

STORMWATER MANAGEMENT REPORT

233 DUNLOP STREET WEST
CITY OF BARRIE, COUNTY OF SIMCOE



PEARSON
ENGINEERING LTD.

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12081.01



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STORMWATER MANAGEMENT REPORT

233 DUNLOP STREET WEST - BARRIE

1. INTRODUCTION

PEARSON Engineering Ltd. has been retained by MDM Developments (Client) to prepare a Stormwater Management (SWM) Report in support of the proposed 8-storey residential building with ground floor commercial space located at 233, 237, 241, and 245 Dunlop Street West in the City of Barrie (City), County of Simcoe (County).

The subject property is approximately 0.72 ha in size and currently contains one residential lot and three vacant lots. The existing site drains to the south sloping towards Bunkers Creek at the rear of the property. It is proposed to construct a mixed-use residential and commercial building with an adjacent asphalt parking area. The location of the site can be seen on Figure 1.

1.1. TERMS OF REFERENCE

The intent of this SWM Report is to:

- Identify the existing site characteristics including any external drainage conditions;
- Illustrate the design of the stormwater conveyance and detention system, capable of accommodating both minor and major storm flows from the site;
- Incorporate the appropriate Best Management Practices for controlling on-site erosion and sedimentation during construction while ultimately ensuring that the post-development release of stormwater is of adequate quality; and
- Summarize this design in a technically comprehensive and concise manner.

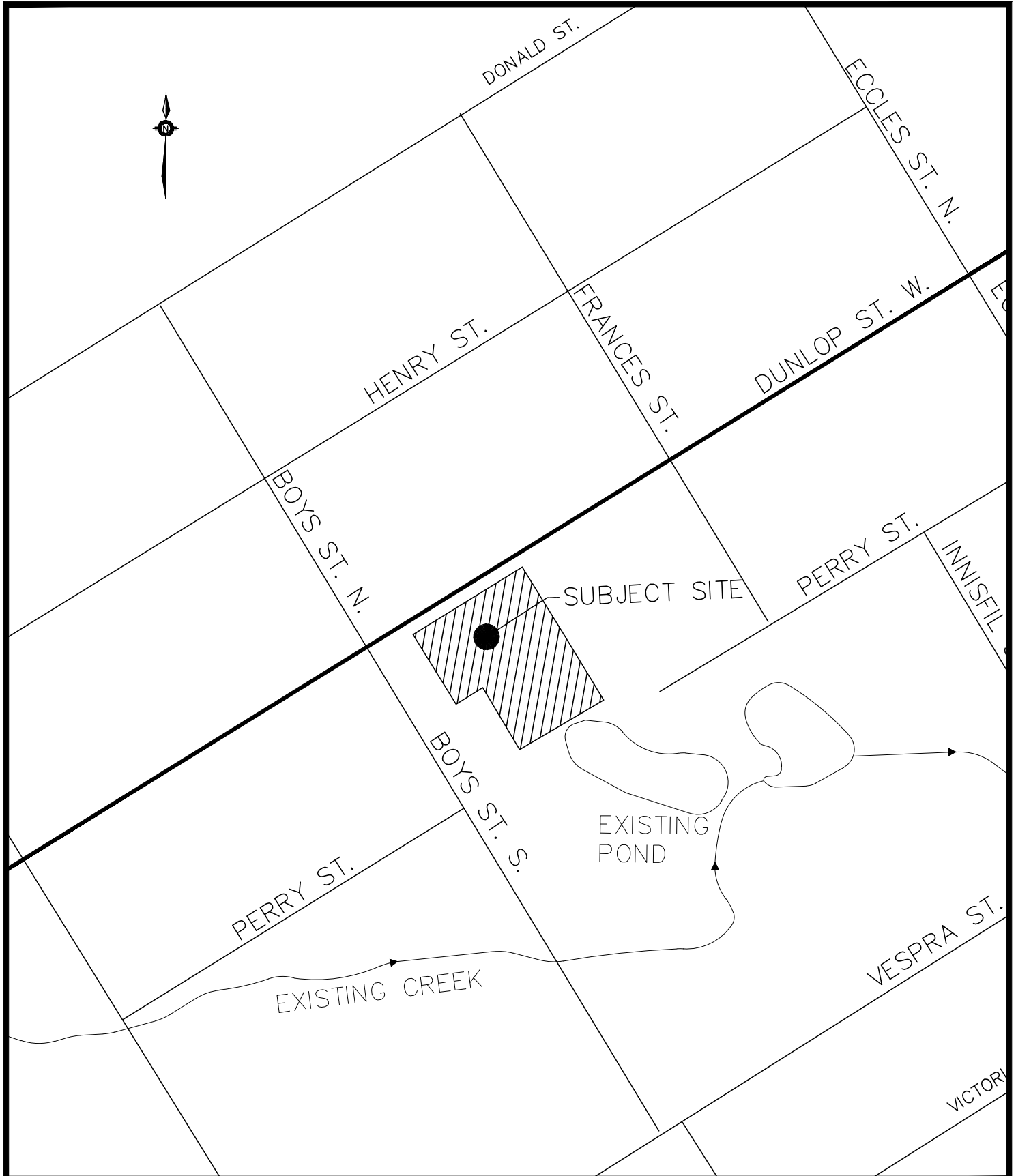
2. STORMWATER MANAGEMENT

A key component of the development is the need to address environmental and related SWM issues. These are examined in a framework aimed at meeting the City, Lake Simcoe Region Conservation Authority (LSRCA) and the Ministry of the Environment, Conservation, and Parks (MECP) requirements. SWM parameters have evolved from an understanding of the location and sensitivity of the site's natural systems. This report focuses on the necessary measures to satisfy the MECP's SWM requirements.

It is understood the objectives of the SWM plan are to:

- Protect life and property from flooding and erosion.
- Maintain water quality for ecological integrity, recreational opportunities etc.
- Protect and maintain groundwater flow regime(s).
- Protect aquatic and fishery communities and habitats.
- Maintain and protect significant natural features.
- Incorporate Low Impact Development (LID) practices to promote infiltration and reduce phosphorus levels to downstream watercourses.

P:\Autodesk Vault\Working Folders\12081.01 - Gray - 233 Dunlop St., Barrie\Engineering\12081.01 - BASE.dwg Layout:FIG-1 Plotted Nov 21, 2018 @ 10:34am by MPinkney @ PEARSON ENGINEERING LTD.



233 DUNLOP STREET WEST
BARRIE, ONTARIO

LOCATION PLAN



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DESIGNED BY	MWD	HORIZ SCALE	1:750	PROJECT #	12081.01
DRAWN BY	MJWP	VERT SCALE		DRAWING #	FIG-1
CHECKED BY	MWD	DATE	NOV 2018	REVISION #	0



2.1. ANALYSIS METHODOLOGY

The design of the SWM Facilities for this site has been conducted in accordance with:

- The Ministry of the Environment Stormwater Management Planning and Design Manual, March 2003
- City of Barrie, Storm Drainage and Stormwater Management Policies and Design Guidelines, December 2017
- Lake Simcoe Region Conservation Authority Technical Guidelines for Stormwater Management Submissions, September 2016
- Toronto and Region Conservation Authority Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, 2010

In order to design the facilities to meet these requirements, it is essential to select the appropriate modeling methodology for the storm system design. Given the size of the site, the Modified Rational Method is appropriate for the design for the SWM system.

2.2. EXISTING DRAINAGE CONDITIONS

The existing Project site currently consists of vacant and residential lots. The majority of the site's stormwater flows from north to south overland at approximately 1% to 2%. The rear of the property slopes down to the existing creek corridor at approximately 30% to 50%. The flows that are conveyed overland to Bunkers Creek will ultimately outlet to Kempenfelt Bay. Details of existing storm drainage conditions are shown on Drawing STM-1 in Appendix G.

According to Peto MacCallum Limited's Geotechnical Investigation, dated November 2019, the project site is comprised of gravelly and silty fill with an underlying layer of sand with traces to some silt and gravel. Piezometers were installed in nine borehole locations which determined that the groundwater levels vary from 3.8 m to 4.5 m (average of 4.2 m) below existing ground. This soil is characterized as having good drainage. In-situ infiltration rates are to be confirmed by a geotechnical engineer prior to construction. Refer to Appendix F for the geotechnical report.

Given the size of the site, the Modified Rational Method will be used to determine the pre-development peak flows. IDF curve parameters were taken from the City of Barrie Stormwater Management Guidelines to determine the storm intensity values. The pre-development peak flows for the site can be seen in Table 1 below. Detailed calculations can be found in Appendix A.

Table 1: Pre-Development Peak Flows

	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
Total Flow (m ³ /s)	0.02	0.03	0.03	0.04	0.05	0.06



2.3. PROPOSED DRAINAGE CONDITIONS

The post-development storm drainage for the project will generally follow pre-development conditions. The proposed drainage from the rooftop area will be conveyed through a 300 mm diameter storm sewer to Stormtech SC-310 underground storage chambers in the parking lot area south of the proposed building designed to infiltrate the roof runoff. The majority of the parking lot has been graded to direct stormwater towards two proposed permeable paver areas in the south portion of the parking lot. Stormtech SC-740 underground storage chambers will be provided for quantity control and will be designed as an off-line system. Stormwater will flow through an OGS treatment unit before draining to the south through an outlet structure with a headwall, ultimately draining to Bunkers Creek. A small portion north of the proposed building will drain uncontrolled to Dunlop Street West and the environmentally protected land to the south of the proposed development will continue to drain southerly to Bunkers Creek.

The proposed storm sewer was sized for the 5-year storm event using the rational method. In the event of a storm greater than the 5-year event, the storm sewer will surcharge, forcing stormwater to the surface. A 1.0 m wide major storm control weir is located in the southwest corner of the parking lot which will convey storms greater than the 25-year storm southerly via overland flow. In the event of a storm greater than the 100-year storm or if the orifice tube becomes blocked, the site has been graded to allow stormwater to be conveyed southerly towards Bunker's Creek without negatively impacting the proposed building. The proposed post-development storm drainage patterns can be found on Drawing STM-2 in Appendix G.

2.4. STORMWATER QUANTITY CONTROL

The proposed development will increase the imperviousness of the site and as such the post-development peak flows will increase. It is important to quantify the increase in stormwater runoff rates and attenuate these increases. The calculated post-development runoff coefficient of 0.73 is greater than the pre-development runoff coefficient of 0.16.

Considerations were taken to reduce post-development peak flows to pre-development values. Given the size of the site, the Modified Rational Method will be used to determine the SWM release rates. A 75 mm diameter orifice tube is proposed upstream of the OGS unit, causing stormwater to back up into the subsurface storage units. Calculations in Appendix A demonstrate that 163 m³ is required to control the 100-year storm event to pre-development values. Underground storage chambers containing a total of 135 m³ are proposed, with the remaining 31 m³ through above grade parking lot storage located around CB1 and CB2 for a total quantity storage of 166 m³.

Table 2 below summarizes post-development peak flows, and by comparing with Table 1 it can be seen that the post-development flows for all storm events are smaller than or equal to the pre-development peak flows.

Table 2: Post-Development Peak Flows

	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
Controlled Area (m ³ /s)	0.01	0.02	0.02	0.02	0.03	0.04
Uncontrolled Area (m ³ /s)	0.01	0.01	0.01	0.01	0.01	0.02
Total Flow (m³/s)	0.02	0.03	0.03	0.03	0.05	0.06



2.5. VOLUME CONTROL

Since the project site meets the definition of Major Development as per LSRCA Guidelines, considerations were taken to meet the volume control criteria detailed in section 2.2.2. The LSRCA guidelines state that for a new development that creates 0.50 ha or more of impervious surfaces, 25 mm of runoff over the total impervious area of the site is to be retained and treated on site, with flexible alternatives if this criterion cannot be met. The 25 mm storm event over the site's impervious area is a total volume of 100.1 m³.

As the site is located within a highly vulnerable aquifer, infiltration of road runoff is prohibited as road salts used in the winter will negatively impact groundwater quality and therefore only the rooftop runoff will be infiltrated. This storage is provided within 31.0 m³ of StormTech SC-310 underground infiltration tanks treating runoff from the rooftop and 87.3 m³ of filtration storage located within the proposed permeable pavers to treat the concrete and asphalt surfaces, resulting in a total of 118.3 m³ of storage. Therefore, the proposed design meets the LSRCA guidelines. Refer to Appendix A for quantity control calculations and Appendix C for the volume control calculations. The StormTech system information can be found in Appendix D.

2.6. STREAM EROSION CONTROL

As the site is located near an existing watercourse, considerations were taken to protect against stream erosion. As per LSRCA Guidelines, erosion control is typically completed for sites located upstream of a known erosion site, if the site drains to a first or second order headwater stream, or as part of Master Drainage Plan for a Secondary Planning Area.

However, as the site is less than 2.00 ha, no additional erosion control is proposed.

2.7. STORMWATER QUALITY CONTROL

The Ministry of the Environment, Conservation, and Parks (MECP) in March 2003 issued a "Stormwater Management Planning and Design Manual". This manual has been adopted by a variety of agencies including the City of Barrie. The development's Stormwater Quality Control objective is to provide Enhanced Protection quality control as stated in the MECP manual. To achieve enhanced protection, permanent and temporary control of erosion and sediment transport are proposed using a treatment train approach and are discussed in the following sections.

2.7.1. PERMANENT QUALITY CONTROL

The development's active parking facilities pose a risk to stormwater quality through the collection of grit, salt, sand and oils on the paved surfaces. Stormwater from the parking lot area will be receive pretreatment from the proposed permeable pavers by filtering through and draining into a perforated pipe located within the pavers. Stormwater flows from the landscaped areas west of the proposed building and parking lot will flow via grassed swales to the south towards Bunkers Creek. As the site is located within a highly vulnerable aquifer, infiltration of road runoff is prohibited as road salts used in the winter will negatively impact groundwater quality. As such, the permeable paver areas around CB1 and CB2 have been designed with an impermeable liner, and the permeable pavers located along the eastern edge of the property have been graded to ensure no parking lot drainage is conveyed towards them. The design of the drive aisle and parking area has been graded in such a manner to minimize potential salt concentrations.



The catchbasins include sumps which will settle larger sediment particles. Heavy metals have an affinity to adsorb to sediment particles in runoff and the OGS unit is proposed to remove accumulated sediment from the stormwater. Stormwater will be conveyed by the storm sewer system and will flow through an oil/grit separator (OGS) unit prior to draining to Bunkers Creek. A CDS PMSU20_15_4 treatment unit is the proposed OGS which will treat the post-development flows with a TSS removal rate of approximately 82.6%. The OGS is sized to treat the controlled area of 0.41 ha with a runoff coefficient of 0.90.

The MECP standard stipulates a Total Suspended Solids (TSS) removal of at least 80% for the enhanced protection level according to Table 3.2 in the MECP SWM Planning & Design Manual. The LSRCA guidelines state that an OGS unit can only provide a maximum of 50% TSS removal, leaving the remaining 30% to be treated using LID features as the rooftop will receive 80% TSS removal with the proposed infiltration chambers, and all remaining impervious surfaces will drain to permeable pavers, underground storage, and OGS unit in series, the quality control objective for the project has been met. Refer to calculations in Appendix A for more details.

Regular inspections and proper maintenance of the proposed OGS unit will ensure the TSS removal rate will be achieved as well as protect the downstream watercourse from oil, grease, and heavy metals. Detailed information regarding the OGS unit can be seen in Appendix E.

2.7.2. QUALITY CONTROL DURING CONSTRUCTION

During construction, earth grading and excavation will create the potential for soil erosion and sedimentation. It is imperative that effective environmental and sedimentation controls are in place and maintained throughout the duration of construction activities to ensure the stormwater runoff's quality.

Therefore, the following recommendations shall be implemented and maintained during construction to achieve acceptable stormwater runoff quality:

- Installation of silt fence along the entire perimeter of the site to reduce sediment migration onto surrounding properties;
- Installation of a construction entrance mat to minimize transportation of sediment onto roadways;
- Restoration of exposed surfaces with vegetative and non-vegetative material as soon as construction schedules permit. The duration in which surfaces are disturbed/exposed shall not exceed 30 days;
- Reduce stormwater drainage velocities where possible; and
- Minimize the amount of existing vegetation removed.

The Environmental Protection and Removals Plan has been included in Appendix G.

3. WATER BALANCE

Since the post-development state will increase the imperviousness of the site, considerations were taken in regard to groundwater recharge. A water budget was completed as per LSRCA guidelines. Under pre-development conditions, the project site had an annual recharge volume of 850 m³. With the increased imperviousness of the site, this recharge will be reduced to 232 m³, resulting in a deficit volume of 618 m³.

In order to infiltrate an additional 618 m³ annually, a yearly rainfall depth of 538.5 mm from the rooftop is required to be infiltrated resulting in a storage volume of 9 m³. This percentage of annual rainfall occurs for rain events of 7 mm or less. However, it is proposed to provide retention for the first 5 mm of rainfall over the site area as per City of Barrie Guidelines resulting in a required storage volume of 31 m³.



StormTech underground infiltration chambers are proposed to be utilized to meet the volume requirement by providing a storage volume of 31 m³. The StormTech chambers are designed with a flat bottom in order to ensure equal infiltration throughout the chambers as per TRCA guidelines. The MECP recommends a minimum separation of 1.0 m from the bottom of the infiltration feature to the water table. The water table is 3.8 m to 4.5 m (average of 4.2 m) below ground as per the Geotechnical Investigation and therefore this criteria has been met.

No pre-treatment is being proposed based on the stormwater runoff being conveyed from the rooftop of the proposed building and rooftop runoff is considered generally clean. When the chambers back up due to the facility being at capacity, it will discharge through the overflow manhole and/or overflow pipe and be conveyed to the storm sewer system.

The geotextile is to be a non-woven needle punched, or woven monofilament geotextile fabric and is to be installed around the stone reservoir infiltration chambers with a minimum overlap at the top of 300 mm meeting TRCA guidelines.

As previously mentioned in Section 2.2, in-situ testing will be completed prior to construction to confirm infiltration rates. The soil infiltration rates are to be used in drawdown calculations for the sizing of the infiltration facilities. As per the geotechnical investigation, general soil types are expected to be conducive for infiltration and a conservative infiltration rate of 20 mm/hr was assumed for the preliminary design. A summary of water balance calculations can be seen in Table 4 below. Detailed water balance calculations have been provided in Appendix C.

Table 4: Water Balance Calculations Summary

Characteristic	Site		
	Pre-Development	Post-Development	Change (Pre to Post)
Inputs (Volumes)			
Precipitation (m ³ /yr)	4,780	4,780	0.0%
Run-On (m ³ /yr)	0	0	0.0%
Other Inputs (m ³ /yr)	0	0	0.0%
Total Inputs (m³/yr)	4,780	4,780	0.0%
Outputs (Volumes)			
Precipitation Surplus (m ³ /yr)	1,606	3,936	145.1%
Net Surplus (m ³ /yr)	1,606	3,936	145.1%
Evapotranspiration (m ³ /yr)	3,174	844	-73.4%
Infiltration (m ³ /yr)	850	232	-77.3%
Rooftop Infiltration (m ³ /yr)	0	0	0.0%
Total Infiltration (m ³ /yr)	850	232	0.0%
Runoff Pervious Areas (m ³ /yr)	567	154	-65.9%
Runoff Impervious Areas (m ³ /yr)	189	3,550	1,428.6%
Total Runoff (m ³ /yr)	756	3,705	308.2%
Total Outputs (m³/yr)	4,780	4,780	0.0%

Note: Tabulated values taken from calculation sheets in Appendix C.



4. PHOSPHORUS BUDGET

4.1. PHOSPHOROUS BUDGET TOOL

Local conservation authorities have determined the importance of reducing phosphorus levels in water courses in this area. The reduction was based on conservative values derived by the LSRCA using data contained within the MECP's Lake Simcoe Phosphorous Loading Development Tool. As such, best efforts are to be employed in order to reduce phosphorus levels to pre-development levels or better. The existing site generates approximately 0.16 kg of phosphorus annually and the proposed Project will generate approximately 0.54 kg of phosphorus annually if uncontrolled. Best efforts will be used in order to reduce the phosphorus loading as much as is reasonably possible.

To minimize the amount of phosphorus discharged from the site, a treatment train approach is to be utilized. Rooftop runoff will be conveyed to an underground infiltration system, which will infiltrate the equivalent of the first 25 mm over the total rooftop area. Stormwater from the parking areas will drain to two permeable paver areas acting as a filter for the storm runoff prior to entering the storm sewer system. The permeable pavers be wrapped in an impermeable liner and will contain a perforated pipe at the base of the clear stone layer, directing treated flows to the storm sewer. A catch basin within the permeable pavers includes a sump which will settle larger particles. Groundwater is an average of 4.2 m below existing grade, therefore the minimum 1.0 m separation between groundwater and the bottom of the permeable pavers will be maintained. However, permeable pavers are to be lined with an impermeable liner and therefore groundwater is not to negatively impact the pavers.

Stormwater will then flow through an OGS unit and outlet on the slope on the southern side of the site before entering Bunkers Creek. According to the LSRCA Standards, the typical phosphorus reduction is 45% for permeable pavers, 60% for underground infiltration chambers, and 25% for underground storage chambers. Refer to Section 3 for infiltration chamber requirements and criteria. The phosphorous catchment areas are shown on Figure 2.

Additionally, while LSRCA guidelines state that the OGS unit receives 0% phosphorous removal, it will assist in the capture of sediment and therefore inherently provide some reduction in phosphorous levels. The following Table 3 details the anticipated phosphorus loadings for the pre and post-development conditions.

Table 3: Phosphorus Loadings

	Total P (kg)
Pre-Development	0.16
Uncontrolled Post-Development	0.54
Controlled Post-Development	0.34

Detailed calculations can be found in Appendix B.

4.2. PHOSPHOROUS OFFSETTING POLICY

The LSRCA has implemented a Phosphorous Offsetting Policy in September 2017 which has a goal that all new development must reduce 100% of the phosphorous leaving the property. A fee of \$87,500 per annual kg is required for anything above a net 0 kg of phosphorous running off the site. Therefore, the required fee for the proposed development is as follows:

$$\text{LSPOP Fee} = \$35,000 \times 2.5 \times 0.34 \text{ kg} = \mathbf{\$29,750}$$

Refer to Appendix B for detailed phosphorous budget calculations.



5. MAINTENANCE

5.1. PERMEABLE PAVERS

Permeable pavement requires regular inspection and maintenance to ensure that it functions properly. The limiting factor for permeable pavers is clogging within the aggregate layers, filler, or underdrain. The pavers themselves can be reused. Annual inspections of permeable pavement should be conducted in the spring to ensure continued infiltration performance. These inspections should check for spilling or deterioration and investigate whether water is draining between storms. The pavement reservoir should drain completely within 48 hours of the end of the storm event.

5.2. STORMTECH UNDERGROUND CHAMBERS

The StormTech underground chambers are proposed to provide 31.0 m³ of underground storage volume for infiltration and 135.0 m³ for quantity control. The chambers should be inspected every six months during the first year to ensure that the storm tanks are free of any debris. In subsequent years, the chambers should be inspected annually, or more if deemed necessary for this specific site.

If the average depth of sediment accumulates throughout the length of the chamber, a cleanout should be performed. Maintenance should be executed using the JetVac process and a vacuum pump truck to evacuate sediment and debris from the system and is to be performed in dry weather. Material removed from the unit will be disposed of in a similar manner to that of other stormwater management facilities. The owner should keep a Record of Maintenance Book to log inspection results and cleanout frequency. The maintenance manual from the manufacturer is included in Appendix D.

5.3. OIL/GRIT SEPARATOR UNIT

The OGS unit should be inspected on a monthly basis during the rainy season to ensure that the unit is cleaned out at the appropriate time. Where site conditions may cause a rapid accumulation of pollutants, more frequent inspections should be carried out. It is recommended that the OGS unit be cleaned out at the end of the rainy season. The CDS PMSU20_15_4 system should be cleaned when the sump has reached 75% capacity, or the sediment depth has accumulated to a depth of 650 mm. Maintenance is to be performed in dry weather. Material removed from the unit will be disposed of in a similar manner to other stormwater management facilities.

When oils are encountered in the unit, they should be immediately removed upon discovery using a small portable pump and/or adsorbent pads and the remaining water should be decanted to the sanitary sewer system for treatment at the local sewage treatment facility. Contact the supplier for a listing of recommended Oil Sorbents. Any sludge or sediment in the bottom of the unit should be removed and disposed of appropriately. Servicing should be performed immediately after any oil/containment spills in the area. Regular maintenance of the OGS unit will ensure satisfactory and long-term treatment.

5.4. ORIFICE TUBE

The orifice tube controlling flows towards Bunkers Creek is located just downstream of MH1 and should be inspected monthly during the first year of operation and in the spring and fall thereafter. Any standing water observed during inspection of the catchbasin manhole that does not drain away may indicate a blocked orifice tube. The orifice tube should be kept clear of debris and any offending debris should be removed. Access to the orifice tube can be achieved through MH1.



6. CONCLUSIONS

Quantity control for the development is provided in the Brentwood underground storage units and surface ponding allowing post development peak flows to be released at pre-development values through an orifice tube.

A treatment train approach is implemented consisting of permeable pavers and an oil/grit separator to obtain quality control for the site and reduce phosphorus levels leaving the site.

Water balance for the site is achieved by infiltration of runoff from the rooftop.

All of which is respectfully submitted,

PEARSON ENGINEERING LTD.

Taylor Arkell, P.Eng.
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Manager of Engineering Services





APPENDIX A

STORMWATER MANAGEMENT CALCULATIONS

233 Dunlop Street West Calculation of Runoff Coefficients

Runoff Coefficient	=	0.15	0.08	0.95	0.95	0.60	0.95		Weighted
Surface Cover	=	Grass	Forest	Asphalt	Building	Gravel	Concrete		Runoff Coefficient
<u>PRE</u>	Total Area	Area	Area	Area	Area	Area	Area		
<u>DEVELOPMENT</u>	(m ²)	(m ²)	(m ²)	(m ²)	(m ²)	(m ²)	(m ²)		
1	5124	4104	806	54	159	0	0		0.17
Pre Total	5124	4104	806	54	159	0	0		0.17

<u>POST</u> <u>DEVELOPMENT</u>	Total Area (m ²)	Area (m ²)	Area (m ²)	Area (m ²)	Area (m ²)	Area (m ²)	Area (m ²)		
1	1220	0	0	0	1220	0	0		0.95
2	725	57	0	581	0	0	87		0.89
3	2186	216	0	1882	0	0	88		0.87
4	433	433	0	0	0	0	0		0.15
5	560	413	0	54	0	0	94		0.36
Post Total	5124	1118	0	2517	1220	0	269		0.78

233 Dunlop Street West Pre-Development Peak Flows

Storm (yrs)	City of Barrie Coeff A	Coeff B	Coeff C	Modified Rational Method $Q = C_i C_i A / 360$
2	678.085	4.699	0.781	
5	853.608	4.699	0.766	
10	975.865	4.699	0.760	
25	1146.275	4.922	0.757	
50	1236.152	4.699	0.751	
100	1426.408	5.273	0.759	

Where:

- Q - Flow Rate (m^3/s)
- C_i - Peaking Coefficient
- C - Rational Method Runoff Coefficient
- I - Storm Intensity (mm/hr)
- A - Area (ha.)

Area Number	1
Area	0.51 ha
Runoff Coefficient	0.17
Time of Concentration	10 min
Return Rate	2 year
Peaking Coefficient (C_i)	1.0
Rainfall Intensity	83.1 mm/hr
Pre-Development Peak Flow	0.02 m^3/s
Return Rate	5 year
Peaking Coefficient (C_i)	1.0
Rainfall Intensity	108.9 mm/hr
Pre-Development Peak Flow	0.03 m^3/s
Return Rate	10 year
Peaking Coefficient (C_i)	1.0
Rainfall Intensity	126.5 mm/hr
Pre-Development Peak Flow	0.03 m^3/s
Return Rate	25 year
Peaking Coefficient (C_i)	1.1
Rainfall Intensity	148.2 mm/hr
Pre-Development Peak Flow	0.04 m^3/s
Return Rate	50 year
Peaking Coefficient (C_i)	1.2
Rainfall Intensity	164.2 mm/hr
Pre-Development Peak Flow	0.05 m^3/s
Return Rate	100 year
Peaking Coefficient (C_i)	1.25
Rainfall Intensity	180.2 mm/hr
Pre-Development Peak Flow	0.06 m^3/s

233 Dunlop Street West Post-Development Peak Flows

City of Barrie
 Storm (yrs) Coeff A Coeff B Coeff C Modified Rational Method
 $Q = C_i C_i A / 360$

2	678.085	4.699	0.781
5	853.608	4.699	0.766
10	975.865	4.699	0.760
25	1146.275	4.922	0.757
50	1236.152	4.699	0.751
100	1426.408	5.273	0.759

Where:

Q - Flow Rate (m³/s)
 C_i - Peaking Coefficient
 C - Rational Method Runoff Coefficient
 I - Storm Intensity (mm/hr)
 A - Area (ha.)

Area Number	Areas to Quantity Control 1, 2 & 3	Total Uncontrolled Flows 4 & 5
Area	0.41 ha	0.10 ha
Runoff Coefficient	0.90	0.27
Time of Concentration	10 min	10 min
Return Rate	2 year	2 year
Peaking Coefficient (C _i)	1.00	1.00
Rainfall Intensity	83.1	83.1
Post-Development Peak Flow	0.09 m ³ /s	0.01 m ³ /s
Return Rate	5 year	5 year
Peaking Coefficient (C _i)	1.00	1.00
Rainfall Intensity	108.9	108.9
Post-Development Peak Flow	0.11 m ³ /s	0.01 m ³ /s
Return Rate	10 year	10 year
Peaking Coefficient (C _i)	1.00	1.00
Rainfall Intensity	126.5	126.5
Post-Development Peak Flow	0.13 m ³ /s	0.01 m ³ /s
Return Rate	25 year	25 year
Peaking Coefficient (C _i)	1.10	1.10
Rainfall Intensity	148.2	148.2
Post-Development Peak Flow	0.17 m ³ /s	0.01 m ³ /s
Return Rate	50 year	50 year
Peaking Coefficient (C _i)	1.20	1.20
Rainfall Intensity	164.2	164.2
Post-Development Peak Flow	0.19 m ³ /s	0.01 m ³ /s
Return Rate	100 year	100 year
Peaking Coefficient (C _i)	1.25	1.25
Rainfall Intensity	180.2	180.2
Post-Development Peak Flow	0.21 m ³ /s	0.02 m ³ /s

233 Dunlop Street West Stage-Storage-Discharge Table

Elevation (m)	Area (m ²)	Volume (m ³)	Cum. Vol. (m ³)	Orifice Head (m)	Orifice Flow (m ³ /s)	Weir Head (m)	Weir Flow (m ³ /s)	Total Flow (m ³ /s)
225.84	174	0	0	0.35	0.009	0.000	0.000	0.009
225.90	174	10	10	0.41	0.010	0.000	0.000	0.010
226.00	174	17	28	0.51	0.011	0.000	0.000	0.011
226.10	174	17	45	0.61	0.012	0.000	0.000	0.012
226.20	174	17	63	0.71	0.013	0.000	0.000	0.013
226.30	174	17	80	0.81	0.014	0.000	0.000	0.014
226.40	174	17	97	0.91	0.015	0.000	0.000	0.015
226.50	174	17	115	1.01	0.016	0.000	0.000	0.016
226.60	174	17	132	1.11	0.017	0.000	0.000	0.017
226.70	0	0	132	1.21	0.017	0.000	0.000	0.017
226.80	0	0	132	1.31	0.018	0.000	0.000	0.018
226.90	0	0	132	1.41	0.019	0.000	0.000	0.019
227.00	0	0	132	1.51	0.019	0.000	0.000	0.019
227.10	0	0	132	1.61	0.020	0.000	0.000	0.020
227.20	0	0	132	1.71	0.020	0.000	0.000	0.020
227.30	0	0	132	1.81	0.021	0.000	0.000	0.021
227.40	0	0	132	1.91	0.022	0.000	0.000	0.022
227.50	0	0	132	2.01	0.022	0.000	0.000	0.022
227.55	0	0	132	2.06	0.022	0.000	0.000	0.022
227.60	49	1	133	2.11	0.023	0.000	0.000	0.023
227.65	145	5	138	2.16	0.023	0.000	0.000	0.023
227.70	258	10	148	2.21	0.023	0.000	0.000	0.023
227.75	474	18	167	2.26	0.024	0.050	0.019	0.043

Orifice	
Diameter	75 mm
Invert Elevation	225.45
Orifice Constant	0.80
Orifice Centroid	225.49
Orifice Flow Formula	$0.80\pi(D/2000)^2 \times (2 \times 9.81 \times H)^{0.5}$

Major Storm Control Weir	
Width	1.00 m
Invert of Weir	227.70 m
Weir Flow Formula	$1.7WH^{1.5}$

233 Dunlop Street West
Quantity Control Volume Calculations

DATE: 18-Feb-20
FILE: 12081.01
CONTRACT/PROJECT: 233 DUNLOP STREET WEST
COMPLETED BY: MJWP

Modified Rational Method Parameters

Pre Development Area (ha)	Post Development Area (ha)	Time of Concentration (min)	Time Increments (min)	Pre Development Runoff Coefficient	Post Development Runoff Coefficient
0.51	0.41	10	5	0.17	0.90

Note: Refer to page Calculation of Runoff Coefficients for detailed calculations of Modified Rational Method parameters.

Pre-Development Runoff Rate

	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
C	0.17	0.17	0.17	0.17	0.17	0.17
C _i	1.00	1.00	1.00	1.10	1.20	1.25
I	83.11	108.92	126.55	148.15	164.22	180.15
A	0.51	0.51	0.51	0.51	0.51	0.51
Q	0.02	0.03	0.03	0.04	0.05	0.06

Note: Q= 0.00278CC_iA

Rainfall Station	Barrie
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SWM Pond Design Input

Storm Event (yrs)	Chicago Storm Coefficient	Chicago Storm Coefficient	Chicago Storm Coefficient	Allowable Outflow	Post Development Runoff Coefficient
	A	B	C	(m3/s)	
2	678.085	4.699	0.781	0.014	0.90
5	853.608	4.699	0.766	0.015	0.90
10	975.865	4.699	0.760	0.017	0.90
25	1146.275	4.922	0.757	0.025	0.99
50	1236.152	4.699	0.751	0.032	1.00
100	1426.408	5.273	0.759	0.040	1.00

Results

Storm Event (yrs)	Storage (m³)	Time (min)
2	69	65
5	100	80
10	119	90
25	150	85
50	157	70
100	164	65

Note: Storage volume calculated as per Hydrology Handbook, Second Edition, American Society of Civil Engineers, 1996

Time (min)	2 Year					Difference	5 Year					Difference	10 Year					Difference	25 Year					Difference	50 Year					Difference	100 Year					Difference
	Intensity mm/hr	Inflow m³/s	Outflow m³/s	Storage m³	Intensity mm/hr		Inflow m³/s	Outflow m³/s	Storage m³	Intensity mm/hr	Inflow m³/s		Outflow m³/s	Storage m³	Intensity mm/hr	Inflow m³/s	Outflow m³/s		Storage m³	Intensity mm/hr	Inflow m³/s	Outflow m³/s	Storage m³		Intensity mm/hr	Inflow m³/s	Outflow m³/s	Storage m³	Intensity mm/hr		Inflow m³/s	Outflow m³/s	Storage m³			
5	114.99	0.12	0.01	29	14	149.77	0.15	0.02	39	19	173.57	0.18	0.02	46	22	201.77	0.23	0.02	57	28	224.41	0.26	0.03	63	31	243.43	0.28	0.04	66	34						
10	83.11	0.09	0.01	43	8	108.92	0.11	0.02	58	11	126.55	0.13	0.02	68	13	148.15	0.17	0.02	86	17	164.22	0.19	0.03	94	18	180.15	0.21	0.04	100	20						
15	66.12	0.07	0.01	51	5	87.04	0.09	0.02	69	8	101.30	0.10	0.02	81	9	119.04	0.13	0.02	103	12	131.81	0.15	0.03	112	12	145.31	0.17	0.04	120	13						
20	55.41	0.06	0.01	56	4	73.19	0.08	0.02	77	5	85.30	0.09	0.02	90	7	100.48	0.11	0.02	114	8	111.22	0.13	0.03	124	9	122.92	0.14	0.04	134	9						
25	47.98	0.05	0.01	60	3	63.55	0.07	0.02	82	4	74.15	0.08	0.02	96	5	87.49	0.10	0.02	123	6	96.84	0.11	0.03	133	6	107.18	0.12	0.04	143	7						
30	42.49	0.04	0.01	63	2	56.41	0.06	0.02	86	3	65.88	0.07	0.02	101	4	77.83	0.09	0.02	129	5	86.16	0.10	0.03	140	5	95.44	0.11	0.04	150	5						
35	38.25	0.04	0.01	65	1	50.89	0.05	0.02	90	3	59.47	0.06	0.02	105	3	70.33	0.08	0.02	134	4	77.87	0.09	0.03	144	4	86.31	0.10	0.04	154	4						
40	34.87	0.04	0.01	66	1	46.47	0.05	0.02	92	2	54.35	0.06	0.02	108	2	64.32	0.07	0.02	138	3	71.24	0.08	0.03	148	3	78.97	0.09	0.04	158	3						
45	32.09	0.03	0.01	67	1	42.84	0.04	0.02	94	2	50.14	0.05	0.02	111	2	59.39	0.07	0.02	141	2	65.78	0.08	0.03	151	2	72.93	0.08	0.04	161	2						
50	29.78	0.03	0.01	68	0	39.81	0.04	0.02	96	1	46.61	0.05	0.02	113	2	55.25	0.06	0.02	143	2	61.21	0.07	0.03	153	2	67.87	0.08	0.04	162	1						
55	27.81	0.03	0.01	68	0	37.23	0.04	0.02	97	1	43.62	0.04	0.02	114	1	51.72	0.06	0.02	145	1	57.32	0.07	0.03	155	1	63.55	0.07	0.04	163	1						
60	26.12	0.03	0.01	68	0	35.00	0.04	0.02	98	1	41.03	0.04	0.02	116	1	48.68	0.06	0.02	147	1	53.96	0.06	0.03	156	1	59.82	0.07	0.04	164	0						
65	24.64	0.03	0.01	69	0	33.06	0.03	0.02	99	1	38.77	0.04	0.02	117	1	46.02	0.05	0.02	148	1	51.03	0.06	0.03	156	0	56.56	0.06	0.04	164	0						
70	23.35	0.02	0.01	69	0	31.35	0.03	0.02	99	0	36.78	0.04	0.02	118	1	43.67	0.05	0.02	149	1	48.44	0.06	0.03	157	0	53.69	0.06	0.04	164	-1						
75	22.19	0.02	0.01	68	0	29.84	0.03	0.02	100	0	35.02	0.04	0.02	118	0	41.59	0.05	0.02	149	0	46.14	0.05	0.03	157	0	51.13	0.06	0.04	163	-1						
80	21.16	0.02	0.01	68	0	28.48	0.03	0.02	100	0	33.44	0.03	0.02	119	0	39.72	0.04	0.02	150	0	44.08	0.05	0.03	156	-1	48.84	0.06	0.04	162	-1						
85	20.24	0.02	0.01	68	0	27.25	0.03	0.02	100	0	32.01	0.03	0.02	119	0	38.04	0.04	0.02	150	0	42.22	0.05	0.03	156	-1	46.77	0.05	0.04	161	-1						
90	19.40	0.02	0.01	67	-1	26.14	0.03	0.02	100	0	30.72	0.03	0.02	119	0	36.51	0.04	0.02	150	0	40.54	0.05	0.03	155	-1	44.90	0.05	0.04	159	-2						
95	18.63	0.02	0.01	67	-1	25.13	0.03	0.02	100	0	29.54	0.03	0.02	119	0	35.12	0.04	0.02	149	0	39.00	0.04	0.03	154	-1	43.19	0.05	0.04	158	-2						
100	17.94	0.02	0.01	66	-1	24.21	0.02	0.02	100	0	28.46	0.03	0.02	119	0	33.84	0.04	0.02	149	-1	37.59	0.04	0.03	153	-1	41.62	0.05	0.04	156	-2						
105	17.29	0.02	0.01	66	-1	23.36	0.02	0.02	99	0	27.47	0.03	0.02	118	0	32.67	0.04	0.02	148	-1	36.30	0.04	0.03	152	-1	40.18	0.05	0.04	154	-2						
110	16.70	0.02	0.01	65	-1	22.58	0.02	0.02	99	0	26.55	0.03	0.02	118	0	31.59	0.04	0.02	148	-1	35.10	0.04	0.03	151	-1	38.85	0.04	0.04	151	-2						
115	16.15	0.02	0.01	64	-1	21.85	0.02	0.02	99	-1	25.71	0.03	0.02	118	0	30.59	0.03	0.02	147	-1	34.00	0.04	0.03	149	-2	37.62	0.04	0.04	149	-2						
120	15.65	0.02	0.01	63	-1	21.18	0.02	0.02	98	-1	24.92	0.03	0.02	117	-1	29.66	0.03	0.02	146	-1	32.97	0.04	0.03	148	-2	36.47	0.04	0.04	147	-3						

Maximum Storage Volume

233 Dunlop Street West Permeable Pavers Sizing Calculations

Infiltration volumes from MOE Stormwater Management Planning and Design Manual to size Permeable Pavers

Table 3.2 Water Quality Storage Requirements are as follows:

Catchment Area 2 Total	=	0.07	ha	
Total Imperviousness	=	80%		
Storage Volume	=	38.2	m ³ /ha	(Enhanced 80% long-term S.S. removal)
Area 2 Storage Volume Required	=	0.07	x	38.2
	=	2.8	m ³	
Catchment Area 3 Total	=	0.22	ha	
Total Imperviousness	=	86%		
Storage Volume	=	40.0	m ³ /ha	(Enhanced 80% long-term S.S. removal)
Area 3 Storage Volume Required	=	0.22	x	40.0
	=	8.7	m ³	

As per LSRCA Guidelines Section 2.2, the required storage volume calculated over 25 mm of the total impervious area on the site:

Storage Volume	=	4,006	x	0.025
Area Storage Volume Required	=	100.1	m ³	

Required storage volume calculated over 25 mm of the total impervious area excluding the rooftop:

Storage Volume	=	2,786	x	0.025
Area Storage Volume Required	=	69.6	m ³	

Note: The 25 mm storm event is being infiltrated from the roof area and therefore the roof area is to be neglected for permeable paver sizing purposes. The permeable pavers shall infiltrate a total of 69.6 m³.

Find storage volume provided in permeable pavers:

Area of West Pavers (A ₁)	=	89.6	m ²
Depth of Trench (d)	=	0.40	m
Storage Volume (V)	=	0.4 (A x d)	
	=	14.3	m ³
Area of South Pavers (A ₂)	=	118.8	m ²
Depth of Trench (d)	=	0.40	m
Storage Volume (V)	=	0.4 (A x d)	
	=	19.0	m ³
Area of East Pavers (A ₃)	=	337.5	m ²
Depth of Trench (d)	=	0.40	m
Storage Volume (V)	=	0.4 (A x d)	
	=	54.0	m ³

		Required		Provided	
Total Area Storage Volume	=	69.6	m ³	87.3	m ³

Use MOE Equation 4.12 to find area of permeable pavers:

Area Design Volume (V)	=	69.6	m ³
Depth of Controlling Filter Medium (d)	=	0.40	m
Coefficient of Permeability of the Controlling Filter Media (k)	=	45.0	mm/hr
Design Drawdown Time (t)	=	24	hr

Surface Area Of Filter (A)	=	$\frac{1000Vd}{kdt}$	
	=	64.5	m ²

		Required		Provided	
Total Area Surface Area	=	64.5	m ²	545.9	m ²

$Q = 0.0028 \cdot C \cdot I \cdot A$ (cms)
 $C = \text{RUNOFF COEFFICIENT}$
 $I = \text{RAINFALL INTENSITY} = \frac{A}{(\text{Time} + B)^C}$
 $A = \text{AREA}$ (ha)

233 Dunlop Street West Storm Sewer Design 5-Year Storm Event

DATE: 18-Feb-20
 FILE: 12081.01
 CONTRACT/PROJECT: 233 DUNLOP ST. W.

Areas	MANHOLE		LENGTH (m)	INCREMENT			TOTAL CA	FLOW TIME (min)		I (mm/h)	TOTAL Q (cms)	S (%)	D (mm)	Q FULL (cms)	V FULL (m/s)
	FROM	TO		C	A	CA		TO	IN						
Area 1	ROOF	CBMH1	2.1	0.95	0.12	0.12	0.12	10.00	0.03	108.92	0.04	1.0	300	0.10	1.37
-	CBMH1	STM TANKS	4.6	0.00	0.00	0.00	0.12	10.03	0.03	108.78	0.04	5.0	300	0.22	3.06
	STM TANKS	CB1	5.9	0.00	0.00	0.00	0.12	10.05	0.03	108.64	0.03	5.1	300	0.22	3.09
Area 2	CB1	MH2	25.2	0.89	0.07	0.06	0.18	10.08	0.31	108.46	0.05	1.0	300	0.10	1.37
-	MH2	MH1	16.7	0.00	0.00	0.00	0.18	10.39	0.20	106.76	0.05	1.0	300	0.10	1.37
Area 3	CB2	MH1	9.9	0.87	0.22	0.19	0.19	10.00	0.07	108.92	0.06	2.7	300	0.16	2.25
	MH1	STM OGS	2.0	0.00	0.00	0.00	0.37	10.59	0.02	105.67	0.02*	1.0	300	0.10	1.37
	STM OGS	OUTLET	12.6	0.00	0.00	0.00	0.37	10.62	0.11	105.54	0.02*	2.0	300	0.14	1.94

* denotes 100 year flow through orifice tube taken from SSD.

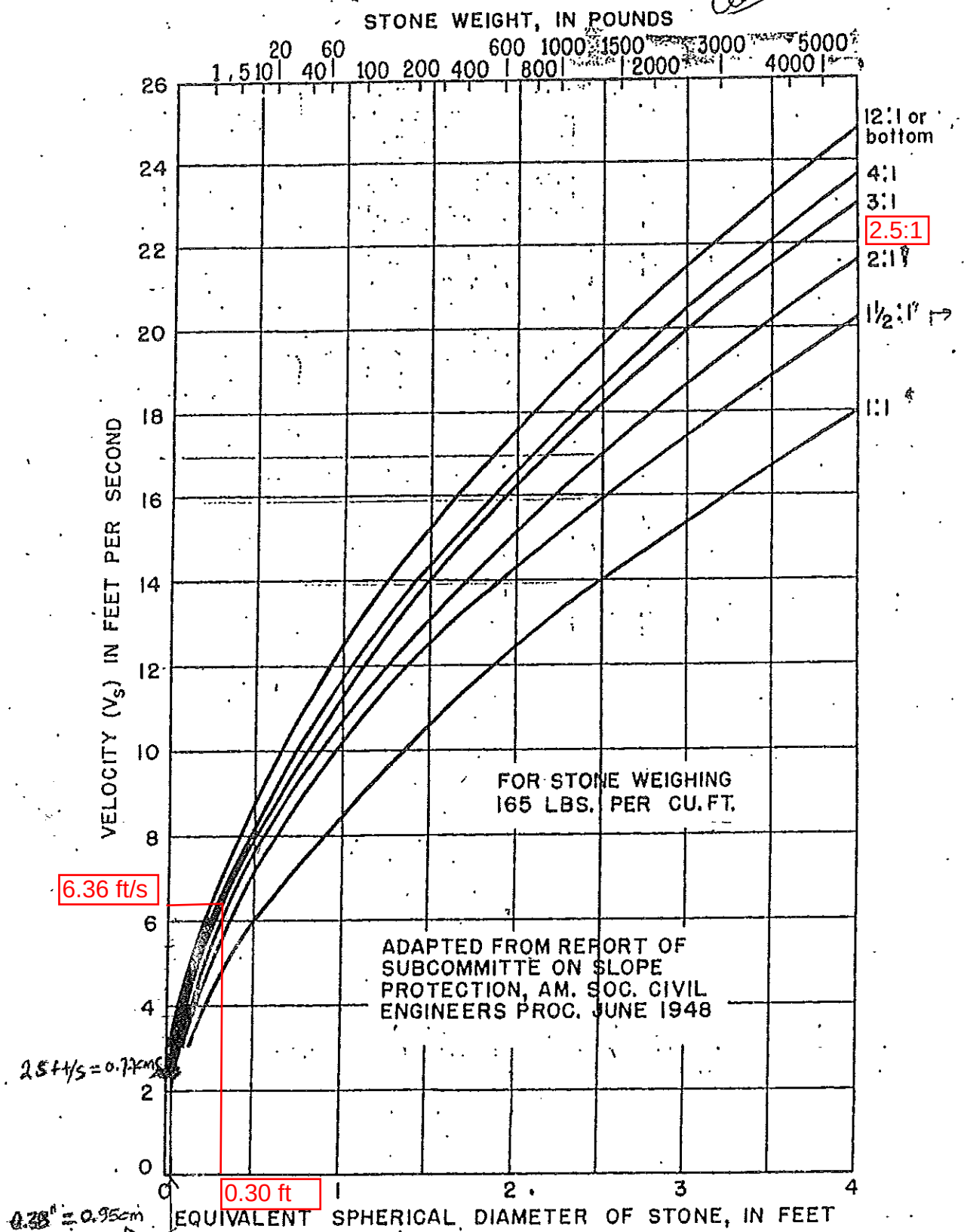


FIG. 2-SIZE OF STONE THAT WILL RESIST DISPLACEMENT
FOR VARIOUS VELOCITIES AND SIDE SLOPES



APPENDIX B

PHOSPHOROUS BUDGET CALCULATIONS

DUNLOP ST. W.

EX. 300 mm# GAS

EX. C/L OF ROAD

EX. MH

EX. CURB AND GUTTER

EX. CONC SWK

LINE OF 3.0m WIDENING DEEDED LAND
4.5m WIDENING

INFILTRATION
0.12 ha

MECHANICAL
& ELECTRICAL
ROOM

PAVERS
0.29 ha

LEGEND

LID FACILITY

INFILTRATION

0.08 ha

AREA

6m TOP OF BANK SETBACK

EX. TOP OF BANK

400'g

E.P. DEDICATION LAND

EXISTING CREEK

233 DUNLOP STREET WEST
BARRIE, ONTARIO



PEARSON
ENGINEERING LTD.

PEARSONENG.COM PH. 705.719.4785

PHOSPHORUS CATCHMENT AREAS

DESIGNED BY	TJCA	HORIZ SCALE	1:500	PROJECT #	12081.01
DRAWN BY	JPE	VERT SCALE		DRAWING #	FIG-6
CHECKED BY	MWD	DATE	FEBRUARY 2020	REVISION #	0

233 Dunlop Street West Phosphorus Budget Tool

	High Intensity Residential	Low Intensity Residential	Pasture	Forest
Phosphorus Export (kg/ha/year)	1.32	1.82	0.07	0.05

Pre-Development Condition

	High Intensity Residential	Low Intensity Residential	Pasture	Forest
Area (ha):	0.00	0.07	0.36	0.08
Total P (kg):	0.00	0.13	0.03	0.00

Total Pre-Development P (kg): 0.16

Post-Development Condition (Uncontrolled)

<u>Total Area</u>	High Intensity Residential	Low Intensity Residential	Pasture	Forest
Area (ha):	0.40	0.00	0.11	0.00
Total P (kg):	0.53	0.00	0.01	0.00

Total Post-Development P (kg): 0.54

Post Development Condition (Controlled)

<u>Untreated Area</u>	High Intensity Residential	Low Intensity Residential	Pasture	Forest
Area (ha):	0.10	0.00	0.00	0.00
Total P (kg):	0.13	0.00	0.00	0.00

Area Draining to Infiltration Chambers

Area (ha):	0.12	0.00	0.00	0.00
Total P (kg):	0.16	0.00	0.00	0.00

Infiltration Chambers Treatment

Infiltration Chambers Proficiency (%):	60
P Removed (kg):	0.10
P Remaining (kg):	0.06

Area Draining to Permeable Pavers

Area (ha):	0.29	0.00	0.00	0.00
Total P (kg):	0.38	0.00	0.00	0.00

Permeable Pavers Treatment

Permeable Pavers Proficiency (%):	45
P Removed (kg):	0.17
P Remaining (kg):	0.21

Underground Storage Treatment

P from Permeable Pavers & Infiltration Trench (kg):	0.28
Underground Storage Proficiency (%):	25
P Removed (kg):	0.07
P Remaining (kg):	0.21

Total Post-Development P (kg) : 0.34

Table 1. Description of Berger (2010) Land Uses in the Lake Simcoe Watershed

Berger (2010) Land Use	Included LSRCA Land Use(s)	Land Use Description
Hay / Pasture	Non-intensive Agriculture	Hay and pasture fields, including the related agricultural buildings such as barns, silos and the farm residence. Fields are dominated with herbaceous vegetation and grasses with an understory of similar material in a state of decay. Weedy hay and/or pasture covers more than 50% of the area.
Crop Land	Intensive Agriculture	Cultivated row crops, including the related agricultural buildings (e.g., barns, silos and the farm residence), producing crops in varying degrees (e.g., corn and wheat) and includes specialty agriculture (i.e., orchards, market gardens, Christmas tree plantations and nurseries).
Sod Farm / Golf Course	Sod Farm	Sod farms.
	Golf Course	Golf courses, including lane ways, but not the isolated woodlots within, unless the area of the woodlots is < 0.5 ha.
Low Intensity Development	Estate Residential	A home including the manicured area around the home and driveway, within a natural heritage feature. The natural heritage feature is not included in the Estate Residential land use classification.
	Manicured Open Space	Cleared areas with a low density of trees, including lawns and landscaping. Land use is dominated by gardens, parkland and lawns, e.g., cemeteries, urban parks, ski hills and residential/industrial open space with a minimum size of 2 ha.
	Rail	Rail lines and the associated cleared adjacent areas.
	Rural Development	Properties not directly associated with an agricultural operation and that contain residential, commercial or other buildings, as well as a manicured open space, within a natural heritage or agricultural feature (e.g., estate residential or service station). On developed portions, these properties are under intensive use. Based on canopy cover, these areas will often appear as Cultural Savannah or Cultural Woodland in aerial photographs or satellite imagery. However, the presence of buildings and manicured lands identify the properties as Rural Development.
High Intensity Development¹ (Commercial /Industrial)	Commercial	Impervious properties that contain a building and an adjacent parking lot (e.g., shopping and strip malls, power centres, scrap yards). Excludes green land areas such as parks or river valleys.
	Industrial	Impervious properties that are not commercial and include industrial operations e.g., factories, manufacturing facilities, processing facilities, bulk fuel storage. Excludes green land areas such as parks or river valleys.
	Institutional	Schools, hospitals and other institutional structures. May include large storm water management ponds. Excludes green land areas such as parks or river valleys.
High Intensity Development¹ (Residential)	Urban	Urban related land uses including continuous ribbon development. Interpreted from aerial photographs or satellite imagery by many roof tops and/or groupings of 5 or more residential properties with a combined area of ≥ 2 ha. Residential properties include single and semi-detached dwellings, apartment buildings and associated out-buildings, driveways and parking lots. Excludes green land areas such as parks or river valleys.
Quarry	Active Aggregate	Areas that are currently being excavated or have recently been excavated. Identified by pits, extraction machinery, unvegetated landscape and/or piles of extracted materials. Active aggregate areas may contain open water.
	Inactive Aggregate	Former aggregate sites that have been recently revegetated; vegetation is established and growing. Depending on their characteristics, in aerial photographs or satellite imagery, these properties may appear to be comparable to an abandoned field or forming wetland.
Road	Road	Unpaved roads, including the shoulder. Does not include driveways.

Berger (2010) Land Use	Included Ecological Land Classifications (ELC(s))	Land Use Description
Transitional	Open Alvar	Cover varies from patchy shrub and tree cover to continuous meadow. Tree cover is $\leq 25\%$; shrub cover is $\leq 25\%$. Typically restricted to bare rock and patchy, shallow substrates.
	Cultural Meadow	Tree cover is $\leq 25\%$ and shrub cover is $\leq 25\%$. The plant community is a result of, or maintained by, anthropogenic disturbances or culture.
	Cultural Thicket	Tree cover is $\leq 25\%$ and shrub cover is $> 25\%$. The plant community is a result of, or maintained by, anthropogenic disturbances or culture.
	Open Tallgrass Prairie	The ground layer of plants is dominated by prairie graminoids (grasses and grass-like plants, including sedges) such as Big and Little Bluestem, as well as Indian Grass. Tree cover is $\leq 25\%$ and shrub cover is $\leq 25\%$. Soils are well drained with prolonged summer drought and frequent disturbance by fire.
Forest ²	Cultural Plantation, Coniferous	Tree cover is $> 60\%$ of the area, with coniferous trees $> 75\%$ of the canopy area. The plant community is a result of, or maintained by, anthropogenic disturbances or culture.
	Cultural Woodland	Tree cover is between 35% and 60% of the area. There is often a large proportion of non-native plant species, and the plant community is a result of, or maintained by, anthropogenic disturbances or culture.
	Coniferous Forest	Tree cover is $> 60\%$ of the area, with coniferous trees $> 75\%$ of the canopy area.
	Cultural Plantation, Deciduous	Tree cover is greater than 60% of the area, with deciduous trees greater than 75% of the canopy area. The plant community is a result of, or maintained by, anthropogenic disturbances or culture.
	Deciduous Forest	Tree cover is $> 60\%$ of the area, with deciduous trees $> 75\%$ of the canopy area.
	Cultural Plantation	Tree cover $> 60\%$ of the area, with coniferous trees $> 25\%$ of the canopy area and deciduous trees $> 25\%$ of the canopy area. The plant community is a result of, or maintained by, anthropogenic disturbances or culture.
	Mixed Forest	Tree cover is $> 60\%$ of the area, with coniferous trees $> 25\%$ of the canopy area and deciduous trees $> 25\%$ of the canopy area.
Wetland ²	Shrub Bog	Continuous <i>Sphagnum</i> spp. moss cover. Trees > 2 m tall cover $\leq 10\%$ of the area and shrubs cover $> 25\%$ of the area. Land is rarely flooded but always saturated with water. Organic substrate > 40 cm deep consisting of <i>Sphagnum</i> peat.
	Treed Bog	Continuous <i>Sphagnum</i> spp. moss cover. Trees > 2 m tall cover 10% to 25% of the area. Land is rarely flooded but always saturated with water. Organic substrate > 40 cm deep consisting of <i>Sphagnum</i> peat.
	Open Fen	Sedges, grasses and low shrubs (< 2 m high) dominate; trees > 2 m high cover $\leq 10\%$ of the area and shrubs cover $\leq 25\%$ of the area. Land is rarely flooded but always saturated with water. Organic substrate > 40 cm deep consisting of moss or sedged peat.
	Shrub Fen	Sedges, grasses and low shrubs (< 2 m high) dominate; trees > 2 m high cover $\leq 10\%$ of the area and shrubs cover $> 25\%$ of the area. Land is rarely flooded but always saturated with water. Organic substrate > 40 cm deep consisting of moss or sedged peat.
	Treed Fen	Sedges, grasses and low shrubs (< 2 m high) dominate; trees > 2 m high cover 10% to 25% of the area. Land is rarely flooded but always saturated with water with organic substrate and > 40 cm deep moss or sedged peat.

Berger (2010) Land Use	Included Ecological Land Classifications (ELC(s))	Land Use Description
	Meadow Marsh	Dominated by emergent hydrophytic aquatic plants (grow wholly or partially in water); tree and shrub cover $\leq 25\%$. Variable flooding regimes and water depth 2m.
	Shallow Marsh	Emergent hydrophytic aquatic plant cover $\geq 25\%$, tree and shrub cover $\leq 25\%$ of the area. Water up to 2 m deep; standing or flowing water for much or all of the growing season.
Wetland³	Floating-Leaved Shallow Aquatic	Floating leaved aquatic vegetation covers $> 25\%$ of the area; no tree or shrub cover. Water up to 2 m deep; standing water is always present.
	Mixed Shallow Aquatic	A mixture of submerged and floating leaved aquatic vegetation covers $> 25\%$ of the area; no tree or shrub cover. Water up to 2 m deep; standing water is always present.
	Submerged Shallow Aquatic	Submerged aquatic vegetation covers $> 25\%$ of the area; no tree or shrub cover. Water up to 2 m deep; standing water is always present.
	Coniferous Swamp	Tree cover is $> 25\%$ of the area with trees > 5 m tall, and coniferous trees $> 75\%$ of the canopy area. Water depth is < 2 m with variable flooding regimes; standing water or spring (vernal) pooling covers $> 20\%$ of the ground.
	Deciduous Swamp	Tree cover is $> 25\%$ of the area with trees > 5 m tall, and deciduous trees $> 75\%$ of the canopy area. Water depth is < 2 m with variable flooding regimes; standing water or spring (vernal) pooling covers $> 20\%$ of the ground.
	Mixed Swamp	Tree cover is $> 25\%$ of the area with trees > 5 m tall; coniferous trees $> 25\%$ of the canopy area and deciduous trees $> 25\%$ of the canopy area. Water depth is < 2 m with variable flooding regimes; standing water or spring (vernal) pooling covers $> 20\%$ of the ground.
	Thicket Swamp	Tree or shrub cover $> 25\%$, dominated by hydrophytic shrub and tree species (grow wholly or partially in water); tree cover $\leq 25\%$, hydrophytic shrub cover $> 25\%$. Water depth is < 2 m with variable flooding regimes; standing water or spring (vernal) pooling covers $> 20\%$ of the ground.
Open Water⁴		Lakes, rivers and ponds including stormwater management ponds.

Notes: ¹High Intensity Development areas were further separated for the Tool into commercial/industrial and residential classes because the percentage of impervious area is typically much higher in commercial/industrial areas than in residential areas resulting in a greater amount of storm water runoff, ²includes CANWET classes of Coniferous Woodland, Deciduous Woodland and Mixed Woodland, ³includes CANWET classes of Emergent Wetland and Woody Wetland. ⁴Not included in the Berger (2010) land classes but added for the purposes of the Tool recognizing that some development areas may have open water areas that should be included in calculations of phosphorus export.

3.2.1.1 Derivation of Export Coefficients

Export coefficients for all land classes were derived based on total phosphorus loading estimates reported by Berger (2010) for individual subwatersheds with the exception of High Intensity Development, which was derived from measured loads in MOE's Stormwater Management Monitoring and Performance Program (SWAMP, 2005; MOE, unpublished data) and Open Water which was derived from estimates of atmospheric loads to the surface of Lake Simcoe (Scott et al., 2006; LSRCA, 2009). The following describes the derivation and rationale for the selection of export coefficients from these sources for each land use in each subwatershed as provided in Table 1.

Table 2. Land-Use Specific Phosphorus Export Coefficients (kg/ha/yr) for Lake Simcoe Subwatersheds

Subwatershed	Phosphorus Export (kg/ha/yr)											
	Cropland	Hay-Pasture	Sod Farm/Golf Course	High Intensity Development		Low Intensity Development	Quarry	Unpaved Road	Forest	Transition	Wetland	Open Water
				Commercial /Industrial	Residential							
Monitored Subwatersheds												
Beaver River	0.22	0.04	0.01	1.82	1.32	0.19	0.06	0.83	0.02	0.04	0.02	0.26
Black River	0.23	0.08	0.02	1.82	1.32	0.17	0.15	0.83	0.05	0.06	0.04	0.26
East Holland River	0.36	0.12	0.24	1.82	1.32	0.13	0.08	0.83	0.10	0.16	0.10	0.26
Hawkestone Creek	0.19	0.10	0.06	1.82	1.32	0.09	0.10	0.83	0.03	0.04	0.03	0.26
Lovers Creek	0.16	0.07	0.17	1.82	1.32	0.07	0.06	0.83	0.06	0.06	0.05	0.26
Pefferlaw/Uxbridge Brook	0.11	0.06	0.02	1.82	1.32	0.13	0.04	0.83	0.03	0.04	0.04	0.26
Whites Creek	0.23	0.10	0.42	1.82	1.32	0.15	0.08	0.83	0.10	0.11	0.09	0.26
Unmonitored Subwatersheds												
Barrie Creeks	0.19	0.07	0.12	1.82	1.32	0.13	0.08	0.83	0.05	0.06	0.05	0.26
GeorginaCreeks	0.36	0.12	0.24	1.82	1.32	0.13	0.08	0.83	0.10	0.16	0.10	0.26
Hewitts Creek	0.19	0.07	0.12	1.82	1.32	0.13	0.08	0.83	0.05	0.06	0.05	0.26
Innisfil Creeks	0.19	0.07	0.12	1.82	1.32	0.13	0.08	0.83	0.05	0.06	0.05	0.26
Maskinonge River	0.19	0.07	0.12	1.82	1.32	0.13	0.08	0.83	0.05	0.06	0.05	0.26
Oro Creeks North	0.36	0.12	0.24	1.82	1.32	0.13	0.08	0.83	0.10	0.16	0.10	0.26
Oro Creeks South	0.19	0.07	0.12	1.82	1.32	0.13	0.08	0.83	0.05	0.06	0.05	0.26
Ramara Creeks	0.19	0.07	0.12	1.82	1.32	0.13	0.08	0.83	0.05	0.06	0.05	0.26
Talbot/Upper Talbot River	0.19	0.07	0.12	1.82	1.32	0.13	0.08	0.83	0.05	0.06	0.05	0.26
West Holland River	0.36	0.12	0.24	1.82	1.32	0.13	0.08	0.83	0.10	0.16	0.10	0.26

3.2.2 Methods - Calculating Pre-development Conditions

The pre-development or “existing conditions” phosphorus load is calculated through the following steps, by the user:

1. The user will rely on the information documented and detailed in the EIS for the development that will be used to support the planning application to the Municipality.
2. The user will choose the subwatershed or geographic area of the Lake Simcoe watershed in which the development is proposed from a drop down list provided by the database. If the development area spans two or more subwatersheds, the areas within each subwatershed should be modelled separately.
3. Specific land use classifications will be delineated and their boundaries overlain on an orthographic aerial photograph that shall be included in their submission.



APPENDIX C

WATER BALANCE CALCULATIONS

**233 Dunlop Street West
Total Water Surplus Calculations**

Month	Mean Temperature (°C)	Heat Index	Potential Evapotranspiration (mm)	Daylight Correction Value	Adjusted Potential Evapotranspiration (mm)	Total Precipitation (mm)	Surplus (mm)	Defecit (mm)
January	-7.7	0.0	0.0	0.81	0.0	82.5	82.5	0.0
February	-6.6	0.0	0.0	0.81	0.0	61.8	61.8	0.0
March	-2.1	0.0	0.0	1.02	0.0	58.1	58.1	0.0
April	5.6	1.2	25.4	1.12	28.5	62.2	33.7	0.0
May	12.3	3.9	59.2	1.27	75.2	82.4	7.2	0.0
June	17.9	6.9	88.6	1.29	114.3	84.8	0.0	29.5
July	20.8	8.7	104.1	1.30	135.3	77.2	0.0	58.1
August	19.7	8.0	98.1	1.20	117.7	89.9	0.0	27.8
September	15.3	5.4	74.9	1.04	77.9	94.0	16.1	0.0
October	8.7	2.3	40.7	0.95	38.7	77.5	38.8	0.0
November	2.7	0.4	11.6	0.80	9.2	88.9	79.7	0.0
December	-3.5	0.0	0.0	0.74	0.0	73.6	73.6	0.0
TOTAL		36.8	502.5		596.7	932.9	451.5	115.4

TOTAL WATER SURPLUS 336.2 mm

Notes:

1. Mean Temperature and Total Precipitation taken from Environment Canada for the Barrie WPCC rainfall station.

2. Heat Index formula is as follows:

$$I = (T_a/5)^{1.514}$$

Where:

I is the Heat Index

T_a is the mean temperature

3. Potential Evapotranspiration formula is as follows:

$$PET = 16(L/12)(N/30)(10T_a/I)^\alpha$$

Where:

PET is the Potential Evapotranspiration

L is the average day length

N is the number of days in the month

T_a is the mean temperature

$$\alpha = (6.75 \times 10^{-7})I^3 - (7.71 \times 10^{-5})I^2 + (1.792 \times 10^{-2})I + 0.49239$$

Where:

I is the sum of all Heat Indices

**233 Dunlop Street West
Pre Development Water Balance**

Catchment Designation	Site			
	Grassed	Forest	Impervious	Total
Area	4104	806	214	5124
Pervious Area	4104	806	0	4910
Impervious Area	0	0	214	214
Infiltration Factors				
Topography Infiltration Factor	0.3	0.3	0.0	
Soil Infiltration Factor	0.3	0.3	0.0	
Land Cover Infiltration Factor	0.0	0.2	0.0	
MOE Infiltration Factor	0.6	0.8	0.0	
Actual Infiltration Factor	0.6	0.8	0.0	
Run-Off Coefficient	0.4	0.2	1.0	
Runoff from Impervious Surfaces	0.0	0.0	0.95	
Inputs (per Unit Area)				
Precipitation	932.9	932.9	932.9	932.9
Run-On	0.0	0.0	0.0	0.0
Other Inputs	0.0	0.0	0.0	0.0
Total Inputs	932.9	932.9	932.9	932.9
Outputs (per Unit Area)				
Precipitation Surplus	345.2	0.0	886.3	313.4
Net Surplus	345.2	0.0	886.3	313.4
Evapotranspiration	587.7	932.9	46.6	619.5
Infiltration	207.1	0.0	0.0	165.9
Rooftop Infiltration	0.0	0.0	0.0	0.0
Total Infiltration	207.1	0.0	0.0	165.9
Runoff Pervious Areas	138.1	0.0	0.0	110.6
Runoff Impervious Areas	0.0	0.0	886.3	36.9
Total Runoff	138.1	0.0	886.3	147.5
Total Outputs	932.9	932.9	932.9	932.9
Difference (Inputs - Outputs)	0.0	0.0	0.0	0.0
Inputs (Volumes)				
Precipitation	3829	752	199	4780
Run-On	0	0	0	0
Other Inputs	0	0	0	0
Total Inputs	3829	752	199	4780
Outputs (Volumes)				
Precipitation Surplus	1417	0	189	1606
Net Surplus	1417	0	189	1606
Evapotranspiration	2412	752	10	3174
Infiltration	850	0	0	850
Rooftop Infiltration	0	0	0	0
Total Infiltration	850	0	0	850
Runoff Pervious Areas	567	0	0	567
Runoff Impervious Areas	0	0	189	189
Total Runoff	567	0	189	756
Total Outputs	3829	752	199	4780
Difference (Inputs - Outputs)	0	0	0	0

(From MOE Table 3.1 for Flat Land)
(From MOE Table 3.1 for Medium combinations of clay and loam)

(Precipitation values from Environment Canada)

Note: Highlighted cells are input cells.

233 Dunlop Street West
Post Development Water Balance (No Infiltration)

Catchment Designation	Site			
	Grassed	Impervious	Building	Total
Area	1118	2786	1220	5124
Pervious Area	1118	0	0	1118
Impervious Area	0	2786	1220	4006
Infiltration Factors				
Topography Infiltration Factor	0.3	0.0	0.0	
Soil Infiltration Factor	0.3	0.0	0.0	
Land Cover Infiltration Factor	0.0	0.0	0.0	
MOE Infiltration Factor	0.6	0.0	0.0	
Actual Infiltration Factor	0.6	0.0	0.0	
Run-Off Coefficient	0.4	1.0	1.0	
Runoff from Impervious Surfaces	0.0	0.95	0.95	
Inputs (per Unit Area)				
Precipitation	932.9	932.9	932.9	932.9
Run-On	0.0	0.0	0.0	0.0
Other Inputs	0.0	0.0	0.0	0.0
Total Inputs	932.9	932.9	932.9	932.9
Outputs (per Unit Area)				
Precipitation Surplus	345.2	886.3	886.3	768.2
Net Surplus	345.2	886.3	886.3	768.2
Evapotranspiration	587.7	46.6	46.6	164.7
Infiltration	207.1	0.0	0.0	45.2
Rooftop Infiltration	0.0	0.0	0.0	0.0
Total Infiltration	207.1	0.0	0.0	45.2
Runoff Pervious Areas	138.1	0.0	0.0	30.1
Runoff Impervious Areas	0.0	886.3	886.3	692.9
Total Runoff	138.1	886.3	886.3	723.0
Total Outputs	932.9	932.9	932.9	932.9
Difference (Inputs - Outputs)	0.0	0.0	0.0	0.0
Inputs (Volumes)				
Precipitation	1043	2599	1138	4780
Run-On	0	0	0	0
Other Inputs	0	0	0	0
Total Inputs	1043	2599	1138	4780
Outputs (Volumes)				
Precipitation Surplus	386	2469	1081	3936
Net Surplus	386	2469	1081	3936
Evapotranspiration	657	130	57	844
Infiltration	232	0	0	232
Rooftop Infiltration	0	0	0	0
Total Infiltration	232	0	0	232
Runoff Pervious Areas	154	0	0	154
Runoff Impervious Areas	0	2469	1081	3550
Total Runoff	154	2469	1081	3705
Total Outputs	1043	2599	1138	4780
Difference (Inputs - Outputs)	0	0	0	0

(From MOE Table 3.1 for Flat Land)
(From MOE Table 3.1 for Medium combinations of clay and loam)

(Precipitation values from Environment Canada)

Note: Highlighted cells are input cells.

233 Dunlop Street West
Post Development Water Balance (With Infiltration)

Catchment Designation	Site			
	Grassed	Paved	Building (With Infiltration)	Total
Area	1118	2786	1220	5124
Pervious Area	1118	0	0	1118
Impervious Area	0	2786	1220	4006
Infiltration Factors				
Topography Infiltration Factor	0.2	0.0	0.0	
Soil Infiltration Factor	0.2	0.0	0.0	
Land Cover Infiltration Factor	0.1	0.0	0.0	
MOE Infiltration Factor	0.5	0.0	0.0	
Actual Infiltration Factor	0.5	0.0	0.0	
Run-Off Coefficient	0.5	1.0	1.0	
Runoff from Impervious Surfaces	0.0	0.95	0.95	
Inputs (per Unit Area)				
Precipitation	932.9	932.9	932.9	932.9
Run-On	0.0	0.0	0.0	0.0
Other Inputs	0.0	0.0	0.0	0.0
Total Inputs	932.9	932.9	932.9	932.9
Outputs (per Unit Area)				
Precipitation Surplus	345.2	886.3	886.3	768.2
Net Surplus	345.2	886.3	886.3	768.2
Evapotranspiration	587.7	46.6	46.6	164.7
Infiltration	172.6	0.0	0.0	37.7
Rooftop Infiltration	0.0	0.0	538.5	128.2
Total Infiltration	172.6	0.0	538.5	165.9
Runoff Pervious Areas	172.6	0.0	0.0	37.7
Runoff Impervious Areas	0.0	886.3	347.8	564.6
Total Runoff	172.6	886.3	347.8	602.3
Total Outputs	932.9	932.9	932.9	932.9
Difference (Inputs - Outputs)	0.0	0.0	0.0	0.0
Inputs (Volumes)				
Precipitation	1043	2599	1138	4780
Run-On	0	0	0	0
Other Inputs	0	0	0	0
Total Inputs	1043	2599	1138	4780
Outputs (Volumes)				
Precipitation Surplus	386	2469	1081	3936
Net Surplus	386	2469	1081	3936
Evapotranspiration	657	130	57	844
Infiltration	193	0	0	193
Rooftop Infiltration	0	0	657	657
Total Infiltration	193	0	657	850
Runoff Pervious Areas	193	0	0	193
Runoff Impervious Areas	0	2469	424	2893
Total Runoff	193	2469	424	3086
Total Outputs	1043	2599	1138	4780
Difference (Inputs - Outputs)	0	0	0	0

(From MOE Table 3.1 for Flat Land)
(From MOE Table 3.1 for Medium combinations of clay and loam)

(Precipitation values from Environment Canada)

Depth of rainfall over the rooftop required to be infiltrated to achieve water balance.

Note: Highlighted cells are input cells.

233 Dunlop Street West Water Balance Calculations

Annual Rainfall Depth Required:

$$\text{Depth of Rainfall Required} = 538.5 \text{ m}^3 \quad (\text{From Post-Development Water Balance (With Infiltration)})$$

Find Percent of Annual Rainfall that Required Rainfall Depth represents:

$$\begin{aligned} \text{Annual Rainfall for Study Area} &= 932.9 \text{ mm} \\ \% \text{ Annual Rainfall} &= \frac{538.5 \text{ mm}}{932.9 \text{ mm}} \\ &= 58\% \end{aligned}$$

From MOE Figure C-2, 58% of annual rainfall occurs for storm events of 7 mm or less.

Find storage volume required for rainfall events of 7 mm to Rooftop Infiltration Gallery:

$$\begin{aligned} \text{Roof Top Area} &= 1,220 \text{ m}^2 \\ \text{Rainfall Depth} &= 7 \text{ mm} \\ \text{Storage Volume Required} &= A \times D \\ &= 1,220 \times 7 \\ &= 9 \text{ m}^3 \end{aligned}$$

Minimum Infiltration Volume as per City of Barrie Storm Drainage and Stormwater Management Policies and Design Guidelines Section 4.1.3 is as follows:

$$\begin{aligned} \text{Storage Volume Required} &= \text{Site Area} \times 5 \text{ mm} \\ &= 5,124 \times 0.005 \\ &= 25.6 \text{ m}^3 \end{aligned}$$

It is proposed to infiltrate the 25 mm storm event over the rooftop area, resulting in a storage volume of 31.0 m^3 exceeding the City of Barrie Criteria. Therefore, water balance for the site is achieved.

233 Dunlop Street West Rooftop Infiltration Calculations

Using the Governing 5 mm Storm Event over the Site Area as per Water Balance Calculations:

Site Area (A)	=	5,124	m ²	(from Water Balance Calculations)
Storm Event (D)	=	5	mm	(from Water Balance Calculations)
Volume (V)	=	A x D		
	=	25.6	m ³	

Calculate Design Infiltration Rate:

Infiltration Rate at the Bottom of the BMP	=	20	mm/hr	Note: Conservative Infiltration Rate Estimates an In-Situ Infiltration Rate of 20 mm/hr. To Be Confirmed Prior to Construction.
Infiltration Rate of Least Permeable Soil on Site	=	20	mm/hr	
Ratio of Mean Measured Infiltration Rates	=	$\frac{20}{20}$		
	=	1.0		

Therefore, based on the TRCA LID Guide, Appendix C, Table C2, the Infiltration Safety Correction Factor is:

Safety Correction Factor	=	2.5	
Design Infiltration Rate (i)	=	$\frac{20}{2.5}$	
	=	8.0	mm/hr

Calculate Required TRCA Maximum Allowable Infiltration Chamber Depth:

Design Infiltration Rate (i)	=	8.0	mm/hr	
Drawdown time (t _s)	=	48	hr	
Porosity (V _r)	=	0.4		(for Clear Stone)
Maximum Depth (d _{r max})	=	$\frac{i \times t_s}{V_r}$		
	=	960	mm	
Depth Provided	=	706	mm	

Calculate Required TRCA Infiltration Chamber Bottom Area:

Water Quality Volume (WQV)	=	25.6	m ³	
Stone Reservoir Depth (d _r)	=	0.71	m	
Porosity (V _r)	=	0.4		(for Clear Stone)
Required Footprint Surface Area (A _r)	=	$\frac{WQV}{d_r \times V_r}$		
	=	90.7	m ²	
Provided Footprint Surface Area (A)	=	92.5	m ²	

Therefore, 36 StormTech infiltration chambers for the project will achieve infiltration targets and meet the requirements for a drawdown time of 24 hours.

Figure C.1 Annual Precipitation Event Distribution

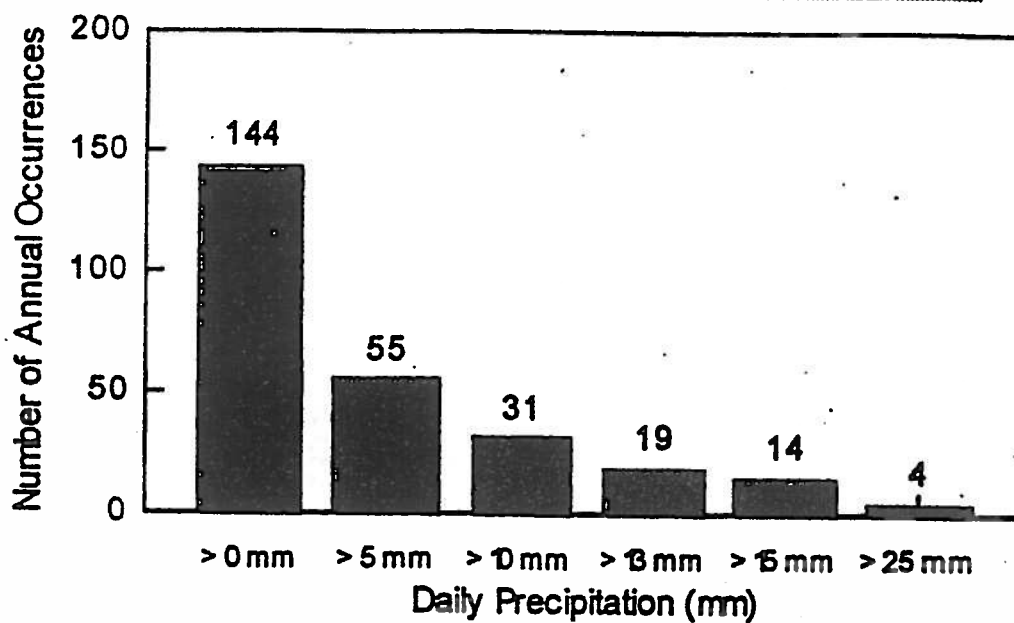


Figure C.2 Annual Capture Rate for Daily Capture Amounts

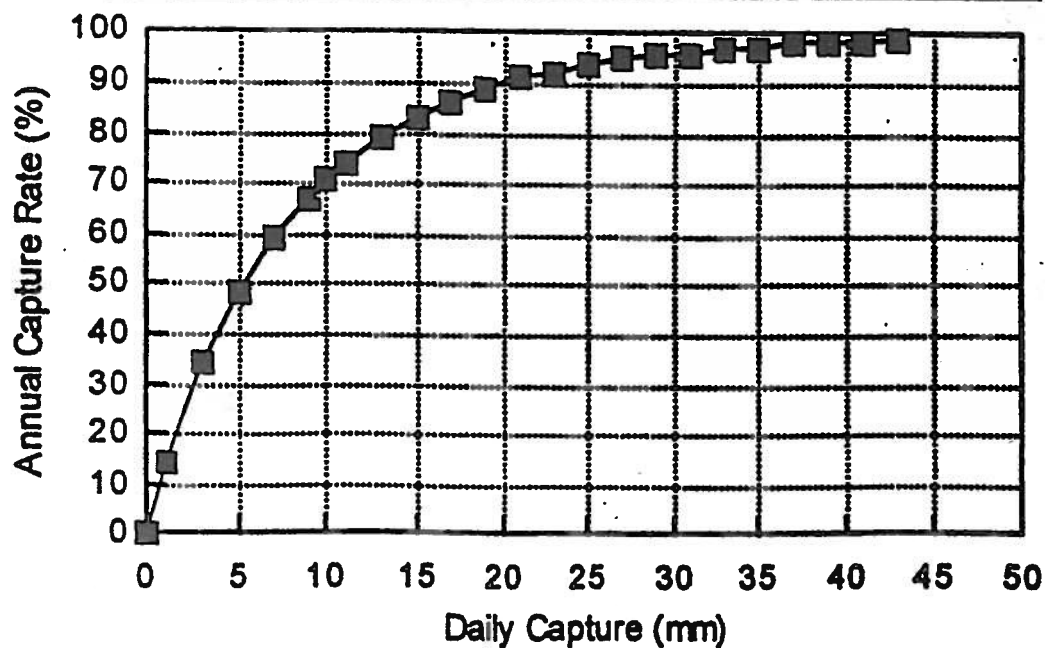


Table 3.1: Hydrologic Cycle Component Values

	Water Holding Capacity mm	Hydrologic Soil Group	Precipitation mm	Evapo- transpiration mm	Runoff mm	Infiltration* mm
Urban Lawns/Shallow Rooted Crops (spinach, beans, beets, carrots)						
Fine Sand	50	A	940	515	149	276
Fine Sandy Loam	75	B	940	525	187	228
Silt Loam	125	C	940	536	222	182
Clay Loam	100	CD	940	531	245	164
Clay	75	D	940	525	270	145
Moderately Rooted Crops (corn and cereal grains)						
Fine Sand	75	A	940	525	125	291
Fine Sandy Loam	150	B	940	539	160	241
Silt Loam	200	C	940	543	199	199
Clay Loam	200	CD	940	543	218	179
Clay	150	D	940	539	241	160
Pasture and Shrubs						
Fine Sand	100	A	940	531	102	307
Fine Sandy Loam	150	B	940	539	140	261
Silt Loam	250	C	940	546	177	217
Clay Loam	250	CD	940	546	197	197
Clay	200	D	940	543	218	179
Mature Forests						
Fine Sand	250	A	940	546	79	315
Fine Sandy Loam	300	B	940	548	118	274
Silt Loam	400	C	940	550	156	234
Clay Loam	400	CD	940	550	176	215
Clay	350	D	940	549	196	196
Notes: Hydrologic Soil Group A represents soils with low runoff potential and Soil Group D represents soils with high runoff potential. The evapotranspiration values are for mature vegetation. Streamflow is composed of baseflow and runoff.						
<i>*This is the total infiltration of which some discharges back to the stream as base flow. The infiltration factor is determined by summing a factor for topography, soils and cover.</i>						
<u>Topography</u>	Flat Land, average slope < 0.6 m/km	0.3				
	Rolling Land, average slope 2.8 m to 3.8 m/km	0.2				
	Hilly Land, average slope 28 m to 47 m/km	0.1				
<u>Soils</u>	Tight impervious clay	0.1				
	Medium combinations of clay and loam	0.2				
	Open Sandy loam	0.4				
<u>Cover</u>	Cultivated Land	0.1				
	Woodland	0.2				

Barrie Annual Rainfall Data

▼ Precipitation

1981 to 2010 Canadian Climate Normals station data

Precipitation														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Rainfall (mm)	16.6	16.0	29.2	56.6	82.3	84.8	77.2	89.9	94.0	75.2	66.0	22.2	709.9	C
Snowfall (cm)	66	46	29	6	0	0	0	0	0	2	23	51	223	C
Precipitation (mm)	82.5	61.8	58.1	62.2	82.4	84.8	77.2	89.9	94.0	77.5	88.9	73.6	932.9	C
Average Snow Depth (cm)	16	17	8	1	0	0	0	0	0	0	2	9	4	D
Median Snow Depth (cm)	17	17	8	0	0	0	0	0	0	0	1	8	4	D
Snow Depth at Month-end (cm)	17	15	1	0	0	0	0	0	0	0	4	11	4	C
Extreme Daily Rainfall (mm)	27.0	35.0	43.0	40.0	54.4	96.0	75.0	79.0	80.0	48.8	50.0	28.6		
Date (yyyy/dd)	1998/05	1997/21	1990/11	1995/21	2004/23	1995/02	1980/20	1995/31	1986/11	1995/05	1999/02	1979/24		
Extreme Daily Snowfall (cm)	65	32	22	17	2	0	0	0	0	12	27	44		
Date (yyyy/dd)	1978/09	1984/29	1984/10	1979/04	1989/07	1978/01	1978/01	1978/01	1977/01	1997/26	2000/21	1995/10		
Extreme Daily Precipitation (mm)	65.0	35.0	43.0	40.0	54.4	96.0	75.0	79.0	80.0	48.8	52.0	44.0		
Date (yyyy/dd)	1978/09	1997/21	1990/11	1995/21	2004/23	1995/02	1980/20	1995/31	1986/11	1995/05	1999/02	1995/10		
Extreme Snow Depth (cm)	57	59	50	21	0	0	0	0	0	8	29	54		
Date (yyyy/dd)	1981/07	2001/09	2003/05	1987/01	1981/01	1981/01	1981/01	1981/01	1981/01	1997/27	1995/28	1995/11		

Government of Canada, "Canadian Climate Normals 1981-2010 Station Data For Barrie WPCC." Climate. July 9, 2014. Accessed August 6, 2014.

http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=4408&lang=e&stationName=barrie&SearchType=Contains&stnNameSubmit=go&dCode=4&dispBack=1



APPENDIX D

STORMTECH UNDERGROUND STORAGE CHAMBER INFORMATION



SC-160LP, SC-310, SC-740 & DC-780 Design Manual

StormTech® Chamber Systems for Stormwater Management



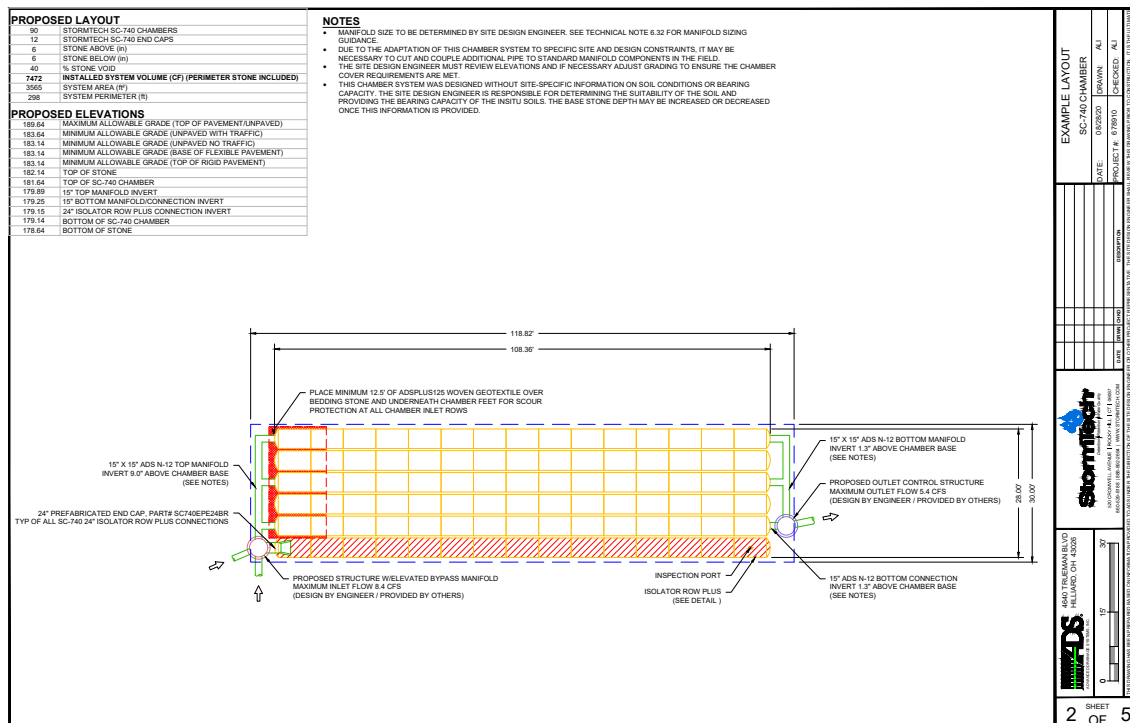
THE MOST **ADVANCED** NAME IN WATER MANAGEMENT SOLUTIONS®



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* For MC-3500 and MC-4500 designs, please refer to the MC-3500/MC-4500 Design Manual.

The StormTech Technical Services Department assists design professionals in specifying StormTech storm water systems. This assistance includes the layout of chambers to meet the engineer's volume requirements and the connections to and from the chambers. The Technical Department can also assist converting and cost engineering projects currently specified with ponds, pipe, concrete and other manufactured storm water detention/retention products. Please note that it is the responsibility of the design engineer to ensure that the chamber bed layout meets all design requirements and is in compliance with applicable laws and regulations governing this project.



This manual is exclusively intended to assist engineers in the design of subsurface stormwater systems using StormTech chambers.

1.0 Introduction

1.1 INTRODUCTION

StormTech stormwater management systems allow storm water professionals to create more profitable, environmentally sound developments. Compared with other subsurface systems, StormTech systems offer lower overall installed cost, superior design flexibility and enhanced performance. Applications include commercial, residential, agricultural and highway drainage.

StormTech has invested over \$10 million and many years in the development of StormTech chambers. These innovative products exceed the rigorous requirements of the standards governing the design of thermoplastic structures.

1.2 THE GOLD STANDARD IN STORMWATER MANAGEMENT

The advanced designs of StormTech chambers were created by implementing an aggressive research, development, design and manufacturing protocol. StormTech chamber products establish the new gold standard in stormwater management through:

- Collaborations with experts in the field of buried plastic structures and polyolefin materials
- The development and utilization of new testing methods and proprietary test methods
- The use of thermoformed prototypes to verify engineering models, perform in-ground testing and install observation sites
- The investment in custom-designed, injection molding equipment
- The utilization of polypropylene and polyethylene as manufacturing materials
- The design of molded-in features not possible with traditional thermoformed chambers

Section 3.0 of this design manual, Structural Capabilities, provides a detailed description of the research, development and design process.

Many of StormTech's unique chamber features can benefit a site developer, stormwater system designer, and installer. Where applicable, StormTech Product Specifications are referenced throughout this design manual. If StormTech's unique product benefits are important to a stormwater system design, consider including the applicable StormTech Product Specifications on the site plans. This can prevent substitutions with inferior products. Refer to Section 14.0, *StormTech Product Specifications*.

1.3 PRODUCT QUALITY AND DESIGN TO INTERNATIONAL STANDARDS

StormTech chambers are designed to meet the full scope of design requirements of Section 12.12 of the AASHTO

LRFD Bridge Design Specifications and produced to the requirements of the American Society of Testing Materials (ASTM) International specifications F2418 (polypropylene chambers) and F2922 (polyethylene chambers).

StormTech chambers provide the full AASHTO safety factors for live loads and permanent earth loads. The two ASTM standards mentioned previously are linked to the AASHTO LRFD Bridge Design Specifications Section 12.12 design standard. Both ASTM standards require that the safety factors included in the AASHTO guidance are achieved as a prerequisite to meeting either ASTM F2418 or ASTM F2922. StormTech chambers are also designed in accordance with ASTM F2787, Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers which provides specific guidance on how to design thermoplastic chambers in accordance with AASHTO Section 12.12. These standards provide both the assurance of product quality and safe structural design.

For non-proprietary specifications for public bids that ensure high product quality and safe design, consider including the specification in Section 15.0 Chamber Specifications for Contract Documents.

1.4 TECHNICAL SUPPORT FOR PLAN REVIEWS

StormTech's in-house technical support staff is available to review proposed plans that incorporate StormTech chamber systems. They are also available to assist with plan conversions from existing products to StormTech. Not all plan sheets are necessary for StormTech's review. Required sheets include plan view sheet(s) with design contours, cross sections of the stormwater system including catch basins and drainage details.

When specifying StormTech chambers it is recommended that the following items are included in project plans: StormTech chamber system General Notes, applicable StormTech chamber illustrations and StormTech chamber system Product Specifications. These items are available in various formats and can be obtained by contacting StormTech at **1-860-529-8188** or may be downloaded at **www.stormtech.com**.

StormTech's plan review is limited to the sole purpose of determining whether plans meet StormTech chamber systems' minimum requirements. **It is the ultimate responsibility of the design engineer to assure that the stormwater system's design is in full compliance with all applicable laws and regulations.** StormTech products must be designed and installed in accordance with StormTech's minimum requirements.

SEND PLANS TO:

E-mail: info@stormtech.com.

2.1 PRODUCT APPLICATIONS

StormTech chamber systems may function as stormwater detention, retention, first-flush storage, or some combination of these. The StormTech chambers can be used for commercial, municipal, industrial, recreational, and residential applications especially for installations under parking lots and commercial roadways.

One of the key advantages of the StormTech chamber system is its design flexibility. Chambers may be configured into beds or trenches of various sizes or shapes. They can be centralized or decentralized, and fit on nearly all sites. Chamber lengths enhance the ability to develop on both existing and pre-developed projects. The systems can be designed easily and efficiently around utilities, natural or man-made structures and any other limiting boundaries.

2.2 CHAMBERS FOR STORMWATER DETENTION

Chamber systems have been used effectively for storm water detention for over 15 years. A detention system temporarily holds water while it is released at a defined rate through an outlet. While some infiltration may occur in a detention system, it is often considered an environmental benefit and a storage safety factor. Over 70% of StormTech's installations are non-watertight detention systems. There are only a few uncommon situations where a detention system might need to limit infiltration: the subgrade soil's bearing capacity is significantly affected by saturation such as with expansive clays or karst soils, and; in sensitive aquifer areas where the depth to groundwater does not meet local guidelines. Adequate pretreatment could eliminate concerns for the latter case. A thermoplastic liner may be considered for both situations to limit infiltration.

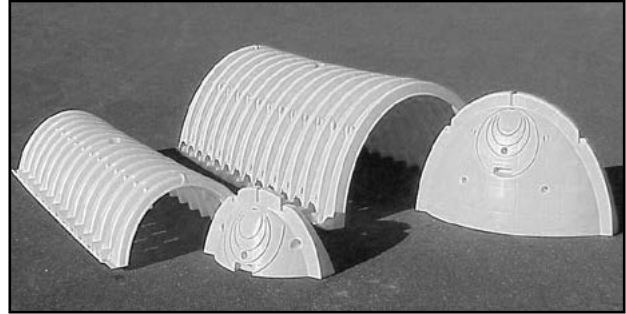
2.3 STONE POROSITY ASSUMPTION

A StormTech chamber system requires the application of clean, crushed, angular stone below, between and above the chambers. This stone serves as a structural component while allowing conveyance and storage of stormwater. Storage volume examples throughout this Design Manual are calculated with an assumption that the stone has an industry standard porosity of 40%. Actual stone porosity may vary. Contact StormTech for information on calculating storm water volumes with varying stone porosity assumptions.

2.4 CHAMBER SELECTION

Primary considerations when selecting between the SC-160LP, SC-310, SC-740 and DC-780 chambers are the depth to restrictive layer, available area for subsurface storage, cover height and outfall restrictions.

The StormTech SC-160LP chamber shown on page 4 is the smallest of the chamber family and has been optimized to fit in the shallowest of applications. This extra low profile chamber allows for storage of 1.01 ft³/ft² (0.3m³/m²) [minimum] of storage.



The SC-310 and SC-740 chambers and end plates.



StormTech systems can be integrated into retrofit and new construction projects.

The StormTech SC-310 chamber shown on page 6 is ideal for systems requiring low-rise and wide-span solutions. This low profile chamber allows the storage of large volumes, 1.3 ft³/ft² (0.40 m³/m²) [minimum], at minimum depths.

Like the Stormtech SC-310, the StormTech SC-310-3 found on page 8 allows for a design option for sites with both limited cover and limited space. With only 3 of spacing between the chambers, the SC-310-3 still provides 1.3 ft³/ft² (0.40 m³/m²) [minimum] of storage.

The StormTech SC-740 chamber shown on page 10 optimizes storage volumes in relatively small footprints. By providing 2.2 ft³/ft² (0.67 m³/m²) [minimum] of storage, the SC-740 chambers can minimize excavation, backfill and associated costs.

The DC-780 chamber shown on page 12 has been developed for those applications which exceed the maximum 8 ft (2.44 m) burial depth of the SC-740 and SC-310 chambers. The DC-780 is a modified version of the SC-740 allowing it to reach a maximum burial depth of 12 ft (3.66 m). The design of the DC-780 chamber, like other StormTech chambers, is designed and manufactured in accordance with the AASHTO LRFD Bridge Design Specifications as well as ASTM F 2418 and ASTM F 2787 ensuring structural adequacy for deeper systems.

The end corrugations of the DC-780 chamber have not been modified in order to allow connections to the SC-740 chamber. This will allow hybrid systems utilizing both chambers in one system design.

StormTech SC-310 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for private (commercial) and public applications. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.

StormTech SC-310 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	85.4 x 34.0 x 16.0 (2170 x 864 x 406 mm)
Chamber Storage	14.7 ft ³ (0.42 m ³)
Min. Installed Storage*	31.0 ft ³ (0.88 m ³)
Weight	37.0 lbs (16.8 kg)

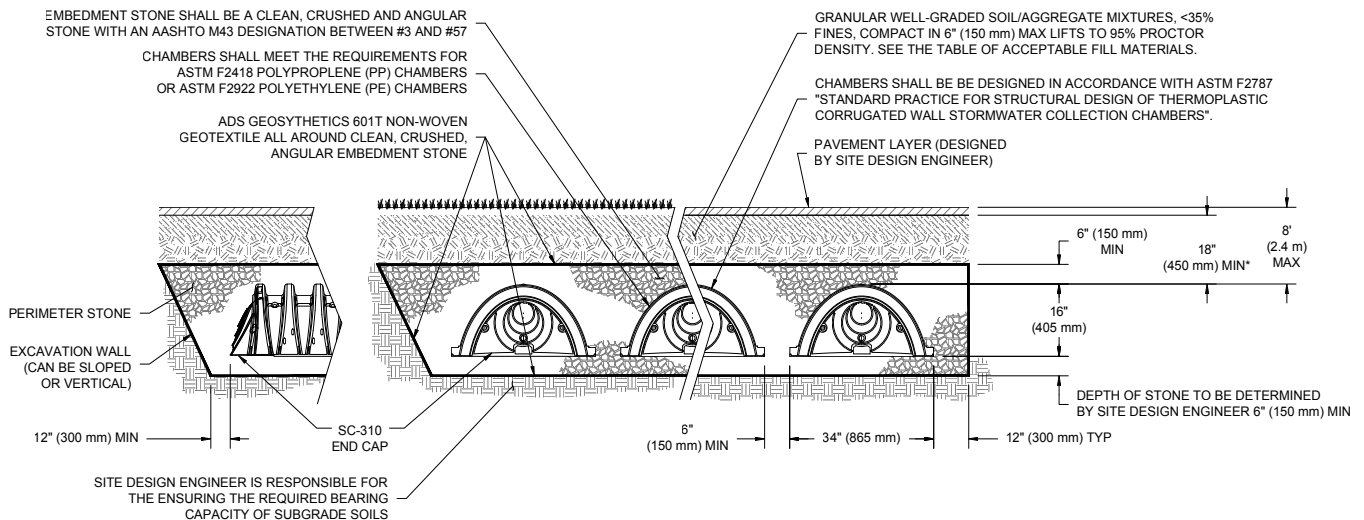
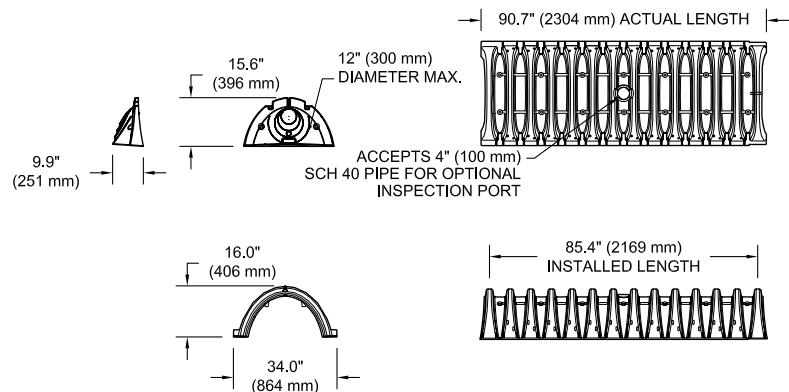
*Assumes 6 (150 mm) stone above, below and between chambers and 40% stone porosity.

Shipping

41 chambers/pallet

108 end caps/pallet

18 pallets/truck



*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 24" (600 mm).

THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

SC-310 Cumulative Storage Volumes per chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6 (150 mm) Stone Base Under Chambers.

Depth of Water in System Inches (mm)		Cumulative Chamber Storage ft ³ (m ³)	Total System Cumulative Storage ft ³ (m ³)
28 (711)	↑ Stone Cover ↓	14.70 (0.416)	31.00 (0.878)
27 (686)		14.70 (0.416)	30.21 (0.855)
26 (680)		14.70 (0.416)	29.42 (0.833)
25 (610)		14.70 (0.416)	28.63 (0.811)
24 (609)		14.70 (0.416)	27.84 (0.788)
23 (584)		14.70 (0.416)	27.05 (0.766)
22 (559)		14.70 (0.416)	26.26 (0.748)
21 (533)		14.64 (0.415)	25.43 (0.720)
20 (508)		14.49 (0.410)	24.54 (0.695)
19 (483)		14.22 (0.403)	23.58 (0.668)
18 (457)	↓	13.68 (0.387)	22.47 (0.636)
17 (432)		12.99 (0.368)	21.25 (0.602)
16 (406)		12.17 (0.345)	19.97 (0.566)
15 (381)		11.25 (0.319)	18.62 (0.528)
14 (356)		10.23 (0.290)	17.22 (0.488)
13 (330)		9.15 (0.260)	15.78 (0.447)
12 (305)		7.99 (0.227)	14.29 (0.425)
11 (279)		6.78 (0.192)	12.77 (0.362)
10 (254)		5.51 (0.156)	11.22 (0.318)
9 (229)		4.19 (0.119)	9.64 (0.278)
8 (203)	↑ Stone Foundation ↓	2.83 (0.081)	8.03 (0.227)
7 (178)		1.43 (0.041)	6.40 (0.181)
6 (152)		0	4.74 (0.134)
5 (127)		0	3.95 (0.112)
4 (102)		0	3.16 (0.090)
3 (76)		0	2.37 (0.067)
2 (51)		0	1.58 (0.046)
1 (25)		0	0.79 (0.022)

Note: Add 0.79 ft³ (0.022 m³) of storage for each additional inch. (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage ft ³ (m ³)	Chamber and Stone Foundation Depth in. (mm)		
		6 (150)	12 (300)	18 (450)
StormTech SC-310	14.7 (0.4)	31.0 (0.9)	35.7 (1.0)	40.4 (1.1)

Note: Assumes 6 (150 mm) of stone above chambers, 6 (150 mm) row spacing and 40% stone porosity.

Amount of Stone Per Chamber

TONS (yds ³)	Stone Foundation Depth		
	6	12	18
StormTech SC-310	2.1 (1.5 yd ³)	2.7 (1.9 yd ³)	3.4 (2.4 yd ³)
KILOGRAMS (m ³)	150 mm	300 mm	450 mm
StormTech SC-310	1,830 (1.1 m ³)	2,490 (1.5 m ³)	2,990 (1.8 m ³)

Note: Assumes 6 (150 mm) of stone above, and between chambers.

Volume Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6 (150 mm)	12 (300 mm)	18 (450 mm)
StormTech SC-310	2.9 (2.2)	3.4 (2.6)	3.8 (2.9)

Note: Assumes 6 (150 mm) of row separation and 18 (450 mm) of cover. The volume of excavation will vary as the depth of the cover increases.



StormTech SC-740 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for private (commercial) and public applications. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.

StormTech SC-740 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	85.4 x 51.0 x 30.0 (2,170 x 1,295 x 762 mm)
Chamber Storage	45.9 ft ³ (1.30 m ³)
Min. Installed Storage*	74.9 ft ³ (2.12 m ³)
Weight	74.0 lbs (33.6 kg)

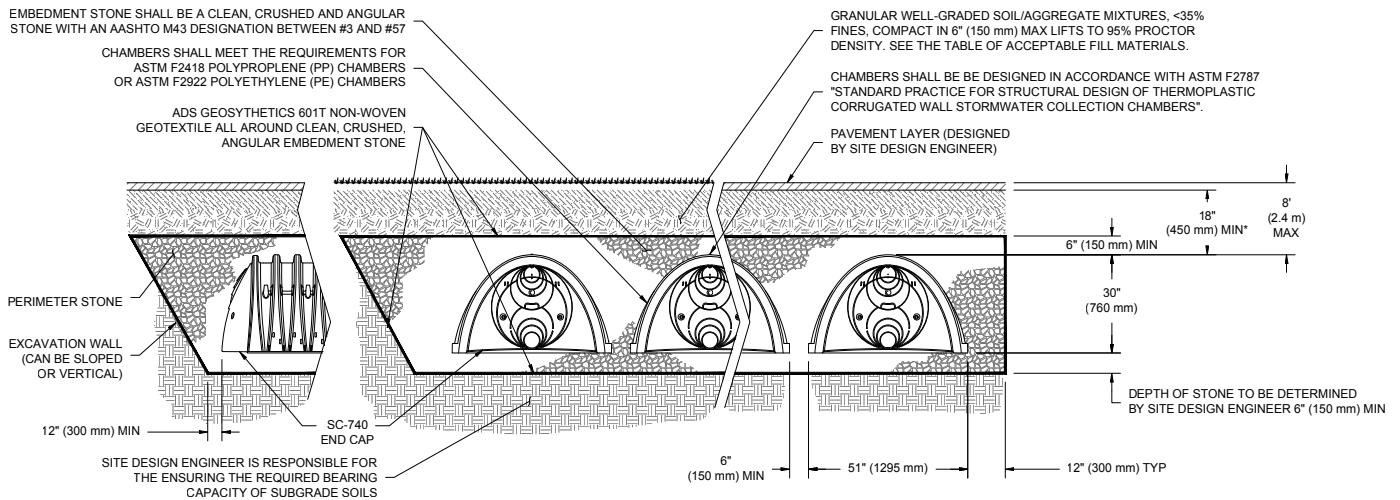
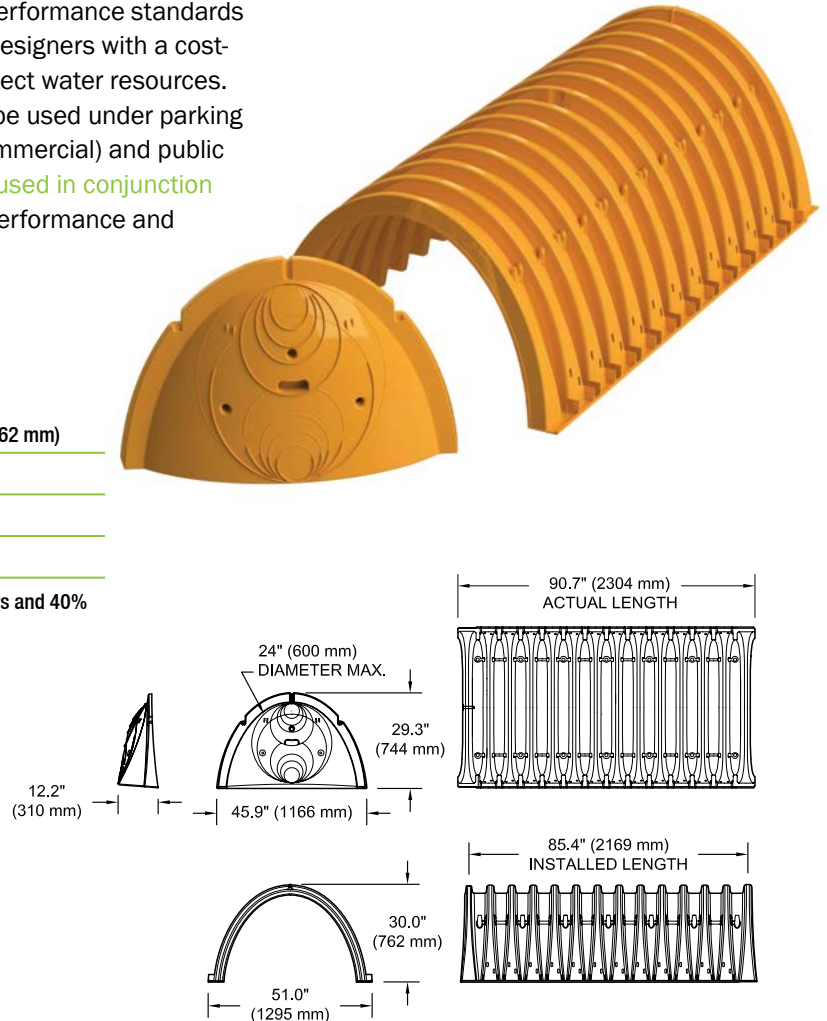
*Assumes 6 (150 mm) stone above, below and between chambers and 40% stone porosity.

Shipping

30 chambers/pallet

60 end caps/pallet

12 pallets/truck



*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 24" (600 mm).

THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

SC-740 Cumulative Storage Volumes per chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6 (150 mm) Stone Base Under Chambers.

Depth of Water in System Inches (mm)		Cumulative Chamber Storage ft ³ (m ³)	Total System Cumulative Storage ft ³ (m ³)
42 (1067)	Stone Cover	45.90 (1.300)	74.90 (2.121)
41 (1041)		45.90 (1.300)	73.77 (2.089)
40 (1016)		45.90 (1.300)	72.64 (2.057)
39 (991)		45.90 (1.300)	71.52 (2.025)
38 (965)		45.90 (1.300)	70.39 (1.993)
37 (940)		45.90 (1.300)	69.26 (1.961)
36 (914)		45.90 (1.300)	68.14 (1.929)
35 (889)		45.85 (1.298)	66.98 (1.897)
34 (864)		45.69 (1.294)	65.75 (1.862)
33 (838)		45.41 (1.286)	64.46 (1.825)
32 (813)	Stone Foundation	44.81 (1.269)	62.97 (1.783)
31 (787)		44.01 (1.246)	61.36 (1.737)
30 (762)		43.06 (1.219)	59.66 (1.689)
29 (737)		41.98 (1.189)	57.89 (1.639)
28 (711)		40.80 (1.155)	56.05 (1.587)
27 (686)		39.54 (1.120)	54.17 (1.534)
26 (660)		38.18 (1.081)	52.23 (1.479)
25 (635)		36.74 (1.040)	50.23 (1.422)
24 (610)		35.22 (0.977)	48.19 (1.365)
23 (584)		33.64 (0.953)	46.11 (1.306)
22 (559)	Stone Foundation	31.99 (0.906)	44.00 (1.246)
21 (533)		30.29 (0.858)	41.85 (1.185)
20 (508)		28.54 (0.808)	39.67 (1.123)
19 (483)		26.74 (0.757)	37.47 (1.061)
18 (457)		24.89 (0.705)	35.23 (0.997)
17 (432)		23.00 (0.651)	32.96 (0.939)
16 (406)		21.06 (0.596)	30.68 (0.869)
15 (381)		19.09 (0.541)	28.36 (0.803)
14 (356)		17.08 (0.484)	26.03 (0.737)
13 (330)		15.04 (0.426)	23.68 (0.670)
12 (305)	Stone Foundation	12.97 (0.367)	21.31 (0.608)
11 (279)		10.87 (0.309)	18.92 (0.535)
10 (254)		8.74 (0.247)	16.51 (0.468)
9 (229)		6.58 (0.186)	14.09 (0.399)
8 (203)		4.41 (0.125)	11.66 (0.330)
7 (178)		2.21 (0.063)	9.21 (0.264)
6 (152)		0 (0)	6.76 (0.191)
5 (127)		0 (0)	5.63 (0.160)
4 (102)		0 (0)	4.51 (0.128)
3 (76)		0 (0)	3.38 (0.096)
2 (51)	Stone Foundation	0 (0)	2.25 (0.064)
1 (25)		0 (0)	1.13 (0.032)

Note: Add 1.13 ft³ (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage ft ³ (m ³)	Chamber and Stone Foundation Depth in. (mm)		
		6 (150)	12 (300)	18 (450)
SC-740 Chamber	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)

Note: Assumes 6 (150 mm) stone above chambers, 6 (150 mm) row spacing and 40% stone porosity.

Amount of Stone Per Chamber

TONS (yds ³)	Stone Foundation Depth		
	6	12	16
SC-740	3.8 (2.8)	4.6 (3.3)	5.5 (3.9)
KILOGRAMS (m ³)	150 mm	300 mm	450 mm
SC-740	3,450 (2.1)	4,170 (2.5)	4,490 (3.0)

Note: Assumes 6 (150 mm) of stone above and between chambers.

Volume Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6 (150)	12 (300)	18 (450)
SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)

Note: Assumes 6 (150 mm) of row separation and 18 (450 mm) of cover. The volume of excavation will vary as depth of cover increases.



2.0 Product Information

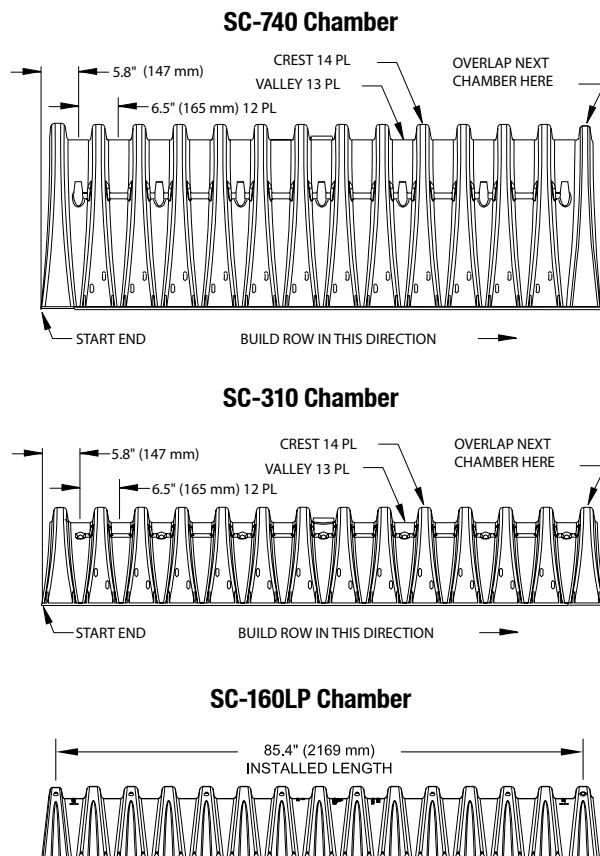
2.5 STORMTECH CHAMBERS

StormTech chamber systems have unique features to improve site optimization and reduce product waste. The SC-160LP, SC-310, SC-740, and DC-780 chambers can be cut at the job site in approximately 6.5 (165 mm) increments to shorten a chamber's length. Designing and constructing chamber rows around site obstacles is easily accomplished by including specific cutting instructions or a well placed cut to fit note on the design plans. The last chamber of a row can be cut in any of its corrugation's valleys. An end cap placed into the trimmed corrugation's crest completes the row. The trimmed-off piece of a StormTech chamber may then be used to start the next row. See **Figure 4**.

To assist the contractor, StormTech chambers are molded with simple assembly instructions and arrows that indicate the direction in which to build rows. Rows are formed by overlapping the next chamber's Start End corrugation with the previously laid chamber's end corrugation. Two people can safely and efficiently form rows of chambers without complicated connectors, special tools or heavy equipment.

Product Specifications: 2.2, 2.4, 2.5, 2.9 and 3.2.

FIGURE 4 - Distance Between Corrugations (not to scale)



2.6 STORMTECH END CAPS

The StormTech end cap has features which make the chamber system simple to design, easy to build and more versatile than other products. StormTech end caps can be easily secured within any corrugation's crest. A molded-in handle makes attaching the end cap a one-person operation. Tools or fasteners are not required.

StormTech end caps are required at each end of a chamber row to prevent stone intrusion (two per row). The SC-740 and DC-780 end caps will accept up to a 24 (600 mm) HDPE inlet pipe. The SC-310 end cap will accept up to a 12 (300 mm) HDPE inlet pipe. The SC-160LP will accept either a 6 or 8 (150 mm or 200 mm) HDPE inlet pipe. See **Figure 5**.

Product Specifications: 3.1, 3.2, 3.3 and 3.4

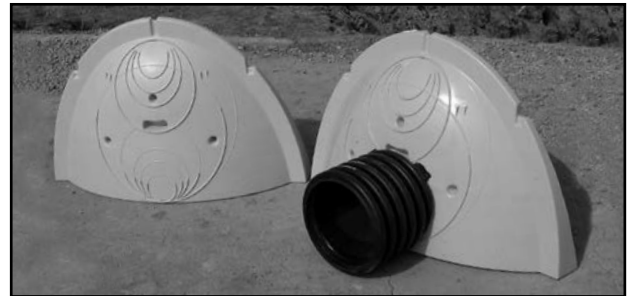
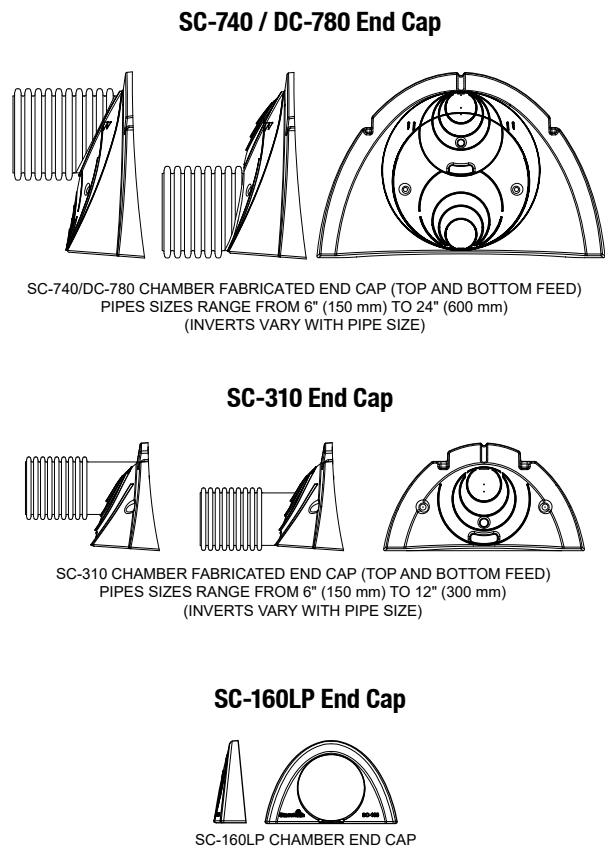


FIGURE 5 - Chamber End Caps (not to scale)



3.0 Structural Capabilities



3.1 STRUCTURAL DESIGN APPROACH

When installed per StormTech's minimum requirements, StormTech products are designed to exceed American Association of State Highway and Transportation Officials (AASHTO) LRFD recommended design factors for Earth loads and Vehicular live loads. AASHTO Vehicular live loads (previously HS-20) consist of two heavy axle configurations, that of a single 32 (142 kN) kip axle and that of tandem 25 (111 kN) kip axles. Factors for impact and multiple presences of vehicles ensure a conservative design where structural adequacy is assumed for a wide range of street legal vehicle weights and axle configurations.

Computer models of the chambers under shallow and deep conditions were developed. Utilizing design forces from computer models, chamber sections were evaluated using AASHTO procedures that consider thrust and moment, and check for local buckling capacity. The procedures also considered the time-dependent strength and stiffness properties of polypropylene and polyethylene. These procedures were developed in a research study conducted by the National Cooperative Highway Research Program (NCHRP) for AASHTO, and published as NCHRP Report 438 Recommended LRFD Specifications for Plastic Pipe and Culverts. *Product Specifications: 2.12.*

StormTech does not recommend installing StormTech products underneath buildings or parking garages. When specifying the StormTech products in close proximity to buildings, it is important to ensure that the StormTech products are not receiving any loads from these structures that may jeopardize the long term performance of the chambers.



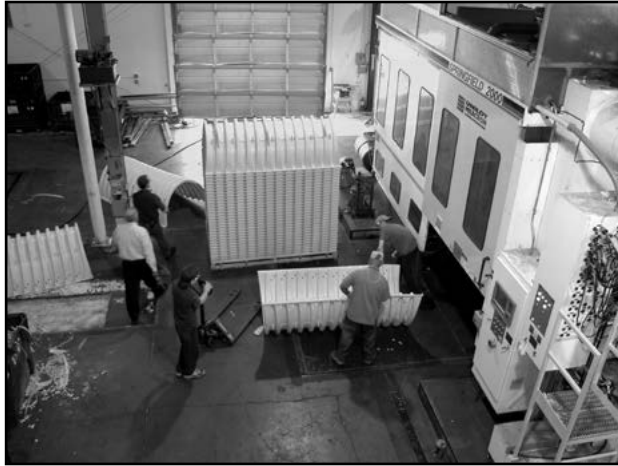
3.2 FULL SCALE TESTING

After developing the StormTech chamber designs, the chambers were subjected to rigorous full-scale testing. The test programs verified the predicted safety factors of the designs by subjecting the chambers to more severe load conditions than anticipated during service life. Capacity under live loads and deep fill was investigated by conducting tests with a range of cover depths. Monitoring of long term deep fill installations has been done to validate the long term performance of the StormTech products.

3.3 INDEPENDENT EXPERT ANALYSIS

StormTech worked closely with the consulting firm Simpson Gumpertz & Heger Inc. (SGH) to develop and evaluate the SC-160LP, SC-310, SC-740 and DC-780 chamber designs. SGH has world-renowned expertise in the design of buried drain age structures. The firm was the principal investigator for the NCHRP research program that developed the structural analysis and design methods adopted by AASHTO for thermoplastic culverts. SGH conducted design calculations and computer simulations of chamber performance under various installation and live load conditions. They worked with StormTech to design the full-scale test programs to verify the structural capacity of the chambers. SGH also observed all full-scale tests and inspected the chambers after completion of the tests. SGH continues to be StormTech's structural consultant.

3.0 Structural Capabilities



3.4 INJECTION MOLDING

To comply with both the structural and design requirements of AASHTO's LRFD specifications and ASTM F2787 as well as the product requirements of ASTM F2418 or ASTM F2922, StormTech uses proprietary injection molding equipment to manufacture the chambers and end caps.

In addition to meeting structural goals, injection molding allows StormTech to design added features and advantages into StormTech's parts including:

- Precise control of wall thickness throughout parts
- Precise fit of joints and end caps
- Molded-in inspection port fitting
- Molded-in handles on end caps
- Molded-in pipe guides with blade starter slots
- Repeatability for Quality Control (See Section 3.6)

Product Specifications: 2.1, 3.1 and 3.3

3.5 POLYPROPYLENE AND POLYETHYLENE RESIN

StormTech chambers are injection molded from polypropylene and polyethylene. Polypropylene and polyethylene chambers are inherently resistant to chemicals typically found in stormwater run-off. StormTech chambers maintain a greater portion of their structural stiffness through higher installation and service temperatures.

StormTech polypropylene and polyethylene are virgin materials specially designed to achieve a high 75-year creep modulus that is necessary to provide a sound long-term structural design. Since the modulus remains high well beyond the 75-year value, StormTech chambers can exhibit a service life in excess of 75 years.



3.6 QUALITY CONTROL

StormTech chambers are manufactured under tight quality control programs. Materials are routinely tested in an environmentally controlled lab that is verified every six months via the external ASTM Proficiency Testing Program. The chamber material properties are measured and controlled with procedures following ISO 9001:2000 requirements.

Statistical Process Control (SPC) techniques are applied during manufacturing. Established upper and lower control limits are maintained on key manufacturing parameters to maintain consistent product.

Product Specifications: 2.13 and 3.6

4.0 Foundation for Chambers

4.1 FOUNDATION REQUIREMENTS

StormTech chamber systems and embedment stone may be installed in various native soil types. The subgrade bearing capacity and chamber cover height determine the required depth of clean, crushed, angular stone for the chamber foundation. The chamber foundation is the clean, crushed, angular stone placed between the subgrade soils and the feet of the chamber.

As cover height increases (top of chamber to top of finished grade) the chambers foundation requirements increase. Foundation strength is the product of the subgrade soils bearing capacity and the depth of clean, crushed, angular stone below the chamber foot. **Table 1** for the SC-160LP, **Table 2** for the SC-740 and SC-310, **Table 3** for the SC-310-3, and **Table 4** for the DC-780 specify the required minimum foundation depth for varying cover heights and subgrade bearing capacities. For additional guidance on foundation stone design please see our Technical Note 6.22 - StormTech Subgrade Performance.

4.2 WEAKER SOILS

For sub-grade soils with allowable bearing capacity less than 2000 pounds per square foot [(2.0 ksf) (96 kPa)], a geotechnical engineer should evaluate the specific conditions. These soils are often highly variable, may contain organic materials and could be more sensitive to

moisture. A geotechnical engineer's recommendations may include increasing the stone foundation, improving the bearing capacity of the sub-grade soils through compaction, replacement, or other remedial measures including the use of geogrids. The use of a thermoplastic liner may also be considered for systems installed in subgrade soils that are highly affected by moisture. The project engineer is responsible for ensuring overall site settlement is within acceptable limits. A geotechnical engineer should always review installation of StormTech chambers on organic soils.

4.3 CHAMBER SPACING OPTION

No spacing is required between the SC-160LP chambers. StormTech requires a minimum of 6 (150 mm) clear spacing between the feet of chambers rows for the SC-310, SC-740 and DC-780 chambers. However, increasing the spacing between chamber rows may allow the application of StormTech chambers with either less foundation stone or with weaker subgrade soils. This may be a good option where a vertical restriction on site prevents the use of a deeper foundation. Contact StormTech's Technical Service Department for more information on this option. In all cases, StormTech recommends consulting a geotechnical engineer for subgrade soils with a bearing capacity less than 2.0 ksf (96 kPa).

TABLE 1 - SC-160LP Bearing Capacity Table

(Assumes no spacing) Minimum Required Foundation Depth in Inches (mm)

Cover Hgt. ft. (m)	Minimum Bearing Resistance for Service Loads ksf (kPa)																		
	4.4-3.8 (211 to 182)	3.7 (177)	3.6 (172)	3.5 (168)	3.4 (163)	3.3 (158)	3.2 (153)	3.1 (148)	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)	2.1 (101)	2.0 (95)
1.0 (0.31)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)
1.2 (0.46)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)
1.5 (0.46)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)
2.0 (0.61)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)
2.5 (0.76)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)
3.0 (0.91)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)
3.5 to 6.0 (1.07 to 1.86)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)
6.5 (1.98)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)
7.0 (2.13)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)
7.5 (2.30)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)
8.0 (2.44)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)
8.5 (2.59)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)
9.0 (2.74)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)
9.5 (2.89)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)
10.0 (3.05)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

4.0 Foundations for Chambers

TABLE 2 - SC-310 Minimum Required Foundation Depth in inches (millimeters)

Cover Hgt. ft. (m)	Minimum Required Bearing Resistance for Service Loads ksf (kPa)																			
	4.1 (196)	4.0 (192)	3.9 (187)	3.8 (182)	3.7 (177)	3.6 (172)	3.5 (168)	3.4 (163)	3.3 (158)	3.2 (153)	3.1 (148)	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)
1.5 (0.46)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)
2.0 (0.61)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)
2.5 (0.76)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)
3.0 (0.91)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)
3.5 (1.07)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)
4.0 (1.22)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)
4.5 (1.37)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)
5.0 (1.52)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)
5.5 (1.68)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)
6.0 (1.83)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)
6.5 (1.98)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)
7.0 (2.13)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)
7.5 (2.30)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)
8.0 (2.44)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

TABLE 3 - SC-740 Minimum Required Foundation Depth in inches (millimeters)

Cover Hgt. ft. (m)	Minimum Required Bearing Resistance for Service Loads ksf (kPa)																			
	4.1 (196)	4.0 (192)	3.9 (187)	3.8 (182)	3.7 (177)	3.6 (172)	3.5 (168)	3.4 (163)	3.3 (158)	3.2 (153)	3.1 (148)	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)
1.5 (0.46)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
2.0 (0.61)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
2.5 (0.76)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
3.0 (0.91)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
3.5 (1.07)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
4.0 (1.22)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
4.5 (1.37)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
5.0 (1.52)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
5.5 (1.68)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
6.0 (1.83)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
6.5 (1.98)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
7.0 (2.13)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
7.5 (2.30)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)
8.0 (2.44)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	15 (375)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

4.0 Foundations for Chambers

TABLE 4 - SC-310-3 Minimum Required Foundation Depth in inches (millimeters)

Cover Hgt. ft. (m)	Minimum Required Bearing Resistance for Service Loads ksf (kPa)										
	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)	2.1 (101)	2.0 (96)
1.5 (0.46)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)
2.0 (0.61)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)
2.5 (0.76)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)
3.0 (0.91)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)
3.5 (1.07)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)
4.0 (1.22)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)
4.5 (1.37)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)
5.0 (1.52)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)
5.5 (1.68)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)
6.0 (1.83)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)
6.5 (1.98)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)
7.0 (2.13)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)
7.5 (2.30)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)
8.0 (2.44)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

Table 5 – DC-780 Minimum Required Foundation Depth in inches (millimeters)

Cover Hgt. ft. (m)	Minimum Required Bearing Resistance for Service Loads ksf (kPa)																			
	4.1 (196)	4.0 (192)	3.9 (187)	3.8 (182)	3.7 (177)	3.6 (172)	3.5 (168)	3.4 (163)	3.3 (158)	3.2 (153)	3.1 (148)	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)
8.5 (2.59)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)
9.0 (2.74)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)
9.5 (2.90)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)
10.0 (3.05)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)
10.5 (3.20)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)
11.0 (3.35)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	30 (750)
11.5 (3.50)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	30 (750)
12.0 (3.66)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

5.0 Cumulative Storage Volumes

Tables 4, 5, 6 and 7 provide cumulative storage volumes for the SC-160LP, SC-310, SC-740 and DC-780 chamber systems. This information may be used to calculate a detention/retention system's stage storage volume. A spreadsheet is available at www.stormtech.com in which the number of chambers can be input for quick cumulative storage calculations.

Product Specifications: 1.1, 2.2, 2.3, 2.4, and 2.6

Table 4 - SC-160LP Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 4 (100 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft ³ (m ³)	Total System Cumulative Storage ft ³ (m ³)
22 (559)	6.85 (0.194)	14.98 (0.424)
21 (533)	6.85 (0.194)	14.49 (0.410)
20 (508)	6.85 (0.194)	14.00 (0.396)
19 (483)	6.85 (0.194)	13.50 (0.382)
18 (457)	6.85 (0.194)	13.01 (0.368)
17 (432)	6.85 (0.194)	12.51 (0.354)
16 (406)	6.85 (0.194)	12.02 (0.340)
15 (381)	6.80 (0.193)	11.49 (0.325)
14 (356)	6.67 (0.189)	10.92 (0.309)
13 (330)	6.38 (0.181)	10.25 (0.290)
12 (305)	5.94 (0.168)	9.49 (0.269)
11 (279)	5.40 (0.153)	8.67 (0.246)
10 (254)	4.78 (0.135)	7.81 (0.221)
9 (229)	4.10 (0.116)	6.91 (0.196)
8 (203)	3.36 (0.095)	5.97 (0.169)
7 (178)	2.58 (0.073)	5.01 (0.142)
6 (152)	1.76 (0.050)	4.02 (0.114)
5 (127)	0.89 (0.025)	3.01 (0.085)
4 (102)	0 (0)	1.98 (0.056)
3 (76)	0 (0)	1.48 (0.042)
2 (51)	0 (0)	0.99 (0.028)
1 (25)	0 (0)	0.49 (0.014)

Note: Add 0.49 ft³ (0.014 m³) of storage for each additional inch (25 mm) of stone foundation.

Table 5 - SC-310 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6 (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft ³ (m ³)	Total System Cumulative Storage ft ³ (m ³)
28 (711)	14.70 (0.416)	31.00 (0.878)
27 (686)	14.70 (0.416)	30.21 (0.855)
26 (680)	14.70 (0.416)	29.42 (0.833)
25 (635)	14.70 (0.416)	28.63 (0.811)
24 (610)	14.70 (0.416)	27.84 (0.788)
23 (584)	14.70 (0.416)	27.05 (0.766)
22 (559)	14.70 (0.416)	26.26 (0.748)
21 (533)	14.64 (0.415)	25.43 (0.720)
20 (508)	14.49 (0.410)	24.54 (0.695)
19 (483)	14.22 (0.403)	23.58 (0.668)
18 (457)	13.68 (0.387)	22.47 (0.636)
17 (432)	12.99 (0.368)	21.25 (0.602)
16 (406)	12.17 (0.345)	19.97 (0.566)
15 (381)	11.25 (0.319)	18.62 (0.528)
14 (356)	10.23 (0.290)	17.22 (0.488)
13 (330)	9.15 (0.260)	15.78 (0.447)
12 (305)	7.99 (0.227)	14.29 (0.425)
11 (279)	6.78 (0.192)	12.77 (0.362)
10 (254)	5.51 (0.156)	11.22 (0.318)
9 (229)	4.19 (0.119)	9.64 (0.278)
8 (203)	2.83 (0.081)	8.03 (0.227)
7 (178)	1.43 (0.041)	6.40 (0.181)
6 (152)	0	4.74 (0.134)
5 (127)	0	3.95 (0.112)
4 (102)	0	3.16 (0.090)
3 (76)	0	2.37 (0.067)
2 (51)	0	1.58 (0.046)
1 (25)	0	0.79 (0.022)

Note: Add 0.79 ft³ (0.022 m³) of storage for each additional inch (25 mm) of stone foundation.

5.0 Cumulative Storage Volumes

Table 6 - SC-740 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6 (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft ³ (m ³)	Total System Cumulative Storage ft ³ (m ³)
42 (1067)	↑ 45.90 (1.300)	74.90 (2.121)
41 (1041)	↑ 45.90 (1.300)	73.77 (2.089)
40 (1016)	Stone 45.90 (1.300)	72.64 (2.057)
39 (991)	Cover 45.90 (1.300)	71.52 (2.025)
38 (965)	↓ 45.90 (1.300)	70.39 (1.993)
37 (948)	↓ 45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.17 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	41.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.69 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.309)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	↑ 0	6.76 (0.191)
5 (127)	↑ 0	5.63 (0.160)
4 (102)	Stone 0	4.51 (0.125)
3 (76)	Foundation 0	3.38 (0.095)
2 (51)	↓ 0	2.25 (0.064)
1 (25)	↓ 0	1.13 (0.032)

Note: Add 1.13 ft³ (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Table 7 - DC-780 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 9 (230 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft ³ (m ³)	Total System Cumulative Storage ft ³ (m ³)
45 (1143)	↑ 46.27 (1.310)	78.47 (2.222)
44 (1118)	↑ 46.27 (1.310)	77.34 (2.190)
43 (1092)	Stone 46.27 (1.310)	76.21 (2.158)
42 (1067)	Cover 46.27 (1.310)	75.09 (2.126)
41 (1041)	↓ 46.27 (1.310)	73.96 (2.094)
40 (1016)	↓ 46.27 (1.310)	72.83 (2.062)
39 (991)	46.27 (1.310)	71.71 (2.030)
38 (965)	46.21 (1.309)	70.54 (1.998)
37 (948)	46.04 (1.304)	69.32 (1.963)
36 (914)	45.76 (1.296)	68.02 (1.926)
35 (889)	45.15 (1.278)	66.53 (1.884)
34 (864)	44.34 (1.255)	64.91 (1.838)
33 (838)	43.38 (1.228)	63.21 (1.790)
32 (813)	42.29 (1.198)	61.43 (1.740)
31 (787)	41.11 (1.164)	59.59 (1.688)
30 (762)	39.83 (1.128)	57.70 (1.634)
29 (737)	38.47 (1.089)	55.76 (1.579)
28 (711)	37.01 (1.048)	53.76 (1.522)
27 (686)	35.49 (1.005)	51.72 (1.464)
26 (660)	33.90 (0.960)	49.63 (1.405)
25 (635)	32.24 (0.913)	47.52 (1.346)
24 (610)	30.54 (0.865)	45.36 (1.285)
23 (584)	28.77 (0.815)	43.18 (1.223)
22 (559)	26.96 (0.763)	40.97 (1.160)
21 (533)	25.10 (0.711)	38.72 (1.096)
20 (508)	23.19 (0.657)	36.45 (1.032)
19 (483)	21.25 (0.602)	34.16 (0.967)
18 (457)	19.26 (0.545)	31.84 (0.902)
17 (432)	17.24 (0.488)	29.50 (0.835)
16 (406)	15.19 (0.430)	27.14 (0.769)
15 (381)	13.10 (0.371)	24.76 (0.701)
14 (356)	10.98 (0.311)	22.36 (0.633)
13 (330)	8.83 (0.250)	19.95 (0.565)
12 (305)	6.66 (0.189)	17.52 (0.496)
11 (279)	4.46 (0.126)	15.07 (0.427)
10 (254)	2.24 (0.064)	12.61 (0.357)
9 (229)	↑ 0	10.14 (0.287)
8 (203)	↑ 0	9.01 (0.255)
7 (178)	↑ 0	7.89 (0.223)
6 (152)	↑ 0	6.76 (0.191)
5 (127)	Stone 0	5.63 (0.160)
4 (102)	Foundation 0	4.51 (0.128)
3 (76)	↓ 0	3.38 (0.096)
2 (51)	↓ 0	2.25 (0.064)
1 (25)	↓ 0	1.13 (0.032)

Note: Add 1.13 ft³ (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

6.0 Required Materials/Row Separation

6.1 CHAMBER ROW SEPARATION

StormTech SC-740, SC-310 and DC-780 chambers must be specified with a minimum 6 (150 mm) space between the feet of adjacent parallel chamber rows. No spacing is required between the SC-160LP chambers. Increasing the space between rows is acceptable. This will increase the storage volume due to additional stone voids.

6.2 STONE SURROUNDING CHAMBERS

Refer to **Table 8** for acceptable stone materials. StormTech requires clean, crushed, angular stone below, between and above chambers as shown in **Figure 6**. Acceptable gradations are listed in **Table 8**. Subrounded and rounded stone are not acceptable.

6.3 GEOTEXTILE SEPARATION REQUIREMENT

A non-woven geotextile that meets AASHTO M288 Class 2 Separation requirements must be applied as a separation layer to prevent soil intrusion into the clean,

crushed, angular stone as shown in **Figure 6**. The geotextile is required between the clean, crushed, angular stone and the subgrade soils, the excavation's sidewalls and the fill materials. The geotextile should completely envelope the clean, crushed, angular stone. Overlap adjacent geotextile rolls per AASHTO M288 separation guidelines. Contact StormTech for a list of acceptable geotextiles.

6.4 FILL ABOVE CHAMBERS

Refer to **Table 8** and **Figure 6** for acceptable fill material above the 6 (150 mm) of clean, crushed, angular stone. Minimum and maximum fill requirements for the SC-160LP, SC-740, SC-310 and DC-780 chambers are shown in **Figure 6** below. StormTech requires a minimum of 24 (600 mm) of fill in non-paved installations where rutting from vehicles may occur. **Table 8** provides details on soil class and compaction requirements for suitable fill materials.

Table 8 – Acceptable Fill Materials

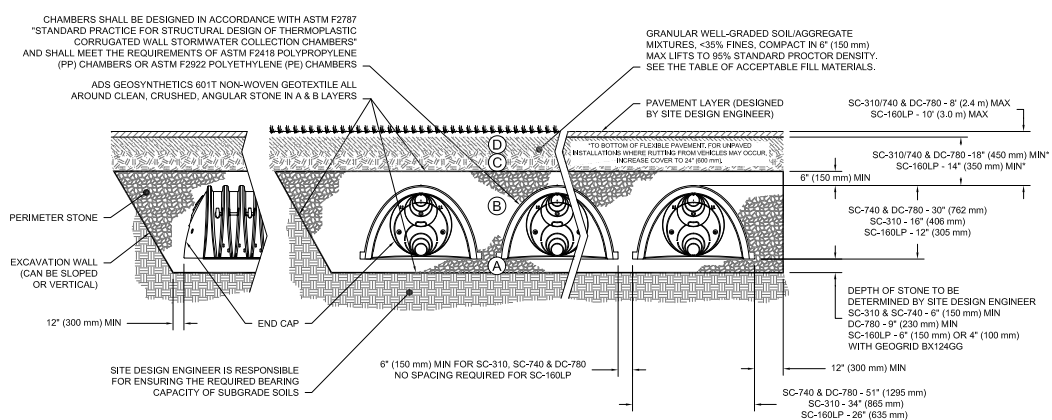
Material Location		Description	AASHTO Material Classifications	Compaction / Density Requirement
D	Final Fill: Fill material for layer 'D' starts from the top of the 'C' layer to the bottom of the flexible pavement to unpaved finished grade above. Note that pavement subbase may be part of the 'D' layer.	Any soil/rock material, native soils, or per Engineer's plans. Check plans for pavement subgrade requirements	N/A	Prepare per site design Engineer's plans. Paved installations may have stringent material and preparation requirements.
C	Initial Fill: Fill material for layer 'C' starts form the top of the embedment stone ('B' Layer) to 18 (450 mm) above the top of the chamber. Note that pavement subbase may be a part of the 'C' layer.	Granular well-graded soil/ aggregate mixtures, <35% fines or processed aggregate Most pavement subbase materials can be used in lieu of this layer	AASHTO M145 ¹ A-1, A-2-4, A-3 OR AASHTO M43 ¹ 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	Begin Compactions after 12 (300 mm) of material over the chambers is reached. Compact additional layers in 6 (150 mm) max lifts to a min. 95% proctor density for well graded material and 95% relative Density for processed aggregate materials. Roller gross vehicle weight not to exceed 12,000 lbs (53 kN). Dynamic force not to exceed 20,000 lbs (89 kN)
B	Embedment stone: Fill surrounding the chambers from the foundation stone ('A' layer) to the 'C' layer above	Clean, crushed, angular stone, nominal size distribution between ¾-2 inch (20-50 mm)	AASHTO M145 ¹ 3, 357, 4, 467, 5, 56, 57	No compaction required.
A	Foundation stone: Fill below chambers from the subgrade up to the foot (bottom) of the chamber.	Clean, crushed, angular stone, nominal size distribution between ¾-2 inch (20-50 mm)	AASHTO M145 ¹ 3, 357, 4, 467, 5, 56, 57	Plate compact or roll to achieve a flat surface. ^{2 3}

Please Note:

- The listed AASHTO designations are for gradations only. The stone must also be clean, crushed, angular. For example, a specification for #4 Stone would state: clean, crushed, angular No. 4 (AASHTO M43) Stone.
- StormTech compaction requirements are met for 'A' location materials when placed and compacted in 6 (150 mm) (MAX) Lifts using two full coverages with a vibratory compactor.
- Where infiltration surfaces may be compromised by compaction, for standard design load conditions, a flat surface may be achieved by raking of dragging without compaction equipment. For special load designs, contact StormTech for compaction requirements.

Figure 6 – Fill Material Locations

Once layer 'C' is placed any soil/ material can be placed in layer 'D' up to the finished grade. Most pavement subbase soils can be used to replace the materials requirements of layer 'C' or 'D' at the design engineer's discretion.



7.0 Inletting the Chambers

The design flexibility of a StormTech chamber system includes many inletting possibilities. Contact StormTech's Technical Service Department for guidance on designing an inlet system to meet specific site goals.

7.1 TREATMENT TRAIN

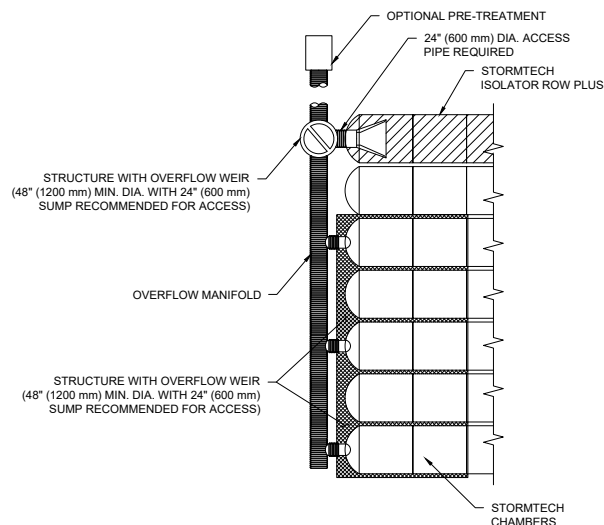
A properly designed inlet system can ensure good water quality, easy inspection and maintenance, and a long system service life. StormTech recommends a treatment train approach for inletting an underground stormwater management system under a typical commercial parking area. Treatment train is an industry term for a multi-tiered water quality network. As shown in **Figure 7**, a StormTech recommended inlet system can inexpensively have tiers of treatment upstream of the StormTech chambers:

Tier 1 – Pre-treatment (BMP)

Tier 2 – StormTech Isolator® Row PLUS

Tier 3 – Enhanced Treatment (BMP)

Figure 7 - Typical StormTech Treatment Train Inlet System



7.2 PRE-TREATMENT (BMP) – TREATMENT TIER 1

In some areas pre-treatment of the stormwater is required prior to entry into a stormwater system. By treating the stormwater prior to entry into the system, the service life of the system can be extended, pollutants such as hydrocarbons may be captured, and local regulations met. Pre-treatment options are often described as a Best Management Practice or simply a BMP.

Pre-treatment devices differ greatly in complexity, design and effectiveness. Depending on a site's characteristics and treatment goals, the simple, least expensive pretreatment solutions can sometimes be just as effective as the complex systems. Options include a simple deep sumped manhole with a 90° bend on its outlet, baffle boxes, swirl concentrators, and devices that combine these processes. Some of the most effective pretreatment options combine engineered site grading with vegetation such as bio-swales or grassy strips.

The type of pretreatment device specified as the first level of treatment up-stream of a StormTech chamber

system can vary greatly throughout the country and from site-to-site. It is the responsibility of the design engineer to understand the water quality requirements and design a stormwater treatment system that will satisfy local regulators and follow applicable laws. A design engineer should apply their understanding of local weather conditions, site topography, local maintenance requirements, expected service life, etc. to select an appropriate stormwater pre-treatment system.

7.3 STORMTECH ISOLATOR ROW PLUS – TREATMENT TIER 2

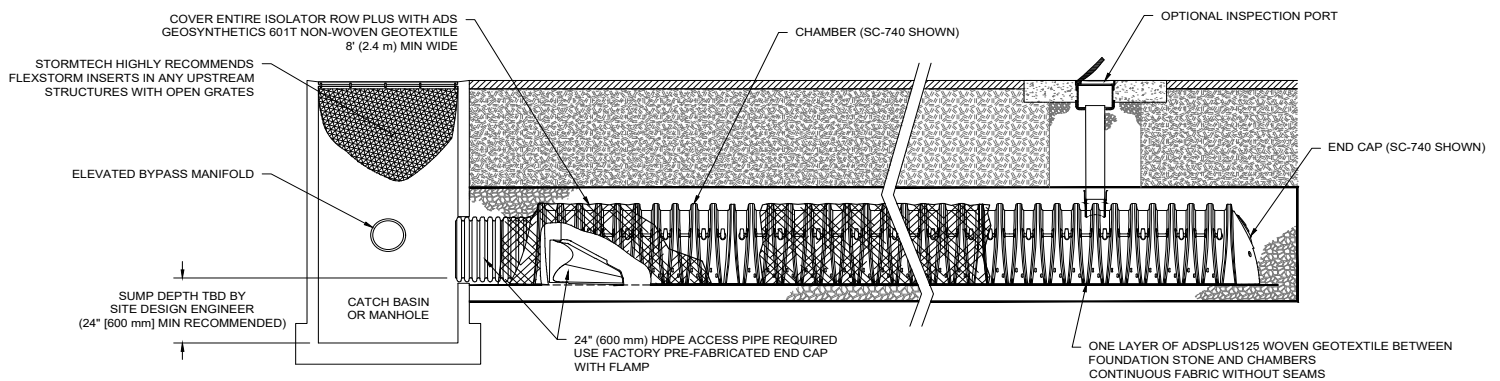
StormTech has a patented technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance. The StormTech Isolator Row PLUS is a row of standard StormTech chambers surrounded with appropriate filter fabrics and connected to a manhole for easy access. This application basically creates a filter/detention basin that allows water to egress through the surrounding filter fabric while sediment is trapped within. It may be best to think of the Isolator Row PLUS as a first-flush treatment device. First-Flush is a term typically used to describe the first 1/2 to 1 (13-25 mm) of rainfall or runoff on a site. The majority of stormwater pollutants are carried in the sediments of the firstflush, therefore the Isolator Row PLUS is an effective component of a treatment train.

The StormTech Isolator Row PLUS should be designed with a manhole with an overflow weir at its upstream end. The diversion manhole is multi-purposed. It can provide access to the Isolator Row PLUS for both inspection and maintenance and acts as a diversion structure. The manhole is connected to the Isolator Row PLUS with a short length of 8 (200mm) pipe for the SC-160LP chambers, 12 (300 mm) pipe for the SC-310 chamber and 24 (600 mm) pipe for the SC-740 and DC-780 chambers. These pipes are connected to the Isolator Row PLUS with an 8 (200mm) precored end cap for the SC-160LP, a 12 (300 mm) fabricated end cap for the SC-310 chamber and a 24 (600 mm) fabricated end cap for the SC-740 and DC-780 chambers. The overflow weir typically has its crest set between the top of the chamber and its midpoint. This allows storm water in excess of the Isolator Row PLUS's storage/conveyance capacity to bypass into the chamber system through the downstream manifold system.

Specifying and installing proper geotextiles is essential for efficient operation and to prevent damage to the system during the JetVac maintenance process. In a typical configuration, a single layer of ADS PLUS fabric is placed between the chambers and stone foundation. This fabric traps and filters sediments as well as protects the stone base during cleaning and maintenance. A strip of non-woven AASHTO M288 Class 2 geotextile is draped over the Isolator PLUS chamber row. This 6-8 oz. (217-278 g/m²) nonwoven filter fabric prevents sediments from migrating out of the chamber perforations while allowing modest amounts of water to flow out of the Isolator Row PLUS. **Figure 8** is a detail of the Isolator Row PLUS that shows proper application of the geotextiles. Contact StormTech for a table of acceptable geotextiles.

7.0 Inletting the Chambers

Figure 8 – StormTech Isolator Row PLUS Detail



Note: Non-woven geotextile over DC-780 Isolator Row PLUS chambers is not required.

For SC-310 and SC-740 Isolator PLUS Rows, a FLAMP (flared end ramp) is attached to the inlet pipe on the inside of the chamber end cap to provide a smooth transition from pipe invert to fabric bottom. It is configured to improve chamber function performance over time by distributing sediment and debris that would otherwise collect at the inlet. It also serves to improve the fluid and solid flow back into the inlet pipe during maintenance and cleaning, and to guide cleaning and inspection equipment back into the inlet pipe when complete.



Inspection is easily accomplished through the upstream manhole or optional inspection ports. Maintenance of an Isolator Row PLUS is fast and easy using the JetVac process through the upstream manhole. Section 12.0 explains the inspection and maintenance process in more detail.

Isolator Plus Rows can be sized to accommodate either a water quality volume or a water quality flow rate requirement. The use of filter fabric around the Isolator Row PLUS chambers allows stormwater to egress out of the row during and between storm events. The rate of egression for design is dependent upon the chamber model and sediment accumulation on the geotextile. Contact StormTech's Technical Services Department for more information on Isolator Row PLUS sizing.

7.4 ENHANCED TREATMENT (BMP) – TREATMENT TIER 3

As regulations have become more stringent, requiring higher levels of containment removal, water quality systems may be required to treat higher flow rates, greater volumes or to provide a higher level of filtration or other more sophisticated treatment process. StormTech systems can easily be configured with enhanced treatment techniques located either upstream or downstream of the retention or detention chamber system. Located upstream of an infiltration bed, between the pretreatment device and the Isolator Row PLUS, enhanced treatment provides a high level of contaminant removal which protects groundwater or better preserves the infiltration surface. Located downstream of detention, enhanced treatment provides a higher level of contaminant removal prior to discharge to a receiving body.

Enhanced treatment BMPs are normally applied where specific regulations and specific water quality product approvals are in place. StormTech works closely with providers of enhanced treatment technologies to meet local requirements.

7.5 TREATMENT TRAIN CONCLUSION

The treatment train is a highly effective water-quality approach that may not add significant cost to a StormTech system being installed under commercial parking areas. The StormTech Isolator Row PLUS adds a significant level of treatment, easy inspection and maintenance, while maintaining storage volume credit for the cost of a modest amount of geotextile. Finally where higher levels of treatment are required, StormTech can integrate other technologies into the treatment train to provide the most cost effective treatment approach. This treatment train concept provides three levels of treatment, inspection and maintenance upstream and downstream of the StormTech detention/retention bed.

7.0 Inletting the Chambers

7.6 OTHER INLET OPTIONS

While the three-tiered treatment train approach is the recommended method of inletting StormTech chambers for typical under-commercial parking applications, there are other effective inlet methods that may be considered. For instance, the Isolator Row PLUS, while adding an inexpensive level of confidence, are not always necessary. A header system with fewer inlets can be designed to further minimize the cost of a StormTech system. There may be applications where stormwater pre-treatment may not be necessary at all and the system can be inlet directly from the source. Contact StormTech's Technical Service Department to discuss inlet options.

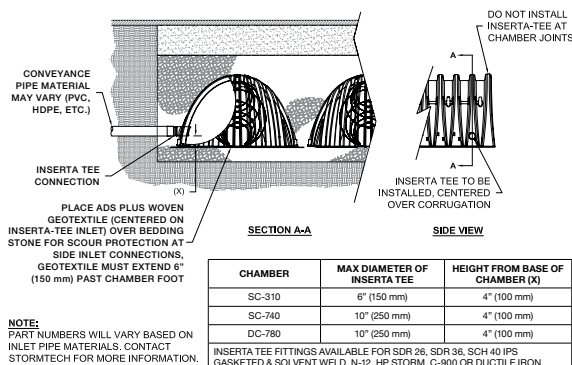
7.7 LATERAL FLOW RATES

The embedment stone surrounding the StormTech chambers allows the rapid conveyance of stormwater between chamber rows. Stormwater will rise and fall evenly within a bed of chambers. A single StormTech SC-740 chamber is able to release or accept stormwater at a rate of at least 0.5 cfs (14.2 l/s) through the surrounding stone.

7.8 INLETTING PERPENDICULAR TO A ROW OF CHAMBERS WITH INSERTA TEE

There is an easy, inexpensive method to perpendicularly inlet a row of chambers. Simply connect the inlet directly to the chamber with an Inserta Tee. Figure 9 shows a typical detail along with the standard sizes offered for each chamber model.

Figure 9 – Inserta Tee Side Detail



NOTE: SIDE INSERTA TEES CANNOT BE USED ON SC-160LP CHAMBERS.

7.9 MAXIMUM INLET PIPE VELOCITIES TO PREVENT SCOURING OF THE STONE FOUNDATION

The primary function of the inlet manifold is to convey and distribute flows to a sufficient number of rows in the chamber bed such that there is ample conveyance capacity to pass the peak flows without creating an unacceptable backwater condition in upstream piping or scour the foundation stone under the chambers.

Manifolds are connected to the end caps either at the top or bottom of the end cap. High inlet flow rates from either connection location produce a shear scour potential of the

foundation stone. Inlet flows from top inlets also produce impingement scour potential. Scour potential is reduced when standing water is present over the foundation stone. However, for safe design across the wide range of applications, StormTech assumes minimal standing water at the time the design flow occurs.

To minimize scour potential, StormTech recommends the installation of woven scour protection fabric at each inlet row. This enables a protected transition zone from the concentrated flow coming out of the inlet pipe to a uniform flow across the entire width of the chamber for both top and bottom connections. Allowable flow rates for design are dependent upon: the elevation of inlet pipe, foundation stone size and scour protection. An appropriate scour protection geotextile is installed from the end cap to at least 10.5' (3.2 m) for the SC-310, SC-740 and DC 780 chambers for both top and bottom feeding inlet pipes.

See StormTech's Tech Note 6.32 for guidance on manifold sizing. ADS's Technical Services department can also assist with sizing inlet manifolds for the StormTech chamber systems.

Table 9A – Standard Distances from Base of Chamber to Invert of Inlet and Outlet Manifolds on StormTech End Caps

SC-160LP END CAPS				
	PIPE DIA.	INV. (IN)	INV. (FT)	INV. (MM)
	6 (150mm)	0.66	0.05	16
	8 (200mm)	0.80	0.07	20
	8 (200mm) Cored	0.96	0.08	24

SC-310 END CAPS				
	PIPE DIA.	INV. (IN)	INV. (FT)	INV. (MM)
TOP	6 (150 mm)	5.8	0.48	146
	8 (200 mm)	3.5	0.29	88
	10 (250 mm)	1.4	0.12	37
BOTTOM	6 (150 mm)	0.5	0.04	12
	8 (200 mm)	0.6	0.05	15
	10 (250 mm)	0.7	0.06	18
	12 (750 mm)	0.9	0.08	24

SC-740 / DC-780 ENDCAPS				
	PIPE DIA.	INV. (IN)	INV. (FT)	INV. (MM)
TOP	6 (150 mm)	18.5	1.54	469
	8 (200 mm)	16.5	1.38	421
	10 (250 mm)	14.5	1.21	369
	12 (300 mm)	12.5	1.04	317
	15 (375 mm)	9	0.75	229
	18 (450 mm)	5	0.42	128
BOTTOM	6 (150 mm)	0.5	0.04	12
	8 (200 mm)	0.6	0.05	15
	10 (250 mm)	0.7	0.06	18
	12 (750 mm)	1.2	0.10	30
	15 (900 mm)	1.3	0.11	34
	18 (1050 mm)	1.6	0.13	40
	24 (1200 mm)	0.1	0.01	3

See StormTech's Tech Sheet #7 for manifold sizing guidance

8.0 Outlets for Chambers

8.0 OUTLETS FOR STORMTECH CHAMBER SYSTEMS

The majority of StormTech installations are detention systems and have some type of outlet structure. An outlet manifold is generally designed to ensure that peak flows can be conveyed to the outlet structure.

To drain the system completely, an underdrain system is located at or below the bottom of the foundation stone. Some beds may be designed with a pitched base to ensure complete drainage of the system. A grade of $\frac{1}{2}\%$ is usually satisfactory.

An outlet pipe may be located at a higher invert within a bed. This allows a designed volume of water to infiltrate while excess volumes are outlet as necessary. This is an excellent method of recharging groundwater, replicating a site's pre-construction hydraulics.

Depending on the bed layout and inverts, outlet pipes should be placed in the embedment stone along the bed's perimeter as shown in **Figures 10 and 11**. Solid outlet pipes should also be used to penetrate the StormTech end caps at the designed outlet invert as shown in **Figure 12**. An Isolator Row PLUS should not be directly penetrated with an outlet pipe. For systems requiring higher outlet flow rates, a combination of connections may be utilized as shown in **Figure 13**.

In detention and retention applications the discharge of water from the stormwater management system is determined based on the hydrology of the area and the hydraulic design of the system. It is the design engineer's responsibility to design an outlet system that meets their hydraulic objectives while following local laws and regulations.

Table 9B – Maximum Outlet Flow Rate Capacities from StormTech Manifolds

OUTLET FLOW		
PIPE DIA.	FLOW (CFS)	FLOW (L/S)
6 (150 mm)	0.4	11.3
8 (200 mm)	0.7	19.8
10 (250 mm)	1.0	28.3
12 (300 mm)	2.0	56.6
15 (375 mm)	2.7	76.5
18 (450 mm)	4.0	113.3
24 (600 mm)	7.0	198.2
30 (750 mm)	11.0	311.5
36 (900 mm)	16.0	453.1
42 (1050 mm)	22.0	623.0
48 (1200 mm)	28.0	792.9

Figure 10 – Underdrain Parallel

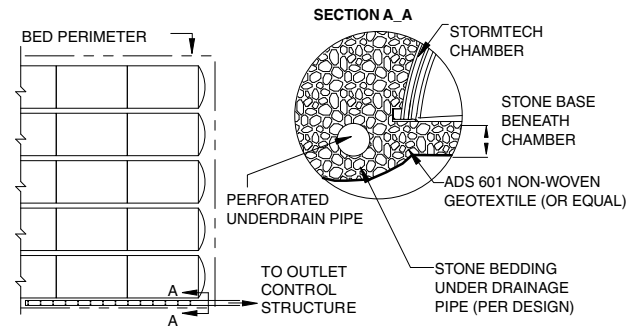


Figure 11 – Underdrain Perpendicular

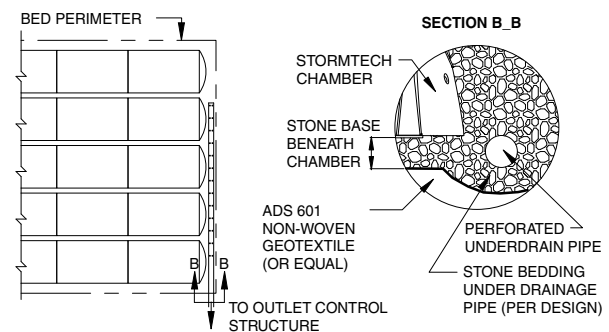


Figure 12 – Outlet Manifold

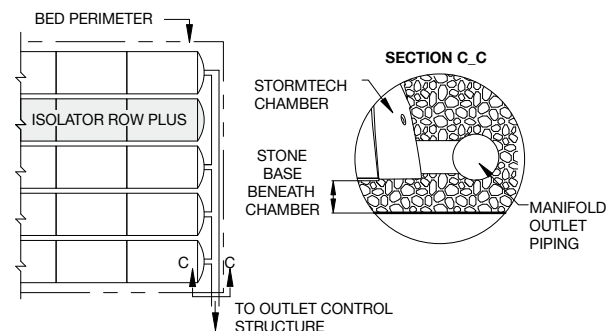
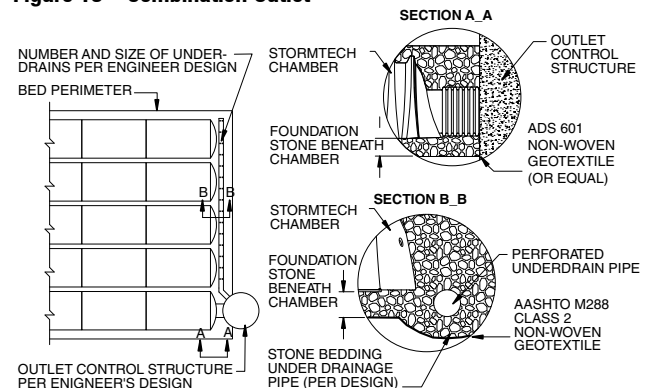


Figure 13 – Combination Outlet



9.1 EROSION CONTROL

Erosion and sediment control measures must be integrated into the plan to protect the stormwater system both during and after construction. These practices may have a direct impact on the system's infiltration performance and longevity. Vegetation, temporary sediment barriers (silt fences, hay bales, fabric-wrapped catch basin grates), and strategic stormwater runoff management may be used to control erosion and sedimentation. StormTech recommends the use of pipe plugs on the inlet pipe until the system is in service.

9.2 SITE IMPROVEMENT TECHNIQUES

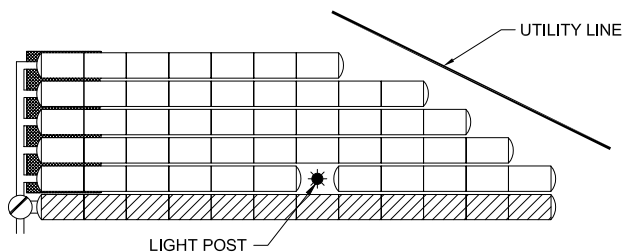
When site conditions are less than optimal, StormTech recognizes many methods for improving a site for construction. Some techniques include the removal and replacement of poor materials, the use of engineered subgrade materials, aggregates, chemical treatment, and mechanical treatments including the use of geosynthetics. StormTech recommends referring to AASHTO M 288 guidelines for the appropriate use of geotextiles.

StormTech also recognizes geogrid as a potential component of an engineered solution to improve site conditions or as a construction tool for the experienced contractor. StormTech chamber systems are compatible with the use of geosynthetics. The use of geosynthetics or any other site improvement method does not eliminate or modify any of StormTech's requirements. **It is the ultimate responsibility of the design engineer to ensure that site conditions are suitable for a StormTech chamber system.**

9.3 CONFORMING TO SITE CONSTRAINTS

StormTech chambers have the unique ability to conform to site constraints such as utility lines, light posts, large trees, etc. Rows of chambers can be ended short or interrupted by placing an end cap at the desired location, leaving the required number of chambers out of the row to get by the obstruction, then starting the row of chambers again with another end cap. See **Figure 14** for an example.

Figure 14 – Ability to Conform to Site Constraints



9.4 LINERS

StormTech chambers offer the distinct advantage and versatility that allow them to be designed as an open bottom detention or retention system. In fact, the vast majority of StormTech installations and designs are open bottom detention systems. Using an open bottom system enables treatment of the storm water through the underlying soils and provides a volume safety factor based on the infiltrative capacity of the underlying soils.

In some applications, however, open bottom detention systems may not be allowed. StormTech's Tech Sheet #2 provides guidance for the design and installation of thermoplastic liners for detention systems using StormTech chambers. The major points of the memo are:

- Infiltration of stormwater is generally a desirable stormwater management practice, often required by regulations. Lined systems should only be specified where unique site conditions preclude significant infiltration.
- Thermoplastic liners provide cost effective and viable means to contain stormwater in StormTech subsurface systems where infiltration is undesirable.
- PVC and LLDPE are the most cost effective, installed membrane materials.
- Enhanced puncture resistance from angular aggregate on the water side and from protrusions on the soil side can be achieved by placing a non-woven geotextile reinforcement on each side of the geomembrane. A sand underlayment in lieu of the geotextile reinforcement on the soil side may be considered when cost effective.
- StormTech does not design, fabricate, sell or install thermoplastic liners. StormTech recommends consulting with liner professionals for final design and installation advice.

Figure 15 – Chamber bed placed around light post.



10.0 System Sizing

For quick calculations, refer to the Site Calculator on StormTech's website at www.stormtech.com.

10.1 SYSTEM SIZING

The following steps provide the calculations necessary to size a system. If you need assistance determining the number of chambers per row or customizing the bed configuration to fit a specific site, call StormTech's Technical Services Department at 1-888-892-2694.

1) Determine the amount of storage volume (V_s) required.

It is the design engineer's sole responsibility to determine the storage volume required by local codes.

TABLE 10 - Storage Volume Per Chamber

	Bare Chamber Storage ft ³ (m ³)	Chamber and Stone Foundation Depth in. (mm)		
		6 (150)	12 (300)	18 (450)
SC-160LP	6.85 (0.19)	15.0 (0.42)	17.9 (0.51)	20.9 (0.59)
SC-310	14.7 (0.4)	31.0 (0.9)	35.7 (1.0)	40.4 (1.1)
SC-740	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)
	ft ³ (m ³)	9 (230)	12 (300)	18 (450)
DC-780	46.2 (1.3)	78.4 (2.2)	81.8 (2.3)	88.6 (2.5)

Note: Assumes 40% porosity for the stone plus the chamber volume.

2) Determine the number of chambers (C) required.

To calculate the number of chambers needed for adequate storage, divide the storage volume (V_s) by the volume of the selected chamber, as follows:

$$C = V_s / \text{Volume per Chamber}$$

3) Determine the required bed size (S).

To find the size of the bed, multiply the number of chambers needed (C) by either:

StormTech SC-160LP

bed area per chamber = 14.8 ft² (1.3 m²)

StormTech SC-310

bed area per chamber = 23.7 ft² (2.2 m²)

StormTech SC-740 / DC-780

bed area per chamber = 33.8 ft² (3.1 m²)

$$S = (C \times \text{bed area per chamber}) +$$

[1 foot (0.3 m) x bed perimeter in feet (meters)]

NOTE: It is necessary to add one foot (0.3 m) around the perimeter of the bed for end caps and working space.

4) Determine the amount of clean, crushed, angular stone (V_{st}) required.

TABLE 11 - Amount of Stone Per Chamber

	Stone Foundation Depth		
	6	12	18
ENGLISH tons (yd ³)			
SC-160LP	1.2 (0.9)	1.6 (1.2)	1.9 (1.4)
SC-310	2.1 (1.5)	2.7 (1.9)	3.4 (2.4)
SC-740	3.8 (2.8)	4.6 (3.3)	5.5 (3.9)
METRIC kg (m ³)	150 mm	300 mm	450 mm
SC-160LP	1088 (0.7)	1452 (0.9)	1724 (1.0)
SC-310	1830 (1.1)	2490 (1.5)	2990 (1.8)
SC-740	3450 (2.1)	4170 (2.5)	4490 (3.0)
ENGLISH tons (yd ³)	9	12	18
DC-780	4.2 (3.0)	4.7 (3.3)	5.6 (3.9)
METRIC kg (m ³)	230 mm	300 mm	450 mm
DC-780	3810 (2.3)	4264 (2.5)	5080 (3.0)

Note: Assumes 6 (150 mm) of stone above, and between chambers. For SC-310, SC-740 and DC-780 Chambers only.

To calculate the total amount of clean, crushed, angular stone required, multiply the number of chambers (C) by the selected weight of stone from **Table 11**.

NOTE: Clean, crushed, angular stone is also required around the perimeter of the system.

5) Determine the volume of excavation (E_x) required.

6) Determine the area of filter fabric (F) required.

TABLE 12 - Volume of Excavation Per Chamber

	Stone Foundation Depth yd ³ (m ³)		
	6 (150 mm)	12 (300 mm)	18 (450 mm)
SC-160LP	1.5 (1.1)	1.8 (1.3)	2.1 (1.5)
SC-310	2.9 (2.2)	3.4 (2.6)	3.8 (2.9)
SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)
	9 (230 mm)	12 (300 mm)	18 (450 mm)
DC-780	5.9 (4.5)	6.3 (4.8)	6.9 (5.3)

Note: Assumes 6 (150 mm) of separation between chamber rows (no spacing for the SC-160LP) and 18 (450 mm) of cover. The volume of excavation will vary as the depth of the cover increases.

Each additional foot of cover will add a volume of excavation of 1.3 yds³ (1.0 m³) per SC-740 / DC-780, 0.9 yds³ (0.7 m³) per SC-310 chamber and 0.55 yds³ (0.4 m³) per SC-160LP chamber.

The bottom and sides of the bed and the top of the embedment stone must be covered with ADS 601 (or equal) a non-woven geotextile (filter fabric). The area of the sidewalls must be calculated and a 2 foot (0.6 m) overlap must be included where two pieces of filter fabric are placed side-by-side or end-to-end. Geotextiles typically come in 15 foot (4.6 m) wide rolls.

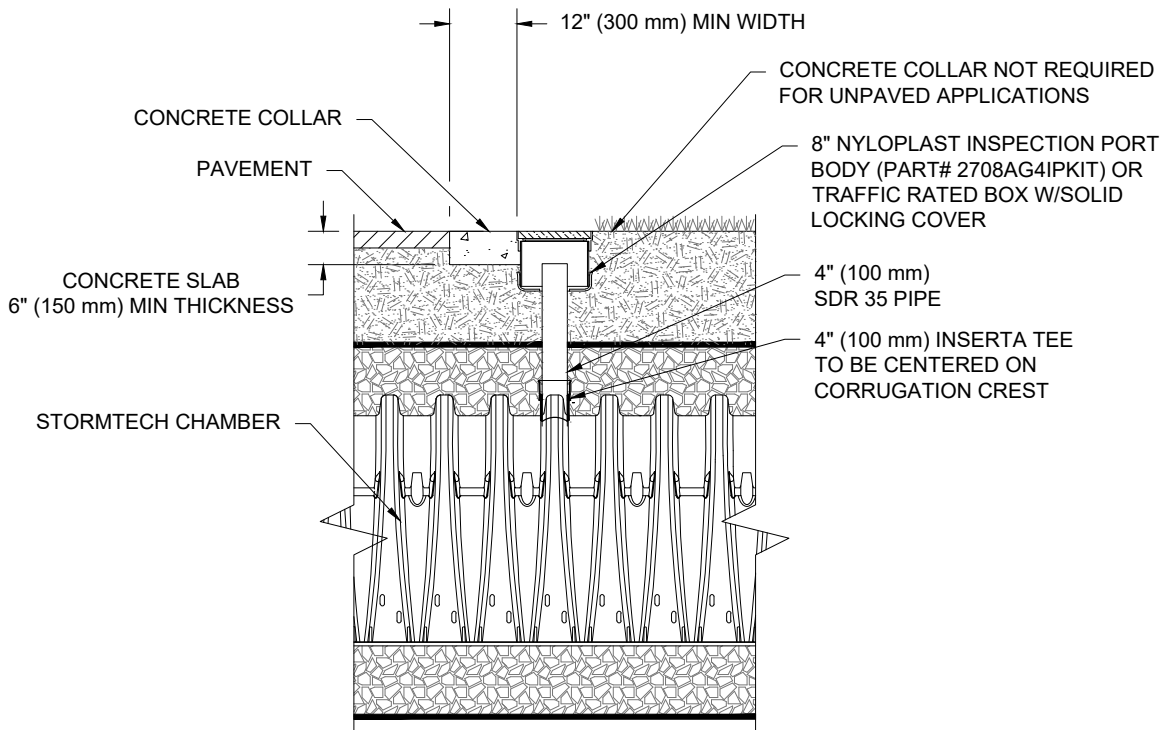
7) Determine the number of end caps (E_c) required.

Each row of chambers requires two end caps.

$$E_c = \text{number of rows} \times 2$$

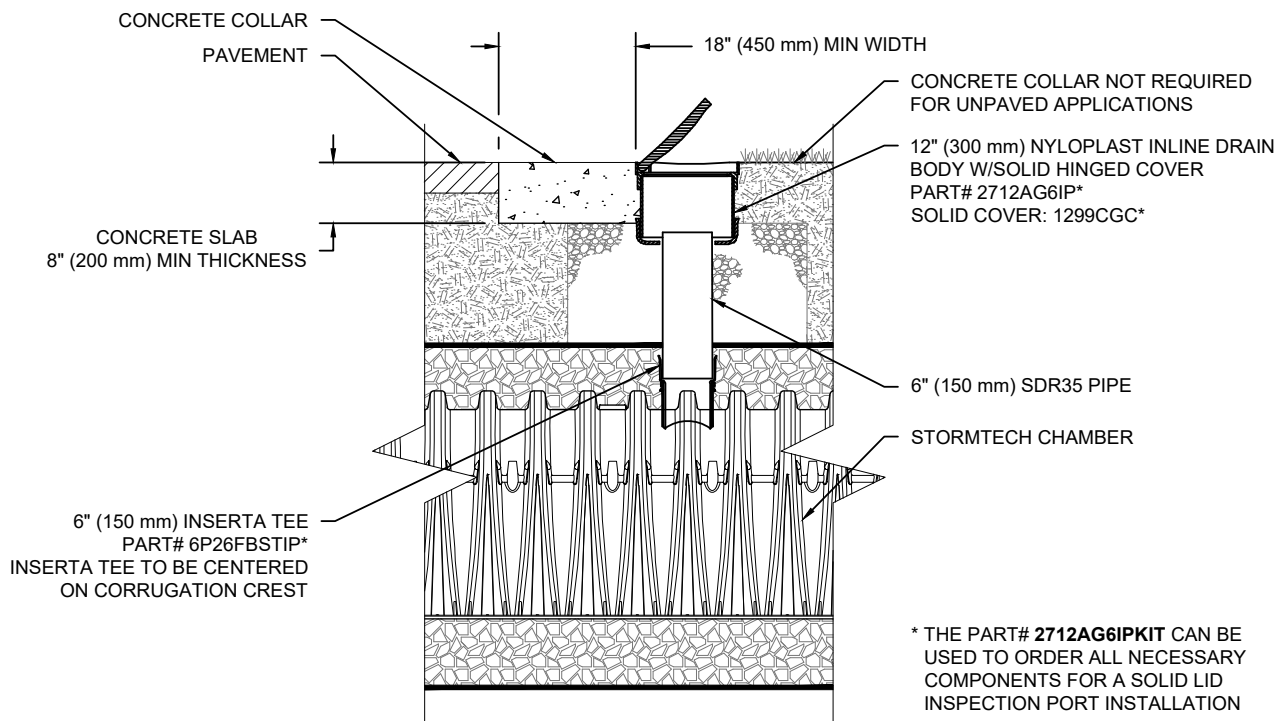
11.0 Detail Drawings

Figure 16 – 4" PVC Inspection Port Detail (SC Series Chamber)



NOTE:
INSPECTION PORTS MAY BE CONNECTED THROUGH ANY CHAMBER CORRUGATION CREST.

Figure 17 – 6 Inspection Port Detail



* THE PART# 2712AG6IPKIT CAN BE USED TO ORDER ALL NECESSARY COMPONENTS FOR A SOLID LID INSPECTION PORT INSTALLATION

11.0 Detail Drawings

Figure 18 – Under Drain Detail

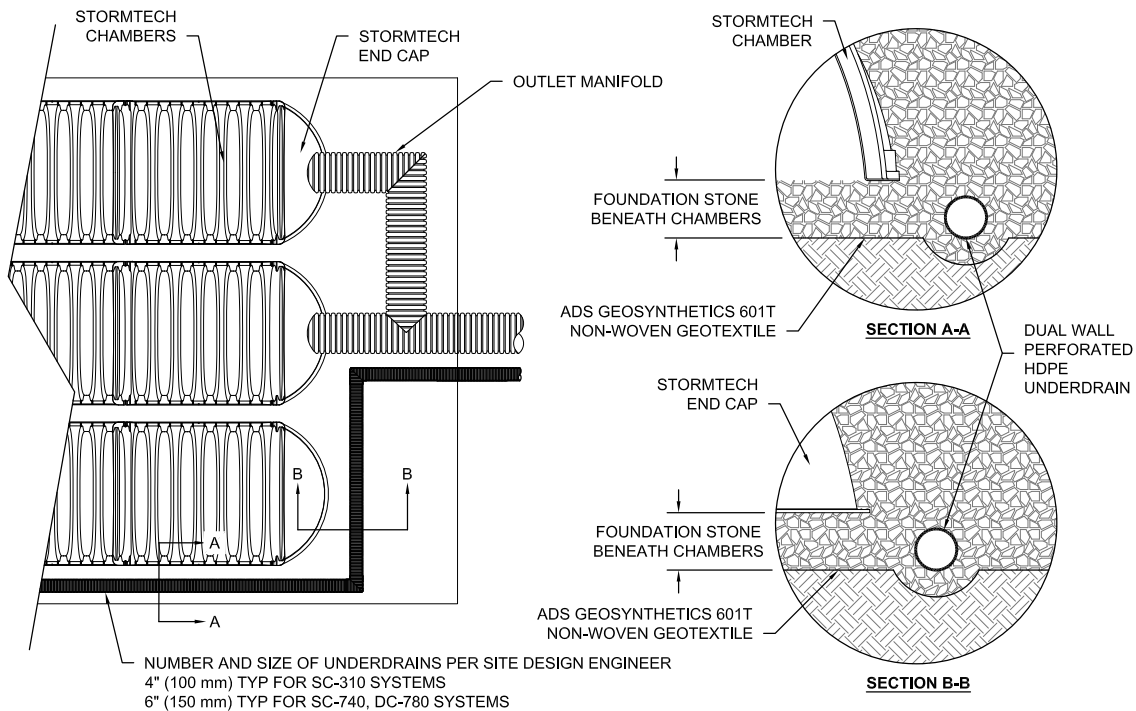
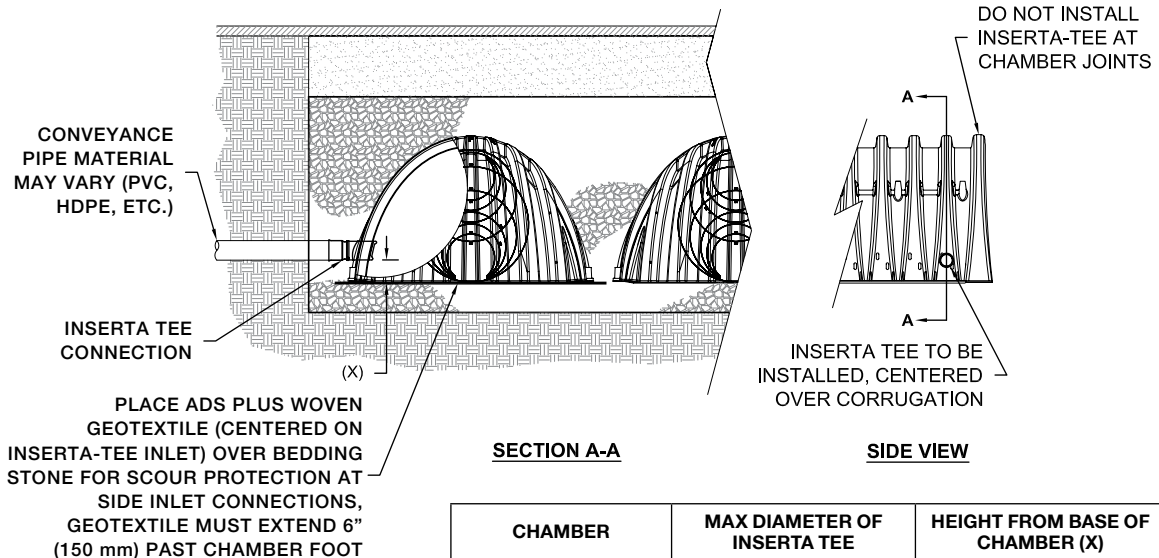


Figure 19 – INSERTA TEE Side Detail



NOTE:
PART NUMBERS WILL VARY BASED ON INLET PIPE MATERIALS. CONTACT STORMTECH FOR MORE INFORMATION.

CHAMBER	MAX DIAMETER OF INSERTA TEE	HEIGHT FROM BASE OF CHAMBER (X)
SC-310	6\" (150 mm)	4\" (100 mm)
SC-740	10\" (250 mm)	4\" (100 mm)
DC-780	10\" (250 mm)	4\" (100 mm)
INSERTA TEE FITTINGS AVAILABLE FOR SDR 26, SDR 36, SCH 40 IPS GASKETED & SOLVENT WELD, N-12, HP STORM, C-900 OR DUCTILE IRON.		

NOTE: SIDE INSERTA TEES CANNOT BE USED ON SC-160LP CHAMBERS.

12.1 ISOLATOR ROW PLUS INSPECTION

Regular inspection and maintenance are essential to assure a properly functioning stormwater system. Inspection is easily accomplished through the manhole or optional inspection ports of an Isolator Row PLUS. Please follow local and OSHA rules for a confined space entry.

Inspection ports can allow inspection to be accomplished completely from the surface without the need for a confined space entry. Inspection ports provide visual access to the system with the use of a flashlight. A stadia rod may be inserted to determine the depth of sediment. If upon visual inspection it is found that sediment has accumulated to an average depth exceeding 3 (76 mm), cleanout is required.

A StormTech Isolator Row PLUS should initially be inspected immediately after completion of the site's construction. While every effort should be made to prevent sediment from entering the system during construction, it is during this time that excess amounts of sediments are most likely to enter any stormwater system. Inspection and maintenance, if necessary, should be performed prior to passing responsibility over to the site's owner. Once in normal service, a StormTech Isolator Row PLUS should be inspected bi-annually until an understanding of the sites characteristics is developed. The site's maintenance manager can then revise the inspection schedule based on experience or local requirements.

12.2 ISOLATOR ROW PLUS MAINTENANCE

JetVac maintenance is recommended if sediment has been collected to an average depth of 3 (76 mm) inside the Isolator Row PLUS. More frequent maintenance may be required to maintain minimum flow rates through the Isolator Row PLUS. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row PLUS while scouring and suspending sediments. As the nozzle is retrieved, a wave of suspended sediments is flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/ JetVac combination vehicles. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45 (1143 mm) are best. StormTech recommends a maximum nozzle pressure of 2000 psi be utilized during cleaning. The JetVac process shall only be performed on StormTech Rows that have ADS PLUS fabric over the foundation stone.



Looking down the Isolator Row PLUS



A typical JetVac truck (This is not a StormTech product.)



Examples of culvert cleaning nozzles appropriate for Isolator Row PLUS maintenance. (These are not StormTech products).

12.0 Inspection & Maintenance

STORMTECH ISOLATOR ROW PLUS - STEP-BY-STEP MAINTENANCE PROCEDURES

Step 1) Inspect Isolator Row PLUS for sediment

- A) Inspection ports (if present)
 - i. Remove lid from floor box frame
 - ii. Remove cap from inspection riser
 - iii. Using a flashlight and stadia rod, measure depth of sediment
 - iv. If sediment is at, or above, 3 (76 mm) depth proceed to Step 2. If not proceed to Step 3.
- B) All Isolator Plus Rows
 - i. Remove cover from manhole at upstream end of Isolator Row PLUS
 - ii. Using a flashlight, inspect down Isolator Row PLUS through outlet pipe
 - 1. Follow OSHA regulations for confined space entry if entering manhole
 - 2. Mirrors on poles or cameras may be used to avoid a confined space entry
 - iii. If sediment is at or above the lower row of sidewall holes [approximately 3 (76 mm)] proceed to Step 2. If not proceed to Step 3.

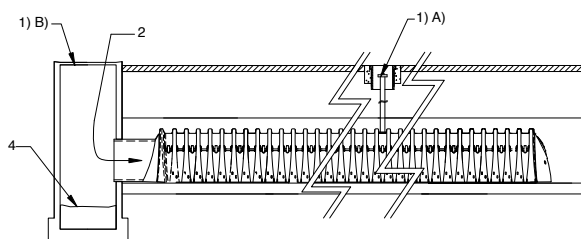
Step 2) Clean out Isolator Row PLUS using the JetVac process

- A) A fixed floor cleaning nozzle with rear facing nozzle spread of 45 (1143 mm) or more is preferable
- B) Apply multiple passes of JetVac until backflush water is clean
- C) Vacuum manhole sump as required during jetting

Step 3) Replace all caps, lids and covers

Step 4) Inspect and clean catch basins and manholes upstream of the StormTech system following local guidelines.

Figure 20 – StormTech Isolator Row PLUS (not to scale)



12.3 ECCENTRIC PIPE HEADER INSPECTION

These guidelines do not supersede a pipe manufacturer's recommended I&M procedures. Consult with the manufacturer of the pipe header system for specific I&M procedures. Inspection of the header system should be carried out quarterly. On sites which generate higher levels of sediment more frequent inspections may be necessary. Headers may be accessed through risers, access ports or manholes. Measurement of sediment may be taken with a stadia rod or similar device. Cleanout of sediment should occur when the sediment volume has reduced the storage area by 25% or the depth of sediment has reached approximately 25% of the diameter of the structure.

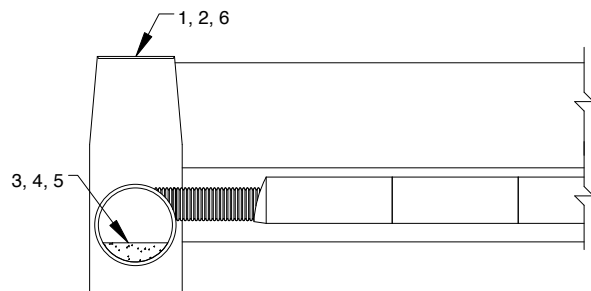
12.4 ECCENTRIC PIPE MANIFOLD MAINTENANCE

Cleanout of accumulated material should be accomplished by vacuum pumping the material from the header. Cleanout should be accomplished during dry weather. Care should be taken to avoid flushing sediments out through the outlet pipes and into the chamber rows.

Eccentric Header Step-by-Step Maintenance Procedures

- 1. Locate manholes connected to the manifold system
- 2. Remove grates or covers
- 3. Using a stadia rod, measure the depth of sediment
- 4. If sediment is at a depth of about 25% pipe volume or 25% pipe diameter proceed to step 5. If not proceed to step 6.
- 5. Vacuum pump the sediment. Do not flush sediment out inlet pipes.
- 6. Replace grates and covers
- 7. Record depth and date and schedule next inspection

Figure 21 – Eccentric Manifold Maintenance



Please contact StormTech's Technical Services Department at 888-892-2894 for a spreadsheet to estimate cleaning intervals.

1. StormTech requires installing contractors to use and understand StormTech's latest Installation Instructions prior to beginning system installation.
2. Our Technical Services Department offers installation consultations to installing contractors. Contact our Technical Service Representatives at least 30 days prior to system installation to arrange a preinstallation consultation. Our representatives can then answer questions or address comments on the StormTech chamber system and inform the Installing contractor of the minimum installation requirements before beginning the system's construction. Call **860-529-8188** to speak to a Technical Service Representative or visit **www.stormtech.com** to receive a copy of our Installation Instructions.
3. StormTech's requirements for systems with pavement design (asphalt, concrete pavers, etc.): Minimum cover for the SC-740, DC-780 and SC-310 chambers is 18 (457 mm) not including pavement; Minimum cover for the SC-160LP chamber is 14 (350 mm); Maximum cover for the SC-740 and SC-310 chambers is 96 (2.4 m) including pavement design; Maximum cover for the SC-160LP chamber is 10' (3.0 m); Maximum cover for the DC-780 chamber is 12' (3.6 m) including pavement design. For installations that do not include pavement, where rutting from vehicles may occur, minimum required cover is 24 (610 mm), maximum cover is as stated above.
4. The contractor must report any discrepancies with the bearing capacity of the chamber foundation materials to the design engineer.
5. AASHTO M288 Class 2 non-woven geotextile (filter fabric) must be used as indicated in the project plans.
6. Stone placement between chamber rows and around perimeter must follow instructions as indicated in the most current version of StormTech's Installation Instructions.
7. Backfilling over the chambers must follow requirements as indicated in the most current version of StormTech's Installation Instructions.
8. The contractor must refer to StormTech's Installation Instructions for a Table of Acceptable Vehicle Loads at various depths of cover. This information is also available at StormTech's website: **www.stormtech.com**. The contractor is responsible for preventing vehicles that exceed StormTech's requirements from traveling across or parking over the stormwater system. Temporary fencing, warning tape and appropriately located signs are commonly used to prevent unauthorized vehicles from entering sensitive construction areas.
9. The contractor must apply erosion and sediment control measures to protect the stormwater system during all phases of site construction per local codes and design engineer's specifications.
10. STORMTECH PRODUCT WARRANTY IS LIMITED. Contact StormTech for warranty information.

14.0 StormTech Product Specifications

1.0 GENERAL

- 1.1 StormTech chambers are designed to control storm water runoff. As a subsurface retention system, StormTech chambers retain and allow effective infiltration of water into the soil. As a subsurface detention system, StormTech chambers detain and allow for the metered flow of water to an outfall.

2.0 CHAMBER PARAMETERS

- 2.1 The Chamber shall be injection molded of an impact modified polypropylene or polyethylene copolymer to maintain adequate stiffness through higher temperatures experienced during installation and service.
- 2.2 The nominal chamber dimensions of the StormTech SC-740 and DC-780 shall be 30.0 (762 mm) tall, 51.0 (1295 mm) wide and 90.7 (2304 mm) long. The nominal chamber dimensions of the StormTech SC-310 shall be 16.0 (406 mm) tall, 34.0 (864 mm) wide and 90.7 (2304 mm) long. SC-160LP shall be 12(305mm) tall, 25 (635 mm) wide and 90.7 (2304mm) long. The installed length of a joined chamber shall be 85.4 (2169 mm).
- 2.3 The chamber shall have a continuously curved section profile.
- 2.4 The chamber shall be open-bottomed.
- 2.5 The chamber shall incorporate an overlapping corrugation joint system to allow chamber rows of almost any length to be created. The overlapping corrugation joint system shall be effective while allowing a chamber to be trimmed to shorten its overall length.
- 2.6 The nominal storage volume of all StormTech chambers includes the volume of the clean, crushed, angular stone with an assumed 40% porosity. The nominal storage volume of a joined StormTech SC-740 chamber shall be 74.9 ft³ (2.1 m³) per chamber when installed per StormTech's typical details. This equates to a storage volume per unit area of bed of 2.2 ft³/ft² (0.67 m³/m²). The nominal storage volume of a joined StormTech DC-780 chamber shall be 78.4 ft³ (2.2 m³) per chamber when installed per StormTech's typical details. This equates to a storage volume per unit area of bed of 2.3 ft³/ft² (0.70 m³/m²). The nominal storage volume of a joined StormTech SC-310 chamber shall be 31.0 ft³ (0.88 m³) per chamber when installed per StormTech's typical details. This equates to a storage volume per unit area of bed of 1.3 ft³/ft² (0.40 m³/m²). The nominal storage volume of a joined StormTech SC-160LP chamber shall be 15 ft³ (0.42 m³) per chamber when installed per StormTech's typical details. This equates to a storage volume per unit area of bed of 1.0 ft³/ft² (0.30 m³/m²).

- 2.7 The SC-740 and SC-310 chambers shall have forty eight orifices penetrating the sidewalls to allow for lateral conveyance of water.

- 2.8 The chamber shall have two orifices near its top to allow for equalization of air pressure between its interior and exterior.

- 2.9 The chamber shall have both of its ends open to allow for unimpeded hydraulic flows and visual inspections down a row's entire length.

- 2.10 The chamber shall have 14 corrugations.

- 2.11 The chamber shall be analyzed and designed using AASHTO methods for thermoplastic culverts contained in the LRFD Bridge Design Specifications, 2nd Edition, including Interim Specifications through 2001. Design live load shall be the AASHTO design truck. Design shall consider earth and live loads as appropriate for the minimum to maximum specified depth of fill.

- 2.12 The chamber shall be manufactured in an ISO 9001:2000 certified facility.

3.0 END CAP PARAMETERS

- 3.1 The end cap shall be designed to fit into any corrugation of a chamber, which allows: capping a chamber that has its length trimmed; segmenting rows into storage basins of various lengths.
- 3.2 The end cap shall have saw guides to allow easy cutting for various diameters of pipe that may be used to inlet the system.
- 3.3 The end cap shall have excess structural adequacies to allow cutting an orifice of any size at any invert elevation.
- 3.4 The primary face of an end cap shall be curved outward to resist horizontal loads generated near the edges of beds.
- 3.5 The end cap shall be manufactured in an ISO 9001:2000 certified facility.

15.0 Chamber Specifications for Contract Documents

SC-160LP STORMTECH CHAMBER SPECIFICATIONS

1. Chambers shall be Stormtech SC-160LP.
2. Chambers shall be arch-shaped and shall be manufactured from virgin, impact-modified polypropylene copolymers.
3. Chambers shall meet the requirements of ASTM F2418-16A, Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers
4. Chamber rows shall provide continuous, unobstructed internal space with no internal supports that would impede flow or limit access for inspection.
5. The structural design of the chambers, the structural backfill, and the installation requirements shall ensure that the load factors specified in the AASHTO LRFD bridge design specifications, Section 12.12, are met for: 1) long-duration dead loads and 2) short-duration live loads, based on the AASHTO design truck with consideration for impact and multiple vehicle presences.
6. Chambers shall be designed, tested and allowable load configurations determined in accordance with ASTM F2787, Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers. Load configurations shall include: 1) instantaneous (<1 min) AASHTO design truck live load on minimum cover 2) maximum permanent (75-yr) cover load and 3) allowable cover with parked (1-week) aashto design truck.
7. Requirements for handling and installation:
 - To maintain the width of chambers during shipping and handling, chambers shall have integral, interlocking stacking lugs.
8. Only chambers that are approved by the site design engineer will be allowed. The chamber manufacturer shall submit the following upon request to the site design engineer for approval before delivering chambers to the project site:
 - A structural evaluation sealed by a registered professional engineer that demonstrates that the safety factors are greater than or equal to 1.95 for dead load and 1.75 for live load, the minimum required by ASTM F2787 and by AASHTO for thermoplastic pipe.
 - A structural evaluation sealed by a registered professional engineer that demonstrates that the load factors specified in the AASHTO LRFD bridge design specifications, Section 12.12, are met. The 50 year creep modulus data specified in ASTM F2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.

Chambers and end caps shall be produced at an ISO 9001 certified manufacturing facility.

SC-310 STORMTECH CHAMBER SPECIFICATIONS

1. Chambers shall be Stormtech SC-310.
2. Chambers shall be arch-shaped and shall be manufactured from virgin, impact-modified polypropylene or polyethylene copolymers.
3. Chambers shall meet the requirements of ASTM F2922 (polyethylene) or ASTM F2418-16A (polypropylene), Standard Specification for Corrugated Wall Stormwater Collection Chambers
4. Chamber rows shall provide continuous, unobstructed internal space with no internal supports that would impede flow or limit access for inspection.
5. The structural design of the chambers, the structural backfill, and the installation requirements shall ensure that the load factors specified in the AASHTO LRFD bridge design specifications, Section 12.12, are met for: 1) long-duration dead loads and 2) short-duration live loads, based on the AASHTO design truck with consideration for impact and multiple vehicle presences.
6. Chambers shall be designed, tested and allowable load configurations determined in accordance with ASTM F2787, Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers. Load configurations shall include: 1) instantaneous (<1 min) AASHTO design truck live load on minimum cover 2) maximum permanent (75-yr) cover load and 3) allowable cover with parked (1-week) AASHTO to design truck.
7. Requirements for handling and installation:
 - To maintain the width of chambers during shipping and handling, chambers shall have integral, interlocking stacking lugs.
8. Only chambers that are approved by the site design engineer will be allowed. The chamber manufacturer shall submit the following upon request to the site design engineer for approval before delivering chambers to the project site:
 - To ensure a secure joint during installation and backfill, the height of the chamber joint shall not be less than 2.
 - To ensure the integrity of the arch shape during installation, a) the arch stiffness constant as defined in Section 6.2.8 of ASTM F2418 shall be greater than or equal to 400 lbs/in/in. And b) to resist softening during hot, sunny installation conditions, chambers shall be produced from light, reflective gold or yellow colors.

Chambers and end caps shall be produced at an ISO 9001 certified manufacturing facility.

15.0 Chamber Specifications for Contract Documents

SC-740 STORMTECH CHAMBER SPECIFICATIONS

1. Chambers shall be Stormtech SC-740.
2. Chambers shall be arch-shaped and shall be manufactured from virgin, impact-modified polypropylene copolymers.
3. Chambers shall meet the requirements of ASTM F2418-16A, Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers
4. Chamber rows shall provide continuous, unobstructed internal space with no internal supports that would impede flow or limit access for inspection.
5. The structural design of the chambers, the structural backfill, and the installation requirements shall ensure that the load factors specified in the AASHTO LRFD bridge design specifications, Section 12.12, are met for: 1) long-duration dead loads and 2) short-duration live loads, based on the AASHTO design truck with consideration for impact and multiple vehicle presences.
6. Chambers shall be designed, tested and allowable load configurations determined in accordance with ASTM F2787, Standard practice for structural design of Thermoplastic Corrugated Wall Stormwater Collection Chambers. Load configurations shall include: 1) instantaneous (<1 min) AASHTO design truck live load on minimum cover 2) maximum permanent (75-yr) cover load and 3) allowable cover with parked (1-week) AASHTO design truck.
7. Requirements for handling and installation:
 - To maintain the width of chambers during shipping and handling, chambers shall have integral, interlocking stacking lugs.
8. Only chambers that are approved by the site design engineer will be allowed. The chamber manufacturer shall submit the following upon request to the site design engineer for approval before delivering chambers to the project site:
 - To ensure a secure joint during installation and backfill, the height of the chamber joint shall not be less than 2.
 - To ensure the integrity of the arch shape during installation, a) the arch stiffness constant as defined in Section 6.2.8 of ASTM F2418 shall be greater than or equal to 550 lbs/in/in. And b) to resist softening during hot, sunny installation conditions, chambers shall be produced from light, reflective gold or yellow colors.
 - A structural evaluation sealed by a registered professional engineer that demonstrates that the safety factors are greater than or equal to 1.95 for dead load and 1.75 for live load, the minimum required by ASTM F2787 and by AASHTO for thermoplastic pipe.
 - A structural evaluation sealed by a registered professional engineer that demonstrates that the load factors specified in the AASHTO LRFD bridge design specifications, Section 12.12, are met. The 50 year creep modulus data specified in ASTM F2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.

Chambers and end caps shall be produced at an ISO 9001 certified manufacturing facility.

DC-780 STORMTECH CHAMBER SPECIFICATIONS

1. Chambers shall be Stormtech DC-780.
2. Chambers shall be arch-shaped and shall be manufactured from virgin, impact-modified polypropylene copolymers.
3. Chambers shall meet the requirements of ASTM F2418-16A, Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers
4. Chamber rows shall provide continuous, unobstructed internal space with no internal supports that would impede flow or limit access for inspection.
5. The structural design of the chambers, the structural backfill, and the installation requirements shall ensure that the load factors specified in the AASHTO LRFD bridge design specifications, Section 12.12, are met for: 1) long-duration dead loads and 2) short-duration live loads, based on the AASHTO design truck with consideration for impact and multiple vehicle presences.
6. Chambers shall be designed, tested and allowable load configurations determined in accordance with ASTM F2787, Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers. Load configurations shall include: 1) instantaneous (<1 min) AASHTO design truck live load on minimum cover 2) maximum permanent (75-yr) cover load and 3) allowable cover with parked (1-week) AASHTO design truck.
7. Requirements for handling and installation:
 - To maintain the width of chambers during shipping and handling, chambers shall have integral, interlocking stacking lugs.
8. Only chambers that are approved by the site design engineer will be allowed. The chamber manufacturer shall submit the following upon request to the site design engineer for approval before delivering chambers to the project site:
 - To ensure a secure joint during installation and backfill, the height of the chamber joint shall not be less than 2.
 - To ensure the integrity of the arch shape during installation, a) the arch stiffness constant as defined in Section 6.2.8 of ASTM F2418 shall be greater than or equal to 550 lbs/in/in. And b) to resist softening during hot, sunny installation conditions, chambers shall be produced from light, reflective gold or yellow colors.
 - A structural evaluation sealed by a registered professional engineer that demonstrates that the safety factors are greater than or equal to 1.95 for dead load and 1.75 for live load, the minimum required by ASTM F2787 and by AASHTO for thermoplastic pipe.
 - A structural evaluation sealed by a registered professional engineer that demonstrates that the load factors specified in the AASHTO LRFD bridge design specifications, Section 12.12, are met. The 50 year creep modulus data specified in ASTM F2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.

Chambers and end caps shall be produced at an ISO 9001 certified manufacturing facility.



A Family of Products and Services for the Stormwater Industry:

- MC-3500 and MC-4500 Chambers and End Caps
- SC-160LP, SC-310 and SC-740 Chambers & End Caps
- DC-780 Chambers and End Caps
- Fabricated End Caps
- Fabricated Manifold Fittings
- Patented Isolator Row PLUS for Maintenance and Water Quality
- Chamber Separation Spacers
- In-House System Layout Assistance
- On-Site Educational Seminars
- Worldwide Technical Sales Group
- Centralized Product Applications Department
- Research and Development Team
- Technical Literature, O&M Manuals and Detailed CAD drawings all downloadable via our Website

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APPENDIX E

OIL/GRIT SEPARATOR DETAILS & MAINTENANCE MANUAL

CDS Average Annual Efficiency For TSS Removal & Total Annual Volume Treated

Area = 0.41 ha C = 0.90 CDS Model: PMSU2015_4 Flowrate: 20 l/s IDF Data: Barrie PSD: FINE	Upstream Storage: Storage 164 m ³	Engineer: Pearson Engineering Contact: M. Dejean, P.Eng. Date: 6-Feb-20 Project: 233 Dunlop Street West Location: Barrie, ON OGS ID: OGS
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Return	Period	Peak Flow	TSS Percentage Captured	Treated Flow Volume	Total Flow Volume	Annual Exceedance Probability	System Flow	CDS Flow	By-Pass Flow	Volume Percentage Treated
month / yr	Yr	l/s	%	litres	litres	%	l/s	l/s	l/s	%
1-M	0.08	3.14	95.89	8269	8269	100.00	3.14	3.14	0.00	100.00
2-M	0.17	4.43	94.72	11526	11526	99.75	4.43	4.43	0.00	100.00
3-M	0.25	5.51	93.72	14268	14268	98.17	5.51	5.51	0.00	100.00
4-M	0.33	6.49	92.81	16785	16785	95.04	6.49	6.49	0.00	100.00
5-M	0.42	7.26	92.09	18755	18755	90.91	7.26	7.26	0.00	100.00
6-M	0.50	8.02	91.38	20725	20725	86.47	8.02	8.02	0.00	100.00
7-M	0.58	8.60	90.84	22224	22224	82.01	8.60	8.60	0.00	100.00
8-M	0.67	9.17	90.30	23724	23724	77.67	9.17	9.17	0.00	100.00
9-M	0.75	9.75	89.76	25223	25223	73.64	9.75	9.75	0.00	100.00
10-M	0.83	10.20	89.33	26422	26422	69.90	10.20	10.20	0.00	100.00
11-M	0.92	10.66	88.90	27620	27620	66.40	10.66	10.66	0.00	100.00
1-Yr	1	11.11	88.47	28818	28818	63.21	11.11	11.11	0.00	100.00
2-Yr	2	14.90	84.88	38953	38953	39.35	14.90	14.90	0.00	100.00
5-Yr	5	15.76	84.06	41307	41307	18.13	15.76	15.76	0.00	100.00
10-Yr	10	18.70	81.25	49412	49412	9.52	18.70	18.70	0.00	100.00
25-Yr	25	25.71	71.91	64528	69557	3.92	25.71	20.10	5.61	92.77
50-Yr	50	32.46	63.12	74850	90222	1.98	32.46	20.10	12.35	82.96
100-Yr	100	40.02	55.06	84623	115216	1.00	40.02	20.10	19.92	73.45

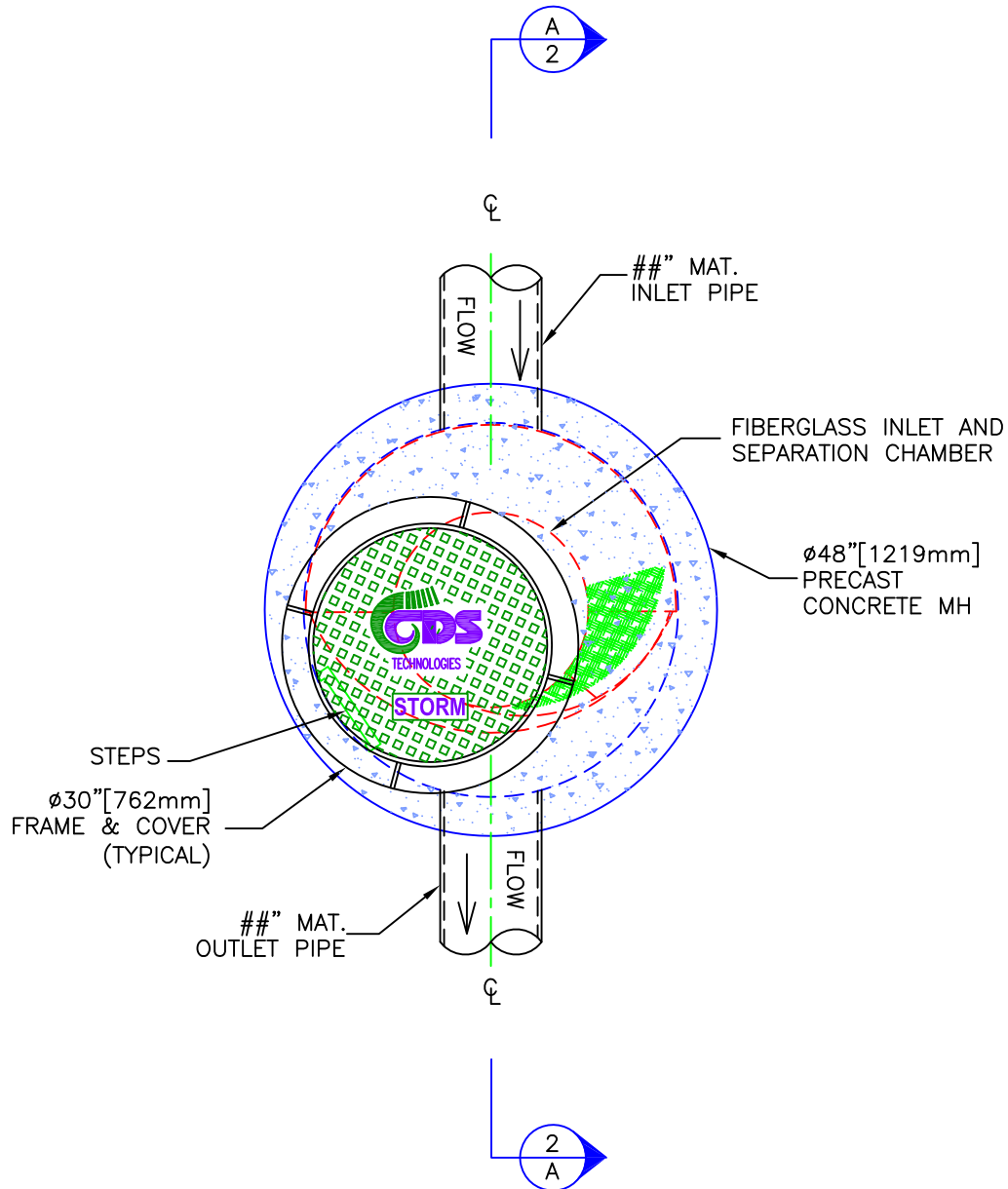
Average Annual TSS Removal Efficiency [%]:	91.7	Ave. Ann. T. Volume [%]:	99.9
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Notes:

- 1) CDS Efficiency based on testing conducted at the University of Central Florida
- 2) CDS design flowrate and scaling based on standard manufacturer model & product specifications



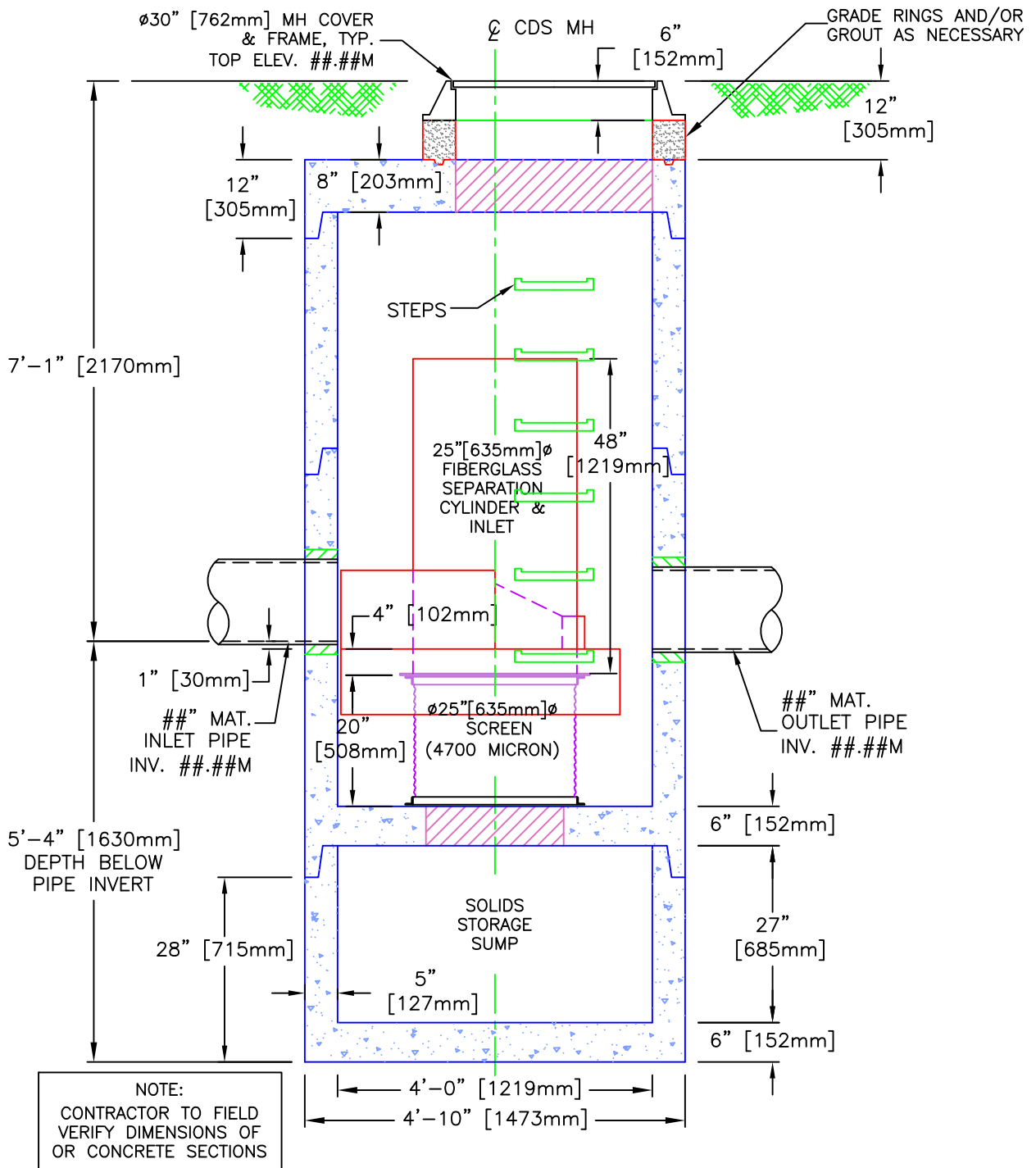
PLAN VIEW



CDS MODEL PMSU20_15_4m STORMWATER TREATMENT UNIT



SECTION A-A ELEVATION VIEW



**CDS MODEL PMSU20_15_4m
STORMWATER TREATMENT UNIT**



PROJECT NAME
CITY, STATE

JOB# XX-##-###

DATE ##/##/##

DRAWN INITIALS

APPROV.

SCALE
1" = 2'

SHEET

2



CDS[®] System

Maintenance

Procedures For General Inspection and Cleaning

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant deposition and transport may vary from year to year and regular inspections will help insure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (i.e. spring and fall), however; more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Additionally, installations where excessive amounts of trash are expected should be inspected more frequently.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions to inlet and/or separation screen. The inspection should also identify evidence of vector infestation and accumulations of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If sorbent material is used for enhanced removal of hydrocarbons then the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of a permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (center cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained behind the screen. For units possessing a sizable depth below grade (depth to pipe), a single manhole access point would allow both sump cleanout and access behind the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump and/or when an appreciable level of hydrocarbons and trash has accumulated. If sorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded; however, it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Finer, silty particles at the top of the pile typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine if the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of the CDS systems should be done during dry weather conditions when no flow is entering the system. Cleanout of the CDS with a vacuum truck is generally the most effective and convenient method of excavating pollutants from the system. Simply remove the manhole

covers and insert the vacuum hose into the sump through the center cylinder. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should be pumped out also if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use adsorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash can be netted out if you wish to separate it from the other pollutants. If the screen requires cleaning, it can be washed from the surface or from the CDS inlet structure through the center cylinder.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure proper safety precautions. Confined Space Entry procedures need to be followed.

Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many locations, disposal of evacuated sediments may be handled in the same manner as disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

SAMPLE INSPECTION & MAINTENANCE LOG

DATE/ INSPECTOR	FUNCTIONALITY/ COMPONENTS	FLOATABLES LAYER THICKNESS (IN)	DEPTH TO SEDIMENT (A) (FT)	SEDIMENT CAPACITY USED ((B-A)/D*100) %	SORBENT DISCOLORATION	MAINTENANCE PERFORMED
11/1/06/TPG	OK	.5	14	33	SLIGHT	NONE
5/1/07	OK	1	13	67	MODERATE	NONE
10/1/07	OK	2	12.5	83	HIGH	CLEANING SCHEDULED
11/1/07	OK	0	15	0	NONE	SYSTEM CLEANED

(B) DEPTH FROM GROUND SURFACE TO BOTTOM OF SUMP: 15 (FT)

(C) DEPTH FROM GROUND SURFACE TO TOP SUMP: 12 (FT)

(D) HEIGHT OF SUMP = B - C = 3 (FT)

OBSERVATIONS OF FUNCTION: _____

CDS SYSTEM INSPECTION AND MAINTENANCE LOG

[illegible]

(B) DEPTH FROM GROUND SURFACE TO BOTTOM OF SUMP: _____ (FT)

(C) DEPTH FROM GROUND SURFACE TO TOP SUMP: _____ (FT)

(D) HEIGHT OF SUMP = B - C = _____ (FT)

OBSERVATIONS OF FUNCTION: _____



CANADIAN ENVIRONMENTAL TECHNOLOGY VERIFICATION

Enhancing the Credibility of Environmental Technologies

TECHNOLOGY VERIFIED: CDS Hydrodynamic Separator®

Performance Claim

Capture test^a:

During the sediment capture test, the Contech CDS OGS device with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L, removed 74, 70, 63, 53, 45, 42, 32 and 23 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, 1400 and 1893 L/min/m², respectively.

Scour test^a:

During the scour test, the Contech CDS OGS device with preloaded test sediment reaching 50% of the manufacturer's recommended maximum sediment storage depth, generated corrected effluent concentrations of 1.8, 6.5, 8.2, 11.2, and 309.3 mg/L during a test run¹ with approximately 5 minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m², respectively.

Light liquid re-entrainment test^a:

During the light liquid re-entrainment test, the Contech CDS OGS device with surrogate low-density polyethylene beads preloaded within the oil collection skirt area, representing floating liquid to a volume equal to a depth of 50.8 mm over the sedimentation area, retained 100, 99.9, 98.6, 99.5, and 99.7 percent of loaded beads by volume during a test run^b with 5 minutes duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m², respectively.

^a The claim can be applied to other units smaller or larger than the tested unit as long as the untested units meet the scaling rule specified in the Procedure for Laboratory of Testing of Oil Grit Separators (Version 3.0, June 2014)

^b See variance #1 in "Variances from testing procedure" section

VERIFIED* PERFORMANCE:
MARCH 2017

License Number: ETV 2017-02

Issued to: CONTECH Engineered Solutions LLC

Expiration Date: March 31, 2020


John D. Wiebe, PhD
Executive Chairman



Canada

* This verification conforms to the Canadian ETV Program's General Verification Protocol and the ISO 14034:2016.
Please refer to Technology Fact Sheet for additional information on the verification of this performance claim.

CANADIAN ETV VERIFIED

CDS Hydrodynamic Separator®

Technology Fact Sheet for CONTECH Engineered Solutions LLC



Technology description and application

The CDS® is a Stormwater treatment device designed to remove pollutants, including sediment, trash and hydrocarbons from Stormwater runoff. The CDS is typically comprised of a manhole that houses flow and screening controls that use a combination of swirl concentration and continuous deflective separation.

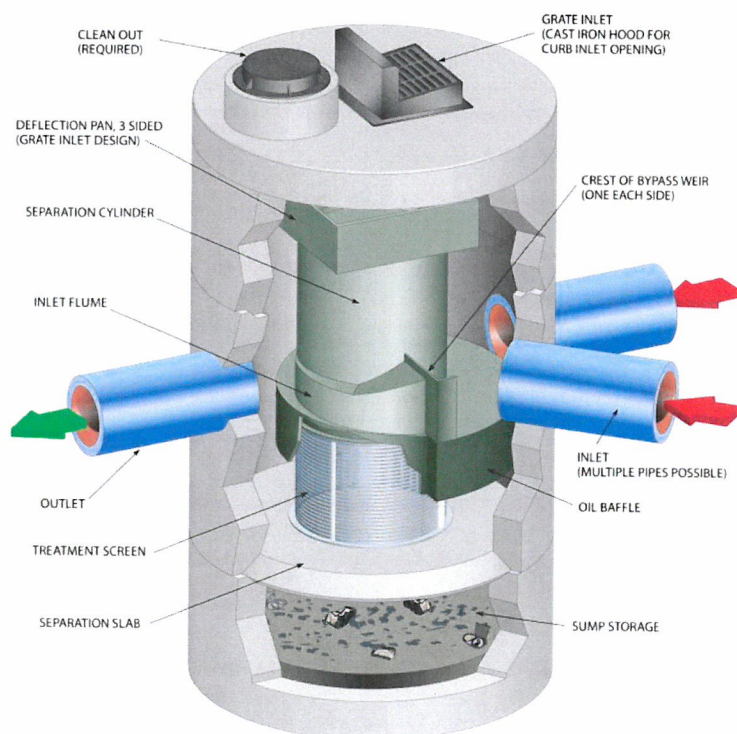


Figure 1. Graphic of typical inline CDS unit and core components.

When stormwater runoff enters the CDS unit's diversion chamber, the diversion pan guides the flow into the unit's separation chamber. The water and associated gross pollutants contained within the separation cylinder are kept in continuous circular motion by the energy generated from the incoming flow. This has the effect of a continuous deflective separation of the pollutants and their eventual deposition into the sump storage below. A perforated screen plate allows the filtered water to pass through to a volute return system and thence to the outlet pipe. The oil and other light liquids are retained within the oil baffle. Figure 1 shows a schematic representation of a typical CDS unit including critical components.

Performance conditions

The data and results published in this Technology Fact Sheet were obtained from the testing program conducted on the Contech CDS-4 OGS device, in accordance with the Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014). The Procedure was prepared by the Toronto and Region Conservation Authority (TRCA) for Environment Canada's Environmental Technology Verification (ETV) Program requirements. A copy of the Procedure may be accessed on the Canadian ETV website at www.etvcanada.ca.

Performance claim(s)

Capture test^a:

During the sediment capture test, the Contech CDS OGS device with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L, removed 74, 70, 63, 53, 45, 42, 32 and 23 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, 1400 and 1893 L/min/m², respectively.

Scour test^a:

During the scour test, the Contech CDS OGS device with preloaded test sediment reaching 50% of the manufacturer's recommended maximum sediment storage depth, generated corrected effluent concentrations of 1.8, 6.5, 8.2, 11.2, and 309.3 mg/L during a test run^b with approximately 5 minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m², respectively.

Light liquid re-entrainment test^a:

During the light liquid re-entrainment test, the Contech CDS OGS device with surrogate low-density polyethylene beads preloaded within the oil collection skirt area, representing floating liquid to a volume equal to a depth of 50.8 mm over the sedimentation area, retained 100, 99.9, 98.6, 99.5, and 99.7 percent of loaded beads by volume during a test run^b with 5 minutes duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m², respectively.

Performance results

The test sediment consisted of ground silica (1 – 1000 micron) with a specific gravity of 2.65, uniformly mixed to meet the particle size distribution specified in the testing procedure. The *Procedure for Laboratory Testing of Oil Grit Separators* requires that the three sample average of the test sediment particle size distribution (PSD) meet the specified PSD percent less than values within a boundary threshold of 6%. The comparison of the average test sediment PSD to the CETV specified PSD in Figure 2 indicates that the test sediment used for the capture and scour tests met this condition.

^a The claim can be applied to other units smaller or larger than the tested unit as long as the untested units meet the scaling rule specified in the Procedure for Laboratory Testing of Oil Grit Separators (Version 3.0, June 2014)

^b See variance #1 in "Variances from testing procedure" section below.

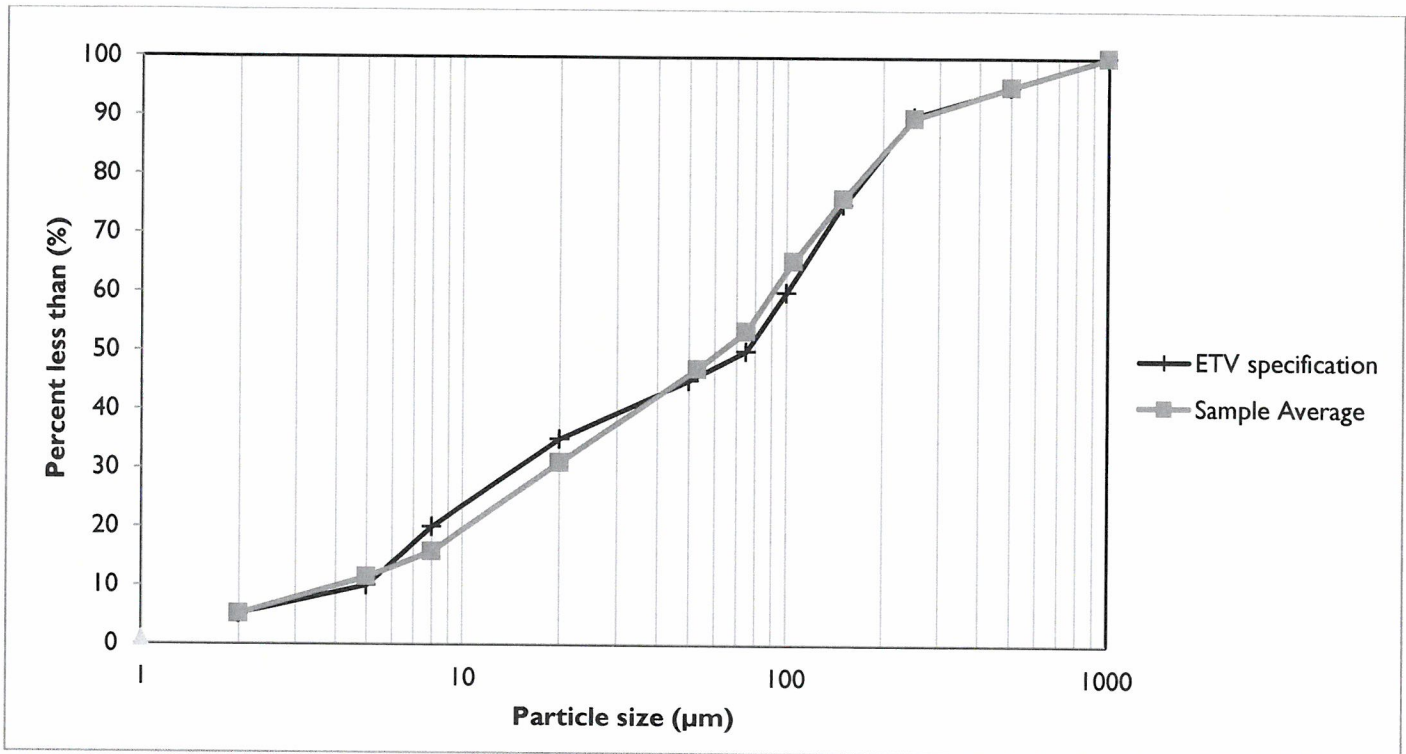


Figure 2. The three sample average particle size distribution (PSD) of the test sediment used for the capture and scour test compared to the specified PSD.

The capacity of the device to retain sediment was determined at eight surface loading rates using the modified mass balance method. This method involved measuring the mass and particle size distribution of the injected and retained sediment for each test run. Performance was evaluated with a false floor simulating the technology filled to 50% of the manufacturer’s recommended maximum sediment storage depth. The test was carried out with clean water that maintained a sediment concentration below 20 mg/L. Based on these conditions, removal efficiencies for individual particle size classes and for the test sediment as a whole were determined for each of the tested surface loading rates (Table I).

In some instances, the calculated removal efficiencies were above 100% for certain particle size fractions (marked with asterisks in Table I). These discrepancies are not entirely avoidable and may be attributed to errors relating to the blending of sediment, collection of representative samples, and laboratory analysis of PSD. Due to these errors, caution should be exercised in applying the removal efficiencies by particle size fraction for the purposes of sizing the tested device (see [Bulletin # CETV 2016-11-0001](#)). The results for “all particle sizes by mass balance” in Table I are based on measurements of the total injected and retained sediment mass, and are therefore not subject to sampling or PSD analysis errors.

Environmental Technology Verification

Table I. Removal efficiencies (%) at specified surface loading rates.

Particle size fraction (μm)	Surface loading rate ($\text{L}/\text{min}/\text{m}^2$)							
	40	80	200	400	600	1000	1400	1893
>500	100	100*	66	79	97	100*	84	77
250 - 500	100*	100*	85	95	100*	91	100*	75
150 - 250	99	100*	100*	97	100	75	68	37
105 - 150	100	100*	100*	74	47	45	30	27
75 - 105	90	91	100*	61	33	36	26	18
53 - 75	71	27	54	100	42	44	15	16
20 - 53	65	51	20	8	10	8	5	4
8 - 20	28	22	9	7	1	1	2	1
5 - 8	30	9	0	8	2	0	1	0
<5	11	8	16	2	6	5	2	2
All particle sizes by mass balance	73.5	70.3	63.4	52.6	45.1	41.5	32.4	23.0

* Removal efficiencies were calculated to be above 100%. Calculated values typically ranged between 101 and 175% (average 126%). Higher values were observed for the >500 μm and 150-250 μm size fractions during the 80 $\text{L}/\text{min}/\text{m}^2$ test run. See text and [Bulletin # CETV 2016-11-0001](#) for more information.

Figure 3 compares the particle size distribution (PSD) of the three sample average of the test sediment to the PSD of the retained sediment at each of the tested surface loading rates. As expected, the capture efficiency for fine particles was generally found to decrease as surface loading rates increased.

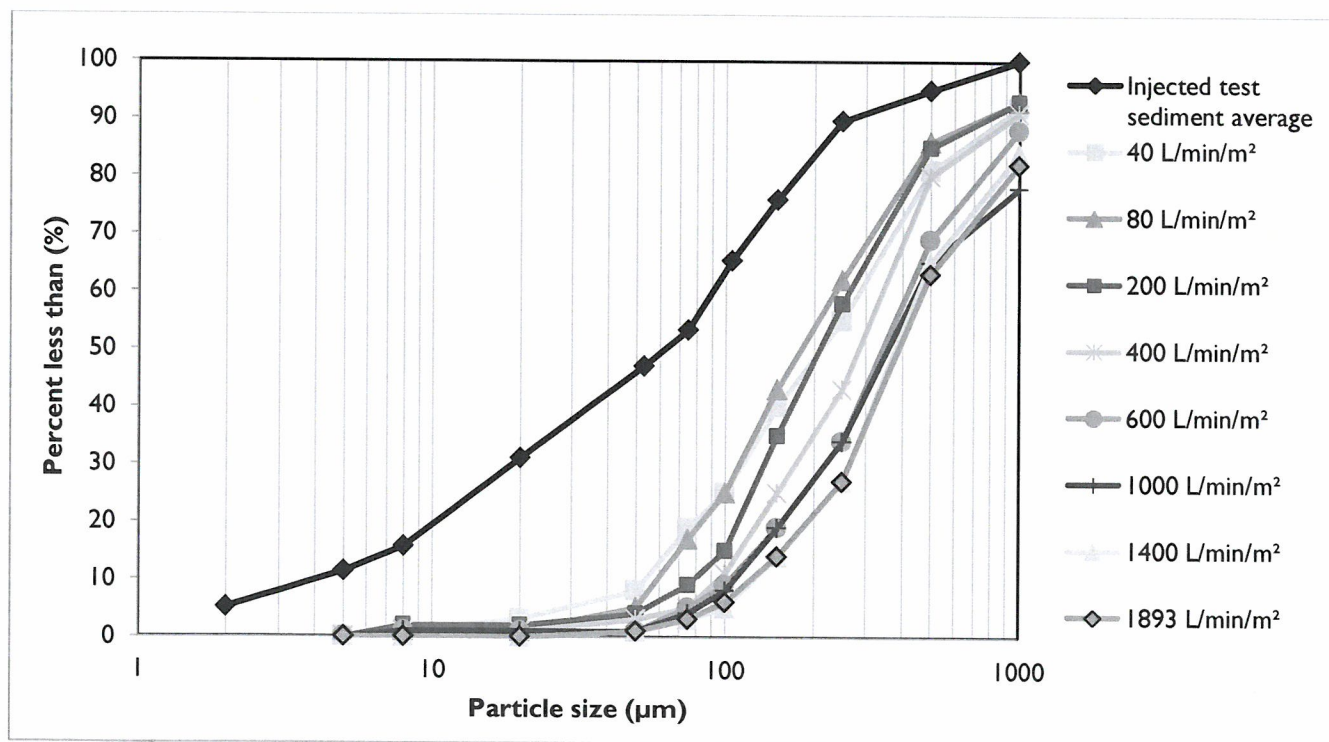


Figure 3. Particle size distribution of retained sediment in relation to the injected test sediment average.

Environmental Technology Verification

Table 2 shows the results of the sediment scour and re-suspension test. This test involved preloading 10.2 cm of fresh test sediment into the sedimentation sump of the device. The sediment was placed on a false floor to mimic a device filled to 50% of the maximum recommended sediment storage depth. Sediment was also pre-loaded to the same depth on the separation slab (see Figure 1) since sediment was observed to have been deposited in this area during the sediment capture test. Clean water was run through the device at five surface loading rates over a 36 minute period. The test was stopped and started after the second flow rate in order to change flow meters. Each flow rate was maintained for 5 minutes with a one minute transition time between flow rates. Effluent samples were collected at one minute sampling intervals and analyzed for Suspended Sediment Concentration (SSC) and PSD by recognized methods. The effluent samples were subsequently adjusted based on the background concentration of the influent water and the smallest 5% of particles captured during the 40 L/min/m² sediment capture test, as per the method described in [Bulletin # CETV 2016-09-0001](#).

Table 2. Scour test adjusted effluent sediment concentration.

Run	Surface loading rate (L/min/m ²)	Run time (min)	Background sample concentration (mg/L)	Adjusted effluent suspended sediment concentration (mg/L) [†]	Average (mg/L)
1	200	1.03	0.5	1.0	1.8
		2.03		1.6	
		3.03		1.8	
		4.03		1.8	
		5.03		2.6	
2	800	6.23	2.0	5.0	6.5
		7.23		6.7	
		8.23		9.4	
		9.23		5.4	
		10.23		5.9	
3	1400	11.43 [‡]	2.0	3.1	8.2
		12.43		11.0	
		13.43		14.6	
		14.43		7.1	
		15.43		5.2	
4	2000	17.20	3.2	7.3	11.2
		18.20		22.8	
		19.20		6.9	
		20.20		6.8	
		21.20		12.1	
5	2600	22.40	8.5	248.5	309.3
		23.40		83.0	
		24.40		438.9	
		25.40		338.7	
		26.40		437.5	

[†] The adjusted effluent suspended sediment concentration represents the actual measured effluent concentration minus the smallest 5% of sediment particles (i.e. d₅) removed during the 40 L/min/m² capture test, minus the background concentration. For more information see [Bulletin # CETV 2016-09-0001](#).

[‡] See variance #1 in "Variances from testing procedure" section below.

Environmental Technology Verification

The results of the light liquid re-entrainment test used to evaluate the unit's capacity to prevent re-entrainment of light liquids are reported in Table 3. The test involved preloading 58.3 L (corresponding to a 5 cm depth over the collection sump area of 1.17m²) of surrogate low-density polyethylene beads within the oil collection skirt and running clean water through the device at five surface loading rates (200, 800, 1400, 2000, and 2600 L/min/m²) over a 38 minute period. As with the sediment scour test, flow was stopped and started after the second flow rate to change flow meters. Each flow rate was maintained for 5 minutes with approximately 1 minute transition time between flow rates. The effluent flow was screened to capture all re-entrained pellets throughout the test.

Table 3. Light liquid re-entrainment test results.

Target Flow (L/min/m ²)	Time Stamp	Collected Volume (L)	Collected Mass (g)	Percent re-entrained by volume	Percent retained by volume
200	10:48:42	27 pellets	0.8	0.01	99.99
800	10:55:09	0.07	41	0.12	99.88
1400	11:06:59	0.8	439	1.37	98.63
2000	11:13:00	0.31	177	0.53	99.47
2600	11:19:00	0.18	98	0.31	99.69
Interim Collection Net		0.025	14.2	0.04	99.96
Total Loaded		58.3	33398	--	--
Total Re-entrained		1.385	770	--	--
Percent Re-entrained and retained		--	--	2.38	97.62

Variances from testing Procedure

The following minor deviations from the *Procedure for Laboratory Testing of Oil-Grit Separators* (Version 3.0, June 2014) have been noted:

1. It was necessary to change flow meters during the scour and light liquid re-entrainment test, as the required flows exceeded the minimum and/or maximum range of any single meter. After the loading rate of 800 L/min/m², the flow was gradually shut down and re-initiated through the larger meter immediately after closing the valve controlling flows to the small meter. The transition time of 1-minute for each target flow was followed, resulting in an elapsed time of 3 minutes to reach the next target flow of 1400 L/min/m². This procedure was approved by CETV prior to testing, in recognition that most particles susceptible to scour at low flows would not be in the sump at higher flows. Similarly, re-entrainment of the oil beads was not expected to be significantly affected by the flow meter change.
2. As part of the capture test, evaluation of the 40 L/min/m² surface loading rate was split into 3 parts due to the long duration needed to feed the required minimum of 11.3 kg of test sediment into the unit. At the end of the first and second parts of the test, the flow rates were gradually shutdown to prevent capture of particles that would have been washed out under normal circumstances. The amended procedure was reviewed and approved by the verifier prior to testing.
3. Inflow concentrations during the 40 L/min/m² surface loading rate varied from 162 mg/L to 246 mg/L, which is wider than specified ± 25 mg/L range in the Procedure.

Environmental Technology Verification

Verification

The verification was completed by Toronto and Region Conservation Authority, using the Canadian ETV Program's General Verification Protocol (March, 2000) and taking into account ISO 14034:2016. Data and information provided by Contech Engineered Solutions to support the performance claim included the following: Performance test report prepared by Alden Research Laboratory, Inc, and dated February 2015; the report is based on testing completed in accordance with the Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014).

What is Canadian ETV?

Canadian Environmental Technology Verification (ETV) is delivered by GLOBE Performance Solutions under a license agreement from Environment Canada. Canadian ETV is designed to support Canada's environment industry by providing credible and independent verification of technology performance claims.

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APPENDIX F

SUPPLEMENTAL GEOTECHNICAL INVESTIGATION



**SUPPLEMENTAL GEOTECHNICAL INVESTIGATION
PROPOSED CONDOMINIUM BUILDING
233 DUNLOP STREET WEST
BARRIE, ONTARIO**
for
MDM DEVELOPMENTS

PETO MacCALLUM LTD.
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1 cc: PML Barrie

PML Ref.: 19BF037
Report: 1
November 2019

November 21, 2019

PML Ref.: 19BF037
Report: 1

Mr. Luke Wilson
MDM Developments
190 Hotchkiss Street
Gravenhurst, Ontario
P1P 1H6

Dear Mr. Wilson

**Supplemental Geotechnical Investigation
Proposed Condominium Building
233 Dunlop Street West
Barrie, Ontario**

Peto MacCallum Ltd. (PML) is pleased to present the results of the supplemental geotechnical investigation recently completed at the above noted project site. Authorization for this work was provided by Mr. L. Wilson in the signed Engineering Services Agreement, dated September 12, 2019.

An eight-storey slab-on-grade building is proposed for the property at 233 Dunlop Street West in Barrie. A parking garage will be at grade and seven stories of residential space will be constructed above the parking garage. Paved parking and access beyond the building parking garage will also be provided. The current configuration is shown on Drawing 1, appended.

A previous geotechnical investigation was carried out by others in June of 2017, however, the building has shifted to the west onto a recently purchased piece of property. The recently purchased property has a house that will be demolished.

The purpose of this supplemental investigation was to explore the subsurface conditions at the most recent building location, and based on this information, provide geotechnical engineering recommendations for building foundations and pavement design.

Geoenvironmental services (observations, recording, testing or assessment of the environmental conditions of the soil and ground water) were not within the terms of reference for this assignment, and no work has been carried out in this regard. If excess excavated soils requiring transportation off-site are generated, a program of soil sampling and chemical testing will be needed to determine the chemical properties of the soil to evaluate appropriate receiving site options, in accordance with the MOECC document; Management of Excess Soil – A Guide for Best Management Practices, January, 2014.

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BARRIE, COLLINGWOOD, HAMILTON, KITCHENER, LONDON, TORONTO



The comments and recommendations provided in this report are based on the site conditions at the time of the supplemental investigation, and are applicable only to the proposed works as addressed in the report. Any changes in the proposed plans will require review by PML to reassess the validity of the report, and may require modified recommendations, additional investigation and/or analysis.

INVESTIGATION PROCEDURES

The field work for this supplemental investigation was carried out on October 28, 2019, and consisted of Boreholes 101 to 105 advanced to 6.5 m depth in the latest proposed building location. Borehole locations are shown on Drawing 1, appended.

The approximate location of previous boreholes by others is also shown on Drawing 1, appended. Copies of the borehole logs are provided in Appendix A.

PML laid out the boreholes in the field. The ground surface elevation at the borehole locations was obtained with a Sokkia SHC5000 Global Navigation Satellite System (GNSS). Vertical and horizontal accuracy of this unit are 0.1 m and 0.5 m, respectively.

Co-ordination for clearances of underground utilities was provided by PML with the aid of a private locator. The boreholes were drilled cognizant of the underground utilities.

The boreholes were advanced using continuous flight solid stem augers, powered by a rubber tire mounted CME-750 drill rig, equipped with an automatic hammer, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of PML's engineering staff.

Representative samples of the overburden were recovered at frequent depth intervals for identification purposes using a conventional split spoon sampler. Standard penetration tests were carried out simultaneously with the sampling operations to assess the strength characteristics of the substrata. The ground water conditions in the boreholes were assessed during drilling by visual examination of the soil samples, the sampler, and drill rods as the samples were retrieved, and measurement of water in the open boreholes upon completion, if any.



A piezometer, comprising 19 mm diameter pipe with slots cut in the bottom 1.5 m, filter sand, bentonite seal and an above grade protective cover was installed in Borehole 101 to permit ground water level monitoring. It should be noted that the piezometer becomes the property of the Owner and will have to be decommissioned by the Owner. PML would be pleased to assist in this regard. The four other boreholes were backfilled in accordance with O.Reg. 903

Water levels in the piezometer and one other existing monitoring well were measured on multiple occasions and the results are present herein.

All recovered soil samples were returned to our laboratory for moisture content determinations and detailed examination to confirm field classification.

SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Log of Borehole sheets for details of the subsurface conditions, including soil classifications, inferred stratigraphy, Standard Penetration N Values, details, ground water observations and the results of laboratory water content determinations.

Due to the soil sampling procedures and limited sample size, the depth demarcations on the borehole logs must be viewed as "transitional" zones between layers, and cannot be construed as exact geologic boundaries between layers. PML would be pleased to assist with this during construction, if required.

Topsoil was present at the surface of Borehole 101 and Borehole 104, being 160 mm and 150 mm thick, respectively.



Beneath the topsoil in Boreholes 101 and 104, and at the surface of Boreholes 102, 103 and 105, a fill unit was present to 0.7 to 2.1 m depth (elevation 225.8 to 227.25). The fill consisted of sand, trace silt and trace gravel and graded to gravelly sand, trace silt in two boreholes. Trace organics were noted in Boreholes 101 and 104. N Values in the fill ranged from 2 to 17, indicating variable compactive effort then the fill was placed. The moisture contents ranged from 2 to 15%, typically less than 8%, with the soil being moist.

A major native sand deposit was below the fill in all boreholes, extending to the 6.5 m depth of exploration. The deposit comprised sand with trace to some silt and trace gravel. The sand was loose to dense with depth, typically loose in the upper 0.5 to 1.5 m of the unit becoming compact to dense below the upper 0.5 to 1.5 m (N Values range from 7 to 41). The deposit was moist, becoming wet with depth and moisture contents were 3 to 21%.

The first water strike (ground water first encountered during drilling), the ground water levels measured in the boreholes upon completion of augering, and the ground water levels measured in the piezometer and existing monitoring well are summarized in the table below, on a borehole by borehole basis:

BOREHOLE	FIRST STRIKE DURING DRILLING DEPTH (m) /ELEVATION	UPON COMPLETION OF AUGERING DEPTH (m) /ELEVATION	IN PIEZOMETER OR EXISTING WELL		
			SEP.12, 2019	OCT.15, 2019	NOV.18, 2019
101	4.3/224.1	4.0/224.4	--	4.1/224.3	Blocked
102	4.3/223.8	3.8/224.3	--	--	--
103	4.3/223.7	3.8/224.2	--	--	--
104	4.3/223.6	4.0/223.9	--	--	--
105	4.2/223.7	4.0/223.9	--	--	--
4 (existing well)	--	--	4.5/224.6	4.5/224.6	4.1/225.0

Note: Existing Borehole 4 is located in a local elevated area about 0.75 m above the surrounding grade.



Based on the data above and the moisture content profile the ground water is anticipated to stabilize at about 3.0 to 4.5 m depth below grade corresponding to about elevation 223.5 to 225.5.

Ground water levels are subject to seasonal fluctuations, and in response to variations in precipitation.

GEOTECHNICAL ENGINEERING CONSIDERATIONS

Site Grading and Engineered Fill

An eight-storey slab-on-grade building is proposed for the property at 233 Dunlop Street West in Barrie. A parking garage will be at grade and seven stories of residential space will be constructed above the parking garage. It is understood that the ground floor slab will be set at elevation 228.5 with surrounding grades at about elevation 228.0. Paved parking and access beyond the building parking garage will also be provided. The current configuration is shown on Drawing 1, appended.

Based on the boreholes for this supplemental investigation, ground surface elevations within the building footprint ranged from elevation 227.9 to 228.35, and only very minor grading adjustments will be required.

The topsoil, existing fill and the upper 0.5 to 2.0 m of loose native are unsuitable to support footings designed for the desired 200 kPa geotechnical bearing resistance at Serviceability Limit State (SLS). The topsoil and existing fill are unsuitable to support the slab-on-grade.

In the area of the existing house on the recently purchased property, the in-situ fill and foundations will have to be removed, such that the extent of the excavation extends to native soil in all directions. It is noted that fill may be deeper around the existing house than indicated at the borehole locations. Further, it is uncertain how the excavations for previously demolished buildings were backfilled and existing fill in these two areas may be deeper than the boreholes indicate.



Two options are provided for construction of the proposed building:

- Option 1: Extend all footings down to native soil capable of supporting 200 kPa at SLS (detailed later in the report). Remove topsoil and existing fill inside the building footprint and replace with engineered fill in order to support the slab-on-grade.
- Option 2: Remove topsoil, existing fill and loose native soil (upper 0.5 to 2.0 m of the native sand deposit) and replace with engineered fill comprising Granular B to the footing founding level, followed by engineered fill comprising site soil to the underside of the slab-on-grade.

Option 1 has less requirement for engineered fill however, footings will need to be deeper than frost depth due to the loose nature of the upper portion of the native soil. If ground water levels rise in the spring then this option could be problematic when trying to achieve the requirement to have a 0.5 m buffer between the high ground water level and the footings (particularly near Boreholes 104 and 105). Option 2 requires more effort for engineered fill, however once engineered fill is constructed there is no limitation for footing depth and footings can be raised to frost depth or other desired levels (provided Granular B is placed accordingly). The 0.5 m buffer between the high ground water level and the footing should not be an issue with raised footings in Option 2.

Reference is made to Appendix A for guidelines for engineered fill construction. The following general highlights are provided:

- Strip existing topsoil, existing fill (including house foundations and associated existing fill), upper loose native soil (to depths provided below – Option 2 only) and other deleterious materials down to competent native soil, subject to geotechnical review during construction.

BOREHOLE	REMOVAL DEPTH OF LOOSE NATIVE SOIL FOR OPTION 2 DEPTH (m)/ELEVATION
101	2.3/226.1
102	2.7/225.4
103	1.5/226.5
104	2.8/225.1
105	2.8/225.1



- The excavated inorganic soil (excluding topsoil and fill with organics) is predominately suitable for reuse as engineered fill for the floor slab-on-grade. Excavated materials should be segregated and stockpiled separately, based on geotechnical review;
- Proofroll exposed subgrade using a heavy roller to targeted 100% Standard Proctor maximum dry density, under geotechnical review;
- Following geotechnical review and approval of the subgrade, spread approved material in maximum 200 mm thick lifts and uniformly compacted to 100% Standard Proctor maximum dry density. For Option 2, imported Granular B will be utilized from the base of the excavation to the underside of footings (elevations to be determined by designer). For Option 1 or above footing founding elevation for Option 2, on-site inorganic soil can be utilized, subject to geotechnical review. If wet subgrade conditions are present the use of Granular B Type II may be required for the first lift or two of engineered fill (both Option 1 and 2);
- For Option 2, engineered fill pad must extend at least 1 m beyond the structure to be supported, then outwards and downwards at no steeper than 45° to the horizontal to meet the underlying approved native subgrade. In this regard, strict survey control and detailed documentation of the lateral and vertical extent of the engineered fill limits should be carried out to ensure that the engineered fill pad fully incorporates the structure to be supported. For Option 1, engineered fill is required on the interior of the building below the slab-on-grade;
- Engineered fill construction must be carried out under full-time field review by PML, to approve sub-excavation and subgrade preparation, backfill materials, placement and compaction procedures, and to verify that the specified compaction standards are achieved throughout.

Foundations

The slab-on-grade is proposed at elevation 228.5. As noted above two, options are provided for footings in order to achieve the desired 200 kPa geotechnical bearing resistance at SLS and the factored bearing resistance at Ultimate Limit State (ULS) of 300 kPa.



For Option 1, footings are to be extended down to native soils capable of providing the desired 200 kPa geotechnical bearing resistance at SLS and the factored bearing resistance at ULS of 300 kPa. The depths are provided in the table below on a borehole by borehole basis.

BOREHOLE	DEPTH (m)/ELEVATION
101	2.3/226.1
102	2.7/225.4
103	1.5/226.5
104	2.8/225.1
105	2.8/225.1

For Option 2, footings founded on engineered fill, comprised of Granular B and constructed as discussed above, and can be designed for a geotechnical bearing resistance at SLS of 200 kPa and a factored bearing resistance at ULS of 300 kPa, at any depth. It is noted that the designer will determine the depth of the footings and therefore the thickness of Granular B.

The geotechnical bearing resistance at SLS is based on 25 mm of settlement in the bearing stratum with differential settlement not exceeding 75% of the value.

Footings subject to frost action should be provided with a minimum 1.2 m of earth cover or equivalent insulation. It is noted that 25 mm of polystyrene insulation is equivalent to 600 mm of earth cover.

Prior to placement of structural concrete, all founding surfaces should be reviewed by PML to verify the design bearing capacity is available, or to reassess the design parameters based on the actual conditions revealed in the excavation.

Based on the soil profile (N Values) revealed in the boreholes, Site Classification D is applicable for Seismic Site Response as set out in Table 4.1.8.4.A of the Ontario Building Code (2012). Based on the type and relative density of the soil cover at the site there is a low potential for liquefaction of soils to occur.



Floor Slab-On-Grade

Floor slab-on-grade construction is feasible on engineered fill, constructed as describe below.

A minimum 200 mm thick base layer of crushed stone (nominal 19 mm size) is recommended directly under the slab. A polyethylene sheet vapour barrier should be incorporated under the ground floor slab if a vapour sensitive floor finish is planned.

Exterior grades should be established to promote surface drainage away from the building.

Excavation and Ground Water Control

Based on the proposed grades, proposed building floor slab elevation and borehole information, excavation for the building foundations or engineered fill is anticipated to extend a maximum 3.0 m below existing grade.

Type 3 soil conditions are present and excavation side walls should be constructed no steeper than three horizontal to one vertical (3H:1V), in accordance with the Occupational Health and Safety Act (OHSA).

The ground water in the boreholes is anticipated to stabilize about 3.0 to 4.5 m below existing grade at elevation 223.5 to 225.5. Excavation is anticipated above the ground water table to slightly below the ground water table. Where excavation is carried out to or slightly below the ground water table it is recommend that excavation and backfilling be carried out in small manageable sections. For excavation as noted above, conventional sump pumping should be sufficient to control ground water seepage for the most part. Greater pumping efforts or pumping from keg wells may be required in areas where excavation is slightly below the ground water table.

Excavation below the depths noted above will be well below the ground water table and dewatering will be required. The ground water level will have to be lowered a minimum 0.5 m below the excavation in order to carry out the work in dry conditions. Dewatering systems should be designed an installed by specialists in this field.



Water taking in Ontario is governed by the Ontario Water Resources Act (OWRA) and the Water Takings and Transfer Regulation O. Reg. 387/04. Section 34 of the OWRA requires anyone taking more than 50,000 L/d to notify the Ministry of the Environment, Conservation and Parks (MECP). This requirement applies to all withdrawals, whether for consumption, temporary construction dewatering, or permanent drainage improvements. Where it is assessed that more than 50,000 L/d but less than 400,000 L/d of ground water taking is required, the Owner can register online via the Environmental Activity and Sector Registry (EASR) system. Where it is assessed that more than 400,000 L/d of ground water taking is required then a Category 3 Permit-To-Take-Water (PTTW) is required.

Based on the boreholes and excavation as described above, a PTTW is not anticipated. Registry on the EASR may be prudent. For excavation below the depth noted above a PTTW will be required.

Pavement Design and Construction

Currently, it is anticipated that the site grades will only require minor adjustment. Based on this, it is anticipated that the pavement subgrade will typically comprise the sand fill which is considered low to moderately frost susceptible. The following pavement structure thicknesses are recommended and should be reviewed when grading/subgrade soils are determined:

MATERIAL	LIGHT DUTY (mm)	HEAVY DUTY/FIRE ROUTE (mm)
Asphalt	90	110
Granular A Base Course	150	150
Granular B Subbase Course	300	450
Total Thickness	540	710

In general, it is recommended that following rough grading to the subgrade level, subgrade preparation should include proofrolling and compacting the exposed subgrade with a heavy compactor to minimum 95% Standard Proctor maximum dry density under geotechnical review. Any unstable zones identified during this process should be sub-excavated and replaced with compacted select site material at a suitable moisture content placed in 200 mm thick lifts and



compacted to minimum 95% Standard Proctor maximum dry density, subject to geotechnical field review.

The pavement design considering that construction will be carried out during the dry time of the year and that the subgrade is relatively dry and is stable, as determined by proofrolling operations described above. If the pavement subgrade is wet, remediation may include increasing the thickness/depth of the subbase, the use of Granular B Type II and/or the use of geogrid reinforcement, subject to geotechnical review during construction.

Imported material for the granular base and subbase should conform to OPSS gradation specifications for Granular A and Granular B, and should be compacted to 100% Standard Proctor maximum dry density. Asphalt should be compacted in accordance with OPSS 310.

For the pavement to function properly, it is essential that provisions be made for water to drain out of and not collect in the base material. The incorporation of subdrains is recommended in conjunction with crowning of the final subgrade to promote drainage towards the pavement edge. Subdrains should be installed at least 300 mm below the subgrade level. Refer to OPSS 216. Series for details regarding pipe, filter fabric or filter sock, bedding and cover material. Maintenance holes/catchbasins should be backfilled with free draining Granular B. The above measures will help drain the pavement structure as well as alleviate the problems of differential frost movement between the catchbasins and pavement.



Geotechnical Review and Construction Inspection and Testing

It is recommended that the final design drawings be submitted to PML for geotechnical review for compatibility with site conditions and recommendations of this report.

Earthworks operations should be carried out under the supervision of PML to approve subgrade preparation, backfill materials, placement and compaction procedures and check the specified degree of compaction is achieved throughout.

Prior to placement of structural concrete, all founding surfaces must be inspected by PML to verify the design bearing capacity is available, or to reassess the design parameters based on the actual conditions.

The comments and recommendations provided in the report are based on information revealed in the boreholes. Conditions away from and between boreholes may vary. Geotechnical review during construction should be ongoing to confirm the subsurface conditions are substantially similar to those encountered in the boreholes, which may otherwise require modification to the original recommendations.



CLOSURE

We trust this report is complete within our terms of reference, and the information presented is sufficient for your present purposes. If you have any questions, or when we may be of further assistance, please do not hesitate to call our office.

Sincerely

Peto MacCallum Ltd.



Geoffrey R. White, P.Eng.
Director
Manager, Geotechnical and Geoenvironmental Services

GRW;jlb

Enclosure(s):

List of Abbreviations
Log of Borehole Nos. 101 to 105
Drawing No. 1 – Borehole Location Plan
Appendix A – Borehole Logs by Others
Appendix B – Engineered Fill

LIST OF ABBREVIATIONS



PENETRATION RESISTANCE

Standard Penetration Resistance N: - The number of blows required to advance a standard split spoon sampler 0.3 m into the subsoil. Driven by means of a 63.5 kg hammer falling freely a distance of 0.76 m.

Dynamic Penetration Resistance: - The number of blows required to advance a 51 mm, 60 degree cone, fitted to the end of drill rods, 0.3 m into the subsoil. The driving energy being 475 J per blow.

DESCRIPTION OF SOIL

The consistency of cohesive soils and the relative density or denseness of cohesionless soils are described in the following terms:

<u>CONSISTENCY</u>	<u>N (blows/0.3 m)</u>	<u>c (kPa)</u>	<u>DENSENESS</u>	<u>N (blows/0.3 m)</u>
Very Soft	0 - 2	0 - 12	Very Loose	0 - 4
Soft	2 - 4	12 - 25	Loose	4 - 10
Firm	4 - 8	25 - 50	Compact	10 - 30
Stiff	8 - 15	50 - 100	Dense	30 - 50
Very Stiff	15 - 30	100 - 200	Very Dense	> 50
Hard	> 30	> 200		
WTLL	Wetter Than Liquid Limit			
WTPL	Wetter Than Plastic Limit			
APL	About Plastic Limit			
DTPL	Drier Than Plastic Limit			

TYPE OF SAMPLE

SS	Split Spoon	ST	Slotted Tube Sample
WS	Washed Sample	TW	Thinwall Open
SB	Scraper Bucket Sample	TP	Thinwall Piston
AS	Auger Sample	OS	Oesterberg Sample
CS	Chunk Sample	FS	Foil Sample
GS	Grab Sample	RC	Rock Core
	PH	Sample Advanced Hydraulically	
	PM	Sample Advanced Manually	

SOIL TESTS

Qu	Unconfined Compression	LV	Laboratory Vane
Q	Undrained Triaxial	FV	Field Vane
Qcu	Consolidated Undrained Triaxial	C	Consolidation
Qd	Drained Triaxial		

LOG OF BOREHOLE NO. 101

1 of 1

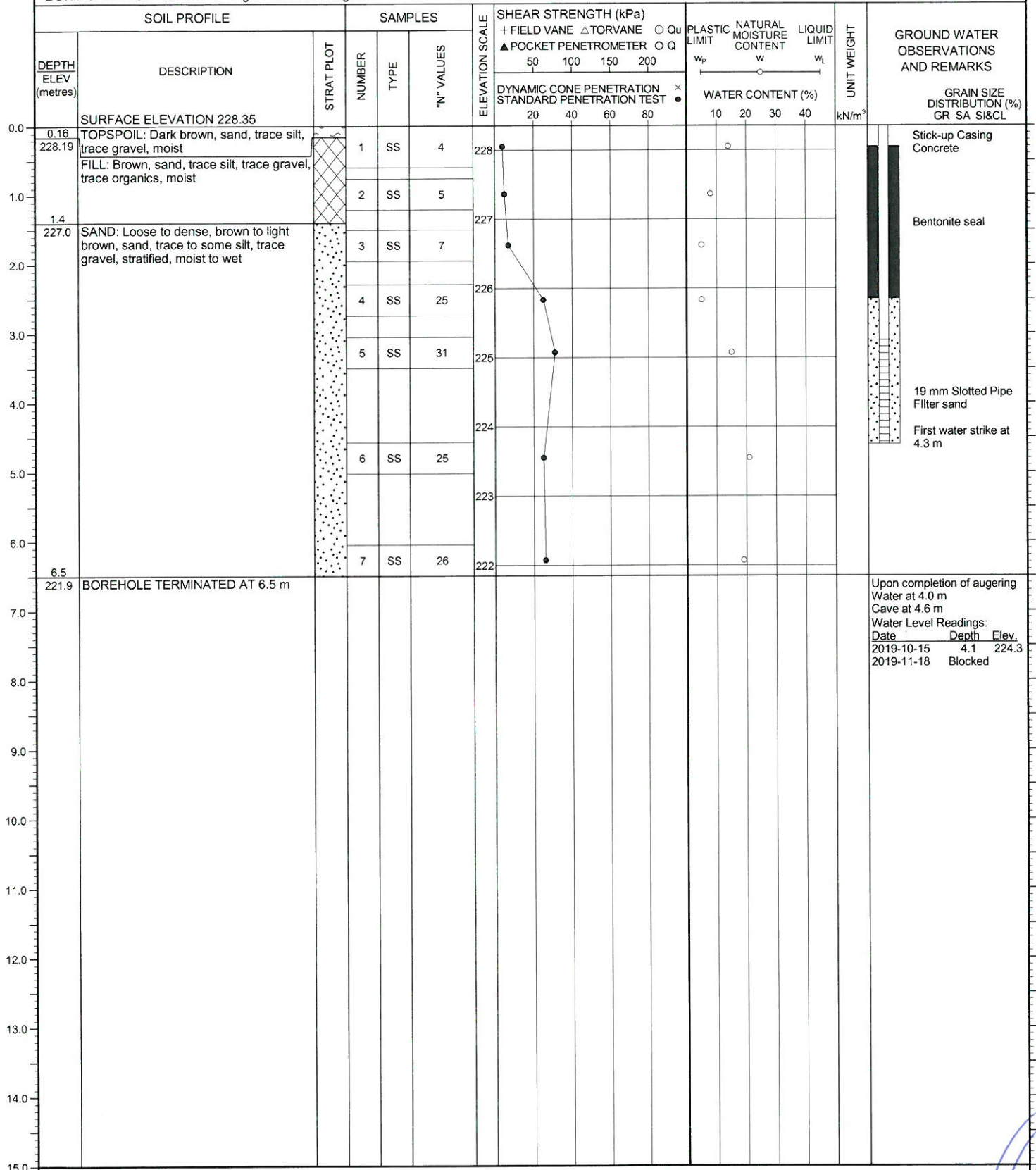
PROJECT Proposed Condominium Building
LOCATION 233 Dunlop Street West, Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE October 2, 2019

PML REF. 19BF037

ENGINEER GW

TECHNICIAN AT



NOTES

LOG OF BOREHOLE NO. 102

1 of 1

PROJECT Proposed Condominium Building
LOCATION 233 Dunlop Street West, Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE October 2, 2019

PML REF. 19BF037

ENGINEER GW

TECHNICIAN AT

SOIL PROFILE			SAMPLES			ELEVATION SCALE	SHEAR STRENGTH (kPa)		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT kN/m ³	GROUND WATER OBSERVATIONS AND REMARKS			
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		+ FIELD VANE Δ TORVANE ○ Q _u ▲ POCKET PENETROMETER ○ Q									
							DYNAMIC CONE PENETRATION STANDARD PENETRATION TEST ×									
							50	100	150	200	WATER CONTENT (%)					
							20	40	60	80	10	20	30	40		
0.0	SURFACE ELEVATION 228.10					228										
	FILL: Brown, gravelly sand, trace silt, over sand, trace silt, trace gravel, moist			1	SS	11	228									
1.0				2	SS	7	227									
1.4																
226.7	SAND: Loose to dense, brown to light brown, sand, trace to some silt, trace gravel, stratified, moist to wet			3	SS	8	226									
				4	SS	17	226									
2.0																
				5	SS	26	225									
3.0																
4.0							224									
			6	SS	37	223										
5.0																
6.0						222										
6.5			7	SS	36	222										
221.6	BOREHOLE TERMINATED AT 6.5 m															
7.0																
8.0																
9.0																
10.0																
11.0																
12.0																
13.0																
14.0																
15.0																

NOTES

LOG OF BOREHOLE NO. 103

1 of 1

17T 4915330E 603414N

PROJECT Proposed Condominium Building
LOCATION 233 Dunlop Street West, Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE October 2, 2019

PML REF. 19BF037

ENGINEER GW

TECHNICIAN AT

SOIL PROFILE			SAMPLES			SHEAR STRENGTH (kPa)				PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT kN/m ³	GROUND WATER OBSERVATIONS AND REMARKS
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	+ FIELD VANE Δ TORVANE ○ Qu ▲ POCKET PENETROMETER ○ Q				w _p	w	w _L	WATER CONTENT (%)						
							DYNAMIC CONE PENETRATION STANDARD PENETRATION TEST × ●													
0.0	SURFACE ELEVATION 227.95					20	40	60	80	10	20	30	40							
0.70	FILL: Brown, gravelly sand, trace silt, moist		1	SS	17	227														
227.25	SAND: Loose to dense, brown to light brown, sand, trace to some silt, trace gravel, stratified, moist to wet		2	SS	8	226														
			3	SS	29	225														
			4	SS	18	224														
			5	SS	29	223														
			6	SS	36	222														
6.5	BOREHOLE TERMINATED AT 6.5 m		7	SS	29	221.5														
221.5																				
7.0																				
8.0																				
9.0																				
10.0																				
11.0																				
12.0																				
13.0																				
14.0																				
15.0																				

First water strike at 4.3 m

Upon completion of augering
Water at 3.8 m
Cave at 4.0 m

NOTES

LOG OF BOREHOLE NO. 104

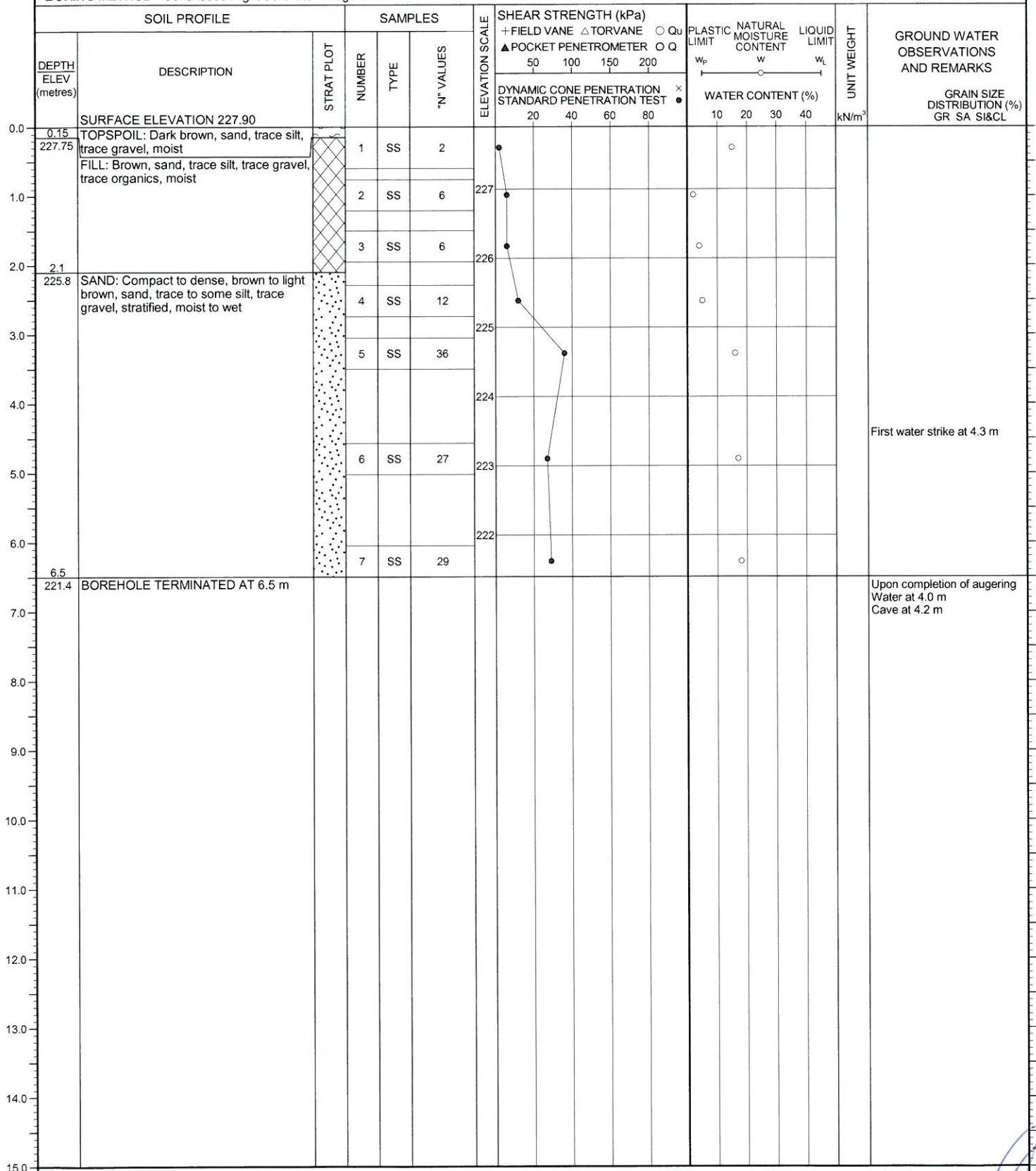
17T 4915311E 603390N

1 of 1

PROJECT Proposed Condominium Building
LOCATION 233 Dunlop Street West, Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE October 2, 2019

PML REF. 19BF037
ENGINEER GW
TECHNICIAN AT



NOTES

LOG OF BOREHOLE NO. 105

1 of 1

PROJECT Proposed Condominium Building
LOCATION 233 Dunlop Street West, Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE October 2, 2019

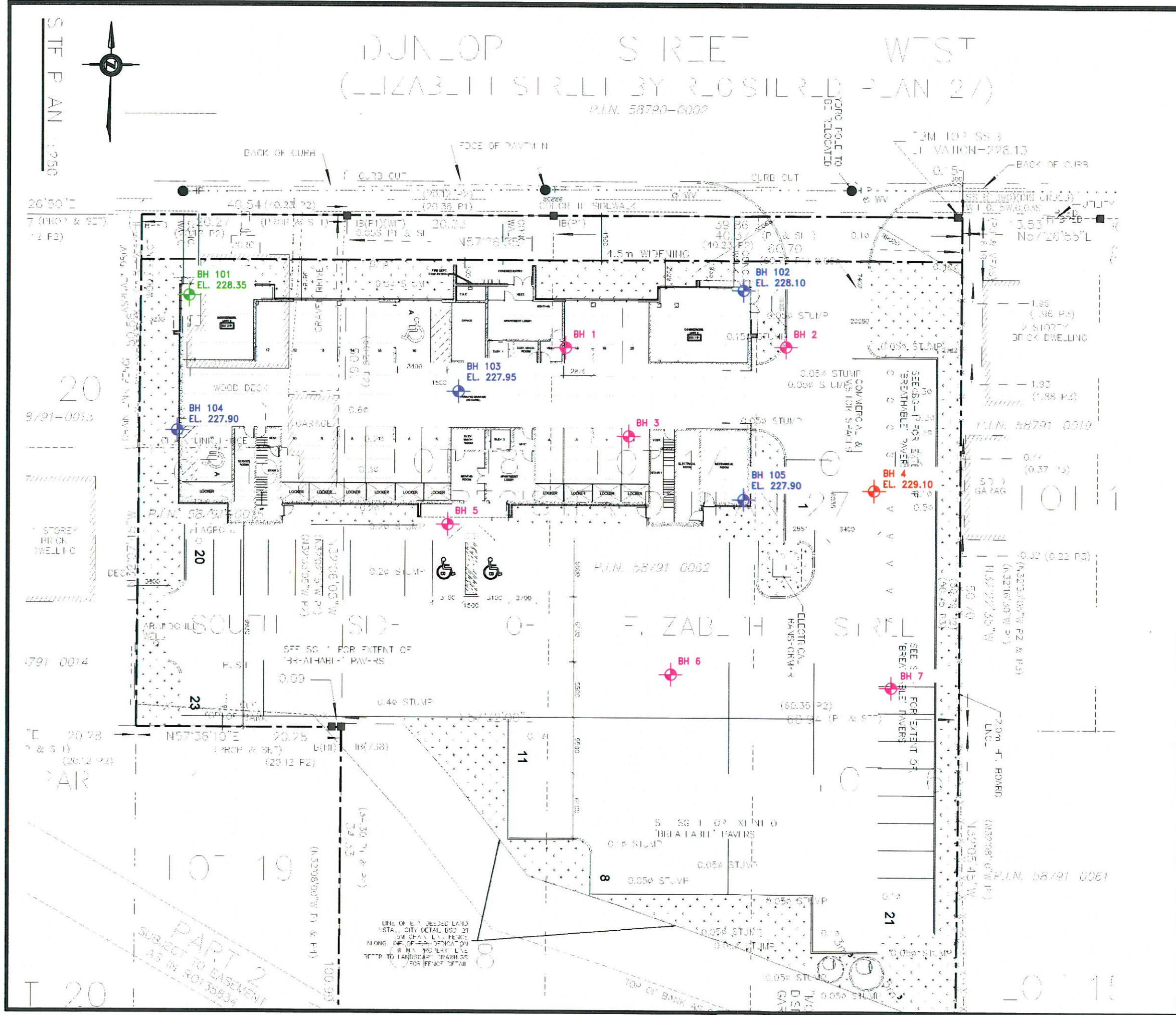
PML REF. 19BF037

ENGINEER GW

TECHNICIAN AT

SOIL PROFILE			SAMPLES			ELEVATION SCALE	SHEAR STRENGTH (kPa)				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT kN/m ³	GROUND WATER OBSERVATIONS AND REMARKS
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		+ FIELD VANE Δ TORVANE ○ Qu ▲ POCKET PENETROMETER ○ Q								
							DYNAMIC CONE PENETRATION STANDARD PENETRATION TEST × ●								
							50 100 150 200				10 20 30 40				
0.0	SURFACE ELEVATION 227.90														
0.70	FILL: Brown, gravelly sand, trace silt, moist		1	SS	12	227									
227.20	SAND: Loose to dense, brown to light brown, sand, trace to some silt, trace gravel, stratified, moist to wet		2	SS	9	227									
1.0			3	SS	8	226									
2.0			4	SS	15	225									
3.0			5	SS	29	224									
4.0															
5.0			6	SS	41	223									
6.0						222									
6.5			7	SS	29										
221.4	BOREHOLE TERMINATED AT 6.5 m														First water strike at 4.2 m
7.0															Upon completion of augering Water at 4.0 m Cave at 4.2 m
8.0															
9.0															
10.0															
11.0															
12.0															
13.0															
14.0															
15.0															

NOTES



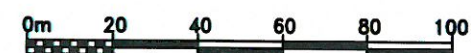
KEY PLAN
BARRIE, ONTARIO

LEGEND:

- BH 101
EL. 228.35 BOREHOLE 101 (WITH PIEZOMETER)
SURFACE ELEVATION
- BH 102
EL. 228.10 BOREHOLE 102
SURFACE ELEVATION
- BH 1 EXISTING BOREHOLE 1 (BY OTHERS)
- BH 4
EL. 229.10 EXISTING BOREHOLE 4 (BY OTHERS)
WITH MONITORING WELL
SURFACE ELEVATION

REFERENCE:

BASE PLAN PROVIDED BY CLIENT.



BOREHOLE LOCATION PLAN

PROPOSED CONDOMINIUM BUILDING
233 DUNLOP STREET WEST
BARRIE, ONTARIO



DRAWN	KH	DATE	SCALE	PML REF.	DRAWING NO.
CHECKED	RB	NOV. 2019	AS SHOWN	198F037	1
APPROVED	GW				



APPENDIX A

Borehole Logs by Others

CLIENT: Trinity Consultants Ontario Inc				METHOD: Split Spoon Sampling				BH No.: BH1									
PROJECT: 233, 237, and 241 Dunlop Street West				PROJECT ENGINEER: VN				ELEV. (m) 99.15									
LOCATION: Barrie, Ontario				NORTHING:				EASTING:									
PROJECT NO.: 17-048																	
SAMPLE TYPE ☐ AUGER ☒ DRIVEN ☒ CORING ☐ DYNAMIC CONE ☐ SHELBY ☐ SPLIT SPOON																	
GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa)				Water Content (%)			SAMPLE NO.	SAMPLE TYPE	SPT (N)	Well Construction	REMARKS	
					40	80	120	160	PL	W.C.	LL						
		Crusher Run Limestone	0	99									1A		15		Borehole cave-in at 3.5 m below ground surface.
		damp, dark brown, sand, trace silt (FILL)	0.5	98.5	15								1B				
			1	98	6								2		6		
		loose	1.5	97.5									3		18		
		damp	2	97	18								4		18		
		compact	2.5	96.5	18								5A		27		
			3	96	27								5B				
		moist	3.5	95.5									6		28		
		brown (with black stained layering)	4	95	28								7A		56		
		SILTY SAND to SAND, trace silt	4.5	94.5	56								7B				
			5	94									8		79		
		wet	5.5	93.5									9		55		
		very dense	6	93	79												
			6.5	92.5													
			7	92													
			7.5	91.5													
			8	91	55												
		END OF BOREHOLE															

CLIENT: Trinity Consultants Ontario Inc			METHOD: Split Spoon Sampling			BH No.: BH2								
PROJECT: 233, 237, and 241 Dunlop Street West			PROJECT ENGINEER: VN		ELEV. (m) 99.06									
LOCATION: Barrie, Ontario			NORTHING:		EASTING:		PROJECT NO.: 17-048							
SAMPLE TYPE ☐ AUGER ☒ DRIVEN ☒ CORING ☐ DYNAMIC CONE ☐ SHELBY ☐ SPLIT SPOON														
GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa)		Water Content (%)			SAMPLE NO.	SAMPLE TYPE	SPT (N)	Well Construction	REMARKS
					40	80	120	160	PL					
		TOP SOIL (150 mm)	0	99						1A				Borehole cave-in at 3.5 m below ground surface.
			0.5	98.5						1B		10		
			1	98						2		6		
		loose	1.5	97.5						3		6		
			2	97						4A		13		
			2.5	96.5						4B				
		compact	3	96						5		19		
			3.5	95.5						6		30		
			4	95						7		42		
		brown (with black stained layering) SILTY SAND to SAND, trace silt	4.5	94.5						8		49		
			5	94						9		30		
		dense	5.5	93.5						10		24		
			6	93										
			6.5	92.5										
			7	92										
			7.5	91.5										
			8	91										
		compact	8.5	90.5										
			9	90										
			9.5	89.5										
END OF BOREHOLE														

alston associates
 geotechnical division of TERRAPEX

LOGGED BY: SA
 REVIEWED BY: VN

DRILLING DATE: May 25, 2017
 Page 1 of 1

CLIENT: Trinity Consultants Ontario Inc			METHOD: Split Spoon Sampling			BH No.: BH3								
PROJECT: 233, 237, and 241 Dunlop Street West			PROJECT ENGINEER: VN			ELEV. (m) 98.96								
LOCATION: Barrie, Ontario			NORTHING:			EASTING:								
PROJECT NO.: 17-048														
SAMPLE TYPE			AUGER			DRIVEN								
CORING			DYNAMIC CONE			SHELBY								
SPLIT SPOON														
GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa)		Water Content (%)			SAMPLE NO.	SAMPLE TYPE	SPT (N)	Well Construction	REMARKS
					40	80	120	160	PL					
		Crusher Run Limestone	0	98.96	14		4			1A		14		Borehole cave-in at 3.6 m below ground surface.
			0.5	98.5			5			1B				
			1	98	7		5			2		7		
		loose	1.5	97.5			6			3		7		
			2	97	7									
			2.5	96.5	5		11			4		5		
			3	96										
		compact	3.5	95.5	19		20			5		19		Slightly Wet spoon on retrieval of sample 5.
			4	95	28		22			6		28		Wet spoon on retrieval of sample 6.
			4.5	94.5										
		dense	5	94	36		20			7		36		
		brown (with black stained layering) SILTY SAND to SAND, trace silt	5.5	93.5										
			6	93										
		wet	6.5	92.5	61		19			8		61		
			7	92										
		very dense	7.5	91.5			20			9		50/150		
			8	91	50/150									
			8.5	90.5										
		dense	9	90			24			10		32		
			9.5	89.5	32									
END OF BOREHOLE														
alston associates					LOGGED BY: SA					DRILLING DATE: May 24, 2017				
geotechnical division of TERRAPEX					REVIEWED BY: VN					Page 1 of 1				

CLIENT: Trinity Consultants Ontario Inc			METHOD: Split Spoon Sampling			BH No.: MW4														
PROJECT: 233, 237, and 241 Dunlop Street West			PROJECT ENGINEER: VN						ELEV. (m) 99.71											
LOCATION: Barrie, Ontario			NORTHING:			EASTING:			PROJECT NO.: 17-048											
SAMPLE TYPE			AUGER			DRIVEN			CORING			DYNAMIC CONE			SHELBY			SPLIT SPOON		
GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa)				Water Content (%)			SAMPLE NO.	SAMPLE TYPE	SPT (N)	Well Construction	REMARKS				
					40	80	120	160	PL	W.C.	LL									
		Top Soil mixed with damp, dark brown, sand, trace silt some organics and rootlets (FILL)	0	99.5																
		damp, brown, sand, trace silt (POSSIBLE FILL)	0.5	99																
		loose	1	98.5																
		damp	1.5	98																
		compact	2	97.5																
		moist	2.5	97																
			3	96.5																
			3.5	96																
			4	95.5																
		brown (with black stained layering) SILTY SAND to SAND, trace silt	4.5	95																
			5	94.5																
			5.5	94																
			6	93.5																
		dense to very dense	6.5	93																
			7	92.5																
			7.5	92																
			8	91.5																
			8.5	91																
			9	90.5																
			9.5																	
END OF BOREHOLE																				

CLIENT: Trinity Consultants Ontario Inc				METHOD: Split Spoon Sampling				BH No.: BH5										
PROJECT: 233, 237, and 241 Dunlop Street West				PROJECT ENGINEER: VN				ELEV. (m) 98.71										
LOCATION: Barrie, Ontario				NORTHING:				EASTING:										
PROJECT NO.: 17-048																		
SAMPLE TYPE				AUGER				DRIVEN										
				CORING				DYNAMIC CONE										
								SHELBY										
								SPLIT SPOON										
GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa)				Water Content (%)				SAMPLE NO.	SAMPLE TYPE	SPT (N)	Well Construction	REMARKS	
					40	80	120	160	PL	W.C.	LL							
		TOP SOIL (300 mm)	0	98.5	8									1A		8		Borehole open and dry on completion.
			0.5	98										1B				
		loose damp, brown (with black stained layering) SILTY SAND	1	97.5	7									2		7		
		to SAND, trace silt	1.5	97	11									3		11		
		compact	2															
		END OF BOREHOLE																

CLIENT: Trinity Consultants Ontario Inc				METHOD: Split Spoon Sampling				BH No.: BH6									
PROJECT: 233, 237, and 241 Dunlop Street West				PROJECT ENGINEER: VN		ELEV. (m) 98.78											
LOCATION: Barrie, Ontario				NORTHING:		EASTING:		PROJECT NO.: 17-048									
SAMPLE TYPE ☐ AUGER ☒ DRIVEN ☒ CORING ☐ DYNAMIC CONE ☐ SHELBY ☐ SPLIT SPOON																	
GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa)				Water Content (%)			SAMPLE NO.	SAMPLE TYPE	SPT (N)	Well Construction	REMARKS	
					N-Value (Blows/300mm)				PL	W.C.	LL						
		TOP SOIL (300 mm)	0	98.5	11								1A		11		Borehole open and dry on completion.
		compact	0.5	98									1B				
		loose damp, brown (with black stained layering)	1	97.5	5								2		5		
		compact SAND, trace silt	2	97	19								3		19		
		END OF BOREHOLE															
					LOGGED BY: SA				DRILLING DATE: May 25, 2017								
					REVIEWED BY: VN				Page 1 of 1								

CLIENT: Trinity Consultants Ontario Inc				METHOD: Split Spoon Sampling				BH No.: BH7									
PROJECT: 233, 237, and 241 Dunlop Street West				PROJECT ENGINEER: VN				ELEV. (m) 98.79									
LOCATION: Barrie, Ontario				NORTHING:				EASTING:									
PROJECT NO.: 17-048																	
SAMPLE TYPE ☐ AUGER ☒ DRIVEN ☒ CORING ☐ DYNAMIC CONE ☐ SHELBY ☐ SPLIT SPOON																	
GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa)				Water Content (%)				SAMPLE NO.	SAMPLE TYPE	SPT (N)	Well Construction	REMARKS
					40	80	120	160	PL	W.C.	LL						
		TOP SOIL (300 mm)	0	98.5	6									1A		6	Borehole open and dry on completion.
		loose damp, brown (with black stained layering) SILTY SAND to SAND, trace silt compact	0.5	98										1B			
			1	97.5	5									2		5	
			1.5	97	12									3		12	
		END OF BOREHOLE	2														



APPENDIX B

Engineered Fill

The information presented in this appendix is intended for general guidance only. Site specific conditions and prevailing weather may require modification of compaction standards, backfill type or procedures. Each site must be discussed, and procedures agreed with Peto MacCallum Ltd. prior to the start of the earthworks and must be subject to ongoing review during construction. This appendix is not intended to apply to embankments. Steeply sloping ravine residential lots require special consideration.

For fill to be classified as engineered fill suitable for supporting structural loads, a number of conditions must be satisfied, including but not necessarily limited to the following:

1. Purpose

The site specific purpose of the engineered fill must be recognized. In advance of construction, all parties should discuss the project and its requirements and agree on an appropriate set of standards and procedures.

2. Minimum Extent

The engineered fill envelope must extend beyond the footprint of the structure to be supported. The minimum extent of the envelope should be defined from a geotechnical perspective by:

- at founding level, extend a minimum 1.0 m beyond the outer edge of the foundations, greater if adequate layout has not yet been completed as noted below; and
- extend downward and outward at a slope no greater than 45° to meet the subgrade

All fill within the envelope established above must meet the requirements of engineered fill in order to support the structure safely. Other considerations such as survey control, or construction methods may require an envelope that is larger, as noted in the following sections.

Once the minimum envelope has been established, structures must not be moved or extended without consultation with Peto MacCallum Ltd. Similarly, Peto MacCallum Ltd. should be consulted prior to any excavation within the minimum envelope.

3. Survey Control

Accurate survey control is essential to the success of an engineered fill project. The boundaries of the engineered fill must be laid out by a surveyor in consultation with engineering staff from Peto MacCallum Ltd. Careful consideration of the maximum building envelope is required.

During construction it is necessary to have a qualified surveyor provide total station control on the three dimensional extent of filling.

4. Subsurface Preparation

Prior to placement of fill, the subgrade must be prepared to the satisfaction of Peto MacCallum Ltd. All deleterious material must be removed and in some cases, excavation of native mineral soils may be required.

Particular attention must be paid to wet subgrades and possible additional measures required to achieve sufficient compaction. Where fill is placed against a slope, benching may be necessary and natural drainage paths must not be blocked.

5. Suitable Fill Materials

All material to be used as fill must be approved by Peto MacCallum Ltd. Such approval will be influenced by many factors and must be site and project specific. External fill sources must be sampled, tested and approved prior to material being hauled to site.

6. Test Section

In advance of the start of construction of the engineered fill pad, the Contractor should conduct a test section. The compaction criterion will be assessed in consultation with Peto MacCallum Ltd. for the various fill material types using different lift thicknesses and number of passes for the compaction equipment proposed by the Contractor.

Additional test sections may be required throughout the course of the project to reflect changes in fill sources, natural moisture content of the material and weather conditions.

The Contractor should be particularly aware of changes in the moisture content of fill material. Site review by Peto MacCallum Ltd. is required to ensure the desired lift thickness is maintained and that each lift is systematically compacted, tested and approved before a subsequent lift is commenced.

7. Inspection and Testing

Uniform, thorough compaction is crucial to the performance of the engineered fill and the supported structure. Hence, all subgrade preparation, filling and compacting must be carried out under the full time inspection by Peto MacCallum Ltd.

All founding surfaces for all buildings and residential dwellings or any part thereof (including but not limited to footings and floor slabs) on structural fill or native soils must be inspected and approved by PML engineering personnel prior to placement of the base/subbase granular material and/or concrete. The purpose of the inspection is to ensure the subgrade soils are capable of supporting the building/house foundation and floor slab loads and to confirm the building/house envelope does not extend beyond the limits of any structural fill pads.

8. Protection of Fill

Fill is generally more susceptible to the effects of weather than natural soil. Fill placed and approved to the level at which structural support is required must be protected from excessive wetting, drying, erosion or freezing. Where adequate protection has not been provided, it may be necessary to provide deeper footings or to strip and recompact some of the fill.

9. Construction Delay Time Considerations

The integrity of the fill pad can deteriorate due to the harsh effects of our Canadian weather. Hence, particular care must be taken if the fill pad is constructed over a long time period.

It is necessary therefore, that all fill sources are tested to ensure the material compactability prior to the soil arriving at site. When there has been a lengthy delay between construction periods of the fill pad, it is necessary to conduct subgrade proof rolling, test pits or boreholes to verify the adequacy of the exposed subgrade to accept new fill material.

When the fill pad will be constructed over a lengthy period of time, a field survey should be completed at the end of each construction season to verify the areal extent and the level at which the compacted fill has been brought up to, tested and approved.

In the following spring, subexcavation may be necessary if the fill pad has been softened attributable to ponded surface water or freeze/thaw cycles.

A new survey is required at the beginning of the next construction season to verify that random dumping and/or spreading of fill has not been carried out at the site.

10. Approved Fill Pad Surveillance

It should be appreciated that once the fill pad has been brought to final grade and documented by field survey, there must be ongoing surveillance to ensure that the integrity of the fill pad is not threatened.

Grading operations adjacent to fill pads can often take place several months or years after completion of the fill pad.

It is imperative that all site management and supervision staff, the staff of Contractors and earthwork operators be fully aware of the boundaries of all approved engineered fill pads.

Excavation into an approved engineered fill pad should never be contemplated without the full knowledge, approval and documentation by the geotechnical consultant.

If the fill pad is knowingly built several years in advance of ultimate construction, the areal limits of the fill pad should be substantially overbuilt laterally to allow for changes in possible structure location and elevation and other earthwork operations and competing interests on the site. The overbuilt distance required is project and/or site specified.

Iron bars should be placed at the corner/intermediate points of the fill pad as a permanent record of the approved limits of the work for record keeping purposes.

11. Unusual Working Conditions

Construction of fill pads may at times take place at night and/or during periods of freezing weather conditions because of the requirements of the project schedule. It should be appreciated therefore, that both situations present more difficult working conditions. The Owner, Contractor, Design Consultant and Geotechnical Engineer must be willing to work together to revise site construction procedures, enhance field testing and surveillance, and incorporate design modifications as necessary to suit site conditions.

When working at night there must be sufficient artificial light to properly illuminate the fill pad and borrow areas.

Placement of material to form an engineered fill pad during winter and freezing temperatures has its own special conditions that must be addressed. It is imperative that each day prior to placement of new fill, the exposed subgrade must be inspected and any overnight snow or frozen material removed. Particular attention should be given to the borrow source inspection to ensure only nonfrozen fill is brought to the site.

The Contractor must continually assess the work program and have the necessary spreading and compacting equipment to ensure that densification of the fill material takes place in a minimum amount of time. Changes may be required to the spreading methods, lift thickness, and compaction techniques to ensure the desired compaction is achieved uniformly throughout each fill lift.

The Contractor should adequately protect the subgrade at the end of each shift to minimize frost penetration overnight. Since water cannot be added to the fill material to facilitate compaction, it is imperative that densification of the fill be achieved by additional compaction effort and an appropriate reduced lift thickness. Once the fill pad has been completed, it must be properly protected from freezing temperatures and ponding of water during the spring thaw period.

If the pad is unusually thick or if the fill thickness varies dramatically across the width or length of the fill pad, Peto MacCallum Ltd. should be consulted for additional recommendations. In this case, alternative special provisions may be recommended, such as providing a surcharge preload for a limited time or increase the degree of compaction of the fill.



APPENDIX G

PEARSON ENGINEERING DRAWINGS



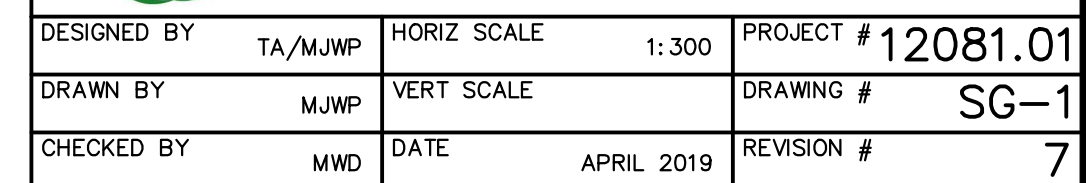
BENCHMARK:
HORIZONTAL
MTO MONUMENT 03120040223 MONUMENT CAP IS LOCATED ON THE NORTHEAST CORNER OF DUNLOP ST. W
AND GUYANA ST BETWEEN THE SIDEWALK AND THE PROPERTY LINE.
MTO MONUMENT 03120080022 MONUMENT CAP IS LOCATED ON THE SE CORNER OF INNISFIL ST AND
VESPERA ST APPROXIMATELY 18.5M FROM CENTERLINE OF INNISFIL ST AND APPROXIMATELY 13M FROM
VESPERA ST.
VERTICAL
MTO MONUMENT 00119310455 ELEVATION 228.735 BARRIE FUNDAMENTAL BENCHMARK LOCATED IN QUEENS
PARK ON THE NORTHEAST OF CURB AT NORTHEAST SIDE OF PARKSIDE DRIVE, 1.8 M NORTHEAST OF
BOUNDARY BETWEEN PARK AND DRILL HALL GROUNDS, TABLET IN TOP.
MTO MONUMENT 00119484119 ELEVATION 232.056 BARRIE FUND.
BUILDING, TABLET ON CORNER OF COLLIER AND OWEN STREETS, TABLET IN EAST SIDE
OF BUILDING WALL IN SHEDS. FIRST CORNER OF COLLIER AND OWEN STREETS, TABLET IN BRICK
IN WALL, 7.0 M NORTH OF SOUTHEAST CORNER OF BUILDING, 0.3 CM BELOW BRICK SIDING.

CONTRACTOR TO CONFIRM LOCATION AND SIZE OF EXISTING SERVICES PRIOR TO CONSTRUCTION. ENGINEER TO BE NOTIFIED OF ANY DISCREPANCIES

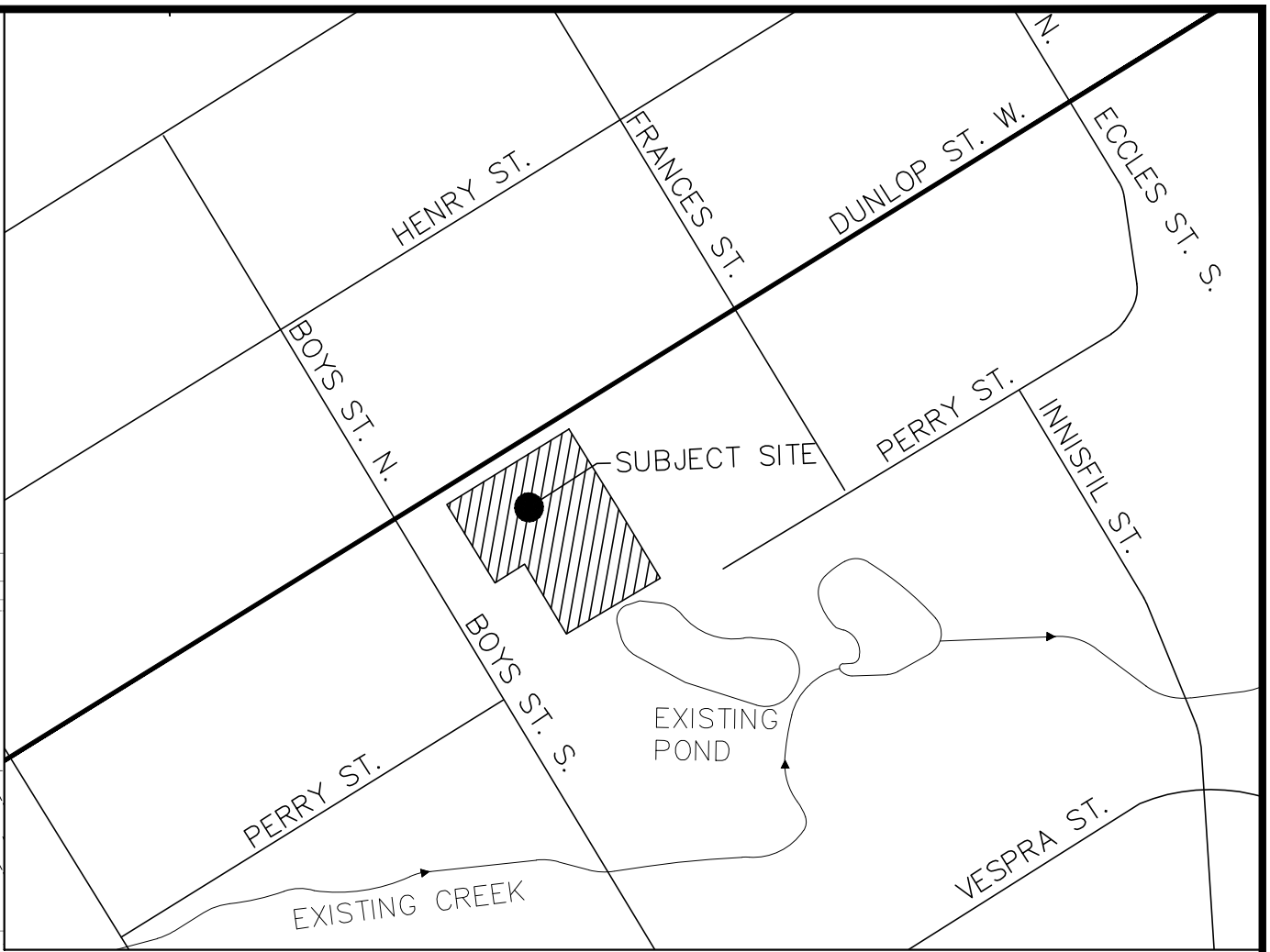
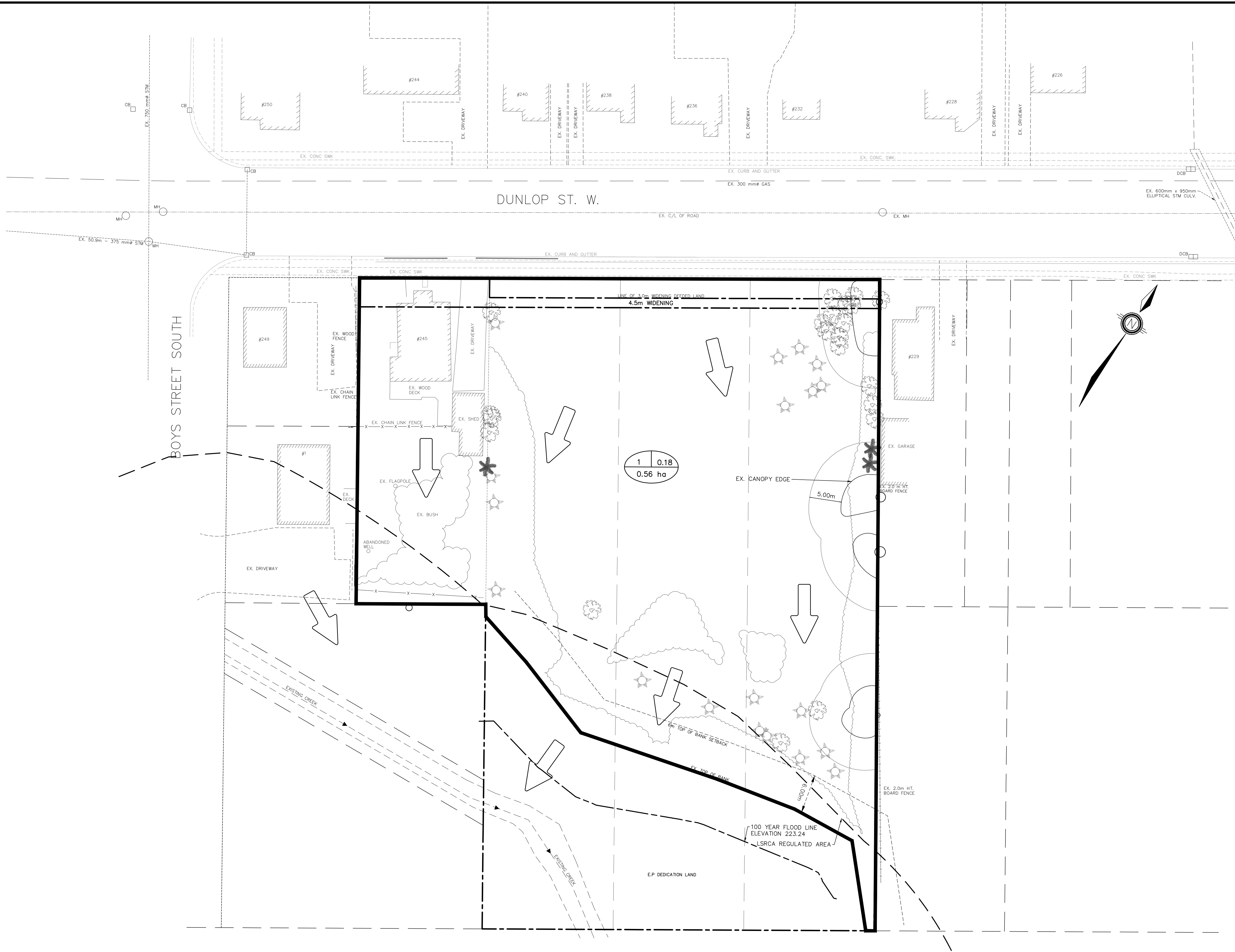
 PEARSON ENGINEERING PEARSONENG.COM PH. 705.719.4785					
DESIGNED BY	TA/MJMP	HORIZ SCALE	1:300	PROJECT #	12081.01
DRAWN BY	MJMP	VERT SCALE		DRAWING #	SS-1
CHECKED BY	MWD	DATE	APRIL 2019	REVISION #	7



BENCHMARK:
HORIZONTAL
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COLLIER ST BETWEEN THE SIDEWALK AND THE PROPERTY LINE
MTO MONUMENT 00120080022 MONUMENT CAP IS LOCATED ON THE SE CORNER OF INNISNIL ST AND
VESPERA ST APPROXIMATELY 18.5M FROM ELEVATION OF INNISNIL ST AND APPROXIMATELY 13M FROM
CENTERLINE OF VESPERA ST
VERTICAL
MTO MONUMENT 00119334455 ELEVATION 228.735 BARRIE FUNDAMENTAL BENCH MARK IN QUEENS
PARK NORTHEAST OF CURB AT NORTHEAST SIDE OF PARKSIDE DRIVE, 1.8 M NORTHEAST OF
BOUNDARY BETWEEN PARK AND DRILL HALL GROUNDS, TABLET IN TOP.
MTO MONUMENT 00119481119 ELEVATION 232.055 BARRIE FUNDAMENTAL BENCH MARK IN QUEENS
PARK NORTHEAST OF CURB AND COLLIER AND OWEN STREETS, TABLET IN EAST SIDE
OF BUILDING WALL, IN SHED AT FIRST CORNER OF COLLIER AND OWEN STREETS, 1.8 M NORTH
IN WALL, 7.0 M NORTH OF SOUTHEAST CORNER OF PARKSIDE, 13 CM BELOW BRICK SIDING.



C:\Users\jvans\PENG\AppData\Local\Temp\AcPublish_2476A\2081.01 - BASE_REV7.dwg Layout:STM-1 Plotted Mar. 31, 2021 @ 7:49am by jvans @ PEARSON ENGINEERING LTD.



KEYMAP

LEGEND

- CB CATCHBASIN
- CBMH CATCHBASIN MANHOLE
- MH CATCHBASIN MANHOLE C/W CLOSED STORM LID AS PER OPSD 410.010
- MH SANITARY MANHOLE
- SERVICE CAP
- HYD. FIRE HYDRANT
- VB WATER VALVE
- CS CURB STOP W/ SERVICE
- VB PROPOSED 50mmØ BLOWOFF C/W GATE VALVE
- RWL PROPOSED RAINWATER LEADER
- LS PROPOSED LIGHT STANDARD
- PROPOSED RIP-RAP
- PROPOSED 3:1 MAX SLOPE
- PROPOSED ELEVATION
- EXISTING ELEVATION
- PROPOSED DIRECTION AND GRADE
- PROPOSED LIGHT STANDARD
- BACK OF CURB
- EDGE OF PAVEMENT
- CURB CUT LOCATION
- HIGH POINT
- PROPOSED RETAINING WALL
- PROPOSED BUILDING ENTRANCE
- PROPOSED DRAINAGE SWALE
- OVERLAND FLOW DIRECTION
- CATCHMENT AREA 1 0.75 RUNOFF COEFFICIENT
- AREA IN HECTARES
- CATCHMENT BOUNDARY

7.	REVISED FOR SITE PLAN AMMENDMENT	03/30/21	JPE
6.	REVISED BASED ON CAR PORT LOCATION	12/16/20	JPE
5.	REVISED SERVICING/GRADING	10/29/20	JPE
4.	ISSUED FOR TENDER	06/15/20	JPE
3.	ISSUED FOR APPROVAL	03/12/20	JPE
NO.	REVISION NOTE	DATE	BY

BENCHMARK:
HORIZONTAL
MTO MONUMENT 03120040023 MONUMENT CAP IS LOCATED ON THE NORTHEAST CORNER OF DUNLOP ST. W AND ECCLES ST BETWEEN THE SIDEWALK AND THE PROPERTY LINE.
MTO MONUMENT 03120080022 MONUMENT CAP IS LOCATED ON THE SE CORNER OF INNISFIL ST AND APPROXIMATELY 13M FROM CENTERLINE OF VESPRE ST.
VERTICAL
MTO MONUMENT 0011931U4555 ELEVATION 228.735 BARRIE FUNDAMENTAL BENCH-MARK IN QUEENS PARK, 12.2 M NORTHEAST OF CURB AT NORTHEAST SIDE OF PARKSIDE DRIVE, 1.8 M NORTHEAST OF BOUNDARY BETWEEN PARK AND DRILL HALL GROUNDS, TABLET IN TOP.
MTO MONUMENT 0011984U119 ELEVATION 232.085 BARRIE FEDERAL BUILDING, AT CORNER OF COLLIER AND OWEN STREETS, TABLET IN EAST SIDE SMOOTH STONE FOUNDATION WALL, IN CENTRE OF FIRST STONE NORTH OF NOTCH IN WALL, 7.0 M NORTH OF SOUTHEAST CORNER OF BUILDING, 30 CM BELOW BRICK SIDING.

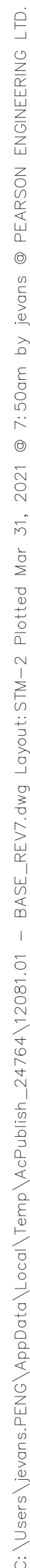


MDM DEVELOPMENTS
233 DUNLOP STREET WEST
CITY OF BARRIE

PRE-DEVELOPMENT STORM
CATCHMENT PLAN



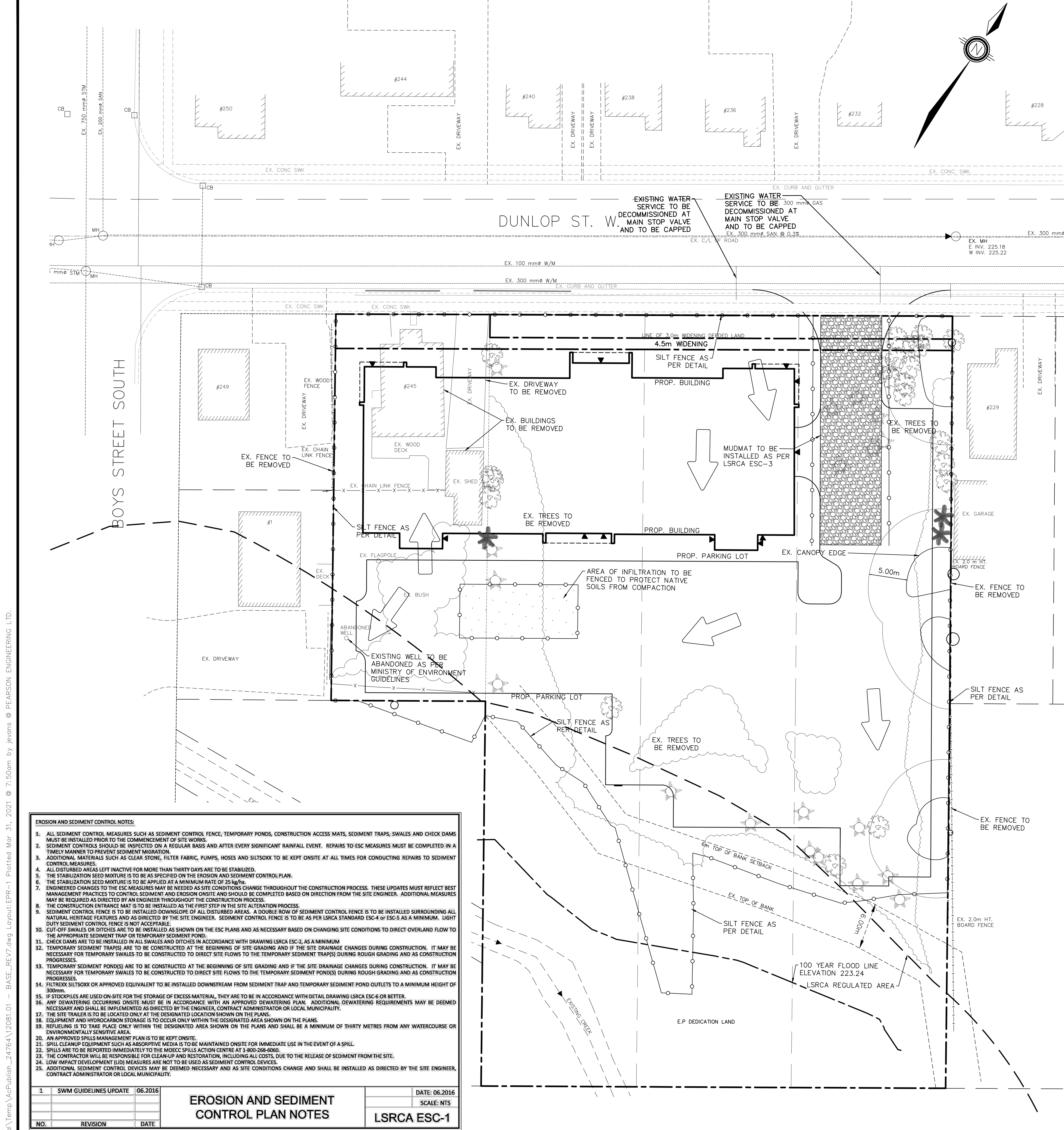
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DRAWN BY	MJWP	VERT SCALE		DRAWING #	STM-1
CHECKED BY	MWD	DATE	APRIL 2019	REVISION #	7



BENCHMARK:
HORIZONTAL
MTO MONUMENT 03120040023 MONUMENT CAP IS LOCATED ON THE NORTHEAST CORNER OF DUNLOP ST. W
AND COLLIER ST BETWEEN THE SIDEWALK AND THE PROPERTY LINE.
MTO MONUMENT 03120080022 MONUMENT CAP IS LOCATED ON THE SE CORNER OF INNISNIL ST. AND
VESPERA ST. APPROXIMATELY 18.9M FROM ELEVATION OF INNISNIL ST AND APPROXIMATELY 13M FROM
VESPERA ST.
VERTICAL
MTO MONUMENT 00119310455 CENELENE 228.735 BARRIE FUNDAMENTAL BENCH-MARK IN QUEENS
PARK MONUMENT NORTHEAST OF CURB AT NORTHEAST SIDE OF PARKSIDE DRIVE, 1.8 M NORTHEAST OF
BOUNDARY BETWEEN PARK AND DRILL HALL GROUNDS, TABLET IN TOP.
MTO MONUMENT 00119480119 ELEVATION 232.050 BARRIE FEDERAL
MONUMENT NORTHEAST OF CORNER OF COLLIER AND OWEN STREETS, TABLET IN EAST SIDE
OF BUILDING WALL. IN SHED ON FIRST FLOOR. 1.5 M NORTH OF CORNER OF COLLIER AND
OWEN WALL, 7.0 M NORTH OF SOUTHEAST CORNER OF BUILDING, 3.0 CM BELOW BRICK SIDING.



DESIGNED BY	TA/MJWP	HORIZ SCALE	1:300	PROJECT #	12081.01
DRAWN BY	MJWP	VERT SCALE		DRAWING #	STM-2
CHECKED BY	MWD	DATE	APRIL 2019	REVISION #	7



SITE DATA

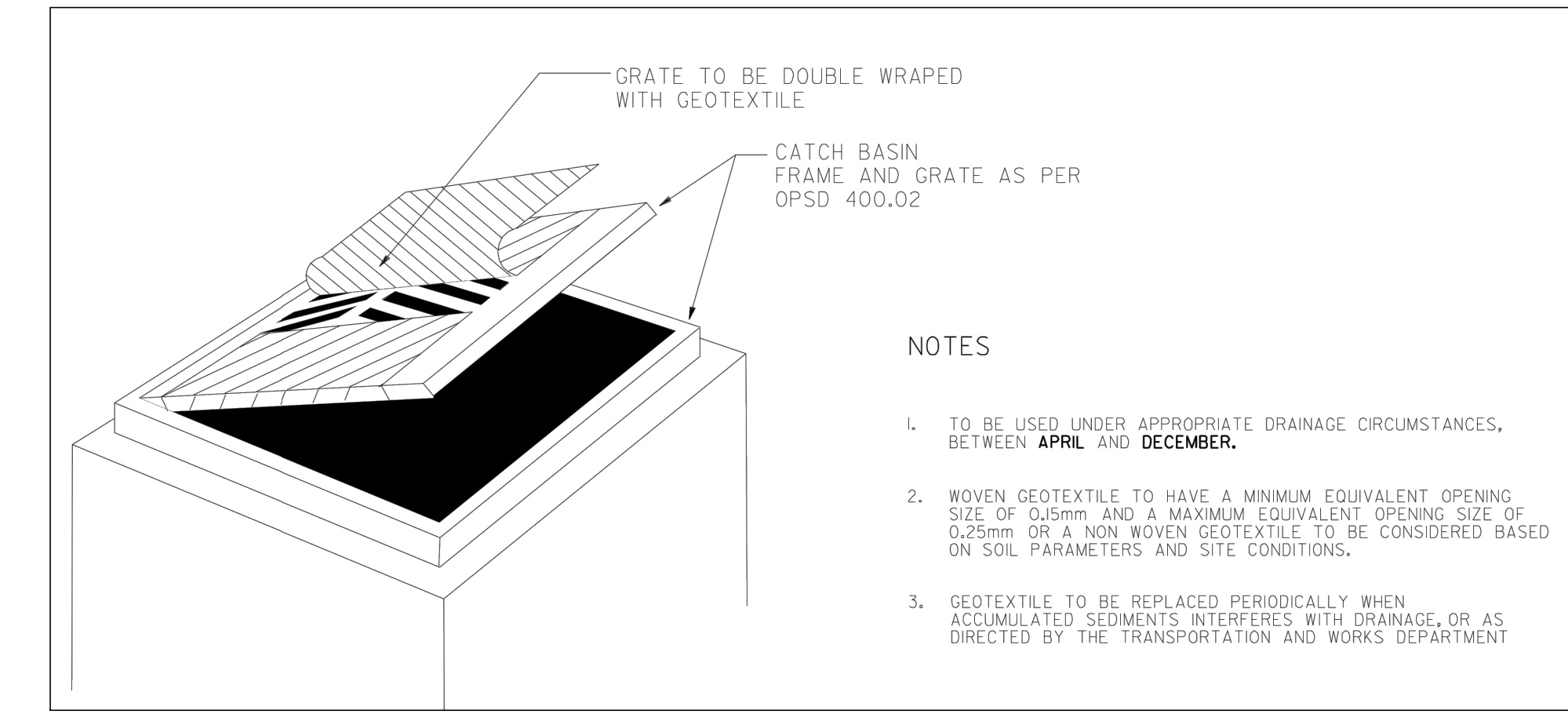
1. OVERALL SITE AREA - 0.72 ha
2. EXISTING LAND USE - RESIDENTIAL & VACANT

SEQUENCE OF CONSTRUCTION

1. ENGINEER TO BE NOTIFIED PRIOR TO INITIATION OF ANY ON SITE WORKS.
2. SILT FENCE AND CONSTRUCTION ACCESS MATS TO BE INSTALLED PRIOR TO THE COMMENCEMENT OF ANY WORKS ON SITE.
3. VEGETATION REMOVAL MAY COMMENCE AFTER ALL SILT FENCE IS INSTALLED AND APPROVED BY THE ENGINEER.
4. COMMENCE WITH EARTH EXCAVATION AND SITE SERVING (TO BE REMOVED FROM SITE - NO STOCKPILE).
5. EROSION CONTROL MEASURES TO BE MAINTAINED AS DIRECTED BY THE ENGINEER DURING THE CONSTRUCTION PERIOD.
6. ADDITIONAL CONTROL MEASURES MAY BE REQUIRED AT THE DISCRETION OF THE ENGINEER.
7. ALL DISTURBED GROUND LEFT INACTIVE FOR MORE THAN 30 DAYS SHALL BE STABILIZED WITH SEED, SOD, MULCH OR OTHER ADEQUATE COVERING, AS INSTRUCTED BY THE ENGINEER.
8. PERMEABLE PAVERS AND INFILTRATION TANK AREAS NOT TO BE COMPACTED.

NOTES FOR SEDIMENT & EROSION CONTROL

1. DISTURBED AREAS THAT HAVE FAILED TO HAVE STABLE GROUND COVER ESTABLISHED BY OCTOBER 30TH SHALL BE PROTECTED WITH A SILTATION CONTROL FENCE OR STRAW MULCH ETC. AND MAINTAINED BY THE CONTRACTOR UNTIL VEGETATION BECOMES ESTABLISHED IN THE SUBSEQUENT GROWING SEASON.
2. ANY DOWATERING WASTE SHALL BE DISCHARGED TO A VEGETATED AREA AT LEAST 30m FROM ANY WATERCOURSE AND FILTERED. FILTERING METHODS MUST BE APPROVED BY THE SITE ADMINISTRATOR. DISCHARGE TO MUNICIPAL SERVICES MUST BE APPROVED BY THE CITY OF BARRIE PRIOR TO STARTING WORK AND ADHERE TO CITY OF BARRIE STANDARDS.
3. SILT FENCE SHALL BE PUT IN PLACE PRIOR TO AND MAINTAINED DURING ALL GRADING. SILT FENCE TO BE INSPECTED PRIOR TO COMMENCEMENT OF EARTH GRADING ACTIVITIES. SILT FENCE TO BE INSPECTED AND REPAIRED OR REPLACED IF DAMAGED AS DIRECTED BY THE SITE ADMINISTRATOR. SILT CONTROLS TO BE INSPECTED ON A REGULAR BASIS AND AFTER EVERY RAIN EVENT. INSTALLATION SHALL BE TO THE MANUFACTURER'S SUGGESTED SPECIFICATIONS.
4. THE CONTRACTOR SHALL BE PREPARED FOR UNEXPECTED CONDITIONS AND ACCORDINGLY HAVE STOCKPILED MATERIALS ON SITE FOR NECESSARY REPAIRS AS A RESULT OF FAILED OR INADEQUATE CONTROL MEASURES. ALL SEDIMENT AND EROSION CONTROL MEASURES SHALL BE INSPECTED AT LEAST ONCE A WEEK, AND AFTER EVERY RAINFALL EVENT.
5. CONTRACTOR SHALL OBTAIN A CURRENT COPY AND BECOME FAMILIAR WITH OPS5 577, CONSTRUCTION SPECIFICATION FOR TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES AS WELL AS ALL APPLICABLE MUNICIPAL STANDARDS.
6. THE CONTRACTOR MAY CONSIDER ALTERNATIVE SEDIMENT AND EROSION CONTROL MEASURES. SUCH MEASURES SHOULD BE PRESENTED IN WRITING FOR APPROVAL OF THE SITE ADMINISTRATOR AND MUST BE APPROVED IN WRITING BY THE MUNICIPALITY AND CONSERVATION AUTHORITY.
7. THE TOPS OF ALL FILTER FABRIC MUST BE A MINIMUM OF 1.0 METRES ABOVE THE GROUND LEVEL AND ATTACHED TO THE FENCE WITH A CONTINUOUS STEEL WIRE. ALTERNATIVELY, THE FILTER FABRIC MUST BE FOLDED OVER THE TOP OF THE FENCE AND THE FENCE WITH WIRE LOOPED THROUGH THE FABRIC ON BOTH SIDES OF THE FENCE. FILTER FABRIC IS TO BE TERRAFIX 270R OR EQUIVALENT.
8. ALL DISTURBED GROUND LEFT INACTIVE SHALL BE STABILIZED BY SEEDING, SODDING, MULCHING, OR COVERING OR OTHER EQUIVALENT CONTROL MEASURES. THIS PERIOD OF INACTIVITY SHALL BE AT THE DISCRETION OF THE CITY OF BARRIE MANAGER OF ENGINEERING BUT SHALL NOT EXCEED THIRTY DAYS.
9. CONTRACTOR SHALL INSTALL AND MAINTAIN CATCHBASIN SEDIMENT BARRIERS THROUGHOUT THE SITE DURING ALL CONSTRUCTION ACTIVITIES IN ORDER TO TRAP SEDIMENT. REFER TO DETAIL.



NOTES

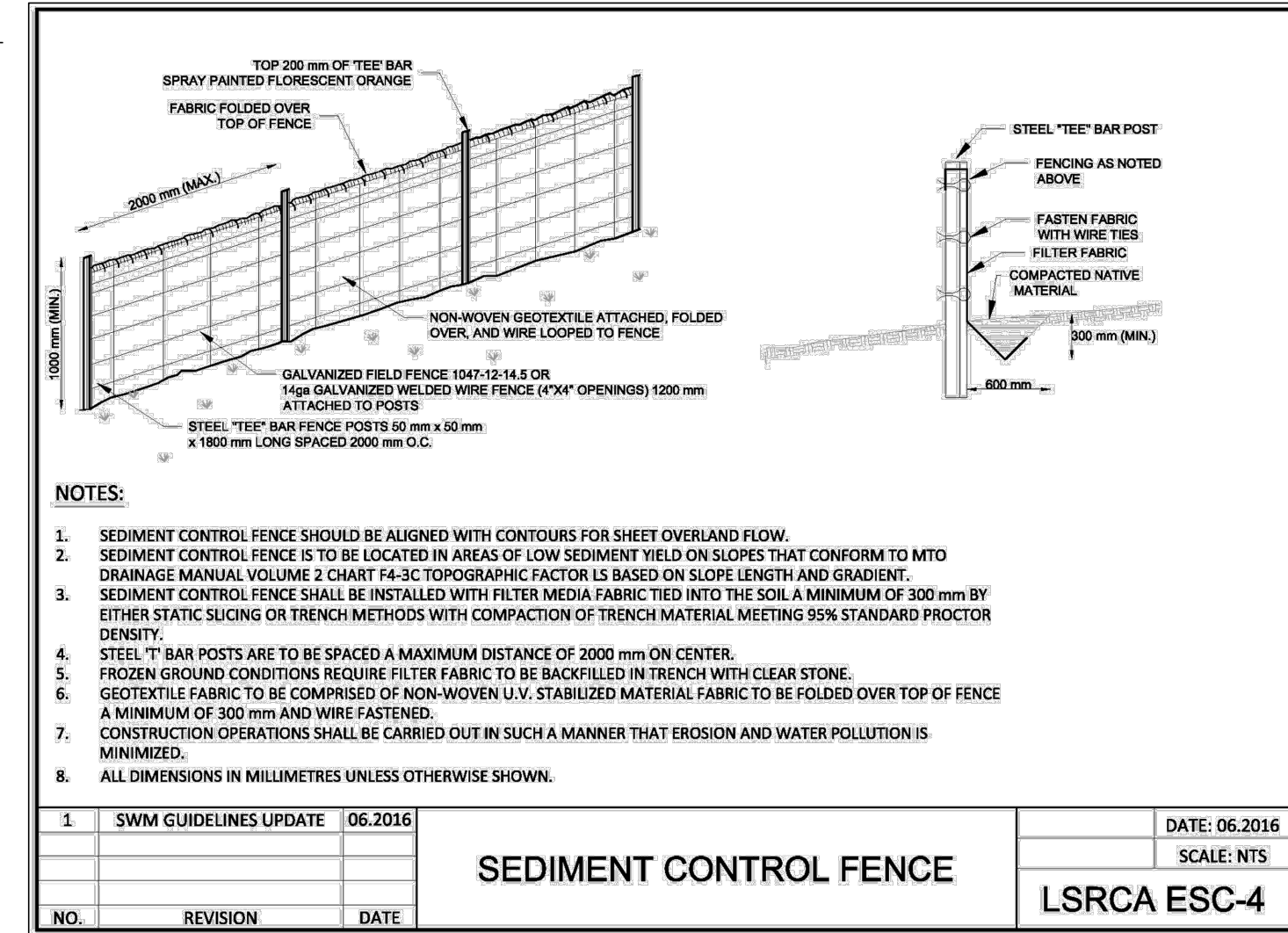
1. TO BE USED UNDER APPROPRIATE DRAINAGE CIRCUMSTANCES, BETWEEN APRIL AND DECEMBER.
2. WOVEN GEOTEXTILE TO HAVE A MINIMUM EQUIVALENT OPENING SIZE OF 0.15mm AND A MAXIMUM EQUIVALENT OPENING SIZE OF 0.25mm OR A NON WOVEN GEOTEXTILE TO BE CONSIDERED BASED ON SOIL PARAMETERS AND SITE CONDITIONS.
3. GEOTEXTILE TO BE REPLACED PERIODICALLY WHEN ACCUMULATED SEDIMENTS INTERFERES WITH DRAINAGE OR AS DIRECTED BY THE TRANSPORTATION AND WORKS DEPARTMENT

KEYMAP

LEGEND

- HYD. FIRE HYDRANT
VB. WATER VALVE
EX-CS. EXISTING CURB STOP
EX-MH. EX. SANITARY MANHOLE
EX-SH. EX. STORM MANHOLE
EX-CB. EX. CATCH BASIN
EX-SB. EX. SEPTIC BED AREA
PROP. BIO-RETENTION OR INFILTRATION AREA TO BE FENCED
EX. OVERLAND FLOW ROUTE
PROP. OVERLAND FLOW ROUTE
EX. TREES TO BE REMOVED
SILT FENCE

EXISTING WELLS AND SEPTIC SYSTEMS ON SITE ARE TO BE IDENTIFIED AND ABANDONED AS PER MINISTRY OF ENVIRONMENT GUIDELINES.



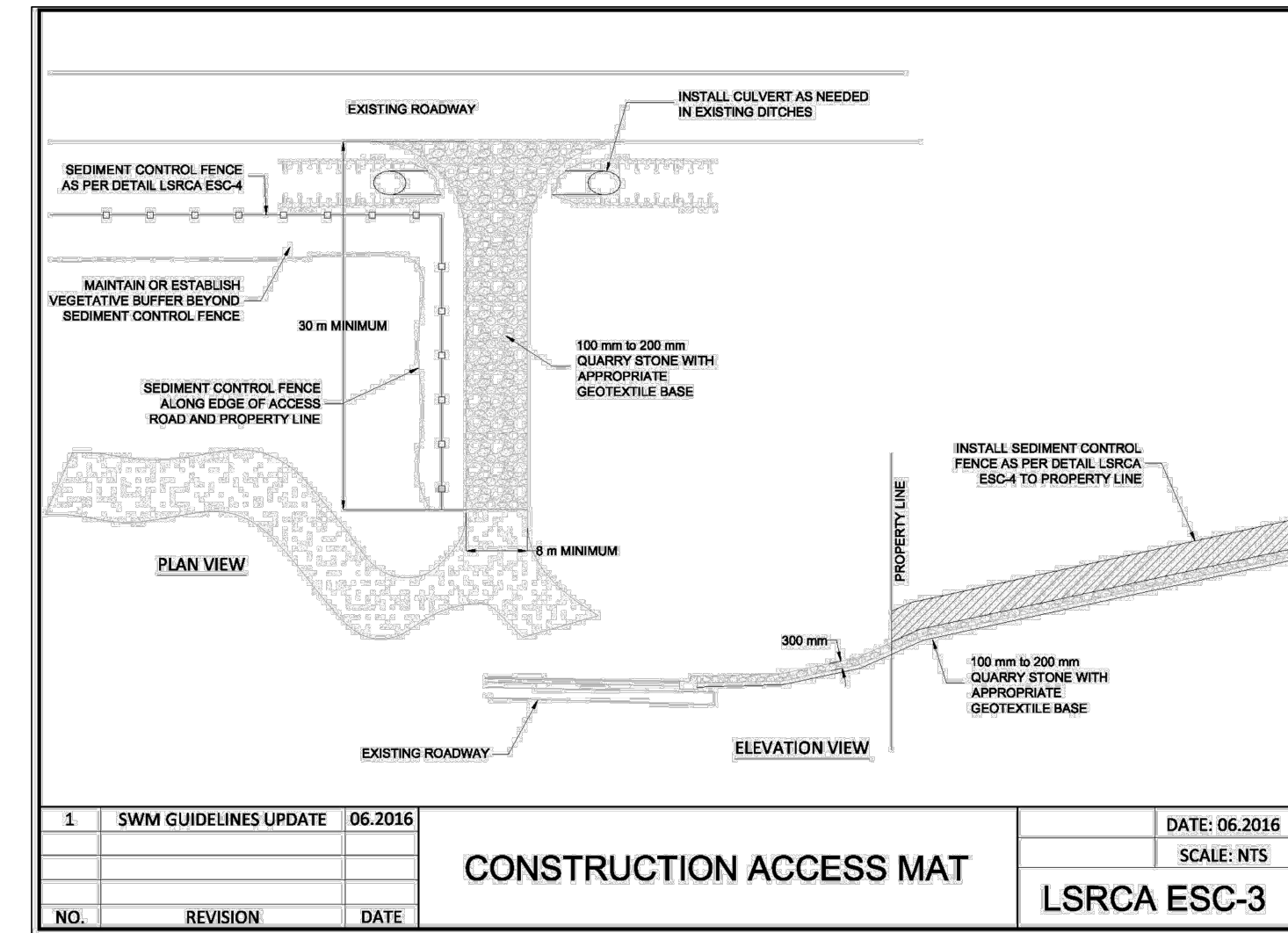
NOTES

1. SEDIMENT CONTROL FENCE SHOULD BE ALIGNED WITH CONTOURS FOR SHEET OVERLAND FLOW.
2. SEDIMENT CONTROL FENCE IS TO BE LOCATED IN AREAS OF LOW SEDIMENT YIELD ON SLOPES THAT CONFORM TO MTO DRAINAGE MANUAL VOLUME 5 CHART 14-3C TOPOGRAPHIC FACTOR IS BASED ON SLOPE LENGTH AND GRADING.
3. SEDIMENT CONTROL FENCE SHALL BE INSTALLED WITH FILTER MEDIA FABRIC TIED INTO THE SOIL A MINIMUM OF 300 mm BY EITHER STATIC SLICING OR TRENCH METHODS WITH COMPACTION OF TRENCH MATERIAL MEETING 95% STANDARD PROCTOR DENSITY.
4. STEEL "T" BAR POSTS ARE TO BE SPACED A MAXIMUM DISTANCE OF 2000 mm ON CENTER.
5. FROZEN GROUND CONDITIONS REQUIRE FILTER FABRIC TO BE BACKFILLED IN TRENCH WITH CLEAR STONE.
6. GEOTEXTILE FABRIC TO BE COMPRISED OF NON-WOVEN U.V. STABILIZED MATERIAL FABRIC TO BE FOLDED OVER TOP OF FENCE A MINIMUM OF 300 mm AND WIRE FASTENED.
7. CONSTRUCTION OPERATIONS SHALL BE CARRIED OUT IN SUCH A MANNER THAT EROSION AND WATER POLLUTION IS MINIMIZED.
8. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.

NO.	REVISION	DATE
1	SWM GUIDELINES UPDATE	06.2016

SEDIMENT CONTROL FENCE

DATE: 06.2016
SCALE: NTS
LSRCA ESC-4



NOTES

1. SEDIMENT CONTROL FENCE SHOULD BE ALIGNED WITH CONTOURS FOR SHEET OVERLAND FLOW.
2. SEDIMENT CONTROL FENCE IS TO BE LOCATED IN AREAS OF LOW SEDIMENT YIELD ON SLOPES THAT CONFORM TO MTO DRAINAGE MANUAL VOLUME 5 CHART 14-3C TOPOGRAPHIC FACTOR IS BASED ON SLOPE LENGTH AND GRADING.
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8. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.

NO.	REVISION	DATE
1	SWM GUIDELINES UPDATE	06.2016

CONSTRUCTION ACCESS MAT

DATE: 06.2016
SCALE: NTS
LSRCA ESC-3

NO.	REVISION	DATE	BY	BENCHMARK
7.	REVISED FOR SITE PLAN AMMENDMENT	03/30/21	JPE	HORIZONTAL
6.	REVISED BASED ON CAR PORT LOCATION	12/16/20	JPE	MTD MONUMENT 03120040023 MONUMENT CAP IS LOCATED ON THE NORTHEAST CORNER OF DUNLOP ST. W. AND ECCLES ST BETWEEN THE SIDEWALK AND THE PROPERTY LINE.
5.	REVISED SERVING/GRADING	10/29/20	JPE	MTD MONUMENT 03120080022 MONUMENT CAP IS LOCATED ON THE SE CORNER OF INNISFIL ST. AND VESPERA ST APPROXIMATELY 18.5M FROM CENTERLINE OF INNISFIL ST AND APPROXIMATELY 13M FROM CENTERLINE OF VESPERA ST.
4.	ISSUED FOR TENDER	06/15/20	JPE	VERTICAL
3.	ISSUED FOR APPROVAL	03/12/20	JPE	MTD MONUMENT 0011931U4555 ELEVATION 228.735 BARRIE FUNDAMENTAL BENCH-MARK IN QUEENS PARK, 12.2 M NORTHEAST OF CURB AT NORTHEAST SIDE OF PARKSIDE DRIVE, 1.8 M NORTHEAST OF BOUNDARY BETWEEN PARK AND DRILL HALL GROUNDS, TABLET IN TOP.
2.				MTD MONUMENT 0011984U119 ELEVATION 232.095 BARRIE FEDERAL BUILDING, AT CORNER OF COLLIER AND OWEN STREETS, TABLET IN EAST SIDE SMOOTH STONE FOUNDATION WALL, IN CENTRE OF FIRST STONE NORTH OF NOTCH IN WALL, 7.0 M NORTH OF SOUTHEAST CORNER OF BUILDING, 30 CM BELOW BRICK SIDING.

Professional Engineer's Stamp for M.W. Dejean, dated March 30, 2021, Province of Ontario.

MDM DEVELOPMENTS
233 DUNLOP STREET WEST
CITY OF BARRIE
ENVIRONMENTAL PROTECTION AND REMOVALS PLAN

PEARSON ENGINEERING
DESIGNED BY: TA/MJWP
DRAWN BY: MJWP
CHECKED BY: MWD
HORIZ SCALE: 1:300
VERT SCALE:
DATE: APRIL 2019
PROJECT # 12081.01
DRAWING # EPR-1
REVISION # 7