Lansdowne Development – Phase 1
Preliminary Stormwater Management Report

Prepared for:

10194549 Canada Ltd. and 10725994 Canada Ltd.
c/o Mr. Shane Kelly

Prepared by:

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Date: October 2022

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October 14, 2022

10194549 Canada Ltd.
& 10725994 Canada Ltd.
c/o Mr. Shane Kelly
377 Cadillac Avenue South
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Dear Mr. Kelly,

Regarding: Lansdowne Development – Phase 1
Preliminary Stormwater Management Report

The enclosed report details the existing drainage conditions and provides preliminary recommendations for stormwater management and drainage for the proposed Phase 1 of Lansdowne development.

Phase 1 of the Lansdowne development proposes approximately 53 single detached residential lots, 15 semi-detached residential lots, parkland, open space, an interim stormwater management facility block and three new municipal streets. The commercial block is proposed to be zoned as "Holding Symbol" until such time that the conditions for removing the Holding Symbol are met.

Post development flows will be limited to pre-development levels for the proposed development. A normal level of quality control is required onsite. Post development flows are to be controlled by an interim wet pond type stormwater management facility for the site.

Detailed design of storm sewers, culvert crossings, outfalls and stormwater management facility outlet structures will be provided during the final engineering design of the subdivision.

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.

Kyle Nielissen, P.Eng.
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FOREFRONT Signatures

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1. Introduction

Forefront has assembled relevant supporting information for the proposed Lansdowne Development, adjacent to Prince Street (County Road 3), Railway Street, and the Canadian National Railway. The legal description of the land is Parts 1 to 6, Registered Plan 194, Geographic Township of Lansdowne, Township of Leeds and the Thousand Islands, County of Leeds. The property is located north of County Road 2 and bounded by Railway Street to the north and divided by Prince Street. Please refer to Figure 1: Location Plan for the site location.

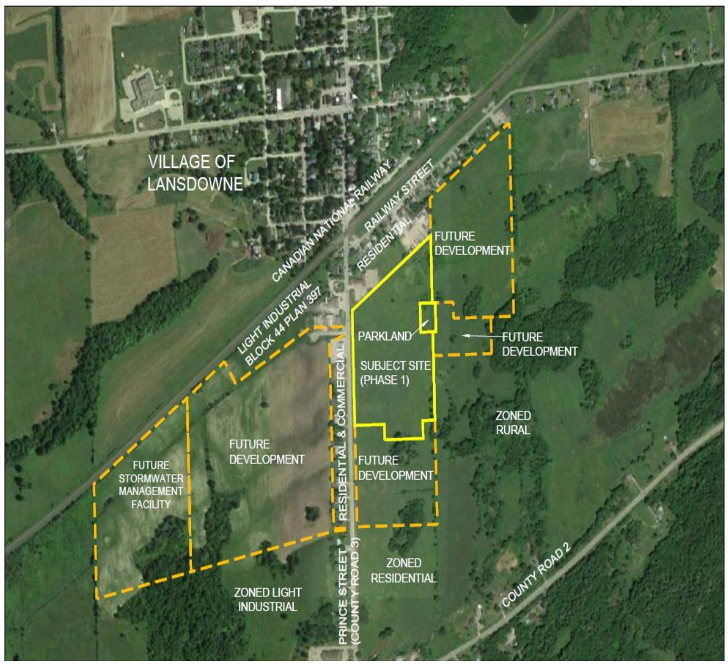


Figure 1: Location Plan

Phase 1 of the Lansdowne development includes approximately 8.23 hectares. The lands south of the site are vacant lands. East of the site is Prince Street with existing residential and commercial land uses. North of the subject site is Railway Street which is fronted by residential dwellings.

Phase 1 of the Lansdowne development proposes approximately 61 single detached residential lots, 15 semi-detached lots (30 units), parkland, an interim stormwater management facility block and three new municipal streets. The commercial block is proposed to be zoned as “Holding Symbol” until such time that the conditions for removing the Holding Symbol are met.

The general topography of the site slopes southwesterly, with a portion of the east parcel sloping northwesterly

Development of Phase 1 of Lansdowne Development will result in an increase in impervious areas. This Report recommends drainage requirements onsite and stormwater management mitigation measures to accommodate an increase in the imperviousness onsite.

Please refer to Appendix A, for the proposed development Draft Plan.

2. Existing Site Condition

The existing subject site is currently vacant and is not serviced by any storm sewer or stormwater management facilities. There are no storm sewers within the vicinity of the subject site. Stormwater runoff from the site generally sheet drains to the onsite channel, roadside ditches, rear yard ditches and culverts along Prince Street and the CN railway.

Existing drainage conditions include two main catchment areas. The west catchment area eventually drains to the southwest into Landon's Bay via an intermittent seasonal drainage channel. The east catchment drains to Larue Mills Creek to the east of the site.

<u>West Catchment</u>
The west catchment is generally vacant agricultural fields with sparse woodland, draining via sheet flow westerly to an intermittent seasonal channel. The entire site west of Prince Street (Area EX1) drains to the intermittent channel and off-site through **Outlet 1B**. Continuing southwesterly the channel crosses under County Road 2 through a culvert adjacent to civic number 805, approximately 2 kilometres southwest of the site. The intermittent channel eventually drains into Landon's Bay.

Drainage area EX4 outlets to a 1200mm culvert crossing under the CN railway and eventually drains into the intermittent channel. Area EX2 consists of residential dwellings and several commercial lots along Prince Street that drain westerly into EX1.

Runoff from areas EX5, EX6, and EX7 drain west via sheet flow, and the rear yard swale of residences along Railway Street all drain to **Outlet 1A**, a 1200mm box culvert under Prince Street, eventually outletting to **Outlet 1B**.

A total pre-development area of approximately 8.80 hectares drains to **Outlet 1A**.

Catchment areas EX9 and EX10 drain west via sheet flow to a 600mm diameter culvert under Prince Street, eventually outletting to **Outlet 1B** to the west.

A total pre-development area of approximately 84.94 hectares drains to **Outlet 1B**.

<u>East Catchment</u>
The east catchment is generally vacant agricultural fields with sparse woodland.

Drainage from areas EX11, EX12 and EX13 are directed towards a low lying area and an intermittent seasonal channel that borders the far east property limit, eventually draining north-easterly towards **Outlet 2**. **Outlet 2** consists of three 600mm diameter culverts crossing beneath Railway Street, eventually draining to Larue Mills Creek. The balance of the site (EX15 and EX16) drains south towards a 1200mm box culvert passing under Prince Street.

A total pre-development area of approximately 17.00 hectares drains to **Outlet 2**.

The Soil Survey of Leeds County identifies the soil cover in this area as Napanee Clay (Nc). The soil characteristics of Napanee Clay include low organic content, high clay content, and is considered a poor draining soil.

Please refer to Appendix A, **Figure 2**: Pre-Development Catchment Areas, for the pre-development condition details.

Source Water Protection

The subject site is part of the Cataraqui Source Protection Area (SPA). The site is outside the Wellhead Protection Zone of the Lansdowne deep wells and is not within any Intake Protection Zone. A portion of the east parcel is considered a significant groundwater recharge area with a vulnerability score of 4. Parts of the west parcel are considered a highly vulnerable aquifer with a vulnerability score 6. The outlet for the site is not considered a significant groundwater recharge area. Refer to Appendix A, Source Protection Map for further details.

3. Proposed Development

Phase 1 of the Lansdowne development is approximately 8.23 ha including for the residential lots, the commercial block, parkland, and the interim stormwater management facility. For the purposes of this report the commercial block 210 is assumed developed. All combined the site area is 8.23 ha. Including external areas, a total catchment area of 11.62 ha was analysed to **Outlet 1A**.

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.

Outlets that experienced concentrated flows and sheet flows under pre-development condition are expected to maintain relatively similar flow characteristics post development.

3.1 Drainage Plan

It is recommended that drainage from the proposed development be directed to the existing outlet at **Outlet 1A**.

A storm sewer system is proposed throughout Phase 1 to convey stormwater to the proposed stormwater management facility. Storm sewers and asphalt roads with curb and gutters are proposed throughout. Grading for the development should incorporate lot level conveyance controls minimizing grades to promote reduced peak flows, retention and infiltration.

Proposed areas draining to **Outlet 1A** will direct flow to an interim wet pond type stormwater management facility located on the future residential block 209. The stormwater management facility will provide quality and quantity control for the entire proposed phase 1 development outletting to **Outlet 1A**. Existing external areas are proposed to bypass the stormwater management facility.

The storm sewer system is to be designed to convey the minor storm event. Major flow paths will be directed to a low point along Street B and conveyed to the interim SWM facility via the overland major flow path.

Quality and quantity control for the commercial block is to be provided by the stormwater management facility.

Refer to Appendix A, **Figure 3** for post-development catchment details.

3.2 Storm sewers

Storm sewers are proposed throughout the majority of the development. The storm sewer will be designed for the minor design storm, which is a 5 year design event. Storm sewers will provide surcharge protection for all major flow events. All lots are required to have a backwater prevention devices installed on the storm sewer lateral where provided.

The Ministry of the Environment, Conservation and Park’s (MECP) Guidelines stipulates that the storm water collection system be designed to accommodate runoff as per the formula:

$$Q = 2.78AIR$$

where Q = Design flow in L/s,
A = area in hectares

I = rainfall intensity in mm/hr, and
R = runoff coefficient.

Storm sewers shall be designed for the 5 year storm event and intensities based on the Brockville IDF curve for the area. As is standard stormwater management practice, a minimum t_c (time of concentration) of 15 minutes is to be used for the design of the storm sewer system.

Refer to Appendix A **Figure 4**, for Storm Sewer details and Appendix B for the preliminary Storm Sewer Design Sheet.

3.3 Water Quantity

Urbanization leads to an increase in impermeable surfaces (roof tops 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 will be downstream quantity impacts.

Consistent with general Stormwater Management practices, both stormwater quality and quantity control is proposed for the majority of the site. Post development flows will be maintained to pre-development levels for all storm events up to and including the 100 year design event.

3.3.1 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 facilities 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.

3.3.1.1 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 Environment Canada, see Appendix B**: Brockville Short Duration Rainfall Intensity-Duration-Frequency Data**. Using these rainfall intensities, rainfall hyetographs were developed for each return period with a 6-hour SCS Type II Distribution. The 6-hour SCS Type II distribution is as per MTO Design Chart 1.05 SCS Type II Distributions.

The design storm events include:

- 2-year return period / 6-hour duration: 38.4 mm
- 5-year return period / 6-hour duration: 50.4 mm
- 100-year return period / 6-hour duration: 83.2 mm

Note, SCS Type II 24-hour distributions were also analysed and those results are available for review upon request. The SCS Type II 6 hour distribution was the most conservative and appropriate distribution given the catchment size and characteristics.

An additional “Erosion Control” design storm was used in this study, defined as a small, frequent storm representing 25mm 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 25mm or less. This rainfall amount over a 4-hour duration has an approximate 6 month return period in this region.

3.3.1.2 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.
- 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 the proposed municipal right-of-way 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 the clay characteristics were used, which are values taken from the *Handbook of Hydrology* (D.R. Maidment *et al.*., 1993). 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 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	0.6	0.203

Based on the drainage characteristics of the soil onsite, there is little opportunity for infiltration.

3.3.1.3 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. For the purpose of Phase 1 of the development, the study area is limited in scope to drainage to **Outlet 1A**.

Table 3-3 Existing Conditions

Lansdowne Development (Pre-Development)						
Hydrologic Units - Existing Conditions						
Hydrologic Unit	Description	% Impervious	Area (ha)	Length (m)	Average Width (m)	Grade (%)
Outlet 1A – 1200mm x 1200mm Box Culvert						
EX.5	Drainage to 1200mm Culvert	25.5%	3.16	65	265	0.50%
EX.6	ROW Drainage to 1200mm Culvert	39.3%	0.23	100	15	1.00%
EX.7	Sheet Flow to 1200mm Culvert	2.4%	5.41	250	350	0.20%
Within Limit of Development Area (ha):			**5.41 ha**			
Exterior to Limit of Development Area (ha):			**3.39 ha**			
Total Area to Outlet 1A (ha):			**8.80 ha**			

Results shown 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. Note that **Outlet 1A** peak flows are also separated by proposed development areas and external site areas. External areas EX.5 and EX.6 are proposed to bypass the stormwater management facility.

Table 3-4 Peak Flows in Pre-Development Conditions

Peak Flows in Pre-Development Conditions (m^3/s)				
Outlet	Area (ha)	1:2 Year Storm	1:5 Year Storm	1:100 Year Storm
		SCS II-6hr	SCS II-6hr	SCS II-6hr
Site Area	5.41	0.03	0.04	0.18
Outlet 1A - Total	8.80	0.07	0.10	0.31

3.3.1.4 Post Development Flows

The development of this site will increase the imperviousness of the site and hence the runoff. Based on Table 3-1 in Appendix B and the proposed catchment conditions in Table 3-5, post development flows were calculated for the proposed development.

Table 3-5 Proposed Conditions

Lansdowne Development Phase 1 (Pre-Development)						
Hydrologic Units - Post-Development Conditions						
Hydrologic Unit	Description	% Impervious	Area (ha)	Length (m)	Average Width (m)	Grade (%)
Outlet 1A – 1200mm x 1200mm Box Culvert						
P9	Ext. ROW to Bypass Swale	39.3%	0.23	100	15	1.00%
P10 - Site	Residential to Storm Sewers	**55.3%**	**6.05**	300	170	0.60%
P11 - Site	Commercial to Storm Sewers	**70.0%**	**1.72**	50	210	0.50%
P12 - Site	Interim SWM Facility	**46.0%**	**0.46**	30	70	0.50%
P13	Ext. Residential to Storm Sewers	25.5%	3.16	65	265	0.50%
Total Development Area (Site) (ha):			**7.77 ha**			
Stormwater Management Facility Lands (Site) (ha):			**0.46 ha**			
Exterior to Limit of Development Area (ha):			**3.39 ha**			
Total Area to Outlet 1A (ha):			**11.62 ha**			

Note, areas in **bold** are the subject development area of 8.23 ha.

Results shown in Table 3-6 quantify the peak rate of surface runoff that has been routed through the collection system, ultimately discharging to the various outlets downstream.

Table 3-6 Uncontrolled Peak Flows in Post Development Conditions

Uncontrolled Peak Flows in the Post-Development Conditions (m^3/s)						
Outlet	Ext. Area (ha)	Site Area (ha)	25mm- Storm	1:2 Year Storm	1:5 Year Storm	1:100 Year Storm
				SCS II-6hr	SCS II-6hr	SCS II-6hr
Site to Interim SWMF	-	8.23	0.28	0.32	0.47	0.96
Outlet 1A	3.39	8.23	-	0.37	0.53	1.06

The total pre-development 100 year storm event peak flow at **Outlet 1A** is 0.31 m^3/s; of which 0.13 m^3/s is contributed by the external bypass flow and 0.18 m^3/s is contributed by the subject site. An uncontrolled 100 year storm event post development peak flow of 0.93 m^3/s is estimated by the proposed development during Phase 1 of development.

Flows outletting from the interim stormwater management facility shall be limited to 0.03 m^3/s for the 2 year event, 0.04 m^3/s for the 5 year event and 0.18 m^3/s for the 100 year event. Peak flows from external areas are proposed to bypass the stormwater management facility.

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.

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

Storage Calculation Summary							
Outlet	Site Areas to Facility	1:2 Year Storm		1:5 Year Storm		1:100 Year Storm	
		Post Controlled (m^3/s)	Storage (m^3)	Post Controlled (m^3/s)	Storage (m^3)	Post Controlled (m^3/s)	Storage (m^3)
Phase 1 Interim SWMF	P10, P11, P12	0.03	392	0.04	1,119	0.18	2,514

The SWM facility bypass flows are not included in Table 3-7.

Conveyance control and storage systems are proposed to limit post development flows from Table 3-7 to pre-development levels. Storage is to be provided by a proposed interim wet pond type stormwater management facility.

Roads and major drainage channels are to be designed for the 100 year storm event and are to be protected at the inlet and outlet with rip rap.

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

Quality and quantity control for the commercial block is to be provided by the interim stormwater management facility.

Refer to Appendix B for the Stage Storage Discharge Outlet Calculations.

Refer to Appendix B for the 100 year stage storage design curve and the 25mm stage storage curve.

Modeling of the 100 year event for the pre-development and post-development conditions are included in Appendix B.

3.4 Water Quality

The Stormwater Management Planning and Design Manual by the MECP describes various levels of protection of water quality, based on a general relationship between the end-of-pipe stormwater management facilities 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, Normal Protection (corresponding to the end-of-pipe storage volumes required for the long-term removal of 70% of suspended solids) is required. Stormwater management measures will be implemented to provide in excess of 70% long term removal of suspended solids.

3.4.1 Phase 1 Interim Stormwater Management Facility – Outlet 1A

A wet facility is the preferred choice for a Stormwater Management facility as they have been proven to be very effective and can be constructed to aesthetically blend in with the natural and built site. The primary goal of the proposed facility is to address stormwater quality and quantity. The facility will need to consider large flows through the facility.

The Stormwater Management Planning and Design Manual by the MECP suggests that, for receiving waters requiring Level 2 Normal protection, 130 m^3 / ha of water total quality storage for sites with 70% impervious levels is required (permanent pool plus extended detention), for sites with an impervious level of 35%, 90 m^3 / ha is required. 40 m^3 / ha represents the extended detention storage. Impervious levels can be extrapolated and interpolated where appropriate from Table 3.2 in the MECP Design Manual. 80 m^3 / ha of extended detention storage is provided for external and undeveloped lands that discharge to the stormwater management facility.

External areas P9 and P13 are proposed to bypass the stormwater management facility. No quality or quantity control is proposed for external areas that bypass the stormwater management facility.

The proposed site has varying levels of imperviousness corresponding to the proposed land uses. Refer to Table 3-8 for a summary of the imperviousness levels and corresponding water quality and quantity volume requirements for the phase 1 of the development. Detailed impervious calculations have been included for the existing and proposed development, please refer to Appendix B for details.

Phase 1 Interim Stormwater Management Facility Requirements

Table 3-8 Phase 1 Wet Pond Storage Requirements

Phase 1 - Wet Pond Storage Requirements									
Developed Site Area (ha)	Description	Comp. % Imp.	Developed Quality Volume (m^3/ha)	Quality Volume (m^3/ha)	Total Quality Volume (m^3)	Permanent Pool Volume (cm)	Extended Detention Volume (cm)	Total Quantity Control Volume 100 yr (cm)	Total Volume (Quantity and Quality) (cm)
Stormwater Management Facility									
6.05	P10	55.0	111	40	670	428	242		670
1.72	P11	70.0	129	40	224	154	154		191
7.77	TOTAL				893	582	311	2,514	3,407

External catchment areas P9 and P13 are to remain in their existing conditions and bypass the proposed stormwater management facility.

In addition to reviewing Table 3.2 values in the MECP design manual, a 25mm - 4hr storm event was modeled and erosion control volume calculated is calculated to be 1,024 m^3. The erosion control volume of 1,024 m^3 is greater than the 311 m^3 extended detention calculated using the MECP Table 3.2 values, therefore the higher value of 1,024 m^3 is the requirement.

For Phase 1 of development a permanent pool volume of 582m^3 is required for quality control – approximately 1,312m^3 is proposed. The volume of extended detention required for quality control is 1,024 m^3, approximately 1,024m^3 is available. Quantity control volumes required and proposed phase 1 of development based on the 2 year, 5 year and 100-year design storms and modeling are 392 m^3, 1,119m^3 and 2,514 m^3.

The total permittable 100 year storm event peak flow to **Outlet 1A** is 0.31 m^3/s, of which 0.13 m^3/s is attributed to external bypass flows and 0.18 m^3/s is the allowable peak outflow from the stormwater management facility.

Quantity and quality control are not proposed for external areas bypassing the facility.

There is more than sufficient quantity and quality control volume available for this development based on the proposed facility characteristics in Table 3-9 stage – storage relationship summary. For further details regarding the stage-storage relationship, refer to the stage-storage curves and the structure stage-storage outlet calculations in Appendix B.

Table 3-9 Phase 1 Interim Stormwater Management Facility Wet Pond Stage Storage Relationship

Phase 1 Interim SWM Facility - Stage - Storage Relationship								Peak Outflow (m³/s)			
Elevation (m)	Surface Area at Elevation (m²)	Incremental Depth (m)	Incremental Volume (m³)	Active Storage (m³)	Total Depth (m)	Total Volume (m³)	Comment	100mm Orifice	150mm Orifice	290mm Orifice	Total
98.28	871	0.00	0	N/A	0	0	Bottom of Pond	-	-	-	-
98.78	1,272	1.00	561	N/A	0.50	561	Permanent Pool Required	-	-	-	-
99.28	1,763	1.00	1,312	N/A	1.00	1,312	Permanent Pool (NWL)	-	-	-	-
99.76	2,646	0.90	1,024	1,024	1.48	2,336	Extended Detention	0.014	-	-	**0.014**
99.91	2,819	0.15	392	1,416	1.63	2,726	2yr Event	-	0.03	-	**0.03**
100.15	3,453	0.39	1,119	2,143	1.87	3,453	5yr Event	-	0.04	-	**0.04**
100.54	3,917	0.78	2,514	3,538	2.19	4,848	100yr Event (HWL)	-	-	0.18	**0.18**
100.84	4,150	0.30	N/A	N/A	2.49	5,802	FreeBoard (0.3m)	N/A	N/A	N/A	N/A

Note: Volume is beyond the Extended Detention

<u>Outlet Structure</u>

Preliminary design of the outlet structure includes two pre-cast ditch inlet concrete structures consisting of 150mm orifice plate to control the 2 and 5 year storm events and a 290mm orifice plate to control flows greater than the minor event up to the 100 year event and a 450mm diameter outlet pipe. During detailed design a concrete weir type structure may also be considered and appropriately sized in its place. Above the 100 year storage elevation a rip rap weir is to be sized for the emergency overflow event. The outlet invert of the structure is set above the highwater level of the existing channel and box culvert. Calculations for the existing box culvert highwater level are provided in Appendix B.

A 150mm bottom draw reverse slope pipe is proposed for quality control. The outlet pipe is to be located at the far end of the facility to ensure the longest flow path to the bottom draw structure. A minimum of 24 hours drawdown time with a 150mm bottom draw outlet pipe with 100mm orifice plate is proposed, refer to Drawdown Calculations and 25mm stage storage curve in Appendix B for further details.

Refer to **Figure 5** in Appendix A for Preliminary Stormwater Management Facility details.

The proposed wet pond type facility should at a minimum provide the following features:

- The permanent pool depth is to a be a minimum of 1.0 m in depth.

- The side slopes on the inner perimeter are to be 5:1 (H:V) or flatter for safety.
- A forebay will promote pre-treatment and retention of sediment and will facilitate maintenance and improve pollutant removal by trapping the larger particles near the facility inlet.
- Minor flows will be directed to the facility by the storm sewer. Major flows will be directed to the facility by the road network.
- A quantity control structure is to be provided at the outlet.
- A bottom drawdown outlet with a reverse slope pipe and minimum of 150mm in diameter and orifice plate to control the drawdown for quality control.
- Rock rip rap will be placed in the major flow paths and the inlet and outlet.
- A minimum drawdown detention time of 24 hours
- In excess of 0.3m of freeboard is to be provided.
- An emergency overflow for storms in excess of a 100-year design storm.
- A maintenance access entrance to the outlet structure and main bay off of Prince Street is proposed. The final location of the maintenance access can be considered at detailed design.

3.4.1.1 Forebay

The forebay is an essential part of the wet pond stormwater management facility. The forebay serves to slow the water entering the wet pond from the storm sewer system allowing for sediment settling. As a result, many of the larger grained sediments are removed prior to reaching the wet pond. These sediments which are often part of the first flush flows are generally heavier and do not require the 24 hours of settlement time as with the smaller sediment particles.

As the forebay is smaller than the wet pond and traps the majority of the larger particles, more frequent maintenance is to be undertaken in the forebay than the wet pond itself.

3.5 Maintenance

3.5.1 Stormwater Management Facility

Maintenance access to the facility and the outlet structure is to be provided via the access lane. This area should be accessible using excavators and dump trucks.

Periodic maintenance inspection of the facilities should be undertaken and annual maintenance reports should be completed. 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 wet pond will require routine periodic maintenance including grass cutting and weed control. Trash removal will be required several times per year. Removal of accumulated sediment in the upstream ditches and the facility itself will be required. Upon completion and stabilization of the contributing area, it is expected that removal of accumulated sediment within the wet pond will be required prior to Final Certificate of Approval of the works at a minimum every 25 years thereafter. Refer to the Forebay Sizing calculations in Appendix B for further details.

4. Quality Control (Short Term)

Erosion and sediment control plans will be provided during the final subdivision design submission.

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 timeframe for land to remain 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 is the developer's responsibility until such time as the Final Certificate of Approval of the Works is issued.

5. Conclusions

Preliminary analysis recommends that the development proceed with the mitigation measures detailed in this report to address storm water quality, storm water quantity, and erosion concerns on the site.

The development is to be designed in accordance with Ministry of the Environment, Conservation and Parks Guidelines and Township and Conservation Authority Guidelines and Technical Standards.

Post development peak flows are to be controlled to pre-development peak flows by the proposed interim wet pond type stormwater management facility for the site.

Detailed design of culvert crossings, outfalls and stormwater management facility outlet structures will be provided during the final engineering design of the subdivision.

Preliminary facility details are contained in this report.

Appendix A

Draft Plan – Phase 1

Figure 2 – Pre-Development Catchment Areas

Figure 3 – Post-Development Catchment Areas

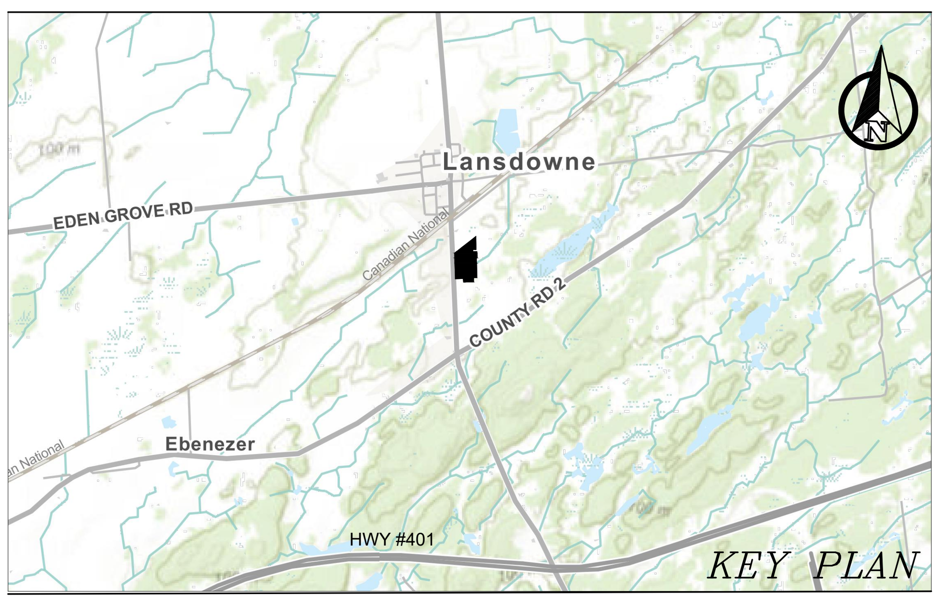
Figure 4 – Post Development Storm Sewer

Figure 5 – Phase 1 Concept Stormwater Management Facility

Source Protection Map

DRAFT PLAN of SUBDIVISION

ALL of LOTS 56 to 65, 68 to 87, 90 to 109, 112 to 131, 134 to 143, PART of BLOCKS C and D, PART of LOTS 45 to 55, 66, 67, 88, 89, 110, 111, 132, and 133. PART of UNNAMED STREET, CALUMET STREET, ONTARIO STREET, DARLING STREET, LAPPAN STREET AND JOHN STREET
REGISTERED PLAN 194
Geographic Township of Lansdowne
TOWNSHIP of LEEDS and the THOUSAND ISLANDS
COUNTY of LEEDS



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 Applicants Have An Interest Are Shown On the Key Plan.
d: Residential & Commercial
e: Shown On Draft Plan
f: Shown On Draft Plan
g: Shown On Draft Plan
h: Municipal Water Supply
i: Napanee Clay
j: Shown On Draft Plan
k: Road Maintenance, Garbage Collection, Phone, Cable, Gas, Sanitary and Hydro
l: Shown On Draft Plan

LEGEND

LANDS TO BE SUBDIVIDED
FUTURE EASEMENT

OWNER'S CERTIFICATE

I, SHANE KELLY, HEREBY AUTHORIZE FOREFRONT TO PREPARE AND SUBMIT THIS PLAN FOR REVIEW AND APPROVAL.

SHANE KELLY, PRESIDENT
10194549 CANADA LTD.

DATE

I HAVE THE AUTHORITY TO BIND THE CORPORATION

SURVEYOR'S CERTIFICATE:

I CERTIFY THAT:

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 W. CHITTY – O.L.S.

DATE

SITE DATA

LAND USE	LOTS & BLOCKS	AREA ±	UNITS	DENSITY
RESIDENTIAL	LOTS 1–76	3.83 ha	76	19.84 u/ha.
COMMERCIAL	BLOCK 210	1.72 ha		
TEMPORARY STORM WATER	BLOCK 209	0.46 ha		
STREETS/RESERVES	MUNICIPAL RIGHT OF WAY BLOCKS 216, 217, 218	1.92 ha		
PARKLAND	BLOCK 214	0.28 ha		
EASEMENT	BLOCK 215	0.02 ha		
TOTAL		8.23± ha	76	9.23 u/ha.

PARKLAND DEDICATION

LAND USE	AREA ±	REQUIRED	PROVIDED
RESIDENTIAL	3.83 ha	(5%) 0.19ha	
COMMERCIAL	1.72 ha	(5%) 0.09ha	
PUBLIC PARK	0.28 ha	0.28 ha	0.28 ha

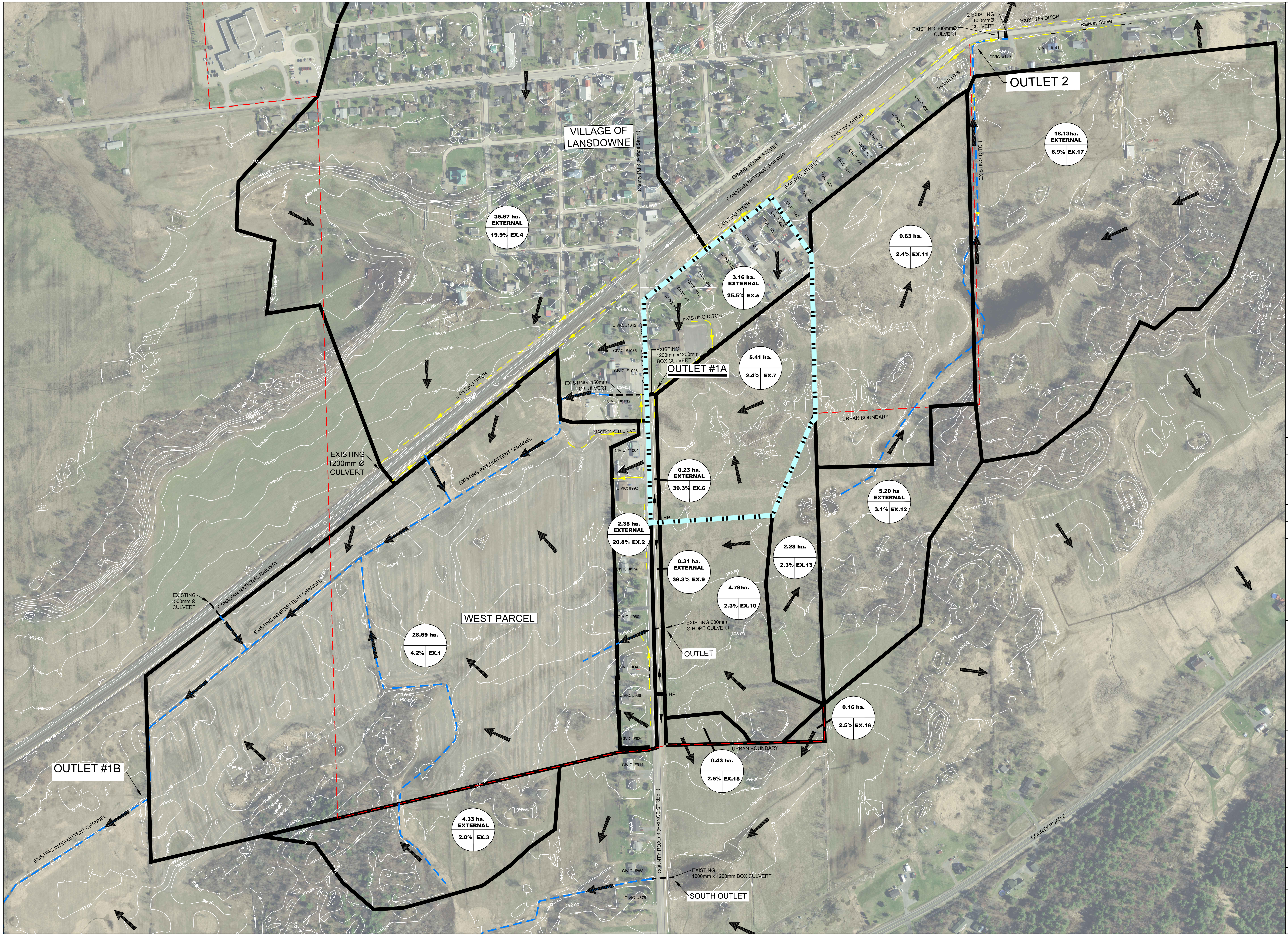
SCALE = 1:1500

0 40m 200m

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

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

Date Issued: OCTOBER 14, 2022



LEGEND:

EX. DENOTES EXISTING
HP HIGH POINT
MINOR FLOW DIRECTION
MAJOR FLOW DIRECTION

##.## ha — AREA (hectares)
0.50 — % IMPERVIOUS
CB# — INLET

0 50 100 m H=1:2500

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

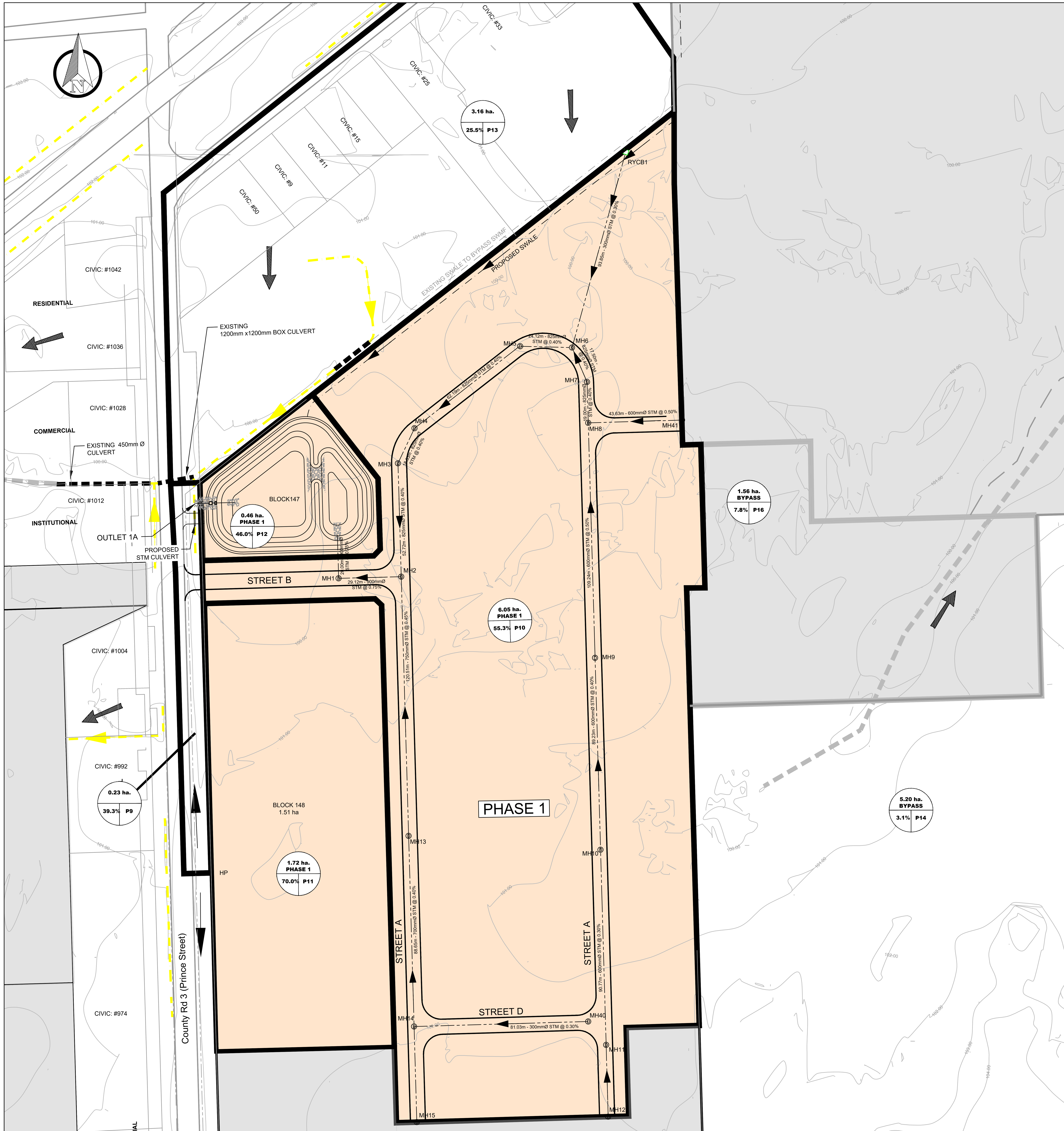
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.888.884.9392 fax.

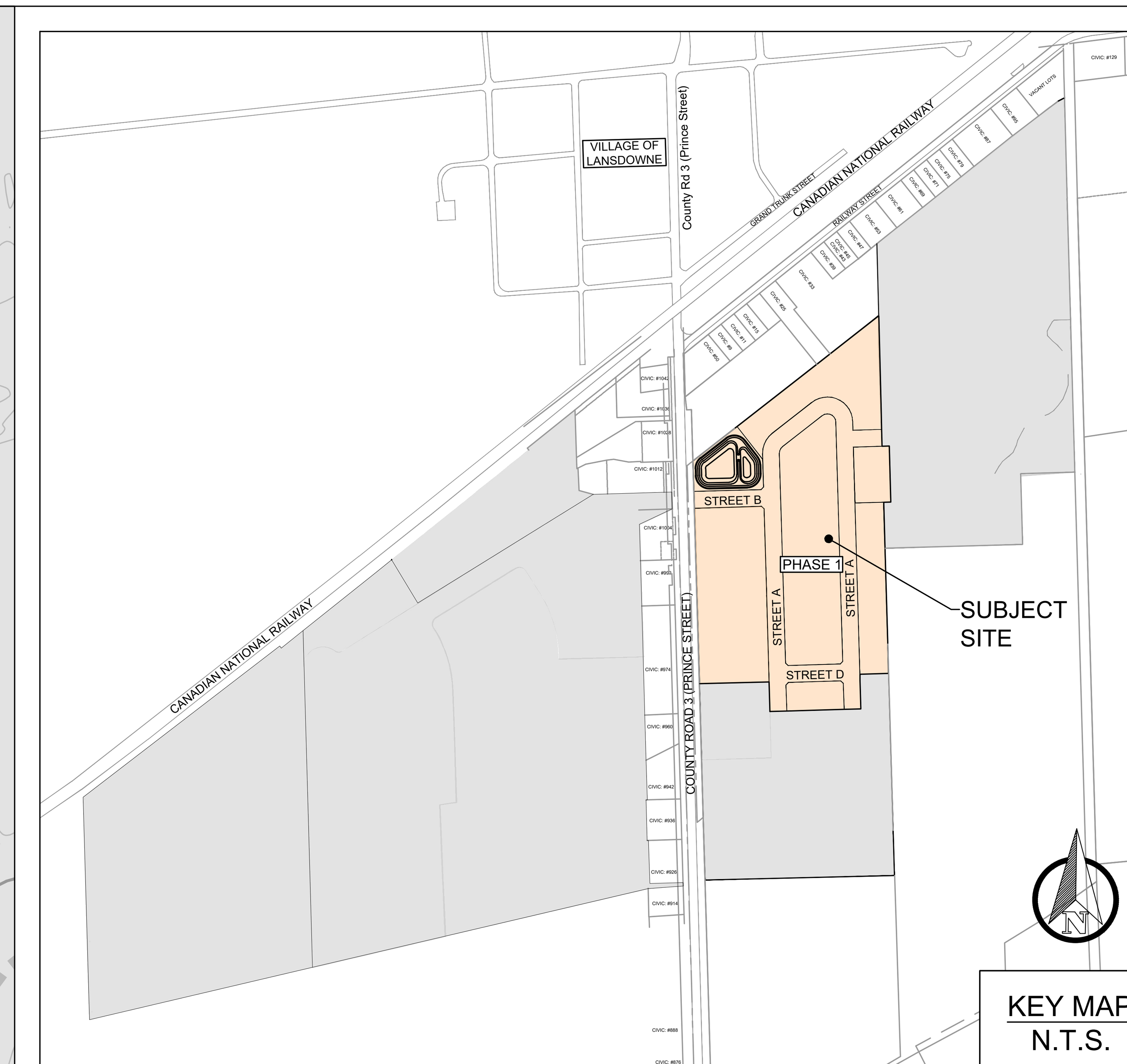
Client
10194549 CANADA
c/o SHANE KELLY

Project
LANSDOWNE DEVELOPMENT

Drawing
PREDEVLOPMENT CATCHMENT AREAS

Drawn by: JB	Checked by: KMN	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.
Date: MARCH 2020		FIG.2
Scale: 1:2500 (ANSI D)		





LEGEND:

EX. DENOTES EXISTING

DI DITCH INLET

HP HIGH POINT

MINOR FLOW DIRECTION

MAJOR FLOW DIRECTION

AREA (hectares)

##.## ha PHASE # ##% CB#

PHASE

% IMPERVIOUS

INLET

PHASE 1

FUTURE

0 20 40 m H=1:1000

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

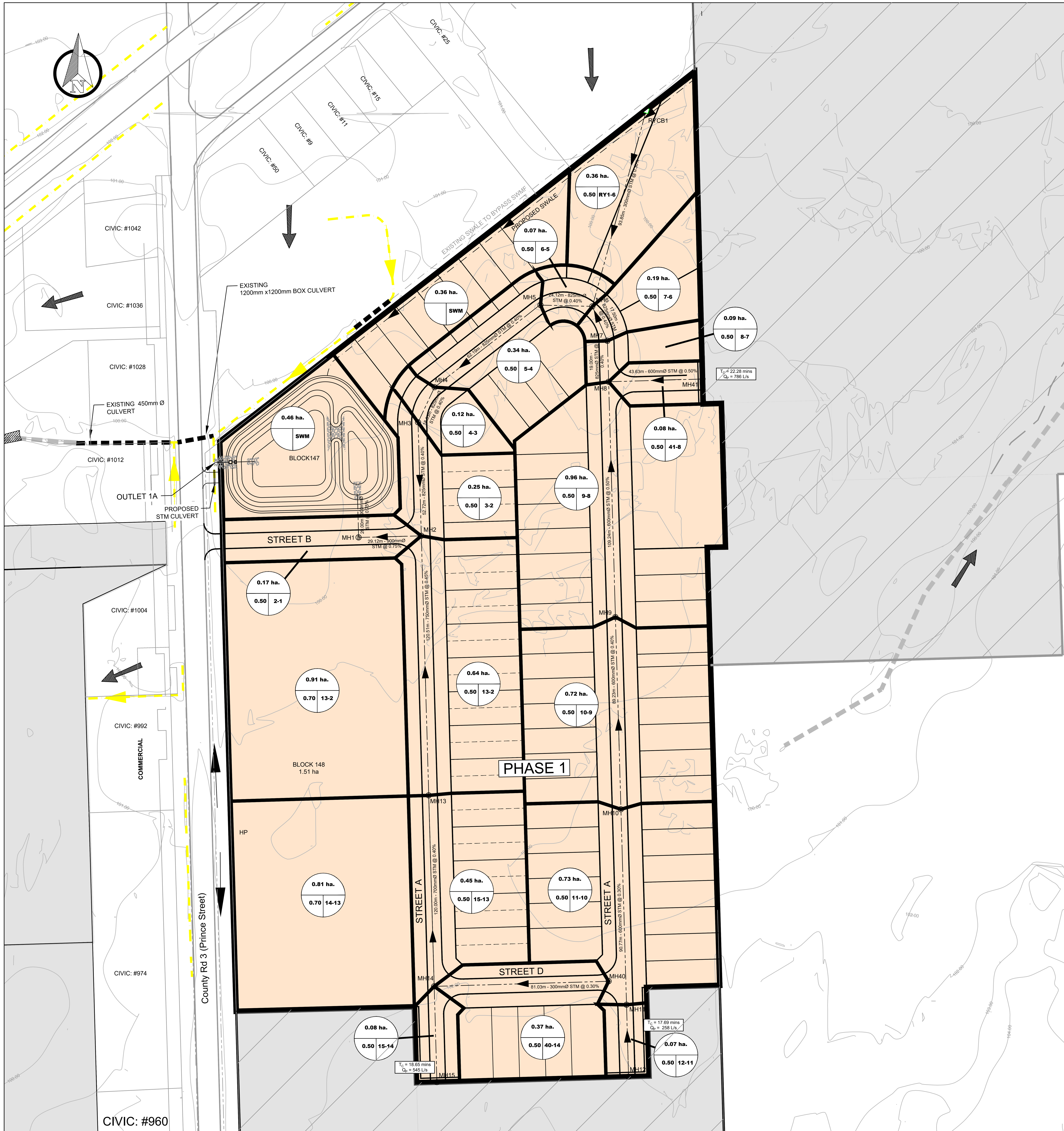
1329 Gardiners Road, Suite 210
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.888.884.9392 fax.

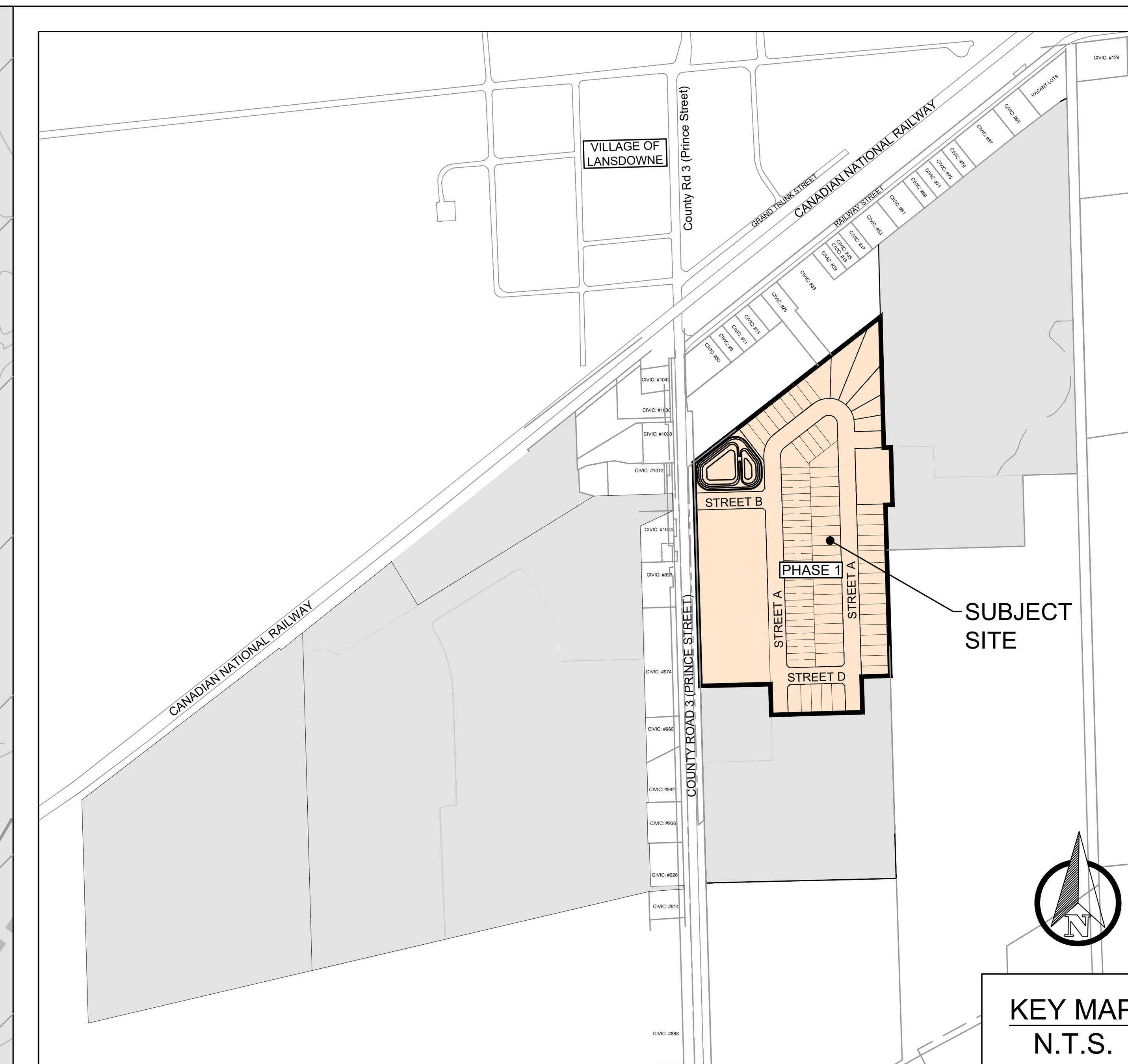
Client
10194549 CANADA
c/o SHANE KELLY

Project
LANSDOWNE DEVELOPMENT

Drawing
POST DEVLOPMENT CATCHMENT AREAS
(PHASE 1)

Drawn by: PB	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.
Date: SEPTEMBER 2022		FIG.3
Scale: 1:1000 (ANSI D)		





LEGEND:

EX. DENOTES EXISTING

DI DITCH INLET

HP HIGH POINT

MINOR FLOW DIRECTION

MAJOR FLOW DIRECTION

##.## ha AREA (hectares)

0.50 RUNOFF COEFFICENT

CB# INLET

PHASE 1

FUTURE

0 20 40 m H=1:1000

Benchmark

No.	Revision/Issue	Date

Forefront Engineering Inc

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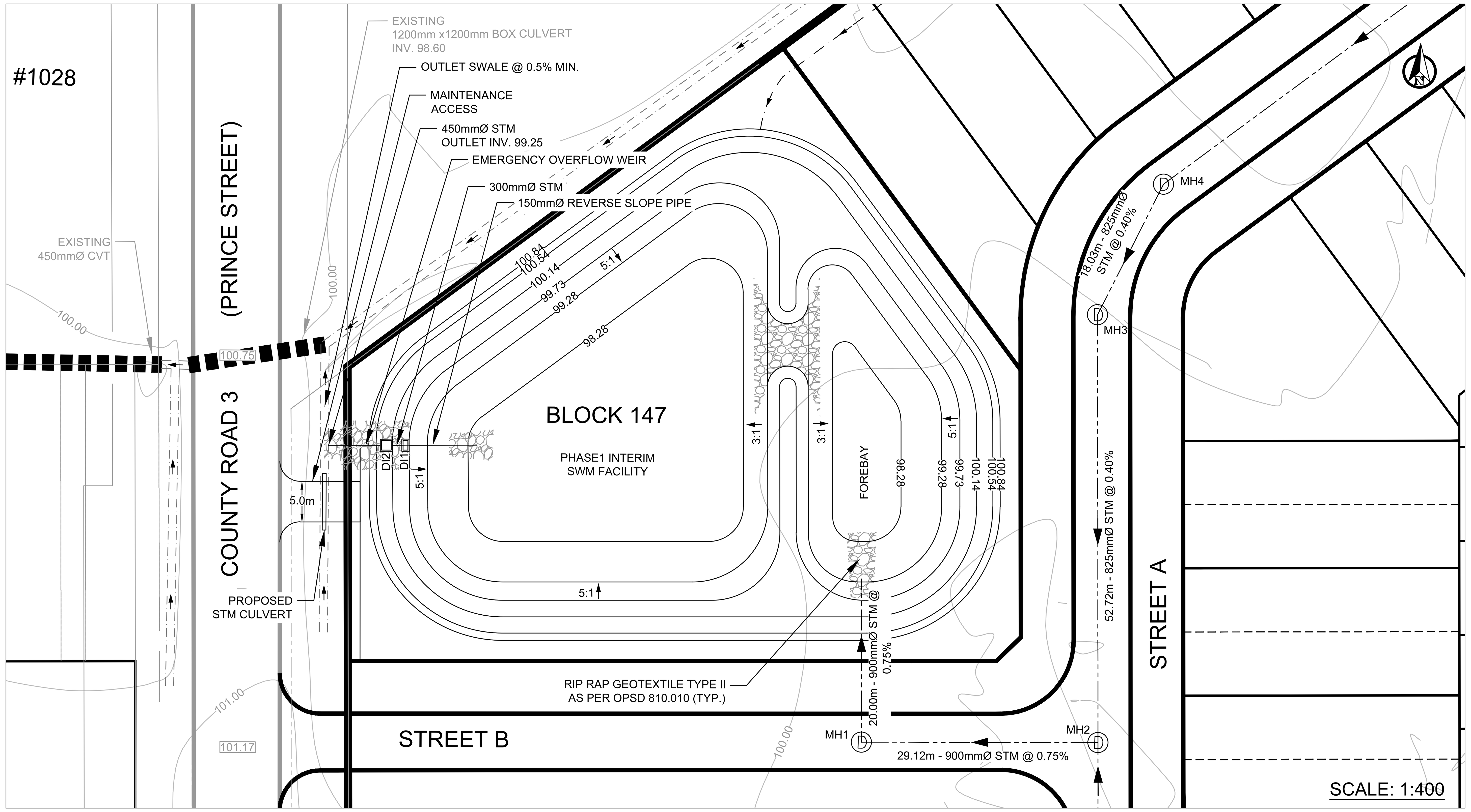
Kingston, ON, Canada K7P 0L8
613.634.9009 tel.
1.888.884.9392 fax.

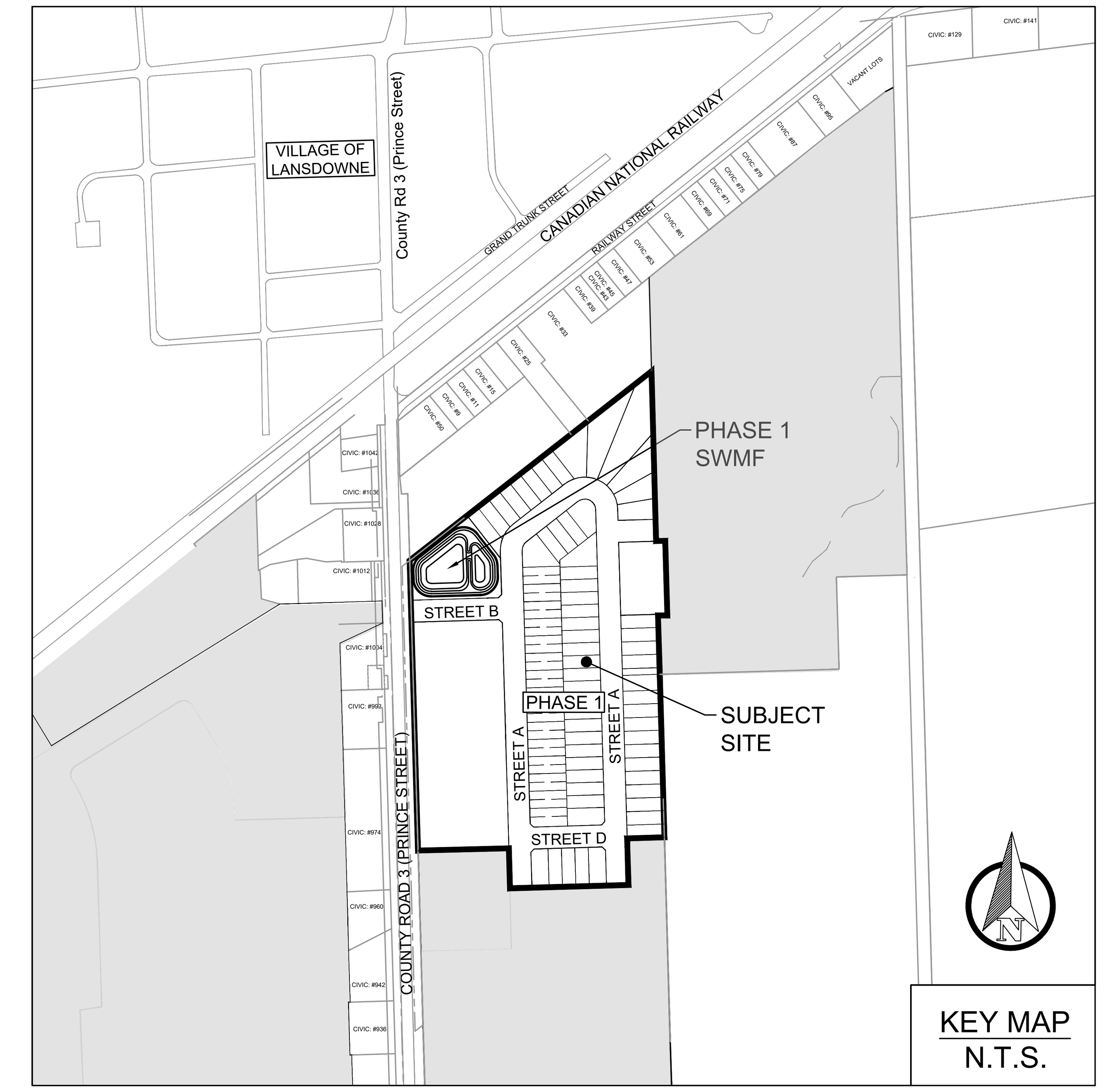
Client
10194549 CANADA
c/o SHANE KELLY

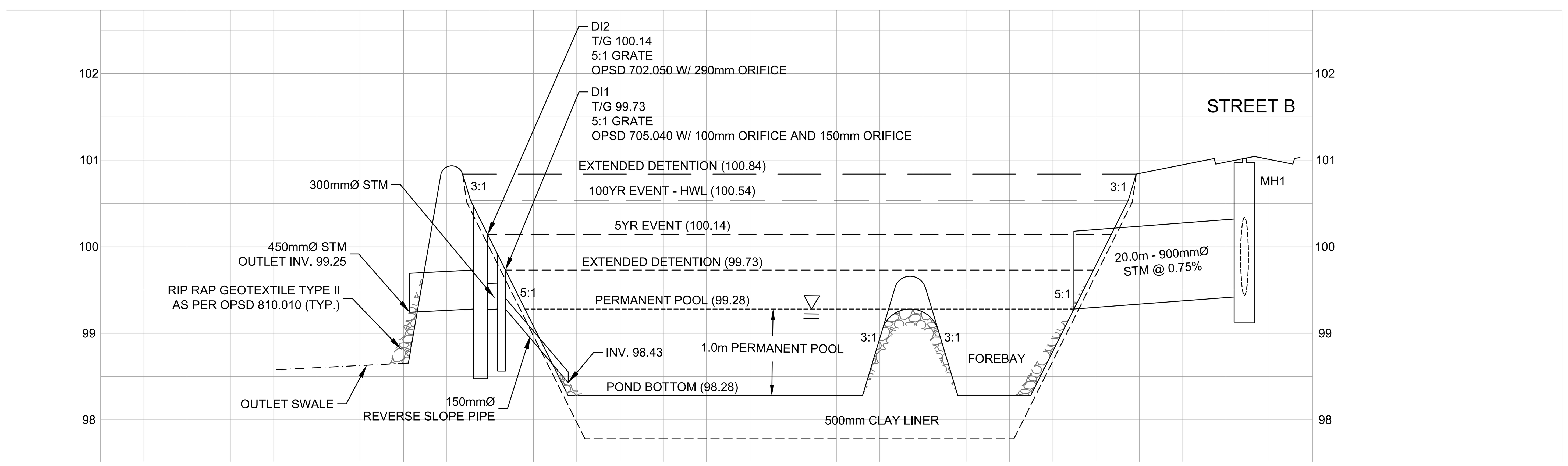
Project
LANSDOWNE DEVELOPMENT

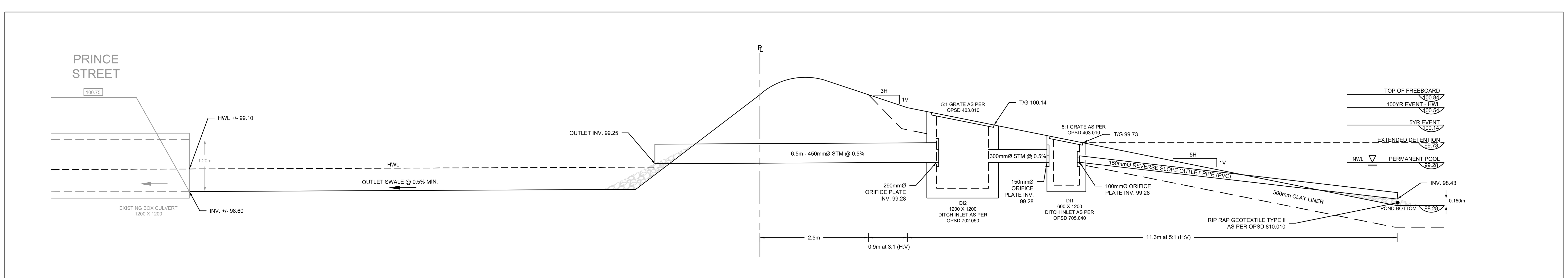
Drawing
POST DEVLOPMENT STORM SEWER DESIGN (PHASE 1)

Drawn by: PB	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.
Date: SEPTEMBER 2022		FIG.4
Scale: 1:1000 (ANSI D)		









PHASE 1 STORMWATER MANAGEMENT FACILITY OUTLET 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.
1.888.884.9392 fax.

Client
10194549 CANADA
c/o SHANE KELLY

Project
LANSDOWNE DEVELOPMENT

Drawing
PHASE 1 INTERIM
STORMWATER MANAGEMENT FACILITY

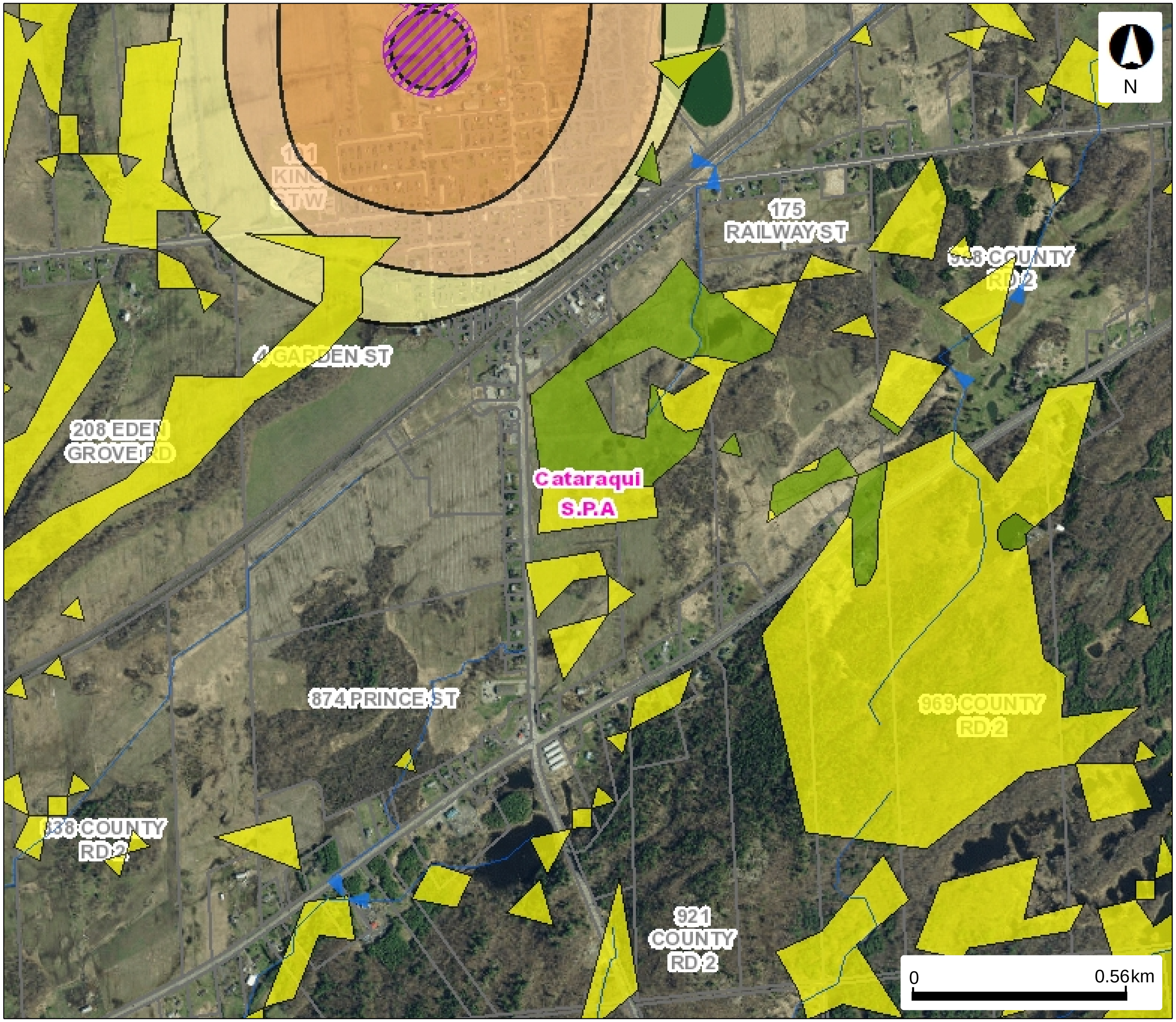
Drawn by: PB	Checked by: JH	Project No.
Designed by: KMN	Approved by: KMN	Drawing No.

Date: SEPTEMBER 2022

Scale: 1:400 (ANSI D)

FIG.5

Source Water Protection Map



Legend

- Source Protection Areas
- Watercourse Direction
- Issue Contributing Areas
- Significant Groundwater Recharge Area
  - 0
  - 2
  - 4
  - 6
- WHPA Groundwater Under Direct Influence (WHPA-E)
- Wellhead Protection Area
  - A
  - B
  - C
  - C1
  - D
  - F
- Intake Protection Zone 1
- Event Based Areas
- Intake Protection Zone 2
- Assessment Parcel

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 Environment, Conservation and Parks (MECP) shall not be liable in any way for the use or any information on this map. of, or reliance upon, this map.

Ontario

Map Created: 3/10/2020
Map Center: 44.39864 N, -76.01578 W

Appendix B

Brockville Short Duration Rainfall Intensity-Duration-Frequency Data

Table 3-1: Surface Cover Parameter Calculations

Impervious Calculations

Storm Sewer Design Sheet

100-Year Event Pre-development Modelling (6hr SCS II)

100-Year Event Post-development Modelling (6hr SCS II)

Stage Storage Discharge Outlet Calculations

Stage Storage Curves (100yr, 25mm)

Extended Detention Drawdown Calculations

Forebay Sizing Calculations

1200mm x 1200mm Culvert Analysis

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

2021/03/26

==

BROCKVILLE PCC ON 6100971

Latitude: 44 36'N Longitude: 75 40'W Elevation/Altitude: 96 m

Years/Années : 1967 - 2017 # Years/Années : 43

==

****

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

****

Year Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1967	6.9	11.9	14.5	26.4	35.6	36.6	39.9	43.7	51.3
1968	5.8	7.9	8.4	9.9	16.0	24.4	39.6	48.0	54.4
1969	6.3	11.7	11.7	13.2	18.3	25.4	34.5	50.8	59.7
1970	11.2	13.0	19.0	20.6	26.2	40.4	41.7	46.2	62.2
1971	8.4	8.9	9.1	9.7	18.0	24.1	29.0	31.0	31.0
1972	9.7	14.2	17.0	18.8	23.4	27.4	46.5	62.2	64.0
1973	8.6	14.7	20.8	25.4	29.0	29.2	29.5	29.5	29.5
1974	19.3	27.9	38.1	49.3	52.1	54.1	55.1	55.1	55.1
1975	10.7	17.5	21.1	26.9	34.5	55.9	55.9	69.8	82.5
1976	7.4	13.2	15.2	16.8	19.6	27.7	30.2	35.1	40.1
1977	9.4	12.2	15.2	29.7	40.9	47.8	47.8	50.8	52.6
1978	7.4	10.4	10.8	11.2	13.3	16.6	21.4	24.6	24.6
1980	8.4	15.3	16.6	18.9	19.0	21.9	32.0	32.0	56.6
1981	-99.9	-99.9	-99.9	25.1	27.6	28.4	30.3	42.6	50.0
1982	10.1	16.2	19.4	22.6	23.9	28.6	62.5	70.4	70.4
1983	9.7	12.4	12.6	12.8	15.9	21.1	35.5	37.8	37.8
1984	5.2	7.4	8.8	14.2	22.3	31.8	37.7	39.4	39.4
1985	7.9	9.4	9.4	15.2	19.7	24.7	38.0	49.6	52.8
1986	9.8	15.7	23.0	42.2	48.4	50.2	55.6	63.0	64.7
1987	7.6	10.2	10.8	15.4	21.4	31.4	42.4	50.7	61.2
1988	5.2	7.0	8.4	9.5	13.2	16.4	29.4	41.4	42.2
1989	11.2	20.4	29.4	47.9	49.0	52.6	89.0	89.5	89.7
1990	6.4	12.8	15.5	17.2	19.4	19.7	35.8	37.4	42.0
1991	7.6	8.8	11.0	14.4	21.8	25.8	28.4	42.3	52.4
1992	5.9	7.2	8.0	12.6	24.4	37.0	45.3	46.4	46.4
1995	9.7	12.0	14.1	16.9	19.0	20.0	40.6	61.7	68.8
1996	6.4	12.6	14.9	22.7	29.6	34.2	38.6	40.2	58.4

1997	10.6	12.7	12.9	13.6	21.5	29.5	37.2	42.8	44.6
1998	10.9	16.7	21.0	22.5	25.2	29.4	31.5	35.4	41.6
1999	9.1	10.7	11.7	13.7	14.6	16.8	33.5	36.6	54.4
2000	6.0	7.4	9.7	12.3	17.4	22.2	30.8	34.0	43.9
2001	10.5	12.6	15.6	19.3	20.4	21.4	38.9	65.4	79.5
2002	7.1	9.0	9.2	9.2	9.8	13.8	32.1	39.4	42.4
2003	8.5	11.2	14.7	16.0	17.3	17.7	29.3	44.1	54.7
2004	12.1	17.7	18.3	24.7	25.3	31.8	63.6	100.0	109.6
2005	8.1	11.5	12.7	14.2	21.3	33.1	66.9	81.7	83.3
2008	10.7	14.5	15.5	22.7	32.1	33.4	43.2	51.2	51.6
2009	6.0	11.7	14.7	15.4	16.5	18.1	23.0	26.1	30.8
2012	8.1	12.1	13.1	15.1	15.6	23.6	28.2	39.2	39.2
2013	8.3	16.0	21.4	30.9	31.1	38.4	42.1	43.9	46.0
2014	5.5	7.7	10.0	16.8	20.1	30.1	40.1	43.4	48.5
2015	8.4	13.6	17.4	20.7	20.9	23.8	39.2	39.2	44.2
2016	8.0	13.4	16.7	21.0	25.2	25.7	29.3	40.1	57.6
2017	4.4	6.9	9.4	13.5	18.9	31.0	67.9	108.7	116.7
# Yrs. Années	43	43	43	44	44	44	44	44	44
Mean Moyenne	8.5	12.5	15.0	19.7	24.0	29.4	40.7	49.1	55.2
Std. Dev. Écart-type	2.6	4.0	5.9	9.2	9.5	10.4	13.6	18.4	19.2
Skew. Dissymétrie	1.72	1.36	1.72	1.75	1.47	1.03	1.51	1.58	1.35
Kurtosis	9.37	7.01	7.71	6.45	5.15	3.85	5.84	5.64	5.46

*-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
1974	5 min	19.3	16.5
1974	10 min	27.9	25.1
1974	15 min	38.1	33.6
1974	30 min	49.3	48.5
1989	6 h	89.0	83.2
2017	12 h	108.7	106.9
2017	24 h	116.7	115.5

****

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

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	8.1	10.3	11.8	13.7	15.1	16.5	43
10 min	11.8	15.4	17.7	20.7	22.9	25.1	43
15 min	14.1	19.3	22.8	27.1	30.4	33.6	43
30 min	18.2	26.3	31.7	38.5	43.5	48.5	44
1 h	22.4	30.8	36.3	43.4	48.6	53.7	44

2 h	27.7	36.8	42.9	50.6	56.3	61.9	44
6 h	38.4	50.4	58.4	68.4	75.8	83.2	44
12 h	46.1	62.4	73.2	86.8	96.9	106.9	44
24 h	52.0	69.0	80.3	94.5	105.1	115.5	44

****

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%

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	96.7	123.8	141.8	164.5	181.3	198.1	43
	+/- 8.4	+/- 14.2	+/- 19.2	+/- 25.8	+/- 30.9	+/- 36.0	43
10 min	70.9	92.2	106.3	124.2	137.4	150.6	43
	+/- 6.6	+/- 11.2	+/- 15.1	+/- 20.3	+/- 24.3	+/- 28.3	43
15 min	56.3	77.2	91.0	108.5	121.5	134.3	43
	+/- 6.5	+/- 10.9	+/- 14.8	+/- 19.9	+/- 23.8	+/- 27.7	43
30 min	36.4	52.6	63.4	77.0	87.0	97.0	44
	+/- 5.0	+/- 8.4	+/- 11.3	+/- 15.3	+/- 18.3	+/- 21.3	44
1 h	22.4	30.8	36.3	43.4	48.6	53.7	44
	+/- 2.6	+/- 4.3	+/- 5.9	+/- 7.9	+/- 9.4	+/- 11.0	44
2 h	13.8	18.4	21.5	25.3	28.1	31.0	44
	+/- 1.4	+/- 2.4	+/- 3.2	+/- 4.3	+/- 5.2	+/- 6.0	44
6 h	6.4	8.4	9.7	11.4	12.6	13.9	44
	+/- 0.6	+/- 1.0	+/- 1.4	+/- 1.9	+/- 2.3	+/- 2.6	44
12 h	3.8	5.2	6.1	7.2	8.1	8.9	44
	+/- 0.4	+/- 0.7	+/- 0.9	+/- 1.3	+/- 1.5	+/- 1.8	44
24 h	2.2	2.9	3.3	3.9	4.4	4.8	44
	+/- 0.2	+/- 0.4	+/- 0.5	+/- 0.7	+/- 0.8	+/- 0.9	44

****

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)

****

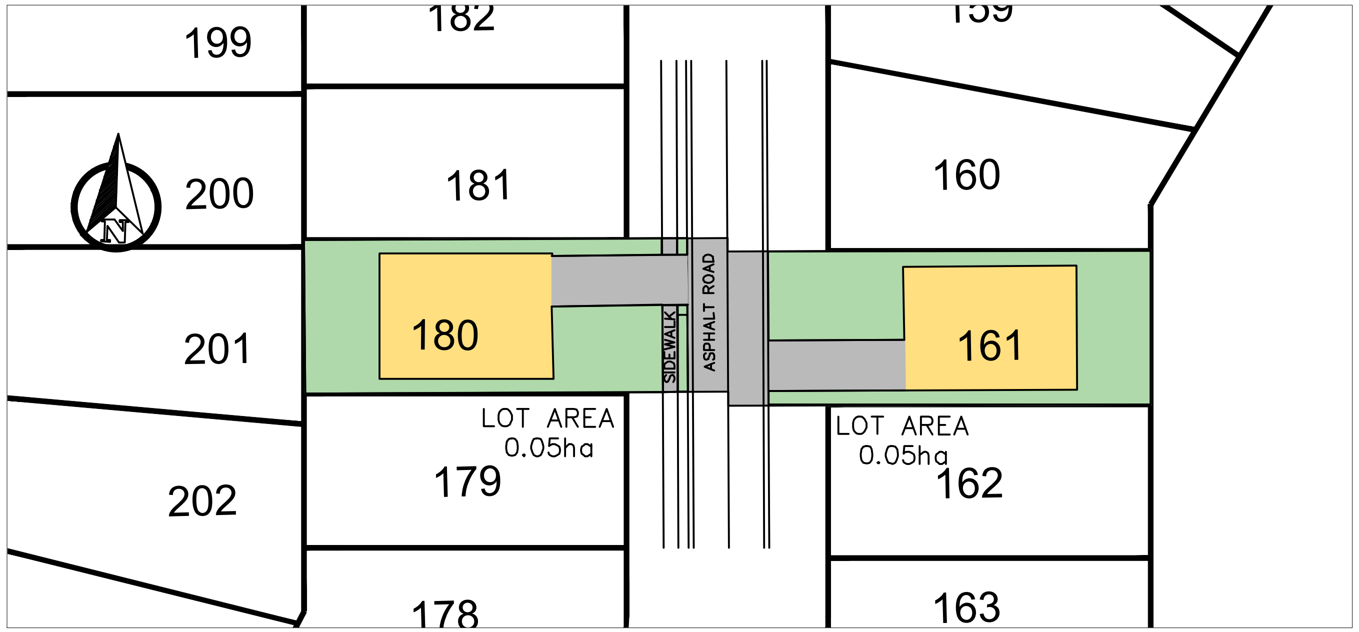
Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans
Mean of RR/Moyenne de RR	34.3	45.7	53.3	62.8	69.9	76.9
Std. Dev. /Écart-type (RR)	33.6	43.5	50.1	58.5	64.7	70.9
Std. Error/Erreur-type	6.5	11.3	14.5	18.5	21.5	24.4
Coefficient (A)	21.0	28.2	32.9	38.9	43.4	47.8
Exponent/Exposant (B)	-0.679	-0.679	-0.678	-0.678	-0.677	-0.677
Mean % Error/% erreur moyenne	6.3	8.2	9.1	10.1	10.6	11.1

Table 3-1: Surface Cover Parameter Calculations - Lansdowne Development

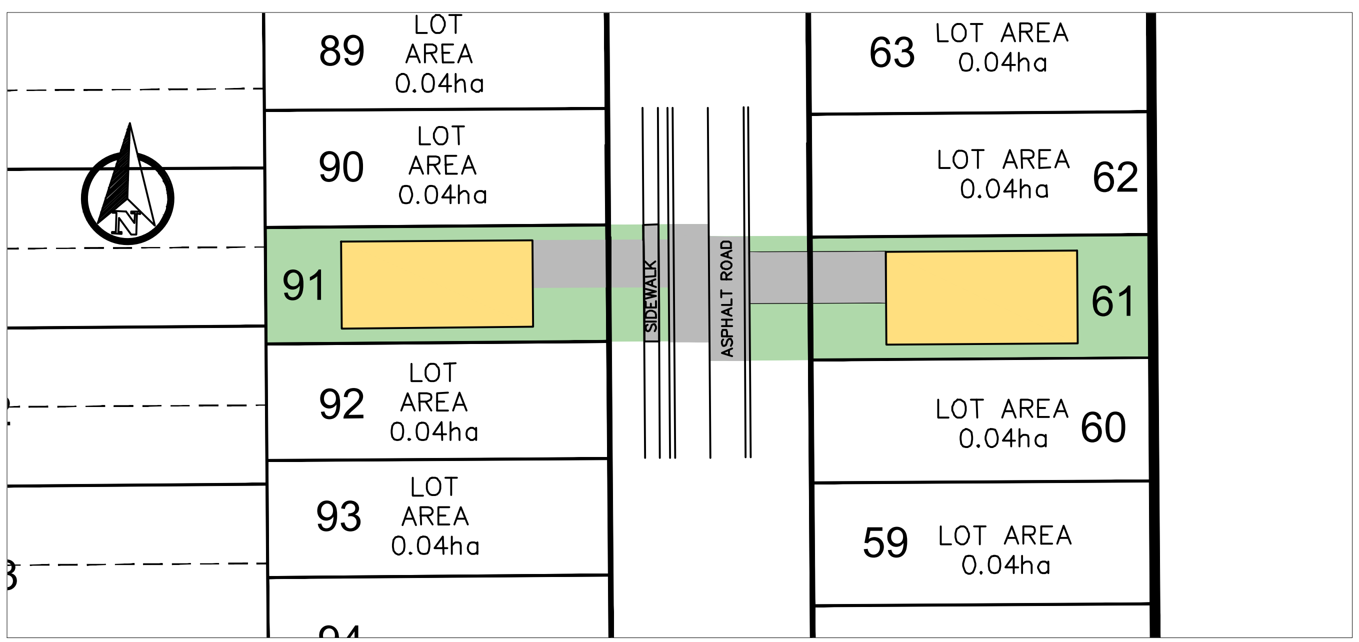
Surface Cover Type	Manning's "n"		Dep. Storage (mm)		% Impervious	Subarea Routing	% Routed	% Impervious without Storage
	Impervious	Pervious	Impervious	Pervious				
Forest	0.03	0.4	10	15	1		100	10
Grass	0.025	0.25	5	10	2.5		75	10
BioRet	0.025	0.3	25	30	2.5		75	10
Bare	0.02	0.15	5	7.5	5		50	10
GrnRoof	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			
Lansdowne Development (Pre-Development)																					
EX.1	10.00%	85.00%		3.00%					1.00%	1.00%			100.00%	4.2	0.02525	0.2605	5.475	10.35	10.20	76	Impervious to Pervious
EX.2		80.00%					5.00%		10.00%	5.00%			100.00%	20.8	0.0235	0.2325	4.625	9.125	12.25	63	Impervious to Pervious
EX.3	40.00%	55.00%		5.00%									100.00%	2.0	0.02675	0.305	7	11.875	10.00	84	Impervious to Pervious
EX.4	2.00%	79.00%					8.00%		9.00%	2.00%			100.00%	19.9	0.0234	0.235	4.675	9.2	12.3	63	Impervious to Pervious
EX.5		70.00%		5.00%			5.00%		15.00%	5.00%			100.00%	25.5	0.02275	0.2225	4.5	8.75	12.75	58	Impervious to Pervious
EX.6		60.00%							35.00%	5.00%			100.00%	39.3	0.0215	0.2125	4.125	8.125	14	50	Impervious to Pervious
EX.7	10.00%	90.00%											100.00%	2.4	0.0255	0.265	5.5	10.5	10	78	Impervious to Pervious
EX.9		60.00%							35.00%	5.00%			100.00%	39.3	0.0215	0.2125	4.125	8.125	14.00	50	Impervious to Pervious
EX.10	15.00%	85.00%											100.00%	2.3	0.02575	0.2725	5.75	10.75	10.00	79	Impervious to Pervious
EX.11	15.00%	85.00%											100.00%	2.3	0.02575	0.2725	5.75	10.75	10.00	79	Impervious to Pervious
EX.12	35.00%	58.00%		5.00%							2.00%		100.00%	3.1	0.0263	0.2995	6.65	11.725	10.00	82	Impervious to Pervious
EX.13	15.00%	85.00%											100.00%	2.3	0.02575	0.2725	5.75	10.75	10.00	79	Impervious to Pervious
EX.15		100.00%											100.00%	2.5	0.025	0.25	5	10	10.00	75	Impervious to Pervious
EX.16		100.00%											100.00%	2.5	0.025	0.25	5	10	10	75	Impervious to Pervious
EX.17	35.00%	53.00%		5.00%			1.00%				4.00%	2.00%	100.00%	6.9	0.0258	0.2958	6.425	11.575	9.95	79	Impervious to Pervious
Lansdowne Development (Post-Development)																					
P1	5.00%	85.00%										10.00%	100.00%	12.2	0.02425	0.234	4.75	9.25	9.00	69	Impervious to Pervious
P2		30.00%					30.00%		40.00%				100.00%	67.3	0.018	0.18	3.25	6.5	18.50	30	Pervious to Impervious
P3	40.00%	55.00%		5.00%									100.00%	2.0	0.02675	0.305	7	11.875	10.00	84	Impervious to Pervious
P4	2.00%	79.00%					8.00%		9.00%	2.00%			100.00%	19.9	0.0234	0.235	4.675	9.2	12.3	63	Impervious to Pervious
P5		30.00%					30.00%		40.00%				100.00%	67.3	0.018	0.18	3.25	6.5	18.5	30	Pervious to Impervious
P6		30.00%					30.00%		40.00%				100.00%	67.3	0.018	0.18	3.25	6.5	18.5	30	Pervious to Impervious
P7		80.00%					5.00%		10.00%	5.00%			100.00%	20.8	0.0235	0.2325	4.625	9.125	12.25	63	Impervious to Pervious
P8		60.00%							35.00%	5.00%			100.00%	39.3	0.0215	0.2125	4.125	8.125	14.00	50	Impervious to Pervious
P9		60.00%							35.00%	5.00%			100.00%	39.3	0.0215	0.2125	4.125	8.125	14.00	50	Impervious to Pervious
P10		43.00%					32.00%		25.00%				100.00%	55.2	0.0193	0.193	3.575	7.15	17.30	38	Pervious to Impervious
P11		30.00%					30.00%		40.00%				100.00%	67.3	0.018	0.18	3.25	6.5	18.50	30	Pervious to Impervious
P12		27.00%					30.00%		43.00%				100.00%	70.0	0.0177	0.177	3.175	6.35	18.80	28	Pervious to Impervious
P13		70.00%		5.00%			5.00%		15.00%	5.00%			100.00%	25.5	0.02275	0.2225	4.5	8.75	12.75	58	Impervious to Pervious
P14	35.00%	58.00%		5.00%							2.00%		100.00%	3.1	0.0263	0.2995	6.65	11.725	10.00	82	Impervious to Pervious
P15A		43.00%					32.00%		25.00%				100.00%	55.2	0.0193	0.193	3.575	7.15	17.30	38	Pervious to Impervious
P15B		70.00%					20.00%				10.00%		100.00%	25.8	0.022	0.24	4	9.5	13.00	60	Impervious to Pervious
P16		94.00%								6.00%			100.00%	7.8	0.025	0.247	5	9.85	10.60	72	Impervious to Pervious
P17	35.00%	53.00%		5.00%			1.00%				4.00%	2.00%	100.00%	6.9	0.0258	0.2958	6.425	11.575	9.95	79	Impervious to Pervious
P12 - PH1 SWMF		55.00%							5.00%			40.00%	100.00%	46.1	0.0205	0.151	2.875	5.75	6.50	42	Impervious to Pervious



East Parcel (Lot 161 & Lot 180) (Detached)	Impervious Areas (m2)	Pervious Areas (m2)	Direct Connected Impervious Areas (m2)
House roof			416.1
Driveway	135.0		
Street	122.1		
Lawn		583.7	
Sidewalk	15.4		
Sub Totals	272.5	583.7	416.1
Total Lot Area	1272.3		
% Impervious Areas	54.1		
% Pervious Areas		45.9	
% Direct Connected Impervious Areas			32.7



East Parcel (Lot 61 & Lot 91) (Detached)	Impervious Areas (m2)	Pervious Areas (m2)	Direct Connected Impervious Areas (m2)
House roof			337.9
Driveway	130.9		
Street	95.9		
Lawn		475.8	
Sidewalk	16.0		
Sub Totals	242.8	475.8	337.9
Total Lot Area	1056.5		
% Impervious Areas	55.0		
% Pervious Areas		45.0	
% Direct Connected Impervious Areas			32.0

PERMEABLE AREA

IMPERVIOUS AREA

DIRECTLY CONNECTED IMPERVIOUS AREA

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
10194549 CANADA
c/o SHANE KELLY

Project
LANSDOWNE DEVELOPMENT

Drawing
PERVIOUS/IMPERVIOUS AREA CALCULATION

Drawn by: CGD
Checked by: JH
Project No.
Designed by: KMN
Approved by: KMN
Drawing No.
Date: APRIL 2021
Scale: N.T.S.

SK1

MINOR STORM SEWER DESIGN SHEET - LANSDOWNE DEVELOPMENT - PHASE 1

CLIENT	10194549 c/o Shane Kelly			DESIGN FREQUENCY	5 100
PROJECT NAME	Lansdowne Development	Min. V =	0.75 m/s	RAINFALL STATIONS	Brockville IDF
DATE	October 2022	Max. V =	6 m/s	DESIGNED 'n'	0.013

LOCATION: LANSDOWNE DEVELOPMENT — DRAINAGE AREA = 17.64 ha — RUNOFF 3 — PIPE SELECTION

Area (ha)	Street	Inlet Description	FROM	TO	R = 0.30 ha	R = 0.50 ha	R = 0.60 ha	High Density R = 0.70 ha	5 Year Indiv. 2.78AC ha	5 Year Accum. 2.78AC ha	Time of Conc. (min)	5 Year Intensity I (mm/hr)	Peak Flow Q (L/S)	Type of Pipe	Required Pipe Diameter D (m)	Nominal Diameter D (mm)	Pipe Length (m)	Grade S	Full Capacity (L/S)	Full Flow Velocity V (m/s)	Time of Flow (min)	Capacity Used Q/Q(f)	Actual Velocity (m/s)	Normal Depth (mm)	Free Outfall D/S HGL (m)	Fall in Sewer (m)	US Inv (m)	DS Inv (m)
0.21	STREET F	34-33	MH34	MH33		0.210			0.292	0.292	15.00	78	23	HDPE	0.218	300	63.17	0.30%	53.0	0.75	1.41	0.43	0.72	137	102.98	0.190	103.04	102.85
0.13	STREET F	33-32	MH33	MH32		0.130			0.181	0.472	16.41	74	35	HDPE	0.257	300	21.28	0.30%	53.0	0.75	0.47	0.66	0.80	177	102.94	0.064	102.83	102.76
0.26	STREET F	32-31	MH32	MH31		0.260			0.361	0.833	16.88	73	61	HDPE	0.316	375	46.72	0.30%	96.0	0.87	0.90	0.63	0.92	215	102.76	0.140	102.69	102.55
0.20	STREET F	31-30	MH31	MH30		0.200			0.278	1.111	17.77	71	79	HDPE	0.348	375	18.11	0.30%	96.0	0.87	0.35	0.82	0.97	258	102.73	0.054	102.53	102.47
0.34	STREET F	30-29	MH30	MH29		0.340			0.472	1.583	18.12	70	111	HDPE	0.395	450	65.18	0.30%	156.2	0.98	1.11	0.71	1.06	279	102.48	0.196	102.40	102.20
0.11	STREET F	29-28	MH29	MH28		0.110			0.153	1.736	19.23	67	117	HDPE	0.404	450	18.00	0.30%	156.2	0.98	0.31	0.75	1.08	291	102.42	0.054	102.18	102.13
0.38	STREET F	28-27	MH28	MH27		0.380			0.528	2.264	19.53	67	151	HDPE	0.421	450	70.28	0.40%	180.3	1.13	1.03	0.84	1.27	315	102.14	0.281	102.11	101.83
0.14	STREET F	27-26	MH27	MH26		0.140			0.194	2.458	20.57	65	160	HDPE	0.430	450	23.54	0.40%	180.3	1.13	0.35	0.88	1.28	329	102.04	0.094	101.81	101.71
0.55	STREET F	26-19	MH26	MH19		0.550			0.764	3.222	20.91	64	207	HDPE	0.474	525	62.59	0.40%	272.0	1.26	0.83	0.76	1.38	341	101.73	0.250	101.64	101.39
0.73	STREET E	25-24	MH25	MH24		0.730			1.014	1.014	15.00	78	79	HDPE	0.348	375	127.78	0.30%	96.0	0.87	2.45	0.82	0.97	258	102.58	0.383	102.70	102.32
0.15	STREET E	24-23	MH24	MH23		0.150			0.208	1.222	17.45	72	87	HDPE	0.362	375	25.39	0.30%	96.0	0.87	0.49	0.91	0.98	280	102.50	0.076	102.30	102.22
0.58	STREET E	23-22	MH23	MH22		0.580			0.806	2.028	17.94	70	143	HDPE	0.435	450	78.00	0.30%	156.2	0.98	1.32	0.91	1.11	338	102.25	0.234	102.15	101.91
0.26	STREET E	22-21	MH22	MH21		0.260			0.361	2.389	19.26	67	161	HDPE	0.432	450	31.67	0.40%	180.3	1.13	0.47	0.89	1.28	331	102.10	0.127	101.89	101.77
0.38	STREET E	21-20	MH21	MH20		0.380			0.528	2.917	19.73	66	194	HDPE	0.488	525	60.50	0.30%	235.6	1.09	0.93	0.82	1.21	361	101.87	0.182	101.69	101.51
0.05	STREET E	20-19	MH20	MH19		0.050			0.069	2.986	20.65	65	193	HDPE	0.487	525	33.79	0.30%	235.6	1.09	0.52	0.82	1.21	361	101.75	0.101	101.49	101.39
0.17	STREET F	19-41	MH19	MH41		0.170			0.236	6.444	21.74	63	404	HDPE	0.584	600	5.53	0.50%	434.2	1.54	0.06	0.93	1.74	457	101.74	0.028	101.31	101.29
0.08	STREET F	41-8	MH41	MH8		0.080			0.111	6.556	22.22	62	405	HDPE	0.585	600	43.63	0.50%	434.2	1.54	0.47	0.93	1.74	459	101.30	0.218	101.06	100.84
1.43	STREET A	13-12	MH13	MH12		1.430			1.986	1.986	15.00	78	154	HDPE	0.448	525	142.47	0.30%	235.6	1.09	2.18	0.66	1.16	308	102.56	0.427	102.68	102.25
0.07	STREET A	12-11	MH12	MH11		0.070			0.097	2.083	15.00	78	162	HDPE	0.456	525	33.35	0.30%	235.6	1.09	0.51	0.69	1.17	319	102.45	0.100	102.23	102.13
0.73	STREET A	11-10	MH11	MH10		0.730			1.014	3.097	15.51	76	237	HDPE	0.526	600	90.77	0.30%	336.3	1.19	1.27	0.70	1.29	370	102.16	0.272	102.06	101.79
0.72	STREET A	10-9	MH10	MH9		0.720			1.000	4.097	16.78	73	300	HDPE	0.545	600	89.23	0.40%	388.3	1.37	1.08	0.77	1.52	395	101.80	0.357	101.77	101.41
0.96	STREET A	9-8	MH9	MH8		0.960			1.333	5.431	17.87	71	383	HDPE	0.573	600	109.24	0.50%	434.2	1.54	1.19	0.88	1.73	436	101.28	0.546	101.39	100.84
0.09	STREET A	8-7	MH8	MH7		0.090			0.125	12.111	22.69	61	741	HDPE	0.764	825	19.00	0.40%	907.8	1.70	0.19	0.82	1.89	564	101.11	0.076	100.62	100.54
0.19	STREET A	7-6	MH7	MH6		0.190			0.264	12.375	22.88	61	753	HDPE	0.769	825	17.50	0.40%	907.8	1.70	0.17	0.83	1.90	570	101.02	0.070	100.52	100.45
0.36		RY1-6	RYCB1	MH6		0.360			0.500	0.500	15.00	78	39	HDPE	0.267	300	93.85	0.30%	53.0	0.75	2.09	0.73	0.82	190	101.17	0.282	101.26	100.98
0.07	STREET A	6-5	MH6	MH5		0.070			0.097	12.972	23.05	61	785	HDPE	0.781	825	24.12	0.40%	907.8	1.70	0.24	0.86	1.91	590	100.93	0.096	100.43	100.34
0.34	STREET A	5-4	MH5	MH4		0.340			0.472	13.444	23.28	60	809	HDPE	0.790	825	62.19	0.40%	907.8	1.70	0.61	0.89	1.92	606	100.67	0.249	100.32	100.07
0.12	STREET A	4-3	MH4	MH3		0.120			0.167	13.611	23.89	59	806	HDPE	0.789	825	18.03	0.40%	907.8	1.70	0.18	0.89	1.92	603	100.58	0.072	100.05	99.97
0.25	STREET A	3-2	MH3	MH2		0.250			0.347	13.958	24.07	59	823	HDPE	0.795	825	52.72	0.40%	907.8	1.70	0.52	0.91	1.92	612	100.36	0.211	99.95	99.74
0.47	STREET C	19-17	MH19	MH17		0.470			0.653	0.653	15.00	78	51	HDPE	0.280	300	73.94	0.40%	61.2	0.87	1.42	0.83	0.97	209	102.21	0.296	102.29	102.00
0.47	STREET C	18-17	MH18	MH17		0.470			0.653	0.653	15.00	78	51	HDPE	0.280	300	84.22	0.40%	61.2	0.87	1.62	0.83	0.97	209	102.21	0.337	102.34	102.00
1.16	STREET A	17-16	MH17	MH16		0.410		0.750	2.028	3.333	16.42	74	247	HDPE	0.506	525	84.05	0.40%	272.0	1.26	1.11	0.91	1.42	392	102.62	0.336	102.56	102.22
1.14	STREET A	16-15	MH16	MH15		0.390		0.750	2.000	5.333	16.62	73	392	HDPE	0.602	525	71.43	0.40%	272.0	1.26	0.95	1.44	1.26	525	102.01	0.286	101.77	101.49
0.37	Street D	40-14	MH40	MH14		0.370			0.514	0.514	16.42	74	38	HDPE	0.265	300	81.03	0.30%	53.0	0.75	1.80	0.72	0.81	188	100.78	0.243	100.83	100.59
0.08	STREET A	15-14	MH15	MH14		0.080			0.111	5.444	17.57	71	388	HDPE	0.575	600	84.55	0.50%	434.2	1.54	0.92	0.89	1.74	441	101.43	0.423	101.41	100.99
1.35	STREET A	14-13	MH14	MH13		0.540		0.810	2.325	8.283	18.49	69	573	HDPE	0.694	700	120.00	0.40%	585.8	1.52	1.31	0.98	1.73	561	100.97	0.480	100.89	100.41
1.56	STREET A	13-2	MH13	MH2		0.640		0.920	2.678	10.961	19.80	66	726	HDPE	0.742	750	120.51	0.45%	746.8	1.69	1.19	0.97	1.93	595	100.41	0.542	100.36	99.82
0.17	STREET B	2-1	MH2	MH1		0.170			0.236	25.156	24.59	58	1,464	HDPE	0.877	900	29.12	0.75%	1567.8	2.46	0.20	0.93	2.80	688	100.14	0.218	99.67	99.45
0.82		1-SWM	MH1	SWM					0.000	25.156	24.79	58	1,456	HDPE	0.875	900	20.00	0.75%	1567.8	2.46	0.14	0.93	2.80	685	99.97	0.150	99.43	99.28

*Note Phase 1 devlopment highlighted

PRE-DEVELOPMENT - 100 YR 6 HR SCS II (OUTLET 1A)

```
Autodesk® Storm and Sanitary Analysis 2016 - Version 13.0.94 (Build 0)
----------------------------------------------------------------------------------------

*******************
Project Description
*******************
File Name ................. Lansdowne Pre-development (Outlet 1A).SPF


****************
Analysis Options
****************
Flow Units ................ cms
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ....... Green-Ampt
Link Routing Method ....... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date ............. SEP-05-2022 00:00:00
Ending Date ............... SEP-08-2022 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 ....... 6
Number of nodes ........... 5
Number of links ........... 3
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Subbasin Summary
****************
Subbasin                 Total    Equiv.   Imperv.   Average    Raingage
                          Area     Width      Area     Slope
ID                    hectares         m         %         %
------------------------------------------------------------------------
EX11                      8.33    275.00      2.30    0.4000    -
EX12                      6.39    200.00      3.10    1.5000    -
EX13                      2.28    110.00      2.30    2.0000    -
EX5                       3.16     65.00     25.50    0.5000    -
EX6                       0.23    100.00     39.30    1.0000    -
EX7                       5.41    250.00      2.40    0.2000    -


************
Node Summary
************
Node                Element              Invert   Maximum    Ponded    External
ID                  Type              Elevation     Elev.      Area      Inflow
                                              m         m        m²
------------------------------------------------------------------------------
BOX_CULV_IN         JUNCTION              98.60    100.75     0.000
EX5_CHANNEL_IN      JUNCTION              99.75    101.00     0.000
OUTLET2_INLET       JUNCTION              98.55    100.00     0.000
OUTLET_1A           OUTFALL               98.40     98.65     0.000
OUTLET_2            OUTFALL               98.45     99.05     0.000
```

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
3-600_DIA_CULV	OUTLET2_INLET	OUTLET_2	CONDUIT	20.0	0.5000	0.0150
EX5_CHANNEL	EX5_CHANNEL_IN	BOX_CULV_IN	CHANNEL	150.2	0.7657	0.0320
Link-36	BOX_CULV_IN	OUTLET_1A	DIRECT	16.0	0.6250	0.0150

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m^2	Full Flow Hydraulic Radius m	Design Flow Capacity cms
3-600_DIA_CULV	CIRCULAR	0.60	0.60	3	0.28	0.15	0.38
EX5_CHANNEL	TRAPEZOIDAL	1.20	7.95	1	5.22	0.63	10.45
Link-36	DUMMY	0.00	0.00	1	0.00	0.00	0.00

****
Runoff Quantity Continuity
****

	Volume hectare-m	Depth mm
Total Precipitation	2.149	83.300
Evaporation Loss	0.000	0.000
Infiltration Loss	1.176	45.576
Surface Runoff	0.967	37.499
Final Surface Storage	0.007	0.254
Continuity Error (%)	-0.035	

****
Flow Routing Continuity
****

	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.967	9.675
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.968	9.677
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.002
Final Stored Volume	0.000	0.000
Continuity Error (%)	-0.007	

****
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 EX11
----------------

        Flow length (m):                          302.91
        Pervious Manning's Roughness:            0.27250
        Impervious Manning's Roughness:          0.02575
        Pervious Rainfall Intensity (mm/hr):    13.88333
        Impervious Rainfall Intensity (mm/hr):  13.88333
        Slope (%):                               0.40000
        Computed TOC (minutes):                   181.98

----------------
Subbasin EX12
----------------

        Flow length (m):                          319.50
        Pervious Manning's Roughness:            0.29200
        Impervious Manning's Roughness:          0.02550
        Pervious Rainfall Intensity (mm/hr):    13.88333
        Impervious Rainfall Intensity (mm/hr):  13.88333
        Slope (%):                               1.50000
        Computed TOC (minutes):                   131.39

----------------
Subbasin EX13
----------------

        Flow length (m):                          207.27
        Pervious Manning's Roughness:            0.27250
        Impervious Manning's Roughness:          0.02375
        Pervious Rainfall Intensity (mm/hr):    13.88333
        Impervious Rainfall Intensity (mm/hr):  13.88333
        Slope (%):                               2.00000
        Computed TOC (minutes):                    89.32

---------------
Subbasin EX5
---------------

        Flow length (m):                          486.15
        Pervious Manning's Roughness:            0.22250
        Impervious Manning's Roughness:          0.02275
        Pervious Rainfall Intensity (mm/hr):    13.88333
        Impervious Rainfall Intensity (mm/hr):  13.88333
        Slope (%):                               0.50000
        Computed TOC (minutes):                   170.21

---------------
Subbasin EX6
---------------

        Flow length (m):                           23.00
        Pervious Manning's Roughness:            0.21250
        Impervious Manning's Roughness:          0.02150
        Pervious Rainfall Intensity (mm/hr):    13.88333
```

Impervious Rainfall Intensity (mm/hr): 13.88333
Slope (%): 1.00000
Computed TOC (minutes): 18.67

Subbasin EX7

Flow length (m):	216.40
Pervious Manning's Roughness:	0.26500
Impervious Manning's Roughness:	0.02550
Pervious Rainfall Intensity (mm/hr):	13.88333
Impervious Rainfall Intensity (mm/hr):	13.88333
Slope (%):	0.20000
Computed TOC (minutes):	180.05

****
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
EX11	83.30	41.37	0.00	51.79	72.78	0.37	0.584	0 03:01:58
EX12	83.30	15.64	0.00	44.87	53.92	0.34	0.545	0 02:11:23
EX13	83.30	0.00	0.00	39.39	43.84	0.16	0.526	0 01:29:18
EX5	83.30	0.00	0.00	34.65	47.69	0.16	0.572	0 02:50:12
EX6	83.30	860.36	0.00	27.20	915.29	0.18	0.970	0 00:18:40
EX7	83.30	0.00	0.00	46.62	36.58	0.17	0.439	0 03:00:02

****
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
BOX_CULV_IN	0.01	0.01	98.61	0	04:01	0	0	0:00:00
EX5_CHANNEL_IN	0.04	0.23	99.98	0	04:01	0	0	0:00:00
OUTLET2_INLET	0.07	0.27	98.82	0	05:05	0	0	0:00:00
OUTLET_1A	0.00	0.00	98.40	0	00:00	0	0	0:00:00
OUTLET_2	0.06	0.23	98.68	0	05:05	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 hh:mm
BOX_CULV_IN	JUNCTION	0.175	0.315	0	04:02	0.00	
EX5_CHANNEL_IN	JUNCTION	0.161	0.161	0	03:59	0.00	
OUTLET2_INLET	JUNCTION	0.374	0.374	0	05:04	0.00	
OUTLET_1A	OUTFALL	0.000	0.315	0	04:02	0.00	
OUTLET_2	OUTFALL	0.000	0.374	0	05:05	0.00	

Outfall Loading Summary

Outfall Node ID	Flow Frequency (%)	Average Flow cms	Peak Inflow cms
OUTLET_1A	38.68	0.121	0.315
OUTLET_2	40.63	0.188	0.374
System	39.65	0.309	0.661

Link Flow Summary

Link ID	Element Type	Time of Peak Flow Occurrence days	Time of Peak Flow Occurrence 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
3-600_DIA_CULV	CONDUIT	0	05:05	1.13	1.00	0.374	1.129	0.33	0.41	0	Calculated
EX5_CHANNEL	CHANNEL	0	04:01	1.19	1.00	0.156	10.447	0.01	0.10	0	Calculated
Link-36	DIRECT	0	04:02			0.315					

Flow Classification Summary

Link	--- Fraction of Time in Flow Class ---- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change

```
---------------------------------------------------------------------------
3-600_DIA_CULV    0.03  0.00  0.00  0.94  0.02  0.00  0.00     0.35   0.0002
EX5_CHANNEL       0.01  0.00  0.00  0.75  0.25  0.00  0.00     0.35   0.0000


***************************
Time-Step Critical Elements
***************************
Link 3-600_DIA_CULV (31.00%)


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


*************************
Routing Time Step Summary
*************************
Minimum Time Step          :     6.04 sec
Average Time Step          :    22.93 sec
Maximum Time Step          :    30.00 sec
Percent in Steady State    :     0.00
Average Iterations per Step :     2.00


Analysis began on:  Wed Sep 28 10:40:08 2022
Analysis ended on:  Wed Sep 28 10:40:13 2022
Total elapsed time: 00:00:05
```

POST-DEVELOPMENT - 100 YR 6 HR SCS II (OUTLET 1A)

Autodesk® Storm and Sanitary Analysis 2016 - Version 13.0.94 (Build 0)

****
Project Description
****

File Name .... Lansdowne Post-development Phase 1.SPF

****
Analysis Options
****

Flow Units .... cms
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method .... Green-Ampt
Link Routing Method .... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date SEP-10-2022 00:00:00
Ending Date SEP-12-2022 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 5
Number of nodes 6
Number of links 5
Number of pollutants 0
Number of land uses 0

****
Subbasin Summary
****

Subbasin ID	Total Area hectares	Equiv. Width m	Imperv. Area %	Average Slope %	Raingage
P10	6.05	170.00	55.30	0.6000	-
P11	1.72	50.00	70.00	0.5000	-
P13	3.16	65.00	25.50	0.5000	-
P9	0.23	100.00	39.30	1.0000	-
SWM_IN	0.46	30.00	46.00	2.0000	-

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
BOX_CULV_IN	JUNCTION	98.60	101.50	0.000	
CHANNEL	JUNCTION	99.20	101.00	0.000	
EX5_CHANNEL_IN	JUNCTION	99.75	101.50	0.000	
SWM_OUT	JUNCTION	99.28	101.00	0.000	
OUTLET_1A	OUTFALL	98.40	99.75	0.000	
SWMF_IN	STORAGE	98.28	101.50	0.000	

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
BOX_CULV_OUT	BOX_CULV_IN	OUTLET_1A	CONDUIT	15.0	1.3333	0.0150
EX_CHANNEL	EX5_CHANNEL_IN	CHANNEL	CHANNEL	120.0	0.4583	0.0320
EX_CHANNEL_OUT	CHANNEL	BOX_CULV_IN	CHANNEL	45.0	1.3333	0.0320
SWM_OUT	SWM_OUT	CHANNEL	CONDUIT	10.0	0.8000	0.0150
RatingCurve	SWMF_IN	SWM_OUT	OUTLET			

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m^2	Full Flow Hydraulic Radius m	Design Flow Capacity cms
BOX_CULV_OUT	RECT_CLOSED	1.20	1.20	1	1.44	0.30	4.97
EX_CHANNEL	TRAPEZOIDAL	1.50	9.75	1	7.88	0.77	13.99
EX_CHANNEL_OUT	TRAPEZOIDAL	1.60	10.60	1	9.28	0.83	29.69
SWM_OUT	CIRCULAR	0.45	0.45	1	0.16	0.11	0.22

****
Runoff Quantity Continuity
****

	Volume hectare-m	Depth mm
Total Precipitation	0.968	83.300
Evaporation Loss	0.000	0.000
Infiltration Loss	0.246	21.132
Surface Runoff	0.706	60.744
Final Surface Storage	0.018	1.509
Continuity Error (%)	-0.102	

****
Flow Routing Continuity
****

	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.706	7.059
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.694	6.937
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.143	1.434
Final Stored Volume	0.156	1.558
Continuity Error (%)	-0.022	

```
***************************************************
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 P10
---------------

        Flow length (m):                          355.88
        Pervious Manning's Roughness:            0.19300
        Impervious Manning's Roughness:          0.01930
        Pervious Rainfall Intensity (mm/hr):    13.88333
        Impervious Rainfall Intensity (mm/hr):  13.88333
        Slope (%):                               0.60000
        Computed TOC (minutes):                   103.82

---------------
Subbasin P11
---------------

        Flow length (m):                          344.00
        Pervious Manning's Roughness:            0.17000
        Impervious Manning's Roughness:          0.01700
        Pervious Rainfall Intensity (mm/hr):    13.88333
        Impervious Rainfall Intensity (mm/hr):  13.88333
        Slope (%):                               0.50000
        Computed TOC (minutes):                    84.71

---------------
Subbasin P13
---------------

        Flow length (m):                          486.15
        Pervious Manning's Roughness:            0.22250
        Impervious Manning's Roughness:          0.02275
        Pervious Rainfall Intensity (mm/hr):    13.88333
        Impervious Rainfall Intensity (mm/hr):  13.88333
        Slope (%):                               0.50000
        Computed TOC (minutes):                   170.21

--------------
Subbasin P9
--------------

        Flow length (m):                           23.00
        Pervious Manning's Roughness:            0.21250
        Impervious Manning's Roughness:          0.02150
        Pervious Rainfall Intensity (mm/hr):    13.88333
        Impervious Rainfall Intensity (mm/hr):  13.88333
        Slope (%):                               1.00000
        Computed TOC (minutes):                    18.67

------------------
Subbasin SWM_IN
------------------
```

Flow length (m): 153.33
Pervious Manning's Roughness: 0.18850
Impervious Manning's Roughness: 0.02400
Pervious Rainfall Intensity (mm/hr): 13.88333
Impervious Rainfall Intensity (mm/hr): 13.88333
Slope (%): 2.00000
Computed TOC (minutes): 42.11

****
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
P10	83.30	20.29	0.00	16.97	85.05	0.96	0.821	0 01:43:48
P11	83.30	0.00	0.00	10.04	71.36	0.26	0.857	0 01:24:42
P13	83.30	0.00	0.00	34.65	47.69	0.16	0.572	0 02:50:12
P9	83.30	0.00	0.00	19.09	62.98	0.04	0.756	0 00:18:40
SWM_IN	83.30	1118.54	0.00	25.58	1175.35	0.96	0.978	0 00:42:06

****
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
BOX_CULV_IN	0.26	0.44	99.04	0	04:29	0	0	0:00:00
CHANNEL	0.08	0.20	99.40	0	04:27	0	0	0:00:00
EX5_CHANNEL_IN	0.04	0.25	100.00	0	04:01	0	0	0:00:00
SWM_OUT	0.17	0.42	99.70	0	00:00	0	0	0:00:00
OUTLET_1A	0.00	0.00	98.40	0	00:00	0	0	0:00:00
SWMF_IN	1.72	2.28	100.56	0	06:00	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow	Peak Inflow	Time of Peak Inflow Occurrence	Maximum Flooding Overflow	Time of Peak Flooding Occurrence

		cms	cms	days	hh:mm	cms	days	hh:mm
BOX_CULV_IN	JUNCTION	0.040	0.320	0	04:27	0.00		
CHANNEL	JUNCTION	0.000	0.315	0	04:25	0.00		
EX5_CHANNEL_IN	JUNCTION	0.161	0.161	0	03:59	0.00		
SWM_OUT	JUNCTION	0.000	0.185	0	06:00	0.00		
OUTLET_1A	OUTFALL	0.000	0.317	0	04:29	0.00		
SWMF_IN	STORAGE	0.957	0.957	0	04:05	0.00		

****
Storage Node Summary
****

Storage Node ID	Maximum Ponded Volume 1000 m^3	Maximum Ponded Volume (%)	Time of Max Ponded Volume days hh:mm	Average Ponded Volume 1000 m^3	Average Ponded Volume (%)	Maximum Storage Node Outflow cms	Maximum Exfiltration Rate cmm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 m^3
SWMF_IN	4.858	54	0 06:00	3.188	36	0.19	0.00	0:00:00	0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cms	Peak Inflow cms
OUTLET_1A	99.96	0.086	0.317
System	99.96	0.086	0.317

****
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
BOX_CULV_OUT	CONDUIT	0 04:29	1.22	1.00	0.317	4.969	0.06	0.18	0	Calculated

EX_CHANNEL	CHANNEL	0	04:01	0.58	1.00	0.158	13.990	0.01	0.13	0	Calculated
EX_CHANNEL_OUT	CHANNEL	0	04:27	0.90	1.00	0.309	29.688	0.01	0.20	0	Calculated
SWM_OUT	CONDUIT	0	06:00	1.95	1.00	0.185	0.221	0.84	0.59	0	Calculated
RatingCurve	OUTLET	0	06:00			0.185					

****
Flow Classification Summary
****

	--- Fraction of Time in Flow Class ----							Avg.	Avg.
		Up	Down	Sub	Sup	Up	Down	Froude	Flow
Link	Dry	Dry	Dry	Crit	Crit	Crit	Crit	Number	Change
BOX_CULV_OUT	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.80	0.0000
EX_CHANNEL	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.12	0.0000
EX_CHANNEL_OUT	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.19	0.0000
SWM_OUT	0.00	0.01	0.00	0.02	0.97	0.00	0.00	1.53	0.0001

****
Time-Step Critical Elements
****
Link SWM_OUT (89.44%)

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

****
Routing Time Step Summary
****
Minimum Time Step : 2.19 sec
Average Time Step : 6.23 sec
Maximum Time Step : 30.00 sec
Percent in Steady State : 0.00
Average Iterations per Step : 2.02

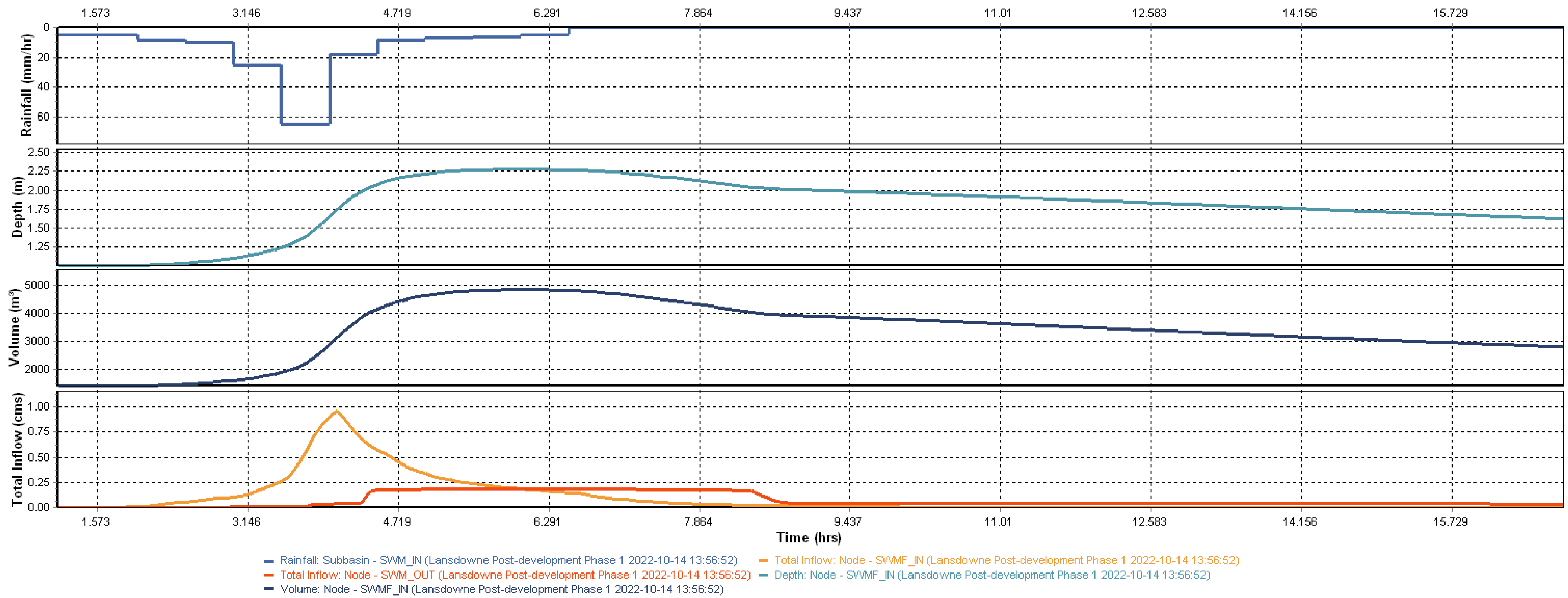
Analysis began on: Fri Oct 14 13:56:47 2022
Analysis ended on: Fri Oct 14 13:56:51 2022
Total elapsed time: 00:00:04

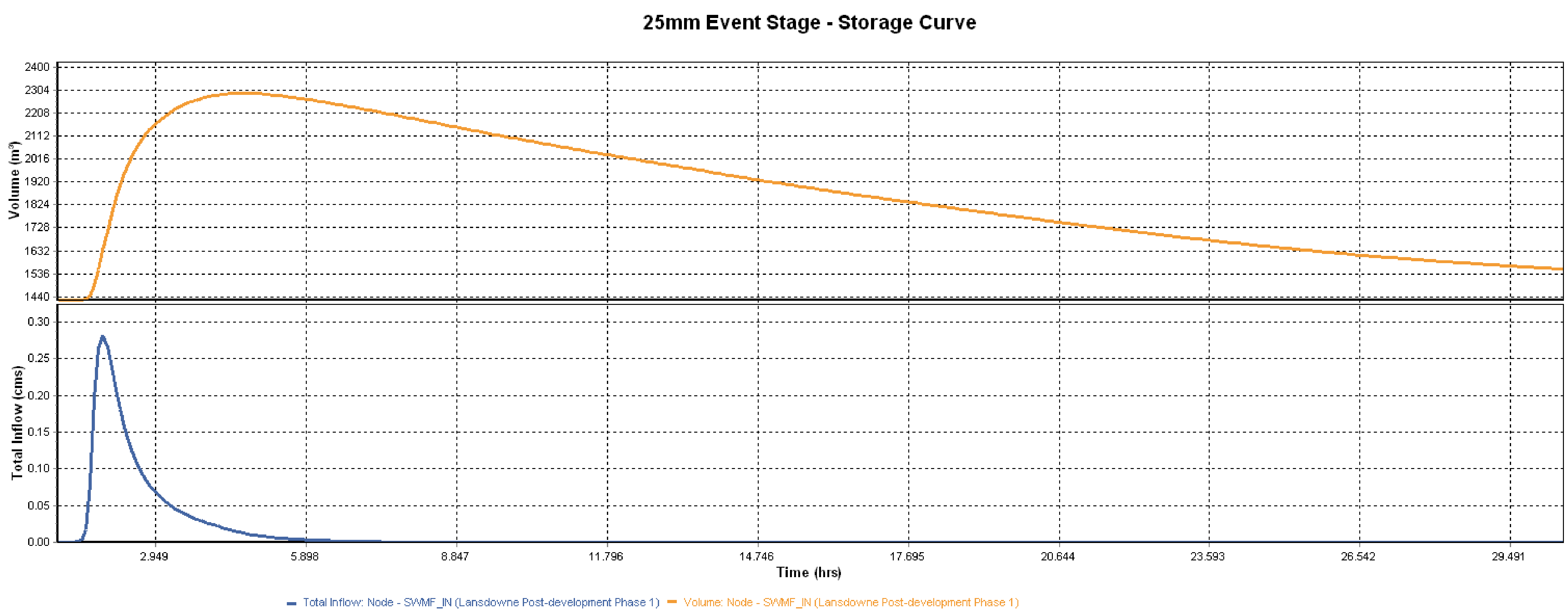
Lansdowne Interim Phase 1 SWM Facility
Stage - Storage Discharge Outlet Calculations

Orifice Equation	$0.6*A*(2gh)^{1/2}$
NWL	99.28
Drawdown Size	0.100 m
Orifice (1) Plate Invert (DI1)	99.28
Orifice (1) Plate Size	0.15 m
Orifice (1) Centreline	99.36
Orifice (2) Plate Invert (DI2)	99.28
Orifice (2) Plate Size	0.29 m
Orifice (2) Centreline	99.43

Depth (m)	Water Surface Elevation (m)	Inc. Depth (m)	Surface Area (m^2)	Inc. Volume (m^3)	Total Volume (m^3)	Quantity Volume (m^3)	Drawdown Release Rate (m^3/s)	Orifice 1 Release Rate (m^3/s)	Orifice 2 Release Rate (m^3/s)	Total Release Rate (m^3/s)	Notes
0.00	98.28	0.030	871		0					0.000	
0.03	98.31	0.030	880	26	26					0.000	
0.06	98.34	0.030	890	27	53					0.000	
0.09	98.37	0.030	920	27	80					0.000	
0.12	98.40	0.030	968	28	108					0.000	
0.15	98.43	0.030	993	29	138					0.000	
0.18	98.46	0.030	1,017	30	168					0.000	
0.21	98.49	0.030	1,051	31	199					0.000	
0.24	98.52	0.030	1,078	32	231					0.000	
0.27	98.55	0.030	1,105	33	264					0.000	
0.30	98.58	0.030	1,132	34	297					0.000	
0.33	98.61	0.030	1,159	34	331					0.000	
0.36	98.64	0.030	1,186	35	367					0.000	
0.39	98.67	0.030	1,213	36	403					0.000	
0.42	98.70	0.030	1,240	37	439					0.000	
0.45	98.73	0.030	1,267	38	477					0.000	
0.48	98.76	0.030	1,294	38	515					0.000	
0.51	98.79	0.030	1,321	39	555					0.000	
0.54	98.82	0.030	1,348	40	595					0.000	
0.57	98.85	0.030	1,375	41	636					0.000	
0.60	98.88	0.030	1,402	42	677					0.000	
0.63	98.91	0.030	1,429	42	720					0.000	
0.66	98.94	0.030	1,456	43	763					0.000	
0.69	98.97	0.030	1,483	44	807					0.000	
0.72	99.00	0.030	1,510	45	852					0.000	
0.75	99.03	0.030	1,537	46	898					0.000	
0.78	99.06	0.030	1,564	47	944					0.000	
0.81	99.09	0.030	1,591	47	991					0.000	
0.84	99.12	0.030	1,618	48	1,040					0.000	
0.87	99.15	0.030	1,645	49	1,089					0.000	
0.90	99.18	0.030	1,672	50	1,138					0.000	
0.93	99.21	0.030	1,699	51	1,189					0.000	
0.96	99.24	0.030	1,726	51	1,240					0.000	
1.00	99.28	0.040	1,762	70	1,310	0				0.000	NWL
1.03	99.31	0.030	1,789	53	1,363	53	0.002			0.002	
1.06	99.34	0.030	1,816	54	1,417	107	0.003			0.003	
1.09	99.37	0.030	1,843	55	1,472	162	0.004			0.004	
1.12	99.40	0.030	1,981	57	1,530	220	0.006			0.006	
1.15	99.43	0.030	2,036	60	1,590	280	0.007			0.007	
1.18	99.46	0.030	2,091	62	1,652	342	0.008			0.008	
1.21	99.49	0.030	2,049	62	1,714	404	0.008			0.008	
1.24	99.52	0.030	2,077	62	1,776	466	0.009			0.009	
1.27	99.55	0.030	2,105	63	1,838	528	0.010			0.010	
1.30	99.58	0.030	2,134	64	1,902	592	0.010			0.010	
1.33	99.61	0.030	2,162	64	1,966	656	0.011			0.011	
1.36	99.64	0.030	2,190	65	2,032	722	0.012			0.012	
1.39	99.67	0.030	2,219	66	2,098	788	0.012			0.012	
1.42	99.70	0.030	2,475	70	2,168	858	0.013			0.013	
1.45	99.73	0.030	2,560	76	2,244	934	0.013			0.013	
1.48	99.76	0.030	2,646	78	2,322	1,012	0.014			0.014	Extended
1.51	99.79	0.030	2,610	79	2,401	1,091		0.031		0.031	
1.54	99.82	0.030	2,662	79	2,480	1,170		0.032		0.032	
1.57	99.85	0.030	2,714	81	2,560	1,250		0.033		0.033	
1.60	99.88	0.030	2,767	82	2,643	1,333		0.034		0.034	
1.63	99.91	0.030	2,819	84	2,726	1,416		0.035		0.035	2yr
1.66	99.94	0.030	2,871	85	2,812	1,502		0.036		0.036	
1.69	99.97	0.030	2,924	87	2,899	1,589		0.037		0.037	
1.72	100.00	0.030	2,976	88	2,987	1,677		0.038		0.038	
1.75	100.03	0.030	3,028	90	3,077	1,767		0.039		0.039	
1.78	100.06	0.030	3,080	92	3,169	1,859		0.039		0.039	
1.81	100.09	0.030	3,133	93	3,262	1,952		0.040		0.040	
1.84	100.12	0.030	3,185	95	3,357	2,047		0.041		0.041	
1.87	100.15	0.030	3,237	96	3,453	2,143		0.042		0.042	5yr
1.90	100.18	0.030	3,290	98	3,551	2,241			0.153	0.153	
1.93	100.21	0.030	3,342	99	3,651	2,341			0.156	0.156	
1.96	100.24	0.030	3,394	101	3,752	2,442			0.158	0.158	
1.99	100.27	0.030	3,447	103	3,854	2,544			0.161	0.161	
2.02	100.30	0.030	3,499	104	3,958	2,648			0.164	0.164	
2.05	100.33	0.030	3,551	106	4,064	2,754			0.167	0.167	
2.08	100.36	0.030	3,603	107	4,171	2,861			0.170	0.170	
2.11	100.39	0.030	3,656	109	4,280	2,970			0.172	0.172	
2.14	100.42	0.030	3,708	110	4,391	3,081			0.175	0.175	
2.17	100.45	0.030	3,760	112	4,503	3,193			0.178	0.178	
2.20	100.48	0.030	3,813	114	4,616	3,306			0.180	0.180	
2.23	100.51	0.030	3,865	115	4,732	3,422			0.183	0.183	
2.26	100.54	0.030	3,917	117	4,848	3,538			0.185	0.185	100yr
2.29	100.57	0.030	3,969	118	4,967	3,657			0.188	0.188	
2.32	100.60	0.030	4,022	120	5,086	3,776			0.190	0.190	
2.35	100.63	0.030	4,074	121	5,208	3,898			0.193	0.193	
2.38	100.66	0.030	4,126	123	5,331	4,021			0.195	0.195	
2.41	100.69	0.030	4,179	125	5,455	4,145			0.197	0.197	
2.44	100.72	0.030	4,231	126	5,582	4,272			0.200	0.200	
2.47	100.75	0.030	4,283	128	5,709	4,399			0.202	0.202	

100 Year Event - 6 Hour SCS II - Stage Storage Curve





25mm Event Stage - Storage Curve
Volume (m³)
2400
2304
2208
2112
2016
1920
1824
1728
1632
1536
1440
Total Inflow (cms)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
2.949
5.898
8.847
11.796
14.746
17.695
20.644
23.593
26.542
29.491
Time (hrs)
Total Inflow: Node - SWMF_IN (Lansdowne Post-development Phase 1)
Volume: Node - SWMF_IN (Lansdowne Post-development Phase 1)

Drawdown Time- Falling Head Orifice Equation	
Bottom Of Pond Elevation (m):	98.28
NWL (m)	99.28
Extended Detention (m)	99.76
Extended Detention Volume (m^3)	907
Average 24hr Release Rate (Lps)	10
Estimated Orifice Diameter (mm)	134
Proposed Orifice Diameter (mm)	100
Proposed Orifice Area (mm^2)	7850
Orifice Invert (m)	99.28
Surface area at NWL (m^2)	1762
Discharge Coefficient (0.63 typical)	0.63
Starting height above orifice (m)	0.38
Ending Water height above orifice (m)	0
Drawdown Time (s)	99218
Drawdown Time (hr)	27.56
Velocity (m/s)	1.83
Qpeak (lps)	14.36
Drawdown Volume (l)	1424498
Qpeak Considering Headloss (lps)	14.00
Drawdown Time (s)	101750
Drawdown Time Considering Headloss (hr)	28.26

$$t = \frac{2\,A_p}{C\,A_o(2g)^{0.5}}\left(h_1^{0.5} - h_2^{0.5}\right)$$ **Equation 4.10: Drawdown Time**

or if a relationship between A_p and h is known (i.e., $A = C_2h + C_3$)

$$t = \frac{0.66\,C_2h^{1.5} + 2\,C_3h^{0.5}}{2.75\,A_o}$$ **Equation 4.11**

where
- t = drawdown time in seconds
- A_p = surface area of the pond (m^2)
- C = discharge coefficient (typically 0.63)
- A_o = cross-sectional area of the orifice (m^2)
- g = gravitational acceleration constant (9.81 m/s^2)
- h_1 = starting water elevation above the orifice (m)
- h_2 = ending water elevation above the orifice (m)
- h = maximum water elevation above the orifice (m)
- C_2 = slope coefficient from the area-depth linear regression
- C_3 = intercept from the area-depth linear regression

Minimum Orifice Size

The smallest diameter orifice accepted by most municipalities to ensure that clogging does not occur in a stormwater system is 75 mm. The preferred minimum orifice size is 100 mm where the effects of freezing are a concern. It is recommended that this latter size be maintained for exposed outlet designs (i.e., reverse sloped pipes). In instances where a perforated riser outlet is designed, the orifice is protected by the smaller perforations in the riser and a minimum orifice size of 50 mm is acceptable. Where small orifices are required, consideration should be given to providing an overflow outlet which would operate in the event that blockage of the primary orifice occurs.

Forebay Sizing - Phase 1 SWMF

Project:	Lansdowne (Interim Phase 1 SWMF)	Date:	Sept 2022	
		Des:	JH	Chk:

		Forebay 1.1	1.1 Check
Calculated Quality Storm Forebay Inflow (m^3/s)=	Q_{i25mm}	0.280	
Peak Flow From Pond During Quality Storm (m^3/s)=	Q_{o25mm}	0.014	
Forebay Side Slope=	H:V	5:1	
Forebay Top End Width (m)=	W	18	
Forebay Minimum Bottom Width (m)=	W_b	9	
Forebay Top Length (m)=	Dist	40	
Forebay Depth (m)=	d	1.4	
Forebay Volume (m^3)=		578	
1) Settling Calculations			
Min. Forebay Settling Length Check (m)=	MOE Eq. 4.5	10.2	OK
2) Dispersion Length			
Minimum Dispersion Length Check (m)=	MOE Eq. 4.6	10.7	OK
Length to Width Ratio=	Must be >2:1	2.2	OK
Minimum Forebay Deep Zone Bottom Width (m)=	MOE Eq. 4.7	5	OK
3) Clearout Frequency			
% Impervious=		55	
Annual Sediment Load per ha (m^3)=		1.9	
% Captured =		70	
Contributing Area (ha)=		7.53	
Suggested Cleanout Frequency (yrs)=		25	
Calculated Cleanout Frequency (yrs)=		29	OK

Culvert Report

1200 x 1200 Box Culvert HWL - 0.31cms - 100 Year Storm Event

Invert Elev Dn (m)	=	98.4000
Pipe Length (m)	=	20.0000
Slope (%)	=	1.0000
Invert Elev Up (m)	=	98.6000
Rise (mm)	=	1200.0
Shape	=	Box
Span (mm)	=	1200.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Rectagular Concrete
Culvert Entrance	=	Side tapered, less favorable edges
Coeff. K,M,c,Y,k	=	0.56, 0.667, 0.0446, 0.85, 0.5

Embankment

Top Elevation (m)	=	100.8000
Top Width (m)	=	10.0000
Crest Width (m)	=	5.0000

Calculations

Qmin (cms)	=	0.1000
Qmax (cms)	=	0.3500
Tailwater Elev (m)	=	(dc+D)/2

Highlighted

Qtotal (cms)	=	0.3100
Qpipe (cms)	=	0.3100
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	0.3718
Veloc Up (m/s)	=	0.5218
HGL Dn (m)	=	99.0948
HGL Up (m)	=	99.0951
Hw Elev (m)	=	99.1160
Hw/D (m)	=	0.4300
Flow Regime	=	Outlet Control