Thousand Island Parkway (Greene) Subdivision
Preliminary Stormwater Management Report

Prepared for:

Greene's Electric, Plumbing & Heating Ltd.

Prepared by:

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Date: January 2025

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January 23, 2025

Dan Greene
Greene's Electric, Plumbing & Heating Ltd.
210 County Road 32,
Gananoque, ON
K7G 2V3

Regarding: Thousand Island Parkway (Greene) Subdivision
Preliminary Stormwater Management Report

Dear Mr. Greene,

The enclosed report details the existing and proposed drainage conditions and stormwater management controls for the proposed Thousand Island Parkway (Greene) Subdivision, located east of Gananoque, Ontario.

Thousand Island Parkway (Greene) Subdivision proposes 25 estate residential lots. Development of the subject site will result in an increase in impervious surfaces and could potentially impact stormwater quantity and quality.

It is recommended that a treatment train approach utilizing lot-level conveyance controls and enhanced swales be developed for the proposed development to mitigate any adverse water quantity and water quality effects that site runoff may have on the downstream network and natural environment.

Preliminary facility details are contained in this report, along with recommended maintenance procedures.

If you have any enquiries or wish to discuss further, please contact this office.

Sincerely,
FOREFRONT Engineering Inc.

Jeff Homer, P.Eng.
Civil Engineer
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FOREFRONT Signatures

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Report Prepared By:

Jeff Homer, P. Eng.

Table of Contents

Statement of Qualifications and Limitations
Letter of Transmittal

- OWIT Map

Appendix C

- 6 Hour SCS II - 100-Year Event Pre-Development Modeling
- 6 Hour SCS II - 100-Year Event Controlled Post-Development Modeling
- 24 Hour SCS II – 100-Year Pre-Development Modeling
- 25mm - 4 Hour Event Controlled Post-Development Modeling
- Stage – Storage Curve
- 25mm Event Velocity and Depth

1. Introduction

Forefront has assembled relevant supporting information for the proposed Thousand Island Parkway (Greene) Subdivision, located east of Gananoque, Ontario. The legal description of the land is Part of Lots 19 and 20, Concession 1, Part 1 of Registered Plan 28R-2382, in the Township of Leeds and the Thousand Islands, in the United Counties of Leeds and Grenville, Ontario. The subdivision is bounded by Thousand Island Parkway to the south, Highway 401 to the north, a residential neighborhood to the west, and a retirement residence to the east. Refer to Figure 1: Location Plan for the site location.

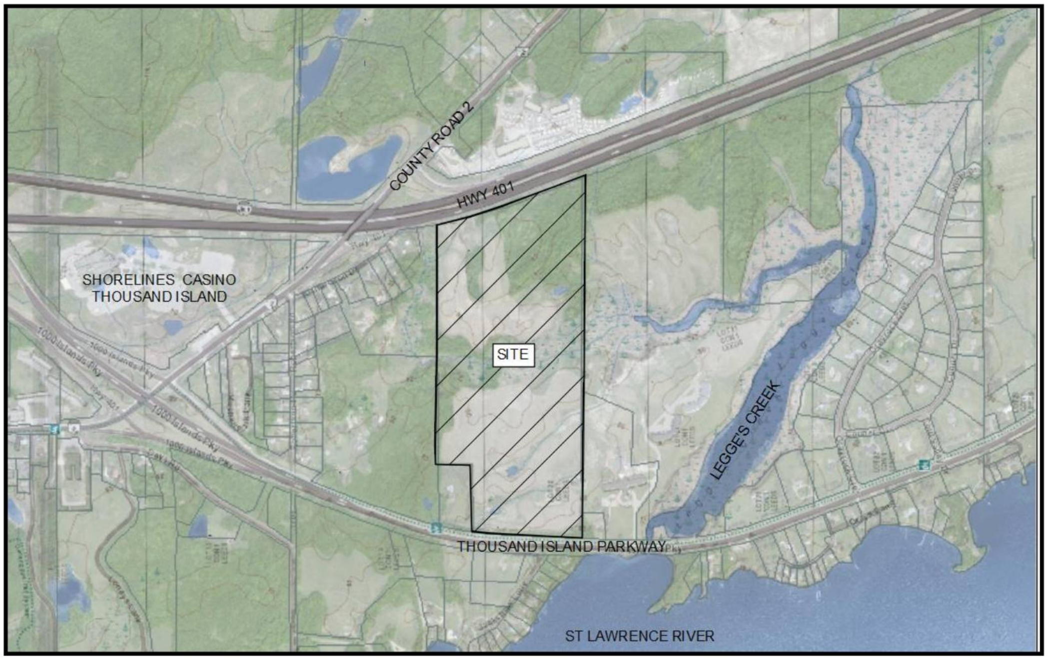


Figure 1: Location Plan

The proposed Thousand Island Parkway (Greene) Subdivision proposes 25 estate residential lots, a proposed road with a single connection to Thousand Island Parkway with an additional cul-de-sac extending at the north of the site. Roadside ditches are proposed throughout. The site area is approximately 28.10 ha.

The development of Thousand Island Parkway (Greene) Subdivision will result in an increase in impervious surfaces and could potentially impact stormwater quantity and quality. This development may have potential impacts on the natural drainage and environment.

This Stormwater Management Report proposes a plan to address stormwater management concerns and minimize the impacts on the natural drainage and environment. The report recommends mitigation measures and provides preliminary recommendations for the design of the site.

Refer to **Appendix A**, **Draft Plan** and **Concept Plan** for the proposed development plan.

2. Existing Site Condition

The subject site area is rural, comprising agricultural land interspersed with woodland. A major watercourse and Provincially Significant Wetland (PSW) run through the middle of the site. The major watercourse is a branch of Legge's Creek.

The total area of the site is approximately 28.10 hectares. The site's topography generally slopes toward the centre, directing drainage toward the Legge's Creek PSW.

The Soil Survey of Leeds County identifies the soil cover in this area as primarily Napanee Clay with a portion of the site being rockland. Napanee Clay is considered poor draining soil since the clay texture restricts the movement of percolating water. Refer to the **Soil Survey Map** provided in **Appendix B** for further details. The soil depth of rockland is typically characterized as 0.3 m of topsoil on bedrock. The majority of the rockland area is within the PSW area.

According to the Cataraqui Source Protection Plan, the subject site and outlet are not located within an intake protection zone (IPZ) or wellhead protection area (WHPA). The site is considered a highly vulnerable aquifer (HVA) with a vulnerability score of six and is located within a Significant Groundwater Recharge Area (SGRA) having a score of four. HVA and SGRA account for 90% of the entire Cataraqui Source Protection Area and are characterized by thin soils on fractured bedrock. Refer to the **Source Water Protection Map** in **Appendix B** for reference. As the vulnerability scores are less than eight, the risk is considered low. Where a vulnerability score for HVA and SGRA is four or less there is no threat.

Given the proposed activity involves small-scale (< 30 ha) rural residential stormwater management practices, little to no source water threats are anticipated from stormwater infiltration or runoff.

A branch of the Legge's Creek watercourse and PSW (herein referred to as the major watercourse) traverses the site from west to east. This major watercourse is a tributary of Legge's Creek PSW, which outlets to the St. Lawrence River directly southeast of the site. According to the Environmental Impact Statement (EIS) prepared by Ecological Services, there is potential for fish habitat within the major watercourse.

The details of the upstream external catchment area were obtained from The Ontario Watershed Information Tool (OWIT). Refer to the **OWIT Map** in **Appendix B** for reference. Discussions with the CRCA indicate a floodplain analysis has not previously been completed for Legge's Creek. Further discussion of the upstream external catchment area and the major watercourse floodplain is provided below in Section 4.0 of this report.

The major watercourse connects to Legge's Creek and ultimately the St. Lawrence River. According to CRCA *Lake Ontario / St. Lawrence River Shoreline 100-Year Flood Level and Wave Uprush*, the 100-year floodplain elevation of the St. Lawrence River is identified as 75.9 m.

A minor watercourse with unevaluated wetland cells is located in the southern portion of the site draining to Legge's Creek. Discussions with the CRCA have indicated that the southern minor watercourse and unevaluated wetland cells are to be preserved.

The subject site is approximately 28.10 ha in area. Including external areas, the catchment area to **Outlet 1** is approximately 511.97 ha.

All drainage from the site ultimately flows to the Legge's Creek PSW herein referred to as **Outlet 1**. Minor catchment areas are delineated based on the site's topography and drainage patterns, with several intermediary outlets, designated as Outlet 1A, 1B, and 1C are analyzed.

- **Catchment Areas E1A and EX.1A:** The site catchment area (10.69 ha) and external catchment area (1.22 ha) drain directly to the major watercourse, referred to as Outlet 1A.

- **Catchment Area E1B:** This site catchment area (4.86 ha) drains to a minor watercourse in the northwest corner of the site, referred to as Outlet 1B, which eventually connects to the major watercourse.

- **Catchment Areas E1C and EX.1C:** The site catchment area (8.36 ha) and external catchment area (2.65 ha) drain to a minor watercourse referred to as Outlet 1C, which drains to the major watercourse east of the subject site.

- **Upstream External Catchment Area and Bypass:** Approximately 480.0 ha is included in the upstream external catchment area, and a site area of 4.19 ha is included in the bypass area for a combined area of 484.19 ha.

Refer to **Figure 2**: **Pre-Development Catchment Areas** in **Appendix A,** and **Pre-Development Modeling Schematic** for further details regarding pre-development conditions.

3. Proposed Development

The proposed Thousand Island Parkway (Greene) Subdivision proposes 25 estate residential lots, a proposed road with a single connection to Thousand Island Parkway with a cul-de-sac extending at the north of the site. Roadside ditches are proposed throughout.

Development will result in an increase in impervious surfaces and could potentially impact stormwater quantity and quality. This development may have potential impacts on the natural drainage and environment.

Given the topography of the site and the site having several outlets, a number of conveyance controls are required to maintain the flow regime to pre-development conditions. Outlets that experienced concentrated flows and sheet flows under pre-development conditions are expected to retain relatively similar flow characteristics post-development.

3.1 Drainage Plan

Roadside, side yard, and rear yard ditches are proposed throughout the development. Areas proposed for development will drain to roadside ditches with the remaining areas generally being intercepted by side yard and rear yard swales.

Enhanced swales are proposed within the municipal right-of-way and are to be sized to convey the minor and major storm events including for 0.3m of freeboard. Driveway culverts are to be sized for minor (5-year) storm events. Cross culverts passing under the road are to be sized for up to the major (100-year) event. Refer to **Appendix A**, **20m Typical Right of Way** detail for the proposed right-of-way details.

Quantity and quality controls are proposed. Post-development peak flows are to match pre-development levels for all storm events up to the major storm event.

A "treatment train" approach is proposed combining several best management practices (BMPs). Lot-level conveyance controls such as disconnected downspouts draining to side yard grass swales are proposed to promote infiltration onsite to the extent feasible. Conveyance controls in the form of hybrid enhanced swales/dry ponds with check dams having a flat bottom cross-section with gentle longitudinal slopes are proposed within the municipal right-of-way to provide quality control and quantity control.

Concentrated outlet locations will be enhanced with rip-rap and geotextile to prevent erosion downstream. No direct quality or quantity control is proposed for drainage areas external to the development.

The design of the enhanced swales is as per the Ministry of the Environment, Conservation and Parks (MECP) *Stormwater Management Planning and Design Manual* (2003) and the *Low Impact Development (LID) Stormwater Management Planning and Design Guide* by the Toronto and Region Conservation Authority (TRCA, 2010). Enhanced swale design recommendations by the TRCA are provided in the **Enhanced Swale Fact Sheet** provided in **Appendix A**. Detailed design of the enhanced swale BMPs is to be included in the final engineering drawings, preliminary details are provided herein.

As per the TRCA manual, infiltration based LID practices (bioretention, infiltration basins, soakaways, etc.) are not recommended where they would come in contact with shallow bedrock or where soils are poorly draining. Runoff from residential rooftops is considered moderately clean water and should be treated with some level of filtration via swales prior to discharge or infiltration. Runoff from rear yards is considered relatively clean cool water and is considered suitable for direct discharge to receiving watercourses.

Lot-level conveyance controls and further details will be provided during the detailed design of the grading and drainage of these areas. These details will be depicted on the final engineering drawings.

Enhanced swales are recommended to have a minimum slope of 0.5% to a maximum slope of 6%, and side yard swales are to have a minimum slope of 1.0%. To address potential long-term ponding, a subdrain is proposed at the rock check dams.

Refer to **Appendix A**: **Figure 3** and **Figure 4**; Proposed Minor Catchment Areas and Proposed Major Catchment Areas, for the post-development condition details including preliminary swale sizing and culvert calculations. Figure 3 includes roadside ditch and culvert sizing calculations. Refer to **Post-Development Schematic** in **Appendix A** for reference. Refer to **Figure 6 Rear Yard Swales Plan and Profile** for further preliminary rear yard swale design details.

3.2 Quantity

Urbanization leads to an increase in impermeable surfaces (rooftops and parking areas). The resultant increased peak flows increase the risk to life, environment, and property damage. Water quantity control is generally required when there may be downstream quantity impacts.

Consistent with general stormwater management practices, stormwater quantity and quality control are both proposed for the development. Post-development flows will be maintained to pre-development levels for all storm events up to and including the 100-year design event. Minor storm drainage systems will be designed for the 5-year design event in accordance with general stormwater management practices. Major overland flow paths are to convey the 100-year storm event.

3.2.1 Analysis

The hydrologic and hydraulic analysis for the site was conducted using a recent version of the U.S. Environmental Protection Agency's StormWater Management Model (SWMM5). The model has been widely used in similar stormwater management analyses in Ontario and is recognized as a reliable modeling technique for estimating pre-development and post development hydrologic and hydraulic responses for both rural and urban watersheds.

- Hydrology: the generation of stormwater runoff from the various catchment surfaces in response to rainfall. The hydrologic module of SWMM5 was used in this study to simulate the surface runoff and abstraction characteristics of land surfaces (i.e., evapotranspiration, infiltration, and surface storage) in response to meteorological inputs. It is a dynamic computer model that uses a non-linear reservoir approximation to represent overland flow. The hydrology module requires input data that describes the characteristics of local rainfall, overland flow, land use, and soil properties. Results include flow hydrographs for sub-catchment areas that were used as input to the hydraulic routing module.

- Hydraulics: the conveyance, attenuation, and routing of stormwater through the collection system and storage/treatment facilities. The hydraulic module of SWMM5 was used in this study to represent the complex hydraulics of open channel watercourses, piped collection systems, surface storage, overland flow routes, and SWM facilities (including swales, detention/retention ponds and associated control structures such as orifices and weirs). It is a dynamic computer model that accounts for the conservation of mass and momentum using the Saint-Venant equations for gradually varied unsteady flow.

Note that in SWMM5, the time of concentration is not explicitly calculated as in other models. Instead, it is embedded within the model's computations through the kinematic wave dynamic flow equation, which considers the catchment geometry and hydraulic properties. In SWMM5, the value referred to as 'time of concentration' in the output is more accurately described as 'time to peak,' as it is influenced by the rainfall hyetograph, including event duration and intensity, as well as the catchment characteristics.

3.2.1.1 Design Storm Events

Design storm events were based on IDF rainfall statistics that describe the frequency of rainfall depths over a specified duration. Rainfall intensities with various durations and return periods for the site were obtained from the latest Environment Canada Kingston East Short Duration Rainfall Intensity-Duration-Frequency Data, see **Appendix B**: **Short Duration Rainfall Intensity-Duration-Frequency Data (6104175, 2022)**. Using these rainfall intensities, rainfall hyetographs were developed for each return period with a 6-hour SCS Type II distribution. The 6-hour SCS II distribution is to be used as it is the more conservative event for sizing the quantity storage requirements and is appropriate given the size of the subdivision catchment area. The 24-hour 100-year event is appropriate for assessing the floodplain given the size of the upstream rural catchment area.

The design storm events include:

- 2-year return period / 6-hour duration: 34.9 mm
- 5-year return period / 6-hour duration: 46.3 mm
- 100-year return period / 6-hour duration: 77.5 mm

As noted above, the 24-hour SCS Type II distribution was also analyzed. The 6-hour SCS Type II distribution is the most conservative and appropriate distribution given the subdivision catchment size (< 30 ha) and characteristics. The 24-hour SCS Type II is used for assessing the floodplain.

The design considers the 2-year, 5-year, and 100-year design storm events. The 2-year is reviewed to address low-intensity storms typically associated with erosion control. The 5-year is chosen to evaluate mid-range intensities relevant to the conveyance system design. The 100-year event is included to ensure protection against flooding during significant events. Together these events provide a comprehensive assessment of the stormwater management system's performance under a range of conditions.

An additional "Erosion Control" design storm (also known as the 90th percentile event or first flush) was used in this study, defined as a small, frequent storm representing 25 mm of rainfall over a short duration. Based on long-term rainfall observations in Southern Ontario, 90-95 percent of all rainfall events have a total rainfall depth of 25 mm or less. This rainfall amount over a 4-hour duration has an approximate 6-month return period in this region.

<u>Water Balance</u>

Site constraints for the use of water balance strategies include shallow bedrock and potentially shallow seasonal water table. Water balance criteria have not been recommended as part of an area-specific assessment study, natural heritage study or Class EA. For all of the above noted reasons the use of water balance LIDs is limited onsite and in general is not recommended in this case. Disconnected roof leaders, lot-level grass swales, and enhanced swales are recommended throughout to promote infiltration to the extent feasible.

As per the MECP guidelines and CLI-ECA *Appendix A Stormwater Management Criteria*, where the use of infiltration and retention LID strategies are limited in obtaining water balance, conventional stormwater management practices are to be utilized and are proposed.

3.2.1.2 Hydrology

In order to reflect the unique hydrologic properties within each sub-catchment, a variety of surface cover types were defined. The surface cover types used in this study are described as follows:

- Forest: Forest/meadow, heavy vegetation with high transpiration rates and a deep root zone.
- Grass: Grass/turf, light vegetation, cultivated or landscaped areas with a shallow root zone.
- BioRet: Bioretention, rain garden, or planter with engineered soil/media and underdrain system. This can be used to represent LID source control facilities.
- Bare: Un-vegetated soil, loose granular materials, or legacy compacted fill
- GrnRoof:Building structures with vegetated roof. This can be used to represent LID source control facilities.
- RegRoof: Building structures with regular rooftop construction and materials.
- Ex Bed Rock: Exposed Bedrock.
- PrmPave: Permeable paved surfaces with underdrain system. This can be used to represent LID source control facilities.
- ImpPave: Regular impermeable paved surfaces with underdrain system. (i.e. roadways, parking, driveways).
- Gravel: Gravel and compacted granular in traffic areas.
- Wetland: Hydrologic parameters reflect an area that is roughly half open water and half heavily vegetated.
- Water: Open water surface, including Stormwater Management Facility detention facilities.

For existing and proposed conditions, surface cover types were interpreted using available mapping and aerial imagery of the subject site. Characteristic hydrologic properties were assigned to each surface cover type as shown in **Appendix B Table 3-1: Surface Cover Parameter Calculations** based on literature values and similar studies throughout North America.

Infiltration parameters were determined for the Green-Ampt method based on soil texture properties. For this development, clay characteristics consistent with Clay were used. Values are taken from the source: *Rawls, W.J. et. al., (1983), Journal of Hydraulic Engineering, 109:1316.* Infiltration parameters include:

- Capillary tension, a measure of how tightly water is held within the soil pore space;
- Saturated hydraulic conductivity, a measure of how quickly the water can be drained vertically; and
- Porosity (or initial soil water deficit), the volumetric fraction of water within the soil pore space under initially dry conditions.

The parameters for Napanee Clay are shown in Table 3-2.

Table 3-2 Infiltration Parameters

Texture	Capillary Tension		Saturated Hydr. Conductivity		Porosity
	In	mm	in/hr	mm/hr	
Clay	12.45	315	0.02	0.06	0.203

Based on the drainage characteristics of the soil of the site, there is limited to moderate opportunity for infiltration. The Soil Survey of Leeds County considers Napanee Clay poor draining soil.

3.2.1.3 Pre-Development Flows

Based on Table 3-1 in **Appendix B** and the existing catchment conditions in Table 3-3, pre-development flows were calculated for the existing development.

Table 3-3 Existing Conditions

Hydrologic Units - Existing Conditions						
Hydrologic Unit	Description	Area (ha)	% Impervious	Catchment Length (m)	Average Width (m)	Average Grade(%)
Outlet 1						
E1A	Subject Site (North of Wetland)	6.93	7.8	224	311	3.0
E1A	Subject Site (South of Wetland)	3.76	7.8	162	232	2.0
E1B	Subject Site	4.86	6.0	226	215	7.1
E1C	Subject Site	8.36	7.6	327	256	1.4
EX.1C	External Residence	2.65	7.6	265	100	5.0
EX.1A	External Woodland	1.22	5.0	167	73	8.0
EXT Upstream	OWIT Catchment Area & Bypass	484.19	11.3	6,621	725	4.5
Total	**Total Study Area to Outlet 1 (ha):**	**511.97**				
	Total Site Area (ha):	**28.10**				
	Total Exterior Area (ha):	**483.87**				
	Total Study Area (ha):	**511.97 ha**				

Results in Table 3-4 quantify the pre-development peak rate of surface runoff that has been routed through the collection system, eventually discharging to the various outlets downstream. Results are grouped by outfall location for all the rainfall events.

Table 3-4 Peak Flows in Predevelopment Conditions

Peak Flows in Pre-Development Conditions (m^3/s)					
Outlet	Area (ha)	% Imp.	1:2 Year Storm	1:5 Year Storm	1:100 Year Storm
			6-hour SCS II	6-hour SCS II	6-hour SCS II
Outlet 1A – Major Watercourse	500.96	11.2%	0.79	1.53	4.74
- E1A & EX.E1A	11.91	7.5%	0.07	0.22	0.91
- E1B	4.86	6.0%	0.03	0.09	0.42
Outlet 1C – Minor Watercourse	11.01	7.6%	0.05	0.14	0.54
Total Study Area to Outlet 1	**511.97**		**0.84**	**1.67**	**5.28**
Note: Areas are sub-catchments of Outlet 1A					

Refer to the **6-hour SCS II 100-Year Event Pre-development Modeling** in **Appendix C** for further pre-development modeling details.

3.2.1.4 Post-Development Flows

The proposed development will increase the imperviousness of the site and hence the runoff. Based on **Table 3-1** in **Appendix B**, **SK.1 Impervious/Pervious Area Calculations** in **Appendix B**, and the proposed catchment conditions in Table 3-4 post-development flows were calculated for the proposed development.

Table 3-5 Proposed Conditions

Hydrologic Units - Post-Development Conditions						
Hydrologic Unit	Description	Area (ha)	% Impervious	Catchment Length (m)	Average Width (m)	Average Grade(%)
Outlet 1						
P1A	Subject Site (Controlled)	4.38	25.0	367	120	3.0
P2A	Subject Site (Uncontrolled)	3.28	8.0	145	226	5.5
P3A	Subject Site (Controlled)	1.86	8.0	83	224	3.0
P1B	Subject Site (Uncontrolled)	4.14	8.0	105	394	7.6
P1C	Subject Site (Controlled)	3.30	8.0	179	184	0.5
P2C	Subject Site (Controlled)	4.45	25.0	281	152	0.7
P3C	Subject Site (Uncontrolled)	0.83	8.0	98	85	2.0
P4C	Subject Site (Uncontrolled)	1.67	8.0	127	131	4.0
EX.1C	External Residence	2.99	7.6	269	100	5.0
EX.1A	External Woodland	0.88	5.0	168	52	8.0
EXT Upstream	OWIT Catchment Area & Bypass	484.19	11.3	6620	725	4.5
Total	**Total Study Area to Outlet 1 (ha):**	**511.97**				
	Total Site Area (ha):	**28.10**				
	Total Exterior Area (ha):	**483.87**				
	Total Study Area (ha):	**511.97**				

Results shown in Table 3-6 quantify the peak rate of surface runoff that has been routed through the collection system, ultimately discharging to **Outlet 1A, 1B and 1C**. Results are grouped by scenario and outfall location for all the rainfall events.

Table 3-6 Uncontrolled Peak Flows in Post-Development Conditions

Uncontrolled Peak Flows in Post-Development Conditions (m^3/s)						
Outlet	Area (ha) (incl. External)	% Imp.	25mm-4-hour Storm	1:2 Year Storm	1:5 Year Storm	1:100 Year Storm
				6-hour SCS II	6-hour SCS II	6-hour SCS II
Outlet 1A – Major Watercourse	498.73	11.2%	N/A	0.85	1.71	5.07
- P1A, EX.P1A & P2A	10.40	14.9%	0.13	0.12	0.34	1.13
- P1B	4.14	8.0%	0.02	0.04	0.15	0.52
Outlet 1C – Minor Watercourse	13.24	13.6%	0.12	0.08	0.19	0.74
Total Study Area to Outlet 1	511.97		N/A	0.93	1.90	5.79

Note: Areas are sub-catchments of Outlet 1A

Refer to the **6-hour SCS II 100-Year Event Controlled Post-Development Modeling** in **Appendix C** for further modeling details.

Peak flows outletting from the proposed enhanced swales at **Outlet 1A** and **1C** shall be limited to pre-development peak flows.

Results shown in Table 3-7 quantify the quantity control volumes required to limit post-development flows to pre-development levels for the proposed development.

No formal quality or quantity controls are proposed for external catchment areas.

Table 3-7 Comparison of Uncontrolled and Controlled Peak Flows in Post Development

Storage Calculation Summary						
Outlet	**1:2 Year Storm**		**1:5 Year Storm**		**1:100 Year Storm**	
	Post Controlled (m^3/s)	Quantity Storage (m^3)	Post Controlled (m^3/s)	Quantity Storage (m^3)	Post Controlled (m^3/s)	Quantity Storage (m^3)
Enhanced Swale - Outlet 1A	0.07	305	0.22	445	0.91	950
Enhanced Swale - Outlet 1C	0.05	220	0.14	390	0.54	520

Conveyance controls and storage systems are proposed to limit post-development peak flows from Table 3-7 to pre-development levels. Storage is to be provided by enhanced swales prior to discharging at **Outlets 1A and 1C**.

Rear yards are proposed to discharge directly to the outlets bypassing the enhanced swales. Additional storage is provided in the right-of-way enhanced swales to ensure post-development peak flows equal pre-development peak flows for the entire site.

Quantity control storage within the enhanced swales is to be provided by a system of rock check dams. The north enhanced swale draining to **Outlet 1A** is to range from 0.5% to 6.0% slope with a 1.0m flat bottom and 3H:1V side slopes. The south enhanced swale draining to **Outlet 1C** is to range from 0.5% slope to 6.0% with a 1.0m flat bottom and 3H:1V side slopes. Periodic 400 mm diameter equalizing culverts crossing Street A are recommended to be placed along the length of the enhanced swales to optimize storage and conveyance.

The road and major overland drainage paths are to be designed for up to the 100-year storm event and are to be protected at the inlet and outlet with rip rap.

The design of grading, drainage, and landscape works will be finalized during the detailed design/approval process.

Quality and quantity control for the site is provided by a treatment train approach with flow attenuation primarily provided by the enhanced swales.

Modeling of the 100-year Event for the pre-development and post-development conditions are included in **Appendix B** and **Stage Storage Curves** are provided in **Appendix C**.

3.3 Water Quality

The Stormwater Management Planning and Design Manual by the Ministry of the Environment, Conservation and Parks (MECP) describes various levels of protection of water quality, based on a general relationship between the end-of-pipe stormwater management facility's long-term suspended solids removal and the lethal and chronic effects of suspended solids on aquatic life.

Based on the characteristics of the receiving watercourse, Enhanced Protection (corresponding to the end-of-pipe storage volumes required for the long-term removal of 80% of total suspended solids (TSS)) is required. Stormwater management measures will be implemented to provide in excess of 80% long-term removal of suspended solids.

3.3.1 Enhanced Grassed Swales

Enhanced grassed swales are proposed located within the right-of-way. Quantity control for the lots is provided via the enhanced swale and rock check dams noting that the enhanced swale provides additional retention for larger storm events. Runoff from rear yards is considered relatively clean cool water and is suitable for direct discharge to receiving watercourses.

Enhanced grass swales are a low-impact-development type of stormwater management control. The MECP Stormwater Design Manual (2003), TRCA *Low Impact Development Stormwater Management Planning and Design Guide* (2010), and the Environmental Protection Agency (EPA) website have been used as our terms of reference.

Unlike the general MECP Table 4.3 manual approach which proposes volume recommendations for quality control and a minimum 24-hour drawdown time, enhanced swales are flow rate-based and are to be designed to certain flow criteria and not actually retain a specific volume for quality control. Enhanced swales treat flows through vegetation slowing the water to allow sedimentation and filtering through a subsoil matrix. Rock check dams have been included in the design to promote the treatment quality and further reduce velocities. 100 mm diameter subdrain is provided at the check dams to ensure the flow depth during the 25 mm event is less than 100 mm on average and the flow velocity is below ±0.5 m/s.

Where soil conditions allow, enhanced swales can also encourage infiltration into the underlying soils over a 24 to 72-hour period. In cases where soil conditions do not permit infiltration at the check dams, or where the slope is relatively flat, a subdrain at the rock check dam is recommended. It is recommended that the rock check dams include a subdrain to allow the enhanced swales to drain over 24 to 72 hours during low-flow events.

The TRCA LID guidelines recommend a maximum ratio of impervious drainage area to treatment facility area in the range of 10:1 for enhanced swales. For the proposed site, this ratio is less than 5:1, well within the recommended range.

Stormwater runoff onsite will be directed to a 1.0 m wide flat bottom enhanced swale with 3H:1V side slopes located within the right-of-way. Regular 0.3 m weir rock check dams are proposed at regular intervals where the enhanced grade is 0.5% to 6.0%. Rock check dams are to be sized to reduce peak flow velocities to 0.5 m/s during the 25 mm storm event.

Refer to **Appendix A**, **Figure 5 Street A Plan and Profile** and the **Enhanced Swale Fact Sheet** for further preliminary enhanced swale design details.

Pollutant removal in excess of 80% of suspended solids is anticipated. The EPA estimates the following removal rates for various pollutants for enhanced swales:

Total Suspended Solids: 81%
Total Phosphorous: 29%
Nitrate Nitrogen: 38%
Metals: 14% to 55%
Bacteria: 50%

The enhanced grass swales include the following features:

- Flow depth of less than 100 mm and flow velocities below 0.5 m/s during the 25 mm 4hr design storm
- Flow depth of ±500 mm under peak flow conditions for the 6 hours SCS II 100-year event
- 1.0 m wide flat bottom ditch
- The interior side slopes of the enhanced swale are 3:1 (H:V).
- 0.3m of freeboard has been provided for the banks
- 0.3% to 1.0% swale slope
- A manning's 'n' of 0.035 for a low maintenance swale
- 0.3 m high rock check dams with 100 mm subdrain for additional retention

Refer to the **25 mm Event - Depth and Velocity Curves** in **Appendix C**, demonstrating that the depth for the 25 mm event is less than 100 mm and the velocities are less than 0.5 m/s.

In addition to providing quality control, quantity control storage within the enhanced swales is to be provided by a system of rock check dams. The north enhanced swale draining to **Outlet 1** is to be approximately 0.5% slope up to 6.0% with a 1.0m flat bottom and 3H:1V side slopes. The south enhanced swale draining to **Outlet 1C** is to be approximately 0.5% to 6.0% slope with a 1.0 m flat bottom and 3H:1V side slopes. Rock check dams are to be placed approximately every 30 m to 60 m dependent on the slope of the swale. Regularly spaced 400 mm diameter equalizing culverts crossing Street 'A' are recommended to be placed along the length of the enhanced swales to optimize storage and conveyance.

In summary, a treatment train approach to stormwater management is proposed, in alignment with MECP guidelines, incorporating measures for water quality, erosion control, and quantity control. The quality control strategy aims to provide enhanced protection by achieving an 80% reduction in total suspended solids. Protection against the 25 mm event (90th percentile event) will also be provided, in accordance with MECP guidelines, offering additional pollutant removal and erosion control benefits. Quantity controls are designed to ensure that post-development runoff matches pre-development flow conditions up to the 100-year event. By maintaining pre-development flow levels at each outlet, there will be no increase in flood risk downstream. This proposed stormwater management strategy ensures that runoff from the subdivision will not negatively impact the natural environment or downstream infrastructure.

Site constraints for the use of water balance strategies include shallow bedrock and tight soils. Disconnected roof leaders, lot-level grass swales, and enhanced swales are recommended throughout to promote infiltration to the extent feasible.

3.3.2 Maintenance

Periodic maintenance inspection of the facilities (roadside ditches, enhanced swales, level spreader) should be undertaken and annual maintenance reports should be completed by the Municipality. The report should provide a summary of the following items:

- Observations resulting from the inspection of the facility over the course of the year. These observations should include comments on the:
  - hydraulic operation of the facilities (detention time, evidence or occurrence of overflows)
  - condition of vegetation in and around facility
  - occurrence of obstructions at the inlet and outlet
  - evidence of spills and oil/grease contamination
  - frequency of trash build-up;
- Measured sediment depths in the facilities;
- Maintenance and operational control undertaken during the year;
- Recommendations for inspection and maintenance program for the coming year.

The enhanced grass swales will require routine periodic maintenance including weed control, grass cutting and trash removal at least twice per year. Removal of accumulated sediment, and replacement of the rock check dams will be required when clogging occurs. The grass should be maintained at minimum height of 100 mm to promote quality control. Removal of sediment should be completed when exceeding a depth of 25 mm. The lifespan of the sub-drain (where utilized) largely depends on the efficiency of the annual maintenance and should be replaced when the homeowners notice ponding on a regular basis in the facility after the annual sediment removal has taken place.

4. Major and Minor Watercourses

4.1 Major Watercourse

Drainage from an upstream external rural drainage area is conveyed through the site from west to east connecting to Legge's Creek PSW. The following hydrologic and hydraulic analysis is provided to determine the 100-year high water level for the major watercourse and PSW within the subdivision limits in order to prevent unwanted encroachment into the floodplain.

An existing access lane with a 600 mm diameter equalization culvert crosses the major watercourse on the subject site. The 600 mm culvert was partially submerged during a site review. The hydraulic analysis revealed that there is an overtopping (relief flow) at a low point of the access lane during the 100-year rainfall event.

The major watercourse and PSW high-water level within the development area varies in width and depth. A natural shallow meandering watercourse approximately 1 m wide with an average depth of 0.3 m traverses the wetland area. This shallow channel is expected to convey the majority of annual rainfall events throughout the year while overtopping into the greater PSW area during significant storm events.

At the widest section of the watercourse and wetland near station 0+200, the high-water level opens up to a width of ±90 m across within the wetland area, while upstream at section 0+400 narrows to ±12 m in width.

Given the size of the upstream catchment area and variation in the watercourse and wetland characteristics, a sensitivity analysis was performed to confirm the reasonableness of parameter estimates.

<u>Background Information</u>

From discussion with the CRCA staff, it is understood that Legge's Creek and the adjacent area do not have a completed floodplain study. Water Survey of Canada does not maintain a hydrometric gauge within Legge's Creek watershed. The Ontario Watershed Information Tool (OWIT), Soil Survey of Leeds County, and LIDAR are used as the basis for the following hydrologic and hydraulic study. A narrowly scoped topographic survey was conducted in the vicinity of the road crossing and 600 mm diameter culvert.

Soil information for the study area was obtained from the Soil Survey of Leeds County. The soil in this area is defined as Napanee Clay and rockland. Napanee Clay is classified as having poor infiltration. Rockland is considered rapidly draining.

4.1.1.1 Hydrology

The external rural catchment area draining to the major watercourse is approximately 480 ha at the north limit where the watercourse enters the site south of Highway 401, and approximately 500.96 ha at the east limit of the site near the access road crossing. The catchment is divided into two sub-watersheds to estimate peak flows at the two locations.

According to the OWIT mapping, the length of the main channel where is crosses Highway 401 is approximately ±6.5 km. The maximum elevation at the upstream study area is ±111 m with a downstream elevation of ±75.4 m within the site. The average slope of the major watercourse is ±0.5%, with an average slope within the catchment area of 4.5%. Given the upstream rural catchment characteristics, a percent impervious of ±11% is assigned to the upstream catchment area considering rockland soil type, upstream rural residential neighborhoods, and Highway 401.

The following parameters were reviewed to determine the sensitivity of the model, including, the 6-hour SCS Type II, 24-hour SCS Type II storm distributions, Mannings n values for watercourses and floodplains of between 0.035 to 0.060, and downstream Legge's Creek normal water level.

The normal water level of Legge's Creek at the access road crossing at the time of the site visit was measured at ±75.85 on both sides of the culvert. The culvert was partially submerged, and the water level was static. The 100-year water level of the St. Lawrence River downstream in this area is 75.9 m. A normal water level of between 75.5 m and 76.2 m at the downstream side (east side) of the 600 mm diameter culvert was reviewed as part of the sensitivity analysis.

Refer to **Appendix C** for further information regarding the **6-hour** and **24-hour** SCS II Pre-development modeling results.

4.1.1.2 Hydraulics

Further hydraulic analysis for the site was conducted using a recent version of the US Army Corps of Engineers HEC-RAS River Analysis System software (Version 6.5, released March 2024). The software has been widely used in similar open channel flow analyses in Ontario and is recognized as a reliable technique for estimating one-dimensional steady-state flow, unsteady state flow calculations, sediment transport, bed computations, water temperature modeling, and their associated parameters.

- Hydrology: Two nodes within the watercourse and wetland area were reviewed for peak flow. The peak flows were taken at stations 0+750 and 0+350.

Station	Catchment Area (ha)	100-Year 6-hour / 24 hour SCS II (m^3/s)
0+750	480.00	3.84 / 4.81
0+350	500.96	4.74 / 5.90

- Hydraulics: A Steady State Flow analysis with a combination of subcritical and supercritical flow (mixed flow regime) was conducted for the proposed channel design. The software utilizes the one-dimensional energy equation and or momentum equations combined with Manning's equation to calculate the water surface profile, critical depth, velocity, shear stress, Froude Number and maximum flow depth for the proposed scenario.

The profile and sections utilize information gathered from limited topographic survey and are supplemented by LIDAR data where survey data is incomplete, particularly in areas with heavier brush.

The sensitivity analysis demonstrated that, due to the width of the watercourse and the expansive wetland area, the system is not significantly affected by variations in Manning's n value or the downstream normal water level east of the 600 mm diameter culvert. Adjusting the outlet water surface elevation resulted in a ±0.02 m variation in upstream water levels, while deviations in Manning's n produced an average water level difference of ±0.05 m. The calculated difference in water surface elevation between the 6-hour and 24-hour design storms was 0.03 m at the widest section and 0.10 m at the narrowest section. The 24-hour storm is considered the conservative design storm for the major watercourse and is appropriate given the size and extent of the upstream catchment area.

The average depth of the 100-year high-water level within the major watercourse and wetland ranges from ±0.30 m to ±0.45 m, with a maximum depth of ±0.97 m in the narrowest section. At the access road crossing, the depth reaches up to ±0.88 m due to a backwater effect caused by energy losses at the culvert inlet. The sensitivity analysis indicated that flows exceeding 0.7 m^3/s (equivalent to events greater than the 2-year return period) begin to surcharge the 600 mm diameter culvert.

Table 4-1 below summarizes the results of the existing conditions HEC-RAS analysis. Table 4-1 is the results given a 100-year 24-hour SCS II design storm, a Mannings n value of 0.060, and a downstream water level of 76.2 m.

Table 4-1 HEC-RAS Modeling Results (Existing Conditions)

W.S. = Water Surface, E.G. = Energy Grade Line, Elev. = Elevation, Crit. = Critical Flow

Station	Q (m^3/s)	Min. Elev. (m)	W.S. Elev. (m)	W.S. Crit. (m)	W.S. Height (m)	E.G. Elev (m)	E.G. Slope (m/m)	Velocity (m/s)	Flow Area (m^2)	Froude Chl.
750	4.81	78.00	78.44	78.23	0.44	78.45	0.005	0.56	8.62	0.32
700	4.81	78.00	78.37		0.37	78.38	0.001	0.20	24.68	0.11
650	4.81	78.00	78.34		0.34	78.34	0.001	0.20	23.92	0.12
610	4.81	78.00	78.16	78.16	0.16	78.24	0.066	1.23	3.95	1.00
550	4.81	77.00	77.97	77.4	0.97	77.97	0.001	0.27	18.17	0.13
500	4.81	77.00	77.91		0.91	77.91	0.002	0.33	14.47	0.19
470	4.81	77.01	77.84		0.83	77.85	0.002	0.47	10.3	0.23
400	4.81	77.00	77.48		0.48	77.52	0.012	0.90	5.37	0.48

350	5.90	77.00	77.40		0.40	77.40	0.001	0.28	20.94	0.14
300	5.90	77.00	77.36		0.36	77.36	0.001	0.23	25.63	0.13
270	5.90	77.00	77.31		0.31	77.32	0.003	0.38	15.65	0.22
200	5.90	76.61	76.91		0.30	76.93	0.024	0.72	8.18	0.60
150	5.90	76.00	76.28		0.28	76.30	0.008	0.49	12.14	0.36
115	5.90	75.40	76.28	75.50	0.88	76.28	0.000	0.11	53.8	0.04
110	Culvert									
75	5.90	75.30	76.21		0.91	76.21	0.000	0.26	22.2	0.16
10	5.90	75.00	76.20	75.38	1.20	76.20	0.000	0.09	64.68	0.04

A road crossing is proposed and located to utilize the existing access road. It is recommended that the existing 600 mm diameter culvert be upsized to reduce the backwater effect at the culvert. The proposed final culvert sizing for the crossing can be completed at the detailed design stage. If the road is raised at this location, the proposed culvert(s) should be appropriately sized to minimize the backwater effect and maintain it at an elevation of ±76.28.

A reduced boulevard road cross-section where the road crosses the wetland area can be considered to minimize the cutting and filling of the floodplain area.

The CRCA requires floodplain compensation for the proposed roadway crossing ensuring there is no floodplain storage loss below the 100-year event level. Refer to **Figure 7 - Floodplain Compensation Plan** in **Appendix A**, for details regarding the preliminary compensation plan. Final compensation calculations can be provided at the detailed design stage.

A 15 m floodplain offset to buildings is recommended for the subject site.

4.2 Minor Watercourse

A minor watercourse with unevaluated wetland cells is located at the south portion of the site having a catchment area of less than 10 ha. The central channel of the minor watercourse is a confined channel, with a 0.3 m wide flat bottom and clearly defined banks at an approximate average depth of 0.4 m. The main channel lies approximately 1 to 1.5 m below the surrounding elevated fields. The bottom of the western wetland cell is at an approximate elevation of 78.3 m, draining east downstream to an elevation of 77.4 m at the eastern edge. The surrounding fields and proposed building locations are elevated above 80 m.

Discussions with the CRCA have indicated that the southern minor watercourse and unevaluated wetland cells are to be preserved.

The 100-year event (6-hour SCS Type II) peak flow within the watercourse is approximately 0.54 m^3/s at Outlet 1C. Calculations find that the peak flow is confined to the watercourse.

A 15 m setback from buildings is recommended from the top of the banks of the minor watercourse and unevaluated wetland area.

A block is proposed along the east property line to provide for an outlet swale to Outlet 1C.

5. Erosion and Sediment Control (Short Term)

An Erosion and Sediment Control Plan is to be provided at detailed design for the development.

Erosion and sediment control details will be provided on the subdivision design drawings. Silt fencing is to be provided at all side slopes and down gradient locations to ensure sediment and erosion control during construction. Other control devices such as straw bales will also be provided where drainage is concentrated. Sediment and erosion management measures also serve to provide a limit to the grading operations.

The stormwater facilities and components are to be constructed concurrently with the initial phases of development. The time that land remains exposed before it is stabilized with sod, mulch, or hydroseeding is to be minimized. Topsoil is to be stockpiled away from watercourses and wetlands.

Rock check dams or straw bale filters are to be provided in overland swale and ditch systems.

Inspection of the sediment control works should be undertaken before and after all rainfall (and snowmelt) events. Maintenance is to be undertaken as required to ensure the proper operation of all sediment and erosion controls. Inspection and maintenance are the developer's responsibility until such time as the Final Certificate of Approval of the Works is issued.

6. Conclusions

It is recommended that the Thousand Island Parkway (Greene) Subdivision proceed with the mitigation measures detailed in this report to address stormwater quality, stormwater quantity, and erosion concerns on the site.

The development is to be designed in accordance with the Ministry of the Environment, Conservation and Parks, and CRCA Guidelines.

Stormwater runoff within the Thousand Island Parkway (Greene) Subdivision should be directed to enhanced swales. A Consolidated Linear Infrastructure Environmental Compliance Approval (CLI-ECA) is required for the enhanced swales prior to construction.

Stormwater runoff from the subdivision will not adversely impact the natural environment or downstream infrastructure.

Detailed design of enhanced swales, roadside ditches, culvert crossings, and stormwater management facilities will be provided during the final engineering design of the subdivision.

Appendix A

Draft Plan
Concept Plan
Figure 2 - Existing Catchment Areas
Figure 3 – Post-Development Minor Catchment Areas
Figure 4 – Post-Development Major Catchment Areas
Figure 5 – Street ‘A’ Plan and Profile
Figure 6 – Rear Yard Swales Plan and Profile
Figure 7 – Floodplain Compensation Analysis
Pre-Development and Post-Development Modeling Schematics
Enhanced Swale Fact Sheet
Typical Right of Way Detail

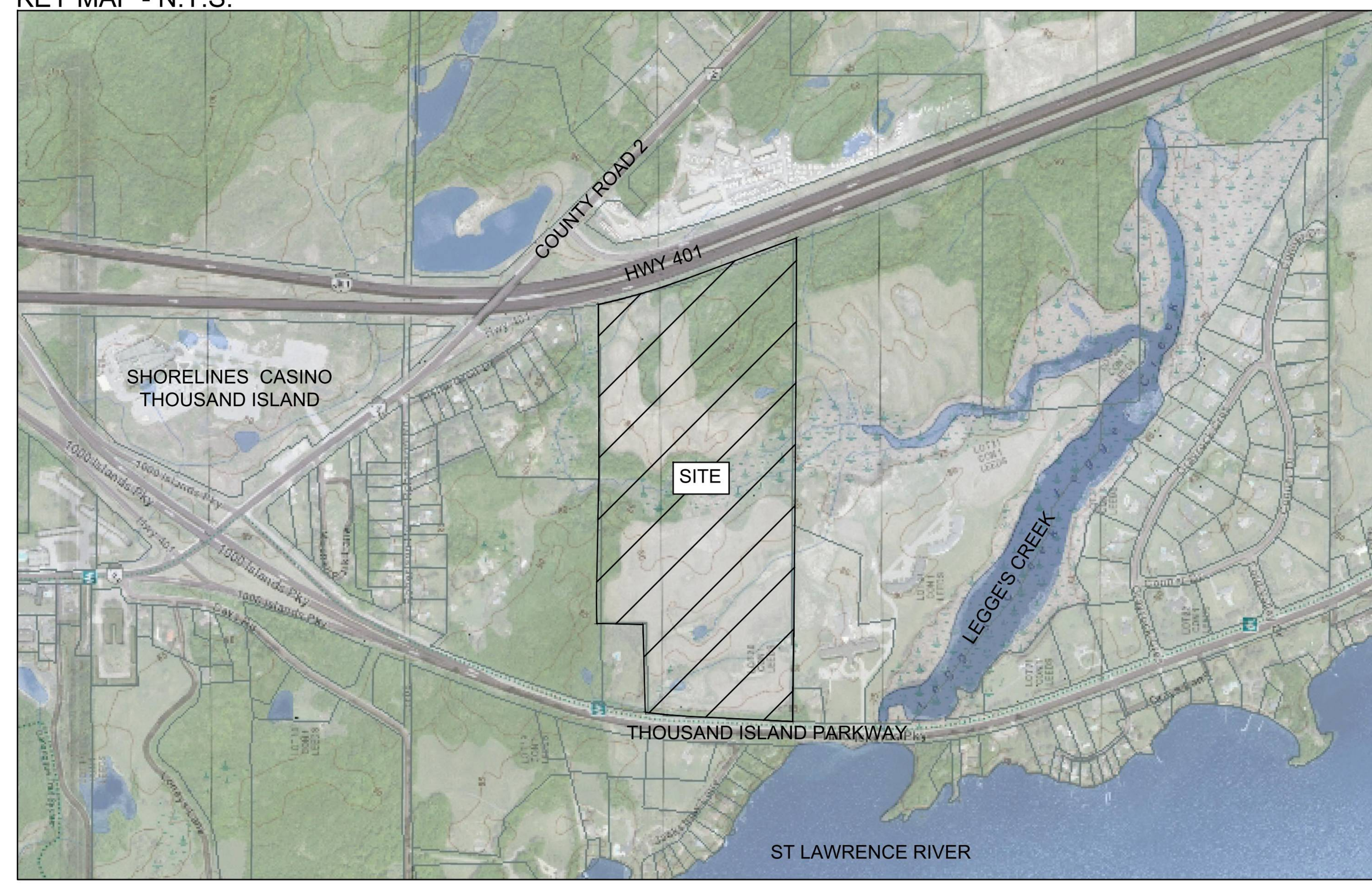
DRAFT PLAN of PROPOSED SUBDIVISION

PART OF LOTS 19 & 20, CONCESSION 1
Geographic Township of Leeds
TOWNSHIP OF LEEDS AND THE THOUSAND ISLANDS
COUNTY of LEEDS

SCALE = 1:1500

0 40 80 m H=1:1500

KEY MAP - N.T.S.



Forefront Engineering Inc
FOREFRONT Engineering Inc.
1329 Gardiners Road, Suite 210, Kingston, Ontario, Canada, K7P 0L8
T613.634.9009 F888.884.9392

ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51.17(A–L) OF THE PLANNING ACT

- a: Shown on Draft Plan
- b: Shown on Draft Plan
- c: All Lands Owned, or In Which the Applicant Have An Interest Are Shown On the Key Plan.
- d: Residential
- e: Shown On Draft Plan
- f: Shown On Draft Plan
- g: Shown On Draft Plan
- h: Well Supplied
- i: Napanee Clay, and Rockland
- j: Shown On Draft Plan
- k: Road Maintenance, Garbage Collection, Phone, Cable, and Hydro
- l: Shown on Draft Plan

OWNER'S CERTIFICATE

I, DAN GREENE, HEREBY AUTHORIZE FOREFRONT TO PREPARE AND SUBMIT THIS PLAN FOR REVIEW AND APPROVAL.

GREENE'S ELECTRIC, PLUMBING & HEATING LTD.

DAN GREENE.

DATE: ____________

SURVEYOR'S CERTIFICATE

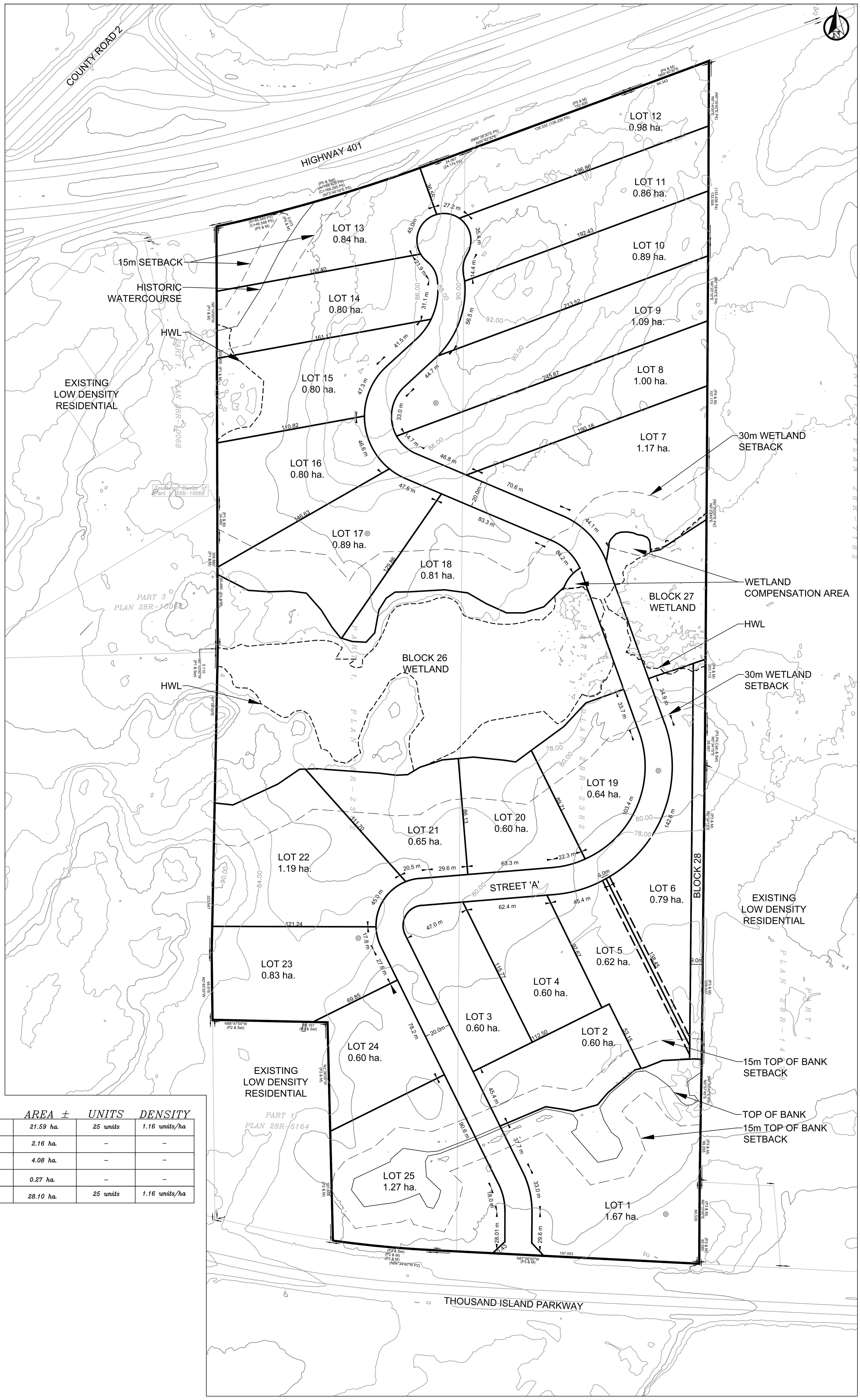
1. THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AND THE RELATIONSHIP TO THE ADJACENT LANDS ARE CORRECTLY SHOWN.

HOPKINS CHITTY LAND SURVEYORS INC.

PHIL CHITTY – O.L.S.

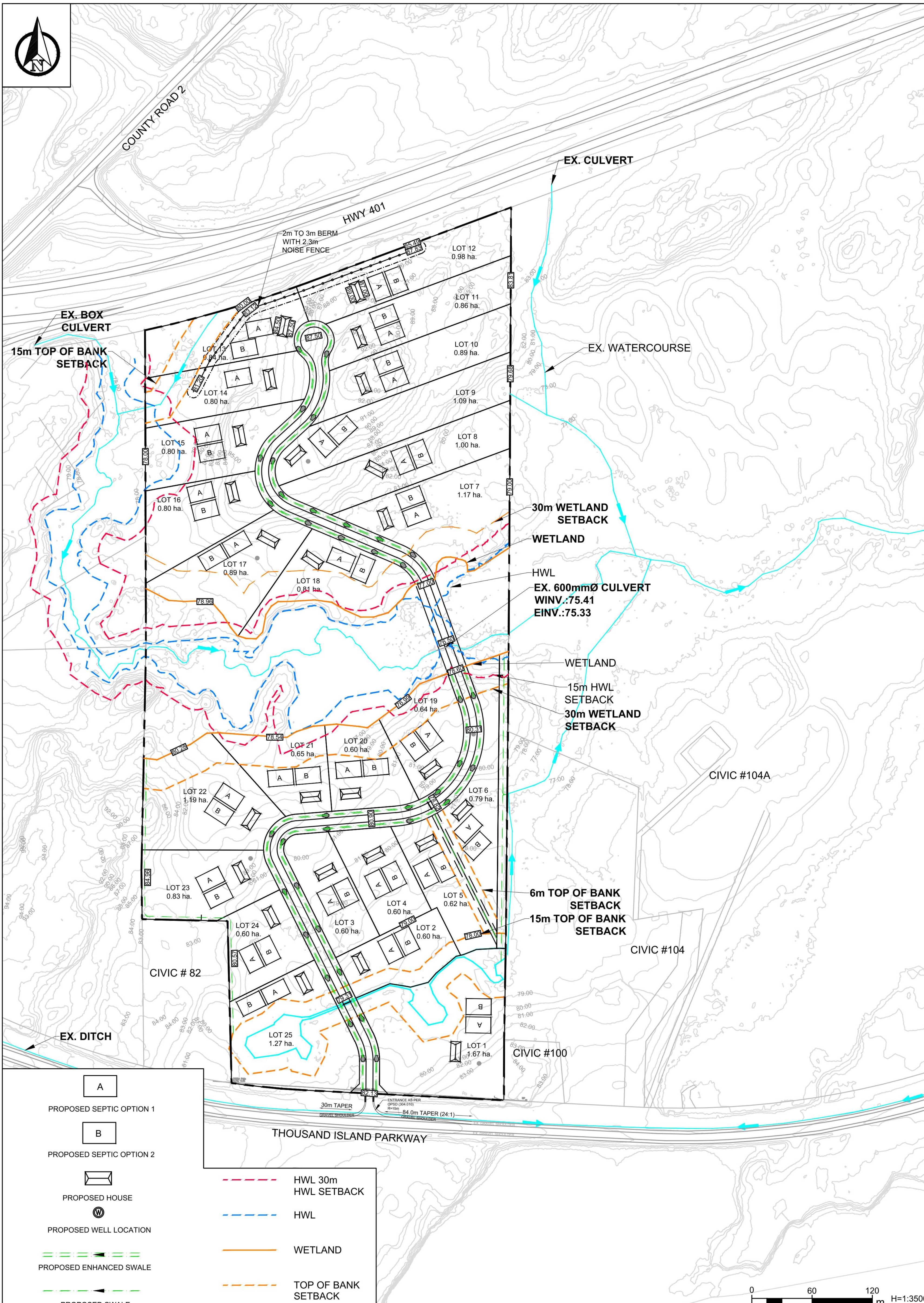
DATE: ____________

METRIC
DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048



SITE DATA

LAND USE	LOTS & BLOCKS	AREA ±	UNITS	DENSITY
SINGLE DETACHED	LOTS 1–25	21.59 ha.	25 units	1.16 units/ha
STREETS/RESERVES	STREET 'A'	2.16 ha.	–	–
WETLAND	BLOCK 26, BLOCK 27	4.08 ha.	–	–
AREA COMPENSATION	BLOCK 28	0.27 ha.	–	–
TOTAL		28.10 ha.	25 units	1.16 units/ha



No.	Revision/Issue	Date

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Kingston, ON, Canada K7P 0L8
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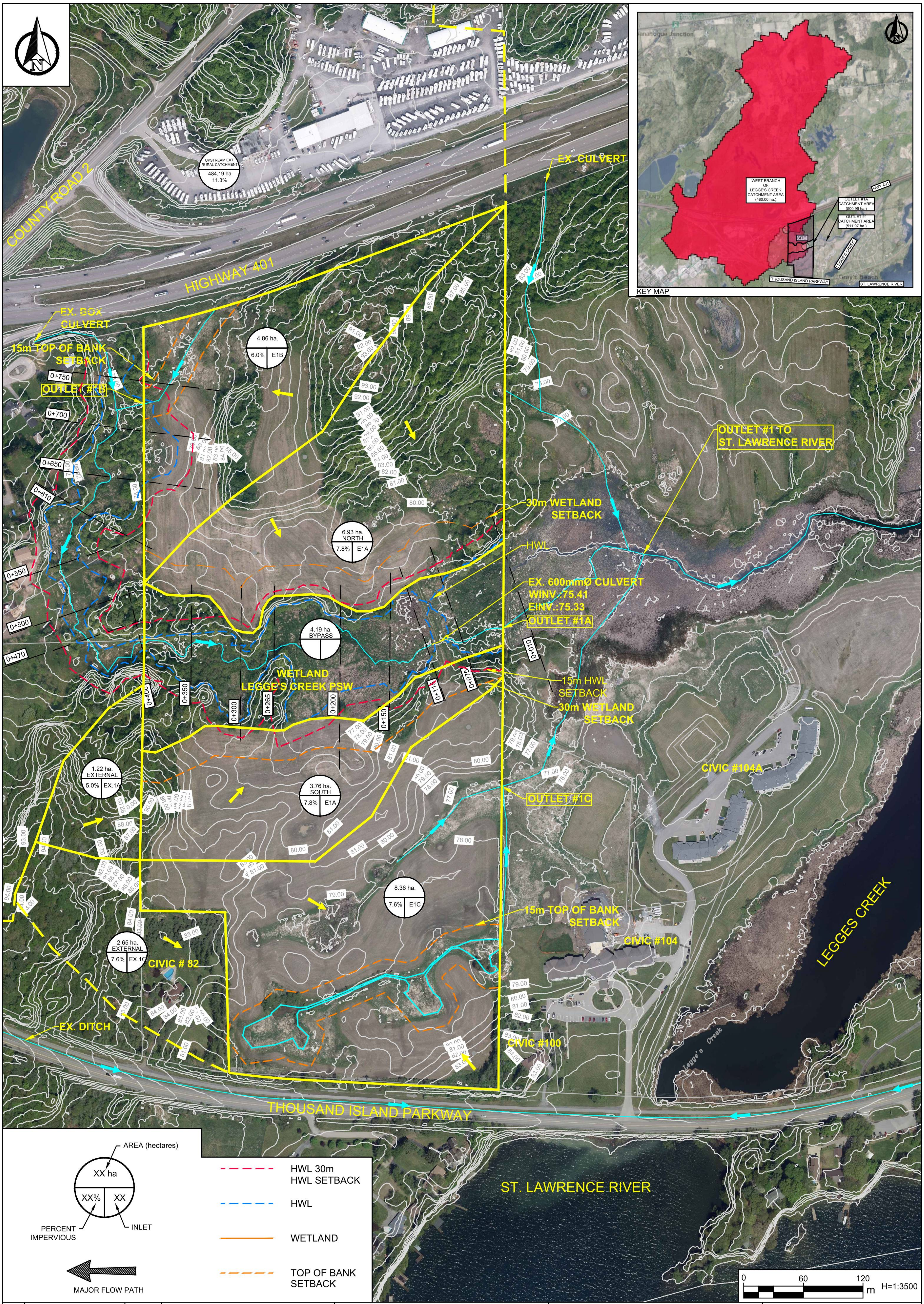
1.888.884.9392 fax.

Client
GREENE'S ELECTRIC, PLUMBING & HEATING LTD.

Project
THOUSAND ISLAND PARKWAY SUBDIVISION

Drawing
CONCEPT PLAN

Drawn by:	Checked by:	Project No.
EP	JH	
Designed by: KMN	Approved by: KMN	Drawing No. CP
Date: JANUARY 2025		
Scale: 1:3500 (11X17)		



No.	Revision/Issue	Date

Forefront Engineering Inc

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Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.888.884.9392 fax.

Client
GREENE'S ELECTRIC, PLUMBING & HEATING LTD.

Project
THOUSAND ISLAND PARKWAY SUBDIVISION

SITE AREA = 28.10 ha.
TOTAL STUDY AREA = 511.97 ha.

Drawing
EXISTING CATCHMENT AREAS

Drawn by:	Checked by:	Project No.
EP	JH	
Designed by: KMN	Approved by: KMN	Drawing No.
Date: JANUARY 2025		FIG.2
Scale: 1:3500 (11X17)		

Hydrologic Units - Proposed Conditions

Drainage Area / Drainage Area Characteristics / Rational Design Flow

Section ID	Hydrologic Unit	Description	Est'd C	Area (ha)	Watershed Length (m)	Average Grade(%)	1:5 year Velocity	Upstream Tc	Cumulative Tc	Cumulative Area (ha)	Cumulative CxA	Cumulative 2.78 AC (ha)	1:2 year Intensity (mm/hr)	1:2 year Storm (L/s)	1:5 year Intensity (mm/hr)	1:5 year Storm (L/s)	1:100 year Intensity (mm/hr)	1:100 year Storm (L/s)
Outlet 1A																		
101	A1	Directed to West Roadside Enhanced Swale	0.45	0.77	121	0.50	0.39	15.0	15.0	0.77	0.35	0.96	49.09	**47**	63.65	**61**	103.83	**100**
103	A3	Directed to West Roadside Enhanced Swale	0.45	0.39	119	6.00	0.97	5.0	20.0	1.16	0.52	1.45	40.32	**59**	52.34	**76**	85.49	**124**
105	A5	Directed to West Roadside Enhanced Swale	0.45	0.59	128	2.00	0.77	2.2	22.2	1.75	0.79	2.19	37.55	**82**	48.76	**107**	79.69	**174**
102	A2	Directed to East Roadside Enhanced Swale	0.45	0.96	121	0.50	0.42	15.0	15.0	0.96	0.43	1.20	49.09	**59**	63.65	**76**	103.83	**125**
104	A4	Directed to East Roadside Enhanced Swale	0.45	1.01	119	6.00	1.18	4.7	19.7	1.97	0.89	2.46	40.80	**101**	52.95	**131**	86.50	**213**
106	A6	Directed to East Roadside Enhanced Swale	0.45	0.66	128	2.00	0.87	1.8	21.5	2.63	1.18	3.29	38.43	**126**	49.90	**164**	81.54	**268**
108	A8	Directed to East Roadside Enhanced Swale	0.35	0.06	61	5.50	0.30	15.0	15.0	0.06	0.02	0.06	49.09	**3**	63.65	**4**	103.83	**6**
109	A9	Directed to West Roadside Enhanced Swale	0.35	0.06	61	5.50	0.30	15.0	15.0	0.06	0.02	0.06	49.09	**3**	63.65	**4**	103.83	**6**
110	A10	Directed to Rear Yard Swale	0.35	0.23	75	6.00	0.73	15.0	15.0	0.23	0.08	0.22	49.09	**11**	63.65	**14**	103.83	**23**
111	A11	Directed to Legge's Creek	0.35	1.51	83	3.00	-	15.0	15.0	1.51	0.53	1.47	49.09	**72**	63.65	**94**	103.83	**153**
112	A12	Directed to Rear Yard Swale	0.35	0.88	168	8.00	1.15	15.0	15.0	0.88	0.31	0.86	49.09	**42**	63.65	**54**	103.83	**89**
Outlet 1B																		
B1	201	Directed to Rear Yard Swale	0.35	4.14	105	7.50	1.72	15.0	15.0	4.14	1.45	4.03	49.09	**198**	63.65	**256**	103.83	**418**
Outlet 1C																		
301	C1	Directed to West Roadside Enhanced Swale	0.45	0.62	84	4.00	0.75	15.0	15.0	0.62	0.28	0.78	49.09	**38**	63.65	**49**	103.83	**81**
302	C2	Directed to East Roadside Enhanced Swale	0.35	0.15	84	4.00	0.79	15.0	15.0	0.77	0.33	0.92	49.09	**45**	63.65	**59**	103.83	**96**
303	C3	Directed to West Roadside Enhanced Swale	0.45	0.29	78	0.60	0.31	15.0	15.0	0.29	0.13	0.36	49.09	**18**	63.65	**23**	103.83	**38**
305	C5	Directed to West Roadside Enhanced Swale	0.35	1.81	73	0.60	0.51	4.0	19.0	2.10	0.76	2.12	41.82	**89**	54.27	**115**	88.64	**188**
307	C7	Directed to West Roadside Enhanced Swale	0.35	1.17	130	0.60	0.56	4.2	23.2	3.27	1.17	3.26	36.48	**119**	47.37	**155**	77.44	**253**
309	C9	Directed to West Roadside Enhanced Swale	0.35	0.09	96	3.50	0.32	15.0	15.0	0.09	0.03	0.09	49.09	**4**	63.65	**6**	103.83	**9**
310	C10	Directed to Rear Yard Swale	0.35	2.99	311	3.00	1.07	20.0	20.0	2.99	1.05	2.91	40.36	**117**	52.39	**152**	85.58	**249**
311	C11	Directed to Existing Watercourse	0.35	0.83	98	2.00	-	1.5	21.5	7.18	2.54	7.07	38.38	**271**	49.83	**352**	81.44	**576**
304	C4	Directed to East Roadside Enhanced Swale	0.45	0.57	170	0.60	0.39	15.0	15.0	0.57	0.26	0.71	49.09	**35**	63.65	**45**	103.83	**74**
306	C6	Directed to East Roadside Enhanced Swale	0.45	0.42	110	0.60	0.43	4.7	19.7	0.99	0.45	1.24	40.71	**50**	52.83	**65**	86.30	**107**
308	C8	Directed to East Roadside Enhanced Swale	0.35	0.10	96	3.50	0.45	15.0	15.0	0.10	0.04	0.10	49.09	**5**	63.65	**6**	103.83	**10**
312	C12	Directed to Existing Watercourse	0.35	1.67	127	4.00	-	3.8	27.0	9.94	3.61	10.03	32.90	**330**	42.76	**429**	69.95	**701**
313	C13	Directed to Rear Yard Swale	0.45	2.53	140	0.50	0.83	5.2	32.2	13.24	5.08	14.11	29.19	**412**	37.96	**536**	62.16	**877**

Roadside Ditches / Rear Yard Swales / Driveway Culverts

Section ID	Design Peak Flow (l/s) 1:5 yr / (1:100 yr)	Swale Grade S	Side Slope (z:1)	Channel Manning's 'n'	Base Width	Swale Depth (mm)	Velocity (m/s)	Normal Depth (mm)	# of CVTs	Type	Nominal Diameter D (mm)	Grade S	Culvert Manning's 'n'	Full Capacity (cms)	Full Flow Velocity (m/s)	Actual Velocity (m/s)	Capacity Used Q/Q(f)	Normal Depth (mm)
Outlet 1A																		
101	61	0.50	3:1	0.035	1	700	0.39	110	1	HDPE	400	0.50%	0.014	0.137	1.1	1.1	45%	186
103	76	6.00	3:1	0.035	1	700	0.97	60	1	HDPE	400	6.00%	0.015	0.442	3.5	2.6	17%	111
105	107	2.00	3:1	0.035	1	200	0.77	105	1	HDPE	400	2.00%	0.015	0.255	2.0	1.9	42%	179
102	76	0.50	3:1	0.035	1	700	0.42	125	1	HDPE	400	0.50%	0.015	0.128	1.0	1.1	60%	223
104	131	6.00	3:1	0.035	1	700	1.18	85	1	HDPE	400	6.00%	0.014	0.474	3.8	3.2	28%	143
106	164	2.00	3:1	0.035	1	700	0.87	130	1	HDPE	400	2.00%	0.014	0.273	2.2	2.3	60%	223
108	4	5.50	3:1	0.035	1	700	0.30	10	-	-	-	-	-	-	-	-	-	-
109	4	5.50	3:1	0.035	1	700	0.30	10	-	-	-	-	-	-	-	-	-	-
110	14	6.00	3:1	0.035	V-ditch	150	0.73	45	-	-	-	-	-	-	-	-	-	-
111	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
112	54	8.00	3:1	0.035	V-ditch	150	1.15	80	-	-	-	-	-	-	-	-	-	-
Outlet 1B																		
B1	256	7.50	3:1	0.035	V-ditch	450	1.72	175	-	-	-	-	-	-	-	-	-	-
Outlet 1C																		
301	49	4.00	3:1	0.035	1	700	0.75	55	1	HDPE	400	4.00%	0.014	0.387	3.1	2.1	13%	96
302	59	4.00	3:1	0.035	1	700	0.79	60	1	HDPE	400	4.00%	0.014	0.387	3.1	2.2	15%	105
303	23	0.60	3:1	0.035	1	700	0.31	60	1	HDPE	400	0.60%	0.014	0.150	1.2	1.0	25%	137
305	115	0.60	3:1	0.035	1	700	0.51	150	1	HDPE	500	0.60%	0.014	0.272	1.4	1.5	69%	304
307	155	0.60	3:1	0.035	1	700	0.56	175	1	HDPE	500	0.60%	0.014	0.272	1.4	1.4	57%	270
309	6	3.50	3:1	0.035	1	700	0.32	15	-	-	-	-	-	-	-	-	-	-
310	152	3.00	3:2	0.035	V-ditch	300	1.07	170	-	-	-	-	-	-	-	-	-	-
311	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
304	45	0.60	3:1	0.035	1	700	0.39	90	1	HDPE	400	0.60%	0.014	0.150	1.2	1.0	30%	150
306	65	0.60	3:1	0.035	1	700	0.43	110	1	HDPE	400	0.60%	0.014	0.150	1.2	1.1	44%	184
308	6	3.50	3:1	0.035	1	700	0.32	15	-	-	-	-	-	-	-	-	-	-
312	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
313	(877)	0.50	3:1	0.035	1.5	700	0.83	390	-	-	-	-	-	-	-	-	-	-

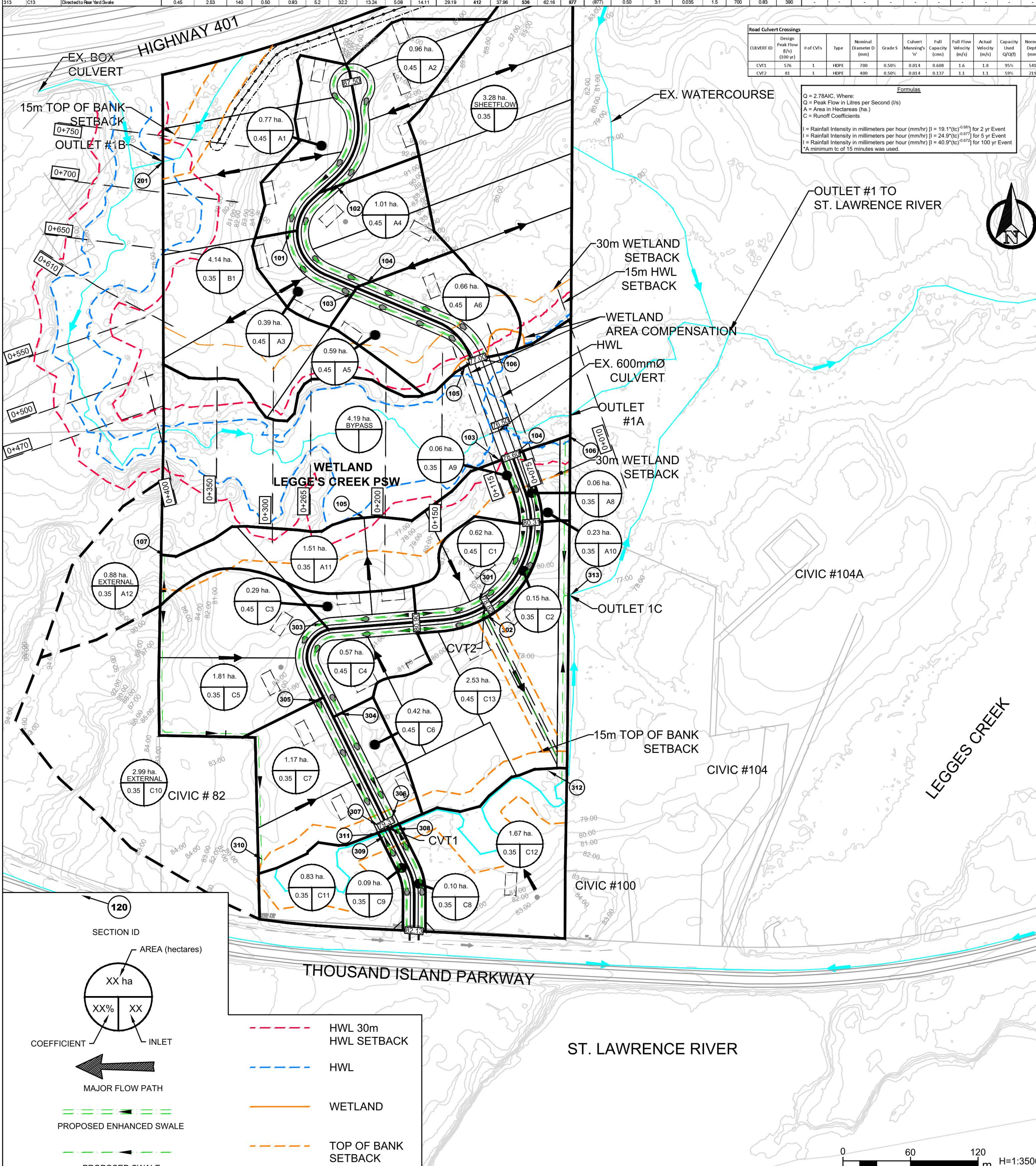
Road Culvert Crossings

CULVERT ID	Design Peak Flow (l/s) (100 yr)	# of CVTs	Type	Nominal Diameter D (mm)	Grade S	Culvert Manning's 'n'	Full Capacity (cms)	Full Flow Velocity (m/s)	Actual Velocity (m/s)	Capacity Used Q/Q(f)	Normal Depth (mm)
CVT1	576	1	HDPE	700	0.50%	0.014	0.608	1.6	1.8	95%	541
CVT2	81	1	HDPE	400	0.50%	0.014	0.137	1.1	1.1	59%	219

Formulas

Q = 2.78AIC, Where:
Q = Peak Flow in Litres per Second (l/s)
A = Area in Hectareas (ha.)
C = Runoff Coefficients

I = Rainfall Intensity in millimeters per hour (mm/hr) [$I = 19.1*(tc)^{-0.681}$] for 2 yr Event
I = Rainfall Intensity in millimeters per hour (mm/hr) [$I = 24.9*(tc)^{-0.677}$] for 5 yr Event
I = Rainfall Intensity in millimeters per hour (mm/hr) [$I = 40.9*(tc)^{-0.672}$] for 100 yr Event
*A minimum tc of 15 minutes was used.



No.	Revision/Issue	Date

Forefront Engineering Inc

1329 Gardiners Road Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.888.884.9392 fax.

Client
GREENE'S ELECTRIC, PLUMBING & HEATING LTD.

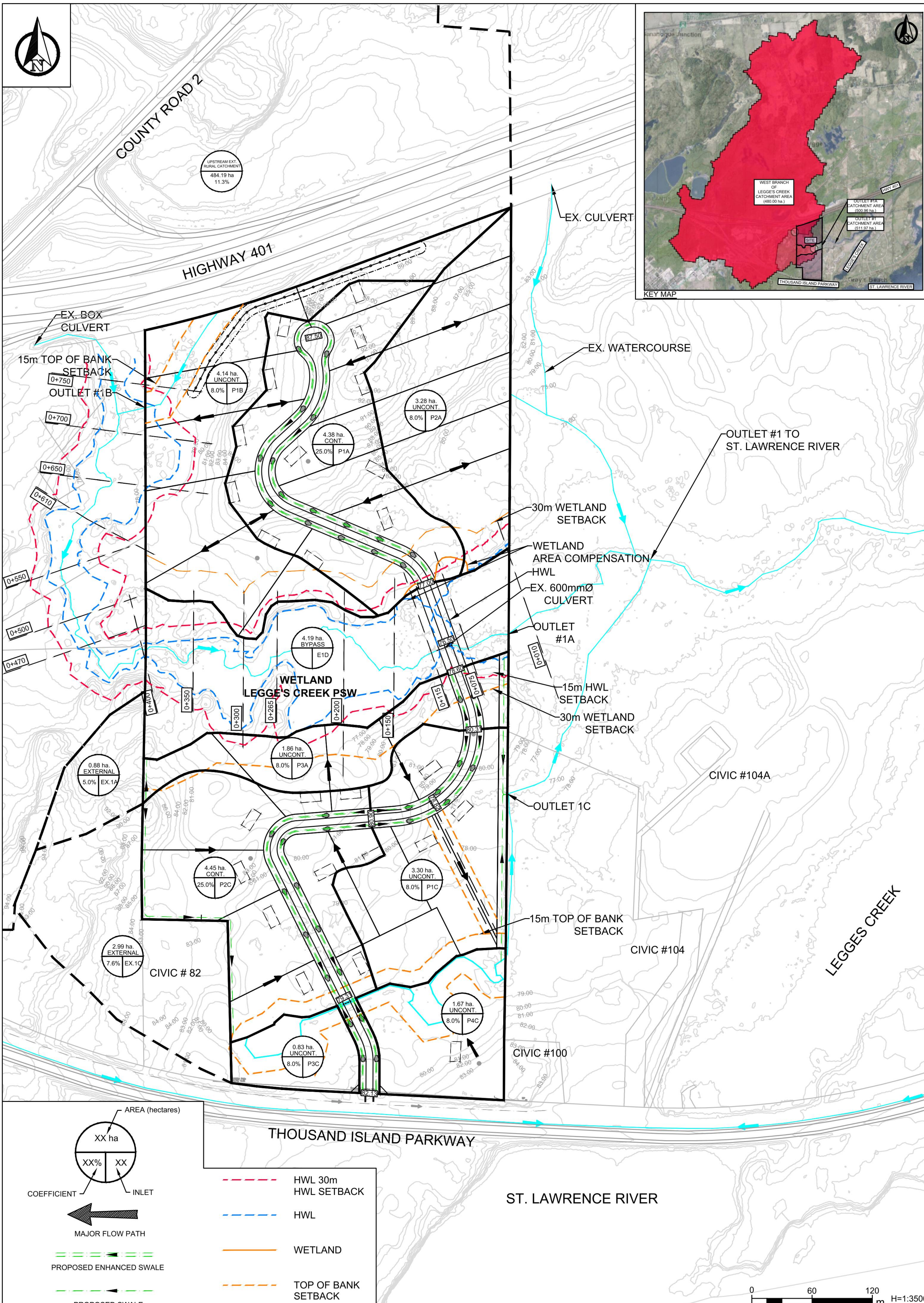
Project
THOUSAND ISLAND PARKWAY SUBDIVISION

SITE AREA = 28.10 ha.
TOTAL STUDY AREA = 511.97 ha.

Drawing
POST-DEVELOPMENT MINOR CATCHMENT AREAS

Drawn by: EP
Checked by: JH
Project No.
Designed by: KMN
Approved by: KMN
Drawing No.
Date: JANUARY 2025
Scale: 1:3500 (11X17)

FIG.3



No.	Revision/Issue	Date

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1.888.884.9392 fax.

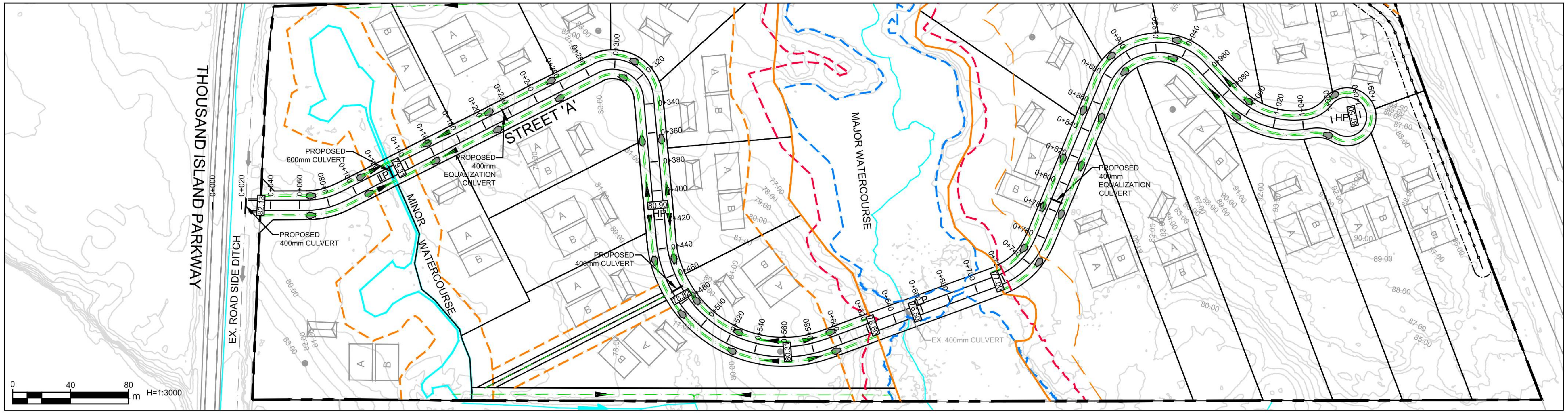
Client
GREENE'S ELECTRIC, PLUMBING & HEATING LTD.

Project
THOUSAND ISLAND PARKWAY SUBDIVISION

SITE AREA = 28.10 ha.
TOTAL STUDY AREA = 511.97 ha.

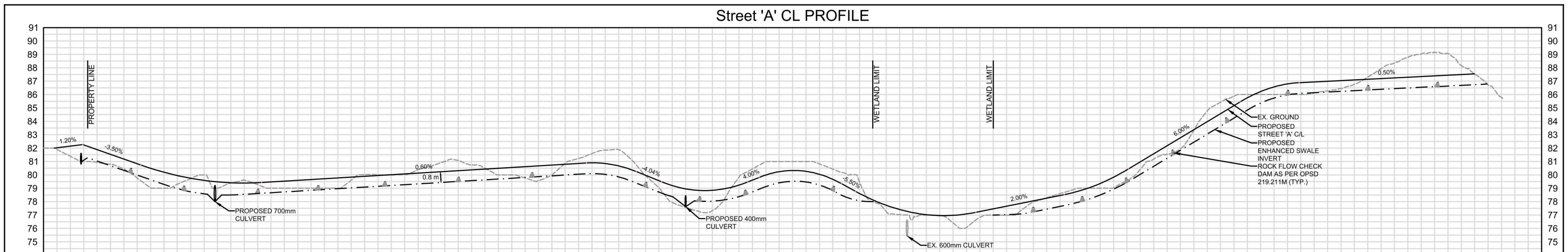
Drawing
POST-DEVELOPMENT MAJOR CATCHMENT AREAS

Drawn by:	Checked by:	Project No.
EP	JH	
Designed by: KMN	Approved by: KMN	Drawing No.
Date: JANUARY 2025		FIG.4
Scale: 1:3500 (11X17)		

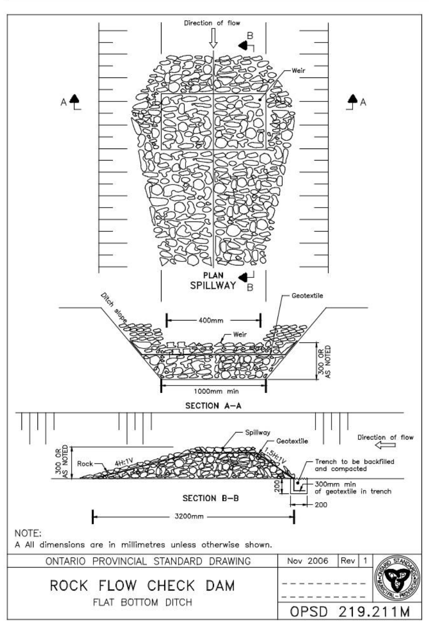


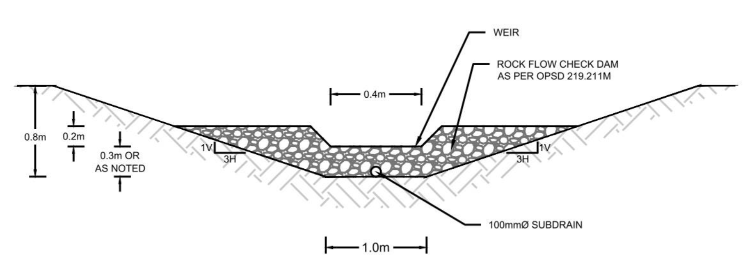
HWL 30m HWL SETBACK
HWL
WETLAND
TOP OF BANK SETBACK

Street 'A' CL PROFILE



Station	PROP.C/L	OG
0+040	81.88	80.935
0+080	80.49	79.022
0+120	79.59	80.000
0+160	79.41	79.275
0+200	79.65	79.000
0+240	79.89	80.021
0+280	80.13	80.392
0+320	80.37	80.743
0+360	80.61	79.766
0+400	80.85	81.228
0+440	80.37	81.090
0+480	78.96	77.572
0+520	79.24	79.843
0+560	80.33	81.000
0+600	79.16	80.096
0+640	77.41	77.032
0+680	76.98	76.414
0+720	77.66	76.998
0+760	78.46	78.598
0+800	79.82	79.028
0+840	82.17	81.546
0+880	84.57	85.436
0+920	86.57	86.000
0+960	86.99	86.263
1+000	87.19	87.941
1+040	87.39	89.148
1+080		86.716





TYPICAL ENHANCED SWALE DETAIL
N.T.S.

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

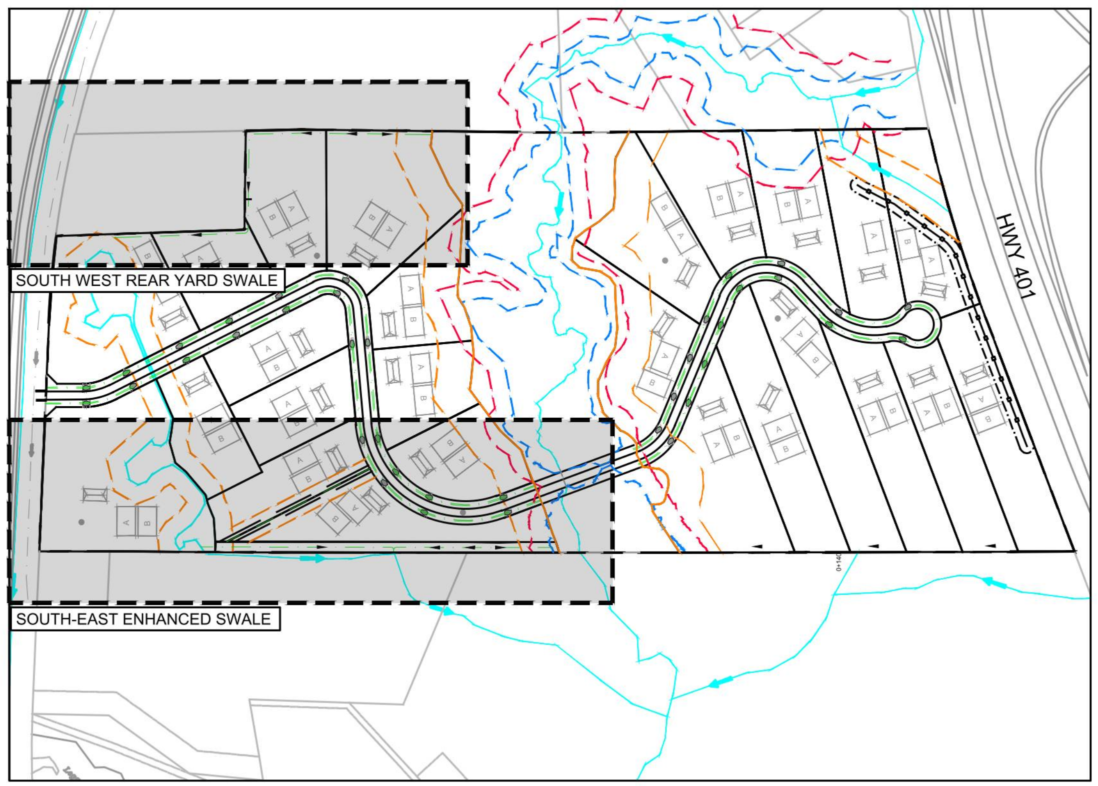
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.866.884.9392 fax.

Client: GREENE'S ELECTRIC, PLUMBING & HEATING LTD.

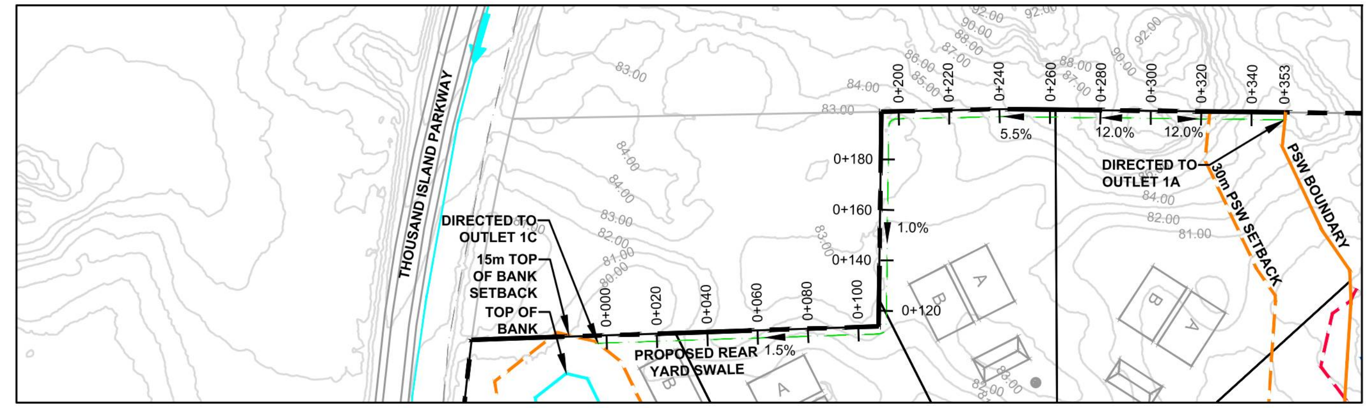
Project: THOUSAND ISLAND PARKWAY SUBDIVISION

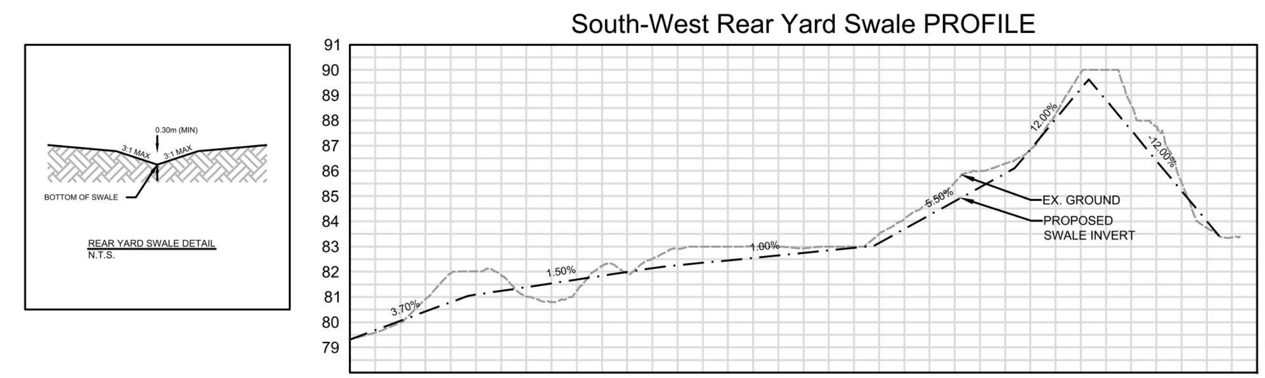
Drawing: STREET 'A' PLAN & PROFILE

Drawn by: EP	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.
Date: JANUARY 2025		FIG.5
Scale: 1:3000 (11x17)		

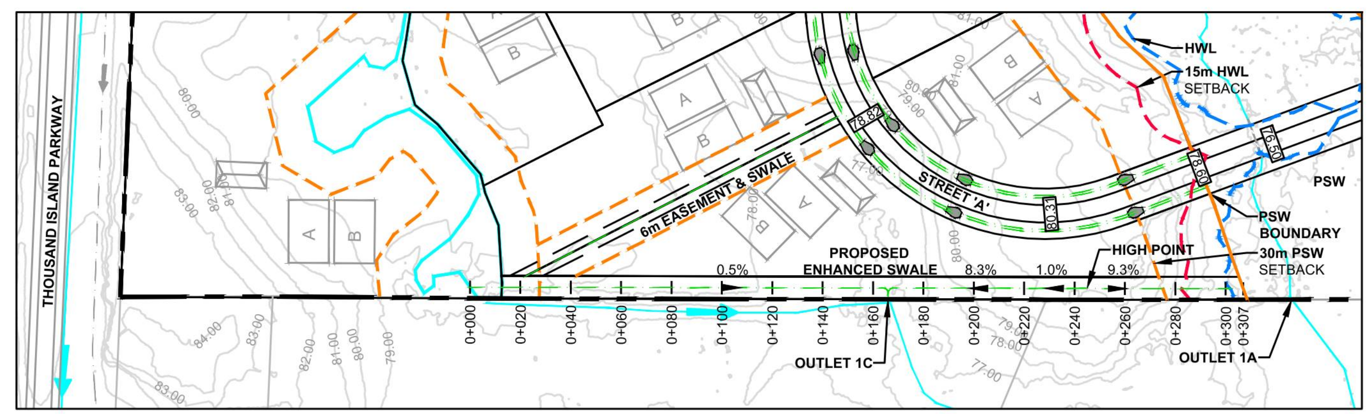


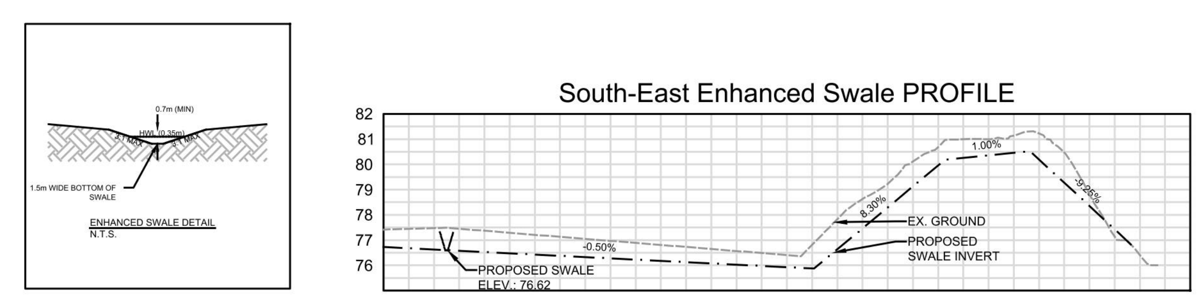
KEY MAP





PROP.C/L / OG	0+040	0+080	0+120	0+160	0+200	0+240	0+280	0+320
PROP.C/L	80.79	81.54	82.14	82.55	82.95	84.79	88.05	86.41
OG	81.938	80.799	82.511	83.002	82.996	85.538	88.247	87.761





PROP.C/L / OG	0+040	0+080	0+120	0+160	0+200	0+240	0+280
PROP.C/L	76.53	76.33	76.13	75.93	78.30	80.35	78.35
OG	77.370	77.050	76.730	76.410	79.234	81.000	78.824

HWL 30m HWL SETBACK
HWL
WETLAND
TOP OF BANK SETBACK

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.866.884.9392 fax.

Client: GREENE'S ELECTRIC, PLUMBING & HEATING LTD.

Project: THOUSAND ISLAND PARKWAY SUBDIVISION

Drawing: REAR YARD SWALES PLAN & PROFILE

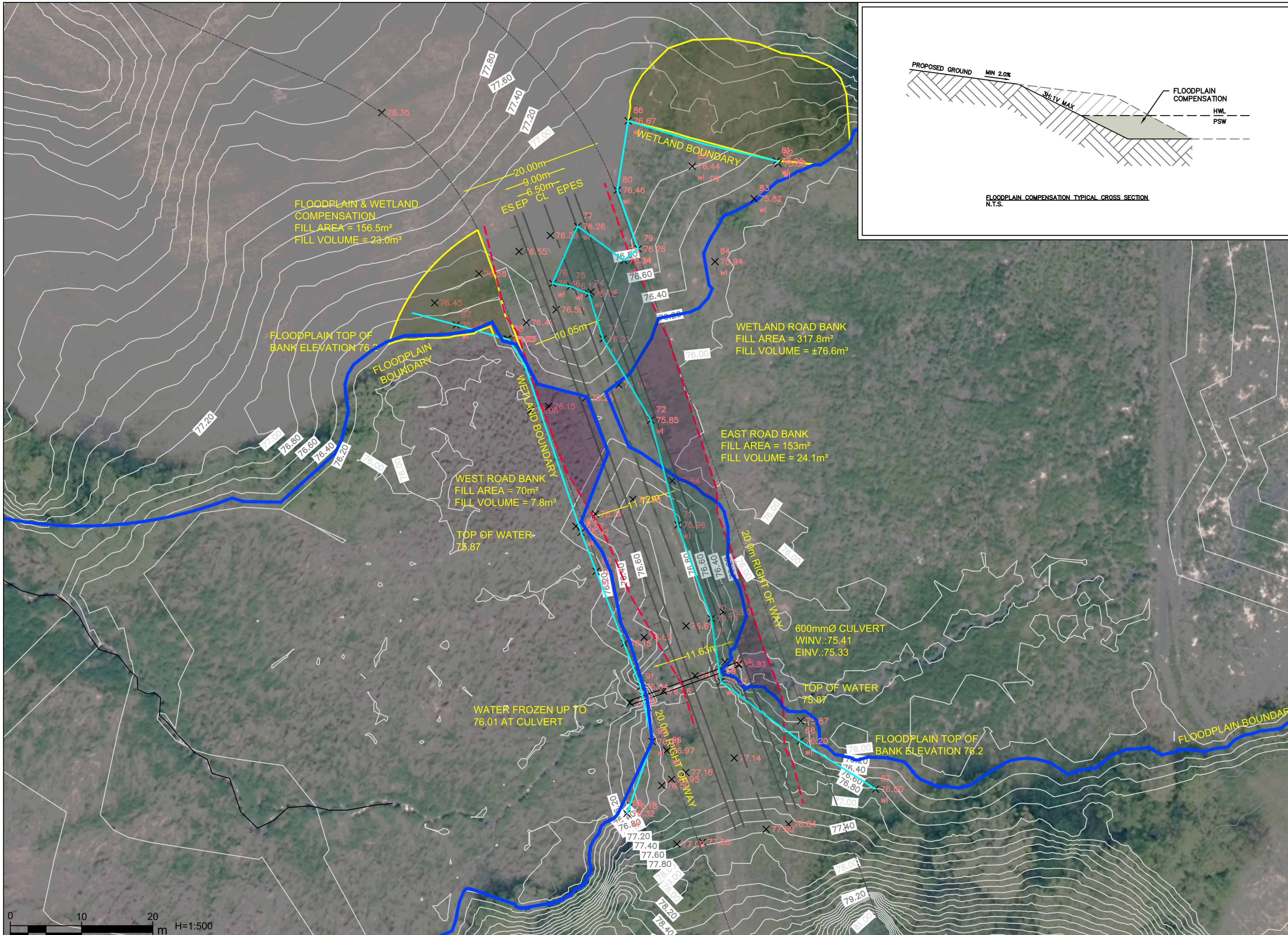
Drawn by: EP | Checked by: JH | Project No.

Designed by: KMN | Approved by: KMN | Drawing No.

Date: JANUARY 2025

Scale: 1:3000 (11x17)

FIG.6



LEGEND

	FLOOD PLAIN / WETLAND COMPENSATION AREA
	FILL AREA
	WETLAND IMPACTED AREA
	FLOODPLAIN BOUNDARY
	WETLAND BOUNDARY
	TOE OF SLOPE

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

1329 Gardiners Road, Suite 210
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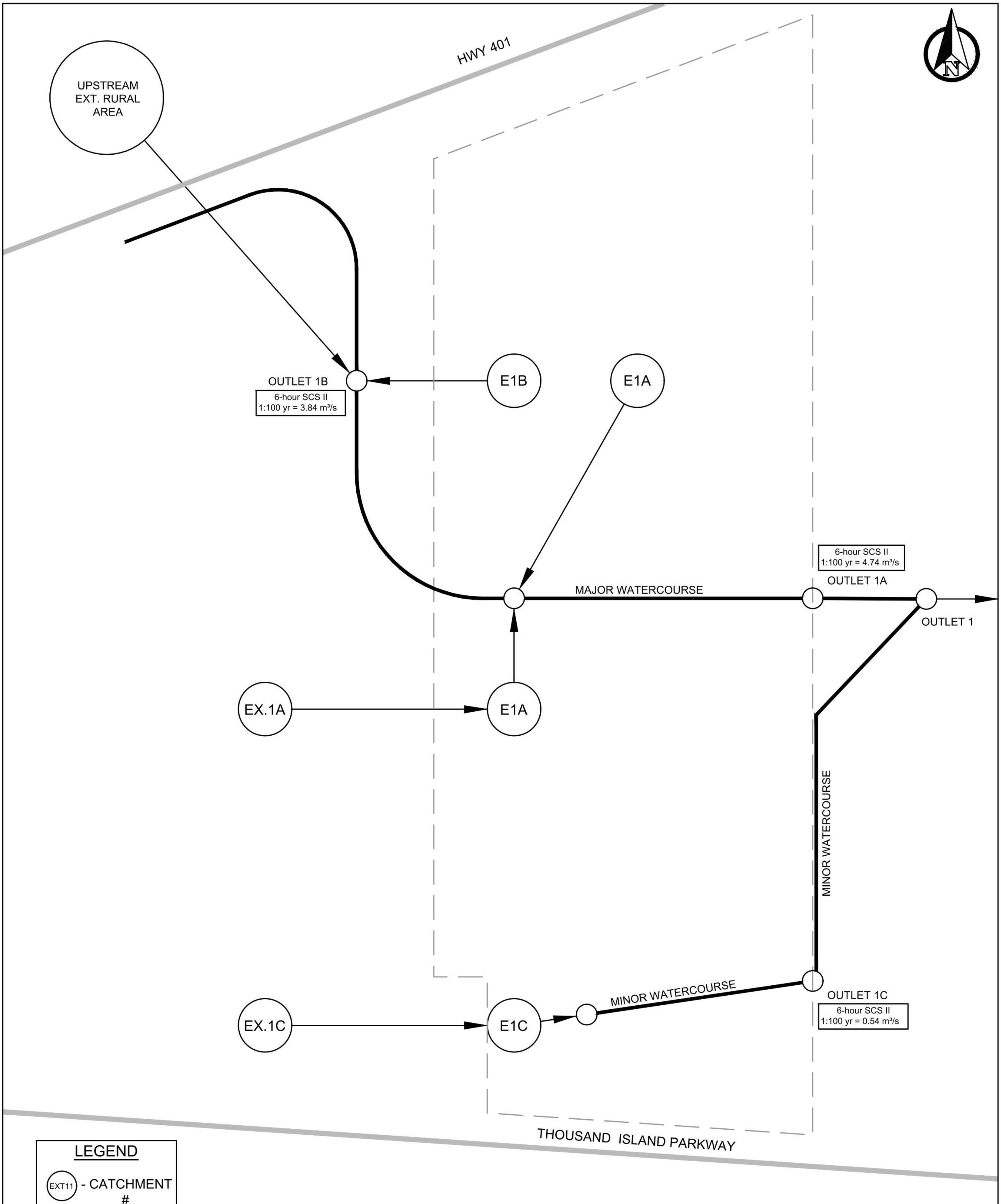
1.866.884.9392 fax.

Client
GREENE'S ELECTRIC, PLUMBING & HEATING LTD.

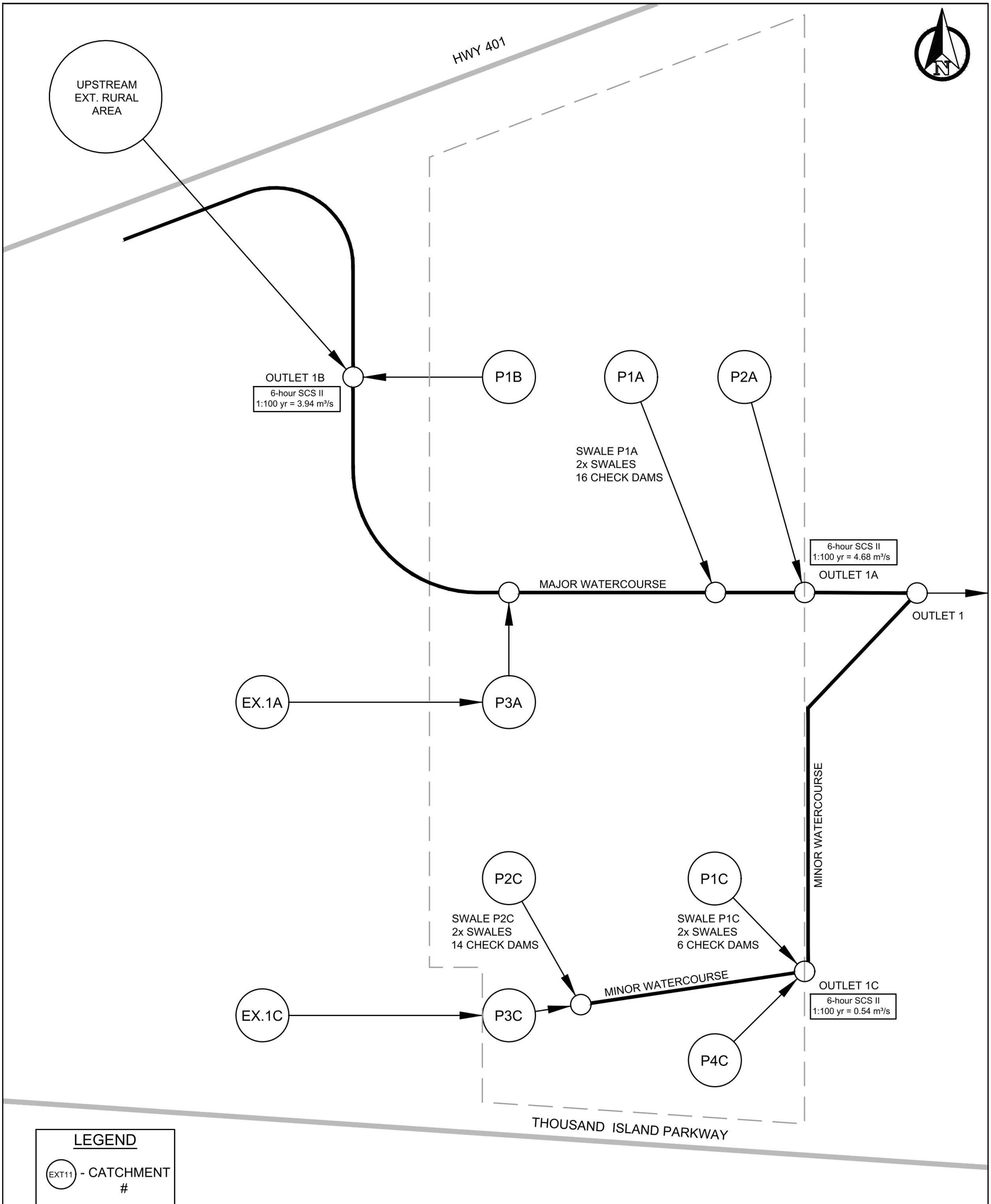
Project
THOUSAND ISLAND PARKWAY SUBDIVISION

Drawing
FLOODPLAIN COMPENSATION ANALYSIS

Drawn by: EP	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.
Date: JANUARY 2025		FIG.7
Scale: 1:500 (11x17)		



PRE-DEVELOPMENT MODELING SCHEMATIC



POST-DEVELOPMENT MODELING SCHEMATIC

ENHANCED GRASS SWALES

CVC/TRCA LOW IMPACT DEVELOPMENT
PLANNING AND DESIGN GUIDE - FACT SHEET

GENERAL DESCRIPTION

Enhanced grass swales are vegetated open channels designed to convey, treat and attenuate stormwater runoff (also referred to as enhanced vegetated swales). Check dams and vegetation in the swale slows the water to allow sedimentation, filtration through the root zone and soil matrix, evapotranspiration, and infiltration into the underlying native soil. Simple grass channels or ditches have long been used for stormwater conveyance, particularly for roadway drainage. Enhanced grass swales incorporate design features such as modified geometry and check dams that improve the contaminant removal and runoff reduction functions of simple grass channel and roadside ditch designs.

Where development density, topography and depth to water table permit, enhanced grass swales are a preferred alternative to both curb and gutter and storm drains as a stormwater conveyance system. When incorporated into a site design, they can reduce impervious cover, accent the natural landscape, and provide aesthetic benefits.

DESIGN GUIDANCE

GEOMETRY AND SITE LAYOUT

- Shape: Should be designed with a trapezoidal or parabolic cross section. Trapezoidal swales will generally evolve into parabolic swales over time, so the initial trapezoidal cross-section design should be checked for capacity and conveyance assuming it is a parabolic cross-section. Swale length between culverts should be 5 metres or greater.
- Bottom Width: Should be designed with a bottom width between 0.75 and 3.0 metres. Should allow for shallow flows and adequate water quality treatment, while preventing flows from concentrating and creating gullies.
- Longitudinal Slope: Slopes should be between 0.5% and 4%. Check dams should be incorporated on slopes greater than 3%.
- Length: When used to convey and treat road runoff, the length simply parallels the road, and therefore should be equal to, or greater than the contributing roadway length.
- Flow Depth: A maximum flow depth of 100 mm is recommended during a 4 hour, 25 mm Chicago storm event.
- Side Slopes: Should be as flat as possible to aid in providing pretreatment for lateral incoming flows and to maximize the swale filtering surface. Steeper side slopes are likely to have erosion gullying from incoming lateral flows. A maximum slope of 2.5:1 (H:V) is recommended and a 4:1 slope is preferred where space permits.

PRE-TREATMENT

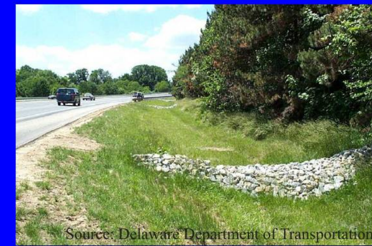
A pea gravel diaphragm located along the top of each bank can be used to provide pretreatment of any runoff entering the swale laterally along its length. Vegetated filter strips or mild side slopes (3:1) also provide pretreatment for any lateral sheet flow entering the swale. Sedimentation forebays at inlets to the swale are also a pretreatment option.

CONVEYANCE AND OVERFLOW

Grass swales must be designed for a maximum velocity of 0.5 m/s or less for the 4 hour 25 mm Chicago storm event. The swale should also convey the locally required design storm (usually the 10 year storm) at non-erosive velocities.

SOIL AMENDMENTS

If soils along the location of the swale are highly compacted, or of such low fertility that vegetation cannot become established, they should be tilled to a depth of 300 mm and amended with compost to achieve an organic content of 8 to 15% by weight or 30 to 40% by volume.

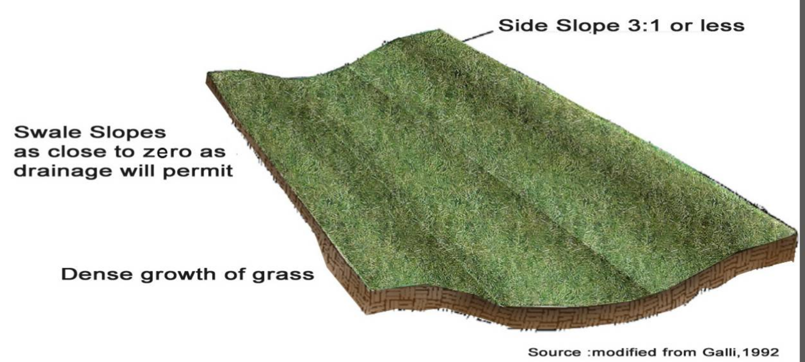

Source: Delaware Department of Transportation

Source: Seattle Public Utilities


Source: Thomas Engineering

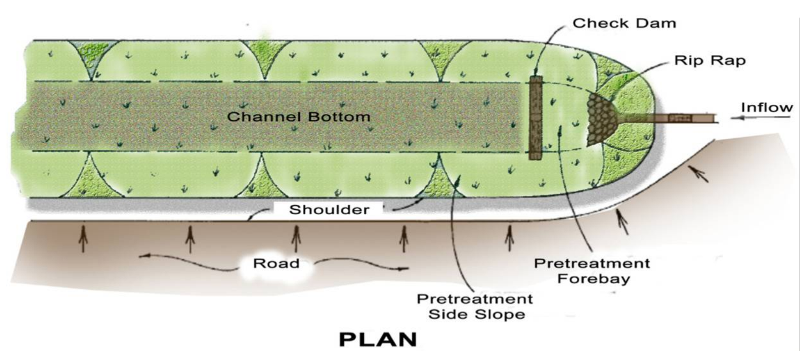

Source: Sue Donaldson

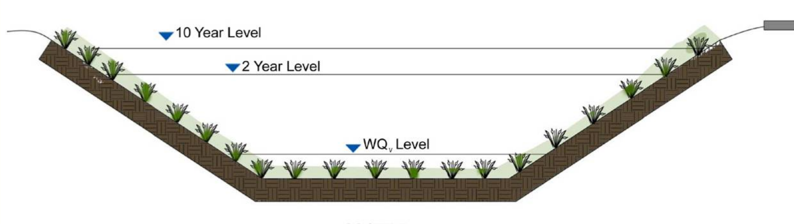

Source: CWP



Source :modified from Galli,1992

PLAN VIEW OF A GRASS SWALE





PLAN AND PROFILE VIEWS

ABILITY TO MEET SWM OBJECTIVES

BMP	Water Balance Benefit	Water Quality Improvement	Stream Channel Erosion Control Benefit
Enhanced Grass Swale	Partial - depends on soil infiltration rate	Yes, if design velocity is 0.5 m/s or less for a 4 hour, 25 mm Chicago storm	Partial - depends on soil infiltration rate

GENERAL SPECIFICATIONS

Component	Specification	Quantity
Check Dams	Constructed of a non-erosive material such as suitably sized aggregate, wood, gabions, riprap, or concrete. All check dams should be underlain with geotextile filter fabric. Wood used for check dams should consist of pressure treated logs or timbers, or water-resistant tree species such as cedar, hemlock, swamp oak or locust.	Spacing should be based on the longitudinal slope and desired ponding volume.
Gravel Diaphragm	Washed stone between 3 and 10 mm in diameter.	Minimum of 300 mm wide and 600 mm deep.

CONSTRUCTION CONSIDERATIONS

Grass swales should be clearly marked before site work begins to avoid disturbance during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within the swale site. Any accumulation of sediment that does occur within the swale must be removed during the final stages of grading to achieve the design cross-section. Final grading and planting should not occur until the adjoining areas draining into the swale are stabilized. Flow should not be diverted into the swale until the banks are stabilized.

Preferably, the swale should be planted in the spring so that the vegetation can become established with minimal irrigation. Installation of erosion control matting or blanketing to stabilize soil during establishment of vegetation is highly recommended. If sod is used, it should be placed with staggered ends and secured by rolling the sod. This helps to prevent gullies.

OPERATION AND MAINTENANCE

Generally, routine maintenance will be the same as for any other landscaped area; weeding, pruning, and litter removal. Grassed swales should be mown at least twice yearly to maintain grass height between 75 and 150 mm. The lightest possible mowing equipment should be used to prevent soil compaction. Routine roadside ditch maintenance practices such as scraping and re-grading should be avoided. Regular watering may be required during the first two years until vegetation is established. Routine inspection is very important to ensure that dense vegetation cover is maintained and inlets and pretreatment devices are free of debris.

For the first two years following construction the swale should be inspected at least quarterly and after every major storm event (> 25 mm). Subsequently, inspections should be conducted in the spring and fall of each year and after major storm events. Inspect for vegetation density (at least 80% coverage), damage by foot or vehicular traffic, accumulation of debris, trash and sediment, and structural damage to pretreatment devices.

Trash and debris should be removed from pretreatment devices and the surface of the swale at least twice annually. Other maintenance activities include weeding, replacing dead vegetation, repairing eroded areas, dethatching and aerating as needed. Remove accumulated sediment on the swale surface when dry and exceeding 25 mm depth.

SITE CONSIDERATIONS

Available Space
Grass swales usually consume about 5 to 15% of their contributing drainage area. A width of at least 2 metres is needed.

Site Topography
Site topography constrains the application of grass swales. Longitudinal slopes between 0.5 and 6% are allowable. This prevents ponding while providing residence time and preventing erosion. On slopes steeper than 3%, check dams should be used.

Drainage Area & Runoff Volume
The conveyance capacity should match the drainage area. Sheet flow to the grass swale is preferable. If drainage areas are greater than 2 hectares, high discharge through the swale may not allow for filtering and infiltration, and may create erosive conditions. Typical ratios of impervious drainage area to treatment facility area range from 5:1 to 10:1.

Soil
Grass swales can be applied on sites with any type of soils.

Pollution Hot Spot Runoff
To protect groundwater from possible contamination, source areas where land uses or human activities have the potential to generate highly contaminated runoff (e.g., vehicle fueling, servicing and demolition areas, outdoor storage and handling areas for hazardous materials and some heavy industry sites) should not be treated by grass swales.

Proximity to Underground Utilities
Utilities running parallel to the grass swale should be offset from the centerline of the swale. Underground utilities below the bottom of the swale are not a problem.

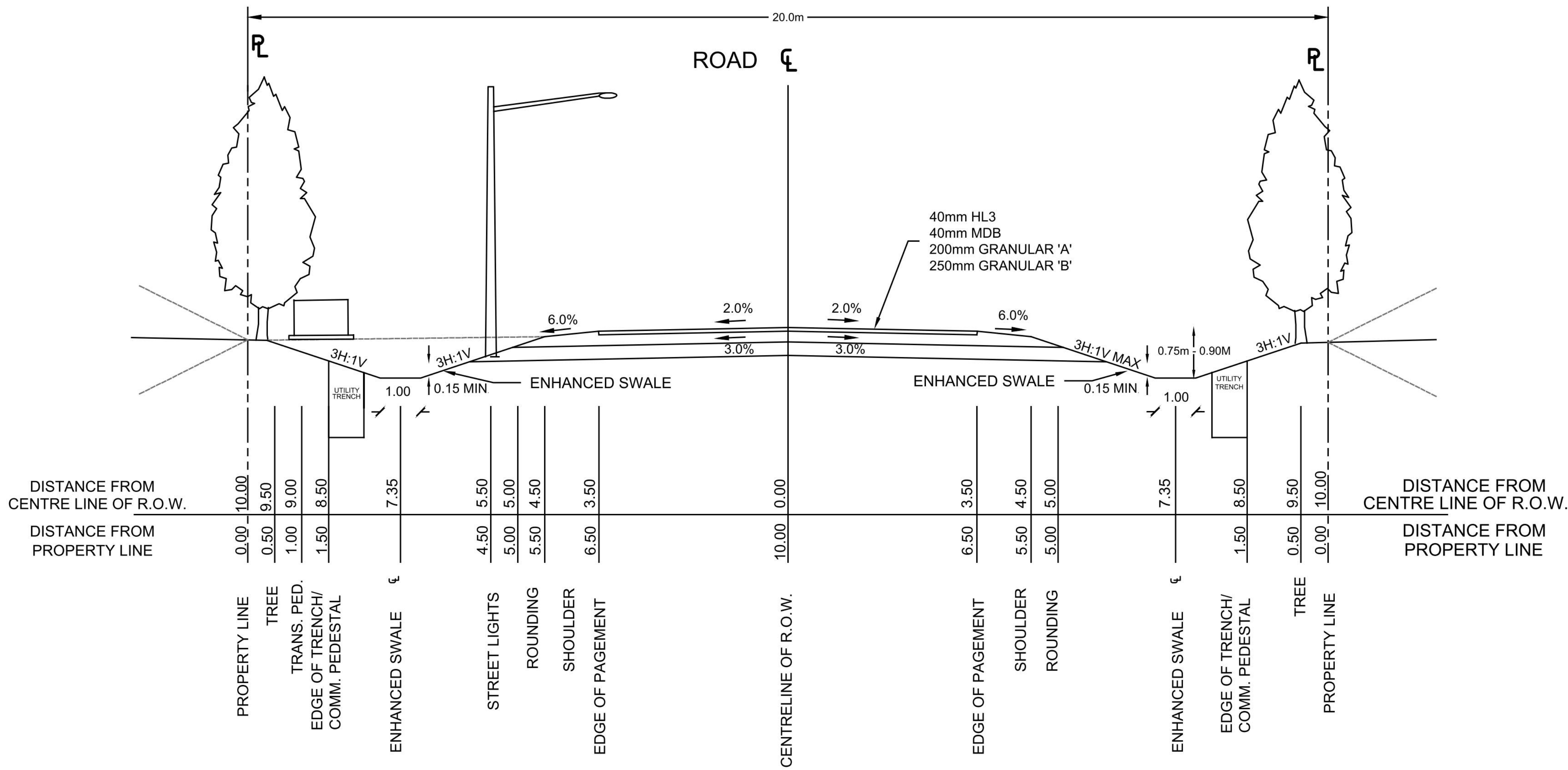
Water Table
The bottom of the swale should be separated from the seasonally high water table or top of bedrock elevation by at least one (1) metre.

Setback from Buildings
Should be located a minimum of four (4) metres from building foundations to prevent water damage.

TORONTO AND REGION Conservation for The Living City

CVC CREDIT VALLEY CONSERVATION

FOR FURTHER DETAILS SEE SECTION 4.8 OF THE CVC/TRCA LID SWM GUIDE



PROPOSED RURAL 20m RIGHT OF WAY WITH ENHANCED SWALE

N.T.S.

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.866.884.9392 fax.

Client: GREENE'S ELECTRIC, PLUMBING & HEATING

Project: THOUSAND ISLAND PARKWAY SUBDIVISION

Drawing: ROAD CROSS SECTIONS

Drawn by: EP	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.
Date: JANUARY 2025		D1
Scale: N.T.S.		

Appendix B

Short Duration Rainfall Intensity-Duration-Frequency Data
Table 3-1: Surface Cover Parameter Calculations
SK.1 – Impervious / Pervious Area Calculations
Source Water protection Map
Soil Survey Map
OWIT Map

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2022/10/31

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KINGSTON PUMPING STATION (composite) ON 6104175
Latitude: 44 14'N Longitude: 76 29'W Elevation/Altitude: 76 m

Years/Années : 1914 - 2007 # Years/Années : 63

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Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

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Year Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1914	5.8	7.9	9.7	12.2	19.3	25.4	29.2	37.1	40.1
1915	3.6	5.3	7.6	10.2	16.0	28.2	45.2	58.9	65.0
1921	8.1	16.0	17.0	18.0	18.3	18.3	25.9	27.9	45.0
1922	4.8	6.9	9.7	15.7	20.6	22.6	32.3	32.3	36.1
1926	8.6	13.0	18.0	23.4	33.5	48.8	54.6	54.6	57.9
1927	8.6	13.0	16.5	21.8	39.1	39.9	40.1	40.1	49.8
1928	10.9	16.8	22.6	29.0	34.8	35.8	41.1	41.7	48.0
1929	10.7	14.7	14.7	18.8	23.9	28.4	30.2	39.6	52.8
1930	8.4	11.4	11.4	13.2	15.7	17.0	21.8	34.8	44.4
1931	6.9	10.7	14.2	17.5	18.8	25.9	27.7	39.4	39.4
1932	8.9	15.7	18.3	21.3	21.3	21.3	26.9	34.3	50.8
1933	7.1	11.2	12.2	14.7	15.5	18.3	38.4	47.0	51.1
1934	5.1	9.1	11.4	15.2	18.5	20.1	26.7	40.4	45.0
1935	10.2	14.2	19.8	34.5	40.4	55.4	59.4	59.4	64.5
1936	4.6	8.1	8.4	10.9	15.0	22.6	32.8	47.5	49.5
1937	10.2	15.0	19.8	28.7	42.4	52.3	62.5	78.7	79.8
1938	8.9	13.0	13.0	13.0	19.0	33.5	42.7	42.7	57.9
1961	5.3	9.4	13.2	13.2	13.2	20.6	32.3	34.5	35.8
1962	10.7	13.2	19.8	24.1	24.4	25.4	30.2	40.6	42.2
1963	7.6	8.9	12.4	17.8	21.6	27.9	32.3	32.8	39.6
1964	4.1	6.3	6.6	7.6	10.4	16.3	23.6	32.8	33.3
1965	5.6	8.1	9.4	16.0	23.4	26.2	26.7	33.5	37.3

1966	5.1	9.1	10.9	15.0	23.6	24.1	46.7	47.0	47.0
1967	12.4	14.2	16.3	24.9	35.8	37.1	37.1	46.2	51.3
1968	10.4	13.2	16.0	19.3	21.1	22.9	30.2	43.7	45.0
1969	6.9	8.4	9.9	10.4	15.7	19.6	32.0	39.9	47.8
1970	5.6	9.1	12.4	21.6	24.1	26.7	26.9	28.2	28.4
1971	8.1	10.2	10.7	14.0	15.2	17.5	25.4	30.0	47.0
1972	9.7	11.4	12.7	15.5	20.8	36.1	54.1	79.2	79.5
1973	8.6	10.4	12.2	16.5	24.1	26.9	33.5	34.8	43.4
1974	4.8	6.3	7.1	7.6	8.9	14.0	17.3	20.8	23.9
1975	7.6	13.2	15.2	16.3	17.0	22.6	40.1	52.1	65.0
1976	10.9	14.5	16.0	16.3	27.4	35.8	37.1	38.4	41.7
1977	8.1	9.7	11.4	13.0	14.2	19.0	42.2	45.2	45.5
1978	7.4	10.0	12.8	16.4	17.1	23.8	36.0	40.2	43.0
1979	7.4	10.2	12.4	14.1	22.4	37.9	100.6	126.0	127.1
1980	8.6	11.7	14.8	19.9	28.0	43.9	44.8	44.8	53.0
1981	6.4	8.1	9.5	17.6	28.8	39.3	56.3	57.0	59.1
1982	9.3	14.4	15.8	16.0	16.0	23.7	39.7	45.0	45.0
1983	15.4	18.2	18.6	21.0	26.9	34.1	50.8	55.4	70.6
1984	6.4	6.6	7.1	10.4	15.7	22.5	30.6	38.6	45.4
1985	15.8	19.8	26.7	34.3	39.0	50.5	53.6	53.6	53.7
1986	7.0	9.0	9.7	15.0	19.8	26.7	50.2	65.3	74.2
1987	4.0	6.5	9.7	10.5	14.3	16.8	30.0	48.4	56.6
1988	6.6	10.3	12.8	16.2	25.5	28.1	28.8	28.8	30.2
1989	3.8	6.6	8.4	11.5	12.0	15.2	30.5	33.7	42.0
1990	7.4	10.8	14.3	14.3	16.5	20.7	37.9	38.7	41.4
1991	11.4	12.7	13.1	19.3	33.9	34.6	37.4	37.6	43.4
1992	7.6	10.8	14.2	24.0	35.1	41.9	44.7	46.2	46.2
1993	8.0	12.8	16.0	24.6	28.6	31.7	32.5	32.9	64.6
1994	11.1	14.1	16.4	20.3	25.6	29.4	47.7	51.8	52.8
1995	4.4	5.7	7.2	8.5	13.0	18.3	33.7	49.2	56.1
1996	5.7	7.7	8.5	10.9	13.0	18.0	28.0	33.8	44.5
1997	9.4	13.2	15.5	21.2	21.2	28.3	33.1	34.0	39.2
1998	10.4	14.1	16.6	19.0	20.8	21.0	28.9	32.9	35.0
1999	6.5	9.8	10.8	12.0	16.2	22.0	28.3	41.2	44.7
2000	7.7	8.1	9.8	11.4	17.8	20.8	28.1	35.7	49.4
2001	5.8	8.8	11.9	19.3	20.8	21.2	27.4	36.9	44.8
2002	8.0	10.0	10.4	12.6	15.2	19.7	26.4	36.9	43.1
2003	8.4	15.4	17.7	25.1	28.0	31.6	38.2	43.2	45.0
2005	9.2	13.8	14.9	20.0	20.8	24.3	49.2	63.2	65.1
2006	9.0	11.6	12.9	15.7	22.8	25.8	28.8	35.0	39.1
2007	7.1	12.0	13.4	14.5	19.6	21.2	24.4	34.5	36.6
# Yrs. Années	63	63	63	63	63	63	63	63	63
Mean Moyenne	7.9	11.1	13.3	17.2	22.0	27.4	37.0	43.8	49.6
Std. Dev. Écart-type	2.5	3.2	4.0	5.8	7.8	9.5	12.9	15.4	15.2
Skew. Dissymétrie	0.73	0.32	0.70	0.90	0.88	1.14	2.21	2.89	2.42
Kurtosis	4.18	2.78	3.95	4.10	3.34	3.97	11.33	15.59	13.18

*-99.9 Indicates Missing Data/Données manquantes

Warning: annual maximum amount greater than 100-yr return period amount
Avertissement : la quantité maximale annuelle excède la quantité
pour une période de retour de 100 ans

Year/Année	Duration/Durée	Data/Données	100-yr/ans
1979	6 h	100.6	77.5
1979	12 h	126.0	92.0
1979	24 h	127.1	97.1
1985	15 min	26.7	25.9

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Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

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Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	7.5	9.7	11.2	13.1	14.5	15.9	63
10 min	10.6	13.4	15.3	17.7	19.5	21.2	63
15 min	12.6	16.2	18.5	21.5	23.7	25.9	63
30 min	16.2	21.4	24.8	29.1	32.3	35.5	63
1 h	20.7	27.6	32.2	37.9	42.2	46.4	63
2 h	25.8	34.2	39.8	46.8	52.1	57.3	63
6 h	34.9	46.3	53.8	63.4	70.5	77.5	63
12 h	41.2	54.8	63.8	75.2	83.7	92.0	63
24 h	47.1	60.5	69.3	80.5	88.8	97.1	63

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Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

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Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	89.9	116.8	134.7	157.2	173.9	190.5	63
	+/- 6.9	+/- 11.6	+/- 15.7	+/- 21.2	+/- 25.4	+/- 29.5	63
10 min	63.5	80.6	91.9	106.3	116.9	127.4	63
	+/- 4.4	+/- 7.4	+/- 10.0	+/- 13.5	+/- 16.1	+/- 18.7	63
15 min	50.6	64.8	74.2	86.1	94.9	103.6	63
	+/- 3.6	+/- 6.1	+/- 8.3	+/- 11.2	+/- 13.4	+/- 15.6	63
30 min	32.5	42.8	49.6	58.2	64.6	70.9	63
	+/- 2.6	+/- 4.5	+/- 6.0	+/- 8.1	+/- 9.7	+/- 11.3	63
1 h	20.7	27.6	32.2	37.9	42.2	46.4	63

	+/- 1.8	+/- 3.0	+/- 4.0	+/- 5.4	+/- 6.5	+/- 7.5	63
2 h	12.9	17.1	19.9	23.4	26.0	28.6	63
	+/- 1.1	+/- 1.8	+/- 2.5	+/- 3.3	+/- 4.0	+/- 4.6	63
6 h	5.8	7.7	9.0	10.6	11.7	12.9	63
	+/- 0.5	+/- 0.8	+/- 1.1	+/- 1.5	+/- 1.8	+/- 2.1	63
12 h	3.4	4.6	5.3	6.3	7.0	7.7	63
	+/- 0.3	+/- 0.5	+/- 0.7	+/- 0.9	+/- 1.1	+/- 1.2	63
24 h	2.0	2.5	2.9	3.4	3.7	4.0	63
	+/- 0.1	+/- 0.2	+/- 0.3	+/- 0.4	+/- 0.5	+/- 0.6	63

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Table 3 : Interpolation Equation / Équation d'interpolation: R = A*T^B

R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)
RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)
T = Rainfall duration (h) / Durée de la pluie (h)

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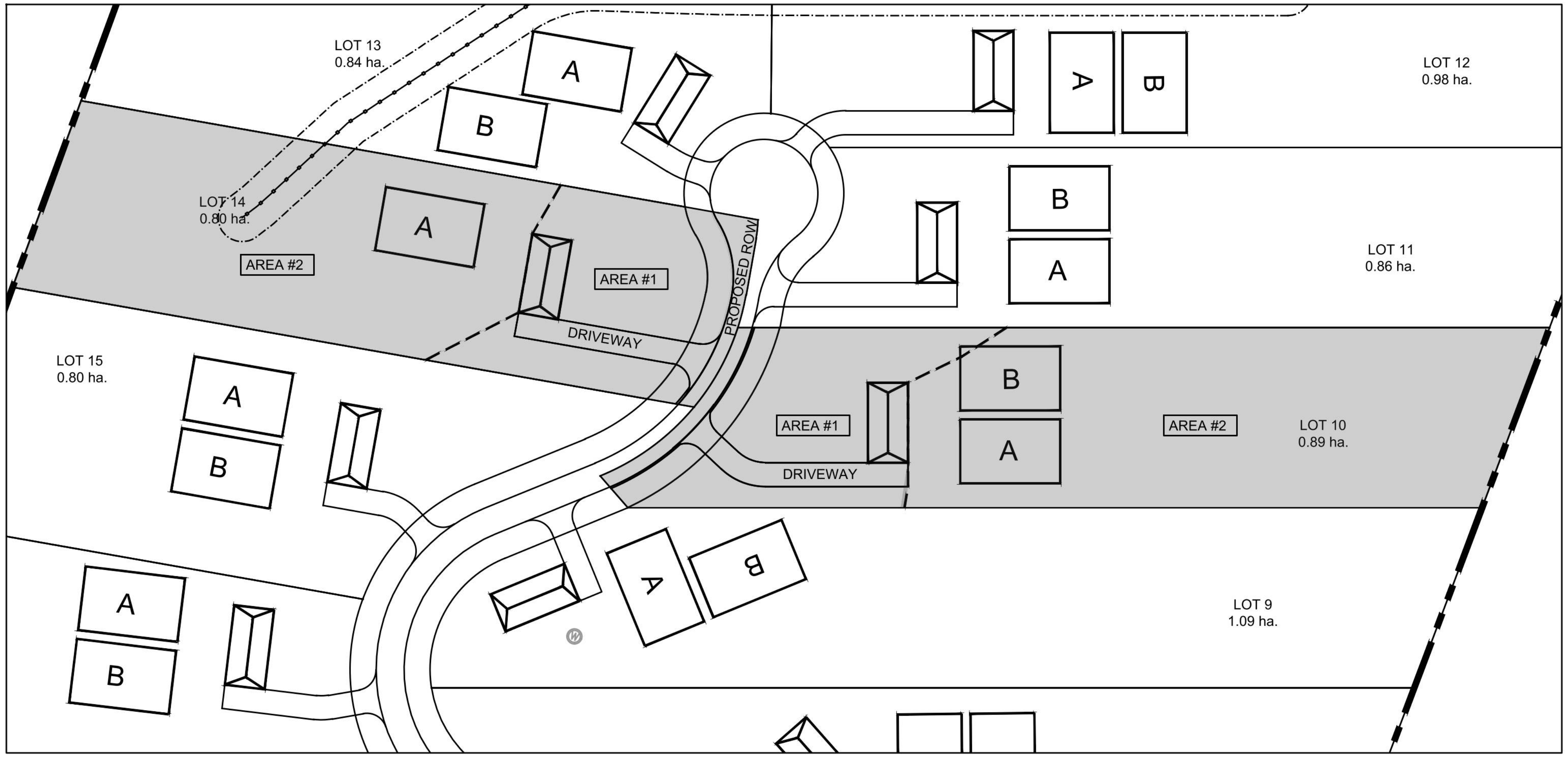
Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans
Mean of RR/Moyenne de RR	31.3	40.5	46.6	54.4	60.1	65.8
Std. Dev. /Écart-type (RR)	30.8	39.6	45.5	52.9	58.3	63.8
Std. Error/Erreur-type	5.3	6.8	7.8	9.1	10.1	11.1
Coefficient (A)	19.1	24.9	28.8	33.6	37.3	40.9
Exponent/Exposant (B)	-0.681	-0.677	-0.676	-0.674	-0.673	-0.672
Mean % Error/% erreur moyenne	6.6	7.4	7.7	8.1	8.3	8.5

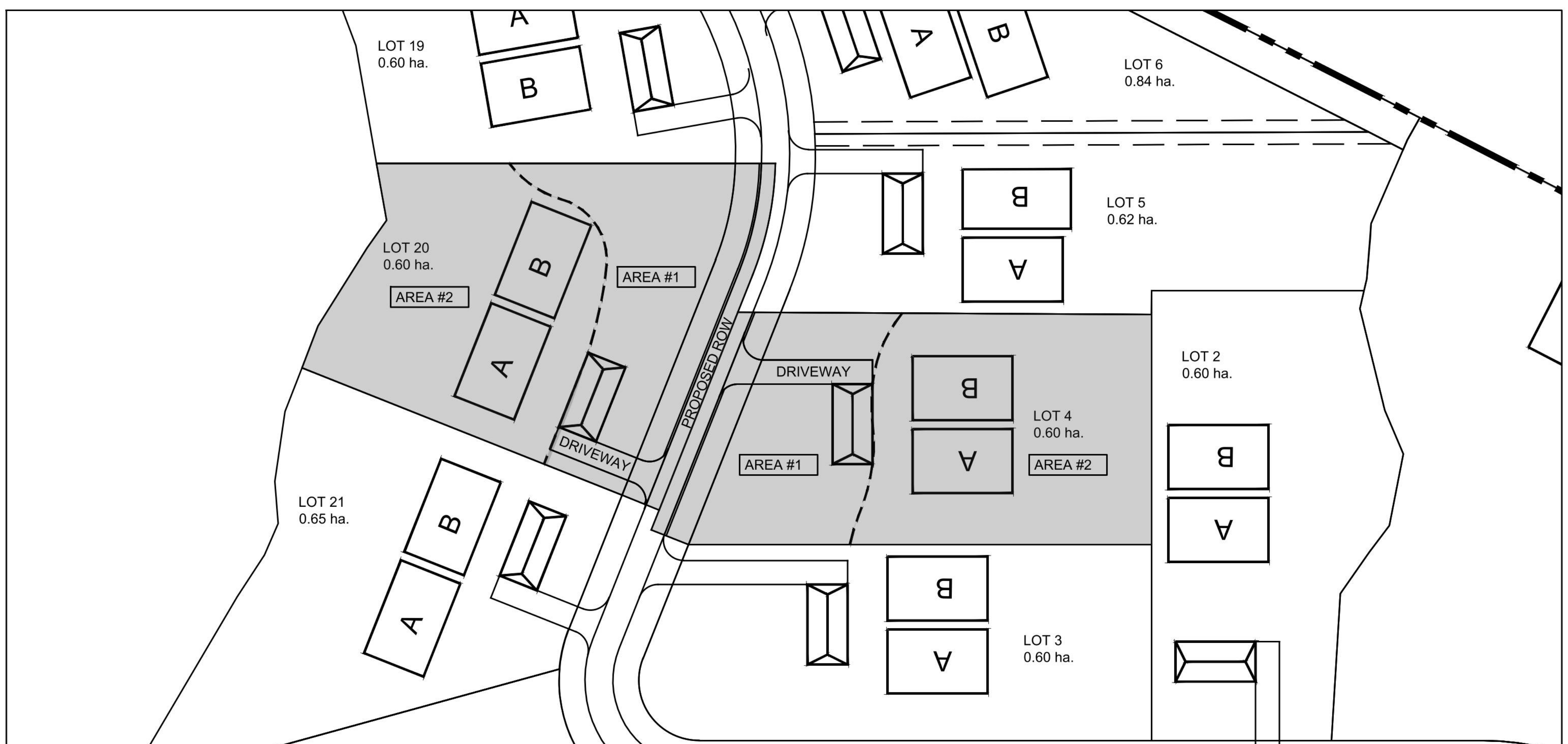
Table 3-1: Surface Cover Parameter Calculations - Thousand Islands Parkway Subdivision

Surface Cover Type	Manning's "n" Impervious	Manning's "n" Pervious	Dep. Storage (mm) Impervious	Dep. Storage (mm) Pervious	% Impervious	Subarea Routing	% Routed	% Impervious without Storage
Forest	0.03	0.4	10	15	1		100	10
Grass	0.025	0.25	5	10	2.5		75	10
BioRet	0.025	0.3	25	30	2.5		75	10
Bare	0.02	0.15	5	7.5	5		50	10
GrnRoof	0.025	0.3	17.5	20	25		25	15
Ex Bed Rock	0.025	0.2	5	7.5	90		25	20
RegRoof	0.015	0.15	2.5	5	95		10	25
PrmPave	0.02	0.2	12.5	15	50		25	15
ImpPave	0.015	0.15	2.5	5	95		10	20
Gravel	0.025	0.2	5	7.5	90		25	20
Wetland	0.015	0.35	0	15	50		50	10
Water	0.015	0.015	0	0	100		0	0

Code	Description
Forest	Forest/meadow, heavy vegetation with high transpiration/deep root zone
Grass	Grass/turf, light vegetation/landscaped areas with shallow roots
BioRet	Bioretention/rain garden/planter, engineered with underdrain
Bare	Un-vegetated soil or loos granular materials
GrnRoof	Green roof
RegRoof	Regular roof
Ex Bed Rock	Exposed bedrock
PrmPave	Permeable paved surfaces (with underdrain)
ImpPave	Impermeable paved surfaces (i.e. roadways, parking, driveways)
Gravel	Gravel and compacted granular in traffic areas
Wetland	Roughly half open water and half heavily vegetated
Water	Open water surface

Hydrologic Unit Name	Percent by Surface Cover Type													% Impervious	Manning's "N"		Dep. Storage (mm)		% Impervious without Storage	% Routed	Subarea Routing
	Forest	Grass	BioRet	Bare	GrnRoof	Ex Bed Rock	RegRoof	PrmPave	ImpPave	Gravel	Wetland	Water	Total		Impervious	Pervious	Impervious	Pervious			
(Pre-Development)																					
E1A (North)	44.00%	10.00%		38.00%		3.00%					5.00%		100.00%	7.8	0.0248	0.2815	6.95	11.425	10.30	74	Impervious to Pervious
E1A (South)	15.00%	2.00%		79.00%		4.00%							100.00%	7.8	0.0218	0.1915	5.75	8.675	10.40	57	Impervious to Pervious
E1B	50.00%	15.00%		31.00%		4.00%							100.00%	6.0	0.02595	0.292	7.5	11.625	10.40	78	Impervious to Pervious
E1C	5.00%	25.00%		66.00%		4.00%							100.00%	7.6	0.02195	0.1895	5.25	8.5	10.40	58	Impervious to Pervious
EX.1C	78.00%	15.00%				4.00%	1.00%		1.00%	1.00%			100.00%	7.6	0.0287	0.3625	8.85	13.675	10.75	91	Impervious to Pervious
EX.1A	76.00%	15.00%		5.00%		4.00%							100.00%	5.0	0.0286	0.357	8.8	13.575	10.40	91	Impervious to Pervious
Upstream Ext. Rural Catchment	54.80%	24.00%		10.00%		1.00%	2.50%		4.80%	1.00%	1.90%		100.00%	11.3	0.0263	0.3158	7.4625	12.17	11.06	80	Impervious to Pervious
(Post-Development)																					
P1A		75.70%					7.00%		16.30%	1.00%			100.00%	24.9	0.02267	0.2262	4.4175	8.81	12.78	59	Impervious to Pervious
P2A	50.70%	19.00%		24.00%		4.00%	1.50%		0.80%				100.00%	8.0	0.026105	0.29775	7.4775	11.72	10.71	78	Impervious to Pervious
P3A	50.70%	19.00%		24.00%		4.00%	1.50%		0.80%				100.00%	8.0	0.026105	0.29775	7.4775	11.72	10.71	78	Impervious to Pervious
P1B	50.70%	19.00%		24.00%		4.00%	1.50%		0.80%				100.00%	8.0	0.026105	0.29775	7.4775	11.72	10.71	78	Impervious to Pervious
P1C	50.70%	19.00%		24.00%		4.00%	1.50%		0.80%				100.00%	8.0	0.026105	0.29775	7.4775	11.72	10.71	78	Impervious to Pervious
P2C		75.70%					7.00%		16.30%	1.00%			100.00%	24.9	0.02267	0.2262	4.4175	8.81	12.78	59	Impervious to Pervious
P3C	50.70%	19.00%		24.00%		4.00%	1.50%		0.80%				100.00%	8.0	0.026105	0.29775	7.4775	11.72	10.71	78	Impervious to Pervious
P4C	50.70%	19.00%		24.00%		4.00%	1.50%		0.80%				100.00%	8.0	0.026105	0.29775	7.4775	11.72	10.71	78	Impervious to Pervious
EX.1C	78.00%	15.00%				4.00%	1.00%		1.00%	1.00%			100.00%	7.6	0.0287	0.3625	8.85	13.675	10.75	91	Impervious to Pervious
EX.1A	76.00%	15.00%		5.00%		4.00%							100.00%	5.0	0.02855	0.357	8.8	13.575	10.40	91	Impervious to Pervious
Upstream Ext. Rural Catchment	54.80%	24.00%		10.00%		1.00%	2.50%		4.80%	1.00%	1.90%		100.00%	11.3	0.0263	0.3158	7.4625	12.17	11.06	80	Impervious to Pervious





AREA #1

Combined Areas Lots 10 & 14 Area #1	Impervious Area (m^2)	Direct Connected Impervious (m^2)	Pervious Areas (m^2)	Percentage %
House Roof	400.0			7.2%
Drive way (Pavement)		666.0		12.0%
Gravel		40.0		0.7%
Street		417.0		7.5%
Lawn			4017.0	72.5%
Sub Totals	400.0	1123.0	4017.0	100%
Total Lot Areas	5540.0			

AREA #2

Combined Areas Lots 10 & 14 Area #2	Impervious Area (m^2)	Direct Connected Impervious (m^2)	Pervious Areas (m^2)	Percentage %
House Roof				0.0%
Drive way (Pavement)				0.0%
Gravel				0.0%
Street				0.0%
Lawn / Forest			12464.0	100.0%
Sub Totals	0.0	0.0	12464.0	100%
Total Lot Areas	12464.0			

AREA #1

Combined Areas Lots 4 & 20 Area #1	Impervious Area (m^2)	Direct Connected Impervious (m^2)	Pervious Areas (m^2)	Percentage %
House Roof	400.0			7.0%
Drive way (Pavement)		405.0		7.1%
Gravel		62.0		1.1%
Street		526.0		9.2%
Lawn			4343.0	75.7%
Sub Totals	400.0	993.0	4343.0	100%
Total Lot Areas	5736.0			

AREA #2

Combined Areas Lots 4 & 20 Area #2	Impervious Area (m^2)	Direct Connected Impervious (m^2)	Pervious Areas (m^2)	Percentage %
House Roof				0.0%
Drive way (Pavement)				0.0%
Gravel				0.0%
Street				0.0%
Lawn / Forest			7871.0	100.0%
Sub Totals	0.0	0.0	7871.0	100%
Total Lot Areas	7871.0			

LEGEND:

- PERMEABLE AREA
- IMPERVIOUS AREA
- GRAVEL

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.866.884.9392 fax.

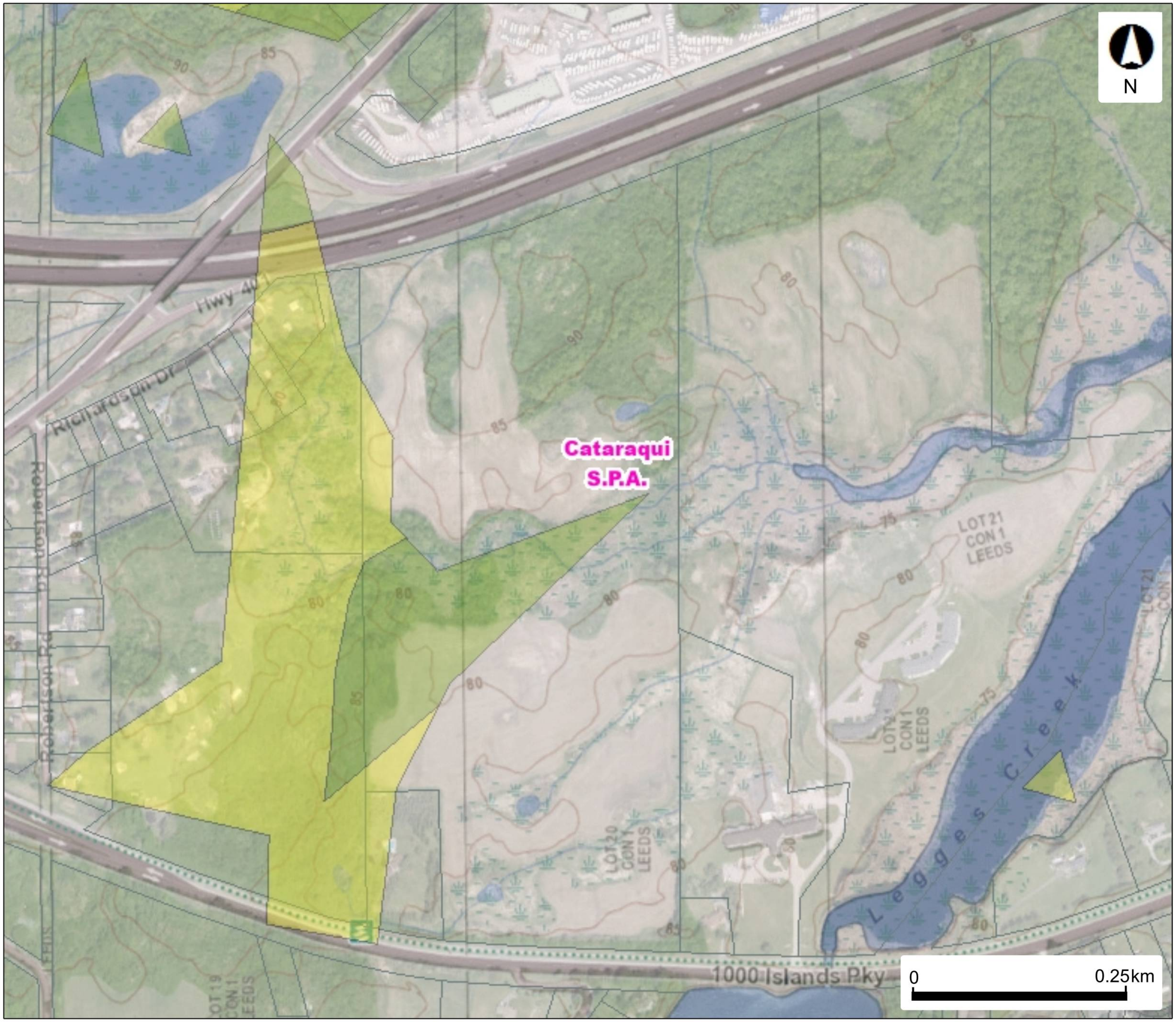
Client: GREENE'S ELECTRIC, PLUMBING & HEATING LTD.

Project: THOUSAND ISLAND PARKWAY SUBDIVISION

Drawing: IMPERVIOUS / PERMEABLE

Drawn by: EP	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No. SK.1
Date: JANUARY 2025		
Scale: 1:1000 (11x17)		

Source Water Protection Map



Legend

- Intake Protection Zone Q
- Wellhead Protection Area Q1
- Wellhead Protection Area Q2
- Significant Groundwater Recharge Area
  - N/A
  - 0
  - 2
  - 4
  - 6
- Issue Contributing Areas
- WHPA-E
- Wellhead Protection Area
  - A
  - B
  - C
  - C1
  - D
  - F
- Intake Protection Zone 1
- Event Based Areas
- Intake Protection Zone 2
- Intake Protection Zone 3
- Vulnerable Scoring Area - Surface Water
  - 0 - 3.9
  - 4 - 7.9
  - 8 - 8.9
  - 9 - 10

Map Created: 1/6/2025

Map Center: 44.34062 N, -76.12961 W

Soil Survey Map

Legend

Assessment Parcel

Soil Name Label

Hydrologic Soil Group

- A - High
- B - Moderate
- C - Slow
- D - Very Slow

This map should not be relied on as a precise indicator of routes or locations, nor as a guide to navigation. The Ontario Ministry of Agriculture, Food and Agribusiness (OMAFA) shall not be liable in any way for the use or any information on this map. of, or reliance upon, this map.

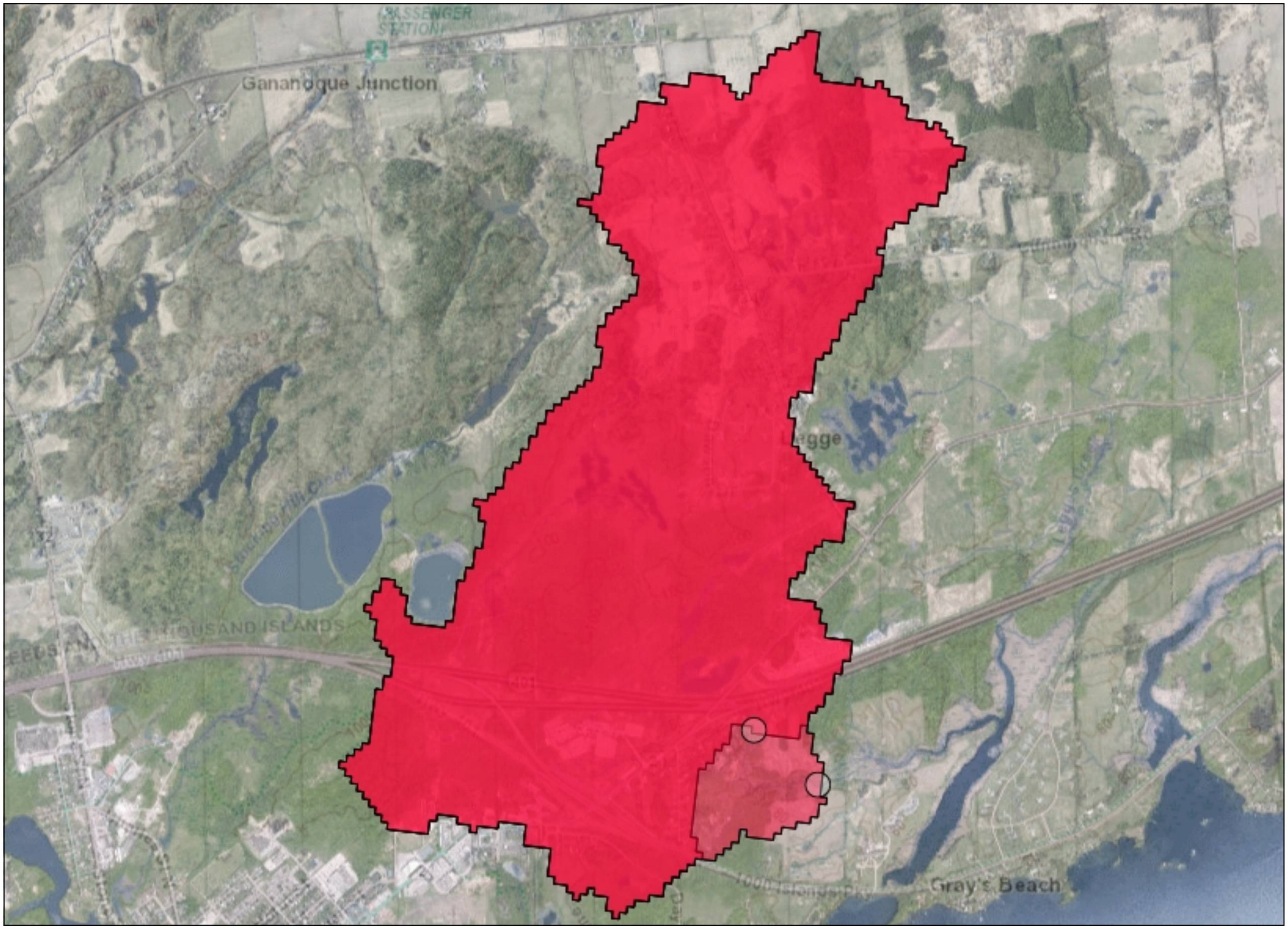
Map Created: 1/3/2025

Map Center: 44.34031 N, -76.13088 W

Ontario
MINISTRY OF NATURAL RESOURCES
Ontario Watershed Information Tool

OWIT Map

Notes:



Legend

- Assessment Parcel
- Secondary Watershed
- Tertiary Watershed
- Quaternary Watershed
- Great Lakes - St. Lawrence Basin
- Hudson - James Bay Basin
- Nelson River Basin
- Hydrometric Monitoring Station
- Diversions
- Waterbody Outlet
- Conservation Authority Dam
- Provincial Dam
- Federal Dam
- OPG Dam
- Other Dam
- Virtual Flow Segment

Land Cover Compilation

- Other
- Cloud/Shadow
- Clear Open Water
- Turbid Water
- Shoreline
- Mudflats
- Marsh
- Swamp
- Fen
- Bog
- Heath
- Sparse Treed
- Treed Upland
- Deciduous Treed
- Mixed Treed
- Coniferous Treed
- Plantations - Treed Cultivated
- Hedge Rows
- Disturbance
- Open Cliff and Talus
- Alvar
- Sand Barren and Dune
- Open Tallgrass Prairie
- Tallgrass Savannah
- Tallgrass Woodland
- Sand/Gravel/Mine Tailings/Extraction
- Bedrock
- Community/Infrastructure
- Agriculture and Undifferentiated Rural Land Use

1.3 0 km 0.66 1.3

Scale: 1 : 25,822

Projection: Web Mercator

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Appendix C

6 Hour SCS II - 100 -Year Event Pre-Development Modelling
6 Hour SCS II - 100 -Year Event Controlled Post-Development Modelling
24 Hour SCS II - 100 -Year Event Pre-Development Modelling (Major Watercourse)
25mm - 4 Hour Event Controlled Post-Development Modelling
Stage- Storage Curves
25mm Event Velocity and Depth

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.4.304 (Build 0)

Project Description

File Name .... Thousand Island Parkway Pre.SPF

Analysis Options

Flow Units .... cms
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method .... Green-Ampt
Link Routing Method .... Steady Flow
Storage Node Exfiltration.. None
Starting Date MAR-07-2023 00:00:00
Ending Date MAR-09-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step .... 30.00 sec

Element Count

Number of rain gages 1
Number of subbasins 7
Number of nodes 4
Number of links 2
Number of pollutants 0
Number of land uses 0

Subbasin Summary

Subbasin ID	Total Area hectares	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
E1A_NORTH	6.93	310.00	7.80	3.0000	-
E1A_SOUTH	3.76	232.00	7.80	2.0000	-
E1B	4.86	215.00	6.00	7.1000	-
E1C	8.36	256.00	7.60	1.4000	-
EX.1A	1.22	73.00	5.00	8.0000	-
EX.1C	2.65	100.00	7.60	5.0000	-
UPSTREAM_EXT	484.19	725.00	11.30	4.5000	-

Node Summary

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
MAJOR_WC_450	JUNCTION	77.00	78.00	25000.000	
OUTLET_1B	JUNCTION	78.00	79.00	0.000	
OUTLET_1A	OUTFALL	75.33	76.33	0.000	
OUTLET_1C	OUTFALL	77.00	77.00	0.000	

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
MAJOR_WC1	OUTLET_1B	MAJOR_WC_450	CHANNEL	350.0	0.2857	0.0320
MAJOR_WC2	MAJOR_WC_450	OUTLET_1A	CHANNEL	450.0	0.3711	0.0320

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity cms
MAJOR_WC1	RECT_OPEN	1.00	20.00	1	20.00	0.91	31.36
MAJOR_WC2	RECT_OPEN	1.00	50.00	1	50.00	0.96	92.74

****
Runoff Quantity Continuity
****

	Volume hectare-m	Depth mm
Total Precipitation	39.678	77.500
Evaporation Loss	0.000	0.000
Infiltration Loss	30.038	58.672
Surface Runoff	9.242	18.051
Final Surface Storage	0.404	0.789
Continuity Error (%)	-0.015	

****
Flow Routing Continuity
****

	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	9.242	92.417
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	9.242	92.417
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
EPA SWMM Time of Concentration Computations Report
****

$$Tc = (0.94 * (L^{0.6}) * (n^{0.6})) / ((i^{0.4}) * (S^{0.3}))$$

Where:

Tc = Time of Concentration (min)

```
        L  = Flow Length (ft)
        n  = Manning's Roughness
        i  = Rainfall Intensity (in/hr)
        S  = Slope (ft/ft)

---------------------
Subbasin E1A_NORTH
---------------------

        Flow length (m):                          223.55
        Pervious Manning's Roughness:            0.28150
        Impervious Manning's Roughness:          0.02480
        Pervious Rainfall Intensity (mm/hr):    12.91667
        Impervious Rainfall Intensity (mm/hr):  12.91667
        Slope (%):                               3.00000
        Computed TOC (minutes):                    85.01

---------------------
Subbasin E1A_SOUTH
---------------------

        Flow length (m):                          162.07
        Pervious Manning's Roughness:            0.19150
        Impervious Manning's Roughness:          0.02180
        Pervious Rainfall Intensity (mm/hr):    12.91667
        Impervious Rainfall Intensity (mm/hr):  12.91667
        Slope (%):                               2.00000
        Computed TOC (minutes):                    62.62

---------------
Subbasin E1B
---------------

        Flow length (m):                          226.05
        Pervious Manning's Roughness:            0.29200
        Impervious Manning's Roughness:          0.02595
        Pervious Rainfall Intensity (mm/hr):    12.91667
        Impervious Rainfall Intensity (mm/hr):  12.91667
        Slope (%):                               7.10000
        Computed TOC (minutes):                    68.26

---------------
Subbasin E1C
---------------

        Flow length (m):                          326.56
        Pervious Manning's Roughness:            0.18950
        Impervious Manning's Roughness:          0.02195
        Pervious Rainfall Intensity (mm/hr):    12.91667
        Impervious Rainfall Intensity (mm/hr):  12.91667
        Slope (%):                               1.40000
        Computed TOC (minutes):                   105.63

-----------------
Subbasin EX.1A
-----------------

        Flow length (m):                          167.12
        Pervious Manning's Roughness:            0.35700
        Impervious Manning's Roughness:          0.02860
        Pervious Rainfall Intensity (mm/hr):    12.91667
        Impervious Rainfall Intensity (mm/hr):  12.91667
        Slope (%):                               8.00000
        Computed TOC (minutes):                    62.45

-----------------
Subbasin EX.1C
```

Flow length (m): 265.00
Pervious Manning's Roughness: 0.36250
Impervious Manning's Roughness: 0.02870
Pervious Rainfall Intensity (mm/hr): 12.91667
Impervious Rainfall Intensity (mm/hr): 12.91667
Slope (%): 5.00000
Computed TOC (minutes): 94.91

Subbasin UPSTREAM_EXT

Flow length (m): 6678.49
Pervious Manning's Roughness: 0.30840
Impervious Manning's Roughness: 0.02620
Pervious Rainfall Intensity (mm/hr): 12.91667
Impervious Rainfall Intensity (mm/hr): 12.91667
Slope (%): 4.50000
Computed TOC (minutes): 600.68

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff cms	Runoff Coefficient	Time of Concentration days hh:mm:ss
E1A_NORTH	77.50	0.00	0.00	36.91	40.16	0.49	0.518	0 01:25:00
E1A_SOUTH	77.50	12.66	0.00	33.30	56.53	0.42	0.627	0 01:02:37
E1B	77.50	0.00	0.00	36.39	40.77	0.42	0.526	0 01:08:15
E1C	77.50	11.76	0.00	37.12	51.83	0.54	0.581	0 01:45:37
EX.1A	77.50	0.00	0.00	38.16	39.02	0.11	0.503	0 01:02:26
EX.1C	77.50	0.00	0.00	39.85	37.10	0.15	0.479	0 01:34:54
UPSTREAM_EXT	77.50	0.00	0.00	59.93	16.77	3.42	0.216	0 10:00:40

****
Node Depth Summary
****

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days hh:mm	Total Flooded Volume ha-mm	Total Time Flooded minutes	Retention Time hh:mm:ss

MAJOR_WC_450	0.05	0.28	77.28	0	04:00	0	0	0:00:00
OUTLET_1B	0.05	0.28	78.28	0	04:00	0	0	0:00:00
OUTLET_1A	0.03	0.17	75.50	0	04:00	0	0	0:00:00
OUTLET_1C	0.00	0.00	77.00	0	00:00	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cms	Peak Inflow cms	Time of Peak Inflow Occurrence days	hh:mm	Maximum Flooding Overflow cms	Time of Peak Flooding Occurrence days	hh:mm
MAJOR_WC_450	JUNCTION	0.907	4.743	0	04:00	0.00		
OUTLET_1B	JUNCTION	3.836	3.836	0	04:00	0.00		
OUTLET_1A	OUTFALL	0.000	4.743	0	04:00	0.00		
OUTLET_1C	OUTFALL	0.536	0.536	0	04:00	0.00		

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cms	Peak Inflow cms
OUTLET_1A	98.96	0.515	4.743
OUTLET_1C	21.70	0.116	0.536
System	60.33	0.631	5.279

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis cms	Design Flow Capacity cms	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
MAJOR_WC1	CHANNEL	0 04:00	0.70	1.00	3.836	31.356	0.12	0.28	0	Calculated
MAJOR_WC2	CHANNEL	0 04:00	0.57	1.00	4.743	92.745	0.05	0.17	0	Calculated

****
Highest Flow Instability Indexes
****
All links are stable.

```
*************************
Routing Time Step Summary
*************************
Minimum Time Step          :    30.00 sec
Average Time Step          :    30.00 sec
Maximum Time Step          :    30.00 sec
Percent in Steady State    :     0.00
Average Iterations per Step :     1.00


Analysis began on:  Tue Jan 21 16:04:57 2025
Analysis ended on:  Tue Jan 21 16:04:58 2025
Total elapsed time: 00:00:01
```

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Autodesk® Storm and Sanitary Analysis 2016 - Version 13.4.304 (Build 0)

****
Project Description
****

File Name .... Thousand Island Parkway Post Controlled.SPF

****
Analysis Options
****

Flow Units .... cms
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method .... Green-Ampt
Link Routing Method .... Steady Flow
Storage Node Exfiltration.. None
Starting Date MAR-07-2023 00:00:00
Ending Date MAR-09-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step .... 30.00 sec

****
Element Count
****

Number of rain gages 1
Number of subbasins 11
Number of nodes 15
Number of links 13
Number of pollutants 0
Number of land uses 0

****
Subbasin Summary
****

Subbasin ID	Total Area hectares	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
EX.1A	0.88	52.00	5.00	8.0000	-
EX.1C	2.99	100.00	7.60	5.0000	-
P1A	4.38	170.00	25.00	6.0000	-
P1B	4.14	394.00	8.00	7.6000	-
P1C	3.30	184.00	8.00	0.5000	-
P2A	3.28	250.00	8.00	5.5000	-
P2C	4.45	152.00	25.00	0.7000	-
P3A	1.86	224.00	8.00	3.0000	-
P3C	0.83	85.00	8.00	2.0000	-
P4C	1.67	131.00	8.00	4.0000	-
UPSTREAM_EXT	484.19	725.00	11.30	4.5000	-

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
21	JUNCTION	75.82	77.82	0.000	
CD_P1A_OUT	JUNCTION	78.60	79.60	0.000	

CVT2_IN	JUNCTION	78.00	79.00	0.000
CVT2_OUT	JUNCTION	77.90	78.90	0.000
MAJOR_WC_450	JUNCTION	77.00	78.00	0.000
OUTLET_1B	JUNCTION	78.00	79.00	0.000
P1C_OUT	JUNCTION	77.20	78.20	0.000
SWALE_P1A_IN	JUNCTION	87.20	88.20	0.000
SWALE_P1C_IN	JUNCTION	80.80	81.80	0.000
SWALE_P2C_IN	JUNCTION	80.40	81.40	0.000
OUTLET_1A	OUTFALL	75.33	75.33	0.000
OUTLET_1C	OUTFALL	77.00	78.00	0.000
CD_P1A_IN	STORAGE	78.60	79.60	0.000
CD_P1C_IN	STORAGE	77.20	78.20	0.000
CD_P2C_IN	STORAGE	78.90	79.90	0.000

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
CVT2	CVT2_IN	CVT2_OUT	CONDUIT	20.0	0.5000	0.0150
Link-24	CD_P1A_OUT	21	DIRECT	105.4	0.7876	0.0150
Link-26	21	OUTLET_1A	DIRECT	133.0	0.3685	0.0320
MAJOR_WC1	OUTLET_1B	MAJOR_WC_450	CHANNEL	350.0	0.2857	0.0320
MAJOR_WC2	MAJOR_WC_450	21	DIRECT	317.0	0.3722	0.0320
MINOR_SWALE_1C	CVT2_OUT	P1C_OUT	CHANNEL	138.0	0.5072	0.0350
MINOR_SWALE_P1C_OUT	P1C_OUT	OUTLET_1C	CHANNEL	138.0	0.1449	0.0350
SWALE_P1A	SWALE_P1A_IN	CD_P1A_IN	CHANNEL	360.0	2.3889	0.0500
SWALE_P1C	SWALE_P1C_IN	CD_P1C_IN	CHANNEL	90.0	3.9889	0.0500
SWALE_P2C	SWALE_P2C_IN	CD_P2C_IN	CHANNEL	300.0	0.5000	0.0500
CD_P1A	CD_P1A_IN	CD_P1A_OUT	OUTLET			
CD_P1C	CD_P1C_IN	P1C_OUT	OUTLET			
CD_P2C	CD_P2C_IN	CVT2_OUT	OUTLET			

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity cms
CVT2	CIRCULAR	0.70	0.70	1	0.38	0.17	0.57
Link-24	DUMMY	0.00	0.00	1	0.00	0.00	0.00
Link-26	DUMMY	0.00	0.00	1	0.00	0.00	0.00
MAJOR_WC1	RECT_OPEN	1.00	20.00	1	20.00	0.91	31.36
MAJOR_WC2	DUMMY	0.00	0.00	1	0.00	0.00	0.00
MINOR_SWALE_1C	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	5.44
MINOR_SWALE_P1C_OUT	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	2.91
SWALE_P1A	TRAPEZOIDAL	1.00	7.00	2	4.00	0.55	8.26
SWALE_P1C	TRAPEZOIDAL	1.00	7.00	2	4.00	0.55	

10.68
SWALE_P2C TRAPEZOIDAL 1.00 7.00 2 4.00 0.55
3.78

```
  **************************        Volume         Depth
  Runoff Quantity Continuity     hectare-m            mm
  **************************     ---------       -------
  Total Precipitation ......        39.678        77.500
  Evaporation Loss .........         0.000         0.000
  Infiltration Loss ........        29.970        58.538
  Surface Runoff ...........         9.304        18.172
  Final Surface Storage ....         0.411         0.802
  Continuity Error (%) .....        -0.017


  **************************        Volume        Volume
  Flow Routing Continuity        hectare-m       Mliters
  **************************     ---------     ---------
  Dry Weather Inflow .......         0.000         0.000
  Wet Weather Inflow .......         9.304        93.038
  Groundwater Inflow .......         0.000         0.000
  RDII Inflow ..............         0.000         0.000
  External Inflow ..........         0.000         0.000
  External Outflow .........         9.304        93.036
  Surface Flooding .........         0.000         0.000
  Evaporation Loss .........         0.000         0.000
  Initial Stored Volume ....         0.000         0.000
  Final Stored Volume ......         0.000         0.000
  Continuity Error (%) .....         0.003


  **************************************************
  EPA SWMM Time of Concentration Computations Report
  **************************************************

          Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

          Where:

          Tc = Time of Concentration (min)
          L  = Flow Length (ft)
          n  = Manning's Roughness
          i  = Rainfall Intensity (in/hr)
          S  = Slope (ft/ft)

  -----------------
  Subbasin EX.1A
  -----------------

          Flow length (m):                              169.23
          Pervious Manning's Roughness:                0.35700
          Impervious Manning's Roughness:              0.02860
          Pervious Rainfall Intensity (mm/hr):        12.91667
          Impervious Rainfall Intensity (mm/hr):      12.91667
          Slope (%):                                   8.00000
          Computed TOC (minutes):                        62.92

  -----------------
  Subbasin EX.1C
  -----------------

          Flow length (m):                              299.00
          Pervious Manning's Roughness:                0.36250
          Impervious Manning's Roughness:              0.02870
          Pervious Rainfall Intensity (mm/hr):        12.91667
```

```
        Impervious Rainfall Intensity (mm/hr):   12.91667
        Slope (%):                                5.00000
        Computed TOC (minutes):                   102.04

---------------
Subbasin P1A
---------------

        Flow length (m):                          257.65
        Pervious Manning's Roughness:            0.22620
        Impervious Manning's Roughness:          0.02267
        Pervious Rainfall Intensity (mm/hr):     12.91667
        Impervious Rainfall Intensity (mm/hr):   12.91667
        Slope (%):                                6.00000
        Computed TOC (minutes):                    57.96

---------------
Subbasin P1B
---------------

        Flow length (m):                          105.08
        Pervious Manning's Roughness:            0.29775
        Impervious Manning's Roughness:          0.02610
        Pervious Rainfall Intensity (mm/hr):     12.91667
        Impervious Rainfall Intensity (mm/hr):   12.91667
        Slope (%):                                7.60000
        Computed TOC (minutes):                    42.39

---------------
Subbasin P1C
---------------

        Flow length (m):                          179.35
        Pervious Manning's Roughness:            0.29775
        Impervious Manning's Roughness:          0.02610
        Pervious Rainfall Intensity (mm/hr):     12.91667
        Impervious Rainfall Intensity (mm/hr):   12.91667
        Slope (%):                                0.50000
        Computed TOC (minutes):                   130.16

---------------
Subbasin P2A
---------------

        Flow length (m):                          131.20
        Pervious Manning's Roughness:            0.29775
        Impervious Manning's Roughness:          0.02610
        Pervious Rainfall Intensity (mm/hr):     12.91667
        Impervious Rainfall Intensity (mm/hr):   12.91667
        Slope (%):                                5.50000
        Computed TOC (minutes):                    53.35

---------------
Subbasin P2C
---------------

        Flow length (m):                          292.76
        Pervious Manning's Roughness:            0.22620
        Impervious Manning's Roughness:          0.02267
        Pervious Rainfall Intensity (mm/hr):     12.91667
        Impervious Rainfall Intensity (mm/hr):   12.91667
        Slope (%):                                0.70000
        Computed TOC (minutes):                   118.82

---------------
Subbasin P3A
---------------
```

```
        Flow length (m):                          83.04
        Pervious Manning's Roughness:           0.29775
        Impervious Manning's Roughness:         0.02610
        Pervious Rainfall Intensity (mm/hr):   12.91667
        Impervious Rainfall Intensity (mm/hr): 12.91667
        Slope (%):                              3.00000
        Computed TOC (minutes):                   47.92

---------------
Subbasin P3C
---------------

        Flow length (m):                          97.65
        Pervious Manning's Roughness:           0.29775
        Impervious Manning's Roughness:         0.02610
        Pervious Rainfall Intensity (mm/hr):   12.91667
        Impervious Rainfall Intensity (mm/hr): 12.91667
        Slope (%):                              2.00000
        Computed TOC (minutes):                   59.62

---------------
Subbasin P4C
---------------

        Flow length (m):                         127.48
        Pervious Manning's Roughness:           0.29775
        Impervious Manning's Roughness:         0.02610
        Pervious Rainfall Intensity (mm/hr):   12.91667
        Impervious Rainfall Intensity (mm/hr): 12.91667
        Slope (%):                              4.00000
        Computed TOC (minutes):                   56.83

------------------------
Subbasin UPSTREAM_EXT
------------------------

        Flow length (m):                        6678.49
        Pervious Manning's Roughness:           0.30840
        Impervious Manning's Roughness:         0.02620
        Pervious Rainfall Intensity (mm/hr):   12.91667
        Impervious Rainfall Intensity (mm/hr): 12.91667
        Slope (%):                              4.50000
        Computed TOC (minutes):                  600.68


***********************
Subbasin Runoff Summary
***********************
```

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff cms	Runoff Coefficient	Time of Concentration days hh:mm:ss
EX.1A	77.50	0.00	0.00	38.20	38.98	0.08	0.503	0 01:02:55
EX.1C	77.50	0.00	0.00	40.42	36.53	0.15	0.471	0 01:42:02
P1A	77.50	0.00	0.00	26.55	50.08	0.52	0.646	0

00:57:57

P1B	77.50	0.00	0.00	33.70	43.37	0.52	0.560	0	00:42:23
P1C	77.50	0.00	0.00	40.74	36.27	0.14	0.468	0	02:10:09
P2A	77.50	0.00	0.00	34.54	42.52	0.36	0.549	0	00:53:20
P2C	77.50	0.00	0.00	30.81	45.78	0.29	0.591	0	01:58:49
P3A	77.50	18.44	0.00	35.20	60.31	0.25	0.629	0	00:47:55
P3C	77.50	131.58	0.00	39.98	168.68	0.17	0.807	0	00:59:37
P4C	77.50	0.00	0.00	34.84	42.20	0.17	0.545	0	00:56:49
UPSTREAM_EXT	77.50	0.00	0.00	59.93	16.77	3.42	0.216	0	10:00:40

****

Node Depth Summary

****

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume ha-mm	Total Time Flooded minutes	Retention Time hh:mm:ss
21	1.18	1.18	77.00	0	00:00	0	0	0:00:00
CD_P1A_OUT	0.00	0.00	78.60	0	00:00	0	0	0:00:00
CVT2_IN	0.02	0.26	78.26	0	04:30	0	0	0:00:00
CVT2_OUT	0.03	0.27	78.17	0	04:37	0	0	0:00:00
MAJOR_WC_450	0.05	0.28	77.28	0	04:00	0	0	0:00:00
OUTLET_1B	0.05	0.28	78.28	0	04:00	0	0	0:00:00
P1C_OUT	0.05	0.43	77.63	0	04:32	0	0	0:00:00
SWALE_P1A_IN	0.01	0.20	87.40	0	04:00	0	0	0:00:00
SWALE_P1C_IN	0.01	0.08	80.88	0	04:00	0	0	0:00:00
SWALE_P2C_IN	0.01	0.22	80.62	0	04:00	0	0	0:00:00
OUTLET_1A	0.00	0.00	75.33	0	00:00	0	0	0:00:00
OUTLET_1C	0.05	0.43	77.43	0	04:32	0	0	0:00:00
CD_P1A_IN	0.12	0.80	79.40	0	04:44	0	0	0:00:00
CD_P1C_IN	0.07	0.64	77.84	0	04:06	0	0	0:00:00
CD_P2C_IN	0.13	0.68	79.58	0	04:52	0	0	0:00:00

****

Node Flow Summary

****

Node ID	Element Type	Maximum Lateral Inflow cms	Peak Inflow cms	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow cms	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
21	JUNCTION	0.356	4.684	0	04:00	0.00		
CD_P1A_OUT	JUNCTION	0.000	0.180	0	04:05	0.00		
CVT2_IN	JUNCTION	0.169	0.169	0	04:30	0.00		
CVT2_OUT	JUNCTION	0.000	0.321	0	04:37	0.00		
MAJOR_WC_450	JUNCTION	0.250	4.193	0	04:00	0.00		
OUTLET_1B	JUNCTION	3.943	3.943	0	04:00	0.00		
P1C_OUT	JUNCTION	0.000	0.445	0	04:32	0.00		
SWALE_P1A_IN	JUNCTION	0.521	0.521	0	04:00	0.00		

SWALE_P1C_IN	JUNCTION	0.138	0.138	0	04:00	0.00
SWALE_P2C_IN	JUNCTION	0.289	0.289	0	04:00	0.00
OUTLET_1A	OUTFALL	0.000	4.684	0	04:00	0.00
OUTLET_1C	OUTFALL	0.170	0.538	0	04:30	0.00
CD_P1A_IN	STORAGE	0.000	0.521	0	04:00	0.00
CD_P1C_IN	STORAGE	0.000	0.138	0	04:00	0.00
CD_P2C_IN	STORAGE	0.000	0.289	0	04:00	0.00

****
Storage Node Summary
****

Storage Node ID	Maximum Ponded Volume 1000 m³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days hh:mm	Average Ponded Volume 1000 m³	Average Ponded Volume (%)	Maximum Storage Node Outflow cms	Maximum Exfiltration Rate cmm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 m³
CD_P1A_IN	0.950	60	0 04:44	0.084	5	0.18	0.00	0:00:00	0.000
CD_P1C_IN	0.041	28	0 04:05	0.003	2	0.13	0.00	0:00:00	0.000
CD_P2C_IN	0.638	44	0 04:52	0.079	6	0.17	0.00	0:00:00	0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cms	Peak Inflow cms
OUTLET_1A	98.96	0.513	4.684
OUTLET_1C	41.82	0.074	0.538
System	70.39	0.587	5.155

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis cms	Design Flow Capacity cms	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition

```
  -------------------------------
  CVT2                  CONDUIT      0  04:30      1.29    1.00        0.169        0.568       0.30
0.37          0  Calculated
  Link-24               DIRECT       0  04:05                          0.180
  Link-26               DIRECT       0  04:00                          4.684
  MAJOR_WC1             CHANNEL      0  04:00      0.70    1.00        3.943       31.356       0.13
0.28          0  Calculated
  MAJOR_WC2             DIRECT       0  04:00                          4.193
  MINOR_SWALE_1C        CHANNEL      0  04:37      0.65    1.00        0.321        5.439       0.06
0.27          0  Calculated
  MINOR_SWALE_P1C_OUT   CHANNEL      0  04:32      0.45    1.00        0.445        2.907       0.15
0.43          0  Calculated
  SWALE_P1A             CHANNEL      0  04:00      0.83    1.00        0.521       16.525       0.03
0.20          0  Calculated
  SWALE_P1C             CHANNEL      0  04:00      0.67    1.00        0.138       21.354       0.01
0.08          0  Calculated
  SWALE_P2C             CHANNEL      0  04:00      0.40    1.00        0.289        7.560       0.04
0.22          0  Calculated
  CD_P1A                OUTLET       0  04:05                          0.180
  CD_P1C                OUTLET       0  04:06                          0.129
  CD_P2C                OUTLET       0  04:52                          0.168


  *********************************
  Highest Flow Instability Indexes
  *********************************
  All links are stable.


  *************************
  Routing Time Step Summary
  *************************
  Minimum Time Step           :    30.00 sec
  Average Time Step           :    30.00 sec
  Maximum Time Step           :    30.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     1.00




  Analysis began on:  Tue Jan 21 16:22:42 2025
  Analysis ended on:  Tue Jan 21 16:22:44 2025
  Total elapsed time: 00:00:02
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Autodesk® Storm and Sanitary Analysis 2016 - Version 13.4.304 (Build 0)

****
Project Description
****
File Name .... Thousand Island Parkway Pre.SPF

****
Analysis Options
****
Flow Units .... cms
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method .... Green-Ampt
Link Routing Method .... Steady Flow
Storage Node Exfiltration.. None
Starting Date MAR-07-2023 00:00:00
Ending Date MAR-09-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step .... 30.00 sec

****
Element Count
****
Number of rain gages 1
Number of subbasins 7
Number of nodes 4
Number of links 2
Number of pollutants 0
Number of land uses 0

****
Subbasin Summary
****

Subbasin ID	Total Area hectares	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
E1A_NORTH	6.93	310.00	7.80	3.0000	-
E1A_SOUTH	3.76	232.00	7.80	2.0000	-
E1B	4.86	215.00	6.00	7.1000	-
E1C	8.36	256.00	7.60	1.4000	-
EX.1A	1.22	73.00	5.00	8.0000	-
EX.1C	2.65	100.00	7.60	5.0000	-
UPSTREAM_EXT	484.19	725.00	11.30	4.5000	-

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m^2	External Inflow
MAJOR_WC_450	JUNCTION	77.00	78.00	25000.000	
OUTLET_1B	JUNCTION	78.00	79.00	0.000	
OUTLET_1A	OUTFALL	75.33	76.33	0.000	
OUTLET_1C	OUTFALL	77.00	77.00	0.000	

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
MAJOR_WC1	OUTLET_1B	MAJOR_WC_450	CHANNEL	350.0	0.2857	0.0320
MAJOR_WC2	MAJOR_WC_450	OUTLET_1A	CHANNEL	450.0	0.3711	0.0320

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity cms
MAJOR_WC1	RECT_OPEN	1.00	20.00	1	20.00	0.91	31.36
MAJOR_WC2	RECT_OPEN	1.00	50.00	1	50.00	0.96	92.74

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	49.712	97.100
Evaporation Loss	0.000	0.000
Infiltration Loss	33.862	66.140
Surface Runoff	13.553	26.472
Final Surface Storage	2.305	4.503
Continuity Error (%)	-0.016	

Flow Routing Continuity	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	13.559	135.591
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	13.559	135.591
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)

```
        L  = Flow Length (ft)
        n  = Manning's Roughness
        i  = Rainfall Intensity (in/hr)
        S  = Slope (ft/ft)

---------------------
Subbasin E1A_NORTH
---------------------

        Flow length (m):                          223.55
        Pervious Manning's Roughness:            0.28150
        Impervious Manning's Roughness:          0.02480
        Pervious Rainfall Intensity (mm/hr):     4.04583
        Impervious Rainfall Intensity (mm/hr):   4.04583
        Slope (%):                               3.00000
        Computed TOC (minutes):                   135.28

---------------------
Subbasin E1A_SOUTH
---------------------

        Flow length (m):                          162.07
        Pervious Manning's Roughness:            0.19150
        Impervious Manning's Roughness:          0.02180
        Pervious Rainfall Intensity (mm/hr):     4.04583
        Impervious Rainfall Intensity (mm/hr):   4.04583
        Slope (%):                               2.00000
        Computed TOC (minutes):                    99.65

---------------
Subbasin E1B
---------------

        Flow length (m):                          226.05
        Pervious Manning's Roughness:            0.29200
        Impervious Manning's Roughness:          0.02595
        Pervious Rainfall Intensity (mm/hr):     4.04583
        Impervious Rainfall Intensity (mm/hr):   4.04583
        Slope (%):                               7.10000
        Computed TOC (minutes):                   108.62

---------------
Subbasin E1C
---------------

        Flow length (m):                          326.56
        Pervious Manning's Roughness:            0.18950
        Impervious Manning's Roughness:          0.02195
        Pervious Rainfall Intensity (mm/hr):     4.04583
        Impervious Rainfall Intensity (mm/hr):   4.04583
        Slope (%):                               1.40000
        Computed TOC (minutes):                   168.09

-----------------
Subbasin EX.1A
-----------------

        Flow length (m):                          167.12
        Pervious Manning's Roughness:            0.35700
        Impervious Manning's Roughness:          0.02860
        Pervious Rainfall Intensity (mm/hr):     4.04583
        Impervious Rainfall Intensity (mm/hr):   4.04583
        Slope (%):                               8.00000
        Computed TOC (minutes):                    99.37

-----------------
Subbasin EX.1C
```

Flow length (m): 265.00
Pervious Manning's Roughness: 0.36250
Impervious Manning's Roughness: 0.02870
Pervious Rainfall Intensity (mm/hr): 4.04583
Impervious Rainfall Intensity (mm/hr): 4.04583
Slope (%): 5.00000
Computed TOC (minutes): 151.03

Subbasin UPSTREAM_EXT

Flow length (m): 6678.49
Pervious Manning's Roughness: 0.30840
Impervious Manning's Roughness: 0.02620
Pervious Rainfall Intensity (mm/hr): 4.04583
Impervious Rainfall Intensity (mm/hr): 4.04583
Slope (%): 4.50000
Computed TOC (minutes): 955.87

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall mm	Total Runon mm	Total Evap. mm	Total Infil. mm	Total Runoff mm	Peak Runoff cms	Runoff Coefficient	Time of Concentration days hh:mm:ss
E1A_NORTH	97.10	0.00	0.00	51.43	45.24	0.57	0.466	0 02:15:16
E1A_SOUTH	97.10	13.83	0.00	48.33	62.27	0.52	0.561	0 01:39:38
E1B	97.10	0.00	0.00	52.01	44.74	0.51	0.461	0 01:48:37
E1C	97.10	13.50	0.00	49.98	60.30	0.61	0.545	0 02:48:05
EX.1A	97.10	0.00	0.00	54.27	42.51	0.13	0.438	0 01:39:22
EX.1C	97.10	0.00	0.00	54.02	42.52	0.17	0.438	0 02:31:01
UPSTREAM_EXT	97.10	0.00	0.00	67.01	25.37	4.30	0.261	0 15:55:52

****
Node Depth Summary
****

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days hh:mm	Total Flooded Volume ha-mm	Total Time Flooded minutes	Retention Time hh:mm:ss

MAJOR_WC_450	0.08	0.32	77.32	0	12:06	0	0	0:00:00
OUTLET_1B	0.08	0.32	78.32	0	12:06	0	0	0:00:00
OUTLET_1A	0.04	0.19	75.52	0	12:06	0	0	0:00:00
OUTLET_1C	0.00	0.00	77.00	0	00:00	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cms	Peak Inflow cms	Time of Peak Inflow Occurrence days hh:mm	Maximum Flooding Overflow cms	Time of Peak Flooding Occurrence days hh:mm
MAJOR_WC_450	JUNCTION	1.093	5.902	0 12:06	0.00	
OUTLET_1B	JUNCTION	4.809	4.809	0 12:06	0.00	
OUTLET_1A	OUTFALL	0.000	5.902	0 12:06	0.00	
OUTLET_1C	OUTFALL	0.613	0.613	0 12:06	0.00	

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cms	Peak Inflow cms
OUTLET_1A	99.69	0.758	5.902
OUTLET_1C	52.49	0.056	0.613
System	76.09	0.813	6.516

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis cms	Design Flow Capacity cms	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
MAJOR_WC1	CHANNEL	0 12:06	0.76	1.00	4.809	31.356	0.15	0.32	0	Calculated
MAJOR_WC2	CHANNEL	0 12:06	0.62	1.00	5.902	92.745	0.06	0.19	0	Calculated

****
Highest Flow Instability Indexes
****

All links are stable.

```
*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    30.00 sec
Average Time Step           :    30.00 sec
Maximum Time Step           :    30.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00


Analysis began on:  Tue Jan 21 16:08:42 2025
Analysis ended on:  Tue Jan 21 16:08:43 2025
Total elapsed time: 00:00:01
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Autodesk® Storm and Sanitary Analysis 2016 - Version 13.4.304 (Build 0)

****
Project Description
****
File Name .... Thousand Island Parkway Post Controlled.SPF

****
Analysis Options
****
Flow Units .... cms
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method .... Green-Ampt
Link Routing Method .... Steady Flow
Storage Node Exfiltration.. None
Starting Date MAR-07-2023 00:00:00
Ending Date MAR-09-2023 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step .... 30.00 sec

****
Element Count
****
Number of rain gages 1
Number of subbasins 11
Number of nodes 15
Number of links 13
Number of pollutants 0
Number of land uses 0

****
Subbasin Summary
****

Subbasin ID	Total Area hectares	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
EX.1A	0.88	52.00	5.00	8.0000	-
EX.1C	2.99	100.00	7.60	5.0000	-
P1A	4.38	170.00	25.00	6.0000	-
P1B	4.14	394.00	8.00	7.6000	-
P1C	3.30	184.00	8.00	0.5000	-
P2A	3.28	250.00	8.00	5.5000	-
P2C	4.45	152.00	25.00	0.7000	-
P3A	1.86	224.00	8.00	3.0000	-
P3C	0.83	85.00	8.00	2.0000	-
P4C	1.67	131.00	8.00	4.0000	-
UPSTREAM_EXT	484.19	725.00	11.30	4.5000	-

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
21	JUNCTION	75.82	77.82	0.000	
CD_P1A_OUT	JUNCTION	78.60	79.60	0.000	

CVT2_IN	JUNCTION	78.00	79.00	0.000
CVT2_OUT	JUNCTION	77.90	78.90	0.000
MAJOR_WC_450	JUNCTION	77.00	78.00	0.000
OUTLET_1B	JUNCTION	78.00	79.00	0.000
P1C_OUT	JUNCTION	77.20	78.20	0.000
SWALE_P1A_IN	JUNCTION	87.20	88.20	0.000
SWALE_P1C_IN	JUNCTION	80.80	81.80	0.000
SWALE_P2C_IN	JUNCTION	80.40	81.40	0.000
OUTLET_1A	OUTFALL	75.33	75.33	0.000
OUTLET_1C	OUTFALL	77.00	78.00	0.000
CD_P1A_IN	STORAGE	78.60	79.60	0.000
CD_P1C_IN	STORAGE	77.20	78.20	0.000
CD_P2C_IN	STORAGE	78.90	79.90	0.000

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
CVT2	CVT2_IN	CVT2_OUT	CONDUIT	20.0	0.5000	0.0150
Link-24	CD_P1A_OUT	21	DIRECT	105.4	0.7876	0.0150
Link-26	21	OUTLET_1A	DIRECT	133.0	0.3685	0.0320
MAJOR_WC1	OUTLET_1B	MAJOR_WC_450	CHANNEL	350.0	0.2857	0.0320
MAJOR_WC2	MAJOR_WC_450	21	DIRECT	317.0	0.3722	0.0320
MINOR_SWALE_1C	CVT2_OUT	P1C_OUT	CHANNEL	138.0	0.5072	0.0350
MINOR_SWALE_P1C_OUT	P1C_OUT	OUTLET_1C	CHANNEL	138.0	0.1449	0.0350
SWALE_P1A	SWALE_P1A_IN	CD_P1A_IN	CHANNEL	360.0	2.3889	0.0500
SWALE_P1C	SWALE_P1C_IN	CD_P1C_IN	CHANNEL	90.0	3.9889	0.0500
SWALE_P2C	SWALE_P2C_IN	CD_P2C_IN	CHANNEL	300.0	0.5000	0.0500
CD_P1A	CD_P1A_IN	CD_P1A_OUT	OUTLET			
CD_P1C	CD_P1C_IN	P1C_OUT	OUTLET			
CD_P2C	CD_P2C_IN	CVT2_OUT	OUTLET			

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity cms
CVT2	CIRCULAR	0.70	0.70	1	0.38	0.17	0.57
Link-24	DUMMY	0.00	0.00	1	0.00	0.00	0.00
Link-26	DUMMY	0.00	0.00	1	0.00	0.00	0.00
MAJOR_WC1	RECT_OPEN	1.00	20.00	1	20.00	0.91	31.36
MAJOR_WC2	DUMMY	0.00	0.00	1	0.00	0.00	0.00
MINOR_SWALE_1C	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	5.44
MINOR_SWALE_P1C_OUT	TRAPEZOIDAL	1.00	7.00	1	4.00	0.55	2.91
SWALE_P1A	TRAPEZOIDAL	1.00	7.00	2	4.00	0.55	8.26
SWALE_P1C	TRAPEZOIDAL	1.00	7.00	2	4.00	0.55	

```
10.68
  SWALE_P2C        TRAPEZOIDAL        1.00          7.00              2          4.00          0.55
3.78

  **************************        Volume         Depth
  Runoff Quantity Continuity     hectare-m            mm
  **************************     ---------       -------
  Total Precipitation ......        12.799        25.000
  Evaporation Loss .........         0.000         0.000
  Infiltration Loss ........        12.124        23.680
  Surface Runoff ...........         0.276         0.539
  Final Surface Storage ....         0.411         0.802
  Continuity Error (%) .....        -0.086

  **************************        Volume        Volume
  Flow Routing Continuity        hectare-m       Mliters
  **************************     ---------     ---------
  Dry Weather Inflow .......         0.000         0.000
  Wet Weather Inflow .......         0.276         2.759
  Groundwater Inflow .......         0.000         0.000
  RDII Inflow ..............         0.000         0.000
  External Inflow ..........         0.000         0.000
  External Outflow .........         0.276         2.759
  Surface Flooding .........         0.000         0.000
  Evaporation Loss .........         0.000         0.000
  Initial Stored Volume ....         0.000         0.000
  Final Stored Volume ......         0.000         0.000
  Continuity Error (%) .....         0.006


  **************************************************
  EPA SWMM Time of Concentration Computations Report
  **************************************************

        Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

        Where:

        Tc = Time of Concentration (min)
        L  = Flow Length (ft)
        n  = Manning's Roughness
        i  = Rainfall Intensity (in/hr)
        S  = Slope (ft/ft)

  -----------------
  Subbasin EX.1A
  -----------------

        Flow length (m):                           169.23
        Pervious Manning's Roughness:             0.35700
        Impervious Manning's Roughness:           0.02860
        Pervious Rainfall Intensity (mm/hr):      6.25000
        Impervious Rainfall Intensity (mm/hr):    6.25000
        Slope (%):                                8.00000
        Computed TOC (minutes):                     84.13

  -----------------
  Subbasin EX.1C
  -----------------

        Flow length (m):                           299.00
        Pervious Manning's Roughness:             0.36250
        Impervious Manning's Roughness:           0.02870
        Pervious Rainfall Intensity (mm/hr):      6.25000
```

```
        Impervious Rainfall Intensity (mm/hr):    6.25000
        Slope (%):                                5.00000
        Computed TOC (minutes):                    136.44

---------------
Subbasin P1A
---------------

        Flow length (m):                           257.65
        Pervious Manning's Roughness:             0.22620
        Impervious Manning's Roughness:           0.02267
        Pervious Rainfall Intensity (mm/hr):      6.25000
        Impervious Rainfall Intensity (mm/hr):    6.25000
        Slope (%):                                6.00000
        Computed TOC (minutes):                     77.50

---------------
Subbasin P1B
---------------

        Flow length (m):                           105.08
        Pervious Manning's Roughness:             0.29775
        Impervious Manning's Roughness:           0.02610
        Pervious Rainfall Intensity (mm/hr):      6.25000
        Impervious Rainfall Intensity (mm/hr):    6.25000
        Slope (%):                                7.60000
        Computed TOC (minutes):                     56.68

---------------
Subbasin P1C
---------------

        Flow length (m):                           179.35
        Pervious Manning's Roughness:             0.29775
        Impervious Manning's Roughness:           0.02610
        Pervious Rainfall Intensity (mm/hr):      6.25000
        Impervious Rainfall Intensity (mm/hr):    6.25000
        Slope (%):                                0.50000
        Computed TOC (minutes):                    174.04

---------------
Subbasin P2A
---------------

        Flow length (m):                           131.20
        Pervious Manning's Roughness:             0.29775
        Impervious Manning's Roughness:           0.02610
        Pervious Rainfall Intensity (mm/hr):      6.25000
        Impervious Rainfall Intensity (mm/hr):    6.25000
        Slope (%):                                5.50000
        Computed TOC (minutes):                     71.33

---------------
Subbasin P2C
---------------

        Flow length (m):                           292.76
        Pervious Manning's Roughness:             0.22620
        Impervious Manning's Roughness:           0.02267
        Pervious Rainfall Intensity (mm/hr):      6.25000
        Impervious Rainfall Intensity (mm/hr):    6.25000
        Slope (%):                                0.70000
        Computed TOC (minutes):                    158.88

---------------
Subbasin P3A
---------------
```

```
        Flow length (m):                           83.04
        Pervious Manning's Roughness:            0.29775
        Impervious Manning's Roughness:          0.02610
        Pervious Rainfall Intensity (mm/hr):     6.25000
        Impervious Rainfall Intensity (mm/hr):   6.25000
        Slope (%):                               3.00000
        Computed TOC (minutes):                    64.07

  ---------------
  Subbasin P3C
  ---------------

        Flow length (m):                           97.65
        Pervious Manning's Roughness:            0.29775
        Impervious Manning's Roughness:          0.02610
        Pervious Rainfall Intensity (mm/hr):     6.25000
        Impervious Rainfall Intensity (mm/hr):   6.25000
        Slope (%):                               2.00000
        Computed TOC (minutes):                    79.72

  ---------------
  Subbasin P4C
  ---------------

        Flow length (m):                          127.48
        Pervious Manning's Roughness:            0.29775
        Impervious Manning's Roughness:          0.02610
        Pervious Rainfall Intensity (mm/hr):     6.25000
        Impervious Rainfall Intensity (mm/hr):   6.25000
        Slope (%):                               4.00000
        Computed TOC (minutes):                    75.99

  ------------------------
  Subbasin UPSTREAM_EXT
  ------------------------

        Flow length (m):                         6678.49
        Pervious Manning's Roughness:            0.30840
        Impervious Manning's Roughness:          0.02620
        Pervious Rainfall Intensity (mm/hr):     6.25000
        Impervious Rainfall Intensity (mm/hr):   6.25000
        Slope (%):                               4.50000
        Computed TOC (minutes):                   803.18


  ***********************
  Subbasin Runoff Summary
  ***********************
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Subbasin ID	Total Rainfall (mm)	Total Runon (mm)	Total Evap. (mm)	Total Infil. (mm)	Total Runoff (mm)	Peak Runoff (cms)	Runoff Coefficient	Time of Concentration (days hh:mm:ss)
EX.1A	25.00	0.00	0.00	24.64	0.10	0.00	0.004	0 01:24:07
EX.1C	25.00	0.00	0.00	24.35	0.14	0.00	0.005	0 02:16:26
P1A	25.00	0.00	0.00	18.81	5.45	0.11	0.218	0

01:17:29								
P1B	25.00	0.00	0.00	23.47	1.23	0.02	0.049	0
00:56:40								
P1C	25.00	0.00	0.00	23.77	0.79	0.02	0.032	0
02:54:02								
P2A	25.00	0.00	0.00	23.65	1.02	0.01	0.041	0
01:11:19								
P2C	25.00	0.00	0.00	20.30	3.85	0.08	0.154	0
02:38:52								
P3A	25.00	0.05	0.00	23.41	1.33	0.01	0.053	0
01:04:04								
P3C	25.00	0.49	0.00	23.84	1.32	0.01	0.052	0
01:19:42								
P4C	25.00	0.00	0.00	23.49	1.17	0.01	0.047	0
01:15:59								
UPSTREAM_EXT	25.00	0.00	0.00	23.75	0.45	0.53	0.018	0
13:23:10								

****
Node Depth Summary
****

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	hh:mm	Total Flooded Volume ha-mm	Total Time Flooded minutes	Retention Time hh:mm:ss
21	1.18	1.18	77.00	0	00:00	0	0	0:00:00
CD_P1A_OUT	0.00	0.00	78.60	0	00:00	0	0	0:00:00
CVT2_IN	0.00	0.05	78.05	0	01:40	0	0	0:00:00
CVT2_OUT	0.01	0.05	77.95	0	01:40	0	0	0:00:00
MAJOR_WC_450	0.00	0.09	77.09	0	01:50	0	0	0:00:00
OUTLET_1B	0.00	0.09	78.09	0	01:50	0	0	0:00:00
P1C_OUT	0.01	0.09	77.29	0	01:40	0	0	0:00:00
SWALE_P1A_IN	0.00	0.08	87.28	0	01:40	0	0	0:00:00
SWALE_P1C_IN	0.00	0.03	80.83	0	01:40	0	0	0:00:00
SWALE_P2C_IN	0.00	0.11	80.51	0	01:40	0	0	0:00:00
OUTLET_1A	0.00	0.00	75.33	0	00:00	0	0	0:00:00
OUTLET_1C	0.01	0.09	77.09	0	01:40	0	0	0:00:00
CD_P1A_IN	0.04	0.35	78.95	0	03:06	0	0	0:00:00
CD_P1C_IN	0.00	0.34	77.54	0	01:44	0	0	0:00:00
CD_P2C_IN	0.03	0.28	79.18	0	03:06	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cms	Peak Inflow cms	Time of Peak Inflow Occurrence days	hh:mm	Maximum Flooding Overflow cms	Time of Peak Flooding Occurrence days	hh:mm
21	JUNCTION	0.012	0.578	0	01:50	0.00		
CD_P1A_OUT	JUNCTION	0.000	0.010	0	02:05	0.00		
CVT2_IN	JUNCTION	0.006	0.006	0	01:40	0.00		
CVT2_OUT	JUNCTION	0.000	0.010	0	02:10	0.00		
MAJOR_WC_450	JUNCTION	0.014	0.559	0	01:50	0.00		
OUTLET_1B	JUNCTION	0.552	0.552	0	01:50	0.00		
P1C_OUT	JUNCTION	0.000	0.020	0	01:40	0.00		
SWALE_P1A_IN	JUNCTION	0.109	0.109	0	01:40	0.00		

SWALE_P1C_IN	JUNCTION	0.022	0.022	0	01:40	0.00
SWALE_P2C_IN	JUNCTION	0.079	0.079	0	01:40	0.00
OUTLET_1A	OUTFALL	0.000	0.578	0	01:50	0.00
OUTLET_1C	OUTFALL	0.012	0.032	0	01:40	0.00
CD_P1A_IN	STORAGE	0.000	0.109	0	01:40	0.00
CD_P1C_IN	STORAGE	0.000	0.022	0	01:40	0.00
CD_P2C_IN	STORAGE	0.000	0.079	0	01:40	0.00

****
Storage Node Summary
****

Storage Node ID	Maximum Ponded Volume 1000 m³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days hh:mm	Average Ponded Volume 1000 m³	Average Ponded Volume (%)	Maximum Storage Node Outflow cms	Maximum Exfiltration Rate cmm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 m³
CD_P1A_IN	0.171	11	0 03:05	0.015	1	0.01	0.00	0:00:00	0.000
CD_P1C_IN	0.005	4	0 01:44	0.000	0	0.01	0.00	0:00:00	0.000
CD_P2C_IN	0.102	7	0 03:05	0.008	1	0.01	0.00	0:00:00	0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cms	Peak Inflow cms
OUTLET_1A	97.10	0.015	0.578
OUTLET_1C	20.15	0.007	0.032
System	58.63	0.022	0.603

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis cms	Design Flow Capacity cms	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition

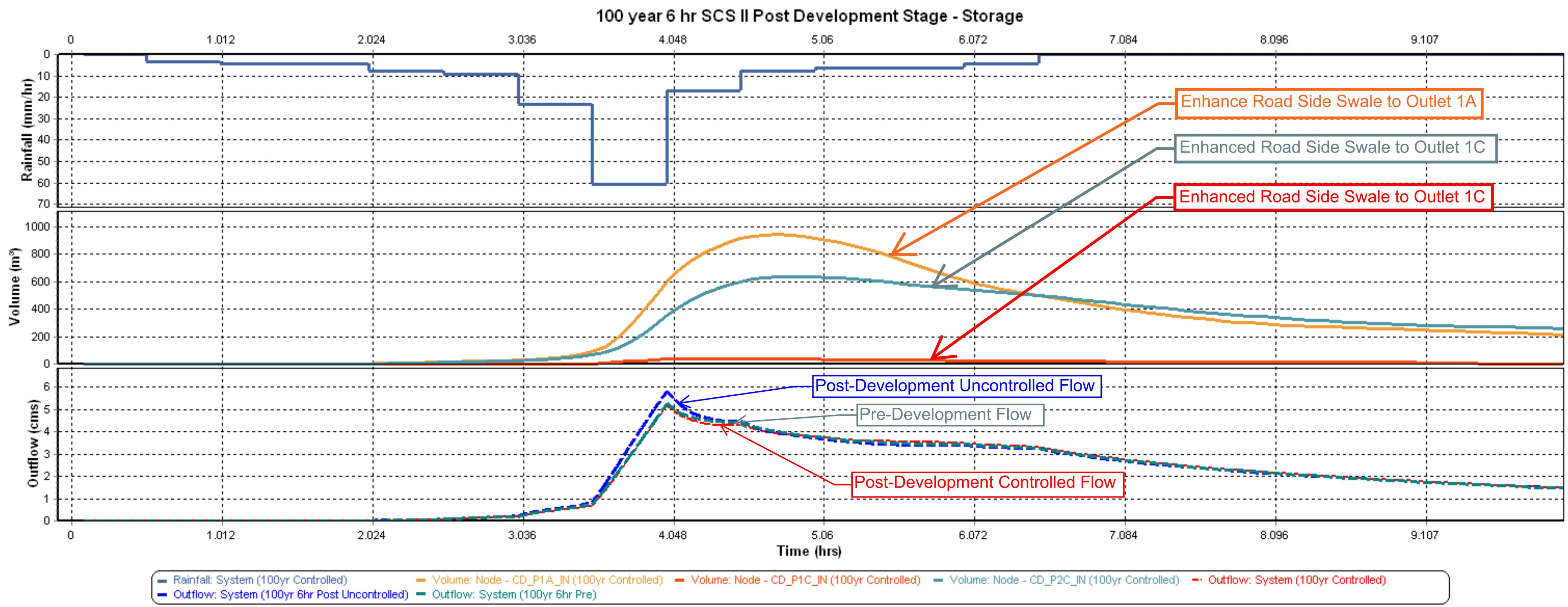
```
-------------------------------
  CVT2                  CONDUIT      0  01:40      0.48    1.00        0.006       0.568       0.01
0.07           0  Calculated
  Link-24               DIRECT       0  02:05                          0.010
  Link-26               DIRECT       0  01:50                          0.578
  MAJOR_WC1             CHANNEL      0  01:50      0.32    1.00        0.552      31.356       0.02
0.09           0  Calculated
  MAJOR_WC2             DIRECT       0  01:50                          0.559
  MINOR_SWALE_1C        CHANNEL      0  02:10      0.23    1.00        0.010       5.439       0.00
0.04           0  Calculated
  MINOR_SWALE_P1C_OUT  CHANNEL      0  01:40      0.19    1.00        0.020       2.907       0.01
0.09           0  Calculated
  SWALE_P1A             CHANNEL      0  01:40      0.52    1.00        0.109      16.525       0.01
0.08           0  Calculated
  SWALE_P1C             CHANNEL      0  01:40      0.36    1.00        0.022      21.354       0.00
0.03           0  Calculated
  SWALE_P2C             CHANNEL      0  01:40      0.27    1.00        0.079       7.560       0.01
0.11           0  Calculated
  CD_P1A                OUTLET       0  02:05                          0.010
  CD_P1C                OUTLET       0  01:40                          0.010
  CD_P2C                OUTLET       0  03:06                          0.009


  *******************************
  Highest Flow Instability Indexes
  *******************************
  All links are stable.

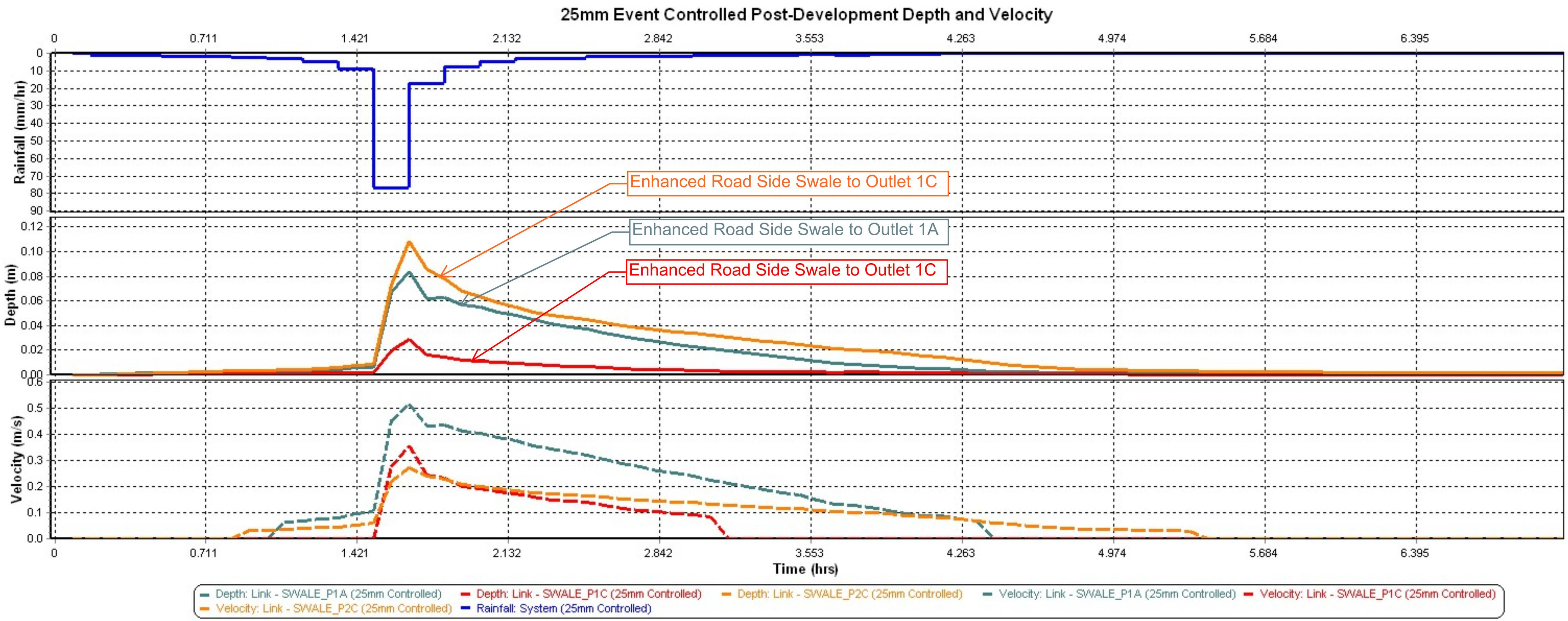

  *************************
  Routing Time Step Summary
  *************************
  Minimum Time Step          :    30.00 sec
  Average Time Step          :    30.00 sec
  Maximum Time Step          :    30.00 sec
  Percent in Steady State    :     0.00
  Average Iterations per Step :     1.00



  Analysis began on:  Tue Jan 21 16:19:49 2025
  Analysis ended on:  Tue Jan 21 16:19:51 2025
  Total elapsed time: 00:00:02
```



Autodesk Storm and Sanitary Analysis



Autodesk Storm and Sanitary Analysis