Appendix E:

Stormwater Management Analysis

BAYVIEW DRIVE/BIG BAY POINT ROAD CLASS ENVIRONMENTAL ASSESSMENT

City of Barrie

Drainage and Stormwater Management Technical Memorandum

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1 Introduction

The following technical memorandum summarizes work completed for the Bayview Drive and Big Bay Point Road Class EA project with respect to storm drainage and stormwater management (SWM). The study area consists of Big Bay Point Road from Bayview Drive to Huronia Road and Bayview Drive from Big Bay Point Road to Little Avenue, in the City of Barrie.

1.1 Objectives

The purpose of this memorandum is to:

- Identify existing drainage conditions;
- Assess existing drainage infrastructure and identify functional deficiencies;
- Identify drainage/SWM criteria to be applied to proposed road improvements; and
- Evaluate alternative SWM approaches and recommend feasible options.

1.2 Guidelines & Background Reports

This report was prepared recognizing provincial guidelines on water resources and the environment, including the following publications:

- City of Barrie, Storm Drainage and Stormwater Management Policies and Design Guidelines (2009);
- Ministry of Environment [now Ministry of Environment and Climate Change (MOECC)] Stormwater Management Practices Planning and Design Manual (2003);
- Ministry of Natural Resources (MNR) Natural Hazards Training Manual: Provincial Policy Statement, Public Health and Safety Policies 3.1 (1997);
- Lake Simcoe Regional Conservation Authority (LSRCA) Technical Guidelines for Stormwater Management Submissions (April 26, 2013); and
- MOECC Lake Simcoe Protection Plan (LSPP) (2009).

In addition, the following relevant background reports were considered in the development of this report.

The Whiskey Creek Master Drainage Plan (AECOM, 2009) documents existing drainage conditions in the Whiskey Creek subwatershed and identifies future improvements that should be undertaken to address exiting deficiencies and/or allow for future planned development. The Master Drainage Plan (MDP) was relied upon for background information and served as a guidance document, as all proposed drainage and SWM works should demonstrate conformance to the plan. However, the Whiskey Creek MDP did not use the updated Intensity Duration Frequency (IDF) curves that are available from the City, resulting in some variation between calculated peak flows in MDP and those in this technical memorandum.

The City's Comprehensive SWM Master Plan (Phase 1) for the Annexation Lands and the Barrie Creeks Study Area (CCTA, 2015) was also reviewed and referenced in the development of this report.

2 Existing Drainage Conditions

2.1 Existing Storm Drainage Infrastructure

2.1.1 Bayview Drive

There are two major watercourse crossings and three minor crossings that convey flow across the two lane municipal road and to tributaries of Whiskey Creek. Bayview Drive is categorized as a major collector road, and culvert crossings must convey the 50-year storm per City standards. The approved Whiskey Creek MDP has established that 100-year conveyance criteria should apply for the two major watercourse crossings (Culverts 3 and 5, as identified on **Table 1**).

There are no specific water quality controls in place for the runoff that is generated from the existing road surface; however, the roadside ditches do provide some measure of water quality control through filtration/settling mechanisms. Existing drainage features for Bayview Drive are shown on the attached **Figure 1**.

2.1.2 Big Bay Point Road

The subject section of Big Bay Point Road has a rural road cross section with two lanes, gravel shoulders and grass ditches. Big Bay Point Road is categorized as an arterial road, and culvert crossings must convey the 100-year storm without overtopping the crown of the road.

There is one culvert crossing (Culvert 6, as identified in **Table 1**) that conveys drainage from an external drainage catchment on the north side of Big Bay Point Road under the adjacent railway line to the ditch on the north side of Big Bay Point Road. Although the external catchment is a substantial drainage area for the outlet on the north side of Big Bay Point Road (approximately 15 ha), the railway line acts as a berm, causing drainage to back up on the north side. The ditch system on Big Bay Point Road between Bayview Drive and Welham Road drains to a low point located on the south side of the road near 131 Big Bay Point Road. A second culvert crossing (Culvert 7, as identified in **Table 1**) conveys drainage from the ditch on the north side of Big Bay Point Road across to the low point, where it is diverted via a drainage channel to the Ellis Natural Area, which discharges into a SWM pond (LV-2) before entering a tributary of Lovers Creek.

Along Big Bay Point Road east of Welham Road, the ditch system is connected to the existing storm sewer system at Huronia Road, which proceeds 180 m eastwards along Big Bay Point Road, where it turns northwards and is routed through Huronia North Park to Whiskey Creek. Existing drainage features for Big Bay Point Road are shown on the attached **Figure 2**. The existing storm sewer is shown on the attached **Figure 3**.

Table 1: Summary of Existing Culvert Structures

Crossing No.	Road	Location	Data Source	Culvert Description	Current Condition
1	Bayview Drive	Adjacent to Tamarack Woods Townhomes	Field Investigation	No invert located on west side of Bayview Drive, flow is assumed to travel overland to a catchbasin manhole (CBMH) on the east side. An obvert was discovered downstream of the CBMH approximately 0.15 m underground. No outlet was located.	Unknown.
2	Bayview Drive	Across from the Allandale Recreation Centre	Topographic Survey	20 m – 450 mm diameter CSP culvert that outlets to a manhole on the east side of Bayview Drive. 64 m – 600 mm CSP diameter culvert provides conveyance from the manhole to Lackie's Bush.	West 450mm diameter culvert end in poor condition. Insufficient to convey the 25-year peak flow. East end of 600mm diameter culvert in good condition. Erosion noted on east side of road during topographic survey.
3	Bayview Drive	North of Mollard Court at West Tributary Crossing	Whiskey Creek MDP, Topographic Survey, Field Investigation	35 m – 1200 mm diameter CSP culvert.	East culvert end in poor condition. Insufficient to convey the 25-year peak flow per MDP.
4	Bayview Drive	250 Bayview Drive, North of Mollard Court	Topographic Survey	25.9 m – 300 mm diameter CSP culvert.	Insufficient to convey the 25-year peak flow and appears to have been implemented to provide conveyance for the more-recently developed parking lot.
5	Bayview Drive	315 Bayview Drive	Whiskey Creek MDP, Topographic Survey, Field Investigation	Twin 32.7 m – 1600 x 1100 mm Corrugated Steel Pipe Arch (CSPA) culvert that transitions below grade to a 20.7 m – 3600 x 1800 mm open bottom cast in place box culvert	Recently replaced per MDP recommendation and in excellent condition. Able to convey the 100-year peak flow. Open bottom structure for naturalized channel bottom. Condition assessment report included in **Appendix H**.
6	Big Bay Point Road	Under Railway Berm at approximately 131 Big Bay Point Road	Record Drawing	450 mm diameter CSP culvert of unknown length.	Unknown – unable to locate during topographic survey and follow-up site visit. City records indicate culvert is still in operation.
7	Big Bay Point Road	Under Big Bay Point Road at approximately 131 Big Bay Point Road	Field Investigation, Record Drawing	600 mm diameter CSP culvert of unknown length.	North end in good condition, unable to locate south end during topographic survey and follow-up site visit. City records indicate culvert is still in operation.
8	Mollard Court	Bayview Drive ROW, under Mollard Court	Topographic Survey	25 m – 600 mm diameter CSP culvert.	North end in good condition, south end in poor condition.
9	Welham Road	North Side of Big Bay Point Rd ROW, under Welham Road	Record Drawing	15.2 m – 450 mm diameter CSP culvert	

Note: Driveway culverts have not been included in this summary

2.2 Assessment of Existing Drainage Infrastructure

2.2.1 Hydrologic Analysis

For the purposes of hydrologic modelling and based on the Ontario Soil Survey, the soils in the study area have been classified as Tioga sand loam (Type A). For the purpose of this assessment, the study area has been divided into 5 drainage outlet locations, which are shown on **Figure 1** and **Figure 2**. The existing site conditions have been modelled using the Visual OTTHYMO (VO2) hydrologic modelling software for the 4-hour Chicago (CHI), 6-hour Soil Conservation Service (SCS) Type II, 12-hour SCS storm Type II distributions and the historical Hurricane Hazel storm. Detailed model results are provided in **Appendix A**. A summary of the existing peak flow rates is provided in **Table 2**.

Table 2: Existing Conditions Peak Flow Summary

Storm Event	Catchment 101 (Bayview South)	Catchment 102 (Bayview Central)	Catchment 103 (Bayview North)	Catchment 105 (Big Bay West)	Catchment 107 (Big Bay East)
6-hour SCS Type II Distribution					
2-year	0.10	0.14	0.13	0.24	0.16
5-year	0.15	0.21	0.18	0.35	0.24
10-year	0.18	0.26	0.23	0.43	0.30
25-year	0.22	0.33	0.29	0.55	0.37
50-year	0.25	0.38	0.33	0.63	0.43
100-year	0.28	0.43	0.37	0.71	0.48
12-hour SCS Type II Distribution					
2-year	0.10	0.14	0.12	0.23	0.15
5-year	0.14	0.20	0.17	0.33	0.22
10-year	0.16	0.24	0.21	0.39	0.27
25-year	0.20	0.30	0.26	0.50	0.34
50-year	0.23	0.35	0.30	0.57	0.39
100-year	0.26	0.39	0.34	0.64	0.44
4-hour Chicago Distribution					
2-year	0.11	0.15	0.13	0.23	0.17

Storm Event	Catchment 101 (Bayview South)	Catchment 102 (Bayview Central)	Catchment 103 (Bayview North)	Catchment 105 (Big Bay West)	Catchment 107 (Big Bay East)
5-year	0.16	0.22	0.20	0.37	0.26
10-year	0.19	0.28	0.24	0.46	0.32
25-year	0.22	0.32	0.28	0.52	0.36
50-year	0.24	0.36	0.31	0.59	0.40
100-year	0.27	0.41	0.35	0.67	0.45
Hurricane Hazel	0.16	0.20	0.12	0.31	0.22

2.2.2 Existing Storm Sewer Capacity

As noted in Section 2.1.1 above, drainage from Big Bay Point Road east of Welham Road is collected by an existing storm sewer system that runs easterly along Big Bay Point Road and then turns north at Willow Landing Elementary School and outlets into a channel in North Huronia Park. The location and general alignment of the storm sewer system are shown on **Figure 3**. The capacity of the existing storm sewer has been calculated from record drawings provided by the City. A brief summary of the existing storm sewer system capacity at key locations is provided in **Table 3**.

Table 3: Big Bay Point/Huronia Road Existing Storm Sewer Summary

Pipe Location	Contributing Drainage Area (ha)	Ex. Pipe Size (mm)	Ex. 5-year flow (m^3/s)	Ex. Pipe Capacity (m^3/s)
East of Huronia Road to Junction Manhole	1.85	858x1016*	0.28	1.60
Willow Landing Elementary Property Line to Junction Manhole	0.53	750	0.08	0.66
Junction Manhole to North Huronia Park Swale	4.14	1350	0.50	3.94

*Elliptical Pipe (Rise x Span)

2.2.3 Capacity of Downstream Receivers

Drainage from the majority of the existing study area (approximately 6.3 ha) discharges to Whiskey Creek, which is known to be a constrained receiver. Sections of Whiskey Creek downstream of Lackie's Bush are known to experience flooding under frequent storm events due to undersized existing infrastructure. Whiskey Creek also experiences erosion of open channel sections through its downstream reaches due to the highly urbanized catchment area. As a result, the SWM controls required for the Big Bay Point Road and Bayview Drive expansion must ensure that proposed Big Bay Point Road and Bayview Drive improvements result in no adverse impact on this already constrained receiver, both in terms of water quality and water quantity.

The remaining 3.4 ha of drainage from the study area discharges to Lovers Creek through a set of naturalized stormwater conveyance channels and a stormwater detention pond. The rating curve for the stormwater detention pond SWMF LV-2 (appended) demonstrates that the runoff received from the study area is adequately controlled for quantity. The SWM controls that are required for the increased runoff that would result from the Big Bay Point Road expansion must ensure that proposed improvements cause no adverse water quality or quantity impacts on Lovers Creek.

3 Future Drainage Conditions

3.1 Proposed Road Improvements

Post development hydrologic modelling results are included in **Appendix B** for reference.

3.1.1 Big Bay Point Road

Four alternatives have been identified for improvements to Big Bay Point Road, all of which include urbanizing the road section to replace the roadside ditches with curb and gutter and a storm sewer system. The first two alternatives feature an expanded right-of-way (ROW) and widening of asphalt surface to accommodate 7 lanes of traffic to an approximate width of 40 m. The other two alternatives feature a configuration with 5 traffic lanes that could potentially be expanded to 7 lanes. The proposed alternatives for Big Bay Point Road also feature bike lane infrastructure, boulevards and sidewalks. The City has indicated that the preferred alternative for Big Bay Point Road is Alternative 4, which features 5 traffic lanes that could potentially be expanded to 7 lanes in the future.

3.1.2 Bayview Drive

Three alternatives have been identified as potential Bayview Drive configurations, all of which include urbanizing the road section to replace the roadside ditches with curb and gutter and a storm sewer system. Two of the alternatives involve widening of asphalt to accommodate 3 lanes of traffic, while the third alternative features 5 lanes of traffic. Each of the proposed alternatives will widen the ROW from its existing footprint and incorporate bike lane infrastructure and sidewalks. The City has indicated that the preferred alternative for Bayview Drive is Alternative 1, which features 3 traffic lanes.

3.2 Design Criteria

The proposed road improvements should satisfy the following criteria with respect to water quantity and water quality control:

- Provide Enhanced level water quality protection, which corresponds to 80% long term suspended solids removal for all impervious surfaces (existing and proposed) in the ROW;
- Post-development peak flow rates must be controlled to pre-development rates for any additional impervious surfaces that are proposed as part of the road improvements to ensure no adverse impacts for downstream landowners and City infrastructure;
- Storm sewer to provide conveyance for minor (5-year) flows;

- Address safe conveyance of runoff from the regulatory storm event (i.e. greater of the 100-year storm and Hurricane Hazel) from the road allowance to SWM facilities or open channels without flooding adjacent private properties;

- Major collector road culvert crossings should be designed to convey the 50-year design storm under the road and the 100-year event with a maximum overtopping depth of 0.1 m; and

- Arterial road culvert crossings should be designed to convey the 100-year design storm under the road.

The LSRCA has released new Technical Guidelines for SWM Submissions which came into effect on September 1, 2016. The guidelines include new volume control criteria for linear infrastructure projects, where the runoff from the greater of the 12.5 mm storm event on the entire reconstructed surface, or the 25 mm storm event on net increase in impervious area on the site must be infiltrated. Based on discussions with LSRCA, we understand that the implementation of the linear infrastructure criteria will happen through a memorandum of understanding (MOU) developed with each member municipality and it is expected that projects that are currently going through Class EA process will be exempt from the new criteria and instead subject to the old guideline plus best efforts to meet the new guidelines.

3.3 Assessment of Proposed Drainage Infrastructure

3.3.1 Minor System – Storm Sewer

An analysis of proposed condition peak flows has been completed for the most constrained alternatives that have been proposed for Big Bay Point Road and Bayview Drive to develop a 5-year storm sewer design sheet. The runoff coefficients for each catchment have been adjusted to account for the increased impervious areas resulting from Alternative 2 for Big Bay Point Road and Alternative 3 for Bayview Drive. A storm sewer design sheet was created to determine the most critical downstream pipe sizes on Big Bay Point Road and Bayview Drive and also to confirm that the existing storm sewer at Huronia Road has capacity to receive additional flow generated from Welham Road to Huronia Road under the proposed development scenario. The storm sewer design sheets have been provided in **Appendix C**. At the detailed design stage, a more discrete analysis of the contributing drainage areas should be performed to further assess increase in peak flows, and provide a more detailed storm sewer design.

3.3.2 Major System – Overland Flow in ROW

The overland flow conveyance capacity of the proposed ROW options for Big Bay Point Road and Bayview Drive have been modelled using the Hydraulic Express Extension for Autodesk AutoCAD Civil 3D design software to determine the maximum flow capacity within the proposed typical ROW cross sections. The overland flow capacities have been compared against the most constrained 100-year overland design flows (100-year flows under fully blocked conditions) obtained from VO2. A summary is provided in **Table 4** for cross sections on Big Bay Point Road and Bayview Drive. A full summary of conveyance calculations has been included in **Appendix F**.

City of Barrie guidelines state that roads may be used for major system overland flow conveyance during the Regulatory event (100-year storm, in this case) provided that the depth of ponding on the road does not exceed 0.10 m above the crown of the road on collector roads and that one lane remains open on arterial roads. These standards were used to evaluate the overland flow conveyance of each of the proposed road configurations. Conveyance calculations have been completed using the uncontrolled peak flow rates obtained from the 100-year 6-hour SCS design storm in VO2. It was assumed that the proposed storm sewer systems were completely blocked and that the full 100-year peak flow would be conveyed overland.

Table 4: Overland Flow Conveyance Summary

ROW Configuration	Typical Cross Section (allowing for City of Barrie standard)		100-year Flow (from VO2)	
	Capacity (m^3/s)	Depth (m)	Peak Flow (m^3/s)	Depth (m)
7 Lane Configuration (Arterial Road)	3.93	0.22*	1.45	0.14
5 Lane Configuration (Arterial Road)	2.78	0.19*	1.21	0.13
5 Lane Configuration (Major Collector Road)	4.08	0.26 (0.03 above crown)	0.90	0.13 (0.00 above crown)
3 Lane Configuration (Major Collector Road)	3.09	0.25 (0.10 above crown)	0.63	0.12 (0.00 above crown)

*One lane width remains open

The proposed 7 lane and 5 lane options meet this criterion, as they are able to maintain one lane open at a maximum flow of 3.93 m^3/s and 2.78 m^3/s respectively. The 3 lane and 5 lane options for Bayview Drive are also able to meet the City of Barrie standard, as the corresponding flow depths do not overtop the crown of the road under 100-year peak flow conditions.

3.4 Watercourse Crossing Replacement

The proposed urbanization of Big Bay Point Road and Bayview Drive limits the opportunity for the continued use of the watercourse crossings that currently receive drainage from the existing ditch system. As the ditch system is to be removed, it is expected that the minor drainage that was previously conveyed through the ditch system and minor crossings will be conveyed through the proposed storm sewer system. However, three watercourse crossings will be maintained, as to not disturb the function of the watercourses.

At the detailed design stage, a feature based water balance and/or geomorphological assessment may be required if it is determined that the collection of minor drainage in the storm sewer will pose impacts to the study area's natural heritage features.

The following actions, as summarized in **Table 5** below, are recommended for the existing watercourse crossings on Big Bay Point Road and Bayview Drive. Supporting culvert sizing calculations are included in **Appendix H**.

Table 5: Recommended Actions for Existing Culvert Structures

Crossing No.	Road	Location	Recommended Action
1	Bayview Drive	Adjacent to Tamarack Woods Townhomes	If culvert is within ROW, remove
2	Bayview Drive	Across from the Allandale Rec Centre	Remove
3	Bayview Drive	North of Mollard Court at West Tributary Crossing	Replace with 1 – 2400 x 1200 mm Hy-Span per MDP*
4	Bayview Drive	250 Bayview Drive, North of Mollard Court	Remove
5	Bayview Drive	315 Bayview Drive	Keep existing structure in place
6	Big Bay Point Road	Under Railway Berm at approximately 131 Big Bay Point Road	Remove
7	Big Bay Point Road	Approximately 131 Big Bay Point Road	Replace with 2 – 45 m long 800 mm diameter CSP culverts
8	Mollard Court	Bayview Drive ROW, under Mollard Court	Assess condition in field and replace if necessary
9	Welham Road	North Side of Big Bay Point Rd ROW, under Welham Road	Assess condition in field and replace if necessary

* If fill is proposed within the area of the replacement culvert, an incremental cut/fill analysis will be required at the detailed design stage.

At the detailed design stage, a full hydrologic and hydraulic analysis of each culvert, including HEC-RAS modelling analysis for culverts at water crossings will be required to satisfy LSRCA requirements. The flows used to confirm the sizing of these structures will need to conform to the results of the City-wide hydrologic model and Master Drainage Plan Updates scheduled to be completed in 2017 and 2018 respectively. In the interim, contributing peak flows should be determined using the City of Barrie's latest IDF curves.

4 SWM Plan Alternatives

A number of quantity and quality control measures are available and are identified here for consideration. Opportunities and constraints for maximizing the effective use of the control measures are discussed in this section.

4.1 SWM Quality Controls

The existing stormwater quality controls provided for the runoff discharging into Whiskey Creek (approximate drainage area of 6.3 ha within the study limits) consist of the ditch system adjacent on both sides of each roadway. The existing stormwater quality controls provided for the runoff discharging into Lovers Creek consist of the natural area storm water conveyance channels and the Lovers Creek SWMF LV-2. The City's Part 1 Comprehensive Stormwater Management Report recommends retrofits to provide water quality control for previously uncontrolled areas to be included as part of road reconstruction projects where possible. This practice is consistent with the City's typical approach and the requirements of Lake Simcoe Region Conservation Authority (LSRCA).

4.1.1 Perforated Storm Sewer System (Exfiltration)

A perforated pipe storm sewer system could be implemented within the proposed road section in order to provide quality control via infiltration for the contributing runoff. Perforated pipe systems are essentially long infiltration trenches or linear soakaways that are designed for both conveyance and infiltration of stormwater runoff. They are underground stormwater conveyance systems designed to attenuate runoff volume and, thereby, reduce contaminant loads to receiving waters. They are composed of perforated pipes installed in gently sloping granular stone beds that are lined with geotextile fabric that allow infiltration of runoff into the gravel bed and underlying native soil while it is being conveyed from source areas to an end-of-pipe facility or receiving waterbody. Perforated pipe systems can be used in place of conventional storm sewer pipes, where topography, water table depth, and runoff quality conditions are suitable. They are suitable for treating runoff from roofs, walkways, parking lots and low to medium traffic roads, with adequate pretreatment. A design variation can include perforated catch basins where the catch basin sump is perforated to allow runoff to infiltrate into the underlying native soil. The implementation of this option may be feasible as the storm sewer system will be entirely new construction, with details to be resolved at the final design stage.

The benefit of these systems is that they promote water balance as well as water quality control. The soils in the area consist of sandy loam, which is suitable for infiltration practices. However, this type of system may be difficult to co-ordinate with utilities. Detailed design of this system would be required at the final design stage. For more information, please refer to the Chapter 4.10 of the Credit Valley Conservation/Toronto Region Conservation Authority (CVC/TRCA) Low Impact Development Stormwater Management Planning and Design Guide.

4.1.2 Oil Grit Separators (OGS)

OGS units are typically placed in-line in storm sewer systems to provide sediment removal, screen debris and separate oil from stormwater runoff before it discharges from the storm sewer system. LSRCA notes that OGS units can be used effectively as part of a treatment train to reduce the amount of oil and grit in stormwater in their draft Technical Guidelines for Stormwater Management Submissions (2016).

LSRCA credits a TSS removal rate of 50% for units that have been sized for “Enhanced” protection under the MOE SWM Manual. Therefore, to attain the “Enhanced” protection level for stormwater quality controls, OGS units must be considered in combination with other LID practices during the detailed design stage.

4.1.3 Sand Filters

Sand filter structures could be implemented in place of OGS units to provide TSS removal for stormwater runoff prior to discharging into the natural system. Sand filters typically consist of a sedimentation basin and a filtration basin. The sedimentation basin typically removes floating debris and heavy particles from runoff before it passes through a trash rack and perforated riser into the filtration basin. The filtration basin removes additional pollutants by filtering the runoff through a sand bed to a perforated underdrain which conveys the filtered discharge to the system outlet. Sand filters are well suited for treating runoff that contains oil and grease from drainage areas with heavy vehicle usage.

Sand filters are often preferred over infiltration practices because they can be constructed with impermeable bottoms that help to collect, treat and release runoff to the system outlet with no contact between the contaminated runoff and groundwater. This eliminates concerns associated with de-icing salts and the mobilization of heavy metals in soil.

LSRCA lists sand filters as an end-of-pipe control that may be used to address SWM requirements. Sand filters are also credited with 45% removal rate of phosphorus by the LSRCA.

For more information, please refer to the Environmental Protection Agency (EPA) Sand Filters Storm Water Technology Fact Sheet that has been included in **Appendix G**.

4.1.4 Enhanced Low Impact Development (LID) Road Cross Section (Bioretention)

Increasingly in many urban centres, stormwater quality controls are being provided with the implementation of bioretention practices within the ROW. These practices include enhanced swales, enhanced curb extensions, tree pits and planters which act as a stormwater management filtration and infiltration practice. The primary component of a bioretention practice is the filter media which is a mixture of sand, fines, organic material, mulch ground cover and plants adapted to the conditions of a stormwater practice. Bioretention is designed to capture runoff from frequent storm events. An overflow or bypass is necessary to convey large storm events. The benefit of the bioretention system is that it promotes water balance as well as providing water quality control. The soils in the area consist of sandy loam, which is suitable for infiltration practices.

4.2 Water Balance/Infiltration

As identified in Section 3.2, LSRCA's new guidelines include volume control requirements for linear infrastructure projects. Linear projects that create 0.5 ha of new and/or fully reconstructed impervious surfaces are required to capture and retain the greater of the 12.5 mm storm event runoff from the fully reconstructed surface or the 25 mm storm event runoff from the net increase of impervious surface. This volume control is to be facilitated via infiltration, reuse & rainwater harvesting, canopy interception, evapotranspiration and or other low impact development techniques that include volume reduction.

Each of the volume control options noted above have been evaluated with respect to their feasibility in the setting of a linear development. Due to the nature of the proposed roadway expansions, infiltration controls were determined to be the only feasible option, as rainwater harvesting has no appropriate use in a roadway, and literature defining canopy interception and evapotranspiration techniques are not currently available for roadway settings. The available infiltration practices include linear bioretention cells located in the proposed boulevards or exfiltration storm sewers.

4.3 Peak Flow Control

Options for providing peak flow control in a ROW are very limited, as there isn't space available for SWM ponds. The use of underground storage will be required in the form of oversized storm sewer pipes. This linear storage can be accommodated into the alignment of other services in the ROW, as opposed to underground storage chambers, which would likely conflict with other pipe alignments.

An oversized storm sewer system typically consists of up-sized pipes that provide underground storage to reduce peak flows to allowable rates. Orifice plates are fitted to the outlet pipes at the downstream end of each pipe run to control peak flows to the allowable release rates.

4.3.1 Previously Identified Future Retrofit Opportunities

Through our review of the City's Comprehensive SWM Master Plan (Phase 1) for the Annexation Lands and the Barrie Creeks Study Area, the Whiskey Creek Master Drainage Plan (MDP) and vacant industrial lands adjacent to the study area, we have identified a number of proposed stormwater detention facilities located downstream of the proposed storm sewer outlets that could provide quantity control for the proposed development and reduce flood conditions downstream. A brief description of each proposed stormwater control option is provided below. Excerpts from the Whiskey Creek MDP and the Comprehensive SWM Master Plan concerning the design of each noted facility have been appended to this memorandum in **Appendix E**.

- **Vacant Industrial Land across from 131 Big Bay Point Road** - the vacant lot across from 131 Big Bay Point Road backs onto Whiskey Creek at the rear of the lot. The north end of this 10.22 ha land parcel could be acquired by the City for the purpose of implementing an offline stormwater facility to provide water quantity controls for the South Bayview catchment. This facility would also have the potential to reduce erosion conditions that have been noted for Lackie's Bush in the Comprehensive SWM Master Plan.

- **North of Big Bay Point Road and between Huronia Road and Pickett Crescent (Huronia North Park)** - proposed under the Comprehensive SWM Master Plan, identified as retrofit opportunity No. 26. This wet pond would receive the drainage that is currently routed to Huronia North Park via an existing storm sewer from the East Big Bay catchment in addition to the additional drainage resulting from the Big Bay Point Road expansion.

- **Vacant Industrial Land at 131 Big Bay Point Road (Cowden Woods)** - the vacant lot at 131 Big Bay Point Road is already partially used for stormwater conveyance, as a storm drainage channel runs across it. This 1.28 ha land parcel could be acquired by the City for the purpose of implementing a stormwater facility to provide water quantity controls for the West Big Bay catchment.

- **Drainage Easement South of Ellis Drive** - proposed under Comprehensive SWM Master Plan, identified as Retrofit Opportunity No. 67. This wet pond could provide additional storage to what is already provided by SWMF LV-2 for the West Big Bay catchment.

- **SWMF LV-2** - located to the east of Welham Road on the west side of the Canadian National Railway line, LV-2 was approved by the Environmental Approvals and Land Use Planning Branch of the Ministry of the Environment (now the Ministry of Environment and Climate Change) in 1987. The facility was approved as per its original design which is documented in the "Storm Servicing Report for South Barrie Business Park" (January 1984), which the City does not have on file. The pond was originally designed with a minimum storage capacity of 77,200 m^3 to control the South Barrie Business Park Phase 2 post development runoff to pre development levels during design storms up to and including the regional return storm event. LV-2 has not been recommended for improvements or expansion in recent reports such as the "Comprehensive SWM Master Plan, Part 1" (CCTA, 2014) and Aquafor Beech's subsequent "City of Barrie Comprehensive Stormwater Management Master Plan Interim Draft Report" dated December, 2015. Through the CCTA City Wide Minor / Major SWM Model Development, stage-storage-discharge curves have been developed using GIS and field investigation data. While it is unlikely that LV-2 has capacity to accommodate increased flows from future Big Bay Point Road expansions in addition to the increased upstream development in the 32 years following its design, there is potential for additional available storage within this SWM facility through pond modifications. Therefore, LV-2 could possibly provide quantity controls for the West Big Bay Catchment, depending on its condition. If use of this facility is to be pursued, a thorough investigation of the pond's drainage area must be completed to ensure that there is adequate storage to provide quantity control for the West Big Bay Point Road catchment.

Each of these facilities could provide additional storage to reduce the oversized storm sewer pipe sizes and/or provide additional control to reduce flows to floodprone areas.

5 Proposed SWM Plan

From the alternative quantity and quality control measures identified in the previous section, a SWM plan that includes bio-swales and oversized storm sewers is proposed. Design information has been provided to demonstrate the feasibility of each of the proposed controls for the preferred road cross section alternatives.

5.1.1 Enhanced Low Impact Development (LID) Road Cross Section (Bioretention)

Bio-swales are recommended to meet water quality and infiltration criteria. The proposed bio-swales have been designed to provide water quality storage volumes as specified in Table 3.2 of the MOECC SWM Practices Planning and Design Manual (2003). The corresponding storage volumes for infiltration based practices are 35.1 m^3/ha for Bayview Drive and 38.1 m^3/ha for Big Bay Point Road to achieve Enhanced water quality control, corresponding to 80% TSS removal. Therefore, the total required storage volume for the bio-swales are 144.4 m^3 on Bayview Drive and 171.0 m^3 on Big Bay Point Road. The water quality calculations for the bio-swales are provided in **Appendix G**.

In addition, LSRCA's infiltration criteria have been considered to demonstrate that best efforts have been made towards meeting the criteria. An infiltration volume of 334 m^3 for the Bayview Drive preferred alternative and 414 m^3 for the Big Bay Point Road preferred alternative would be required for full compliance with the new standard. Detailed calculations for the infiltration control volumes are provided in **Appendix D**.

Bio-swales consisting of a trapezoidal channel with a bottom width of 0.1 m, a top width of 1.0 m and 3:1 side slopes overlaying a 1.5 m deep filter bed with 1 m depth of filter media and 0.5 m depth of gravel wrapped in filter fabric have been sized for the Bayview Drive ROW. This bio-swale configuration requires a total length of 806 m to provide the control volume required for Bayview Drive. The width of the bio-swale (1 m) corresponds to half of the ROW width, allowing space for utility corridors.

On Big Bay Point Road, the north ROW is the only available area for the implementation of bio-swales, due to the proposed sidewalk located in the south ROW of the preferred option. Bio-swales consisting of a triangular channel with a top width of 1.2 m and 3:1 side slopes overlaying a 1.5 m deep filter bed with 1m depth of filter media and 0.5 m depth of gravel wrapped in filter fabric have been sized for the Big Bay Point Road ROW. This bio-swale configuration requires a total length of 730 m to provide the control volume required for Big Bay Point Road. The width of the bio-swale (1.2 m) corresponds to less than half of the available ROW width, allowing space for a utility corridor.

The infiltration volumes provided by the conceptual bio-swales (339 m^3 and 416 m^3 for Bayview Drive and Big Bay Point Road respectively) satisfy both the Enhanced level water quality volumes and LSRCA's volume control requirement for linear developments, demonstrating that it appears to be feasible to meet the requirements.

For more information, please refer to the Chapter 4.5 of the CVC/TRCA Low Impact Development Stormwater Management Planning and Design Guide.

Given that both roads may undergo widening in two stages (i.e. expand to 3 lanes and later 5, or expand to 5 lanes and later 7), and that bio-swales would need to be relocated to accommodate the future widening, bioswales may be less desirable. The exfiltration pipe system would not require relocation under a future widening scenario and may be preferred for this reason. A hydrogeological investigation will also be required at the detailed design stage to confirm the infiltration capacity of native site soils.

5.1.2 OGS Units

The inclusion of OGS units as part of a treatment train is recommended based on the untested nature of LID facilities in the ROW in Barrie, however, the use of both OGS units and LID facilities is not required on Bayview Drive if the LID facilities perform adequately. On Big Bay Point Road, the LID facilities are located on the north side of the ROW, and will only capture half of the drainage from the ROW, therefore the use of OGS units is recommended to provide water quality control for drainage from the opposite side of the road. This can be resolved at the detail design stage.

Preliminary sizing for two OGS units on Big Bay Point Road and three OGS units on Bayview Drive to provide 80% Total Suspended Solids (TSS) removal and treat at least 90% of the total site runoff has been completed using PCSWMM for Stormceptor sizing software for each alternative. As noted previously, LSRCA credits OGS units that have been designed to provide 80% TSS removal with 50% TSS removal, therefore OGS units cannot provide standalone water quality control. The Stormceptor OGS unit has been registered by the Canadian ETV program and currently has a “Renewal in Progress” status. The external areas on Bayview Drive and Big Bay Point Road have not been provided with OGS units due to the large external drainage area and the fact that these drainage areas are outside of the study area limits. A summary of the sizing is provided in **Table 6** below and sizing details have been provided in **Appendix G**.

Table 6: Summary of Required OGS Units

Catchment Name	Catchment ID	Stormceptor Unit Required to Provide 80% TSS Removal
Bayview South	201	STC 2000
Bayview Central	202	STC 4000
Bayview North	203	STC 4000
Big Bay West	505	STC 6000
Big Bay East	507	STC 4000

5.1.3 Oversized Storm Sewers

The required storage to control the runoff from the 100-year storm post-development peak flow rates to the existing conditions flow rates was determined using Visual OTTHYMO (VO2) hydrologic modelling software for each alternative. The required storage volumes are identified below in **Tables 7 and 8**.

Table 7: Summary of Required Quantity Control Volumes for Bayview Drive Alternatives

Catchment Name	Catchment ID	Catchment Area	% Impervious	Uncontrolled 100-yr 12 hr. SCS Design Storm Peak Flow (m^3/s)	100-yr 12hr. SCS Design Storm Required Storage (m^3)
EXISTING CONDITIONS					
Bayview South	101	0.96	62%	0.26	N/A
Bayview Central	102	1.67	50%	0.39	N/A
Bayview North	103	1.37	54%	0.34	N/A
ALTERNATIVE 1 - 3 LANE CONFIGURATION					
Bayview South	201	1.06	68%	0.38	234
Bayview Central	202	1.68	65%	0.54	282
Bayview North	203	1.38	80%	0.45	234
ALTERNATIVE 2 - 3 LANE CONFIGURATION					
Bayview South	301	1.06	72%	0.38	232
Bayview Central	302	1.68	69%	0.55	308
Bayview North	303	1.38	85%	0.47	263
ALTERNATIVE 3 - 5 LANE CONFIGURATION					
Bayview South	401	1.21	87%	0.46	357
Bayview Central	402	2.15	80%	0.77	639
Bayview North	403	1.70	79%	0.61	467

Table 8: Summary of Required Quantity Control Volumes for Big Bay Point Road Alternatives

Catchment Name	Catchment ID	Catchment Area	% Impervious	Uncontrolled 100-yr 12 hr. SCS Design Storm Peak Flow (m^3/s)	100-yr 12hr. SCS Design Storm Required Storage (m^3)
EXISTING CONDITIONS					
Big Bay West	105	2.62	54%	0.64	N/A
Big Bay East	107	1.85	51%	0.44	N/A
ALTERNATIVE 1 - 7 LANE CONFIGURATION					
Big Bay West	205	3.38	84%	1.25	1021
Big Bay East	207	2.20	81%	0.80	615
ALTERNATIVE 2 - 7 LANE CONFIGURATION					
Big Bay West	305	3.11	85%	1.16	888
Big Bay East	307	1.98	86%	0.74	538
ALTERNATIVE 3 - 5 LANE CONFIGURATION					
Big Bay West	405	2.88	81%	1.04	707
Big Bay East	407	1.91	78%	0.68	407
ALTERNATIVE 4 - 5 LANE CONFIGURATION					
Big Bay West	505	2.63	81%	0.95	573
Big Bay East	507	1.86	77%	0.65	401

LSRCA allows for the infiltration volume provided to be included as part of the peak flow control calculation. To determine the reduction in water quantity control volume that will be required in the overside pipe system, we applied an initial abstraction value to each catchment in VO2 to represent the infiltration storage volume. **Table 9** summarizes the required quantity control volumes to provide post-to-pre peak flow matching with the implementation of bio-swale volume controls for the preferred alternatives. Detailed calculations have been included in **Appendix D**.

Table 9: Summary of Required Quantity Control Storage Volumes if Infiltration Controls Implemented

Catchment Name	Catchment ID	Required Storage Volume with no Infiltration Controls (m^3)	Required Storage Volume with Infiltration Controls (m^3)
Bayview South	201	234	230
Bayview Central	202	282	270
Bayview North	203	234	227
Big Bay West	505	573	561
Big Bay East	507	401	395
Big Bay East	507	401	395

An Excel spreadsheet was developed to calculate the storage that could be made available through the implementation of an oversized pipe system of 5 sections, with each section discharging to an existing outlet. Outlet elevations obtained during topographic survey were used to verify the feasibility of the system. The oversized pipe system will use an orifice to control peak flows to pre-development flow rates. Peak flow rates have also been calculated for the preferred alternatives using VO2. A summary of the oversized pipe system capacity and peak flow rate calculations is provided in **Table 10**. Supporting design calculations for the oversized pipe system are provided in **Appendix D**.

Table 10: Summary of Proposed Water Quantity Controls

Catchment Name	Catchment ID	Provided Storage (m^3)	Existing Condition Peak Flow (m^3/s)	Proposed Condition Peak Flow (m^3/s)	Percent Difference (%)
Bayview South	201	242	0.26	0.24	-
Bayview Central	202	532	0.39	0.29	-
Bayview North	203	240	0.34	0.32	-
Big Bay West	505	486	0.64	0.66	3%
Big Bay East	507	401	0.44	0.42	-

As shown, the storage that is provided by the oversized pipe system is generally sufficient to provide quantity controls for the preferred alternative. We note that the peak flow from Catchment 505 is slightly higher than under existing conditions (an increase of 3%) but this increase is very minor and it is expected that it can be resolved at the detailed design stage.

5.1.4 Previously Identified Retrofit Options

The previously identified retrofit options described in Section 4.3.1 can be given further consideration at the detailed design stage. We understand that over the next two years, the City will be updating the Master Drainage Plans for all watercourses and more definitive direction on proposed watershed improvements will be available at that time.

6 Conclusion

The existing rural road cross section along Big Bay Point Road and Bayview Drive will be converted to urbanized road sections complete with storm sewer, curb and gutter as part of the proposed road improvements. Water quantity control is required to attenuate the increase in runoff that would result from the construction of additional impervious surface, to ensure no negative impacts are caused to the receiving watercourses. Water quality controls should be provided for both the new impervious area as well as the existing, uncontrolled road surface.

During the detailed design phase of the Big Bay Point Road and Bayview Drive improvement project, a complete storm sewer design should be performed to confirm all required storm pipe sizes throughout the project limits. Water quantity controls should be provided through a combination of pipe storage, LID bioretention storage and pond retrofit opportunities. Water quality controls should be provided using a combination of OGS units with upstream LID controls and/or perforated pipe systems to provide additional water quality control and promote infiltration. The portions of the proposed development that extend into LSRCA regulated area will require a permit from LSRCA prior to construction. Environmental Compliance Approval from MOECC will be required for all components of the stormwater system.

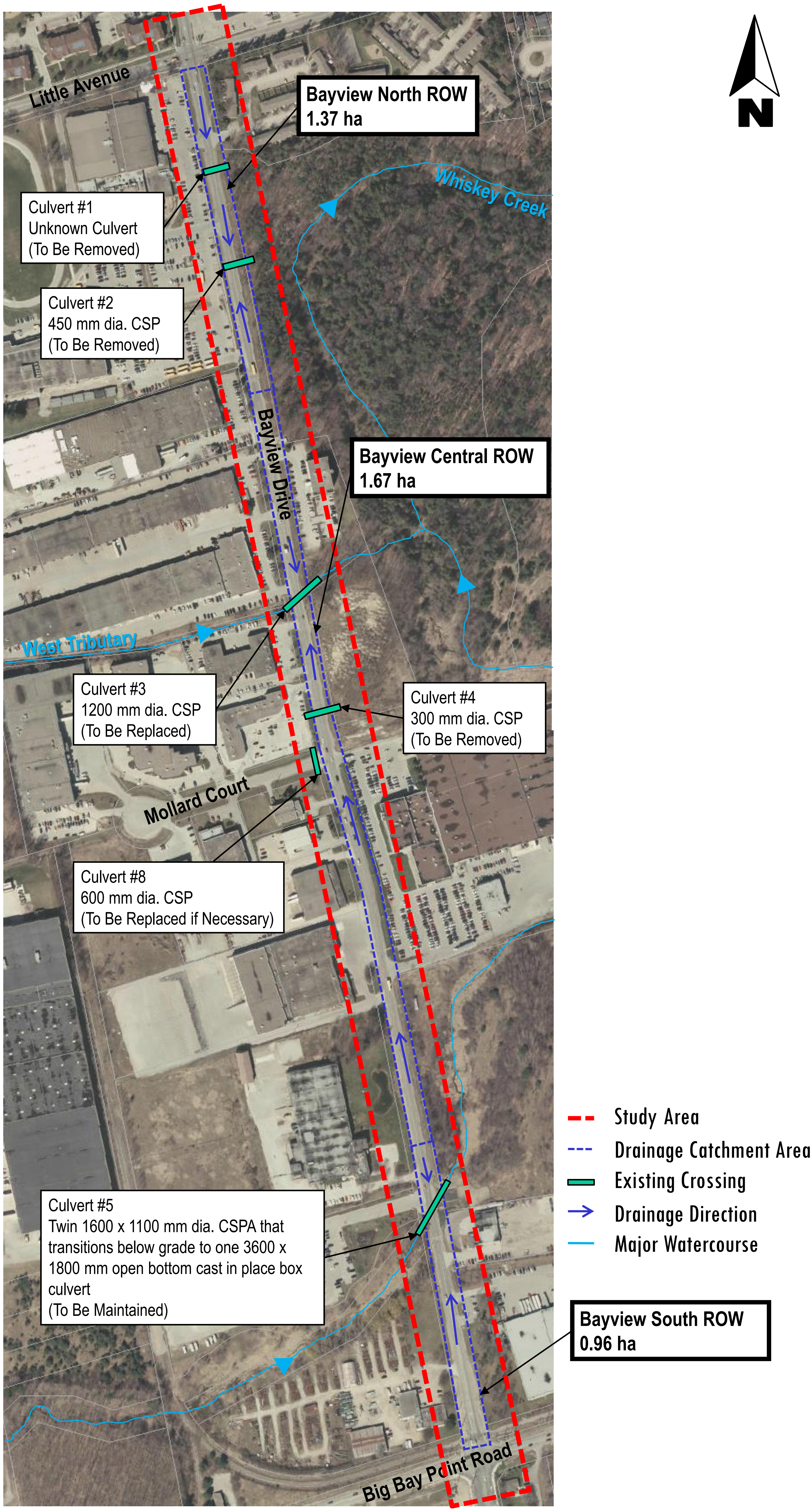
All of which is respectfully submitted,

C.C. Tatham & Associates Ltd.

Nicole Foris

A Kellett

Authored by:	Nicole Foris, B.A.Sc., EIT Intern Engineer	Reviewed by:	Amanda Kellett, B.Sc.Eng., P.Eng. Project Manager

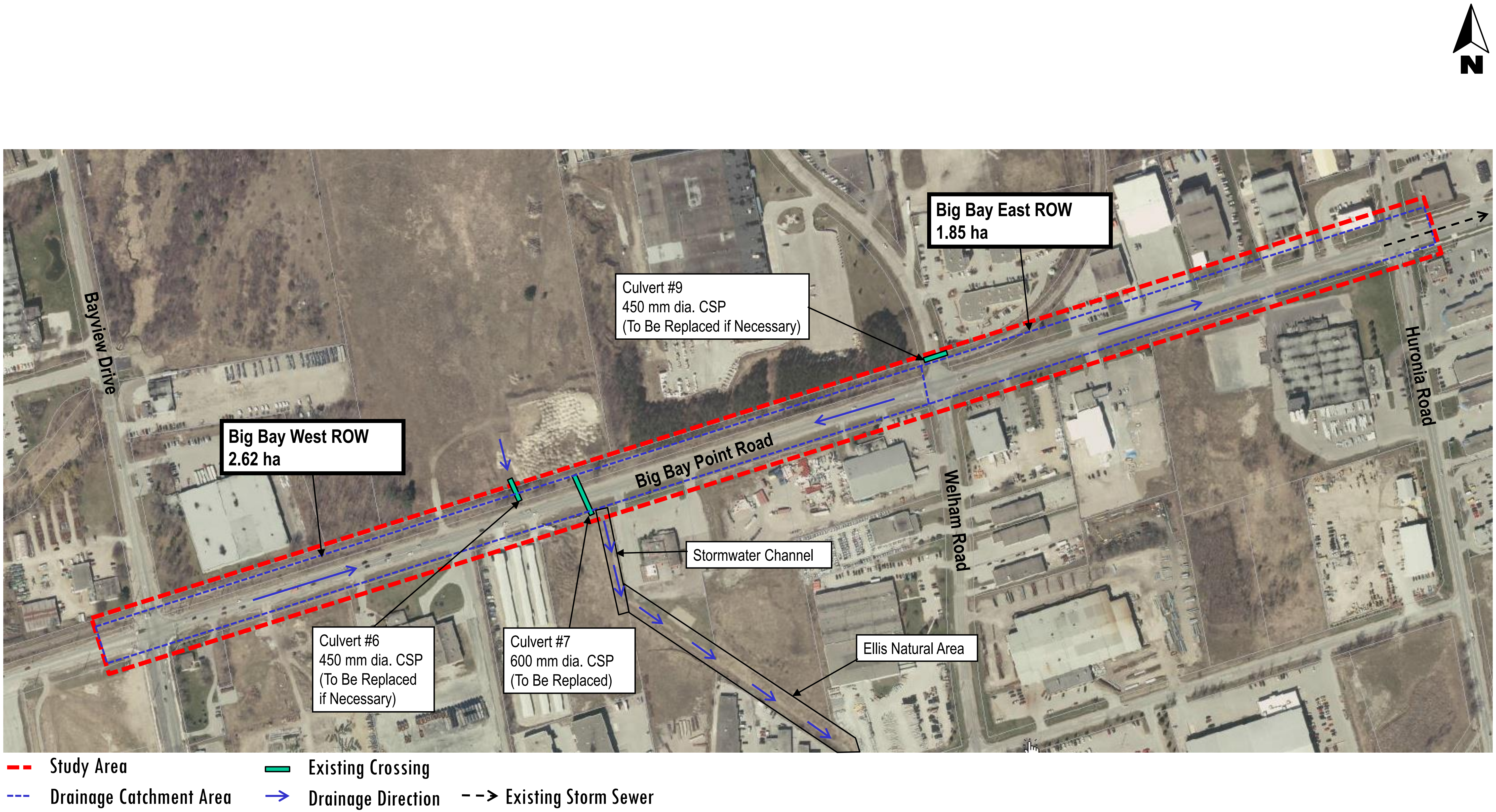


C.C. Tatham & Associates Ltd.
Consulting Engineers

Bayview Drive & Big Bay Point Road Class EA

Study Area – Bayview Drive

Figure 1



C.C. Tatham & Associates Ltd.
Consulting Engineers

Bayview Drive & Big Bay Point Road Class EA

Study Area – Big Bay Point Road

Figure

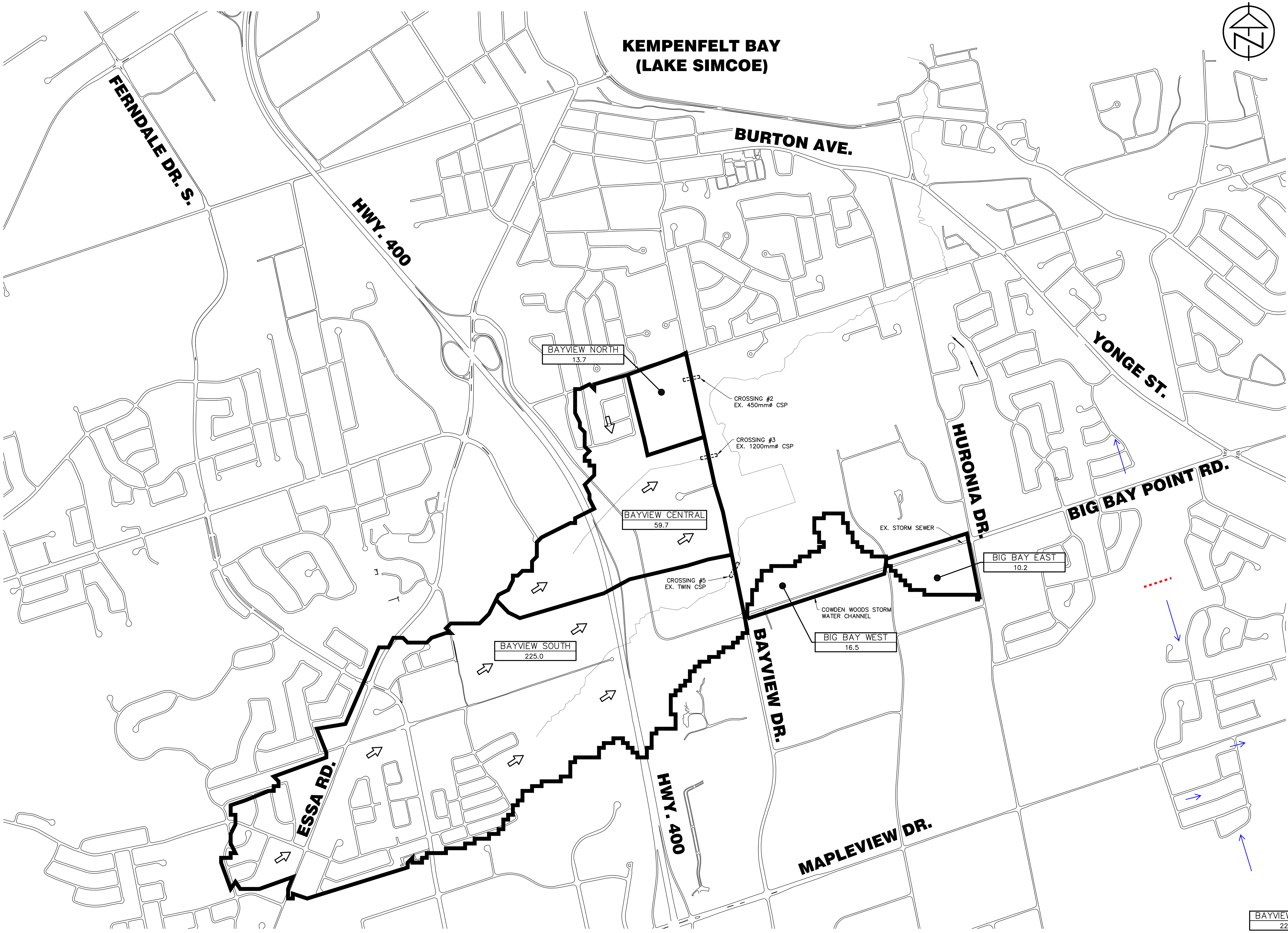
2

C.C.Tatham & Associates Ltd.
Consulting Engineers

Bayview Drive & Big Bay Point Road Class EA

Existing Storm Sewer

Figure 3



LEGEND

BAYVIEW SOUTH	CATCHMENT ID
225.0	AREA (ha)

LEGEND

CONTRACT DRAWINGS

CONTRACTOR MUST VERIFY ALL DIMENSIONS AND BE RESPONSIBLE FOR SAME. ANY DISCREPANCIES MUST BE REPORTED TO THE ENGINEER BEFORE COMMENCING WORK. DRAWINGS ARE NOT TO BE SCALED.

NO.	REVISIONS	DATE	INITIAL

APPROVED

BAYVIEW DR. & BIG BAY POINT RD. EA BARRIE, ONT

OVERALL DRAINAGE PLAN

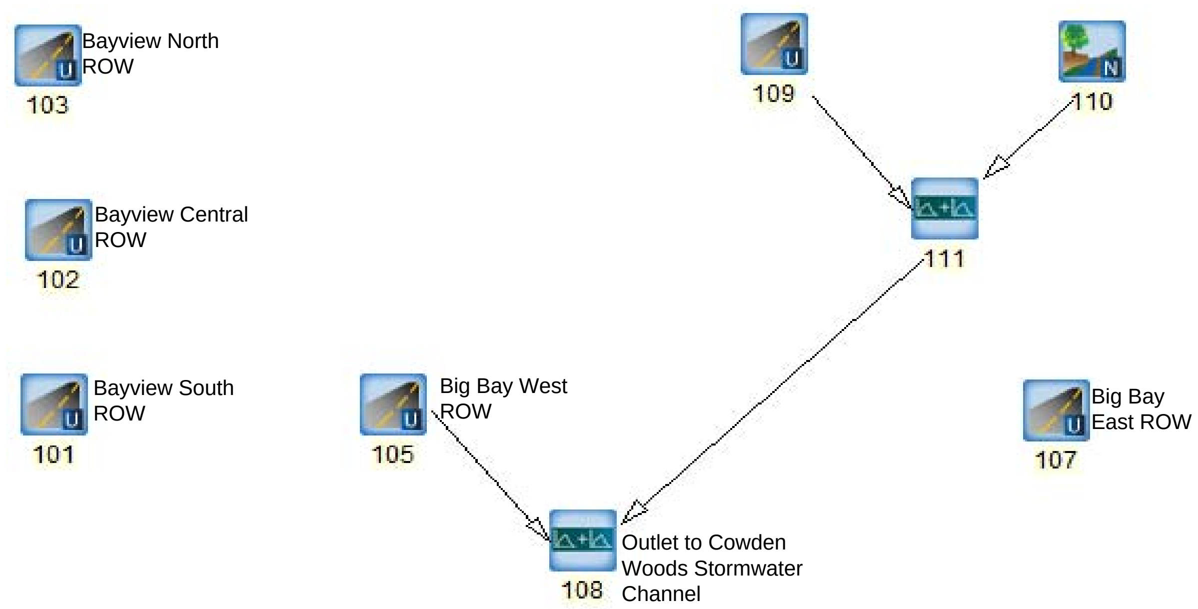
C.C. Tatham & Associates Ltd.
Consulting Engineers
Collingwood Bracebridge Orillia Barrie

SCALE: 1:10000		JOB NO.	415375
DESIGN: NHF	CHECKED: ALK	DWG.	DP-1
DRAWN: SD	DATE: FEBRUARY 2016		

APPENDIX A:

EXISTING HYDROLOGIC CONDITIONS

BIG BAY POINT RD & BAYVIEW DRIVE EA
EXISTING CONDITIONS



Nashyd	Route Pipe	Duhyd
Standhyd	Route Channel	Diverthyd
Addhyd	Route Reservoir	

C.C. TATHAM & ASSOCIATES LTD.
Consulting Engineers

Project:	Big Bay Point Rd and Bayview Dr
File No.:	415375
Subject:	Otthymo Flow Schematic
Date:	Jan-16 **Figure:** 1

C.C. Tatham & Associates Ltd. Consulting Engineers — Collingwood, Bracebridge, Orillia, Barrie	

Project:	Big Bay Point Road and Bayview Drive EA
File No.:	415375
Date:	13-Oct-15
Designed By:	NHF
Checked By:	ALK
Subject:	CN Calculator - Culvert Capacity

Big Bay Point Road and Bayview Drive EA
CURVE NUMBER, INITIAL ABSTRACTION & TIME TO PEAK CALCULATIONS

CONDITIONS

Catchment 110 **Area** 10.15 ha

WEIGHTED CN VALUE

Soil Series	Soil Series	Hydrologic Soil Group	Soil Texture	Runoff Coefficient Type	Catchment Soil Characteristics		Forest/Woodland			Pasture/Lawns			Meadows			Gravel			Impervious			Wetland/Lakes/SWMF			Average CN for Soil Type
					Area	Percent	Area	Percent	CN	Area	Percent	CN	Area	Percent	CN	Area	Percent	CN	Area	Percent	CN	Area	Percent	CN	
tisl	TIOGA	A	Sand Loam	1	10.15	1	0	0	32	6.699	0.66	49	0		38	0	0	89	3.451	0.34	100	0		50	66.34
	#N/A	#N/A	#N/A	#N/A	0		0		#N/A	0		#N/A	0		#N/A	0		89	0		#N/A	0		#N/A	0
	#N/A	#N/A	#N/A	#N/A	0		0		#N/A	0		#N/A	0		#N/A	0		89	0		#N/A	0		#N/A	0
	#N/A	#N/A	#N/A	#N/A	0		0		#N/A	0		#N/A	0		#N/A	0		89	0		#N/A	0		#N/A	0
	#N/A	#N/A	#N/A	#N/A	0		0		#N/A	0		#N/A	0		#N/A	0		#N/A	0		#N/A	0		#N/A	0
				Totals	**10.15**	**1**	**0**	**0**		**6.699**	**0.66**		**0**	**0**		**0**	**0**		**3.451**	**0.34**		**0**	**0**		**66.3**

Time of Concentration Calculations

Initial Abstraction	**3.98 mm**

Wetlands	12
Woods	10
Meadows	8
Gravel	3
Lawns	5
Impervious	2

For Runoff Coefficients greater than 0.4

Bransby-Williams Formula

Maximum Catchment Elevation	279	m
Minimum Catchment Elevation	271	m
Catchment length	350	m
Catchment Slope	2%	
Catchment Area	10.15	ha
Time of Concentration (Minutes)	**13.41**	
Time of Concentration (Hours)	**0.22**	
Time to Peak (2/3 x Time of Concentration)	**0.15**	

For Runoff Coefficients less than 0.4

Airport Method

Maximum Catchment Elevation	279	m
Minimum Catchment Elevation	271	m
Catchment length	350	m
Catchment Slope	2%	
Catchment Area	10.15	ha
Time of Concentration (Minutes)	**33.01**	
Time of Concentration (Hours)	**0.55**	
Time to Peak (2/3 x Time of Concentration)	**0.37**	

Time to Peak	**0.37 hrs**

Runoff Coefficient	**0.39**

Landuse Type	Soil Series				
	tisl	0	0	0	0
	1	#N/A	#N/A	#N/A	#N/A
Forest/Woodland	0.08	#N/A	#N/A	#N/A	#N/A
Gravel	0.6	#N/A	#N/A	#N/A	#N/A
Pasture/Lawn	0.1	#N/A	#N/A	#N/A	#N/A
Impervious	0.95	#N/A	#N/A	#N/A	#N/A
Wetland/Lake/SWMF	0.05	#N/A	#N/A	#N/A	#N/A
Meadows	0.09	#N/A	#N/A	#N/A	#N/A
Soil Series Total	0.389	#N/A	#N/A	#N/A	#N/A

```
================================================================================

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      V    V   I    SS     U   U   A A   L
       V  V    I     SS    U   U  AAAAA  L
       V  V    I      SS   U   U  A   A  L
        VV     I    SSSSS  UUUUU  A   A  LLLLL

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      O   O    T      T    H   H   Y Y   MM MM  O   O
      O   O    T      T    H   H    Y    M   M  O   O
       OOO     T      T    H   H    Y    M   M   OOO

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                   *****  S U M M A R Y   O U T P U T  *****


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DATE: 1/15/2016                           TIME: 2:28:20 PM

USER:
            Existing Conditions - Chicago Design Storms
COMMENTS: ____________________________________________________________

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*
      ADD [0111 + 0105]  0108  3  5.0   18.18     .98  1.50  24.75  n/a    .000
*
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  ****************************

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*
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                                   min      ha      cms   hrs     mm          cms

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      --------------------
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*
  *   CALIB STANDHYD     0101  1  5.0     .96     .22  1.50  57.47  .69    .000
      [I%=62.0:S%= 2.00]
*
```

```
 *   CALIB STANDHYD     0107  1  5.0    1.85     .36  1.50  50.42  .61    .000
     [I%=51.0:S%= 2.00]
*
 *   CALIB STANDHYD     0109  1  5.0    5.41     .65  1.50  39.52  .48    .000
     [I%=34.0:S%= 2.00]
*
 *   CALIB NASHYD       0110  1 10.0   10.15     .49  2.00  29.05  .36    .000
     [CN=66.3         ]
     [ N = 3.0:Tp  .37]
*
 *   CALIB STANDHYD     0105  1  5.0    2.62     .52  1.50  52.35  .63    .000
     [I%=54.0:S%= 2.00]
*
     ADD [0109 + 0110]  0111  3  5.0   15.56     .87  1.50  32.69  n/a    .000
*
     ADD [0111 + 0105]  0108  3  5.0   18.18    1.40  1.50  35.53  n/a    .000
*
 ****************************
 ** SIMULATION NUMBER:   5 **
 ****************************
```

50 year 4-hour Chicago Storm

```
 W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                 min     ha     cms   hrs     mm          cms

     START @   .00 hrs
     --------------------
     READ STORM                 10.0
     [ Ptot= 85.51 mm ]
     fname : T:\2015 PROJECTS\415375 - Bayview Dr & Big Bay Pt Rd EA\Design\SWM\VO2\City of Barrie Old\barrrie(ch
     remark: 4hr 50year CHICAGO STORM - CITY OF BARRIE
*
 *   CALIB STANDHYD     0103  1  5.0    1.37     .31  1.50  54.28  .63    .000
     [I%=54.0:S%= 2.00]
*
 *   CALIB STANDHYD     0102  1  5.0    1.67     .36  1.50  51.65  .60    .000
     [I%=50.0:S%= 2.00]
*
 *   CALIB STANDHYD     0101  1  5.0     .96     .24  1.50  59.54  .70    .000
     [I%=62.0:S%= 2.00]
*
 *   CALIB STANDHYD     0107  1  5.0    1.85     .40  1.50  52.31  .61    .000
     [I%=51.0:S%= 2.00]
*
 *   CALIB STANDHYD     0109  1  5.0    5.41     .74  1.50  41.14  .48    .000
     [I%=34.0:S%= 2.00]
*
 *   CALIB NASHYD       0110  1 10.0   10.15     .55  1.83  30.77  .36    .000
     [CN=66.3         ]
     [ N = 3.0:Tp  .37]
*
 *   CALIB STANDHYD     0105  1  5.0    2.62     .59  1.50  54.28  .63    .000
     [I%=54.0:S%= 2.00]
*
     ADD [0109 + 0110]  0111  3  5.0   15.56    1.00  1.50  34.37  n/a    .000
*
     ADD [0111 + 0105]  0108  3  5.0   18.18    1.58  1.50  37.24  n/a    .000
*
 ****************************
 ** SIMULATION NUMBER:   6 **
 ****************************
```

100 year 4-hour Chicago Storm

```
 W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                 min     ha     cms   hrs     mm          cms

     START @   .00 hrs
     --------------------
     READ STORM                 10.0
     [ Ptot= 95.00 mm ]
     fname : T:\2015 PROJECTS\415375 - Bayview Dr & Big Bay Pt Rd EA\Design\SWM\VO2\City of Barrie Old\barrrie(ch
     remark: 4hr 100year CHICAGO STORM - CITY OF BARRIE
*
 *   CALIB STANDHYD     0103  1  5.0    1.37     .35  1.50  61.27  .64    .000
     [I%=54.0:S%= 2.00]
*
 *   CALIB STANDHYD     0102  1  5.0    1.67     .41  1.50  58.43  .62    .000
     [I%=50.0:S%= 2.00]
*
 *   CALIB STANDHYD     0101  1  5.0     .96     .27  1.50  66.96  .70    .000
     [I%=62.0:S%= 2.00]
*
 *   CALIB STANDHYD     0107  1  5.0    1.85     .45  1.50  59.14  .62    .000
     [I%=51.0:S%= 2.00]
*
 *   CALIB STANDHYD     0109  1  5.0    5.41     .84  1.50  47.04  .50    .000
     [I%=34.0:S%= 2.00]
*
 *   CALIB NASHYD       0110  1 10.0   10.15     .68  1.83  36.72  .39    .000
     [CN=66.3         ]
     [ N = 3.0:Tp  .37]
```

```
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .67  1.50  61.27  .64    .000
      [I%=54.0:S%= 2.00]
*
      ADD [0109 + 0110]  0111  3  5.0   15.56    1.16  1.50  40.31  n/a    .000
*
      ADD [0111 + 0105]  0108  3  5.0   18.18    1.82  1.50  43.33  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   7 **
  ****************************
```

Hurricane Hazel

```
  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.    Qbase
                                   min    ha     cms   hrs     mm           cms

      START @   .00 hrs
      --------------------
      READ STORM                 60.0
      [ Ptot=212.00 mm ]
      fname : T:\2015 PROJECTS\415375 - Bayview Dr & Big Bay Pt Rd EA\Design\SWM\VO2\City of Barrie Old\barrrie(ch
      remark: Hurricane Hazel for the last 12 hrs of the storm -INTENSITIE
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .16 10.00 155.75  .73    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .20 10.00 150.95  .71    .000
      [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .12 10.00 165.36  .78    .000
      [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .22 10.00 152.15  .72    .000
      [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .57 10.00 131.74  .62    .000
      [I%=34.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15    1.07 10.00 128.11  .60    .000
      [CN=66.3         ]
      [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .31 10.00 155.75  .73    .000
      [I%=54.0:S%= 2.00]
*
      ADD [0109 + 0110]  0111  3  5.0   15.56    1.64 10.00 129.37  n/a    .000
*
      ADD [0111 + 0105]  0108  3  5.0   18.18    1.95 10.00 133.18  n/a    .000
*
 FINISH

============================================================================================================
```

```
================================================================================

      V    V   I    SSSSS  U   U    A    L
      V    V   I    SS     U   U   A A   L
       V  V    I     SS    U   U  AAAAA  L
       V  V    I      SS   U   U  A   A  L
        VV     I    SSSSS  UUUUU  A   A  LLLLL

       OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
      O   O    T      T    H   H   Y Y   MM MM  O   O
      O   O    T      T    H   H    Y    M   M  O   O
       OOO     T      T    H   H    Y    M   M   OOO
```

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```
                   *****  S U M M A R Y   O U T P U T  *****

  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.2\voin.dat
  Output  filename: T:\2015PR~1\415375~1\Design\SWM\VO2\V02\SCS Design Storm - Existing.out
  Summary filename: T:\2015PR~1\415375~1\Design\SWM\VO2\V02\SCS Design Storm - Existing.sum

DATE: 1/15/2016                          TIME: 2:26:59 PM

USER:

COMMENTS: Existing Conditions - SCS Design Storms

  ****************************
  ** SIMULATION NUMBER:   1 ** 2 year 12-hour SCS Storm
  ****************************

  W/E COMMAND              HYD ID   DT    AREA    Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha      cms   hrs     mm          cms

      START @   .00 hrs
      --------------------
      MASS STORM                  15.0
      [ Ptot= 40.80 mm ]
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .12  6.00  23.45  .57    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .14  6.00  22.03  .54    .000
      [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .09  6.00  26.29  .64    .000
      [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .15  6.00  22.39  .55    .000
      [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .23  6.00  23.45  .57    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15     .15  6.17   8.16  .20    .000
      [CN=66.3         ]
      [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .29  6.00  16.35  .40    .000
      [I%=34.0:S%= 2.00]
*
      ADD [0110 + 0109]  0111  3  5.0   15.56     .40  6.00  11.01  n/a    .000
*
      ADD [0105 + 0111]  0108  3  5.0   18.18     .63  6.00  12.80  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   2 **  5 year 12-hour SCS Storm
  ****************************

  W/E COMMAND              HYD ID   DT    AREA    Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha      cms   hrs     mm          cms

      START @   .00 hrs
      --------------------
      MASS STORM                  15.0
      [ Ptot= 56.40 mm ]
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .17  6.00  33.76  .60    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .20  6.00  31.88  .57    .000
```

```
     [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .14  6.00  37.52  .67    .000
      [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .22  6.00  32.35  .57    .000
      [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .33  6.00  33.76  .60    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15     .29  6.17  15.12  .27    .000
      [CN=66.3         ]
      [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .42  6.00  24.36  .43    .000
      [I%=34.0:S%= 2.00]
*
      ADD [0110 + 0109]  0111  3  5.0   15.56     .64  6.00  18.33  n/a    .000
*
      ADD [0105 + 0111]  0108  3  5.0   18.18     .97  6.00  20.56  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   3 ** 10 year 12-hour SCS Storm
  ****************************

  W/E COMMAND             HYD ID   DT     AREA    Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha      cms   hrs     mm          cms

      START @   .00 hrs
      --------------------
      MASS STORM                 15.0
      [ Ptot= 66.00 mm ]
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .21  6.00  40.36  .61    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .24  6.00  38.22  .58    .000
      [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .16  6.00  44.64  .68    .000
      [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .27  6.00  38.75  .59    .000
      [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .39  6.00  40.36  .61    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15     .38  6.17  20.10  .30    .000
      [CN=66.3         ]
      [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .51  6.00  29.65  .45    .000
      [I%=34.0:S%= 2.00]
*
      ADD [0110 + 0109]  0111  3  5.0   15.56     .81  6.00  23.42  n/a    .000
*
      ADD [0105 + 0111]  0108  3  5.0   18.18    1.20  6.00  25.86  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   4 **  25 year 12-hour SCS Storm
  ****************************

  W/E COMMAND             HYD ID   DT     AREA    Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha      cms   hrs     mm          cms

      START @   .00 hrs
      --------------------
      MASS STORM                 15.0
      [ Ptot= 79.20 mm ]
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .26  6.00  49.71  .63    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .30  6.00  47.23  .60    .000
      [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .20  6.00  54.66  .69    .000
      [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .34  6.00  47.85  .60    .000
      [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .50  6.00  49.71  .63    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15     .53  6.17  27.65  .35    .000
      [CN=66.3         ]
```

```
      [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .66  6.00  37.32  .47    .000
      [I%=34.0:S%= 2.00]
*
      ADD [0110 + 0109]  0111  3  5.0   15.56    1.08  6.00  31.01  n/a    .000
*
      ADD [0105 + 0111]  0108  3  5.0   18.18    1.58  6.00  33.71  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   5 **  50 year 12-hour SCS Storm
  ****************************

  W/E COMMAND             HYD ID   DT     AREA   Qpeak Tpeak   R.V. R.C.    Qbase
                                  min      ha     cms   hrs     mm           cms

      START @   .00 hrs
      --------------------
      MASS STORM                15.0
      [ Ptot= 88.80 mm ]
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .30  6.00  56.69  .64    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .35  6.00  53.98  .61    .000
      [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .23  6.00  62.10  .70    .000
      [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .39  6.00  54.66  .62    .000
      [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .57  6.00  56.69  .64    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15     .65  6.17  33.58  .38    .000
      [CN=66.3         ]
      [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .76  6.00  43.16  .49    .000
      [I%=34.0:S%= 2.00]
*
      ADD [0110 + 0109]  0111  3  5.0   15.56    1.28  6.00  36.91  n/a    .000
*
      ADD [0105 + 0111]  0108  3  5.0   18.18    1.85  6.00  39.76  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   6 **  100 year 12-hour SCS Storm
  ****************************

  W/E COMMAND             HYD ID   DT     AREA   Qpeak Tpeak   R.V. R.C.    Qbase
                                  min      ha     cms   hrs     mm           cms

      START @   .00 hrs
      --------------------
      MASS STORM                15.0
      [ Ptot= 98.40 mm ]
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .33  6.00  63.81  .65    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .39  6.00  60.89  .62    .000
      [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .26  6.00  69.65  .71    .000
      [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .44  6.00  61.62  .63    .000
      [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .64  6.00  63.81  .65    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15     .78  6.17  39.82  .40    .000
      [CN=66.3         ]
      [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .87  6.00  49.21  .50    .000
      [I%=34.0:S%= 2.00]
*
      ADD [0110 + 0109]  0111  3  5.0   15.56    1.49  6.00  43.09  n/a    .000
*
      ADD [0105 + 0111]  0108  3  5.0   18.18    2.13  6.00  46.07  n/a    .000
*
 FINISH

=============================================================================================
```

```
================================================================================

      V    V   I    SSSSS  U   U    A    L
      V    V   I    SS     U   U   A A   L
       V  V    I     SS    U   U  AAAAA  L
       V  V    I      SS   U   U  A   A  L
        VV     I    SSSSS  UUUUU  A   A  LLLLL

       OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
      O   O    T      T    H   H   Y Y   MM MM  O   O
      O   O    T      T    H   H    Y    M   M  O   O
       OOO     T      T    H   H    Y    M   M   OOO
```

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***** S U M M A R Y   O U T P U T *****

```
  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.2\voin.dat
  Output  filename: T:\2015PR~1\415375~1\Design\SWM\VO2\VO2-6H~1\6hr SCS Storm - Existing.out
  Summary filename: T:\2015PR~1\415375~1\Design\SWM\VO2\VO2-6H~1\6hr SCS Storm - Existing.sum
```

DATE: 8/17/2016   TIME: 1:09:45 PM

USER:

COMMENTS: Existing Conditions - SCS Design Storms

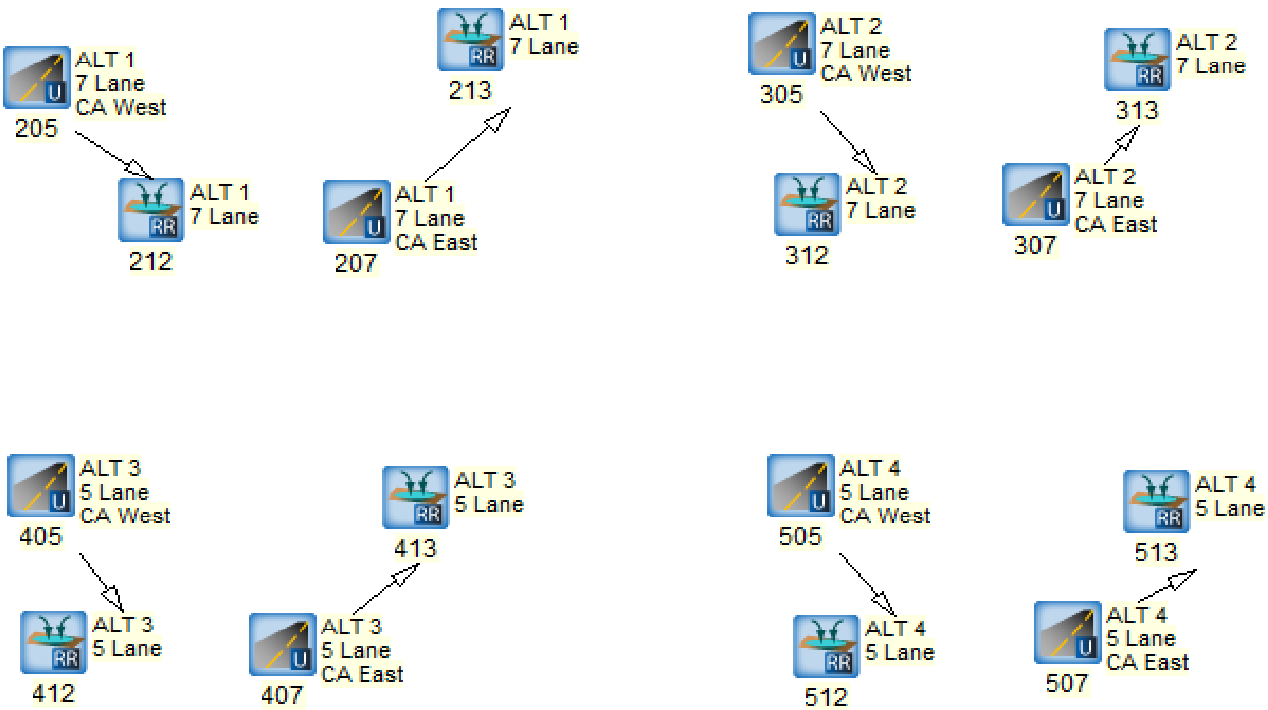
```
  ****************************
  ** SIMULATION NUMBER:   1 **   2 year 6-hour SCS Storm
  ****************************

  W/E COMMAND             HYD ID   DT    AREA    Qpeak Tpeak   R.V.  R.C.   Qbase
                                   min    ha      cms   hrs     mm           cms

      START @   .00 hrs
      --------------------
      MASS STORM                   5.0
      [ Ptot= 36.60 mm ]
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .13  3.00  20.77  .57    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .14  3.00  19.49  .53    .000
      [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .10  3.00  23.35  .64    .000
      [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .16  3.00  19.81  .54    .000
      [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .24  3.00  20.77  .57    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15     .14  3.17   6.57  .18    .000
      [CN=66.3         ]
      [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .30  3.00  14.27  .39    .000
      [I%=34.0:S%= 2.00]
*
      ADD [0110 + 0109]  0111  3  5.0   15.56     .40  3.00   9.25  n/a    .000
*
      ADD [0105 + 0111]  0108  3  5.0   18.18     .64  3.00  10.91  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   2 **   5 year 6-hour SCS Storm
  ****************************

  W/E COMMAND             HYD ID   DT    AREA    Qpeak Tpeak   R.V.  R.C.   Qbase
                                   min    ha      cms   hrs     mm           cms

      START @   .00 hrs
      --------------------
      MASS STORM                   5.0
      [ Ptot= 51.60 mm ]
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .18  3.00  30.53  .59    .000
      [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .21  3.00  28.79  .56    .000
```

```
     [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .15  3.00  34.02  .66    .000
     [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .24  3.00  29.23  .57    .000
     [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .35  3.00  30.54  .59    .000
     [I%=54.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15     .28  3.17  12.82  .25    .000
     [CN=66.3         ]
     [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .45  3.00  21.72  .42    .000
     [I%=34.0:S%= 2.00]
*
      ADD [0110 + 0109]  0111  3  5.0   15.56     .66  3.00  15.91  n/a    .000
*
      ADD [0105 + 0111]  0108  3  5.0   18.18    1.01  3.00  18.02  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   3 ** 10 year 6-hour SCS Storm
  ****************************

  W/E COMMAND             HYD ID   DT     AREA    Qpeak Tpeak    R.V. R.C.    Qbase
                                  min      ha      cms   hrs      mm           cms

      START @   .00 hrs
      --------------------
      MASS STORM                  5.0
      [ Ptot= 61.80 mm ]
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .23  3.00  37.45  .61    .000
     [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .26  3.00  35.42  .57    .000
     [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .18  3.00  41.51  .67    .000
     [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .30  3.00  35.93  .58    .000
     [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .43  3.00  37.45  .61    .000
     [I%=54.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15     .39  3.17  17.86  .29    .000
     [CN=66.3         ]
     [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .55  3.00  27.19  .44    .000
     [I%=34.0:S%= 2.00]
*
      ADD [0110 + 0109]  0111  3  5.0   15.56     .85  3.00  21.10  n/a    .000
*
      ADD [0105 + 0111]  0108  3  5.0   18.18    1.28  3.00  23.46  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   4 ** 25 year 6-hour SCS Storm
  ****************************

  W/E COMMAND             HYD ID   DT     AREA    Qpeak Tpeak    R.V. R.C.    Qbase
                                  min      ha      cms   hrs      mm           cms

      START @   .00 hrs
      --------------------
      MASS STORM                  5.0
      [ Ptot= 74.40 mm ]
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .29  3.00  46.27  .62    .000
     [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .33  3.00  43.91  .59    .000
     [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .22  3.00  50.99  .69    .000
     [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .37  3.00  44.50  .60    .000
     [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .55  3.00  46.27  .62    .000
     [I%=54.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15     .55  3.17  24.82  .33    .000
     [CN=66.3         ]
```

```
     [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .72  3.00  34.33  .46    .000
     [I%=34.0:S%= 2.00]
*
     ADD [0110 + 0109]  0111  3  5.0   15.56    1.14  3.00  28.13  n/a    .000
*
     ADD [0105 + 0111]  0108  3  5.0   18.18    1.69  3.00  30.74  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   5 **50 year 6-hour SCS Storm
  ****************************

  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha     cms   hrs     mm          cms

     START @   .00 hrs
     --------------------
     MASS STORM                    5.0
     [ Ptot= 83.40 mm ]
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .33  3.00  52.74  .63    .000
     [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .38  3.00  50.17  .60    .000
     [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .25  3.00  57.90  .69    .000
     [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .43  3.00  50.81  .61    .000
     [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .63  3.00  52.74  .63    .000
     [I%=54.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15     .68  3.17  30.20  .36    .000
     [CN=66.3         ]
     [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .83  3.00  39.68  .48    .000
     [I%=34.0:S%= 2.00]
*
     ADD [0110 + 0109]  0111  3  5.0   15.56    1.35  3.00  33.50  n/a    .000
*
     ADD [0105 + 0111]  0108  3  5.0   18.18    1.98  3.00  36.27  n/a    .000
*
  ****************************
  ** SIMULATION NUMBER:   6 **100 year 6-hour SCS Storm
  ****************************

  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                   min     ha     cms   hrs     mm          cms

     START @   .00 hrs
     --------------------
     MASS STORM                    5.0
     [ Ptot= 92.40 mm ]
*
  *   CALIB STANDHYD     0103  1  5.0    1.37     .37  3.00  59.34  .64    .000
     [I%=54.0:S%= 2.00]
*
  *   CALIB STANDHYD     0102  1  5.0    1.67     .43  3.00  56.56  .61    .000
     [I%=50.0:S%= 2.00]
*
  *   CALIB STANDHYD     0101  1  5.0     .96     .28  3.00  64.92  .70    .000
     [I%=62.0:S%= 2.00]
*
  *   CALIB STANDHYD     0107  1  5.0    1.85     .48  3.00  57.25  .62    .000
     [I%=51.0:S%= 2.00]
*
  *   CALIB STANDHYD     0105  1  5.0    2.62     .71  3.00  59.34  .64    .000
     [I%=54.0:S%= 2.00]
*
  *   CALIB NASHYD       0110  1 10.0   10.15     .81  3.17  35.89  .39    .000
     [CN=66.3         ]
     [ N = 3.0:Tp  .37]
*
  *   CALIB STANDHYD     0109  1  5.0    5.41     .95  3.00  45.21  .49    .000
     [I%=34.0:S%= 2.00]
*
     ADD [0110 + 0109]  0111  3  5.0   15.56    1.58  3.00  39.13  n/a    .000
*
     ADD [0105 + 0111]  0108  3  5.0   18.18    2.28  3.00  42.04  n/a    .000
*
 FINISH

=========================================================================================================
```

APPENDIX B:
PROPOSED HYDROLOGIC CONDITIONS

BIG BAY POINT RD & BAYVIEW DRIVE EA
PROPOSED CONDITIONS
BIG BAY POINT RD ALTERNATIVES



Nashyd	Route Pipe	Duhyd
Standhyd	Route Channel	Diverthyd
Addhyd	Route Reservoir	

C.C. TATHAM & ASSOCIATES LTD.
Consulting Engineers

Project:	Big Bay Point Rd and Bayview Dr		
File No.:	415375		
Subject:	Otthymo Flow Schematic		
Date:	Jan-16	**Figure:**	2

```
======================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
```

Developed and Distributed by Clarifica Inc.

***** S U M M A R Y   O U T P U T *****

```
  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.2\voin.dat
  Output  filename: T:\2015PR~1\415375~1\Design\SWM\VO2\V02\CHI Design Storm - Proposed Road Use (Climate Change) - Big Bay.out
  Summary filename: T:\2015PR~1\415375~1\Design\SWM\VO2\V02\CHI Design Storm - Proposed Road Use (Climate Change) - Big Bay.sum
```

DATE: 2/2/2016   TIME: 5:07:35 PM

USER:

COMMENTS: Big Bay Point Road Alternatives - Chicago Design Storm

```
  ****************************
  ** SIMULATION NUMBER:   6 **   100-year 4 hour Chicago Design Storm
  ****************************

  W/E COMMAND             HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                   min    ha     cms   hrs     mm          cms

      START @   .00 hrs
      --------------------
      CHIC STORM                  10.0
      [ Ptot= 87.58 mm ]
*
  *   CALIB STANDHYD     0205  1  5.0    3.38    1.45  1.33  75.87  .87    .000
      [I%=84.0:S%= 2.00]
*
  *   CALIB STANDHYD     0207  1  5.0    2.20     .93  1.33  73.86  .84    .000
      [I%=81.0:S%= 2.00]
*
  *   CALIB STANDHYD     0305  1  5.0    3.11    1.35  1.33  76.54  .87    .000
      [I%=85.0:S%= 2.00]
*
  *   CALIB STANDHYD     0307  1  5.0    1.98     .87  1.33  77.21  .88    .000
      [I%=86.0:S%= 2.00]
*
  *   CALIB STANDHYD     0405  1  5.0    2.88    1.21  1.33  73.86  .84    .000
      [I%=81.0:S%= 2.00]
*
  *   CALIB STANDHYD     0407  1  5.0    1.91     .78  1.33  71.86  .82    .000
      [I%=78.0:S%= 2.00]
*
  *   CALIB STANDHYD     0505  1  5.0    2.63    1.11  1.33  73.86  .84    .000
      [I%=81.0:S%= 2.00]
*
  *   CALIB STANDHYD     0507  1  5.0    1.86     .76  1.33  71.86  .82    .000
      [I%=78.0:S%= 2.00]
*
      RESRVR [ 2 : 0205] 0212  1  5.0    3.38     .58  1.42  75.86  n/a    .000
      {ST=   .09 ha.m }
*
      RESRVR [ 2 : 0207] 0213  1  5.0    2.20     .40  1.42  73.85  n/a    .000
      {ST=   .05 ha.m }
*
      RESRVR [ 2 : 0305] 0312  1  5.0    3.11     .59  1.42  76.53  n/a    .000
      {ST=   .08 ha.m }
*
      RESRVR [ 2 : 0307] 0313  1  5.0    1.98     .41  1.42  77.20  n/a    .000
      {ST=   .05 ha.m }
*
      RESRVR [ 2 : 0405] 0412  1  5.0    2.88     .60  1.42  73.86  n/a    .000
      {ST=   .06 ha.m }
*
      RESRVR [ 2 : 0407] 0413  1  5.0    1.91     .42  1.42  71.85  n/a    .000
```

```
      {ST=    .04 ha.m }
*
      RESRVR [ 2 : 0505] 0512  1  5.0    2.63     .61  1.42  73.86  n/a    .000
      {ST=    .05 ha.m }
*
      RESRVR [ 2 : 0507] 0513  1  5.0    1.86     .42  1.42  71.85  n/a    .000
      {ST=    .04 ha.m }
*
 FINISH

===========================================================================================================
```

==

```
       V     V   I     SSSSS  U    U     A     L
       V     V   I     SS     U    U    A A    L
        V   V    I      SS    U    U   AAAAA   L
        V   V    I       SS   U    U   A    A  L
         VV      I     SSSSS  UUUUU   A    A  LLLLL

        OOO    TTTTT  TTTTT  H    H  Y    Y  M    M   OOO
       O   O     T      T    H    H   Y Y    MM MM   O   O
       O   O     T      T    H    H    Y     M    M  O   O
        OOO      T      T    H    H    Y     M    M   OOO
```

Developed and Distributed by Clarifica Inc.

***** S U M M A R Y   O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.2\voin.dat
Output filename: T:\2015PR~1\415375~1\Design\SWM\VO2\V02\SCS Design Storm - Proposed Road Use (Climate Change) - Big Bay.out
Summary filename: T:\2015PR~1\415375~1\Design\SWM\VO2\V02\SCS Design Storm - Proposed Road Use (Climate Change) - Big Bay.sum

DATE: 2/2/2016   TIME: 5:06:42 PM

USER:

COMMENTS: Big Bay Point Road Alternatives - SCS Design Storm

****
** SIMULATION NUMBER: 6 ** 100-year 12 hour SCS Design Storm
****

W/E	COMMAND	HYD	ID	DT min	AREA ha	Qpeak cms	Tpeak hrs	R.V. mm	R.C.	Qbase cms
	START @ .00 hrs									
	MASS STORM [Ptot=112.80 mm]			15.0						
*	CALIB STANDHYD [I%=84.0:S%= 2.00]	0205	1	5.0	3.38	1.25	6.00	98.91	.88	.000
*	CALIB STANDHYD [I%=81.0:S%= 2.00]	0207	1	5.0	2.20	.80	6.00	96.49	.86	.000
*	CALIB STANDHYD [I%=85.0:S%= 2.00]	0305	1	5.0	3.11	1.16	6.00	99.71	.88	.000
*	CALIB STANDHYD [I%=86.0:S%= 2.00]	0307	1	5.0	1.98	.74	6.00	100.52	.89	.000
*	CALIB STANDHYD [I%=81.0:S%= 2.00]	0405	1	5.0	2.88	1.04	6.00	96.49	.86	.000
*	CALIB STANDHYD [I%=78.0:S%= 2.00]	0407	1	5.0	1.91	.68	6.00	94.07	.83	.000
*	CALIB STANDHYD [I%=81.0:S%= 2.00]	0505	1	5.0	2.63	.95	6.00	96.49	.86	.000
*	CALIB STANDHYD [I%=78.0:S%= 2.00]	0507	1	5.0	1.86	.66	6.00	94.07	.83	.000
	RESRVR [2 : 0205] {ST= .10 ha.m }	0212	1	5.0	3.38	.64	6.08	98.90	n/a	.000
	RESRVR [2 : 0207] {ST= .06 ha.m }	0213	1	5.0	2.20	.44	6.08	96.48	n/a	.000
	RESRVR [2 : 0305] {ST= .09 ha.m }	0312	1	5.0	3.11	.64	6.08	99.70	n/a	.000
	RESRVR [2 : 0307] {ST= .05 ha.m }	0313	1	5.0	1.98	.44	6.08	100.51	n/a	.000
	RESRVR [2 : 0405] {ST= .07 ha.m }	0412	1	5.0	2.88	.64	6.08	96.48	n/a	.000
	RESRVR [2 : 0407]	0413	1	5.0	1.91	.44	6.00	94.06	n/a	.000

```
      {ST=   .04 ha.m }
*
      RESRVR [ 2 : 0505] 0512  1  5.0    2.63     .64  6.00  96.48  n/a    .000
      {ST=   .06 ha.m }
*
      RESRVR [ 2 : 0507] 0513  1  5.0    1.86     .44  6.00  94.07  n/a    .000
      {ST=   .04 ha.m }
*
 FINISH

==========================================================================================================
```

```
===========================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
```



```
                   *****  S U M M A R Y   O U T P U T  *****

  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.2\voin.dat
  Output  filename: T:\2015PR~1\415375~1\Design\SWM\VO2\VO2-6H~1\6hr SCS Storm - Proposed Road Use (Climate Change) - Big
Bay.out
  Summary filename: T:\2015PR~1\415375~1\Design\SWM\VO2\VO2-6H~1\6hr SCS Storm - Proposed Road Use (Climate Change) - Big
Bay.sum

DATE: 8/17/2016                          TIME: 1:32:12 PM

USER:

COMMENTS: Big Bay Point Road Alternatives - SCS Design Storm

  ****************************
  ** SIMULATION NUMBER:   6 ** 100-year 6 hour SCS Design Storm
  ****************************

  W/E COMMAND              HYD ID   DT    AREA    Qpeak Tpeak   R.V. R.C.    Qbase
                                    min    ha      cms   hrs     mm           cms

      START @   .00 hrs
      --------------------
      MASS STORM                    5.0
      [ Ptot=106.20 mm ]
*
  *   CALIB STANDHYD     0205  1  5.0    3.38    1.39  3.00  92.85  .87    .000
      [I%=84.0:S%= 2.00]
*
  *   CALIB STANDHYD     0207  1  5.0    2.20     .89  3.00  90.53  .85    .000
      [I%=81.0:S%= 2.00]
*
  *   CALIB STANDHYD     0305  1  5.0    3.11    1.29  3.00  93.62  .88    .000
      [I%=85.0:S%= 2.00]
*
  *   CALIB STANDHYD     0307  1  5.0    1.98     .83  3.00  94.39  .89    .000
      [I%=86.0:S%= 2.00]
*
  *   CALIB STANDHYD     0405  1  5.0    2.88    1.16  3.00  90.53  .85    .000
      [I%=81.0:S%= 2.00]
*
  *   CALIB STANDHYD     0407  1  5.0    1.91     .75  3.00  88.22  .83    .000
      [I%=78.0:S%= 2.00]
*
  *   CALIB STANDHYD     0505  1  5.0    2.63    1.06  3.00  90.53  .85    .000
      [I%=81.0:S%= 2.00]
*
  *   CALIB STANDHYD     0507  1  5.0    1.86     .73  3.00  88.22  .83    .000
      [I%=78.0:S%= 2.00]
*
      RESRVR [ 2 : 0205] 0212  1  5.0    3.38     .72  3.08  92.84  n/a    .000
      {ST=   .11 ha.m }
*
      RESRVR [ 2 : 0207] 0213  1  5.0    2.20     .49  3.08  90.52  n/a    .000
      {ST=   .07 ha.m }
*
      RESRVR [ 2 : 0305] 0312  1  5.0    3.11     .72  3.08  93.61  n/a    .000
      {ST=   .10 ha.m }
*
      RESRVR [ 2 : 0307] 0313  1  5.0    1.98     .49  3.08  94.38  n/a    .000
      {ST=   .06 ha.m }
*
      RESRVR [ 2 : 0405] 0412  1  5.0    2.88     .71  3.08  90.53  n/a    .000
      {ST=   .08 ha.m }
*
      RESRVR [ 2 : 0407] 0413  1  5.0    1.91     .49  3.00  88.21  n/a    .000
```

```
      {ST=   .05 ha.m }
*
      RESRVR [ 2 : 0505] 0512  1  5.0    2.63     .72  3.00  90.53  n/a    .000
      {ST=   .06 ha.m }
*
      RESRVR [ 2 : 0507] 0513  1  5.0    1.86     .49  3.00  88.21  n/a    .000
      {ST=   .05 ha.m }
*
 FINISH

=============================================================================================================
```

BIG BAY POINT RD & BAYVIEW DRIVE EA
PROPOSED CONDITIONS
BAYVIEW DRIVE ALTERNATIVES

Nashyd	Route Pipe	Duhyd
Standhyd	Route Channel	Diverthyd
Addhyd	Route Reservoir	

C.C. TATHAM & ASSOCIATES LTD.
Consulting Engineers

Project:	Big Bay Point Rd and Bayview Dr		
File No.:	415375		
Subject:	Otthymo Flow Schematic		
Date:	Jan-16	**Figure:**	3

```
=====================================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO

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                   *****  S U M M A R Y   O U T P U T  *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.2\voin.dat
  Output  filename: T:\2015PR~1\415375~1\Design\SWM\VO2\V02\CHI Design Storms - Proposed (w Climate Change) - Bayview
Altern.out
  Summary filename: T:\2015PR~1\415375~1\Design\SWM\VO2\V02\CHI Design Storms - Proposed (w Climate Change) - Bayview
Altern.sum


DATE: 2/2/2016                          TIME: 5:03:12 PM

USER:

COMMENTS: Bayview Drive Alternatives - Chicago Design Storm


  ****************************
  ** SIMULATION NUMBER:   6 ** 100-year 4 hour Chicago Design Storm
  ****************************

  W/E COMMAND              HYD ID   DT     AREA    Qpeak Tpeak    R.V. R.C.    Qbase
                                    min     ha      cms   hrs      mm           cms

      START @   .00 hrs
      --------------------
      CHIC STORM                   10.0
      [ Ptot= 87.58 mm ]
*
  *   CALIB STANDHYD     0203  1  5.0    1.38     .51  1.33  65.16  .74     .000
      [I%=68.0:S%= 2.00]
*
  *   CALIB STANDHYD     0202  1  5.0    1.67     .60  1.33  63.42  .72     .000
      [I%=65.4:S%= 2.00]
*
  *   CALIB STANDHYD     0201  1  5.0    1.05     .44  1.33  73.19  .84     .000
      [I%=80.0:S%= 2.00]
*
  *   CALIB STANDHYD     0303  1  5.0    1.38     .54  1.33  67.84  .77     .000
      [I%=72.0:S%= 2.00]
*
  *   CALIB STANDHYD     0302  1  5.0    1.68     .63  1.33  65.83  .75     .000
      [I%=69.0:S%= 2.00]
*
  *   CALIB STANDHYD     0301  1  5.0    1.01     .44  1.33  76.54  .87     .000
      [I%=85.0:S%= 2.00]
*
  *   CALIB STANDHYD     0403  1  5.0    1.70     .70  1.33  72.52  .83     .000
      [I%=79.0:S%= 2.00]
*
  *   CALIB STANDHYD     0402  1  5.0    2.15     .90  1.33  73.19  .84     .000
      [I%=80.0:S%= 2.00]
*
  *   CALIB STANDHYD     0401  1  5.0    1.21     .54  1.33  77.88  .89     .000
      [I%=87.0:S%= 2.00]
*
      RESRVR [ 2 : 0203] 0209  1  5.0    1.38     .31  1.42  65.15  n/a     .000
      {ST=   .02 ha.m }
*
      RESRVR [ 2 : 0202] 0210  1  5.0    1.67     .36  1.42  63.42  n/a     .000
      {ST=   .03 ha.m }
*
      RESRVR [ 2 : 0201] 0211  1  5.0    1.06     .24  1.42  73.18  n/a     .000
      {ST=   .02 ha.m }
*
      RESRVR [ 2 : 0303] 0309  1  5.0    1.38     .31  1.42  67.83  n/a     .000
      {ST=   .02 ha.m }
*
      RESRVR [ 2 : 0302] 0310  1  5.0    1.68     .37  1.42  65.83  n/a     .000
```

```
      {ST=   .03 ha.m }
*
      RESRVR [ 2 : 0301] 0311  1  5.0    1.01     .24  1.42  76.52  n/a    .000
      {ST=   .02 ha.m }
*
      RESRVR [ 2 : 0403] 0409  1  5.0    1.70     .31  1.42  72.51  n/a    .000
      {ST=   .04 ha.m }
*
      RESRVR [ 2 : 0402] 0410  1  5.0    2.15     .35  1.42  73.18  n/a    .000
      {ST=   .05 ha.m }
*
      RESRVR [ 2 : 0401] 0411  1  5.0    1.21     .24  1.42  77.85  n/a    .000
      {ST=   .03 ha.m }
*
 FINISH

=============================================================================================================
```

```
=====================================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO

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                   *****  S U M M A R Y   O U T P U T  *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.2\voin.dat
  Output  filename: T:\2015PR~1\415375~1\Design\SWM\VO2\V02\SCS Design Storm - Proposed (w Climate Change) - Bayview
Alterna.out
  Summary filename: T:\2015PR~1\415375~1\Design\SWM\VO2\V02\SCS Design Storm - Proposed (w Climate Change) - Bayview
Alterna.sum


DATE: 2/2/2016                           TIME: 4:49:26 PM

USER:

COMMENTS: Bayview Drive Alternatives - SCS Design Storm


  ****************************
  ** SIMULATION NUMBER:   6 **100-year 12 hour SCS Design Storm
  ****************************

  W/E COMMAND             HYD ID   DT     AREA    Qpeak Tpeak    R.V. R.C.    Qbase
                                   min     ha      cms   hrs      mm           cms

      START @   .00 hrs
      --------------------
      MASS STORM                  15.0
      [ Ptot=112.80 mm ]
*
  *   CALIB STANDHYD     0203  1  5.0    1.38     .45  6.00  86.02  .76    .000
      [I%=68.0:S%= 2.00]
*
  *   CALIB STANDHYD     0202  1  5.0    1.67     .54  6.00  83.92  .74    .000
      [I%=65.4:S%= 2.00]
*
  *   CALIB STANDHYD     0201  1  5.0    1.05     .38  6.00  95.68  .85    .000
      [I%=80.0:S%= 2.00]
*
  *   CALIB STANDHYD     0303  1  5.0    1.38     .47  6.00  89.24  .79    .000
      [I%=72.0:S%= 2.00]
*
  *   CALIB STANDHYD     0302  1  5.0    1.68     .55  6.00  86.82  .77    .000
      [I%=69.0:S%= 2.00]
*
  *   CALIB STANDHYD     0301  1  5.0    1.01     .38  6.00  99.71  .88    .000
      [I%=85.0:S%= 2.00]
*
  *   CALIB STANDHYD     0403  1  5.0    1.70     .61  6.00  94.88  .84    .000
      [I%=79.0:S%= 2.00]
*
  *   CALIB STANDHYD     0402  1  5.0    2.15     .77  6.00  95.68  .85    .000
      [I%=80.0:S%= 2.00]
*
  *   CALIB STANDHYD     0401  1  5.0    1.21     .46  6.00 101.32  .90    .000
      [I%=87.0:S%= 2.00]
*
      RESRVR [ 2 : 0203] 0209  1  5.0    1.38     .33  6.00  86.01  n/a    .000
      {ST=   .02 ha.m }
*
      RESRVR [ 2 : 0202] 0210  1  5.0    1.67     .39  6.00  83.91  n/a    .000
      {ST=   .03 ha.m }
*
      RESRVR [ 2 : 0201] 0211  1  5.0    1.06     .26  6.00  95.67  n/a    .000
      {ST=   .02 ha.m }
*
      RESRVR [ 2 : 0303] 0309  1  5.0    1.38     .33  6.00  89.23  n/a    .000
      {ST=   .03 ha.m }
*
      RESRVR [ 2 : 0302] 0310  1  5.0    1.68     .39  6.00  86.81  n/a    .000
```

```
      {ST=   .03 ha.m }
*
      RESRVR [ 2 : 0301] 0311  1  5.0    1.01     .26  6.00  99.70  n/a    .000
      {ST=   .02 ha.m }
*
      RESRVR [ 2 : 0403] 0409  1  5.0    1.70     .33  6.08  94.86  n/a    .000
      {ST=   .05 ha.m }
*
      RESRVR [ 2 : 0402] 0410  1  5.0    2.15     .39  6.08  95.67  n/a    .000
      {ST=   .06 ha.m }
*
      RESRVR [ 2 : 0401] 0411  1  5.0    1.21     .25  6.08 101.30  n/a    .000
      {ST=   .04 ha.m }
*
 FINISH

=============================================================================================================
```

==

```
      V    V   I    SSSSS  U   U    A    L
      V    V   I    SS     U   U   A A   L
       V  V    I     SS    U   U  AAAAA  L
       V  V    I      SS   U   U  A   A  L
        VV     I    SSSSS  UUUUU  A   A  LLLLL

       OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
      O   O    T      T    H   H   Y Y   MM MM  O   O
      O   O    T      T    H   H    Y    M   M  O   O
       OOO     T      T    H   H    Y    M   M   OOO
```

Developed and Distributed by Clarifica Inc.

***** S U M M A R Y   O U T P U T *****

Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.2\voin.dat
Output filename: T:\2015PR~1\415375~1\Design\SWM\VO2\VO2-6H~1\6hr SCS Storm - Proposed (w Climate Change) - Bayview Alterna.out
Summary filename: T:\2015PR~1\415375~1\Design\SWM\VO2\VO2-6H~1\6hr SCS Storm - Proposed (w Climate Change) - Bayview Alterna.sum

DATE: 8/17/2016   TIME: 1:35:47 PM

USER:

COMMENTS: Bayview Drive Alternatives - SCS Design Storm

```
****************************
** SIMULATION NUMBER:   6 **   100-year 6 hour SCS Design Storm
****************************
```

```
 W/E COMMAND             HYD ID   DT     AREA    Qpeak Tpeak   R.V. R.C.    Qbase
                                  min     ha      cms   hrs     mm           cms

     START @   .00 hrs
     --------------------
     MASS STORM                   5.0
     [ Ptot=106.20 mm ]
*
  *  CALIB STANDHYD     0203  1  5.0    1.38     .50  3.00  80.50  .76     .000
     [I%=68.0:S%= 2.00]
*
  *  CALIB STANDHYD     0202  1  5.0    1.67     .60  3.00  78.49  .74     .000
     [I%=65.4:S%= 2.00]
*
  *  CALIB STANDHYD     0201  1  5.0    1.05     .42  3.00  89.76  .85     .000
     [I%=80.0:S%= 2.00]
*
  *  CALIB STANDHYD     0303  1  5.0    1.38     .52  3.00  83.59  .79     .000
     [I%=72.0:S%= 2.00]
*
  *  CALIB STANDHYD     0302  1  5.0    1.68     .61  3.00  81.27  .77     .000
     [I%=69.0:S%= 2.00]
*
  *  CALIB STANDHYD     0301  1  5.0    1.01     .42  3.00  93.62  .88     .000
     [I%=85.0:S%= 2.00]
*
  *  CALIB STANDHYD     0403  1  5.0    1.70     .67  3.00  88.99  .84     .000
     [I%=79.0:S%= 2.00]
*
  *  CALIB STANDHYD     0402  1  5.0    2.15     .86  3.00  89.76  .85     .000
     [I%=80.0:S%= 2.00]
*
  *  CALIB STANDHYD     0401  1  5.0    1.21     .51  3.00  95.16  .90     .000
     [I%=87.0:S%= 2.00]
*
     RESRVR [ 2 : 0203] 0209  1  5.0    1.38     .37  3.00  80.49  n/a     .000
     {ST=   .03 ha.m }
*
     RESRVR [ 2 : 0202] 0210  1  5.0    1.67     .44  3.00  78.49  n/a     .000
     {ST=   .03 ha.m }
*
     RESRVR [ 2 : 0201] 0211  1  5.0    1.06     .29  3.00  89.75  n/a     .000
     {ST=   .03 ha.m }
*
     RESRVR [ 2 : 0303] 0309  1  5.0    1.38     .37  3.00  83.58  n/a     .000
     {ST=   .03 ha.m }
*
     RESRVR [ 2 : 0302] 0310  1  5.0    1.68     .44  3.00  81.26  n/a     .000
```

```
      {ST=   .03 ha.m }
*
      RESRVR [ 2 : 0301] 0311  1  5.0    1.01     .29  3.00  93.61  n/a    .000
      {ST=   .03 ha.m }
*
      RESRVR [ 2 : 0403] 0409  1  5.0    1.70     .37  3.08  88.98  n/a    .000
      {ST=   .05 ha.m }
*
      RESRVR [ 2 : 0402] 0410  1  5.0    2.15     .44  3.08  89.75  n/a    .000
      {ST=   .07 ha.m }
*
      RESRVR [ 2 : 0401] 0411  1  5.0    1.21     .28  3.08  95.14  n/a    .000
      {ST=   .04 ha.m }
*
 FINISH

===========================================================================================================
```

APPENDIX C:

STORM SEWER DESIGN SHEETS

CITY OF BARRIE

PRELIMINARY STORM SEWER DESIGN SHEET - 5 YEAR STORM

CCTA Project No.: 415375

BAYVIEW DR AND BIG BAY POINT RD EA
EXISTING BIG BAY POINT RD SEWER

red = user input

Area ID#	Maintenance Hole		Length (m)	Increment			Total CA	Flow Time (min)		I (mm/hr)	Total Q (cms)	S (%)	Nominal DIA (mm)	Actual DIA (mm)	Q Full (cms)	V Full (m/s)	Percent Capacity (%)
	From	To		C	A	CA		To	In								
Ex. Pipe 1	EX. STM MH #1	EX. STM MH #2	29.0	0.53	1.51	0.81	0.81	10.00	0.17	108	0.241	1.2	750	762	1.272	2.8	19%
Ex. Pipe 2	EX. STM MH #2	EX. STM MH #3	66.0	0.53	0.10	0.05	0.86	10.17	0.28	106	0.254	2.4	750	762	1.814	4.0	14%
Ex. Pipe 3	EX. STM MH #3	EX. STM MH#6	85.0	0.53	0.23	0.12	0.98	10.45	0.81	102	0.279	0.4	858	871.728	1.601	1.7	17%
Ex. Pipe 4	EX. STM MH#4	EX. STM MH#5	95.3	0.53	0.24	0.13	0.13	10.00	1.10	103	0.037	0.6	450	457.2	0.236	1.4	16%
Ex. Pipe 5	EX. STM MH#5	EX. STM MH#6	96.5	0.53	0.29	0.15	0.28	11.10	1.12	98	0.076	0.3	750	762	0.657	1.4	12%
Ex. Pipe 6	EX. STM MH#6	EX. STM MH#7	17.5	0.16	4.14	0.67	1.93	12.22	0.11	97	0.522	0.6	1200	1219.2	3.151	2.7	17%
Ex. Pipe 7	EX. STM MH#7	EX. STM MH#8	8.5	0.10	0.00	0.00	1.93	12.33	0.01	97	0.522	16.5	1350	1371.6	22.618	15.3	2%
Ex. Pipe 8	EX. STM MH#8	EX. STM MH#9	155.0	0.10	0.00	0.00	1.93	12.34	0.77	94	0.505	0.8	1350	1371.6	4.980	3.4	10%
Ex. Pipe 9	EX. STM MH#9	Ex. Huronia North Park Outlet	5.0	0.10	0.00	0.00	1.93	13.10	0.03	94	0.504	0.5	1350	1371.6	3.937	2.7	13%

$I = A/(t_d + B)^c$

A = 853.608

B = 4.699

C= 0.766

t_d = Storm Duration (mins)

Q = (C*I*A)/360 (cms)

C: Runoff Coefficient

I: Rainfall Intensity (mm/hr)

A: Area (ha)

Date: 17-Oct-16

Calculated By: NHF

Checked By: NM

Table 3.1: Barrie WPCC IDF Curve Parameters - Adjusted to Account for Climate Change

Parameter	Return Period					
	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
A	678.085	**853.608**	975.865	1146.275	1236.152	1426.408
B	4.699	**4.699**	4.699	4.922	4.699	5.273
C	0.781	**0.766**	0.76	0.757	0.751	0.759

CITY OF BARRIE

PRELIMINARY STORM SEWER DESIGN SHEET - 5 YEAR STORM

CCTA Project No.: 415375

BAYVIEW DR AND BIG BAY POINT RD EA
PROPOSED BIG BAY POINT RD SEWER
ALTERNATIVE 2 - 7 LANE CONFIGURATION

red = user input

Area ID#	Maintenance Hole		Length (m)	Increment			Total CA	Flow Time (min)		I (mm/hr)	Total Q (cms)	S (%)	Nominal DIA (mm)	Actual DIA (mm)	Q Full (cms)	V Full (m/s)	Percent Capacity (%)
	From	To		C	A	CA		To	In								
Pipe 29	MH #24	MH #25	40.0	0.82	0.16	0.13	0.13	10.00	0.33	107	0.040	2.2	300	304.8	0.148	2.0	27%
Pipe 30	MH #25	MH #26	40.0	0.82	0.16	0.13	0.27	10.33	0.33	105	0.078	2.2	300	304.8	0.148	2.0	53%
Pipe 31	MH #26	MH #27	40.0	0.82	0.16	0.13	0.40	10.66	0.33	104	0.116	2.2	300	304.8	0.148	2.0	78%
Pipe 32	MH #27	MH #28	40.0	0.82	0.16	0.13	0.54	10.99	0.28	102	0.152	2.2	375	381	0.268	2.4	57%
Pipe 33	MH #28	MH #29	40.0	0.82	0.16	0.13	0.67	11.27	0.28	101	0.188	2.2	375	381	0.268	2.4	70%
Pipe 34	MH #29	MH #30	40.0	0.82	0.16	0.13	0.80	11.55	0.28	100	0.222	2.2	375	381	0.268	2.4	83%
Pipe 35	MH #30	MH #31	40.0	0.82	0.16	0.13	0.94	11.84	0.28	98	0.256	2.2	375	381	0.268	2.4	95%
Pipe 36	MH #31	MH #32	40.0	0.82	0.16	0.13	1.07	12.12	0.25	97	0.289	2.2	450	457.2	0.436	2.7	66%
Pipe 37	MH #32	MH #33	40.0	0.82	0.16	0.13	1.21	12.37	0.25	96	0.322	2.2	450	457.2	0.436	2.7	74%
Pipe 38	MH #33	STC#1	40.0	0.82	0.16	0.13	1.34	12.62	0.25	95	0.353	2.2	450	457.2	0.436	2.7	81%
Pipe 39	MH #34	MH #35	45.0	0.82	0.18	0.15	0.15	10.00	0.37	107	0.045	2.2	300	304.8	0.148	2.0	30%
Pipe 40	MH #35	MH #36	40.0	0.82	0.16	0.13	0.28	10.37	0.33	105	0.083	2.2	300	304.8	0.148	2.0	56%
Pipe 41	MH #36	MH #37	40.0	0.82	0.16	0.13	0.42	10.70	0.33	103	0.120	2.2	300	304.8	0.148	2.0	81%
Pipe 42	MH #37	MH #38	40.0	0.82	0.16	0.13	0.55	11.03	0.28	102	0.157	2.2	375	381	0.268	2.4	58%
Pipe 43	MH #38	MH #39	40.0	0.82	0.16	0.13	0.69	11.31	0.28	101	0.192	2.2	375	381	0.268	2.4	72%
Pipe 44	MH #39	MH #40	40.0	0.82	0.16	0.13	0.82	11.59	0.28	99	0.226	2.2	375	381	0.268	2.4	84%
Pipe 45	MH #40	MH #41	40.0	0.82	0.16	0.13	0.95	11.88	0.28	98	0.260	2.2	375	381	0.268	2.4	97%
Pipe 46	MH #41	MH #42	40.0	0.82	0.16	0.13	1.09	12.16	0.25	97	0.293	2.2	450	457.2	0.436	2.7	67%
Pipe 47	MH #42	STC#1	40.0	0.82	0.16	0.13	1.22	12.41	0.25	96	0.325	2.2	450	457.2	0.436	2.7	75%
Pipe 48	STC#1	Ellis Natural Area Outlet	25.0	0.82	0.00	0.00	2.56	12.87	0.13	94	0.672	2.2	600	609.6	0.939	3.2	72%
Pipe 49	MH #43	MH #44	50.0	0.83	0.22	0.18	0.18	10.00	0.41	107	0.054	2.2	300	304.8	0.148	2.0	37%
Pipe 50	MH #44	MH #45	50.0	0.83	0.22	0.18	0.37	10.41	0.41	104	0.106	2.2	300	304.8	0.148	2.0	72%
Pipe 51	MH #45	MH #46	50.0	0.83	0.22	0.18	0.55	10.82	0.35	103	0.157	2.2	375	381	0.268	2.4	58%
Pipe 52	MH #46	MH #47	50.0	0.83	0.22	0.18	0.73	11.18	0.35	101	0.205	2.2	375	381	0.268	2.4	77%
Pipe 53	MH #47	MH #48	50.0	0.83	0.22	0.18	0.91	11.53	0.35	99	0.252	2.2	375	381	0.268	2.4	94%
Pipe 54	MH #48	MH #49	50.0	0.83	0.22	0.18	1.10	11.88	0.31	98	0.298	2.2	450	457.2	0.436	2.7	68%
Pipe 55	MH #49	MH #50	50.0	0.83	0.22	0.18	1.28	12.20	0.31	97	0.343	2.2	450	457.2	0.436	2.7	79%
Pipe 56	MH #50	STC #2	50.0	0.83	0.22	0.18	1.46	12.51	0.31	95	0.387	2.2	450	457.2	0.436	2.7	89%
Pipe 57	STC #2	EX. STM MH #1	50.0	0.83	0.22	0.18	1.65	12.83	0.31	94	0.429	2.2	450	457.2	0.436	2.7	98%
Ex. Pipe 1	EX. STM MH #1	EX. STM MH #2	29.0	0.83	0.22	0.18	1.83	13.14	0.17	93	0.474	1.2	750	762	1.272	2.8	37%
Ex. Pipe 2	EX. STM MH #2	EX. STM MH #3	66.0	0.83	0.10	0.08	1.91	13.31	0.28	92	0.490	2.4	750	762	1.814	4.0	27%
Ex. Pipe 3	EX. STM MH #3	EX. STM MH#6	85.0	0.83	0.23	0.19	2.11	13.59	0.81	89	0.521	0.4	858	871.728	1.601	1.7	33%
Ex. Pipe 4	EX. STM MH#4	EX. STM MH#5	95.3	0.83	0.24	0.20	0.20	10.00	1.10	103	0.057	0.6	450	457.2	0.236	1.4	24%
Ex. Pipe 5	EX. STM MH#5	EX. STM MH#6	96.5	0.83	0.29	0.24	0.44	11.10	1.12	98	0.119	0.3	750	762	0.657	1.4	18%
Ex. Pipe 6	EX. STM MH#6	EX. STM MH#7	17.5	0.20	4.14	0.84	3.39	14.40	0.11	89	0.836	0.6	1200	1219.2	3.151	2.7	27%
Ex. Pipe 7	EX. STM MH#7	EX. STM MH#8	8.5	0.10	0.00	0.00	3.39	14.51	0.05	89	0.834	0.6	1350	1371.6	4.313	2.9	19%
Ex. Pipe 8	EX. STM MH#8	EX. STM MH#9	155.0	0.10	0.00	0.00	3.39	14.56	0.77	86	0.809	0.8	1350	1371.6	4.980	3.4	16%
Ex. Pipe 9	EX. STM MH#9	Ex. Huronia North Park Outlet	5.0	0.10	0.00	0.00	3.39	15.33	0.03	86	0.808	0.5	1350	1371.6	3.937	2.7	21%

$I = A/(t_d + B)^c$
A = 853.608
B = 4.699
C= 0.766

Q = (C*I*A)/360 (cms)
C: Runoff Coefficient
I: Rainfall Intensity (mm/hr)
A: Area (ha)

Date: 17-Oct-16
Calculated By: NHF
Checked By: NM

Table 3.1: Barrie WPCC IDF Curve Parameters - Adjusted to Account for Climate Change

Parameter	Return Period					
	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
A	678.085	**853.608**	975.865	1146.275	1236.152	1426.408
B	4.699	**4.699**	4.699	4.922	4.699	5.273
C	0.781	**0.766**	0.76	0.757	0.751	0.759

ALTERNATIVE 2 - 7 LANE CONFIGURATION

C-305		C-307	
Total Area	31112.5	Total Area	19780.6
Impervious Area	26469.6	Impervious Area	17039
Pervious Area	4642.9	Pervious Area	2741.6
RC =	0.82	RC =	0.83

Note: RC Land use = (Impervious Area *.95 + Pervious Area *.1) / Total Area

CITY OF BARRIE

PRELIMINARY STORM SEWER DESIGN SHEET - 5 YEAR STORM

CCTA Project No.: 415375

BAYVIEW DR AND BIG BAY POINT RD EA
PROPOSED BIG BAY POINT RD SEWER
ALTERNATIVE 3 - 5 LANE CONFIGURATION

red = user input

Area ID#	Maintenance Hole		Length (m)	Increment			Total CA	Flow Time (min)		I (mm/hr)	Total Q (cms)	S (%)	Nominal DIA (mm)	Actual DIA (mm)	Q Full (cms)	V Full (m/s)	Percent Capacity (%)
	From	To		C	A	CA		To	In								
Pipe 29	MH #24	MH #25	40.0	0.79	0.15	0.12	0.12	10.00	0.33	107	0.035	2.2	300	304.8	0.148	2.0	24%
Pipe 30	MH #25	MH #26	40.0	0.79	0.15	0.12	0.24	10.33	0.33	105	0.070	2.2	300	304.8	0.148	2.0	47%
Pipe 31	MH #26	MH #27	40.0	0.79	0.15	0.12	0.36	10.66	0.33	104	0.103	2.2	300	304.8	0.148	2.0	70%
Pipe 32	MH #27	MH #28	40.0	0.79	0.15	0.12	0.48	10.99	0.33	102	0.135	2.2	300	304.8	0.148	2.0	91%
Pipe 33	MH #28	MH #29	40.0	0.79	0.15	0.12	0.60	11.32	0.28	101	0.166	2.2	375	381	0.268	2.4	62%
Pipe 34	MH #29	MH #30	40.0	0.79	0.15	0.12	0.71	11.60	0.28	99	0.197	2.2	375	381	0.268	2.4	73%
Pipe 35	MH #30	MH #31	40.0	0.79	0.15	0.12	0.83	11.88	0.28	98	0.227	2.2	375	381	0.268	2.4	85%
Pipe 36	MH #31	MH #32	40.0	0.79	0.15	0.12	0.95	12.17	0.28	97	0.256	2.2	375	381	0.268	2.4	96%
Pipe 37	MH #32	MH #33	40.0	0.79	0.15	0.12	1.07	12.45	0.25	96	0.285	2.2	450	457.2	0.436	2.7	65%
Pipe 38	MH #33	STC#1	40.0	0.79	0.15	0.12	1.19	12.70	0.25	95	0.313	2.2	450	457.2	0.436	2.7	72%
Pipe 39	MH #34	MH #35	45.0	0.79	0.17	0.13	0.13	10.00	0.37	107	0.040	2.2	300	304.8	0.148	2.0	27%
Pipe 40	MH #35	MH #36	40.0	0.79	0.15	0.12	0.25	10.37	0.33	105	0.074	2.2	300	304.8	0.148	2.0	50%
Pipe 41	MH #36	MH #37	40.0	0.79	0.15	0.12	0.37	10.70	0.33	103	0.107	2.2	300	304.8	0.148	2.0	72%
Pipe 42	MH #37	MH #38	40.0	0.79	0.15	0.12	0.49	11.03	0.33	102	0.139	2.2	300	304.8	0.148	2.0	94%
Pipe 43	MH #38	MH #39	40.0	0.79	0.15	0.12	0.61	11.36	0.28	100	0.170	2.2	375	381	0.268	2.4	63%
Pipe 44	MH #39	MH #40	40.0	0.79	0.15	0.12	0.73	11.64	0.28	99	0.201	2.2	375	381	0.268	2.4	75%
Pipe 45	MH #40	MH #41	40.0	0.79	0.15	0.12	0.85	11.92	0.28	98	0.231	2.2	375	381	0.268	2.4	86%
Pipe 46	MH #41	MH #42	40.0	0.79	0.15	0.12	0.97	12.21	0.28	97	0.260	2.2	375	381	0.268	2.4	97%
Pipe 47	MH #42	STC#1	40.0	0.79	0.15	0.12	1.09	12.49	0.25	96	0.288	2.2	450	457.2	0.436	2.7	66%
Pipe 48	STC#1	Ellis Natural Area Outlet	25.0	0.79	0.00	0.00	2.28	12.95	0.14	94	0.596	2.2	525	533.4	0.658	2.9	91%
Pipe 49	MH #43	MH #44	50.0	0.76	0.21	0.16	0.16	10.00	0.41	107	0.048	2.2	300	304.8	0.148	2.0	32%
Pipe 50	MH #44	MH #45	50.0	0.76	0.21	0.16	0.32	10.41	0.41	104	0.094	2.2	300	304.8	0.148	2.0	64%
Pipe 51	MH #45	MH #46	50.0	0.76	0.21	0.16	0.49	10.82	0.41	102	0.138	2.2	300	304.8	0.148	2.0	94%
Pipe 52	MH #46	MH #47	50.0	0.76	0.21	0.16	0.65	11.23	0.35	101	0.181	2.2	375	381	0.268	2.4	68%
Pipe 53	MH #47	MH #48	50.0	0.76	0.21	0.16	0.81	11.59	0.35	99	0.223	2.2	375	381	0.268	2.4	83%
Pipe 54	MH #48	MH #49	50.0	0.76	0.21	0.16	0.97	11.94	0.35	97	0.263	2.2	375	381	0.268	2.4	98%
Pipe 55	MH #49	MH #50	50.0	0.76	0.21	0.16	1.13	12.30	0.31	96	0.303	2.2	450	457.2	0.436	2.7	69%
Pipe 56	MH #50	STC #2	50.0	0.76	0.21	0.16	1.30	12.61	0.31	95	0.341	2.2	450	457.2	0.436	2.7	78%
Pipe 57	STC #2	EX. STM MH #1	50.0	0.76	0.21	0.16	1.46	12.92	0.31	94	0.379	2.2	450	457.2	0.436	2.7	87%
Ex. Pipe 1	EX. STM MH #1	EX. STM MH #2	29.0	0.76	0.21	0.16	1.62	13.24	0.17	93	0.418	1.2	750	762	1.272	2.8	33%
Ex. Pipe 2	EX. STM MH #2	EX. STM MH #3	66.0	0.76	0.10	0.08	1.70	13.41	0.28	92	0.433	2.4	750	762	1.814	4.0	24%
Ex. Pipe 3	EX. STM MH #3	EX. STM MH#6	85.0	0.76	0.23	0.18	1.88	13.69	0.81	89	0.462	0.4	858	871.728	1.601	1.7	29%
Ex. Pipe 4	EX. STM MH#4	EX. STM MH#5	95.3	0.76	0.24	0.18	0.18	10.00	1.10	103	0.053	0.6	450	457.2	0.236	1.4	22%
Ex. Pipe 5	EX. STM MH#5	EX. STM MH#6	96.5	0.76	0.29	0.22	0.40	11.10	1.12	98	0.110	0.3	750	762	0.657	1.4	17%
Ex. Pipe 6	EX. STM MH#6	EX. STM MH#7	17.5	0.19	4.14	0.80	3.08	14.50	0.11	88	0.757	0.6	1200	1219.2	3.151	2.7	24%
Ex. Pipe 7	EX. STM MH#7	EX. STM MH#8	8.5	0.10	0.00	0.00	3.08	14.61	0.05	88	0.755	0.6	1350	1371.6	4.313	2.9	18%
Ex. Pipe 8	EX. STM MH#8	EX. STM MH#9	155.0	0.10	0.00	0.00	3.08	14.66	0.77	86	0.733	0.8	1350	1371.6	4.980	3.4	15%
Ex. Pipe 9	EX. STM MH#9	Ex. Huronia North Park Outlet	5.0	0.10	0.00	0.00	3.08	15.42	0.03	86	0.732	0.5	1350	1371.6	3.937	2.7	19%

$I = A/(t_d + B)^C$ Q = (C*I*A)/360 (cms)
A = 853.608 C: Runoff Coefficient
B = 4.699 I: Rainfall Intensity (mm/hr)
C= 0.766 A: Area (ha)

Date: 17-Oct-16
Calculated By: NHF
Checked By: NM

Table 3.1: Barrie WPCC IDF Curve Parameters - Adjusted to Account for Climate Change

Parameter	Return Period					
	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
A	678.085	**853.608**	975.865	1146.275	1236.152	1426.408
B	4.699	**4.699**	4.699	4.922	4.699	5.273
C	0.781	**0.766**	0.76	0.757	0.751	0.759

ALTERNATIVE 3 - 5 LANE CONFIGURATION

C-305		C-307	
Total Area	28831.3	Total Area	19102
Impervious Area	23400.8	Impervious Area	14917.6
Pervious Area	5430.5	Pervious Area	4184.4
RC =	0.79	RC =	0.76

Note: RC Land use = (Impervious Area *.95 + Pervious Area *.1) / Total Area

CITY OF BARRIE

STORM SEWER DESIGN SHEET - 5 YEAR STORM

CCTA Project No.: 415375

BIG BAY POINT ROAD & BAYVIEW DRIVE EA
PROPOSED BAYVIEW DRIVE STORM SEWER
ALTERNATIVE 2 - 3 LANE CONFIGURATION

red = user input

Area ID#	Maintenance Hole From	Maintenance Hole To	Length (m)	Increment C	Increment A	Increment CA	Total CA	Flow Time (min) To	Flow Time (min) In	I (mm/hr)	Total Q (cms)	S (%)	Nominal DIA (mm)	Actual DIA (mm)	Q Full (cms)	V Full (m/s)	Percent Capacity (%)
Pipe 1	MH #0	MH #1	50.0	0.71	0.16	0.11	0.11	10.00	0.43	107	0.033	2.0	300	304.8	0.143	2.0	23%
Pipe 2	MH #1	MH #2	50.0	0.71	0.16	0.11	0.22	10.43	0.43	104	0.065	2.0	300	304.8	0.143	2.0	45%
Pipe 3	MH #2	MH #3	50.0	0.71	0.16	0.11	0.33	10.85	0.43	102	0.095	2.0	300	304.8	0.143	2.0	67%
Pipe 4	MH #3	STC#3	50.0	0.71	0.16	0.11	0.45	11.28	0.43	100	0.124	2.0	300	304.8	0.143	2.0	87%
Pipe 5	MH #4	MH #5	50.0	0.71	0.16	0.11	0.11	10.00	0.43	107	0.033	2.0	300	304.8	0.143	2.0	23%
Pipe 6	MH #5	MH #6	50.0	0.71	0.16	0.11	0.22	10.43	0.43	104	0.065	2.0	300	304.8	0.143	2.0	45%
Pipe 7	MH #6	MH #7	50.0	0.71	0.16	0.11	0.33	10.85	0.43	102	0.095	2.0	300	304.8	0.143	2.0	67%
Pipe 8	MH #7	MH #8	50.0	0.71	0.16	0.11	0.45	11.28	0.43	100	0.124	2.0	300	304.8	0.143	2.0	87%
Pipe 9	MH #8	STC#3	50.0	0.71	0.16	0.11	0.56	11.70	0.37	98	0.152	2.0	375	381	0.259	2.3	59%
Pipe 10	STC#3	Crossing #2 Outlet	15.0	0.71	0.00	0.00	1.00	12.07	0.10	98	0.273	2.0	450	457.2	0.421	2.6	65%
Pipe 11	MH #9	MH #10	50.0	0.69	0.16	0.11	0.11	10.00	0.43	107	0.032	2.0	300	304.8	0.143	2.0	22%
Pipe 12	MH #10	STC#4	40.0	0.69	0.13	0.09	0.19	10.43	0.34	105	0.056	2.0	300	304.8	0.143	2.0	40%
Pipe 13	MH #11	MH #12	75.0	0.69	0.23	0.16	0.16	10.00	0.64	105	0.047	2.0	300	304.8	0.143	2.0	33%
Pipe 14	MH #12	MH #13	75.0	0.69	0.23	0.16	0.32	10.64	0.64	102	0.092	2.0	300	304.8	0.143	2.0	64%
Pipe 15	MH #13	MH #14	75.0	0.69	0.23	0.16	0.48	11.28	0.64	99	0.133	2.0	300	304.8	0.143	2.0	94%
Pipe 16	MH #14	MH #15	75.0	0.69	0.23	0.16	0.65	11.92	0.55	97	0.174	2.0	375	381	0.259	2.3	67%
Pipe 17	MH #15	MH #16	75.0	0.69	0.23	0.16	0.81	12.47	0.55	94	0.212	2.0	375	381	0.259	2.3	82%
Pipe 18	MH #16	MH #17	50.0	0.69	0.16	0.11	0.92	13.02	0.37	93	0.236	2.0	375	381	0.259	2.3	91%
Pipe 19	MH #17	MH #18	50.0	0.69	0.16	0.11	1.02	13.39	0.33	92	0.260	2.0	450	457.2	0.421	2.6	62%
Pipe 20	MH #18	STC#4	50.0	0.69	0.16	0.11	1.13	13.71	0.33	90	0.284	2.0	450	457.2	0.421	2.6	68%
Pipe 21	STC#4	Crossing #4 Outlet	15.0	0.69	0.00	0.00	1.32	14.04	0.10	90	0.331	2.0	450	457.2	0.421	2.6	79%
Pipe 22	MH #19	MH #20	50.0	0.82	0.16	0.13	0.13	10.00	0.43	107	0.038	2.0	300	304.8	0.143	2.0	27%
Pipe 23	MH #20	MH #21	50.0	0.82	0.16	0.13	0.26	10.43	0.43	104	0.074	2.0	300	304.8	0.143	2.0	52%
Pipe 24	MH #21	MH #22	50.0	0.82	0.16	0.13	0.38	10.85	0.43	102	0.109	2.0	300	304.8	0.143	2.0	77%
Pipe 25	MH #22	MH #23	50.0	0.82	0.16	0.13	0.51	11.28	0.37	100	0.143	2.0	375	381	0.259	2.3	55%
Pipe 26	MH #23	STC#5	50.0	0.82	0.16	0.13	0.64	11.65	0.37	99	0.176	2.0	375	381	0.259	2.3	68%
Pipe 28	STC#5	Crossing #5 Outlet	15.0	0.69	0.00	0.00	0.64	12.01	0.11	98	0.175	2.0	375	381	0.259	2.3	68%

$I = A/(t_d + B)^c$

A = 853.608

B = 4.699

C= 0.766

t_d = Storm Duration (mins)

Q = (C*I*A)/360 (cms)

C: Runoff Coefficient

I: Rainfall Intensity (mm/hr)

A: Area (ha)

Date: 17-Oct-16
Calculated By: NHF
Checked By: NM

Table 3.1: Barrie WPCC IDF Curve Parameters - Adjusted to Account for Climate Change

Parameter	Return Period 2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
A	678.085	**853.608**	975.865	1146.275	1236.152	1426.408
B	4.699	**4.699**	4.699	4.922	4.699	5.273
C	0.781	**0.766**	0.76	0.757	0.751	0.759

ALTERNATIVE 2 - 3 LANE CONFIGURATION

C-303		C-302		C-301	
Total Area	13809	Total Area	16754	Total Area	10640
Impervious Area	9929	Impervious Area	11574	Impervious Area	8992
Pervious Area	3879	Pervious Area	5180	Pervious Area	1648
RC =	0.71	RC =	0.69	RC =	0.82

Note: RC Land use = (Impervious Area *.95 + Pervious Area *.1) / Total Area

CITY OF BARRIE

STORM SEWER DESIGN SHEET - 5 YEAR STORM

CCTA Project No.: 415375

BIG BAY POINT ROAD & BAYVIEW DRIVE EA
PROPOSED BAYVIEW DRIVE STORM SEWER
ALTERNATIVE 3 - 5 LANE CONFIGURATION

red = user input

Area ID#	Maintenance Hole		Length (m)	Increment			Total CA	Flow Time (min)		I (mm/hr)	Total Q (cms)	S (%)	Nominal DIA (mm)	Actual DIA (mm)	Q Full (cms)	V Full (m/s)	Percent Capacity (%)
	From	To		C	A	CA		To	In								
Pipe 1	MH #0	MH #1	50.0	0.78	0.19	0.15	0.15	10.00	0.43	107	0.044	2.0	300	304.8	0.143	2.0	31%
Pipe 2	MH #1	MH #2	50.0	0.78	0.19	0.15	0.29	10.43	0.43	104	0.085	2.0	300	304.8	0.143	2.0	60%
Pipe 3	MH #2	MH #3	50.0	0.78	0.19	0.15	0.44	10.85	0.43	102	0.125	2.0	300	304.8	0.143	2.0	88%
Pipe 4	MH #3	STC#3	50.0	0.78	0.19	0.15	0.59	11.28	0.37	100	0.164	2.0	375	381	0.259	2.3	63%
Pipe 5	MH #4	MH #5	50.0	0.78	0.19	0.15	0.15	10.00	0.43	107	0.044	2.0	300	304.8	0.143	2.0	31%
Pipe 6	MH #5	MH #6	50.0	0.78	0.19	0.15	0.29	10.43	0.43	104	0.085	2.0	300	304.8	0.143	2.0	60%
Pipe 7	MH #6	MH #7	50.0	0.78	0.19	0.15	0.44	10.85	0.43	102	0.125	2.0	300	304.8	0.143	2.0	88%
Pipe 8	MH #7	MH #8	50.0	0.78	0.19	0.15	0.59	11.28	0.37	100	0.164	2.0	375	381	0.259	2.3	63%
Pipe 9	MH #8	STC#3	50.0	0.78	0.19	0.15	0.74	11.65	0.37	99	0.202	2.0	375	381	0.259	2.3	78%
Pipe 10	STC#3	Crossing #2 Outlet	15.0	0.78	0.00	0.00	1.32	12.01	0.10	98	0.361	2.0	450	457.2	0.421	2.6	86%
Pipe 11	MH #9	MH #10	50.0	0.79	0.17	0.14	0.14	10.00	0.43	107	0.041	2.0	300	304.8	0.143	2.0	29%
Pipe 12	MH #10	STC#4	40.0	0.79	0.14	0.11	0.25	10.43	0.34	105	0.072	2.0	300	304.8	0.143	2.0	51%
Pipe 13	MH #11	MH #12	75.0	0.79	0.26	0.21	0.21	10.00	0.64	105	0.061	2.0	300	304.8	0.143	2.0	43%
Pipe 14	MH #12	MH #13	75.0	0.79	0.26	0.21	0.41	10.64	0.64	102	0.118	2.0	300	304.8	0.143	2.0	82%
Pipe 15	MH #13	MH #14	75.0	0.79	0.26	0.21	0.62	11.28	0.55	100	0.172	2.0	375	381	0.259	2.3	66%
Pipe 16	MH #14	MH #15	75.0	0.79	0.26	0.21	0.83	11.83	0.55	97	0.224	2.0	375	381	0.259	2.3	86%
Pipe 17	MH #15	MH #16	75.0	0.79	0.26	0.21	1.04	12.38	0.49	95	0.273	2.0	450	457.2	0.421	2.6	65%
Pipe 18	MH #16	MH #17	50.0	0.79	0.17	0.14	1.17	12.87	0.33	94	0.306	2.0	450	457.2	0.421	2.6	73%
Pipe 19	MH #17	MH #18	50.0	0.79	0.17	0.14	1.31	13.19	0.33	92	0.337	2.0	450	457.2	0.421	2.6	80%
Pipe 20	MH #18	STC#4	50.0	0.79	0.17	0.14	1.45	13.52	0.33	91	0.367	2.0	450	457.2	0.421	2.6	87%
Pipe 21	STC#4	Crossing #4 Outlet	15.0	0.79	0.00	0.00	1.70	13.84	0.09	91	0.429	2.0	525	533.4	0.634	2.8	68%
Pipe 22	MH #19	MH #20	50.0	0.84	0.24	0.20	0.20	10.00	0.43	107	0.060	2.0	300	304.8	0.143	2.0	42%
Pipe 23	MH #20	MH #21	50.0	0.84	0.24	0.20	0.40	10.43	0.43	104	0.117	2.0	300	304.8	0.143	2.0	82%
Pipe 24	MH #21	MH #22	50.0	0.84	0.24	0.20	0.61	10.85	0.37	102	0.173	2.0	375	381	0.259	2.3	67%
Pipe 25	MH #22	MH #23	50.0	0.84	0.24	0.20	0.81	11.22	0.37	101	0.226	2.0	375	381	0.259	2.3	88%
Pipe 26	MH #23	STC#5	50.0	0.84	0.24	0.20	1.01	11.59	0.33	99	0.279	2.0	450	457.2	0.421	2.6	66%
Pipe 28	STC#5	Crossing #5 Outlet	15.0	0.79	0.00	0.00	1.01	11.91	0.10	99	0.278	2.0	450	457.2	0.421	2.6	66%

$I = A/(t_d + B)^c$

A = 853.608

B = 4.699

C= 0.766

t_d = Storm Duration (mins)

Q = (C*I*A)/360 (cms)

C: Runoff Coefficient

I: Rainfall Intensity (mm/hr)

A: Area (ha)

Date: 17-Oct-16

Calculated By: NHF

Checked By: NM

Table 3.1: Barrie WPCC IDF Curve Parameters - Adjusted to Account for Climate Change

Parameter	Return Period					
	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
A	678.085	**853.608**	975.865	1146.275	1236.152	1426.408
B	4.699	**4.699**	4.699	4.922	4.699	5.273
C	0.781	**0.766**	0.76	0.757	0.751	0.759

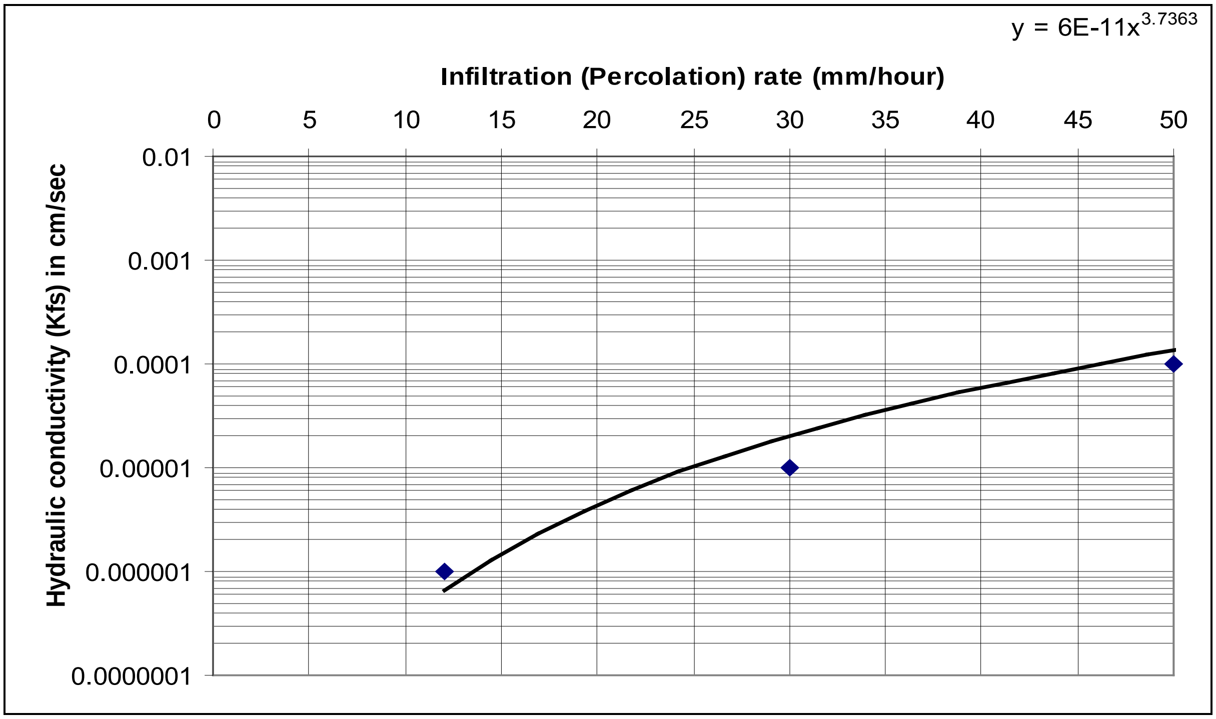
ALTERNATIVE 3 - 5 LANE SCENARIO (MOST CONSTRAINED)

C-403		C-402		C-401	
Total Area	16983.1	Total Area	21514.3	Total Area	12115
Impervious Area	13433.7	Impervious Area	17210.1	Impervious Area	10480.5
Pervious Area	4773.8	Pervious Area	6438.9	Pervious Area	1634.5
RC =	0.78	RC =	0.79	RC =	0.84

Note: RC Land use = (Impervious Area *.95 + Pervious Area *.1) / Total Area

APPENDIX D:
WATER QUANTITY CONTROL DESIGN CALCULATIONS

Figure C1: Approximate relationship between infiltration rate and hydraulic conductivity



Source: Ontario Ministry of Municipal Affairs and Housing (OMMAH). 1997. Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions. Toronto, Ontario.

The measured infiltration rate (in millimetres per hour) at the proposed bottom elevation of the BMP must be divided by a safety correction factor selected from Table C2 to calculate the design infiltration rate. To select a safety correction factor from Table C2, calculate the ratio of the mean (geometric) measured infiltration rate at the proposed bottom elevation of the BMP to the rate in the least permeable soil horizon within 1.5 metres below the bottom of the BMP. Based on this ratio, a safety correction factor is selected from Table C2. For example, where the mean infiltration rate measured at the proposed bottom elevation of the BMP is 30 mm/h, and the mean infiltration rate measured in an underlying soil horizon within 1.5 metres of the bottom is 12 mm/h, the ratio would be 2.5, the safety correction factor would be 3.5, and the design infiltration rate would be 8.6 mm/h. Where the soil horizon is continuous within 1.5 metres below the proposed bottom of the BMP, the mean infiltration rate measured at the bottom elevation of the BMP should be divided by a safety correction factor of 2.5 to calculate the design infiltration rate.

BAYVIEW DRIVE & BIG BAY POINT ROAD EA
CITY OF BARRIE

LSRCA Infiltration Calculations for Linear Developments
Bayview Drive - Alternative 1

12.5mm Storm for *fully reconstructed area*
From VO2:

Catchment	Area ha	Runoff Volume mm	Total Runoff to Infiltrate cu.m
201	1.055	9.238	97
202	1.675	7.591	127
203	1.384	7.883	109

25mm Storm for *net increase in impervious area*
From VO2:

Catchment	Area ha	Runoff Volume mm	Total Runoff to Infiltrate cu.m
201	0.25	23.769	59
202	0.25	23.769	59
203	0.2	23.757	48

** Must Infiltrate the 12.5mm Storm for the fully reconstructed area
Total Volume to Infiltrate = **334 m^3**

Maximum Filter Media Bed Depth Calculation

Assumed Native Soil Hydraulic Conductivity =	0.0001	cm/s	From Fetter 2001, Table 3.7 for Silty Sand
Assumed Infiltration Rate of Native Soils =	45	mm/hr	Per TRCA LID Manual Figure C1
Infiltration Rate with Safety Factor (i) =	18.00	mm/hr	Safety Factor Assumed to be 2.5

Infiltration Rate is less than 15 mm/hr, underdrain required

Void Space Ratio for Aggregate Used (Vr) =	0.4	
Time to Drain (ts) =	48	hr
Max Depth of Stone Reservoir Below Underdrain =	2.16	m

BAYVIEW DRIVE & BIG BAY POINT ROAD EA
CITY OF BARRIE

Bio-Swale Calculation (as per TRCA LID SWM Planning and Design Guide)
Bayview Drive - Alternative 1

Swale Dimensions

Area (m^2)	Bottom Width (m)	Top Width (m)	Depth (m)	Length (m)
0.0825	0.1	1	0.15	806

Available Lengths

E. Side	1190m
W. Side	855m

Infiltration Volume Calculation

void ratio for gravel	0.4
soil	0.25

Stage	Elevation (m)	Depth (m)	Surface Area (m^2/m length)	Volume (m^3/m length)	Volume per Complete System
Gravel	100	0	0.75	0.00	0.0
	100.1	0.1	0.75	0.03	24.2
	100.2	0.2	0.75	0.06	48.4
	100.3	0.3	0.75	0.09	72.5
	100.4	0.4	0.75	0.12	96.7
Pea Gravel	100.5	0.5	0.75	0.15	120.9
	100.6	0.6	0.75	0.17	136.0
	100.7	0.7	0.75	0.19	151.1
	100.8	0.8	0.75	0.21	166.2
Engineered	100.9	0.9	0.75	0.22	181.3
Soil	101	1	0.75	0.24	196.5
	101.1	1.1	0.75	0.26	211.6
	101.2	1.2	0.75	0.28	226.7
	101.3	1.3	0.75	0.30	241.8
	101.4	1.4	0.75	0.32	256.9
	101.5	1.5	0.75	0.34	272.0

Underground Storage Volume Provided **272 m^3**

Ponding Storage Volume Provided **66 m^3**

Total Storage Volume Provided **339 m^3**

BAYVIEW DRIVE & BIG BAY POINT ROAD EA
CITY OF BARRIE

LSRCA Infiltration Calculations for Linear Developments
Big Bay Point Road - Alternative 4

12.5mm Storm for *fully reconstructed area*

From VO2:

Catchment	Area	Runoff Volume	Total Runoff to Infiltrate
	ha	mm	cu.m
505	2.63	9.353	246
507	1.861	9.013	168

25mm Storm for *net increase in impervious area*

From VO2:

Catchment	Area	Runoff Volume	Total Runoff to Infiltrate
	ha	mm	cu.m
505	0.71	23.769	169
507	0.51	23.767	121

** Must Infiltrate the 12.5mm Storm for the fully reconstructed area

Total Volume to Infiltrate = **414 m^3**

Maximum Filter Media Bed Depth Calculation

Assumed Native Soil Hydraulic Conductivity =	0.00001	cm/s	From Fetter 2001, Table 3.7 for Till
Assumed Infiltration Rate of Native Soils =	24	mm/hr	Per TRCA LID Manual Figure C1
Infiltration Rate with Safety Factor (i) =	9.60	mm/hr	Safety Factor Assumed to be 2.5

Infiltration Rate is less than 15 mm/hr, underdrain required

Void Space Ratio for Aggregate Used (Vr) =	0.4	
Time to Drain (ts) =	48	hr
Max Depth of Stone Reservoir Below Underdrain =	1.15	m

BAYVIEW DRIVE & BIG BAY POINT ROAD EA
CITY OF BARRIE

Bio-Swale Calculation (as per TRCA LID SWM Planning and Design Guide)
Big Bay Point Road - Alternative 4

Area (m^2)	Bottom Width (m)	Top Width (m)	Depth (m)	Length (m)
0.12	0	1.2	0.2	730

Available Lengths

N. Side	1060 m
S. Side	1035 m

Infiltration Volume Calculation

void ratio for gravel	0.4
soil	0.25

Stage	Elevation (m)	Depth (m)	Surface Area (m^2/m length)	Volume (m^3/m length)	Volume per Complete System
Gravel	100	0	1.0	0.00	0.0
	100.1	0.1	1.0	0.04	29.2
	100.2	0.2	1.0	0.08	58.4
	100.3	0.3	1.0	0.12	87.6
	100.4	0.4	1.0	0.16	116.8
Pea Gravel	100.5	0.5	1.0	0.20	146.0
	100.6	0.6	1.0	0.22	164.2
	100.7	0.7	1.0	0.25	182.5
	100.8	0.8	1.0	0.27	200.7
Engineered	100.9	0.9	1.0	0.30	219.0
Soil	101	1	1.0	0.32	237.2
	101.1	1.1	1.0	0.35	255.5
	101.2	1.2	1.0	0.37	273.7
	101.3	1.3	1.0	0.40	292.0
	101.4	1.4	1.0	0.42	310.2
	101.5	1.5	1.0	0.45	328.5

Underground Storage Volume Provided **328 m^3**

Ponding Storage Volume Provided **88 m^3**

Total Storage Volume Provided **416 m^3**

Big Bay Point Road and Bayview Drive EA
CCTA PROJECT NO.: 415375

Red Text denotes inlet elevation for existing storm sewer from record drawing.
This value has been used to check system for feasibility.

Bayview Drive - Catchment 201 (South Bayview)

ID	MH #19	MH #20	MH #21	MH #22	MH #23	Orifice #5
T/G	278.53	277.68	276.61	275.19	273.96	273.34
INV	275.98	275.00	274.02	273.04	272.06	271.08
Diameter (m)	1.5	1.5	1.5	1.5	1.5	1.5
Length (m)	-	-	-	-	-	-
Width (m)	-	-	-	-	-	-
Area (sq.m)	1.77	1.77	1.77	1.77	1.77	1.77

Slope = 0.019

ID	Pipe 22	Pipe 23	Pipe 24	Pipe 25	Pipe 26	Pipe 28
Diameter	1.050	1.050	1.050	1.050	1.050	0.375
U/S INV	275.98	275.00	274.02	273.04	272.06	271.08
D/S INV	275.03	274.05	273.07	272.09	271.11	270.85
AVG INV	275.51	274.53	273.55	272.57	271.59	270.96
Length	50	50	50	50	50	15

Type	Orifice 1
Diameter	0.275
Area	0.0593957
INV	271.08
C\	0.63

Elevation (m)	Maintenance Hole/Catchbasin Storage							Elevation (m)	Storm Sewer Storage							TOTAL STORAGE	TOTAL STORAGE
	MH #19 (cu.m)	MH #20 (cu.m)	MH #21 (cu.m)	MH #22 (cu.m)	MH #23 (cu.m)	Orifice #5 (cu.m)	Total (cu.m)		Pipe 22 (cu.m)	Pipe 23 (cu.m)	Pipe 24 (cu.m)	Pipe 25 (cu.m)	Pipe 26 (cu.m)	Pipe 28 (cu.m)	Total (cu.m)	(cu.m)	(ha-m)
273.20	0.00	0.00	0.00	0.28	2.01	3.75	6.04	273.20	0.00	0.00	0.00	25.55	43.30	1.66	68.85	74.89	0.0075
273.30	0.00	0.00	0.00	0.46	2.19	3.92	6.57	273.30	0.00	0.00	0.00	30.65	43.30	1.66	73.95	80.52	0.0081
273.40	0.00	0.00	0.00	0.64	2.37	3.99	7.00	273.40	0.00	0.00	0.00	35.40	43.30	1.66	78.70	85.70	0.0086
273.50	0.00	0.00	0.00	0.81	2.54	3.99	7.35	273.50	0.00	0.00	0.00	39.50	43.30	1.66	82.80	90.15	0.0090
273.60	0.00	0.00	0.00	0.99	2.72	3.99	7.70	273.60	0.00	0.00	0.75	42.55	43.30	1.66	86.60	94.30	0.0094
273.70	0.00	0.00	0.00	1.17	2.90	3.99	8.06	273.70	0.00	0.00	3.80	43.30	43.30	1.66	90.40	98.46	0.0098
273.80	0.00	0.00	0.00	1.34	3.07	3.99	8.41	273.80	0.00	0.00	7.90	43.30	43.30	1.66	94.50	102.91	0.0103
273.90	0.00	0.00	0.00	1.52	3.25	3.99	8.77	273.90	0.00	0.00	12.65	43.30	43.30	1.66	99.25	108.02	0.0108
274.00	0.00	0.00	0.00	1.70	3.36	3.99	9.05	274.00	0.00	0.00	17.75	43.30	43.30	1.66	104.35	113.40	0.0113
274.10	0.00	0.00	0.14	1.87	3.36	3.99	9.37	274.10	0.00	0.00	22.95	43.30	43.30	1.66	109.55	118.92	0.0119
274.20	0.00	0.00	0.32	2.05	3.36	3.99	9.72	274.20	0.00	0.00	28.15	43.30	43.30	1.66	114.75	124.47	0.0124
274.30	0.00	0.00	0.49	2.23	3.36	3.99	10.07	274.30	0.00	0.00	33.10	43.30	43.30	1.66	119.70	129.77	0.0130
274.40	0.00	0.00	0.67	2.40	3.36	3.99	10.43	274.40	0.00	0.00	37.55	43.30	43.30	1.66	124.15	134.58	0.0135
274.50	0.00	0.00	0.85	2.58	3.36	3.99	10.78	274.50	0.00	0.00	41.20	43.30	43.30	1.66	127.80	138.58	0.0139
274.60	0.00	0.00	1.02	2.76	3.36	3.99	11.13	274.60	0.00	0.75	43.30	43.30	43.30	1.66	130.65	141.78	0.0142
274.70	0.00	0.00	1.20	2.93	3.36	3.99	11.49	274.70	0.00	3.80	43.30	43.30	43.30	1.66	133.70	145.19	0.0145
274.80	0.00	0.00	1.38	3.11	3.36	3.99	11.84	274.80	0.00	7.90	43.30	43.30	43.30	1.66	137.80	149.64	0.0150
274.90	0.00	0.00	1.56	3.29	3.36	3.99	12.19	274.90	0.00	12.65	43.30	43.30	43.30	1.66	142.55	154.74	0.0155
275.00	0.00	0.00	1.73	3.46	3.36	3.99	12.55	275.00	0.00	17.75	43.30	43.30	43.30	1.66	147.65	160.20	0.0160
275.10	0.00	0.18	1.91	3.64	3.36	3.99	13.08	275.10	0.00	22.95	43.30	43.30	43.30	1.66	152.85	165.93	0.0166
275.20	0.00	0.35	2.09	3.80	3.36	3.99	13.59	275.20	0.00	28.15	43.30	43.30	43.30	1.66	158.05	171.64	0.0172
275.30	0.00	0.53	2.26	3.80	3.36	3.99	13.94	275.30	0.00	33.10	43.30	43.30	43.30	1.66	163.00	176.94	0.0177
275.40	0.00	0.71	2.44	3.80	3.36	3.99	14.30	275.40	0.00	37.55	43.30	43.30	43.30	1.66	167.45	181.75	0.0182
275.50	0.00	0.88	2.62	3.80	3.36	3.99	14.65	275.50	0.00	41.20	43.30	43.30	43.30	1.66	171.10	185.75	0.0186
275.60	0.00	1.06	2.79	3.80	3.36	3.99	15.00	275.60	0.75	43.30	43.30	43.30	43.30	1.66	173.95	188.95	0.0189
275.70	0.00	1.24	2.97	3.80	3.36	3.99	15.36	275.70	3.80	43.30	43.30	43.30	43.30	1.66	177.00	192.36	0.0192
275.80	0.00	1.41	3.15	3.80	3.36	3.99	15.71	275.80	7.90	43.30	43.30	43.30	43.30	1.66	181.10	196.81	0.0197
275.90	0.00	1.59	3.32	3.80	3.36	3.99	16.06	275.90	12.65	43.30	43.30	43.30	43.30	1.66	185.85	201.91	0.0202
276.00	0.04	1.77	3.50	3.80	3.36	3.99	16.45	276.00	17.75	43.30	43.30	43.30	43.30	1.66	190.95	207.40	0.0207
276.10	0.21	1.94	3.68	3.80	3.36	3.99	16.98	276.10	22.95	43.30	43.30	43.30	43.30	1.66	196.15	213.13	0.0213
276.20	0.39	2.12	3.85	3.80	3.36	3.99	17.51	276.20	28.15	43.30	43.30	43.30	43.30	1.66	201.35	218.86	0.0219
276.30	0.57	2.30	4.03	3.80	3.36	3.99	18.04	276.30	33.10	43.30	43.30	43.30	43.30	1.66	206.30	224.34	0.0224
276.40	0.74	2.47	4.21	3.80	3.36	3.99	18.57	276.40	37.55	43.30	43.30	43.30	43.30	1.66	210.75	229.32	0.0229
276.50	0.92	2.65	4.38	3.80	3.36	3.99	19.10	276.50	41.20	43.30	43.30	43.30	43.30	1.66	214.40	233.50	0.0234
276.60	1.10	2.83	4.56	3.80	3.36	3.99	19.63	276.60	43.30	43.30	43.30	43.30	43.30	1.66	216.50	236.13	0.0236
276.70	1.27	3.00	4.58	3.80	3.36	3.99	20.00	276.70	43.30	43.30	43.30	43.30	43.30	1.66	216.50	236.50	0.0237
276.80	1.45	3.18	4.58	3.80	3.36	3.99	20.36	276.80	43.30	43.30	43.30	43.30	43.30	1.66	216.50	236.86	0.0237
276.90	1.63	3.36	4.58	3.80	3.36	3.99	20.71	276.90	43.30	43.30	43.30	43.30	43.30	1.66	216.50	237.21	0.0237
277.00	1.80	3.53	4.58	3.80	3.36	3.99	21.06	277.00	43.30	43.30	43.30	43.30	43.30	1.66	216.50	237.56	0.0238
277.10	1.98	3.71	4.58	3.80	3.36	3.99	21.42	277.10	43.30	43.30	43.30	43.30	43.30	1.66	216.50	237.92	0.0238
277.20	2.16	3.89	4.58	3.80	3.36	3.99	21.77	277.20	43.30	43.30	43.30	43.30	43.30	1.66	216.50	238.27	0.0238
277.30	2.33	4.06	4.58	3.80	3.36	3.99	22.12	277.30	43.30	43.30	43.30	43.30	43.30	1.66	216.50	238.62	0.0239
277.40	2.51	4.24	4.58	3.80	3.36	3.99	22.48	277.40	43.30	43.30	43.30	43.30	43.30	1.66	216.50	238.98	0.0239
277.50	2.69	4.42	4.58	3.80	3.36	3.99	22.83	277.50	43.30	43.30	43.30	43.30	43.30	1.66	216.50	239.33	0.0239
277.60	2.86	4.59	4.58	3.80	3.36	3.99	23.18	277.60	43.30	43.30	43.30	43.30	43.30	1.66	216.50	239.68	0.0240
277.70	3.04	4.74	4.58	3.80	3.36	3.99	23.50	277.70	43.30	43.30	43.30	43.30	43.30	1.66	216.50	240.00	0.0240
277.80	3.22	4.74	4.58	3.80	3.36	3.99	23.68	277.80	43.30	43.30	43.30	43.30	43.30	1.66	216.50	240.18	0.0240
278.50	4.45	4.74	4.58	3.80	3.36	3.99	24.92	278.50	43.30	43.30	43.30	43.30	43.30	1.66	216.50	241.42	0.0241
278.53	4.51	4.74	4.58	3.80	3.36	3.99	24.97	278.53	43.30	43.30	43.30	43.30	43.30	1.66	216.50	241.47	0.0241

Elevation (m)	Discharge		
	Head 1 (m)	Orifice 1 (cms)	Total (cms)
273.20	1.9825	0.233	0.233
273.30	2.0825	0.239	0.239
273.34	2.1225	0.241	0.241

Big Bay Point Road and Bayview Drive EA
CCTA PROJECT NO.: 415375

Red Text denotes inlet elevation for existing storm sewer from record drawing.
This value has been used to check system for feasibility.

Bayview Drive - Catchment 202 (Mid Bayview)

ID	MH #9	MH #10	MH #11	MH #12	MH #13	MH #14	MH #15	MH #16	MH #17	MH #18	Orifice #4
T/G	271.90	272.30	273.34	272.89	272.46	272.06	271.69	271.03	270.50	270.48	271.45
INV	269.35	266.82	270.79	269.94	269.08	268.23	267.37	266.52	265.94	265.36	264.78
Diameter (m)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Length (m)	-	-	-	-	-	-	-	-	-	-	-
Width (m)	-	-	-	-	-	-	-	-	-	-	-
Area (sq.m)	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77

	Slope = 0.05	Slope = 0.011									
ID	Pipe 11	Pipe 12	Pipe 13	Pipe 14	Pipe 15	Pipe 16	Pipe 17	Pipe 18	Pipe 19	Pipe 20	Pipe 21
Diameter	1.050	1.050	1.050	1.050	1.050	1.050	1.050	1.050	1.050	1.050	0.675
U/S INV	269.35	266.82	270.79	269.94	269.08	268.23	267.37	266.52	265.94	265.36	264.78
D/S INV	266.85	264.82	269.97	269.11	268.26	267.40	266.55	265.97	265.39	264.81	264.30
AVG INV	268.10	265.82	270.38	269.52	268.67	267.81	266.96	266.24	265.66	265.08	264.54
Length	50	40	75	75	75	75	75	50	50	50	15

Type	Orifice #4
Diameter	0.250
Area	0.0490874
INV	264.78
C\	0.63

Elevation (m)	Maintenance Hole/Catchbasin Storage											
	MH #9 (cu.m)	MH #10 (cu.m)	MH #11 (cu.m)	MH #12 (cu.m)	MH #13 (cu.m)	MH #14 (cu.m)	MH #15 (cu.m)	MH #16 (cu.m)	MH #17 (cu.m)	MH #18 (cu.m)	Orifice #4 (cu.m)	Total (cu.m)
268.00	0.00	2.09	0.00	0.00	0.00	0.00	1.11	2.62	3.65	4.67	5.70	19.85
268.10	0.00	2.26	0.00	0.00	0.00	0.00	1.29	2.80	3.83	4.85	5.88	20.91
268.20	0.00	2.44	0.00	0.00	0.00	0.00	1.47	2.98	4.00	5.03	6.05	21.97
268.30	0.00	2.62	0.00	0.00	0.00	0.13	1.64	3.15	4.18	5.20	6.23	23.16
268.40	0.00	2.79	0.00	0.00	0.00	0.31	1.82	3.33	4.36	5.38	6.41	24.40
268.50	0.00	2.97	0.00	0.00	0.00	0.49	2.00	3.51	4.53	5.56	6.58	25.63
268.60	0.00	3.15	0.00	0.00	0.00	0.66	2.17	3.68	4.71	5.73	6.76	26.87
268.70	0.00	3.32	0.00	0.00	0.00	0.84	2.35	3.86	4.89	5.91	6.94	28.11
268.80	0.00	3.50	0.00	0.00	0.00	1.02	2.53	4.04	5.06	6.09	7.11	29.34
268.90	0.00	3.68	0.00	0.00	0.00	1.19	2.70	4.21	5.24	6.26	7.29	30.58
269.00	0.00	3.85	0.00	0.00	0.00	1.37	2.88	4.39	5.42	6.44	7.47	31.82
269.10	0.00	4.03	0.00	0.00	0.04	1.55	3.06	4.57	5.59	6.62	7.64	33.09
269.20	0.00	4.21	0.00	0.00	0.21	1.72	3.23	4.74	5.77	6.79	7.82	34.50
269.30	0.00	4.38	0.00	0.00	0.39	1.90	3.41	4.92	5.95	6.97	8.00	35.92
269.40	0.09	4.56	0.00	0.00	0.57	2.08	3.59	5.10	6.12	7.15	8.17	37.42
269.50	0.27	4.74	0.00	0.00	0.74	2.25	3.76	5.27	6.30	7.32	8.35	39.01
269.60	0.44	4.91	0.00	0.00	0.92	2.43	3.94	5.45	6.48	7.50	8.53	40.60
269.70	0.62	5.09	0.00	0.00	1.10	2.61	4.12	5.63	6.65	7.68	8.70	42.19
269.80	0.80	5.27	0.00	0.00	1.27	2.78	4.29	5.81	6.83	7.85	8.88	43.78
269.90	0.97	5.44	0.00	0.00	1.45	2.96	4.47	5.98	7.01	8.03	9.06	45.37
270.00	1.15	5.62	0.00	0.11	1.63	3.14	4.65	6.16	7.18	8.21	9.23	47.08
270.10	1.33	5.80	0.00	0.29	1.80	3.31	4.82	6.34	7.36	8.39	9.41	48.84
270.20	1.50	5.97	0.00	0.47	1.98	3.49	5.00	6.51	7.54	8.56	9.59	50.61
270.30	1.68	6.15	0.00	0.65	2.16	3.67	5.18	6.69	7.71	8.74	9.76	52.38
270.40	1.86	6.33	0.00	0.82	2.33	3.84	5.35	6.87	7.89	8.92	9.94	54.15
270.50	2.03	6.50	0.00	1.00	2.51	4.02	5.53	7.04	8.07	9.06	10.12	55.88
270.60	2.21	6.68	0.00	1.18	2.69	4.20	5.71	7.22	8.07	9.06	10.29	57.29
270.70	2.39	6.86	0.00	1.35	2.86	4.37	5.88	7.40	8.07	9.06	10.47	58.70
270.80	2.56	7.03	0.02	1.53	3.04	4.55	6.06	7.57	8.07	9.06	10.65	60.14
270.90	2.74	7.21	0.19	1.71	3.22	4.73	6.24	7.75	8.07	9.06	10.82	61.73
271.00	2.92	7.39	0.37	1.88	3.39	4.90	6.41	7.93	8.07	9.06	11.00	63.32
271.10	3.09	7.56	0.55	2.06	3.57	5.08	6.59	7.98	8.07	9.06	11.18	64.78
271.20	3.27	7.74	0.72	2.24	3.75	5.26	6.77	7.98	8.07	9.06	11.35	66.20
271.30	3.45	7.92	0.90	2.41	3.92	5.43	6.94	7.98	8.07	9.06	11.53	67.61
271.40	3.62	8.09	1.08	2.59	4.10	5.61	7.12	7.98	8.07	9.06	11.71	69.02
271.50	3.80	8.27	1.25	2.77	4.28	5.79	7.30	7.98	8.07	9.06	11.80	70.35
271.60	3.98	8.45	1.43	2.94	4.45	5.96	7.48	7.98	8.07	9.06	11.80	71.59
271.70	4.15	8.62	1.61	3.12	4.63	6.14	7.63	7.98	8.07	9.06	11.80	72.81
271.80	4.33	8.80	1.78	3.30	4.81	6.32	7.63	7.98	8.07	9.06	11.80	73.87
271.90	4.51	8.98	1.96	3.47	4.98	6.49	7.63	7.98	8.07	9.06	11.80	74.93
272.00	4.51	9.15	2.14	3.65	5.16	6.67	7.63	7.98	8.07	9.06	11.80	75.81
272.10	4.51	9.33	2.31	3.83	5.34	6.78	7.63	7.98	8.07	9.06	11.80	76.62
272.20	4.51	9.51	2.49	4.00	5.51	6.78	7.63	7.98	8.07	9.06	11.80	77.33
272.30	4.51	9.68	2.67	4.18	5.69	6.78	7.63	7.98	8.07	9.06	11.80	78.04
272.40	4.51	9.68	2.85	4.36	5.87	6.78	7.63	7.98	8.07	9.06	11.80	78.57
272.50	4.51	9.68	3.02	4.53	5.97	6.78	7.63	7.98	8.07	9.06	11.80	79.03
272.60	4.51	9.68	3.20	4.71	5.97	6.78	7.63	7.98	8.07	9.06	11.80	79.38
272.70	4.51	9.68	3.38	4.89	5.97	6.78	7.63	7.98	8.07	9.06	11.80	79.73
272.80	4.51	9.68	3.55	5.06	5.97	6.78	7.63	7.98	8.07	9.06	11.80	80.09
272.90	4.51	9.68	3.73	5.22	5.97	6.78	7.63	7.98	8.07	9.06	11.80	80.42
273.00	4.51	9.68	3.91	5.22	5.97	6.78	7.63	7.98	8.07	9.06	11.80	80.60
273.10	4.51	9.68	4.08	5.22	5.97	6.78	7.63	7.98	8.07	9.06	11.80	80.78
273.20	4.51	9.68	4.26	5.22	5.97	6.78	7.63	7.98	8.07	9.06	11.80	80.95
273.30	4.51	9.68	4.44	5.22	5.97	6.78	7.63	7.98	8.07	9.06	11.80	81.13
273.34	4.51	9.68	4.51	5.22	5.97	6.78	7.63	7.98	8.07	9.06	11.80	81.20

Elevation (m)	Storm Sewer Storage												TOTAL STORAGE	TOTAL STORAGE
	Pipe 11 (cu.m)	Pipe 12 (cu.m)	Pipe 13 (cu.m)	Pipe 14 (cu.m)	Pipe 15 (cu.m)	Pipe 16 (cu.m)	Pipe 17 (cu.m)	Pipe 18 (cu.m)	Pipe 19 (cu.m)	Pipe 20 (cu.m)	Pipe 21 (cu.m)	Total (cu.m)	(cu.m)	(ha-m)
268.00	0.00	34.64	0.00	0.00	0.00	5.70	63.83	43.30	43.30	43.30	5.37	234.07	253.91	0.0254
268.10	0.00	34.64	0.00	0.00	0.00	11.85	64.95	43.30	43.30	43.30	5.37	241.34	262.25	0.0262
268.20	2.10	34.64	0.00	0.00	0.00	18.98	64.95	43.30	43.30	43.30	5.37	250.57	272.53	0.0273
268.30	5.75	34.64	0.00	0.00	0.00	26.63	64.95	43.30	43.30	43.30	5.37	261.87	285.02	0.0285
268.40	10.20	34.64	0.00	0.00	0.00	34.43	64.95	43.30	43.30	43.30	5.37	274.12	298.51	0.0299
268.50	15.15	34.64	0.00	0.00	0.00	42.23	64.95	43.30	43.30	43.30	5.37	286.87	312.50	0.0312
268.60	20.35	34.64	0.00	0.00	0.00	49.65	64.95	43.30	43.30	43.30	5.37	299.49	326.36	0.0326
268.70	25.55	34.64	0.00	0.00	0.00	56.33	64.95	43.30	43.30	43.30	5.37	311.37	339.47	0.0339
268.80	30.65	34.64	0.00	0.00	3.15	61.80	64.95	43.30	43.30	43.30	5.37	325.09	354.43	0.0354
268.90	35.40	34.64	0.00	0.00	8.63	64.95	64.95	43.30	43.30	43.30	5.37	338.47	369.05	0.0369
269.00	39.50	34.64	0.00	0.00	15.30	64.95	64.95	43.30	43.30	43.30	5.37	349.24	381.06	0.0381
269.10	42.55	34.64	0.00	0.00	22.73	64.95	64.95	43.30	43.30	43.30	5.37	359.72	392.80	0.0393
269.20	43.30	34.64	0.00	0.00	30.53	64.95	64.95	43.30	43.30	43.30	5.37	368.27	402.77	0.0403
269.30	43.30	34.64	0.00	0.00	38.33	64.95	64.95	43.30	43.30	43.30	5.37	376.07	411.98	0.0412
269.40	43.30	34.64	0.00	0.00	45.98	64.95	64.95	43.30	43.30	43.30	5.37	383.72	421.13	0.0421
269.50	43.30	34.64	0.00	0.00	53.10	64.95	64.95	43.30	43.30	43.30	5.37	390.84	429.85	0.0430
269.60	43.30	34.64	0.00	1.13	59.25	64.95	64.95	43.30	43.30	43.30	5.37	398.12	438.72	0.0439
269.70	43.30	34.64	0.00	5.70	63.83	64.95	64.95	43.30	43.30	43.30	5.37	407.27	449.46	0.0449
269.80	43.30	34.64	0.00	11.85	64.95	64.95	64.95	43.30	43.30	43.30	5.37	414.54	458.32	0.0458
269.90	43.30	34.64	0.00	18.98	64.95	64.95	64.95	43.30	43.30	43.30	5.37	421.67	467.04	0.0467
270.00	43.30	34.64	0.00	26.63	64.95	64.95	64.95	43.30	43.30	43.30	5.37	429.32	476.39	0.0476
270.10	43.30	34.64	0.00	34.43	64.95	64.95	64.95	43.30	43.30	43.30	5.37	437.12	485.96	0.0486
270.20	43.30	34.64	0.00	42.23	64.95	64.95	64.95	43.30	43.30	43.30	5.37	444.92	495.53	0.0496
270.30	43.30	34.64	0.00	49.65	64.95	64.95	64.95	43.30	43.30	43.30	5.37	452.34	504.72	0.0505
270.40	43.30	34.64	0.00	56.33	64.95	64.95	64.95	43.30	43.30	43.30	5.37	459.02	513.16	0.0513
270.50	43.30	34.64	3.15	61.80	64.95	64.95	64.95	43.30	43.30	43.30	5.37	467.64	523.52	0.0524
270.60	43.30	34.64	8.63	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	476.27	533.56	0.0534
270.70	43.30	34.64	15.30	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	482.94	541.64	0.0542
270.80	43.30	34.64	22.73	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	490.37	550.50	0.0551
270.90	43.30	34.64	30.53	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	498.17	559.89	0.0560
271.00	43.30	34.64	38.33	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	505.97	569.28	0.0569
271.10	43.30	34.64	45.98	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	513.62	578.40	0.0578
271.20	43.30	34.64	53.10	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	520.74	586.94	0.0587
271.30	43.30	34.64	59.25	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	526.89	594.50	0.0595
271.40	43.30	34.64	63.83	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	531.47	600.49	0.0600
271.50	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	602.94	0.0603
271.60	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	604.18	0.0604
271.70	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	605.40	0.0605
271.80	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	606.46	0.0606
271.90	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	607.52	0.0608
272.00	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	608.40	0.0608
272.10	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	609.21	0.0609
272.20	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	609.92	0.0610
272.30	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	610.63	0.0611
272.40	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	611.16	0.0611
272.50	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	611.62	0.0612
272.60	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	611.97	0.0612
272.70	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	612.32	0.0612
272.80	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	612.68	0.0613
272.90	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	613.01	0.0613
273.00	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	613.19	0.0613
273.10	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	613.37	0.0613
273.20	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	613.54	0.0614
273.30	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	613.72	0.0614
273.34	43.30	34.64	64.95	64.95	64.95	64.95	64.95	43.30	43.30	43.30	5.37	532.59	613.79	0.0614

Elevation (m)	Discharge		
	Head 1 (m)	Orifice #4 (cms)	Total (cms)
268.00	3.1000	0.241	0.241
268.10	3.2000	0.245	0.245
268.20	3.3000	0.249	0.249
268.30	3.4000	0.253	0.253
268.40	3.5000	0.256	0.256
268.50	3.6000	0.260	0.260
268.60	3.7000	0.263	0.263
268.70	3.8000	0.267	0.267
268.80	3.9000	0.271	0.271
268.90	4.0000	0.274	0.274
269.00	4.1000	0.277	0.277
269.10	4.2000	0.281	0.281
269.20	4.3000	0.284	0.284
269.30	4.4000	0.287	0.287
269.40	4.5000	0.291	0.291
269.50	4.6000	0.294	0.294
269.60	4.7000	0.297	0.297
269.70	4.8000	0.300	0.300
269.80	4.9000	0.303	0.303
269.90	5.0000	0.306	0.306
270.00	5.1000	0.309	0.309
270.10	5.2000	0.312	0.312
270.20	5.3000	0.315	0.315
270.30	5.4000	0.318	0.318
270.40	5.5000	0.321	0.321
270.50	5.6000	0.324	0.324
270.60	5.7000	0.327	0.327
270.70	5.8000	0.330	0.330
270.80	5.9000	0.333	0.333
270.90	6.0000	0.336	0.336
271.00	6.1000	0.338	0.338
271.10	6.2000	0.341	0.341
271.20	6.3000	0.344	0.344
271.30	6.4000	0.347	0.347
271.40	6.5000	0.349	0.349
271.45	6.5500	0.351	0.351

Big Bay Point Road and Bayview Drive EA
CCTA PROJECT NO.: 415375

Bayview Drive - Catchment 203 (North Bayview)

Red Text denotes inlet elevation for existing storm sewer from record drawing.
This value has been used to check system for feasibility.

ID	MH #0	MH #1	MH #2	MH #3	MH #4	MH #5	MH #6	MH #7	MH #8	Orifice #3
T/G	270.13	270.60	270.40	270.20	269.90	273.07	272.90	271.90	269.90	269.90
INV	268.43	267.90	267.37	266.84	267.73	267.20	266.67	266.14	265.61	264.21
Diameter (m)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Length (m)	-	-	-	-	-	-	-	-	-	-
Width (m)	-	-	-	-	-	-	-	-	-	-
Area (sq.m)	1.13	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77

	Slope = 0.01					Slope = 0.01				
ID	Pipe 1	Pipe 2	Pipe 3	Pipe 4	Pipe 5	Pipe 6	Pipe 7	Pipe 8	Pipe 9	Pipe 10
Diameter	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.825	0.675	0.300
U/S INV	268.43	267.90	267.37	266.84	267.73	267.20	266.67	266.14	265.61	264.21
D/S INV	267.93	267.40	266.87	266.34	267.23	266.70	266.17	265.64	265.11	257.88
AVG INV	268.18	267.65	267.12	266.59	267.48	266.95	266.42	265.89	265.36	261.04
Length	50	50	50	50	50	50	50	50	50	30

Type	Orifice #3
Diameter	0.250
Area	0.0490874
INV	264.21
C\	0.63

Elevation (m)	Maintenance Hole/Catchbasin Storage										
	MH #0 (cu.m)	MH #1 (cu.m)	MH #2 (cu.m)	MH #3 (cu.m)	MH #4 (cu.m)	MH #5 (cu.m)	MH #6 (cu.m)	MH #7 (cu.m)	MH #8 (cu.m)	Orifice #3 (cu.m)	Total (cu.m)
266.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	1.58	4.06	6.28
266.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82	1.76	4.23	6.81
266.70	0.00	0.00	0.00	0.00	0.00	0.00	0.06	1.00	1.94	4.41	7.40
266.80	0.00	0.00	0.00	0.00	0.00	0.00	0.24	1.18	2.11	4.59	8.11
266.90	0.00	0.00	0.00	0.11	0.00	0.00	0.42	1.35	2.29	4.76	8.93
267.00	0.00	0.00	0.00	0.29	0.00	0.00	0.59	1.53	2.47	4.94	9.82
267.10	0.00	0.00	0.00	0.47	0.00	0.00	0.77	1.71	2.64	5.12	10.70
267.20	0.00	0.00	0.00	0.65	0.00	0.01	0.95	1.88	2.82	5.29	11.59
267.30	0.00	0.00	0.00	0.82	0.00	0.19	1.12	2.06	3.00	5.47	12.65
267.40	0.00	0.00	0.06	1.00	0.00	0.36	1.30	2.24	3.17	5.65	13.77
267.50	0.00	0.00	0.24	1.18	0.00	0.54	1.48	2.41	3.35	5.82	15.01
267.60	0.00	0.00	0.42	1.35	0.00	0.72	1.65	2.59	3.53	6.00	16.25
267.70	0.00	0.00	0.59	1.53	0.00	0.89	1.83	2.77	3.70	6.18	17.49
267.80	0.00	0.00	0.77	1.71	0.13	1.07	2.01	2.94	3.88	6.35	18.86
267.90	0.00	0.01	0.95	1.88	0.31	1.25	2.18	3.12	4.06	6.53	20.28
268.00	0.00	0.19	1.12	2.06	0.49	1.42	2.36	3.30	4.23	6.71	21.87
268.10	0.00	0.36	1.30	2.24	0.66	1.60	2.54	3.47	4.41	6.88	23.46
268.20	0.00	0.54	1.48	2.41	0.84	1.78	2.71	3.65	4.59	7.06	25.05
268.30	0.00	0.72	1.65	2.59	1.02	1.95	2.89	3.83	4.76	7.24	26.64
268.40	0.00	0.89	1.83	2.77	1.19	2.13	3.07	4.00	4.94	7.41	28.23
268.50	0.08	1.07	2.01	2.94	1.37	2.31	3.24	4.18	5.12	7.59	29.91
268.60	0.20	1.25	2.18	3.12	1.55	2.48	3.42	4.36	5.29	7.77	31.61
268.70	0.31	1.42	2.36	3.30	1.72	2.66	3.60	4.53	5.47	7.94	33.31
268.80	0.42	1.60	2.54	3.47	1.90	2.84	3.77	4.71	5.65	8.12	35.02
268.90	0.54	1.78	2.71	3.65	2.08	3.01	3.95	4.89	5.82	8.30	36.72
269.00	0.65	1.95	2.89	3.83	2.25	3.19	4.13	5.06	6.00	8.47	38.42
269.10	0.76	2.13	3.07	4.00	2.43	3.37	4.30	5.24	6.18	8.65	40.13
269.20	0.88	2.31	3.24	4.18	2.61	3.54	4.48	5.42	6.35	8.83	41.83
269.30	0.99	2.48	3.42	4.36	2.78	3.72	4.66	5.59	6.53	9.00	43.53
269.40	1.10	2.66	3.60	4.53	2.96	3.90	4.83	5.77	6.71	9.18	45.24
269.50	1.21	2.84	3.77	4.71	3.14	4.07	5.01	5.95	6.88	9.36	46.94
269.60	1.33	3.01	3.95	4.89	3.31	4.25	5.19	6.12	7.06	9.53	48.64
269.70	1.44	3.19	4.13	5.06	3.49	4.43	5.36	6.30	7.24	9.71	50.35
269.80	1.55	3.37	4.30	5.24	3.67	4.60	5.54	6.48	7.41	9.89	52.05
269.90	1.67	3.54	4.48	5.42	3.84	4.78	5.72	6.65	7.59	10.06	53.75
270.00	1.78	3.72	4.66	5.59	3.84	4.96	5.89	6.83	7.59	10.06	54.93
270.10	1.89	3.90	4.83	5.77	3.84	5.13	6.07	7.01	7.59	10.06	56.10
270.20	1.93	4.07	5.01	5.95	3.84	5.31	6.25	7.18	7.59	10.06	57.19
270.30	1.93	4.25	5.19	5.95	3.84	5.49	6.42	7.36	7.59	10.06	58.08
270.40	1.93	4.43	5.36	5.95	3.84	5.66	6.60	7.54	7.59	10.06	58.96
270.50	1.93	4.60	5.36	5.95	3.84	5.84	6.78	7.71	7.59	10.06	59.67
270.60	1.93	4.78	5.36	5.95	3.84	6.02	6.95	7.89	7.59	10.06	60.37
270.70	1.93	4.78	5.36	5.95	3.84	6.19	7.13	8.07	7.59	10.06	60.91
270.80	1.93	4.78	5.36	5.95	3.84	6.37	7.31	8.24	7.59	10.06	61.44
270.90	1.93	4.78	5.36	5.95	3.84	6.55	7.48	8.42	7.59	10.06	61.97
271.00	1.93	4.78	5.36	5.95	3.84	6.72	7.66	8.60	7.59	10.06	62.50
271.10	1.93	4.78	5.36	5.95	3.84	6.90	7.84	8.77	7.59	10.06	63.03
271.20	1.93	4.78	5.36	5.95	3.84	7.08	8.01	8.95	7.59	10.06	63.56
271.30	1.93	4.78	5.36	5.95	3.84	7.25	8.19	9.13	7.59	10.06	64.09
271.40	1.93	4.78	5.36	5.95	3.84	7.43	8.37	9.30	7.59	10.06	64.62
271.50	1.93	4.78	5.36	5.95	3.84	7.61	8.54	9.48	7.59	10.06	65.15
271.60	1.93	4.78	5.36	5.95	3.84	7.78	8.72	9.66	7.59	10.06	65.68
271.70	1.93	4.78	5.36	5.95	3.84	7.96	8.90	9.83	7.59	10.06	66.21
271.80	1.93	4.78	5.36	5.95	3.84	8.14	9.07	10.01	7.59	10.06	66.74
271.90	1.93	4.78	5.36	5.95	3.84	8.31	9.25	10.19	7.59	10.06	67.27
272.00	1.93	4.78	5.36	5.95	3.84	8.49	9.43	10.19	7.59	10.06	67.62
272.10	1.93	4.78	5.36	5.95	3.84	8.67	9.60	10.19	7.59	10.06	67.97
272.20	1.93	4.78	5.36	5.95	3.84	8.84	9.78	10.19	7.59	10.06	68.33
272.30	1.93	4.78	5.36	5.95	3.84	9.02	9.96	10.19	7.59	10.06	68.68
272.40	1.93	4.78	5.36	5.95	3.84	9.20	10.13	10.19	7.59	10.06	69.03
272.50	1.93	4.78	5.36	5.95	3.84	9.37	10.31	10.19	7.59	10.06	69.39
272.60	1.93	4.78	5.36	5.95	3.84	9.55	10.49	10.19	7.59	10.06	69.74
272.70	1.93	4.78	5.36	5.95	3.84	9.73	10.66	10.19	7.59	10.06	70.09
272.80	1.93	4.78	5.36	5.95	3.84	9.90	10.84	10.19	7.59	10.06	70.45
272.90	1.93	4.78	5.36	5.95	3.84	10.08	11.02	10.19	7.59	10.06	70.80
273.00	1.93	4.78	5.36	5.95	3.84	10.26	11.02	10.19	7.59	10.06	70.98
273.07	1.93	4.78	5.36	5.95	3.84	10.38	11.02	10.19	7.59	10.06	71.10

Elevation (m)	Storm Sewer Storage											TOTAL STORAGE	TOTAL STORAGE
	Pipe 1 (cu.m)	Pipe 2 (cu.m)	Pipe 3 (cu.m)	Pipe 4 (cu.m)	Pipe 5 (cu.m)	Pipe 6 (cu.m)	Pipe 7 (cu.m)	Pipe 8 (cu.m)	Pipe 9 (cu.m)	Pipe 10 (cu.m)	Total (cu.m)	(cu.m)	(ha-m)
266.50	0.00	0.00	0.00	0.00	0.00	0.00	0.60	20.85	17.89	2.12	39.34	45.62	0.0046
266.60	0.00	0.00	0.00	0.00	0.00	0.00	2.95	24.20	17.89	2.12	45.04	51.85	0.0052
266.70	0.00	0.00	0.00	1.65	0.00	0.00	6.05	26.50	17.89	2.12	52.09	59.49	0.0059
266.80	0.00	0.00	0.00	4.45	0.00	0.00	9.40	26.75	17.89	2.12	58.49	66.60	0.0067
266.90	0.00	0.00	0.00	7.70	0.00	0.00	12.75	26.75	17.89	2.12	65.09	74.02	0.0074
267.00	0.00	0.00	0.00	11.10	0.00	0.60	15.70	26.75	17.89	2.12	72.04	81.86	0.0082
267.10	0.00	0.00	0.00	14.30	0.00	2.95	17.75	26.75	17.89	2.12	79.64	90.34	0.0090
267.20	0.00	0.00	0.60	16.90	0.00	6.05	17.89	26.75	17.89	2.12	86.08	97.67	0.0098
267.30	0.00	0.00	2.95	17.89	0.00	9.40	17.89	26.75	17.89	2.12	92.77	105.42	0.0105
267.40	0.00	0.00	6.05	17.89	0.00	12.75	17.89	26.75	17.89	2.12	99.22	112.99	0.0113
267.50	0.00	0.00	9.40	17.89	0.00	15.70	17.89	26.75	17.89	2.12	105.52	120.53	0.0121
267.60	0.00	0.00	12.75	17.89	1.65	17.75	17.89	26.75	17.89	2.12	112.57	128.82	0.0129
267.70	0.00	0.60	15.70	17.89	4.45	17.89	17.89	26.75	17.89	2.12	119.06	136.55	0.0137
267.80	0.00	2.95	17.75	17.89	7.70	17.89	17.89	26.75	17.89	2.12	126.71	145.57	0.0146
267.90	0.00	6.05	17.89	17.89	11.10	17.89	17.89	26.75	17.89	2.12	133.35	153.63	0.0154
268.00	0.00	9.40	17.89	17.89	14.30	17.89	17.89	26.75	17.89	2.12	139.90	161.77	0.0162
268.10	0.00	12.75	17.89	17.89	16.90	17.89	17.89	26.75	17.89	2.12	145.85	169.31	0.0169
268.20	0.00	15.70	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	149.79	174.84	0.0175
268.30	1.65	17.75	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	153.49	180.13	0.0180
268.40	4.45	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	156.43	184.66	0.0185
268.50	7.70	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	159.68	189.59	0.0190
268.60	11.10	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	163.08	194.69	0.0195
268.70	14.30	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	166.28	199.59	0.0200
268.80	16.90	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	168.88	203.90	0.0204
268.90	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	206.59	0.0207
269.00	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	208.29	0.0208
269.10	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	210.00	0.0210
269.20	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	211.70	0.0212
269.30	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	213.40	0.0213
269.40	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	215.11	0.0215
269.50	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	216.81	0.0217
269.60	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	218.51	0.0219
269.70	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	220.22	0.0220
269.80	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	221.92	0.0222
269.90	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	223.62	0.0224
270.00	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	224.80	0.0225
270.10	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	225.97	0.0226
270.20	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	227.06	0.0227
270.30	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	227.95	0.0228
270.40	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	228.83	0.0229
270.50	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	229.54	0.0230
270.60	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	230.24	0.0230
270.70	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	230.78	0.0231
270.80	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	231.31	0.0231
270.90	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	231.84	0.0232
271.00	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	232.37	0.0232
271.10	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	232.90	0.0233
271.20	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	233.43	0.0233
271.30	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	233.96	0.0234
271.40	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	234.49	0.0234
271.50	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	235.02	0.0235
271.60	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	235.55	0.0236
271.70	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	236.08	0.0236
271.80	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	236.61	0.0237
271.90	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	237.14	0.0237
272.00	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	237.49	0.0237
272.10	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	237.84	0.0238
272.20	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	238.20	0.0238
272.30	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	238.55	0.0239
272.40	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	238.90	0.0239
272.50	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	239.26	0.0239
272.60	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	239.61	0.0240
272.70	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	239.96	0.0240
272.80	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	240.32	0.0240
272.90	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	240.67	0.0241
273.00	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	240.85	0.0241
273.07	17.89	17.89	17.89	17.89	17.89	17.89	17.89	26.75	17.89	2.12	169.87	240.97	0.0241

Elevation (m)	Discharge		
	Head 1 (m)	Orifice #3 (cms)	Total (cms)
266.50	2.1700	0.202	0.202
266.60	2.2700	0.206	0.206
266.70	2.3700	0.211	0.211
266.80	2.4700	0.215	0.215
266.90	2.5700	0.220	0.220
267.00	2.6700	0.224	0.224
267.10	2.7700	0.228	0.228
267.20	2.8700	0.232	0.232
267.30	2.9700	0.236	0.236
267.40	3.0700	0.240	0.240
267.50	3.1700	0.244	0.244
267.60	3.2700	0.248	0.248
267.70	3.3700	0.251	0.251
267.80	3.4700	0.255	0.255
267.90	3.5700	0.259	0.259
268.00	3.6700	0.262	0.262
268.10	3.7700	0.266	0.266
268.20	3.8700	0.269	0.269
268.30	3.9700	0.273	0.273
268.40	4.0700	0.276	0.276
268.50	4.1700	0.280	0.280
268.60	4.2700	0.283	0.283
268.70	4.3700	0.286	0.286
268.80	4.4700	0.290	0.290
268.90	4.5700	0.293	0.293
269.00	4.6700	0.296	0.296
269.10	4.7700	0.299	0.299
269.20	4.8700	0.302	0.302
269.30	4.9700	0.305	0.305
269.40	5.0700	0.308	0.308
269.50	5.1700	0.311	0.311
269.60	5.2700	0.314	0.314
269.70	5.3700	0.317	0.317
269.80	5.4700	0.320	0.320
269.90	5.5700	0.323	0.323

Big Bay Point Road and Bayview Drive EA
CCTA PROJECT NO.: 415375

Big Bay Point Road - Catchment 205 (West Big Bay Pt)

ID	MH #24	MH #25	MH #26	MH #27	MH #28	MH #29	MH #30	MH #31	MH #32	MH #33	MH #34	MH #35	MH #36	MH #37	MH #38	MH #39	MH #40	MH #41	MH #42	Orifice #1
T/G	278.59	277.92	277.07	276.22	275.25	274.33	273.40	272.48	271.61	270.90	273.18	273.50	274.09	274.27	273.93	273.20	272.31	271.43	270.84	270.68
INV	276.04	275.33	274.62	273.91	273.20	272.49	271.78	271.07	270.36	269.65	271.31	270.78	270.28	269.78	269.28	268.78	268.28	267.78	267.28	266.78
Diameter (m)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Length (m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width (m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Area (sq.m)	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77

Red Text denotes surveyed outlet invert elevation
This value has been used to check system for feasibility. Oversized pipes are not feasible for this catchment if the existing outlet elevation is to be maintained.

ID	Pipe 29	Pipe 30	Pipe 31	Pipe 32	Pipe 33	Pipe 34	Pipe 35	Pipe 36	Pipe 37	Pipe 38	Pipe 39	Pipe 40	Pipe 41	Pipe 42	Pipe 43	Pipe 44	Pipe 45	Pipe 46	Pipe 47	Pipe 48
	Slope = 0.017										Slope = 0.005									
Diameter	1.050	1.050	1.050	1.050	1.050	1.050	1.050	1.050	1.050	1.050	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.525
U/S INV	276.04	275.33	274.62	273.91	273.20	272.49	271.78	271.07	270.36	269.65	271.31	270.78	270.28	269.78	269.28	268.78	268.28	267.78	267.28	266.78
D/S INV	275.36	274.65	273.94	273.23	272.52	271.81	271.10	270.39	269.68	268.97	271.08	270.58	270.08	269.58	269.08	268.58	268.08	267.58	267.08	268.77
AVG INV	275.70	274.99	274.28	273.57	272.86	272.15	271.44	270.73	270.02	269.31	271.19	270.68	270.18	269.68	269.18	268.68	268.18	267.68	267.18	267.78
Length	40	40	40	40	40	40	40	40	40	40	45	40	40	40	40	40	40	40	40	25

Type	Orifice 1
Diameter	0.390
Area	0.1194591
INV	266.78
C\	0.63

Elevation (m)	Maintenance Hole/Catchbasin Storage																				
	MH #24 (cu.m)	MH #25 (cu.m)	MH #26 (cu.m)	MH #27 (cu.m)	MH #28 (cu.m)	MH #29 (cu.m)	MH #30 (cu.m)	MH #31 (cu.m)	MH #32 (cu.m)	MH #33 (cu.m)	MH #34 (cu.m)	MH #35 (cu.m)	MH #36 (cu.m)	MH #37 (cu.m)	MH #38 (cu.m)	MH #39 (cu.m)	MH #40 (cu.m)	MH #41 (cu.m)	MH #42 (cu.m)	Orifice #1 (cu.m)	Total (cu.m)
270.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	1.68	0.00	0.00	0.57	1.45	2.33	3.22	4.10	4.98	5.87	6.75	31.37
270.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.86	0.00	0.00	0.74	1.63	2.51	3.39	4.28	5.16	6.04	6.89	33.10
270.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	2.03	0.00	0.04	0.92	1.80	2.69	3.57	4.45	5.34	6.22	6.89	34.72
270.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	2.21	0.00	0.21	1.10	1.98	2.86	3.75	4.63	5.51	6.29	6.89	36.39
271.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.13	2.21	0.00	0.39	1.27	2.16	3.04	3.92	4.81	5.69	6.29	6.89	37.80
271.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	1.31	2.21	0.00	0.57	1.45	2.33	3.22	4.10	4.98	5.87	6.29	6.89	39.27
271.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	1.48	2.21	0.00	0.74	1.63	2.51	3.39	4.28	5.16	6.04	6.29	6.89	40.86
271.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	1.66	2.21	0.00	0.92	1.80	2.69	3.57	4.45	5.34	6.22	6.29	6.89	42.45
271.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	1.84	2.21	0.17	1.10	1.98	2.86	3.75	4.63	5.51	6.40	6.29	6.89	44.21
271.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	2.01	2.21	0.34	1.27	2.16	3.04	3.92	4.81	5.69	6.45	6.29	6.89	45.85
271.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94	2.19	2.21	0.52	1.45	2.33	3.22	4.10	4.98	5.87	6.45	6.29	6.89	47.44
271.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	2.21	2.21	0.70	1.63	2.51	3.39	4.28	5.16	6.04	6.45	6.29	6.89	48.87
271.80	0.00	0.00	0.00	0.00	0.00	0.00	0.04	1.29	2.21	2.21	0.87	1.80	2.69	3.57	4.45	5.34	6.22	6.45	6.29	6.89	50.32
271.90	0.00	0.00	0.00	0.00	0.00	0.00	0.21	1.47	2.21	2.21	1.05	1.98	2.86	3.75	4.63	5.51	6.40	6.45	6.29	6.89	51.91
272.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	1.64	2.21	2.21	1.23	2.16	3.04	3.92	4.81	5.69	6.57	6.45	6.29	6.89	53.50
272.10	0.00	0.00	0.00	0.00	0.00	0.00	0.57	1.82	2.21	2.21	1.40	2.33	3.22	4.10	4.98	5.87	6.75	6.45	6.29	6.89	55.09
272.20	0.00	0.00	0.00	0.00	0.00	0.00	0.74	2.00	2.21	2.21	1.58	2.51	3.39	4.28	5.16	6.04	6.93	6.45	6.29	6.89	56.68
272.30	0.00	0.00	0.00	0.00	0.00	0.00	0.92	2.17	2.21	2.21	1.76	2.69	3.57	4.45	5.34	6.22	7.10	6.45	6.29	6.89	58.27
272.40	0.00	0.00	0.00	0.00	0.00	0.00	1.10	2.35	2.21	2.21	1.94	2.86	3.75	4.63	5.51	6.40	7.12	6.45	6.29	6.89	59.70
272.50	0.00	0.00	0.00	0.00	0.00	0.02	1.27	2.49	2.21	2.21	2.11	3.04	3.92	4.81	5.69	6.57	7.12	6.45	6.29	6.89	61.10
272.60	0.00	0.00	0.00	0.00	0.00	0.19	1.45	2.49	2.21	2.21	2.29	3.22	4.10	4.98	5.87	6.75	7.12	6.45	6.29	6.89	62.51
272.70	0.00	0.00	0.00	0.00	0.00	0.37	1.63	2.49	2.21	2.21	2.47	3.39	4.28	5.16	6.04	6.93	7.12	6.45	6.29	6.89	63.93
272.80	0.00	0.00	0.00	0.00	0.00	0.55	1.80	2.49	2.21	2.21	2.64	3.57	4.45	5.34	6.22	7.10	7.12	6.45	6.29	6.89	65.34
272.90	0.00	0.00	0.00	0.00	0.00	0.72	1.98	2.49	2.21	2.21	2.82	3.75	4.63	5.51	6.40	7.28	7.12	6.45	6.29	6.89	66.75
273.00	0.00	0.00	0.00	0.00	0.00	0.90	2.16	2.49	2.21	2.21	3.00	3.92	4.81	5.69	6.57	7.46	7.12	6.45	6.29	6.89	68.17
273.10	0.00	0.00	0.00	0.00	0.00	1.08	2.33	2.49	2.21	2.21	3.17	4.10	4.98	5.87	6.75	7.63	7.12	6.45	6.29	6.89	69.58
273.20	0.00	0.00	0.00	0.00	0.00	1.25	2.51	2.49	2.21	2.21	3.31	4.28	5.16	6.04	6.93	7.81	7.12	6.45	6.29	6.89	70.96
273.30	0.00	0.00	0.00	0.00	0.18	1.43	2.69	2.49	2.21	2.21	3.31	4.45	5.34	6.22	7.10	7.81	7.12	6.45	6.29	6.89	72.20
273.40	0.00	0.00	0.00	0.00	0.35	1.61	2.86	2.49	2.21	2.21	3.31	4.63	5.51	6.40	7.28	7.81	7.12	6.45	6.29	6.89	73.43
273.50	0.00	0.00	0.00	0.00	0.53	1.78	2.86	2.49	2.21	2.21	3.31	4.81	5.69	6.57	7.46	7.81	7.12	6.45	6.29	6.89	74.49
273.60	0.00	0.00	0.00	0.00	0.71	1.96	2.86	2.49	2.21	2.21	3.31	4.81	5.87	6.75	7.63	7.81	7.12	6.45	6.29	6.89	75.38
273.70	0.00	0.00	0.00	0.00	0.88	2.14	2.86	2.49	2.21	2.21	3.31	4.81	6.04	6.93	7.81	7.81	7.12	6.45	6.29	6.89	76.26
273.80	0.00	0.00	0.00	0.00	1.06	2.31	2.86	2.49	2.21	2.21	3.31	4.81	6.22	7.10	7.99	7.81	7.12	6.45	6.29	6.89	77.14
273.90	0.00	0.00	0.00	0.00	1.24	2.49	2.86	2.49	2.21	2.21	3.31	4.81	6.40	7.28	8.16	7.81	7.12	6.45	6.29	6.89	78.03
274.00	0.00	0.00	0.00	0.16	1.41	2.67	2.86	2.49	2.21	2.21	3.31	4.81	6.57	7.46	8.22	7.81	7.12	6.45	6.29	6.89	78.95
274.10	0.00	0.00	0.00	0.34	1.59	2.85	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.63	8.22	7.81	7.12	6.45	6.29	6.89	79.81
274.20	0.00	0.00	0.00	0.51	1.77	3.02	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.81	8.22	7.81	7.12	6.45	6.29	6.89	80.52
274.30	0.00	0.00	0.00	0.69	1.94	3.20	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	81.17
274.40	0.00	0.00	0.00	0.87	2.12	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	81.58
274.50	0.00	0.00	0.00	1.04	2.30	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	81.93
274.60	0.00	0.00	0.00	1.22	2.47	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	82.29
274.70	0.00	0.00	0.14	1.40	2.65	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	82.78
274.80	0.00	0.00	0.32	1.57	2.83	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	83.31
274.90	0.00	0.00	0.49	1.75	3.00	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	83.84
275.00	0.00	0.00	0.67	1.93	3.18	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	84.37
275.10	0.00	0.00	0.85	2.10	3.36	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	84.90
275.20	0.00	0.00	1.02	2.28	3.53	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	85.43
275.30	0.00	0.00	1.20	2.46	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	85.87
275.40	0.00	0.12	1.38	2.63	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	86.35
275.50	0.00	0.30	1.56	2.81	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	86.88
275.60	0.00	0.48	1.73	2.99	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	87.41
275.70	0.00	0.65	1.91	3.16	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	87.94
275.80	0.00	0.83	2.09	3.34	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	88.47
275.90	0.00	1.01	2.26	3.52	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	89.00
276.00	0.00	1.18	2.44	3.69	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	89.53
276.10	0.11	1.36	2.62	3.87	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	90.17
276.20	0.28	1.54	2.79	4.05	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	90.88
276.30	0.46	1.71	2.97	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	91.44
276.40	0.64	1.89	3.15	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	91.97
276.50	0.81	2.07	3.32	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	92.50
276.60	0.99	2.24	3.50	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	93.03
276.70	1.17	2.42	3.68	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	93.56
276.80	1.34	2.60	3.85	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	94.09
276.90	1.52	2.77	4.03	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	94.62
277.00	1.70	2.95	4.21	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	95.15
277.10	1.87	3.13	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	95.63
277.20	2.05	3.30	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	95.98
277.30	2.23	3.48	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	96.34
277.40	2.40	3.66	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	96.69
277.50	2.58	3.83	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	97.04
277.60	2.76	4.01	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	97.40
277.70	2.93	4.19	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	97.75
277.80	3.11	4.36	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	98.10
277.90	3.29	4.54	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	98.46
278.00	3.46	4.58	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	98.67
278.10	3.64	4.58	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	98.85
278.20	3.82	4.58	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	99.02
278.30	3.99	4.58	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	99.20
278.40	4.17	4.58	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	99.38
278.50	4.35	4.58	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	99.55
278.59	4.51	4.58	4.33	4.08	3.62	3.25	2.86	2.49	2.21	2.21	3.31	4.81	6.73	7.93	8.22	7.81	7.12	6.45	6.29	6.89	99.71

Elevation (m)	Storm Sewer Storage																					TOTAL STORAGE	TOTAL STORAGE
	Pipe 29 (cu.m)	Pipe 30 (cu.m)	Pipe 31 (cu.m)	Pipe 32 (cu.m)	Pipe 33 (cu.m)	Pipe 34 (cu.m)	Pipe 35 (cu.m)	Pipe 36 (cu.m)	Pipe 37 (cu.m)	Pipe 38 (cu.m)	Pipe 39 (cu.m)	Pipe 40 (cu.m)	Pipe 41 (cu.m)	Pipe 42 (cu.m)	Pipe 43 (cu.m)	Pipe 44 (cu.m)	Pipe 45 (cu.m)	Pipe 46 (cu.m)	Pipe 47 (cu.m)	Pipe 48 (cu.m)	Total (cu.m)	(cu.m)	(ha-m)
270.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.36	34.64	0.00	0.00	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	83.91	115.28	0.0115
270.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.52	34.64	0.00	0.00	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	88.07	121.17	0.0121
270.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	26.48	34.64	0.00	0.94	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	93.58	128.30	0.0128
270.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.04	30.04	34.64	0.00	2.40	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	101.03	137.41	0.0137
271.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.32	32.96	34.64	0.00	3.79	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	108.62	146.42	0.0146
271.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.12	34.64	34.64	0.00	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	114.73	153.99	0.0154
271.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.20	34.64	34.64	0.00	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	118.81	159.66	0.0160
271.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.36	34.64	34.64	1.06	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	124.03	166.48	0.0166
271.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.52	34.64	34.64	2.70	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	129.82	174.03	0.0174
271.50	0.00	0.00	0.00	0.00	0.00	0.00	0.60	26.48	34.64	34.64	4.26	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	135.95	181.80	0.0182
271.60	0.00	0.00	0.00	0.00	0.00	0.00	3.04	30.04	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	142.66	190.10	0.0190
271.70	0.00	0.00	0.00	0.00	0.00	0.00	6.32	32.96	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	148.86	197.73	0.0198
271.80	0.00	0.00	0.00	0.00	0.00	0.00	10.12	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	154.34	204.66	0.0205
271.90	0.00	0.00	0.00	0.00	0.00	0.00	14.20	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	158.42	210.33	0.0210
272.00	0.00	0.00	0.00	0.00	0.00	0.00	18.36	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	162.58	216.08	0.0216
272.10	0.00	0.00	0.00	0.00	0.00	0.00	22.52	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	166.74	221.83	0.0222
272.20	0.00	0.00	0.00	0.00	0.00	0.60	26.48	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	171.30	227.98	0.0228
272.30	0.00	0.00	0.00	0.00	0.00	3.04	30.04	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	177.30	235.57	0.0236
272.40	0.00	0.00	0.00	0.00	0.00	6.32	32.96	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	183.50	243.20	0.0243
272.50	0.00	0.00	0.00	0.00	0.00	10.12	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	188.98	250.08	0.0250
272.60	0.00	0.00	0.00	0.00	0.00	14.20	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	193.06	255.57	0.0256
272.70	0.00	0.00	0.00	0.00	0.00	18.36	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	197.22	261.14	0.0261
272.80	0.00	0.00	0.00	0.00	0.00	22.52	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	201.38	266.72	0.0267
272.90	0.00	0.00	0.00	0.00	0.00	26.48	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	205.34	272.09	0.0272
273.00	0.00	0.00	0.00	0.00	1.68	30.04	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	210.58	278.74	0.0279
273.10	0.00	0.00	0.00	0.00	4.60	32.96	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	216.42	286.00	0.0286
273.20	0.00	0.00	0.00	0.00	8.16	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	221.66	292.62	0.0293
273.30	0.00	0.00	0.00	0.00	12.12	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	225.62	297.81	0.0298
273.40	0.00	0.00	0.00	0.00	16.28	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	229.78	303.21	0.0303
273.50	0.00	0.00	0.00	0.00	20.44	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	233.94	308.43	0.0308
273.60	0.00	0.00	0.00	0.00	24.52	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	238.02	313.39	0.0313
273.70	0.00	0.00	0.00	1.68	28.32	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	243.50	319.76	0.0320
273.80	0.00	0.00	0.00	4.60	31.60	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	249.70	326.84	0.0327
273.90	0.00	0.00	0.00	8.16	34.04	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	255.70	333.72	0.0334
274.00	0.00	0.00	0.00	12.12	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	260.26	339.20	0.0339
274.10	0.00	0.00	0.00	16.28	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	264.42	344.23	0.0344
274.20	0.00	0.00	0.00	20.44	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	268.58	349.10	0.0349
274.30	0.00	0.00	0.00	24.52	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	272.66	353.83	0.0354
274.40	0.00	0.00	1.68	28.32	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	278.14	359.72	0.0360
274.50	0.00	0.00	4.60	31.60	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	284.34	366.27	0.0366
274.60	0.00	0.00	8.16	34.04	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	290.34	372.62	0.0373
274.70	0.00	0.00	12.12	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	294.90	377.68	0.0378
274.80	0.00	0.00	16.28	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	299.06	382.37	0.0382
274.90	0.00	0.00	20.44	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	303.22	387.06	0.0387
275.00	0.00	0.00	24.52	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	307.30	391.67	0.0392
275.10	0.00	1.68	28.32	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	312.78	397.68	0.0398
275.20	0.00	4.60	31.60	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	318.98	404.41	0.0404
275.30	0.00	8.16	34.04	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	324.98	410.85	0.0411
275.40	0.00	12.12	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	329.54	415.89	0.0416
275.50	0.00	16.28	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	333.70	420.58	0.0421
275.60	0.00	20.44	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	337.86	425.27	0.0425
275.70	0.00	24.52	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	341.94	429.88	0.0430
275.80	1.68	28.32	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	347.42	435.89	0.0436
275.90	4.60	31.60	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	353.62	442.62	0.0443
276.00	8.16	34.04	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	359.62	449.15	0.0449
276.10	12.12	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	364.18	454.34	0.0454
276.20	16.28	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	368.34	459.21	0.0459
276.30	20.44	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	372.50	463.94	0.0464
276.40	24.52	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	376.58	468.55	0.0469
276.50	28.32	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	380.38	472.88	0.0473
276.60	31.60	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	383.66	476.69	0.0477
276.70	34.04	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.10	479.66	0.0480
276.80	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	480.79	0.0481
276.90	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	481.32	0.0481
277.00	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	481.85	0.0482
277.10	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	482.33	0.0482
277.20	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	482.68	0.0483
277.30	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	483.03	0.0483
277.40	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	483.39	0.0483
277.50	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	483.74	0.0484
277.60	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	484.09	0.0484
277.70	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	484.45	0.0484
277.80	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	484.80	0.0485
277.90	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	485.15	0.0485
278.00	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	485.36	0.0485
278.10	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	485.54	0.0486
278.20	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	485.72	0.0486
278.30	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	485.89	0.0486
278.40	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	486.07	0.0486
278.50	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	486.25	0.0486
278.59	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	4.97	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.41	386.70	486.41	0.0486

Elevation (m)	Discharge		
	Head 1 (m)	Orifice 1 (cms)	Total (cms)
270.60	3.6250	0.635	0.635
270.68	3.7050	0.642	0.642

Big Bay Point Road and Bayview Drive EA
CCTA PROJECT NO.: 415375

Red Text denotes inlet elevation for existing storm sewer from record drawing.
This value has been used to check system for feasibility.

Big Bay Point Road - Catchment 207 (East Big Bay Pt)

ID	MH #43	MH #44	MH #45	MH #46	MH #47	MH #48	MH #49	MH #50	Orifice #2
T/G	273.18	272.66	271.79	270.48	268.80	266.96	265.09	263.22	259.59
INV	270.63	269.10	267.57	266.04	264.51	262.98	261.45	259.92	258.39
Diameter (m)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Length (m)	-	-	-	-	-	-	-	-	-
Width (m)	-	-	-	-	-	-	-	-	-
Area (sq.m)	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77

Slope = 0.03

ID	Pipe 49	Pipe 50	Pipe 51	Pipe 52	Pipe 53	Pipe 54	Pipe 55	Pipe 56	Pipe 57
Diameter	1.050	1.050	1.050	1.050	1.050	1.050	1.050	1.050	1.050
U/S INV	270.63	269.10	267.57	266.04	264.51	262.98	261.45	259.92	258.39
D/S INV	269.13	267.60	266.07	264.54	263.01	261.48	259.95	258.42	257.70
AVG INV	269.88	268.35	266.82	265.29	263.76	262.23	260.70	259.17	258.04
Length	50	50	50	50	50	50	50	50	50

Type	Orifice 2
Diameter	0.450
Area	0.1590431
INV	258.39
C\	0.63

Elevation (m)	Maintenance Hole/Catchbasin Storage										Elevation (m)	Storm Sewer Storage										TOTAL STORAGE	TOTAL STORAGE
	MH #43 (cu.m)	MH #44 (cu.m)	MH #45 (cu.m)	MH #46 (cu.m)	MH #47 (cu.m)	MH #48 (cu.m)	MH #49 (cu.m)	MH #50 (cu.m)	Orifice #2 (cu.m)	Total (cu.m)		Pipe 49 (cu.m)	Pipe 50 (cu.m)	Pipe 51 (cu.m)	Pipe 52 (cu.m)	Pipe 53 (cu.m)	Pipe 54 (cu.m)	Pipe 55 (cu.m)	Pipe 56 (cu.m)	Pipe 57 (cu.m)	Total (cu.m)	(cu.m)	(ha-m)
259.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.08	1.08	259.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.20	0.00	1.08	0.0001
259.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.25	1.25	259.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.30	0.00	1.25	0.0001
259.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	1.43	259.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.30	0.00	1.43	0.0001
259.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.61	1.61	259.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10	43.30	2.10	3.71	0.0004
259.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.78	1.78	259.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.75	43.30	5.75	7.53	0.0008
259.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.96	1.96	259.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.20	43.30	10.20	12.16	0.0012
259.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.12	2.12	259.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.15	43.30	15.15	17.27	0.0017
259.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.12	2.12	259.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.35	43.30	20.35	22.47	0.0022
259.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.12	2.12	259.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.55	43.30	25.55	27.67	0.0028
259.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.12	2.12	259.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.65	43.30	30.65	32.77	0.0033
260.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	2.12	2.26	260.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.40	43.30	35.40	37.66	0.0038
260.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	2.12	2.44	260.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.50	43.30	39.50	41.94	0.0042
260.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	2.12	2.62	260.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.55	43.30	42.55	45.17	0.0045
260.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	2.12	2.79	260.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	46.09	0.0046
260.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85	2.12	2.97	260.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	46.27	0.0046
260.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	2.12	3.15	260.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	46.45	0.0046
260.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	2.12	3.32	260.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	46.62	0.0047
260.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.38	2.12	3.50	260.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	46.80	0.0047
260.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56	2.12	3.68	260.80	0.00	0.00	0.00	0.00	0.00	0.00	2.10	43.30	43.30	45.40	49.08	0.0049
260.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.73	2.12	3.85	260.90	0.00	0.00	0.00	0.00	0.00	0.00	5.75	43.30	43.30	49.05	52.90	0.0053
261.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.91	2.12	4.03	261.00	0.00	0.00	0.00	0.00	0.00	0.00	10.20	43.30	43.30	53.50	57.53	0.0058
261.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.09	2.12	4.21	261.10	0.00	0.00	0.00	0.00	0.00	0.00	15.15	43.30	43.30	58.45	62.66	0.0063
261.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.26	2.12	4.38	261.20	0.00	0.00	0.00	0.00	0.00	0.00	20.35	43.30	43.30	63.65	68.03	0.0068
261.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.44	2.12	4.56	261.30	0.00	0.00	0.00	0.00	0.00	0.00	25.55	43.30	43.30	68.85	73.41	0.0073
261.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.62	2.12	4.74	261.40	0.00	0.00	0.00	0.00	0.00	0.00	30.65	43.30	43.30	73.95	78.69	0.0079
261.50	0.00	0.00	0.00	0.00	0.00	0.00	0.09	2.79	2.12	5.00	261.50	0.00	0.00	0.00	0.00	0.00	0.00	35.40	43.30	43.30	78.70	83.70	0.0084
261.60	0.00	0.00	0.00	0.00	0.00	0.00	0.27	2.97	2.12	5.35	261.60	0.00	0.00	0.00	0.00	0.00	0.00	39.50	43.30	43.30	82.80	88.15	0.0088
261.70	0.00	0.00	0.00	0.00	0.00	0.00	0.44	3.15	2.12	5.71	261.70	0.00	0.00	0.00	0.00	0.00	0.00	42.55	43.30	43.30	85.85	91.56	0.0092
261.80	0.00	0.00	0.00	0.00	0.00	0.00	0.62	3.32	2.12	6.06	261.80	0.00	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	86.60	92.66	0.0093
261.90	0.00	0.00	0.00	0.00	0.00	0.00	0.80	3.50	2.12	6.41	261.90	0.00	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	86.60	93.01	0.0093
262.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	3.68	2.12	6.77	262.00	0.00	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	86.60	93.37	0.0093
262.10	0.00	0.00	0.00	0.00	0.00	0.00	1.15	3.85	2.12	7.12	262.10	0.00	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	86.60	93.72	0.0094
262.20	0.00	0.00	0.00	0.00	0.00	0.00	1.33	4.03	2.12	7.48	262.20	0.00	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	86.60	94.08	0.0094
262.30	0.00	0.00	0.00	0.00	0.00	0.00	1.50	4.21	2.12	7.83	262.30	0.00	0.00	0.00	0.00	0.00	0.75	43.30	43.30	43.30	87.35	95.18	0.0095
262.40	0.00	0.00	0.00	0.00	0.00	0.00	1.68	4.38	2.12	8.18	262.40	0.00	0.00	0.00	0.00	0.00	3.80	43.30	43.30	43.30	90.40	98.58	0.0099
262.50	0.00	0.00	0.00	0.00	0.00	0.00	1.86	4.56	2.12	8.54	262.50	0.00	0.00	0.00	0.00	0.00	7.90	43.30	43.30	43.30	94.50	103.04	0.0103
262.60	0.00	0.00	0.00	0.00	0.00	0.00	2.03	4.74	2.12	8.89	262.60	0.00	0.00	0.00	0.00	0.00	12.65	43.30	43.30	43.30	99.25	108.14	0.0108
262.70	0.00	0.00	0.00	0.00	0.00	0.00	2.21	4.91	2.12	9.24	262.70	0.00	0.00	0.00	0.00	0.00	17.75	43.30	43.30	43.30	104.35	113.59	0.0114
262.80	0.00	0.00	0.00	0.00	0.00	0.00	2.39	5.09	2.12	9.60	262.80	0.00	0.00	0.00	0.00	0.00	22.95	43.30	43.30	43.30	109.55	119.15	0.0119
262.90	0.00	0.00	0.00	0.00	0.00	0.00	2.56	5.27	2.12	9.95	262.90	0.00	0.00	0.00	0.00	0.00	28.15	43.30	43.30	43.30	114.75	124.70	0.0125
263.00	0.00	0.00	0.00	0.00	0.00	0.04	2.74	5.44	2.12	10.34	263.00	0.00	0.00	0.00	0.00	0.00	33.10	43.30	43.30	43.30	119.70	130.04	0.0130
263.10	0.00	0.00	0.00	0.00	0.00	0.21	2.92	5.62	2.12	10.87	263.10	0.00	0.00	0.00	0.00	0.00	37.55	43.30	43.30	43.30	124.15	135.02	0.0135
263.20	0.00	0.00	0.00	0.00	0.00	0.39	3.09	5.80	2.12	11.40	263.20	0.00	0.00	0.00	0.00	0.00	41.20	43.30	43.30	43.30	127.80	139.20	0.0139
263.30	0.00	0.00	0.00	0.00	0.00	0.57	3.27	5.83	2.12	11.79	263.30	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	43.30	129.90	141.69	0.0142
263.40	0.00	0.00	0.00	0.00	0.00	0.74	3.45	5.83	2.12	12.14	263.40	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	43.30	129.90	142.04	0.0142
263.50	0.00	0.00	0.00	0.00	0.00	0.92	3.62	5.83	2.12	12.49	263.50	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	43.30	129.90	142.39	0.0142
263.60	0.00	0.00	0.00	0.00	0.00	1.10	3.80	5.83	2.12	12.85	263.60	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	43.30	129.90	142.75	0.0143
263.70	0.00	0.00	0.00	0.00	0.00	1.27	3.98	5.83	2.12	13.20	263.70	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	43.30	129.90	143.10	0.0143
263.80	0.00	0.00	0.00	0.00	0.00	1.45	4.15	5.83	2.12	13.55	263.80	0.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	43.30	129.90	143.45	0.0143
263.90	0.00	0.00	0.00	0.00	0.00	1.63	4.33	5.83	2.12	13.91	263.90	0.00	0.00	0.00	0.00	2.10	43.30	43.30	43.30	43.30	132.00	145.91	0.0146
264.00	0.00	0.00	0.00	0.00	0.00	1.80	4.51	5.83	2.12	14.26	264.00	0.00	0.00	0.00	0.00	5.75	43.30	43.30	43.30	43.30	135.65	149.91	0.0150
264.10	0.00	0.00	0.00	0.00	0.00	1.98	4.68	5.83	2.12	14.61	264.10	0.00	0.00	0.00	0.00	10.20	43.30	43.30	43.30	43.30	140.10	154.71	0.0155
264.20	0.00	0.00	0.00	0.00	0.00	2.16	4.86	5.83	2.12	14.97	264.20	0.00	0.00	0.00	0.00	15.15	43.30	43.30	43.30	43.30	145.05	160.02	0.0160
264.30	0.00	0.00	0.00	0.00	0.00	2.33	5.04	5.83	2.12	15.32	264.30	0.00	0.00	0.00	0.00	20.35	43.30	43.30	43.30	43.30	150.25	165.57	0.0166
264.40	0.00	0.00	0.00	0.00	0.00	2.51	5.21	5.83	2.12	15.67	264.40	0.00	0.00	0.00	0.00	25.55	43.30	43.30	43.30	43.30	155.45	171.12	0.0171
264.50	0.00	0.00	0.00	0.00	0.00	2.69	5.39	5.83	2.12	16.03	264.50	0.00	0.00	0.00	0.00	30.65	43.30	43.30	43.30	43.30	160.55	176.58	0.0177
264.60	0.00	0.00	0.00	0.00	0.16	2.86	5.57	5.83	2.12	16.54	264.60	0.00	0.00	0.00	0.00	35.40	43.30	43.30	43.30	43.30	165.30	181.84	0.0182
264.70	0.00	0.00	0.00	0.00	0.34	3.04	5.74	5.83	2.12	17.07	264.70	0.00	0.00	0.00	0.00	39.50	43.30	43.30	43.30	43.30	169.40	186.47	0.0186
264.80	0.00	0.00	0.00	0.00	0.51	3.22	5.92	5.83	2.12	17.60	264.80	0.00	0.00	0.00	0.00	42.55	43.30	43.30	43.30	43.30	172.45	190.05	0.0190
264.90	0.00	0.00	0.00	0.00	0.69	3.39	6.10	5.83	2.12	18.13	264.90	0.00	0.00	0.00	0.00	43.30	43.30	43.30	43.30	43.30	173.20	191.33	0.0191
265.00	0.00	0.00	0.00	0.00	0.87	3.57	6.27	5.83	2.12	18.66	265.00	0.00	0.00	0.00	0.00	43.30	43.30	43.30	43.30	43.30	173.20	191.86	0.0192
265.10	0.00	0.00	0.00	0.00	1.04	3.75	6.43	5.83	2.12	19.17	265.10	0.00	0.00	0.00	0.00	43.30	43.30	43.30	43.30	43.30	173.20	192.37	0.0192
265.20	0.00	0.00	0.00	0.00	1.22	3.92	6.43	5.83	2.12	19.53	265.20	0.00	0.00	0.00	0.00	43.30	43.30	43.30	43.30	43.30	173.20	192.73	0.0193
265.30	0.00	0.00	0.00	0.00	1.40	4.10	6.43	5.83	2.12	19.88	265.30	0.00	0.00	0.00	0.00	43.30	43.30	43.30	43.30	43.30	173.20	193.08	0.0193
265.40	0.00	0.00	0.00	0.00	1.57	4.28	6.43	5.83	2.12	20.23	265.40	0.00	0.00	0.00	2.10	43.30	43.30	43.30	43.30	43.30	175.30	195.53	0.0196
265.50	0.00	0.00	0.00	0.00	1.75	4.45	6.43	5.83	2.12	20.59	265.50	0.00	0.00	0.00	5.75	43.30	43.30	43.30	43.30	43.30	178.95	199.54	0.0200
265.60	0.00	0.00	0.00	0.00	1.93	4.63	6.43	5.83	2.12	20.94	265.60	0.00	0.00	0.00	10.20	43.30	43.30	43.30	43.30	43.30	183.40	204.34	0.0204
265.70	0.00	0.00	0.00	0.00	2.10	4.81	6.43	5.83	2.12	21.29	265.70	0.00	0.00	0.00	15.15	43.30	43.30	43.30	43.30	43.30	188.35	209.64	0.0210
265.80	0.00	0.00	0.00	0.00	2.28	4.98	6.43	5.83	2.12	21.65	265.80	0.00	0.00	0.00	20.35	43.30	43.30	43.30	43.30	43.30	193.55	215.20	0.0215
265.90	0.00	0.00	0.00	0.00	2.46	5.16	6.43	5.83	2.12	22.00	265.90	0.00	0.00	0.00	25.55	43.30	43.30	43.30	43.30	43.30	198.75	220.75	0.0221
266.00	0.00	0.00	0.00	0.00	2.63	5.34	6.43	5.83	2.12	22.35	266.00	0.00	0.00	0.00	30.65	43.30	43.30	43.30	43.30	43.30	203.85	226.20	0.0226
266.10	0.00	0.00	0.00	0.11	2.81	5.51	6.43	5.83	2.12	22.81	266.10	0.00	0.00	0.00	35.40	43.30	43.30	43.30	43.30	43.30	208.60	231.41	0.0231
266.20	0.00	0.00	0.00	0.28	2.99	5.69	6.43	5.83	2.12	23.34	266.20	0.00	0.00	0.00	39.50	43.30	43.30	43.30	43.30	43.30	212.70	236.04	0.0236
266.30	0.00	0.00	0.00	0.46	3.16	5.87	6.43	5.83	2.12	23.87	266.30	0.00	0.00	0.00	42.55	43.30	43.30	43.30	43.30	43.30	215.75	239.62	0.0240
266.40	0.00	0.00	0.00	0.64	3.34	6.04	6.43	5.83	2.12	24.40	266.40	0.00	0.00	0.00	43.30	43.30	43.30	43.30	43.30	43.30	216.50	240.90	0.0241
266.50	0.00	0.00	0.00	0.81	3.52	6.22	6.43	5.83	2.12	24.93	266.50	0.00	0.00	0.00	43.30	43.30	43.30	43.30	43.30	43.30	216.50	241.43	0.0241
266.60	0.00	0.00	0.00	0.99	3.69	6.40	6.43	5.83	2.12	25.46	266.60	0.00	0.00	0.00	43.30	43.30	43.30	43.30	43.30	43.30	216.50	241.96	0.0242
266.70	0.00	0.00	0.00	1.17	3.87	6.57	6.43	5.83	2.12	25.99	266.70	0.00	0.00	0.00	43.30	43.30	43.30	43.30	43.30	43.30	216.50	242.49	0.0242
266.80	0.00	0.00	0.00	1.34	4.05	6.75	6.43	5.83	2.12	26.52	266.80	0.00	0.00	0.00	43.30	43.30	43.30	43.30	43.30	43.30	216.50	243.02	0.0243
266.90	0.00	0.00	0.00	1.52	4.22	6.93	6.43	5.83	2.12	27.06	266.90	0.00	0.00	0.75	43.30	43.30	43.30	43.30	43.30	43.30	217.25	244.31	0.0244
267.00	0.00	0.00	0.00	1.70	4.40	7.03	6.43	5.83	2.12	27.51	267.00	0.00	0.00	3.80	43.30	43.30	43.30	43.30	43.30	43.30	220.30	247.81	0.0248
267.10	0.00	0.00	0.00	1.87	4.58	7.03	6.43	5.83	2.12	27.87	267.10	0.00	0.00	7.90	43.30	43.30	43.30	43.30	43.30	43.30	224.40	252.27	0.0252
267.20	0.00	0.00	0.00	2.05	4.75	7.03	6.43	5.83	2.12	28.22	267.20	0.00	0.00	12.65	43.30	43.30	43.30	43.30	43.30	43.30	229.15	257.37	0.0257
267.30	0.00	0.00	0.00	2.23	4.93	7.03	6.43	5.83	2.12	28.57	267.30	0.00	0.00	17.75	43.30	43.30	43.30	43.30	43.30	43.30	234.25	262.82	0.0263
267.40	0.00	0.00	0.00	2.40	5.11	7.03	6.43	5.83	2.12	28.93	267.40	0.00	0.00	22.95	43.30	43.30	43.30	43.30	43.30	43.30	239.45	268.38	0.0268
267.50	0.00	0.00	0.00	2.58	5.28	7.03	6.43	5.83	2.12	29.28	267.50	0.00	0.00	28.15	43.30	43.30	43.30	43.30	43.30	43.30	244.65	273.93	0.0274
267.60	0.00	0.00	0.05	2.76	5.46	7.03	6.43	5.83	2.12	29.69	267.60	0.00	0.00	33.10	43.30	43.30	43.30	43.30	43.30	43.30	249.60	279.29	0.0279
267.70	0.00	0.00	0.23	2.93	5.64	7.03	6.43	5.83	2.12	30.22	267.70	0.00	0.00	37.55	43.30	43.30	43.30	43.30	43.30	43.30	254.05	284.27	0.0284
267.80	0.00	0.00	0.41	3.11	5.81	7.03	6.43	5.83	2.12	30.75	267.80	0.00	0.00	41.20	43.30	43.30	43.30	43.30	43.30	43.30	257.70	288.45	0.0288
267.90	0.00	0.00	0.58	3.29	5.99	7.03	6.43	5.83	2.12	31.28	267.90	0.00	0.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	259.80	291.08	0.0291
268.00	0.00	0.00	0.76	3.46	6.17	7.03	6.43	5.83	2.12	31.81	268.00	0.00	0.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	259.80	291.61	0.0292
268.10	0.00	0.00	0.94	3.64	6.34	7.03	6.43	5.83	2.12	32.34	268.10	0.00	0.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	259.80	292.14	0.0292
268.20	0.00	0.00	1.11	3.82	6.52	7.03	6.43	5.83	2.12	32.87	268.20	0.00	0.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	259.80	292.67	0.0293
268.30	0.00	0.00	1.29	3.99	6.70	7.03	6.43	5.83	2.12	33.40	268.30	0.00	0.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	259.80	293.20	0.0293
268.40	0.00	0.00	1.47	4.17	6.87	7.03	6.43	5.83	2.12	33.93	268.40	0.00	0.75	43.30	43.30	43.30	43.30	43.30	43.30	43.30	260.55	294.48	0.0294
268.50	0.00	0.00	1.64	4.35	7.05	7.03	6.43	5.83	2.12	34.46	268.50	0.00	3.80	43.30	43.30	43.30	43.30	43.30	43.30	43.30	263.60	298.06	0.0298
268.60	0.00	0.00	1.82	4.52	7.23	7.03	6.43	5.83	2.12	34.99	268.60	0.00	7.90	43.30	43.30	43.30	43.30	43.30	43.30	43.30	267.70	302.69	0.0303
268.70	0.00	0.00	2.00	4.70	7.40	7.03	6.43	5.83	2.12	35.52	268.70	0.00	12.65	43.30	43.30	43.30	43.30	43.30	43.30	43.30	272.45	307.97	0.0308
268.80	0.00	0.00	2.17	4.88	7.58	7.03	6.43	5.83	2.12	36.05	268.80	0.00	17.75	43.30	43.30	43.30	43.30	43.30	43.30	43.30	277.55	313.60	0.0314
268.90	0.00	0.00	2.35	5.05	7.58	7.03	6.43	5.83	2.12	36.40	268.90	0.00	22.95	43.30	43.30	43.30	43.30	43.30	43.30	43.30	282.75	319.15	0.0319
269.00	0.00	0.00	2.53	5.23	7.58	7.03	6.43	5.83	2.12	36.76	269.00	0.00	28.15	43.30	43.30	43.30	43.30	43.30	43.30	43.30	287.95	324.71	0.0325
269.10	0.00	0.00	2.70	5.41	7.58	7.03	6.43	5.83	2.12	37.11	269.10	0.00	33.10	43.30	43.30	43.30	43.30	43.30	43.30	43.30	292.90	330.01	0.0330
269.20	0.00	0.18	2.88	5.58	7.58	7.03	6.43	5.83	2.12	37.64	269.20	0.00	37.55	43.30	43.30	43.30	43.30	43.30	43.30	43.30	297.35	334.99	0.0335
269.30	0.00	0.35	3.06	5.76	7.58	7.03	6.43	5.83	2.12	38.17	269.30	0.00	41.20	43.30	43.30	43.30	43.30	43.30	43.30	43.30	301.00	339.17	0.0339
269.40	0.00	0.53	3.23	5.94	7.58	7.03	6.43	5.83	2.12	38.70	269.40	0.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	303.10	341.80	0.0342
269.50	0.00	0.71	3.41	6.11	7.58	7.03	6.43	5.83	2.12	39.23	269.50	0.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	303.10	342.33	0.0342
269.60	0.00	0.88	3.59	6.29	7.58	7.03	6.43	5.83	2.12	39.76	269.60	0.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	303.10	342.86	0.0343
269.70	0.00	1.06	3.76	6.47	7.58	7.03	6.43	5.83	2.12	40.29	269.70	0.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	303.10	343.39	0.0343
269.80	0.00	1.24	3.94	6.64	7.58	7.03	6.43	5.83	2.12	40.82	269.80	0.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	303.10	343.92	0.0344
269.90	0.00	1.41	4.12	6.82	7.58	7.03	6.43	5.83	2.12	41.35	269.90	0.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	303.10	344.45	0.0344
270.00	0.00	1.59	4.29	7.00	7.58	7.03	6.43	5.83	2.12	41.88	270.00	2.10	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	305.20	347.08	0.0347
270.10	0.00	1.77	4.47	7.17	7.58	7.03	6.43	5.83	2.12	42.41	270.10	5.75	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	308.85	351.26	0.0351
270.20	0.00	1.94	4.65	7.35	7.58	7.03	6.43	5.83	2.12	42.94	270.20	10.20	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	313.30	356.24	0.0356
270.30	0.00	2.12	4.82	7.53	7.58	7.03	6.43	5.83	2.12	43.47	270.30	15.15	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	318.25	361.72	0.0362
270.40	0.00	2.30	5.00	7.70	7.58	7.03	6.43	5.83	2.12	44.00	270.40	20.35	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	323.45	367.45	0.0367
270.50	0.00	2.47	5.18	7.85	7.58	7.03	6.43	5.83	2.12	44.50	270.50	25.55	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	328.65	373.15	0.0373
270.60	0.00	2.65	5.35	7.85	7.58	7.03	6.43	5.83	2.12	44.85	270.60	30.65	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	333.75	378.60	0.0379
270.70	0.12	2.83	5.53	7.85	7.58	7.03	6.43	5.83	2.12	45.33	270.70	35.40	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	338.50	383.83	0.0384
270.80	0.30	3.00	5.71	7.85	7.58	7.03	6.43	5.83	2.12	45.86	270.80	39.50	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	342.60	388.46	0.0388
270.90	0.48	3.18	5.88	7.85	7.58	7.03	6.43	5.83	2.12	46.39	270.90	42.55	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	345.65	392.04	0.0392
271.00	0.65	3.36	6.06	7.85	7.58	7.03	6.43	5.83	2.12	46.92	271.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	393.32	0.0393
271.10	0.83	3.53	6.24	7.85	7.58	7.03	6.43	5.83	2.12	47.45	271.10	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	393.85	0.0394
271.20	1.01	3.71	6.41	7.85	7.58	7.03	6.43	5.83	2.12	47.98	271.20	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	394.38	0.0394
271.30	1.18	3.89	6.59	7.85	7.58	7.03	6.43	5.83	2.12	48.51	271.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	394.91	0.0395
271.40	1.36	4.06	6.77	7.85	7.58	7.03	6.43	5.83	2.12	49.04	271.40	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	395.44	0.0395
271.50	1.54	4.24	6.94	7.85	7.58	7.03	6.43	5.83	2.12	49.57	271.50	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	395.97	0.0396
271.60	1.71	4.42	7.12	7.85	7.58	7.03	6.43	5.83	2.12	50.10	271.60	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	396.50	0.0396
271.70	1.89	4.59	7.30	7.85	7.58	7.03	6.43	5.83	2.12	50.63	271.70	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	397.03	0.0397
271.80	2.07	4.77	7.46	7.85	7.58	7.03	6.43	5.83	2.12	51.14	271.80	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	397.54	0.0398
271.90	2.24	4.95	7.46	7.85	7.58	7.03	6.43	5.83	2.12	51.49	271.90	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	397.89	0.0398
272.00	2.42	5.12	7.46	7.85	7.58	7.03	6.43	5.83	2.12	51.85	272.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	398.25	0.0398
272.10	2.60	5.30	7.46	7.85	7.58	7.03	6.43	5.83	2.12	52.20	272.10	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	398.60	0.0399
272.20	2.77	5.48	7.46	7.85	7.58	7.03	6.43	5.83	2.12	52.55	272.20	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	398.95	0.0399
272.30	2.95	5.65	7.46	7.85	7.58	7.03	6.43	5.83	2.12	52.91	272.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	399.31	0.0399
272.40	3.13	5.83	7.46	7.85	7.58	7.03	6.43	5.83	2.12	53.26	272.40	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	399.66	0.0400
272.50	3.30	6.01	7.46	7.85	7.58	7.03	6.43	5.83	2.12	53.62	272.50	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	400.02	0.0400
272.60	3.48	6.19	7.46	7.85	7.58	7.03	6.43	5.83	2.12	53.97	272.60	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	400.37	0.0400
272.70	3.66	6.29	7.46	7.85	7.58	7.03	6.43	5.83	2.12	54.25	272.70	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	400.65	0.0401
272.80	3.83	6.29	7.46	7.85	7.58	7.03	6.43	5.83	2.12	54.43	272.80	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	400.83	0.0401
272.90	4.01	6.29	7.46	7.85	7.58	7.03	6.43	5.83	2.12	54.60	272.90	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	401.00	0.0401
273.00	4.19	6.29	7.46	7.85	7.58	7.03	6.43	5.83	2.12	54.78	273.00	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	401.18	0.0401
273.10	4.36	6.29	7.46	7.85	7.58	7.03	6.43	5.83	2.12	54.96	273.10	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	401.36	0.0401
273.18	4.51	6.29	7.46	7.85	7.58	7.03	6.43	5.83	2.12	55.10	273.18	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	43.30	346.40	401.50	0.0401

Elevation (m)	Discharge		
	Head 1 (m)	Orifice 1 (cms)	Total (cms)
259.00	0.3850	0.275	0.275
259.10	0.4850	0.309	0.309
259.20	0.5850	0.339	0.339
259.30	0.6850	0.367	0.367
259.40	0.7850	0.393	0.393
259.50	0.8850	0.418	0.418
259.59	0.9750	0.438	0.438

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==============================================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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***** S U M M A R Y   O U T P U T *****

Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.2\voin.dat
Output filename: T:\2015PR~1\415375~1\Design\SWM\VO2\PROPOS~1\SCS Design Storm - Proposed (w Climate Change) - Bayview Alterna.out
Summary filename: T:\2015PR~1\415375~1\Design\SWM\VO2\PROPOS~1\SCS Design Storm - Proposed (w Climate Change) - Bayview Alterna.sum

DATE: 10/18/2016   TIME: 4:31:14 PM

USER: Bayview Drive - Alternative 1

COMMENTS: Oversized Pipe System

```
 ****************************
 ** SIMULATION NUMBER:   6 **
 ****************************
```
100-year 12 hour SCS Design Storm

```
  W/E COMMAND              HYD ID   DT     AREA    Qpeak Tpeak    R.V. R.C.    Qbase
                                    min     ha      cms   hrs      mm           cms

      START @   .00 hrs
      --------------------
      MASS STORM                   15.0
      [ Ptot=112.80 mm ]
*
  *   CALIB STANDHYD     0203  1  5.0    1.38     .45  6.00  86.02  .76    .000
      [I%=68.0:S%= 2.00]
*
  *   CALIB STANDHYD     0202  1  5.0    1.67     .54  6.00  83.92  .74    .000
      [I%=65.4:S%= 2.00]
*
  *   CALIB STANDHYD     0201  1  5.0    1.05     .38  6.00  95.68  .85    .000
      [I%=80.0:S%= 2.00]
*
      RESRVR [ 2 : 0203] 0209  1  5.0    1.38     .32  6.00  86.01  n/a    .000
      {ST=   .03 ha.m }
*
      RESRVR [ 2 : 0202] 0210  1  5.0    1.67     .29  6.08  83.90  n/a    .000
      {ST=   .04 ha.m }
*
      RESRVR [ 2 : 0201] 0211  1  5.0    1.06     .24  6.00  95.67  n/a    .000
      {ST=   .03 ha.m }
*
 FINISH

==============================================================================================================
```

```
==========================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
```

Developed and Distributed by Clarifica Inc.

***** S U M M A R Y   O U T P U T *****

Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.2\voin.dat
Output filename: T:\2015PR~1\415375~1\Design\SWM\VO2\PROPOS~1\SCS Design Storm - Proposed Road Use (Climate Change) - Big Bay.out
Summary filename: T:\2015PR~1\415375~1\Design\SWM\VO2\PROPOS~1\SCS Design Storm - Proposed Road Use (Climate Change) - Big Bay.sum

DATE: 10/18/2016   TIME: 4:32:46 PM

USER: Big Bay Point Road - Alternative 4

COMMENTS: Oversized Pipe System

```
****************************
** SIMULATION NUMBER:   6 **
****************************
```

100-year 12 hour SCS Design Storm

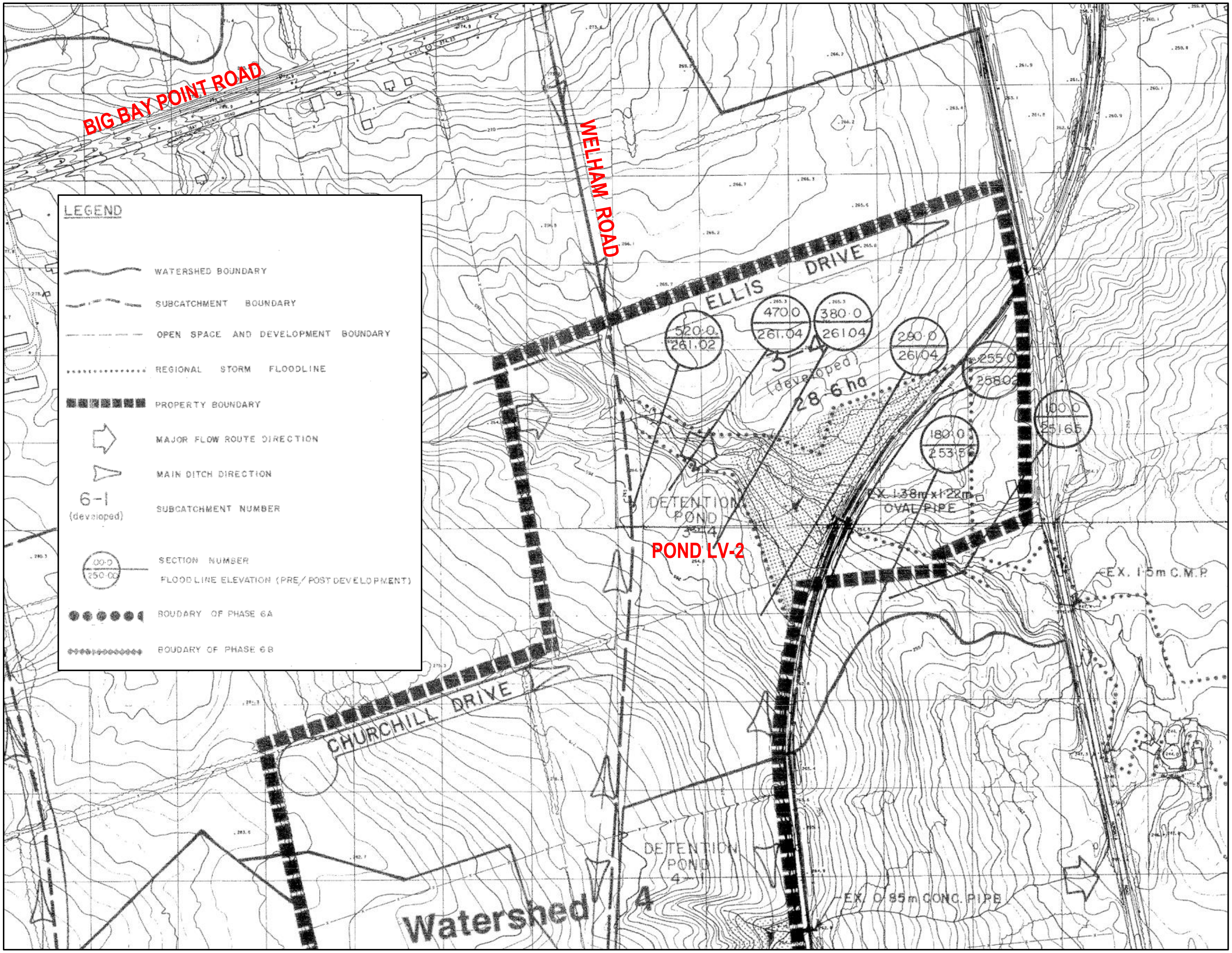
```
 W/E COMMAND            HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.   Qbase
                                min     ha     cms   hrs     mm          cms

     START @   .00 hrs
     --------------------
     MASS STORM                15.0
     [ Ptot=112.80 mm ]
*
  *  CALIB STANDHYD     0505  1  5.0   2.63    .95  6.00  96.49  .86    .000
     [I%=81.0:S%= 2.00]
*
  *  CALIB STANDHYD     0507  1  5.0   1.86    .66  6.00  94.07  .83    .000
     [I%=78.0:S%= 2.00]
*
     RESRVR [ 2 : 0505] 0512  1  5.0   2.63    .66  6.00  96.48  n/a    .000
     {ST=   .05 ha.m }
*
     RESRVR [ 2 : 0507] 0513  1  5.0   1.86    .42  6.00  94.06  n/a    .000
     {ST=   .04 ha.m }
*
 FINISH

==========================================================================================
```

APPENDIX E:
RETROFIT OPPORTUNITIES

Exerpt from Figure 2, South Barrie Business Park Phase 6A and 6B, R. E. Winter & Associates Ltd., 1989 – Pond LV-2



Pond LV-2

storm sewers and two stormwater management facilities and associated appurtenances to be constructed to service the South Barrie Business Park Phase 2 (51R-14253), Lots 9 and 10, Concession 12, in the City of Barrie as follows:

STORM SEWERS

STREET	FROM	TO
Welham Road	Approx. 205 m N. of Mapleview Drive	Approx. 25 m N. of Mapleview Drive

together with two stormwater management facilities

- a stormwater detention pond 4-1 to be located on a site approx. 150^m East of Welham Road, approx. 250 m North of Mapleview Drive and West of CNR Row, having a minimum storage capacity of 0.36^ha.m. to control the post development runoff to an existing watercourse to pre development levels during design storms up to and including the 1:100 year return storm event, L3

- a stormwater detention pond 3-4 to be located on a site East of Welham Road, approx. 175 m South of Ellis Drive and West of CNR Row, having a minimum storage capacity of 7.72 ha.m. to control post development runoff to an existing watercourse to pre development levels during design storms up to and including the regional return storm event, L2

and all associated works including inlet and outlet flow control structures and piping, low flow channels, chain link fencing around outlet structures, etc.,

all in accordance with the plans and report entitled "Storm Servicing Report for South Barrie Business Park January 1984" and stormwater computer modelling printout prepared by R. E. Winter and Associates Limited, Consulting Engineers, at a total estimated cost, including engineering and contingencies, of TWO HUNDRED AND FIFTY SIX THOUSAND NINE HUNDRED DOLLARS ($256,900.00).

Attn:-Mr. R. P. Bates, Clerk, City of Barrie
cc:-Mr. G. Mierzynski, Dir. C Reg., MOE
-R. E. Winter & Assoc. Ltd.
/gc

ENVIRONMENTAL APPROVALS AND
LAND USE PLANNING BRANCH

323-4399

May 20, 1987

Mr. R. P. Bates, Clerk
City of Barrie
Box 400
70 Collier Street
Barrie, Ontario
L4M 4T5

Dear Mr. Bates:

Enclosed herewith is the Ministry's Certificate of Approval No. 3 0294 87 006 for the construction of storm sewers, two stormwater management facilities and associated appurtenances to service the South Barrie Business Park Phase 2, in the City of Barrie, Ontario.

In giving final approval, it is assumed that the City of Barrie will take whatever preventive measures considered necessary to ensure that the overall stormwater management system is not a safety hazard.

Copies of this advisory letter and the attached Certificate of Approval are being forwarded to the persons indicated below.

Yours truly,

T. D. Armstrong
Assistant Director

Encl.

JC/gc

c.c. Mr. G. Mierzynski, Dir. C Reg., MOE
R. E. Winter & Assoc. Ltd.

BARRIE COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
CCTA PROJECT No.: 114001

BARRIE CREEKS STUDY AREA
SWMF RETROFIT OPPORTUNITIES
April 2, 2014

Management Unit	SWMF ID	SWMF Location	Exsisting SWMF	Type of SWMF	Retrofit Opportunity No.	Feasible Treatment Level
Sophia Creek	SP1	Southwest of St.Vincent Street and north of Grove Street East	Yes	Dry Pond (Online)	4	Constrained
	SP3	Southeast of Highway 400 and north of Ottaway Ave.	Yes	Dry Pond	8	Constrained
Kidds Creek	-	Southwest of Bayfield Street between Coulter Street and Highway 400	No	Wet Pond	17	Enhanced
	KD1	North corner of Highway 400 and Sunnidale Road.	Yes	Dry Pond (Online)	14	Enhanced
	KD3	South of Sunnidale Road and northeast of Irwin Drive	Yes	Dry Pond	13	Constrained
	KD6	North corner of Livingstone Street West and Ford Street.	Yes	Dry Pond	11	Normal
Hotchkiss Creek	-	Between Morrow Road and Highway 400 north of Essa Road	No	Wet Pond	44	Enhanced
	-	Between Patterson Road and Highway 400 east of Philips Street	No	Wet Pond	39	Enahnced
	-	West of Patterson Road between Tiffin Street and Philips Street	No	Wet Pond	38	Enhanced
	HT6	West of Bryne Drive, South of Ardagh	Yes	Dry Pond/Infiltration	3	Enhanced
	-	North of Ardagh Road	No	Wet Pond	55	Enahnced
Whiskey Creek	-	North of Big Bay Point Road and between Huronia Road and Pickett Crescent	No	Wet Pond	26	Basic
	-	Southeast corner of Montserrand Street and Beacon Road	No	Wet Pond	42	Enhanced
	-	Northeast corner of Chieftan Crescent	No	Wet Pond	40	Enhanced
	WK1	Northwest corner of Herrell Avenue and Firman Drive	Yes	Dry Pond	25	Enhanced
	WK4	South of Tollendal Mill Road and west of Wallwin's Way	Yes	Wetland	20	Normal
Dyments Creek	DY2	Northwest of McVeigh Drive and south of Cundles Road West .	Yes	Dry Pond	15	Enhanced
Management Unit 1	HR1	West. of Minet's Point Road, between Burton Avenue and Lakeshore Drive	Yes	Dry Pond	28	Basic

1) City of Barrie Secondary Plan, Background Studies & Infrastructure Master Plan Intensification & Annexed Lands. Amec (October 2013).

BARRIE COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
CCTA PROJECT No.: 114001

BARRIE CREEKS STUDY AREA
SWMF RETROFIT OPPORTUNITIES EVALUATION
April 22, 2014

Management Unit	Rank	SWMF ID	SWMF Location	Type of SWMF	Physical Environment								Natural Environment					
					Existing SWM Facility		Land Ownership		Online/Offline		P Removal Opportunity		Impact to Existing	Natural Feature Adjacency	Linkage Opportunity	Potential Fisheries Impact	Potential for Thermal Impacts	
											kg	Score					Type	Score
Sophia Creek	7	SP1	Southwest of St.Vincent Street and north of Grove Street East	Dry Pond	Yes	0	City	2	Online	0	12.8	5	2	1	0	1	Warm	1
	1	SP3	Southeast of Highway 400 and north of Ottaway Ave.	Dry Pond	Yes	1	City	2	Offline	1	8.1	4	3	1	0	2	Warm	1
Kidds Creek	9	-	Southwest of Bayfield Street between Coulter Street and Highway 400	Wet Pond	No	0	City	2	Offline	1	7.2	4	1	0	0	0	Cold	0
	11	KD1	North corner of Highway 400 and Sunnidale Road.	Dry Pond	Yes	0	City	2	Offline	1	3.2	2	0	0	0	0	Cold	0
	2	KD3	South of Sunnidale Road and northeast of Irwin Drive	Dry Pond	Yes	1	City	2	Offline	1	3	2	2	1	0	3	Cold	0
	3	KD6	North corner of Livingstone Street West and Ford Street.	Dry Pond	Yes	1	City	2	Offline	1	8	4	2	1	0	1	Cold	0
Hotchkiss Creek	8	-	Between Morrow Road and Highway 400 north of Essa Road	Wet Pond	No	0	Private	0	Offline	1	2.9	1	3	1	0	2	Cold	0
	10	-	Between Patterson Road and Highway 400 east of Philips Street	Wet Pond	No	0	Private	0	Offline	1	2.7	1	2	1	0	2	Cold	0
	13	-	West of Patterson Road between Tiffin Street and Philips Street	Wet Pond	No	0	Private	0	Offline	1	1.5	0	2	1	0	2	Cold	0
	3	HT6	West of Bryne Drive, South of Ardagh	Dry Pond	Yes	1	City	2	Offline	1	3.7	2	2	0	0	2	Cold	0
	14	-	North of Ardagh Road	Wet Pond	No	0	City	2	Offline	1	1.9	0	0	0	0	2	Cold	0
Whiskey Creek	12	-	North of Big Bay Point Road and between Huronia Road and Pickett Crescent	Wet Pond	No	0	City	2	Offline	1	1.9	0	1	0	0	1	Cold	0
	12	-	Southeast corner of Montserrand Street and Beacon Road	Wet Pond	No	0	Private	0	Offline	1	3.7	2	1	0	0	2	Cold	0
	15	-	Northeast corner of Chieftan Crescent	Wet Pond	No	0	Private	0	Offline	1	1.8	0	3	1	0	2	Cold	0
	5	WK1	Northwest corner of Herrell Avenue and Firman Drive	Dry Pond	Yes	1	City	2	Offline	1	3.4	2	2	1	0	2	Cold	0
	6	WK4	South of Tollendal Mill Road and west of Wallwin's Way	Wetland	Yes	1	City	2	Offline	1	2	0	1	0	0	2	Cold	0
Dyments Creek	3	DY2	Northwest of McVeigh Drive and south of Cundles Road West .	Dry Pond	Yes	1	City	2	Offline	1	3.7	2	2	1	1	3	Cold	0
Management Unit 1	4	HR1	West. of Minet's Point Road, between Burton Avenue and Lakeshore Drive	Dry Pond	Yes	1	Private	0	Offline	1	8.4	4	2	1	1	0	Cold	0
					Evaluation Criteria													
					Existing SWMF (Yes/No)		City / MTO / Private		Online/Offline		kg of P Reduction		Impact (Yes/No)	Sensitive/Non Sensitive	Opportunity (Yes/No)	Impact Potential	Cold/Warm	
				Maximum Score	1		2		1		5		3	1	1	3	1	
				Criteria Weight	3		3		3		5		2	1	1	3	3	

Management Unit	Rank	SWMF ID	SWMF Location	Type of SWMF	Social Environment			Economic Environment			Total Score
					Loss of Recreational	Adjacent Land Uses		Capital Cost			
								$	$/kg P	Score	
Sophia Creek	7	SP1	Southwest of St.Vincent Street and north of Grove Street East	Dry Pond	0	RES	0	$1,242,050	$97,255	2	16.3
	1	SP3	Southeast of Highway 400 and north of Ottaway Ave.	Dry Pond	1	HWY, IND & RES	1	$531,860	$65,588	3	27.0
Kidds Creek	9	-	Southwest of Bayfield Street between Coulter Street and Highway 400	Wet Pond	0	OS & COM	2	$1,147,200	$158,730	1	13.7
	11	KD1	North corner of Highway 400 and Sunnidale Road.	Dry Pond	1	RES & EP	1	$330,660	$104,762	2	13.0
	2	KD3	South of Sunnidale Road and northeast of Irwin Drive	Dry Pond	1	RES & INS	1	$189,473	$62,915	3	22.3
	3	KD6	North corner of Livingstone Street West and Ford Street.	Dry Pond	0	INS & RES	1	$600,000	$75,472	3	20.3
Hotchkiss Creek	8	-	Between Morrow Road and Highway 400 north of Essa Road	Wet Pond	1	IND & OS	3	$672,901	$233,464	0	14.0
	10	-	Between Patterson Road and Highway 400 east of Philips Street	Wet Pond	1	RES	3	$632,616	$236,216	0	13.3
	13	-	West of Patterson Road between Tiffin Street and Philips Street	Wet Pond	1	RES	3	$293,671	$193,189	0	12.3
	3	HT6	West of Bryne Drive, South of Ardagh	Dry Pond	1	COM	3	$582,000	$158,730	1	20.3
	14	-	North of Ardagh Road	Wet Pond	1	IND, RES & INS	0	$198,000	$104,762	2	12.0
Whiskey Creek	12	-	North of Big Bay Point Road and between Huronia Road and Pickett Crescent	Wet Pond	0	IND & INS	2	$122,310	$62,791	3	12.7
	12	-	Southeast corner of Montserrand Street and Beacon Road	Wet Pond	1	RES & IND	2	$583,924	$158,438	1	12.7
	15	-	Northeast corner of Chieftan Crescent	Wet Pond	1	RES & IND	0	$336,252	$183,792	0	10.0
	5	WK1	Northwest corner of Herrell Avenue and Firman Drive	Dry Pond	0	COM & RES	1	$359,766	$104,762	2	18.3
	6	WK4	South of Tollendal Mill Road and west of Wallwin's Way	Wetland	1	OS & RES	1	$147,600	$75,472	3	17.7
Dyments Creek	3	DY2	Northwest of McVeigh Drive and south of Cundles Road West .	Dry Pond	0	RES & OS	1	$383,130	$104,762	2	20.3
Management Unit 1	4	HR1	West. of Minet's Point Road, between Burton Avenue and Lakeshore Drive	Dry Pond	1	COM	3	$1,041,845	$124,328	1	19.3
					Evaluation Criteria						
					Loss (Yes/No)	Adjacent Land Use		$/kg of P Reduction			Total Score
				Maximum Score	1	3		3			32
				Criteria Weight	2	3		3			-

Source 1: Appendix E - Stormwater Management Retrofit Assessment (Staff Report No.: ENG015-09). City of Barrie (February 2009)

Note 1: RES - Residential, COM - Commercial, IND - Industrial, INS - Institutional, HWY - Highway, OP - Open Space, EP - Environmental Protection

Note 2: Scores for each **Evaluation Criteria** are normalized by dividing by the **Maximum Score** before being multiplied by the Criteria Weight and then summed to get the Total Score for the Retrofit Opportunity.

Note 3: Scoring System - Refer to Appendix E - Stormwater Management Retrofit Assessment for full explanation of scoring system.

BARRIE COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
CCTA PROJECT No.: 114001

BARRIE CREEKS STUDY AREA
SWMF RETROFIT OPPORTUNITIES EVALUATION
JULY 24, 2014

EVALUATION CRITERIA

1) RES - Resedential
COM - Commercial
IND - Industrial
INS - Institutional
HWY - Highway
OS - Open Space
EP - Environmental Protection

2) Existing SWM Facility

Is there an existing SWM facility?	Score
Yes	1
No	0

3) Land Ownership

Retrofit Opportunity Value	Score
City	2
Other Public Body	1
Private	0

4) Phosphorus Remnoval Opportunity

Potential Phosphorus Removal (kg)	Score
>= 12 kg	5
< 12 kg, >=7 kg	4
< 7 kg, >=4 kg	3
< 4 kg, >= 3 kg	2
< 3 kg, >= 2 kg	1
< 2 kg	0

5) Online / Offline

Facility Type	Value Score
Offline	1
Online	0

6) Natural Feature Adjacency

Adjacency of Natural Features	Score
Non-sensitive natural feature within 50m of SWM boundary	1
Sensitive natural feature (wetland) within 50m of SWM boundary OR Any natural feature (or portion) within SWM boundary	0

7) Impact to Existing Vegetation

Impact to Existing Trees	Score
None (0 % tree cover)	3
Minor (0 – 25% tree cover)	2
Moderate (25 – 60% tree cover)	1
Significant (>60% tree cover)	0

8) Linkage Opportunity

Linkage Opportunity	Score
Retrofit would create a	1
Otherwise	0

9) Thermal Impacts to Downstream (receiving) Watercourse

Retrofit Opportunity Value	Value Score
Warm water	1
Cold water	0

10) Potential Fisheries Impact

Potential Fisheries Impact	Value Score
Ponds with some distance or a barrier to the watercourse	3
Ponds with creeks nearby	2
Warm water stream online opportunities	1
Presence of SAR fish and mussels or online coldwater stream opportunities	0

11) Adjacent Land Use

Adjacent Land Use Classification	Value Score
Industrial/commercial	3
Park / Open Space / Institutional	2
Residential, existing quantity control pond	1
Residential, no existing pond	0

12) Loss of Park Land Uses

Loss of Parkland	Value Score
No	1
Yes	0

13) Capital Cost

Capital Cost	Score
< $80,000 / kg	3
>= $80,000 / kg, <$120,000 / kg	2
>= $120,000 / kg, <$180,000 / kg	1
>= $180,000 / kg	0

BARRIE COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
CCTA PROJECT No.: 114001

LOVERS CREEK, HEWITTS CREEK AND ANNEXATION LANDS STUDY AREA
SWMF RETROFIT OPPORTUNITIES
April 2, 2014

Management Unit	SWMF ID	SWMF Location	Exsisting SWMF	Type of SWMF	Retrofit Opportunity No.	Feasible Treatment Level
	-	Drainage easement south of Ellis Drive	No	Wet Pond	67	Constrained
Lovers Creek	LV1	South corner of Cox Mill Road and Hurst Drive	Yes	Wet Pond	68	Normal
	LV3	East of Welham Drive. and North of Mapleview Drive.	Yes	Dry Pond	31	Enhanced
	LV5	West of Bayview Drive and north of Saunders Road.	Yes	Dry Pond (Online)	45	Basic
	LV7	West of Bayview Drive, North of Salem Road	Yes	Dry Pond (Online)	65	Basic
	LV10	Northwest corner of Cox Mill Road and Mary Anne Drive	Yes	Dry Pond	37	Constrained
	LV12	East of Welham Road and north of Saunders Road.	Yes	Dry Pond	32	Enhanced
	LV13	Northeast corner of Macmillan Crescent and Tomlin Crescentt.	Yes	Dry Pond	21	Constrained
	LV18	Southeast corner of Chalmers Drive and Loon Avenue	Yes	Dry Pond	24	Basic
Hewitts Creek	-	Southeast corner of Walnut Crescent	No	Wet Pond	27	Enhanced

1) City of Barrie Secondary Plan, Background Studies & Infrastructure Master Plan Intensification & Annexed Lands. Amec (October 2013).

BARRIE COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
CCTA PROJECT No.: 114001

LOVERS CREEK, HEWITTS CREEK AND ANNEXATION LANDS STUDY AREA
SWMF RETROFIT OPPORTUNITIES EVALUATION
April 22, 2014

Management Unit	Rank	SWMF ID	SWMF Location	Type of SWMF	Physical Environment								Natural Environment					
					Existing SWM Facility		Land Ownership		Online/Offline		P Removal Opportunity		Impact to Existing Trees	Natural Feature Adjacency	Linkage Opportunity	Potential Fisheries Impact	Potential for Thermal Impacts	
											kg	Score					Type	Score
Lovers Creek	5	-	Drainage easement south of Ellis Drive	Wet Pond	No	0	City	2	Offline	1	2	0	2	1	0	3	Cold	0
	1	LV1	South corner of Cox Mill Road and Hurst Drive	Wet Pond	Yes	1	City	2	Offline	1	11.8	4	2	1	0	2	Cold	0
	3	LV3	East of Welham Drive. and North of Mapleview Drive.	Dry Pond	Yes	1	City	2	Offline	1	2	1	2	1	0	3	Cold	0
	7	LV5	West of Bayview Drive and north of Saunders Road.	Dry Pond	Yes	1	City	2	Online	0	5.8	3	0	0	0	1	Cold	0
	4	LV7	West of Bayview Drive, North of Salem Road	Dry Pond	Yes	1	City	2	Online	0	11.6	4	3	1	0	1	Cold	0
	3	LV10	Northwest corner of Cox Mill Road and Mary Anne Drive	Dry Pond	Yes	1	City	2	Offline	1	2.3	1	2	1	0	3	Cold	0
	3	LV12	East of Welham Road and north of Saunders Road.	Dry Pond	Yes	1	City	2	Offline	1	3.2	2	2	1	0	2	Cold	0
	6	LV13	Northeast corner of Macmillan Crescent and Tomlin Crescent.	Dry Pond	Yes	1	City	2	Offline	1	1	0	1	0	1	1	Cold	0
	2	LV18	Southeast corner of Chalmers Drive and Loon Avenue	Dry Pond	Yes	1	City	2	Offline	1	2.8	1	3	1	1	2	Cold	0
Hewitts Creek	8	-	Southeast corner of Walnut Crescent	Wet Pond	No	0	City	2	Offline	1	6.7	3	0	0	0	2	Cold	0
					Evaluation Criteria													
					Existing SWMF (Yes/No)		City / MTO / Private		Online/Offline		kg of P Reduction		Impact (Yes/No)	Sensitive/Non Sensitive	Opportunity (Yes/No)	Impact Potential	Cold/Warm	
				Maximum Score	1		2		1		5		3	1	1	3	1	
				Criteria Weight	3		3		3		5		2	1	1	3	3	

Management Unit	Rank	SWMF ID	SWMF Location	Type of SWMF	Social Environment			Economic Environment			Total Score
					Loss of Parkland Uses	Adjacent Land Uses		Capital Cost			
								$	$/kg P	Score	
Lovers Creek	5	-	Drainage easement south of Ellis Drive	Wet Pond	1	IND	3	$77,044	$38,911	3	19.3
	1	LV1	South corner of Cox Mill Road and Hurst Drive	Wet Pond	1	COM & RES	1	$888,000	$75,472	3	23.3
	3	LV3	East of Welham Drive. and North of Mapleview Drive.	Dry Pond	1	IND & EP	3	$318,900	$158,730	1	21.3
	7	LV5	West of Bayview Drive and north of Saunders Road.	Dry Pond	1	COM & IND	3	$619,704	$106,047	2	17.0
	4	LV7	West of Bayview Drive, North of Salem Road	Dry Pond	1	IND	3	$1,231,200	$106,047	2	21.0
	3	LV10	Northwest corner of Cox Mill Road and Mary Anne Drive	Dry Pond	1	RES & OS	1	$80,619	$35,329	3	21.3
	3	LV12	East of Welham Road and north of Saunders Road.	Dry Pond	1	IND & EP	3	$500,880	$158,730	1	21.3
	6	LV13	Northeast corner of Macmillan Crescent and Tomlin Crescent.	Dry Pond	1	OS & RES	1	$76,393	$75,356	3	17.7
	2	LV18	Southeast corner of Chalmers Drive and Loon Avenue	Dry Pond	1	RES & EP	1	$176,985	$62,791	3	22.0
Hewitts Creek	8	-	Southeast corner of Walnut Crescent	Wet Pond	1	RES	0	$697,554	$104,762	2	15.0
					Evaluation Criteria						
					Loss (Yes/No)	Adjacent Land Use		$/kg of P Reduction			Total Score
				Maximum Score	1	3		3			32
				Criteria Weight	2	3		3			-

Source 1: Appendix E - Stormwater Management Retrofit Assessment (Staff Report No.: ENG015-09). City of Barrie (February 2009)

Note 1: RES - Residential, COM - Commercial, IND - Industrial, INS - Institutional, HWY - Highway, OP - Open Space, EP - Environmental Protection

Note 2: Scores for each **Evaluation Criteria** are normalized by dividing by the **Maximum Score** before being multiplied by the Criteria Weight and then summed to get the Total Score for the Retrofit Opportunity.

Note 3: Scoring System - Refer to Appendix E - Stormwater Management Retrofit Assessment for full explanation of scoring system.

BARRIE COMPREHENSIVE STORMWATER MANAGEMENT MASTER PLAN
CCTA PROJECT No.: 114001

LOVERS CREEK, HEWITTS CREEK AND ANNEXATION LANDS STUDY AREA
SWMF RETROFIT OPPORTUNITIES EVALUATION
JULY 24, 2014

EVALUATION CRITERIA

1) RES - Resedential
COM - Commercial
IND - Industrial
INS - Institutional
HWY - Highway
OS - Open Space
EP - Environmental Protection

2) Existing SWM Facility

Is there an existing SWM facility?	Score
Yes	1
No	0

3) Land Ownership

Retrofit Opportunity Value	Score
City	2
Other Public Body	1
Private	0

4) Phosphorus Remnoval Opportunity

Potential Phosphorus Removal (kg)	Score
>= 12 kg	5
< 12 kg, >=7 kg	4
< 7 kg, >=4 kg	3
< 4 kg, >= 3 kg	2
< 3 kg, >= 2 kg	1
< 2 kg	0

5) Online / Offline

Facility Type	Value Score
Offline	1
Online	0

6) Natural Feature Adjacency

Adjacency of Natural Features	Score
Non-sensitive natural feature within 50m of SWM boundary	1
Sensitive natural feature (wetland) within 50m of SWM boundary OR Any natural feature (or portion) within SWM boundary	0

7) Impact to Existing Vegetation

Impact to Existing Trees	Score
None (0 % tree cover)	3
Minor (0 – 25% tree cover)	2
Moderate (25 – 60% tree cover)	1
Significant (>60% tree cover)	0

8) Linkage Opportunity

Linkage Opportunity	Score
Retrofit would create a linkage of 2 non-sensitive natural features	1
Otherwise	0

9) Thermal Impacts to Downstream (receiving) Watercourse

Retrofit Opportunity Value	Value Score
Warm water	1
Cold water	0

10) Potential Fisheries Impact

Potential Fisheries Impact	Value Score
Ponds with some distance or a barrier to the watercourse	3
Ponds with creeks nearby	2
Warm water stream online opportunities	1
Presence of SAR fish and mussels or online coldwater stream opportunities	0

11) Adjacent Land Use

Adjacent Land Use Classification	Value Score
Industrial/commercial	3
Park / Open Space / Institutional	2
Residential, existing quantity control pond	1
Residential, no existing pond	0

12) Loss of Park Land Uses

Loss of Parkland	Value Score
No	1
Yes	0

13) Capital Cost

Capital Cost	Score
< $80,000 / kg	3
>= $80,000 / kg, <$120,000 / kg	2
>= $120,000 / kg, <$180,000 / kg	1
>= $180,000 / kg	0

APPENDIX F:
OVERLAND FLOW CALCULATIONS

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Wednesday, Sep 28 2016

3 Lane Configuration - Bayview Drive

User-defined

Invert Elev (m)	= 1.0000
Slope (%)	= 0.6000
N-Value	= 0.020

Calculations

Compute by:	Known Depth
Known Depth (m)	= 0.2480

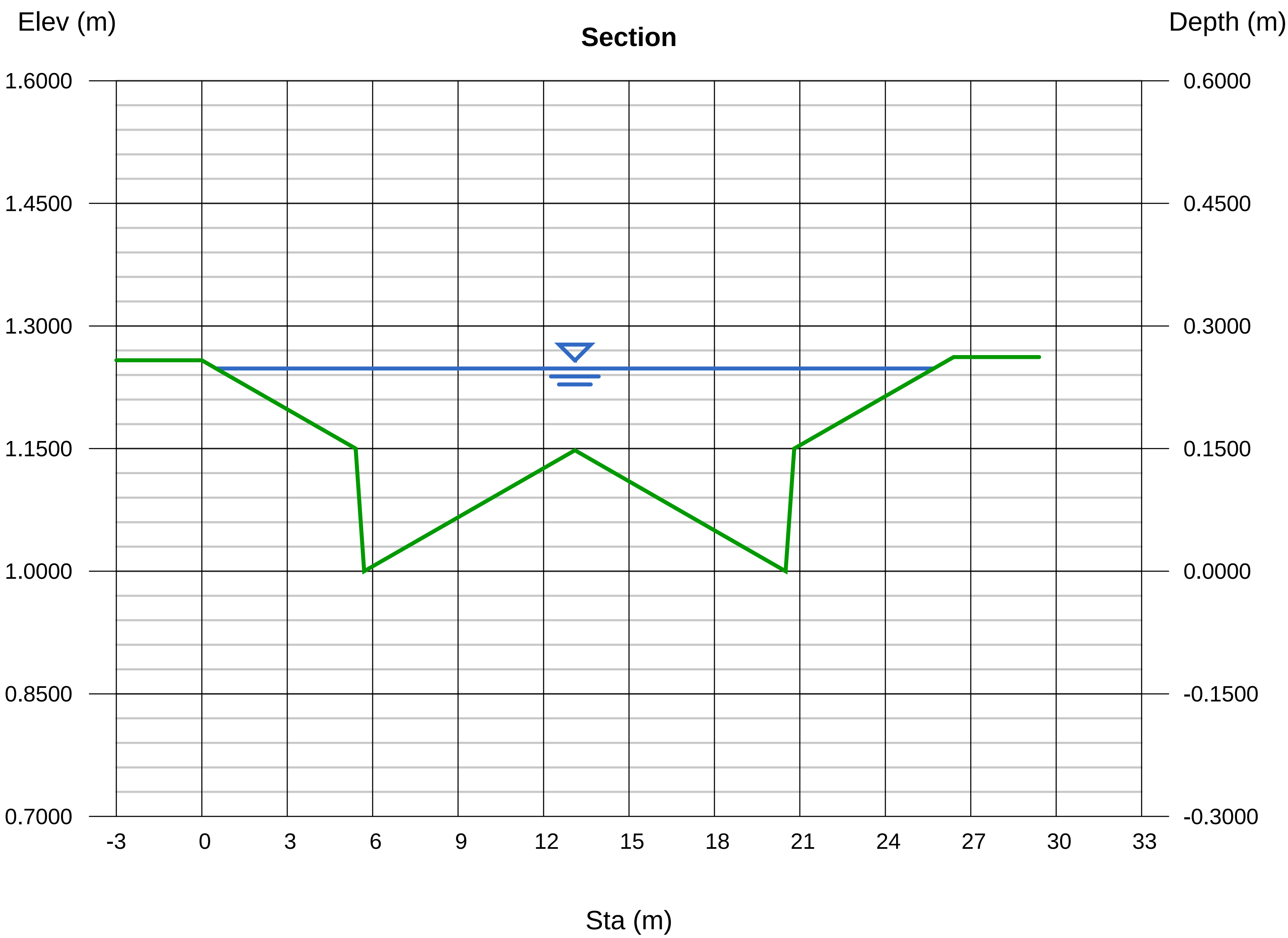
Highlighted

Depth (m)	= 0.2480
Q (cms)	= 3.0909
Area (sqm)	= 3.1592
Velocity (m/s)	= 0.9784
Wetted Perim (m)	= 25.2757
Crit Depth, Yc (m)	= 0.2377
Top Width (m)	= 25.2000
EGL (m)	= 0.2968

(Sta, El, n)-(Sta, El, n)...

(0.0000, 1.2580)-(0.5000, 1.2480, 0.032)-(2.5000, 1.2080, 0.013)-(5.4000, 1.1500, 0.032)-(5.7000, 1.0000, 0.013)-(13.1000, 1.1480, 0.013)-(20.5000, 1.0000, 0.013
-(20.8000, 1.1500, 0.013)-(26.4000, 1.2620, 0.032)

At depth = 0.248 m, water surface is 0.10 m above the crown of the road.



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Wednesday, Sep 28 2016

5 Lane Configuration - Bayview Drive

User-defined

Invert Elev (m)	=	1.0000
Slope (%)	=	0.6000
N-Value	=	0.017

Calculations

Compute by:		Known Depth
Known Depth (m)	=	0.2550

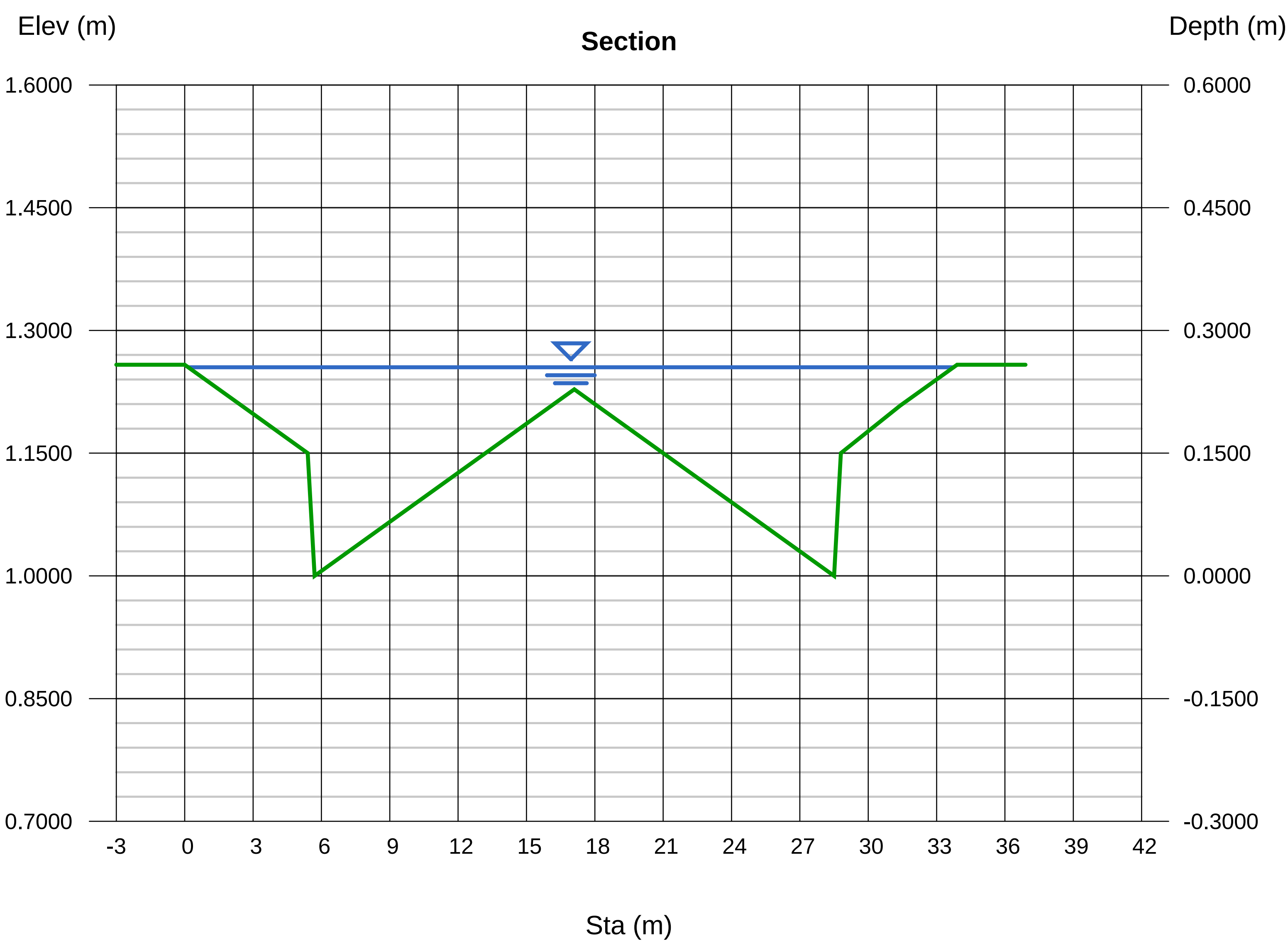
Highlighted

Depth (m)	=	0.2550
Q (cms)	=	4.0843
Area (sqm)	=	3.8512
Velocity (m/s)	=	1.0605
Wetted Perim (m)	=	33.6776
Crit Depth, Yc (m)	=	0.2560
Top Width (m)	=	33.6000
EGL (m)	=	0.3124

(Sta, El, n)-(Sta, El, n)...

(0.0000, 1.2580)-(0.5000, 1.2480, 0.032)-(2.5000, 1.2080, 0.013)-(5.4000, 1.1500, 0.032)-(5.7000, 1.0000, 0.013)-(17.1000, 1.2280, 0.013)-(28.5000, 1.0000, 0.013
-(28.8000, 1.1500, 0.013)-(31.4000, 1.2080, 0.032)-(33.4000, 1.2480, 0.013)-(33.9000, 1.2580, 0.032)

At depth = 0.255 m, water surface is 0.03 m above the crown of the road and ROW is at capacity.



Channel Report

5 Lane Configuration - Big Bay Point Road

User-defined

Invert Elev (m)	=	1.0000
Slope (%)	=	1.5000
N-Value	=	0.017

Calculations

Compute by:		Known Depth
Known Depth (m)	=	0.1930

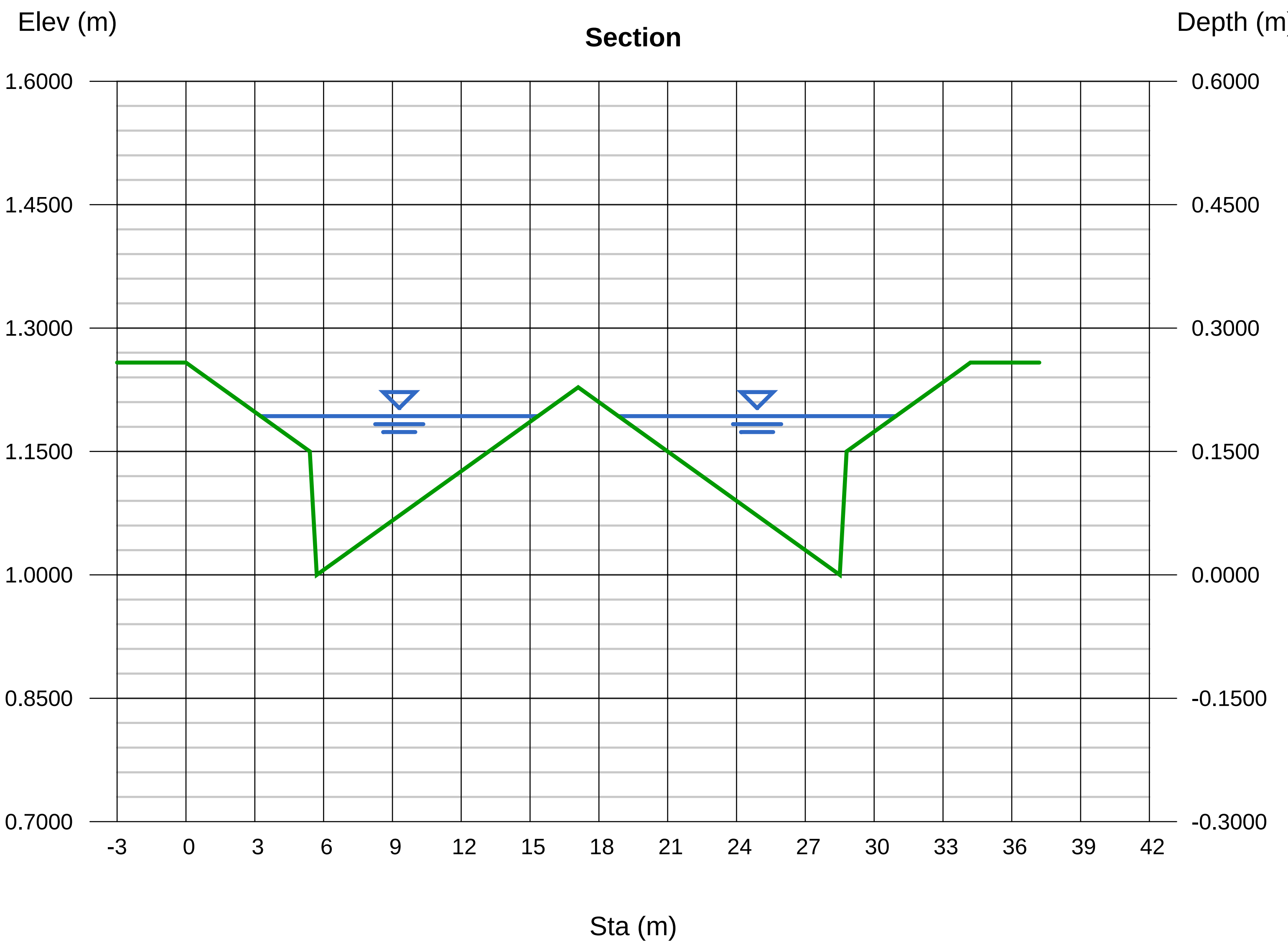
Highlighted

Depth (m)	=	0.1930
Q (cms)	=	2.7771
Area (sqm)	=	2.0257
Velocity (m/s)	=	1.3709
Wetted Perim (m)	=	24.2755
Crit Depth, Yc (m)	=	0.2256
Top Width (m)	=	24.2000
EGL (m)	=	0.2889

(Sta, El, n)-(Sta, El, n)...

(0.0000, 1.2580)-(0.5000, 1.2480, 0.032)-(2.5000, 1.2080, 0.013)-(5.4000, 1.1500, 0.032)-(5.7000, 1.0000, 0.013)-(17.1000, 1.2280, 0.013)-(28.5000, 1.0000, 0.013
-(28.8000, 1.1500, 0.013)-(31.7000, 1.2080, 0.032)-(33.7000, 1.2480, 0.013)-(34.2000, 1.2580, 0.032)

Depth of 0.193 m corresponds to maximum depth of ponding that allows for one 3.5 m width lane of traffic to remain open



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Sep 28 2016

7 Lane Configuration - Big Bay Point Road

User-defined

Invert Elev (m)	=	1.0000
Slope (%)	=	1.5000
N-Value	=	0.017

Calculations

Compute by:		Known Depth
Known Depth (m)	=	0.2180

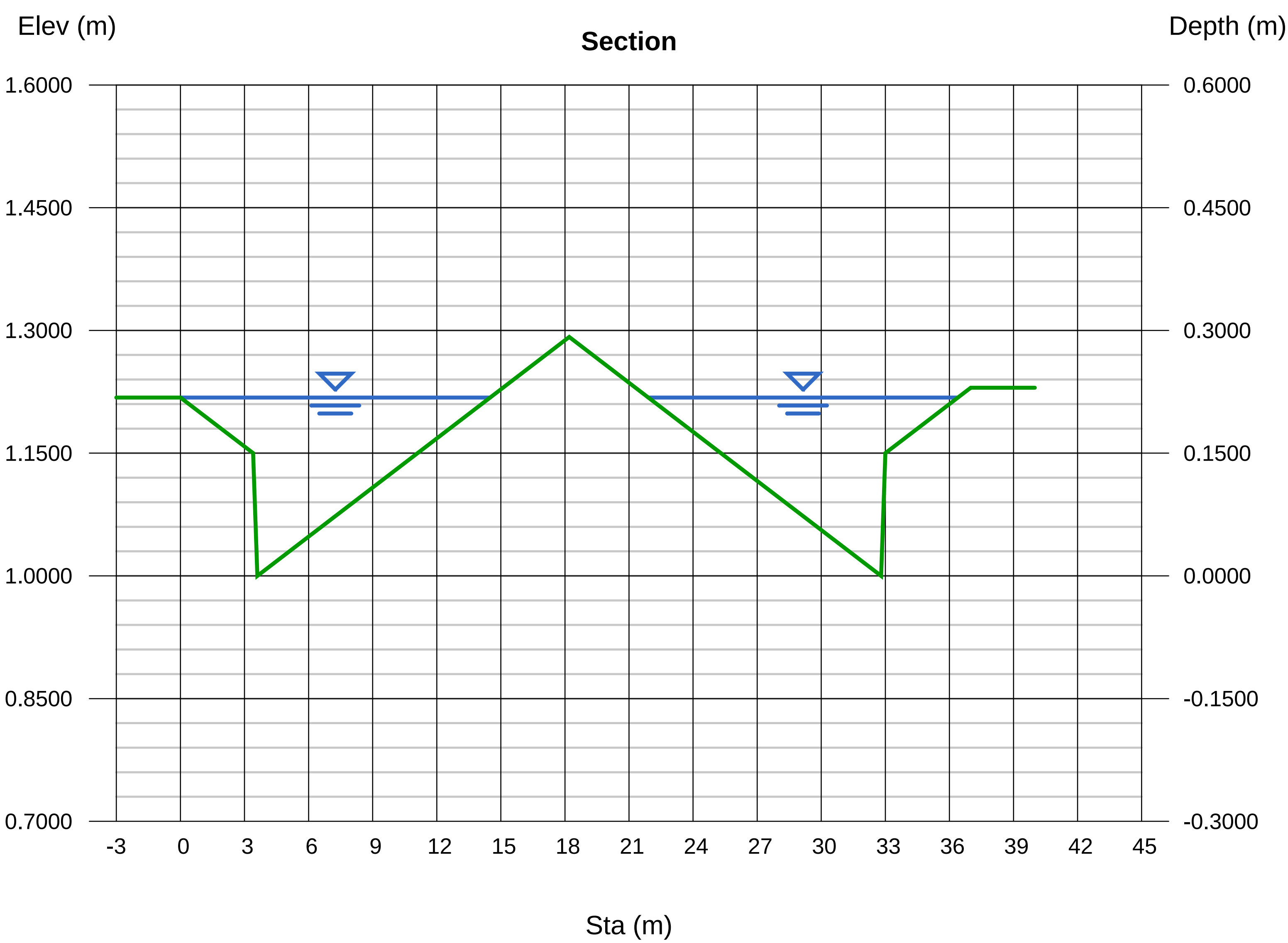
Highlighted

Depth (m)	=	0.2180
Q (cms)	=	3.9297
Area (sqm)	=	2.6646
Velocity (m/s)	=	1.4748
Wetted Perim (m)	=	29.1057
Crit Depth, Yc (m)	=	0.2530
Top Width (m)	=	29.0000
EGL (m)	=	0.3289

(Sta, El, n)-(Sta, El, n)...

(0.0000, 1.2180)-(3.4000, 1.1500, 0.032)-(3.6000, 1.0000, 0.013)-(18.2000, 1.2920, 0.013)-(32.8000, 1.0000, 0.013)-(33.0000, 1.1500, 0.013)-(34.5000, 1.1800, 0.0
-(36.5000, 1.2200, 0.013)-(37.0000, 1.2300, 0.032)

Depth of 0.218 m corresponds to the depth of ponding at the ROW's maximum capacity that allows for a 7.4 m width to remain open at the road center



APPENDIX G:
WATER QUALITY CONTROL SIZING

3.3.2 Water Quality Sizing Criteria

The volumetric water quality criteria are presented in Table 3.2. The values are based on a 24 hour drawdown time and a design which conforms to the guidance provided in this manual. Requirements differ with SWMP type to reflect differences in removal efficiencies. Of the specified storage volume for wet facilities, 40 m^3/ha is extended detention, while the remainder represents the permanent pool.

Table 3.2 Water Quality Storage Requirements based on Receiving Waters[1, 2]

Protection Level	SWMP Type	Storage Volume (m^3/ha) for Impervious Level			
		35%	**55%**	**70%**	**85%**
Enhanced 80% long-term S.S. removal	Infiltration	25	30	35	40
	Wetlands	80	105	120	140
	Hybrid Wet Pond/Wetland	110	150	175	195
	Wet Pond	140	190	225	250
Normal 70% long-term S.S. removal	Infiltration	20	20	25	30
	Wetlands	60	70	80	90
	Hybrid Wet Pond/Wetland	75	90	105	120
	Wet Pond	90	110	130	150
Basic 60% long-term S.S. removal	Infiltration	20	20	20	20
	Wetlands	60	60	60	60
	Hybrid Wet Pond/Wetland	60	70	75	80
	Wet Pond	60	75	85	95
	Dry Pond (Continuous Flow)	90	150	200	240

[1]*Table 3.2 does not include every available SWMP type. Any SWMP type that can be demonstrated to the approval agencies to meet the required long-term suspended solids removal for the selected protection levels under the conditions of the site is acceptable for water quality objectives. The sizing for these SWMP types is to be determined based on performance results that have been peer-reviewed. The designer and those who review the design should be fully aware of the assumptions and sampling methodologies used in formulating performance predictions and their implications for the design.*

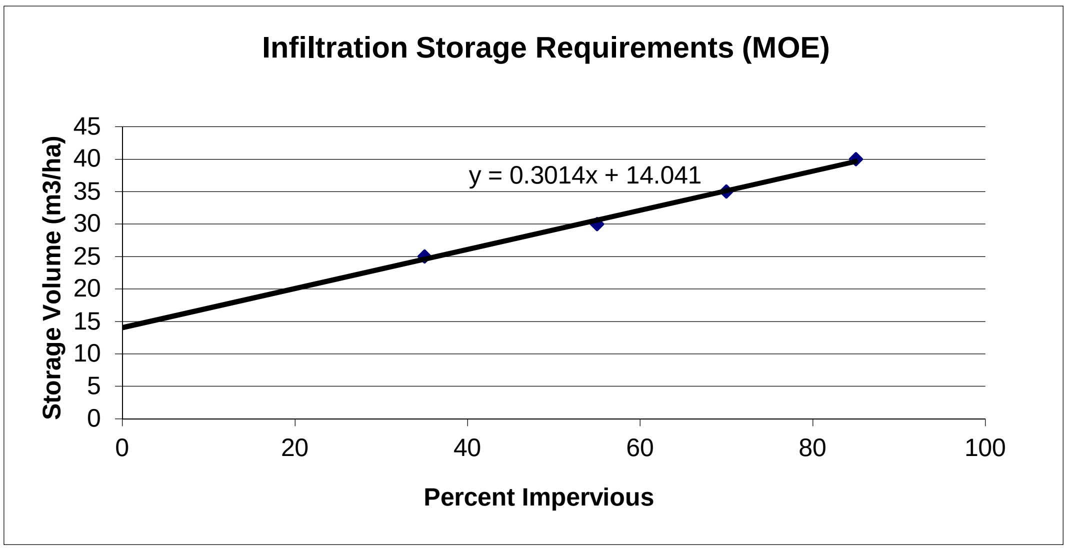
[2]*Hybrid Wet Pond/Wetland systems have 50-60% of their permanent pool volume in deeper portions of the facility (e.g., forebay, wet pond).*

BIG BAY POINT ROAD & BAYVIEW DRIVE EA
CITY OF BARRIE

MOE Water Quality Storage Volumes
Bayview Drive (ALT 1)

Table 3.1 Values

% imp	storage (m^3/ha)
35	25
55	30
70	35
85	40



Contributing Areas

Catchment	Bayveiw Dr	Area	4.11	ha	%Impervious	70
Catchment		Area		ha	%Impervious	
Catchment		Area		ha	%Impervious	
Catchment		Area		ha	%Impervious	
Catchment		Area		ha	%Impervious	
Catchment		Area		ha	%Impervious	
Catchment		Area		ha	%Impervious	
Catchment		Area		ha	%Impervious	
TOTAL AREA			**4.11**	**ha**	**%Impervious**	**70.0**

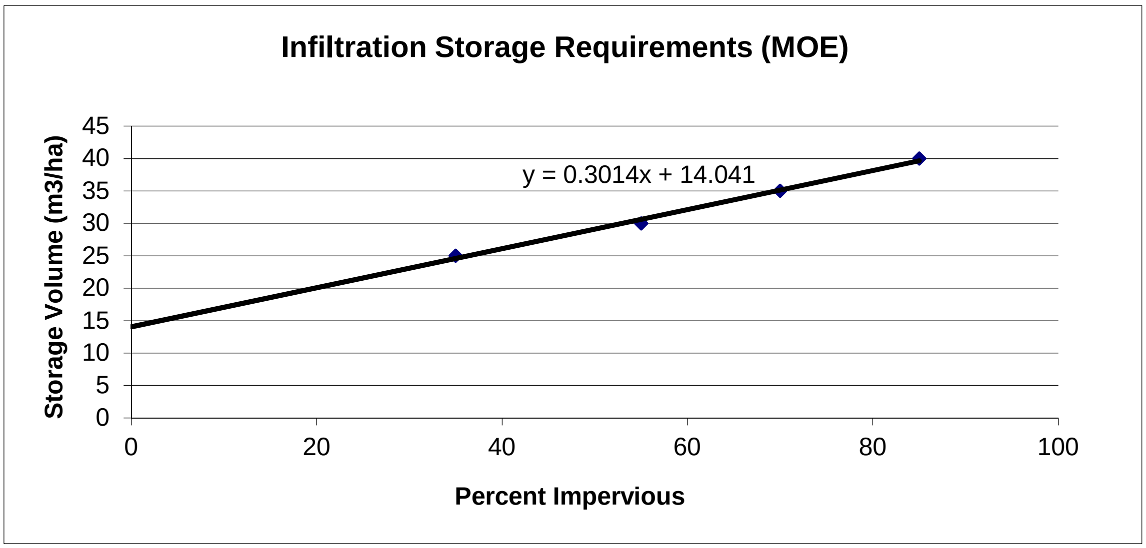
% Impervious	70.0	(imp area)
Storage Volume (m^3/ha)	35.1	
Drainage Area (ha)	4.11	
Total Water Quality Storage Volume (m^3)	**144.4**	

BIG BAY POINT ROAD & BAYVIEW DRIVE EA
CITY OF BARRIE

MOE Water Quality Storage Volumes
Big Bay Point Road (ALT 4)

Table 3.1 Values

% imp	storage (m^3/ha)
35	25
55	30
70	35
85	40



Contributing Areas

Catchment	Big Bay Point Rd	Area	4.49	ha	%Impervious	79.8
Catchment		Area		ha	%Impervious	
Catchment		Area		ha	%Impervious	
Catchment		Area		ha	%Impervious	
Catchment		Area		ha	%Impervious	
Catchment		Area		ha	%Impervious	
Catchment		Area		ha	%Impervious	
Catchment		Area		ha	%Impervious	
TOTAL AREA			**4.49**	**ha**	**%Impervious**	**79.8**

% Impervious	79.8	(imp area)
Storage Volume (m^3/ha)	38.1	
Drainage Area (ha)	4.49	
Total Water Quality Storage Volume (m^3)	**171.0**	

Stormceptor Design Summary
PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Bayview Drive - Alternative 1
Catchment Bayview South (C201)

Drainage Area

Total Area (ha)	1.06
Imperviousness (%)	68

The Stormceptor System model STC 2000 achieves the water quality objective removing 82% TSS for a Fine (organics, silts and sand) particle size distribution and 95% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	66	74
STC 750	76	89
STC 1000	76	89
STC 1500	77	89
STC 2000	**82**	**95**
STC 3000	83	95
STC 4000	86	98
STC 5000	87	98
STC 6000	89	99
STC 9000	91	100
STC 10000	91	100
STC 14000	93	100

Stormceptor®

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)								
Particle Size μm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size μm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor version 1.0
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 300 is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 750 to STC 6000 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Imbrium Systems Inc., 1-800-565-4801.

Stormceptor®

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Bayview Drive - Alternative 1
Catchment Bayview Central (C202)

Drainage Area

Total Area (ha)	1.68
Imperviousness (%)	65

The Stormceptor System model STC 4000 achieves the water quality objective removing 82% TSS for a Fine (organics, silts and sand) particle size distribution and 96% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	60	64
STC 750	71	83
STC 1000	71	83
STC 1500	72	83
STC 2000	78	91
STC 3000	79	91
STC 4000	**82**	**96**
STC 5000	83	96
STC 6000	86	98
STC 9000	89	99
STC 10000	89	99
STC 14000	91	100

Stormceptor®

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)								
Particle Size μm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size μm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor version 1.0
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 300 is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 750 to STC 6000 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Imbrium Systems Inc., 1-800-565-4801.

Stormceptor®

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Bayview Drive - Alternative 1
Catchment Bayview North (C203)

Drainage Area

Total Area (ha)	1.38
Imperviousness (%)	80

The Stormceptor System model STC 4000 achieves the water quality objective removing 82% TSS for a Fine (organics, silts and sand) particle size distribution and 96% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	60	64
STC 750	71	83
STC 1000	71	83
STC 1500	72	83
STC 2000	78	91
STC 3000	79	91
STC 4000	**82**	**96**
STC 5000	83	96
STC 6000	86	98
STC 9000	89	99
STC 10000	89	99
STC 14000	91	100

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)								
Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor version 1.0
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 300 is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 750 to STC 6000 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Imbrium Systems Inc., 1-800-565-4801.

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Bayview Drive - Alternative 2
Catchment Bayview South (C301)

Drainage Area

Total Area (ha)	1.06
Imperviousness (%)	72

The Stormceptor System model STC 2000 achieves the water quality objective removing 81% TSS for a Fine (organics, silts and sand) particle size distribution and 94% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	65	73
STC 750	75	88
STC 1000	75	88
STC 1500	76	88
STC 2000	**81**	**94**
STC 3000	82	94
STC 4000	85	98
STC 5000	86	98
STC 6000	88	99
STC 9000	91	100
STC 10000	91	100
STC 14000	93	100

Stormceptor®

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor version 1.0
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 300 is adaptable to function with a catch basin inlet and/or inline pipes.
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Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
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- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Imbrium Systems Inc., 1-800-565-4801.

Stormceptor®

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Bayview Drive - Alternative 2
Catchment Bayview Central (C302)

Drainage Area

Total Area (ha)	1.68
Imperviousness (%)	69

The Stormceptor System model STC 4000 achieves the water quality objective removing 82% TSS for a Fine (organics, silts and sand) particle size distribution and 95% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	59	63
STC 750	70	82
STC 1000	71	82
STC 1500	72	82
STC 2000	77	90
STC 3000	78	90
STC 4000	**82**	**95**
STC 5000	83	95
STC 6000	85	98
STC 9000	88	99
STC 10000	88	99
STC 14000	91	100

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Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor version 1.0
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 300 is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 750 to STC 6000 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

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Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Bayview Drive - Alternative 2
Catchment Bayview North (C303)

Drainage Area

Total Area (ha)	1.38
Imperviousness (%)	85

The Stormceptor System model STC 4000 achieves the water quality objective removing 82% TSS for a Fine (organics, silts and sand) particle size distribution and 95% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	59	63
STC 750	70	82
STC 1000	71	82
STC 1500	72	82
STC 2000	77	90
STC 3000	78	90
STC 4000	**82**	**95**
STC 5000	83	95
STC 6000	85	98
STC 9000	88	99
STC 10000	88	99
STC 14000	91	100

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)								
Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

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Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

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Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Bayview Drive - Alternative 3
Catchment Bayview South (C401)

Drainage Area

Total Area (ha)	1.21
Imperviousness (%)	87

The Stormceptor System model STC 4000 achieves the water quality objective removing 83% TSS for a Fine (organics, silts and sand) particle size distribution and 96% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	61	66
STC 750	72	84
STC 1000	72	84
STC 1500	73	84
STC 2000	78	91
STC 3000	79	91
STC 4000	**83**	**96**
STC 5000	84	96
STC 6000	86	98
STC 9000	89	99
STC 10000	89	99
STC 14000	91	100

Stormceptor®

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

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- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
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Stormceptor®

Stormceptor Design Summary
PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Bayview Drive - Alternative 3
Catchment Bayview Central (C402)

Drainage Area

Total Area (ha)	2.15
Imperviousness (%)	80

The Stormceptor System model STC 6000 achieves the water quality objective removing 82% TSS for a Fine (organics, silts and sand) particle size distribution and 95% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	53	53
STC 750	65	74
STC 1000	66	74
STC 1500	67	74
STC 2000	73	84
STC 3000	74	84
STC 4000	78	92
STC 5000	79	92
STC 6000	**82**	**95**
STC 9000	86	98
STC 10000	85	98
STC 14000	88	99

Stormceptor®

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

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- Only the Stormceptor models STC 750 to STC 6000 may accommodate multiple inlet pipes.
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Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

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Stormceptor Design Summary
PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Bayview Drive - Alternative 3
Catchment Bayview North (C403)

Drainage Area

Total Area (ha)	1.7
Imperviousness (%)	79

The Stormceptor System model STC 4000 achieves the water quality objective removing 81% TSS for a Fine (organics, silts and sand) particle size distribution and 94% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	57	59
STC 750	69	79
STC 1000	69	79
STC 1500	70	79
STC 2000	76	88
STC 3000	77	88
STC 4000	**81**	**94**
STC 5000	81	94
STC 6000	84	97
STC 9000	87	99
STC 10000	87	99
STC 14000	90	99

Stormceptor®

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

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- Only the Stormceptor models STC 750 to STC 6000 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

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Stormceptor®

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Big Bay Point Road - Alternative 1
Big Bay West (C205)

Drainage Area

Total Area (ha)	3.38
Imperviousness (%)	84

The Stormceptor System model STC 9000 achieves the water quality objective removing 81% TSS for a Fine (organics, silts and sand) particle size distribution and 94% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	45	40
STC 750	58	62
STC 1000	58	62
STC 1500	59	62
STC 2000	66	75
STC 3000	67	75
STC 4000	73	85
STC 5000	73	85
STC 6000	77	90
STC 9000	**81**	**94**
STC 10000	81	94
STC 14000	84	97

Stormceptor®

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

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- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
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Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

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Stormceptor®

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Big Bay Point Road - Alternative 1
Big Bay East (C207)

Drainage Area

Total Area (ha)	2.2
Imperviousness (%)	81

The Stormceptor System model STC 6000 achieves the water quality objective removing 82% TSS for a Fine (organics, silts and sand) particle size distribution and 95% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	52	52
STC 750	65	73
STC 1000	65	73
STC 1500	66	73
STC 2000	72	84
STC 3000	73	84
STC 4000	78	91
STC 5000	79	91
STC 6000	**82**	**95**
STC 9000	85	97
STC 10000	85	97
STC 14000	88	99

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)								
Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

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Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
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Stormceptor®

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Big Bay Point Road - Alternative 2
Big Bay West (C305)

Drainage Area

Total Area (ha)	3.11
Imperviousness (%)	85

The Stormceptor System model STC 9000 achieves the water quality objective removing 82% TSS for a Fine (organics, silts and sand) particle size distribution and 95% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	46	42
STC 750	59	64
STC 1000	59	64
STC 1500	60	64
STC 2000	67	76
STC 3000	68	76
STC 4000	74	86
STC 5000	74	86
STC 6000	78	91
STC 9000	**82**	**95**
STC 10000	82	95
STC 14000	85	97

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
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Stormceptor Design Notes

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Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Big Bay Point Road - Alternative 2
Big Bay East (C307)

Drainage Area

Total Area (ha)	1.98
Imperviousness (%)	86

The Stormceptor System model STC 6000 achieves the water quality objective removing 82% TSS for a Fine (organics, silts and sand) particle size distribution and 95% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	53	53
STC 750	65	74
STC 1000	66	74
STC 1500	67	74
STC 2000	73	85
STC 3000	74	85
STC 4000	78	92
STC 5000	79	92
STC 6000	**82**	**95**
STC 9000	86	98
STC 10000	86	98
STC 14000	88	99

Stormceptor®

Particle Size Distribution

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Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
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Stormceptor Design Notes

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- For pricing inquiries or assistance, please contact Imbrium Systems Inc., 1-800-565-4801.

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Big Bay Point Road - Alternative 3
Catchment Big Bay West (C405)

Drainage Area

Total Area (ha)	2.88
Imperviousness (%)	81

The Stormceptor System model STC 9000 achieves the water quality objective removing 83% TSS for a Fine (organics, silts and sand) particle size distribution and 96% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	48	45
STC 750	61	67
STC 1000	61	67
STC 1500	62	67
STC 2000	69	79
STC 3000	70	79
STC 4000	75	88
STC 5000	76	88
STC 6000	79	92
STC 9000	**83**	**96**
STC 10000	83	96
STC 14000	86	98

Stormceptor®

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor version 1.0
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 300 is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 750 to STC 6000 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Imbrium Systems Inc., 1-800-565-4801.

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Big Bay Point Road - Alternative 3
Catchment Big Bay East (C407)

Drainage Area

Total Area (ha)	1.91
Imperviousness (%)	78

The Stormceptor System model STC 4000 achieves the water quality objective removing 80% TSS for a Fine (organics, silts and sand) particle size distribution and 93% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	55	56
STC 750	67	77
STC 1000	68	77
STC 1500	68	77
STC 2000	74	87
STC 3000	75	87
STC 4000	**80**	**93**
STC 5000	80	93
STC 6000	83	96
STC 9000	87	98
STC 10000	87	98
STC 14000	89	99

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)								
Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
60	20	1.8	0.0016					
150	20	2.2	0.0108					
400	20	2.65	0.0647					
2000	20	2.65	0.2870					

Stormceptor Design Notes

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- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Imbrium Systems Inc., 1-800-565-4801.

Stormceptor®

Stormceptor Design Summary
PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Big Bay Point Road - Alternative 4
Catchment Big Bay West (C505)

Drainage Area

Total Area (ha)	2.63
Imperviousness (%)	81

The Stormceptor System model STC 6000 achieves the water quality objective removing 80% TSS for a Fine (organics, silts and sand) particle size distribution and 93% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	49	47
STC 750	62	69
STC 1000	62	69
STC 1500	63	69
STC 2000	70	81
STC 3000	71	81
STC 4000	76	89
STC 5000	77	89
STC 6000	**80**	**93**
STC 9000	84	96
STC 10000	84	96
STC 14000	87	98

Stormceptor®

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
20	20	1.3	0.0004					
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Stormceptor Design Notes

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Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	4/6/2016
Project Name	Bayview Drive and Big Bay Point Rd EA
Project Number	415375
Location	City of Barrie

Designer Information

Company	C.C. Tatham & Associates Ltd.
Contact	NHF

Notes

Big Bay Point Road - Alternative 4
Catchment Big Bay East (C507)

Drainage Area

Total Area (ha)	1.86
Imperviousness (%)	77

The Stormceptor System model STC 4000 achieves the water quality objective removing 80% TSS for a Fine (organics, silts and sand) particle size distribution and 94% runoff volume.

Rainfall

Name	BARRIE WPCC
State	ON
ID	557
Years of Records	1968 to 2003
Latitude	44°23'N
Longitude	79°41'W

Water Quality Objective

TSS Removal (%)	80
Runoff Volume (%)	90

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %	Runoff Volume %
STC 300	56	58
STC 750	68	78
STC 1000	68	78
STC 1500	69	78
STC 2000	75	87
STC 3000	76	87
STC 4000	**80**	**94**
STC 5000	81	94
STC 6000	84	96
STC 9000	87	98
STC 10000	87	98
STC 14000	89	99

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

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United States Environmental Protection Agency
Office of Water Washington, D.C.
EPA 832-F-99-007
September 1999

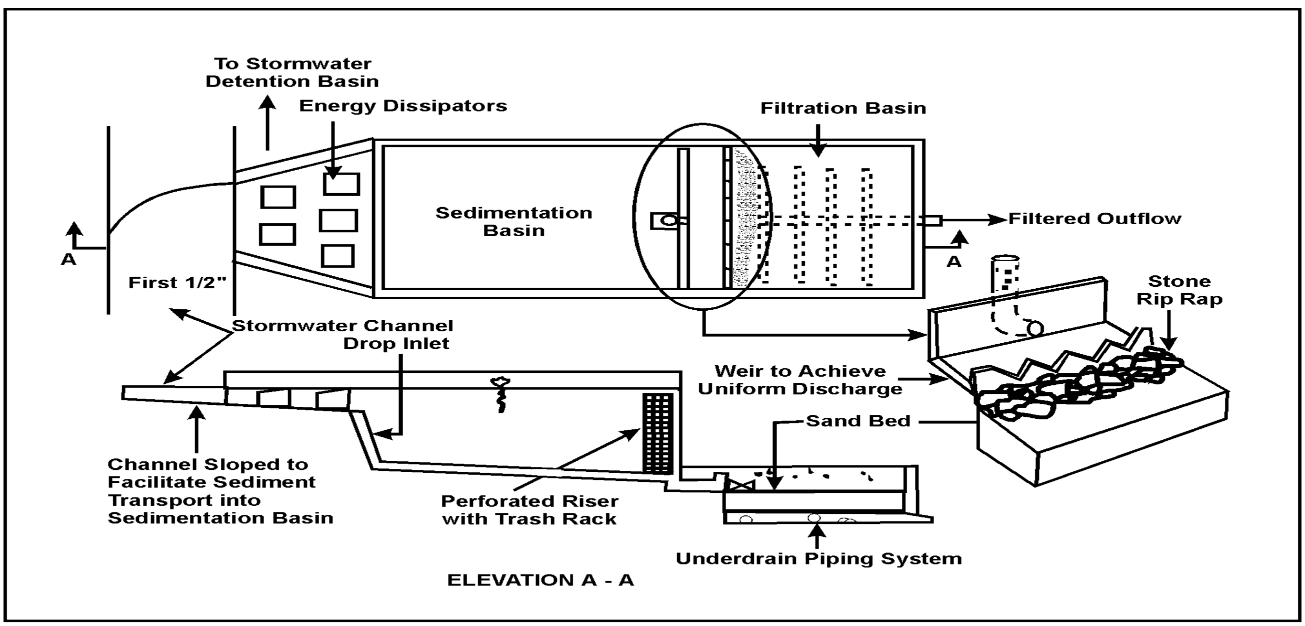
Storm Water Technology Fact Sheet
Sand Filters

DESCRIPTION

Sand filters have proven effective in removing several common pollutants from storm water runoff. Sand filters generally control storm water quality, providing very limited flow rate control.

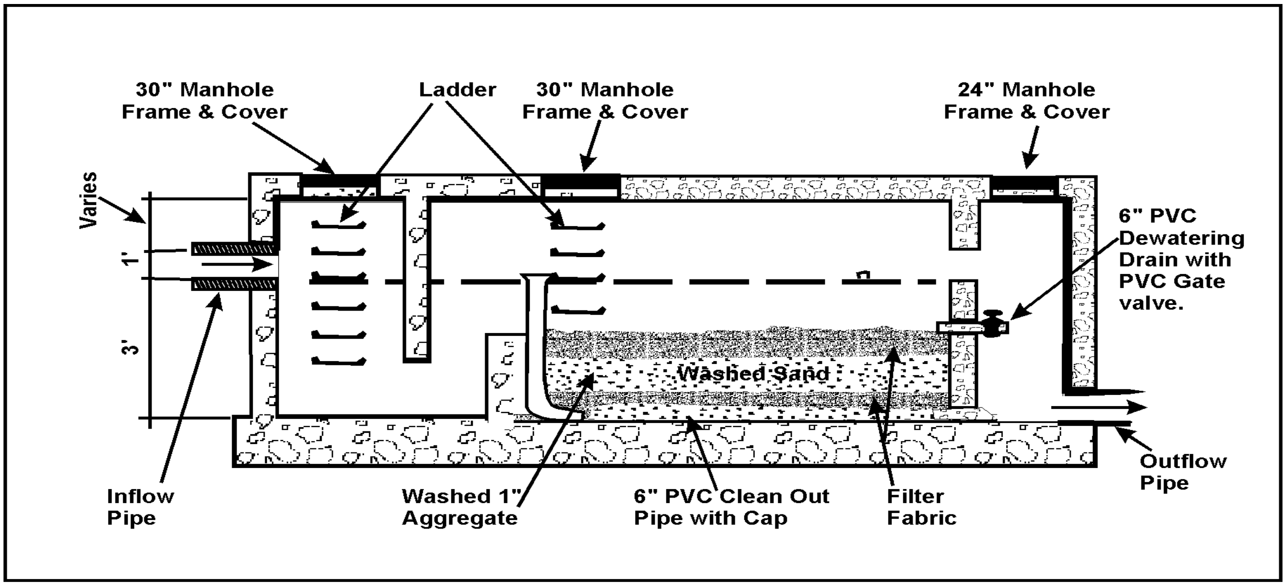
A typical sand filter system consists of two or three chambers or basins. The first is the sedimentation chamber, which removes floatables and heavy sediments. The second is the filtration chamber, which removes additional pollutants by filtering the runoff through a sand bed. The third is the discharge chamber. The treated filtrate normally is then discharged through an underdrain system either to a storm drainage system or directly to surface waters. Sand filters take up little space and can be used on highly developed sites and sites with steep slopes. They can be added to retrofit existing sites. Sand filters are able to achieve high removal efficiencies for sediment, biochemical oxygen demand (BOD), and fecal coliform bacteria. Total metal removal, however, is moderate, and nutrient removal is often low.

There are three main sand filter designs currently in common use: the Austin sand filter (Figure 1); the Washington, D.C., sand filter (Figure 2); and the



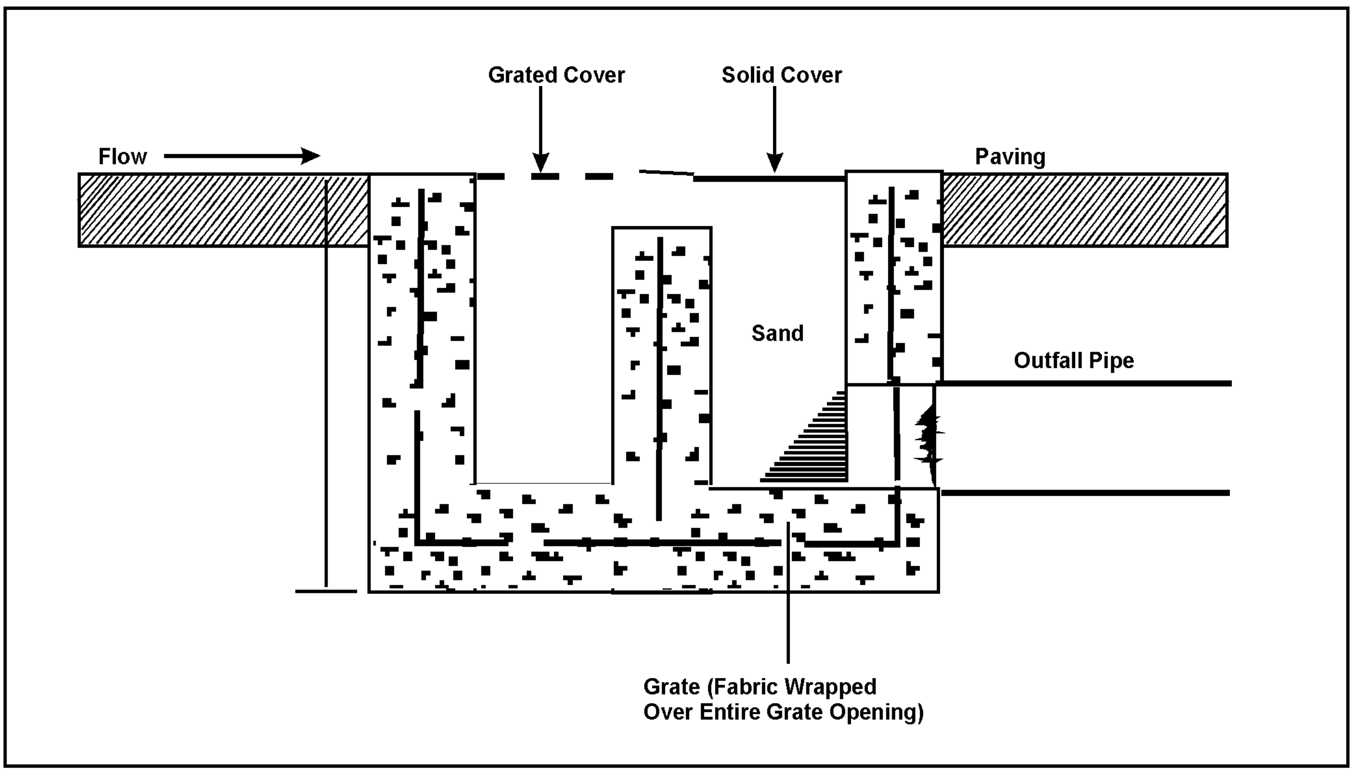
Source: Schueler, 1992.

FIGURE 1 TYPICAL AUSTIN SAND FILTER DESIGN



Source: Troung, 1989.

FIGURE 2 TYPICAL WASHINGTON, D.C. SAND FILTER DESIGN



Source: Shaver, 1991.

FIGURE 3 TYPICAL DELAWARE SAND FILTER DESIGN

Delaware sand filter (Figure 3). The primary differences among these designs are location (i.e., above or below ground), the drainage area served, their filter surface areas, their land requirements, and the quantity of runoff they treat.

Modifications that may improve sand filter design and performance are being tested. One modification is the addition of a peat layer in the filtration chamber. The addition of peat to the sand filter may increase microbial growth within the sand filter and improve metals and nutrient removal rates.

APPLICABILITY

Sand filters are intended primarily for water quality enhancement. In general, sand filters are preferred over infiltration practices, such as infiltration trenches, when contamination of groundwater with conventional pollutants - BOD, suspended solids, and fecal coliform - is of concern. This usually occurs in areas where underlying soils alone cannot treat runoff adequately - or ground water tables are high. In most cases, sand filters can be constructed with impermeable basin or chamber bottoms, which help to collect, treat, and release runoff to a storm drainage system or directly to surface water with no contact between contaminated runoff and groundwater.

The selection of a sand filter design depends largely on the drainage area's characteristics. For example, the Washington, D.C., and Delaware sand filter systems are well suited for highly impervious areas where land available for structural controls is limited, since both are installed underground. They are often used to treat runoff from parking lots, driveways, loading docks, service stations, garages, airport runways/taxiways, and storage yards. The Austin sand filtration system is more suited for large drainage areas that have both impervious and pervious surfaces. This system is located at grade and is often used at transportation facilities, in large parking areas, and in commercial developments.

In general, all three types of sand filters can be used as alternatives for water quality inlets. They are more frequently used to treat runoff contaminated with oil and grease from drainage areas with heavy vehicle usage. In regions where evaporation exceeds rainfall and a wet pond would be unlikely to maintain the required permanent pool, the Austin sand filtration system can be used.

ADVANTAGES AND DISADVANTAGES

Sand filters can be highly effective storm water best management practices (BMPs). All three types of sand filters achieve high removal rates for sediment, BOD, and fecal coliform bacteria. The filter media is periodically removed from the filter unit, thus also permanently removing trapped contaminants. Waste media from the filters does not appear to be toxic and is environmentally safe for landfill disposal. If they are designed with an impermeable basin liner, sand filters can also reduce the potential for groundwater contamination. Finally sand filters also generally require less land than other BMPs, such as ponds or wetlands.

The size and characteristics of the drainage area, as well as the pollutant loading, will greatly influence the effectiveness of the sand filter system. For example, sand filters may be of limited value in some applications because of they are designed to handle runoff from relatively small drainage areas and they have low nutrient removal and metal removal capabilities. In these cases, other BMPs, such as wet ponds, may be less costly and/or more effective. The system also requires routine maintenance to prevent sediment from clogging the filter. In some cases, filter media may need to be replaced 3 to 5 years. Lastly, sand filters generally do not control storm water flow, and consequently, they do not prevent downstream stream bank and channel erosion.

Climatic conditions may also limit the filter's performance. For example, it is not yet known how well sand filters will operate in colder climates or in freezing conditions.

DESIGN CRITERIA

Typically the Austin sand filter system is designed to handle runoff from drainage areas up to 20 hectares (50 acres). The collected runoff is first diverted to the sedimentation basin, where heavy sediments and floatables are removed. There are two designs for the sedimentation basin: the full sedimentation system, as shown in Figure 1; and a partial sedimentation system, where only the initial flow is diverted. Both systems are located off-line and are designed to collect and treat the first 1.3 centimeters (0.5 inches) of runoff. The partial system has the capacity to hold only a portion (at least 20 percent) of the first flush volume in the sedimentation basin, whereas the full system captures and holds the entire flow volume.

Equations used to determine the sedimentation basin surface areas (As) in square and meters acres are shown in Table 1.

TABLE 1 SURFACE AREA EQUATION FOR AUSTIN SAND FILTER SYSTEM

Partial Sedimentation	Full Sedimentation
As=(AD)(H)/(1/Ds-1/10)	As=(AD)(H)/10
Af=(AD)(H)/10	Af=(AD)(H)/18

Note: Designed to collect and treat 0.5 inches of runoff.
Ds (feet)=depth of the sedimentation basin.
H (feet)=depth of rainfall, 0.042ft (0.5 in).
AD(acres)=impervious and pervious areas that provide contributing drainage.

Source: Galli, 1990.

Flow is conveyed from the sedimentation basin, through a perforated riser, a gabion wall, or a berm, to the filtration basin. The filtration basin consists of a 45-centimeter (18-inch) layer of sand particles 0.05 to 0.10 centimeters (0.02 to 0.04 inches) in diameter that may be underlain by a gravel layer. Equations used to determine the surface areas (Af) in acres are also shown in Table 1. The filtrate is discharged from the filtration basin through underdrain piping 10 to 15 centimeters (4 to 6 inches) in diameter with 1-centimeter (0.4 inch) perforations. Filter fabric is placed around the underdrain piping to prevent sand and other particulates from being discharged.

Typically, the Washington, D.C., sand filter system is designed to handle runoff from completely impervious drainage areas of 0.4 hectares (1 acre) or less. The system, as shown in Figure 2, consists of three underground chambers: a sedimentation chamber, a filtration chamber, and a discharge chamber. The sand filter system is designed to accept the first 1.3 centimeters (0.5 inches) of runoff. Coarse sediments and floatables are removed from the runoff within the sedimentation chamber. Runoff is discharged from the sedimentation chamber through a submerged weir, into the filtration chamber, which consists of a combination of sand and gravel layers totaling 1 meter (3 feet) in depth with underdrain piping wrapped in filter fabric. The underdrain system collects the filtered water and discharges it to the third chamber, where the water is collected and discharged to a storm water channel or sewer system. An overflow weir is located between the second and third chambers to bypass excess flow. The Washington, D.C., sand filter is often constructed on-line, but can be constructed off-line. When the system is off-line, the overflow between the second and third chambers is not included.

The Delaware sand filter, shown in Figure 3, is similar to the Washington, D.C., sand filter in that both utilize underground concrete vaults. However, the Delaware sand filter has only two chambers: a sedimentation chamber and a filtration chamber. A 2.5-centimeter (1 inch) design storm was selected for sizing the sedimentation basin because it is representative of large storm events: in Delaware, 92 percent of all storms are less than 2.5 centimeters (1 inch) in depth. Runoff enters the sedimentation chamber through a grated cover and then overflows into the filtration chamber, which contains a sand layer 45 centimeters (18 inches) in depth. Gravel is not normally used in the filtration chamber although the filter can be modified to include it. Typical systems are designed to handle runoff from drainage areas of 2 hectares (5 acres) or less. A major advantage of the Delaware sand filter is its shallow structure depth of only 76 centimeters (30 inches), which reduces construction and maintenance costs.

Proper design and maintenance are also critical factors in maintaining the operating life of any filter system. The life of the filter media may be increased by a number of methods, including:

- Stabilizing the drainage area so that sediment loadings in the runoff are minimized.
- Providing adequate storm water detention times to enhance sedimentation and filtration.
- Inspecting and maintaining the sand filter frequently enough to ensure proper operation.

PERFORMANCE

Sand filters are currently in use in Delaware, Maryland, Florida, Texas, Virginia, and Washington, D.C. Studies on the systems' pollutant removal efficiencies are currently being performed in Washington, D.C., and Austin, TX. Additional evaluations are needed to evaluate alternative sand filter designs and media. Sand filters remove particulates in both the sedimentation and the filtration chambers. The City of Austin has estimated their systems' pollutant removal efficiencies based on preliminary findings of their storm water monitoring program (Austin, 1988). The estimates shown in Table 2 are average values for various sand filters serving drainage areas of several different sizes. As shown in Table 2, no removal of nitrate was observed. No other dissolved pollutants were monitored. Additional monitoring is currently being performed by the City of Austin to supplement the preliminary estimates.

TABLE 2 TYPICAL POLLUTANT REMOVAL EFFICIENCY

Pollutant	Percent Removal
Fecal Coliform	76
Biochemical Oxygen Demand (BOD)	70
Total Suspended Solids (TSS)	70
Total Organic Carbon (TOC)	48
Total Nitrogen (TN)	21
Total Kjeldahl Nitrogen (TKN)	46
Nitrate as Nitrogen (NO_3-N)	0
Total Phosphorus (TP)	33
Iron (Fe)	45
Lead (Pb)	45
Zinc (Zn)	45

Source: Galli, 1990

OPERATION AND MAINTENANCE

All filter system designs must provide adequate access to the filter for inspection and maintenance. The sand filters should be inspected after all storm events to verify that they are working as intended. Since the Washington, D.C., and Austin sand filter systems can be deep, they may be designated as confined spaces and require compliance with confined space entry safety procedures.

Typically, sand filters begin to experience clogging problems within 3 to 5 years (NVPDC, 1992). Accumulated trash, paper and debris should be removed from the sand filters every 6 months or as necessary to keep the filter clean. A record should be kept of the dewatering times for all sand filters to determine if maintenance is necessary. Corrective maintenance of the filtration chamber includes removal and replacement of the top layers of sand, gravel and/or filter fabric that has become clogged. The removed media may usually be disposed in a landfill. The City of Austin tests their waste media before disposal. Results thus far indicate that the waste media is not toxic and can be safely landfilled (Schueler, 1992). Sand filter systems may also require the periodic removal of vegetative growth.

COSTS

The construction cost for an Austin sand filtration system is approximately $18,500 (1997 dollars) for a 0.4 hectare- (1 acre-) drainage area. The cost per hectare decreases with increasing drainage area. The cost for precast Washington, D.C. sand filters, with drainage areas of less than 0.4 hectares (1 acre), ranges between $6,600 and $11,000 (1997 dollars). This is considerably less than the cost for the same size cast-in-place system. Costs for the Delaware sand filter are similar to that of the D.C. system, with the exception of the lower excavation costs due to the Delaware filters' shallowness.

Annual costs for maintaining sand filter systems average about 5 percent of the initial construction cost (Schueler, 1992). Media is replaced as needed. Currently the sand is being replaced in the D.C. filter systems about every 2 years. The cost to replace the gravel layer, filter fabric and top portion of the sand for D.C. sand filters is approximately

$1,700 (1997 dollars). Improvements in Washington, D.C.'s maintenance procedures may extend the life of the filter media and reduce the overall maintenance costs.

REFERENCES

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4. Galli, J., 1990. *Peat Sand Filters: A Proposed Storm Water Management Practice for Urbanized Areas*. Metropolitan Washington Council of Governments.

5. Naval Facilities Engineering Service Center, 1997. "Sand Filter for Treating Storm Water Runoff." *Joint Service Pollution Prevention Opportunity Handbook,* Version 1.1. Internet site at [http://enviro.nfesc.navy.mil/p2library/10-1297.html], accessed June, 1999.

6. Northern Virginia Planning District Commission (NVPDC), 1992. *Northern Virginia BMP Handbook.*

7. Northern Virginia Planning District Commission (NVPDC), 1996. *Northern Virginia BMP Handbook Addendum*, "Sand Filtration Systems."

8. Schueler, T.R., 1992. *A Current Assessment of Urban Best Management Practices*. Metropolitan Washington Council of Governments.

9. Shaver, E., 1991. *Sand Filter Design for Water Quality Treatment*. Delaware Department of Natural Resources and Environmental Control. Updated December, 1998.

10. Troung, H., 1989. *The Sand Filter Water Quality Structure*. The District of Columbia.

11. City of Washington, D.C., 1992. Personal Communication with Parsons Engineering Science, Inc.

ADDITIONAL INFORMATION

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Austin, TX 78767

Baltimore County, Maryland
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Towson, MD 21204

Center for Watershed Protection
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Ellicott City, MD 21043

State of Delaware
Earl Shaver
Delaware Department of Natural Resources and Environmental Control
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Dover, DE 19903

Northern Virginia Planning District Commission
David Bulova
7535 Little River Turnpike, Suite 100
Annandale, VA 22003

The mention of trade names or commercial products does not constitute endorsement or recommendation for the use by the U.S. Environmental Protection Agency.

For more information contact:

Municipal Technology Branch
U.S. EPA
Mail Code 4204
401 M St., S.W.
Washington, DC, 20460

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Excellence in compliance through optimal technical solutions
MUNICIPAL TECHNOLOGY BRANCH

APPENDIX H:
CULVERT ASSESSMENTS

Municipal Structure Inspection Form

Structure Number: 120073015

Inventory Data

Structure Name	Roadway Culvert No. 120073015		
Main Hwy/Road #		On ☑ Under ☐	Crossing Type: Non-navig water
Road Name	Whiskey Creek - Bayview Drive		
Structure Location	0.25 km north of Big Bay Point Rd.		
Latitude	44.352045	Longitude	-79.680551
Owner(s)	City of Barrie		
Heritage Designation	Not "Cons"		
Road Class:			
MTO Region	Central		
MTO District	Central Region	Posted Speed	50
		No of Lanes	2
Old County	Simcoe	AADT	0
		% Trucks	0
Geographic Twp	Barrie	Special Routes:	Transit ☐ Truck ☐ School ☐ Bicycle ☐
Structure Type	Hybrid	Detour Length Around Bridge	(km)
Total Deck Length	44.6 (m)	Fill on Structure	(m)
Overall Str Width	4.1 (m)	Skew Angle	(Degrees)
Total Deck Area	182.86 (sq. m)	Direction of Structure	NE/SW
Roadway Width	7 (m)	No of Spans	2
Span Lengths	North (3.6 m) South (1.8 m, 1.8 m) (m)		

Historical Data

Year Built:		Last Biennial Inspection:	
Current Load Limit:	(tonnes)	Last BridgeMaster Inspection:	
Load Limit By-Law #:		Last Evaluation:	
By-Law Expiry Date:		Last Underwater Inspection:	
Min Vertical Clearance:	(m)	Last Condition Survey:	

Rehab History: (Date/description)

WILLS

Field Inspection Information

Date of Inspection: 5/7/2015 Temperature: 27° C

Inspected By: D.M. Wills Associates Ltd.

Inspector: Ghassan Zanzoul, P. Eng.

Others in Party: Jesse Borges

Equipment Used: Hand Tools, Camera

Weather: Sunny

Additional Investigations Required

	Priority		Estimated Cost
Detailed Deck Condition Survey:			0
DART Survey			0
Detailed Coating Condition Survey:			0
Underwater Investigation:			0
Fatigue Investigation:			0
Seismic Investigation:			0
Structure Evaluation:			0
Load Posting:Estimated Load	0	Total Cost	0
Next Date Inspection:	5/7/2017		

BCI 75

Special Notes:

Suspected Performance Deficiencies

00 None
01 Load carrying capacity
02 Excessive deformations (deflections rotations)
03 Continuing settlement
04 Continuing movements
05 Seized bearings
06 Bearing not uniformly loaded/unstable
07 Jammed expansion joint
08 Pedestrian/vehicular hazard
09 Rough riding surface
10 Surface ponding
11 Deck drainage
12 Slippery surfaces
13 Flooding/channel blockage
14 Undermining of foundation
15 Unstable embankments
16 Other

Maintenance Needs

01 Lift and Swing Bridge Maintenance
02 Bridge Cleaning
03 Bridge Handrail Maintenance
04 Painting Steel Bridge Structures
05 Bridge Deck Joint Repair
06 Bridge Bearing Maintenance
07 Repair to Structural Steel
08 Repair of Bridge Concrete
09 Repair of Bridge Timber
10 Bailey Bridges - Maintenance
11 Animal/Pest Control
12 Bridge Surface Repair
13 Erosion Control at Bridges
14 Concrete Sealing
15 Rout and Seal
16 Bridge deck Drainage
17 Other

Element Data

Element Group:	Culverts	Length:	18.4
Element Name:	Barrels	Width:	3.6
Location:	North Portion	Height:	1.8
Material:	Cast-in-place concrete	Count:	1
Element Type:	Frames - Rigid	Total Quantity:	132.48
Environment:	Benign	Limited Inspection	☐
Protection System:			

Condition Data:	Units	Exc	Good	Fair	Poor
	Sq. m		132.48		

Comments

Recommended Work

Maint. Needs

Perform. Deficiencies: None

Estimated Construction Cost: $0.00

Priority: **None** (options: None, 6-10 yrs, 1-5 yrs, Within 1 yr, Urgent)

Element Group:	Culverts	Length:	26.2
Element Name:	Barrels	Width:	1.8
Location:	South Portion	Height:	1.2
Material:	Corrugated steel	Count:	2
Element Type:	Pipe Arch	Total Quantity:	246.93
Environment:	Benign	Limited Inspection	☐
Protection System:			

Condition Data:	Units	Exc	Good	Fair	Poor
	Sq. m		246.93		

Comments

Undermining at south culvert ends.
Surface rusting of invert.

Recommended Work

Provide scour protection and rock protection at culvert outlet.

Maint. Needs

Perform. Deficiencies: None

Estimated Construction Cost: $25,000.00

Priority: **1-5 yrs** (options: None, 6-10 yrs, 1-5 yrs, Within 1 yr, Urgent)

Element Group:	Decks	Length:	16
Element Name:	Wearing surface	Width:	30
Location:	Roadway + Roadway Extension	Height:	
Material:	Asphalt	Count:	1
Element Type:		Total Quantity:	480
Environment:	Severe	Limited Inspection	☐
Protection System:			

Condition Data:	Units	Exc	Good	Fair	Poor
	Sq. m		480		

Comments

Recommended Work

Maint. Needs

Perform. Deficiencies: None

Estimated Construction Cost: $0.00

Priority: **None** (options: None, 6-10 yrs, 1-5 yrs, Within 1 yr, Urgent)

Element Group:	Embankments & Streams	Length:	
Element Name:	Embankments	Width:	
Location:	All	Height:	
Material:		Count:	4
Element Type:		Total Quantity:	4
Environment:	Benign	Limited Inspection	☐
Protection System:	None		

Condition Data: Units	Exc	Good	Fair	Poor
all		4		

Maint. Needs:

Perform. Deficiencies: None

Estimated Construction Cost: $0.00

Priority: None (selected) / 6-10 yrs / 1-5 yrs / Within 1 yr / Urgent

Comments:

Recommended Work:

Element Group:	Culverts	Length:	10.5
Element Name:	Inlet Components	Width:	0.35
Location:	North (Headwall and Retaining Walls)	Height:	1.7
Material:	Cast-in-place concrete	Count:	1
Element Type:		Total Quantity:	21.53
Environment:	Benign	Limited Inspection	☐
Protection System:			

Condition Data: Units	Exc	Good	Fair	Poor
Sq. m		21.53		

Maint. Needs:

Perform. Deficiencies: None

Estimated Construction Cost: $0.00

Priority: None (selected) / 6-10 yrs / 1-5 yrs / Within 1 yr / Urgent

Comments:

Recommended Work:

Element Group:	Barriers	Length:	10.5
Element Name:	Railing Systems	Width:	0.8
Location:	North	Height:	
Material:	Steel	Count:	1
Element Type:		Total Quantity:	10.5
Environment:	Benign	Limited Inspection	☐
Protection System:	Hot dip galvanizing		

Condition Data: Units	Exc	Good	Fair	Poor
m		10.5		

Maint. Needs:

Perform. Deficiencies: None

Estimated Construction Cost: $0.00

Priority: None (selected) / 6-10 yrs / 1-5 yrs / Within 1 yr / Urgent

Comments:

Recommended Work:

Repair and Rehabilitation Required

Element Group	Element Name	Comments Repair/Rehabilitation	Priority (Years)	Estimated Cost
Culverts	Barrels	Provide scour protection and rock protection at culvert outlet.	1-5 yrs	$25,000.00
			Total	**$25,000.00**

Associated Work

	Comments	Estimated Cost
Approaches		$0.00
Detours		$0.00
Traffic Control		$0.00
Utilities		$0.00
Right of Way		$0.00
Environmental Study		$0.00
Other		$0.00
Contingencies	15% Cost	$3,800.00
	Total Estimated Const. Cost	**$28,800.00**

Justification

WILLS

SITE PHOTOGRAPHS **SITE: 120073015**

Roadway Looking West Over Culvert

Cracks on Wearing Surface

SITE PHOTOGRAPHS **SITE: 120073015**

North Elevation of Concrete Culvert

North Elevation of Steel Barrels

SITE PHOTOGRAPHS **SITE: 120073015**

South Elevation of Steel Barrels

Concrete Barrel Looking South

SITE PHOTOGRAPHS **SITE: 120073015**

West Barrel Looking South

East Barrel Looking South

SITE PHOTOGRAPHS **SITE: 120073015**

Surface Rusting at East Barrel Invert

Undermining of Steel Barrels at South

Summary of Whiskey Creek MDP Culvert Assessment – North of Mollard Court

LOCATION	DESCRIPTION
West Tributary (from Highway 400 to Lackies Bush)	The headwaters of the west tributary of the Whiskey Creek begin on the west side of Highway 400 approximately 600m north of Harvie Road. The west tributary flows under Highway 400 (through a 1.2 x 0.9m concrete box culvert) and continues easterly through an open field to Fairview Road. The Highway 400 culvert will convey the Regional Storm Event with a head of 1.85m. The 1.8 x 0.9m concrete box culvert under Fairview Road has sufficient capacity to convey the 100-year peak flows. However, Regional Event Peak Flows will overtop Fairview Road. East of Fairview Road the tributary traverses currently undeveloped industrial lands to a manmade channel north of Mollard Court. Peak flows are conveyed easterly within the channel to Bayview Drive. The channel north of Mollard Court has capacity to convey the 100-year peak flow (which is larger than the Regional peak flow). The existing 1.2m diameter CSP culvert under Bayview Drive does not have capacity to convey the 25-year peak flow. Since Bayview Drive is classified as a collector road within the City of Barrie Transportation Network the existing culvert is deficient. A 2.4m x 1.2m concrete box culvert will convey the 100-year peak flow without overtopping Bayview Drive. All calculations pertaining to the tributary can be found in Appendix Volume 2, Section 5A.

(Whiskey Creek Master Drainage Plan Update pg.7, 2009)

Appendix Volume 2, Section 5A Excerpt (Page 522 and 523 of PDF):

Check Capacity of channel north of Mollard Court

```
Channel bottom width    = 0.9m
Side Slopes             = 3:1
Channel Slope           = 0.45% min.
```

From the following data it can be seen that the Mollard Court channel has sufficient capacity to convey the 100-year storm peak flows (which are larger than the Regional peak flows).

Channel Calculator

```
Given Input Data:
     Shape ..........................  Trapezoidal
     Solving for ....................  Depth of Flow
     Flowrate .......................  10.1800 cms
     Slope ..........................  0.0045 m/m
     Manning's n ....................  0.0350
     Height .........................  2.0000 m
     Bottom width ...................  0.9000 m
     Left slope .....................  0.3333 m/m (V/H)
     Right slope ....................  0.3333 m/m (V/H)

Computed Results:
     Depth ..........................  1.3502 m
     Velocity .......................  1.5228 mps
     Full Flowrate ..................  26.7788 cms
     Flow area ......................  6.6851 m²
     Flow perimeter .................  9.4403 m
     Hydraulic radius ...............  0.7081 m
     Top width ......................  9.0022 m
     Area ...........................  13.8012 m²
     Perimeter ......................  13.5502 m
     Percent full ...................  67.5113 %
```

Check capacity of 1.2m diameter CSP culvert under Bayview Drive

Check capacity of culvert under inlet control:

Invert of CSP culvert = 268.30m
Road elevation = 271.46m
Maximum allowable head = 271.46 - 268.30
= 3.16m

Using Chart D5-1G,
HW = 3.16 m
HW/D = 3.16/1.2
= 2.63

Therefore,
Q = 4.30 m^3/s

Check capacity of culvert under outlet control:

Using Chart D5-2C,
H = 3.16 m
Ke = 0.90

Therefore,
Q = $\pm$ 5 m^3/s

Since Bayview Drive is classified as a Collector and the City of Barrie standards indicate 25-year flows should be conveyed through the culvert, the existing culvert is deficient. It is standard practice to size collector road culverts to convey Regional or 100-year peak flow were available.

Find culvert size to convey 100-year peak flows of 10.18 m^3/s.

Using HW = 2.75m and Chart D5-1A for a 1.2m high concrete box culvert,

Q = 4.75m3/s/m

At 2.4m in width, Q = 4.75 x 2.4
= 11.4 m3/s.

Therefore, the Bayview Drive culvert should be upgraded to a 2.4m x 1.2m concrete box culvert.
Cost of Culvert = 20m x $3460/m
= $ 69,200

HY-8 Culvert Analysis Report

Site Data - Big Bay Point Rd Crossing

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 269.47 m

Outlet Station: 45.00 m

Outlet Elevation: 268.57 m

Number of Barrels: 2

Culvert Data Summary - Big Bay Point Rd Crossing

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: NONE

Table 1 - Downstream Channel Rating Curve (Crossing: Big Bay Point Rd Crossing)

Flow (cms)	Water Surface Elev (m)	Depth (m)	Velocity (m/s)	Shear (Pa)	Froude Number
0.49	268.93	0.26	1.39	159.68	1.19
0.79	268.98	0.31	1.58	192.29	1.23
1.01	269.01	0.34	1.69	211.97	1.25
1.33	269.05	0.38	1.81	236.65	1.27
1.57	269.08	0.41	1.89	253.06	1.29
1.82	269.10	0.43	1.96	268.56	1.30

Tailwater Channel Data - Big Bay Point Rd Crossing

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0630

User Defined Channel Cross-Section:

Coord No.	Station (m)	Elevation (m)	Manning's n
1	0.00	269.57	0.0320
2	3.66	269.31	0.0320
3	5.20	269.04	0.0320
4	7.06	268.67	0.0320
5	8.10	268.85	0.0320
6	8.99	269.16	0.0320
7	9.60	269.35	0.0320
8	10.97	269.49	0.0000

Roadway Data for Crossing: Big Bay Point Rd Crossing

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 270.71 m

Roadway Surface: Paved

Roadway Top Width: 40.00 m

Table 2 - Summary of Culvert Flows at Crossing: Big Bay Point Rd Crossing

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	Big Bay Point Rd Crossing Discharge (cms)	Roadway Discharge (cms)	Iterations
269.90	2-yr	0.49	0.49	0.00	1
270.05	5-yr	0.79	0.79	0.00	1
270.15	10-yr	1.01	1.01	0.00	1
270.29	25-yr	1.33	1.33	0.00	1
270.42	50-yr	1.57	1.57	0.00	1
270.57	100-yr	1.82	1.82	0.00	1
270.71	Overtopping	2.05	2.05	0.00	Overtopping

Lloyd Spooner

From: Lisa-Beth Bulford <L.Bulford@lsrca.on.ca>
Sent: Thursday, March 24, 2016 3:47 PM
To: Lloyd Spooner
Cc: DPERKS@cctatham.com
Subject: Big Bay Point and Bayview Drive EA cmts
Attachments: 03-23-2016 Bulford Barrie Bayview Drive and Big Bay Point Road EA CMTS.pdf

Lloyd,

Please find our comments attached.

Sincerely,

Lisa

Lisa-Beth Bulford, M.Sc.
Development Planner
Lake Simcoe Region Conservation Authority
120 Bayview Parkway,
Newmarket, Ontario L3Y 3W3
905-895-1281, ext. 239 | 1-800-465-0437
l.bulford@LSRCA.on.ca | www.LSRCA.on.ca

Twitter: @LSRCA
Facebook: LakeSimcoeConservation

Lake Simcoe Region
conservation authority

A Watershed for Life

Sent by E-mail: lloyd.spooner@barrie.ca

March 24, 2016

File No: T05-BA3
IMS File No.: PEAA453

Mr. Lloyd Spooner, C.E.T.
City of Barrie
Engineering Department
70 Collier Street, Box 400
Barrie, ON
L4M 4T5

Dear Mr. Spooner:

Re: Bayview Drive (Big Bay Point to Little Avenue) and Big Bay Point Road (Bayview Drive to Huronia Road) Municipal Class Environmental Assessment Phases 3 & 4 City of Barrie

Thank you for circulating the Lake Simcoe Region Conservation Authority (LSRCA) on the following Technical Report related to this EA:

- C.C.Tatham & Associates Ltd., Drainage and Stormwater Management Technical Memorandum, February 16, 2016

This project is of interest to the LSRCA due to the presence of hazard lands, natural heritage features, and hydrologic features as defined in the Provincial Policy Statement (PPS). Lands within the study area are also under the jurisdiction of Ontario Regulation 179/06 of the *Conservation Authorities Act* related to road crossings at Whiskey Creek tributaries and their associated floodplain and erosion hazards. We also note that the affected lands are adjacent to designated Level 1 Natural Heritage Resources on Schedule H of the City of Barrie Official Plan.

It is our understanding that a Natural Environment Technical Report will be completed as part of the selection process for the preferred detailed design alternative. We recommend that once this report is completed that it be circulated for our review and comment to ensure that it will meet our requirements for the subsequent LSRCA permit process. We recommend that the selected alternative should consider minimizing any impacts to any natural heritage and hydrologic features (i.e. woodlands and watercourses) and that an appropriate mitigation and ecological offsetting strategy be provided for any unavoidable loss or impact to these features.

120 Bayview Parkway, Box 282
Newmarket, Ontario L3Y 4X1
Tel: 905.895.1281 1.800.465.0437
Fax: 905.853.5881
Web: www.LSRCA.on.ca
E-Mail: Info@LSRCA.on.ca

The following comments are provided for your consideration related to our review of the Drainage and Stormwater Management Technical Memorandum:

1. Section 2.1.1 of the report indicates two major watercourse crossings and three minor watercourse crossings on Bayview Drive and refers to Figure 1. Figure 1 appears to only show three crossings in total. Please confirm the number of crossings and update the report and Figure 1 as appropriate.

2. It is noted that based on Table 5 in Section 3.4 of the report that there are 4 potential culverts that are recommended for removal. It is also understood that the proposed approach involves removal of ditches and diversion of flows into proposed storm sewers. Please show the proposed culverts to be removed on Figure 1.

3. If the redirection of the flows mentioned in #3 above into a storm sewer would result in impacts to natural heritage features, a feature based water balance would be required.

4. A potential SWMF is proposed in Lackies Bush. This is based on a recommendation from the Whiskey Creek Master Drainage Plan (Aecom, 2009) which in turn was based on an MDP completed by Andrew Brodie Associates inc. in 1986. Based on available information, the facility proposed would appear to be an online/in-stream facility. As per the LSRCA's Guidelines for the Implementation of Ontario Regulation 179/06 (Development, Interference with Wetlands and Alteration to Shorelines and Watercourses Regulation), Section 9.2.2, the construction of new in-stream or by-pass ponds which are directly connected with a watercourse will not be permitted. If a pond is to be proposed in this location, consultation with LSRCA is recommended to determine feasibility and site-specific requirements. Please clarify the text of the report to indicate that an in-stream facility is not being proposed.

5. The Whiskey Creek Crossing in front of 323 Bayview Drive is located within the floodplain. As such, if fill is proposed within this area, an incremental cut/fill balance will be required. Please include this requirement in the text of the report.

6. How were the hydrologic parameters included in the hydrologic model determined? The report references the 2009 Whiskey Creek MDP prepared by AECOM in 2009. The City of Barrie is currently undertaking work to update the city-wide hydrologic model with MDP's scheduled to be completed in 2017. Ultimately, the flows used for the sizing of structures will need to conform to the results of these studies, once approved by LSRCA and the City of Barrie. In the interim, the flows used should conform to the 2009 MDP and be updated using the City of Barrie's latest IDF curves.

7. Please note that new Technical Guidelines for SWM Submissions are currently scheduled to be released on June 1, 2016. Applications received once these guidelines have come into effect will be required to be in accordance with the new guidelines. Since it is anticipated that the detailed design and approvals will be made following the approval of the new SWM Guidelines, the EA document should indicate that there will be requirements for volume control. The proposed update to the Technical Guidelines for SWM Submissions with respect to volume control for linear developments is as follows:

Linear *development* volume control
Linear projects on sites without restrictions that create 0.5 or greater hectares of new and/or fully reconstructed impervious surfaces, shall capture and retain the larger of the following:
i. The runoff from a 12.5 mm event from the fully reconstructed impervious surface area.
ii. The runoff from a 25 mm event from the net increase in impervious area on the site.

8. Section 4.2.1 of the report indicates that OGS units will be used to provide quality control. LSRCA only recognizes 50% TSS removal credit for an OGS unit. As noted above, updates are proposed to the LSRCA Technical Guidelines for SWM Submissions relating to OGS units that should be reflected in the EA. The proposed updates are as follows:

   The MOE SWM Manual requires that for enhanced protection, Oil/Grit separators be sized to capture and treat at least 90% of the runoff volume that occurs for a site on a long-term average basis and meet the 80% suspended solids removal efficiency. Be advised the LSRCA credits a T.S.S. removal rate of 50% for units sized for 'enhanced' protection.
   To be considered for use within the Lake Simcoe watershed, OGS's must:
   - be certified for use by the Canadian ETV program, or;
   - be registered for testing or have testing completed by the Canadian ETV program;
   - be certified for use by NJDEP or;
   - be previously certified for use by NJDEP or;
   - will be re-certified by NJDEP by January, 2017

9. Please include the SCS Type II 12-hour storm distribution as per LSRCA technical Guidelines.

10. Figure 2 does not show the existing storm sewer alignment as indicated in Section 2.2.2 of the SWM Report. Please show the existing storm sewer alignment on Figure 2 as indicated or include the alignment on a separate figure.

11. The overland flow conveyance discussed in Section 3.3.2 should be based on 100% of the 100-year event needing to be conveyed overland.

12. Please confirm that the overland flow capacity calculations were based on the most constrained cross sections anticipated as part of the design.

13. It is noted in Section 4.1.1 of the report that the oversized pipe storage system is not feasible in some locations and the alternatives of raising the road elevation or lowering the existing outlet should be considered. Have these options been explored to determine if they are feasible? What would be the anticipated environmental impacts associated with raising or lowering the outlet in the location? Further information is needed for LSRCA to complete its review related to this issue.

14. At the detailed design stage, a full hydrologic and hydraulic analysis of each culvert will be required along with all supporting information. Watercourse crossings will need to be modelled using HEC-Ras. The consultant(s) who are retained to complete the detailed design will need to obtain the latest hydraulic and hydrologic modelling information from the City and the LSRCA to form the basis of the analysis. Please include a section in the report that outlines the above requirements.

15. Section 2.1.1, first line indicates Bayview Drive "is also" functioning as a rural road cross section. Should "is also" be revised to "is"? Please revise accordingly.

16. Section 2.1.2, first line indicates Big Bay Point Road "is" functioning as a rural road cross section. Should "is" be revised to "is also"? Please revise accordingly.

17. The second paragraph of Section 2.1.1 refers to Big Bay Point Road. Should this reference be to Bayview Drive? Please confirm and update as appropriate.

We note that a permit from our offices will be required to undertake any proposed development or site alteration within the area regulated under Ontario Regulation 179/06 of the *Conservation Authorities Act.*

If you have any questions or comments, do not hesitate to contact the undersigned at 905-895-1281, extension 239, or by e-mail at l.bulford@lsrca.on.ca. Please reference the above file numbers in future correspondence.

Sincerely,

Lisa-Beth Bulford, M.Sc.
Development Planner

LBB/

c. David Perks, M.Sc. PTP, CC Tatham & Associates Ltd. (*dperks@cctatham.com)*

S:\Planning and Development Services\Other Legislation, Policy and Guidelines\Environmental Assessment Act\Environmental Assessments\Barrie\Barrie 2015\Big Bay Point Road and Bayview\03-23-2016 Bulford Barrie Bayview Drive and Big Bay Point Road EA CMTS.docx

C.C.Tatham & Associates Ltd.
Consulting Engineers

Collingwood Bracebridge Orillia Barrie

41 King Street, Unit 4
Barrie, Ontario L4N 6B5
Tel: (705) 733-9037
Fax: (705) 733-1520
Email: info@cctatham.com
Web: www.cctatham.com

October 26, 2016

via email (l.bulford@lsrca.on.ca)
CCTA File 415375

Lisa-Beth Bulford, M.Sc.
Development Planner
Lake Simcoe Region Conservation Authority
120 Bayview Parkway, P.O. Box 282
Newmarket, Ontario L3Y 4X1

Re: Bayview Drive & Big Bay Point Road Class EA: SWM Technical Memorandum Response to LSRCA Review Comments dated March 24, 2016

Dear Lisa:

C.C. Tatham & Associates Ltd. (CCTA) are writing in response to the Lake Simcoe Region Conservation Authority (LSRCA) review comments dated March 24, 2016. We offer the following response to the comments in the order they were received.

1. Figure 1 has been updated to reflect the total number of water crossings.

2. Figure 1 has been updated to show the proposed culvert removals.

3. Section 3.4 has been updated to indicate that a feature based water balance may be required in the detailed design if it is determined that the collection of minor drainage in the storm sewer will pose impacts to the study area's natural heritage features. However, based on the preliminary screening design where the major outlets to each catchment have been maintained, we do not expect that the study area's natural heritage features will be impacted.

4. Based on City comments, the proposed Lackie's Bush SWM facility has been removed from the previously identified future retrofit opportunities section (updated to Section 4.3.1).

5. Section 3.4 has been updated to indicate that a cut/fill balance will be required at Culvert #3 if fill for the culvert is proposed during the detailed design stage.

6. Section 3.4 has been updated to indicate that the flows used in the detailed design stage will need to conform with the results of the city-wide hydrologic model and updated MDP, or the flows from the MDP updated with current City of Barrie IDF curves in the interim.

7. Section 3.2 has been updated to reference required conformance to the new LSRCA Technical Guidelines for SWM submissions, which we understand were adopted in September 2016.

8. The Oil Grit Separators section (updated to Section 4.1.2) has been updated to indicate that to attain the "Enhanced" protection level for stormwater quality controls, OGS units must be considered in combination with other LID practices during the detailed design stage.

9. Addressed.

10. Figure 3 has been added to identify full extent of storm sewer system.

11. Section 3.3.2 has been updated with uncontrolled flows obtained from VO2 under 100-year Chicago storm conditions in order to represent fully blocked conditions.

12. The overland flow capacity calculations are based on the standard cross sections under maximum flow conditions that have been anticipated as part of the design.

13. As this is a screening report with the purpose of providing a preliminary evaluation of the options, and proposed road profiles have not been completed at this stage, the feasibility of raising the road elevation to accommodate an oversized pipe storage system has not been explored in depth.

14. Section 3.2 has been updated to reference the hydrologic and hydraulic analysis of each culvert that will be required.

15. Addressed.

16. Addressed.

17. Addressed.

Our updated SWM Technical Memorandum has been attached to this letter for reference. If you have any questions or require further information, please do not hesitate to contact the undersigned.

Yours truly,
C.C. Tatham & Associates Ltd.

Nicole Foris

Nicole Foris, B.A.Sc., EIT
Intern Engineer
ALK/NHF:jb

A Kellett

Amanda Kellett, B.Sc.Eng., P.Eng.
Project Manager

copy: Lloyd Spooner, City of Barrie (via email lloyd.spooner@barrie.ca)

T:\2015 PROJECTS\415375 - Bayview Dr & Big Bay Pt Rd EA\Documents\Letters\L - Bulford - Response to LSRCA Comments.docx