minimum 1 m separation from seasonal high groundwater elevation
Bioretention/rain gardens	Soil type: soils must have a percolation rate greater or equal to 15 mm/hour Depression storage: ponding should be a shallow depression storage with a maximum depth of 150 mm Setback from buildings: 4 m setback from building foundations and should not be located over septic bed Groundwater elevation: minimum 1 m separation from seasonal high groundwater elevation

(1) Summarized based on *Low Impact Development Stormwater Management Planning and Design Guide* (CVC and TRCA 2010).

The use of permeable pavers for the residential driveways was considered; however, the mandating of future residents to constantly maintain this type of feature did not seem feasible. The majority of the driveway area would drain to an adjacent grassed area, allowing for infiltration of this runoff with out the reliance on permeable pavers.

4.3.2 Groundwater Levels for Low Impact Development Consideration

Groundwater level data collected by AEL between November 2013 and September 2016 within catchments 110, 230, and 610 (Figure 11) were reviewed for the purpose of assessing feasibility of the proposed infiltration measures.

4.3.2.1 Western Tablelands

MW6 of the draft *Phase II Environmental Site Assessment* (AEL 2015; Appendix A), located within catchment 230 (rear lots 24 to 28), indicated that, based on four groundwater level measurements, the average depth to ground was 1.86 m and ranged from 0.74 to 1.78 m. Additional measurements collected in 2016 are summarized in the AEL *Response to CVC Comments, Item 6b, dated January 29, 2016* (AEL 2017a; Appendix A). The additional measurements at MW403, located within close proximity to MW6, indicated that the average depth to ground, based on five measurements, was 2.00 m and ranged from 1.33 to 2.71 m below ground surface (bgs). As no proposed grading is anticipated along the existing channel, the overland flow is proposed to continue to drain uncontrolled to best simulate existing conditions. It should be noted that erosion protection measures should be implemented during the detailed design phase.

For other lot-level LIDs within the western tablelands, groundwater levels recorded in April 2015 at mwp2007-1 were 5.5 m bgs (Soil Engineers 2015a; Appendix A).

4.3.2.2 Eastern Tablelands

Within catchment area 610 (rear lots 17 to 23), which is proposed to drain uncontrolled to the retrofitted Phase 1 pond, AEL (2015) installed two groundwater wells near the proposed infiltration swale. Again, four groundwater level measurements were taken at these locations, with the average depth from ground surface of 5.39 m and 5.67 m at wells MW301 and MW102, respectively. An additional five groundwater level measurements were collected in 2016 from an additional well, MW402, located within close proximity to the proposed infiltration swale and SWM facility (AEL 2017a). The average depth to ground based on the five measurements was 4.44 m and ranged from 3.82 to 4.76 m bgs.

At the constructed wetland and in the vicinity of proposed SWM facility, the highest groundwater elevation of 254.06 m above sea level (asl; 3.8 m below existing ground surface) was recorded in March 2016 at MW 402, with an average of 4.4 m bgs (AEL 2017a; Appendix A). The gradient of the groundwater elevation is toward the tributary, and elevations are higher further from the tributary and valley. Based on the proposed bottom elevation of the constructed wetland (257.25 m) and Phase 2 SWM facility infiltration gallery (255.30 m), a 1 m separation to the seasonal high groundwater level is achievable.

4.3.3 Preliminary Low Impact Development Design

In consideration of the groundwater levels presented in Section 4.3.2, the grading plan (Section 3.1) and drainage concept (Section 4.2) preliminary LID designs have been developed and are outlined in this section.

The post-development grading will extend the ground surface at the proposed lot-level LID locations. Based on the current groundwater level information, the proposed LIDs are considered feasible to achieve the required 1 m separation between the bottom of infiltration facilities and the water table. This will be confirmed on a lot-by-lot basis during the detailed design stage, and potentially at the building permit stage, to suit individual lot configurations. In particular, the lot level soakaway pits will be designed using the same site-specific inputs as the septic systems. If needed, the size of these features can be adjusted to achieve the design criteria.

Based on the existing geotechnical information (Section 2.1) and Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA; 2020) soils mapping, most of the site consists of fine sandy loam/sandy-silt till with high infiltration rate, and is classified as a Type A hydrologic soil group. AEL (2017a) percolation tests determined existing soils have percolation rates in the eastern tablelands greater than 25 mm/hour, in the western tablelands between 10 to 25 mm/hour, and within the valley lands less than 10 mm/hour (Appendix A). For preliminary LID design, infiltration capacities were based on a percolation rate of 15 mm/hour as a conservative measure. Coordination with the geotechnical consultant will be required during the detailed design and/or at the time of building permit phase to confirm adequate infiltration rate of the fill material for the proposed LID measures.

4.3.3.1 Lot-level Soakaway Pits

Each residential property will be equipped with a lot-level soakaway pit to promote infiltration of roof runoff. Soakaway pits were designed to accommodate roof runoff generated by a 25 mm rainfall event and drain the runoff within 48 to 72 hours. Note that if soils are closer to native sandy loam, the soakaway pits will drain runoff within 48 hours. Based on an assumed roof area of 300 m^2, each soakaway pit will have a 20 m^2 footprint. The drainage area to infiltration facility ratio is 15:1, which is well within the CVC's recommended ratio between 5:1 and 20:1.

Consistent with CVC and Halton Region guidelines, the soakaway pits will be placed on the lot such that there is a 4 m setback from buildings and 5 m setback from septic systems. The proposed placements of soakaway pits are indicated in Figure 2, with typical details on Figure 8. Further, TRCA and CVC (2010) roof downspout disconnect design criteria requires the total contributing roof drainage area should not exceed 100 m^2. Therefore, multiple soakaway pits per household will be considered if required during the detailed design phase to meet this design criteria. Actual proposed roof areas will be used to design the soakaway pits, likely requiring this design to be completed during the building permit stage. It should be noted that other stormwater management features onsite (e.g., SWM facilities, swales etc.) have conservatively left out the effect of soakaway pits in their sizing calculations for runoff conveyance and volumes.

4.3.3.2 Rain Gardens

The Phase 2 development will result in the loss of 1.79 ha of existing conifer plantation located in eight proposed residential lots. The removal of this plantation vegetation has been identified as having potential adverse hydrologic effects in terms of watercourse geomorphology. Accordingly, for areas of proposed plantation removal, there is to be zero post-development runoff for storms equivalent to the initial abstraction value under the pre-development conditions. The pre-development initial abstraction value for the conifer plantation was determined to be 10 mm per CVC standard parameters for woods. Of the catchment areas within the plantation disturbance limit, only portions of catchments 110 and 230 drain uncontrolled to the tributary. The remaining areas (within catchments 100, 200, and 300) have lot-level BMPs (roof to soakaway pits) and are directed to the proposed Phase 2 SWM facility (which outlets to the Phase 1 facility) and will not usually have uncontrolled runoff to the tributary during a 10 mm event.

The uncontrolled areas (i.e., lots 1 and 24 to 28) are proposed to have rear-lot rain gardens with 9 m^3 of retention capacity each, with a maximum depression storage depth of 150 mm. This retention volume will provide the difference between pre- and post-development initial abstraction or 10 mm storm event (Table B). The approximate locations of the rain gardens are shown on Figure 2, with a typical detail indicated on Figure 8. Lot 24 should be evaluated during the detailed design phase based on proposed grades to confirm if the required separation to groundwater level is achievable. On the remaining lots, the separation is achievable and rain gardens could be oversized if lot 24 is not feasible. Also of note, the conifer plantation within lots 2 to 3 is not proposed to be disturbed, and as such, no rain gardens are currently proposed for these lots.

In summary, with these proposed measures in place there would be no post-development runoff from the disturbed plantation removal areas to the tributary for storms up to the pre-development initial abstraction value of 10 mm.

TABLE B Design Summary for Rain Gardens within Conifer Plantation

Catchment ID (Figure 11)	Drainage Description	Best Management Practices	Disturbed Area Within Conifer Plantation Draining Uncontrolled to Tributary (ha)	Total Rain Garden Retention Storage Volume (m^3)
110	Uncontrolled rear lot drainage (lot 1)	Rain gardens sized to provide total initial abstraction of 10 mm	0.13	9
portion of 230	Uncontrolled rear lot drainage (lots 24 to 28)	Rain gardens sized to provide total initial abstraction of 10 mm	0.59	45
100, portion of 200	Front draining lots controlled drainage (via stormwater management facility (SWM)	Lot level best management practices (roof to soakaway pits) and end-of-pipe SWM facility	N/A	N/A
300	Right-of-way controlled drainage (via SWM facility)	End-of-pipe SWM facility	N/A	N/A

N/A - not applicable

4.3.3.3 Infiltration Swale

A swale combined with an underground infiltration trench has been designed to promote infiltration and convey runoff from the rear yards of lots 17 to 23. The infiltration trench has been designed to provide retention storage equivalent to an “enhanced” protection level infiltration volume (MOE 2003), with a retention time of 36 hours using 50 mm clear stone (equivalent to a void ratio of 0.4) and maximum depth of 0.6 m. The proposed design is designed to accommodate the runoff received from the 25 mm storm event.

The swale is proposed to be grassed, with exposed stone on the bottom for erosion protection and improved infiltration. The swale is designed to convey the Regional storm flows from the rear yards with a maximum depth of 0.3 m. With the exception of a steeper slope at the upstream end (lot 17), the infiltration swale has a minimum slope of 1% and maximum slope of 4% in accordance with Town standards. The infiltration swale is combined with the outflows of the Phase 2 SWM facility and conveyed to the Phase 1 wet pond (Section 4.4.2).

A cross-section of the proposed infiltration swale is depicted on Figure 8. Design details are provided in Table C and conveyance calculations are included in Appendix B.

TABLE C Infiltration Trench Sizing Characteristics

Contributing Area (ha)	% Impervious	Total Storage Volume Requirement (m^3) (1)	Retention Time (hour)	Percolation Rate (mm/hour) (2)	Required Trench Bottom Area (m^2)	Maximum Depth (m)
1.85	8	30	24-48	15	150	0.6

(1) Storage volume requirement for enhanced 80% long-term total suspended solids removal of infiltration stormwater management type is 16 m^3/ha based on Table 3.2 of *Stormwater Management Planning and Design Manual* (MOE 2003) and contributing area with 8% impervious coverage assumed to account for 200 m^2 of rear-yard pools/patios for each lot.
(2) Percolation rate assumed as minimum low impact development design per *Stormwater Management Planning and Design Manual* (MOE 2003) and *Low Impact Development Stormwater Management Planning and Design Guide* (CVC and TRCA 2010)

4.4 Stormwater Management Facilities Operating Characteristics

This section outlines the sizing and operating characteristics of the proposed Phase 2 SWM facility, the Phase 2 outlet swale, and the Phase 1 wet pond proposed retrofit.

4.4.1 Phase 2 Stormwater Management Facility

The Phase 2 SWM facility was designed with two components: a dry pond with active storage for attenuation of flows (quantity control) and a subsurface infiltration gallery for erosion and quality control. The SWM facility receives major and minor runoff from an 8.48 ha contributing area which includes the road ROW, lots 4 to 16, the front of lots 1 and 17 to 28, and the driveways within the Phase 2 development. The remaining Phase 2 development rear lot areas flow uncontrolled to the tributaries and have LID measures as outlined in Section 4.3.

The preliminary SWM facility plan and profile are shown in Figures 9a and 9b, respectively, with the following design elevations:

- top elevation = 258.00 m
- bottom of dry pond/top of infiltration gallery = 256.90 m
- bottom of infiltration gallery = 255.30 m

The underground infiltration gallery was sized to provide enhanced water quality treatment according to the MOE (2003) guidelines. The SWM facility water quality sizing requirements are summarized in Table D.

TABLE D Phase 2 Stormwater Management Facility Water Quality Sizing Requirements

Contributing Area (ha)	% Impervious	Storage Volume Requirement for Impervious Level (m^3/ha) (1)	Storage Volume Requirement (m^3)	Underground Storage Volume Provided (m^3) (2)
8.48	26%	22	185	346

(1) Storage volume determined from Table 3.2 of *Stormwater Management Planning and Design Manual* (MOE 2003) for enhanced 80% long-term S.S. removal for an infiltration stormwater management facility.
(2) Provided volume based on 0.4 void ratio for subsurface infiltration gallery in Phase 2 stormwater management facility

Preliminary design of the Phase 2 SWM facility active storage was completed by developing a Visual OTTHYMO (VO) hydrologic model (Civica 2019; Appendix D). The facility's outlet structure includes an orifice sized for the extended detention of the 2-year storm and a ditch inlet catch basin overflow structure, which controls flows up to the 100-year storm. A Regional storm can be safely conveyed through the SWM facility via an emergency overflow weir. The emergency weir is sized to convey the unattenuated Regional storm with 0.30 m of freeboard, also assuming the other outlet structures are blocked. A summary of the attenuation of flows due to the SWM facility, along with required storage volumes, are provided in Table E with design calculations provided in Appendix B. The comparison of post- to pre-development peak flows is provided in Section 5.

There will be an opportunity during the detailed design of the Phase 2 SWM facility to consider adding a forebay or other pre-treatment measures to the SWM facility. Pre-treatment will enhance water quality and the longevity of the facility but is not a requirement to meet MOE (MOE 2003) enhanced protection level.

TABLE E Phase 2 Stormwater Management Facility Performance

Return Period	Inflows to Stormwater Management Facility	Outflows from Stormwater Management Facility	Active Storage Volume (m^3)	Water Elevation (m)
2-year	0.439	0.015	1,043	257.03
5-year	0.619	0.061	1,270	257.17
10-year	0.803	0.165	1,539	257.33
25-year	1.064	0.363	1,788	257.46
50-year	1.283	0.528	1,965	257.55
100-year	1.502	0.703	2,147	257.64
Regional	1.092	1.078	2,358	257.74
Freeboard			2,940	258.00

Return period storm events are based on the 24-hour SCS II design storm distribution.
Regional storm is based on the 48-hour Hurricane Hazel

The Phase 2 SWM facility outflow is combined with the outflows from the infiltration swale (runoff from rear yards of lots 17 to 23) and conveyed to the Phase 1 wet pond via the proposed Phase 2 outlet swale.

4.4.2 Phase 2 Outlet Swale

The outflows from the Phase 2 SWM facility and the rear-yard infiltration swale (Section 4.3.3) are combined and conveyed to the Phase 1 wet pond via an outlet swale. The swale was designed to convey the greater of the 100-year or Regional storm flows to the Phase 1 wet pond. Using the simulated uncontrolled Regional peak flow from the hydrologic model (Section 5), the swale was sized with a base width of 0.5 m and 3H (horizontal):1V (vertical) side slopes. A cross-section of the proposed outlet swale is shown in Figure 8. Conveyance calculations are included in Appendix B.

4.4.3 Retrofit of Phase 1 Wet Pond

The Phase 1 wet pond is proposed to be retrofitted to accommodate additional runoff from the Phase 2 development. The wet pond receives major and minor runoff from 21.52 ha of the Phase 1 development as well as inflows from the Phase 2 SWM facility and the rear yards of lots 17 to 23. Figure 9a indicates detailed grading of the retrofitted Phase 1 SWM facility, which has been completed in accordance with Town standards. The following design aspects are noted:

- Expansion of the pond includes a 3 m wide maintenance road, offset 1 m from the existing property line. The roadway is approximately at grade to the existing elevations of the abutting existing residential lot located to the east. The proposed maintenance roadway could be finished with a topsoil and seeded surface to blend with the adjacent lot.

- Permanent water volume will accommodate the required quality control volume for Phase 1 subdivision.

- Permanent water will be moved down from the existing SWM facility water level by 0.15 m. The existing control structure and outlet pipe configuration from it will allow this “lowering” of the facility, which provides significant additional active storage volume. Final design will require confirmation of invert levels through additional survey.

- Slopes used on the facility are in accordance with Town standards, which are 3:1 above the permanent water, a 5% “bench” at permanent water, then a 4:1 slope below permanent water.

A sediment drying area has not been added to the facility. Significant past and recent experience with SWM pond cleanouts have indicated that a more effective approach to pond clean out is available. Techniques of hauling the sediment wet as well as techniques of “working” and mixing sediments with polymers such that drying is not required.

The Phase 1 wet pond water quality sizing requirements are summarized in Table F. The quality sizing was based on the treatment of Phase 1 lands only. This is in line with MOE (2003) for ponds in series, as quality treatment of Phase 2 lands will be accomplished within the Phase 2 facility.

TABLE F Phase 1 Wet Pond Water Quality Sizing Characteristics

Contributing Area (ha)	% Impervious	Total Storage Volume Requirement (m^3/ha)[1]	Extended Detention Requirement (m^3)[2]	Permanent Pool Requirement (m^3)	Extended Detention Volume Provided (m^3)	Permanent Pool Volume Provided (m^3)
21.52	25%	121	861	1,743	1,316	2,625

(1) Determined from Table 3.2 of *Stormwater Management Planning and Design Manual* (MOE 2003) for enhanced 80% long-term S.S. removal with wet pond.
(2) Extended detention storage volume based on minimum 40 m^3/ha (MOE 2003)

The Phase 1 wet pond operating characteristics were assessed using the VO hydrologic model (Appendix D). The existing outlet structure is proposed to be retrofitted with a resized orifice plate and a ditch inlet catch basin. The retrofit also includes provision for an emergency overflow weir to the valley of the Credit River tributary. Preliminary design calculations are provided in Appendix B.

The predicted performance of the retrofitted Phase 1 wet pond is provided in Table G. The facility is sized to convey post-development flows equal to or below pre-development flows and safely convey the Regional storm while maintaining required freeboard of 0.30 m above the 100-year high-water level. The pond was also designed to overcontrol flows as part of the site's overall strategy to reduce the erosion potential at the outlet to the Credit River tributary.

TABLE G Retrofitted Phase 1 Wet Pond Performance

Design Storm	Inflows to Stormwater Management Facility	Outflows from Stormwater Management Facility	Active Storage Volume (m^3)	Water Elevation (m)
2-year	1.170	0.075	3,464	251.22
5-year	1.625	0.182	4,569	251.46
10-year	2.152	0.398	5,436	251.64
25-year	2.811	0.804	6,532	251.85
50-year	3.459	1.154	7,408	252.01
100-year	4.406	1.503	8,340	252.18
Regional	4.032	3.998	9,337	252.36
Freeboard			10,187	252.50

Return period storm events are based on the 24-hour SCS II design storm distribution.
Regional storm is based on the 48-hour Hurricane Hazel

5 PRELIMINARY HYDROLOGIC ASSESSMENT

A hydrologic model was prepared in VO to calculate pre-development and post-development runoff from the Phase 1 and Phase 2 lands as well as from external areas to onsite tributaries. The VO model was used to assess the effectiveness of the proposed SWM facility designs (Figures 3, 10, and 11). Details of the model development are provided in Appendix D. Several reports were used to inform the hydrologic model development including:

- *Glen Williams Phase 2, Town of Halton Hills, ON, Functional Servicing Report* (BCEL 2015)
- *Stormwater Management Implementation Report, Glen Williams Subdivision Phase 1, Community of Glen Williams, Town of Halton Hills* (Burnside 1999)
- *A Soil Investigation for Proposed Residential Development, Bishop Court and Confederation Street, Town of Halton Hills* (Soil Engineers 2015b)

The VO model parameterization of the Phase 1 area was based on the SWMHYMO model completed by Burnside (1999) for the pond design. Matrix replicated the design conditions from Burnside (1999) to confirm the existing Phase 1 wet pond functions as detailed in the report. Updates were then made to accommodate the Phase 2 lands and proposed retrofits.

BCEL (2015) completed a MIDUSS model of the Phase 2 development. While model catchments were generally preserved, Matrix parameterized the Phase 2 VO model to align with Town and CVC standard parameters, the geotechnical investigations, existing and proposed topography, and land cover. Parameters also account for the potential of future patios/pools in rear lots.

As the Burnside (1999) study simulated the 6-hour Atmospheric Environmental Service (AES) design storm, Matrix assessed this storm distribution as well as the 24-hour Soil Conservation Service (SCS) Type II per Town standards. The 24-hour SCS Type II was the governing design storm in terms of storage volume requirements and was used in further assessments.

5.1 Peak Flow Assessment

A peak flow assessment examined pre-development flows and compared them to post-development flows resulting from:

- Phase 2 uncontrolled catchments
- Phase 1 wet pond outflow (includes Phase 2 development)
- total tributary flows downstream of the Phase 1 development

Results of peak flow comparison of pre- to post-development conditions are summarized in Table H. As shown on Figure 11, there are drainage areas that cannot be conveyed to the Phase 2 SWM facility under post-development conditions, and as such, they outlet directly to valley land areas of one of the tributaries of the Credit River. At the location of the retrofitted Phase 1 SWM facility outlet to the Credit River tributary, the total post-development peak flows to the Credit River tributary are less than pre-development peak flow rates for all storm events (right hand columns of Table H).

TABLE H Pre- and Post-development Peak Flow Assessment

		Phase 2 Uncontrolled Areas (1)		Phase 1 Wet Pond and Wetland (2)		Tributary Flows Downstream of Phase 1 Development (3)	
		Pre-development	Post-development	Pre-development	Post-development	Pre-development	Post-development
Catchment IDs (Figure 11)		10, 11, 12, 20, 21, 22, 23, 24, 30	110, 120, 130, 230, 400, 900	10, 11, 12, 20, 21, 22, 23, 24, 30, 31, 33, 50	100, 110, 120, 130, 200, 230, 300, 400, 500, 510, 520, 530, 540, 550, 560, 570, 580, 590, 620, 640, 660, 680, 700, 800, 820, 830, 900, 9000	All Catchments (including external areas)	All Catchments (including external areas)
Drainage Area(4) (ha)		9.06	7.47	40.93	33.62	205.09	205.09
Peak Flow (5) (m^3/s)	25 mm	0.01	0.02	0.05	0.04	0.59	0.59
	2-year	0.13	0.14	0.40	0.07	2.84	2.57
	5-year	0.20	0.21	0.67	0.18	4.20	3.81
	10-year	0.28	0.29	0.94	0.40	5.63	5.30
	25-year	0.40	0.39	1.30	0.80	7.56	7.37
	50-year	0.50	0.48	1.58	1.15	9.07	8.97
	100-year	0.60	0.57	1.90	1.50	10.64	10.61
	Regional	0.87	0.73	3.39	4.00	19.37	19.61

(1) Phase 2 uncontrolled area is the directly contributing uncontrolled catchment areas and does not include upstream external drainage areas (i.e., hydrograph ID 5 for pre-development and ID 121 for post-development in Appendix D).
(2) Phase 1 wet pond outflows include all areas to the Phase 1 wet pond, which includes the outflows from the Phase 2 SWM facility, rear lots 17 to 23 (catchment 610), plus the constructed wetland (catchment 802) post-development flows (i.e., hydrograph ID 54 for pre-development and ID 75 for post-development in Appendix D).
(3) Drainage area downstream of development is the total drainage area contributing to the Credit River tributary immediately downstream of the Phase 1 development (i.e., including external drainage areas) (i.e., hydrograph ID 4 for pre-development and ID 43 for post-development in Appendix D).
(4) Pre- and post-development catchment areas differ due to proposed grading works.
(5) Peak flows for the 25 mm storm are based on the 4-hour Chicago; for the 2- to 100-year storms are based on the 24-hour SCS Type II; and for the Regional storm are based on the 48-hour Hurricane Hazel. Return period peak flows were also assessed for the 6-hour AES which were lower (see Appendix D).

5.2 Erosion Assessment

To estimate the change in watercourse erosion potential between pre-development and post-development upstream of the existing Bishop Court crossing, the resulting storm hydrographs for the downstream tributary flows under pre- and post-development scenarios were compared. The pre- and post-development hydrographs were examined to determine the duration over which flow is exceeding the erosion threshold (0.16 m^3/s) during a 2-year design storm (Figure A). Under post-development conditions, the 2-year peak flow is lower than the pre-development 2-year peak flow, and there is only an additional 0.5 hours, or a 3.7% increase, in the duration of flows above the erosion threshold during the 2-year storm (Table I). It is noted that these values are extremely conservative, as this hydrologic modelling does not include integration of any proposed upstream LID features. As outlined in Section 4.3, the lot-level LID measures are sized to retain at a minimum the runoff from the 25 mm storm event.

FIGURE A Erosion Threshold Comparison of Pre- and Post-development 2-year Storm Hydrographs

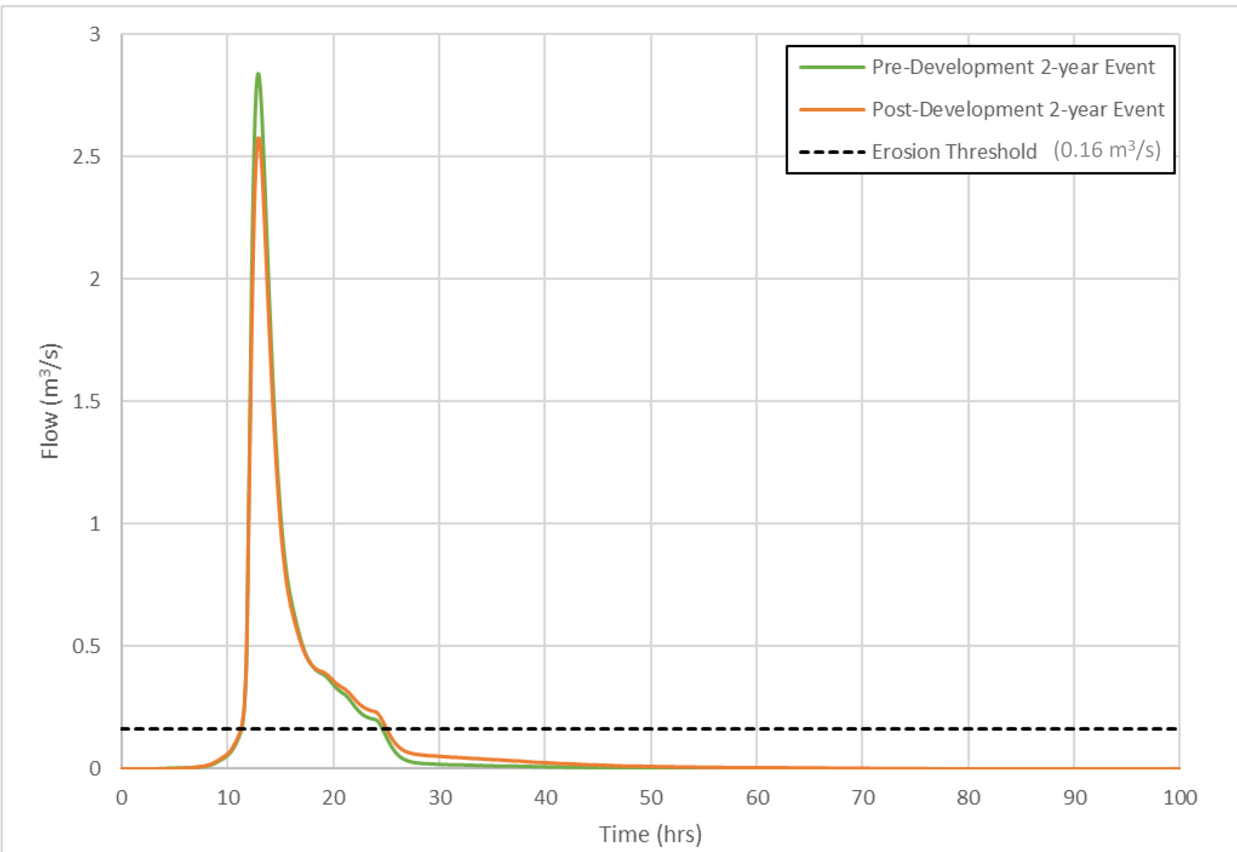

TABLE I Erosion Potential Assessment

Storm	Duration of Erosion Threshold Exceedance (hour)		Difference
	Pre-development	Post-development	
2-year	13.35	13.85	0.5 hour (3.7%)

6 TRIBUTARY CROSSINGS HYDRAULIC ASSESSMENT

The extension of Bishop Court through the Phase 2 development requires new watercourse crossings of Reach 5 and the intermittent eastern tributary. Based on the geomorphic analysis completed (PARISH 2015), a 10.97 m span and 4.0 m span arch culverts are proposed for Reach 5 and the intermittent eastern tributary respectively. The proposed crossing locations are indicated on Figure 2. The existing (pre-development) and post-development watercourse crossings are indicated on Figures 12 and 13, respectively. These figures also outline locations of cross-sections used in hydraulic modelling along with predicted Regional floodlines. Figure 14 includes a cross-section view of the proposed crossings, also indicating the available clearance for the proposed storm sewer to cross the two watercourse structures.

A HEC-RAS model was prepared to assess water elevations within the Credit River tributary under pre- and post-development conditions. The model was developed by cutting cross-sections at appropriate locations from existing contour information (Greer Galloway 2010). The cross-section locations were selected to represent average channel conditions and to capture changes in longitudinal slope. Cross-sections were also placed immediately upstream and downstream of existing and proposed structures in accordance with recommended modelling procedures. Modelling parameters, including Manning's n, expansion and contraction coefficients, and top-of-road weir coefficient, in addition to simulation options, all conform to CVC standard parameter values. Further details of the HEC-RAS model preparation, output, and a digital media device containing the HEC-RAS model is included in Appendix E.

Please refer to the FSR (BCEL 2015) for further details regarding road alignment and the geomorphic analysis (PARISH 2015) regarding the conceptual tributary realignment.

As part of the development, three existing circular culverts will be removed and restored to natural channel conditions: the existing 750 mm diameter culvert immediately downstream of the proposed intermittent tributary crossing, the 1,200 mm diameter culvert that accommodates the existing site haul road, and the existing 450 mm CSP culvert in the southern portion of the development area on the west side of the Credit River tributary.

The peak flow input to the HEC-RAS model is based on the VO hydrologic model (Appendix D) which is summarized in Table J.

TABLE J HEC-RAS Model Peak Flow Input

Return Period (24-hour SCS Type II)	Reach 5 (Western Tributary)				Eastern Tributary				Credit River Tributary (1)	
	Upstream of Site (External Area) HEC-RAS Section 532.31		HEC-RAS Section 302.67		Upstream of Site (External Area) HEC-RAS Section 261.85		HEC-RAS Section 107.88		Downstream of Crossings HEC-RAS Section 131.25	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
2-year	1.85	1.85	1.86	1.86	0.61	0.61	0.62	0.62	2.57	2.49
5-year	2.71	2.71	2.74	2.73	0.89	0.89	0.91	0.91	3.77	3.65
10-year	3.63	3.63	3.66	3.66	1.19	1.19	1.21	1.21	5.06	4.89
25-year	4.87	4.87	4.92	4.92	1.59	1.59	1.63	1.63	6.80	6.56
50-year	5.83	5.83	5.90	5.90	1.90	1.90	1.95	1.95	8.17	7.87
100-year	6.84	6.84	6.92	6.91	2.23	2.23	2.28	2.28	9.59	9.22
Regional	12.11	12.11	12.40	12.37	3.63	3.63	3.80	3.79	17.32	16.42

(1) Post-development Credit River tributary flows are less than pre-development flows, as they do not include outflows from the Phase 1 wet pond, which is downstream of the proposed crossings and outside of the HEC-RAS model extents.

6.1 Pre-development (Existing) Hydraulic Model Results

The HEC-RAS hydraulic model was used to assess water elevations, flood storage, conveyance, and velocities under pre-development conditions. The pre-development HEC-RAS model cross-sections and predicted Regional floodlines are shown on Figure 12. The hydraulic results for the existing 1,200 mm CSP are summarized in Table K. The existing culvert is constricting flows and overtops the road during the 10-year storm. Detailed HEC-RAS model setup and results are provided in Appendix E.

TABLE K Pre-development Hydraulic Model Results - Existing 1,200 mm Corrugated Steel Pipe

Component	Value (m)						
Hydraulic Rise	1.20						
Upstream Invert Elevation	254.81						
Downstream Invert Elevation	254.61						
Top-of-road Elevation	258.00						
Return Period	**2-year**	**5-year**	**10-year**	**25-year**	**50-year**	**100-year**	**Regional**
Water Surface Elevation	256.44	257.46	258.08	258.17	258.21	258.25	258.45
Energy Gradeline Elevation	256.45	257.46	258.09	258.18	258.22	258.25	258.47
Freeboard	1.56	0.54	-0.08	-0.17	-0.21	-0.25	-0.45

6.2 Post-development Hydraulic Model Results

The post-development condition HEC-RAS model was developed based on the pre-development HEC-RAS model. Cross-sections were updated as appropriate to reflect proposed grading and proposed crossing structures (Figure 13). The peak flows to the system were also updated to reflect the post-development hydrology from the VO hydrologic model. Post-development Credit River tributary flows are less than pre-development flows as they do not include outflows from the Phase 1 wet pond as this is downstream of the proposed crossings and outside of the HEC-RAS model extents. The post-development HEC-RAS model demonstrates that the proposed development and crossings will not adversely impact the floodplain and channel dynamics of Reach 5, the eastern tributary, nor the combined Credit River tributary below the confluence of these upstream watercourses.

The results also confirm there is ample hydraulic capacity in the proposed road culverts, with the Regional water level predicted below the obvert of the culverts, with over 2 m of freeboard to the top of the proposed road during the Regional storm. The Regional floodline is equal to or lower than the existing Regional floodline upstream of the proposed crossings. The post-development HEC-RAS model results are summarized in Tables L and M for the new crossings on Reach 5 and the eastern tributary, respectively. Detailed HEC-RAS output is included in Appendix E.

Downstream of the proposed crossings, the post-development Regional floodline is lower than the existing Regional floodlines largely due to the removal of the existing 1,200 mm CSP (Table N).

TABLE L Post-development Hydraulic Model Results - Proposed 10.975 m x 2.44 m Concrete Arch Culvert (Reach 5 Western Tributary)

Component	Value (m)						
Hydraulic Rise	2.44						
Upstream Invert Elevation	257.25						
Downstream Invert Elevation	256.66						
Top-of-road Elevation	260.37						
Return Period	**2-year**	**5-year**	**10-year**	**25-year**	**50-year**	**100-year**	**Regional**
Water Surface Elevation	257.50	257.56	257.62	257.69	257.74	257.79	258.01
Energy Gradeline Elevation	257.51	257.58	257.65	257.72	257.78	257.84	258.09
Freeboard	2.87	2.81	2.75	2.68	2.63	2.58	2.36

TABLE M Post-Development Hydraulic Model Results - Proposed 4.00 m x 1.22 m Concrete Arch Culvert (Eastern Tributary)

Component	Value (m)						
Hydraulic Rise	1.22						
Upstream Invert Elevation	256.91						
Downstream Invert Elevation	256.75						
Top-of-road Elevation	259.86						
Return Period	**2-year**	**5-year**	**10-year**	**25-year**	**50-year**	**100-year**	**Regional**
Water Surface Elevation	257.23	257.31	257.38	257.45	257.51	257.56	257.75
Energy Gradeline Elevation	257.24	257.32	257.39	257.47	257.53	257.58	257.79
Freeboard	2.63	2.55	2.48	2.41	2.35	2.30	2.11

TABLE N Pre- and Post-development Regional Water Surface Elevation Comparison

Reach	Description	HEC-RAS Cross-section ID	Pre-development Regional Water Surface Elevation (m)	Post-development Regional Water Surface Elevation (m)	Difference (m)
Western Tributary/Reach 5	At flow change location	302.67	259.82	259.82	0
	Upstream of proposed crossing	258.01	258.47 (interpolated)	258.01	-0.46
Eastern Tributary	At flow change location	107.88	258.48	257.85	-0.63
	Upstream of proposed crossing	63.33	258.48 (interpolated)	257.75	-0.73
Credit River Tributary	Upstream of existing 1,200 mm CSP (to be removed)	68.22	258.45	256.18	-2.27
	Downstream extent of model	11.26	255.34	255.31	-0.03

7 WATER BALANCE

Potential impacts of urbanization on an area's existing hydrologic regime include reduction in groundwater recharge and evapotranspiration as well as an increase in surface water runoff. In order to predict potential long-term hydrologic changes associated with the proposed development, a simplified water balance approach was used for three scenarios including pre-development, post-development, and post-development with LID. Calculations were based on the simple water balance approach outlined in the *Stormwater Management Planning and Design Manual* (MOE 2003), which uses estimates of hydrologic parameters (e.g., precipitation, evapotranspiration, runoff, and infiltration) adjusted for soil type and land use to estimate pre-development to post-development regime changes resulting from increases to impervious area. Refer to Appendix B for water balance calculation tables.

The pre-development water balance calculations considered the existing soil types, as reported by the OMAFRA (2020) soil mapping and validated with the geotechnical studies (AEL 2015, Soil Engineers 2015a), hydrologic soil group A (86% coverage of the site) and C (14% coverage of the site). The weighted hydrologic cycle component values were calculated for the existing site soil type, these values were very similar to the values for a fine sand due to the coverage of type A on the site. The existing land use types were conservatively assumed to be pasture and meadow for the former gravel extraction lands and valley lands and mature woods for the conifer plantation. Based on the percolation testing by AEL (2017b), the existing percolation rate for the majority of the site is greater than 25 mm/hour, which is in line with a sandy loam (MOE 2003). Sections of the site within the valley lands were reported to have a percolation rates of over 10 mm/hour (AEL 2017b). Accordingly, site LIDs have been designed with an assumed percolation rate of 15 mm/hour, which takes into account both conditions and is the minimum percolation rate for a loam soil type (PARISH 2015) or soil type B (fine sandy loam).

Under post-development and post-development with LID scenarios, land use is comprised of roads, driveways, roofs, patios, yards, and open space, with an overall imperviousness of approximately 13%. Within the post-development water balance, evapotranspiration and infiltration from roads, driveways, and houses were converted to 100% runoff.

The “post-development with LID” water balance scenario introduces infiltration trenches and soakaway pits as mechanisms for infiltration. Assumptions of the infiltration capacity of the SWM controls include the following:

- The Soakaway pits have capacity to infiltrate 90% of annual rooftop runoff.
- The Infiltration trenches have capacity to infiltrate 90% of annual runoff from the contributing rear lots.
- The Phase 2 SWM facility will have capacity to infiltrate 50% of the annual average rainfall on the impervious roadway; this equates approximately to a 5 mm event.

Additional assumptions relevant to the water balance include the following:

- For proposed impervious areas with no LID features, 3 mm of annual average rainfall is assumed to be evapotranspiration.
- Rain gardens have not been included within the water balance and will only increase the post-development with LID infiltration volume.
- Patios/pools are included as an impervious area; however, these will run off to a grassed area.

A summary of the water balance calculated for the site is found in Table O. Overall, the proposed development with no mitigation measures would increase runoff by 27,818 m^3/year (132%) and reduce infiltration by 15,883 m^3/year (26%). With the implementation of LIDs on the site, post-development runoff would increase by 16,146 m^3/year (76%) and infiltration would increase by 5,533 m^3/year (9%) from pre-development conditions. These values are preliminary estimates as a proof of concept. Water balance estimates can be refined at detailed design.

TABLE O Summary of Simplified Water Balance Assessment

Scenario	Total Precipitation (m^3/year)	Evapotranspiration (m^3/year)	Runoff (m^3/year)	Infiltration (m^3/year)
Pre-development	189,579	108,397	21,106	60,077
Post-development - no mitigation	189,579	96,461	48,924	44,194
Percent Change Pre-development to Post-development	N/A	-11%	132%	-26%
Post-development with Low Impact Development	189,579	86,719	37,251	65,609
Percent Change Pre-development to Post-development with Low Impact Development	N/A	20%	76%	9%

N/A - not applicable

8 WETLAND COMPENSATION

This section summarizes the compensation plan for existing wetlands within the development site. Appendix F includes a letter from Matrix to CVC dated May 15, 2018, which was accepted and allowed issuance of a CVC permit prior to the filling of the existing wetland area. The 2018 letter includes a memo prepared by North-South Environmental, dated November 22, 2017, that outlines vegetation within relevant areas approved for wetland compensation (refer to Figure 9a for the proposed wetland compensation). A copy of the CVC permit, dated March 13, 2020, is also included in Appendix F.

It was identified that the available wetland compensation area is 0.409 ha, which is in excess of the 0.33 ha required for compensation (Matrix 2018). The amount of compensation being put forward exceeds the requirement and allows for flexibility of adjusting lines in the field as may be required at final design. The following highlights of the wetland compensation are detailed in Appendix F.

- No areas of significance are proposed to be removed by the compensation plan.
- The valley land and watercourse have potential to be much improved, as compared with existing, when combining the proposed wetland compensation with the proposed watercourse rehabilitation in the adjacent valley lands.
- Compensation east of the watercourse has been maximized by, and provides connectivity to, open space and SWM blocks.

The following items have been updated to address additional information and changes to layout in the vicinity of the Phase 2 SWM facility since the time of the Matrix (2018) letter.

- Groundwater: additional groundwater monitoring in the vicinity of the proposed wetland (MW402 in March 2016 provided highest groundwater elevation of 254.06 m). Based on nearby piezometers, the annual high groundwater level as determined by AEL in the area of the wetland compensation area is at least 1 to 2 m below the proposed wetland bottom (at 257.25 m). No interaction is anticipated, and it can be prevented, as required, through wetland bottom design.

- Hydroperiod: water sources to the wetland can include as much or as little from the nearby infiltration swale as may be required (including filtered flow from a subdrain). Another possibility is to include a portion of subdrain flow (i.e., treated runoff) from a bioswale or infiltration gallery that could be located within the Phase 2 SWM facility.

- Flood plain connectivity: the proposed wetland compensation area has been placed above Regional level of flow in the adjacent tributary. It could be slightly adjusted in size or moved lower or higher, as required, to best suit floodplain and ecological objectives. The overall floodplain connection will be a part of the channel rehabilitation design associated with the culverts under the new Phase 2 roadway and also the removal of the old culvert crossing downstream.

- Interactions with Phase 2 SWM facility: the area of wetland will be "self-drained," in that it will not outlet storm runoff except under very infrequent events. It is not connected to the Phase 2 SWM system and will not receive urban runoff. During detailed design further discussion can confirm the need for an impermeable liner to mitigate interactions with the infiltration gallery.

9 SEDIMENT AND EROSION CONTROL

Please refer to Section 5 the FSR (BCEL 2015) in Appendix A for details.

10 SUMMARY AND CONCLUSION

A summary of the provided SWM quantity, quality, erosion, and water balance controls for the proposed Phase 2 development is included in Table P and discussed below.

TABLE P Summary of Phase 2 Development Stormwater Management Controls

Phase 2 Development Area	Quantity control	Quality Control	Erosion Control and Water Balance
Front of lots 1, 2 to 3, and 17 to 28; lots 4 to 17	Phase 2 stormwater management (SWM) facility → Phase 1 wet pond	Lot-level soakaway pits → Phase 2 SWM facility (infiltration gallery)	Lot-level soakaway pits → Phase 2 SWM facility (infiltration gallery)
Road right-of-way	Phase 2 SWM facility → Phase 1 wet pond	Phase 2 SWM facility (infiltration gallery)	Phase 2 SWM facility (infiltration gallery)
Rear lots 1 and 24 to 28	Uncontrolled to tributary	Rain gardens	Rain gardens
Rear lots 17 to 23	Uncontrolled to Phase 1 wet pond	Infiltration swale	Infiltration swale
Pervious portion of lots 2 to 3	Uncontrolled to tributary	Uncontrolled to tributary	Uncontrolled to tributary

- The erosion potential assessment completed upstream of Bishop Court found that for the 2-year rainfall event, there is no significant difference from pre-development to post-development erosion potential, especially considering the hydrologic modelling does not account for LIDs.
- Preliminary LID designs of soakaway pits and rain gardens were proposed for the western tablelands to ensure no runoff to the tributary under post-development conditions equivalent to the pre-development initial abstraction value of the conifer plantation.
- A preliminary Phase 2 SWM facility was designed for storm attenuation, erosion, and quality control, with a combined outlet with the retrofitted Phase 1 wet pond. Peak flows from the facilities were simulated in VO, with modelling results indicating that post-development peak flow rates will be kept below pre-development rates at the downstream tributary.
- Measured groundwater levels were compared against the proposed grading elevations suggesting there is adequate space for the proposed infiltration measures.
- The hydraulic analysis of the proposed crossings indicates that the structures are adequately sized to convey the Regional storm. There will be no impact to water surface elevation, channel velocity, or total channel conveyance under post-development conditions.

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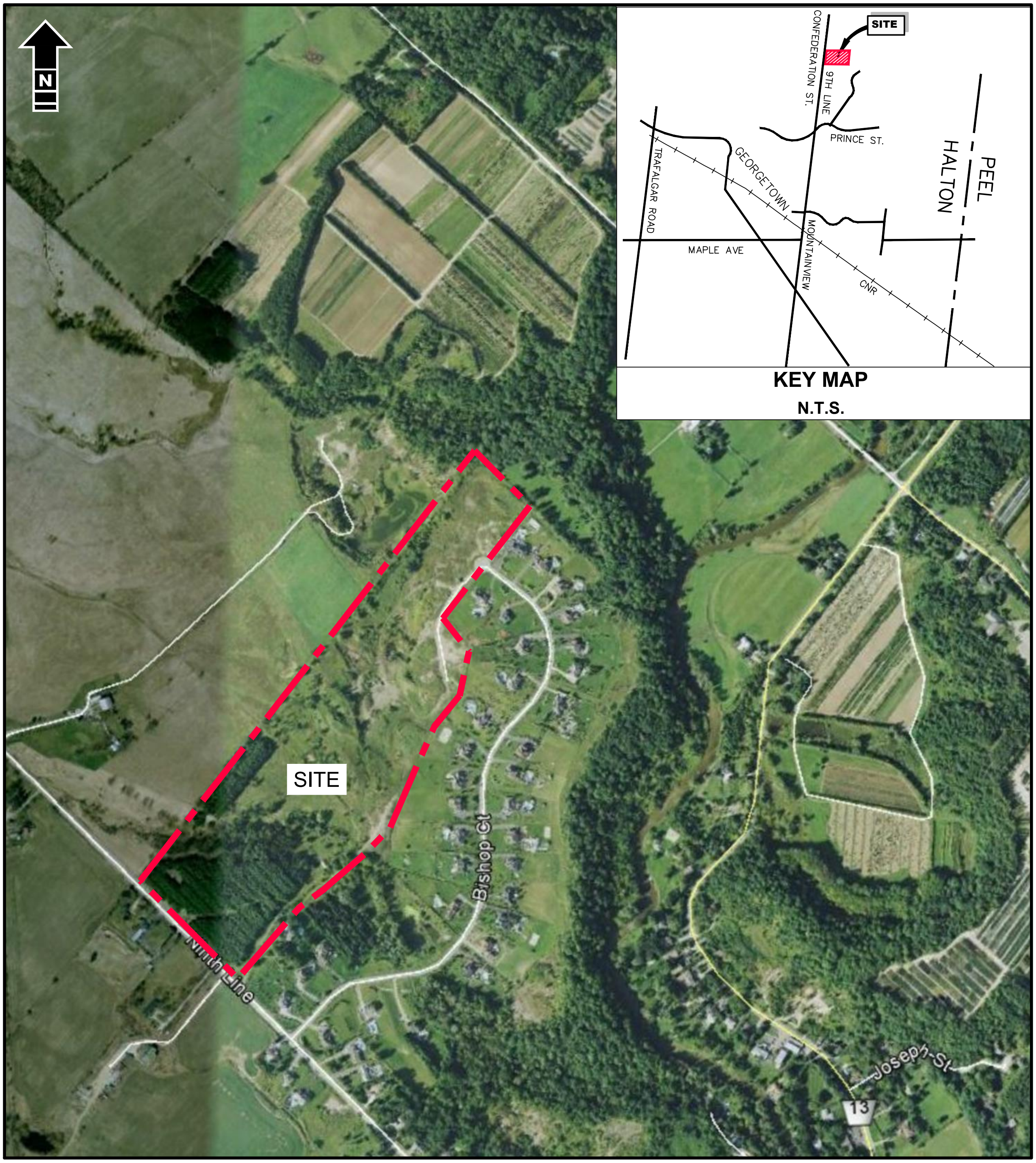

REFERENCE: MICROSOFT BING IMAGERY, DATE UNKNOWN.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

1404649 ONTARIO LTD.
GLEN WILLIAMS, TOWN OF HALTON HILLS

SITE LOCATION PLAN

1 : 10,000 metres
100 0 100 200

Date: MARCH 2021	Project: 21006-01 Key Map	Submitter: A. GROSSE	Reviewer: S. BRAUN

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Figure 1

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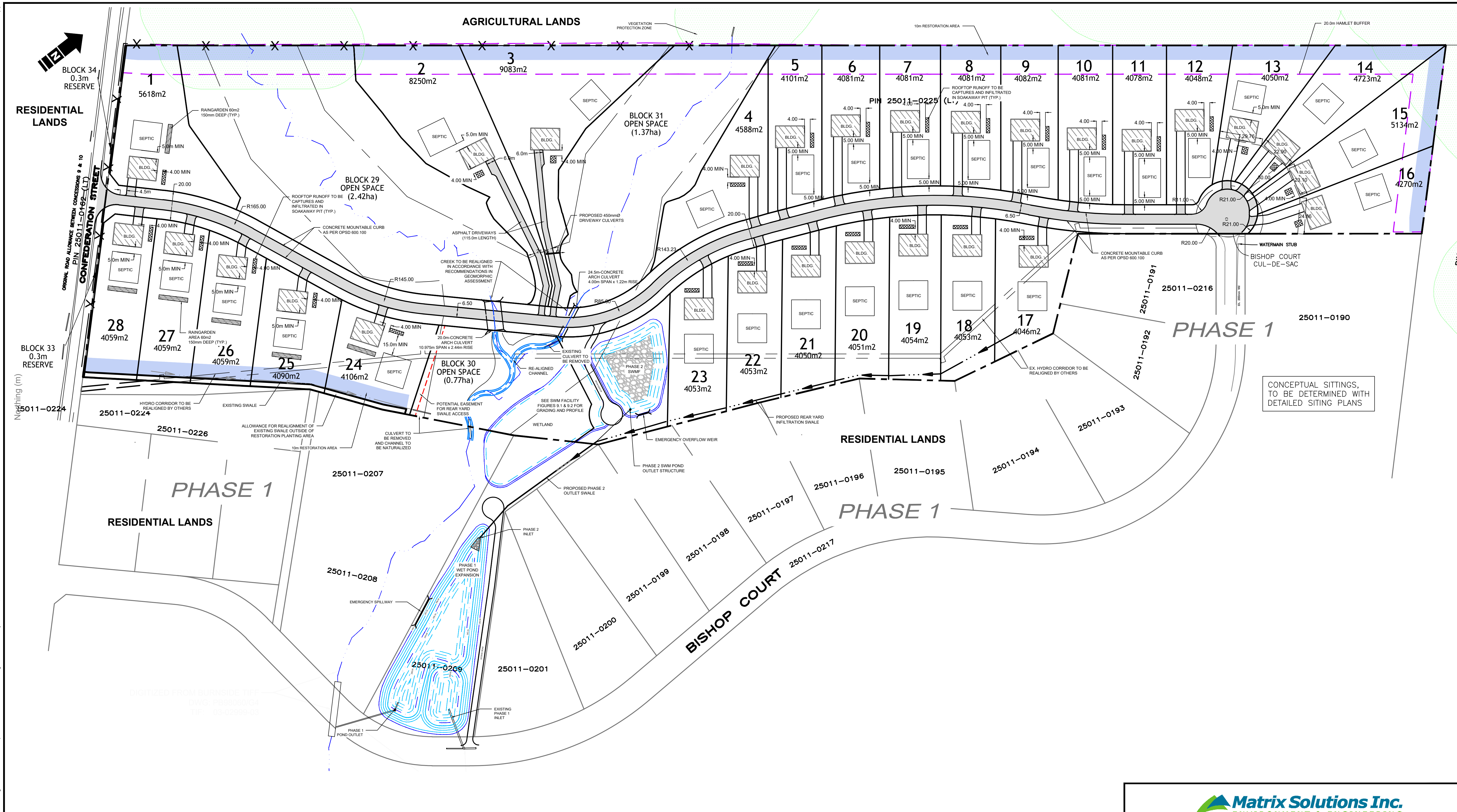
\\matrix-solutions.com\public\Guelph_Projects2\21006_Glen Williams\03 Data\Drafting\C3D\Subdivision\Production\Figs\2021-03-09 CVC Report\21006-01 Key Map.dwg - 01 - March 10, 2021 9:22:28 AM - Greg Schicht

Plot 1:1 = Letter (P)



REFERNCE:

1. EXISTING TOPOGRAPHY, DERIVED FROM THE GREER GALLOWAY GROUP INC. DWG. 0816529-GRADING PLAN 1-3, DATE: 2009-08-06.
2. LEGAL INFORMATION FROM VAN HARTEN SURVEYING INC. PLAN OF SURVEY OF PART OF LOT 23, CONCESSION 10, GEOGRAPHIC TOWNSHIP OF ESQUESING, TOWN OF HALTON HILLS, REGIONAL MUNICIPALITY OF HALTON HILLS. DATE: JANUARY 4, 2011.
3. COORDINATES ON THIS PLAN ARE UTM, ZONE 17, NAD83 (CSRS-2002) ADJUSTMENT AND ARE BASED ON GPS OBSERVATIONS FROM A NETWORK OF PERMANENT GPS REFERENCE STATIONS.
4. EXISTING 30m BUFFER, MEANDER BELT, TOP OF STABLE SLOPE AND 5.0m OFFSET, WETLAND BUFFER AND DEVELOPMENT LIMIT DERIVED FROM NORTH-SOUTH ENVIRONMENTAL, DATE: 2015-02-13.
5. PHASE 1 POND INLET AND OUTLET DERIVED FROM BURNSIDE DEVELOPMENT SERVICES DWG: PB98060/G4 DATE: SEPTEMBER 2000.

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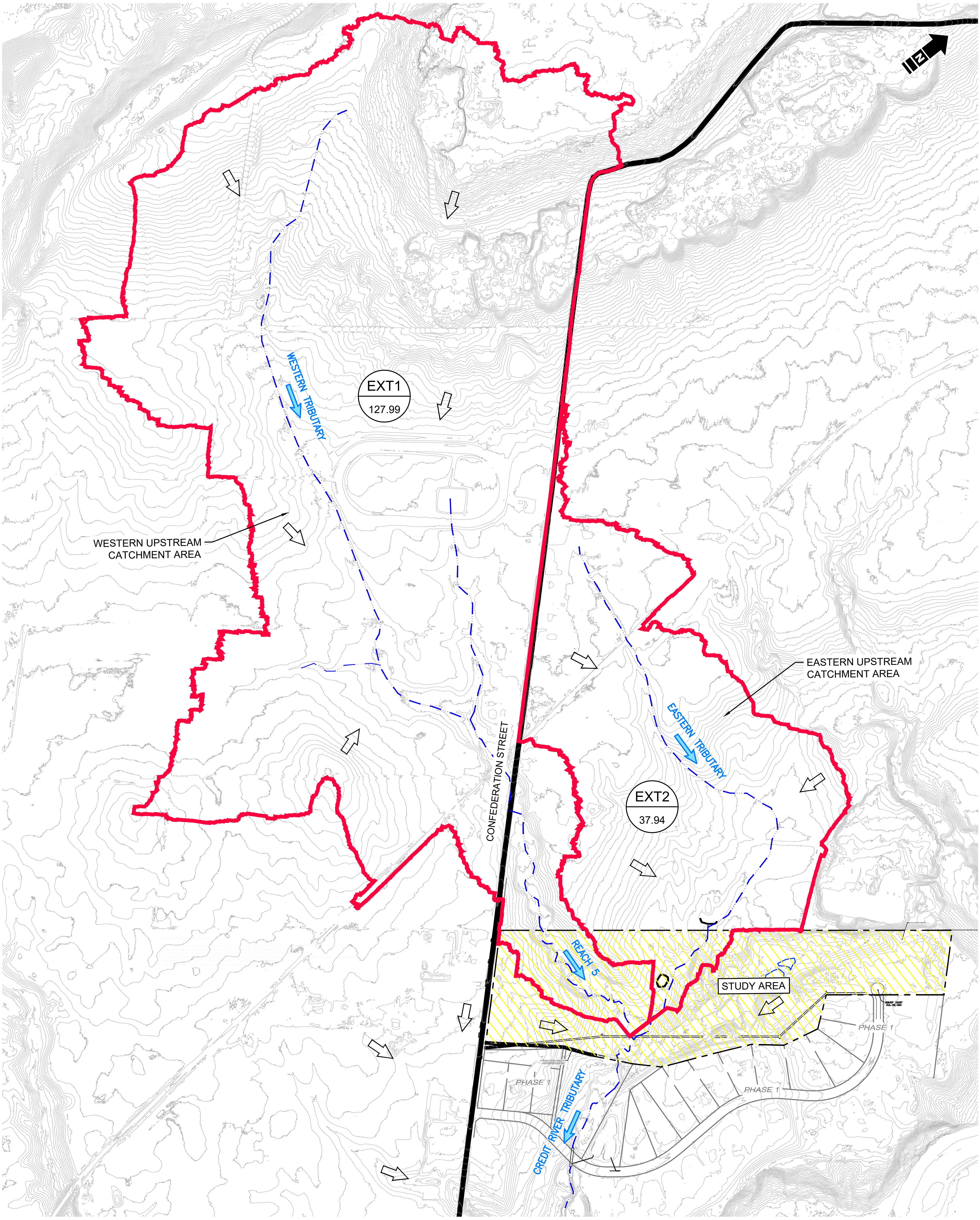
GLEN WILLIAMS, TOWN OF HALTON HILLS

PROPOSED DRAFT PLAN OF SUBDIVISION AND ASSOCIATED DRAINAGE WORKS

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-02 Pr Draft Plan	A. GROSSE	S. BRAUN

Figure 2



LEGEND

PROPERTY LINE

EXISTING TRIBUTARY

EXISTING CONTOURS (1.0m INTERVAL)

CATCHMENT BOUNDARY

1100 — CATCHMENT ID

37.94 — AREA (ha.)

DIRECTION OF DRAINAGE

PHASE 2 DEVELOPMENT AREA

NOTE:
SEE FIGURE 10 FOR EXISTING CATCHMENT AREAS WITHIN THE PHASE 2 DEVELOPMENT AREA.

REFERNCE:

1. EXISTING TOPOGRAPHY DERIVED FROM LIDAR DTM PEEL 2016 PACKAGE A.
2. LEGAL INFORMATION FROM VAN HARTEN SURVEYING INC. PLAN OF SURVEY OF PART OF LOT 23, CONCESSION 10, GEOGRAPHIC TOWNSHIP OF ESQUESING, TOWN OF HALTON HILLS, REGIONAL MUNICIPALITY OF HALTON HILLS. DATE: JANUARY 4, 2011.
3. COORDINATES ON THIS PLAN ARE UTM, ZONE 17, NAD83 (CSRS-2002) ADJUSTMENT AND ARE BASED ON GPS OBSERVATIONS FROM A NETWORK OF PERMANENT GPS REFERENCE STATIONS.

1 : 7,500 metres
75 0 75 150
DATUM

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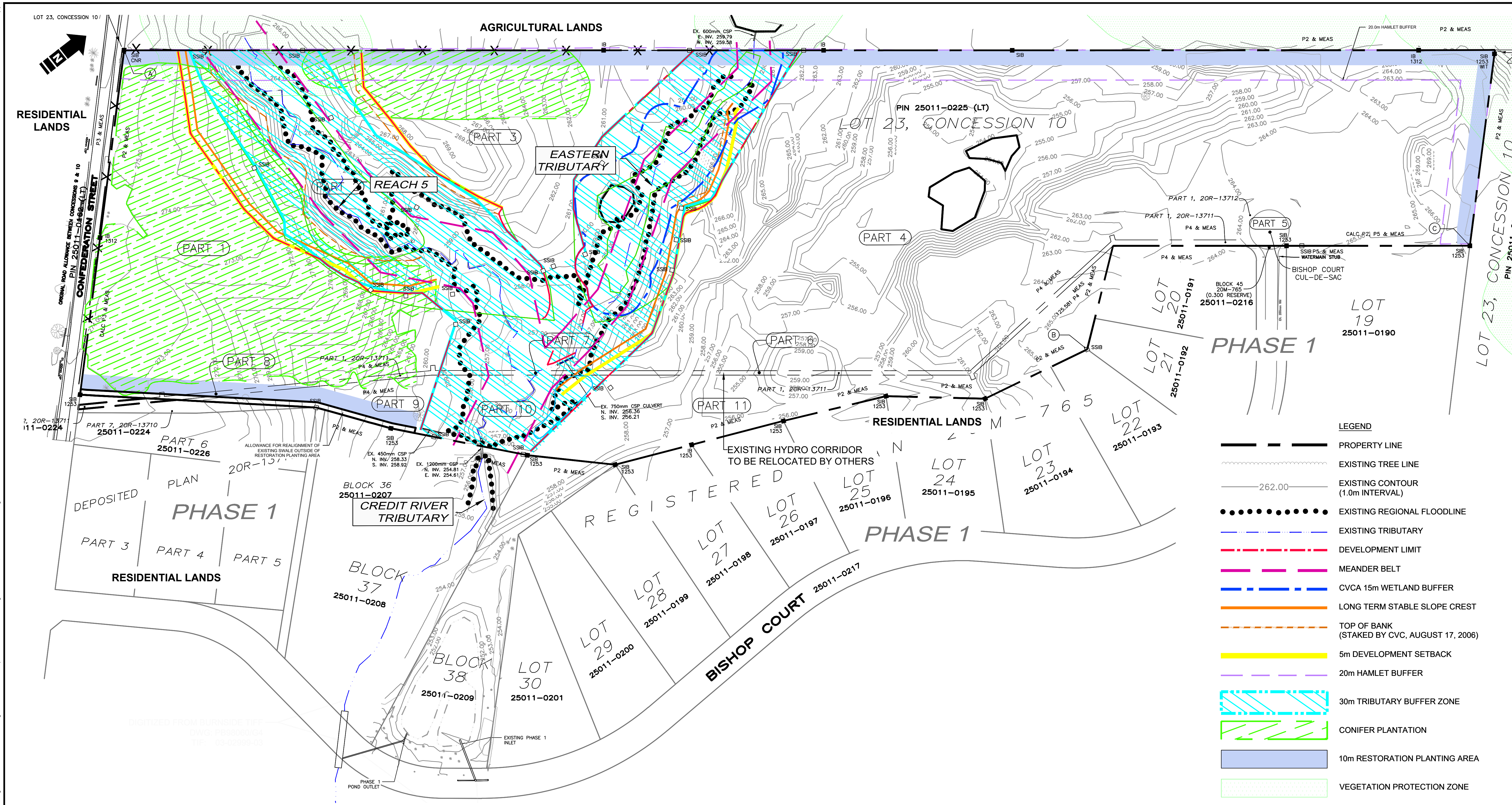
EXTERNAL DRAINAGE AREAS

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-03 External Catchments	A. GROSSE	S. BRAUN

Figure 3



1 : 2,500 metres
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REFERNCE:

1. EXISTING TOPOGRAPHY, DERIVED FROM THE GREER GALLOWAY GROUP INC. DWG. 0816529-GRADING PLAN 1-3, DATE: 2009-08-06.
2. LEGAL INFORMATION FROM VAN HARTEN SURVEYING INC. PLAN OF SURVEY OF PART OF LOT 23, CONCESSION 10, GEOGRAPHIC TOWNSHIP OF ESQUESING, TOWN OF HALTON HILLS, REGIONAL MUNICIPALITY OF HALTON HILLS. DATE: JANUARY 4, 2011.
3. COORDINATES ON THIS PLAN ARE UTM, ZONE 17, NAD83 (CSRS-2002) ADJUSTMENT AND ARE BASED ON GPS OBSERVATIONS FROM A NETWORK OF PERMANENT GPS REFERENCE STATIONS.
4. EXISTING 30m BUFFER, MEANDER BELT, TOP OF STABLE SLOPE AND 5.0m OFFSET, WETLAND BUFFER AND DEVELOPMENT LIMIT DERIVED FROM NORTH-SOUTH ENVIRONMENTAL, DATE: 2015-02-13.

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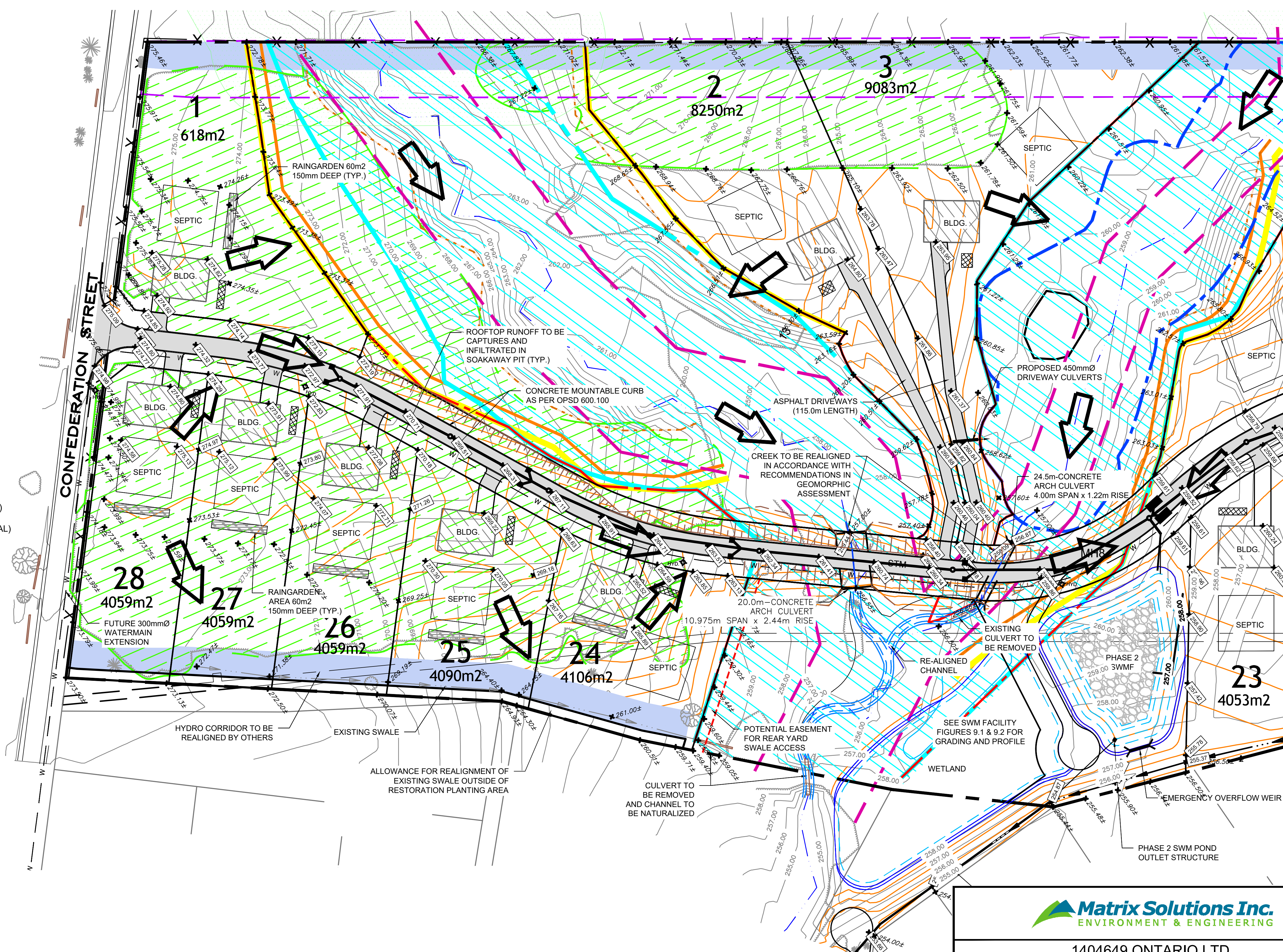
GLEN WILLIAMS, TOWN OF HALTON HILLS

EXISTING CONDITIONS

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-04 Ex Cond	A. GROSSE	S. BRAUN

Figure 4



LEGEND

- PROPERTY LINE
- EXISTING TRIBUTARY
- DEVELOPMENT LIMIT
- MEANDER BELT
- CVCA 15m WETLAND BUFFER
- LONG TERM STABLE SLOPE CREST
- TOP OF BANK (STAKED BY CVC, AUGUST 17, 2006)
- 5m DEVELOPMENT SETBACK
- 20m HAMLET BUFFER
- 30m TRIBUTARY BUFFER ZONE
- CONIFER PLANTATION
- 10m RESTORATION PLANTING AREA
- VEGETATION PROTECTION ZONE
- 274.40± EXISTING GRADE (m)
- 274.00 PROPOSED FINISHED GRADE (m)
- EXISTING CONTOUR (1.0m INTERVAL)
- PROPOSED CONTOUR (1.0m INTERVAL)
- DIRECTION OF DRAINAGE

1 : 1,500 metres
15 0 15 30

REFERNCE:

1. EXISTING TOPOGRAPHY, DERIVED FROM THE GREER GALLOWAY GROUP INC. DWG. 0816529-GRADING PLAN 1-3, DATE: 2009-08-06.
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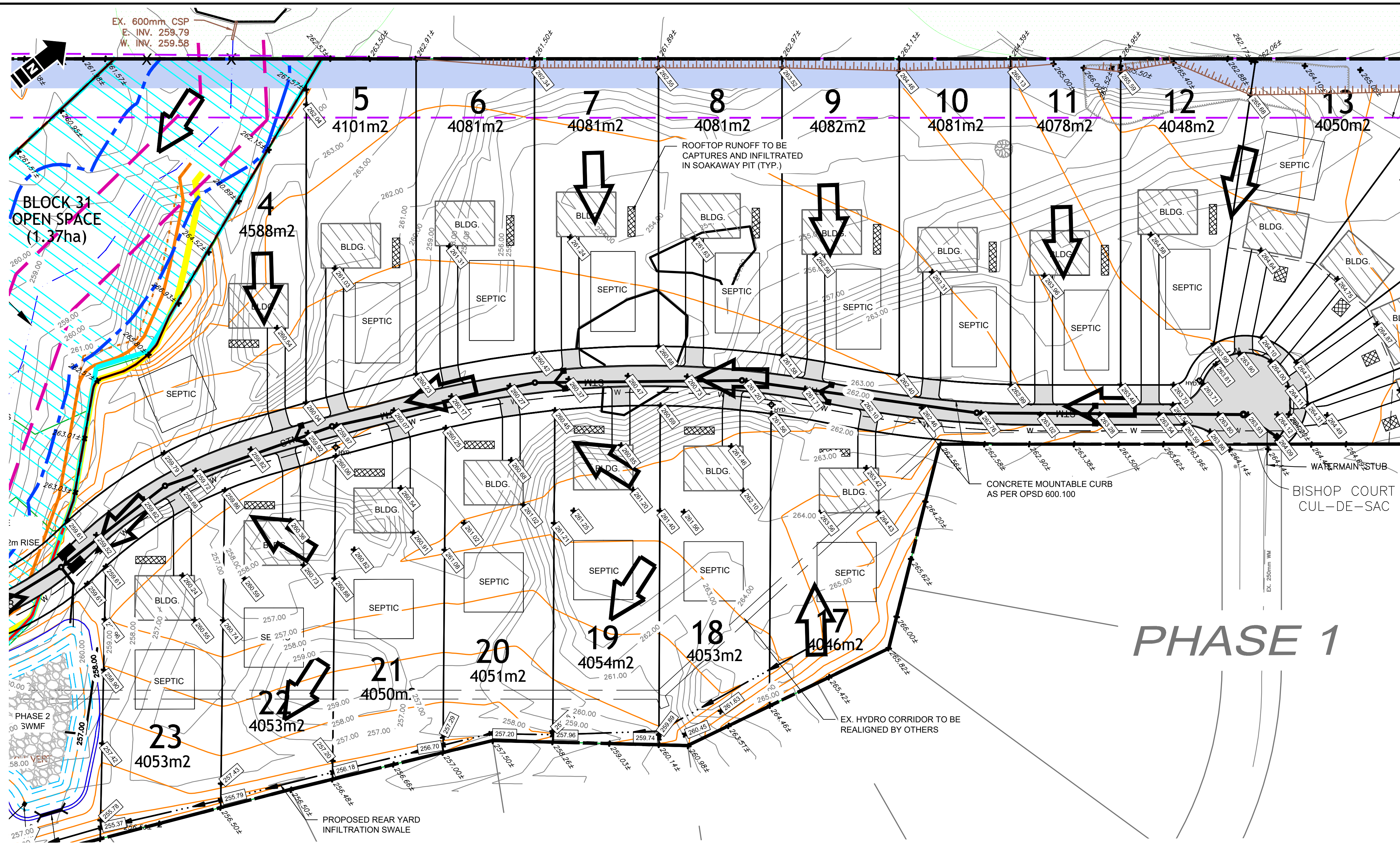
GLEN WILLIAMS, TOWN OF HALTON HILLS

PROPOSED GRADING - WEST

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-05 E-W Pr Grading	A. GROSSE	S. BRAUN

Figure 5a



LEGEND

- PROPERTY LINE
- EXISTING TRIBUTARY
- DEVELOPMENT LIMIT
- MEANDER BELT
- CVCA 15m WETLAND BUFFER
- LONG TERM STABLE SLOPE CREST
- TOP OF BANK (STAKED BY CVC, AUGUST 17, 2006)
- 5m DEVELOPMENT SETBACK
- 20m HAMLET BUFFER
- 30m TRIBUTARY BUFFER ZONE
- CONIFER PLANTATION
- 10m RESTORATION PLANTING AREA
- VEGETATION PROTECTION ZONE
- 274.40± EXISTING GRADE (m)
- 274.00 PROPOSED FINISHED GRADE (m)
- EXISTING CONTOUR (1.0m INTERVAL)
- PROPOSED CONTOUR (1.0m INTERVAL)
- DIRECTION OF DRAINAGE

REFERNCE:

1. EXISTING TOPOGRAPHY, DERIVED FROM THE GREER GALLOWAY GROUP INC. DWG. 0816529-GRADING PLAN 1-3, DATE: 2009-08-06.
2. LEGAL INFORMATION FROM VAN HARTEN SURVEYING INC. PLAN OF SURVEY OF PART OF LOT 23, CONCESSION 10, GEOGRAPHIC TOWNSHIP OF ESQUESING, TOWN OF HALTON HILLS, REGIONAL MUNICIPALITY OF HALTON HILLS. DATE: JANUARY 4, 2011.
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4. EXISTING 30m BUFFER, MEANDER BELT, TOP OF STABLE SLOPE AND 5.0m OFFSET, WETLAND BUFFER AND DEVELOPMENT LIMIT DERIVED FROM NORTH-SOUTH ENVIRONMENTAL, DATE: 2015-02-13.

1 : 1,500 metres
15 0 15 30

Note: Figure(s) must be used in conjunction with the attached report and is subject to the limitations and conditions stated in the report.

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1404649 ONTARIO LTD.
GLEN WILLIAMS, TOWN OF HALTON HILLS

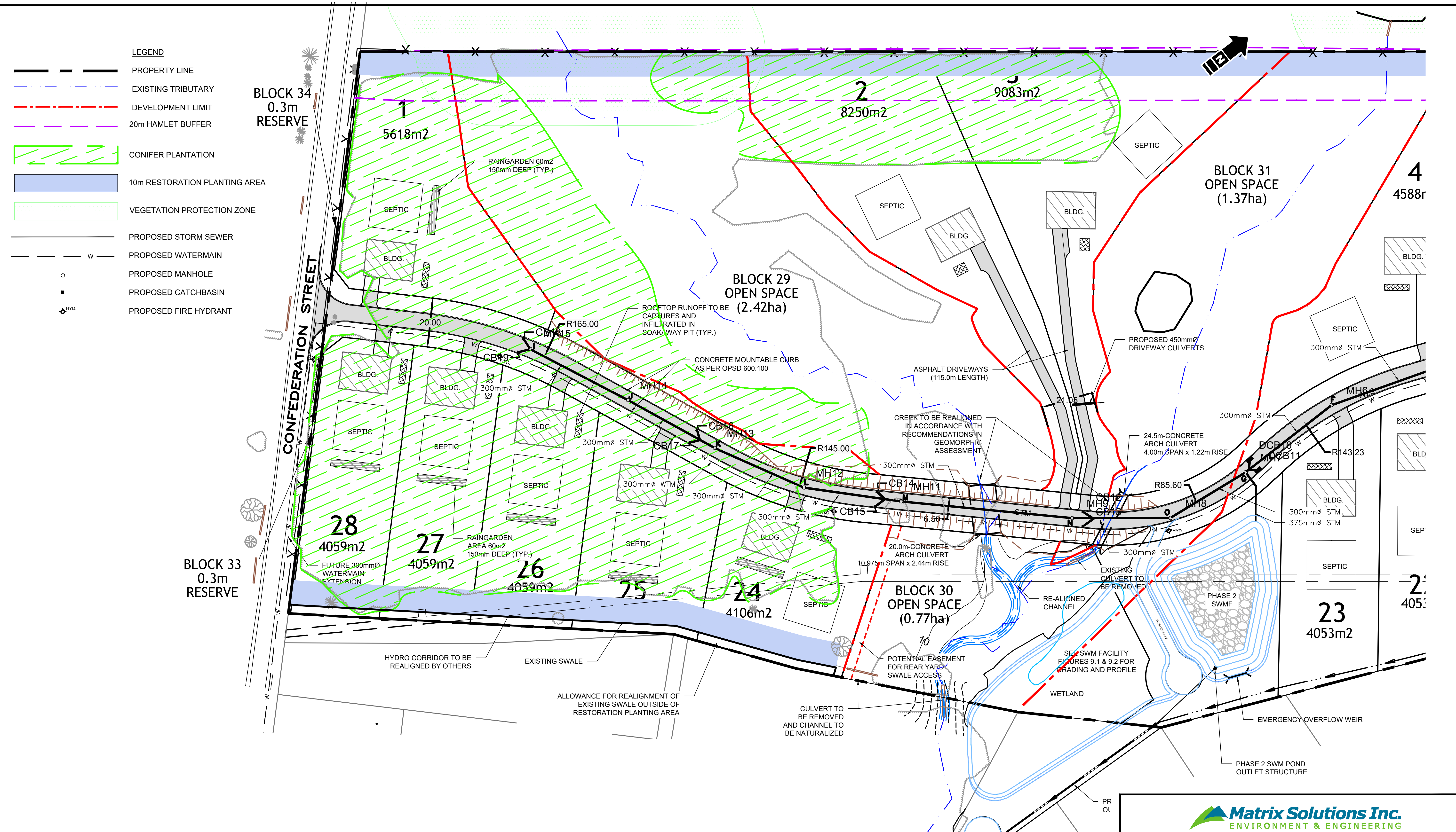
PROPOSED GRADING - EAST

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-05 E-W Pr Grading	A. GROSSE	S. BRAUN

Figure 5b

Plot 1:1 = Tabloid (L)

H:\21006_Glen Williams\03 Data\Drafting\C3D\Subdivision\Production\Figs\2021-04-13 CVC Report\21006-05 E-W Pr Grading.dwg - 05b - Thursday, March 11, 2021 9:31:36 AM - Kim Weiler



REFERENCE:

1. EXISTING TOPOGRAPHY, DERIVED FROM THE GREER GALLOWAY GROUP INC. DWG. 0816529-GRADING PLAN 1-3, DATE: 2009-08-06.
2. LEGAL INFORMATION FROM VAN HARTEN SURVEYING INC. PLAN OF SURVEY OF PART OF LOT 23, CONCESSION 10, GEOGRAPHIC TOWNSHIP OF ESQUESING, TOWN OF HALTON HILLS, REGIONAL MUNICIPALITY OF HALTON HILLS. DATE: JANUARY 4, 2011.
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ENVIRONMENT & ENGINEERING

1404649 ONTARIO LTD.
GLEN WILLIAMS, TOWN OF HALTON HILLS

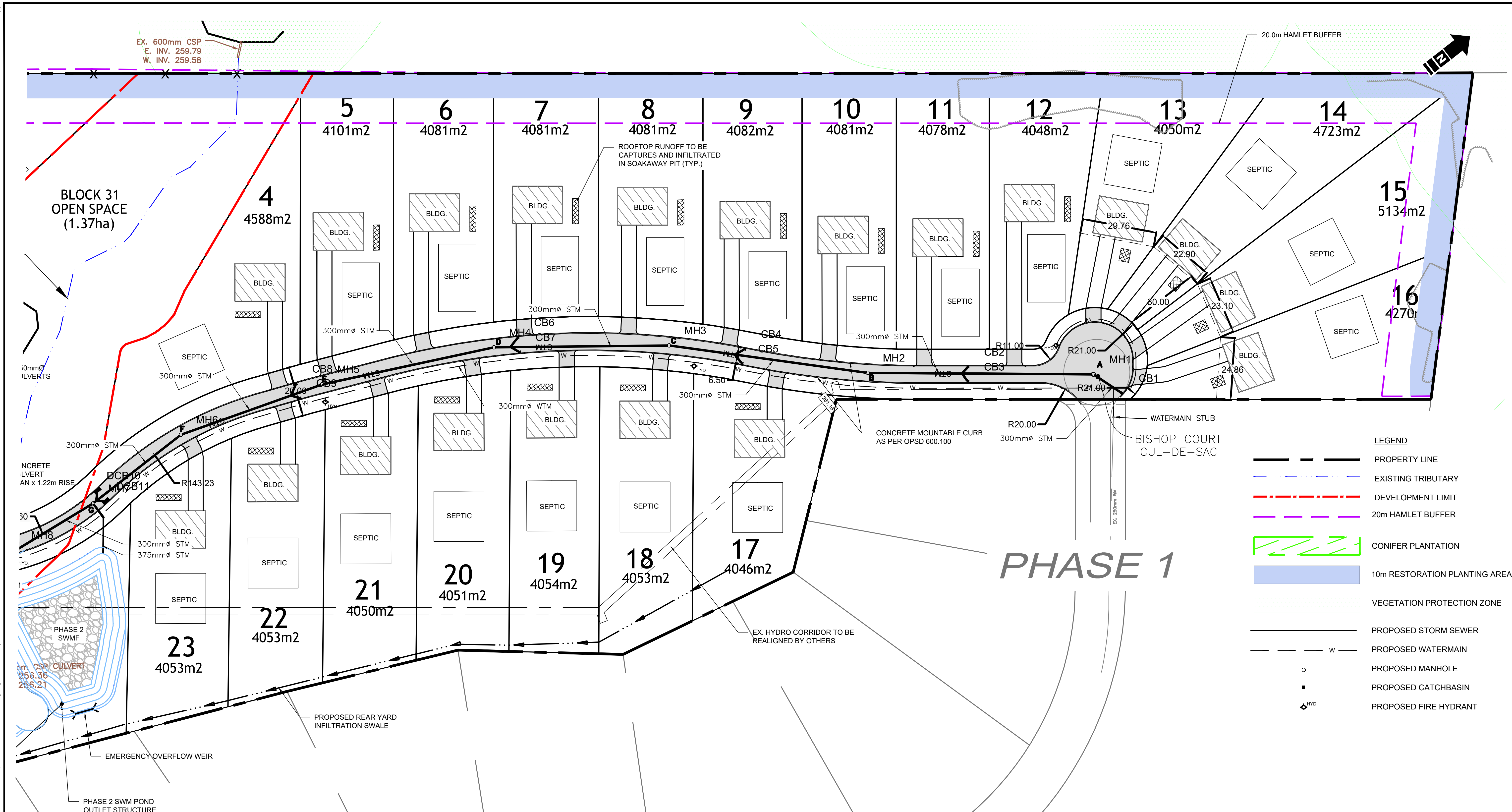
PROPOSED SERVICING - WEST

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-06 E-W Pr Servicing	A. GROSSE	S. BRAUN

Figure 6a

Plot 1:1 = Tabloid (L)

H:\21006_Glen Williams\03 Data\Drafting\C3D\Subdivision\Production\Figs\2021-04-13 CVC Report\21006-06 E-W Pr Servicing.dwg - 06a - Thursday, March 11, 2021 11:30:54 AM - Kim Weiler



REFERNCE:

1. EXISTING TOPOGRAPHY, DERIVED FROM THE GREER GALLOWAY GROUP INC. DWG. 0816529-GRADING PLAN 1-3, DATE: 2009-08-06.
2. LEGAL INFORMATION FROM VAN HARTEN SURVEYING INC. PLAN OF SURVEY OF PART OF LOT 23, CONCESSION 10, GEOGRAPHIC TOWNSHIP OF ESQUESING, TOWN OF HALTON HILLS, REGIONAL MUNICIPALITY OF HALTON HILLS. DATE: JANUARY 4, 2011.
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1 : 1,500 metres
15 0 15 30

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GLEN WILLIAMS, TOWN OF HALTON HILLS

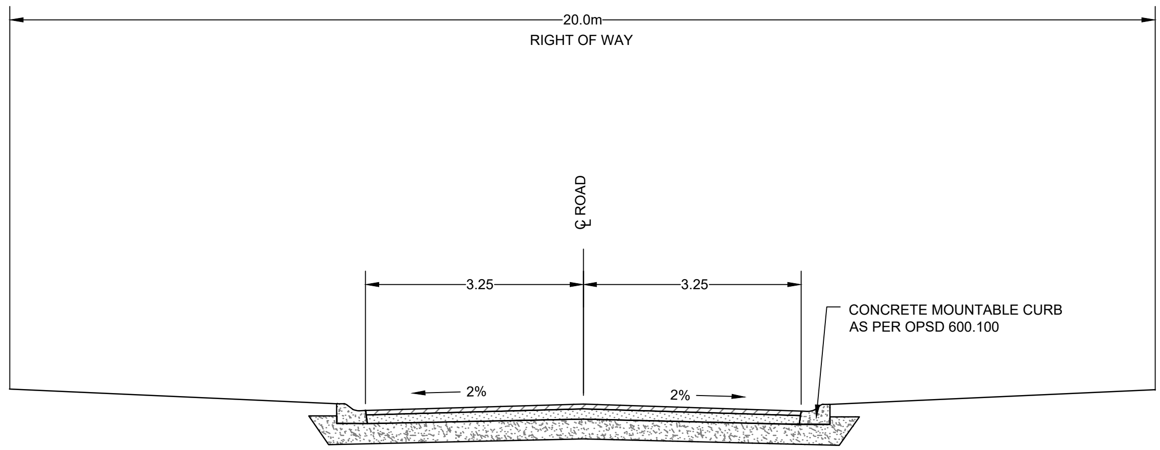
PROPOSED SERVICING - EAST

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-06 E-W Pr Servicing	A. GROSSE	S. BRAUN

Figure 6b

Plot 1:1 = Tabloid (L)

H:\21006_Glen Williams\03 Data\Drafting\C3D\Subdivision\Production\Figs\2021-04-13 CVC Report\21006-06 E-W Pr Servicing.dwg - 06b - Thursday, March 11, 2021 11:30:54 AM - Kim Weiler



TYPICAL ROAD CROSS SECTION - 20 m R.O.W.

NOT TO SCALE

PAVEMENT DESIGN

COURSE	THICKNESS (mm)	OPS SPECIFICATION
ASPHALT SURFACE	40	HL-3
ASPHALT BINDER	50	HL-8
GRANULAR BASE	150	20mm CRUSHER-RUN LIMESTONE OR EQUIVALENT
GRANULAR SUB-BASE	350	50mm CRUSHER-RUN LIMESTONE OR EQUIVALENT

MINIMUM RECOMMENDED PAVEMENT THICKNESS AS PER AEL ENVIRONMENTAL.
GEOTECHNICAL INVESTIGATION DATE: NOVEMBER 2015.

Note: Figure(s) must be used in conjunction with the attached report and is subject to the limitations and conditions stated in the report.

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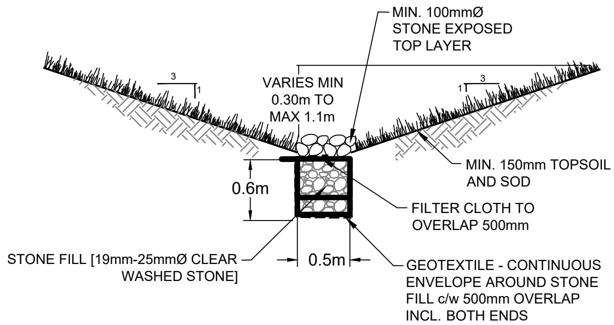
TYPICAL ROAD CROSS SECTION

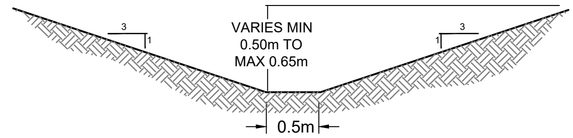
Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-07 Road XS	A. GROSSE	S. BRAUN

Figure 7



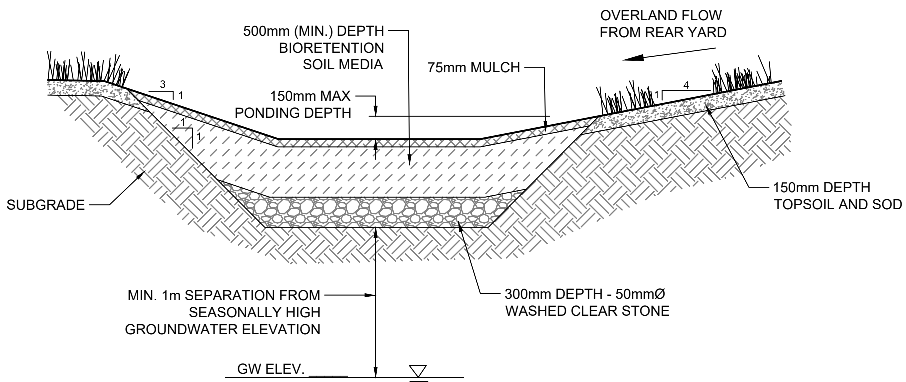
TYPICAL FLAT BOTTOM INFILTRATION SWALE

NOT TO SCALE



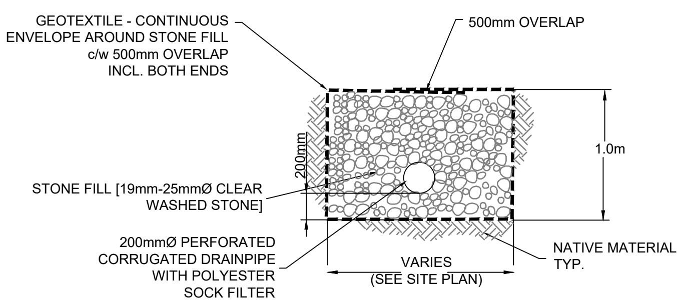
TYPICAL FLAT BOTTOM PHASE 2 OUTLET SWALE

NOT TO SCALE



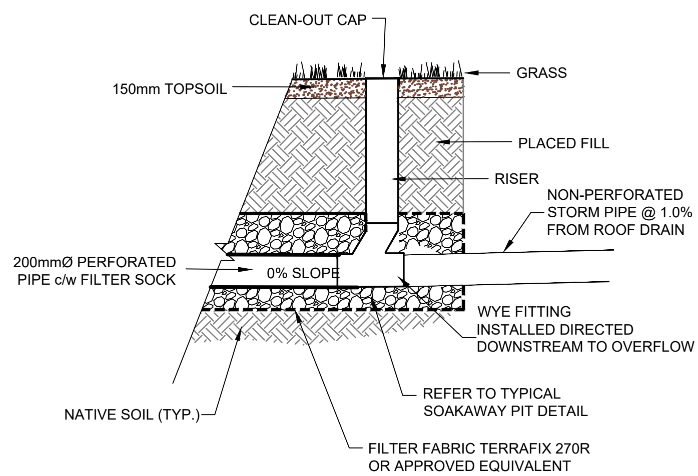
TYPICAL RAINGARDEN DETAIL

NOT TO SCALE



TYPICAL SOAKAWAY PIT DETAIL

NOT TO SCALE



TYPICAL SOAKAWAY PIT CLEANOUT DETAIL

NOT TO SCALE

Note: Figure(s) must be used in conjunction with the attached report and is subject to the limitations and conditions stated in the report.

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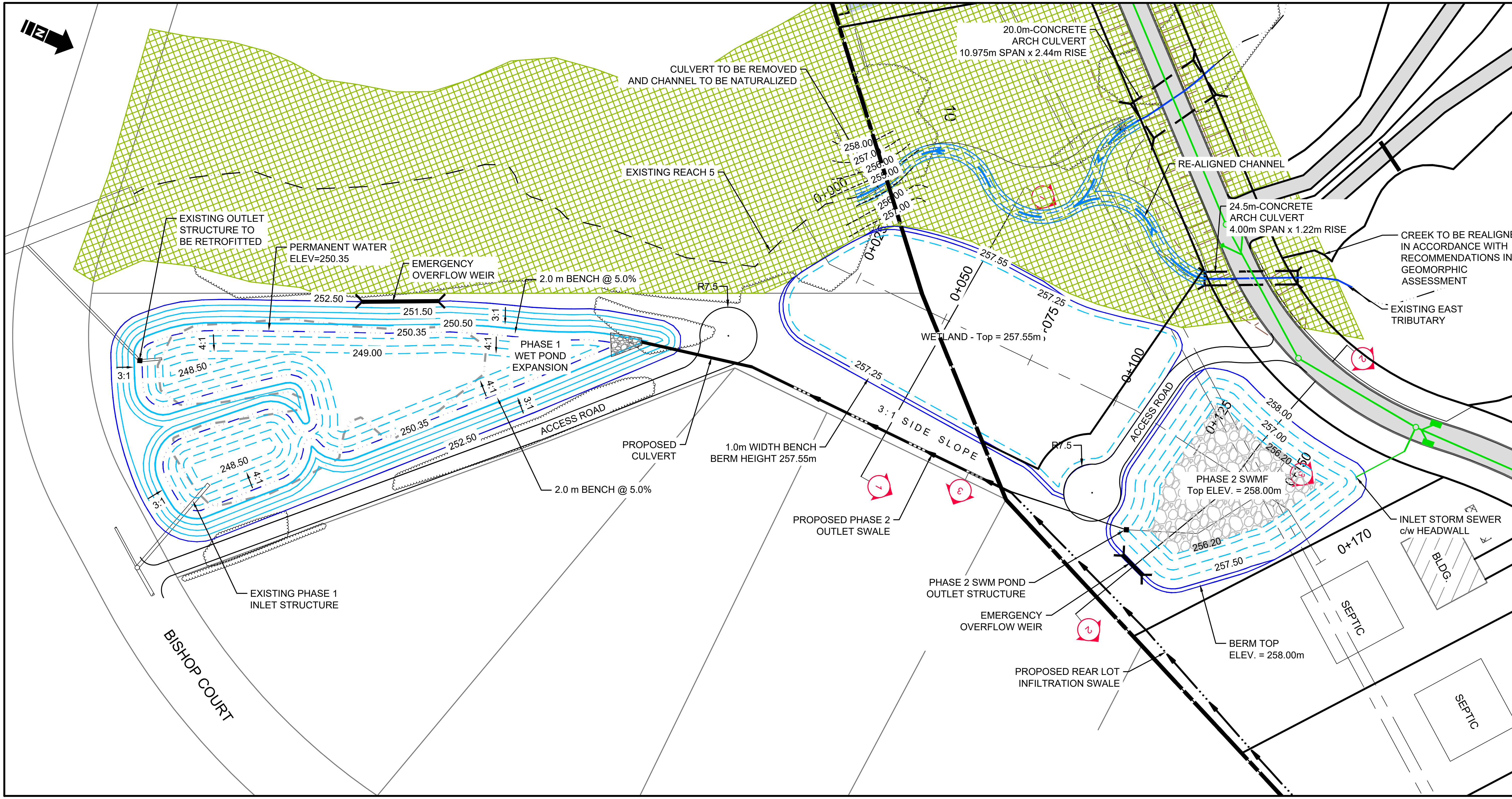
GLEN WILLIAMS, TOWN OF HALTON HILLS

TYPICAL LID DETAILS

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-08 Infiltration Details	A. GROSSE	S. BRAUN

Figure 8



LEGEND

PROPERTY LINE	REALIGNED CHANNEL
EXISTING TRIBUTARY	NATURAL HERITAGE SYSTEM
OUTLINE OF EXISTING SWM FACILITY	INFILTRATION GALLERY STONE
PROPOSED POND CONTOURS	
PROPOSED STORM SEWER	

REFERNCE:

1. EXISTING TOPOGRAPHY, DERIVED FROM THE GREER GALLOWAY GROUP INC. DWG. 0816529-GRADING PLAN 1-3, DATE: 2009-08-06.
2. LEGAL INFORMATION FROM VAN HARTEN SURVEYING INC. PLAN OF SURVEY OF PART OF LOT 23, CONCESSION 10, GEOGRAPHIC TOWNSHIP OF ESQUESING, TOWN OF HALTON HILLS, REGIONAL MUNICIPALITY OF HALTON HILLS. DATE: JANUARY 4, 2011.
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1 : 1,000 metres
10 0 10 20
DATUM

Note: Figure(s) must be used in conjunction with the attached report and is subject to the limitations and conditions stated in the report.

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ENVIRONMENT & ENGINEERING

1404649 ONTARIO LTD.
GLEN WILLIAMS, TOWN OF HALTON HILLS

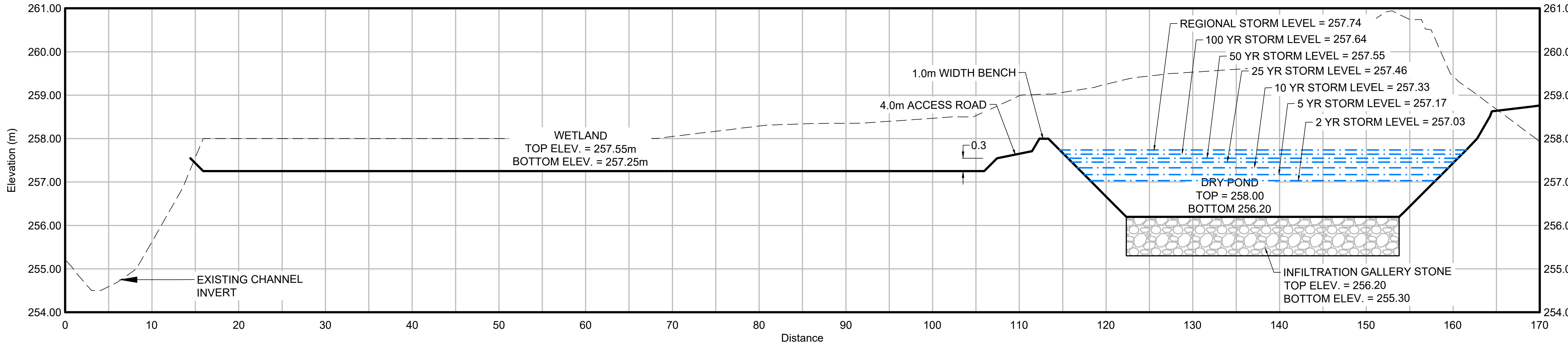
STORMWATER MANAGEMENT FACILITY PLAN VIEW

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-09 Pr SWM Facility	A. GROSSE	S. BRAUN

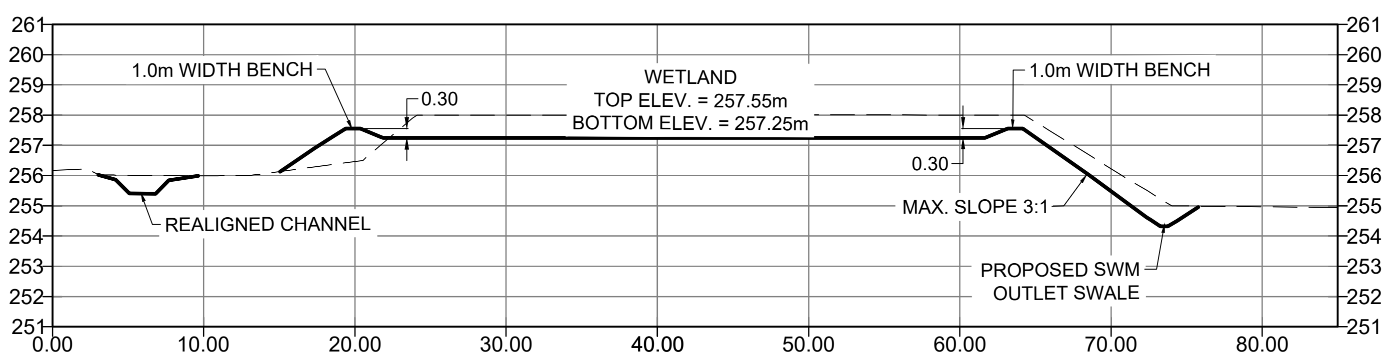
Figure 9a

Plot 1:1 = Tabloid (L)

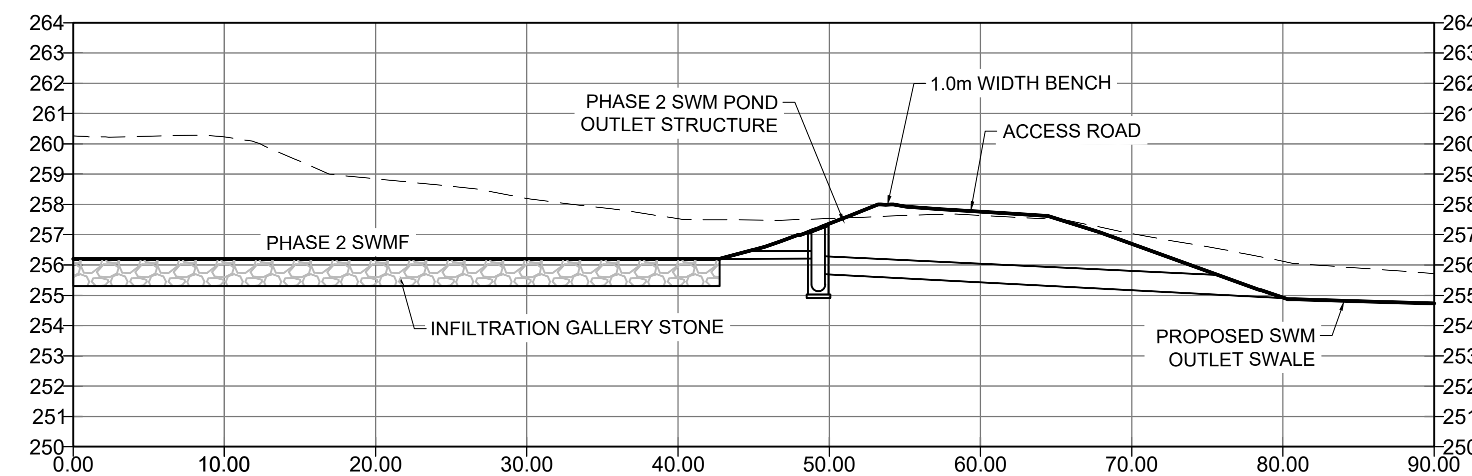
\\matrix-solutions.com\public\Guelph_Projects2\21006_Glen Williams\03 Data\Drafting\C3D\Subdivision\Production\Figs\2021-03-09 CVC Report\21006-09 Pr SWM Facility.dwg - 09a - March 10, 2021 8:15:11 AM - Greg Schicht



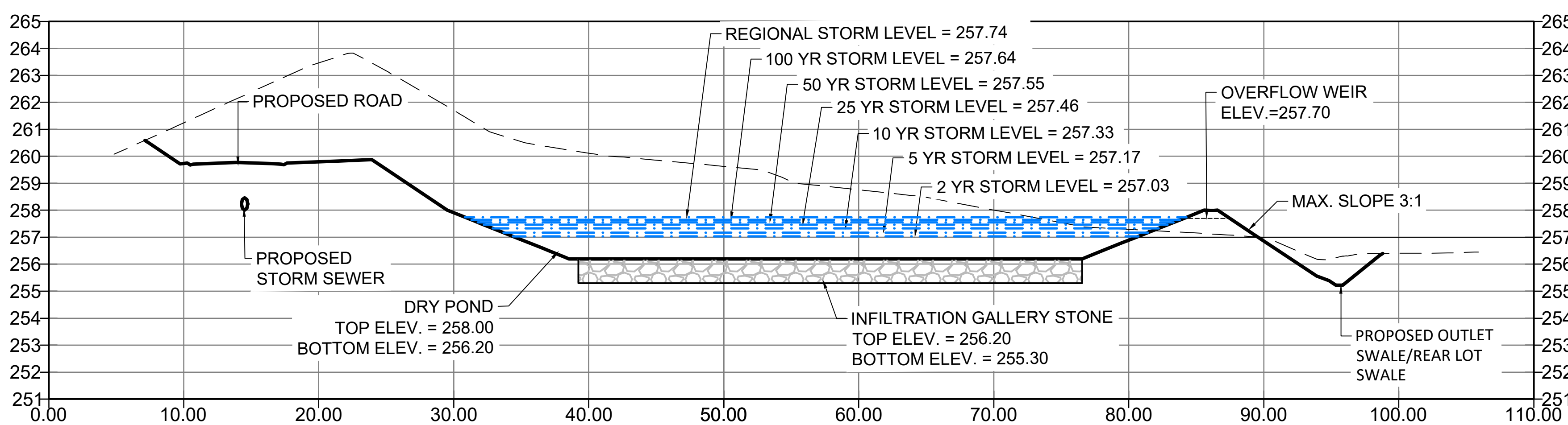
Profile
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



1 Section
1 HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:250



3 Section
1 HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:250



2 Section
1 HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:250

Note: Figure(s) must be used in conjunction with the attached report and is subject to the limitations and conditions stated in the report.

Reference:

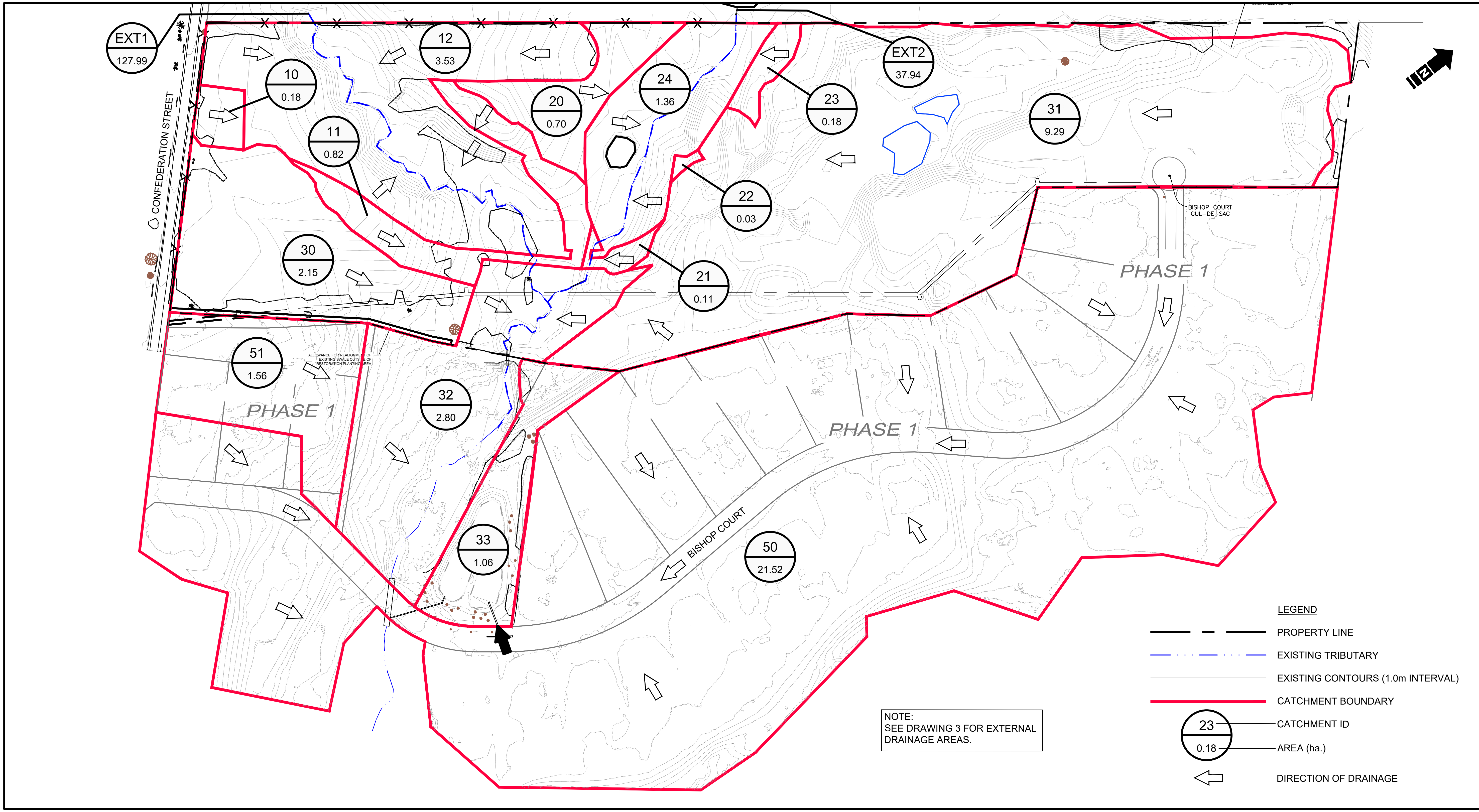
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

1404649 ONTARIO LTD.
GLEN WILLIAMS, TOWN OF HALTON HILLS

STORMWATER MANAGEMENT FACILITY PROFILE VIEW

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-09 Pr SWM Facility	A. GROSSE	S. BRAUN

Figure 9b



REFERNCE:

1. PHASE 2 EXISTING TOPOGRAPHY, DERIVED FROM THE GREER GALLOWAY GROUP INC. DWG. 0816529-GRADING PLAN 1-3, DATE: 2009-08-06.
2. PHASE 1 EXISTING TOPOGRAPHY DERIVED FROM LIDAR DTM PEEL 2016 PACKAGE A.
3. LEGAL INFORMATION FROM VAN HARTEN SURVEYING INC. PLAN OF SURVEY OF PART OF LOT 23, CONCESSION 10, GEOGRAPHIC TOWNSHIP OF ESQUESING, TOWN OF HALTON HILLS, REGIONAL MUNICIPALITY OF HALTON HILLS. DATE: JANUARY 4, 2011.
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1 : 3,000 metres
30 0 30 60
DATUM

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Matrix Solutions Inc.
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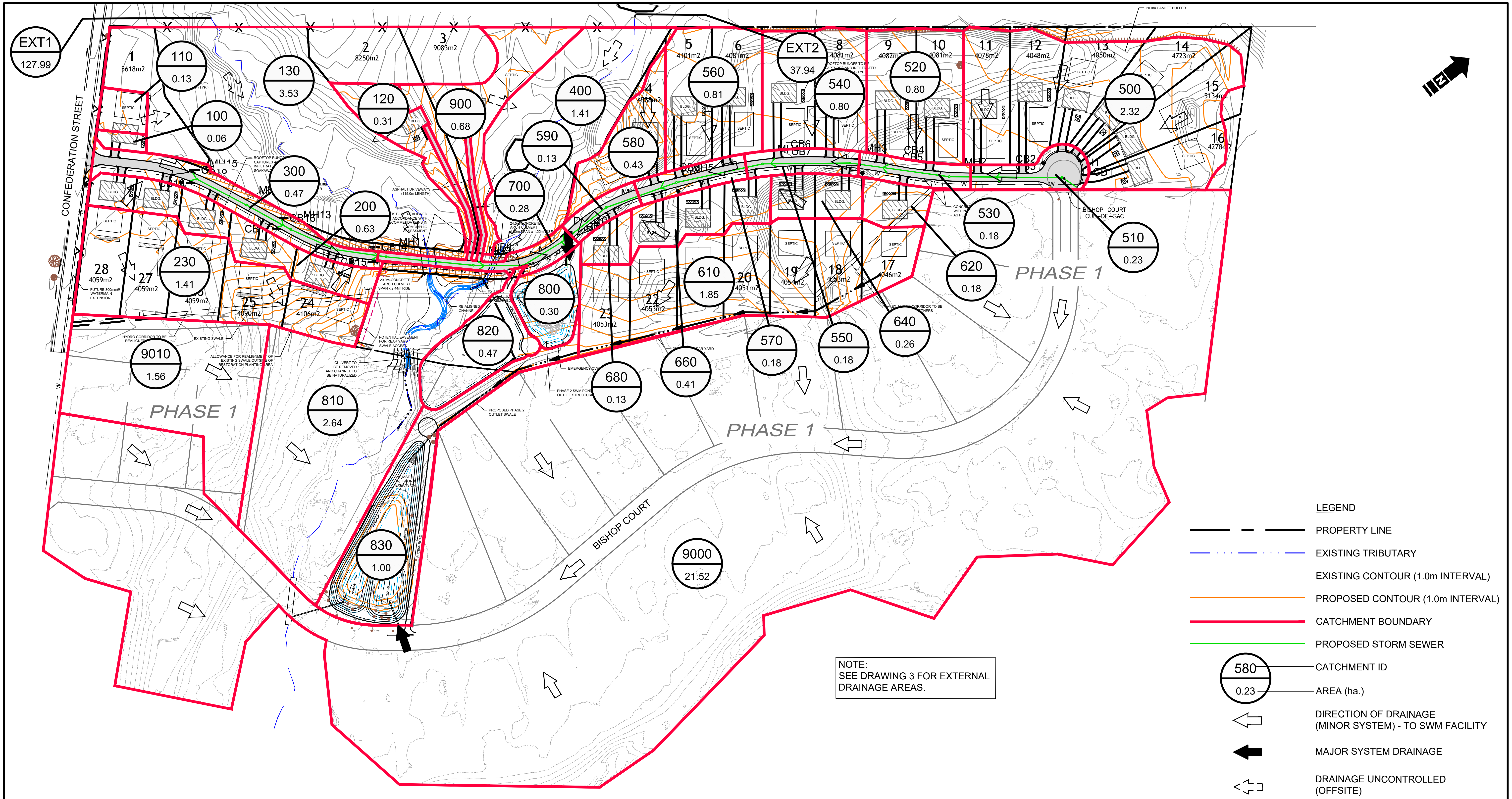
1404649 ONTARIO LTD.
GLEN WILLIAMS, TOWN OF HALTON HILLS

PRE DEVELOPMENT VO MODEL CATCHMENT BOUNDARIES

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-10 Pre Catchments	A. GROSSE	S. BRAUN

Figure
10



LEGEND

PROPERTY LINE

EXISTING TRIBUTARY

EXISTING CONTOUR (1.0m INTERVAL)

PROPOSED CONTOUR (1.0m INTERVAL)

CATCHMENT BOUNDARY

PROPOSED STORM SEWER

580 — CATCHMENT ID

0.23 — AREA (ha.)

DIRECTION OF DRAINAGE (MINOR SYSTEM) - TO SWM FACILITY

MAJOR SYSTEM DRAINAGE

DRAINAGE UNCONTROLLED (OFFSITE)

NOTE:
SEE DRAWING 3 FOR EXTERNAL DRAINAGE AREAS.

REFERNCE:

1. PHASE 2 EXISTING TOPOGRAPHY, DERIVED FROM THE GREER GALLOWAY GROUP INC. DWG. 0816529-GRADING PLAN 1-3, DATE: 2009-08-06.
2. PHASE 1 EXISTING TOPOGRAPHY DERIVED FROM LIDAR DTM PEEL 2016 PACKAGE A.
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1 : 3,000 metres
30 0 30 60
DATUM

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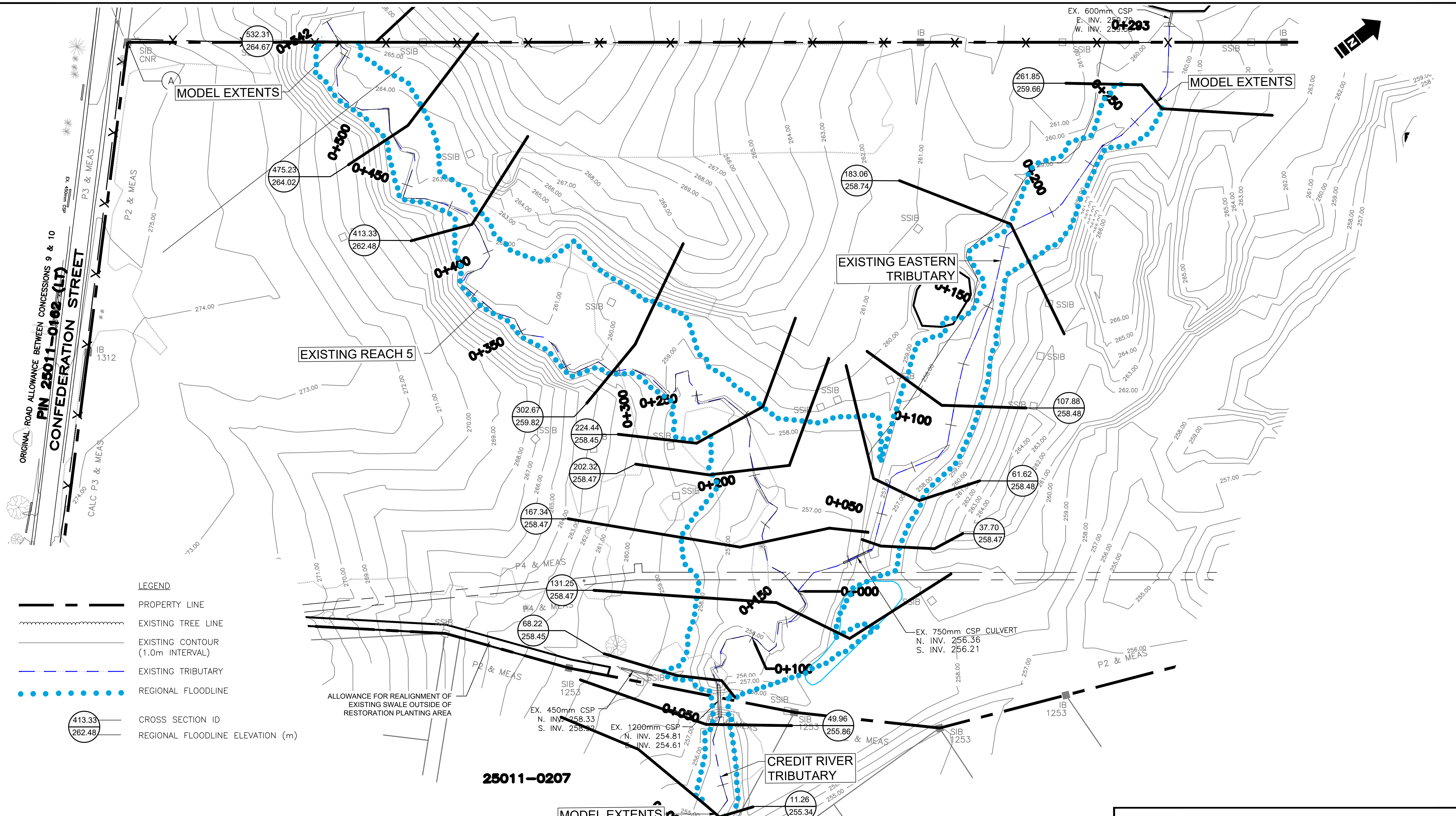
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

1404649 ONTARIO LTD.
GLEN WILLIAMS, TOWN OF HALTON HILLS

POST DEVELOPMENT VO MODEL CATCHMENT BOUNDARIES

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-11 Post Catchments	A. GROSSE	S. BRAUN

Figure 11



LEGEND

- PROPERTY LINE
- EXISTING TREE LINE
- EXISTING CONTOUR (1.0m INTERVAL)
- EXISTING TRIBUTARY
- REGIONAL FLOODLINE
- 413.33 / 262.48 — CROSS SECTION ID / REGIONAL FLOODLINE ELEVATION (m)

REFERNCE:

1. EXISTING TOPOGRAPHY, DERIVED FROM THE GREER GALLOWAY GROUP INC. DWG. 0816529-GRADING PLAN 1-3, DATE: 2009-08-06.
2. LEGAL INFORMATION FROM VAN HARTEN SURVEYING INC. PLAN OF SURVEY OF PART OF LOT 23, CONCESSION 10, GEOGRAPHIC TOWNSHIP OF ESQUESING, TOWN OF HALTON HILLS, REGIONAL MUNICIPALITY OF HALTON HILLS. DATE: JANUARY 4, 2011.
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1 : 1,500 metres
15 0 15 30

Note: Figure(s) must be used in conjunction with the attached report and is subject to the limitations and conditions stated in the report.

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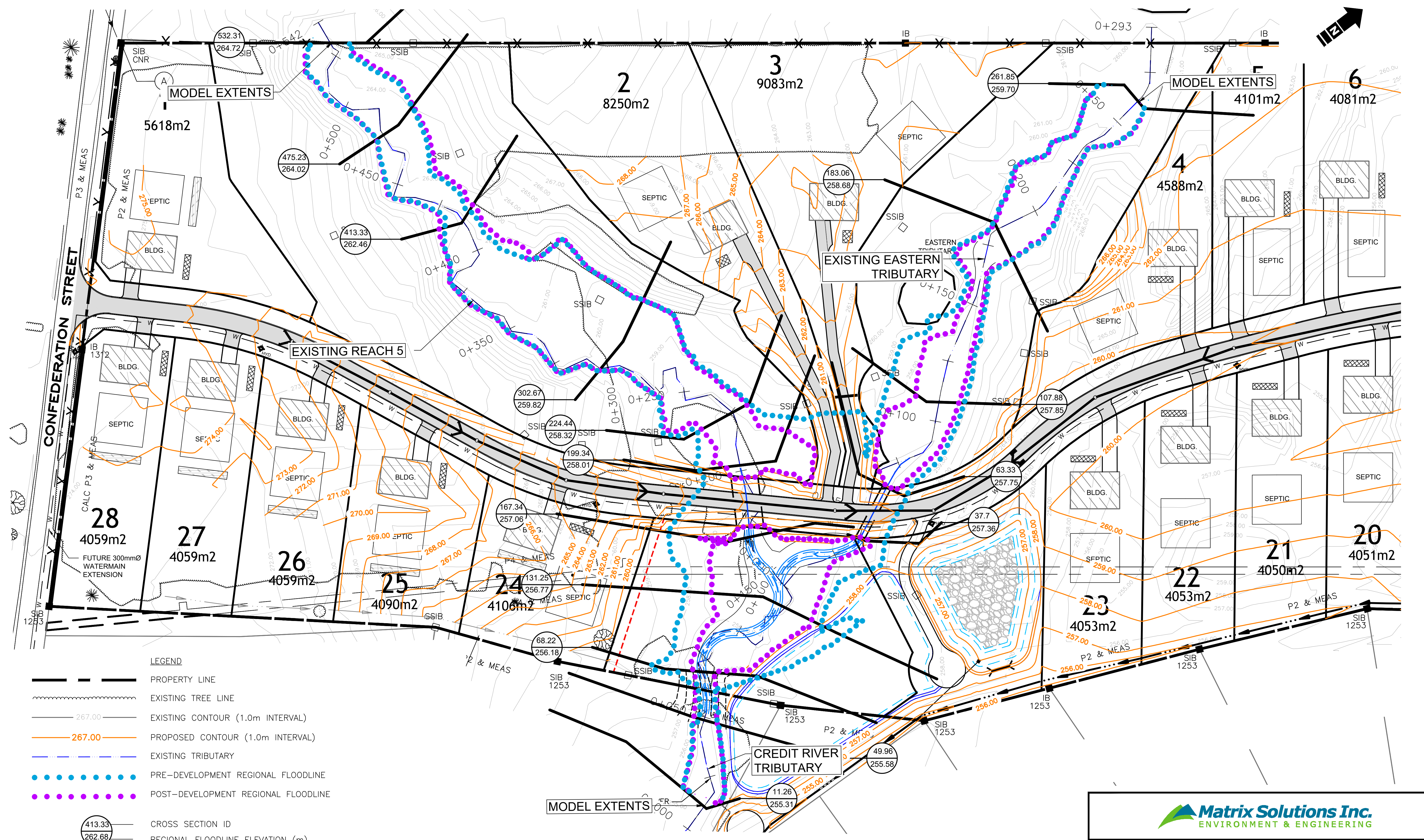
PRE-DEVELOPMENT HEC-RAS CROSSECTIONS

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-12 Ex HecRas XS	A. GROSSE	S. BRAUN

Figure 12



REFERNCE:

1. EXISTING TOPOGRAPHY, DERIVED FROM THE GREER GALLOWAY GROUP INC. DWG. 0816529-GRADING PLAN 1-3, DATE: 2009-08-06.
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1 : 1,500 metres

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Matrix Solutions Inc.
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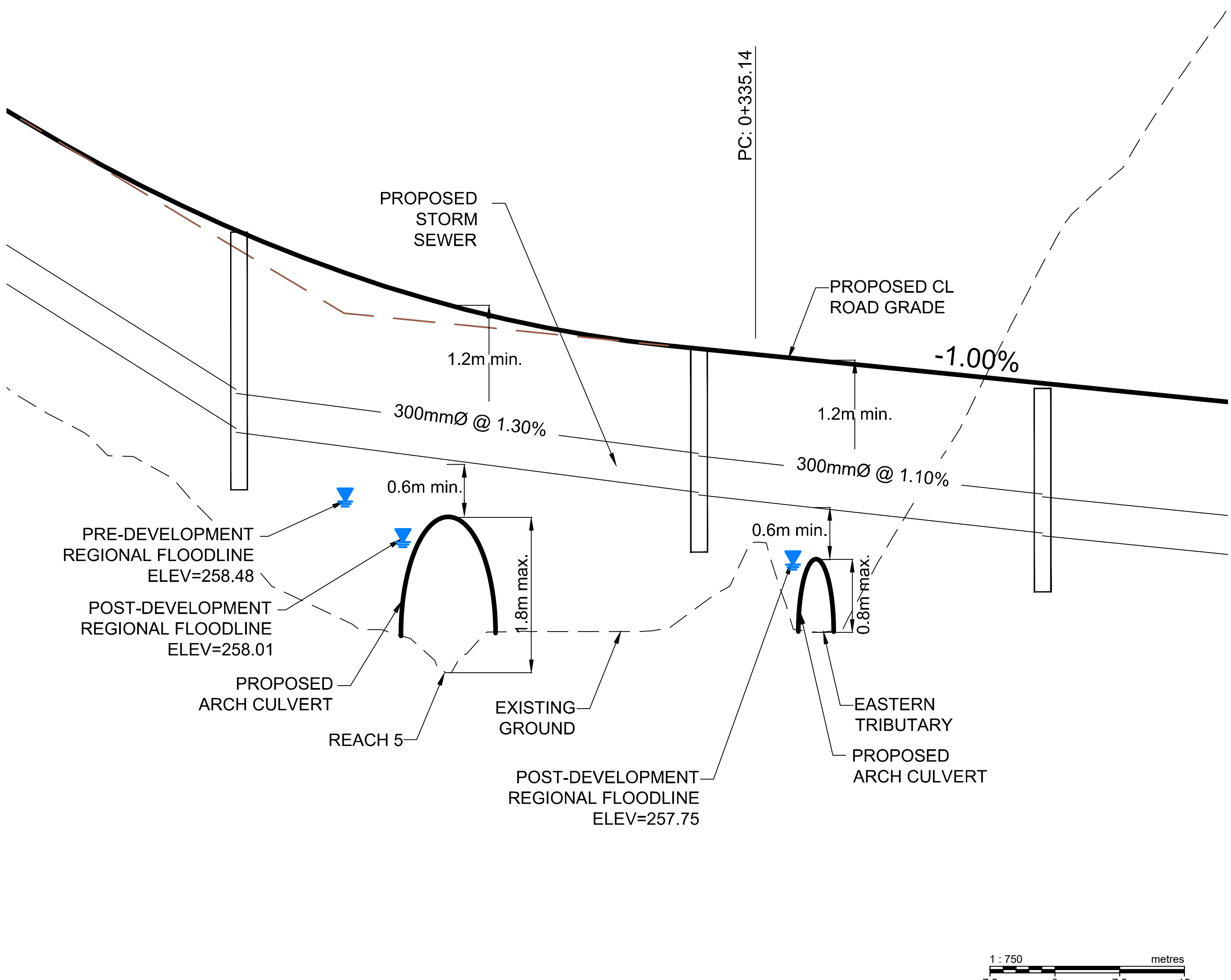
1404649 ONTARIO LTD.
GLEN WILLIAMS, TOWN OF HALTON HILLS

POST-DEVELOPMENT HEC-RAS CROSSECTIONS

Date:	Project:	Submitter:	Reviewer:
MARCH 2021	21006-13 Post HecRas XS	A. GROSSE	S. BRAUN

Figure 13



\\matrix-solutions.com\public\Guelph_Projects2\21006_Glen Williams\03 Data\Drafting\C3D\Subdivision\Production\Figs\2021-03-09 CVC Report\21006-14 Road Crossing.dwg - 14 - December 4, 2020 2:21:05 PM - Greg Schicht

Plot 1:1 = Letter (P)

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1404649 ONTARIO LTD.
GLEN WILLIAMS, TOWN OF HALTON HILLS

PROFILE OF ROAD AT WATERCOURSE CROSSINGS

Date: MARCH 2021	Project: 21006-14 Road Crossing	Submitter: A. GROSSE	Reviewer: S. BRAUN

Figure 14

Note: Figure(s) must be used in conjunction with the attached report and is subject to the limitations and conditions stated in the report.

APPENDIX A
Excerpts from Background Studies

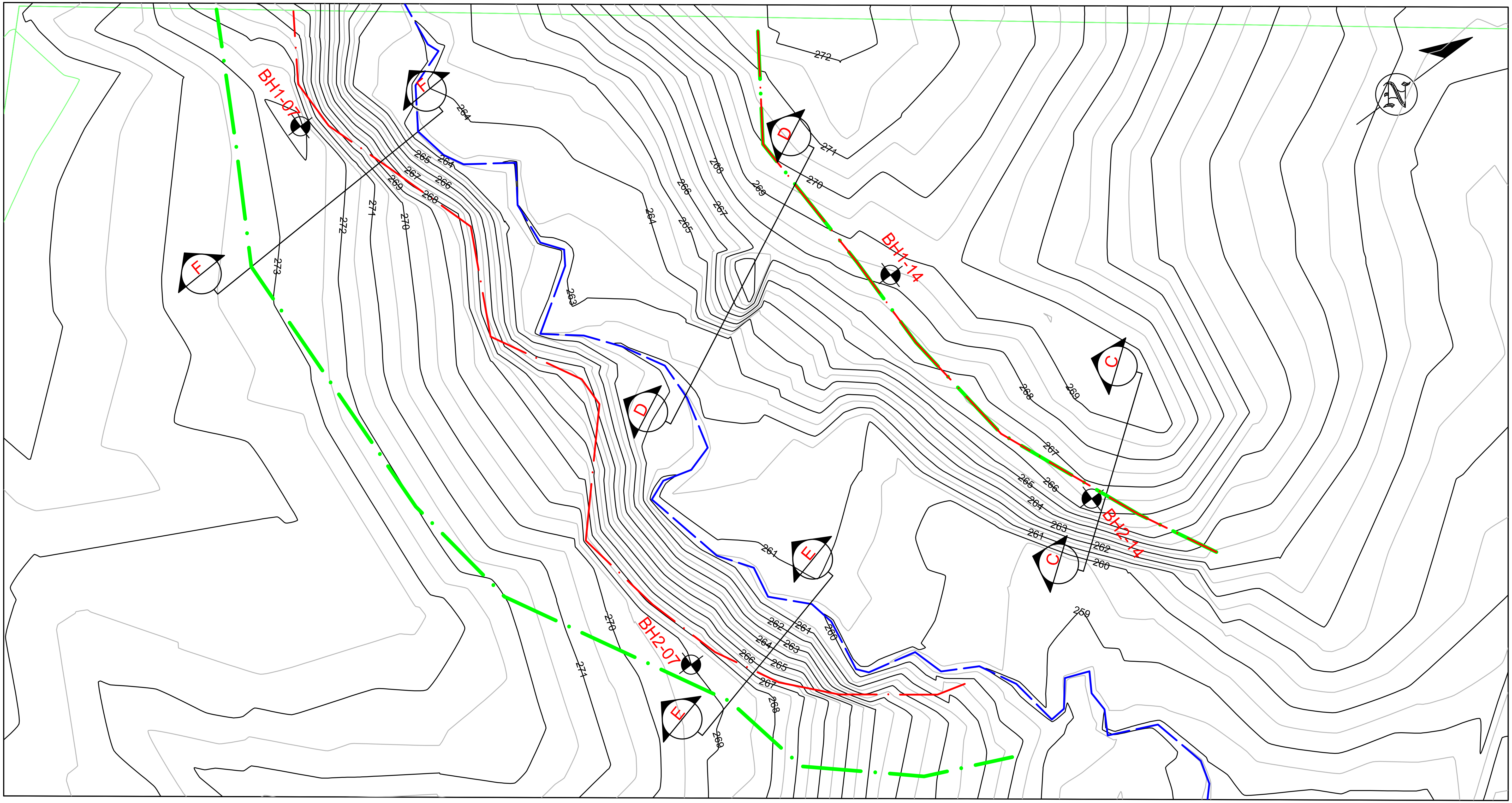
APPENDIX A1
Slope Stability Assessment Report for Proposed Residential Development 12519 Ninth Line, Town of Halton Hills (Soil Engineers 2015a)

Location of Slope	Overall Height (m)	Steepest Slope Gradient	Overall Slope Gradient
East Slope of Eastern Tributary	7± m	1V:1.8± H	1V:2 to 6H
East Slope of Western Tributary	7± m	1V:1.7± H	1V:2 to 6H
West Slope of Western Tributary	7± m	1V:1.8± H	1V:2H

The boreholes revealed that beneath a layer of topsoil, the site is generally underlain by strata of sandy silt till and silt, with localized deposits of silty clay, silty clay till, sand and gravel. Weathered shale was encountered at Borehole 2-14. The relative density of the soils is inferred from the obtained ‘N’ values. The ‘N’ values show the sandy silt till is loose to dense, being generally compact, and the silt is compact to very dense, being generally very dense. The loose condition is restricted to the weathered soil zone within a depth of 1.0± m from the prevailing ground surface.

The groundwater level in the existing monitoring wells that were installed for the previous studies was measured by the client in November 2014. The groundwater level at the newly installed monitoring well at Borehole 2-14 was measured on January 2015. The groundwater levels are given in the following table:

BH ID	Well Depth (m)	Ground Elevation (m)	Groundwater Level (m)	Groundwater Elevation (m)
BH1-07	7.9	273.0	5.0	268.0
BH2-07	8.7	269.0	5.6	263.4
BH1-09	7.9	264.6	6.1	258.5
BH2-09	9.8	267.3	8.7	258.6
BH2-14	7.6	266.4	6.2	260.2



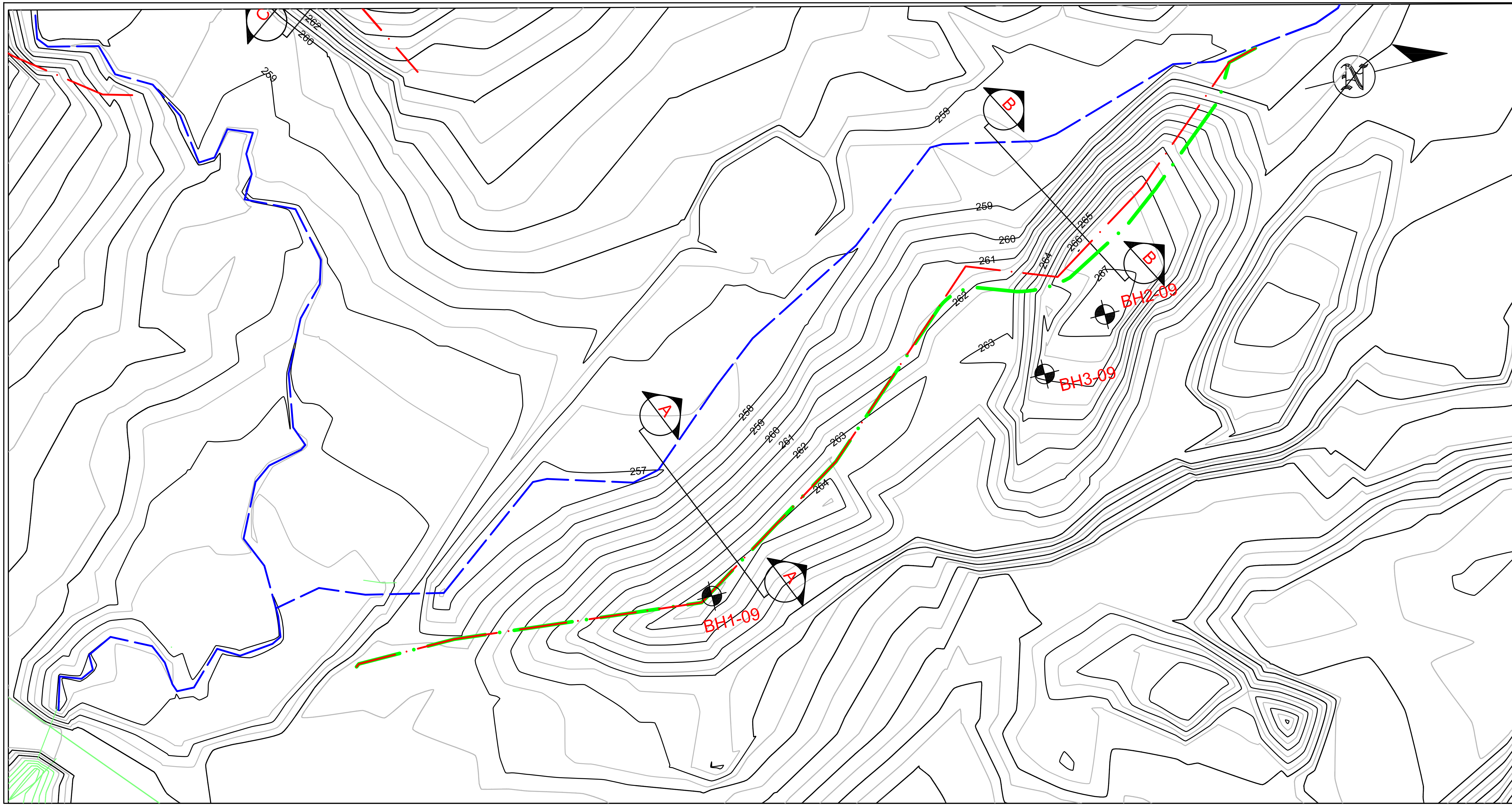
Legend:

— — — (blue)	Creek
— · — (red)	Staked Top of Bank
— · — (green)	Long Term Stable Slope Line

Cross Section Location Plan For West Tributary

Reference No.:	1412-S062
Scale:	1:750
Date:	January 2015
Drawing No.:	1

SOIL ENGINEERS LTD.



Legend:

- Creek
- Staked Top of Bank
- Long Term Stable Slope Line

Cross Section Location Plan For East Tributary	
Reference No.:	1412-S062
Scale:	1:750
Date:	January 2015
Drawing No.:	2

SOIL ENGINEERS LTD.

APPENDIX A2

Phase II Environmental Site Assessment, 12519 Ninth Line, Georgetown, Halton Hills, Ontario (AEL 2015)

AELenvironment
A division of Aeon Egmond Ltd.

Charleston Homes
Phase 1 and 2 Site Stratification

Figure 9

Legend

- Borehole
- Monitoring Wells
- Roads
- Part 1
- Part 2 (RSC Area)
- Water

Notes:

Sources:

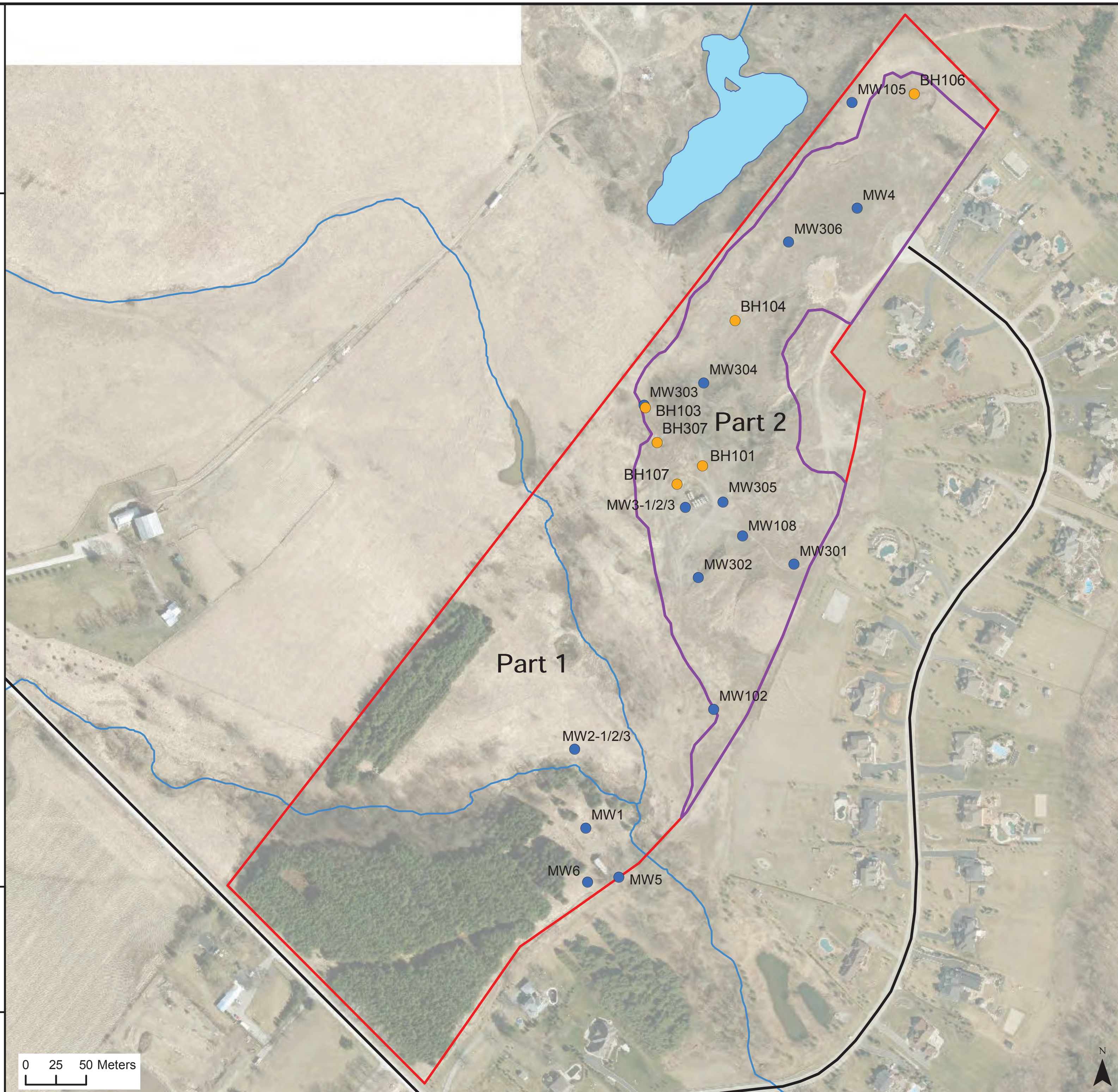


Table 13 - Water Level Measurements

Monitoring Well	Elevation Above Sea Level (asl)(m)	Bottom of Well (m)	November 2013 Water Level Measurement		June 2014 Water Level Measurement		November 2014 Water Level Measurement		February 2015 Water Level Measurement		April 2015 Water Level Measurement	
			Depth to Water† (m)	Depth of Water Above Sea Level (asl)(m)	Depth to Water† (m)	Depth of Water Above Sea Level (asl)(m)	Depth to Water† (m)	Depth of Water Above Sea Level (asl)(m)	Depth to Water† (m)	Depth of Water Above Sea Level (asl)(m)	Depth to Water† (m)	Depth of Water Above Sea Level (asl)(m)
MW1	258.8	9.09	N/M	N/M	2.6	256.2	2.5	256.3	2.58	256.22	2.3	256.5
MW2-3	257.9	6.23	N/M	N/M	1.245	256.655	1.14	256.76	1.745	256.155	0.985	256.915
MW3-1	254.58	4.59	1.29	253.29	1.205	253.375	1.31	253.27	1.445	253.135	0.91	253.67
MW3-2	255.11	4.41	1.6	253.51	1.68	253.43	1.67	253.44	1.98	253.13	1.45	253.66
MW3-3	254.73	9.15	1.055	253.675	1.33	253.4	1.455	253.275	1.87	252.86	1.98	252.75
MW4	264.56	8.67	6.92	257.64	7.03	257.53	7.892	256.668	7.87	256.69	7.315	257.245
MW5	259.33	4.36	N/M	N/M	3.61	255.72	3.85	255.48	3.96	255.37	2.215	257.115
MW6	260.66	4.58	N/M	N/M	1.78	258.88	2.51	258.15	2.42	258.24	0.74	259.92
MW102	258.29	6.24	5.63	252.66	5.715	252.575	5.745	252.545	5.765	252.525	5.445	252.845
MW105	265.57	8.955	8.695	256.875	8.9	256.67	8.91	256.66	8.92	256.65	7.265	258.305
MW108	255.02	5.87	2.35	252.67	2.41	252.61	2.58	252.44	N/M†	N/M†	2.145	252.875
MW301	257.04	7.12	N/M	N/M	5.45	251.59	5.45	251.59	5.865	251.175	4.795	252.245
MW302	256.49	7.77	N/M	N/M	7.09‡	249.4‡	3.44	253.05	3.445	253.045	2.735	253.755
MW303	254.82	4.73	N/M	N/M	0.735	254.085	1.14	253.68	1.7	253.12	0.875	253.945
MW304	254.09	4.33	N/M	N/M	1.055	253.035	1.16	252.93	1.485	252.605	0.4	253.69
MW305	254.24	19.41	N/M	N/M	0.07	254.17	-0.13	254.37	(-)0.23±	254.47	-0.49	254.73
MW306	257.12	5.79	N/M	N/M	5.28	251.84	5.715	251.405	5.695	251.425	5.42	251.7

± - Water level frozen
N/F - Well not found
N/A - Not available
N/M - Water level not measured
† - Well covered in snow & ice (inaccessable)
‡Due to time constraints, the well level was taken 2 days after installation, and had not reached its static water level at the time of measurement

APPENDIX A3
A Soil Investigation for Proposed Residential Development, Bishop Court and Confederation Street, Town of Halton Hills (Soil Engineers 2015b)

5.0 GROUNDWATER CONDITIONS

The boreholes were checked for the presence of groundwater or the occurrence of cave-in upon their completion of the field work.

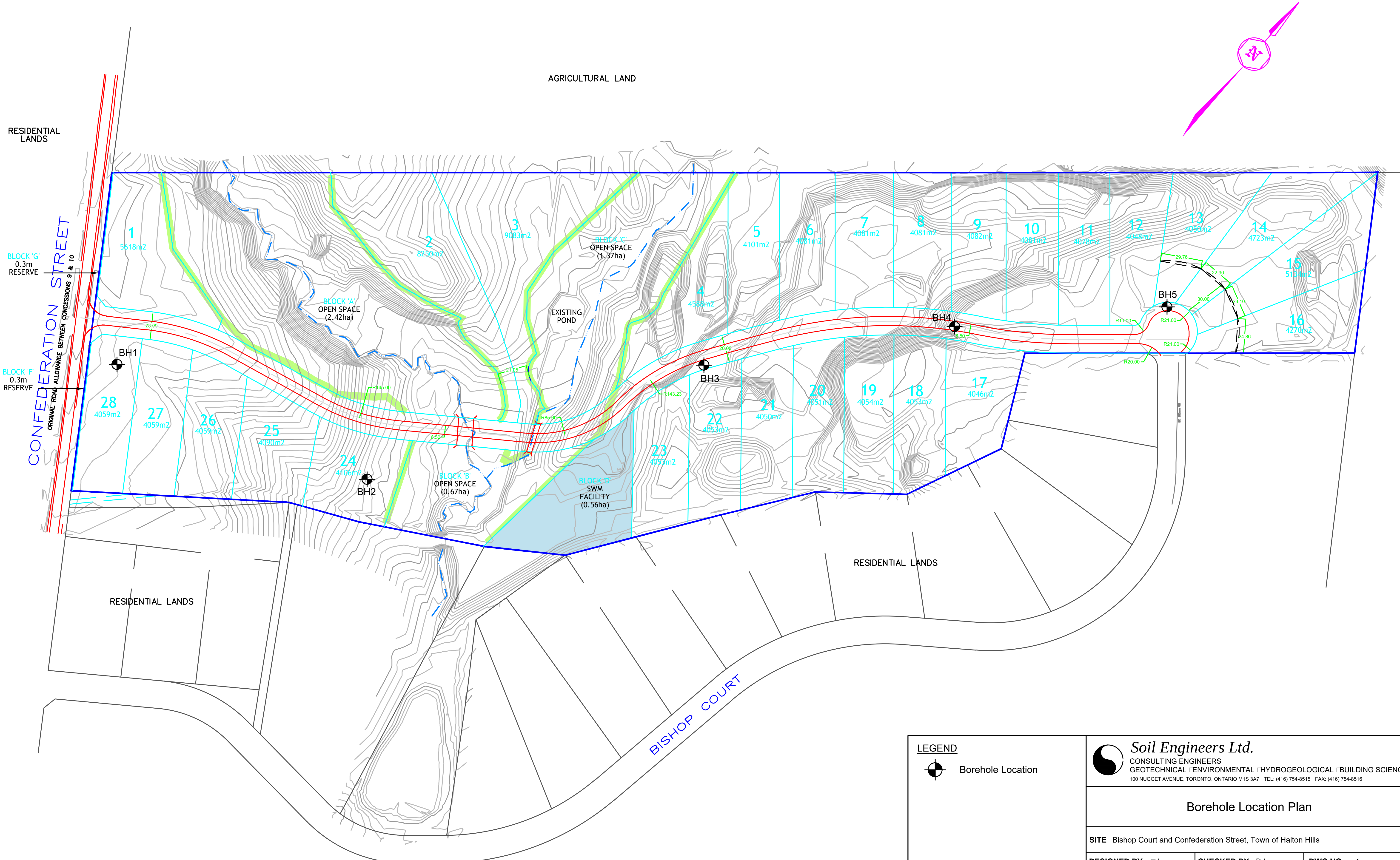
Groundwater was detected at El. 270.6 m (3.4 below grade) and El. 250.0 m (5.5 m below grade) in Boreholes 1 and 3, respectively. The other boreholes remained dry throughout the investigation. It should be noted that the detected groundwater is likely infiltrated precipitation trapped in the voids and fissures of the earth fill, and does not represent the groundwater regime of the site.

In April 2015, a groundwater monitoring event was conducted by the client at the existing monitoring wells on the property. The locations of these monitoring wells are shown on Drawing No. 3. The groundwater data for areas in close proximity to our boreholes were reviewed, and summarized in Table 2:

Table 2 - Groundwater Conditions at Monitoring Wells

BH No.	Ground El. (m)	Nearby MW ID	Groundwater El. (m)	Elevation Difference (m)
1	274.0	mwp2007-1	268.5	5.5
2	260.9	MW6	259.2	1.7
3	255.5	MW302	252.8	2.7
4	261.1	MW304	252.7	8.4
5	264.4	MW4	256.5	7.9

The above groundwater elevations may represent the groundwater regime in this area, and show the groundwater level descends uniformly towards the ravine.



LEGEND

Borehole Location

Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL ENVIRONMENTAL HYDROGEOLOGICAL BUILDING SCIENCE
100 NUGGET AVENUE, TORONTO, ONTARIO M1S 3A7 · TEL: (416) 754-8515 · FAX: (416) 754-8516

Borehole Location Plan

SITE Bishop Court and Confederation Street, Town of Halton Hills

DESIGNED BY D.L.	CHECKED BY B.L.	DWG NO. 1
SCALE 1:2500	REF. NO. 1508-S131	DATE November 2015

REV -

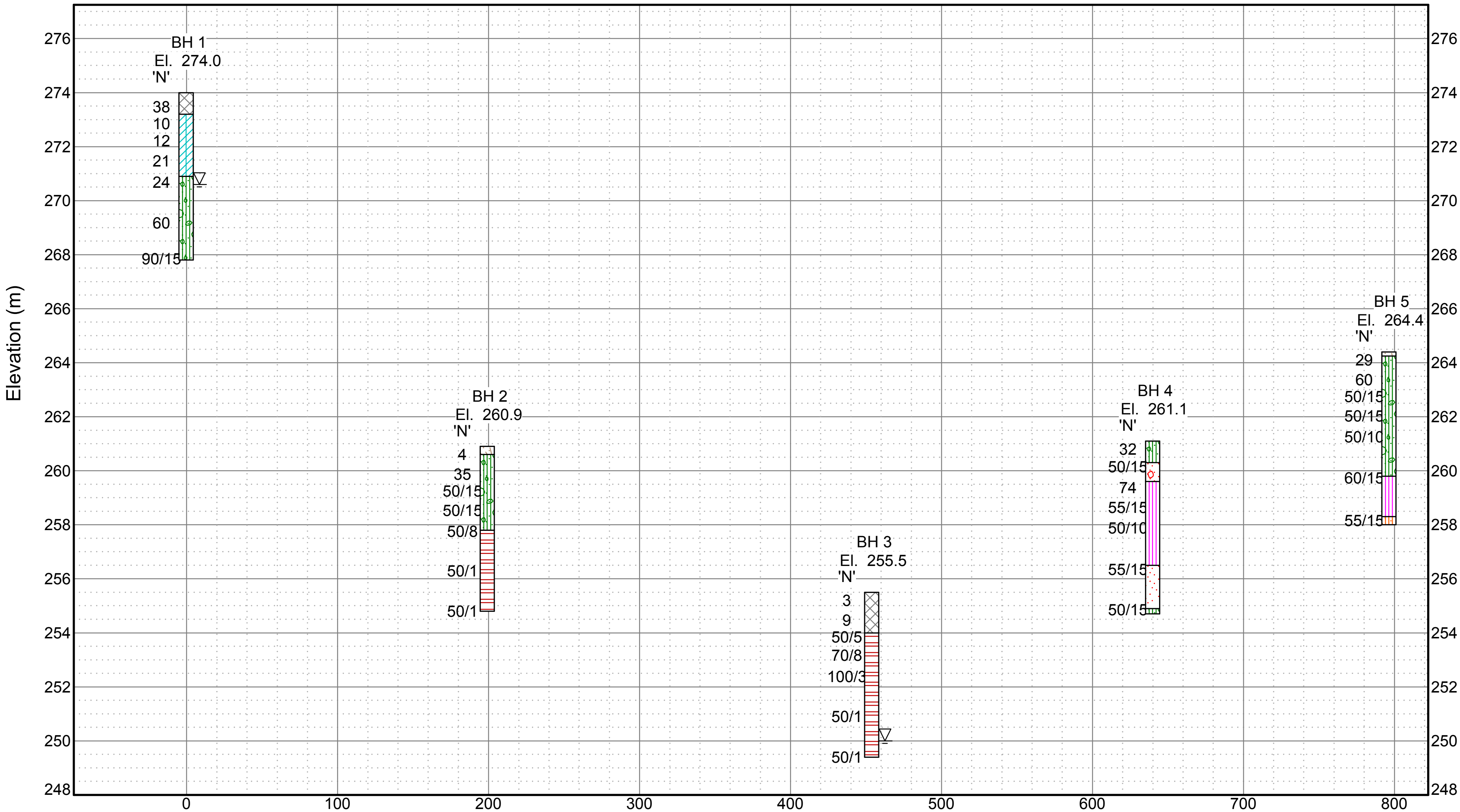
Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE

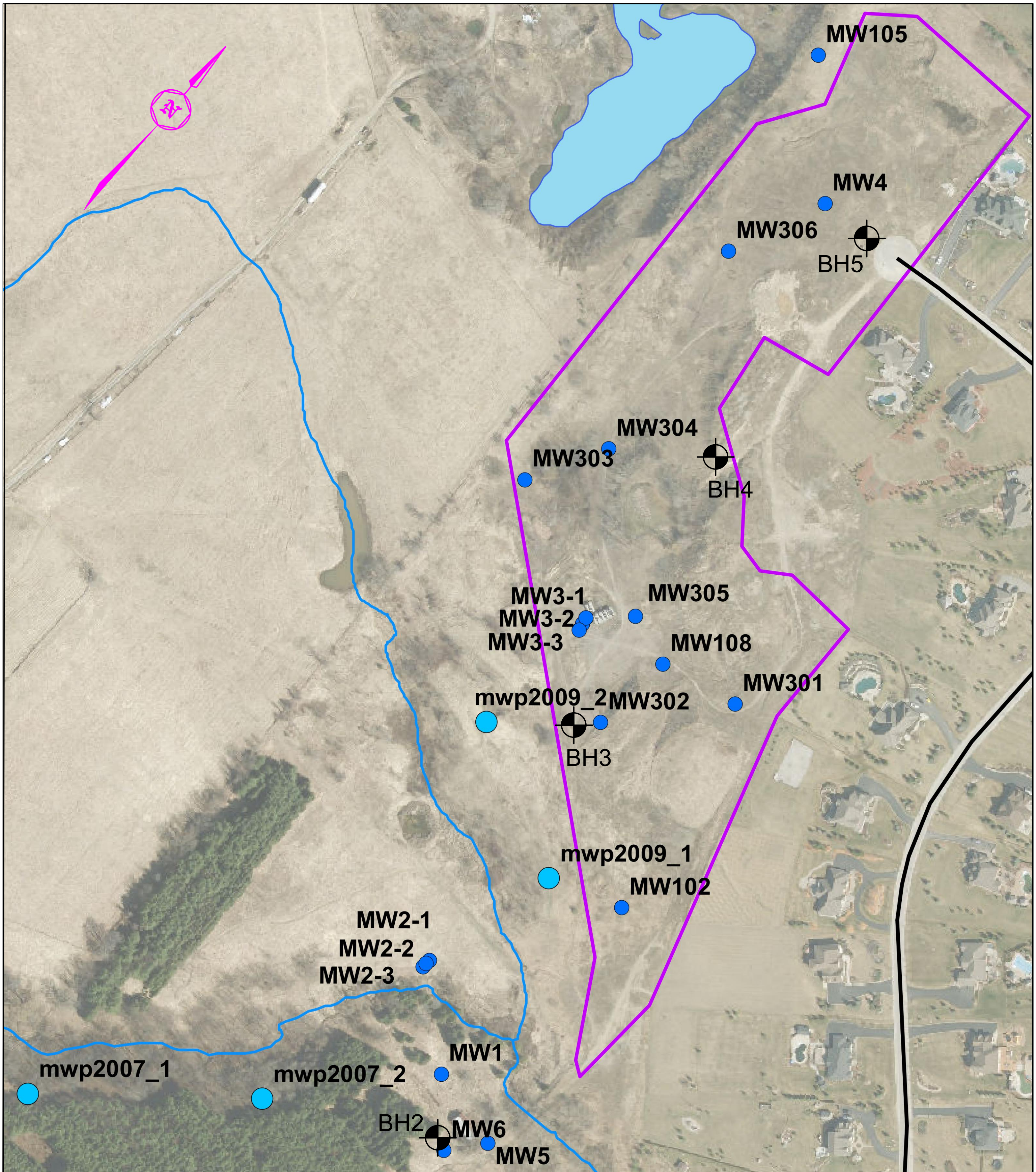
SUBSURFACE PROFILE
DRAWING NO.: 2
SCALE: AS SHOWN

JOB NUMBER: 1508-S131
REPORT DATE: November 2015
JOB LOCATION: Bishop Court and Confederation Street
Town of Halton Hills
JOB DESCRIPTION: Proposed Residential Development

LEGEND

- Water Level (End of Drilling)
- Cave-In
- Water Level (Stabilized)
- Fill
- Silty Clay
- Sandy Silt Till
- Topsoil/Topsoil Fill
- Shale
- F-M/C Sand
- Silt
- Fine Sand
- Sandy Silt





Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL □ENVIRONMENTAL □HYDROGEOLOGICAL □BUILDING SCIENCE
100 NUGGET AVENUE, TORONTO, ONTARIO M1S 3A7 · TEL: (416) 754-8515 · FAX: (416) 754-8516

Existing Monitoring Well Locations

SITE Bishop Court and Confederation Street, Town of Halton Hills

DESIGNED BY □.L.	**CHECKED BY** B.L.	**DWG NO.** 3	
SCALE 1:3000	**REF. NO.** 1508-S131	**DATE** November 2015	**REV** -

APPENDIX A4

Response to CVC Comments, dated July 24, 2015 and January 29, 2016, and Region of Halton Comments, dated November 16, 2015, Charleston Homes Development, part Lot 23, Concession 10, Town of Halton Hills (Glen Williams) (AEL 2017a)

Table 1: Proposed Wetland Area Water Levels

Well	Ground Elevation (m asl)	Well Depth (m)	Water Level (m) March 2016	Water Level Elevation (m asl) March 2016	Water Level (m) April 2016	Water Level Elevation (m asl) April 2016	Water Level (m) May 2016	Water Level Elevation (m asl) May 2016	Water Level (m) June 2016	Water Level Elevation (m asl) June 2016	Water level (m) September 2016	Water level elevation (m asl) September 2016
MW402	257.883	6.11	3.82	254.063	4.37	253.513	4.56	253.323	4.76	253.123	4.7	253.183
MW403	258.331	4.893	1.333	256.998	1.61	256.721	1.973	256.358	2.353	255.978	2.71	255.621
MW404	259.392	4.405	0.37	259.022	0.51	258.882	0.585	258.807	1.145	258.247	1.39	258.002

AELenvironment
A division of Aeon Egmond Ltd.

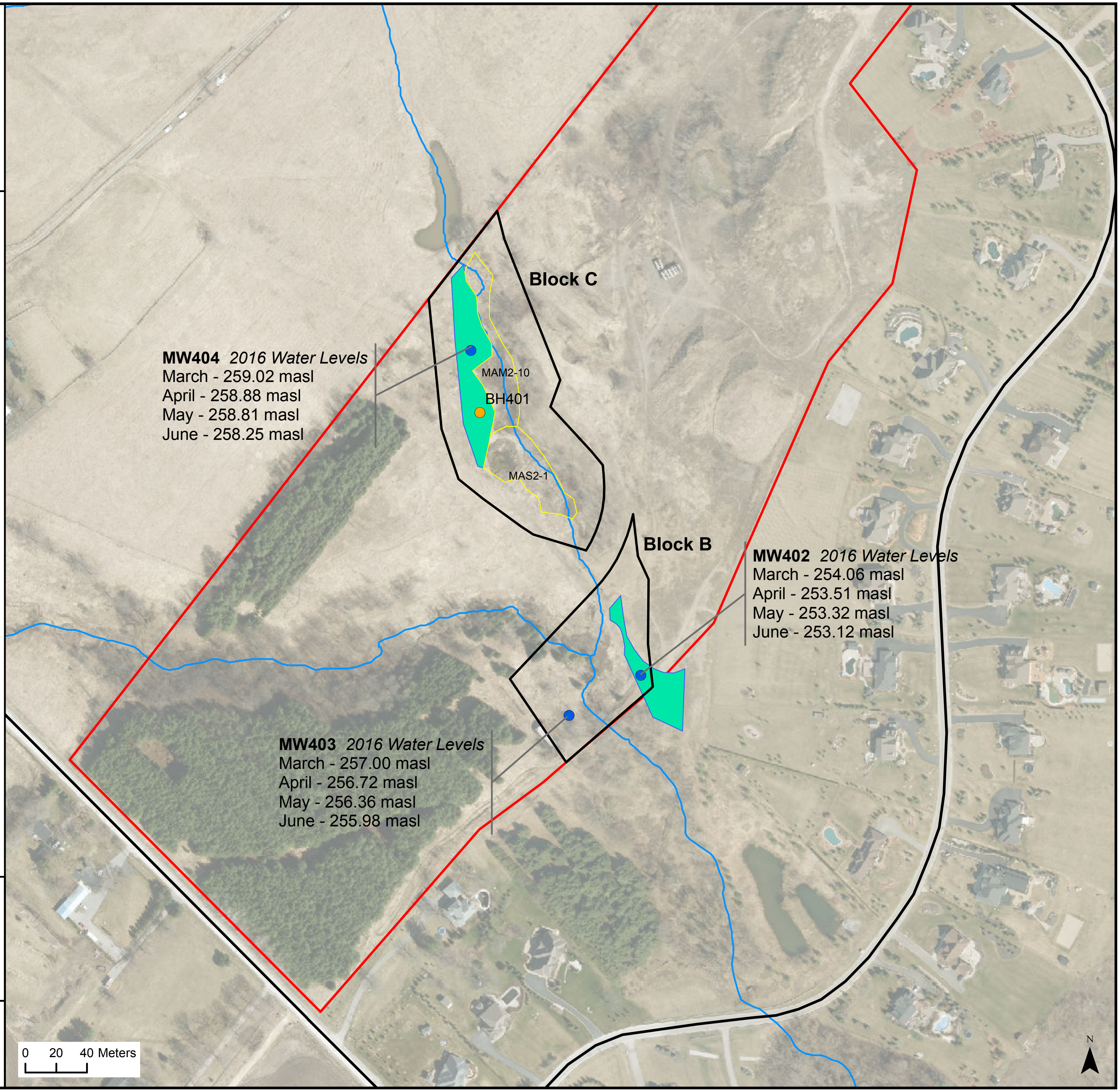
Charleston Homes
Proposed Wetlands and Seasonal Groundwater Levels

Figure 1

#10589

Legend

- Borehole
- Monitoring Well
- Roads
- Development Blocks
- ELC Areas
- Proposed Wetland Creation
- Water
- Property Boundary



Notes:

Sources:

APPENDIX A5

Letter Report re: Percolation tests at 12519 Ninth Line, Georgetown, ON (the Site) (AEL 2017b)

1705 Argentia Road, Unit 3 | Mississauga, Ontario, L5N 3A9
Tel/Fax: 416-657-2367| Toll free: 1-800-267-4797
info@aelenv.com | www.aelenv.com

September 8, 2017

AEL Reference: 10589

Kelly Molnar
Matrix Solutions Inc
2500 Meadowpine Blvd Suite 200
Mississauga, ON L5N 6C4

RE: Letter Report re: Percolation tests at 12519 Ninth, Line, Georgetown, ON (the "Site)

Dear Kelly,

Following our discussions regarding the available infiltration at the site located at 12519 Ninth Line, Georgetown, ON (the "Site"). AEL attended the Site on Thursday July 27th and Friday July 28th, 2017 to perform a series of percolation tests to determine real Site infiltration rates.

Background

The percolation tests completed by AEL at the site were to address the development planning comments from the conservation authority and town. Matrix Solutions Inc has provided AEL with some review documentation and requested AEL comment on their proposed infiltration assumptions for the Site, specifically regarding the infiltration trench and soakaway pits. Percolation tests were to determine if the infiltration rates available in the Site soils could meet the 25 mm/hour hydraulic conductivity assumption made by Matrix Solutions in their site design.

Scope of Work

The scope of work for the project was outlined in the AEL proposal, dated 29 June, 2017 and is summarized as follows:

- AEL staff will facilitate the digging of twelve (12) holes at the Charleston Homes site.
- For each hole, an excavation will be made in the soil layer which is to be assessed with the following dimensions: Diameter: 10 to 30 cm and Depth: 20 cm below the upper level of soil layer being assessed.
- The timing as the water level drops will be recorded.
- Holes will be backfilled with the excavated soil
- Percolation rate will be calculated using an average of three (3) readings.
- AEL will provide a report and opinion presenting infiltration rates of water at the Charleston Homes Site.

Investigation

AEL staff facilitated the digging of twelve (12) holes at the Charleston Homes site. Locations of each hole can be seen in Figure 1.

Each hole was 1′ in diameter and 1′ in depth. Each hole was filled with 2″ of ¾″ gravel and pre-soaked with 6″ of distilled water. When pre-soaking was complete (water drained completely from hole), the hole was filled with 5″ of water and the time it took for the water level to drop to 4″ was recorded. This step was to be repeated three (3) times at each test hole and the average used to determine the percolation rate. Holes were backfilled with the excavated soil after the test was completed.

Findings

Twelve locations were advanced at the site. Of these locations, 1, 2, 3, 4, 9 and 10 meet the 25 mm/hr criteria (60 min/inch). Water at these locations completely drained from the hole after pre-soaking. The hole was refilled for each test, and the time required for water to drop one (1) inch in the hole was recorded.

The remaining locations, 5, 6, 7, 11, 12 and 13, did not meet the 25 mm/hr criteria. At each location, the water did not drain sufficiently from the hole during pre-soaking. Tests for these holes were completed the following day. The un-drained holes were again refilled, and the time it took to drop one (1) inch was recorded. Tests were run one (1) time at these locations.

A more detailed table depicting results, and the sampling times can be seen in Table 1, attached.

Conclusion

We trust that this information is sufficient for your present purposes. The conditions as laid out in the attached Terms of Engagement apply. If you have any questions please do not hesitate to call.

Respectfully submitted;

AELenvironment
A division of Aeon Egmond Ltd.

D. Isabelle

Denise Isabelle	Paul Wilson, P. Eng.
Environmental Scientist	Senior Engineer, QP_{ESA}

AEL environment

A division of Aeon Egmond Ltd.

Charleston Homes

Percolation Test Locations

Legend

- Test Locations
- Roads
- Property Boundary

Notes:

Sources:

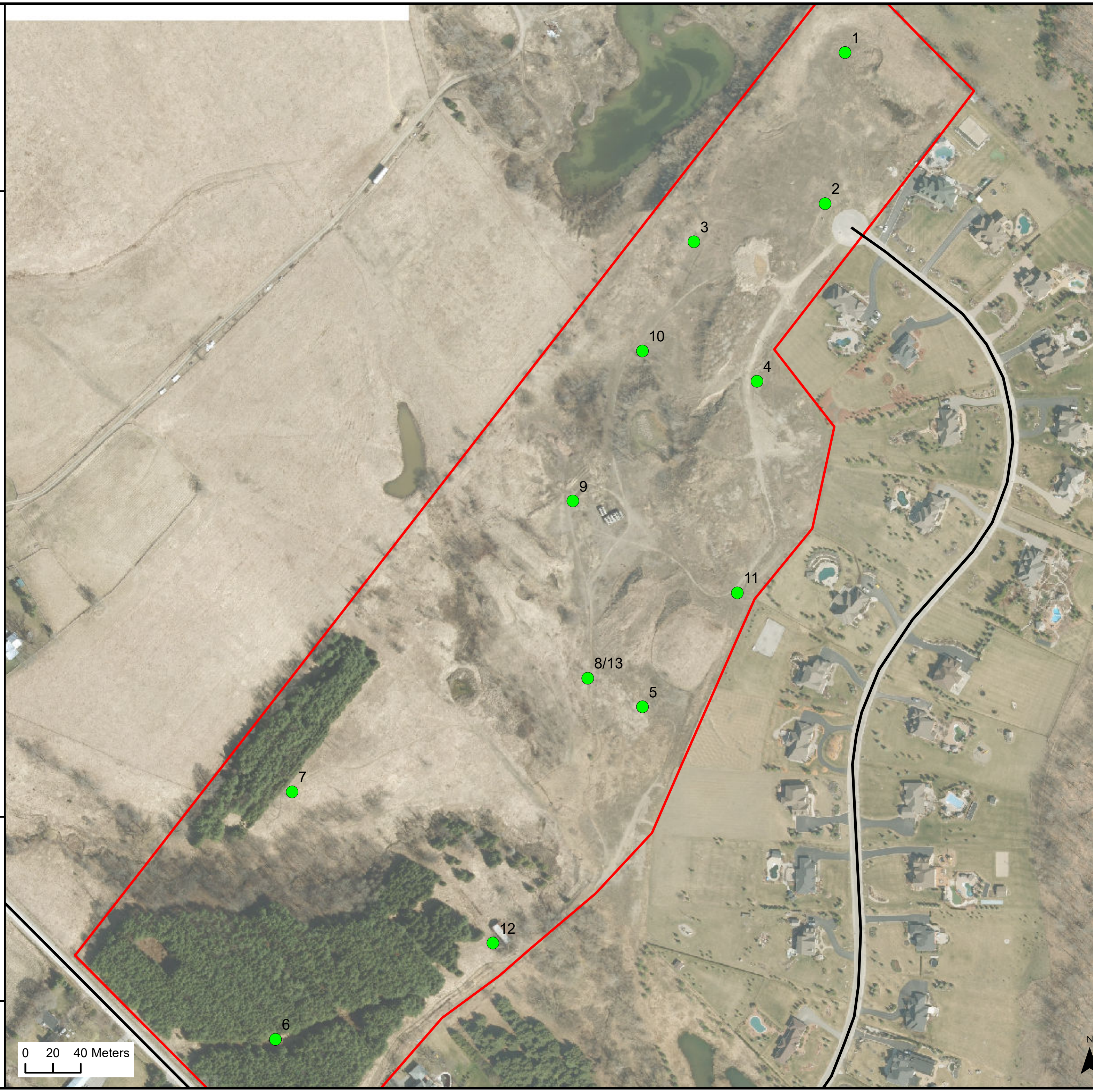


TABLE 1: PERCOLATION TEST RESULTS

Date: July 28, 2017

Location (Hole)	Depth of Hole (inches)	Lithology	First Timing (min/inch)	Second Timing (min/inch)	Third Timing (min/inch)	Notes
1	18	Coarse Sand, Gravel	0:23:56	0:23:31	0:24:15	Hole had completely drained after pre-soaking. Hole was refilled and the time it took for the water to drop one inch was recorded. This test was completed three (3) times.
2	24	Sandy Topsoil and Gravel	0:36:30	0:35:50	0:36:55	Hole had completely drained after pre-soaking. Hole was refilled and the time it took for the water to drop one inch was recorded. This test was completed three (3) times.
3	18	Sandy Topsoil and Gravel	0:21:06	0:21:17	0:22:33	Hole had completely drained after pre-soaking. Hole was refilled and the time it took for the water to drop one inch was recorded. This test was completed three (3) times.
4	12	Sandy Topsoil	0:21:05	0:20:24	0:23:00	Hole had completely drained after pre-soaking. Hole was refilled and the time it took for the water to drop one inch was recorded. This test was completed three (3) times.
5	12	Gravelly Silt	2:36:00			After 12 hours of pre-soaking water dropped 3". Hole was refilled and the time it took for the water to drop one inch was recorded. This test was completed one (1) time.
6	18	Gravelly Silt	1:06:00			After 12 hours of pre-soaking water dropped 2". The hole was refilled at the time and the time it took for the water to drop one inch was recorded. This test was completed one (1) time.
7	18	Gravelly Silt	2:00:00			After twelve hours of pre-soaking water dropped 4". Hole was refilled and the time it took for the water to drop one inch was recorded. This test was completed one (1) time.
9	18	Silty Sand	0:11:25	0:11:19	0:11:40	Hole had completely drained after pre-soaking. Hole was refilled and the time it took for the water to drop one inch was recorded. This test was completed three (3) times.
10	18	Sandy Topsoil and Gravel	0:06:03	0:06:10	0:06:05	Hole had completely drained after pre-soaking. Hole was refilled and the time it took for the water to drop one inch was recorded. This test was completed three (3) times.
11	18	Gravelly Silt	3:00:00			After 12 hours of pre-soaking water dropped 1" more water was added but no drop was recorded while on site. Hole was refilled and the time it took for the water to drop one inch was recorded. This test was completed one (1) time.
12	12	Silty Clay	3:44:00			After 12 hours of pre-saoking the water dropped 1". Hole was refilled and the time it took for the water to drop one inch was recorded. This test was completed one (1) time.
8/13	18	Gravelly Silt	2:40:00			After 12 hours of pre-soaking water dropped 3". Hole was refilled and the time it took for the water to drop one inch was recorded. This test was completed one (1) time.

APPENDIX A6
Glen Williams Phase 2, Town of Halton Hills, ON, Functional Servicing Report (BECL 2015)

APPENDIX A

RELEVANT SECTIONS FROM 2015 FUNCTIONAL SERVICING REPORT - BCEL 2015

The following highlights the section of the FSR Addendum that is referencing the FSR (BCEL 2015) document, and includes the relevant excerpt of the FSR (BCEL 2015) for reference.

FSR ADDENDUM SECTION 3.3.2 – WASTEWATER SERVICING

3.3 Wastewater Servicing

Municipal sanitary servicing is not available in the immediate area and each lot will therefor require a private septic system. The reader is referred to Terraprobe Inc.'s report entitled **Hydrogeologic Investigation, Proposed Residential Subdivision Phase 2** dated April 8, 2010 for a complete discussion of the proposed sewage treatment system for each lot. For completeness, possible leaching bed locations are shown for each lot. It should be noted that Waterloo Biofilter system to control nitrates will be installed as part of each septic design.

FSR ADDENDUM SECTION 3.3 – ROAD ALIGNMENT

3.5 Road Alignment & Cross Section

The extension of Bishop Court requires the crossing of Reach 5 and the intermittent eastern tributary. Based on the CVC review comments every effort has been made to realign the road out of the wetland and associated buffer. Figure 2 Draft Plan of Subdivision illustrates the revised road alignment. The road has a significant grade change, 275mASL at the intersection with Confederation Street to a low of 259.5mASL at the proposed stormwater management

pond to 264.1mASL at the existing Bishop Court terminus. The west tributary (Reach 5) has a channel bottom of 256.7mASL at the road crossing.

Given the range in elevations an asphalt surface with curbs, catchbasins and storm sewer network offers the most efficient cross section to grade back to existing elevations, particularly in the valley lands. The proposed cross section replicates the existing Bishop Court configuration within Phase 1 and ensures conveyance of runoff resulting from infrequent storms is conveyed within the travelled road to the SWM facility for quantity management.

The road will be designed in accordance with the Town of Halton Hills design standards for a rural estate residential road (right-of-way width of 20m). The road illustrated on the proposed servicing figures has a maximum grade of 6.0% and a minimum grade of 0.5%. Vertical curve coefficients of 15 and 15 have been used for crests and sags respectively. Project geotechnical investigations have confirmed the Town of Halton's road structure specification is appropriate for use on the proposed residential rural road.

FSR ADDENDUM SECTION 9 – SEDIMENT AND EROSION

5 Sediment and Erosion

A Sediment and Erosion Control Plan will be prepared for each phase of the development. The plan will be guided by the recommendations in the publication prepared by the Greater Golden Horseshoe Area Conservation Authorities titled **Erosion and Sediment Control Guidelines for Urban Construction** and dated 2006.

Sediment and erosion control measures will be implemented during and also after construction of each phase and will remain in place until the site is fully stabilized. These measures may include sediment fencing, mud mats, temporary sediment traps and filter fabrics over existing and newly constructed catch basins, based on corresponding OPSDs. All sediment and erosion control measures will be monitored throughout the construction period and any required remedial measures will be undertaken immediately.

APPENDIX A7
Interpreted Groundwater Contour – May 2020 (AEL 2020)

AELenvironment
A division of Aeon Egmond Ltd.

Interpreted Groundwater Contours - May 2020

Figure 8d

#10476

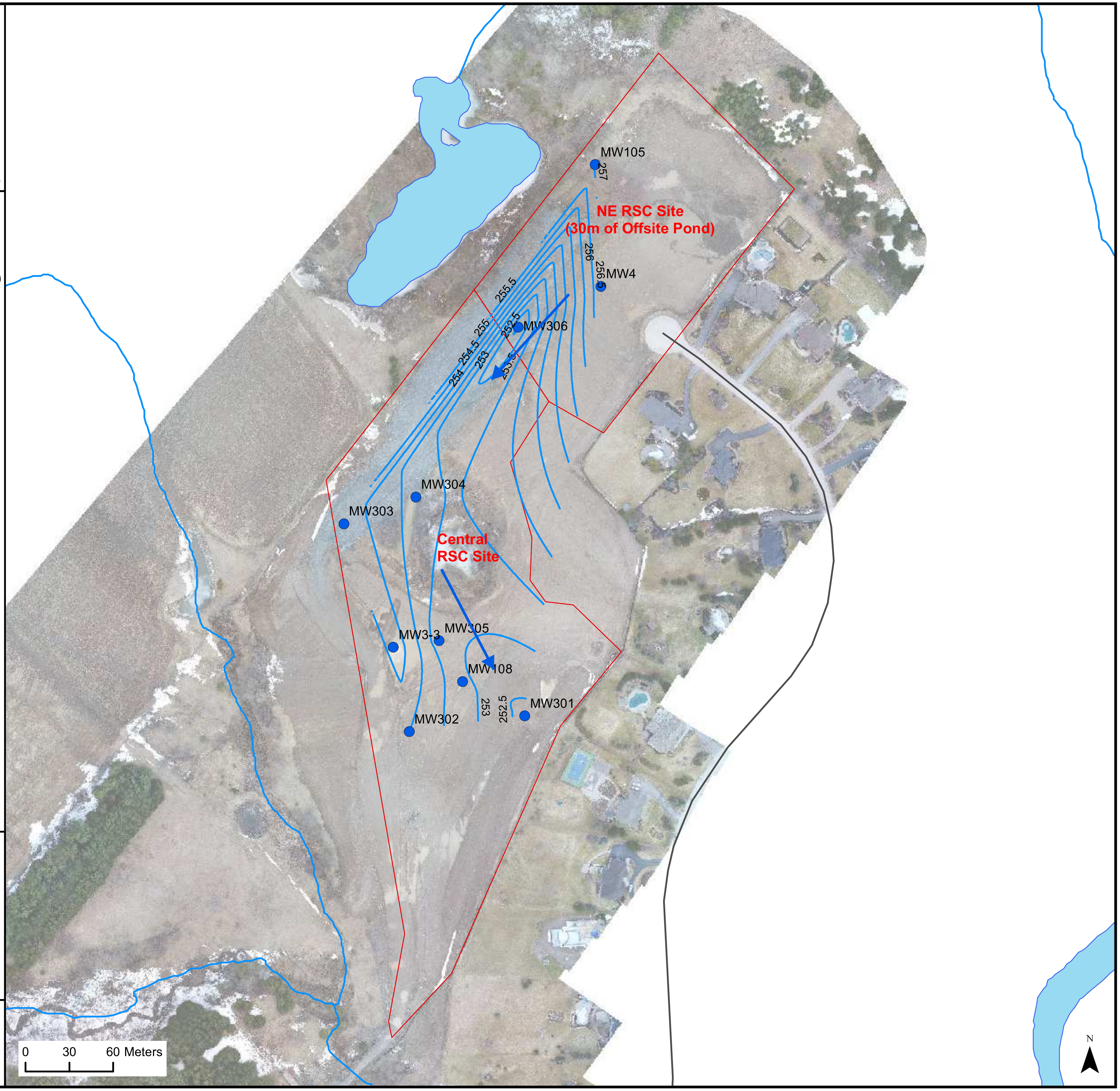
2020-07-05

Legend

- Monitoring Well
- Groundwater Elevation (masl)
- Roads
- RSC Areas
- Water

Notes:

Sources:



APPENDIX A8
Table 15 Monitoring Well Construction and Water Level Measurements (AEL 2020)

Table 15 Monitoring Well Construction and Water Level Measurements

Monitoring Well	Installation Date (dd/mm/yyyy)	Well Depth From Ground Level (m)	Length of Screen (m)	Well Ground Elevation (m asl)	Groundwater Elevation - November 2013 (m)	Groundwater Elevation - May 2014 (m)	Groundwater Elevation - June 2014 (m)	Groundwater Elevation - July 2014 (m)
MW3-1	N/I	9.90	N/I	259.11	253.29	N/M	253.38	N/M
MW3-2	N/I	9.92	N/I	259.64	253.56	N/M	253.43	N/M
MW3-3	N/I	14.66	N/I	259.26	253.68	253.60	253.61	N/M
MW4	N/I	8.70	N/I	264.89	257.64	N/M	257.53	N/M
MW102	13-11-2013	4.28	3.05	260.01	252.62	N/M	252.58	N/M
MW105	11-11-2013	6.57	3.05	266.21	256.88	N/M	256.46	N/M
MW108	12-11-2013	11.73	3.05	259.51	252.65	252.60	252.60	N/M
MW301	25-06-2014	8.60	3.05	259.24	-	-	251.59	N/M
MW302	25-06-2014	10.93	3.05	260.46	-	-	249.40	N/M
MW303	26-06-2014	12.32	3.05	257.87	-	-	254.09	253.92
MW304	24-06-2014	12.77	3.05	256.23	-	-	253.04	N/M
MW305	24-06-2014	25.94	3.05	259.18	-	-	254.17	N/M
MW306	23-06-2014	14.01	3.05	262.61	-	-	251.84	N/M

N/I - Information not available

N/M - Groundwater level was not measured

N/F - Well was damaged and/or no longer functioning

Table 15 Monitoring Well Construction and Water Level Measurements Con't

Monitoring Well	Groundwater Elevation - August 2014 (m)	Groundwater Elevation - November 2014 (m)	Groundwater Elevation - February 2015 (m)	Groundwater Elevation - April 2015 (m)	Groundwater Elevation - May 2015 (m)	Groundwater Elevation - July 2015 (m)	Groundwater Elevation - June 2017 (m)	Groundwater Elevation - May 2020 (m)
MW3-1	N/M	253.27	253.14	253.67	N/M	253.19	N/F	N/F
MW3-2	N/M	253.44	253.13	253.66	N/M	253.21	253.31	254.91
MW3-3	253.31	253.28	252.86	252.73	N/M	253.50	253.62	N/F
MW4	N/M	256.67	256.69	257.25	N/M	256.51	N/M	256.89
MW102	N/M	252.55	252.53	252.85	N/M	252.55	N/F	N/F
MW105	N/M	256.45	256.44	258.10	N/M	256.45	N/M	257.05
MW108	N/M	252.43	N/M	252.87	N/M	252.34	252.02	253.21
MW301	N/M	251.59	251.18	252.25	N/M	251.97	252.05	252.32
MW302	N/M	253.05	253.05	253.76	N/M	253.35	253.01	254.01
MW303	253.86	253.68	253.12	253.95	253.88	253.99	254.28	254.81
MW304	N/M	252.93	253.77	253.69	N/M	253.25	253.42	253.80
MW305	N/M	254.37	254.34	254.73	N/M	254.71	254.65	253.20
MW306	N/M	251.43	257.12	251.70	N/M	251.81	N/M	252.38

N/I - Information not available

N/M - Groundwater level was not measured

N/F - Well was damaged and/or no longer functioning

Table 15 Monitoring Well Construction and Water Level Measurements Con't

Monitoring Well	Groundwater Elevation - June 2020 (m)	Groundwater Elevation - September 2020 (m)
MW3-1	N/F	N/F
MW3-2	N/M	N/M
MW3-3	N/F	N/F
MW4	256.79	N/M
MW102	N/F	N/F
MW105	257.06	N/M
MW108	N/M	N/M
MW301	N/M	N/M
MW302	N/M	N/M
MW303	N/M	N/M
MW304	N/M	N/M
MW305	N/M	N/M
MW306	252.40	N/M

N/I - Information not available

N/M - Groundwater level was not measured

N/F - Well was damaged and/or no longer functioning

APPENDIX B
Stormwater Management Design Calculations

APPENDIX B

STORMWATER MANAGEMENT CALCULATIONS

1 FLOW CONVEYANCE CALCULATIONS

1.1 Right-of-Way Conveyance Criteria

The right-of-way (ROW) must relay the greater of:

- 100-year event as per the Town of Halton Hills Development Manual (Town of Halton Hills n.d.) where *the depth and extent of street flooding for new developments shall be limited in order to protect public safety and allow emergency vehicle access. Local arterial collector roads shall limit the conveyance of the 100-year storm event to 150 mm depth above road crown.*

- Regional event as per the stormwater management (SWM) criteria outlined in Section 4.1 of the report, where “safe conveyance of the Regulatory storm event is provided for quantity control.”

1.2 Assumptions

FlowMaster was used to simulate flow conditions along the RoW with the following assumptions:

- The RoW is based on a typical road cross-section with a 20 m RoW using a concrete curb and gutter as per Ontario Provincial Standard Drawing (OPSD) 600.100.

- As measured in CAD, the smallest road slope (0.5%) was used to simulate the worst-case condition for conveyance.

- Flow from the road was taken from Addhyd 37, which considers all drainage relayed to the Phase 2 SWM facility.

1.3 Design Flows

In a comparison of the 100-year and Regulatory storm event flows, the 100-year event was shown to be more conservative. The 5-year event flow is considered to be contained within the minor storm sewer system; therefore, the 100-year event less the 5-year event flows was used as the maximum flow along the ROW. A summary of the event flows is shown in Table B1.

TABLE B1 Flow Events Summary

Design Storm	Flow (m^3/s)
5-year	0.60
100-year	1.46
Regulatory Storm	1.07
FlowMaster Design Flow	0.86

1.4 Results

For the 0.86 m^3/s design flow with a minimum road slope of 0.5%, the normal depth is 160 mm, which is 100 mm depth above the road crown. Therefore, the major system flows will be contained within the ROW. Under this scenario, the Town of Halton Hills standard of less than 150 mm depth at road crown will be met.

2 FLOWMASTER OUTPUT

FlowMaster output is provided in attached digital files.

3 REFERENCES

Town of Halton Hills. n.d. *Development Manual*. Halton Hills, Ontario. n.d.

Worksheet for ROW section - 5.0 cm curb height

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.50	%
Discharge	0.86	m³/s

Section Definitions

Station (m)	Elevation (m)
0+00	0.19
0+07	0.05
0+07	0.05
0+07	0.00
0+10	0.06
0+13	0.00
0+13	0.05
0+14	0.05
0+20	0.19

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.19)	(0+07, 0.05)	0.030
(0+07, 0.05)	(0+07, 0.00)	0.013
(0+07, 0.00)	(0+10, 0.06)	0.013
(0+10, 0.06)	(0+13, 0.05)	0.013
(0+13, 0.05)	(0+14, 0.05)	0.013
(0+14, 0.05)	(0+20, 0.19)	0.030

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Worksheet for ROW section - 5.0 cm curb height

Results

Normal Depth		0.16	m
Elevation Range	0.00 to 0.19 m		
Flow Area		1.53	m²
Wetted Perimeter		17.68	m
Hydraulic Radius		0.09	m
Top Width		17.58	m
Normal Depth		0.16	m
Critical Depth		0.13	m
Critical Slope		0.01455	m/m
Velocity		0.56	m/s
Velocity Head		0.02	m
Specific Energy		0.18	m
Froude Number		0.61	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.16	m
Critical Depth	0.13	m
Channel Slope	0.50	%
Critical Slope	0.01455	m/m

Worksheet for Infiltration Swale - 610

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.069	
Channel Slope	1.00	%
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Bottom Width	0.50	m
Discharge	0.21	m³/s

Results

Normal Depth	0.31	m
Flow Area	0.45	m²
Wetted Perimeter	2.48	m
Hydraulic Radius	0.18	m
Top Width	2.38	m
Critical Depth	0.18	m
Critical Slope	0.09923	m/m
Velocity	0.47	m/s
Velocity Head	0.01	m
Specific Energy	0.32	m
Froude Number	0.34	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.31	m
Critical Depth	0.18	m
Channel Slope	1.00	%

Worksheet for Infiltration Swale - 610

GVF Output Data

Critical Slope	0.09923	m/m

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Project	21006-530
Technical	S. Blue
Author	Z. Zimmer
Date	2020-11-26

Phase 2 SWM Facility Preliminary Design

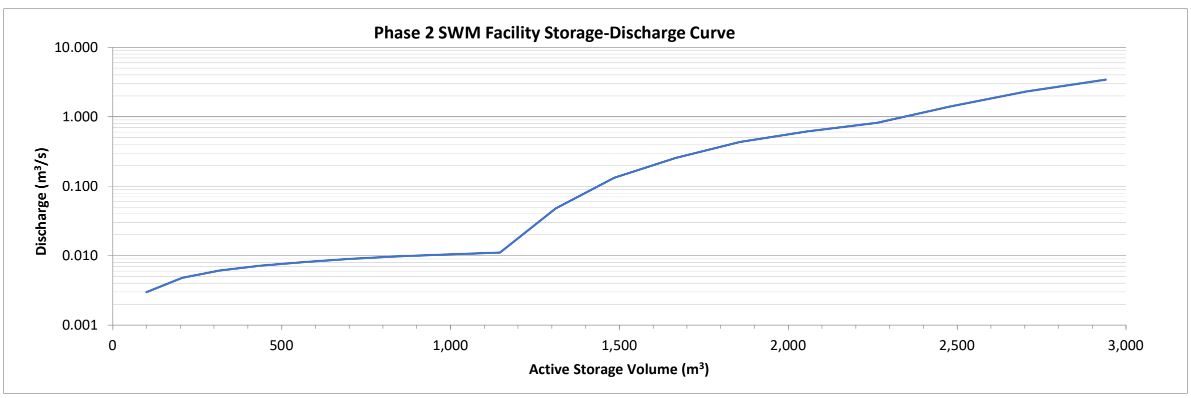
Outlet Configuration	**Outlet Type**	Orifice Plate	DICB	Emergency Weir
	Orifice Dia. (m) / Weir Length (m)	0.075	0.6	7.0
	Invert El. (m)	256.20	257.10	257.70
	Orifice Coefficient	0.61	-	-

Description	**Elevation (masl)**	**Depth of Storage (m)**	**Cumulative Storage (m^3)**	**Controlled Flow (m^3/s)**			
				Orifice Plate[1]	**DICB[2]**	**Emergency Weir[3]**	**Total Flow**
Bottom of Infiltration Gallery	255.30	-	0	-	-	-	-
Top of Infiltration Gallery	256.20	0.9	346	-	-	-	-
Bottom of Dry Pond	256.20	-	-	-	-	-	-
	256.30	0.1	99	0.003	-	-	0.00
	256.40	0.2	205	0.005	-	-	0.00
	256.50	0.3	318	0.006	-	-	0.01
	256.60	0.4	438	0.007	-	-	0.01
	256.70	0.5	565	0.008	-	-	0.01
	256.80	0.6	699	0.009	-	-	0.01
	256.90	0.7	840	0.010	-	-	0.01
	257.00	0.8	990	0.010	-	-	0.01
DICB	257.10	0.9	1,147	0.011	-	-	0.01
	257.20	1.0	1,312	0.012	0.04	-	0.05
	257.30	1.1	1,485	0.012	0.12	-	0.13
	257.40	1.2	1,667	0.013	0.24	-	0.25
	257.50	1.3	1,857	0.013	0.42	-	0.43
	257.60	1.4	2,056	0.014	0.60	-	0.61
Min. Freeboard	257.70	1.5	2,263	0.014	0.81	-	0.82
	257.80	1.6	2,480	0.015	1.02	0.37	1.41
	257.90	1.7	2,705	0.015	1.23	1.07	2.32
Top of Dry Pond	258.00	1.8	2,940	0.016	1.43	1.96	3.40

(1) Orifice Equation $Q = CA\sqrt{(2gh)}$

(2) DICB rating curve obtained from MTO Design Chart 4.20 with 2:1 grate slope. Discharge greater than 0.5 m depth was extrapoalted using the equation $y=-2.5926x^3+5.2302x^2+0.0362x+0.0021$

(3) Calculated using FlowMaster



Hydrologic Performance of Proposed Phase 2 SWM Facility				
Return Period (years)	**Inflow to SWM Facility Flow (m^3/s)**	**Outflow from SWM Facility (m^3/s)**	**Storage Used (m^3)**	**Water Surface Elevation (m)**
2	0.44	0.02	1,043	257.03
5	0.62	0.06	1,270	257.17
10	0.80	0.17	1,539	257.33
25	1.06	0.36	1,788	257.46
50	1.28	0.53	1,965	257.55
100	1.50	0.70	2,147	257.64
Regional	1.09	1.08	2,358	257.74

(1) Freeboard provided is 0.36 m

Emergency Spillway - Ph 2 SWM Facility

Project Description

Solve For	Discharge

Input Data

Headwater Elevation	258.00	m
Crest Elevation	257.70	m
Tailwater Elevation	0.00	m
Crest Surface Type	Paved	
Crest Breadth	0.50	m
Crest Length	7.00	m

Results

Discharge	1.96	m³/s
Headwater Height Above Crest	0.30	m
Tailwater Height Above Crest	-257.70	m
Weir Coefficient	1.70	SI
Submergence Factor	1.00	
Adjusted Weir Coefficient	1.70	SI
Flow Area	2.10	m²
Velocity	0.93	m/s
Wetted Perimeter	7.60	m
Top Width	7.00	m

Worksheet for Phase 2 outlet swale

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.025	
Channel Slope	1.00	%
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Bottom Width	0.50	m
Discharge	1.30	m^3/s

Results

Normal Depth	0.45	m
Flow Area	0.82	m^2
Wetted Perimeter	3.33	m
Hydraulic Radius	0.25	m
Top Width	3.18	m
Critical Depth	0.45	m
Critical Slope	0.01022	m/m
Velocity	1.58	m/s
Velocity Head	0.13	m
Specific Energy	0.57	m
Froude Number	0.99	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.45	m
Critical Depth	0.45	m
Channel Slope	1.00	%

Worksheet for Phase 2 outlet swale

GVF Output Data

Critical Slope	0.01022	m/m

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

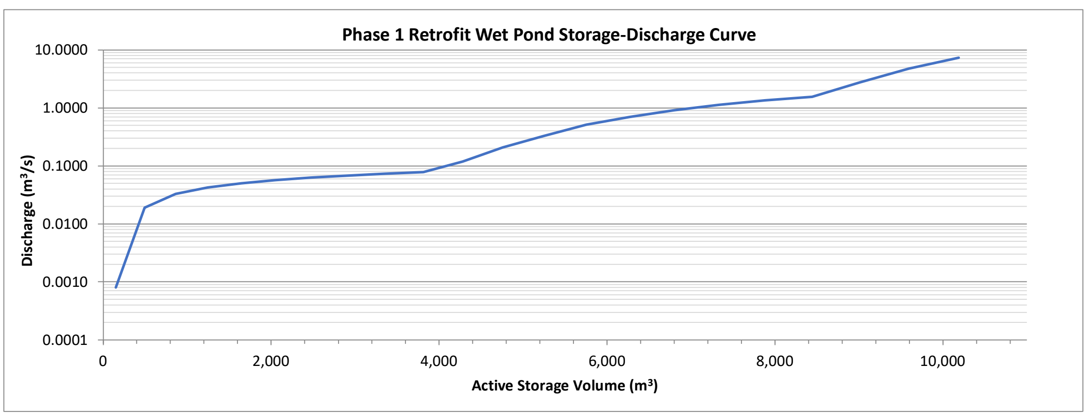
Phase 1 Wet Pond Preliminary Design

Project	21006-530
Technical	S. Blue
Author	Z. Zimmer
Date	2020-11-26

Outlet Configuration				
	Outlet Type	Orifice Plate	DICB	Emergency Weir
	Orifice Dia. (m) / Weir Length (m)	0.2	0.6	20.0
	Invert El. (m)	250.35	251.30	252.20
	Orifice/Weir Flow Coefficient	0.61	-	-

Description	Elevation (masl)[1]	Depth of Storage (m)	Active Storage (m^3)	Controlled Flow (m^3/s)			
				Orifice Plate[2]	DICB[3]	Emergency Weir[4]	Total Flow
Bottom of Pool	248.50	-	-				
Permanent Pool	250.35	-	-	-	-	-	-
	250.40	0.05	150	0.001	-	-	0.00
	250.50	0.15	492	0.019	-	-	0.02
	250.60	0.25	863	0.033	-	-	0.03
	250.70	0.35	1,247	0.042	-	-	0.04
	250.80	0.45	1,643	0.050	-	-	0.05
	250.90	0.55	2,051	0.057	-	-	0.06
	251.00	0.65	2,472	0.063	-	-	0.06
	251.10	0.75	2,907	0.068	-	-	0.07
	251.20	0.85	3,354	0.074	-	-	0.07
	251.30	0.95	3,812	0.078	-	-	0.08
	251.40	1.05	4,280	0.083	0.04	-	0.12
	251.50	1.15	4,759	0.087	0.12	-	0.21
	251.60	1.25	5,249	0.091	0.24	-	0.33
	251.70	1.35	5,752	0.095	0.42	-	0.51
	251.80	1.45	6,268	0.099	0.60	-	0.70
	251.90	1.55	6,795	0.102	0.81	-	0.91
	252.00	1.65	7,334	0.106	1.02	-	1.13
	252.10	1.75	7,883	0.109	1.23	-	1.34
Min. Freeboard	252.20	1.85	8,443	0.112	1.43	-	1.54
	252.30	1.95	9,013	0.115	1.61	1.02	2.74
	252.40	2.05	9,595	0.119	1.75	2.90	4.77
Top of Pond	252.50	2.15	10,187	0.122	1.86	5.32	7.30

(1) Extended Detention has a storage and elevation of 1,316 m^3 and 250.72 masl, respectively.
(2) Orifice Equation Q = CA√(2gh)
(3) DICB rating curve obtained from MTO Design Chart 4.20 with 2:1 grate slope. Discharge greater than 0.5 m depth was extrapoalted using the equation $y=-2.5926x^3+5.2302x^2+0.0362x+0.0021$
(4) Calculated using FlowMaster



Hydrologic Performance of Proposed Wet Pond				
Return Period (years)	Inflow to SWM Facility Flow (m^3/s)	Outflow from SWM Facility (m^3/s)	Storage Used (m^3)	Water Surface Elevation (m)[1]
2	1.17	0.08	3,464	251.22
5	1.63	0.18	4,569	251.46
10	2.15	0.40	5,436	251.64
25	2.81	0.80	6,532	251.85
50	3.46	1.15	7,408	252.01
100	4.41	1.50	8,340	252.18
Regional	4.03	4.00	9,337	252.36

(1) Freeboard provided is 0.32 m

Worksheet for Broad Crested Weir - Ph 1 Emerg

Project Description

Solve For	Discharge	

Input Data

Headwater Elevation	252.50	m
Crest Elevation	252.20	m
Tailwater Elevation	0.00	m
Crest Surface Type	Paved	
Crest Breadth	0.50	m
Crest Length	20.00	m

Results

Discharge	5.60	m³/s
Headwater Height Above Crest	0.30	m
Tailwater Height Above Crest	-252.20	m
Weir Coefficient	1.70	SI
Submergence Factor	1.00	
Adjusted Weir Coefficient	1.70	SI
Flow Area	6.00	m²
Velocity	0.93	m/s
Wetted Perimeter	20.60	m
Top Width	20.00	m

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TABLE A: Water Balance Calculation - Breakdown of Areas

Pre Development:

Catchment ID	Area (m2)	Pasture & Meadow / Quarry (m2)	Mature Woods (m2)	Urban Lawn (m2)	Patios (m2)	Road (m2)	Driveways (m2)	Roof (m2)
10	1800		1800	0	0	0	0	0
11	8200		8200	0	0	0	0	0
12	35300	2156	33144	0	0	0	0	0
20	7000	7000	0	0	0	0	0	0
21	1100	1100	0	0	0	0	0	0
22	300	300	0	0	0	0	0	0
23	1800	1800	0	0	0	0	0	0
24	13600	10497	3103	0	0	0	0	0
30	21500	1411	20089	0	0	0	0	0
31	92900	92900	0	0	0	0	0	0
32	18180	18180	0	0	0	0	0	0
TOTAL	**201680**	**135344**	**66336**	**0**	**0**	**0**	**0**	**0**

Post-Development Conditions

Catchment ID	Area (m2)	Pasture & Meadow / Quarry (m2)	Mature Woods (m2)	Urban Lawn (m2)	Patios (m2)	Road (m2)	Driveways (m2)	Roof (m2)
100	552.0			349			36	167
110	1281.0		26	922	200			133
120	3130.0	13	31	2565	200		21	300
130	35343.0	2179	33144			20		
200	6353.0			4635			218	1500
230	14077.0		4300	8777	1000			
300	4707.0			2688		1785	234	
400	14114.0	10883	3103	127		1		
500	23156.0			19148	1200		1008	1800
510	2328.0			887		1230	211	
520	8012.0			6779	400		233	600
530	1795.0			1016		660	119	
540	7971.0			6731	400		240	600
550	1810.0			954		665	191	
560	8078.0			6816	400		262	600
570	1781.0			932		653	196	
580	4348.0	29		3650	200		169	300
590	1271.0			765		466	40	
610	18557.0			17155	1400			2
620	1822.0			1405			117	300
640	2574.0			1735			239	600
660	4100.0			2809			391	900
680	1311.0			880			131	300
700	2777.0	22	1	669		1172	913	
800	3011.0			3011				
810	15860.0	8027	7805	28				
820	4716.0	4712				4		
900	6845.0		26	6256	200		63	300
TOTAL	**201680.0**	**25865**	**48436**	**101689**	**5600**	**6656**	**5032**	**8402**

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Table B: Water Balance Calculations - Hydraologic Cycle Component Values Used

Pre Development				
Land Use From Table 3.1 (MOE, 2003, Page 3-4)				
Site Weighted 87% Type A, 13% Type C	**Prec=**	**ET+**	**RO+**	**Inf**
Urban lawn	940	517.8	158.9	263.3
Pasture and Shrub	940	533.0	112.1	294.9
Mature Forests	940	546.5	89.4	304.1

Post Development				
Land Use From Table 3.1 (MOE, 2003, Page 3-4)				
Fine Sand Loam (B)	**Prec=**	**ET+**	**RO+**	**Inf**
Urban lawn	940	525	187	228
Pasture and Shrub	940	539	140	261
Mature Forests	940	548	118	274

Post Development with LIDS				
Land Use From Table 3.1 (MOE, 2003, Page 3-4)				
Fine Sand Loam (B)	**Prec=**	**ET+**	**RO+**	**Inf**
Urban lawn	940	525	187	228
Pasture and Shrub	940	539	140	261
Mature Forests	940	548	118	274

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Table C: Water Balance Calculations - Annual Water Volume Determination

Pre Development	**Annual Water Depth expressed as mm/yr**							
	Pasture & Meadow / Quarry (m2)	Mature Woods (m2)	Urban Lawn (m2)	Patios (m2)	Road (m2)	Driveways (m2)	Roof (m2)	
Runoff (mm)	112.1	89.4	N/A	N/A	N/A	N/A	N/A	
Evapotranspiration (mm)	533.0	546.5	N/A	N/A	N/A	N/A	N/A	
Infiltration (mm)	294.9	304.1	N/A	N/A	N/A	N/A	N/A	
								Total Area (m2):
Areas (m2) from Table A:	135344	66336	N/A	N/A	N/A	N/A	N/A	201680
	Annual Volumes expressed as m3/yr							
	Pasture & Meadow / Quarry (m3)	Mature Woods (m3)	Urban Lawn (m3)	Patios (m3)	Road (m3)	Driveways (m3)	Roof (m3)	**TOTAL VOLUME per Year (m3)**
Runoff (m3/yr)	15175	5930	0	0	0	0	0	**21106**
Evapotranspiration (m3/yr)	72142	36255	0	0	0	0	0	**108397**
Infiltration (m3/yr)	39906	20170	0	0	0	0	0	**60077**
TOTAL (m3/year)	127223	62356	0	0	0	0	0	**189579**

Post Development	**Annual Water Depth expressed as mm/yr**							
	Pasture & Meadow / Quarry (m2)	Mature Woods (m2)	Urban Lawn (m2)	Patios (m2)	Road (m2)	Driveways (m2)	Roof (m2)	
Runoff (mm)	140	118	187	910	451	910	940	
Evapotranspiration (mm)	539	548	525	30	341	30	0	
Infiltration (mm)	261	274	228	0	148	0	0	
								Total Area (m2):
Areas (m2) from Table A:	25865	48436	101689	5600	6656	5032	8402	201680
	Annual Volumes expressed as m3/yr							
	Pasture & Meadow / Quarry (m3)	Mature Woods (m3)	Urban Lawn (m3)	Patios (m3)	Road (m3)	Driveways (m3)	Roof (m3)	**TOTAL VOLUME per Year (m3)**
Runoff (m3/yr)	3621	5715	19016	5096	2999	4579	7898	**48924**
Evapotranspiration (m3/yr)	13941	26543	53387	168	2271	151	0	**96461**
Infiltration (m3/yr)	6751	13271	23185	0	986	0	0	**44194**
TOTAL (m3/year)	24313	45530	95588	5264	6257	4730	7898	**189579**

Post Development with LIDS	**Annual Water Depth expressed as mm/yr**								
	Pasture & Meadow / Quarry (m2)	Mature Woods (m2)	Urban Lawn (m2)	Lawns to Infiltration Trench (m2)	Patios (m2)	Road (m2)	Driveways (m3)	Roof to Soak Away Pits(m2)	
Runoff (mm)	140	118	187	0	910	286	910	94	
Evapotranspiration (mm)	539	548	525	0	30	341	30	0	
Infiltration (mm)	261	274	228	940	0	313	0	846	
									Total Area (m2):
Areas (m2) from Table A:	25865	48436	83132	18557	5600	6656	5032	8402	201680
	Annual Volumes expressed as m3/yr								
	Pasture & Meadow / Quarry (m3)	Mature Woods (m3)	Urban Lawn (m3)	Lawns to Infiltration Trench (m3)	Patios (m3)	Road (m3)	Driveways (m3)	Roof to Soak Away Pits(m2)	**TOTAL VOLUME per Year (m3)**
Runoff (m3/yr)	3621	5715	15546	0	5096	1904	4579	790	**37251**
Evapotranspiration (m3/yr)	13941	26543	43644	0	168	2271	151	0	**86719**
Infiltration (m3/yr)	6751	13271	18954	17444	0	2081	0	7108	**65609**
TOTAL (m3/year)	24313	45530	78144	17444	5264	6257	4730	7898	**189579**

APPENDIX C
Water Distribution Analysis
(Westhoff Engineering Resources, Inc.)

May 31, 2017

File: 117-25/3100

Matrix Solutions Inc.
Suite 600, 214 11 Ave SW
Calgary, AB T2R 0K1

Attention: Steve Braun

Senior Water Resource Engineer

Subject: Glen Williams Phase II – Water Distribution Analysis

Introduction

Westhoff Engineering Resources, Inc., (Westhoff) has been retained by Matrix Solutions Inc. to prepare a water distribution analysis for Glen Williams Phase II, a residential subdivision of approximately 19.6 hectare including 28 single detached residential units. The subdivision is located east of Confederation Street and north of Bishop Court. The subdivision will be serviced by connecting to the existing municipal regional water system of the Hamlet of Glen Williams.

On November 16, 2015 a Regional technical comments letter was send by the Halton Region and advised of an updated detailed Functional Servicing Report. This letter provides the required information for the Water Servicing for the subdivision. Also, the letter states that sufficient servicing allocation (28 SDEs) from the Town of Halton Hills must be obtained before the Region issues conditions of a draft approval.

Objective and Tasks

To confirm whether the proposed watermain is adequate to supply the required flows and pressures under maximum day and fire flow conditions the following tasks have been completed are:

- Receive and check the existing water distribution hydraulic model;
- Receive and check water service requirements and conditions for project;
- Update the hydraulic model to represent the latest development concept;
- Run the hydraulic model to:
    - Verify the watermain is sized sufficiently, location of hydrants, valves, etc;
    - Required and expected Fire flows;

- Provide inputs for the update of the existing Functional Servicing Report (FSR);
- Provide input to Matrix for design drawings;
- No phasing was proposed; no phasing analysis completed:
- Prepare a letter report to summarize the methodology, the results of the analyses and provide conclusions. This letter report will be used as input for the Updated Servicing Report, therefor no mapping is included.

References

For the design of the water servicing the following report specifications are used where applicable, but not limited to:

- Ontario Ministry of the Environment (MOE), Design Guidelines for Drinking-Water Systems, 2008;
- Water and Wastewater Linear Design Manual, Regional Municipality of Halton, 2015;
- Technical Requirements (Letter Halton Hills) Region of Halton's Development Engineering Review Manual (DERM), Town of Halton Hills, 2005
- Sustainable Halton Water & Wastewater Master Plan, AECOM, 2011;
- Glen Williams Secondary Plan, Town of Halton Hills, 2005

According to the Water and Wastewater Linear Design Manual (2015) all watermains, appurtenances materials and components shall comply with all applicable current industry standards and specifications for quality management and quality control, such as:

a. The Canadian Standards Association (CSA),

b. American Water Works Association (AWWA),

c. American Standard and Testing Materials (ASTM),

d. Underwriters Laboratory (UL),

e. Factory Mutual (FM),

f. Approved Manufacturer's Product List for Water Systems.

g. NSF International (NSF)

Existing Water Servicing

The proposed subdivision is located in the Georgetown Well Supply system that relies entirely on groundwater supply (Sustainable Halton Water & Wastewater Master Plan, 2011). The water servicing for the subdivision will be connected to zone service 6G6. The subdivision on Bishop Court located east of the project is serviced by a 250 mm PVC watermain and connected to a 300 mm PVC water main along Confederation Street.

The Region of Halton provided the pressures and static head (40 to 65 psi at point of connection, 300 meter) for the existing watermain which is used for this analysis of the subdivision water servicing. Not received were the elevations of existing water pipe at the connection points. Therefore the point of connection is assumed at 1.7 m below the center of the road elevation.

Design Parameters

The water distribution system shall be designed in accordance to:

- All materials shall be new and in the compliance with the most recent standards.
- The Regional Municipality of Halton design criteria that are applicable to the subdivision are summarized in table 1.

Table 1. Design Criteria

Demand	Residential consumption rates (Liters/capita/day)	Total Flows*** m^3/d
Average Daily Demand (ADD)	314*	39.6
Maximum Day Demand (MDD) (Max Day Factor 2.25*)	502	63.3
Peak Hour Demand (PHD) (Peak Hour Factor 4*)	942	118.7
Minimum Fire flow – residential	90 L/s for 2 hours @ min. 140 kPa (20psi)	
System pressure – minimum and maximum operating conditions	275 kPa/ 40 psi to 690 kPa/ 100 psi	
Reduction of pressure required	>80 psi (550 kPa)	
Velocities	MOE: Max velocity < 2m/s During Fire flow < 5m/s	
Hazen Williams Coefficient of Roughness (C):	140	
Minimum pipe size residential	150mm	
Pipe Depth	1.7 m cover (measured from top of pipe to finished grade)	
Creek crossing	Where a watermain crosses under a creek, the minimum cover over the watermain below the creek bottom will be 3.0 m or as required by the appropriate Conservation Authority.	
Hydrant spacing residential	150m	

* Sustainable Halton Water & Wastewater Master Plan, 2011
** Water and Wastewater Linear Design, 2015
***4.5 person per household and 28 Households

Impact of New System on Existing Water System

Through correspondence with the Halton Region (attached as Appendix B), preliminary analysis of the proposed system in the regional water model (InfoWater) shows that there is likely an existing fire flow deficiency in the area due to the dead-end watermain on Bishop Court (70 L/s instead of 90 L/s). The Updated Functional Servicing Report should establish the required fire flow under this sub-standard available fire flow condition, as per Halton Linear Design Manual. The proposed watermain for the development is increased from 250 mm to 300 mm and should provide adequate flow for fire suppression.

Proposed Water Servicing

The subdivision supply main will be connected to the 6G6 service zone water distribution system by a proposed 300 mm PVC watermain. The proposed watermain will be looped by connecting to the existing 250 mm line along Bishop Court and the 300 mm water main along Confederation Street that will be extended to the proposed subdivision entrance.

The water distribution system is proposed to consist of a 300 mm PVC diameter watermain, hydrants, valves, individual service connections and water meters to each of the residential units. The proposed extension along Confederation Street and the dead end in the cul-de-sac are proposed 300 mm PVC watermain.

Creek Crossing

No crossing of watermains with sanitary lines is expected as no sanitary lines are proposed and the residential units will be serviced by septic fields. However, the proposed watermain will cross the existing creek at two locations. The Town of Halton requires: “Where a watermain crosses under a creek, the minimum cover over the watermain below the creek bottom will be 3.0 m or as required by the appropriate Conservation Authority.”

Watermain Layout

Proposed grading of the center line of the proposed subdivision road ranges from 264 meter northeast to 275 meter southwest at Confederation Street. With a minimum bury depth of 1.7 meters, the watermain is at an elevation varying from 273 meter to 262. At the creek crossing the watermain is the deepest, approximately at elevation 253 meter.

The watermain general descriptions, such as sizes, depths and locations of hydrants and valves, are shown on the Updated Servicing Plan. A fire hydrant is located at the end of the cul-de-sac end and serviced by a dead end 300 mm PVC watermain.

Valves and hydrants are to be located at maximum 150 m intervals. In the network isolation valves are required, such that no more than three valves are required to affect a shutdown of any section of the system.

Phasing

No phasing is proposed.

Water Distribution Modelling Approach

The Halton Region has their water distribution model available in InfoWater Software. For this subdivision the distribution network was modeled with WaterCAD, a standalone Software for Water Distribution Modeling and Management. The boundary conditions were received from the InfoWater model. Three scenarios were analyzed:

- Average Daily Demand
- Peak Hour Demand
- Fire Flow Analysis (Maximum Daily Demand plus Fire Flow)

As the subdivision will be connected to the existing 33 residential unit along Bishop Court, the existing watermain with connection is included in the model. The WaterCAD model schematic, input and output files are attached in Appendix A.

Water Distribution Modelling Results

The results for the water distribution modeling are summarized as follows:

- The average daily demand analysis of the network resulted in minimum pressure varying between 292 and 480 kPa (42 to 70 psi).
- The peak hour demand analysis of the network resulted in minimum pressure varying between 233 and 421 kPa (34 to 61 psi).

  The capacity to deliver the required fire flow simultaneously with Maximum Daily Demand was also assessed to confirm the serviceability of this new proposed development area. The fire flow used for this analysis was 90 L/s for 2 hours. The minimum pressure in the system should not be lower than 20 psi as per the Design Parameters. The results show that minimum modeled pressure is varying between 136 and 276 kPa (20 to 40 psi).

Conclusions

The results of the distribution modelling show that the proposed water system will provide adequate flow and pressure. The low head losses in the overall system indicates that the watermains are adequately sized.

Closure

We trust that the information provided is sufficient to use in the updated Functional Servicing Report. Please contact the undersigned if you have questions or comments.

Yours sincerely,

Westhoff Engineering Resources, Inc.

Lotte Vath, M.Sc.
Water Management Specialist

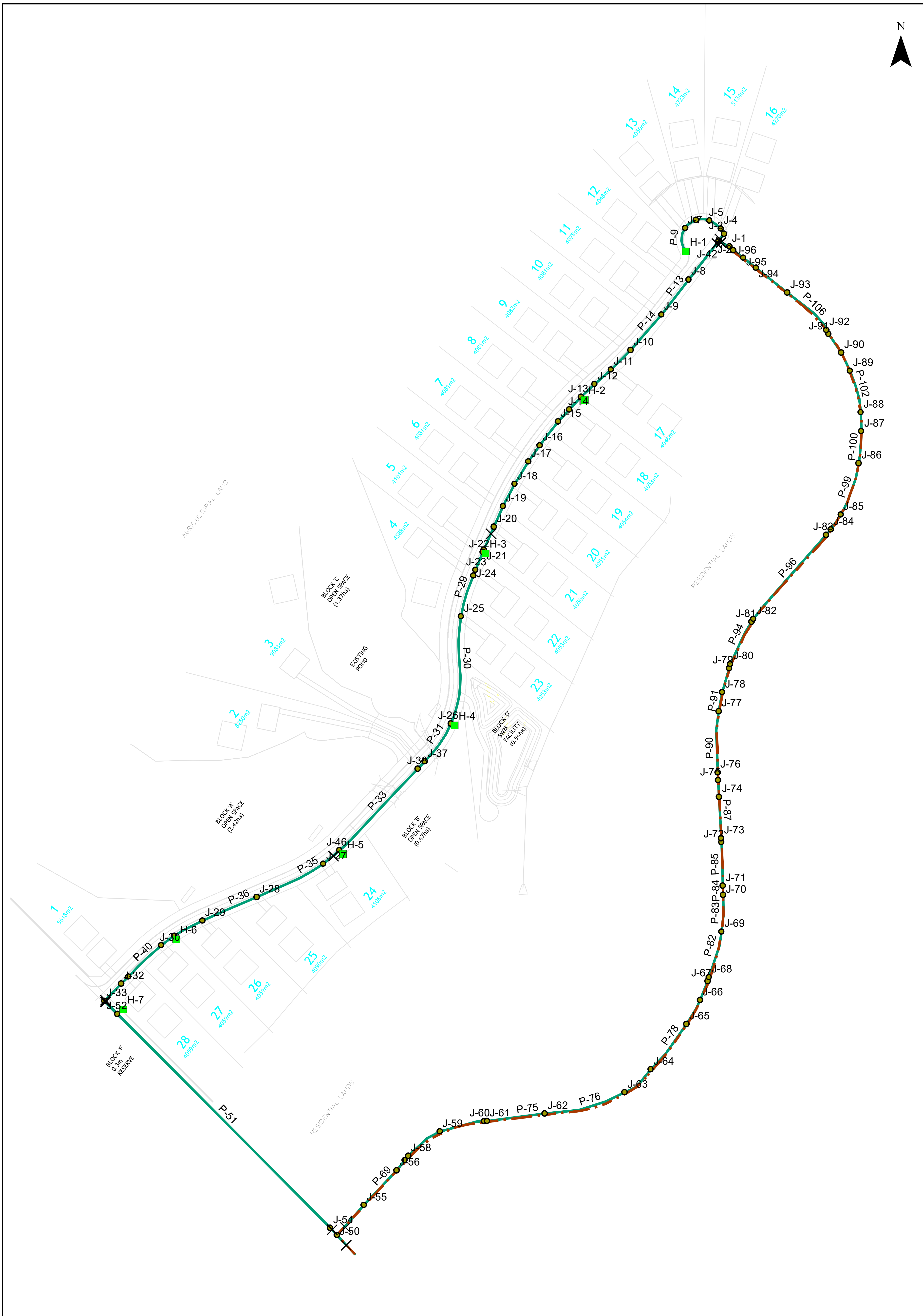
Dennis Westhoff, M.Eng., P.Eng.
Chief Engineer – Water Resources

Review by: Amin A. Samra, B.Sc., Dip.Eng. (ag-Sim)
Hydrometry, Manager

Enclosures:

Appendix A Correspondence with Halton Region

Appendix B WaterCAD Model Input and Output



Legend

■	Proposed Hydrant	— · — ·	Existing Watermain
●	Model Junction	——	Proposed Siteplan
×	Proposed Control Valve		
——	Proposed Watermain		

Client: MATRIX SOLUTIONS INC.			
Project: GLEN WILLIAMS PHASE II			
Title: WATER DISTRIBUTION ANALYSIS - MODEL SETUP			
Date: 29-05-2017	Project No.: WER117-25	Scale: 1:3,000	FIGURE: 1

Westhoff Engineering Resources, Inc.
Land & Water Resources Management Consultants

Average Daily Demand

Junction

Label	Elevation (m)	Demand (L/day)	Demand (Maximum) (L/day)	Hydraulic Grade (m)	Pressure (kPa)	Pressure (Minimum) (kPa)	Pressure (Maximum) (kPa)
J-1	261.7	0	0	302	57	57	57
J-2	261.1	0	0	302	58	58	58
J-3	261.3	0	0	302	58	58	58
J-4	261.3	1,413	1,413	302	58	58	58
J-5	261.2	1,413	1,413	302	58	58	58
J-6	261	1,413	1,413	302	58	58	58
J-7	261	1,413	1,413	302	58	58	58
J-8	260.7	1,413	1,413	302	59	59	59
J-9	260	1,413	1,413	302	60	60	60
J-10	259.9	1,413	1,413	302	60	60	60
J-11	259.1	1,413	1,413	302	61	61	61
J-12	259	1,413	1,413	302	61	61	61
J-13	258.5	0	0	302	62	62	62
J-14	258.1	1,413	1,413	302	62	62	62
J-15	258	1,413	1,413	302	62	62	62
J-16	258	1,413	1,413	302	62	62	62
J-17	258	1,413	1,413	302	62	62	62
J-18	257.9	1,413	1,413	302	63	63	63
J-19	257.4	1,413	1,413	302	63	63	63
J-20	257	1,413	1,413	302	64	64	64
J-21	257	1,413	1,413	302	64	64	64
J-22	257	0	0	302	64	64	64
J-23	257	1,413	1,413	302	64	64	64
J-24	257	1,413	1,413	302	64	64	64
J-25	257	1,413	1,413	302	64	64	64
J-26	253	0	0	302	70	70	70
J-27	263	1,413	1,413	302	55	55	55
J-28	265.5	1,413	1,413	302	52	52	52
J-29	268.3	1,413	1,413	302	48	48	48
J-30	270.4	1,413	1,413	302	45	45	45
J-31	271.4	1,413	1,413	302	43	43	43
J-32	271.6	1,413	1,413	302	43	43	43
J-33	272.2	0	0	302	42	42	42
J-37	253	1,413	1,413	302	70	70	70
J-38	253	1,413	1,413	302	70	70	70
J-42	261.2	0	0	302	58	58	58
J-43	261.2	0	0	302	58	58	58
J-45	261.1	0	0	302	58	58	58
J-46	261	0	0	302	58	58	58
J-47	269.8	0	0	302	46	46	46
J-50	272	0	0	302	43	43	43
J-52	272.2	0	0	302	42	42	42
J-54	272	0	0	302	43	43	43
J-55	269	1,413	1,413	302	47	47	47
J-56	269	1,413	1,413	302	47	47	47
J-57	263	1,413	1,413	302	55	55	55
J-58	263	0	0	302	55	55	55
J-59	263	1,413	1,413	302	55	55	55
J-60	263	1,413	1,413	302	55	55	55
J-61	263	1,413	1,413	302	55	55	55
J-62	256	1,413	1,413	302	65	65	65
J-63	254	0	0	302	68	68	68
J-64	254	1,413	1,413	302	68	68	68
J-65	254	1,413	1,413	302	68	68	68
J-66	254	1,413	1,413	302	68	68	68
J-67	254	0	0	302	68	68	68
J-68	254	1,413	1,413	302	68	68	68
J-69	254	1,413	1,413	302	68	68	68
J-70	254	1,413	1,413	302	68	68	68
J-71	254	1,413	1,413	302	68	68	68
J-72	254	1,413	1,413	302	68	68	68
J-73	254	1,413	1,413	302	68	68	68
J-74	254	0	0	302	68	68	68
J-75	254	1,413	1,413	302	68	68	68
J-76	254	1,413	1,413	302	68	68	68
J-77	254	1,413	1,413	302	68	68	68
J-78	254	1,413	1,413	302	68	68	68
J-79	255	1,413	1,413	302	67	67	67
J-80	255	0	0	302	67	67	67
J-81	256	1,413	1,413	302	65	65	65
J-82	256	1,413	1,413	302	65	65	65
J-83	263	1,413	1,413	302	55	55	55
J-84	263	1,413	1,413	302	55	55	55
J-85	263	0	0	302	55	55	55
J-86	263	1,413	1,413	302	55	55	55
J-87	263	1,413	1,413	302	55	55	55
J-88	262	1,413	1,413	302	57	57	57
J-89	262	1,413	1,413	302	57	57	57
J-90	262	0	0	302	57	57	57
J-91	262	1,413	1,413	302	57	57	57
J-92	262	1,413	1,413	302	57	57	57
J-93	262	1,413	1,413	302	57	57	57
J-94	262	1,413	1,413	302	57	57	57
J-95	262	1,413	1,413	302	57	57	57
J-96	262	0	0	302	57	57	57

Hydrant

Label	Lateral Length (m)	Elevation (m)	Demand (L/day)	Demand (Maximum) (L/day)	Hydraulic Grade (m)	Pressure (kPa)
H-1	6	261	0	0	302	58
H-2	6	258.5	0	0	302	62
H-3	6	257	0	0	302	64
H-4	6	257	0	0	302	64
H-5	6	261	0	0	302	58
H-6	6	269.8	0	0	302	46
H-7	6	272.2	0	0	302	42

Pipe

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/day)	Velocity (m/s)	Headloss Gradient (mm/m)	Headloss Gradient (Maximum) (mm/m)	Headloss (m)
P-1	8	J-1	J-42	250	PVC	140	-6,653	0	0	0	0
P-2	2	J-42	J-2	250	PVC	140	-6,653	0	0	0	0
P-3	2	J-2	J-43	300	PVC	140	5,657	0	0	0	0
P-4	5	J-43	J-3	300	PVC	140	5,657	0	0	0	0
P-5	5	J-3	J-4	300	PVC	140	5,657	0	0	0	0
P-6	11	J-4	J-5	300	PVC	140	4,244	0	0	0	0
P-7	11	J-5	J-6	300	PVC	140	2,831	0	0	0	0
P-8	11	J-6	J-7	300	PVC	140	1,418	0	0	0	0
P-9	17	J-7	CV-1	300	PVC	140	4	0	0	0	0
P-10	3	CV-1	H-1	250	PVC	140	4	0	0	0	0
P-11	3	J-2	J-45	300	PVC	140	-12,310	0	0	0	0
P-12	37	J-45	J-8	300	PVC	140	-12,310	0	0	0	0
P-13	36	J-8	J-9	300	PVC	140	-13,723	0	0.001	0.001	0
P-14	38	J-9	J-10	300	PVC	140	-15,136	0	0	0	0
P-15	22	J-10	J-11	300	PVC	140	-16,549	0	0	0	0
P-16	18	J-11	J-12	300	PVC	140	-17,962	0	0	0	0
P-17	15	J-12	J-13	300	PVC	140	-19,375	0	0	0	0
P-18	14	J-13	J-14	300	PVC	140	-19,379	0	0	0	0
P-19	13	J-14	J-15	300	PVC	140	-20,792	0	0	0	0
P-20	24	J-15	J-16	300	PVC	140	-22,205	0	0	0	0
P-21	16	J-16	J-17	300	PVC	140	-23,618	0	0	0	0
P-22	21	J-17	J-18	300	PVC	140	-25,031	0	0	0	0
P-23	20	J-18	J-19	300	PVC	140	-26,444	0	0	0	0
P-24	18	J-19	J-20	300	PVC	140	-27,857	0	0	0	0
P-25	20	J-20	J-21	300	PVC	140	-29,270	0	0.001	0.001	0
P-26	2	J-21	J-22	300	PVC	140	-30,683	0.01	0	0	0
P-27	16	J-22	J-23	300	PVC	140	-30,688	0.01	0	0	0
P-28	5	J-23	J-24	300	PVC	140	-32,101	0.01	0	0	0
P-29	34	J-24	J-25	300	PVC	140	-33,514	0.01	0	0	0
P-30	87	J-25	J-26	300	PVC	140	-34,927	0.01	0	0	0
P-31	37	J-26	J-37	300	PVC	140	-34,932	0.01	0.001	0.001	0
P-32	8	J-37	J-38	300	PVC	140	-36,345	0.01	0	0	0
P-33	91	J-38	J-46	300	PVC	140	-37,758	0.01	0	0	0
P-34	17	J-46	J-27	300	PVC	140	-37,763	0.01	0	0	0
P-35	60	J-27	J-28	300	PVC	140	-39,176	0.01	0	0	0
P-36	48	J-28	J-29	300	PVC	140	-40,589	0.01	0	0	0
P-37	26	J-29	J-47	300	PVC	140	-42,002	0.01	0	0	0
P-39	13	J-47	J-30	300	PVC	140	-42,007	0.01	0	0	0
P-40	36	J-30	J-31	300	PVC	140	-43,420	0.01	0.001	0.001	0
P-41	8	J-31	J-32	300	PVC	140	-44,833	0.01	0	0	0
P-42	19	J-32	J-33	300	PVC	140	-46,246	0.01	0	0	0
P-48	15	J-33	J-52	300	PVC	140	-46,246	0.01	0.001	0.001	0
P-51	243	J-52	J-54	300	PVC	140	-46,249	0.01	0	0	0
P-52	8	J-54	J-50	300	PVC	140	-46,249	0.01	0	0	0
P-53	6	J-52	H-7	250	PVC	140	3	0	0	0	0
P-54	3	J-47	H-6	250	PVC	140	2	0	0	0	0
P-55	4	J-46	H-5	250	PVC	140	4	0	0	0	0
P-56	3	J-26	H-4	250	PVC	140	4	0	0	0	0
P-57	3	J-22	H-3	250	PVC	140	4	0	0	0	0
P-58	4	J-13	H-2	250	PVC	140	4	0	0	0	0
P-69	38	J-55	J-56	250	PVC	140	39,976	0.01	0	0	0
P-70	10	J-56	J-57	250	PVC	140	38,563	0.01	0.002	0.002	0
P-71	4	J-57	J-58	250	PVC	140	37,150	0.01	0	0	0
P-72	32	J-58	J-59	250	PVC	140	37,150	0.01	0.001	0.001	0
P-73	37	J-59	J-60	250	PVC	140	35,737	0.01	0.001	0.001	0
P-74	2	J-60	J-61	250	PVC	140	34,324	0.01	0	0	0
P-75	47	J-61	J-62	250	PVC	140	32,911	0.01	0	0	0
P-76	67	J-62	J-63	250	PVC	140	31,498	0.01	0	0	0
P-77	29	J-63	J-64	250	PVC	140	31,498	0.01	0.001	0.001	0
P-78	46	J-64	J-65	250	PVC	140	30,085	0.01	0	0	0
P-79	22	J-65	J-66	250	PVC	140	28,672	0.01	0	0	0
P-80	16	J-66	J-67	250	PVC	140	27,259	0.01	0.001	0.001	0
P-81	3	J-67	J-68	250	PVC	140	27,259	0.01	0	0	0
P-82	38	J-68	J-69	250	PVC	140	25,846	0.01	0	0	0
P-83	30	J-69	J-70	250	PVC	140	24,433	0.01	0.001	0.001	0
P-84	7	J-70	J-71	250	PVC	140	23,020	0.01	0	0	0
P-85	35	J-71	J-72	250	PVC	140	21,607	0.01	0	0	0
P-86	3	J-72	J-73	250	PVC	140	20,194	0	0	0	0
P-87	33	J-73	J-74	250	PVC	140	18,781	0	0.001	0.001	0
P-88	13	J-74	J-75	250	PVC	140	18,781	0	0	0	0
P-89	6	J-75	J-76	250	PVC	140	17,368	0	0	0	0
P-90	49	J-76	J-77	250	PVC	140	15,955	0	0	0	0
P-91	15	J-77	J-78	250	PVC	140	14,542	0	0	0	0
P-92	20	J-78	J-79	250	PVC	140	13,129	0	0	0	0
P-93	4	J-79	J-80	250	PVC	140	11,716	0	0	0	0
P-94	38	J-80	J-81	250	PVC	140	11,716	0	0	0	0
P-95	3	J-81	J-82	250	PVC	140	10,303	0	0	0	0
P-96	90	J-82	J-83	250	PVC	140	8,890	0	0	0	0
P-97	6	J-83	J-84	250	PVC	140	7,477	0	0	0	0
P-98	14	J-84	J-85	250	PVC	140	6,064	0	0	0	0
P-99	44	J-85	J-86	250	PVC	140	6,064	0	0	0	0
P-100	26	J-86	J-87	250	PVC	140	4,651	0	0	0	0
P-101	15	J-87	J-88	250	PVC	140	3,238	0	0	0	0
P-102	35	J-88	J-89	250	PVC	140	1,825	0	0	0	0
P-103	16	J-89	J-90	250	PVC	140	412	0	0	0	0
P-104	18	J-90	J-91	250	PVC	140	412	0	0	0	0
P-105	4	J-91	J-92	250	PVC	140	-1,001	0	0	0	0
P-106	44	J-92	J-93	250	PVC	140	-2,414	0	0	0	0
P-107	32	J-93	J-94	250	PVC	140	-3,827	0	0	0	0
P-108	13	J-94	J-95	250	PVC	140	-5,240	0	0	0	0
P-109	10	J-95	J-96	250	PVC	140	-6,653	0	0	0	0
P-110	4	J-96	J-1	250	PVC	140	-6,653	0	0	0	0
P-111	32	J-50	J-55	250	pvc	140	41,389	0.01	0.001	0.001	0
P-112	10	R-3	PMP-3	300	PVC	140	87,638	0.01	0.002	0.002	0
P-113	11	PMP-3	J-50	300	PVC	140	87,638	0.01	0.002	0.002	0

Peak Hour Demand

Junction

Label	Elevation (m)	Demand (L/day)	Demand (Maximum) (L/day)	Hydraulic Grade (m)	Pressure (psi)	Pressure (Minimum) (psi)	Pressure (Maximum) (psi)
J-1	261.7	0	0	302.03	57	49	57
J-2	261.1	0	0	302.03	58	50	58
J-3	261.3	0	0	302.03	58	50	58
J-4	261.3	1,413	5,652	302.03	58	50	58
J-5	261.2	1,413	5,652	302.03	58	50	58
J-6	261	1,413	5,652	302.03	58	50	58
J-7	261	1,413	5,652	302.03	58	50	58
J-8	260.7	1,413	5,652	302.03	59	51	59
J-9	260	1,413	5,652	302.03	60	52	60
J-10	259.9	1,413	5,652	302.03	60	52	60
J-11	259.1	1,413	5,652	302.03	61	53	61
J-12	259	1,413	5,652	302.03	61	53	61
J-13	258.5	0	0	302.03	62	54	62
J-14	258.1	1,413	5,652	302.03	62	54	62
J-15	258	1,413	5,652	302.03	62	55	62
J-16	258	1,413	5,652	302.03	62	55	62
J-17	258	1,413	5,652	302.03	62	55	62
J-18	257.9	1,413	5,652	302.03	63	55	63
J-19	257.4	1,413	5,652	302.03	63	55	63
J-20	257	1,413	5,652	302.03	64	56	64
J-21	257	1,413	5,652	302.03	64	56	64
J-22	257	0	0	302.03	64	56	64
J-23	257	1,413	5,652	302.03	64	56	64
J-24	257	1,413	5,652	302.03	64	56	64
J-25	257	1,413	5,652	302.03	64	56	64
J-26	253	0	0	302.03	70	62	70
J-27	263	1,413	5,652	302.03	55	47	55
J-28	265.5	1,413	5,652	302.03	52	44	52
J-29	268.3	1,413	5,652	302.03	48	40	48
J-30	270.4	1,413	5,652	302.03	45	37	45
J-31	271.4	1,413	5,652	302.03	43	35	43
J-32	271.6	1,413	5,652	302.03	43	35	43
J-33	272.2	0	0	302.03	42	34	42
J-37	253	1,413	5,652	302.03	70	62	70
J-38	253	1,413	5,652	302.03	70	62	70
J-42	261.2	0	0	302.03	58	50	58
J-43	261.2	0	0	302.03	58	50	58
J-45	261.1	0	0	302.03	58	50	58
J-46	261	0	0	302.03	58	50	58
J-47	269.8	0	0	302.03	46	38	46
J-50	272	0	0	302.03	43	35	43
J-52	272.2	0	0	302.03	42	34	42
J-54	272	0	0	302.03	43	35	43
J-55	269	1,413	5,652	302.03	47	39	47
J-56	269	1,413	5,652	302.03	47	39	47
J-57	263	1,413	5,652	302.03	55	47	55
J-58	263	0	0	302.03	55	47	55
J-59	263	1,413	5,652	302.03	55	47	55
J-60	263	1,413	5,652	302.03	55	47	55
J-61	263	1,413	5,652	302.03	55	47	55
J-62	256	1,413	5,652	302.03	65	57	65
J-63	254	0	0	302.03	68	60	68
J-64	254	1,413	5,652	302.03	68	60	68
J-65	254	1,413	5,652	302.03	68	60	68
J-66	254	1,413	5,652	302.03	68	60	68
J-67	254	0	0	302.03	68	60	68
J-68	254	1,413	5,652	302.03	68	60	68
J-69	254	1,413	5,652	302.03	68	60	68
J-70	254	1,413	5,652	302.03	68	60	68
J-71	254	1,413	5,652	302.03	68	60	68
J-72	254	1,413	5,652	302.03	68	60	68
J-73	254	1,413	5,652	302.03	68	60	68
J-74	254	0	0	302.03	68	60	68
J-75	254	1,413	5,652	302.03	68	60	68
J-76	254	1,413	5,652	302.03	68	60	68
J-77	254	1,413	5,652	302.03	68	60	68
J-78	254	1,413	5,652	302.03	68	60	68
J-79	255	1,413	5,652	302.03	67	59	67
J-80	255	0	0	302.03	67	59	67
J-81	256	1,413	5,652	302.03	65	57	65
J-82	256	1,413	5,652	302.03	65	57	65
J-83	263	1,413	5,652	302.03	55	47	55
J-84	263	1,413	5,652	302.03	55	47	55
J-85	263	0	0	302.03	55	47	55
J-86	263	1,413	5,652	302.03	55	47	55
J-87	263	1,413	5,652	302.03	55	47	55
J-88	262	1,413	5,652	302.03	57	49	57
J-89	262	1,413	5,652	302.03	57	49	57
J-90	262	0	0	302.03	57	49	57
J-91	262	1,413	5,652	302.03	57	49	57
J-92	262	1,413	5,652	302.03	57	49	57
J-93	262	1,413	5,652	302.03	57	49	57
J-94	262	1,413	5,652	302.03	57	49	57
J-95	262	1,413	5,652	302.03	57	49	57
J-96	262	0	0	302.03	57	49	57

Label	Elevation (m)	Demand (L/day)	Demand (Maximum) (L/day)	Hydraulic Grade (m)	Pressure (psi)
H-1	261	0	0	301.99	58
H-2	258.5	0	0	301.99	62
H-3	257	0	0	301.99	64
H-4	257	0	0	301.99	64
H-5	261	0	0	301.99	58
H-6	269.8	0	0	301.99	46
H-7	272.2	0	0	301.99	42

Pipe

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/day)	Velocity (m/s)	Headloss Gradient (mm/m)	Headloss Gradient (Maximum) (mm/m)	Headloss (mm)
P-1	8	J-1	J-42	250	PVC	140	-6,781	0	0	0	0
P-2	2	J-42	J-2	250	PVC	140	-6,781	0	0	0	0
P-3	2	J-2	J-43	300	PVC	140	5,765	0	0	0	0
P-4	5	J-43	J-3	300	PVC	140	5,765	0	0	0	0
P-5	5	J-3	J-4	300	PVC	140	5,765	0	0	0	0
P-6	11	J-4	J-5	300	PVC	140	4,325	0	0	0	0
P-7	11	J-5	J-6	300	PVC	140	2,885	0	0	0	0
P-8	11	J-6	J-7	300	PVC	140	1,445	0	0	0	0
P-9	17	J-7	CV-1	300	PVC	140	4	0	0	0	0
P-10	3	CV-1	H-1	250	PVC	140	4	0	0	0	0
P-11	3	J-2	J-45	300	PVC	140	-12,546	0	0	0.007	0
P-12	37	J-45	J-8	300	PVC	140	-12,546	0	0	0	0
P-13	36	J-8	J-9	300	PVC	140	-13,986	0	0	0.001	0
P-14	38	J-9	J-10	300	PVC	140	-15,426	0	0	0	0
P-15	22	J-10	J-11	300	PVC	140	-16,866	0	0	0.001	0
P-16	18	J-11	J-12	300	PVC	140	-18,306	0	0	0.001	0
P-17	15	J-12	J-13	300	PVC	140	-19,746	0	0	0.001	0
P-18	14	J-13	J-14	300	PVC	140	-19,752	0	0	0.001	0
P-19	13	J-14	J-15	300	PVC	140	-21,192	0	0	0.001	0
P-20	24	J-15	J-16	300	PVC	140	-22,632	0	0	0.002	0
P-21	16	J-16	J-17	300	PVC	140	-24,072	0	0	0.001	0
P-22	21	J-17	J-18	300	PVC	140	-25,512	0	0.001	0.002	0.019
P-23	20	J-18	J-19	300	PVC	140	-26,952	0	0	0.002	0
P-24	18	J-19	J-20	300	PVC	140	-28,392	0	0	0.001	0
P-25	20	J-20	J-21	300	PVC	140	-29,832	0	0	0.003	0
P-26	2	J-21	J-22	300	PVC	140	-31,272	0.01	0	0.01	0
P-27	16	J-22	J-23	300	PVC	140	-31,274	0.01	0	0.002	0
P-28	5	J-23	J-24	300	PVC	140	-32,714	0.01	0	0.004	0
P-29	34	J-24	J-25	300	PVC	140	-34,154	0.01	0.001	0.003	0.019
P-30	87	J-25	J-26	300	PVC	140	-35,594	0.01	0	0.003	0.019
P-31	37	J-26	J-37	300	PVC	140	-35,597	0.01	0	0.003	0
P-32	8	J-37	J-38	300	PVC	140	-37,037	0.01	0	0.002	0
P-33	91	J-38	J-46	300	PVC	140	-38,477	0.01	0	0.003	0.019
P-34	17	J-46	J-27	300	PVC	140	-38,483	0.01	0.001	0.003	0.019
P-35	60	J-27	J-28	300	PVC	140	-39,923	0.01	0	0.003	0
P-36	48	J-28	J-29	300	PVC	140	-41,363	0.01	0	0.004	0.019
P-37	26	J-29	J-47	300	PVC	140	-42,803	0.01	0.001	0.004	0.019
P-39	13	J-47	J-30	300	PVC	140	-42,806	0.01	0	0.003	0
P-40	36	J-30	J-31	300	PVC	140	-44,246	0.01	0	0.005	0
P-41	8	J-31	J-32	300	PVC	140	-45,686	0.01	0.002	0.005	0.019
P-42	19	J-32	J-33	300	PVC	140	-47,126	0.01	0	0.004	0
P-48	15	J-33	J-52	300	PVC	140	-47,126	0.01	0	0.005	0
P-51	243	J-52	J-54	300	PVC	140	-47,132	0.01	0	0.005	0.093
P-52	8	J-54	J-50	300	PVC	140	-47,132	0.01	0	0.002	0
P-53	6	J-52	H-7	250	PVC	140	3	0	0	0	0
P-54	3	J-47	H-6	250	PVC	140	7	0	0	0	0
P-55	4	J-46	H-5	250	PVC	140	4	0	0	0	0
P-56	3	J-26	H-4	250	PVC	140	2	0	0	0	0
P-57	3	J-22	H-3	250	PVC	140	2	0	0	0	0
P-58	4	J-13	H-2	250	PVC	140	5	0	0	0	0
P-69	38	J-55	J-56	250	PVC	140	40,739	0.01	0.001	0.009	0.037
P-70	10	J-56	J-57	250	PVC	140	39,299	0.01	0	0.007	0
P-71	4	J-57	J-58	250	PVC	140	37,859	0.01	0	0.008	0
P-72	32	J-58	J-59	250	PVC	140	37,859	0.01	0.001	0.007	0.019
P-73	37	J-59	J-60	250	PVC	140	36,419	0.01	0.001	0.007	0.019
P-74	2	J-60	J-61	250	PVC	140	34,979	0.01	0	0.008	0
P-75	47	J-61	J-62	250	PVC	140	33,539	0.01	0	0.006	0.019
P-76	67	J-62	J-63	250	PVC	140	32,099	0.01	0.001	0.006	0.037
P-77	29	J-63	J-64	250	PVC	140	32,099	0.01	0.001	0.005	0.019
P-78	46	J-64	J-65	250	PVC	140	30,659	0.01	0	0.005	0.019
P-79	22	J-65	J-66	250	PVC	140	29,219	0.01	0	0.005	0
P-80	16	J-66	J-67	250	PVC	140	27,779	0.01	0	0.005	0
P-81	3	J-67	J-68	250	PVC	140	27,779	0.01	0	0.006	0
P-82	38	J-68	J-69	250	PVC	140	26,339	0.01	0	0.004	0.019
P-83	30	J-69	J-70	250	PVC	140	24,899	0.01	0	0.004	0
P-84	7	J-70	J-71	250	PVC	140	23,459	0.01	0	0.002	0
P-85	35	J-71	J-72	250	PVC	140	22,019	0.01	0.001	0.003	0.019
P-86	3	J-72	J-73	250	PVC	140	20,579	0	0	0.006	0
P-87	33	J-73	J-74	250	PVC	140	19,139	0	0	0.002	0
P-88	13	J-74	J-75	250	PVC	140	19,139	0	0	0.001	0
P-89	6	J-75	J-76	250	PVC	140	17,699	0	0	0.003	0
P-90	49	J-76	J-77	250	PVC	140	16,259	0	0	0.002	0.019
P-91	15	J-77	J-78	250	PVC	140	14,819	0	0	0.001	0
P-92	20	J-78	J-79	250	PVC	140	13,379	0	0	0.001	0
P-93	4	J-79	J-80	250	PVC	140	11,939	0	0	0.005	0
P-94	38	J-80	J-81	250	PVC	140	11,939	0	0	0	0
P-95	3	J-81	J-82	250	PVC	140	10,499	0	0	0.007	0
P-96	90	J-82	J-83	250	PVC	140	9,059	0	0	0	0
P-97	6	J-83	J-84	250	PVC	140	7,619	0	0	0	0
P-98	14	J-84	J-85	250	PVC	140	6,179	0	0	0	0
P-99	44	J-85	J-86	250	PVC	140	6,179	0	0	0	0
P-100	26	J-86	J-87	250	PVC	140	4,739	0	0	0.001	0
P-101	15	J-87	J-88	250	PVC	140	3,299	0	0	0.001	0
P-102	35	J-88	J-89	250	PVC	140	1,859	0	0	0	0
P-103	16	J-89	J-90	250	PVC	140	419	0	0	0	0
P-104	18	J-90	J-91	250	PVC	140	419	0	0	0	0
P-105	4	J-91	J-92	250	PVC	140	-1,021	0	0	0	0
P-106	44	J-92	J-93	250	PVC	140	-2,461	0	0	0	0
P-107	32	J-93	J-94	250	PVC	140	-3,901	0	0	0	0
P-108	13	J-94	J-95	250	PVC	140	-5341	0	0	0.001	0
P-109	10	J-95	J-96	250	PVC	140	-6,781	0	0	0	0
P-110	4	J-96	J-1	250	PVC	140	-6,781	0	0	0	0
P-111	32	J-50	J-55	250	pvc	140	42,179	0.01	0.001	0.009	0.019
P-112	10	R-3	PMP-3	300	PVC	140	89,311	0.01	0.002	0.015	0.019
P-113	11	PMP-3	J-50	300	PVC	140	89,311	0.01	0.002	0.017	0.019

Maximum Daily Demand plus Fire Flow

Junction

Label	Elevation (m)	Demand (L/day)	Demand (Maximum) (L/day)	Hydraulic Grade (m)	Pressure (psi)	Pressure (Minimum) (psi)	Pressure (Maximum) (psi)
J-1	261.7	0	0	301.1	56	56	56
J-2	261.1	0	0	301.1	57	57	57
J-3	261.3	0	0	301.1	57	57	57
J-4	261.3	3109	3109	301.1	57	57	57
J-5	261.2	3109	3109	301.1	57	57	57
J-6	261	3109	3109	301.1	57	57	57
J-7	261	3109	3109	301.1	57	57	57
J-8	260.7	3109	3109	301.1	57	57	57
J-9	260	3109	3109	301.1	58	58	58
J-10	259.9	3109	3109	301.1	59	59	59
J-11	259.1	3109	3109	301.1	60	60	60
J-12	259	3109	3109	301.1	60	60	60
J-13	258.5	0	0	301.1	60	60	60
J-14	258.1	3109	3109	301.1	61	61	61
J-15	258	3109	3109	301.1	61	61	61
J-16	258	3109	3109	301.1	61	61	61
J-17	258	3109	3109	301.1	61	61	61
J-18	257.9	3109	3109	301.1	61	61	61
J-19	257.4	3109	3109	301.1	62	62	62
J-20	257	3109	3109	301.1	63	63	63
J-21	257	3109	3109	301.1	63	63	63
J-22	257	0	0	301.1	63	63	63
J-23	257	3109	3109	301.1	63	63	63
J-24	257	3109	3109	301.1	63	63	63
J-25	257	3109	3109	301.1	63	63	63
J-26	253	0	0	301.1	68	68	68
J-27	263	3109	3109	301.1	54	54	54
J-28	265.5	3109	3109	301.1	51	51	51
J-29	268.3	3109	3109	301.1	47	47	47
J-30	270.4	3109	3109	301.1	44	44	44
J-31	271.4	3109	3109	301.1	42	42	42
J-32	271.4	3109	3109	301.1	42	42	42
J-33	272.2	0	0	301.1	41	41	41
J-37	253	3109	3109	301.1	68	68	68
J-38	253	3109	3109	301.1	68	68	68
J-42	261.2	0	0	301.1	57	57	57
J-43	261.2	0	0	301.1	57	57	57
J-45	261.1	0	0	301.1	57	57	57
J-46	261	0	0	301.1	57	57	57
J-47	269.8	0	0	301.1	44	44	44
J-50	272	0	0	301.1	41	41	41
J-52	272.2	0	0	301.1	41	41	41
J-54	272	0	0	301.1	41	41	41
J-55	269	3109	3109	301.1	46	46	46
J-56	269	3109	3109	301.1	46	46	46
J-57	263	3109	3109	301.1	54	54	54
J-58	263	0	0	301.1	54	54	54
J-59	263	3109	3109	301.1	54	54	54
J-60	263	3109	3109	301.1	54	54	54
J-61	263	3109	3109	301.1	54	54	54
J-62	256	3109	3109	301.1	64	64	64
J-63	254	0	0	301.1	67	67	67
J-64	254	3109	3109	301.1	67	67	67
J-65	254	3109	3109	301.1	67	67	67
J-66	254	3109	3109	301.1	67	67	67
J-67	254	0	0	301.1	67	67	67
J-68	254	3109	3109	301.1	67	67	67
J-69	254	3109	3109	301.1	67	67	67
J-70	254	3109	3109	301.1	67	67	67
J-71	254	3109	3109	301.1	67	67	67
J-72	254	3109	3109	301.1	67	67	67
J-73	254	3109	3109	301.1	67	67	67
J-74	254	0	0	301.1	67	67	67
J-75	254	3109	3109	301.1	67	67	67
J-76	254	3109	3109	301.1	67	67	67
J-77	254	3109	3109	301.1	67	67	67
J-78	254	3109	3109	301.1	67	67	67
J-79	255	3109	3109	301.1	65	65	65
J-80	255	0	0	301.1	65	65	65
J-81	256	3109	3109	301.1	64	64	64
J-82	256	3109	3109	301.1	64	64	64
J-83	263	3109	3109	301.1	54	54	54
J-84	263	3109	3109	301.1	54	54	54
J-85	263	0	0	301.1	54	54	54
J-86	263	3109	3109	301.1	54	54	54
J-87	263	3109	3109	301.1	54	54	54
J-88	262	3109	3109	301.1	56	56	56
J-89	262	3109	3109	301.1	56	56	56
J-90	262	0	0	301.1	56	56	56
J-91	262	3109	3109	301.1	56	56	56
J-92	262	3109	3109	301.1	56	56	56
J-93	262	3109	3109	301.1	56	56	56
J-94	262	3109	3109	301.1	56	56	56
J-95	262	3109	3109	301.1	56	56	56
J-96	262	0	0	301.1	56	56	56

Label	Elevation (m)	Demand (L/day)	Demand (Maximum) (L/day)	Hydraulic Grade (m)	Pressure (psi)
H-1	261	0	0	301.1	57
H-2	258.5	0	0	301.1	60
H-3	257	0	0	301.1	63
H-4	257	0	0	301.1	63
H-5	261	0	0	301.1	57
H-6	269.8	0	0	301.1	44
H-7	272.2	0	0	301.1	41

Pipe

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/day)	Velocity (m/s)	Headloss Gradient (mm/m)	Headloss Gradient (Maximum) (mm/m)	Headloss (mm)
P-1	8	J-1	J-42	250	PVC	140	-14,447	0	0	0	0
P-2	2	J-42	J-2	250	PVC	140	-14,447	0	0	0	0
P-3	2	J-2	J-43	300	PVC	140	12,439	0	0	0	0
P-4	5	J-43	J-3	300	PVC	140	12,439	0	0	0	0
P-5	5	J-3	J-4	300	PVC	140	12,439	0	0	0	0
P-6	11	J-4	J-5	300	PVC	140	9,330	0	0	0	0
P-7	11	J-5	J-6	300	PVC	140	6,222	0	0	0	0
P-8	11	J-6	J-7	300	PVC	140	3,113	0	0	0	0
P-9	17	J-7	CV-1	300	PVC	140	2	0	0	0	0
P-10	3	CV-1	H-1	250	PVC	140	4	0	0	0	0
P-11	3	J-2	J-45	300	PVC	140	-26,886	0	0	0	0
P-12	37	J-45	J-8	300	PVC	140	-26,886	0	0	0	0
P-13	36	J-8	J-9	300	PVC	140	-29,994	0	0	0	0
P-14	38	J-9	J-10	300	PVC	140	-33,103	0.01	0	0	0.019
P-15	22	J-10	J-11	300	PVC	140	-36,211	0.01	0	0	0
P-16	18	J-11	J-12	300	PVC	140	-39,320	0.01	0	0	0
P-17	15	J-12	J-13	300	PVC	140	-42,429	0.01	0	0	0
P-18	14	J-13	J-14	300	PVC	140	-42,433	0.01	0.001	0.001	0.019
P-19	13	J-14	J-15	300	PVC	140	-45,542	0.01	0	0	0
P-20	24	J-15	J-16	300	PVC	140	-48,651	0.01	0	0	0
P-21	16	J-16	J-17	300	PVC	140	-51,759	0.01	0.001	0.001	0.019
P-22	21	J-17	J-18	300	PVC	140	-54,868	0.01	0	0	0
P-23	20	J-18	J-19	300	PVC	140	-57,976	0.01	0.001	0.001	0.019
P-24	18	J-19	J-20	300	PVC	140	-61,085	0.01	0	0	0
P-25	20	J-20	J-21	300	PVC	140	-64,194	0.01	0.001	0.001	0.019
P-26	2	J-21	J-22	300	PVC	140	-67,302	0.01	0	0	0
P-27	16	J-22	J-23	300	PVC	140	-67,307	0.01	0.001	0.001	0.019
P-28	5	J-23	J-24	300	PVC	140	-70,415	0.01	0	0	0
P-29	34	J-24	J-25	300	PVC	140	-73,524	0.01	0.001	0.001	0.037
P-30	87	J-25	J-26	300	PVC	140	-76,633	0.01	0.001	0.001	0.074
P-31	37	J-26	J-37	300	PVC	140	-76,639	0.01	0.001	0.001	0.019
P-32	8	J-37	J-38	250	PVC	140	-79,748	0.02	0.005	0.005	0.037
P-33	91	J-38	J-46	300	PVC	140	-82,856	0.01	0.001	0.001	0.093
P-34	17	J-46	J-27	300	PVC	140	-82,859	0.01	0	0	0
P-35	60	J-27	J-28	300	PVC	140	-85,968	0.01	0.001	0.001	0.074
P-36	48	J-28	J-29	300	PVC	140	-89,076	0.01	0.001	0.001	0.056
P-37	26	J-29	J-47	300	PVC	140	-92,185	0.02	0.001	0.001	0.037
P-39	13	J-47	J-30	300	PVC	140	-92,188	0.02	0.001	0.001	0.019
P-40	36	J-30	J-31	300	PVC	140	-95,296	0.02	0.001	0.001	0.037
P-41	8	J-31	J-32	300	PVC	140	-98,405	0.02	0.002	0.002	0.019
P-42	19	J-32	J-33	300	PVC	140	-101,514	0.02	0.001	0.001	0.019
P-48	15	J-33	J-52	300	PVC	140	-101,514	0.02	0.002	0.002	0.037
P-51	243	J-52	J-54	300	PVC	140	-101,517	0.02	0.001	0.001	0.353
P-52	8	J-54	J-50	300	PVC	140	-101,517	0.02	0.002	0.002	0.019
P-53	6	J-52	H-7	250	PVC	140	6.45	0	0	0	0
P-54	3	J-47	H-6	250	PVC	140	2.97	0	0	0	0
P-55	4	J-46	H-5	250	PVC	140	0.03	0	0	0	0
P-56	3	J-26	H-4	250	PVC	140	2.47	0	0	0	0
P-57	3	J-22	H-3	250	PVC	140	2.05	0	0	0	0
P-58	4	J-13	H-2	250	PVC	140	2.16	0	0	0	0
P-69	38	J-55	J-56	250	PVC	140	88,137	0.02	0.002	0.002	0.093
P-70	10	J-56	J-57	250	PVC	140	85,029	0.02	0.004	0.004	0.037
P-71	4	J-57	J-58	250	PVC	140	81,920	0.02	0	0	0
P-72	32	J-58	J-59	250	PVC	140	81,920	0.02	0.003	0.003	0.093
P-73	37	J-59	J-60	250	PVC	140	78,811	0.02	0.002	0.002	0.074
P-74	2	J-60	J-61	250	PVC	140	75,703	0.02	0	0	0
P-75	47	J-61	J-62	250	PVC	140	72,594	0.02	0.002	0.002	0.093
P-76	67	J-62	J-63	250	PVC	140	69,486	0.02	0.002	0.002	0.13
P-77	29	J-63	J-64	250	PVC	140	69,486	0.02	0.002	0.002	0.056
P-78	46	J-64	J-65	250	PVC	140	66,377	0.02	0.002	0.002	0.074
P-79	22	J-65	J-66	250	PVC	140	63,268	0.01	0.001	0.001	0.019
P-80	16	J-66	J-67	250	PVC	140	60,160	0.01	0.002	0.002	0.037
P-81	3	J-67	J-68	250	PVC	140	60,160	0.01	0	0	0
P-82	38	J-68	J-69	250	PVC	140	57,051	0.01	0.001	0.001	0.037
P-83	30	J-69	J-70	250	PVC	140	53,943	0.01	0.001	0.001	0.037
P-84	7	J-70	J-71	250	PVC	140	50,834	0.01	0.002	0.002	0.019
P-85	35	J-71	J-72	250	PVC	140	47,725	0.01	0.001	0.001	0.019
P-86	3	J-72	J-73	250	PVC	140	44,617	0.01	0	0	0
P-87	33	J-73	J-74	250	PVC	140	41,508	0.01	0.001	0.001	0.037
P-88	13	J-74	J-75	250	PVC	140	41,508	0.01	0	0	0
P-89	6	J-75	J-76	250	PVC	140	38,400	0.01	0	0	0
P-90	49	J-76	J-77	250	PVC	140	35,291	0.01	0.001	0.001	0.037
P-91	15	J-77	J-78	250	PVC	140	32,182	0.01	0	0	0
P-92	20	J-78	J-79	250	PVC	140	29,074	0.01	0.001	0.001	0.019
P-93	4	J-79	J-80	250	PVC	140	25,965	0.01	0	0	0
P-94	38	J-80	J-81	250	PVC	140	25,965	0.01	0	0	0
P-95	3	J-81	J-82	250	PVC	140	22,857	0.01	0	0	0
P-96	90	J-82	J-83	250	PVC	140	19,748	0	0	0	0.019
P-97	6	J-83	J-84	250	PVC	140	16,639	0	0	0	0
P-98	14	J-84	J-85	250	PVC	140	13,531	0	0	0	0
P-99	44	J-85	J-86	250	PVC	140	13,531	0	0	0	0
P-100	26	J-86	J-87	250	PVC	140	10,422	0	0	0	0
P-101	15	J-87	J-88	250	PVC	140	7,314	0	0	0	0
P-102	35	J-88	J-89	250	PVC	140	4,205	0	0	0	0
P-103	16	J-89	J-90	250	PVC	140	1,096	0	0	0	0
P-104	18	J-90	J-91	250	PVC	140	1,096	0	0	0	0
P-105	4	J-91	J-92	250	PVC	140	-2,012	0	0	0	0
P-106	44	J-92	J-93	250	PVC	140	-5,121	0	0	0	0
P-107	32	J-93	J-94	250	PVC	140	-8,229	0	0	0	0
P-108	13	J-94	J-95	250	PVC	140	-11,338	0	0	0	0
P-109	10	J-95	J-96	250	PVC	140	-14,447	0	0	0	0
P-110	4	J-96	J-1	250	PVC	140	-14,447	0	0	0	0
P-111	32	J-50	J-55	250	pvc	140	91,246	0.02	0.003	0.003	0.112
P-112	10	R-3	PMP-3	300	PVC	140	192,762	0.03	0.006	0.006	0.056
P-113	11	PMP-3	J-50	300	PVC	140	192,762	0.03	0.005	0.005	0.056

Label	Fire Flow Iterations	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Flow (Total Needed) (L/s)	Flow (Total Available) (L/s)	Pressure (Residual Lower Limit) (psi)	Pressure (Calculated Residual) (psi)	Pressure (Zone Lower Limit) (psi)	Pressure (Calculated Zone Lower Limit) (psi)	Junction w/ Minimum Pressure (Zone)	Pressure (System Lower Limit) (psi)	Pressure (Calculated System Lower Limit) (psi)	Junction w/ Minimum Pressure (System)	Is Fire Flow Run Balanced?
H-1	10	TRUE	90	93.52	90	93.52	20	33	20	20	J-33	20	20	J-33	TRUE
H-2	10	TRUE	90	93.03	90	93.03	20	37	20	20	J-33	20	20	J-33	TRUE
H-3	11	TRUE	90	92.58	90	92.58	20	40	20	20	J-33	20	20	J-33	TRUE
H-4	11	TRUE	90	92.08	90	92.08	20	40	20	20	J-33	20	20	J-33	TRUE
H-5	11	TRUE	90	91.47	90	91.47	20	35	20	20	J-33	20	20	J-33	TRUE
H-6	12	TRUE	90	90.73	90	90.73	20	23	20	20	J-33	20	20	J-33	TRUE
H-7	2	TRUE	90	90	90	90	20	20	20	20	J-52	20	20	J-52	TRUE

Lotte Veth

From: Liu, Mickey <Mickey.Liu@halton.ca>
Sent: Monday, May 29, 2017 1:43 PM
To: Lotte Veth
Cc: Skrins, Tim; Huk, Dave; Florio, Enzo
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hi Lotte

I meant the dead end watermain currently in the cul-de-sac.

Moving forward, please forward any requests to Enzo, the Development Project Manager (DPM) for Georgetown. He will be the Halton contact point for the development matters. Thanks.

From: Lotte Veth [mailto:lveth@westhoff.ab.ca]
Sent: Monday, May 29, 2017 2:14 PM
To: Liu, Mickey
Cc: Skrins, Tim; Huk, Dave
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hi Mickey,
Thanks for your reply. I am not sure which dead end you are referring to in bullet 1, as we are proposing to extend the current deadend on Bishop Ct. Or do you mean the dead end in the cul-de-sac.
Regards,
Lotte Veth

From: Liu, Mickey [mailto:Mickey.Liu@halton.ca]
Sent: Thursday, May 25, 2017 9:21 AM
To: Lotte Veth <lveth@westhoff.ab.ca>
Cc: Skrins, Tim <Tim.Skrins@halton.ca>; Huk, Dave <Dave.Huk@halton.ca>
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hi Lotte

I've overlaid the provided information in the regional water model (InfoWater). The model runs confirm the following:

1) There is likely an existing fire flow deficiency in the area due to the deadend watermain on Bishop Ct.
2) It is recommended to install a 300mm watermain along the proposed alignment.
3) The available fire flow is approximately 70 L/s, which is still lower than the standard 90 L/s for low density residential houses, with the new 300mm watermain.
4) The Functional Servicing Report should establish the required fire flow under this sub-standard available fire flow condition, as per Halton Linear Design Manual.

From: Lotte Veth [mailto:lveth@westhoff.ab.ca]
Sent: Monday, May 15, 2017 7:29 PM

To: Liu, Mickey
Cc: Map Requests; Skrins, Tim
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hi Mickey,
Thanks very much for your assistance. Enclosed I have a GIS geodatabase with the prosed pipe alignment, connections points, hydrants and grading contours.
Please let me know if you need more information. If this does not work could you provide me the maximum daily operating pressures at the connection points.
Regards, Lotte Veth

From: Liu, Mickey [mailto:Mickey.Liu@halton.ca]
Sent: Friday, May 12, 2017 9:31 AM
To: Lotte Veth <lveth@westhoff.ab.ca>
Cc: Map Requests <MapRequests@halton.ca>; Skrins, Tim <Tim.Skrins@halton.ca>
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hi Lotte

The pressures are in the range of 40 to 65 psi with a top water level of approximately 300m. If you can provide proposed size/alignment of the new loop watermain, as well as the site grading plan, I may input them into Halton water model and run the simulation.

Moving forward, please copy Tim on every correspondence so that Halton's response can be properly recorded. Thanks.

Tim, have we yet formally received this application?

From: Lotte Veth [mailto:lveth@westhoff.ab.ca]
Sent: Thursday, May 11, 2017 3:36 PM
To: Map Requests
Cc: Liu, Mickey
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hi Mickey,
We are designing the water distribution line for the extension of the existing watermain in Bishop Court and Confederation Street. For the analysis I need the maximum pressure in the connection points. Could you provide that information as we don't have the Waterinfo software in the office.
Thanks and regards,

Lotte Veth, M.Sc.
Water Management Specialist

Westhoff Engineering Resources, Inc.
Land & Water Resources Management Consultants

Suite 601, 1040 - 7th Avenue S.W.
Calgary, AB T2P 3G9

Phone: 403 264-9366 ext. 293
Fax: 403 264-8796
Email: lveth@westhoff.ab.ca

From: Map Requests [mailto:MapRequests@halton.ca]
Sent: Wednesday, May 10, 2017 9:08 AM
To: Lotte Veth <lveth@westhoff.ab.ca>
Cc: Liu, Mickey <Mickey.Liu@halton.ca>
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hello Veth,

I have checked the zipped folder and found that there are 2 mxds for existing boundaries (EB) and future boundaries (FB)

I will direct you to speak with Mickey whose one of our project manager regarding this issue.

We would be able to assist you better if you could explain the purpose of the max pressure at the nodes desired.

Also please indicate if you're willing to see the max pressure value for current conditions or the future ultimate built out.

Regards,

-Raymond

From: Lotte Veth [mailto:lveth@westhoff.ab.ca]
Sent: Tuesday, May 09, 2017 6:16 PM
To: Map Requests
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hi Raymond,
We only have the FB model in the zipped folder. We don't have the software Infowater in the office. How can I get the max. pressure at the connection points or can you export the results just for the junctions WFT656 and WFT106744?

Thanks,
Lotte

From: Map Requests [mailto:MapRequests@halton.ca]
Sent: Tuesday, May 09, 2017 1:57 PM
To: Lotte Veth <lveth@westhoff.ab.ca>
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hi Veth,

There are 2 water models in a zipped folder called "InfoWater Fully Updated April19-2017-EB"

One is for existing pressure zone boundaries (dated April 19-2017 and having EB as suffix) and another for future zone boundaries (dated April 27-2017 and having FB as suffix).

The existing boundary version (EB) should be used for current situation and the future boundary version (FB) should be used for the ultimate built-out situation.

Hope this helps,

-Raymond

From: Lotte Veth [mailto:lveth@westhoff.ab.ca]
Sent: Tuesday, May 09, 2017 3:10 PM
To: Map Requests
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Thanks, it is working now. Is there a description of the model and how I can find the maximum water pressure at the connection point?

Regards,
Lotte Veth

From: Map Requests [mailto:MapRequests@halton.ca]
Sent: Tuesday, May 09, 2017 12:36 PM
To: Lotte Veth <lveth@westhoff.ab.ca>
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hello Veth,

I have reuploaded the ArcGIS mxds to version 10.0.

Please contact if you're still having issues.

Thanks,

-Raymond

From: Lotte Veth [mailto:lveth@westhoff.ab.ca]
Sent: Tuesday, May 09, 2017 2:14 PM
To: Map Requests
Subject: RE: water servicing Glen Williams, Town of Halton Hills

HI Raymond,
Thanks for the data. We have ArcGIS10 and cannot open the map "InfoSewer-FullyUpdated-Sept27-2016.mxd". would it be possible to save it as a ARCGIS10 map and resend?
Thanks,
Lotte

From: Map Requests [mailto:MapRequests@halton.ca]
Sent: Friday, May 05, 2017 11:44 AM
To: Lotte Veth <lveth@westhoff.ab.ca>
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hello Veth,

I have uploaded the requested DLA file into our FTP server.

The directory is as follows: ftp://ftp.halton.ca/DLA/DLA-Veth/

You will need an ID and a Password in order to access data.

The ID is "hrgiscc" and password is "opengis"

The two compressed file each contains hydraulic model and GIS infrastructures.

Please contact us if there're any issues regarding the DLA request.

Thank you,

-Raymond

From: Lotte Veth [mailto:lveth@westhoff.ab.ca]
Sent: Friday, May 05, 2017 12:46 PM
To: Map Requests
Subject: Re: water servicing Glen Williams, Town of Halton Hills

Hi,
I would also like the info on confederation street as we have to tie in.
Thanks Raymond.
Regards,
Lotte Veth

-------- Original message --------
From: Map Requests <MapRequests@halton.ca>
Date: 2017-05-05 9:02 AM (GMT-07:00)
To: Lotte Veth <lveth@westhoff.ab.ca>
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hello Veth,

It's Raymond from the GIS. I just wanted to clarify on one last thing before I upload the necessary DLA data. Unlike the Bishop Court, extents of Confederation Street run past the study area attached. Would you like to see the all the infrastructures in the Confederation Street or just the ones that are located on the study area? Please advise

Regards,

-Raymond

From: Lotte Veth [mailto:lveth@westhoff.ab.ca]
Sent: Monday, May 01, 2017 5:45 PM
To: Map Requests
Subject: FW: water servicing Glen Williams, Town of Halton Hills

From: Lotte Veth
Sent: Monday, May 01, 2017 3:40 PM
To: 'maprequest@halton.ca' <maprequest@halton.ca>
Cc: 'Liu, Mickey' <Mickey.Liu@halton.ca>; 'Micallef, Michael' <Michael.Micallef@halton.ca>
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hi Michael and Mickey,
For the Update of The Functional Servicing Report for the subdivision of Charleston homes West just outside Glen Williams, see attached location figure. We would like to request:

- A copy of Halton water hydraulic model
- Blockprofiles or GIS layers indicating the existing infrastructure in Confederation Street and Bishop Court.

If we need to sign the DLA, please forward a copy and we will return it asap.

Thanks and regards,

Lotte Veth, M.Sc.
Water Management Specialist

Westhoff Engineering Resources, Inc.
Land & Water Resources Management Consultants

Suite 601, 1040 - 7th Avenue S.W.
Calgary, AB T2P 3G9

Phone: 403 264-9366 ext. 293
Fax: 403 264-8796
Email: lveth@westhoff.ab.ca

From: Lotte Veth
Sent: Thursday, April 27, 2017 9:50 AM
To: 'Liu, Mickey' <Mickey.Liu@halton.ca>; Micallef, Michael <Michael.Micallef@halton.ca>
Cc: Simpson, David <David.Simpson@halton.ca>; Holden, Trish <Trish.Holden@halton.ca>; Najak, Zahir <Zahir.Najak@halton.ca>
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hi Mickey,
Thanks for the reply. Could you please forward the DLW, so we can fill it out and submit to Michael?
Thanks,

Lotte Veth, M.Sc.
Water Management Specialist

Westhoff Engineering Resources, Inc.
Land & Water Resources Management Consultants

Suite 601, 1040 - 7th Avenue S.W.
Calgary, AB T2P 3G9

Phone: 403 264-9366 ext. 293
Fax: 403 264-8796
Email: lveth@westhoff.ab.ca

Lotte Veth

From: Liu, Mickey [mailto:Mickey.Liu@halton.ca]
Sent: Thursday, April 27, 2017 9:23 AM
To: Lotte Veth <lveth@westhoff.ab.ca>
Cc: Simpson, David <David.Simpson@halton.ca>; Holden, Trish <Trish.Holden@halton.ca>; Najak, Zahir <Zahir.Najak@halton.ca>; Micallef, Michael <Michael.Micallef@halton.ca>
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hi Mr. Veth

Halton has the water hydraulic model for the purposes you indicated. In order to acquire a copy of the model, the consultant has to execute a Data Licence Agreement (DLA) with Halton.

The same DLA also applies to Halton GIS layers the consultant may need for its analysis. Please send Michael a formal request for the GIS layers and water model.

Michael, as requested by Zahir, we will release the water model upon the executed DLA. Thanks.

Mickey Liu
Project Manager III
Infrastructure Planning & Policy
Public Works
Halton Region
905-825-6000, ext. 7235 | 1-866-442-5866

From: Simpson, David
Sent: Wednesday, April 26, 2017 3:49 PM
To: Holden, Trish
Cc: 'Lotte Veth'; Liu, Mickey
Subject: RE: water servicing Glen Williams, Town of Halton Hills

Hi Trish,

Could you help out Mr. Veth with his inquiry?

Thanks,
David

David Simpson, P.Eng.
Manager Infrastructure Planning
Infrastructure Planning & Policy
Public Works
Halton Region
905-825-6000, ext. 7601 | 1-866-442-5866

From: Lotte Veth [mailto:lveth@westhoff.ab.ca]
Sent: Wednesday, April 26, 2017 3:47 PM
To: Simpson, David
Subject: water servicing Glen Williams, Town of Halton Hills

Hi David,
We are working for our client on the hydraulic network analysis for a proposed subdivision Glen Williams, Town of Halton Hills. For this I am looking for:

- Halton watermain hydraulic model so we know what the pressures are at the point of connection
- Expected static pressures

Could you indicate if this information is available and if we could receive a copy?

Thanks,

Lotte Veth, M.Sc.
Water Management Specialist

Westhoff Engineering Resources, Inc.
Land & Water Resources Management Consultants

Suite 601, 1040 - 7th Avenue S.W.
Calgary, AB T2P 3G9

Phone: 403 264-9366 ext. 293
Fax: 403 264-8796
Email: lveth@westhoff.ab.ca

APPENDIX D
Visual OTTHYMO Hydrologic Model

APPENDIX D

VISUAL OTTHYMO HYDROLOGIC MODEL

A Visual OTTHYMO (VO) model (Civica 2019) was developed for the purpose of assessing pre- and post-development peak flows and sizing the proposed stormwater management facilities to support the Phase 2 development. The outflows from the model were used as inflows for the hydraulic model to assess Regional floodlines. Parameterization of the hydrologic model are presented herein.

1 PARAMETER DEFINITION

TABLE D1 StandHyd(1) Parameter Summary

Parameter	Phase 1 Development	Phase 2 Development
Area	Measured in CAD	
TIMP	Burnside (1999)	Calculated from impervious areas (road, driveways, houses [including patio areas], wet pond).
XIMP	Burnside (1999)	Calculated from directly connected impervious areas including roads, driveways and wet pond.
SLPP	Burnside (1999)	BCEL (2015) values for pre-development catchments. Post-development catchment slopes were based on the drainage plan and assumed a maximum lot grading of 6%.
LGP	Burnside (1999)	Lot lengths measured in CAD.
MNP	Burnside (1999)	CVC (2011) standard parameters for Manning's roughness coefficient for overland flow with impervious land cover type.
DPSI	Burnside (1999)	CVC (2011) standard parameters for impervious area depression storage.
SLPI	Burnside (1999)	Average slope for impervious area measured in CAD.
LGI	Calculated based on relationship $A=1.5LGI^2$	
MNI	Burnside (1999)	CVC (2011) standard parameters for Manning's roughness coefficient for overland flow based on land cover type.
CN (for pervious areas)	Burnside (1999)	Revised from BCEL (2015) to meet CVC standard parameters based on hydrologic soil group mapping (OMAFRA 2020), geotechnical report (Soil Engineers 2015) and land cover type.
Ia	Burnside (1999)	Based on CVC standard parameters for initial abstraction/depression storage by catchment land cover type.

(1) StandHyd used to simulate catchments with impervious greater than 20%
Burnside - Burnside Development Services, A Division of R. J. Burnside & Associates Limited
CVC - Credit Valley Conservation
BCEL - Braun Consulting Engineers Ltd.
Stormwater Management Implementation Report, Glen Williams Subdivision Phase 1, Community of Glen Williams, Town of Halton Hills (Burnside 1999)
Glen Williams Phase 2, Town of Halton Hills, ON, Functional Servicing Report (BCEL 2015)
CVC Standard Parameters (CVC 2011)
Slope Stability Assessment Report for Proposed Residential Development 12519 Ninth Line, Town of Halton Hills (Soil Engineers 2015)
Agriculture Information Atlas (OMAFRA 2020

TABLE D2 NasHyd[1] Parameter Summary

Parameter	Phase 2 Development	External Drainage Areas to Tributaries
Area	Measured in CAD.	Measured in GIS using LiDAR DTM Peel 2016 Package A (0.5 m) (MNRF 2020).
CN	Revised from BCEL (2015) to meet CVC standard parameters based on hydrologic soil group mapping (CVC 2011), geotechnical report (Soil Engineers 2015) and land cover type.	Estimated using CVC parameters based on hydrologic soil group mapping (CVC 2011) and land cover type.
Ia	Based on CVC standard parameters for initial abstraction/depression storage by catchment land cover type.	
Tp	Calculated using Airport Method: $t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$ Where: C (runoff coefficient) is based on *Halton Hills SWM Guide Development Manual* (Town of Halton Hills n.d.) based on land use (Table 6.1) L (catchment length) is based on catchment flow path length S (catchment slope) is based on catchment slope Tp = 0.67 Tc Airport Method was selected to estimate time of concentration as it is typically used for small (<1 km^2) rural catchments and simple urban systems with runoff coefficients less than 0.4.	

(1) NasHyd used to simulate catchments with impervious area less than 20%.
BCEL - Braun Consulting Engineers Ltd.
CVC - Credit Valley Conservation
DTM - digital terrain model
Glen Williams Phase 2, Town of Halton Hills, ON, Functional Servicing Report (BCEL 2015)
CVC Standard Parameters (CVC 2011)
Slope Stability Assessment Report for Proposed Residential Development 12519 Ninth Line, Town of Halton Hills (Soil Engineers 2015)
Ontario Digital Terrain Model (Lidar-Derived) (MNRF 2020)
Halton Hills SWM Guide Development Manual (Town of Halton Hills n.d.)

2 RAINFALL

Rainfall data used in the model included:

- 25 mm 4-hour Chicago (Town of Halton Hills Standard 108; Town of Halton Hills 1988a)
- 2-year through 100-year Soil Conservation Service (SCS) Type II (Town of Halton Hills Standard 106; Town of Halton Hills 1988b)
- 2-year through 100-year 6-hour Atmospheric Environmental Service (AES; Burnside 1999)
- 48-hour Regional storm (Town of Halton Hills Standard 109; Town of Halton Hills 1988c)

A 6-hour AES was used for comparison to Burnside (1999) Phase 1 model. For design purposes, SCS Type II was used as it provided more conservative storage values.

3 PRE-DEVELOPMENT

3.1 Model Schematic (see Figure 10 in main report)

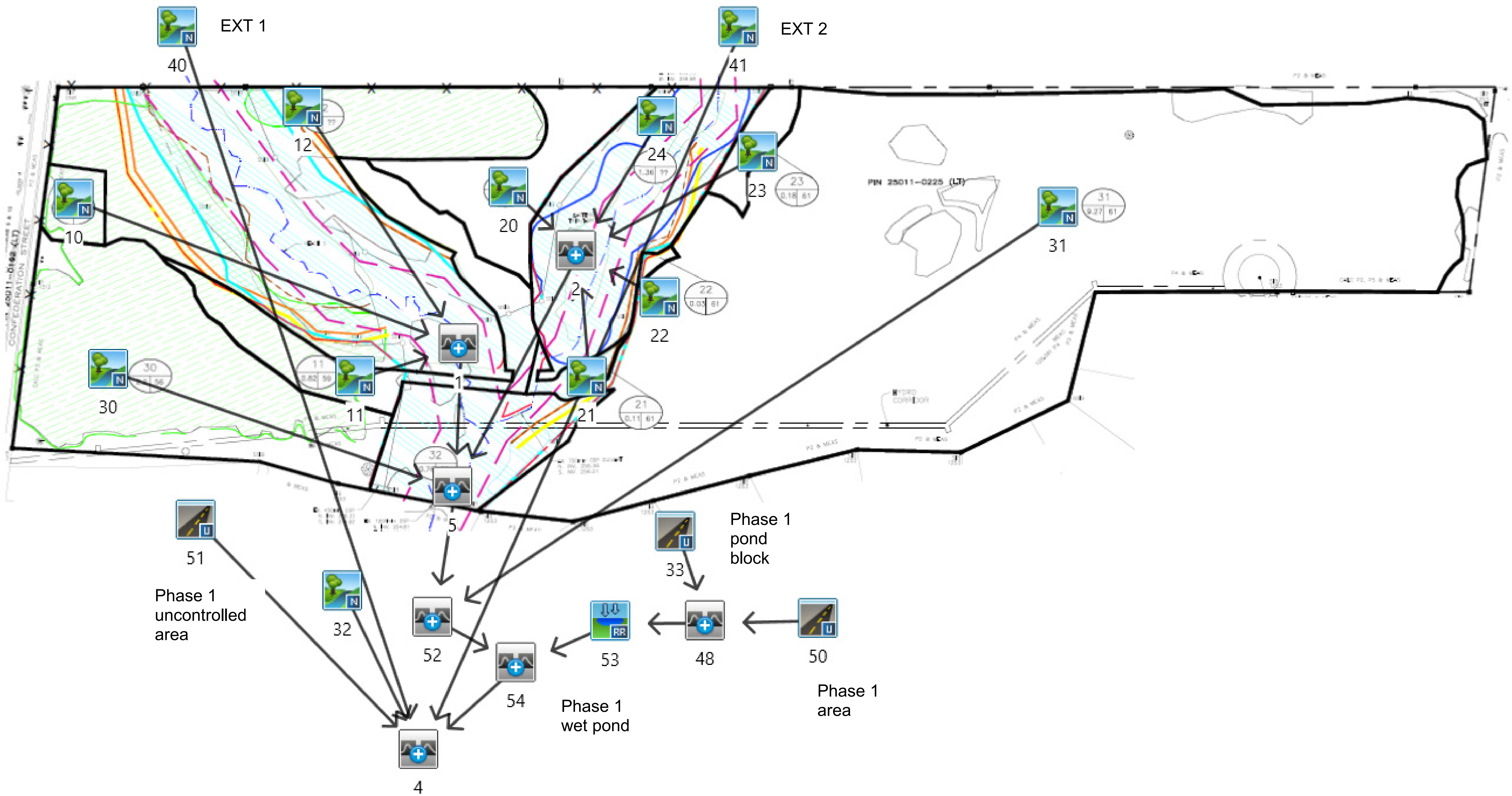


FIGURE D1 Pre-development Model Schematic

3.2 Soils

Hydrologic soil group data for the development area and external tributaries was obtained from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA; 2020).

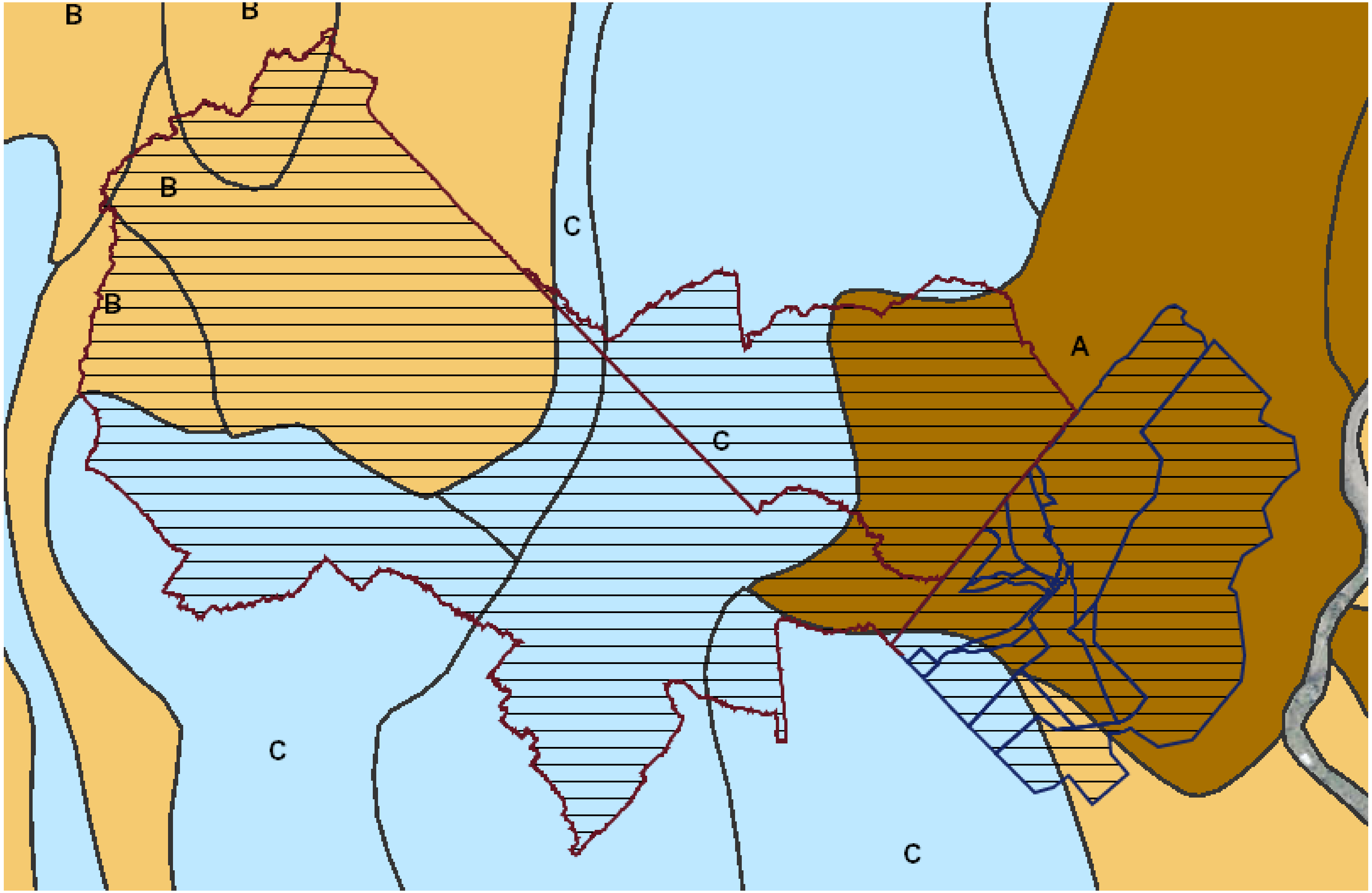


FIGURE D2 Pre-development Hydrologic Soil Groups

3.3 Land Use

The CVC standard land use parameters (2011) for cultivated land was used to represent the former gravel extraction area in Phase 2. Land cover was delineated based on aerial imagery.

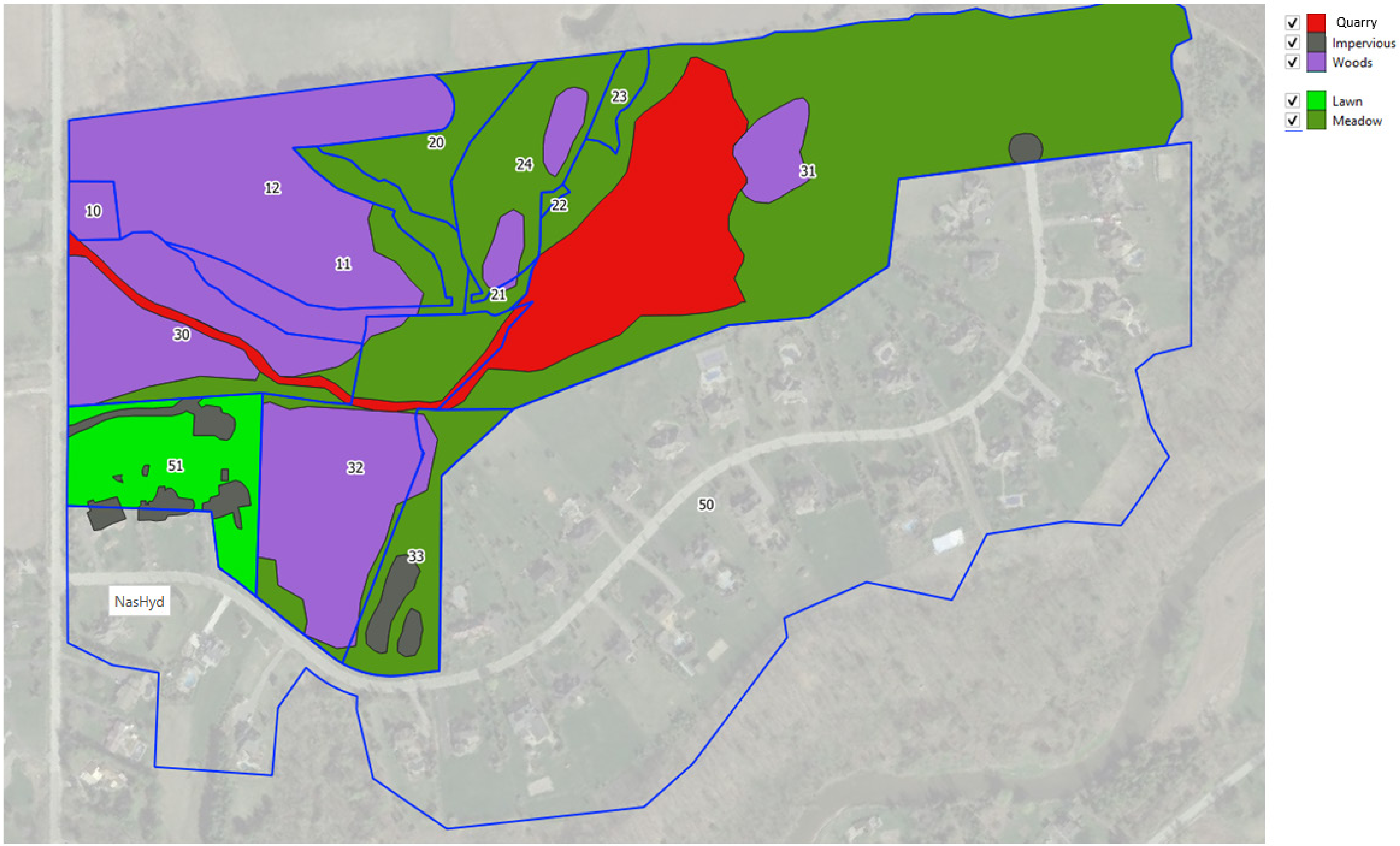


FIGURE D3 **Pre-development Land Use**

3.4 Model Input

TABLE D3 Time to Peak Parameters for NasHyd

Catchment ID	Runoff Coefficient	Catchment Length (m)	Catchment Slope %)	Time of Concentration (minute)
10	0.25	67	4.5	13.81
11	0.25	129	10.9	14.31
12	0.25	290	2.6	34.43
20	0.25	79	9.5	11.72
21	0.25	43	16.3	7.23
22	0.25	22	15.9	5.22
23	0.25	26	6.7	7.54
24	0.25	220	1.1	39.83
30	0.25	265	5.7	25.40
31	0.20	591	0.9	73.85
32	0.25	260	2.2	34.44
40	0.24	2196	2.6	95.40
41	0.24	1225	2.0	78.27

TABLE D4 NasHyd Pre-development Catchment Parameters

Catchment ID	Area (ha)	CN	Ia (mm)	Tp (hour)
10	0.18	73.0	10.0	0.153
11	0.82	45.1	9.0	0.159
12	3.53	43.7	9.9	0.383
20	0.70	46.0	8.0	0.130
21	0.11	45.1	8.2	0.080
22	0.03	46.0	8.0	0.058
23	0.18	46.0	8.0	0.084
24	1.36	43.8	8.4	0.443
30	2.15	66.8	9.2	0.282
31	9.29	51.5	7.0	0.821
32	2.80	43.8	9.1	0.383
40	124.30	74.2	5.8	1.060
41	35.50	72.9	4.3	0.870

TABLE D5 StandHyd Pre-development Catchment Parameters

Catchment ID	Area (ha)	TIMP	XIMP	SLPP (%)	LGP (m)	MNP	DPSI (mm)	SLPI (%)	LGI (m)	MNI	CN	Ia (mm)
33	1.06	0.50	0.50	33	5	0.25	2	1	84.06	0.013	78.0	5.0
50	21.52	0.25	0.20	2	40	0.25	0.8	2	378.77	0.013	58.0	1.5
51	1.56	0.20	0.20	7	78	0.25	2	2	101.98	0.013	77.7	5.0

4 POST-DEVELOPMENT

4.1 Model Schematic (see Figure 11 in main report)

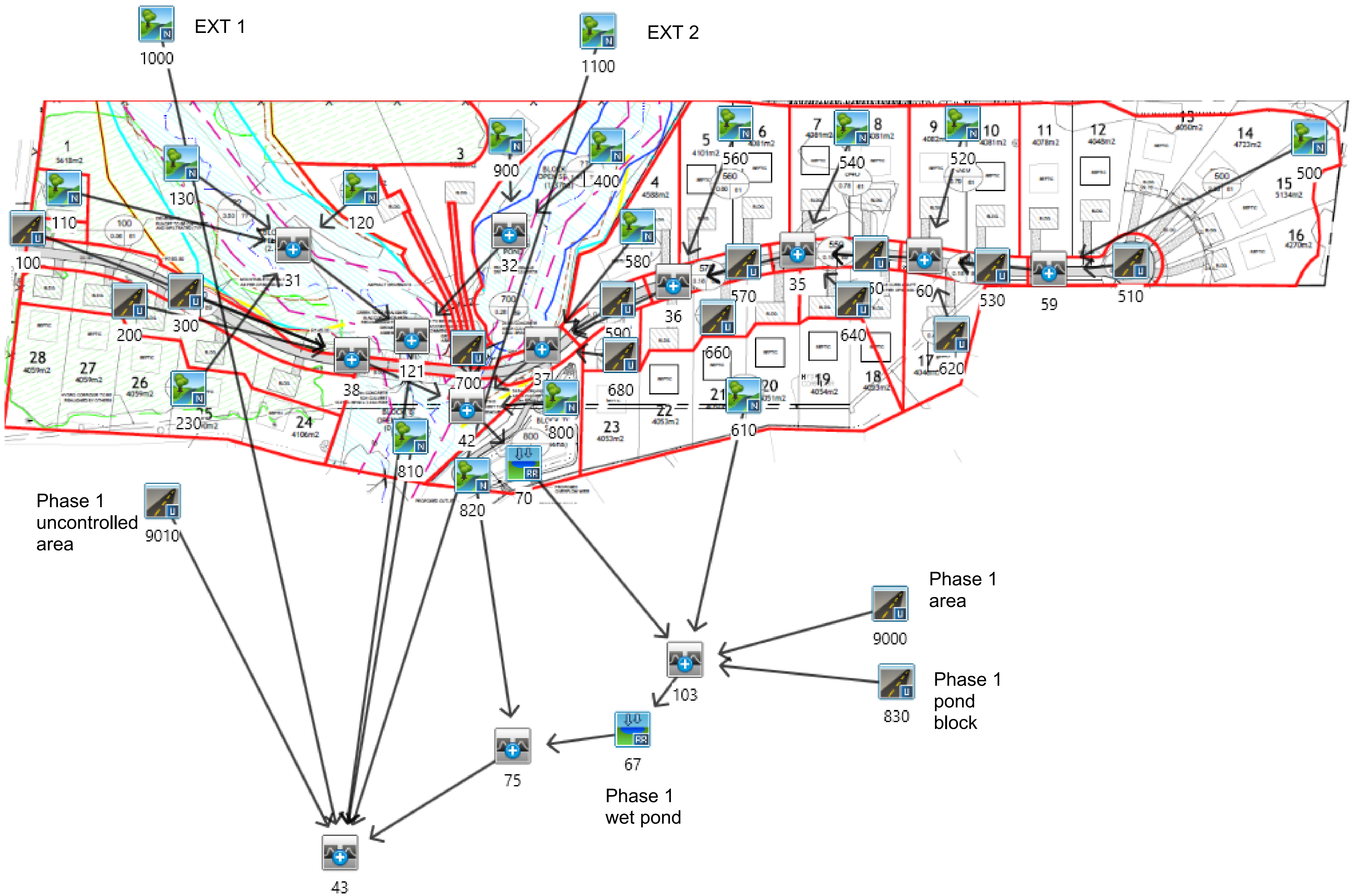


FIGURE D4 Post-development Model Schematic

4.2 Soils

Hydrologic soil group data for the development area and external tributaries was obtained from OMAFRA (2020).

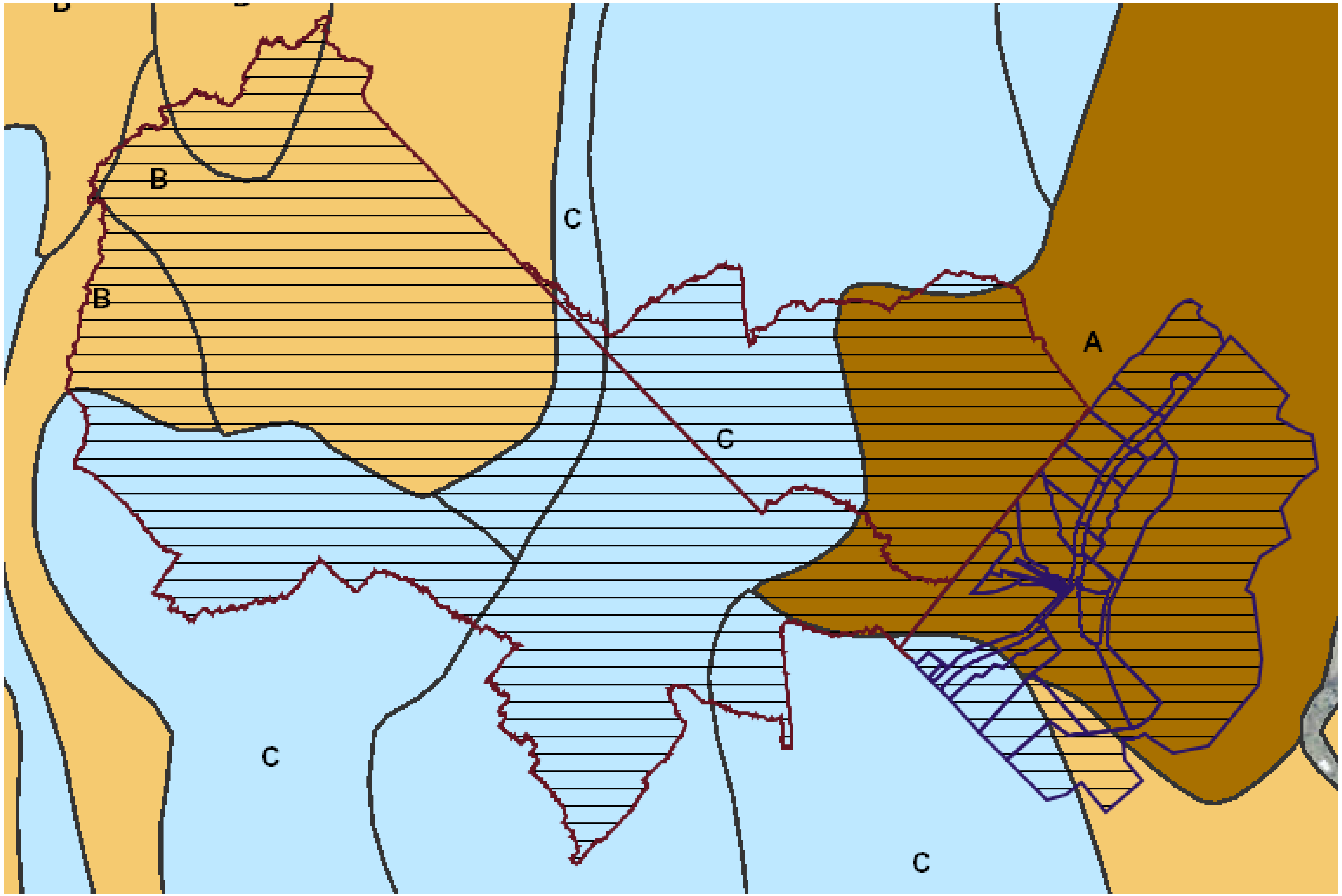


FIGURE D4 Post-development Hydrologic Soil Groups

4.3 Land Use

Land cover was delineated based on existing aerial imagery and the Phase 2 development conditions.

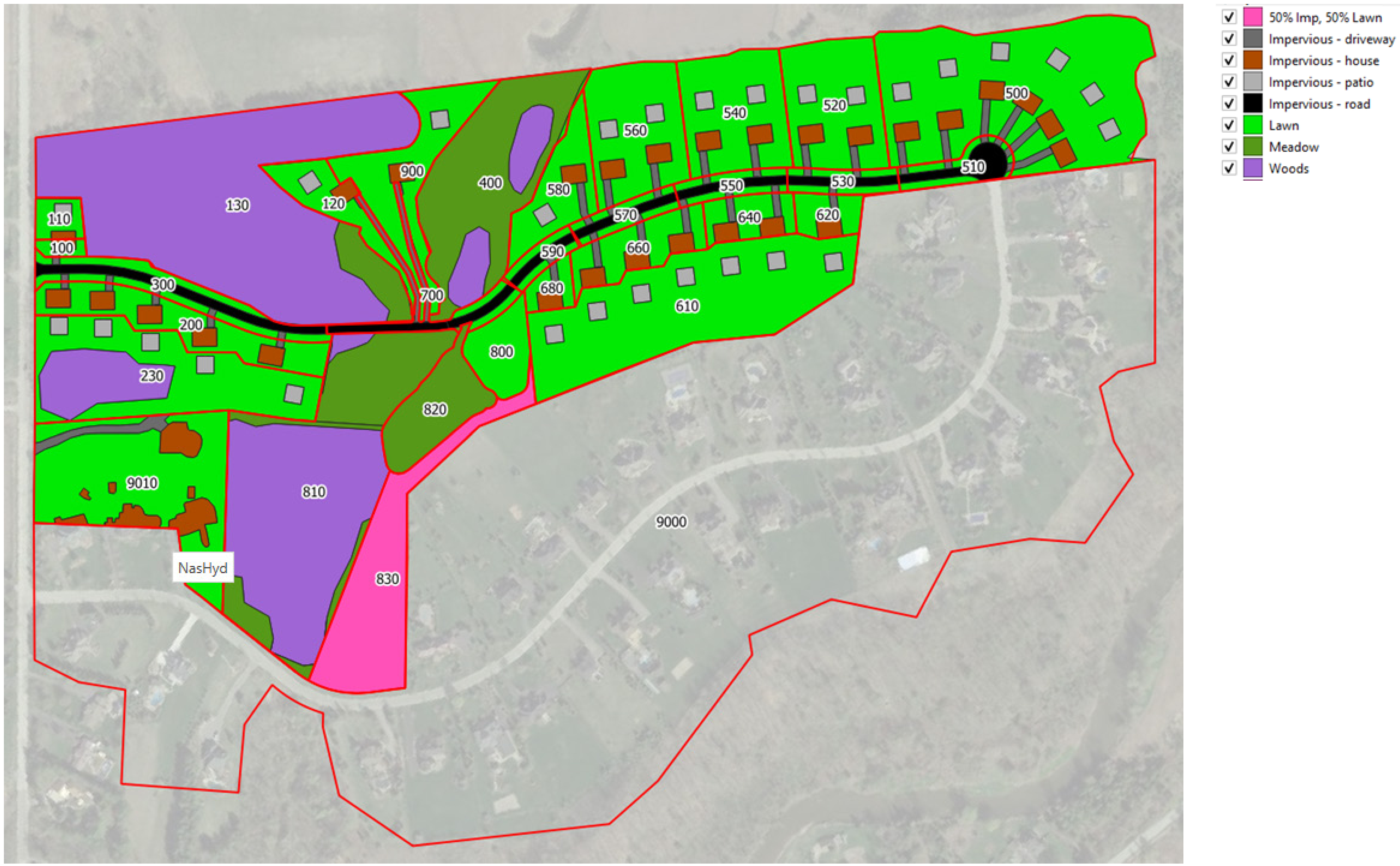


FIGURE D6 Post-development Land Use

4.4 Model Input

TABLE D6 Time to Peak Calculations for NasHyd

Catchment ID	Runoff Coefficient	Catchment Length (m)	Catchment Slope (%)	Time of Concentration (min)
1000	0.24	2196.0	2.6	95.40
110	0.40	35.0	2.5	9.98
1100	0.24	1225.0	2.0	78.27
120	0.40	40.0	4.0	9.13
130	0.25	290.0	2.6	34.43
230	0.40	230.0	5.8	19.38
400	0.25	220.0	1.1	39.83
500	0.40	143.0	2.6	19.91
520	0.40	105.0	2.0	18.60
540	0.40	95.0	2.0	17.69
560	0.40	100.0	2.5	16.87
580	0.40	70.0	4.5	11.62
610	0.40	270.0	3.0	26.09
800	0.25	5.0	20.0	2.31
810	0.25	260.0	2.2	34.44
820	0.25	1.5	20.0	1.26
900	0.40	26.0	4.0	7.36

TABLE D7 NasHyd Post-development Catchment Parameters

Catchment ID	Area (ha)	CN	Ia (mm)	Tp (hr)
1000	124.30	74.2	5.8	1.06
110	0.13	85.8	5.0	0.11
1100	35.50	72.9	4.3	0.87
120	0.31	63.1	5.0	0.10
130	3.53	43.7	9.9	0.38
230	1.41	73.8	6.6	0.22
400	1.41	43.9	8.4	0.44
500	2.32	63.6	5.0	0.22
520	0.8	62.8	5.0	0.21
540	0.8	62.8	5.0	0.20
560	0.81	62.9	5.0	0.19
580	0.43	62.7	5.0	0.13
610	1.85	59.3	5.0	0.29
800	0.3	56.0	5.0	0.03
810	2.64	42.8	9.1	0.38
820	0.47	46.1	25.0	0.01
900	0.68	59.5	5.0	0.08

TABLE D8 StandHyd Post-development Catchment Parameters

Catchment ID	Area (ha)	TIMP	XIMP	SLPP (%)	LGP (m)	MNP	DPSI (mm)	SLPI (%)	LGI (m)	MNI	CN	Ia (mm)
100	0.06	0.31	0.06	3	13	0.25	2	2	20.0	0.013	81.0	5.0
200	0.63	0.27	0.04	4	30	0.25	2	2	64.8	0.013	70.4	5.0
300	0.47	0.42	0.42	2	5	0.25	2	6	56.0	0.013	72.2	5.0
510	0.23	0.62	0.62	2	5	0.25	2	1	39.2	0.013	56.0	5.0
530	0.18	0.42	0.42	2	5	0.25	2	2	34.6	0.013	56.0	5.0
550	0.18	0.46	0.46	2	5	0.25	2	2	34.6	0.013	56.0	5.0
570	0.18	0.45	0.45	2	5	0.25	2	1	34.6	0.013	56.0	5.0
590	0.13	0.38	0.38	2	5	0.25	2	1	29.4	0.013	56.0	5.0
620	0.18	0.23	0.06	5	35	0.25	2	2	34.6	0.013	56.0	5.0
640	0.26	0.32	0.09	2	35	0.25	2	2	41.6	0.013	56.0	5.0
660	0.41	0.32	0.10	2	40	0.25	2	2	52.3	0.013	56.0	5.0
680	0.13	0.33	0.10	2	40	0.25	2	2	29.4	0.013	56.0	5.0
700	0.28	0.77	0.77	2	5	0.25	2	3	43.2	0.013	55.7	5.0
830	1.00	0.50	0.50	33	5	0.25	2	1	81.6	0.013	78.0	5.0
9000	21.52	0.25	0.20	2	40	0.25	0.8	2	378.8	0.013	58.0	1.5
9010	1.56	0.20	0.20	7	78	0.25	2	2	102.0	0.013	77.7	5.0

TABLE D9 Phase 2 Stormwater Management Facility Rating Curve

Discharge (m3/s)	Storage (ha.m)
0	0
0.003	0.010
0.005	0.021
0.006	0.032
0.007	0.044
0.008	0.056
0.009	0.070
0.010	0.084
0.010	0.099
0.011	0.115
0.048	0.131
0.132	0.149
0.253	0.167
0.433	0.186
0.614	0.206
0.822	0.226
1.406	0.248
2.316	0.271
3.405	0.294

TABLE D10 Phase 1 Wet Pond Rating Curve

Discharge (m3/s)	Storage (ha.m)
0	0
0.0008	0.0150
0.0190	0.0492
0.0329	0.0863
0.0424	0.1247
0.0502	0.1643
0.0569	0.2051
0.0630	0.2472
0.0684	0.2907
0.0735	0.3354
0.0783	0.3812
0.1187	0.4280
0.3310	0.5249
0.6986	0.6268
0.9102	0.6795
1.1263	0.7334
1.3396	0.7883
1.5410	0.8443
2.7410	0.9013
7.2997	1.0187

5 HEC-RAS FLOW INPUTS

5.1 Pre-development Visual OTTHYMO Flow Nodes (Yellow)

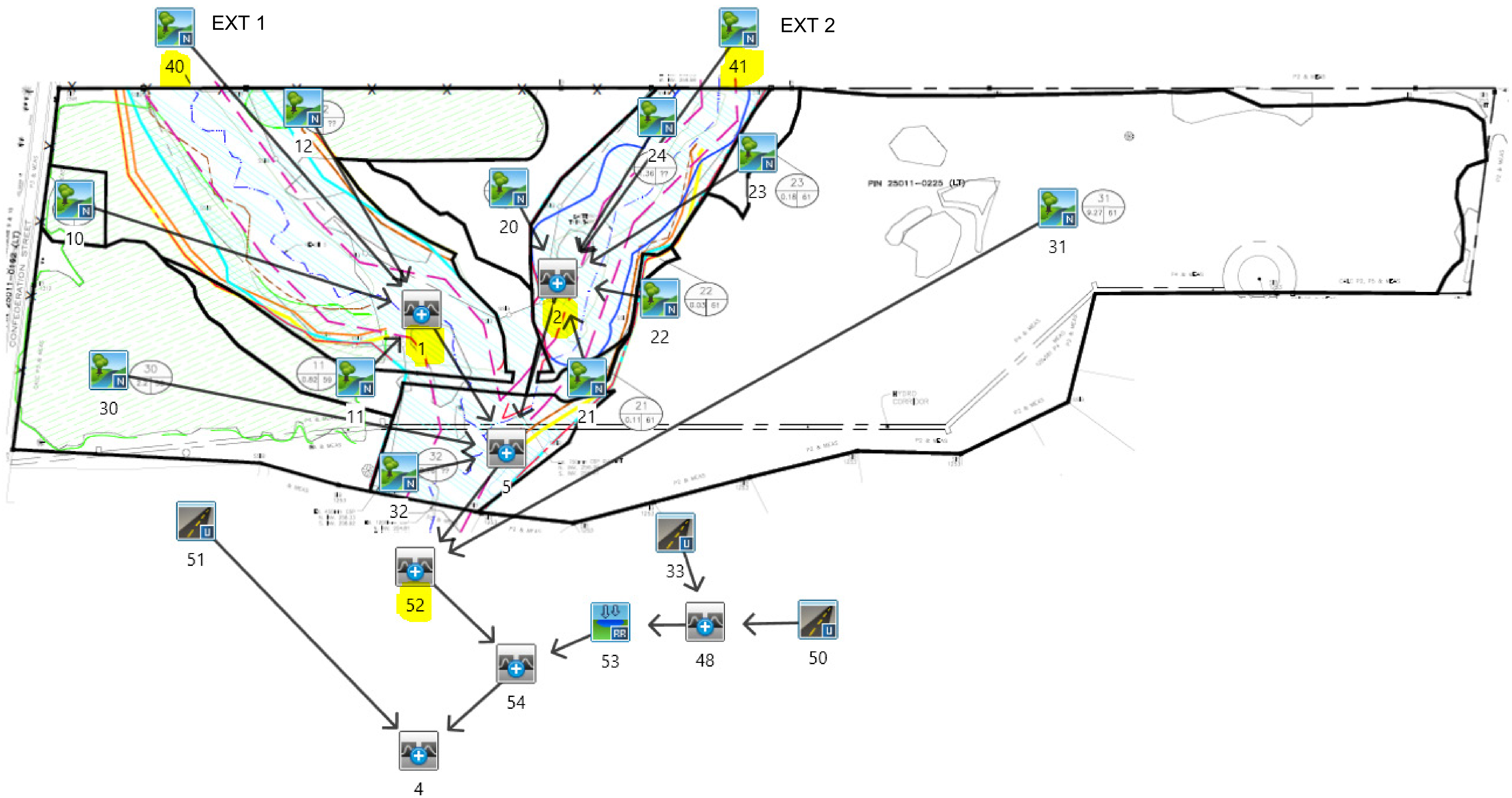


FIGURE D7 Pre-development HEC-RAS Flow Nodes (Yellow)

5.2 Post-development Visual OTTHYMO Flow Nodes (Yellow)

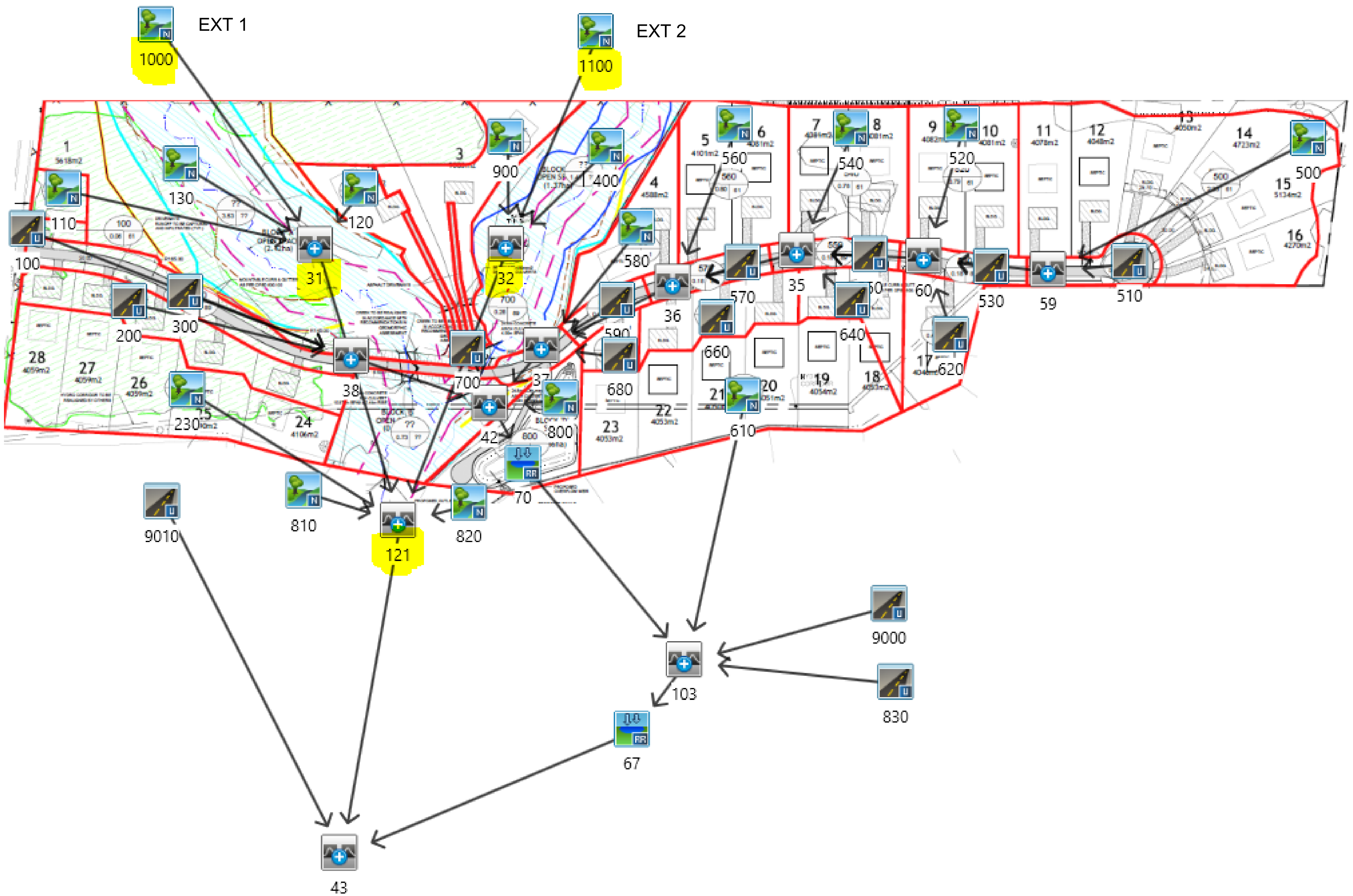


FIGURE D8 Post-development HEC-RAS Flow Nodes (Yellow)

5.3 Flow Inputs

The following peak flows were used as flow inputs to the HEC-RAS hydraulic modelling. Return period flows are based on the 24-hour SCS Type II design storm and the Regional storm is simulated with the 48-hour Hurricane Hazel rainfall per Town of Halton Hills standards.

TABLE D11 HEC-RAS Flow Inputs

Return Period	Reach 5 (Main Branch Western Tributary)				Eastern Tributary				Credit River Tributary	
	Upstream of Site Section 532.31		HEC-RAS Section 202.32 for Pre-Development 302.67 for Post-Development		Upstream of Site HEC-RAS Section 261.85		HEC-RAS Section 107.88		Downstream of Crossings HEC-RAS Section 131.25	
	VO HYD ID Pre-40 Post-1000 (EXT 1)		VO HYD ID Pre-1 Post-31		VO HYD ID Pre-41 Post-1100 (EXT 2)		VO HYD ID Pre-2 Post-32		VO HYD ID Pre-52 Post-121	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
2-year	1.85	1.85	1.86	1.86	0.61	0.61	0.62	0.62	2.57	2.49
5-year	2.71	2.71	2.74	2.73	0.89	0.89	0.91	0.91	3.77	3.65
10-year	3.63	3.63	3.66	3.66	1.19	1.19	1.21	1.21	5.06	4.89
25-year	4.87	4.87	4.92	4.92	1.59	1.59	1.63	1.63	6.80	6.56
50-year	5.83	5.83	5.90	5.90	1.90	1.90	1.95	1.95	8.17	7.87
100-year	6.84	6.84	6.92	6.91	2.23	2.23	2.28	2.28	9.59	9.22
Regional	12.11	12.11	12.40	12.37	3.63	3.63	3.80	3.79	17.32	16.42

VO - Visual OTTHYMO

6 DETAILED VISAUL OTTHYMO MODEL OUTPUT

VO output is provided in attached digital files.

7 REFERENCES

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APPENDIX E
HEC-RAS Hydraulic Model

APPENDIX E

HEC-RAS HYDRAULIC MODEL DEVELOPMENT

1 INTRODUCTION

A hydraulic model of the study area was developed using HEC-RAS version 5.0.1. The model calculates water surface profiles and was used to determine existing flood elevations and also to assess the impacts of the proposed development on the hydraulic regime of the tributaries in the study area.

The HEC-RAS model was used to simulate design storms ranging from the 2-year to Regional storm event. The modelled cross-section locations are shown in Figures 11 and 12 of the Functional Servicing Addendum Report. The model was not calibrated due to lack of observed flow and water level data.

2 MODEL SETUP

2.1 Cross-sections

The HEC-RAS model was created using existing contour data for the study area. Cross-section locations were selected to represent average channel conditions and to capture changes in longitudinal slope. Cross-sections were also placed immediately upstream and downstream of existing and proposed structures.

2.2 Flow Input

The peak flow input for the HEC-RAS model was extracted from the VO4 hydrologic model. Flow change locations were incorporated at key points where inflow is entering the system such as upstream of the development area as well as within the development.

2.3 Boundary Conditions

Boundary conditions must be established for each hydraulic model. Boundary conditions are required to perform steady flow calculations and to establish the starting water surface at the upstream and downstream limits of a river system. Ideally, a HEC-RAS model should originate far enough downstream so that it accounts for any downstream influence on upstream water levels. The downstream boundary condition for this model uses the normal depth which is based on the channel slope based on contour information.

3 MODEL OUTPUT

Output files of the pre-development and post-development simulations are provided below.

3.1 Pre-development HEC-RAS Output

3.1.1 Detailed Output

3.1.1.1 Eastern Tributary

HEC-RAS Plan: 21006-GlenWilliams-Pre_2020_Flow River: Alignment - East Reach: EasternTrib

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
EasternTrib	261.85	2 yr	0.61	259.49	259.55	259.54	259.57	0.014869	0.54	1.24	21.18	0.70
EasternTrib	261.85	5 yr	0.89	259.49	259.58	259.55	259.59	0.010092	0.55	1.76	21.65	0.61
EasternTrib	261.85	10 yr	1.19	259.49	259.59	259.57	259.61	0.011207	0.64	2.04	21.91	0.66
EasternTrib	261.85	25 yr	1.59	259.49	259.61	259.58	259.63	0.012311	0.74	2.37	22.20	0.70
EasternTrib	261.85	50 yr	1.90	259.49	259.62	259.59	259.65	0.012678	0.80	2.62	22.42	0.73
EasternTrib	261.85	100 yr	2.23	259.49	259.63	259.60	259.66	0.013179	0.86	2.87	22.70	0.75
EasternTrib	261.85	Regional	3.63	259.49	259.66	259.64	259.72	0.015856	1.11	3.70	23.74	0.86
EasternTrib	183.06	2 yr	0.61	258.50	258.58		258.59	0.010068	0.53	1.18	15.39	0.60
EasternTrib	183.06	5 yr	0.89	258.50	258.59	258.57	258.61	0.016529	0.71	1.28	15.47	0.78
EasternTrib	183.06	10 yr	1.19	258.50	258.61	258.59	258.64	0.014000	0.76	1.61	15.71	0.74
EasternTrib	183.06	25 yr	1.59	258.50	258.63		258.66	0.012377	0.82	2.00	15.98	0.72
EasternTrib	183.06	50 yr	1.90	258.50	258.65		258.69	0.011807	0.87	2.26	16.17	0.72
EasternTrib	183.06	100 yr	2.23	258.50	258.66		258.71	0.011256	0.91	2.54	16.35	0.72
EasternTrib	183.06	Regional	3.63	258.50	258.74		258.79	0.007768	0.99	3.88	17.23	0.64
EasternTrib	107.88	2 yr	0.62	257.50	257.60	257.59	257.63	0.017500	0.78	0.82	9.79	0.81
EasternTrib	107.88	5 yr	0.91	257.50	257.65	257.61	257.68	0.008300	0.72	1.38	11.84	0.60
EasternTrib	107.88	10 yr	1.21	257.50	258.09		258.09	0.000077	0.18	9.63	25.05	0.07
EasternTrib	107.88	25 yr	1.63	257.50	258.18		258.18	0.000076	0.19	12.04	26.99	0.07
EasternTrib	107.88	50 yr	1.95	257.50	258.22		258.22	0.000087	0.21	13.11	27.80	0.08
EasternTrib	107.88	100 yr	2.28	257.50	258.26		258.26	0.000097	0.23	14.17	28.58	0.09
EasternTrib	107.88	Regional	3.80	257.50	258.48		258.48	0.000094	0.27	20.96	33.12	0.09
EasternTrib	61.62	2 yr	0.62	256.97	257.15		257.16	0.002501	0.43	1.48	9.55	0.34
EasternTrib	61.62	5 yr	0.91	256.97	257.48		257.48	0.000132	0.20	5.01	12.28	0.09
EasternTrib	61.62	10 yr	1.21	256.97	258.09		258.09	0.000012	0.10	16.83	36.01	0.03
EasternTrib	61.62	25 yr	1.63	256.97	258.18		258.18	0.000014	0.12	20.31	39.05	0.04
EasternTrib	61.62	50 yr	1.95	256.97	258.22		258.22	0.000018	0.14	21.85	40.46	0.04
EasternTrib	61.62	100 yr	2.28	256.97	258.26		258.26	0.000021	0.15	23.39	42.10	0.04
EasternTrib	61.62	Regional	3.80	256.97	258.48		258.48	0.000026	0.19	33.23	46.59	0.05
EasternTrib	37.70	2 yr	0.62	256.67	256.97	256.97	257.05	0.022844	1.24	0.50	3.20	1.00
EasternTrib	37.70	5 yr	0.91	256.67	257.47		257.47	0.000266	0.34	3.34	7.66	0.14
EasternTrib	37.70	10 yr	1.21	256.67	258.09		258.09	0.000032	0.19	9.63	12.84	0.05
EasternTrib	37.70	25 yr	1.63	256.67	258.18		258.18	0.000043	0.23	10.84	13.32	0.06
EasternTrib	37.70	50 yr	1.95	256.67	258.22		258.22	0.000054	0.26	11.35	13.52	0.07
EasternTrib	37.70	100 yr	2.28	256.67	258.25		258.26	0.000067	0.29	11.85	13.71	0.08
EasternTrib	37.70	Regional	3.80	256.67	258.47		258.48	0.000101	0.39	14.96	14.84	0.10

3.1.1.2 Western Tributary/Reach 5

HEC-RAS Plan: 21006-GlenWilliams-Pre_2020_Flow River: Alignment - Main Reach: Reach5

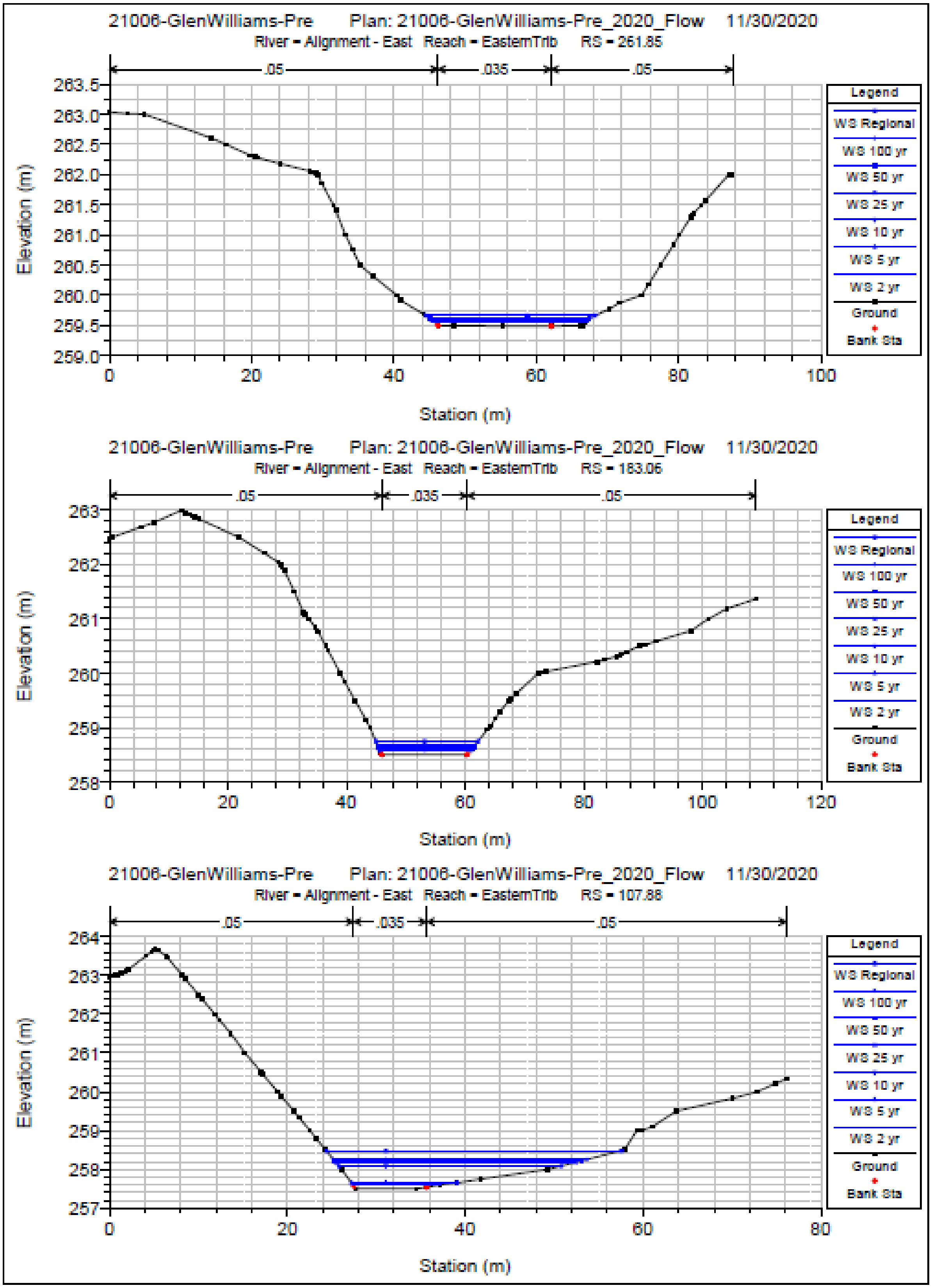
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach5	532.31	25 yr	4.87	263.98	264.48	264.50	264.71	0.019011	2.19	2.57	8.92	1.08
Reach5	532.31	50 yr	5.83	263.98	264.52	264.58	264.78	0.019010	2.34	2.99	10.76	1.10
Reach5	532.31	100 yr	6.84	263.98	264.56	264.64	264.84	0.019012	2.47	3.45	12.08	1.12
Reach5	532.31	Regional	12.11	263.98	264.72	264.83	265.10	0.019012	2.98	5.77	16.22	1.17
Reach5	475.23	2 yr	1.85	263.00	263.60	263.60	263.71	0.011217	1.50	1.53	9.40	0.79
Reach5	475.23	5 yr	2.71	263.00	263.68	263.68	263.80	0.010335	1.63	2.33	11.46	0.78
Reach5	475.23	10 yr	3.63	263.00	263.74	263.74	263.87	0.010219	1.77	3.07	13.07	0.79
Reach5	475.23	25 yr	4.87	263.00	263.79	263.81	263.94	0.011366	1.99	3.81	14.51	0.85
Reach5	475.23	50 yr	5.83	263.00	263.85	263.85	264.00	0.010603	2.04	4.60	15.89	0.83
Reach5	475.23	100 yr	6.84	263.00	263.88	263.89	264.05	0.011176	2.17	5.16	16.81	0.86
Reach5	475.23	Regional	12.11	263.00	264.02	264.05	264.25	0.013181	2.69	7.80	20.45	0.97
Reach5	413.33	2 yr	1.85	261.65	262.03	262.10	262.25	0.035972	2.08	0.90	4.24	1.35
Reach5	413.33	5 yr	2.71	261.65	262.09	262.19	262.38	0.035705	2.40	1.19	5.32	1.39
Reach5	413.33	10 yr	3.63	261.65	262.15	262.27	262.50	0.034689	2.65	1.53	6.45	1.41
Reach5	413.33	25 yr	4.87	261.65	262.22	262.36	262.62	0.032511	2.89	2.02	8.01	1.41
Reach5	413.33	50 yr	5.83	261.65	262.26	262.41	262.70	0.032411	3.07	2.38	8.96	1.43
Reach5	413.33	100 yr	6.84	261.65	262.31	262.46	262.77	0.031344	3.20	2.79	9.95	1.42
Reach5	413.33	Regional	12.11	261.65	262.48	262.68	263.04	0.027944	3.69	4.89	13.38	1.41
Reach5	302.67	2 yr	1.86	259.47	259.64	259.64	259.68	0.026155	1.35	2.59	29.34	1.08
Reach5	302.67	5 yr	2.74	259.47	259.67	259.67	259.72	0.026344	1.50	3.42	32.30	1.12
Reach5	302.67	10 yr	3.66	259.47	259.69	259.69	259.75	0.026108	1.62	4.19	33.63	1.13
Reach5	302.67	25 yr	4.92	259.47	259.72	259.72	259.78	0.027992	1.79	4.94	33.69	1.19
Reach5	302.67	50 yr	5.90	259.47	259.73	259.73	259.81	0.028802	1.90	5.48	33.74	1.23
Reach5	302.67	100 yr	6.92	259.47	259.75	259.75	259.83	0.029372	2.00	6.01	33.78	1.25
Reach5	302.67	Regional	12.40	259.47	259.82	259.83	259.95	0.032412	2.46	8.36	33.96	1.37
Reach5	224.44	2 yr	1.86	257.50	257.90	257.90	258.00	0.020658	1.40	1.33	6.55	0.99
Reach5	224.44	5 yr	2.74	257.50	257.96	257.96	258.08	0.019226	1.52	1.81	8.01	0.99
Reach5	224.44	10 yr	3.66	257.50	258.11	258.02	258.18	0.006726	1.23	3.27	12.50	0.63
Reach5	224.44	25 yr	4.92	257.50	258.19	258.09	258.27	0.006047	1.32	4.37	15.17	0.62
Reach5	224.44	50 yr	5.90	257.50	258.22	258.14	258.32	0.006613	1.44	4.91	16.33	0.65
Reach5	224.44	100 yr	6.92	257.50	258.25	258.18	258.37	0.007105	1.56	5.46	17.43	0.68
Reach5	224.44	Regional	12.40	257.50	258.45	258.37	258.59	0.006325	1.81	9.51	24.28	0.68
Reach5	202.32	2 yr	1.86	256.99	257.30	257.33	257.42	0.031153	1.56	1.28	10.11	1.20
Reach5	202.32	5 yr	2.74	256.99	257.51	257.39	257.54	0.002979	0.81	4.75	21.87	0.42
Reach5	202.32	10 yr	3.66	256.99	258.09		258.09	0.000085	0.25	24.14	43.07	0.08
Reach5	202.32	25 yr	4.92	256.99	258.18		258.18	0.000100	0.29	28.19	44.89	0.09
Reach5	202.32	50 yr	5.90	256.99	258.22		258.22	0.000121	0.33	29.95	45.66	0.10
Reach5	202.32	100 yr	6.92	256.99	258.26		258.26	0.000143	0.37	31.64	46.39	0.11
Reach5	202.32	Regional	12.40	256.99	258.47		258.48	0.000205	0.50	42.26	50.72	0.14
Reach5	167.34	2 yr	1.86	256.50	256.70	256.69	256.75	0.014512	1.15	2.22	18.21	0.84
Reach5	167.34	5 yr	2.74	256.50	257.47		257.47	0.000017	0.11	40.32	62.06	0.04
Reach5	167.34	10 yr	3.66	256.50	258.09		258.09	0.000004	0.07	82.01	72.95	0.02
Reach5	167.34	25 yr	4.92	256.50	258.18		258.18	0.000005	0.09	88.79	74.18	0.02
Reach5	167.34	50 yr	5.90	256.50	258.22		258.22	0.000007	0.11	91.67	74.66	0.03
Reach5	167.34	100 yr	6.92	256.50	258.25		258.26	0.000009	0.12	94.42	74.98	0.03
Reach5	167.34	Regional	12.40	256.50	258.47		258.47	0.000017	0.18	111.04	76.91	0.04

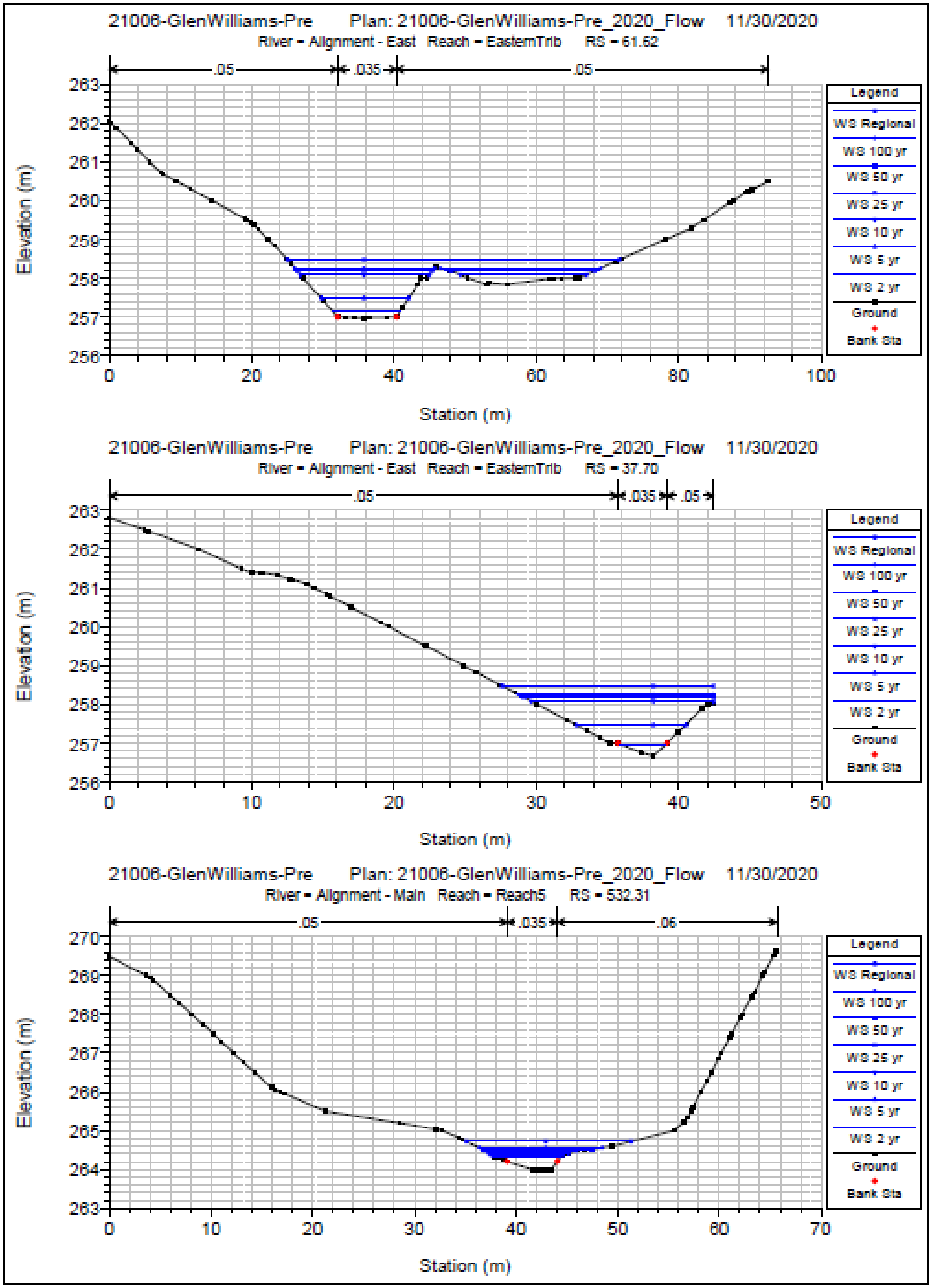
3.1.1.3 Credit River Tributary

HEC-RAS Plan: 21006-GlenWilliams-Pre_2020_Flow River: Alignment - Main Reach: CreditRiverTrib

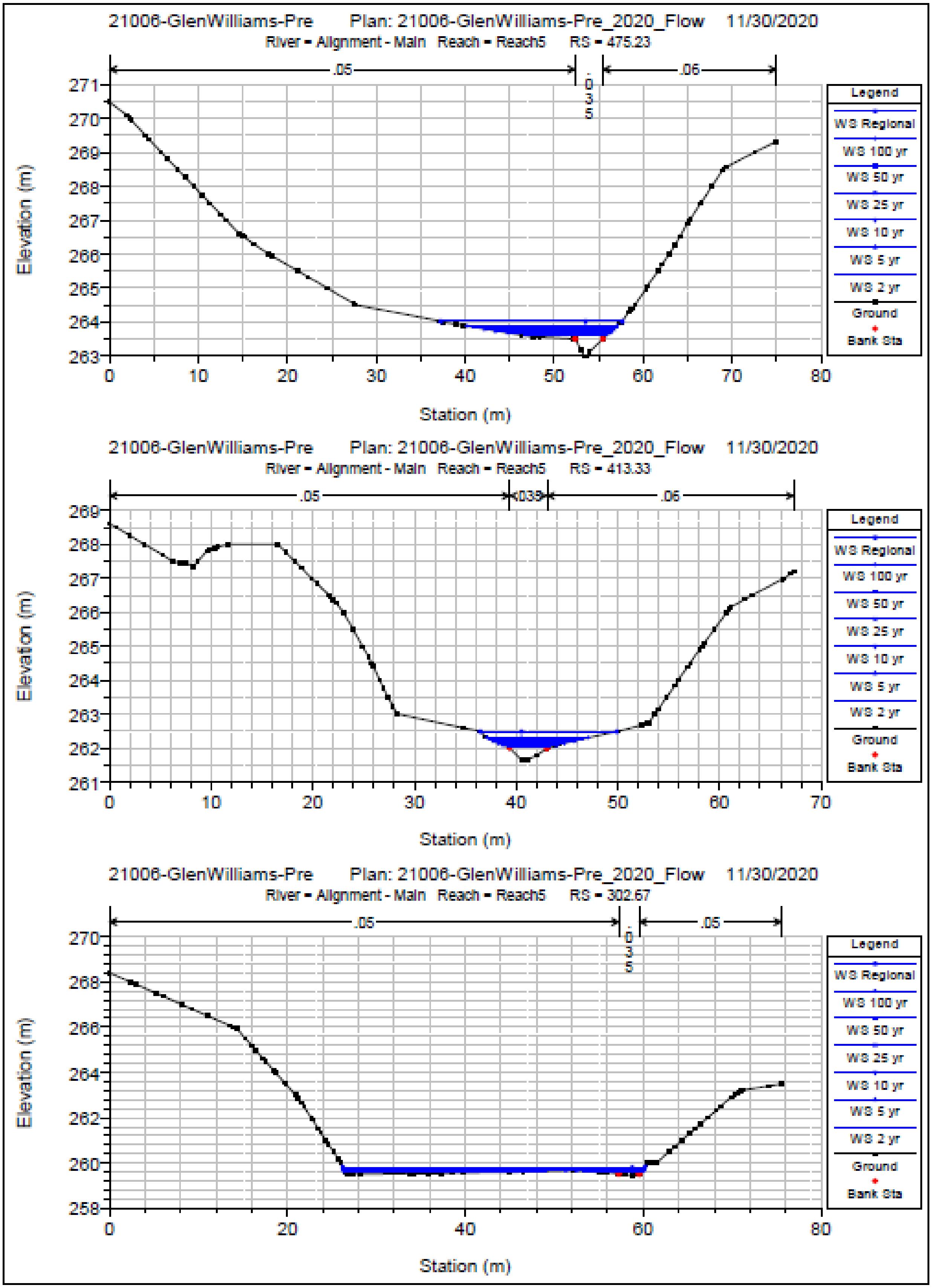
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
CreditRiverTrib	131.25	2 yr	2.57	256.00	256.47	256.20	256.47	0.000492	0.35	9.53	36.17	0.17
CreditRiverTrib	131.25	5 yr	3.77	256.00	257.47		257.47	0.000007	0.10	54.04	49.66	0.03
CreditRiverTrib	131.25	10 yr	5.06	256.00	258.09		258.09	0.000003	0.08	86.55	55.05	0.02
CreditRiverTrib	131.25	25 yr	6.80	256.00	258.18		258.18	0.000005	0.11	91.65	55.81	0.02
CreditRiverTrib	131.25	50 yr	8.17	256.00	258.22		258.22	0.000007	0.13	93.80	56.13	0.03
CreditRiverTrib	131.25	100 yr	9.59	256.00	258.25		258.25	0.000009	0.14	95.89	58.78	0.03
CreditRiverTrib	131.25	Regional	17.32	256.00	258.47		258.47	0.000020	0.23	110.09	71.38	0.05
CreditRiverTrib	68.22	2 yr	2.57	255.00	256.44	255.46	256.45	0.000156	0.41	6.82	9.62	0.11
CreditRiverTrib	68.22	5 yr	3.77	255.00	257.46	255.56	257.46	0.000045	0.32	12.70	14.54	0.07
CreditRiverTrib	68.22	10 yr	5.06	255.00	258.08	255.66	258.09	0.000020	0.25	31.01	23.17	0.05
CreditRiverTrib	68.22	25 yr	6.80	255.00	258.17	255.77	258.18	0.000032	0.33	33.22	26.72	0.06
CreditRiverTrib	68.22	50 yr	8.17	255.00	258.21	255.85	258.22	0.000045	0.39	34.24	29.21	0.07
CreditRiverTrib	68.22	100 yr	9.59	255.00	258.25	255.93	258.25	0.000059	0.45	35.27	30.36	0.08
CreditRiverTrib	68.22	Regional	17.32	255.00	258.45	256.28	258.47	0.000153	0.76	41.73	32.91	0.13
CreditRiverTrib	59.09		Culvert									
CreditRiverTrib	49.96	2 yr	2.57	254.50	255.03	254.96	255.15	0.009859	1.54	1.67	4.05	0.75
CreditRiverTrib	49.96	5 yr	3.77	254.50	255.12	255.07	255.30	0.011754	1.89	2.02	4.37	0.85
CreditRiverTrib	49.96	10 yr	5.06	254.50	255.19	255.17	255.44	0.013527	2.21	2.34	4.65	0.93
CreditRiverTrib	49.96	25 yr	6.80	254.50	255.30	255.30	255.61	0.013597	2.48	2.86	5.05	0.96
CreditRiverTrib	49.96	50 yr	8.17	254.50	255.38	255.38	255.73	0.012991	2.63	3.31	5.39	0.95
CreditRiverTrib	49.96	100 yr	9.59	254.50	255.47	255.47	255.84	0.012234	2.74	3.80	5.74	0.94
CreditRiverTrib	49.96	Regional	17.32	254.50	255.86	255.86	256.35	0.010324	3.23	6.31	7.20	0.92
CreditRiverTrib	11.26	2 yr	2.57	254.50	254.79	254.69	254.83	0.005005	0.87	3.08	12.26	0.52
CreditRiverTrib	11.26	5 yr	3.77	254.50	254.86	254.75	254.91	0.005001	1.00	3.97	13.00	0.54
CreditRiverTrib	11.26	10 yr	5.06	254.50	254.92	254.80	254.98	0.005008	1.12	4.83	13.67	0.56
CreditRiverTrib	11.26	25 yr	6.80	254.50	255.00	254.86	255.08	0.005002	1.26	5.91	14.46	0.57
CreditRiverTrib	11.26	50 yr	8.17	254.50	255.05	254.90	255.14	0.005001	1.35	6.70	14.99	0.58
CreditRiverTrib	11.26	100 yr	9.59	254.50	255.10	254.95	255.20	0.005006	1.43	7.49	15.52	0.59
CreditRiverTrib	11.26	Regional	17.32	254.50	255.34	255.15	255.48	0.005001	1.78	11.37	17.84	0.62

3.1.2 Cross-sections

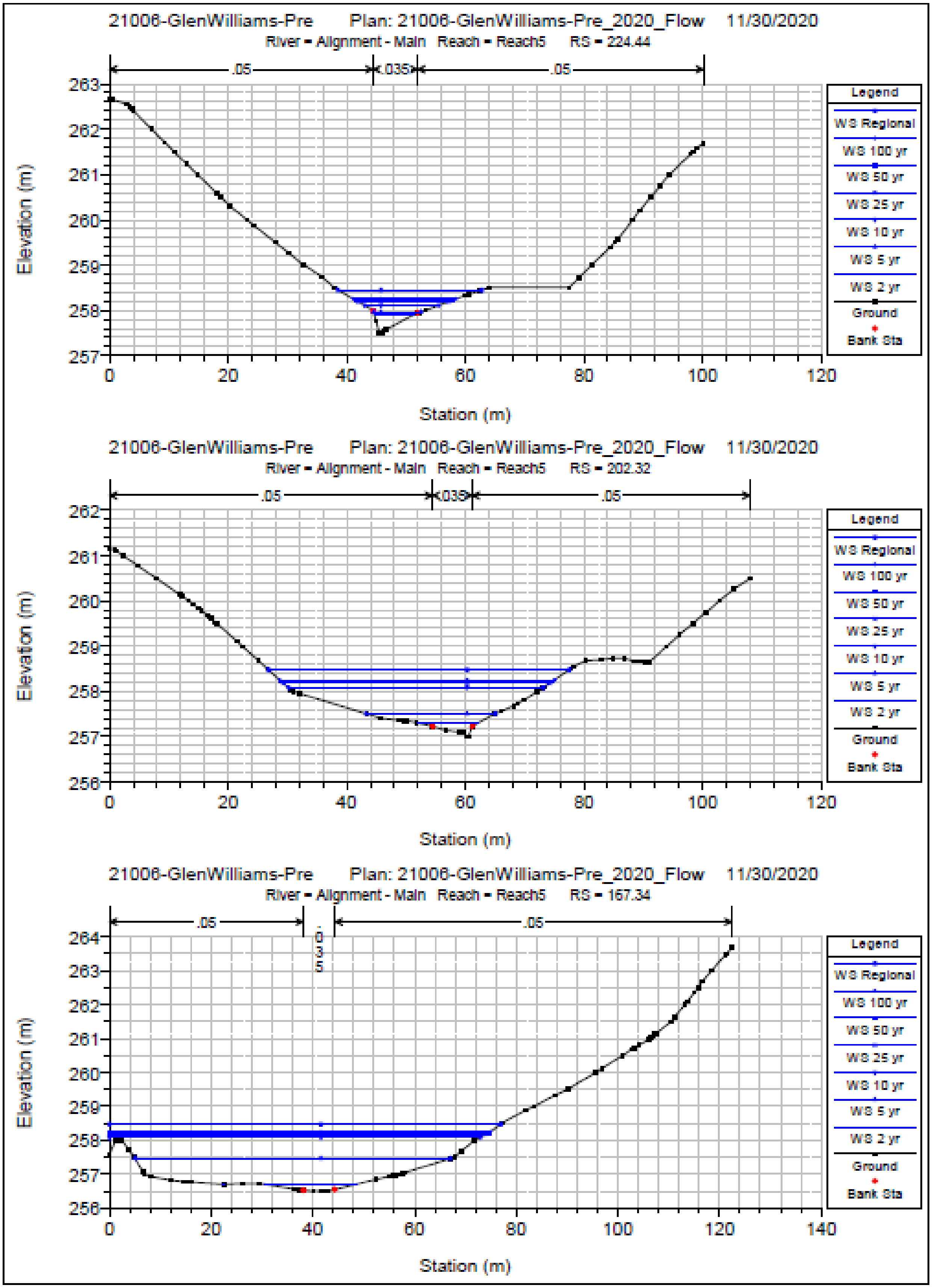




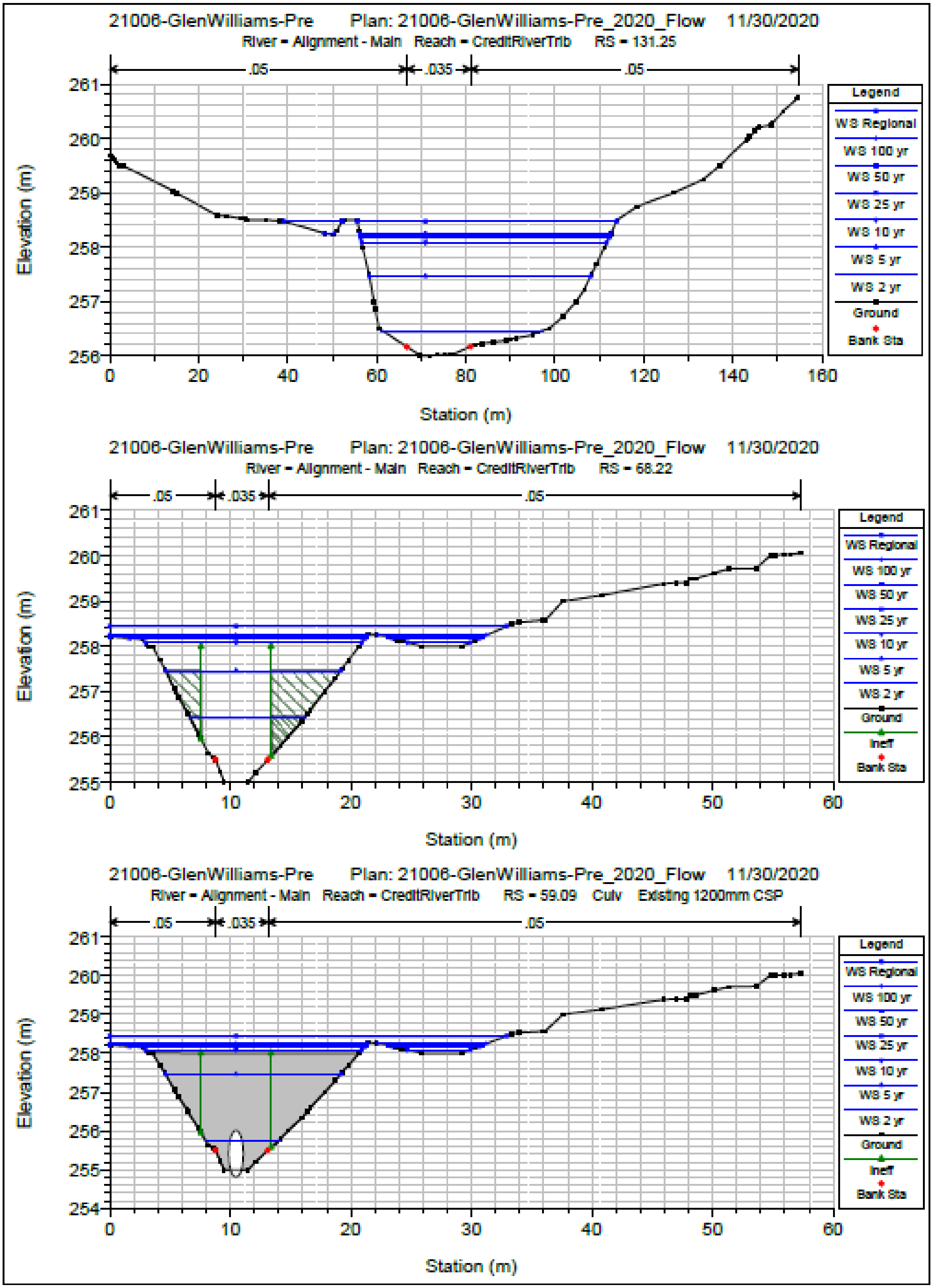
21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - East Reach = EasternTrib RS = 61.62
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta
21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - East Reach = EasternTrib RS = 37.70
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta
21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = Reach5 RS = 532.31
.05
.035
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta

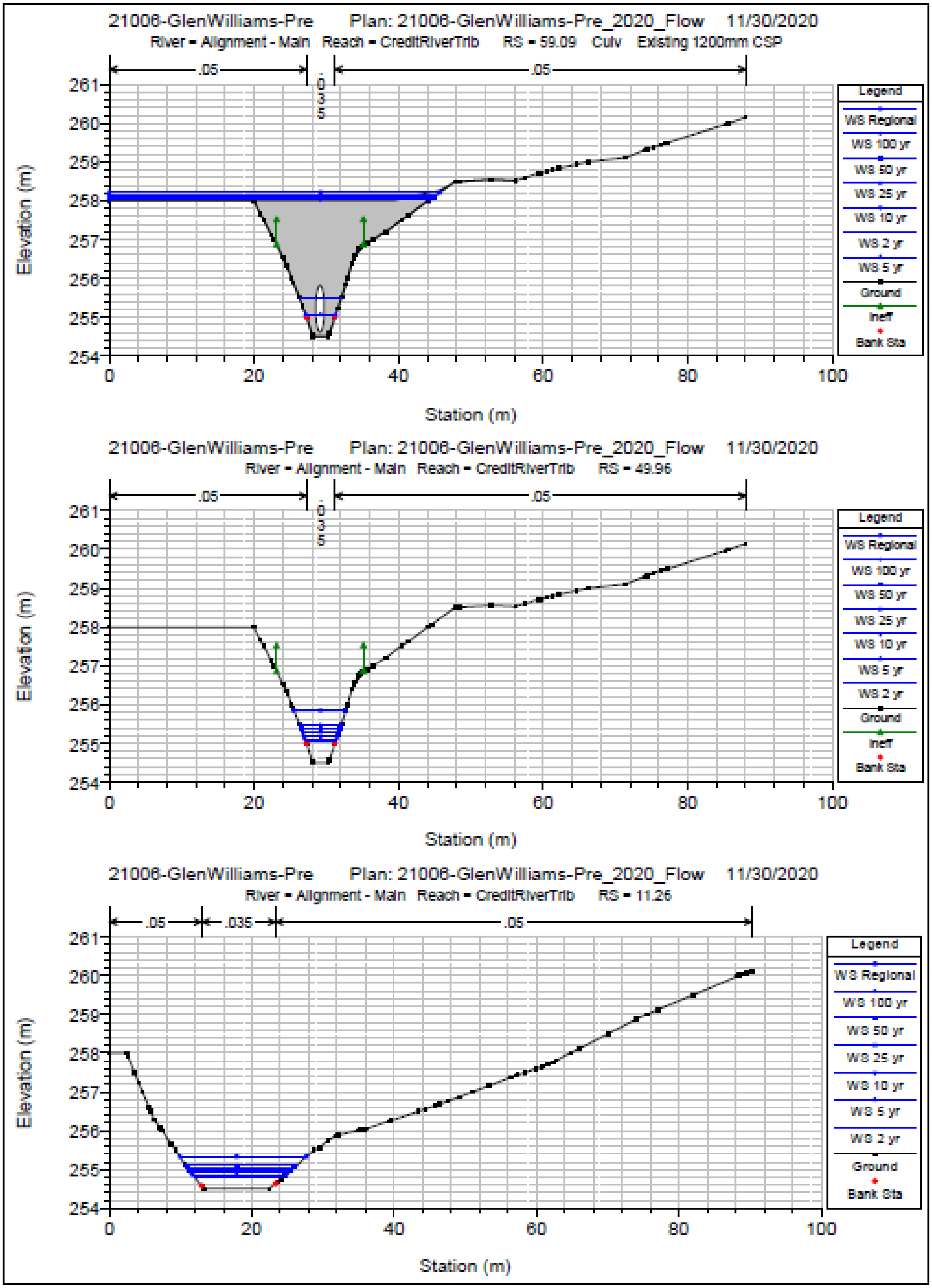


21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = Reach5 RS = 475.23
.05
.035
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta
21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = Reach5 RS = 413.33
.05
.035
.06
Elevation (m)
Station (m)
21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = Reach5 RS = 302.67
.05
.035
.05
Elevation (m)
Station (m)



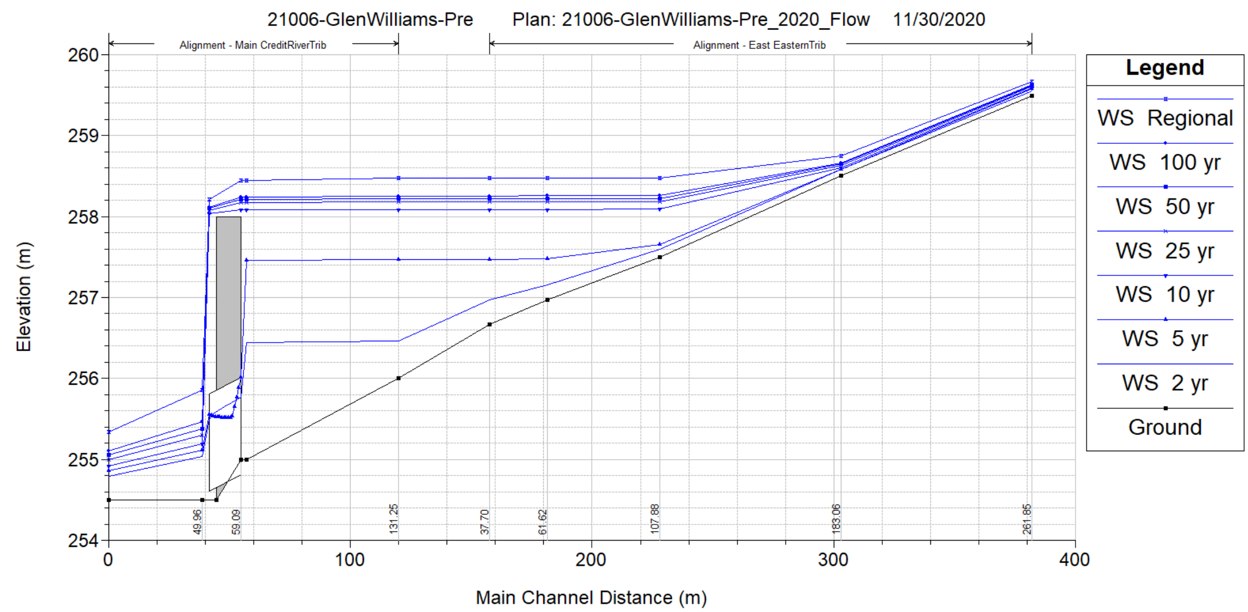
21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = Reach5 RS = 224.44
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta
21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = Reach5 RS = 202.32
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta
21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = Reach5 RS = 167.34
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta


21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = CreditRiverTrib RS = 131.25
.05
.035
.05
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta
Elevation (m)
Station (m)
21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = CreditRiverTrib RS = 68.22
Ineff
21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = CreditRiverTrib RS = 59.09 Culv Existing 1200mm CSP

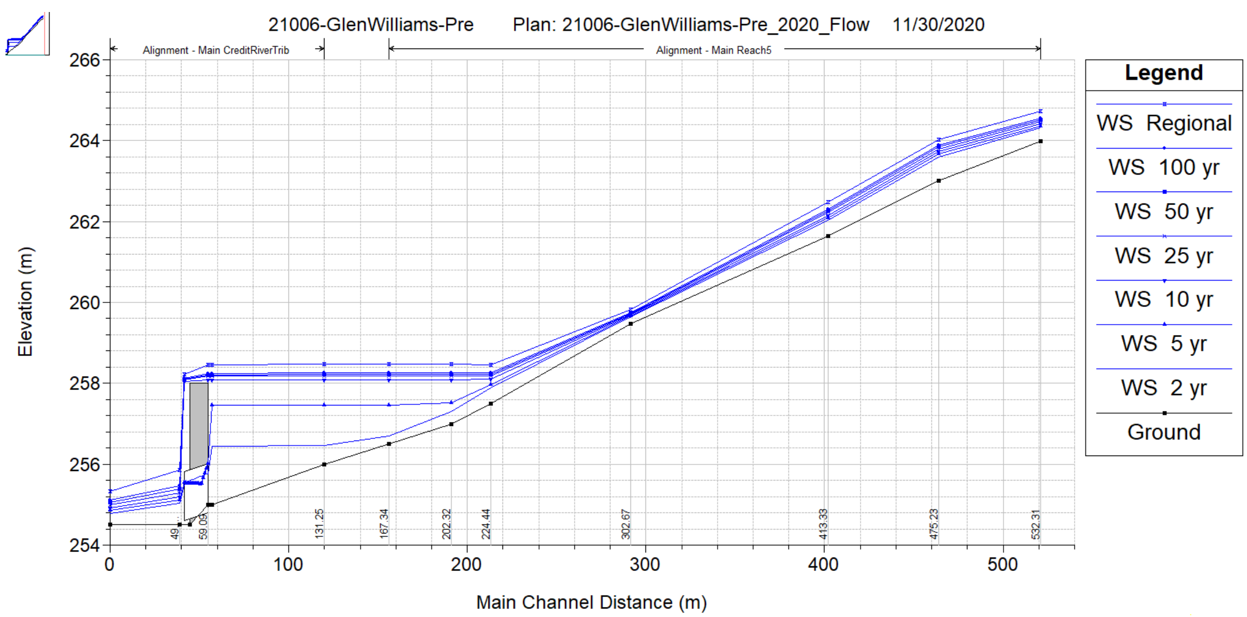

21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = CreditRiverTrib RS = 59.09 Culv Existing 1200mm CSP
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 2 yr
WS 5 yr
Ground
Ineff
Bank Sta
21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = CreditRiverTrib RS = 49.96
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Ineff
Bank Sta
21006-GlenWilliams-Pre Plan: 21006-GlenWilliams-Pre_2020_Flow 11/30/2020
River = Alignment - Main Reach = CreditRiverTrib RS = 11.26
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta

3.1.3 Water Elevation Profile

3.1.3.1 *Eastern Tributary and Credit River Tributary*



3.1.3.2 *Western Tributary/Reach 5 and Credit River Tributary*



3.2 Post-development HEC-RAS Output

3.2.1 Detailed Output

3.2.1.1 Eastern Tributary

HEC-RAS Plan: 21006-GlenWilliams-Post_2020_Edit_XS River: Alignment - East Reach: EasternTrib

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
EasternTrib	261.85	2 yr	0.61	259.49	259.55	259.54	259.56	0.023469	0.61	1.08	21.06	0.86
EasternTrib	261.85	5 yr	0.89	259.49	259.56	259.55	259.58	0.022372	0.70	1.38	21.29	0.87
EasternTrib	261.85	10 yr	1.19	259.49	259.58	259.57	259.60	0.020403	0.77	1.69	21.59	0.86
EasternTrib	261.85	25 yr	1.59	259.49	259.59	259.58	259.63	0.019141	0.84	2.07	21.94	0.86
EasternTrib	261.85	50 yr	1.90	259.49	259.60	259.59	259.64	0.018813	0.90	2.32	22.16	0.87
EasternTrib	261.85	100 yr	2.23	259.49	259.62	259.60	259.66	0.018279	0.95	2.59	22.38	0.87
EasternTrib	261.85	Regional	3.63	259.49	259.70	259.64	259.74	0.008017	0.90	4.62	25.01	0.63
EasternTrib	183.06	2 yr	0.61	258.50	258.59		258.60	0.007541	0.48	1.29	15.48	0.53
EasternTrib	183.06	5 yr	0.89	258.50	258.61		258.62	0.007662	0.56	1.62	15.72	0.55
EasternTrib	183.06	10 yr	1.19	258.50	258.63		258.65	0.008062	0.64	1.91	15.92	0.58
EasternTrib	183.06	25 yr	1.59	258.50	258.65		258.67	0.008350	0.73	2.26	16.16	0.61
EasternTrib	183.06	50 yr	1.90	258.50	258.66		258.69	0.008371	0.78	2.52	16.34	0.62
EasternTrib	183.06	100 yr	2.23	258.50	258.68		258.71	0.008525	0.84	2.77	16.51	0.63
EasternTrib	183.06	Regional	3.63	258.50	258.68	258.68	258.77	0.020978	1.33	2.84	16.55	1.00
EasternTrib	107.88	2 yr	0.62	257.50	257.59	257.59	257.63	0.025910	0.93	0.74	9.55	0.98
EasternTrib	107.88	5 yr	0.91	257.50	257.61	257.61	257.67	0.024335	1.05	0.98	10.42	0.99
EasternTrib	107.88	10 yr	1.21	257.50	257.64	257.64	257.70	0.021894	1.13	1.25	11.38	0.97
EasternTrib	107.88	25 yr	1.63	257.50	257.67	257.67	257.74	0.020081	1.23	1.59	12.36	0.96
EasternTrib	107.88	50 yr	1.95	257.50	257.69	257.69	257.76	0.019714	1.30	1.81	12.91	0.97
EasternTrib	107.88	100 yr	2.28	257.50	257.70	257.70	257.78	0.018912	1.36	2.06	13.47	0.96
EasternTrib	107.88	Regional	3.79	257.50	257.85	257.77	257.91	0.006540	1.16	4.43	18.31	0.62
EasternTrib	63.33	2 yr	0.62	256.89	257.23	257.04	257.24	0.001176	0.42	1.47	5.67	0.25
EasternTrib	63.33	5 yr	0.91	256.89	257.31	257.08	257.32	0.001216	0.48	1.88	5.98	0.26
EasternTrib	63.33	10 yr	1.21	256.89	257.38	257.11	257.39	0.001224	0.53	2.27	6.27	0.27
EasternTrib	63.33	25 yr	1.63	256.89	257.45	257.15	257.47	0.001293	0.60	2.74	6.65	0.28
EasternTrib	63.33	50 yr	1.95	256.89	257.51	257.18	257.53	0.001311	0.64	3.07	6.90	0.29
EasternTrib	63.33	100 yr	2.28	256.89	257.56	257.21	257.58	0.001277	0.67	3.40	7.15	0.29
EasternTrib	63.33	Regional	3.79	256.89	257.75	257.33	257.79	0.001259	0.82	4.63	7.52	0.31
EasternTrib	49.21		Bridge									
EasternTrib	36.44	2 yr	0.62	256.75	257.00	257.00	257.08	0.024090	1.29	0.48	2.88	1.00
EasternTrib	36.44	5 yr	0.91	256.75	257.05	257.05	257.15	0.022617	1.40	0.65	3.22	1.00
EasternTrib	36.44	10 yr	1.21	256.75	257.10	257.10	257.21	0.021780	1.50	0.81	3.50	1.00
EasternTrib	36.44	25 yr	1.63	256.75	257.15	257.15	257.29	0.021116	1.61	1.01	3.85	1.00
EasternTrib	36.44	50 yr	1.95	256.75	257.19	257.19	257.33	0.020416	1.67	1.17	4.09	1.00
EasternTrib	36.44	100 yr	2.28	256.75	257.22	257.22	257.38	0.021058	1.76	1.29	4.27	1.02
EasternTrib	36.44	Regional	3.79	256.75	257.36	257.36	257.56	0.018855	1.96	1.93	6.67	1.00

3.2.1.2 Western Tributary/Reach 5

HEC-RAS Plan: 21006-GlenWilliams-Post_2020_Edit_XS River: Alignment - Main Reach: Reach5

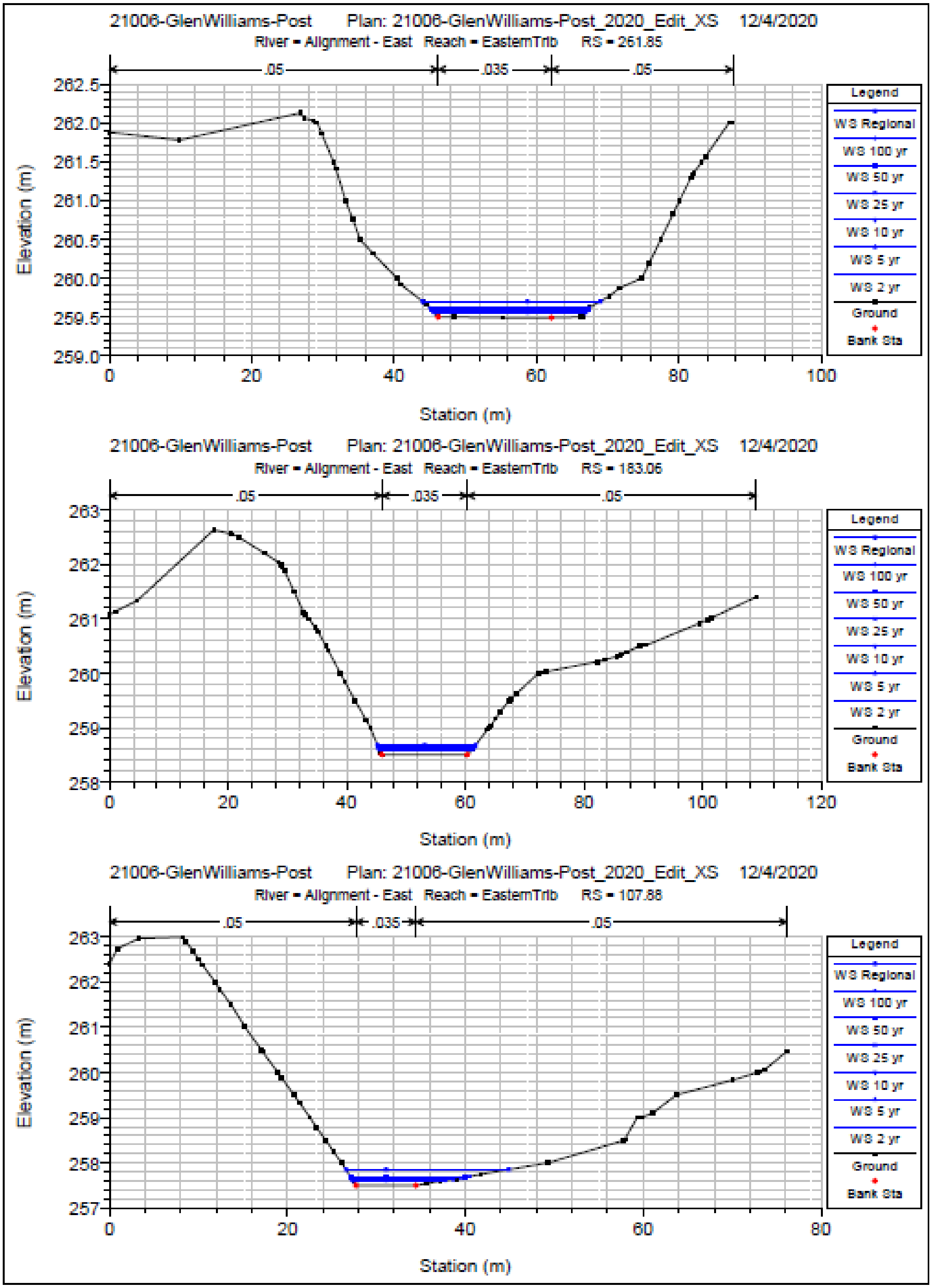
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach5	532.31	2 yr	1.85	263.98	264.33	264.30	264.42	0.013873	1.39	1.41	6.69	0.86
Reach5	532.31	5 yr	2.71	263.98	264.36	264.38	264.52	0.019009	1.76	1.66	7.05	1.02
Reach5	532.31	10 yr	3.63	263.98	264.42	264.44	264.60	0.019021	1.97	2.05	7.85	1.05
Reach5	532.31	25 yr	4.87	263.98	264.48	264.51	264.71	0.019011	2.19	2.57	8.92	1.08
Reach5	532.31	50 yr	5.83	263.98	264.52	264.58	264.78	0.019010	2.34	2.99	10.76	1.10
Reach5	532.31	100 yr	6.84	263.98	264.56	264.63	264.84	0.019012	2.47	3.45	12.08	1.12
Reach5	532.31	Regional	12.11	263.98	264.72	264.83	265.10	0.019012	2.98	5.77	16.22	1.17
Reach5	475.23	2 yr	1.85	263.00	263.60	263.60	263.71	0.011545	1.51	1.51	9.32	0.80
Reach5	475.23	5 yr	2.71	263.00	263.68	263.68	263.80	0.010411	1.64	2.32	11.44	0.78
Reach5	475.23	10 yr	3.63	263.00	263.73	263.73	263.87	0.010770	1.80	3.00	12.93	0.81
Reach5	475.23	25 yr	4.87	263.00	263.80	263.80	263.94	0.010484	1.93	3.95	14.76	0.82
Reach5	475.23	50 yr	5.83	263.00	263.84	263.85	264.00	0.011039	2.07	4.52	15.76	0.85
Reach5	475.23	100 yr	6.84	263.00	263.88	263.88	264.05	0.011530	2.20	5.09	16.70	0.87
Reach5	475.23	Regional	12.11	263.00	264.02	264.05	264.25	0.013370	2.70	7.75	20.42	0.97
Reach5	413.33	2 yr	1.85	261.65	262.00	262.09	262.30	0.062380	2.45	0.75	3.70	1.73
Reach5	413.33	5 yr	2.71	261.65	262.04	262.19	262.47	0.065755	2.90	0.95	4.46	1.83
Reach5	413.33	10 yr	3.63	261.65	262.11	262.26	262.58	0.055789	3.08	1.26	5.52	1.75
Reach5	413.33	25 yr	4.87	261.65	262.17	262.35	262.72	0.051430	3.35	1.66	6.89	1.73
Reach5	413.33	50 yr	5.83	261.65	262.22	262.41	262.79	0.045563	3.43	2.04	8.06	1.67
Reach5	413.33	100 yr	6.84	261.65	262.27	262.46	262.85	0.041489	3.52	2.46	9.16	1.62
Reach5	413.33	Regional	12.11	261.65	262.46	262.68	263.08	0.032088	3.87	4.60	12.97	1.51
Reach5	302.67	2 yr	1.86	259.47	259.64	259.64	259.68	0.025599	1.34	2.61	29.42	1.07
Reach5	302.67	5 yr	2.73	259.47	259.67	259.67	259.72	0.025602	1.49	3.44	32.39	1.10
Reach5	302.67	10 yr	3.66	259.47	259.69	259.69	259.75	0.027529	1.65	4.12	33.63	1.16
Reach5	302.67	25 yr	4.92	259.47	259.72	259.72	259.78	0.028015	1.79	4.94	33.69	1.19
Reach5	302.67	50 yr	5.90	259.47	259.73	259.73	259.81	0.029426	1.92	5.44	33.73	1.24
Reach5	302.67	100 yr	6.91	259.47	259.75	259.75	259.83	0.029606	2.01	5.99	33.78	1.25
Reach5	302.67	Regional	12.37	259.47	259.82	259.82	259.95	0.029564	2.38	8.59	33.98	1.31
Reach5	224.44	2 yr	1.86	257.50	257.89	257.89	258.00	0.021468	1.42	1.31	6.50	1.01
Reach5	224.44	5 yr	2.73	257.50	257.96	257.96	258.08	0.020375	1.55	1.77	7.90	1.01
Reach5	224.44	10 yr	3.66	257.50	258.01	258.02	258.16	0.018277	1.67	2.24	9.28	0.99
Reach5	224.44	25 yr	4.92	257.50	258.07	258.09	258.24	0.017085	1.84	2.86	11.32	0.99
Reach5	224.44	50 yr	5.90	257.50	258.12	258.13	258.30	0.015948	1.92	3.40	12.83	0.98
Reach5	224.44	100 yr	6.91	257.50	258.16	258.18	258.35	0.015429	2.01	3.92	14.14	0.97
Reach5	224.44	Regional	12.37	257.50	258.32	258.36	258.58	0.014025	2.38	6.71	19.71	0.98
Reach5	199.34	2 yr	1.86	257.19	257.50	257.37	257.51	0.002270	0.56	3.34	25.07	0.35
Reach5	199.34	5 yr	2.73	257.19	257.56	257.40	257.58	0.002396	0.66	4.14	26.65	0.37
Reach5	199.34	10 yr	3.66	257.19	257.62	257.44	257.65	0.002503	0.75	4.87	28.10	0.39
Reach5	199.34	25 yr	4.92	257.19	257.69	257.48	257.72	0.002577	0.85	5.77	29.88	0.41
Reach5	199.34	50 yr	5.90	257.19	257.74	257.51	257.78	0.002607	0.92	6.41	31.16	0.42
Reach5	199.34	100 yr	6.91	257.19	257.79	257.55	257.84	0.002610	0.98	7.05	32.42	0.42
Reach5	199.34	Regional	12.37	257.19	258.01	257.70	258.09	0.002646	1.24	9.96	38.09	0.45
Reach5	184.084		Bridge									
Reach5	167.34	2 yr	1.86	256.55	256.79	256.79	256.85	0.025150	1.09	1.70	14.31	1.01
Reach5	167.34	5 yr	2.73	256.55	256.83	256.83	256.90	0.022864	1.16	2.36	16.85	0.99
Reach5	167.34	10 yr	3.66	256.55	256.87	256.87	256.94	0.022718	1.24	2.94	19.03	1.00
Reach5	167.34	25 yr	4.92	256.55	256.90	256.90	256.99	0.021199	1.36	3.62	19.51	1.00
Reach5	167.34	50 yr	5.90	256.55	256.93	256.93	257.03	0.020186	1.44	4.11	19.52	1.00
Reach5	167.34	100 yr	6.91	256.55	256.95	256.95	257.07	0.019293	1.52	4.58	19.54	0.99
Reach5	167.34	Regional	12.37	256.55	257.06	257.06	257.23	0.016743	1.83	6.88	21.38	0.99

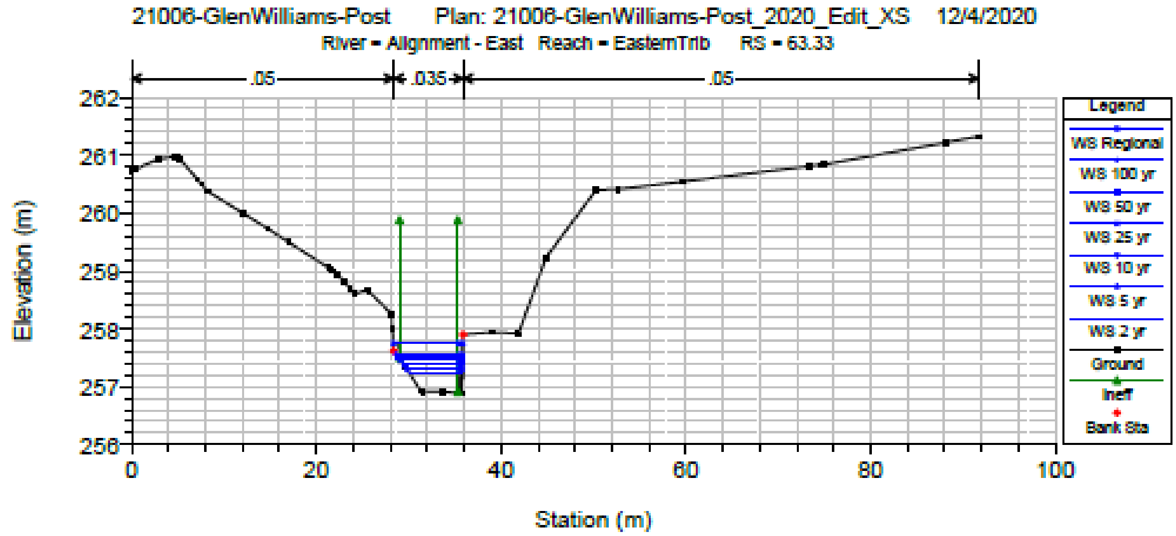
3.2.1.3 Credit River Tributary

HEC-RAS Plan: 21006-GlenWilliams-Post_2020_Edit_XS River: Alignment - Main Reach: CreditRiverTrib

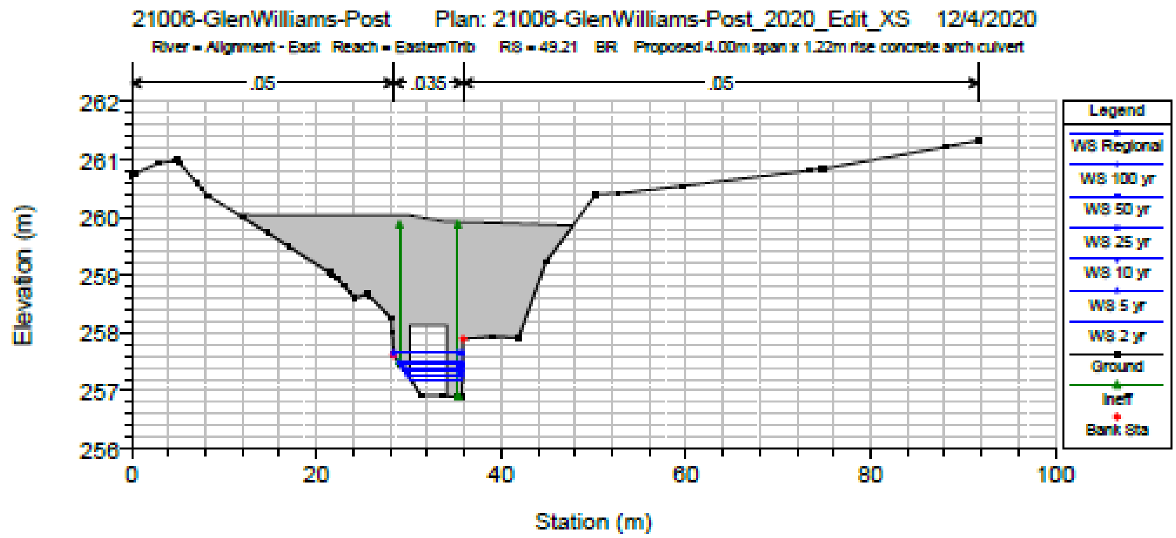
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
CreditRiverTrib	131.25	2 yr	2.49	256.00	256.26	256.20	256.29	0.006956	0.78	3.35	22.61	0.58
CreditRiverTrib	131.25	5 yr	3.65	256.00	256.32	256.25	256.36	0.006018	0.84	4.81	27.46	0.55
CreditRiverTrib	131.25	10 yr	4.89	256.00	256.38	256.29	256.41	0.005236	0.87	6.43	31.58	0.53
CreditRiverTrib	131.25	25 yr	6.56	256.00	256.44	256.33	256.48	0.004374	0.89	8.67	34.96	0.50
CreditRiverTrib	131.25	50 yr	7.87	256.00	256.49	256.36	256.53	0.003802	0.90	10.43	37.10	0.47
CreditRiverTrib	131.25	100 yr	9.22	256.00	256.54	256.39	256.58	0.003368	0.91	12.15	38.47	0.46
CreditRiverTrib	131.25	Regional	16.42	256.00	256.77	256.50	256.81	0.001945	0.94	21.69	42.52	0.37
CreditRiverTrib	68.22	2 yr	2.49	255.00	255.45	255.45	255.61	0.018378	1.76	1.41	4.46	1.00
CreditRiverTrib	68.22	5 yr	3.65	255.00	255.55	255.55	255.74	0.017521	1.92	1.90	5.05	1.00
CreditRiverTrib	68.22	10 yr	4.89	255.00	255.65	255.65	255.86	0.016844	2.05	2.39	5.61	1.00
CreditRiverTrib	68.22	25 yr	6.56	255.00	255.75	255.75	255.99	0.016045	2.17	3.02	6.27	1.00
CreditRiverTrib	68.22	50 yr	7.87	255.00	255.82	255.82	256.08	0.015823	2.26	3.48	6.71	1.00
CreditRiverTrib	68.22	100 yr	9.22	255.00	255.89	255.89	256.17	0.015371	2.33	3.96	7.13	1.00
CreditRiverTrib	68.22	Regional	16.42	255.00	256.18	256.18	256.53	0.014146	2.62	6.26	8.86	1.00
CreditRiverTrib	49.96	2 yr	2.49	254.50	254.91	254.97	255.15	0.033861	2.20	1.13	4.04	1.33
CreditRiverTrib	49.96	5 yr	3.65	254.50	254.99	255.07	255.30	0.033583	2.47	1.48	4.41	1.36
CreditRiverTrib	49.96	10 yr	4.89	254.50	255.07	255.17	255.43	0.032566	2.67	1.83	4.73	1.37
CreditRiverTrib	49.96	25 yr	6.56	254.50	255.16	255.27	255.58	0.031202	2.87	2.29	5.11	1.37
CreditRiverTrib	49.96	50 yr	7.87	254.50	255.23	255.34	255.68	0.029871	2.98	2.64	5.38	1.36
CreditRiverTrib	49.96	100 yr	9.22	254.50	255.29	255.42	255.77	0.028889	3.08	2.99	5.64	1.35
CreditRiverTrib	49.96	Regional	16.42	254.50	255.58	255.73	256.19	0.021216	3.47	4.84	6.95	1.24
CreditRiverTrib	11.26	2 yr	2.49	254.50	254.78	254.69	254.82	0.005006	0.86	3.02	12.21	0.52
CreditRiverTrib	11.26	5 yr	3.65	254.50	254.85	254.74	254.90	0.005001	0.99	3.89	12.93	0.54
CreditRiverTrib	11.26	10 yr	4.89	254.50	254.91	254.79	254.98	0.005009	1.11	4.72	13.58	0.56
CreditRiverTrib	11.26	25 yr	6.56	254.50	254.99	254.85	255.06	0.005003	1.24	5.77	14.36	0.57
CreditRiverTrib	11.26	50 yr	7.87	254.50	255.04	254.89	255.13	0.005001	1.33	6.53	14.88	0.58
CreditRiverTrib	11.26	100 yr	9.22	254.50	255.09	254.93	255.19	0.005000	1.41	7.29	15.39	0.59
CreditRiverTrib	11.26	Regional	16.42	254.50	255.31	255.12	255.45	0.005001	1.75	10.94	17.60	0.62

3.2.2 Cross-sections

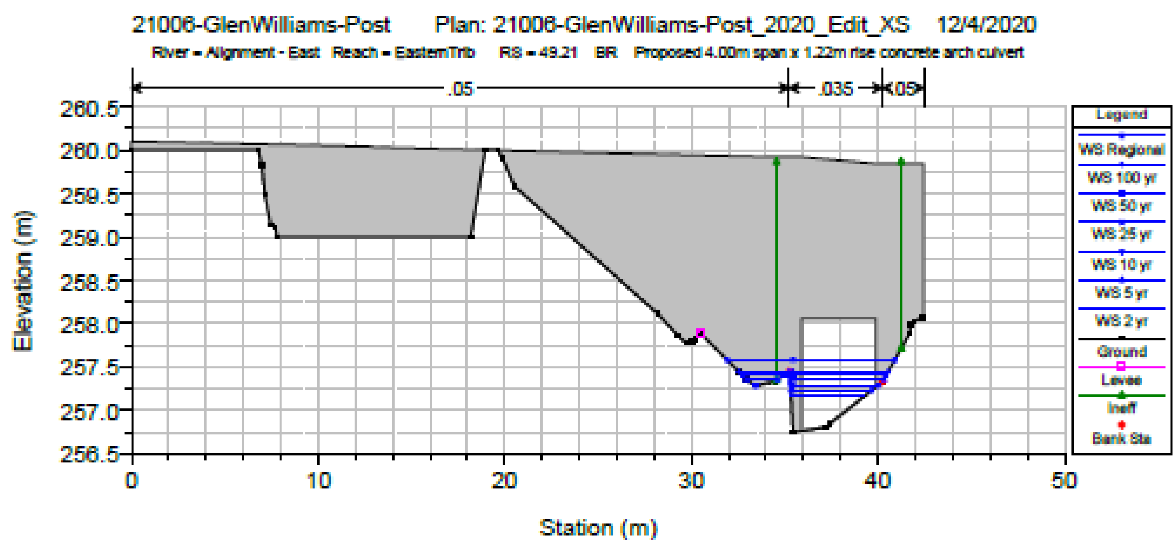




21006-GlenWilliams-Post Plan: 21006-GlenWilliams-Post_2020_Edit_XS 12/4/2020
River = Alignment - East Reach = EasternTrib RS = 63.33
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Ineff
Bank Sta



21006-GlenWilliams-Post Plan: 21006-GlenWilliams-Post_2020_Edit_XS 12/4/2020
River = Alignment - East Reach = EasternTrib RS = 49.21 BR Proposed 4.00m span x 1.22m rise concrete arch culvert
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Ineff
Bank Sta



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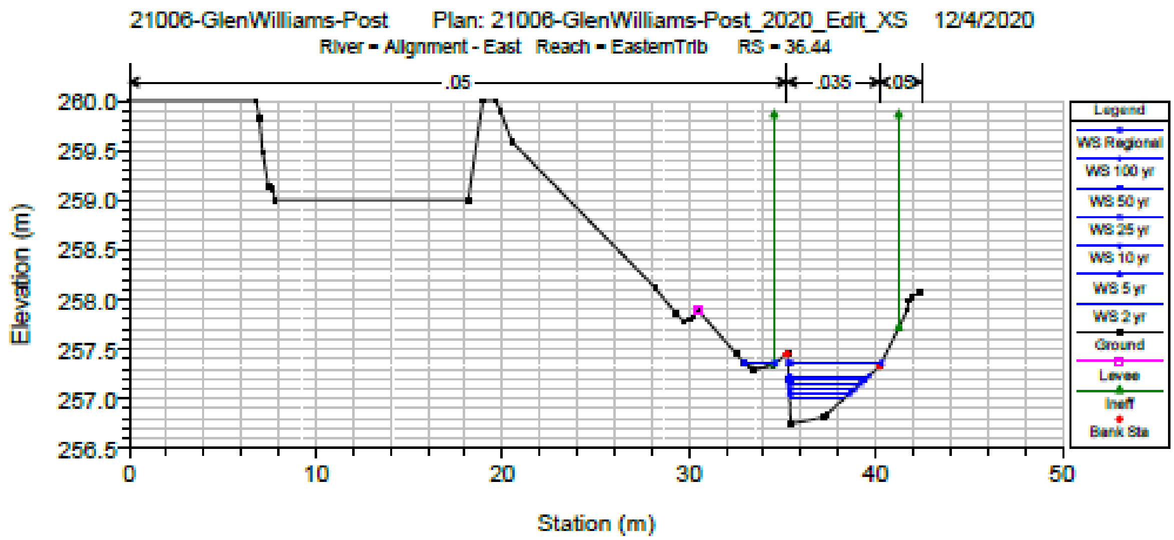
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Levee
Ineff
Bank Sta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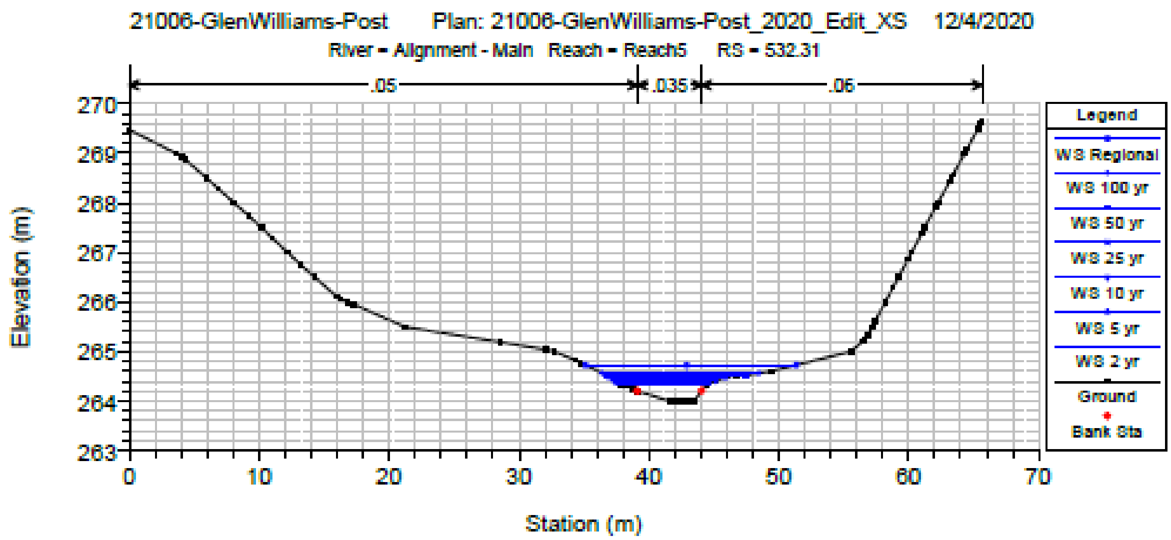
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Levee
Ineff
Bank Sta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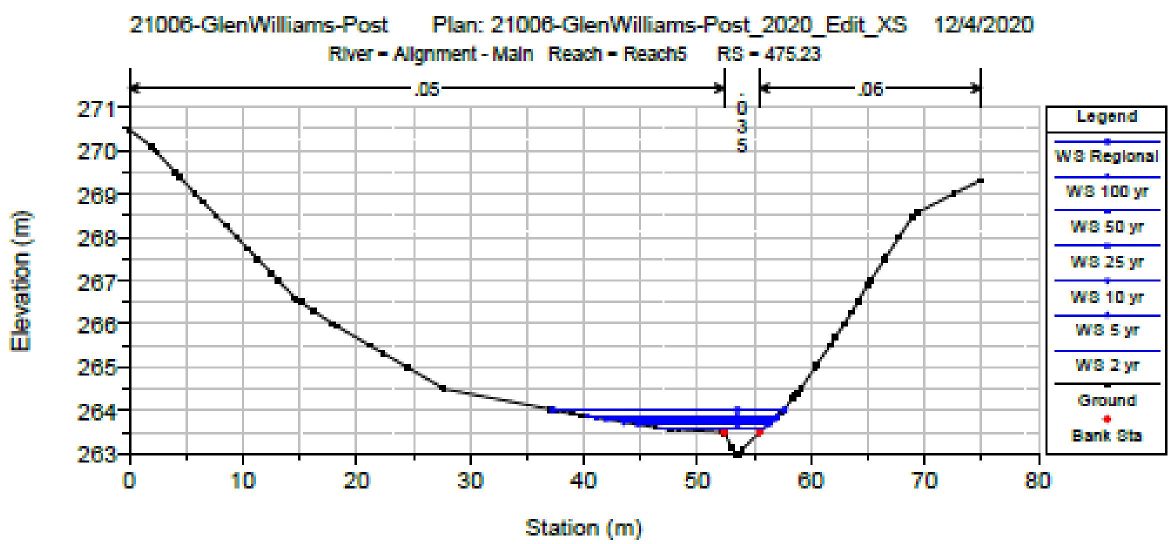
.05
.035
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta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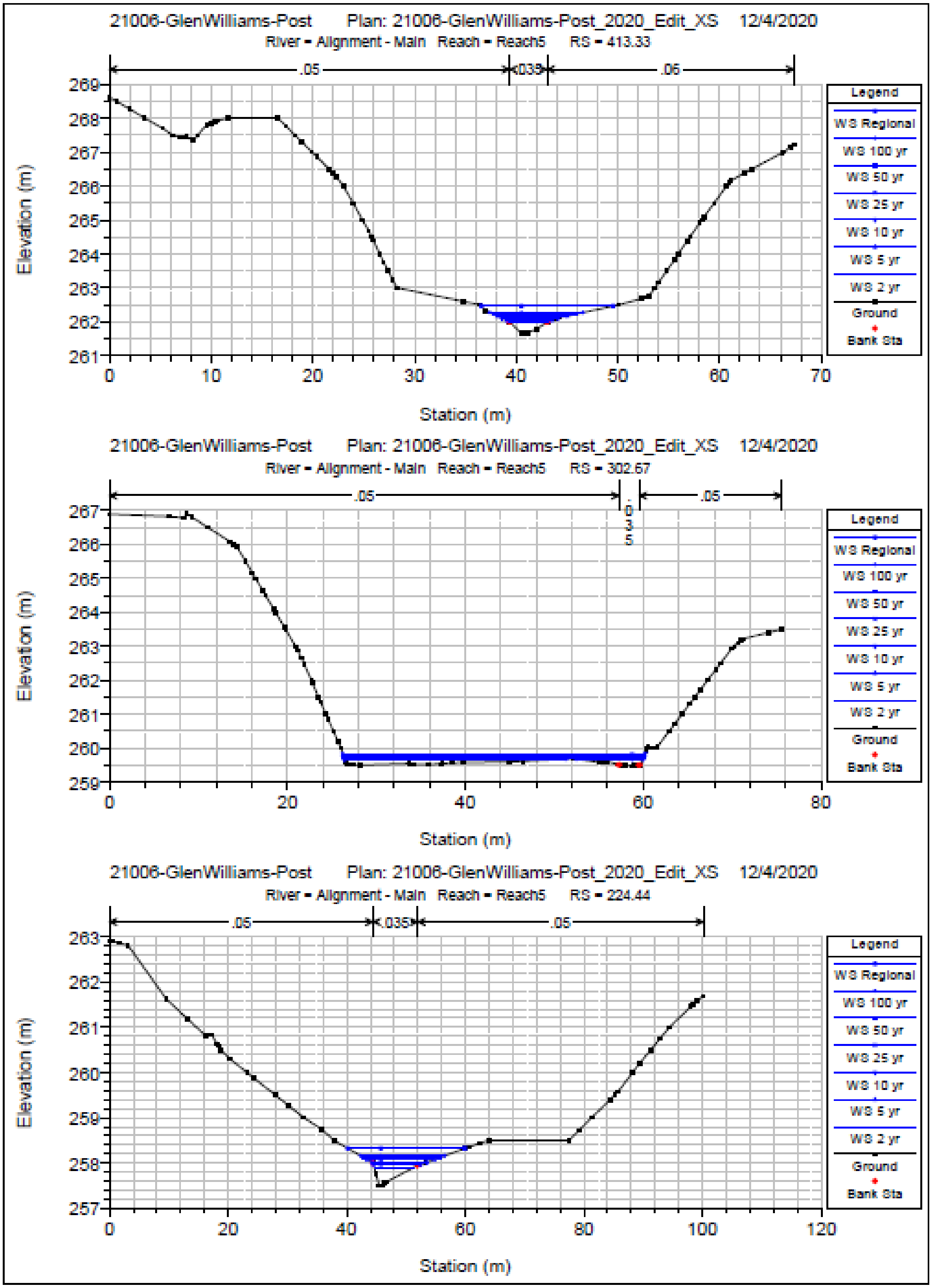
.035
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta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.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta
21006-GlenWilliams-Post Plan: 21006-GlenWilliams-Post_2020_Edit_XS 12/4/2020
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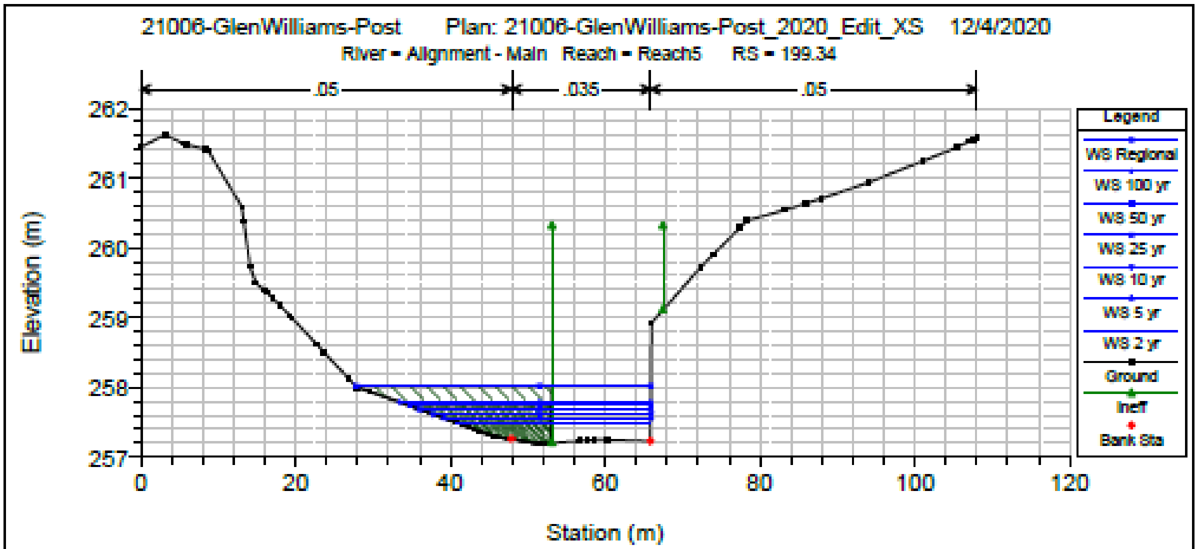
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta
21006-GlenWilliams-Post Plan: 21006-GlenWilliams-Post_2020_Edit_XS 12/4/2020
River = Alignment - Main Reach = Reach5 RS = 224.44
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta


21006-GlenWilliams-Post Plan: 21006-GlenWilliams-Post_2020_Edit_XS 12/4/2020
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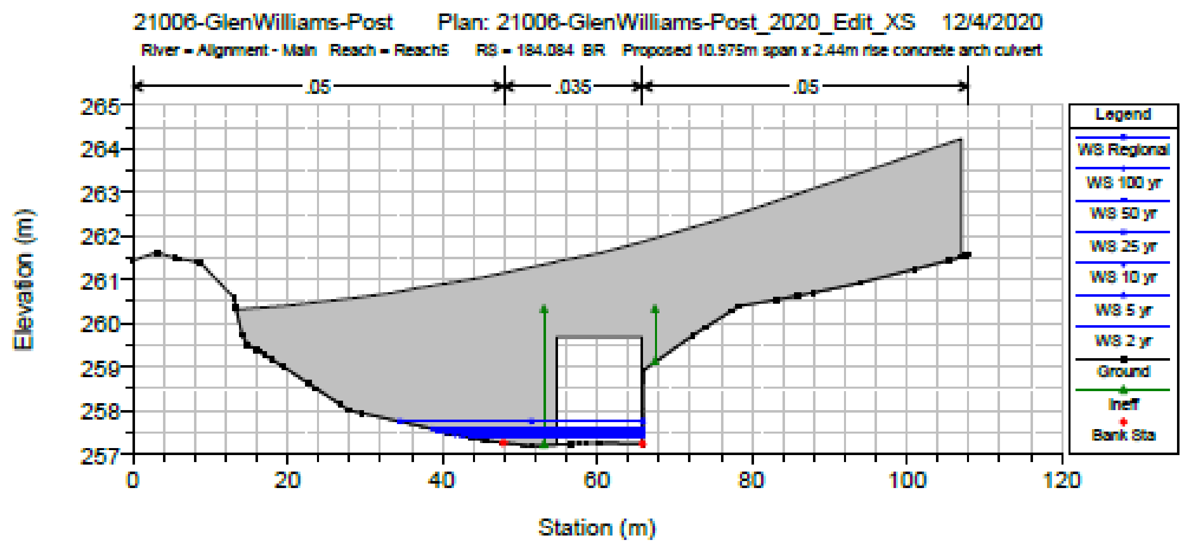
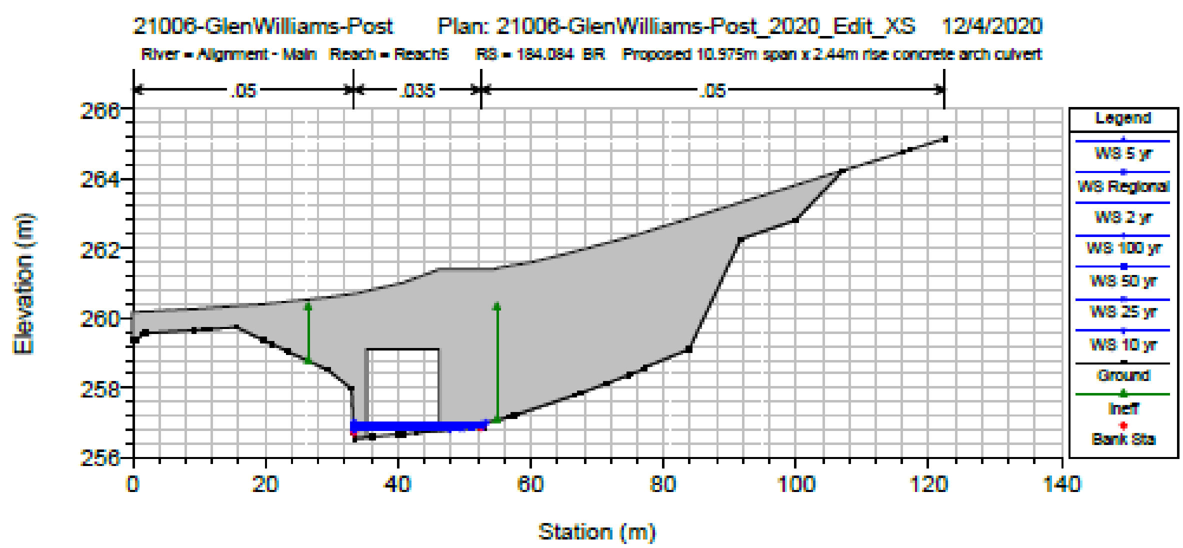
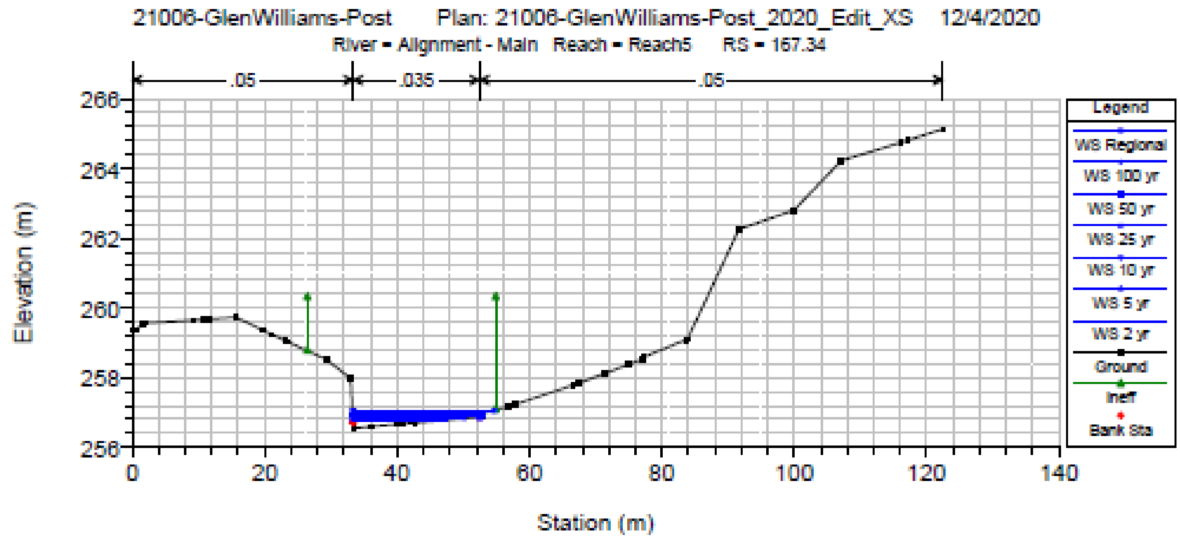
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Ineff
Bank Sta


21006-GlenWilliams-Post Plan: 21006-GlenWilliams-Post_2020_Edit_XS 12/4/2020
River = Alignment - Main Reach = Reach5 RS = 184.084 BR Proposed 10.975m span x 2.44m rise concrete arch culvert
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Ineff
Bank Sta


21006-GlenWilliams-Post Plan: 21006-GlenWilliams-Post_2020_Edit_XS 12/4/2020
River = Alignment - Main Reach = Reach5 RS = 184.084 BR Proposed 10.975m span x 2.44m rise concrete arch culvert
.05
.035
.05
Elevation (m)
Station (m)
Legend
WS 5 yr
WS Regional
WS 2 yr
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
Ground
Ineff
Bank Sta


21006-GlenWilliams-Post Plan: 21006-GlenWilliams-Post_2020_Edit_XS 12/4/2020
River = Alignment - Main Reach = Reach5 RS = 167.34
.05
.035
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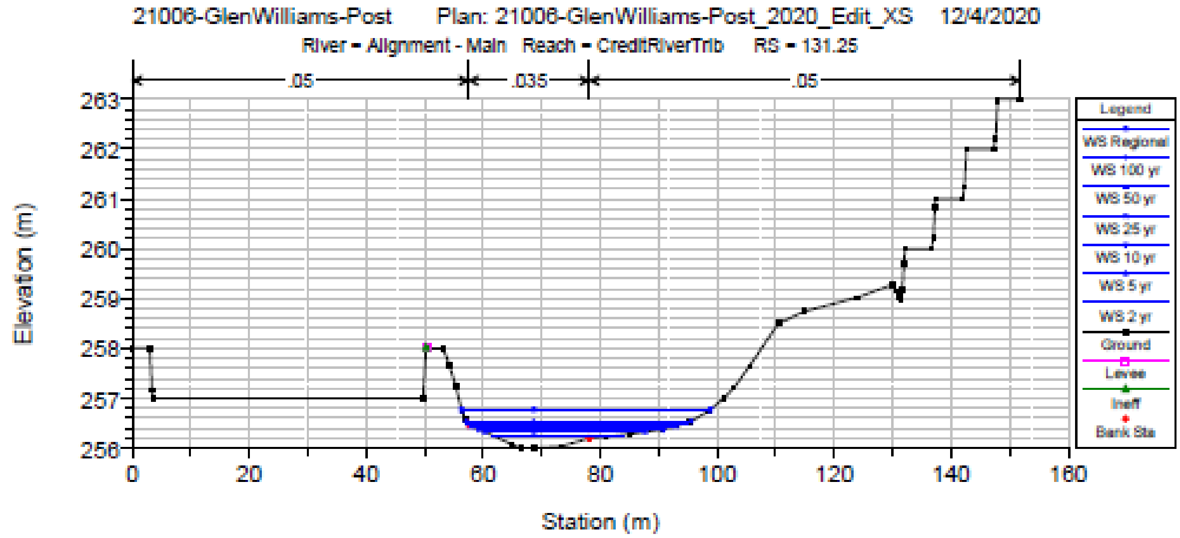
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)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.035
.05
Legend
WS Regional
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WS 50 yr
WS 25 yr
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WS 5 yr
WS 2 yr
Ground
Levee
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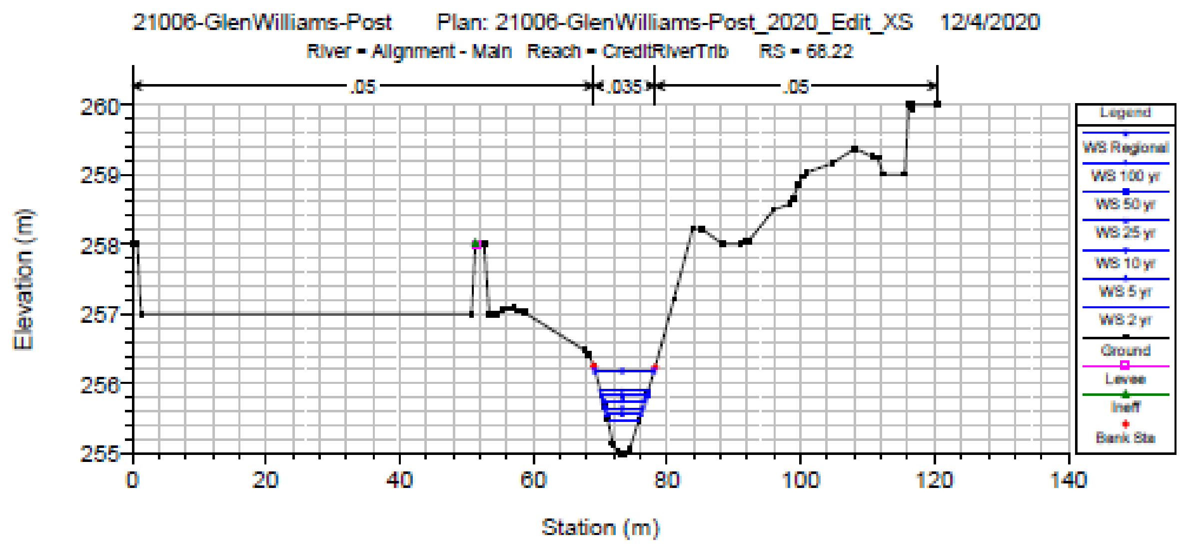
Bank Sta
Elevation (m)
Station (m)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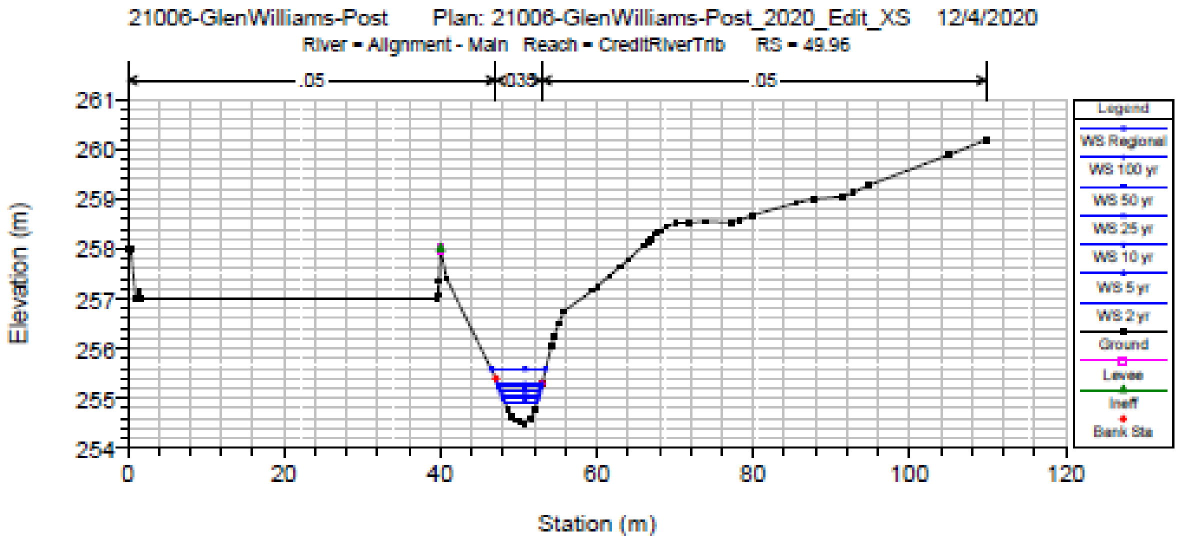
Elevation (m)
Station (m)



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Elevation (m)
Station (m)
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WS 25 yr
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WS 5 yr
WS 2 yr
Ground
Levee
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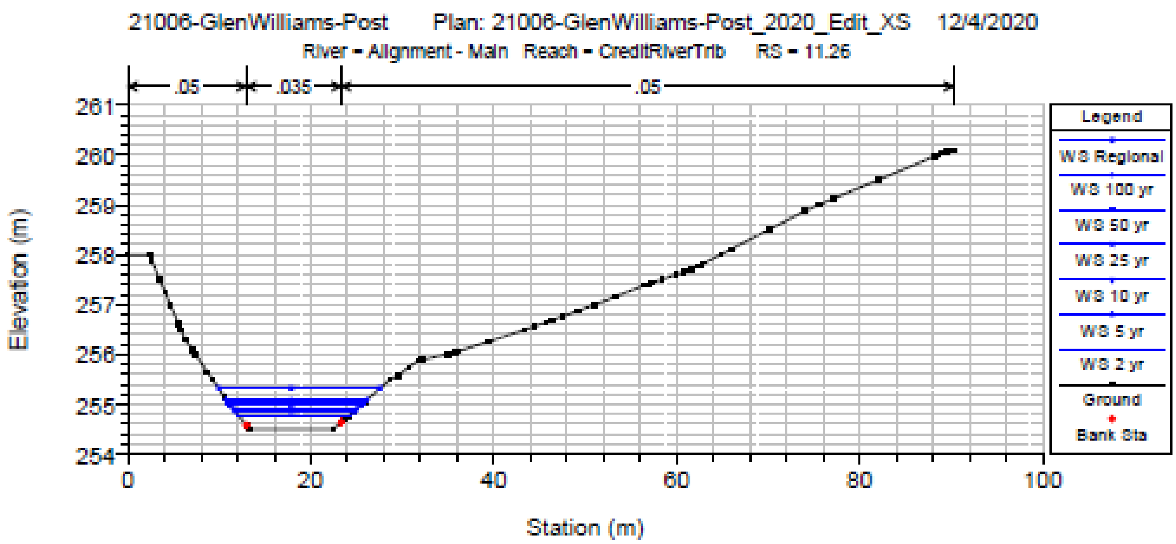

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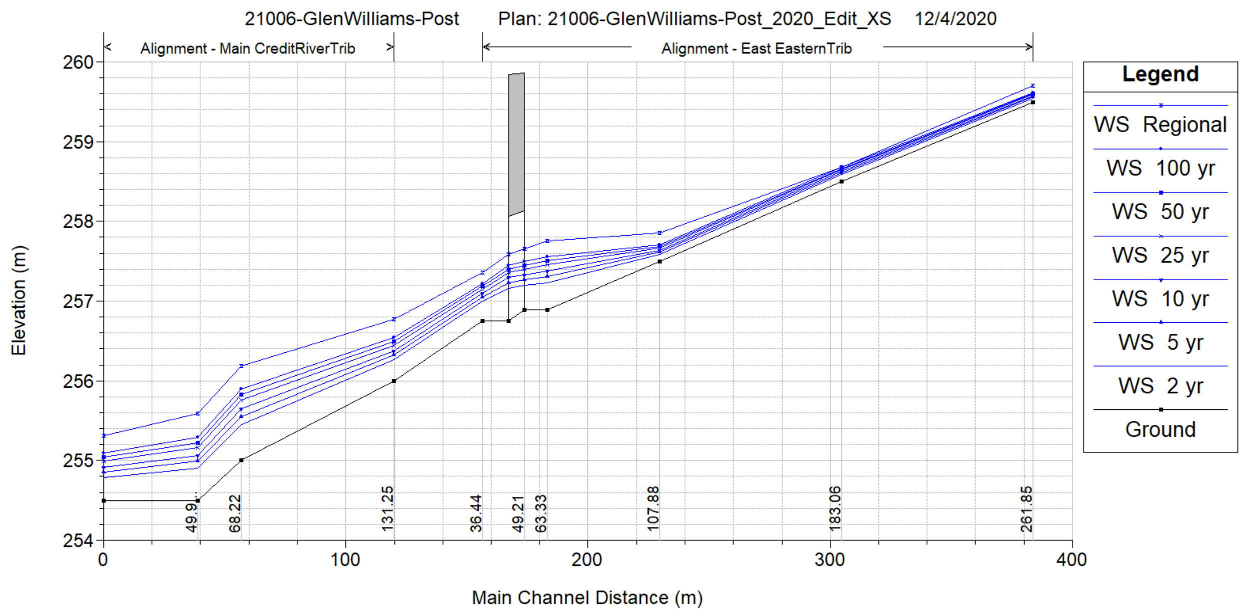
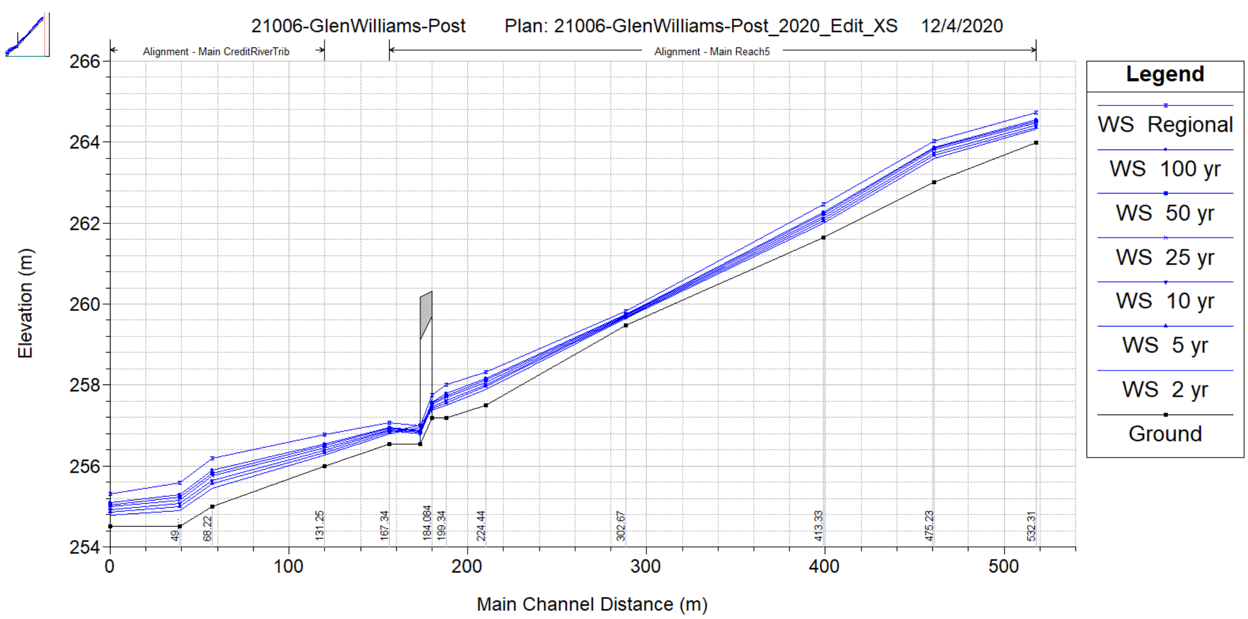
.05
Elevation (m)
Station (m)
Legend
WS Regional
WS 100 yr
WS 50 yr
WS 25 yr
WS 10 yr
WS 5 yr
WS 2 yr
Ground
Bank Sta

3.2.3 Water Elevation Profile

3.2.3.1 Eastern Tributary and Credit River Tributary



3.2.3.2 Western Tributary/Reach 5 and Credit River Tributary



APPENDIX F
Proposed Wetland Compensation Supporting Documents

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

May 15, 2018 Matrix 21006-530

Annie Li, Planner
Planning and Development Services
CREDIT VALLEY CONSERVATION
1255 Old Derry Rd.
Mississauga, ON L5N 6R4

Subject: T83-008 (Charleston Homes)
Part Lot 23, Concession 10
Town of Halton Hills
Wetland Proposal for Discussion

Dear Ms. Li:

Per our most recent meeting with you at Credit Valley Conservation (CVC) offices and to also address items outlined in CVC's letter of January 29, 2016 regarding wetland compensation at the above-referenced property, we are providing a revised conceptual approach for consideration.

The proposed approach for wetland compensation for the site has required integration into a revised approach now proposed for stormwater management (SWM) at the site. Accordingly, Matrix Solutions Inc. has prepared a concept plan that in addition to proposed wetland configuration also outlines how the SWM design is currently being envisaged. The plan is attached to this letter as *Figure A1 - Conceptual SWM and Wetland Compensation Plan*. Details of the modified SWM design, including additional grading, revised modeling, and resulting pond levels will be outlined in a future submission to CVC and the Town.

At this time Matrix has completed sufficient preliminary design and modeling to ascertain that the revised SWM concept presents a feasible and effective approach to that aspect of development servicing. The main components of the revised SWM plan include:

- an expansion to the original Phase 1 SWM facility to the south
- complete integration of Phase 1 and Phase 2 SWM facility outlets (and therefore systems) as envisaged in the original Burnside SWM report (1999)
- a revised Phase 2 SWM facility, functioning as a dry and quantity-control-only facility for greater than 2 Year storm flows
    - Storm runoff from less than a 2 year event rate will proceed directly to the revised/enlarged Phase 1 SWM pond.
- a swale capturing backyard drainage from Phase 2 yards, which bypasses the dry revised Phase 2 SWM facility, and proceeds to the Phase 1 facility

The SWM features described above may be able to incorporate other features such as biofiltration. SWM design will be dependent on ensuring good integration with the wetland compensation area as proposed.

The proposed areas for wetland compensation are also indicated in the attached Figure A1 which has been prepared with input from North-South Environmental. We are also attaching a memo prepared by North-South to this letter dated November 22, 2017, that outlines vegetation within relevant areas now being considered for wetland compensation. This is one of the key items outlined in the CVC letter of January 29, 2016 as being required additional information.

It should be noted that Figure A1 has used the same Natural Heritage System (NHS) boundary as outlined in the North-South letter. If additional clarification of that line in the field is required, sufficient flexibility in the wetland compensation area is available to make some changes (i.e., more than enough compensation area is available).

As outlined in the attached Figure A1, the following areas are made available for wetland compensation:

- 0.180 ha which was formerly part of the SWM block for Phase 2
- 0.095 ha which is part of the SWM block for Phase 1
- 0.094 ha in Phase 2 lands which is between the Phase 2 SWM block and the NHS
- 0.040 ha in Phase 1 lands which is between the Phase 1 SWM block and the NHS

Taken together they form 0.409 ha of area, which is in excess of the 0.33 ha we understand is required for compensation. Please note the area values depicted on North-South memo's Figure 1 are superseded by the above numbers contained on Matrix Figure A1. It should also be noted that the total wetland compensation area required had previously been determined as 0.54 ha, of which 0.21 ha will be provided within Block C on the west side of the tributary and north of the proposed road in Phase 2.

CVC January 29, 2016 Letter - Comment 6

Areas that are being proposed for wetland creation we believe are suitable from a technical standpoint. The amount of compensation being put forward exceeds the requirement and allows for flexibility of adjusting lines in the field as may be required at final design.

i. We understand that all lands south of Phase 2 are in the Town's control. See next comment.

ii. Regarding greater interaction with both the Region of Halton and the Town of Halton Hills, we recognize this requirement and we have copied both agencies with this letter. At this time we are requesting CVC review to ensure feasibility going forward. The Town and Region will likely look to CVC's opinion in their own determinations of acceptability for the conceptual plan.

iii. No areas of significance are proposed to be removed by the compensation plan.

iv. The valleyland feature which is adjacent to the wetland includes a culvert and roadway that will be removed by the Phase 2 development. Significant opportunity exists to rehabilitate the watercourse in this area, and the proposed wetland compensation will have to be integrated with this future plan. On the whole, the valleyland and watercourse have potential to be much improved as compared with existing.

v. We have maximized compensation east of the watercourse as suggested. The original 0.21 ha compensation area in Block C has been maintained, with an additional 0.409 ha available east of the watercourse and adjacent to the SWM Block for Phase 2. Taken together over 0.61 ha will be provided to offset the 0.54 ha required.

Groundwater - Based on nearby piezometers, the annual high groundwater level as determined by AEL in the area of the wetland compensation area is at least 1 to 2 m below the proposed wetland bottom. No interaction will be required, and it can be prevented as required through wetland bottom design.

Hydro-period - Water sources to the wetland can include as much or as little from the nearby backyard swale as may be required (including filtered flow from a subdrain). Another possibility is to include a portion of subdrain flow (i.e., treated runoff) from a bioswale facility that could be located within the Phase 2 dry SWM facility.

Flood plain connectivity - The proposed wetland compensation area has been placed above a 5-year level of flow in the adjacent creek. It could be moved lower or higher as required to best suit objectives. The overall flood plain connection will be a part of the channel rehabilitation design associated with the culverts under the new Phase 2 roadway and also the removal of the old culvert crossing downstream.

Closure

Accordingly, we would request that CVC consider the enclosed material and also propose a time to meet at your offices to outline comments and any requirements for additional information.

After incorporation of comments and revisions as required, we would approach both Town and Region with additional details as required to ensure acceptability of the plan. This will include addressing other issues beyond the Fill Permit and associated wetland compensation.

Please contact me if you have any questions.

Sincerely,

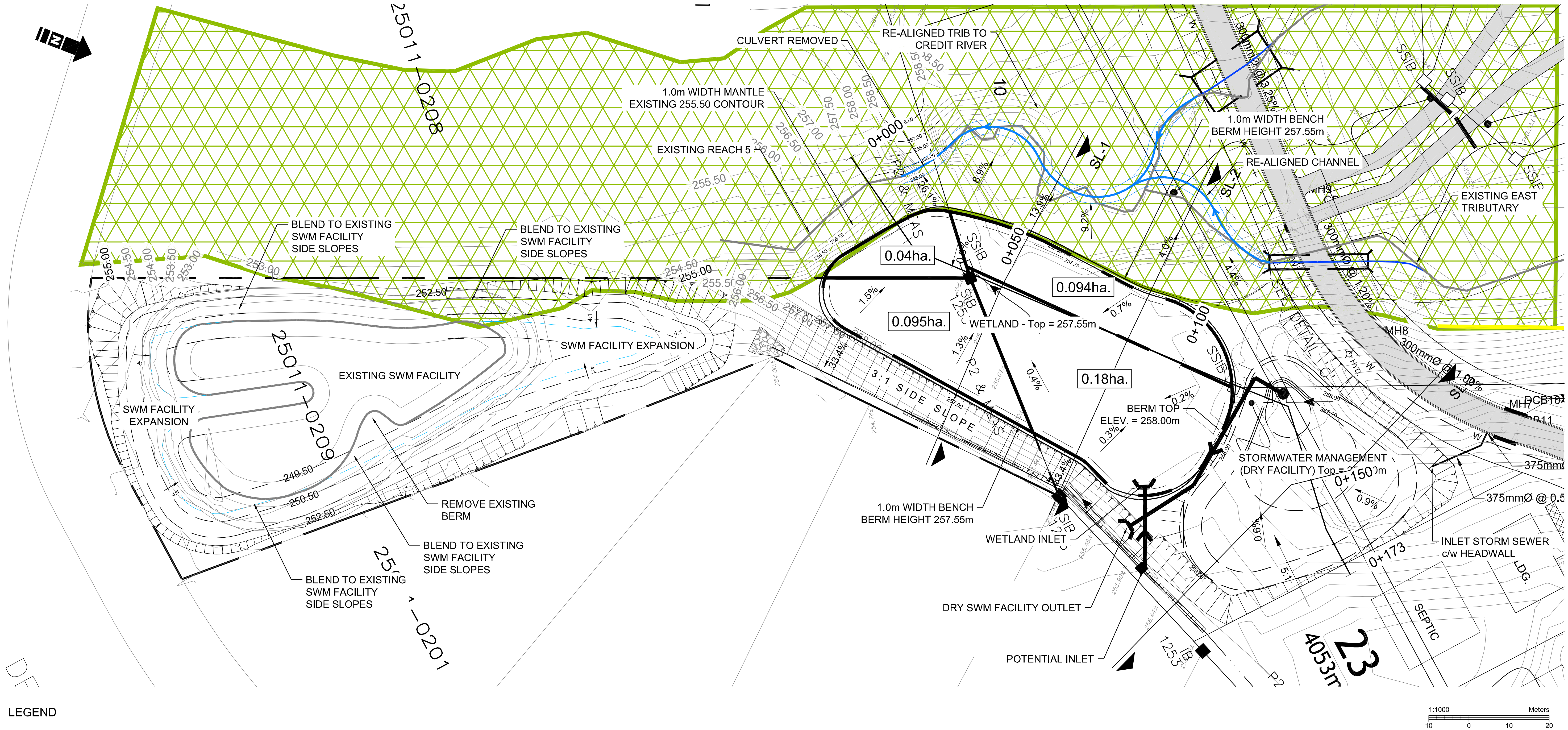
MATRIX SOLUTIONS INC.

Stephen Braun

Stephen Braun, P.Eng.
Senior Water Resources Engineer

SB/ap
Attachments

Copy: Jeff Markowiak - Town of Halton Hills
Shelley Partridge - Halton Region
Chris Matson - Matson McConnell Inc.
Glenn Wellings – Wellings Planning Consultants Inc.
Sarah Mainguy - North-South Environmental Inc.
Paul Wilson - AEL environment



LEGEND

PROPOSED CONTOURS

SLOPE GRADING

NATURAL HERITAGE SYSTEM

SOURCE:

1. LEGAL INFORMATION FROM VAN HARTEN SURVEYING INC. PLAN OF SURVEY OF PART OF LOT 23, CONCESSION 10, GEOGRAPHIC TOWNSHIP OF ESQUESING, TOWN OF HALTON HILLS, REGIONAL MUNICIPALITY OF HALTON HILLS. DATE: JANUARY 4, 2011.
2. BEARINGS ARE GRID BEARINGS AND ARE DERIVED FROM GPS OBSERVATIONS AND ARE REFERRED TO THE UTM PROJECTION, ZONE 17, NAD 83 (CSRS-2002) ADJUSTMENT.
3. COORDINATES ON THIS PLAN ARE UTM, ZONE 17, NAD83 (CSRS-2002) ADJUSTMENT AND ARE BASED ON GPS OBSERVATIONS FROM A NETWORK OF PERMANENT GPS REFERENCE STATIONS.
4. THE POSITION OF POLES, LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.
5. ALL DIMENSIONS AND LOCATION OF ALL AND ANY EXISTING UTILITIES WILL BE CHECKED AND VERIFIED BY THE CONTRACTOR PRIOR TO COMMENCING CONSTRUCTION OF THE WORKS SHOWN HEREON. ANY DISCREPANCY WILL BE REPORTED IMMEDIATELY TO THE ENGINEER.

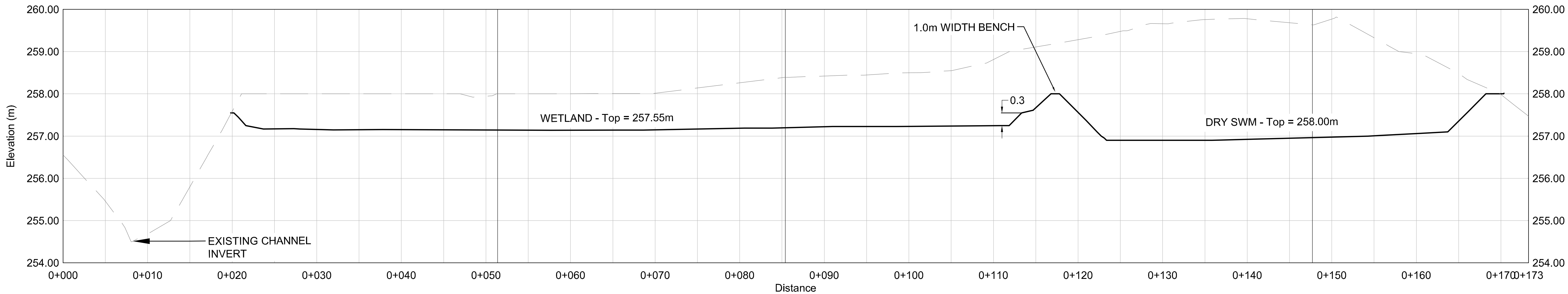
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

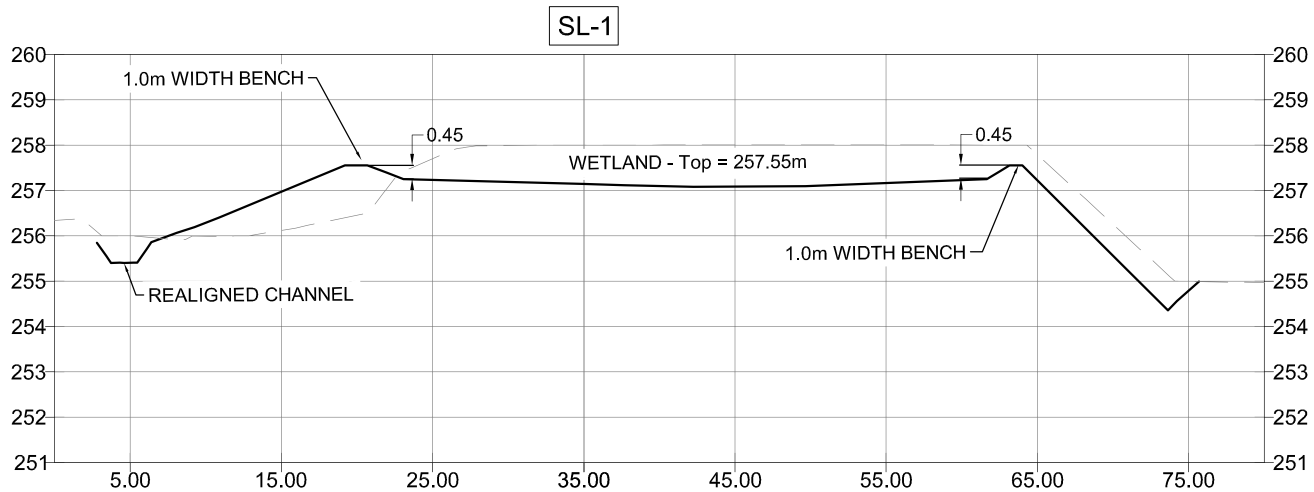
Charleston Homes
Glen Williams, Town of Halton Hills

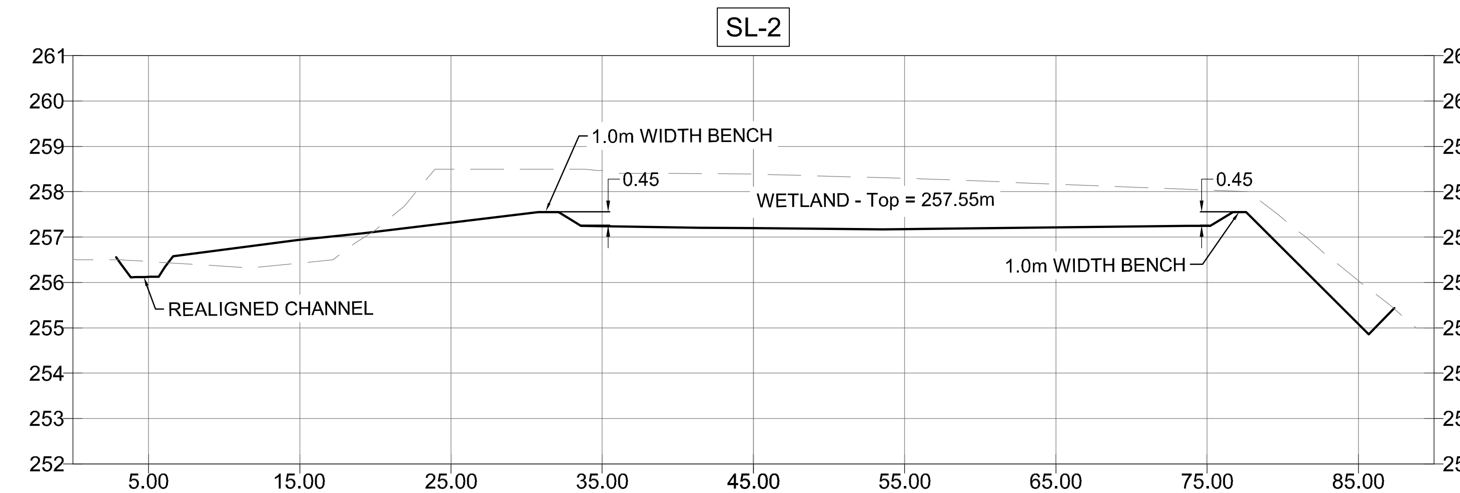
CONCEPTUAL SWM AND WETLAND COMPENSATION PLAN

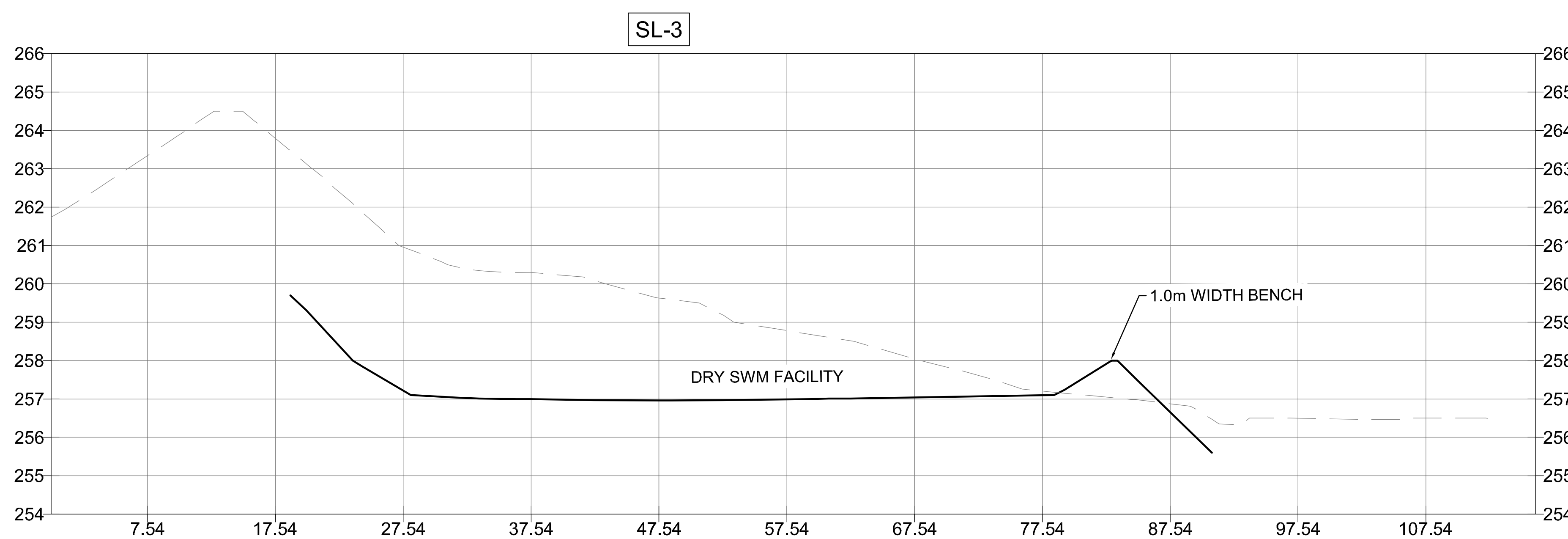
Date:	Project:	Technical:	Reviewer:	Drawn:
11/05/2018	155540-530	KM	SEB	AM

Figure A-1









Horz.: 1:500 Metres

5 0 5 10

Note: Drawing(s) must be used in conjunction with the attached report, Funtional Servicing Addendum Report - Glen Williams Phase 2, dated May 2017 and is subject to the limitations and conditions stated in the report.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Charleston Homes
Glen Williams, Town of Halton Hills

STORMWATER MANAGEMENT FACILITY PROFILE VIEW

Date:	Project:	Technical:	Reviewer:	Drawn:
24/05/2017	155540-530	KM	SEB	AM

Figure 8-2

Plot 1:1 = Tabloid (L)

F:\21006\155540-530\3 CAD\GIS\Matrix\1106-Phase 1 Pond Retrofit - Pr SWM Facility_incld wetland design_FEB 20 2018.dwg - Profile - Friday, February 23, 2018 10:31:15 AM - Alexander Miszczak

MEMORANDUM

To: Kelly Molnar **From: Sarah Mainguy**

Re: Proposed wetland compensation: Glen Williams **Date: 22 November 2017**

Background

Compensation wetlands are required to offset the removal of wetlands at the Glen Williams Phase II site. Wetland compensation is proposed in the areas shown in Figure 1. As requested by CVC, this memo describes the vegetation that occupies this proposed site. The vegetation is mapped on Figure 2.

Vegetation

Vegetation in the area proposed for compensation wetlands consists of three communities highly influenced by human activity: cultural plantation, cultural woodland and cultural meadow. Elements of wetland are also present on the west side of the creek, which is a mosaic of wetland and cultural upland communities. The vegetation on the east sides of the creek slopes very steeply down to the creek, such that there is almost no wetland east of the creek. The vegetation on the west side of the creek occupies a relatively flat floodplain that slopes upward to the conifer plantation to the west.

Cultural Meadow (CUM1)
Cultural meadow surrounds the SWM pond within the Phase I site, extending north beyond the property line as shown in the attached figure. The meadow is dominated mainly by Canada Goldenrod (*Solidago canadensis*) and Smooth Brome (*Bromus inermis*), with abundant Kentucky Bluegrass (*Poa pratensis*). Scattered plantings of White Spruce (*Picea glauca*) and White Pine (*Pinus strobus*) occur along the edges of the area adjacent to the private properties on the east side.

Cultural Woodland (CUW1)
Cultural woodland occupies the slope between the cultural meadow and the east edge of the creek, extending north along a filled slope to just beyond the property line. The creek is incised at the bottom of the slope, so that there are only scattered wetland species along the immediate edge. This community is dominated by widely-spaced Manitoba Maple (*Acer negundo*), with occasional Trembling Aspen (*Populus tremuloides*), Eastern Cottonwood (*P. deltoides*) Common Buckthorn (*Rhamnus cathartica*) and Staghorn Sumac (*Rhus typhina*). The understory is composed of similar species to those found within

cultural meadow, but includes large patches of Garlic-mustard (*Alliaria petiolata*). Trees range from approximately 5 cm dbh to approximately 30 cm.

Cultural Woodland/Thicket Swamp (CUW1/SWT2-2)
Vegetation on the relatively flat west edge of the creek is composed of a mosaic of cultural woodland and thicket swamp, indicating a transitional area between upland and wetland vegetation. Tree species consist of scattered Manitoba Maple, Black Walnut (*Juglans nigra*), American Elm (*Ulmus americana*) and Hybrid Willow (*Salix* x *rubens*). The shrub layer consists of Common Buckthorn and Guelder Rose (*Viburnum opulus*), with patches of shrub willows (*Salix* spp.). The understory consists mainly of Smooth Brome and Canada Goldenrod, with abundant Teasel (*Dipsacus fullonum*) and Elecampane (*Inula helenium*). There is no evidence of organic soils in this community.

Coniferous Cultural Plantation (CUP3)
Cultural plantation was observed from a distance, but was not investigated in detail as it is well outside the area proposed for wetland compensation. The canopy is dominated by White Spruce and White Pine, planted densely. The understory is very sparse.

Conclusions

The vegetation in the area proposed for wetland compensation indicates disturbed conditions. The communities noted in the area proposed for compensation would not qualify as significant woodland under the definition found in the Halton Region Official Plan.

The Halton Region Natural Heritage System incorporates the creek: it runs through the site and continues south of the site (Figure 1). Compensation would not be permitted in the NHS. The boundary of the NHS in this area should be reviewed in finer detail to ensure compensation is proposed outside the NHS.

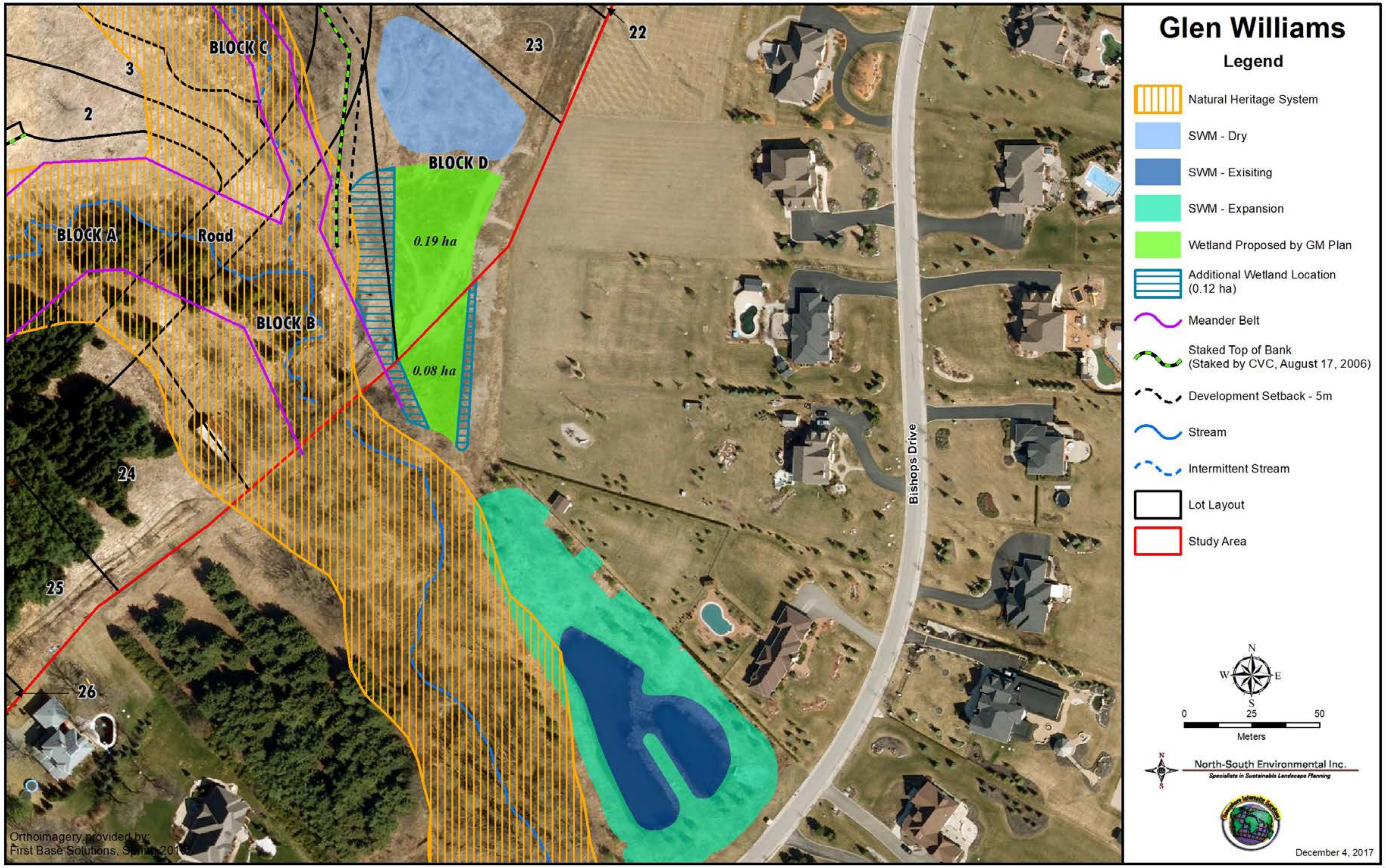


Figure 1. Natural Heritage System on the site and proposed site for wetland compensation

35 Crawford Crescent, Suite U5, P.O. Box 518, Campbellville, ON, Canada L0P 1B0
Ph: 905.854.1112   Fx: 905.854.0001   www.nsenvironmental.com

Figure 2. Ecological Land Classification of vegetation communities in the proposed area of wetland compensation (shown in Figure 1)

Credit Valley Conservation
inspired by nature

Credit Valley Conservation Authority

Date of Issuance: March 13, 2020 **PERMIT 20/059**

IN ACCORDANCE WITH:

ONTARIO REGULATION 160/06, PURSUANT TO SECTION 28 OF THE CONSERVATION AUTHORITIES ACT (R.S.O. 1990 Chapter C.27).

PERMISSION HAS BEEN GRANTED TO:

Owner Name:	1404649 Ontario Limited	**Tel:**	519	856-4009
Address:	143 Dennis Street, Box 760, Rockwood, N0B 2K0			
Agent Name:	McConnell Development Services Inc. c/o Mike Tasker	**Tel:**	647	808-1181
Address:	2430A Bloor St. West, Toronto, ON, M6S 1P9			
Property Location:	**12519 Ninth Line** **Part of Lot 23, Concession 10** **Town of Halton Hills**			

This permit is issued for the above noted property for the purpose of:

Development in the Regulated Area for the purpose of filling in 2 wetlands totaling 5,268.03 m² and associated grading works for works associated with Subdivision T83/008.

This permit is valid for 2 (two) years and is **subject to the following conditions:**

Expiry Date: **March 13, 2022**

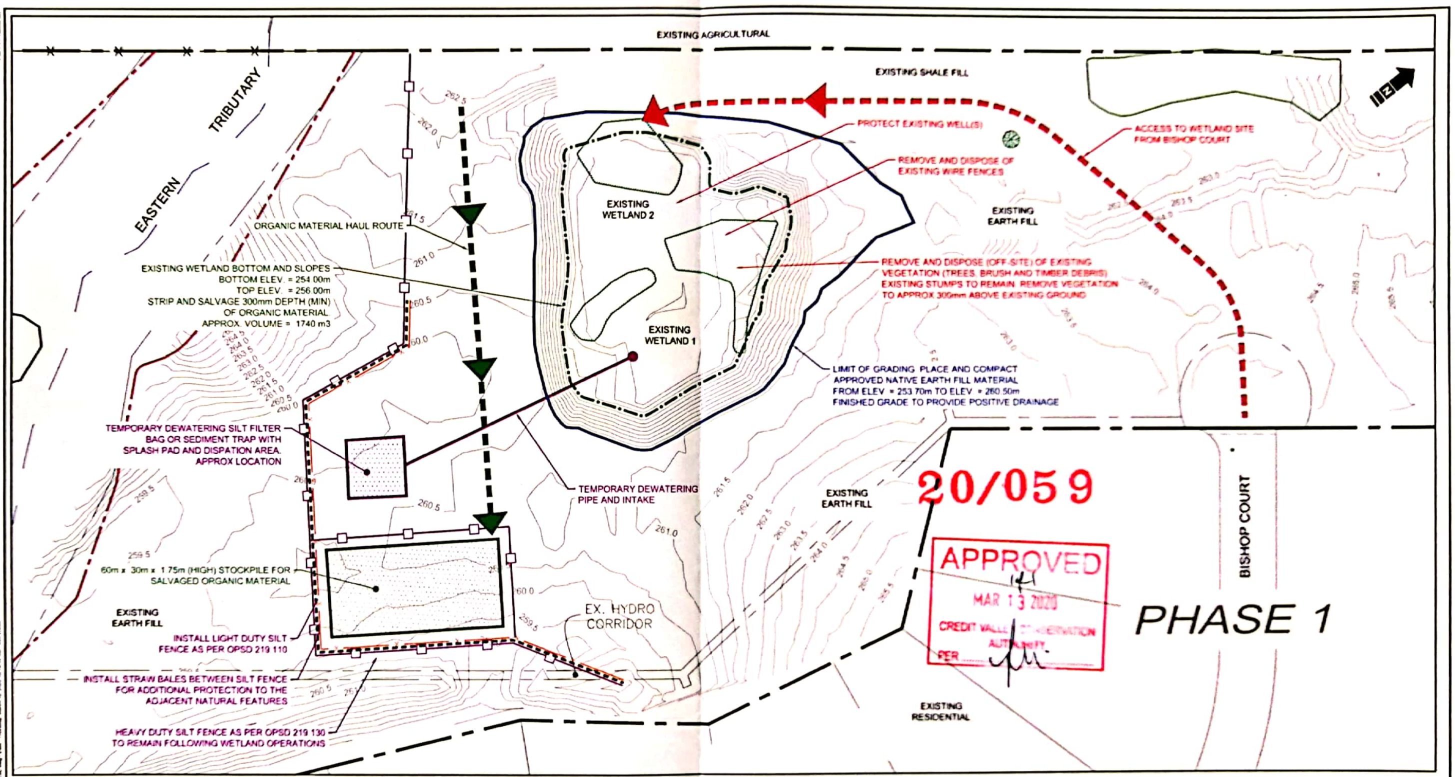
CONDITIONS:

1. That the work be carried out in accordance with the following plans which are marked: **20/059**
   - **Erosion and Sediment Control Plan, Figure 1, prepared by Matrix Solutions dated March 2020 stamped by CVC dated March 13, 2020**
2. That permission granted herein shall lapse on the above noted expiry date, unless the work for which the permission has been given has been completed. If the work has not been completed by the aforementioned date, this permit is invalid and all on-going and future work must cease and a new application be submitted to the Credit Valley Conservation Authority. New applications will be assessed in accordance with information, policies and practices in place as of the date of receipt of the new submission. What shall be deemed as "complete" is within the sole discretion of the Credit Valley Conservation Authority.
3. That the Credit Valley Conservation Authority be notified 48 hours prior to the commencement of any works and be notified of the completion of the project.
4. That appropriate erosion and sediment control measures must be installed prior to construction and maintained until all disturbed areas have been stabilized.
5. That all disturbed areas be stabilized and restored to existing conditions or better immediately upon completion of the works.

INSPECTIONS MAY BE CARRIED OUT BY CVC STAFF MEMBERS TO ENSURE THAT THE WORK IS UNDERTAKEN AND COMPLETED ACCORDING TO THE APPROVED PLANS.

Be advised that the Credit Valley Conservation Authority may, at any time, withdraw this permission, if, in the opinion of the Authority, the conditions of the permit are not being complied with. This approval does not exempt the property owner/applicant/agent from the provisions of any other Federal, Provincial or Municipal statutes, regulations or by-laws, or any rights under common law.

Regulations Officer



REFERENCE

1. EXISTING TOPOGRAPHY DERIVED FROM AEL ENVIRONMENTAL SURVEY COMPLETED JANUARY 2, 2020
2. LEGAL INFORMATION FROM VAN HARTEN SURVEYING INC. PLAN OF SURVEY OF PART OF LOT 23, CONCESSION 10, GEOGRAPHIC TOWNSHIP OF ESQUESING, TOWN OF HALTON HILLS, REGIONAL MUNICIPALITY OF HALTON HILLS. DATE: JANUARY 4, 2011
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LEGEND

- PROPERTY LINE
- EXISTING TREE LINE
- EXISTING CONTOUR (0.5m INTERVAL)
- EXISTING TRIBUTARY
- DEVELOPMENT LIMIT

1:1,250 metres
DATUM

Note: Figure(s) must be used in conjunction with the attached report and is subject to the limitations and conditions stated in the report.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

CHARLESTONE HOMES
GLEN WILLIAMS, TOWN OF HALTON HILLS

EROSION AND SEDIMENT CONTROL PLAN

Date	Project	Submitter	Reviewer
MARCH 2020	21006-ESC	P. CAMPBELL	S. BRAUN

Figure 1