Holiday Inn Express

Stormwater Management Report

Project Location:
326 Bryne Drive, Barrie, ON

Prepared for:
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Prepared by:
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MTE File No.: 45303-100

Engineers, Scientists, Surveyors.

Contents

Figures

Tables

Appendices

Drawings

1.0 Introduction

MTE Consultants Inc. was retained by 2599974 Ontario Inc. to complete the stormwater management design for the proposed Holiday Inn Express hotel development to be constructed at 326 Bryne Drive in the City of Barrie.

The site is located north of intersection of Barrie View Drive and Bryne Drive. The property is bound to the north by forested lands, to the east and south by Bryne Drive and to the west by an existing commercial property and SWM pond. For exact location of the site refer to the key plan located on the enclosed engineering drawings.

The proposed development for the site is the construction of a six storey Holiday Inn Express hotel complete with at grade parking, drive aisles and landscaped areas. The construction of the hotel is part of Phase 1 of the overall development. Due to a future municipal roadway that will bisect the site to the west, Phase 2 of the development will be treated as a separate site as the final site plan layout cannot be finalized at this time. This report has been prepared for Phase 1 only, with Phase 2 having its own separate stormwater management controls.

This report addresses the stormwater management requirements set forth by the City of Barrie and proposes a design which meets the requirements for the site. The grading, servicing and stormwater management details for the site are illustrated on the enclosed MTE engineering drawings, 45303-100 C2.1, C2.2, C2.3 and C2.4.

2.0 Criteria

The site was included in the stormwater management design put forth for the Lover's Creek Stormwater Management pond which is located west of the site, behind the existing Princess Auto industrial development. Refer to Appendix F for the stormwater management report for the Lover's Creek existing SWM pond.

The stormwater management design criteria for the subject site, as established by the City of Barrie and the Lake Simcoe Region Conservation Authority (LSRCA), are as follows:

i) Attenuate the post-development peak flow rates for the 2 to 100-year storm events to a maximum of 146L/s/ha (101.3L/s, 0.101m^3/s);

ii) Implementation of Enhanced Level 1 (80% TSS removal) water quality controls;

iii) Maintain or enhance post-development infiltration volumes and recharges to pre-development levels on a monthly basis; and,

iv) Provide an evaluation of anticipated changes in phosphorus loadings from pre- to post-development and how the loadings from the proposed development shall be minimized, and in addition provide a 100% removal of annual Total Phosphorus (TP) load.

3.0 Methodology

In order to successfully complete the stormwater management design for this site, the following specific tasks were undertaken:

i) Calculated the allowable runoff rate as set forth by the Barrie View Subdivision SWM Pond, with a max allowable release rate of 146L/s/ha (101.3L/s);
ii) Determined the percent impervious of the site and catchment parameters for inclusion in SWMHYMO modeling;
iii) Calculated post-development runoff hydrographs using SWMHYMO;
iv) Revised the site grades to attain the required storage for runoff control;
v) Calculated pre- and-post development phosphorus loading rates using the LRSCA phosphorus budget tool in Microsoft Access; and,
vi) Calculated pre- and post-development monthly water balance for net surface runoff and net infiltration using the Thornthwaite and Mather method.

4.0 Stormwater Management

4.1 Catchment Parameters

The following table summarizes the catchments used in the modelling of the site. The post-development condition for the development was separated into three catchment areas: the building rooftop area, the controlled area, the uncontrolled area. Figure 1.0 illustrates the limits of the post-development catchment areas for the development.

Table 4.1 - Catchment Parameters

#	Catchment	Area (ha)	% Impervious	Pervious CN	Impervious CN	Slope (%)	Flow Length (m)
Post-Development Catchment Areas							
201	Building Rooftop	0.113	100	75	98	1.5	7.5
202	Controlled Area	0.530	87	75	98	2.0	10.0
203	Uncontrolled Area	0.095	40	75	98	10.0	10.0

A geotechnical investigation was undertaken by Toronto Inspection Ltd. and is dated March 8, 2019. A complete copy of their report is included in Appendix C for the City's records. The investigation revealed the site is primarily underlain by sandy silt and silty sand. Therefore, a pervious CN of 75 for grass areas is appropriate. Refer to the enclosed geotechnical report for details regarding the groundwater table elevation.

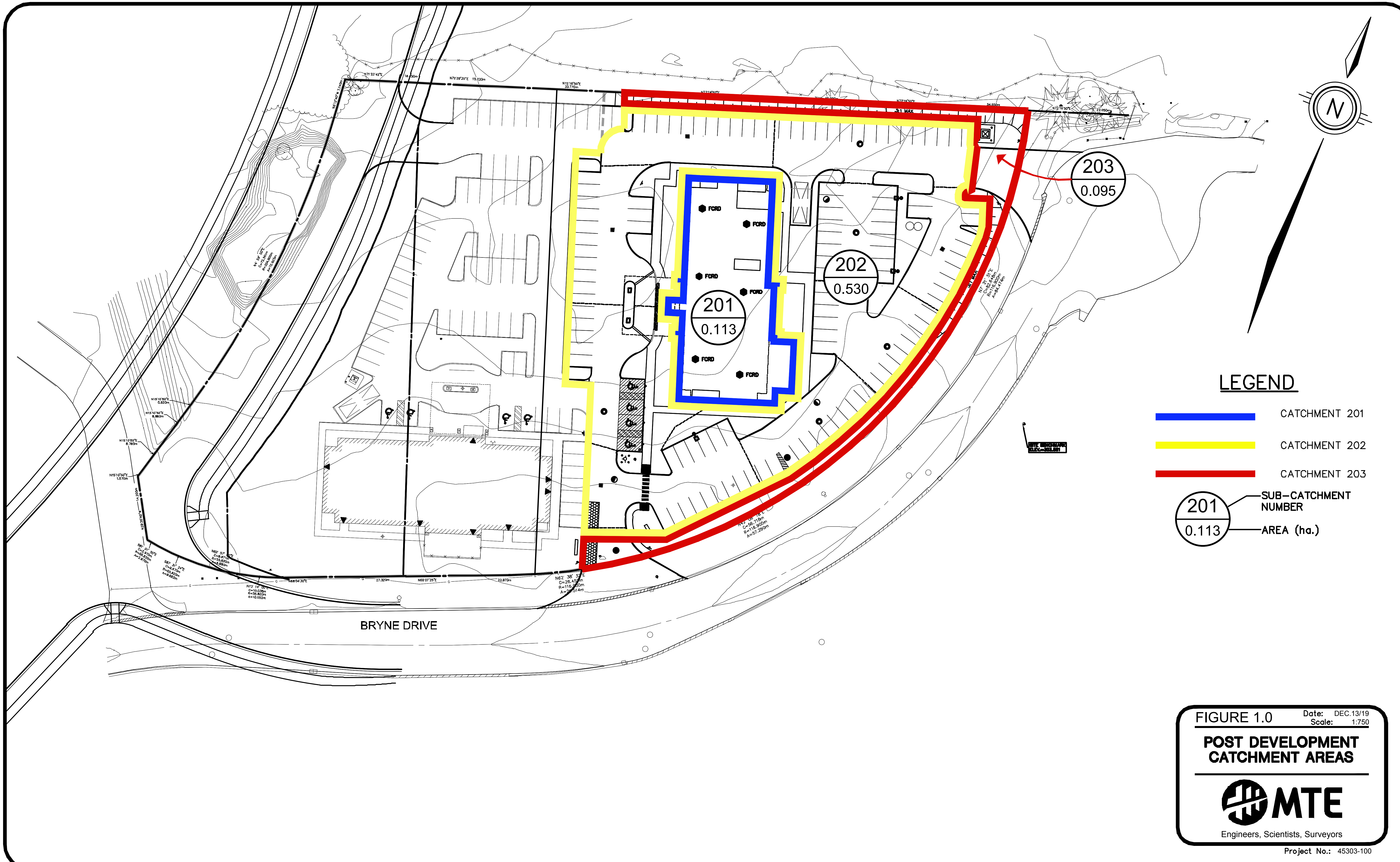

FIGURE 1.0 Date: DEC.13/19 Scale: 1:750

POST DEVELOPMENT CATCHMENT AREAS

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4.2 Water Quantity – Modelling Results

Rooftop Controls

The proposed building will incorporate flow control roof drains on the building rooftop. As per manufacturer's specification, the Zurn Control-Flo Z-105 roof drains have a release rate of 0.012L/s/mm of head per notch. Each drain will have one notch to achieve the desired release rate. Scupper drains are to be added to the parapet walls to limit rooftop ponding to a maximum depth of 0.15m. Overflow from rooftop ponding will discharge to grade for major storms events. Please refer to Appendix A for details of the proposed roof drains.

The rooftop will be equipped with six (6) flow control roof drains. Table 4.2 summarizes the stage-storage-discharge relationship of the flow control roof drains.

Table 4.2 - Stage-Storage-Discharge Information – Rooftop Controls

Depth (m)	Cumulative Storage Volume (m^3) [A]	Discharge, Q (m^3/s) [B]	Comments
0.00	0.0	0.0000	Building Roof
0.05	4.3	0.0037	0.05m (2 inches) ponding on roof
0.10	21.3	0.0074	0.10m (4 inches) ponding on roof
0.15	45.3	0.0112	0.15m (6 inches) ponding on roof

[A] Refer to Appendix A for detailed volume calculations. Roof slope assumed to be 1%.
[B] Discharge based on 6 roof drains with a rating of 0.012 L/s per mm of head (per notch per drain). Note that these FCRD are each required to have one (1) notch to achieve the required flow controls.

Parking Lot Controls

In addition to controlling the runoff generated on the building rooftop, runoff generated from the parking lot and drive aisles will be ultimately conveyed to CBMH7 wherein the flow will be controlled with the installation of a 140mm diameter online orifice plate on the outlet pipe. Storage volume for the orifice will be provided within the parking areas. The maximum depth of ponding permitted by grading it 0.30 metres. Table 4.3 summarizes the stage-storage-discharge relationship of the orifice control.

Table 4.3 - Stage-Storage-Discharge Information – Orifice Control

Elevation (m)	Head (m)	Discharge, Q (m^3/s)[A]	Volume (m^3) [B]	Remarks
301.46	0.00	0.0000	0.0	140mm dia. Online Orifice Invert
303.50	2.17	0.0613	0.0	T/G CB1, CBMH2, CBMH3, CB4, CBMH5
303.55	2.22	0.0620	2.2	T/G CBMH7, CBMH9
303.60	2.27	0.0628	13.8	T/G CB6, CBMH8
303.65	2.32	0.0635	45.8	Contour
303.70	2.37	0.0642	109.7	Contour
303.75	2.42	0.0649	211.9	Contour
303.80	2.47	0.0656	357.2	Max Ponding

[A] From orifice equation $Q = CA\,(2gH)^{0.5}$ for a 140mm diameter orifice pipe.
Where: C = 0.82, A = cross-sectional area, g = 9.81, H = pressure head
[B] Storage volume based on surface ponding in parking lot. Refer to Appendix A.

Refer to Appendix A for details of the stage storage discharge calculations. Refer to Appendix B for the SWMHYMO output files

The following table summarizes the post-development site peak discharge rates for the 2 to 100-year storm events.

Table 4.4 – Summary of Flows

Storm Event [A]	*Post-Development Conditions*			Allowable Site Peak Discharge Rate (m^3/s) [D]
	Controlled Site Discharge (201+202) (m^3/s) [B]	*Uncontrolled Site Discharge (203) (m^3/s) [B]*	*Total Site Discharge to SWM Pond (m^3/s) [C]*	
2-yr	0.063	0.012	**0.075**	*0.101*
5-yr	0.064	0.018	**0.081**	
10-yr	0.064	0.022	**0.085**	
25-yr	0.064	0.027	**0.091**	
50-yr	0.064	0.031	**0.095**	
100-yr	0.064	0.035	**0.099**	

[A] 4-Hour Chicago Storm distribution utilized for modelling post development conditions
[B] Discharge rate taken from SWMHYMO Output
[C] Total discharge (controlled + uncontrolled areas) taken from SWMHYMO Output
[D] Refer to Section 2.0

Table 4.5 summarizes the rooftop storage volume used for the 2 to 100-year storm event.

Table 4.5 – Rooftop Storage Volume

Storm Event [A]	***Building Rooftop (Catchment 201)***	
	Storage Volume Used (m^3) [B]	***Storage Volume Provided (m^3)*** [C]
2-yr	14.8	**45.3**
5-yr	20.4	
10-yr	23.4	
25-yr	26.9	
50-yr	29.4	
100-yr	32.4	

[A] 4-Hour Chicago Storm distribution utilized for modelling post development conditions
[B] Storage volume taken from SWMHYMO Output
[C] Total storage volume provided via rooftop ponding in Catchment 201

Table 4.6 summarizes the parking lot storage volume used for the 2 to 100-year storm event.

Table 4.6 – Parking Lot Storage Volume

Storm Event [A]	***Parking Lot and Landscape Area (Catchment 202)***	
	Storage Volume Used (m^3) [B]	***Storage Volume Provided (m^3)*** [C]
2-yr	28.7	**357.2**
5-yr	50.3	
10-yr	65.9	
25-yr	90.8	
50-yr	109.0	
100-yr	130.0	

[A] 4-Hour Chicago Storm distribution utilized for modelling post development conditions
[B] Storage volume taken from SWMHYMO Output
[C] Total storage volume provided via parking lot ponding in Catchment 202

The analysis indicates the following for the development:

- For the 2-year to 100-year storm events, the total post-development peak discharge rates from the site do not exceed the allowable release rate of 101L/s.
- There is sufficient rooftop storage on the proposed building rooftop to contain the 2-year to 100-year event.

- There is sufficient storage within the proposed parking area to contain the 2-year to 100-year event for the 4-hour Chicago Storm with a maximum surface ponding depth of 303.71m.

4.3 Water Quality Control

A Jellyfish Filter will be installed on the storm sewer, downstream of the online orifice plate, to provide water quality control for the site. The chosen unit is ETV certified and is expected to provide Level 1 (Enhanced) water quality control to achieve 80% TSS removal as well as 49% Total Phosphorus (TP) removal. The Jellyfish Filter will require regular annual maintenance to ensure it is operating properly per the manufacturers guidelines. The owner will enter into a maintenance agreement with a suitable contractor to complete this work. In addition, all the storm structures will have a 600 mm sump. The sizing output, ETV certification and owner's maintenance manual are included in Appendix A.

4.4 Infiltration and Water Balance

The LSRCA requires that a monthly water budget analysis is completed for the site to examine the impacts of the proposed development on infiltration. Monthly water budget analyses using Thornthwaite & Mather method (1957) were conducted for this site under pre- and post-development conditions, to examine the impacts of the proposed development on infiltration. The Canadian Climate Normals data (monthly average precipitation and temperature) between 1981 and 2010 for station Barrie WPCC were applied in the monthly water budget analyses.

The site is located within a Significant Groundwater Recharge Area where infiltration of runoff from paved surfaces is not permitted. However, rooftop drainage is considered a clean source and infiltration is permitted from this source exclusively. Therefore, the proposed infiltration measures on the site include passive infiltration across the site in pervious areas and infiltration of runoff generated on the proposed building rooftop via an infiltration gallery. The infiltration gallery will be sized to accommodate runoff from the rooftop for a 30mm rainfall event. The proposed rooftop area is 1,130m^2, multiplied by 30mm rainfall depth equates to a capture volume of 33.9m^3.

The infiltration gallery is proposed to be installed south of the proposed building, below the proposed parking lot. Based on the hydrogeological investigation, the subsurface soils generally comprise of sand and gravel and an infiltration rate of 200mm/hr has been used. The composite high groundwater elevation was determined to be 300.80 masl. The bottom of the infiltration gallery will have a minimum of 1.0m of separation above the groundwater table, at an elevation of 301.80. The proposed gallery will be an ADS Stormtech system with a total depth of 1.06m and a total storage volume of 43.0m^3 (20% greater than the capture volume of 33.9m^3). The resulting top of gallery elevation will be 302.86, with cover above ranging between 0.74 – 0.96m. An overflow connection to the on-site storm sewer is proposed which will ultimately be directed towards the municipal storm sewer within the Bryne Drive right-of-way. Refer to Figure 2.0 for a cross section of the proposed gallery and Drawing C2.2 for the proposed gallery location.

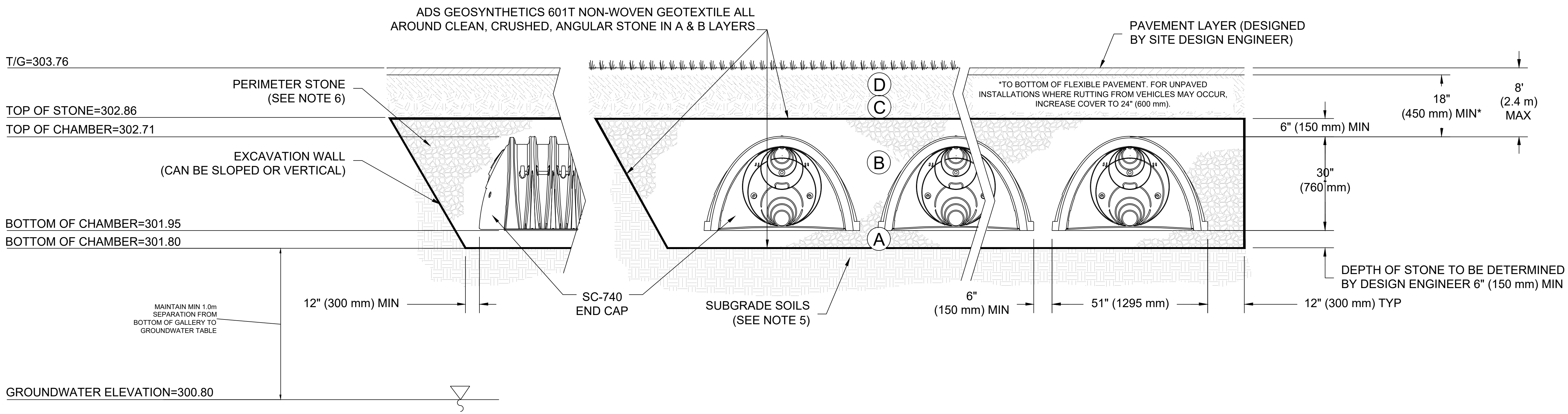

FIGURE 2.0 Date: OCT.23/20 Scale: N.T.S.

INFILTRATION GALLERY CROSS SECTION

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The results of water budget analyses using Thornthwaite & Mather method (1957) are summarized in the following Table 4.7. Details of the water budget analyses are provided in Appendix D.

Table 4.7 –Monthly Water Balance

Month	Precip. (mm)	Pre-Development Infiltration (m^3)	Post-Development Infiltration (m^3)	Difference
JAN	82.5	55	13	-43
FEB	61.8	28	6	-21
MAR	58.1	14	3	-11
APR	62.2	270	145	-125
MAY	82.4	810	369	-441
JUN	84.8	381	234	-147
JUL	77.2	191	157	-33
AUG	89.9	95	142	47
SEP	94.0	48	144	96
OCT	77.5	24	117	94
NOV	88.9	186	151	-35
DEC	73.6	122	29	-93
Total	**932.9**	**2,223**	**1,512**	**-711**

As demonstrated in the table and results provided in Appendix D, the proposed development will result in an overall net decrease in infiltration across the site. As runoff from the parking lot cannot be infiltrated on this site, a water balance cannot be achieved. Therefore, the Water Budget Offsetting Policy will apply. Per the LSRCA Policy document updated in May 2019, the offsetting fee for this site is \$47.00/m³ deficit, resulting in a required fee of \$33,417 (711m³ x \$47/m³).

The LSRCA requires that the runoff collected in the proposed infiltration gallery achieves a draw down time of 48 hours. The time to drain is estimated based on equation 4.3 (Page 4-26 of the MECP SWM manual) as follows:

$A = 1000V/ Pn\Delta t$ where,

A = bottom area of trench (m^2)
V = runoff volume to be infiltrated (m^3)
P = percolation rate of surrounding native soil (mm/hr)
n = porosity of the storage media (0.4 for clear stone)
Δt = retention time (24 to 48 hours)

The proposed infiltration gallery is 4.98m wide by 15.21m long for a bottom area equal to 75.75m².

$\Delta t = 1000 * 43m^3 / 200mm/hr * 0.4 * 75.75m^2$
$\Delta t = 7.09hr$

Therefore, a drawdown time of 7 hours can be achieved within the proposed system. Due to the high percolation rate of the native soils, a draw down time of 24hours is unable to be achieved. Further, the proposed infiltration gallery has been designed within the constraints on the site to achieve a minimum of 1.0m of separation from the high groundwater elevation and minimum cover provided above the system.

4.5 Phosphorus Budget

As outlined in the LSRCA Technical Guidelines for SWM Submissions, an evaluation of anticipated changes in phosphorus loadings between pre-development and post-development is required. To complete this, an area load method measuring kilogram per hectare per year (kg/ha/yr) is to be calculated for the site, utilizing the Phosphorus Budget Tool prepared by the Ministry of the Environment, in Support of Sustainable Development for the Lake Simcoe Watershed. Loading attenuation measures are required to be implemented on the site to provide a composite annual removal efficiency of 100%

Under pre-development conditions the site is a vacant lot that has become vegetated with low grasses and therefore can be classified as Cropland. Under post-development conditions the site is made up of High Intensity Development (Commercial / Industrial) for the proposed building and parking area, and Low Intensity Development for the controlled and uncontrolled landscaped areas. Refer to Appendix E for land use descriptions. Figure 3.0 provides an illustration of the land use under pre-development conditions for the entire site. Figure 4.0 provides an illustration of the division of land uses under post-development conditions.

To reduce the total phosphorus across the site, runoff generated from the building rooftop will be conveyed to an on-site infiltration gallery. Runoff generated the controlled hard surface areas will be conveyed to an on-site Jellyfish Filter before entering the municipal storm sewer. Excess runoff is then conveyed to the existing downstream municipal stormwater management facility which can be considered as an additional level of treatment. In combination these facilities act as a treatment train to achieve the highest removal efficiencies for the site. Refer to Table 4.8 for details on the proposed measures and their associated removal rates. Refer to Appendix F for documentation provided by the City of Barrie for the existing downstream stormwater management facility.

Flows generated within Catchments 401 and 402 will be conveyed through the proposed treatment trains. Flows generated in Catchment 403 will be uncontrolled and will be conveyed through grassed embankments off site.

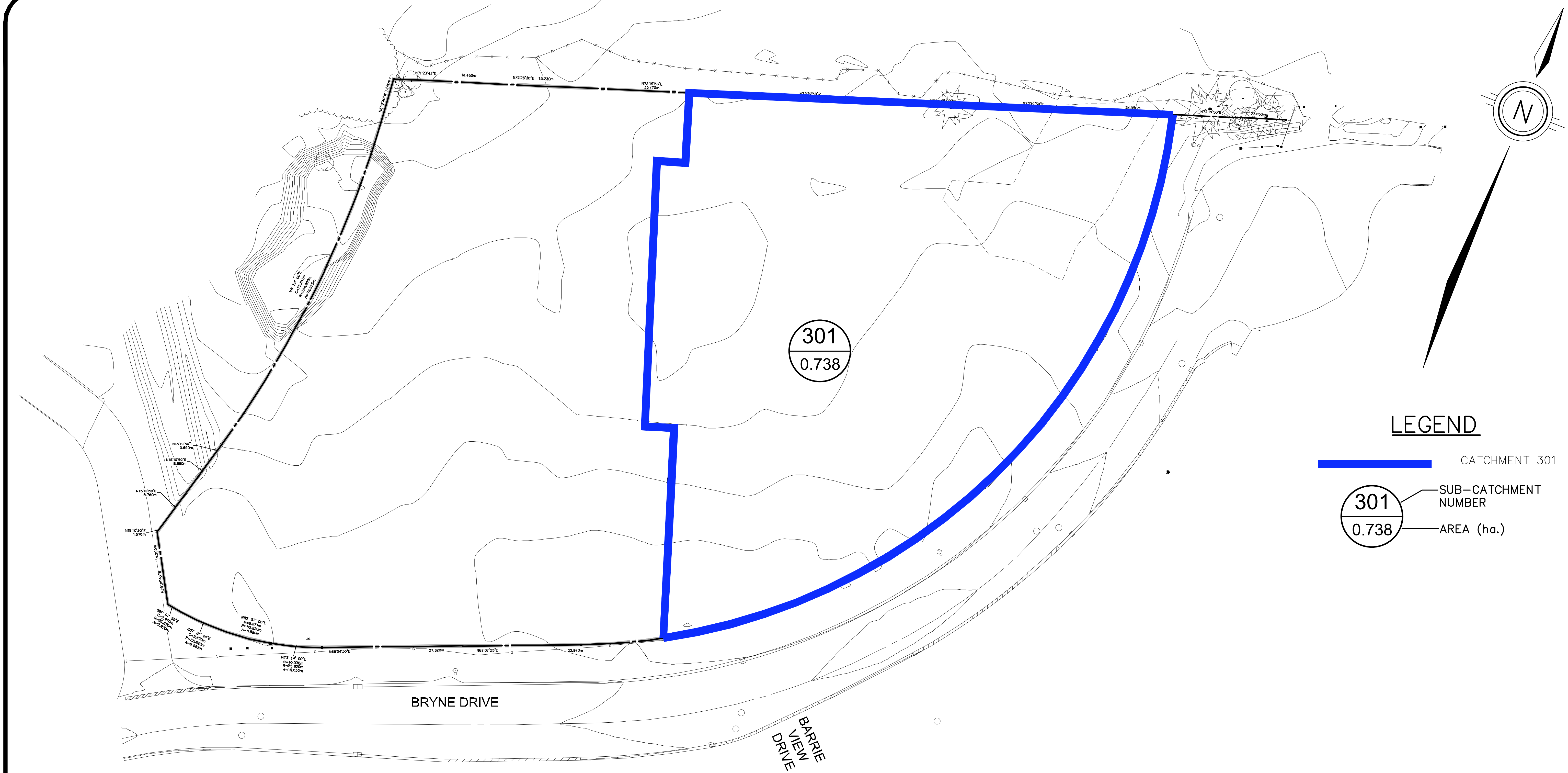

FIGURE 3.0

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PRE-DEVELOPMENT PHOSPHORUS BUDGET LAND USE

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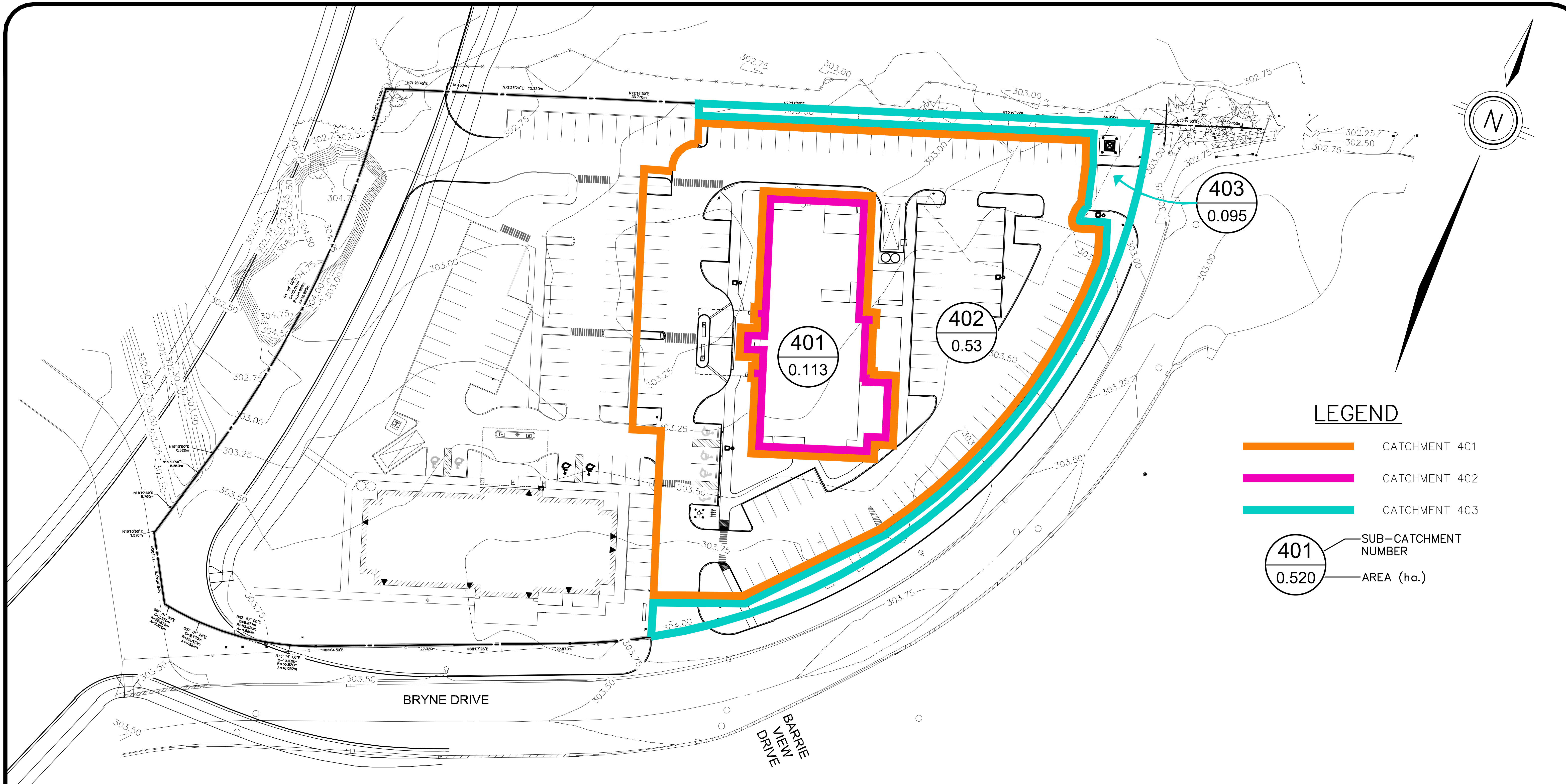

FIGURE 4.0 Date: MAR.26/20 Scale: 1:750

POST DEVELOPMENT PHOSPHORUS BUDGET LAND USE

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Table 4.8 – Phosphorus Removal

Catchment Area	Land Use	Area (ha)	P Coefficient (kg/ha/yr)	Best-Management Practice	Removal Efficiency [A]	P Load (kg/yr)
Pre-Development						
301	Cropland	0.738	0.19	-	-	0.14
Post-Development						
401	High-Intensity Development (Building Rooftop)	0.113	1.82	Treatment Train – Infiltration Gallery + Ex. SWM Facility	83%*	0.05
402	High-Intensity Development (Controlled Asphalt, Sidewalks and Landscape Areas)	0.530	1.82	Treatment Train – Jellyfish Filter + Ex. SWM Facility	83%*	0.14
403	Low-Intensity Development (Uncontrolled Landscaped)	0.095	0.13	Vegetated Filter Strips	65%	0.00
Post Development P load without BMPs (kg/yr)			1.16	*Post Development P load with BMPs (kg/yr)*		0.20
Change without BMPs (Post to Pre) (kg/yr)			+1.02	*Change with BMPs (Post to Pre)*		+0.06
Potential P Load Reduction with BMPs						83%

[A] Composite removal efficiency based on treatment train approach using on-site best management practices and off-site SWM facility using the Lake Simcoe Phosphorus Budget Tool.

Composite Removal Efficiency

Jellyfish Filter = 49%
Infiltration Gallery = 60%
SWM Pond = 63%
Vegetated Filter Strips = 65%

Catchment 401 = 1 – [(1-0.60) x (1-0.63)] = 85%
Catchment 402 = 1 – [(1-0.49) x (1-0.63)] = 81%

*The MOE Phosphorus budget tool will not allow the same land use type to be used for multiple catchment areas, therefore catchment 401 and 402 have been combined in the tool, and an average phosphorus removal of 83% applied to the combined catchments, based on their respective treatment train approaches.

Total Phosphorus Reduction

Post Development P Load without BMPs (kg/yr) = 1.16
Post Development P Load with BMPs (kg/yr) = 0.20

Potential P Load Reduction with BMPs: (1-(0.20/1.16)) x 100 = 82.7%

As illustrated in the above table, the proposed treatment trains consisting of a Jellyfish Filter, an infiltration gallery and the existing downstream municipal stormwater management facility will result in a phosphorus loading of 0.20kg/yr, which is slightly above the pre-development conditions loading on the site. The total phosphorus reduction for the site with the use of the proposed Best Management Practices is 83%, which is less than the required reduction of 100%. Therefore, the Phosphorus Offsetting Policy will apply. Per the LSRCA Policy document updated in May 2019, the offsetting fee calculation for this site is (ratio (2.5) x P deficient in kg x $35,000), resulting in a required fee of (2.5 x 0.20 x $35,000) = $17,500. Refer to Appendix E for detailed phosphorus loading calculation summary utilizing the Phosphorus Budget Tool.

4.6 Erosion & Sediment Control

In order to minimize the effects of erosion during the grading of the site, sediment control fencing will be installed: as shown on the enclosed engineering drawing, around any stockpiles and around the catchbasins during construction. Any sediment that is tracked onto the road way during the course of construction will be cleaned by the contractor. To help minimize the amount of mud being tracked onto the road way, a mud mat will be installed at the primary construction entrance.

5.0 Conclusions and Recommendations

Based on the foregoing analysis, it is concluded that:

i) the proposed stormwater management design provides adequate attenuation of the 2 to 100-year storm events to below the allowable rate of 146L/s/ha;

ii) the proposed Jellyfish Filter will provide Level 1 (Enhanced) water quality treatment;

iii) an infiltration water balance analysis has been completed for the development. The proposed SWM strategy will result in a net loss in annual infiltration on the site;

iv) a phosphorus loading evaluation has been completed for the development. The proposed SWM strategy will result in an 83% reduction in phosphorus loads; and,

v) upon completion of construction, the site will conform to the design criteria specified by the City of Barrie.

It is recommended that:

i) the site grading be undertaken according to the proposed elevations, details and erosion control measures shown on the enclosed engineering drawings;

ii) the stormwater management facilities be installed as detailed on the enclosed engineering drawings; and,

iii) the stormwater management facilities be inspected by MTE Consultants Inc. during construction and certified to the City of Barrie upon completion.

All of which is respectfully submitted,

MTE CONSULTANTS INC.

LICENSED PROFESSIONAL ENGINEER
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Appendix A

Calculations and SWM Details

CALCULATIONS

Orifice Equation (MIDUSS NET)

$Q = C_c$ p/4 D5 sqrt(2g(H-2/3D))

where C_c coefficient of contraction

H head relative to the invert of the orifice

D orifice diameter

g gravitational acceleration

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Design Storm Information

Design storm information used in the hydrologic modeling was based on Chicago Storm distribution Intensity-Duration-Frequency (IDF) equations for City of Barrie [(A)] in the form:

$$i = \frac{A}{(t+B)^C}$$

Where: i = Rainfall intensity (mm/hr)
t = Time of duration (min)
A, B and C = Constant (see below)

The value of the parameters for the various storm events is provided below:

	2-Yr. [(B)]	5-Yr.	10-Yr.	25-Yr.	50-Yr.	100-Yr.
A	678.1	853.6	975.9	1146.3	1236.2	1426.4
B	4.699	4.699	4.699	4.922	4.699	5.273
C	0.781	0.766	0.760	0.757	0.751	0.759

[(A)] IDF parameters from Appendix B - Storm Drainage and Stormwater Management Policies and Design Guidelines, City of Barrie Engineering Department
[(B)] IDF equations used to generate rainfall files with Duration (TD) = 4 hours and Time-to-Peak Ratio (TPR) = 0.33

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PHASE 1 POST DEVELOPMENT CONDITIONS

Catchment	Description	Hydrograph	Area	Perv.	Perv. Ia	Impervious (%)		Flow Length (m)		Manning "n"		Slope (%)		Time to Peak
ID		Method	(ha)	CN [A]	(mm)	TIMP	XIMP	Perv.	Imperv.	Perv.	Imperv.	Perv.	Imperv.	Tp (hrs)
201	Building Rooftop	STANDHYD	0.113	76	5.00	100	100	7.5	7.5	0.250	0.015	1.0	1.0	
202	Controlled Area	STANDHYD	0.530	76	5.00	87	87	5	10	0.250	0.015	2.0	2.0	
203	Uncontrolled Area	STANDHYD	0.095	76	5.00	40	40	3	5	0.250	0.015	10.0	6.0	
Total			**0.74**			**83**	**83**							

Notes:

[A] Curve Number based on underlying sandy silt, as per Toronto Inspections Ltd Geotechnical Investigation for the site

[B] Initital abstraction for impervious surfaces = 2mm

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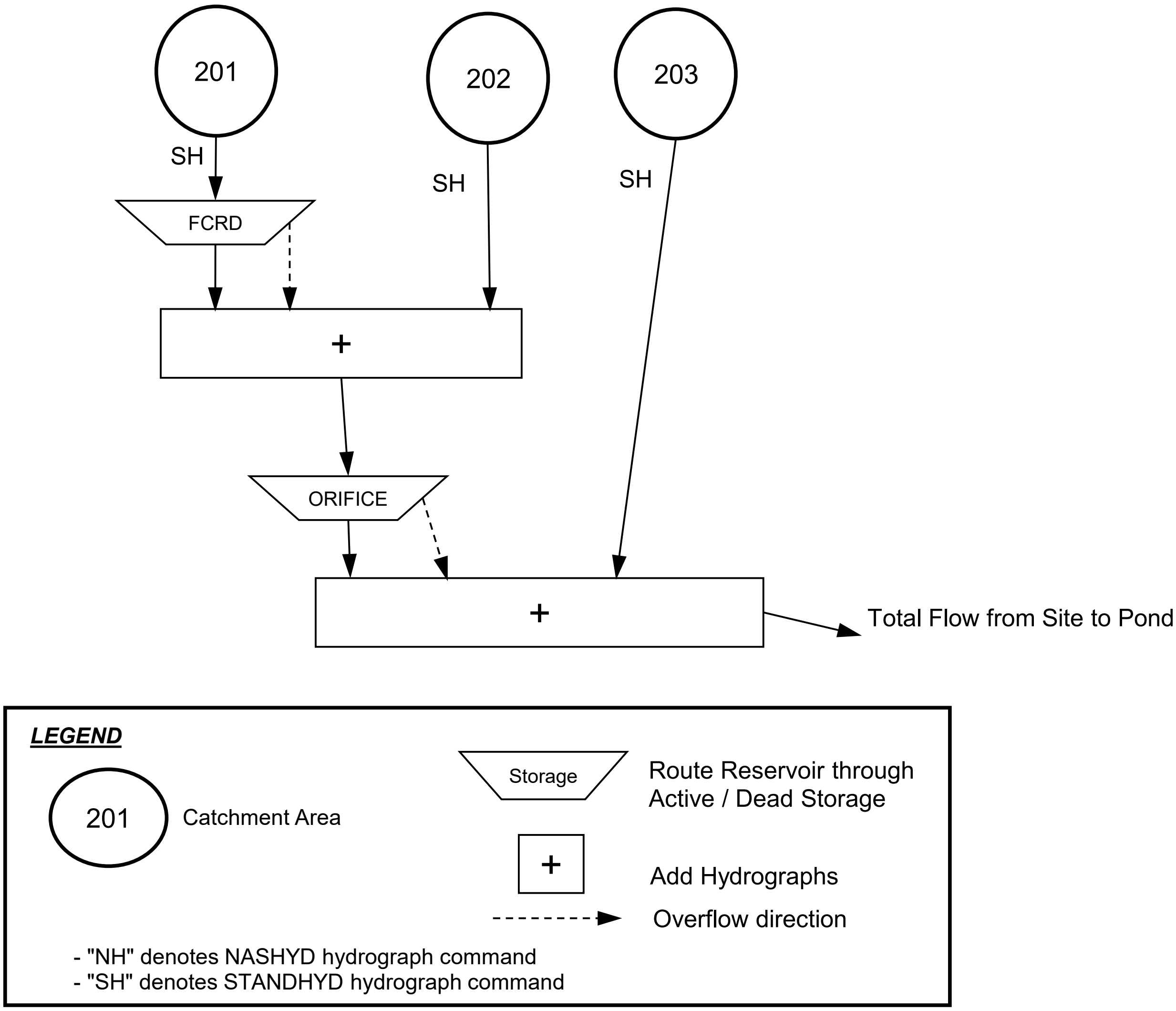
PHASE 1 POST-DEVELOPMENT CONDITIONS MODEL SCHEMATIC



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Stage-Storage-Discharge Relationship Rooftop Flow Controls

Proposed Building Roof Phase 1 (Catchment 201)

Total Roof Area = 0.113 ha
Total Roof Area Avail for Ponding= 0.113 ha
Number of roof drains = 6
Drain discharge = 0.012 l/s/mm head (0.315 l/s per inch of head per notch) - 1 Notch on each

Head	Area	Incremental Volume	Cumulative Volume	Total Discharge
(mm)	(m^2)	(m^3)	(m^3)	(m^3/s)
0	0	0	0.0	0
50	170	4.3	4.3	0.0037
100	682	21.3	25.6	0.0074
150	1130	45.3	70.9	0.0112

Input into SWMHYMO	
Discharge (Q)	Volume
m^3/s	ha.m
0.00000	0.00000
0.00372	0.00043
0.00744	0.00256
0.01116	0.00709

Notes:

-1% slope was assumed to determine ponding area at each stage

Sample Calculations (for when head = 50 mm):

Head (mm) = water level above the top of drain = 50 mm
Area (m^2) = surface area of water at corrosponding head = 236 m^2
Incremental volume (m^3) = (change in head)(average surface area) = [(50+0)/1000][(236+0)/2] = 5.9 m^3
Cumulative Volume (m^3) = current volume + prevous volume = 5.9 + 0 = 5.9 m^3
Total Discharge (m^3/s) = (# roof drains)(discharge/roof drain)(total head) = (3)(0.012)(50/1000) = 0.0124 m^3/s)

HOLIDAY INN EXPRESS
CITY OF BARRIE
STORMWATER MANAGEMENT

Project Number:	45303-100
Date:	July 15, 2020
File:	Q:\TOOLS\DESIGN SHEETS\0000 Storm Sewer Design Sheet Guelph_Rev8.xlsx

Orifice Calculations for Catchment 202

$Q_o=C_d*A_o*(2*g*H_o)^{0.5}$

	Orifice	Description
C_d	0.63	Outlet Pipe
Invert (m)	301.466	
Diameter (mm)	140	
Type (H/V)	V	

STAGE-STORAGE-DISCHARGE RELATIONSHIP

Description	Stage	Area	Incremental Volume	Cumulative Volume	Orifice		
					Orifice Area	H_o	Flow
	m	*m²*	*m³*	*m³*	*m²*	*m*	*m³/s*
Orifice Invert	301.47	0.00	0	0	0.015	0	0
T/G	303.50	0.00	0.0	0.00	0.015	2.03	0.0613
	303.55	90.00	2.3	2.25	0.015	2.08	0.0620
	303.60	373.50	11.6	13.84	0.015	2.13	0.0628
	303.65	905.50	32.0	45.81	0.015	2.18	0.0635
	303.70	1650.50	63.9	109.71	0.015	2.23	0.0642
	303.75	2440.00	102.3	211.98	0.015	2.28	0.0649
Max ponding (0.3m)	303.80	3370.5	145.3	357.24	0.015	2.33	0.0656

STANDARD OFFLINE
Jellyfish Filter Sizing Report

Project Information

Date	Saturday, December 14, 2019
Project Name	Barrie
Project Number	
Location	Barrie

Jellyfish Filter Design Overview

This report provides information for the sizing and specification of the Jellyfish Filter. When designed properly in accordance to the guidelines detailed in the Jellyfish Filter Technical Manual, the Jellyfish Filter will exceed the performance and longevity of conventional horizontal bed and granular media filters.

Please see ***www.ImbriumSystems.com*** *for more information.*

Jellyfish Filter System Recommendation

The Jellyfish Filter model JF6-3-1 is recommended to meet the water quality objective by treating a flow of 17.7 L/s, which meets or exceeds 90% of the average annual rainfall runoff volume based on 36 years of BARRIE WPCC rainfall data for this site. This model has a sediment capacity of 199 kg, which meets or exceeds the estimated average annual sediment load.

Jellyfish Model	Number of High-Flo Cartridges	Number of Draindown Cartridges	Manhole Diameter (m)	Treatment Flow Rate (L/s)	Sediment Capacity (kg)
JF6-3-1	3	1	1.8	17.7	199

The Jellyfish Filter System

The patented Jellyfish Filter is an engineered stormwater quality treatment technology featuring unique membrane filtration in a compact stand-alone treatment system that removes a high level and wide variety of stormwater pollutants. Exceptional pollutant removal is achieved at high treatment flow rates with minimal head loss and low maintenance costs. Each lightweight Jellyfish Filter cartridge contains an extraordinarily large amount of membrane surface area, resulting in superior flow capacity and pollutant removal capacity.

Maintenance

Regular scheduled inspections and maintenance is necessary to assure proper functioning of the Jellyfish Filter. The maintenance interval is designed to be a minimum of 12 months, but this will vary depending on site loading conditions and upstream pretreatment measures. Quarterly inspections and inspections after all storms beyond the 5-year event are recommended until enough historical performance data has been logged to comfortably initiate an alternative inspection interval.

Please see ***www.ImbriumSystems.com*** *for more information.*

Thank you for the opportunity to present this information to you and your client.

Performance

Jellyfish efficiently captures a high level of Stormwater pollutants, including:

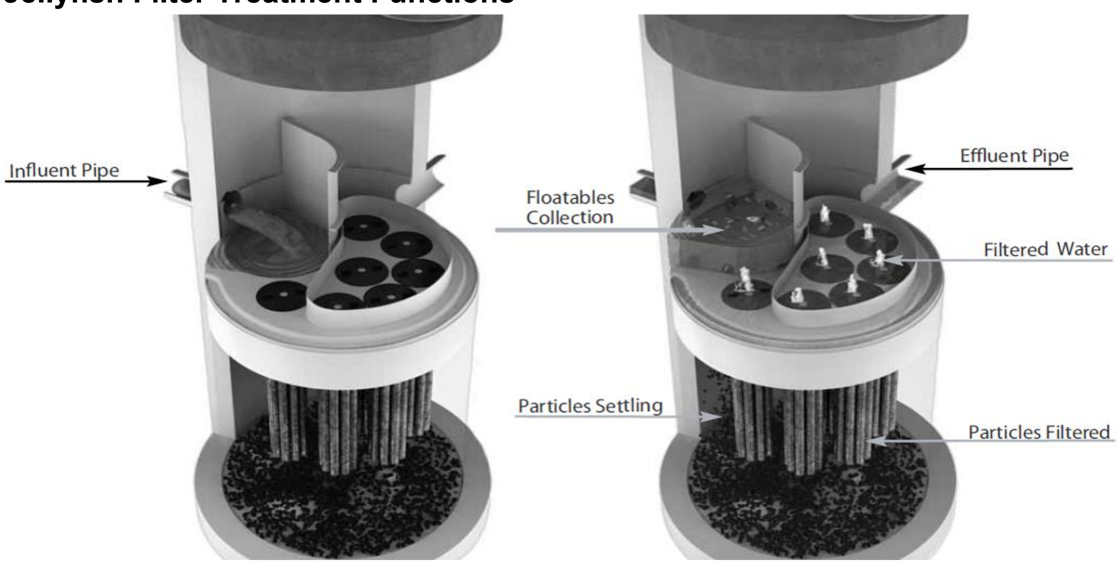
- ☑ 89% of the total suspended solids (TSS) load, including particles less than 5 microns
- ☑ 59% TP removal & 51% TN removal
- ☑ 90% Total Copper, 81% Total Lead, 70% Total Zinc
- ☑ Particulate-bound pollutants such as nutrients, toxic metals, hydrocarbons and bacteria
- ☑ Free oil, Floatable trash and debris

Field Proven Peformance

The Jellyfish filter has been field-tested on an urban site with 25 TARP qualifying rain events and field monitored according to the TARP field test protocol, demonstrating:

- A median TSS removal efficiency of 89%, and a median SSC removal of 99%;
- The ability to capture fine particles as indicated by an effluent d50 median of 3 microns for all monitotred storm events, and a median effluent turbidity of 5 NTUs;
- A median Total Phosphorus removal of 59%, and a median Total Nitrogen removal of 51%.

Jellyfish Filter Treatment Functions



Pre-treatment and Membrane Filtration

Jellyfish® Filter

Project Information

Date:	Saturday, December 14, 2019
Project Name:	Barrie
Project Number:	
Location:	Barrie

Designer Information

Company:	MTE Consultants Inc.
Contact:	Chelsea Hiebert
Phone #:	

Notes

Rainfall

Name:	BARRIE WPCC
State:	ON
ID:	557
Record:	1968 to 2003
Co-ords:	44°23'N, 79°41'W

Drainage Area

Total Area:	0.643 ha
Imperviousness:	89%

Upstream Detention

Peak Release Rate:	n/a
Pretreatment Credit:	n/a

Design System Requirements

Flow Loading	90% of the Average Annual Runoff based on 36 years of BARRIE WPCC rainfall data:	**15.3 L/s**
Sediment Loading	Treating 90% of the average annual runoff volume, 1676 m³, with a suspended sediment concentration of 60 mg/L.	**101 kg**

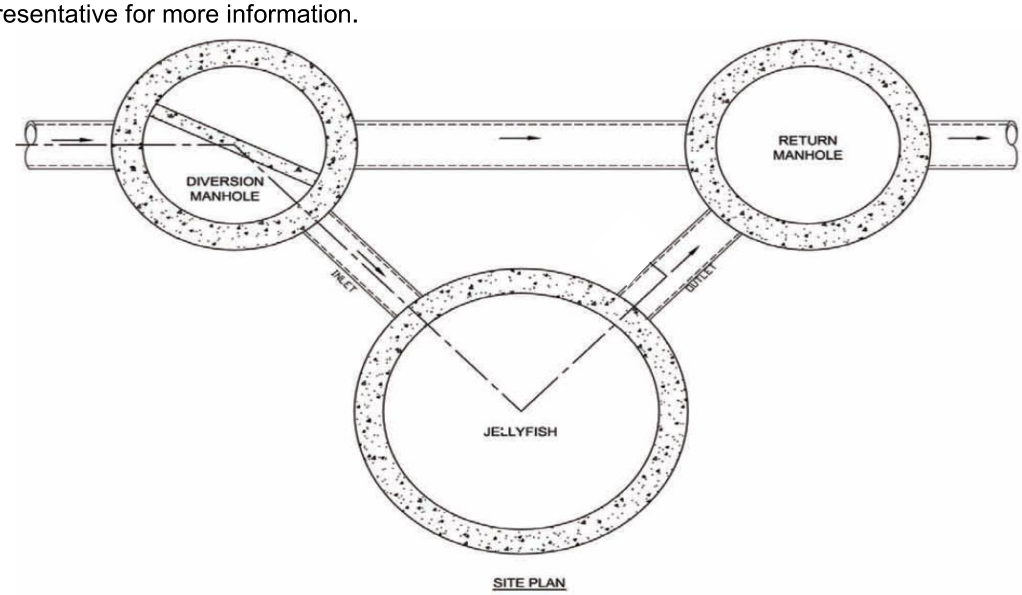
Recommendation

The Jellyfish Filter model JF6-3-1 is recommended to meet the water quality objective by treating a flow of 17.7 L/s, which meets or exceeds 90% of the average annual rainfall runoff volume based on 36 years of BARRIE WPCC rainfall data for this site. This model has a sediment capacity of 199 kg, which meets or exceeds the estimated average annual sediment load.

Jellyfish Model	Number of High-Flo Cartridges	Number of Draindown Cartridges	Manhole Diameter (m)	Wet Vol Below Deck (L)	Sump Storage (m³)	Oil Capacity (L)	Treatment Flow Rate (L/s)	Sediment Capacity (kg)
JF4-1-1	1	1	1.2	2313	0.34	379	7.6	85
JF4-2-1	2	1	1.2	2313	0.34	379	12.6	142
JF6-3-1	**3**	**1**	**1.8**	**5205**	**0.79**	**848**	**17.7**	**199**
JF6-4-1	4	1	1.8	5205	0.79	848	22.7	256
JF6-5-1	5	1	1.8	5205	0.79	848	27.8	313
JF6-6-1	6	1	1.8	5205	0.79	848	28.6	370
JF8-6-2	6	2	2.4	9252	1.42	1469	35.3	398
JF8-7-2	7	2	2.4	9252	1.42	1469	40.4	455
JF8-8-2	8	2	2.4	9252	1.42	1469	45.4	512
JF8-9-2	9	2	2.4	9252	1.42	1469	50.5	569
JF8-10-2	10	2	2.4	9252	1.42	1469	50.5	626
JF10-11-3	11	3	3.0	14456	2.21	2302	63.1	711
JF10-12-3	12	3	3.0	14456	2.21	2302	68.2	768
JF10-12-4	12	4	3.0	14456	2.21	2302	70.7	796
JF10-13-4	13	4	3.0	14456	2.21	2302	75.7	853
JF10-14-4	14	4	3.0	14456	2.21	2302	78.9	910
JF10-15-4	15	4	3.0	14456	2.21	2302	78.9	967
JF10-16-4	16	4	3.0	14456	2.21	2302	78.9	1024
JF10-17-4	17	4	3.0	14456	2.21	2302	78.9	1081
JF10-18-4	18	4	3.0	14456	2.21	2302	78.9	1138
JF10-19-4	19	4	3.0	14456	2.21	2302	78.9	1195
JF12-20-5	20	5	3.6	20820	3.2	2771	113.6	1280
JF12-21-5	21	5	3.6	20820	3.2	2771	113.7	1337
JF12-22-5	22	5	3.6	20820	3.2	2771	113.7	1394
JF12-23-5	23	5	3.6	20820	3.2	2771	113.7	1451
JF12-24-5	24	5	3.6	20820	3.2	2771	113.7	1508
JF12-25-5	25	5	3.6	20820	3.2	2771	113.7	1565
JF12-26-5	26	5	3.6	20820	3.2	2771	113.7	1622
JF12-27-5	27	5	3.6	20820	3.2	2771	113.7	1679

Jellyfish Filter Design Notes

- Typically the Jellyfish Filter is designed in an offline configuration, as all stormwater filter systems will perform for a longer duration between required maintenance services when designed and applied in off-line configurations. Depending on the design parameters, an optional internal bypass may be incorporated into the Jellyfish Filter, however note the inspection and maintenance frequency should be expected to increase above that of an off-line system. Speak to your local representative for more information.



Jellyfish Filter Typical Layout

- Typically, 18 inches (457 mm) of driving head is designed into the system, calculated as the difference in elevation between the top of the diversion structure weir and the invert of the Jellyfish Filter outlet pipe. Alternative driving head values can be designed as 12 to 24 inches (305 to 610mm) depending on specific site requirements, requiring additional sizing and design assistance.
- Typically, the Jellyfish Filter is designed with the inlet pipe configured 6 inches (150 mm) above the outlet invert elevation. However, depending on site parameters this can vary to an optional configuration of the inlet pipe entering the unit below the outlet invert elevation.
- The Jellyfish Filter can accommodate multiple inlet pipes within certain restrictions.
- While the optional inlet below deck configuration offers 0 to 360 degree flexibility between the inlet and outlet pipe, typical systems conform to the following:

Model Diameter (m)	Minimum Angle Inlet / Outlet Pipes	Minimum Inlet Pipe Diameter (mm)	Minimum Outlet Pipe Diameter (mm)
1.2	62º	150	200
1.8	**59º**	**200**	**250**
2.4	52º	250	300
3.0	48º	300	450
3.6	40º	300	450

- The Jellyfish Filter can be built at all depths of cover generally associated with conventional stormwater conveyance systems. For sites that require minimal depth of cover for the stormwater infrastructure, the Jellyfish Filter can be applied in a shallow application using a hatch cover. The general minimum depth of cover is 36 inches (915 mm) from top of the underslab to outlet invert.
- If driving head caclulations account for water elevation during submerged conditions the Jellyfish Filter will function effectively under submerged condtions.
- Jellyfish Filter systems may incorporate grated inlets depending on system configuration.
- For sites with water quality treatment flow rates or mass loadings that exceed the design flow rate of the largest standard Jellyfish Filter manhole models, systems can be designed that hydraulically connect multiple Jellyfish Filters in series or alternatively Jellyfish Vault units can be designed.

STANDARD SPECIFICATION
STORMWATER QUALITY – MEMBRANE FILTRATION TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

Specifies requirements for construction and performance of an underground stormwater quality membrane filtration treatment device that removes pollutants from stormwater runoff through the unit operations of sedimentation, floatation, and membrane filtration.

1.2 REFERENCE STANDARDS

ASTM C 891: Specification for Installation of Underground Precast Concrete Utility Structures
ASTM C 478: Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 443: Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM D 4101: Specification for Copolymer steps construction

CAN/CSA-A257.4-M92
Joints for Circular Concrete Sewer and Culvert Pipe, Manhole Sections and Fittings Using Rubber Gaskets

CAN/CSA-A257.4-M92
Precast Reinforced Circular Concrete Manhole Sections, Catch Basins and Fittings

Canadian Highway Bridge Design Code

1.3 SHOP DRAWINGS

Shop drawings for the structure and performance are to be submitted with each order to the contractor. Contractor shall forward shop drawing submittal to the consulting engineer for approval. Shop drawings are to detail the structure's precast concrete and call out or note the fiberglass (FRP) internals/components.

1.4 PRODUCT SUBSTITUTIONS

No product substitutions shall be accepted unless submitted 10 days prior to project bid date, or as directed by the engineer of record. Submissions for substitutions require review and approval by the Engineer of Record, for hydraulic performance, impact to project designs, equivalent treatment performance, and any required project plan and report (hydrology/hydraulic, water quality, stormwater pollution) modifications that would be required by the approving jurisdictions/agencies. Contractor to coordinate with the Engineer of Record any applicable modifications to the project estimates of cost, bonding amount determinations, plan check fees for changes to approved documents, and/or any other regulatory requirements resulting from the product substitution.

1.5 HANDLING AND STORAGE

Prevent damage to materials during storage and handling.

PART 2 – PRODUCTS

2.1 GENERAL

2.1.1 The device shall be a cylindrical or rectangular, all concrete structure (including risers), constructed from precast concrete riser and slab components or monolithic precast structure(s), installed to conform to ASTM C 891 and to any required state highway, municipal or local specifications; whichever is more stringent. The device shall be watertight.

2.1.2 Cartridge Deck The cylindrical concrete device shall include a fiberglass deck. The rectangular concrete device shall include a coated aluminum deck. In either instance, the insert shall be bolted and sealed watertight inside the precast concrete chamber. The deck shall serve as: (a) a horizontal divider between the lower treatment zone and the upper treated effluent zone; (b) a deck for attachment of filter cartridges such that the membrane filter elements of each cartridge extend into the lower treatment zone; (c) a platform for maintenance workers to service the filter cartridges (maximum manned weight = 450 pounds (204 kg)); (d) a conduit for conveyance of treated water to the effluent pipe.

2.1.3 Membrane Filter Cartridges Filter cartridges shall be comprised of reusable cylindrical membrane filter elements connected to a perforated head plate. The number of membrane filter elements per cartridge shall be a minimum of eleven 2.75-inch (70-mm) diameter elements. The length of each filter element shall be a minimum 15 inches (381 mm). Each cartridge shall be fitted into the cartridge deck by insertion into a cartridge receptacle that is permanently mounted into the cartridge deck. Each cartridge shall be secured by a cartridge lid that is threaded onto the receptacle, or similar mechanism to secure the cartridge into the deck. The maximum treatment flow rate of a filter cartridge shall be controlled by an orifice in the cartridge lid, or on the individual cartridge itself, and based on a design flux rate (surface loading rate) determined by the maximum treatment flow rate per unit of filtration membrane surface area. The maximum design flux rate shall be 0.21 gpm/ft^2 (0.142 lps/m^2).

Each membrane filter cartridge shall allow for manual installation and removal. Each filter cartridge shall have filtration membrane surface area and dry installation weight as follows (if length of filter cartridge is between those listed below, the surface area and weight shall be proportionate to the next length shorter and next length longer as shown below):

Filter Cartridge Length (in / mm)	Minimum Filtration Membrane Surface Area (ft2 / m2)	Maximum Filter Cartridge Dry Weight (lbs / kg)
15	106 / 9.8	10.5 / 4.8
27	190 / 17.7	15.0 / 6.8
40	282 / 26.2	20.5 / 9.3
54	381 / 35.4	25.5 / 11.6

2.1.4 Backwashing Cartridges The filter device shall have a weir extending above the cartridge deck, or other mechanism, that encloses the high flow rate filter cartridges when placed in their respective cartridge receptacles within the cartridge deck. The weir, or other mechanism, shall collect a pool of filtered water during inflow events that backwashes the high flow rate cartridges when the inflow event subsides. All filter cartridges and membranes shall be reusable and allow for the use of filtration membrane rinsing procedures to restore flow capacity and sediment capacity; extending cartridge service life.

2.1.5 Maintenance Access to Captured Pollutants The filter device shall contain an opening(s) that provides maintenance access for removal of accumulated floatable pollutants and sediment, removal of and replacement of filter cartridges, cleaning of the sump, and rinsing of the deck. Access shall have a minimum clear vertical clear space over all of the filter cartridges. Filter cartridges shall be able to be lifted straight vertically out of the receptacles and deck for the entire length of the cartridge.

2.1.6 Bend Structure The device shall be able to be used as a bend structure with minimum angles between inlet and outlet pipes of 90-degrees or less in the stormwater conveyance system.

2.1.7 Double-Wall Containment of Hydrocarbons The cylindrical precast concrete device shall provide double-wall containment for hydrocarbon spill capture by a combined means of an inner wall of fiberglass, to a minimum depth of 12 inches (305 mm) below the cartridge deck, and the precast vessel wall.

2.1.8 Baffle The filter device shall provide a baffle that extends from the underside of the cartridge deck to a minimum length equal to the length of the membrane filter elements. The baffle shall serve to protect the membrane filter elements from contamination by floatables and coarse sediment. The baffle shall be flexible and continuous in cylindrical configurations, and shall be a straight concrete or aluminum wall in rectangular configurations.

2.1.9 Sump The device shall include a minimum 24 inches (610 mm) of sump below the bottom of the cartridges for sediment accumulation, unless otherwise specified by the design engineer. Depths less than 24 inches may have an impact on the total performance and/or longevity between cartridge maintenance/replacement of the device.

2.2 PRECAST CONCRETE SECTIONS

All precast concrete components shall be manufactured to a minimum live load of HS-20 truck loading or greater based on local regulatory specifications, unless otherwise modified or specified by the design engineer, and shall be watertight.

2.3 JOINTS All precast concrete manhole configuration joints shall use nitrile rubber gaskets and shall meet the requirements of ASTM C443, Specification C1619, Class D or engineer approved equal to ensure oil resistance. Mastic sealants or butyl tape are not an acceptable alternative.

2.4 GASKETS Only profile neoprene or nitrile rubber gaskets in accordance to CSA A257.3-M92 will be accepted. Mastic sealants, butyl tape or Conseal CS-101 are not acceptable gasket materials.

2.5 FRAME AND COVER Frame and covers must be manufactured from cast-iron or other composite material tested to withstand H-20 or greater design loads, and as approved by the local regulatory body. Frames and covers must be embossed with the name of the device manufacturer or the device brand name.

2.6 DOORS AND HATCHES If provided shall meet designated loading requirements or at a minimum for incidental vehicular traffic.

2.7 CONCRETE All concrete components shall be manufactured according to local specifications and shall meet the requirements of ASTM C 478.

2.8 FIBERGLASS The fiberglass portion of the filter device shall be constructed in accordance with the following standard: ASTM D-4097: Contact Molded Glass Fiber Reinforced Chemical Resistant Tanks.

2.9 STEPS Steps shall be constructed according to ASTM D4101 of copolymer polypropylene, and be driven into preformed or pre-drilled holes after the concrete has cured, installed to conform to applicable sections of state, provincial and municipal building codes, highway, municipal or local specifications for the construction of such devices.

2.10 INSPECTION All precast concrete sections shall be inspected to ensure that dimensions, appearance and quality of the product meet local municipal specifications and ASTM C 478.

PART 3 – PERFORMANCE

3.1 GENERAL

3.1.1 Verification – The stormwater quality filter must be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV).

3.1.2 Function - The stormwater quality filter treatment device shall function to remove pollutants by the following unit treatment processes; sedimentation, floatation, and membrane filtration.

3.1.3 Pollutants - The stormwater quality filter treatment device shall remove oil, debris, trash, coarse and fine particulates, particulate-bound pollutants, metals and nutrients from stormwater during runoff events.

3.1.4 Bypass - The stormwater quality filter treatment device shall typically utilize an external bypass to divert excessive flows. Internal bypass systems shall be equipped with a floatables baffle, and must avoid passage through the sump and/or cartridge filtration zone.

3.1.5 Treatment Flux Rate (Surface Loading Rate) – The stormwater quality filter treatment device shall treat 100% of the required water quality treatment flow based on a maximum design treatment flux rate (surface loading rate) across the membrane filter cartridges of 0.21 gpm/ft² (0.142 lps/m²).

3.2 FIELD TEST PERFORMANCE

At a minimum, the stormwater quality filter device shall have been field tested and verified with a minimum 25 TARP qualifying storm events and field monitoring shall have been conducted according to the TARP 2009 NJDEP TARP field test protocol, and have received NJCAT verification.

3.2.1 Suspended Solids Removal - The stormwater quality filter treatment device shall have demonstrated a minimum median TSS removal efficiency of 85% and a minimum median SSC removal efficiency of 95%.

3.2.2 Runoff Volume – The stormwater quality filter treatment device shall be engineered, designed, and sized to treat a minimum of 90 percent of the annual runoff volume determined from use of a minimum 15-year rainfall data set.

3.2.3 Fine Particle Removal - The stormwater quality filter treatment device shall have demonstrated the ability to capture fine particles as indicated by a minimum median removal efficiency of 75% for the particle fraction less than 25 microns, an effluent d_{50} of 15 microns or lower for all monitored storm events.

3.2.4 Turbidity Reduction - The stormwater quality filter treatment device shall have demonstrated the ability to reduce the turbidity from influent from a range of 5 to 171 NTU to an effluent turbidity of 15 NTU or lower.

3.2.5 Nutrient (Total Phosphorus & Total Nitrogen) Removal - The stormwater quality filter treatment device shall have demonstrated a minimum median Total Phosphorus removal of 55%, and a minimum median Total Nitrogen removal of 50%.

3.2.6 Metals (Total Zinc & Total Copper) Removal - The stormwater quality filter treatment device shall have demonstrated a minimum median Total Zinc removal of 55%, and a minimum median Total Copper removal of 85%.

3.3 INSPECTION and MAINTENANCE

The stormwater quality filter device shall have the following features:

3.3.1 Durability of membranes are subject to good handling practices during inspection and maintenance (removal, rinsing, and reinsertion) events, and site specific conditions that may have heavier or lighter loading onto the cartridges, and pollutant variability that may impact the membrane structural integrity. Membrane maintenance and replacement shall be in accordance with manufacturer's recommendations.

3.3.2 Inspection which includes trash and floatables collection, sediment depth determination, and visible determination of backwash pool depth shall be easily conducted from grade (outside the structure).

3.3.3 Manual rinsing of the reusable filter cartridges shall promote restoration of the flow capacity and sediment capacity of the filter cartridges, extending cartridge service life.

3.3.4 The filter device shall have a minimum 12 inches (305 mm) of sediment storage depth, and a minimum of 12 inches between the top of the sediment storage and bottom of the filter cartridge tentacles, unless otherwise specified by the design engineer. Variances may have an impact on the total performance and/or longevity between cartridge maintenance/replacement of the device.

3.3.5 Sediment removal from the filter treatment device shall be able to be conducted using a standard maintenance truck and vacuum apparatus, and a minimum one point of entry to the sump that is unobstructed by filter cartridges.

3.3.6 Maintenance access shall have a minimum clear height that provides suitable vertical clear space over all of the filter cartridges. Filter cartridges shall be able to be lifted straight vertically out of the receptacles and deck for the entire length of the cartridge.

3.3.7 Filter cartridges shall be able to be maintained without the requirement of additional lifting equipment.

PART 4 – EXECUTION

4.1 INSTALLATION

4.1.1 PRECAST DEVICE CONSTRUCTION SEQUENCE

The installation of a watertight precast concrete device should conform to ASTM C 891 and to any state highway, municipal or local specifications for the construction of manholes, whichever is more stringent. Selected sections of a general specification that are applicable are summarized below.

4.1.1.1 The watertight precast concrete device is installed in sections in the following sequence:

- aggregate base
- base slab
- treatment chamber and cartridge deck riser section(s)
- bypass section
- connect inlet and outlet pipes
- concrete riser section(s) and/or transition slab (if required)
- maintenance riser section(s) (if required)
- frame and access cover

4.1.2 The precast base should be placed level at the specified grade. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with joint seals, should be installed in accordance with the precast concrete manufacturer's recommendations.

4.1.3 Adjustment of the stormwater quality treatment device can be performed by lifting the upper sections free of the excavated area, re-leveling the base, and re-installing the sections. Damaged sections and gaskets should be repaired or replaced as necessary to restore original condition and watertight seals. Once the stormwater quality treatment device has been constructed, any/all lift holes must be plugged watertight with mortar or non-shrink grout.

4.1.4 Inlet and Outlet Pipes Inlet and outlet pipes should be securely set into the device using approved pipe seals (flexible boot connections, where applicable) so that the structure is watertight, and such that any pipe intrusion into the device does not impact the device functionality.

4.1.5 Frame and Cover Installation Adjustment units (e.g. grade rings) should be installed to set the frame and cover at the required elevation. The adjustment units should be laid in a full bed of mortar with successive units being joined using sealant recommended by the manufacturer. Frames for the cover should be set in a full bed of mortar at the elevation specified.

4.2 MAINTENANCE ACCESS WALL
In some instances the Maintenance Access Wall, if provided, shall require an extension attachment and sealing to the precast wall and cartridge deck at the job site, rather than at the precast facility. In this instance, installation of these components shall be performed according to instructions provided by the manufacturer.

4.3 FILTER CARTRIDGE INSTALLATION Filter cartridges shall be installed in the cartridge deck only after the construction site is fully stabilized and in accordance with the manufacturer's guidelines and recommendations. Contractor to contact the manufacturer to schedule cartridge delivery and review procedures/requirements to be completed to the device prior to installation of the cartridges and activation of the system.

PART 5 – QUALITY ASSURANCE

5.1 FILTER CARTRIDGE INSTALLATION Manufacturer shall coordinate delivery of filter cartridges and other internal components with contractor. Filter cartridges shall be delivered and installed complete after site is stabilized and unit is ready to accept cartridges. Unit is ready to accept cartridges after is has been cleaned out and any standing water, debris, and other materials have been removed. Contractor shall take appropriate action to protect the filter cartridge receptacles and filter cartridges from damage during construction, and in accordance with the manufacturer's recommendations and guidance. For systems with cartridges installed prior to full site stabilization and prior to system activation, the contractor can plug inlet and outlet pipes to prevent stormwater and other influent from entering the device. Plugs must be removed during the activation process.

5.2 INSPECTION AND MAINTENANCE

5.2.1 The manufacturer shall provide an Owner's Manual upon request.

5.2.2 After construction and installation, and during operation, the device shall be inspected and cleaned as necessary based on the manufacturer's recommended inspection and maintenance guidelines and the local regulatory agency/body.

5.3 REPLACEMENT FILTER CARTRIDGES When replacement membrane filter elements and/or other parts are required, only membrane filter elements and parts approved by the manufacturer for use with the stormwater quality filter device shall be installed.

END OF SECTION

◆ Verification Statement ◆ Verification Statement ◆ Verification Statement ◆

VERIFICATION STATEMENT

GLOBE Performance Solutions

Verifies the performance of

Jellyfish® Filter JF4-2-1

Developed by Imbrium Systems, Inc.,
Whitby, Ontario, Canada

In accordance with

ISO 14034:2016

Environmental management —
Environmental technology verification (ETV)

John D. Wiebe, PhD
Executive Chairman
GLOBE Performance Solutions

August 3, 2017
Vancouver, BC, Canada

GLOBE
PERFORMANCE
SOLUTIONS

Verification Body
GLOBE Performance Solutions
404 – 999 Canada Place | Vancouver, B.C | Canada |V6C 3E2

Technology description and application

The Jellyfish® Filter is an engineered stormwater quality treatment technology designed to remove a variety of stormwater pollutants including floatable trash and debris, oil, coarse and fine suspended sediments, and particulate-bound pollutants such as nutrients, heavy metals, and hydrocarbons. The Jellyfish Filter combines gravitational pre-treatment (sedimentation and floatation) and membrane filtration in a single compact structure. The system utilizes membrane filtration cartridges comprised of multiple pleated filter elements ("filtration tentacles") that provide high filtration surface area with the associated advantages of high flow rate, high sediment capacity, and low filtration flux rate.

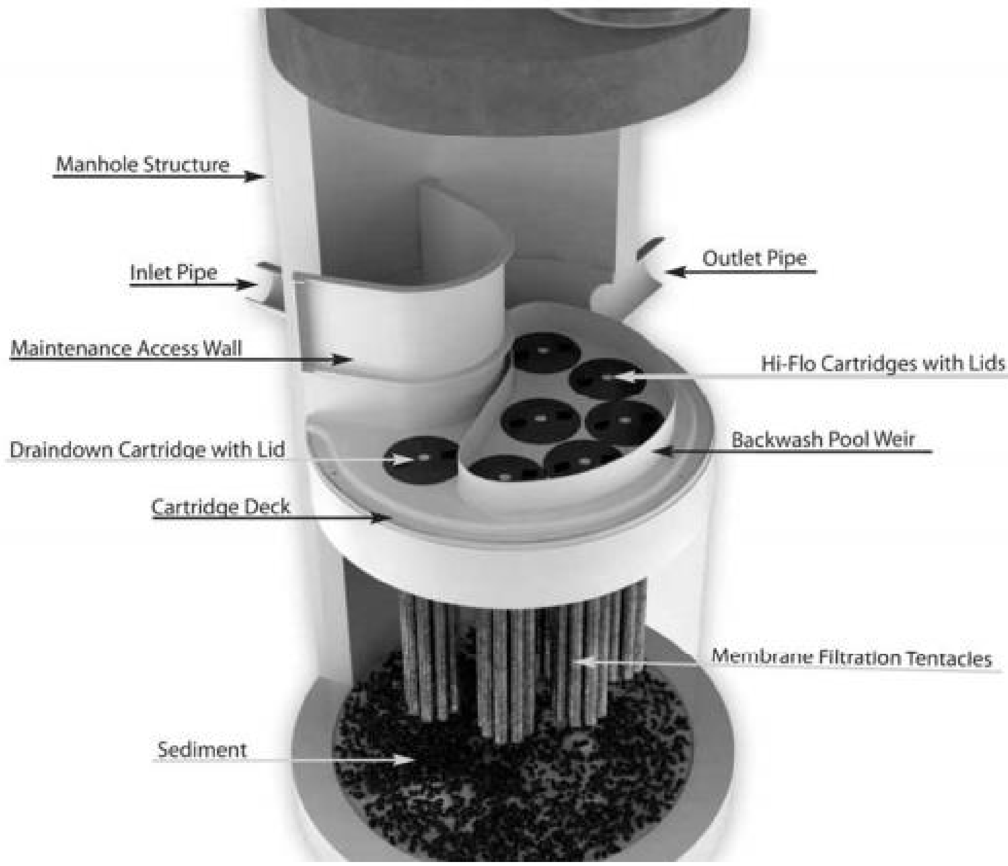


Figure 1. Cut-away graphic of a Jellyfish® Filter manhole with 6 hi-flo cartridges and 1 draindown cartridge

Figure 1 depicts a cut-away graphic of a typical 6-ft diameter Jellyfish® Filter manhole with 6 hi-flo cartridges and 1 draindown cartridge (JF6-6-1). Stormwater influent enters the system through the inlet pipe and builds a pond behind the maintenance access wall, with the pond elevation providing driving head. Flow is channeled downward into the lower chamber beneath the cartridge deck. A flexible separator skirt (not shown in the graphic) surrounds the filtration zone where the filtration tentacles of each cartridge are suspended, and the volume between the vessel wall and the outside surface of the separator skirt comprises a pretreatment channel. As flow spreads throughout the pretreatment channel, floatable pollutants accumulate at the surface of the pond behind the maintenance access wall and also beneath the cartridge deck in the pretreatment channel, while coarse sediments settle to the sump. Flow proceeds under the separator skirt and upward into the filtration zone, entering each filtration tentacle and depositing fine suspended sediment and associated particulate-bound pollutants on the outside surface of the membranes. Filtered water proceeds up the center tube of each tentacle, with the flow from each tentacle combining under the cartridge lid, and discharging to the top of the cartridge deck through the cartridge lid orifice. Filtered effluent from the hi-flo cartridges enters a pool enclosed by a 15-cm high weir, and if storm intensity and resultant driving head is sufficient, filtered water overflows the weir and proceeds across the cartridge deck to the outlet pipe. Filtered effluent discharging from the draindown cartridge(s) passes directly to the outlet pipe, and requires only a minimal amount of driving head (2.5 cm) to provide forward flow. As storm intensity subsides and driving head drops below 15 cm, filtered water within the backwash pool reverses direction and passes backward through the hi-flo cartridges, and thereby dislodges sediment from the membranes which subsequently settles to the sump below the filtration zone. During this passive backwashing process, water in the lower chamber is displaced only through the draindown cartridge(s). Additional self-cleaning processes include gravity, as well as vibrational pulses emitted when flow exits the orifice of each cartridge lid, and these combined processes significantly extend the cartridge service life and maintenance cleaning interval. Sediment removal from the sump by vacuum is required when sediment depths reach 30 cm, and cartridges are typically removed, externally rinsed, and recommissioned on an annual basis, or as site-specific maintenance conditions require. Filtration tentacle replacement is typically required every 3 – 5 years.

Performance conditions

The data and results published in this Technology Fact Sheet were obtained from a field monitoring program conducted on a Jellyfish® Filter JF4-2-1 (4-ft diameter manhole with 2 hi-flo cartridges and 1 draindown cartridge), in accordance with the provisions of the TARP Tier II Protocol (TARP, 2003) and New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2009). Testing was completed by researchers led by Dr. John Sansalone at the University of Florida's Engineering School of Sustainable Infrastructure and Environment. The drainage area providing stormwater runoff to the test unit varied between 502 m^2 and 799 m^2 (5400 ft^2 to 8600 ft^2) depending on storm intensity and wind direction. The unit was monitored for a total of 25 TARP qualifying storm events (i.e. $\geq$ 2.5 mm of rainfall) contributing cumulative rainfall of 381 mm (15 in) over the 13-month period between May 28, 2010 and June 27, 2011. Only TARP-qualified storms were routed through the unit, and maintenance was not required during the testing period based on sediment accumulation less than the depth indicated for maintenance, and also based on hydraulic testing performed on the system after the conclusion of monitoring.

Table 1 shows the specified and achieved amended TARP criteria for storm selection and sampling.
Table 2 shows the observed ranges of operational conditions that occurred over the testing period.

Table 1. Specified and achieved amended TARP criteria for storm selection and sampling

Description	Criteria value	Achieved value
Total rainfall	$\geq$ 2.5 mm (0.1 in)	> 2.5 mm (0.1 in)
Minimum inter-event period	6 hrs	10 hrs
Minimum flow-weighted composite sample storm coverage	70% including as much of the first 20% of the storm	100%
Minimum influent/effluent samples	10, but a minimum of 5 subsamples for composite samples	Minimum of 8 subsamples for composite samples
Total sampled rainfall	Minimum 381 mm (15 in)	384 mm (15.01 in)
Number of storms	Minimum 20	25

Table 2. Observed operational conditions for events monitored over the study period

Operational condition	Observed range
Storm durations	26 – 691 min
Previous dry hours	10 - 910 hrs
Rainfall depth	3 – 50 mm
Initial rainfall to runoff lag time	1 – 34 min
Runoff volume	206 – 13,229 L
Peak rainfall intensity	5 – 137 mm/hr
Peak runoff flow rate	0.5 – 14.3 L/s
Event median flow rate	0.01 – 5.5 L/s

The 4-ft diameter test unit has sedimentation surface area of 1.17 m^2 (12.56 ft^2). Each of the three filter cartridges employed in the test unit uses filtration tentacles of 137 cm (54 in) length, with filter surface area of 35.4 m^2 (381 ft^2) per cartridge, and total filter surface area of 106.2 m^2 (1143 ft^2) for the three cartridges combined. The design treatment flow rate is 5 L/s (80 gal/min) for each of the two hi-flo cartridges and 2.5 L/s (40 gal/min) for the single draindown cartridge, for a total design treatment flow rate of 12.6 L/s (200 gal/min) at design driving head of 457 mm (18 in). This translates to a filtration flux rate (flow rate per unit filter surface area) of 0.14 L/s/m^2 (0.21 gal/min/ft^2) for each hi-flo cartridge and 0.07 L/s/m^2 (0.11 gal/min/ft^2) for the draindown cartridge. The design flow rate for each cartridge is controlled by the sizing of the orifice in the cartridge lid. The distance from the bottom of the filtration tentacles to the sump is 61 cm (24 in).

Performance claims

The Jellyfish® Filter demonstrated the removal efficiencies indicated in **Table 3** for respective constituents during field monitoring of 25 TARP qualified storm events with cumulative rainfall of 381 mm, conducted in accordance with the provisions of the TARP Tier II Protocol (TARP, 2003) and New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2009), and using the following design parameters:

- System hydraulic loading rate (system treatment flow rate per unit of sedimentation surface area) of 10.8 L/s/m^2 (15.9 gal/min/ft^2) or lower
- Filtration flux rate (flow rate per unit filter surface area) of 0.14 L/s/m^2 (0.21 gal/min/ft^2) or lower for each hi-flo cartridge and 0.07 L/s/m^2 (0.11 gal/min/ft^2) or lower for each draindown cartridge
- Distance from the bottom of the filtration tentacles to the sump of 61 cm (24 in) or greater
- Driving head of 457 mm (18 in) or greater

Table 3. Mean, median and 95% confidence interval (median) for removal efficiencies of selected stormwater constituents

Parameter	Mean	Median	Median - 95% Lower Limit	Median - 95% Upper Limit
TSS	84.7	85.6	82.8	89.8
SSC	97.5	98.3	97.1	98.7
Total phosphorus	48.8	49.1	43.3	60.1
Total nitrogen	37.9	39.3	31.2	54.6
Zinc	55.3	69	39	75
Copper	83.0	91.7	75.1	98.9
Oil and grease	60.1	60	42.7	100

N.B. As with any field test of stormwater treatment devices, removal efficiencies will vary based on pollutant influent concentrations and other site specific conditions.

Performance results

The frequency of rainfall depths monitored during the study is presented in **Figure 2**. The median and 90th percentile rainfall depths were 11 mm and 31.7 mm, respectively. These values represent the depth of rainfall that is not exceeded in 50 and 90 percent of the monitored rainfall events.

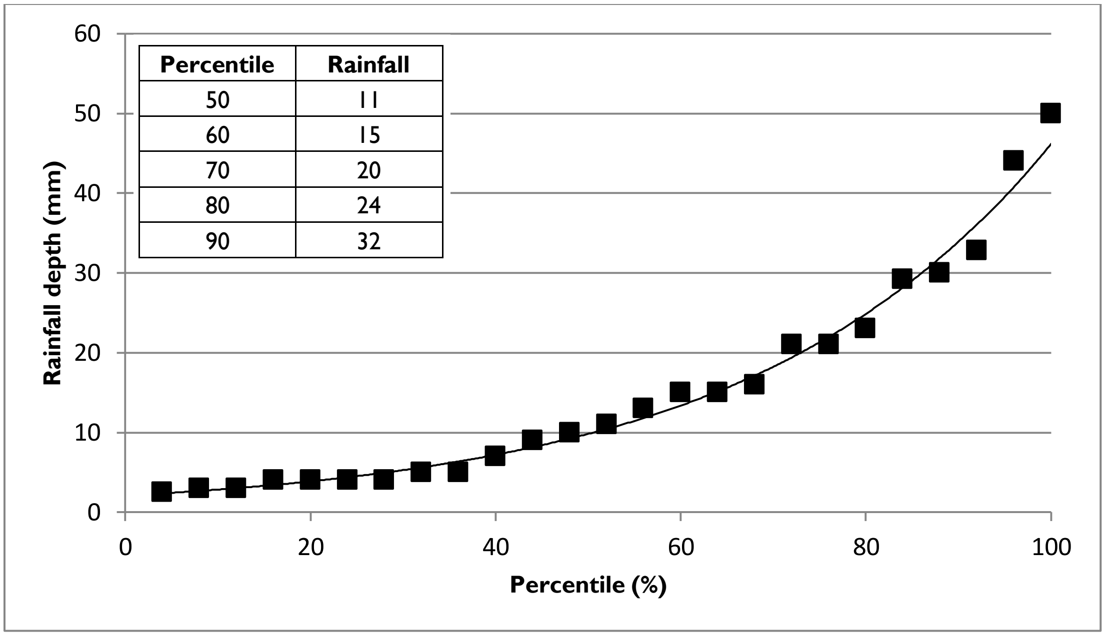


Figure 2. Rainfall depth frequency curve

Sediment removal performance was assessed by measuring the event mean concentration and mass of suspended sediment entering and leaving the unit during runoff events. This involved sampling the full cross-section of influent and effluent flows manually at 2 - 10 minute intervals for the full duration of each storm event and combining discrete samples into flow-weighted composites. Comparing the theoretical mass recovery from the sump calculated by the difference between the influent and effluent mass to the actual dry weight of the recovered sump mass showed an overall mass balance recovery of 94.5% over the study period.

The median d50 particle size (i.e. 50th percentile particle size) of the influent and effluent was 82 and 3 µm, respectively (**Figure 3**). The median influent particles sizes ranged between 22 and 263 µm, whereas median effluent particle sizes ranged between 1 and 11 µm.

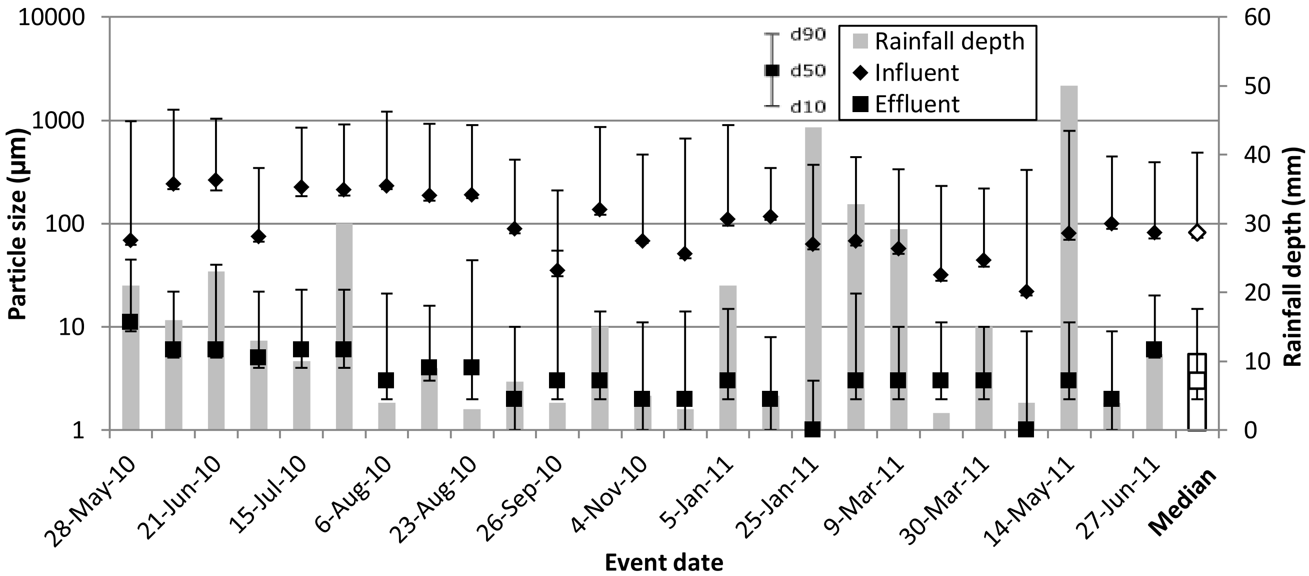


Figure 3. The rainfall depth and d10, d50, and d90 particle sizes of the influent and effluent composite samples for each monitored storm event over the 13-month testing period

Sampling of flows into and out of the Jellyfish Filter over the testing period showed statistically significant reductions ($p < 0.05$; Wilcoxon signed-rank test) in influent event mean concentrations for all selected stormwater constituents (**Table 4** and **Figure 4**). Effluent event mean Suspended Sediment Concentrations (SSC) were below 19 mg/L during all monitored events. Load-based removal rates were also calculated based on the sum of loads over the study period. These removal rages ranged from 46.3 for Total Nitrogen to 98.6 for SSC (**Table 4**).

Table 4. Summary statistics for influent and effluent event mean concentrations for selected constituents

Water Quality Variable	Sampling Location	Min	Max	Median	Range	Mean	SD	Load based removal efficiency (%)
TSS	Influent (mg/L)	16.30	261.00	79.30	244.70	86.26	51.37	87.2
	Effluent (mg/L)	3.20	21.70	11.80	18.50	10.99	4.79	
SSC	Influent (mg/L)	78.20	1401.70	444.50	1323.50	482.26	338.34	98.6
	Effluent (mg/L)	2.80	18.10	7.30	15.30	7.88	3.77	
TP	Influent (µg/L)	887.00	8793.00	3063.00	7906.00	3550.20	1914.50	64.2
	Effluent (µg/L)	472.00	4769.00	1480.00	4297.00	1688.08	1059.98	
TN	Influent (µg/L)	1170.00	10479.00	3110.00	9309.00	3519.32	2161.47	46.3
	Effluent (µg/L)	553.00	6579.00	1610.00	6026.00	2091.76	1613.61	
Zn	Influent (µg/L)	0.005	7600.00	1500.00	7600.00	1792.00	1852.91	76.1
	Effluent (µg/L)	0.005	2760.00	450.00	2760.00	561.64	594.70	
Cu	Influent (µg/L)	0.001	880.40	79.50	880.40	171.28	229.33	92.1
	Effluent (µg/L)	0.001	51.30	6.90	51.30	14.36	17.22	
Oil and Grease	Influent (mg/L)	0.20	4.06	0.93	3.86	1.07	0.82	46.4
	Effluent (mg/L)	0.00	2.32	0.35	2.32	0.50	0.60	

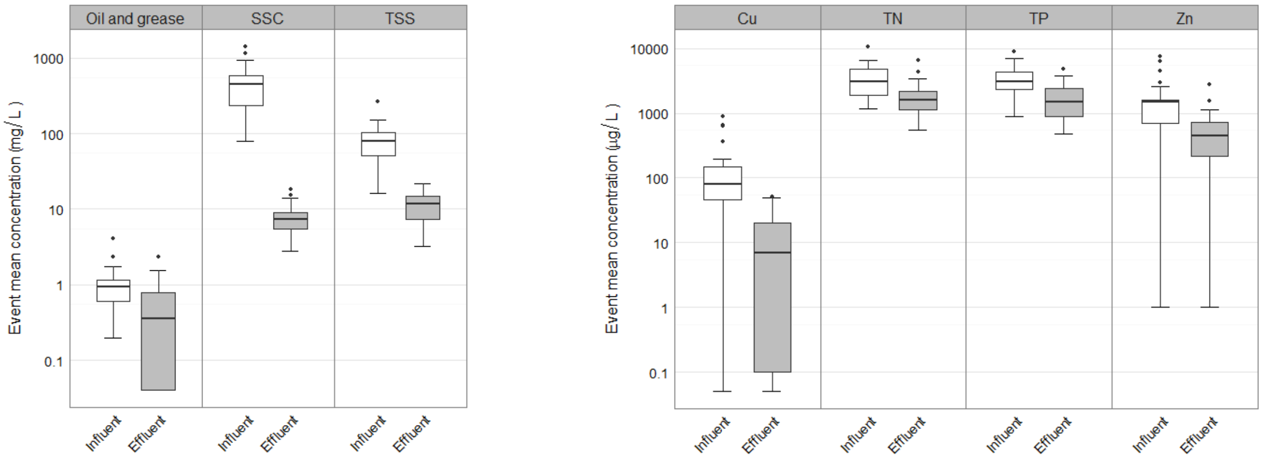


Figure 4. Boxplots showing the distribution of influent and effluent event mean concentrations (EMC) for selected stormwater constituents over the study period

Verification

The verification was completed by the Verification Expert, Toronto and Region Conservation Authority, contracted by GLOBE Performance Solutions, using the International Standard ***ISO 14034:2016 Environmental management -- Environmental technology verification (ETV)***. Data and information provided by Imbrium Systems to support the performance claim included the performance monitoring report prepared by University of Florida, Engineering School of Sustainable Infrastructure and Environment, and dated November 2011. This report is based on testing completed in accordance with the Technology Acceptance Reciprocity Partnership (TARP) Tier II Protocol (2003) and New Jersey Tier II Stormwater Test Requirements--Amendments to TARP Tier II Protocol (NJDEP, 2009).

What is ISO14034:2016 Environmental management – Environmental technology verification (ETV)?

ISO 14034:2016 specifies principles, procedures and requirements for environmental technology verification (ETV), and was developed and published by the *International Organization for Standardization (ISO)*. The objective of ETV is to provide credible, reliable and independent verification of the performance of environmental technologies. An environmental technology is a technology that either results in an environmental added value or measures parameters that indicate an environmental impact. Such technologies have an increasingly important role in addressing environmental challenges and achieving sustainable development.

For more information on the Jellyfish® Filter please contact:

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For more information on ISO 14034:2016 / ETV please contact:

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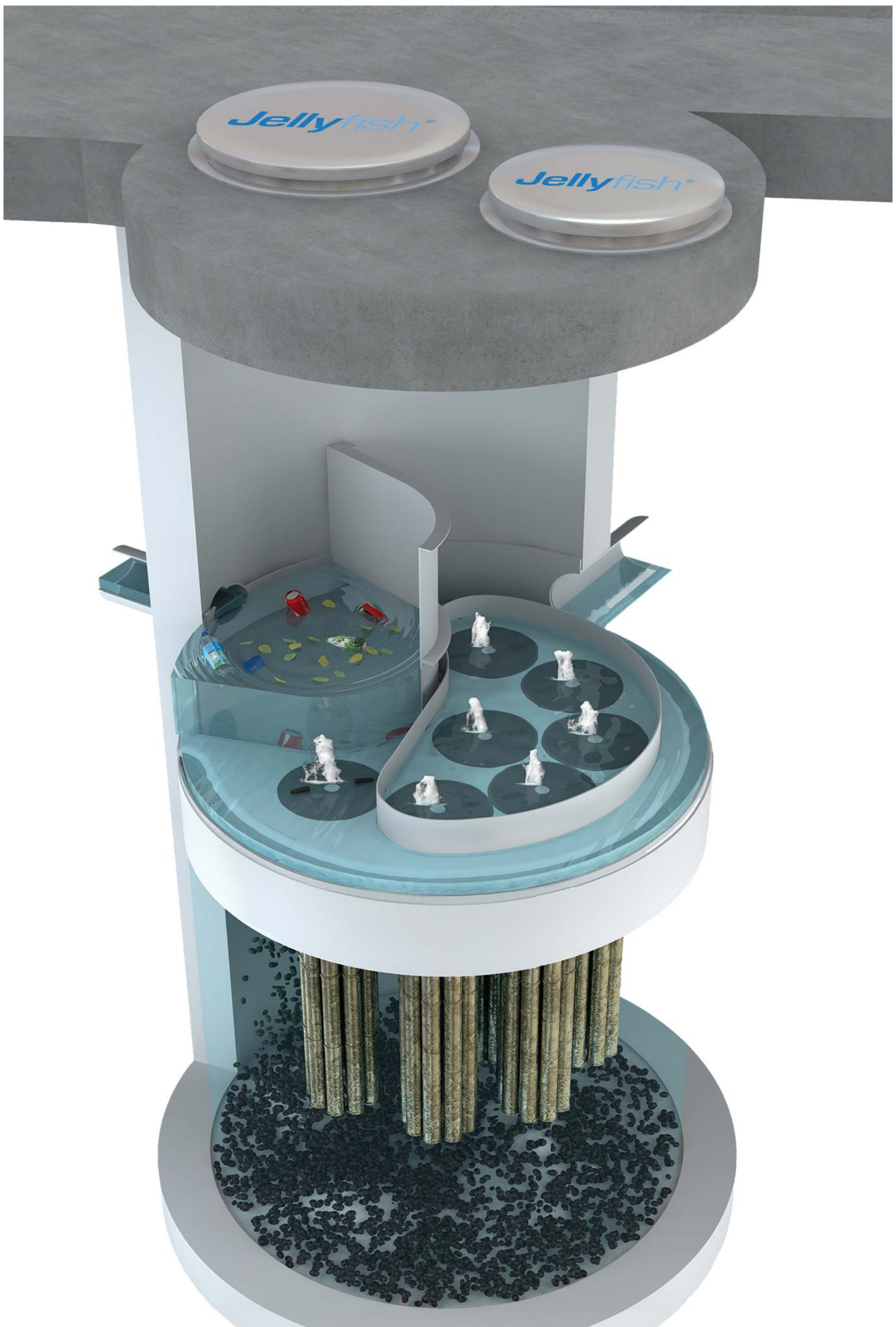
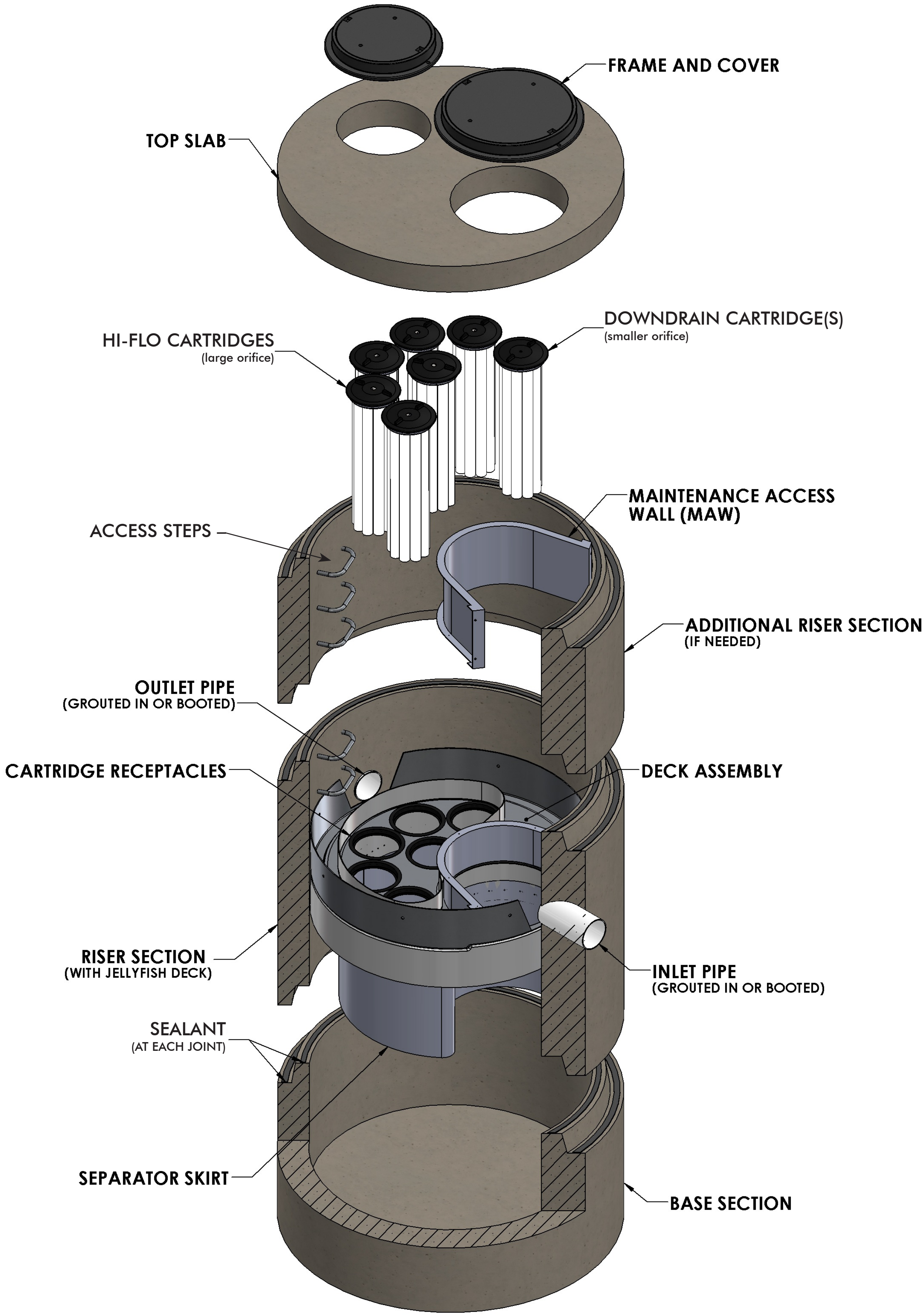
etv@globeperformance.com

Limitation of verification
GLOBE Performance Solutions and the Verification Expert provide the verification services solely on the basis of the information supplied by the applicant or vendor and assume no liability thereafter. The responsibility for the information supplied remains solely with the applicant or vendor and the liability for the purchase, installation, and operation (whether consequential or otherwise) is not transferred to any other party as a result of the verification.

Jellyfish® Filter
Owner's Manual



imbrium®


FRAME AND COVER
TOP SLAB
HI-FLO CARTRIDGES
(large orifice)
DOWNDRAIN CARTRIDGE(S)
(smaller orifice)
MAINTENANCE ACCESS
WALL (MAW)
ACCESS STEPS
ADDITIONAL RISER SECTION
(IF NEEDED)
OUTLET PIPE
(GROUTED IN OR BOOTED)
CARTRIDGE RECEPTACLES
DECK ASSEMBLY
RISER SECTION
(WITH JELLYFISH DECK)
INLET PIPE
(GROUTED IN OR BOOTED)
SEALANT
(AT EACH JOINT)
SEPARATOR SKIRT
BASE SECTION

WARNINGS / CAUTION

1. FALL PROTECTION may be required.
2. WATCH YOUR STEP if standing on the Jellyfish Filter Deck at any time; Great care and safety must be taken while walking or maneuvering on the Jellyfish Filter Deck. Attentive care must be taken while standing on the Jellyfish Filter Deck at all times to prevent stepping onto a lid, into or through a cartridge hole or slipping on the deck.
3. The Jellyfish Filter Deck can be SLIPPERY WHEN WET.
4. If the Top Slab, Covers or Hatches have not yet been installed, or are removed for any reason, great care must be taken to NOT DROP ANYTHING ONTO THE JELLYFISH FILTER DECK. The Jellyfish Filter Deck and Cartridge Receptacle Rings can be damaged under high impact loads. *This type of activity voids all warranties. All damaged items to be replaced at owner's expense*.
5. Maximum deck load 2 persons, total weight 250 lbs. per person.

Safety Notice

Jobsite safety is a topic and practice addressed comprehensively by others. The inclusions here are intended to be reminders to whole areas of Safety Practice that are the responsibility of the Owner(s), Manager(s) and Contractor(s). OSHA and Canadian OSH, and Federal, State/Provincial, and Local Jurisdiction Safety Standards apply on any given site or project. The knowledge and applicability of those responsibilities is the Contractor's responsibility and outside the scope of Imbrium® Systems.

Confined Space Entry

Secure all equipment and perform all training to meet applicable local and OSHA regulations regarding confined space entry. It is the Contractor's or entry personnel's responsibility to proceed safely at all times.

Personal Safety Equipment

Contractor is responsible to provide and wear appropriate personal protection equipment as needed including, but not limited to safety boots, hard hat, reflective vest, protective eyewear, gloves and fall protection equipment as necessary. Make sure all equipment is **staffed with trained and/or certified personnel**, and all equipment is checked for proper operation and safety features prior to use.

- Fall protection equipment
- Eye protection
- Safety boots
- Ear protection
- Gloves
- Ventilation and respiratory protection
- Hard hat
- Maintenance and protection of traffic plan

Thank You for purchasing the Jellyfish® Filter!

Imbrium® Systems would like to thank you for selecting the Jellyfish Filter to meet your project's stormwater treatment needs. With proper inspection and maintenance, the Jellyfish Filter is designed to deliver ongoing, high levels of stormwater pollutant removal.

If you have any questions, please feel free to call us or e-mail us at info@imbriumsystems.com.

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Jellyfish Filter Patents

The Jellyfish Filter is protected by one or more of the following patents:

U.S. Patent No. 8,123,935; U.S. Patent No. 8,287,726; U.S. Patent No. 8,221,618
Australia Patent No. 2008,286,748
Canadian Patent No. 2,696,482
Korean Patent No. 10-1287539
New Zealand Patent No. 583,461; New Zealand Patent No. 604,227
South African Patent No. 2010,01068
**other patents pending*

Table of Contents

Chapter 1

1.0 – Owner Specific Jellyfish Filter Product Information

Below you will find your specific Jellyfish Filter unit information to help you easily inspect, maintain and order parts for your system.

Owner Name:	
Phone Number:	
Site Address:	
Site GPS Coordinates/unit location:	
Unit Location Description:	
Jellyfish Filter Model No.:	
Cartridge Installation Date:	
No. of Hi-Flo Cartridges	
Length of Hi-Flo Cartridges:	
Lid Orifice Diameter on Hi-Flo Cartridge:	
No. of Draindown Cartridges:	
Length of Draindown Cartridges:	
Lid Orifice Diameter on Draindown Cartridge:	
No. of Blank Cartridge Lids:	
Online System (Yes/No):	
Offline System (Yes/No):	

Notes:

Chapter 2

2.0 – Jellyfish Filter System Operations and Functions

The Jellyfish Filter is an engineered stormwater quality treatment technology that removes a high level and wide variety of stormwater pollutants. Each Jellyfish Filter cartridge consists of multiple membrane - encased filter elements ("filtration tentacles") attached to a cartridge head plate. The filtration tentacles provide a large filtration surface area, resulting in high flow and high pollutant removal capacity.

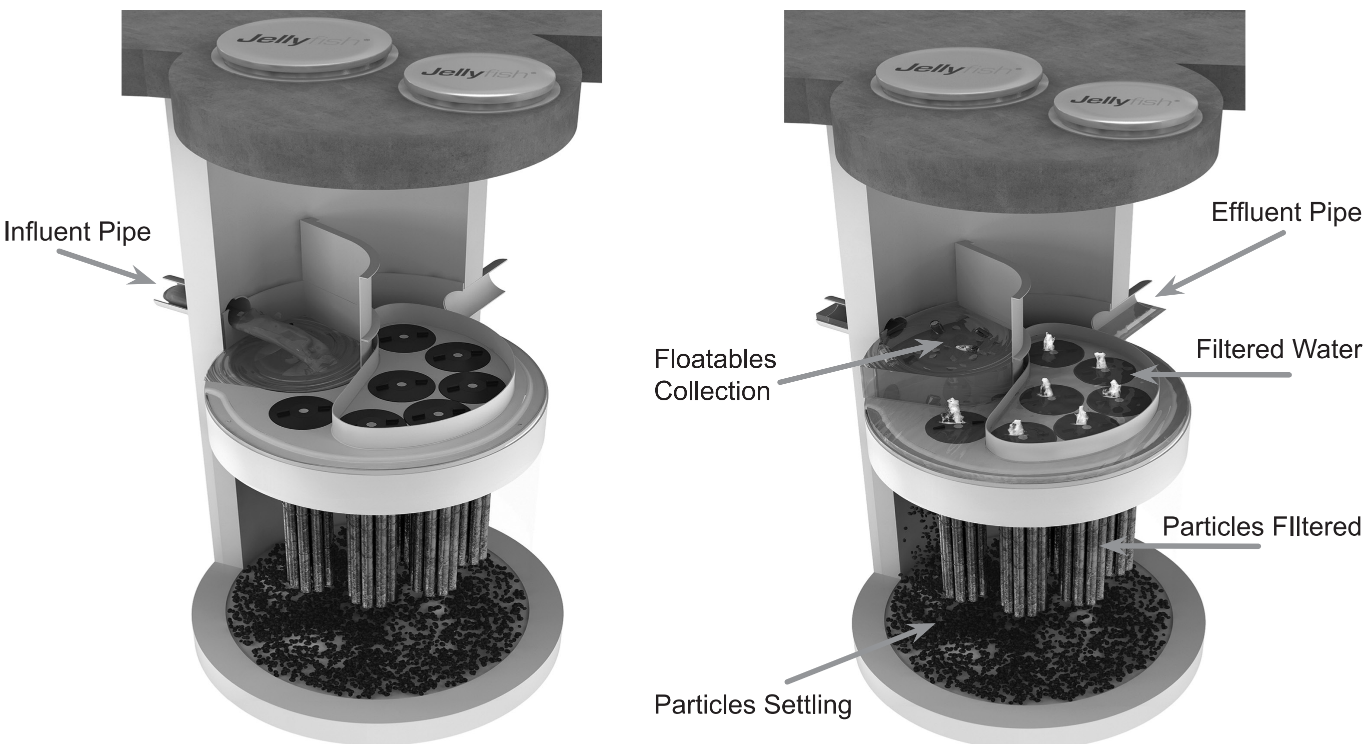
The Jellyfish Filter functions are depicted in **Figure 1** below.

FIGURE 1

Jellyfish Filter Treatment Functions

Membrane Filtration

Section View with Maintenance Access Wall (MAW) Cutaway



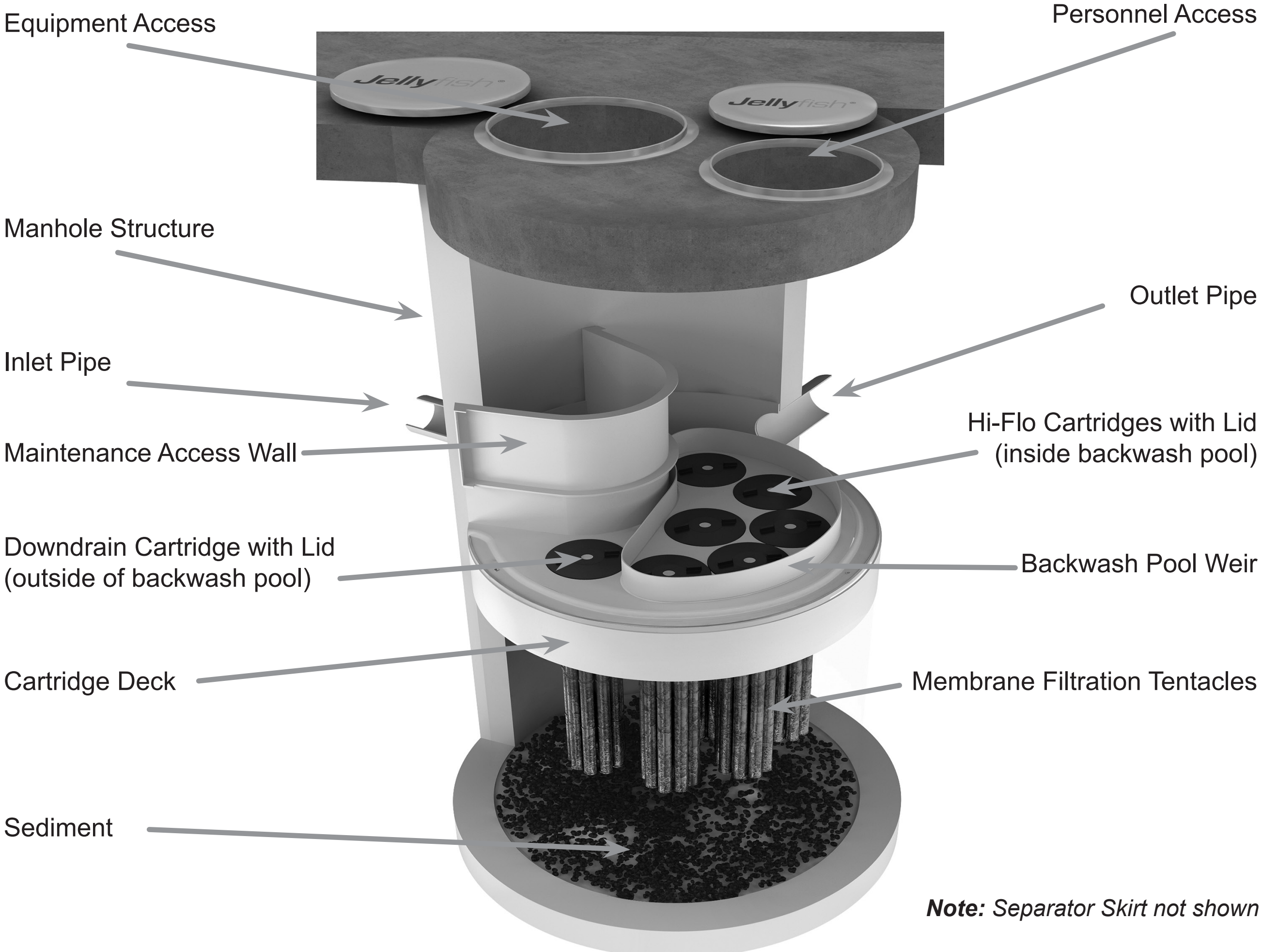
Jellyfish Filter cartridges are backwashed after each peak storm event, which removes accumulated sediment from the membranes. This backwash process extends the service life of the cartridges and increases the time between maintenance events.

For additional details on the operation and pollutant capabilities of the Jellyfish Filter please refer to additional details on our website at www.imbriumsystems.com.

2.1 – Components and Cartridges

The Jellyfish Filter and components are depicted in Figure 2 below.

FIGURE 2 **Jellyfish Filter Components**



Note: *Separator Skirt not shown*

Tentacles are available in various lengths as depicted in Table 1 below.

Table 1 – Cartridge Lengths / Weights and Cartridge Lid Orifice Diameters

Cartridge Lengths	Dry Weight	Hi-Flo Orifice Diameter	Draindown Orifice Diameter
15 inches (381 mm)	10 lbs (4.5 kg)	35 mm	20 mm
27 inches (686 mm)	14.5 lbs (6.6 kg)	45 mm	25 mm
40 inches (1,016 mm)	19.5 lbs (8.9 kg)	55 mm	30 mm
54 inches (1,372 mm)	25 lbs (11.4 kg)	70 mm	35 mm

A Jellyfish membrane filtration cartridge is depicted in Figure 3 below.

FIGURE 3

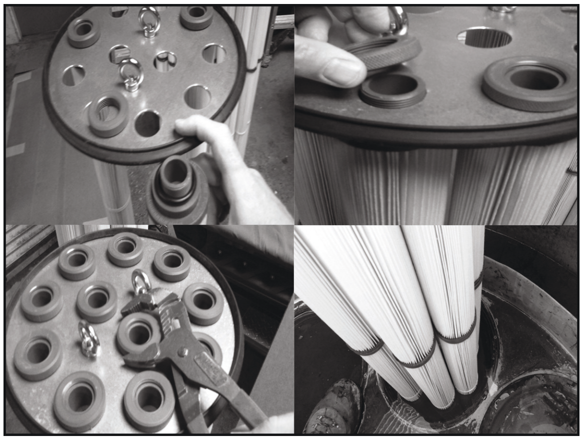
Jellyfish Membrane Filtration Cartridge

2.2 – Jellyfish Membrane Filtration Cartridge Assembly

The Jellyfish Filter utilizes multiple membrane filtration cartridges. Each cartridge consists of removable cylindrical filtration “tentacles” attached to a cartridge head plate. Each filtration tentacle has a threaded pipe nipple and o-ring. To attach, insert the top pipe nipples with the o-ring through the head plate holes and secure with locking nuts. Locking nuts to be hand tighten and checked with a wrench as shown below.

2.3 – Jellyfish Membrane Filtration Cartridge Installation

- After the upstream catchment and site have stabilized, remove any accumulated sediment and debris from the Jellyfish Filter structure and upstream diversion structure (if applicable). Failure to address this step completely will reduce the time between required maintenance.
- Descend to the cartridge deck (see Safety Notice and page 3).
- Lower the Jellyfish membrane filtration cartridges into the cartridge receptacles within the cartridge deck. A filter cartridge should be placed into each of the draindown cartridge receptacles outside the backwash pool weir. It is possible dependent on the Jellyfish Filter model purchased that not all cartridge receptacles will be filled with a filter cartridge. In that case, a blank headplate and blank cartridge lid (has no orfice) would be installed.



Cartridge Assembly

Avoid snagging the cartridge membranes on the recpticle lip when inserting the Jellyfish membrane filtration cartridges into the cartridge receptacles. Use a gentle twisting or sideways motion to clear any potential snag. Do not force the tentacles down into the cartridge receptacle, as this may damage the membranes. Apply downward pressure on the cartridge head plate to seat the rim gasket (thick circular gasket surrounding the circumference of the head plate) into the cartridge receptacle.

- Examine the cartridge lids to differentiate lids with a small orifice, a large orifice, and no orifice.
  - Lids with a small orifice are to be inserted into the draindown cartridge receptacles, outside of the backwash pool weir.
  - Lids with a large orifice are to be inserted into the hi-flo cartridge receptacles within the backwash pool weir.
  - Lids with no orifice (blank cartridge lids) and a blank headplate are to be inserted into unoccupied cartridge receptacles.
- **To install a cartridge lid, align the cartridge lid male threads with the cartridge receptacle female threads. Firmly twist the cartridge lid clockwise a minimum 110º to seat the filter cartridge snugly in place, with a proper watertight seal.**

Chapter 3

3.0 – Inspection and Maintenance Overview

The primary purpose of the Jellyfish Filter is to capture and remove pollutants from stormwater runoff. As with any filtration system, captured pollutants must be removed to maintain the filter's maximum treatment performance. Regular inspection and maintenance are required to insure proper functioning of the system.

Maintenance frequencies and requirements are site specific and vary depending on pollutant loading. Maintenance activities may be required in the event of an upstream chemical spill or due to excessive sediment loading from site erosion or extreme runoff events. It is a good practice to inspect the system after major storm events.

Inspection activities are typically conducted from surface observations and include:

- Observe if standing water is present
- Observe if there is any physical damage to the deck or cartridge lids
- Observe the amount of debris in the Maintenance Access Wall (MAW)

Maintenance activities typically include:

- Removal of oil, floatable trash and debris
- Removal of collected sediments from manhole sump
- Rinsing and re-installing the filter cartridges
- Replace filter cartridge tentacles, as needed.

It is recommended that Jellyfish Filter inspection and maintenance be performed by professionally trained individuals, with experience in stormwater maintenance and disposal services. Maintenance procedures may require manned entry into the Jellyfish structure. Only professional maintenance service providers trained in confined space entry procedures should enter the vessel. Procedures, safety and damage prevention precautions, and other information, included in these guidelines, should be reviewed and observed prior to all inspection and maintenance activities.

3.1 – Inspection

3.1.1 – Timing

Inspection of the Jellyfish Filter is key in determining the maintenance requirements for, and to develop a history of the site's pollutant loading characteristics. In general, inspections should be performed at the times indicated below; *or per the approved project stormwater quality documents (if applicable), whichever is more frequent.*

- Post-construction inspection is required prior to putting the Jellyfish Filter into service. All construction debris or construction-related sediment within the device must be removed, and any damage to system components repaired.
- A minimum of two inspections during the first year of operation to assess the sediment and floatable pollutant accumulation, and to ensure proper functioning of the system.

- Inspection frequency in subsequent years is based on the inspection and maintenance plan developed in the first year of operation. Minimum frequency should be once per year.
- Inspection is recommended after each major storm event.
- Immediately after an upstream oil, fuel or other chemical spill.

3.1.2 – Inspection Tools and Equipment

The following equipment and tools are typically required when performing a Jellyfish Filter inspection:

- Access cover lifting tool
- Sediment probe (clear hollow tube with check valve)
- Tape measure
- Flashlight
- Camera
- Inspection and maintenance log documentation
- Safety cones and caution tape
- Hard hat, safety shoes, safety glasses, and chemical-resistant gloves

3.1.3 – Inspection Procedure

The following procedure is recommended when performing inspections:

- Provide traffic control measures as necessary.
- Inspect the MAW for floatable pollutants such as trash, debris, and oil sheen.
- Measure oil and sediment depth by lowering a sediment probe through the MAW opening until contact is made with the floor of the structure. Retrieve the probe, record sediment depth, and presences of any oil layers and repeat in multiple locations within the MAW opening. **Sediment depth of 12 inches or greater indicates maintenance is required**.
- Inspect cartridge lids. Missing or damaged cartridge lids to be replaced.
- Inspect the MAW, cartridge deck, and backwash pool weir for cracks or broken components. If damaged, repair is required.
- **Dry weather inspections:** inspect the cartridge deck for standing water.
  - No standing water under normal operating condition.
  - Standing water **inside** the backwash pool, but not outside the backwash pool, this condition indicates that the filter cartridges need to be rinsed.
  - Standing water **outside** the backwash pool may indicate a backwater condition caused by high water elevation in the receiving water body, or possibly a blockage in downstream infrastructure.

The depth of sediment and oil can be measured from the surface by using a sediment probe or dipstick tube equipped with a ball check valve and inserted through the Jellyfish Filter's maintenance access wall opening. The large opening provides convenient access for inspection and vacuum removal of water and pollutants.

- **Wet weather inspections:** observe the rate and movement of water in the unit. Note the depth of water above deck elevation within the MAW.
  - **Less than 6 inches**, flow should be exiting the cartridge lids of each of the draindown cartridges (i.e. cartridges located outside the backwash pool).
  - **Greater than 6 inches**, flow should be exiting the cartridge lids of each of the draindown cartridges and each of the hi-flo cartridges (i.e. cartridges located inside the backwash pool), and water should be overflowing the backwash pool weir.
  - **18 inches or greater** and relatively little flow is exiting the cartridge lids and outlet pipe, this condition indicates that the filter cartridges are occluded with sediment and need to be rinsed.

3.2 – Maintenance

3.2.1 – Maintenance Requirements

Required maintenance for Jellyfish Filter units is based upon results of the most recent inspection, historical maintenance records, or the site specific water quality management plan; whichever is more frequent. In general, maintenance requires some combination of the following:

- **Sediment removal for depths reaching 12 inches or greater, or within 3 years of the most recent sediment cleaning, whichever occurs sooner.**
- Floatable trash, debris, and oil must be removed.
- Filter cartridges rinsed and re-installed as required by the most recent inspection results, or within 12 months of the most recent filter rinsing, whichever occurs first.
- Replace filter cartridge if rinsing does not remove accumulated sediment from the tentacles, or if tentacles are damaged or missing. It is recommended that tentacles should remain in service no longer than 5 years before replacement.
- Damaged or missing cartridge deck components must be repaired or replaced as indicated by results of the most recent inspection.
- The unit must be cleaned out and filter cartridges inspected immediately after an upstream oil, fuel, or chemical spill. Filter cartridge tentacles should be replaced if damaged by the spill.

3.2.2 – Maintenance Tools and Equipment

The following equipment and tools are typically required when performing Jellyfish Filter maintenance:

- Vacuum truck
- Ladder
- Garden hose and low pressure sprayer
- Rope or cord to lift filter cartridges from the cartridge deck to the surface
- Adjustable pliers for removing filter cartridge tentacles from cartridge head plate
- Plastic tub or garbage can for collecting effluent from rinsed filter cartridge tentacles
- Access cover lifting tool
- Sediment probe (clear hollow tube with check valve)
- Tape measure
- Flashlight
- Camera
- Inspection and maintenance log documentation
- Safety cones and caution tape
- Hard hats, safety shoes, safety glasses, chemical-resistant gloves, and hearing protection for service providers
- Proper safety equipment for confined space entry
- Replacement filter cartridge tentacles if required

3.2.3 – Maintenance Procedure

The following procedures are recommended when maintaining the Jellyfish Filter:

- Provide traffic control measures as necessary.
- Open all covers and hatches. Use ventilation equipment as required, according to confined space entry procedures.
- **Caution:** Dropping objects onto the cartridge deck may cause damage.
- Perform **Inspection Procedure** prior to maintenance activity.
- To access the cartridge deck for filter cartridge service, descend the ladder and step directly onto the deck. **Caution:** Do not step onto the maintenance access wall (MAW) or backwash pool weir, as damage may result. Note that the cartridge deck may be slippery.

3.2.4 – Filter Cartridge Rinsing Procedure

- Remove a cartridge lid.
- Remove the cartridge from the receptacle using the lifting loops in the cartridge head plate. **Caution:** Should

a snag occur, do not force the cartridge upward as damage to the tentacles may result. Rotate the cartridge with a slight sideways motion to clear the snag and continue removing the cartridge.

- Thread a rope or cord through the lifting loops and lift the filter cartridge from the cartridge deck to the top surface outside the structure.
- **Caution:** Immediately replace and secure the lid on the exposed empty receptacle as a safety precaution. Never expose more than one empty cartridge receptacle.
- Repeat the filter cartridge removal procedure until all of the cartridges are located at the top surface outside the structure.
- Disassemble the tentacles from each filter cartridge by rotating counter-clockwise. Remove the tentacles from the cartridge head plate.
- Position a receptacle in a plastic tub or garbage can such that the rinse water is captured. Using a low-pressure garden hose sprayer, direct a wide-angle water spray at a downward 45° angle onto the tentacle membrane, sweeping from top to bottom along the length of the tentacle. Rinse until all sediment is removed from the membrane. **Caution:** Do not use a high pressure sprayer or focused stream of water on the membrane. Excessive water pressure may damage the membrane. Turn membran upside down and pour out any residual rinsewater to ensure center of tentacle is clear of any sediment.

Rinsing of dirty filter cartridge tentacles with a low-pressure garden hose sprayer, and using a plastic garbage container to capture rinse water.

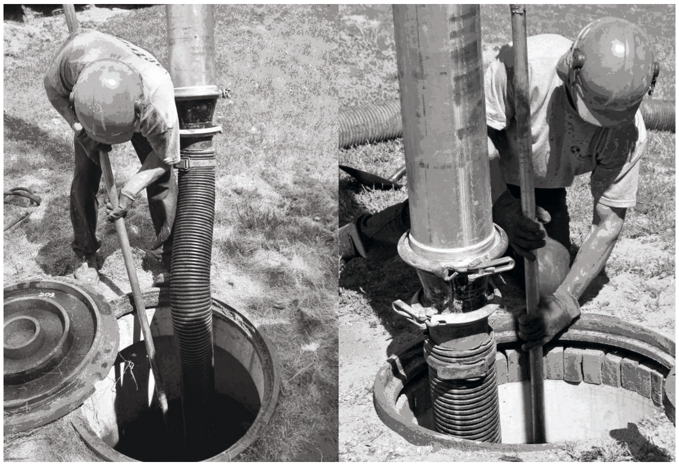
- Remove rinse water from rinse tub or garbage can using a vacuum hose as needed.
- Slip the o-ring over the tentacle nipple and reassemble onto the cartridge head plate; hand-tighten.
- If rinsing is ineffective in removing sediment from the tentacles, or if tentacles are damaged, provisions must be made to replace the spent or damaged tentacles with new tentacles. Contact Imbrium Systems to order replacement tentacles.
- Lower a rinsed filter cartridge to the cartridge deck. Remove the cartridge lid on a receptacle and carefully lower the filter cartridge into the receptacle until the head plate gasket is seated squarely on the lip of the receptacle. **Caution:** Should a snag occur when lowering the cartridge into the receptacle, do not force the cartridge downward; damage may occur. Rotate the cartridge with a slight sideways motion to clear the snag and complete the installation.
- Replace the cartridge lid on the exposed receptacle. Rinse away any accumulated grit from the receptacle threads if needed to get a proper fit. **Align the cartridge lid male threads with the cartridge receptacle female threads. Firmly twist the cartridge lid clockwise a minimum 110º to seat the filter cartridge snugly in place, with a proper watertight seal**.
- Repeat cartridge installation until all cartridges are installed.

3.2.5 – Vacuum Cleaning Procedure

- **Caution:** Perform vacuum cleaning of the Jellyfish Filter only after filter cartridges have been removed from the system. Access the lower chamber for vacuum cleaning **only through the maintenance access wall (MAW) opening**, being careful not to damage the flexible plastic separator skirt that is attached to the underside of the deck. The separator skirt surrounds the filter cartridge zone, and could be torn if contacted by the wand. **Do not lower the vacuum wand through a cartridge receptacle**, as damage to the receptacle will result.
  - To remove floatable trash, debris, and oil, lower the vacuum hose into the MAW opening and vacuum floatable pollutants off the surface of the water. Alternatively, floatable solids may be removed by a net or skimmer.
  - Using a vacuum hose, remove the water from the lower chamber to the sanitary sewer, if permitted by the local regulating authority, or into a separate containment tank.
  - Remove the sediment from the bottom of the unit through the MAW opening.
  - For larger diameter Jellyfish Filter manholes (8-ft, 10-ft, 12-ft diameter), complete sediment removal may be facilitated by removing a cartridge lid from an empty receptacle and inserting a jetting wand (not a vacuum wand) through the receptacle. Use the sprayer to rinse loosened sediment toward the vacuum hose in the MAW opening, being careful not to damage the receptacle..
  - After the unit is clean, re-fill the lower chamber with water if required by the local jurisdiction, and re-install filter cartridges.
  - Dispose of sediment, floatable trash and debris, oil, spent tentacles, and water according to local regulatory requirements.

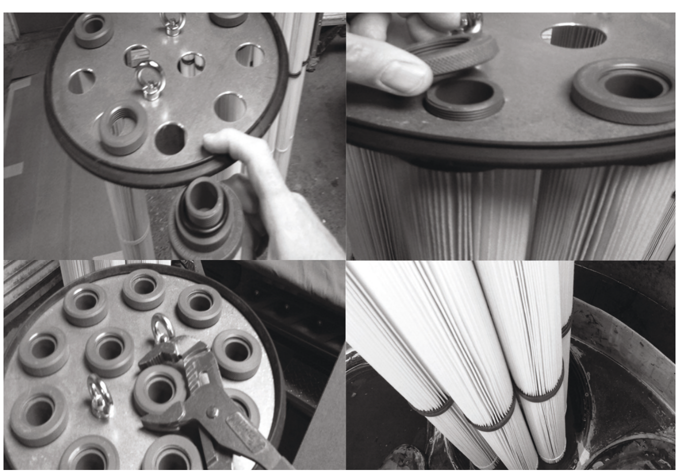
3.2.6 – Chemical Spills

- **Caution**: If a chemical spill has been captured by the Jellyfish Filter, do not attempt maintenance. Immediately contact the local hazard response agency.




A maintenance worker stationed on the surface uses a vacuum hose to evacuate water, sediment, and floatables from the Jellyfish Filter by inserting the vacuum wand through the maintenance access wall opening.


A view of a Jellyfish Filter cartridge deck from the surface showing all the cartridge lids intact and no standing water on the deck (left image), and inspection of the flexible separator skirt from inside the maintenance access wall opening (right image).




Assembly of a Jellyfish Filter cartridge (left) and installation of a filter cartridge into a cartridge receptacle in the deck (right).

3.3 – Disposal Procedures

Disposal requirements for recovered pollutants and spent filtration tentacles may vary depending on local guidelines. In most areas the sediment and spent filtration tentacles, once dewatered, can be disposed of in a sanitary landfill. It is not anticipated that the sediment would be classified as hazardous waste.

Petroleum-based pollutants captured by the Jellyfish Filter, such as oil and fuels, should be removed and disposed of by a licensed waste management company.

Although the Jellyfish Filter captures virtually all free oil, a sheen may still be present at the MAW. A rainbow or sheen can be visible at oil concentrations of less than 10 mg/L (ppm).

Chapter 4

4.0 – Recommended Safety Procedures

Jobsite safety is a topic and a practice addressed comprehensively by others. The inclusions here are merely reminders to whole areas of Safety Practice that are the responsibility of the Owner(s), Manager(s) and Contractor(s). OSHA and Canadian OSH, and Federal, State/Provincial, and Local Jurisdiction Safety Standards apply.

4.1 – Confined Space/Personal Safety Equipment/Warning and Cautions

Please see reference on Page 3.

Chapter 5

5.0 – Jellyfish Filter Replacement Parts

Jellyfish membrane filtration cartridges, cartridge components, cartridge lids, other replacement parts can be ordered by contacting Imbrium Systems at:

United States: 888-279-8826 or 301-279-8827

Canada/International: 800-565-4801 or +1-416-960-9900

info@imbriumsystems.com

5.1 – Jellyfish Filter Replacement Parts List

Note: Jellyfish Cartridges and/or Filtration tentacles are available in the following lengths:

• 15 Inch (381 mm) • 27 Inch (686 mm) • 40 Inch (1,016 mm) • 54 Inch (1,372 mm)

- Jellyfish Cartridge (specify length). Includes head plate with lifting loops, rim gasket, eleven (11) filtration tentacles, eleven (11) o-rings, and eleven (11) locking nuts
- Standard Head plate
- Blank head plate
- Rim gasket (for head plate)
- Locking nuts (for tentacles)
- O-rings (for tentacles)
- Cartridge lids are available with the following orifice sizes: 70mm, 55mm, 45mm, 35mm, 30mm, 25mm, 30mm, blank lid (no orifice)
- Maintenance Access Wall (MAW) extension (18-inch segment)

** Nothing in this catalog should be construed as an expressed warranty or implied warranties, including the warranties of merchantability and of fitness for any particular purpose.*

Jellyfish Filter Inspection and Maintenance Log

Owner: ______________________________ Jellyfish Model No.:______________________

Location: ____________________________ GPS Coordinates: _______________________

Land Use: Commercial:______ Industrial: ______ Service Station:______

Road/Highway:____ Airport: ________ Residential: _________ Parking Lot:______

Date/Time:						
Inspector:						
Maintenance Contractor:						
Visible Oil Present: (Y/N)						
Oil Quantity Removed						
Floatable Debris Present: (Y/N)						
Floatable Debris removed: (Y/N)						
Water Depth in Backwash Pool						
Draindown Cartridges externally rinsed and re-commissioned: (Y/N)						
New tentacles put on Cartridges: (Y/N)						
Hi-Flo cartridges externally rinsed and recommissioned (Y/N):						
New tentacles put on Hi-Flo Cartridges: (Y/N)						
Sediment Depth Measured: (Y/N)						
Sediment Depth (inches or mm):						
Sediment Removed: (Y/N)						
Cartridge Lids intact: (Y/N)						
Observed Damage:						
Comments:						

Appendix B

SWMHYMO Output

MTE

Post-Development

```
2     Metric units
*#*************************************************************************|
*#  Project Name: Holiday Inn Express - Barrie
*#  JOB NUMBER  : 45303-100
*#  Date        : November 2019 - Updated July 2020
*#  Modeller    : AXT
*#  Company     : MTE CONSULTANTS INC.
*#  File        : 45303.dat
*#  Description : Post Development Modeling
*#*************************************************************************|
*#
*# !!! NOTE - THIS MODEL CONTAINS POST DEVELOPMENT MODELING ONLY
*#
*#*************************************************************************|
*#
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[002]
                    CHI2YR.stm
*
READ STORM          STORM_FILENAME "STORM.001"
*
*#*************************************************************************|
*#
*#                  POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#                  ===============================================
*#
*#*************************************************************************|
*# CATCHMENT 201 - Building Rooftop
CALIB STANDHYD      ID=[1], NHYD=["201"], DT=[1](min), AREA=[0.113](ha),
                    XIMP=[.99], TIMP=[.99], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[76],
                    Pervious   surfaces: IAper=[5](mm), SLPP=[1.0](%),
                                         LGP=[7.5](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[2.0](mm), SLPI=[1.0](%),
                                         LGI=[7.5](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|--------------------------------------------------------|
*Control Flows via Flow Control Roof Drains
*%-----------------|--------------------------------------------------------|
ROUTE RESERVOIR     IDout=[2],   NHYD=["CTL"],  IDin=[1],
                    RDT=[1](min),
                          TABLE of ( OUTFLOW-STORAGE ) values
                                      (cms) - (ha-m)
 0.00000    0.00000
 0.00372    0.00043
 0.00744    0.00256
 0.01116    0.00709
                                       -1       -1   (max twenty pts)
                          IDovf=[3], NHYDovf=["R-OVF"]
*%-----------------|--------------------------------------------------------|
*# CATCHMENT 202 - Parking Lot
*%-----------------|--------------------------------------------------------|
CALIB STANDHYD      ID=[4], NHYD=["202"], DT=[1](min), AREA=[0.53](ha),
                    XIMP=[.87], TIMP=[.87], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[76],
                    Pervious   surfaces: IAper=[5](mm), SLPP=[2.0](%),
                                         LGP=[5](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[2.0](mm), SLPI=[2.0](%),
                                         LGI=[10](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|--------------------------------------------------------|
*# ADD 201 and 202 (Roof + Parking Lot)
ADD HYD             IDsum=[5], NHYD=["TOTAL-R+P"], IDs to add=[2 3 4]
*%-----------------|--------------------------------------------------------|
*Control Flows via 140mm Orifice
*%-----------------|--------------------------------------------------------|

*#Route Through Orifice
ROUTE RESERVOIR     IDout=[6],   NHYD=["Orifice"],  IDin=[5],
                    RDT=[1](min),
                          TABLE of ( OUTFLOW-STORAGE ) values
                                     [ 0,0 ]
                                     [ 0.0613,0 ]
                                     [ 0.062,0.0002 ]
                                     [ 0.0628,0.0014 ]
                                     [ 0.0635,0.0046 ]
                                     [ 0.0642,0.011 ]
                                     [ 0.0649,0.0212 ]
                                     [ 0.0656,0.0357 ]
                                    [   -1  ,  -1  ]  (max twenty pts)
                          IDovf=[7], NHYDovf=["OVF"]
*%-----------------|--------------------------------------------------------|
*# CATCHMENT 203 - Uncontrolled Perimeter Flow
*%-----------------|--------------------------------------------------------|
CALIB STANDHYD      ID=[8], NHYD=["203"], DT=[1](min), AREA=[0.095](ha),
                    XIMP=[.40], TIMP=[.40], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[76],
                    Pervious   surfaces: IAper=[5](mm), SLPP=[10.0](%),
                                         LGP=[3](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[2.0](mm), SLPI=[6.0](%),
                                         LGI=[5](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|--------------------------------------------------------|
*# TOTAL PROPOSED FLOW FROM SITE (CONTROLLED + UNCONTROLLED)
ADD HYD             IDsum=[9], NHYD=["TOTAL-POST"], IDs to add=[6 7 8]
*%-----------------|--------------------------------------------------------|
****************************************************************************
*RUN REMAINING DESIGN STORMS (Chicago 5 TO 100-YR)
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[005]
                    CHI5YR.stm
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[010]
                    CHI10YR.stm
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[025]
                    CHI25YR.stm
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[050]
                    CHI50YR.stm
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[100]
                    CHI100YR.stm
*
*%-----------------|--------------------------------------------------------|
FINISH
```

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

   SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999    =========
   S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
   SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9   Ver  4.05
       S   W W   M   M  H   H    Y    M   M  O   O       9999   9999   Sept 2011
   SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9   =========
                                                        9   9  9   9   # 3057174
        StormWater Management HYdrologic Model           999    999    =========

 *******************************************************************************
 ***************************** SWMHYMO Ver/4.05  ******************************
 *********  A single event and continuous hydrologic simulation model  *********
 *********     based on the principles of HYMO and its successors      *********
 *********                OTTHYMO-83 and OTTHYMO-89.                   *********
 *******************************************************************************
 ********* Distributed by:  J.F. Sabourin and Associates Inc.          *********
 *********                  Ottawa,  Ontario: (613) 836-3884           *********
 *********                  Gatineau, Quebec: (819) 243-6858           *********
 *********                  E-Mail: swmhymo@jfsa.Com                   *********
 *******************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++++ Licensed user: MTE Consultants Inc.                         +++++++++
 +++++++++                Kitchener             SERIAL#:3057174        +++++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 *******************************************************************************
 *********           ++++++ PROGRAM ARRAY DIMENSIONS ++++++            *********
 *********           Maximum value for ID numbers  :      10           *********
 *********           Max. number of rainfall points: 105408            *********
 *********           Max. number of flow points    : 105408            *********
 *******************************************************************************


 **********************   D E T A I L E D   O U T P U T   **********************
 *******************************************************************************
 *         DATE: 2020-07-15     TIME: 10:47:08     RUN COUNTER: 000065         *
 *******************************************************************************
 * Input   filename: Q:\45303\100\SWMHYMO\45303.dat                            *
 * Output  filename: Q:\45303\100\SWMHYMO\45303.out                            *
 * Summary filename: Q:\45303\100\SWMHYMO\45303.sum                            *
 * User comments:                                                              *
 * 1:__________________________________________________________________________*
 * 2:__________________________________________________________________________*
 * 3:__________________________________________________________________________*
 *******************************************************************************

--------------------------------------------------------------------------------
001:0001------------------------------------------------------------------------
*#*************************************************************************|
*#  Project Name: Holiday Inn Express - Barrie
*#  JOB NUMBER  : 45303-100
*#  Date        : November 2019 - Updated July 2020
*#  Modeller    :
AXT
*#  Company     : MTE CONSULTANTS
INC.
*#  File        : 45303.dat
*#  Description : Post Development Modeling
*#*************************************************************************|
*#
*# !!! NOTE - THIS MODEL CONTAINS POST DEVELOPMENT MODELING ONLY
*#
*#*************************************************************************|
*#
  ** END OF RUN :   1

*******************************************************************************






--------------------
| START            |  Project  dir.:
Q:\45303\100\SWMHYMO\
--------------------  Rainfall dir.:
Q:\45303\100\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 002
    NSTORM=   1
           #  1=CHI2YR.stm
--------------------------------------------------------------------------------
002:0002------------------------------------------------------------------------
*#*************************************************************************|
*#  Project Name: Holiday Inn Express - Barrie
*#  JOB NUMBER  : 45303-100
*#  Date        : November 2019 - Updated July 2020
*#  Modeller    :
AXT
*#  Company     : MTE CONSULTANTS
INC.
*#  File        : 45303.dat
*#  Description : Post Development Modeling
*#*************************************************************************|
*#
*# !!! NOTE - THIS MODEL CONTAINS POST DEVELOPMENT MODELING ONLY
*#
*#*************************************************************************|
*#
--------------------------------------------------------------------------------
002:0002------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: * City of Barrie - 2 yr Chicago (4hr) +
| Ptotal=  36.95 mm|    Comments: * City of Barrie - 2 yr Chicago (4hr) +
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   2.470 |   1.17  18.780 |   2.17   5.730 |   3.17   2.930
               .33   2.820 |   1.33  83.110 |   2.33   4.890 |   3.33   2.720
               .50   3.310 |   1.50  24.570 |   2.50   4.280 |   3.50   2.550
               .67   4.050 |   1.67  13.010 |   2.67   3.820 |   3.67   2.390
               .83   5.300 |   1.83   9.010 |   2.83   3.460 |   3.83   2.260
              1.00   7.980 |   2.00   6.970 |   3.00   3.170 |   4.00   2.150

--------------------------------------------------------------------------------
002:0003------------------------------------------------------------------------
*
*#*************************************************************************|
*#
*#                POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#                ===============================================
*#
*#*************************************************************************|
*# CATCHMENT 201 - Building Rooftop
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .11
| 01:201    DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
----------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .11          .00
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       1.00         1.00
     Length            (m)=       7.50         7.50
     Mannings n           =       .015         .250
```

```
     Max.eff.Inten.(mm/hr)=      83.11        19.30
                over (min)        1.00         7.00
     Storage Coeff.  (min)=        .63 (ii)    6.78 (ii)
     Unit Hyd. Tpeak (min)=       1.00         7.00
     Unit Hyd. peak  (cms)=       1.35          .17
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .03          .00          .026 (iii)
     TIME TO PEAK    (hrs)=       1.30         1.42         1.333
     RUNOFF VOLUME    (mm)=      34.96         9.10        34.696
     TOTAL RAINFALL   (mm)=      36.96        36.96        36.955
     RUNOFF COEFFICIENT   =        .95          .25          .939

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------------
002:0004----------------------------------------------------------------------------
*Control Flows via Flow Control Roof Drains
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(201   )   |
| OUT<02:(CTL   )   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)     (ha.m.)  |    (cms)     (ha.m.)
                            .000  .0000E+00   |      .007  .2560E-02
                            .004  .4300E-03   |      .011  .7090E-02

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)      (cms)     (hrs)        (mm)
     INFLOW >01: (201   )         .11       .026     1.333     34.696
     OUTFLOW<02: (CTL   )         .11       .006     1.517     34.696
    OVERFLOW<03: (R-OVF )         .00       .000      .000       .000

                  TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                  CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                  PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=   23.212
                  TIME SHIFT OF PEAK FLOW         (min)=    11.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.1740E-02

------------------------------------------------------------------------------------
002:0005----------------------------------------------------------------------------
*# CATCHMENT 202 - Parking Lot
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .53
| 04:202    DT= 1.00 |   Total Imp(%)=   87.00   Dir. Conn.(%)=   87.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .46          .07
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00         5.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      83.11        22.21
                over (min)        1.00         4.00
     Storage Coeff.  (min)=        .61 (ii)    4.31 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.37          .27
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .11          .00          .109 (iii)
     TIME TO PEAK    (hrs)=       1.32         1.37         1.333
     RUNOFF VOLUME    (mm)=      34.95         9.10        31.594
     TOTAL RAINFALL   (mm)=      36.96        36.96        36.955
     RUNOFF COEFFICIENT   =        .95          .25          .855

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------------
002:0006----------------------------------------------------------------------------
*# ADD 201 and 202 (Roof + Parking Lot)
------------------------
| ADD HYD (TOTAL-R+P ) | ID: NHYD         AREA     QPEAK    TPEAK   R.V.    DWF
------------------------                   (ha)      (cms)    (hrs)   (mm)   (cms)
                     ID1 02:CTL             .11      .006     1.52  34.70    .000
                    +ID2 03:R-OVF           .00      .000      .00    .00    .000  **DRY**
                    +ID3 04:202             .53      .109     1.33  31.59    .000
                     ==========================================================
                     SUM 05:TOTAL-R+P       .64      .115     1.33  32.14    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------------
002:0007----------------------------------------------------------------------------
*Control Flows via 140mm Orifice
*#Route Through Orifice
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>05:(TOTAL-)   |
| OUT<06:(Orific)   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)     (ha.m.)  |    (cms)     (ha.m.)
                            .000  .0000E+00   |      .064  .4600E-02
                            .061  .0000E+00   |      .064  .1100E-01
                            .062  .2000E-03   |      .065  .2120E-01
                            .063  .1400E-02   |      .066  .3570E-01

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)      (cms)     (hrs)        (mm)
     INFLOW >05: (TOTAL-)         .64       .115     1.333     32.139
     OUTFLOW<06: (Orific)         .64       .063     1.350     32.144
    OVERFLOW<07: (OVF   )         .00       .000      .000       .000

                  TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                  CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                  PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=   54.922
                  TIME SHIFT OF PEAK FLOW         (min)=     1.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.2871E-02

------------------------------------------------------------------------------------
002:0008----------------------------------------------------------------------------
*# CATCHMENT 203 - Uncontrolled Perimeter Flow
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .09
| 08:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   40.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .04          .06
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       6.00        10.00
     Length            (m)=       5.00         3.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      83.11        24.01
                over (min)        1.00         2.00
```

```
     Storage Coeff.  (min)=        .29 (ii)    1.92 (ii)
     Unit Hyd. Tpeak (min)=       1.00         2.00
     Unit Hyd. peak  (cms)=       1.64          .57
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .01          .00          .012 (iii)
     TIME TO PEAK    (hrs)=       1.23         1.33         1.333
     RUNOFF VOLUME    (mm)=      34.96         9.10        19.444
     TOTAL RAINFALL   (mm)=      36.96        36.96        36.955
     RUNOFF COEFFICIENT   =        .95          .25          .526

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------------
002:0009-----------------------------------------------------------------------------
*# TOTAL PROPOSED FLOW FROM SITE (CONTROLLED + UNCONTROLLED)
------------------------
| ADD HYD (TOTAL-POST) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 06:Orifice         .64     .063    1.35  32.14    .000
                    +ID2 07:OVF             .00     .000     .00    .00    .000  **DRY**
                    +ID3 08:203             .09     .012    1.33  19.44    .000
                     ==========================================================
                     SUM 09:TOTAL-POST      .74     .075    1.33  30.51    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------------
002:0010-----------------------------------------------------------------------------
********************************************************************************
*RUN REMAINING DESIGN STORMS (Chicago 5 TO 100-YR)
*
  ** END OF RUN :   4

*******************************************************************************





--------------------
| START            |  Project  dir.:
Q:\45303\100\SWMHYMO\
--------------------  Rainfall dir.:
Q:\45303\100\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 005
    NSTORM=   1
          #  1=CHI5YR.stm
-------------------------------------------------------------------------------------
005:0002-----------------------------------------------------------------------------
*#****************************************************************************|
*#  Project Name: Holiday Inn Express - Barrie
*#  JOB NUMBER  : 45303-100
*#  Date        : November 2019 - Updated July 2020
*#  Modeller    :
AXT
*#  Company     : MTE CONSULTANTS
INC.
*#  File        : 45303.dat
*#  Description : Post Development Modeling
*#****************************************************************************|
*#
*# !!! NOTE - THIS MODEL CONTAINS POST DEVELOPMENT MODELING ONLY
*#
*#****************************************************************************|
*#
-------------------------------------------------------------------------------------
005:0002-----------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: * City of Barrie - 5 yr Chicago (4hr) +
| Ptotal=  50.52 mm|    Comments: * City of Barrie - 5 yr Chicago (4hr) +
--------------------
             TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
              hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
              .17   3.570 |   1.17  25.640 |   2.17   8.120 |   3.17   4.220
              .33   4.070 |   1.33 108.920 |   2.33   6.960 |   3.33   3.930
              .50   4.760 |   1.50  33.310 |   2.50   6.120 |   3.50   3.680
              .67   5.790 |   1.67  17.990 |   2.67   5.480 |   3.67   3.470
              .83   7.530 |   1.83  12.600 |   2.83   4.970 |   3.83   3.280
             1.00  11.200 |   2.00   9.820 |   3.00   4.560 |   4.00   3.120

-------------------------------------------------------------------------------------
005:0003-----------------------------------------------------------------------------
*
*#****************************************************************************|
*#
*#                 POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#                 ===============================================
*#
*#****************************************************************************|
*# CATCHMENT 201 - Building Rooftop
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .11
| 01:201    DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .11          .00
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       1.00         1.00
     Length            (m)=       7.50         7.50
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     108.92        37.63
                over (min)        1.00         5.00
     Storage Coeff.  (min)=        .57 (ii)    5.27 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=       1.41          .22
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .03          .00          .034 (iii)
     TIME TO PEAK    (hrs)=       1.30         1.38         1.333
     RUNOFF VOLUME    (mm)=      48.52        16.48        48.198
     TOTAL RAINFALL   (mm)=      50.52        50.52        50.518
     RUNOFF COEFFICIENT   =        .96          .33          .954

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------------
005:0004-----------------------------------------------------------------------------
*Control Flows via Flow Control Roof Drains
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(201    )  |
| OUT<02:(CTL    )  |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .000  .0000E+00    |     .007  .2560E-02
                           .004  .4300E-03    |     .011  .7090E-02
```

```
     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)      (cms)     (hrs)       (mm)
     INFLOW >01: (201    )        .11       .034      1.333     48.198
     OUTFLOW<02: (CTL    )        .11       .007      1.517     48.198
    OVERFLOW<03: (R-OVF )         .00       .000       .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   21.310
                   TIME SHIFT OF PEAK FLOW         (min)=    11.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.2441E-02

-------------------------------------------------------------------------------------
005:0005----------------------------------------------------------------------------
*# CATCHMENT 202 - Parking Lot
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .53
| 04:202    DT= 1.00 |   Total Imp(%)=   87.00   Dir. Conn.(%)=   87.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .46          .07
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00         5.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     108.92        40.27
                over (min)        1.00         3.00
     Storage Coeff.  (min)=        .55 (ii)    3.47 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.42          .34
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .14          .01             .145 (iii)
     TIME TO PEAK    (hrs)=       1.30         1.35            1.333
     RUNOFF VOLUME    (mm)=      48.52        16.48           44.353
     TOTAL RAINFALL   (mm)=      50.52        50.52           50.518
     RUNOFF COEFFICIENT   =        .96          .33             .878

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------------
005:0006----------------------------------------------------------------------------
*# ADD 201 and 202 (Roof + Parking Lot)
------------------------
| ADD HYD (TOTAL-R+P ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)      (cms)   (hrs)   (mm)   (cms)
                     ID1 02:CTL             .11      .007    1.52  48.20    .000
                    +ID2 03:R-OVF           .00      .000     .00    .00    .000  **DRY**
                    +ID3 04:202             .53      .145    1.33  44.35    .000
                     ============================================================
                     SUM 05:TOTAL-R+P       .64      .152    1.33  45.03    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------------
005:0007----------------------------------------------------------------------------
*Control Flows via 140mm Orifice
*#Route Through Orifice
---------------------
| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>05:(TOTAL-)    |
| OUT<06:(Orific)    |    =========  OUTLFOW STORAGE TABLE  =========
---------------------      OUTFLOW    STORAGE    |  OUTFLOW    STORAGE
                             (cms)     (ha.m.)    |    (cms)     (ha.m.)
                              .000  .0000E+00    |     .064  .4600E-02
                              .061  .0000E+00    |     .064  .1100E-01
                              .062  .2000E-03    |     .065  .2120E-01
                              .063  .1400E-02    |     .066  .3570E-01

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)      (cms)     (hrs)       (mm)
     INFLOW >05: (TOTAL-)         .64       .152      1.333     45.029
     OUTFLOW<06: (Orific)         .64       .064      1.367     45.162
    OVERFLOW<07: (OVF   )         .00       .000       .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   41.761
                   TIME SHIFT OF PEAK FLOW         (min)=     2.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.5035E-02

-------------------------------------------------------------------------------------
005:0008----------------------------------------------------------------------------
*# CATCHMENT 203 - Uncontrolled Perimeter Flow
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .09
| 08:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   40.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .04          .06
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       6.00        10.00
     Length            (m)=       5.00         3.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     108.92        41.51
                over (min)        1.00         2.00
     Storage Coeff.  (min)=        .26 (ii)    1.57 (ii)
     Unit Hyd. Tpeak (min)=       1.00         2.00
     Unit Hyd. peak  (cms)=       1.66          .65
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .01          .01             .018 (iii)
     TIME TO PEAK    (hrs)=       1.23         1.33            1.333
     RUNOFF VOLUME    (mm)=      48.52        16.48           29.295
     TOTAL RAINFALL   (mm)=      50.52        50.52           50.518
     RUNOFF COEFFICIENT   =        .96          .33             .580

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------------
005:0009----------------------------------------------------------------------------
*# TOTAL PROPOSED FLOW FROM SITE (CONTROLLED + UNCONTROLLED)
------------------------
| ADD HYD (TOTAL-POST) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)      (cms)   (hrs)   (mm)   (cms)
                     ID1 06:Orifice         .64      .064    1.37  45.16    .000
                    +ID2 07:OVF             .00      .000     .00    .00    .000  **DRY**
                    +ID3 08:203             .09      .018    1.33  29.29    .000
                     ============================================================
                     SUM 09:TOTAL-POST      .74      .081    1.33  43.12    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------------
```

```
005:0010--------------------------------------------------------------------------------
*********************************************************************************
*RUN REMAINING DESIGN STORMS (Chicago 5 TO 100-YR)
*
--------------------------------------------------------------------------------
005:0002--------------------------------------------------------------------------------
*
  ** END OF RUN :    9

********************************************************************************





--------------------
| START            |  Project  dir.:
Q:\45303\100\SWMHYMO\
--------------------  Rainfall dir.:
Q:\45303\100\SWMHYMO\
    TZERO =    .00 hrs on         0
    METOUT=   2 (output = METRIC)
    NRUN  = 010
    NSTORM=   1
           #  1=CHI10YR.stm
--------------------------------------------------------------------------------
010:0002--------------------------------------------------------------------------------
*#*****************************************************************************|
*#  Project Name: Holiday Inn Express - Barrie
*#  JOB NUMBER  : 45303-100
*#  Date        : November 2019 - Updated July 2020
*#  Modeller    :
AXT
*#  Company     : MTE CONSULTANTS
INC.
*#  File        : 45303.dat
*#  Description : Post Development Modeling
*#*****************************************************************************|
*#
*# !!! NOTE - THIS MODEL CONTAINS POST DEVELOPMENT MODELING ONLY
*#
*#*****************************************************************************|
*#
--------------------------------------------------------------------------------
010:0002--------------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: * City of Barrie - 10 yr Chicago (4hr) +
| Ptotal=  59.69 mm|    Comments: * City of Barrie - 10 yr Chicago (4hr) +
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   4.320 |   1.17  30.270 |   2.17   9.720 |   3.17   5.090
               .33   4.910 |   1.33 126.550 |   2.33   8.350 |   3.33   4.740
               .50   5.730 |   1.50  39.220 |   2.50   7.350 |   3.50   4.450
               .67   6.960 |   1.67  21.350 |   2.67   6.590 |   3.67   4.190
               .83   9.030 |   1.83  15.010 |   2.83   5.990 |   3.83   3.970
              1.00  13.360 |   2.00  11.740 |   3.00   5.500 |   4.00   3.770

--------------------------------------------------------------------------------
010:0003--------------------------------------------------------------------------------
*
*#*****************************************************************************|
*#
*#                POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#                ===============================================
*#
*#*****************************************************************************|
*# CATCHMENT 201 - Building Rooftop
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .11
| 01:201     DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .11          .00
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       1.00         1.00
     Length            (m)=       7.50         7.50
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     126.55        50.29
                over (min)        1.00         5.00
     Storage Coeff.  (min)=        .54 (ii)    4.73 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=       1.44          .24
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .04          .00          .039 (iii)
     TIME TO PEAK    (hrs)=       1.30         1.37         1.333
     RUNOFF VOLUME    (mm)=      57.69        22.17        57.338
     TOTAL RAINFALL   (mm)=      59.69        59.69        59.693
     RUNOFF COEFFICIENT   =        .97          .37          .961

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0004--------------------------------------------------------------------------------
*Control Flows via Flow Control Roof Drains
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(201    )   |
| OUT<02:(CTL    )   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)     (ha.m.)   |   (cms)     (ha.m.)
                            .000  .0000E+00    |     .007  .2560E-02
                            .004  .4300E-03    |     .011  .7090E-02

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     -------------------        (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (201    )       .11      .039     1.333     57.338
     OUTFLOW<02: (CTL    )       .11      .008     1.517     57.338
    OVERFLOW<03: (R-OVF )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   19.662
                   TIME SHIFT OF PEAK FLOW          (min)=    11.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.2942E-02

--------------------------------------------------------------------------------
010:0005--------------------------------------------------------------------------------
*# CATCHMENT 202 - Parking Lot
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .53
| 04:202     DT= 1.00 |   Total Imp(%)=   87.00   Dir. Conn.(%)=   87.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .46          .07
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00         5.00
     Mannings n           =       .015         .250
```

```
     Max.eff.Inten.(mm/hr)=     126.55        53.43
                over (min)        1.00         3.00
     Storage Coeff.  (min)=        .52 (ii)    3.12 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.45          .37
                                                         *TOTALS*
     PEAK FLOW       (cms)=        .16          .01          .170 (iii)
     TIME TO PEAK    (hrs)=       1.30         1.35         1.333
     RUNOFF VOLUME    (mm)=      57.69        22.17        53.076
     TOTAL RAINFALL   (mm)=      59.69        59.69        59.693
     RUNOFF COEFFICIENT   =        .97          .37          .889

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------------
010:0006----------------------------------------------------------------------------
*# ADD 201 and 202 (Roof + Parking Lot)
------------------------
| ADD HYD (TOTAL-R+P ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 02:CTL             .11      .008    1.52  57.34    .000
                    +ID2 03:R-OVF           .00      .000     .00    .00    .000  **DRY**
                    +ID3 04:202             .53      .170    1.33  53.08    .000
                     ============================================================
                     SUM 05:TOTAL-R+P       .64      .178    1.33  53.82    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------------
010:0007----------------------------------------------------------------------------
*Control Flows via 140mm Orifice
*#Route Through Orifice
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>05:(TOTAL-)   |
| OUT<06:(Orific)   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)     (ha.m.)   |    (cms)     (ha.m.)
                            .000  .0000E+00   |     .064  .4600E-02
                            .061  .0000E+00   |     .064  .1100E-01
                            .062  .2000E-03   |     .065  .2120E-01
                            .063  .1400E-02   |     .066  .3570E-01

     ROUTING RESULTS           AREA     QPEAK     TPEAK       R.V.
     -------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >05: (TOTAL-)        .64      .178     1.333      53.825
     OUTFLOW<06: (Orific)        .64      .064     1.400      53.997
    OVERFLOW<07: (OVF   )        .00      .000      .000        .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   35.836
                   TIME SHIFT OF PEAK FLOW          (min)=     4.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.6595E-02

------------------------------------------------------------------------------------
010:0008----------------------------------------------------------------------------
*# CATCHMENT 203 - Uncontrolled Perimeter Flow
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .09
| 08:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   40.00
```

```
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .04          .06
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       6.00        10.00
     Length            (m)=       5.00         3.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     126.55        56.32
                over (min)        1.00         1.00
     Storage Coeff.  (min)=        .25 (ii)    1.40 (ii)
     Unit Hyd. Tpeak (min)=       1.00         1.00
     Unit Hyd. peak  (cms)=       1.67          .87
                                                         *TOTALS*
     PEAK FLOW       (cms)=        .01          .01          .022 (iii)
     TIME TO PEAK    (hrs)=       1.23         1.33         1.333
     RUNOFF VOLUME    (mm)=      57.69        22.17        36.382
     TOTAL RAINFALL   (mm)=      59.69        59.69        59.693
     RUNOFF COEFFICIENT   =        .97          .37          .609

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------------
010:0009----------------------------------------------------------------------------
*# TOTAL PROPOSED FLOW FROM SITE (CONTROLLED + UNCONTROLLED)
------------------------
| ADD HYD (TOTAL-POST) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 06:Orifice         .64      .064    1.40  54.00    .000
                    +ID2 07:OVF             .00      .000     .00    .00    .000  **DRY**
                    +ID3 08:203             .09      .022    1.33  36.38    .000
                     ============================================================
                     SUM 09:TOTAL-POST      .74      .085    1.33  51.73    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------------
010:0010----------------------------------------------------------------------------
********************************************************************************
*RUN REMAINING DESIGN STORMS (Chicago 5 TO 100-YR)
*
------------------------------------------------------------------------------------
010:0002----------------------------------------------------------------------------
*
------------------------------------------------------------------------------------
010:0002----------------------------------------------------------------------------
*
  ** END OF RUN :  24

*******************************************************************************





--------------------
| START            |  Project  dir.:
Q:\45303\100\SWMHYMO\
--------------------  Rainfall dir.:
Q:\45303\100\SWMHYMO\
    TZERO =    .00 hrs on        0
    METOUT=    2 (output = METRIC)
    NRUN  = 025
    NSTORM=    1
           #  1=CHI25YR.stm
```

```
------------------------------------------------------------------------------------
025:0002----------------------------------------------------------------------------
*#************************************************************************|
*#  Project Name: Holiday Inn Express - Barrie
*#  JOB NUMBER  : 45303-100
*#  Date        : November 2019 - Updated July 2020
*#  Modeller    :
AXT
*#  Company     : MTE CONSULTANTS
INC.
*#  File        : 45303.dat
*#  Description : Post Development Modeling
*#************************************************************************|
*#
*# !!! NOTE - THIS MODEL CONTAINS POST DEVELOPMENT MODELING ONLY
*#
*#************************************************************************|
*#
------------------------------------------------------------------------------------
025:0002----------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: * City of Barrie - 25 yr Chicago (4hr) +
| Ptotal=  71.24 mm|    Comments: * City of Barrie - 25 yr Chicago (4hr) +
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   5.220 |   1.17  36.370 |   2.17  11.740 |   3.17   6.150
               .33   5.940 |   1.33 148.150 |   2.33  10.090 |   3.33   5.740
               .50   6.930 |   1.50  47.060 |   2.50   8.890 |   3.50   5.380
               .67   8.420 |   1.67  25.720 |   2.67   7.960 |   3.67   5.080
               .83  10.910 |   1.83  18.110 |   2.83   7.240 |   3.83   4.800
              1.00  16.130 |   2.00  14.170 |   3.00   6.650 |   4.00   4.570

------------------------------------------------------------------------------------
025:0003----------------------------------------------------------------------------
*
*#************************************************************************|
*#
*#                POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#                ==============================================
*#
*#************************************************************************|
*# CATCHMENT 201 - Building Rooftop
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .11
| 01:201    DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .11          .00
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       1.00         1.00
     Length            (m)=       7.50         7.50
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     148.15        69.15
                over (min)        1.00         4.00
     Storage Coeff.  (min)=        .50 (ii)    4.19 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.47          .27
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .05          .00          .046 (iii)
     TIME TO PEAK    (hrs)=       1.28         1.35         1.333
     RUNOFF VOLUME    (mm)=      69.24        29.96        68.844
     TOTAL RAINFALL   (mm)=      71.24        71.24        71.237
     RUNOFF COEFFICIENT   =        .97          .42          .966

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------------
025:0004----------------------------------------------------------------------------
*Control Flows via Flow Control Roof Drains
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(201    )  |
| OUT<02:(CTL    )  |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)     (ha.m.)  |    (cms)     (ha.m.)
                            .000  .0000E+00   |      .007  .2560E-02
                            .004  .4300E-03   |      .011  .7090E-02

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     -------------------        (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (201   )        .11      .046     1.333     68.844
     OUTFLOW<02: (CTL   )        .11      .008     1.533     68.844
    OVERFLOW<03: (R-OVF )        .00      .000      .000       .000

                  TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                  CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                  PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=   17.960
                  TIME SHIFT OF PEAK FLOW         (min)=    12.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.3604E-02

------------------------------------------------------------------------------------
025:0005----------------------------------------------------------------------------
*# CATCHMENT 202 - Parking Lot
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .53
| 04:202    DT= 1.00 |   Total Imp(%)=   87.00   Dir. Conn.(%)=   87.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .46          .07
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00         5.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     148.15        70.96
                over (min)        1.00         3.00
     Storage Coeff.  (min)=        .49 (ii)    2.81 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.48          .39
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .19          .01          .201 (iii)
     TIME TO PEAK    (hrs)=       1.30         1.33         1.333
     RUNOFF VOLUME    (mm)=      69.24        29.96        64.130
     TOTAL RAINFALL   (mm)=      71.24        71.24        71.237
     RUNOFF COEFFICIENT   =        .97          .42          .900

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------------
025:0006----------------------------------------------------------------------------
*# ADD 201 and 202 (Roof + Parking Lot)
-------------------------
| ADD HYD (TOTAL-R+P ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
```

```
                       ID1 02:CTL              .11      .008    1.53  68.84    .000
                      +ID2 03:R-OVF            .00      .000     .00    .00    .000  **DRY**
                      +ID3 04:202              .53      .201    1.33  64.13    .000
                       ==========================================================
                       SUM 05:TOTAL-R+P        .64      .209    1.33  64.96    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0007------------------------------------------------------------------------
*Control Flows via 140mm Orifice
*#Route Through Orifice
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>05:(TOTAL-)   |
| OUT<06:(Orific)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)     (ha.m.)   |   (cms)     (ha.m.)
                            .000  .0000E+00   |     .064  .4600E-02
                            .061  .0000E+00   |     .064  .1100E-01
                            .062  .2000E-03   |     .065  .2120E-01
                            .063  .1400E-02   |     .066  .3570E-01

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >05: (TOTAL-)        .64      .209     1.333     64.959
     OUTFLOW<06: (Orific)        .64      .064     1.500     65.021
    OVERFLOW<07: (OVF   )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   30.597
                   TIME SHIFT OF PEAK FLOW         (min)=    10.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.9085E-02

--------------------------------------------------------------------------------
025:0008------------------------------------------------------------------------
*# CATCHMENT 203 - Uncontrolled Perimeter Flow
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .09
| 08:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   40.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .04          .06
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       6.00        10.00
     Length            (m)=       5.00         3.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     148.15        74.35
                over (min)        1.00         1.00
     Storage Coeff.  (min)=        .23 (ii)    1.27 (ii)
     Unit Hyd. Tpeak (min)=       1.00         1.00
     Unit Hyd. peak  (cms)=       1.68          .93
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .02          .01          .027 (iii)
     TIME TO PEAK    (hrs)=       1.23         1.33         1.333
     RUNOFF VOLUME    (mm)=      69.24        29.96        45.669
     TOTAL RAINFALL   (mm)=      71.24        71.24        71.237
     RUNOFF COEFFICIENT   =        .97          .42          .641

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
```

```

--------------------------------------------------------------------------------
025:0009------------------------------------------------------------------------
*# TOTAL PROPOSED FLOW FROM SITE (CONTROLLED + UNCONTROLLED)
------------------------
| ADD HYD (TOTAL-POST) | ID: NHYD         AREA     QPEAK    TPEAK    R.V.     DWF
------------------------                  (ha)     (cms)    (hrs)    (mm)    (cms)
                       ID1 06:Orifice      .64      .064     1.50  65.02     .000
                      +ID2 07:OVF          .00      .000      .00    .00     .000  **DRY**
                      +ID3 08:203          .09      .027     1.33  45.67     .000
                       ==========================================================
                       SUM 09:TOTAL-POST   .74      .091     1.33  62.53     .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0010------------------------------------------------------------------------
*****************************************************************************
*RUN REMAINING DESIGN STORMS (Chicago 5 TO 100-YR)
*
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
*
  ** END OF RUN :  49

****************************************************************************






--------------------
| START            |  Project  dir.:
Q:\45303\100\SWMHYMO\
--------------------  Rainfall dir.:
Q:\45303\100\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 050
    NSTORM=   1
           #  1=CHI50YR.stm
--------------------------------------------------------------------------------
050:0002------------------------------------------------------------------------
*#*************************************************************************|
*#  Project Name: Holiday Inn Express - Barrie
*#  JOB NUMBER  : 45303-100
*#  Date        : November 2019 - Updated July 2020
*#  Modeller    :
AXT
*#  Company     : MTE CONSULTANTS
INC.
*#  File        : 45303.dat
*#  Description : Post Development Modeling
*#*************************************************************************|
*#
*# !!! NOTE - THIS MODEL CONTAINS POST DEVELOPMENT MODELING ONLY
*#
*#*************************************************************************|
*#
--------------------------------------------------------------------------------
050:0002------------------------------------------------------------------------
*
--------------------
```

```
| READ STORM       |    Filename: * City of Barrie - 50 yr Chicago (4hr) +
| Ptotal=  79.45 mm|    Comments: * City of Barrie - 50 yr Chicago (4hr) +
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   5.930 |   1.17  40.220 |   2.17  13.200 |   3.17   6.980
               .33   6.740 |   1.33 164.220 |   2.33  11.370 |   3.33   6.510
               .50   7.850 |   1.50  51.920 |   2.50  10.030 |   3.50   6.110
               .67   9.500 |   1.67  28.580 |   2.67   9.000 |   3.67   5.770
               .83  12.270 |   1.83  20.230 |   2.83   8.190 |   3.83   5.460
              1.00  18.040 |   2.00  15.880 |   3.00   7.530 |   4.00   5.190

-------------------------------------------------------------------------------------
050:0003-----------------------------------------------------------------------------
*
*#***************************************************************************|
*#
*#                POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#                ===============================================
*#
*#***************************************************************************|
*# CATCHMENT 201 - Building Rooftop
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .11
| 01:201    DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .11          .00
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       1.00         1.00
     Length            (m)=       7.50         7.50
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     164.22        82.54
                over (min)        1.00         4.00
     Storage Coeff.  (min)=        .48 (ii)    3.92 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.49          .29
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .05          .00          .051 (iii)
     TIME TO PEAK    (hrs)=       1.28         1.35          1.333
     RUNOFF VOLUME    (mm)=      77.45        35.84         77.037
     TOTAL RAINFALL   (mm)=      79.45        79.45         79.453
     RUNOFF COEFFICIENT   =        .97          .45           .970

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------------
050:0004-----------------------------------------------------------------------------
*Control Flows via Flow Control Roof Drains
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(201   )   |
| OUT<02:(CTL   )   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)    |   (cms)     (ha.m.)
                           .000  .0000E+00    |     .007  .2560E-02
                           .004  .4300E-03    |     .011  .7090E-02

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (201   )        .11      .051     1.333     77.037
     OUTFLOW<02: (CTL   )        .11      .009     1.667     77.037
    OVERFLOW<03: (R-OVF )        .00      .000      .000       .000

                     TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                     CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                     PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                     PEAK   FLOW   REDUCTION [Qout/Qin](%)=   16.972
                     TIME SHIFT OF PEAK FLOW          (min)=    20.00
                     MAXIMUM  STORAGE   USED       (ha.m.)=.4089E-02

-------------------------------------------------------------------------------------
050:0005-----------------------------------------------------------------------------
*# CATCHMENT 202 - Parking Lot
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .53
| 04:202    DT= 1.00 |   Total Imp(%)=   87.00   Dir. Conn.(%)=   87.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .46          .07
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00         5.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     164.22        84.55
                over (min)        1.00         3.00
     Storage Coeff.  (min)=        .47 (ii)    2.63 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.50          .41
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .21          .01          .224 (iii)
     TIME TO PEAK    (hrs)=       1.30         1.33          1.333
     RUNOFF VOLUME    (mm)=      77.45        35.84         72.044
     TOTAL RAINFALL   (mm)=      79.45        79.45         79.453
     RUNOFF COEFFICIENT   =        .97          .45           .907

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------------
050:0006-----------------------------------------------------------------------------
*# ADD 201 and 202 (Roof + Parking Lot)
------------------------
| ADD HYD (TOTAL-R+P ) | ID: NHYD         AREA     QPEAK    TPEAK    R.V.     DWF
------------------------                  (ha)     (cms)    (hrs)    (mm)    (cms)
                     ID1 02:CTL            .11      .009     1.67   77.04     .000
                    +ID2 03:R-OVF          .00      .000      .00     .00     .000  **DRY**
                    +ID3 04:202            .53      .224     1.33   72.04     .000
                     ==========================================================
                     SUM 05:TOTAL-R+P      .64      .233     1.33   72.92     .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------------
050:0007-----------------------------------------------------------------------------
*Control Flows via 140mm Orifice
*#Route Through Orifice
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>05:(TOTAL-)   |
| OUT<06:(Orific)   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)    |   (cms)     (ha.m.)
                           .000  .0000E+00    |     .064  .4600E-02
                           .061  .0000E+00    |     .064  .1100E-01
                           .062  .2000E-03    |     .065  .2120E-01
                           .063  .1400E-02    |     .066  .3570E-01
```

```
      ROUTING RESULTS             AREA     QPEAK     TPEAK       R.V.
      --------------------        (ha)     (cms)     (hrs)       (mm)
      INFLOW >05: (TOTAL-)         .64      .233     1.333     72.921
      OUTFLOW<06: (Orific)         .64      .064     1.517     72.969
     OVERFLOW<07: (OVF   )         .00      .000      .000       .000

                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   27.603
                    TIME SHIFT OF PEAK FLOW          (min)=    11.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.1090E-01

 -------------------------------------------------------------------------------------
 050:0008-----------------------------------------------------------------------------
 *# CATCHMENT 203 - Uncontrolled Perimeter Flow
 ----------------------
 | CALIB STANDHYD     |   Area    (ha)=     .09
 | 08:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   40.00
 ----------------------
                              IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=        .04          .06
      Dep. Storage     (mm)=       2.00         5.00
      Average Slope     (%)=       6.00        10.00
      Length            (m)=       5.00         3.00
      Mannings n           =       .015         .250

      Max.eff.Inten.(mm/hr)=     164.22        88.29
                 over (min)        1.00         1.00
      Storage Coeff.  (min)=        .22 (ii)    1.19 (ii)
      Unit Hyd. Tpeak (min)=       1.00         1.00
      Unit Hyd. peak  (cms)=       1.68          .97
                                                               *TOTALS*
      PEAK FLOW       (cms)=        .02          .01             .031 (iii)
      TIME TO PEAK    (hrs)=       1.23         1.33            1.333
      RUNOFF VOLUME    (mm)=      77.45        35.84           52.486
      TOTAL RAINFALL   (mm)=      79.45        79.45           79.453
      RUNOFF COEFFICIENT   =        .97          .45             .661

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  76.0    Ia = Dep. Storage  (Above)
       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 -------------------------------------------------------------------------------------
 050:0009-----------------------------------------------------------------------------
 *# TOTAL PROPOSED FLOW FROM SITE (CONTROLLED + UNCONTROLLED)
 ------------------------
 | ADD HYD (TOTAL-POST) | ID: NHYD         AREA     QPEAK   TPEAK    R.V.     DWF
 ------------------------                  (ha)     (cms)   (hrs)    (mm)    (cms)
                     ID1 06:Orifice         .64      .064    1.52   72.97    .000
                    +ID2 07:OVF             .00      .000     .00     .00    .000  **DRY**
                    +ID3 08:203             .09      .031    1.33   52.49    .000
                     ==========================================================
                     SUM 09:TOTAL-POST      .74      .095    1.33   70.33    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 -------------------------------------------------------------------------------------
 050:0010-----------------------------------------------------------------------------
 ********************************************************************************
 *RUN REMAINING DESIGN STORMS (Chicago 5 TO 100-YR)
 *
 -------------------------------------------------------------------------------------
 050:0002-----------------------------------------------------------------------------
 *
 -------------------------------------------------------------------------------------
 050:0002-----------------------------------------------------------------------------
 *
 -------------------------------------------------------------------------------------
 050:0002-----------------------------------------------------------------------------
 *
 -------------------------------------------------------------------------------------
 050:0002-----------------------------------------------------------------------------
 *
   ** END OF RUN :  99

 ********************************************************************************






 --------------------
 | START              |  Project  dir.:
 Q:\45303\100\SWMHYMO\
 --------------------  Rainfall dir.:
 Q:\45303\100\SWMHYMO\
     TZERO =   .00 hrs on        0
     METOUT=   2 (output = METRIC)
     NRUN  = 100
     NSTORM=   1
            #  1=CHI100YR.stm
 -------------------------------------------------------------------------------------
 100:0002-----------------------------------------------------------------------------
 *#*****************************************************************************|
 *#  Project Name: Holiday Inn Express - Barrie
 *#  JOB NUMBER  : 45303-100
 *#  Date        : November 2019 - Updated July 2020
 *#  Modeller    :
 AXT
 *#  Company     : MTE CONSULTANTS
 INC.
 *#  File        : 45303.dat
 *#  Description : Post Development Modeling
 *#*****************************************************************************|
 *#
 *# !!! NOTE - THIS MODEL CONTAINS POST DEVELOPMENT MODELING ONLY
 *#
 *#*****************************************************************************|
 *#
 -------------------------------------------------------------------------------------
 100:0002-----------------------------------------------------------------------------
 *
 --------------------
 | READ STORM         |    Filename: * City of Barrie - 100 yr Chicago (4hr)
 | Ptotal=  87.58 mm|    Comments: * City of Barrie - 100 yr Chicago (4hr)
 --------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   6.410 |   1.17  45.220 |   2.17  14.500 |   3.17   7.560
               .33   7.290 |   1.33 180.150 |   2.33  12.440 |   3.33   7.040
               .50   8.520 |   1.50  58.540 |   2.50  10.940 |   3.50   6.600
               .67  10.360 |   1.67  31.960 |   2.67   9.800 |   3.67   6.220
               .83  13.450 |   1.83  22.450 |   2.83   8.900 |   3.83   5.890
              1.00  19.960 |   2.00  17.520 |   3.00   8.160 |   4.00   5.590

 -------------------------------------------------------------------------------------
 100:0003-----------------------------------------------------------------------------
 *
 *#*****************************************************************************|
 *#
 *#                POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
 *#                ===============================================
```

```
*#
*#****************************************************************************|
*# CATCHMENT 201 - Building Rooftop
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .11
| 01:201    DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .11          .00
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       1.00         1.00
     Length            (m)=       7.50         7.50
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     180.15        96.36
                over (min)        1.00         4.00
     Storage Coeff.  (min)=        .46 (ii)    3.70 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.50          .30
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .06          .00          .056 (iii)
     TIME TO PEAK    (hrs)=       1.28         1.35         1.333
     RUNOFF VOLUME    (mm)=      85.58        41.89        85.141
     TOTAL RAINFALL   (mm)=      87.58        87.58        87.578
     RUNOFF COEFFICIENT   =        .98          .48          .972

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0004------------------------------------------------------------------------
*Control Flows via Flow Control Roof Drains
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(201    )  |
| OUT<02:(CTL    )  |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .000  .0000E+00    |     .007  .2560E-02
                           .004  .4300E-03    |     .011  .7090E-02

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (201   )        .11      .056     1.333     85.141
     OUTFLOW<02: (CTL   )        .11      .009     1.667     85.141
    OVERFLOW<03: (R-OVF )        .00      .000      .000       .000

                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   16.271
                    TIME SHIFT OF PEAK FLOW         (min)=    20.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.4642E-02

--------------------------------------------------------------------------------
100:0005------------------------------------------------------------------------
*# CATCHMENT 202 - Parking Lot
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .53
| 04:202    DT= 1.00 |   Total Imp(%)=   87.00   Dir. Conn.(%)=   87.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .46          .07
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00         5.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     180.15       100.63
                over (min)        1.00         2.00
     Storage Coeff.  (min)=        .45 (ii)    2.47 (ii)
     Unit Hyd. Tpeak (min)=       1.00         2.00
     Unit Hyd. peak  (cms)=       1.52          .48
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .23          .02          .248 (iii)
     TIME TO PEAK    (hrs)=       1.28         1.33         1.333
     RUNOFF VOLUME    (mm)=      85.58        41.89        79.899
     TOTAL RAINFALL   (mm)=      87.58        87.58        87.578
     RUNOFF COEFFICIENT   =        .98          .48          .912

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0006------------------------------------------------------------------------
*# ADD 201 and 202 (Roof + Parking Lot)
-------------------------
| ADD HYD (TOTAL-R+P ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
-------------------------                 (ha)     (cms)   (hrs)   (mm)   (cms)
                      ID1 02:CTL            .11     .009    1.67  85.14    .000
                     +ID2 03:R-OVF          .00     .000     .00    .00    .000  **DRY**
                     +ID3 04:202            .53     .248    1.33  79.90    .000
                      ===========================================================
                      SUM 05:TOTAL-R+P      .64     .256    1.33  80.82    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0007------------------------------------------------------------------------
*Control Flows via 140mm Orifice
*#Route Through Orifice
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>05:(TOTAL-)   |
| OUT<06:(Orific)   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .000  .0000E+00    |     .064  .4600E-02
                           .061  .0000E+00    |     .064  .1100E-01
                           .062  .2000E-03    |     .065  .2120E-01
                           .063  .1400E-02    |     .066  .3570E-01

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >05: (TOTAL-)        .64      .256     1.333     80.820
     OUTFLOW<06: (Orific)        .64      .064     1.517     80.967
    OVERFLOW<07: (OVF   )        .00      .000      .000       .000

                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   25.084
                    TIME SHIFT OF PEAK FLOW         (min)=    11.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.1300E-01

--------------------------------------------------------------------------------
100:0008------------------------------------------------------------------------
*# CATCHMENT 203 - Uncontrolled Perimeter Flow
```

```
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .09
| 08:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   40.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=        .04          .06
     Dep. Storage      (mm)=       2.00         5.00
     Average Slope      (%)=       6.00        10.00
     Length             (m)=       5.00         3.00
     Mannings n           =        .015         .250

     Max.eff.Inten.(mm/hr)=     180.15       102.61
                over (min)        1.00         1.00
     Storage Coeff.  (min)=        .21 (ii)     1.12 (ii)
     Unit Hyd. Tpeak (min)=       1.00         1.00
     Unit Hyd. peak  (cms)=       1.68         1.00
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .02          .02            .035 (iii)
     TIME TO PEAK    (hrs)=       1.22         1.33           1.333
     RUNOFF VOLUME    (mm)=      85.58        41.89          59.365
     TOTAL RAINFALL   (mm)=      87.58        87.58          87.578
     RUNOFF COEFFICIENT   =        .98          .48            .678

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  76.0     Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------------
100:0009----------------------------------------------------------------------------
*# TOTAL PROPOSED FLOW FROM SITE (CONTROLLED + UNCONTROLLED)
------------------------
| ADD HYD (TOTAL-POST) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 06:Orifice         .64     .064    1.52  80.97    .000
                    +ID2 07:OVF             .00     .000     .00    .00    .000  **DRY**
                    +ID3 08:203             .09     .035    1.33  59.36    .000
                     =========================================================
                     SUM 09:TOTAL-POST      .74     .099    1.33  78.19    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------------
100:0010----------------------------------------------------------------------------
********************************************************************************
*RUN REMAINING DESIGN STORMS (Chicago 5 TO 100-YR)
*
-------------------------------------------------------------------------------------
100:0002----------------------------------------------------------------------------
*
-------------------------------------------------------------------------------------
100:0002----------------------------------------------------------------------------
*
-------------------------------------------------------------------------------------
100:0002----------------------------------------------------------------------------
*
-------------------------------------------------------------------------------------
100:0002----------------------------------------------------------------------------
*
-------------------------------------------------------------------------------------
100:0002----------------------------------------------------------------------------
*
      FINISH
-------------------------------------------------------------------------------------
*************************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2020-07-15     at 10:47:09
=====================================================================================
```

Appendix C

Geotechnical Investigation

MTE

TORONTO INSPECTION LTD.
GEO-ENVIRONMENTAL CONSULTANTS

REPORT ON
GEOTECHNICAL INVESTIGATION
316, 326 AND 336 BRYNE DRIVE
BARRIE, ONTARIO

REPORT NO.: 4649-18-GB
REPORT DATE: MARCH 8, 2019

PREPARED FOR
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Toronto Inspection Ltd.

Table of Contents

1.0 INTRODUCTION

Toronto Inspection Ltd. was retained by Mr. Jay Panchal on behalf of Meridian Credit Union to conduct a geotechnical investigation for the property, located at 316, 326 and 336 Bryne Drive in Aurora, Ontario (hereafter described as "the Site").

It is our understanding that the development at the Site will consist of two six storey hotel buildings. The purpose of the investigation was to determine the subsoil and groundwater conditions at the Site and provide our recommendations for the design and construction of the buildings. In particular, geotechnical data was to be provided for:

- General founding conditions
- Foundation design bearing pressures
- Construction recommendations
- Excavation recommendations

This report is provided on the basis of the above terms of reference and on an assumption that the design of the structure will be in accordance with the applicable guidelines, building codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, our office should be consulted to review the design and to confirm the recommendations and comments provided in the report.

2.0 SITE CONDITION

The Site, approximately 1.6 ha in area and irregular in shape, is located at the northwest side of Bryne Drive in Barrie, Ontario.

At the time of investigation, the Site was a vacant parcel with some trees, vegetation and snow at the ground surface. The site gradient was fairly flat, close to the street level, with slightly sloping down to the north.

3.0 INVESTIGATION PROCEDURE

The field work for the investigation was carried out on January 21 to 23 and 29, 2019. A total of fifteen sampled boreholes (BH-1 to BH-15), extending to depths of 6.4m to 9.8m from grade, were conducted in the property, at the locations as shown in the appended Borehole Location Plan, Drawing No. 1.

The boreholes were advanced using a track mounted drill rig, equipped with continuous flight solid stem augers, sampling rods and a drop hammer, supplied by a specialist drilling contractor. Soil samples were taken at 0.76m intervals to depths of 3.0m below the existing ground level. Below the depth, the sampling frequency was increased to 1.5m. The samples were obtained using a split spoon sampler in conjunction with Standard Penetration Tests using a driving energy of 475 joules (350 ft-lbs). The soil samples were identified and logged in the field and were carefully bagged for later visual identification and the determination of moisture content.

Groundwater observations were made in the boreholes during and upon the completion of drilling. Boreholes BH-1, BH-13 and BH-15 were completed as observation wells to determine the static groundwater condition.

The locations of boreholes, established in the field by our field personnel, are shown on the appended Borehole Location Plan (Drawing No. 1). The ground elevations at the borehole locations were determined using the "TOP OF FIRE HYDRANT", located at the southeast boundary of the Site, approximately 40m northeast of Barrie View Drive, on the west side of Bryne Drive, as a temporary bench mark (TBM).

The assumed elevation of 304.50m for the TBM does not represent the geodetic elevation.

4.0 SUMMARIZED SITE AND SUBSURFACE CONDITIONS

Reference is made to the appended Borehole Location Plan (Drawing No. 1), Logs of Boreholes (Drawing Nos. 2 to 16), for details of field work, including soil classification, inferred stratigraphy, and groundwater observations carried out during and on completion of borehole drilling.

The boreholes revealed that the subsoil, below the topsoil at the ground surface and fill, consisted of native silty sand, sandy silt and sand deposits. Brief descriptions of the sub soils, encountered at the borehole locations, were as follows:

4.1 Topsoil

Topsoil, approximately 125mm to 400mm in thickness, was contacted at the ground surface at all borehole locations.

4.2 Fill

A layer of fill was contacted below the surficial topsoil at all borehole locations, at depths of 0.125m to 0.4m from grade.

The fill consisted of silty sand to sand, trace to some gravel and pockets of clayey silt or sandy silt, with minor to some topsoil or rootlets. The fill extended to depths of 0.6m to 1.4m from grade. It is our opinion that this material probably represents the material disturbed during during the farming process. For identification purpose, this layer has been identified as fill in the borehole logs.

4.3 Silty Sand

A silty sand deposit was contacted below the fill, at BH-8 and BH-13 locations, at depths of 1.1m and 0.6m from grade, respectively. The silty sand deposit contained some sandy silt and gravel.

Based on the Standard Penetration N-values of 10 to 59 blows per 0.3m penetration, the relative density of the silty sand deposit was compact to very dense.

The silty sand deposit, at BH-8 and BH-13 locations, extended to depths of 2.7m from grade.

The insitu moisture content of the soil samples retrieved from this deposit ranged from 8% to 10%, indicating moist to very moist conditions.

4.4 Sandy Silt

A sandy silt deposit was contacted below the fill at BH-9 location, at a depth of 1.2m from grade. The sandy silt deposit contained some silty sand, trace gravel, trace to some clayey silt and an isolated sand layer.

Based on the Standard Penetration N-values of 8 to 11 blows per 0.3m penetration, the relative density of the sandy silt deposit was loose to compact.

The sandy silt deposit, at BH-9 location, extended to a depth of 3.0m from grade.

The insitu moisture content of the soil samples retrieved from this deposit ranged from 12% to 22%, indicating very moist conditions with wet pockets.

4.5 Sand

A sand deposit was contacted below the fill, silty sand and sandy silt deposit, at all borehole locations, at depths of 0.6m to 3.0m from grade. The sand deposit, generally fine to medium grained with occasional coarse grained, contained some or layers of silty sand or sandy silt, and trace to gravel.

Based on the Standard Penetration N-values of 4 to more than 100 blows per 0.3m penetration, the relative density of the sand deposit was generally compact to very dense, with loose condition at the upper portion, at BH-2, BH-4, BH-6, BH-10 and BH-15 locations.

Materials of lower relative density, N-values in the range of 4 to 20 blows fro a penetration of 0.3m penetration, were encountered at a number of boreholes, below the groundwater table. It is our opinion that the lower N-values are due to disturbance of the non-cohesive deposit by an excessive groundwater pressure in the sand deposit.

All the boreholes were terminated in the sand deposit, at depths of 6.4m to 9.8m from grade.

The insitu moisture content of the soil samples retrieved from this deposit ranged from 3% to 22%, indicating moist to wet conditions.

Grain size analyses were carried out on two selected soil samples from this deposit, obtained from Boreholes BH-2 (SS2 – at a depth of 0.9m) and BH-7 (SS3 – at a depth of 1.5m) using mechanical sieves. The grain size distributions are shown on the appended Figure No. 1.

4.6 Groundwater

Free water (cave-in) was recorded at the borehole locations, at depths of 2.7m to 5.8m (2.4m to 6.3m) from grade, during and upon completion of drilling and sampling.

On January 23 and 29, 2019, water levels were recorded in the observation wells at BH-1, BH-13 and BH-15 locations, at depths of 3.4m to 4.1m from grade.

Based on the moisture content profile of the soil samples retrieved from the boreholes and our field observations at the Site, during and upon completion of the drilling process, it is our opinion that there is a continuous groundwater within the sand deposit, at depths of 3.4m to 4.1m from grade. However, perched water may exist within the silty sand and sandy silt deposits or in the fill.

5.0 RECOMMENDATIONS

We understand that the development at the Site will consist of two six storey hotel building without basements, with driveway and parking lot. The slab-on-grade of the proposed buildings were not known at the time of preparation of this report. For the purpose of this report, we have assumed the finished floor elevations of the buildings will be at or above to the street level or the existing ground level.

Based on the subsoil and groundwater conditions encountered at the borehole locations, our comments and recommendations for the design and construction of the proposed structure are as follows:

5.1 Site Preparation

The soil description and the depths of topsoil and fill, as shown on the Borehole Logs, are specific depths at the borehole locations only. The thickness of topsoil, and the depth of fill at locations beyond the boreholes may be thicker or deeper. We recommend that the contractor bidding for the job should determine the depths of fill and any deleterious material by test pits and allow for the removal of the materials, including materials with high moisture and organic content, during the site preparation for site grading.

Any new fill, to be placed within the proposed building and pavement areas, should consist of organics free soil and compacted in 200mm lifts to at least 98% of its Standard Proctor maximum dry density.

Compressible topsoil and the fill material, containing relatively high organic content, will not be suitable for reuse in areas where future settlement cannot be tolerated. This material will have to be disposed off-site or reused in landscaped areas, subject to approval by the landscape architect.

5.2 Foundation Design

The proposed building can be supported on conventional spread/strip footings, founded on the native sand to silty sand deposits. However, the desing bearing pressures will vary due the varying relative density of the subsoils, below the fill at the Site.

The recommended design bearing pressures for conventional spread/strip footings, founded on the sand deposit, at different depths below the existing ground surface, are shown on the following charts:

Phase I Building at West Portion of the Site

Borehole ID	Founding Depth	Design Bearing Pressures		Founding Depth (m)	Design Bearing Pressures	
		SLS (kPa)	ULS (kPa)		SLS (kPa)	ULS (kPa)
BH-1	1.5m	150	220	3.5m	400	600
BH-2	1.5m	75	110	3.5m	400	600
BH-3	1.5m	150	220	2.5m	400	600
BH-4	1.5m	75	110	3.0m	400	600
BH-5	1.5m	200	300	2.5m	400	600

Phase II Building at East Portion of the Site

Borehole ID	Founding Depth	Design Bearing Pressures		Founding Depth (m)	Design Bearing Pressures	
		SLS (kPa)	ULS (kPa)		SLS (kPa)	ULS (kPa)
BH-6	1.5m	150	220	3.5m	400	600
BH-7	1.5m	150	220	2.5m	400	600
BH-8	1.5m	150	220	3.5m	400	600
BH-9	1.5m	100	200	3.5m	400	600
BH-10	1.5m	200	300	3.0m	400	600

The total and differential settlement of footings, designed for the above Serviceability Limit State, will not exceed 25mm and 20mm, respectively.

All perimeter footings or any footings, which may be exposed to freezing conditions, should be placed below the frost penetration depth of 1.5m below the outside grade or provided with an equivalent thermal protection.

It should be noted that the above recommendations for foundations have been analysed by ***Toronto Inspection Ltd.*** from the subsoil information obtained at the borehole locations. The bearing material, the interpretation between the boreholes and the recommendations of this report must be checked through field inspection provided by ***Toronto Inspection Ltd***. to validate the information for use during the construction stage.

5.3 Floor Slab Construction

The floor slab can be designed and constructed as a conventional slab-on-grade method, on the sand deposit, below the fill. The subgrade should be thoroughly proof-rolled under the supervision of a geotechnical technician from ***Toronto Inspection Ltd***. Any compressible, loose, or weak spots encountered during the proof rolling process, should be sub-excavated to a firm ground. Any backfill of the sub-excavated areas or new fill, below the slab-on-grade, should consist of organic free soils, compacted to at least 98% of its Standard Proctor maximum dry density (SPMDD).

A bedding consisting of at least 150 mm of granular A (OPSS Form 1010) or its approved equivalent, is recommended as a moisture barrier under a light to medium loaded floor slab. The bedding should be compacted to at least 100% SPMDD.

5.4 Earthquake Consideration

The Ontario Building Code requires that all buildings be designed to resist earthquake forces. In accordance with Table 4.1.8.4.A of the Ontario Building Code, the site classification for the Seismic Site Response is Class D (stiff soil).

The acceleration and velocity based site coefficients, Fa and Fv, should conform to Tables 4.1.8.4.B and 4.1.8.4.C. These values should be reviewed by the Structural Engineer.

5.5 Excavation and Backfilling

All excavations should comply with the Ontario Occupational Health and Safety Act. Any excavation should be sloped back to a safe angle of 45° or flatter. A flatter slope will be required for excavation in saturated soils.

The insitu moisture content of the fill is apparently higher than its optimum moisture content. This material may not be suitable for backfilling in its current state. Selected on-site excavated soils can be reused for backfilling, provided they are free of organics and allowed to air dry to the dry side of its optimum, prior to placement. The use of the compressible fill should be limited to backfilling of locations where future settlement will be of little consequence.

Topsoil and other compressible fill removed from the Site may be reused in landscape areas, subject to the approval of the landscape architect.

Bedding for the underground services, including catch basins and manholes, should consist of OPSS Granular A, 20mm crusher run limestone, or equivalent.

No significant groundwater conditions are anticipated in excavations to depths of 3.5m from grade. However, the perched water may be encountered in the saturated fill or native deposit. Therefore, provision should be made to use filtered sumps to remove any groundwater seepage from the overburden or saturated soils, if encountered.

5.6 Pavement Construction

The existing on-site material consists of sandy silt to silty sand with trace of clayey silt. These materials are normally susceptible to medium frost.

The following minimum pavement design thicknesses are recommended based on the assumption that perforated sub-drains will be installed to prevent build-up of water in the granular bases of the pavement:

		Light Duty Parking	Heavy Duty Fire Routes
Asphaltic Concrete	OPSS HL3 or equivalent	65mm	40mm
	OPSS HL8 or equivalent	-	60mm
Base:	OPSS Granular A or 20mm crusher-run	150mm	150mm
Sub-base:	OPSS Granular B or 50mm crusher-run	200mm	300mm

The granular base and sub-base should be compacted to a minimum of 100% SPMDD. Asphaltic concrete should be compacted to at least 96% Marshall density.

The above pavement thicknesses are based on the favourable site conditions and the construction being carried out during the drier period of the year and that the subgrade is stable, not heaving under construction traffic. If the subgrade is wet and unstable, additional thickness of sub-base material may be required.

Following site grading, the subgrade of the entire pavement should be proof-rolled using a heavy vibratory roller. Any soft spots revealed by the proof-rolling should be sub-excavated and replaced with an approved dry material and compacted to at least 98% of its SPMDD. If the subgrade is wet and unstable, the wet material should be removed from the subgrade and additional thickness of sub-base be used for road construction.

6.0 GENERAL STATEMENT OF LIMITATION

The comments and recommendations presented in this report are based on the subsoil and ground water conditions encountered at the borehole locations, indicated in the borehole location plan, and are intended for the guidance of the design engineer. Although we consider this report to be representative of the subsurface conditions at the subject property, the soil and the ground water conditions between and beyond the borehole locations may differ from those encountered at the time of our investigation and may become apparent during construction. Any contractor bidding on, or undertaking the works, should decide on their own investigation and interpretations of the groundwater and the soil conditions between the borehole locations.

Any use and/or the interpretation of the data presented in this report, and any decisions made on it by the third party are responsibility of the third parties. The responsibility of ***Toronto Inspection Ltd.*** is limited to the accurate interpretation of the soil and ground water conditions prevailing in the locations investigated and accepts no responsibility for the loss of time and damages, if any, suffered by the third party as a result of decisions or actions based on this report.

Any legal actions arising directly or indirectly from this work and/or ***Toronto Inspection Ltd.'s*** performance of the services shall be filed no longer than two years from the date of ***Toronto Inspection Ltd.'s*** substantial completion of the services. ***Toronto Inspection Ltd.*** shall not be responsible to the client for lost revenues, loss of profits, cost of content, claims of customers, or other special indirect, consequential, or punitive damages.

To the fullest extent permitted by law, the client's maximum aggregate recovery against ***Toronto Inspection Ltd.***, its directors, employees, sub-contractors, and representatives, for any and all claims by clients for all causes including, but not limited to, claims of breach of contract, breach of warranty and/or negligence, shall be the amount of the fee paid to ***Toronto Inspection Ltd.*** for its professional services rendered under the agreement with respect to the particular site which is the subject of the claim by the client.

TORONTO INSPECTION LTD.

LICENSED PROFESSIONAL ENGINEER
S. WANG
100131918
March 8, 2019
PROVINCE OF ONTARIO

David S. Wang

David S. Wang, P.Eng.
Senior Engineer

Upkar S. Sappal, P.Eng.
Principal Engineer

Toronto Inspection Ltd.

Drawings & Figure

Borehole Location Plan

Borehole Logs (BH-1 to BH-15)

Sections

Gradation Curves

LEGEND

Borehole / Monitoring Well Location

Temporary Benchmark Location

NOT TO SCALE

TorontoInspection LTD.
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TITLE:	Borehole / Monitoring Well Location Plan
LOCATION:	316, 326 and 336 Bryne Drive, Barrie, Ontario

PROJECT NO.	DATE :	DRAWING NO :
4649-18-GB	January 2019	1

Project No. 4649-18-GB

Log of Borehole BH-1

Dwg No. 2

Sheet No. 1 of 1

Project: Geothecnical Investigation

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

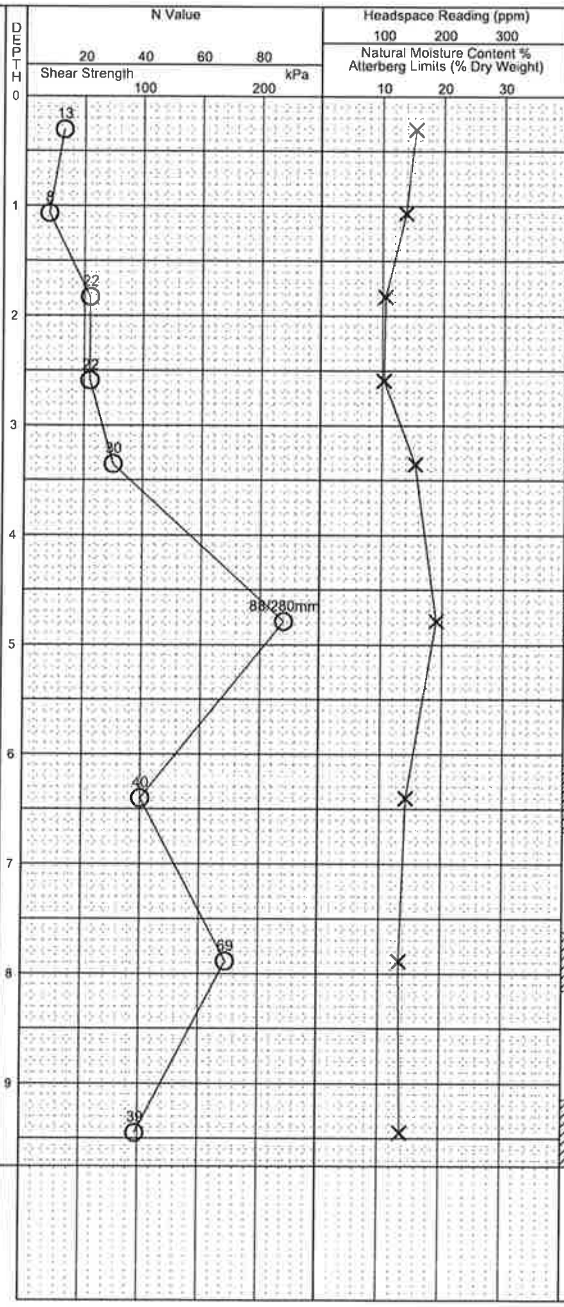
Date Drilled: 1/22/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Legend	Symbol
Auger Sample	⊠
SPT (N) Value	○ ▨
Dynamic Cone Test	—
Shelby Tube	■
Field Vane Test	S
Headspace Reading (ppm)	•
Natural Moisture	×
Plastic and Liquid Limit	├─┤
Unconfined Compression % Strain at Failure	⊗
Penetrometer	▲

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH
		Ground Surface	304.86	0
		TOPSOIL	304.56	
		FILL - brown silty sand to sand, - some topsoil and rootlets, - trace gravel, - pockets of sandy silt or clayey silt, - moist to very moist.	303.49	1
		SAND - compact to very dense, - brown, - fine to medium grained, - occassional coarse grained, - thin layers of clayey silt at 1.5m. - trace gravel, - occassional sandy silt or silty sand, - moist to wet.	301.46	2–9
			295.11	
		END OF BOREHOLE **NOTE:** Upon completion of the drilling: - water level at 5.5m, - caved-in at 5.5m.		



Natural Unit Weight kN/m3

LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)
Jan 23, 2019	3.5m	
Jan 29, 2019	3.4m	

Project No. 4649-18-GB

Log of Borehole BH-2

Dwg No. 3

Sheet No. 1 of 1

Project: Geothecnical Investigation

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

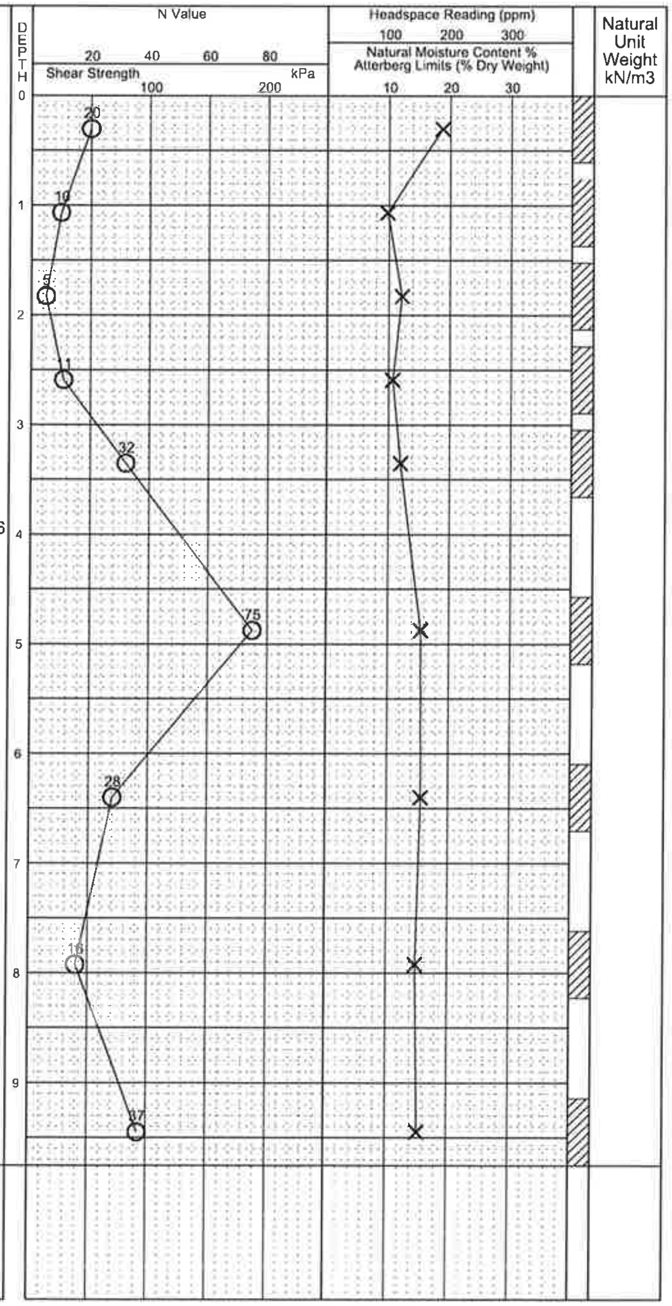
Date Drilled: 1/22/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Legend		Legend	
Auger Sample	⊠	Headspace Reading (ppm)	•
SPT (N) Value	○ ▨	Natural Moisture	×
Dynamic Cone Test	──	Plastic and Liquid Limit	├─┤
Shelby Tube	■	Unconfined Compression % Strain at Failure	⊗
Field Vane Test	S	Penetrometer	▲

GWL	Soil Description	ELEV. m
	Ground Surface	304.96
	TOPSOIL	304.73
	FILL - dark brown to brown silty sand, - some sandy silt, - some topsoil and rootlets, - very moist.	304.20
	SAND - loose to very dense, - brown, - fine to medium grained, - trace gravel, - occassional silty sand or sandy silt, - moist to wet.	
▼		300.96
		295.20
	END OF BOREHOLE **NOTE:** Upon completion of the drilling: - water level at 4.0m, - caved-in at 4.0m.	



LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4649-18-GB

Log of Borehole BH-3

Dwg No. 4

Sheet No. 1 of 1

Project: Geothecnical Investigation

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

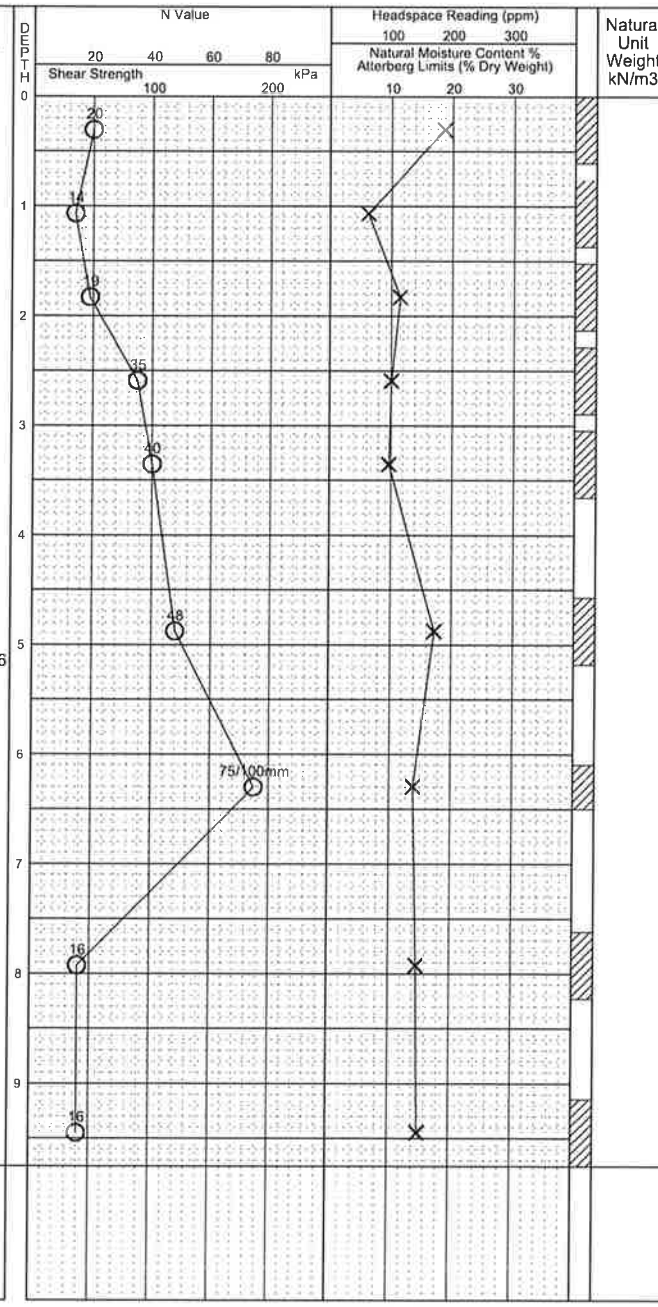
Date Drilled: 1/22/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Symbol	Legend	Symbol	Legend
Auger Sample	⊠	Headspace Reading (ppm)	●
SPT (N) Value	○ ▨	Natural Moisture	✕
Dynamic Cone Test	───	Plastic and Liquid Limit	├──┤
Shelby Tube	■	Unconfined Compression % Strain at Failure	⊗
Field Vane Test	S	Penetrometer	▲

GWL	Soil Description	ELEV. m	DEPTH
	Ground Surface	304.86	0
	TOPSOIL	304.46	
	FILL - brown sand, - minor topsoil, - moist.	304.25	
▼ (5.2 m)	**SAND** - compact to very dense, - brown, - fine to medium grained, - trace gravel, - pockets of silty sand or sandy silt, - moist to wet.	299.66	5
	END OF BOREHOLE	295.11	



END OF BOREHOLE

NOTE:

Upon completion of the drilling:

- water level at 5.2m,
- caved-in at 5.2m.

LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4649-18-GB

Log of Borehole BH-4

Dwg No. 5

Sheet No. 1 of 1

Project: Geothecnical Investigation

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

Date Drilled: 1/23/19

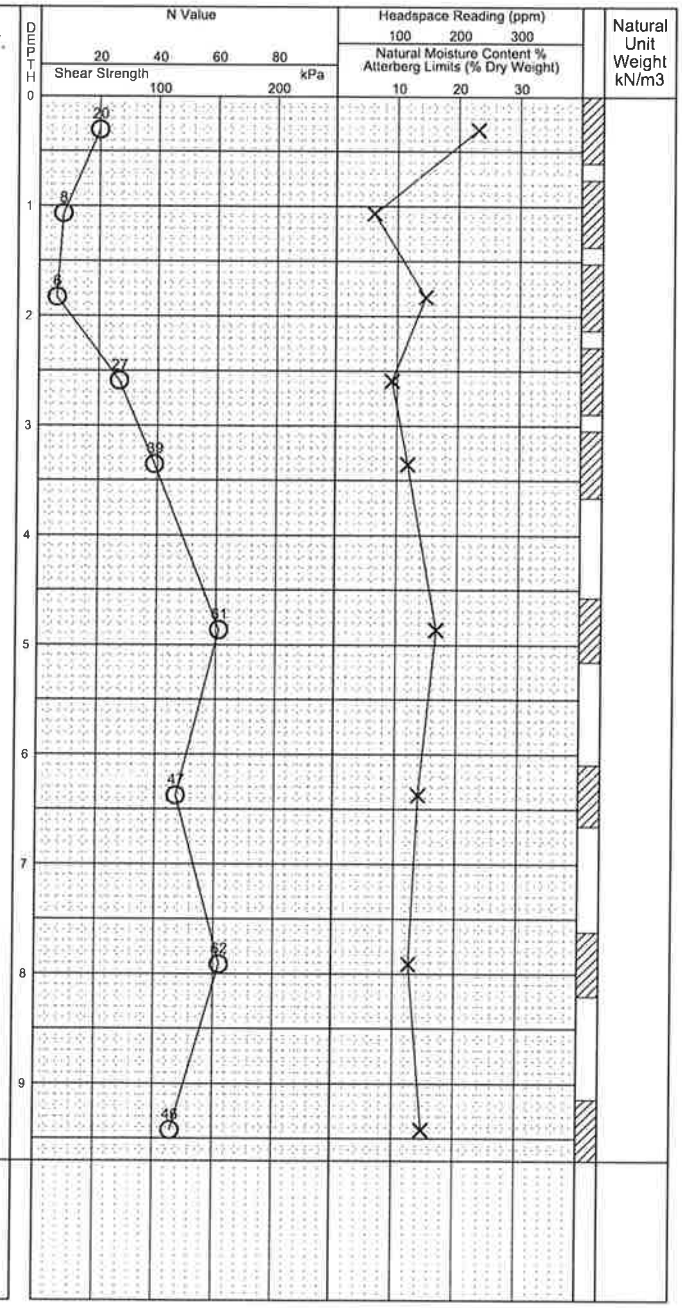
Drill Type: Track Mounted Drill Rig

Datum: Temporary

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Headspace Reading (ppm)
Natural Moisture
Plastic and Liquid Limit
Unconfined Compression
% Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
		Ground Surface	304.90
		TOPSOIL	304.54
		FILL - dark brown to brown silty sand, - minor topsoil, - moist.	304.29
		SAND - loose to very dense, - brown, - fine to medium grained, - a layer of silty sand/ sandy silt at 2.4m to 2.8m, - trace to some gravel, - occassional silty sand or sandy silt, - moist to wet.	295.20
		END OF BOREHOLE **NOTE:** Upon completion of the drilling:	



NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4649-18-GB

Log of Borehole BH-5

Dwg No. 6

Sheet No. 1 of 1

Project: Geothecnical Investigation

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

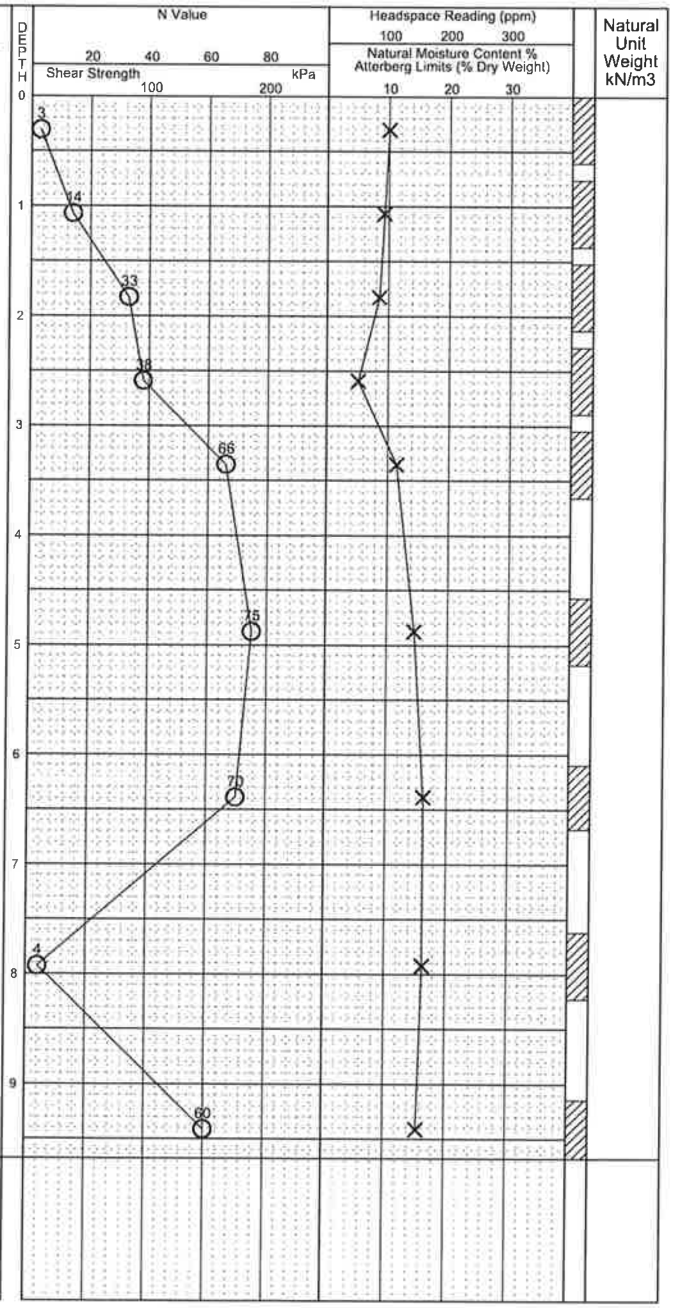
Date Drilled: 1/23/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Legend	Symbol	Legend	Symbol
Auger Sample	⊠	Headspace Reading (ppm)	●
SPT (N) Value	○ ▨	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	├─┤
Shelby Tube	■	Unconfined Compression % Strain at Failure	⊗
Field Vane Test	✚ S	Penetrometer	▲

GWL	SYMBOL	Soil Description	ELEV. m
		Ground Surface	304.91
		TOPSOIL	304.63
		FILL - dark brown to brown silty sand, - minor topsoil, - very moist.	304.30
		SAND - compact to very dense, loose at 7.5m, - brown, - fine to medium grained, - a layer of silty sand at 0.6m to 1.2m, - trace to some gravel, - trace to some silt, - moist to wet.	
			295.23
		END OF BOREHOLE **NOTE:** Upon completion of the drilling: - caved-in at 3.0m.	



Natural Unit Weight kN/m3

LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4649-18-GB

Log of Borehole BH-6

Dwg No. 7

Sheet No. 1 of 1

Project: Geothecnical Investigation

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

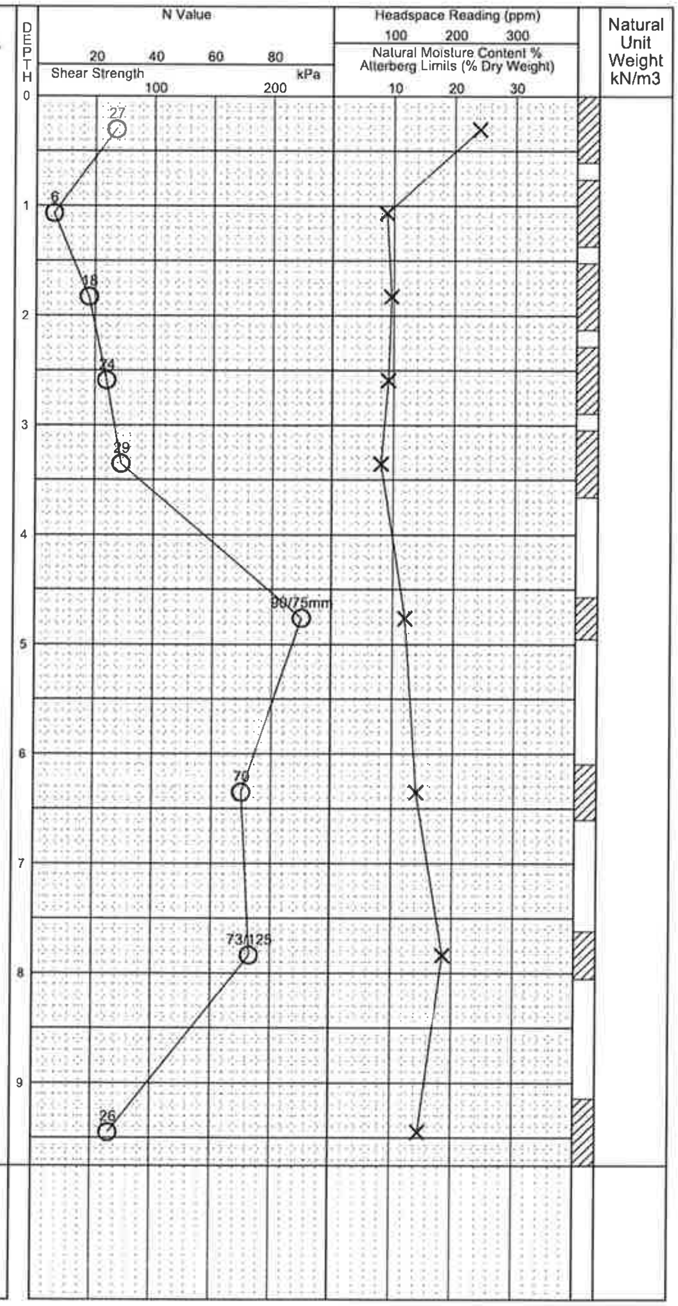
Date Drilled: 1/23/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Legend		Legend	
Auger Sample	⊠	Headspace Reading (ppm)	●
SPT (N) Value	○ ▨	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	├─┤
Shelby Tube	■	Unconfined Compression % Strain at Failure	⊗
Field Vane Test	✚ S	Penetrometer	▲

Soil Description	ELEV. m
Ground Surface	304.92
TOPSOIL	304.59
FILL - dark brown to brown silty sand, - minor topsoil, - very moist.	304.31
SAND - loose to very dense, - brown, - fine to medium grained, - a layer of silty sand at 1.5m to 2.4m, - trace to some silt, - moist to wet.	295.17
END OF BOREHOLE **NOTE:** Upon completion of the drilling: - caved-in at 2.7m.	



LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4649-18-GB

Log of Borehole BH-7

Dwg No. 8

Project: Geothecnical Investigation

Sheet No. 1 of 1

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

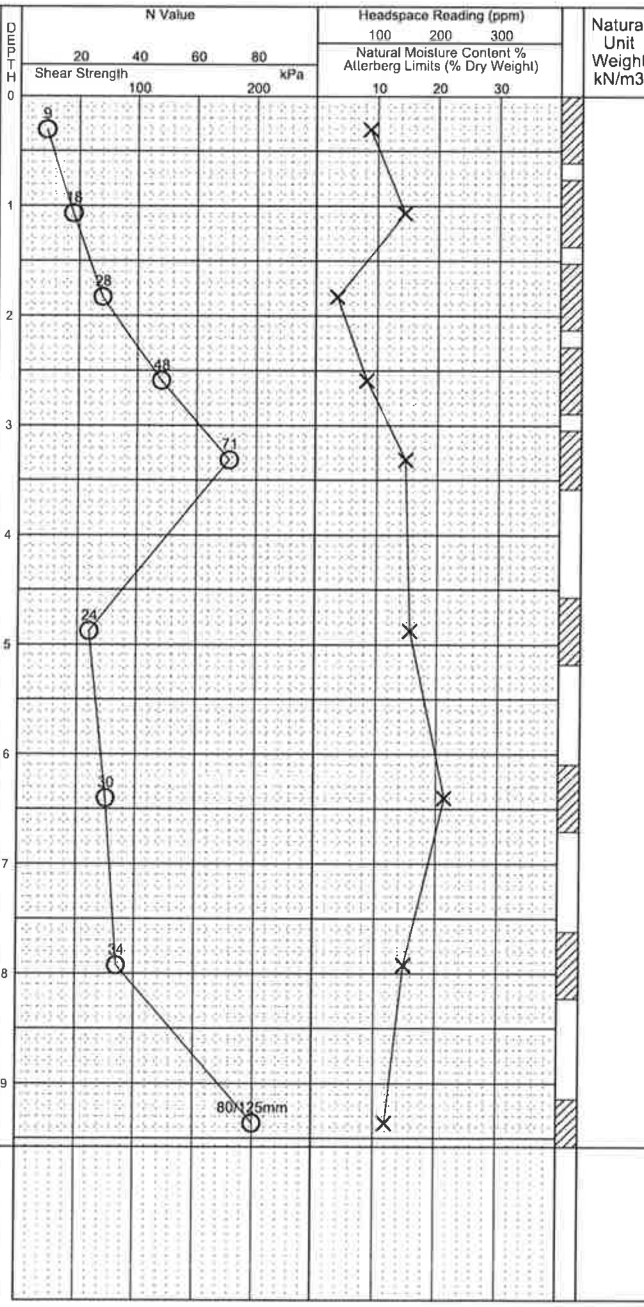
Date Drilled: 1/23/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Legend	Symbol	Legend	Symbol
Auger Sample	⊠	Headspace Reading (ppm)	●
SPT (N) Value	○ ▨	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	⊢—⊣
Shelby Tube	■	Unconfined Compression % Strain at Failure	⊗
Field Vane Test	S	Penetrometer	▲

GWL	Soil Description	ELEV. m	DEPTH
	Ground Surface	304.82	0
	TOPSOIL	304.49	
	FILL - dark brown to brown silty sand, - minor topsoil and rootlets, - very moist.	303.60	1
▼	**SAND** - compact to very dense, - brown, - a thin layer of silty sand at 1.5m, - trace to some silt, - moist to wet.	302.12	2–9
	END OF BOREHOLE **NOTE:** Upon completion of the drilling: - water level at 2.7m, - caved-in at 2.7m.	295.22	



LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4649-18-GB

Log of Borehole BH-8

Dwg No. 9

Project: Geothecnical Investigation

Sheet No. 1 of 1

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

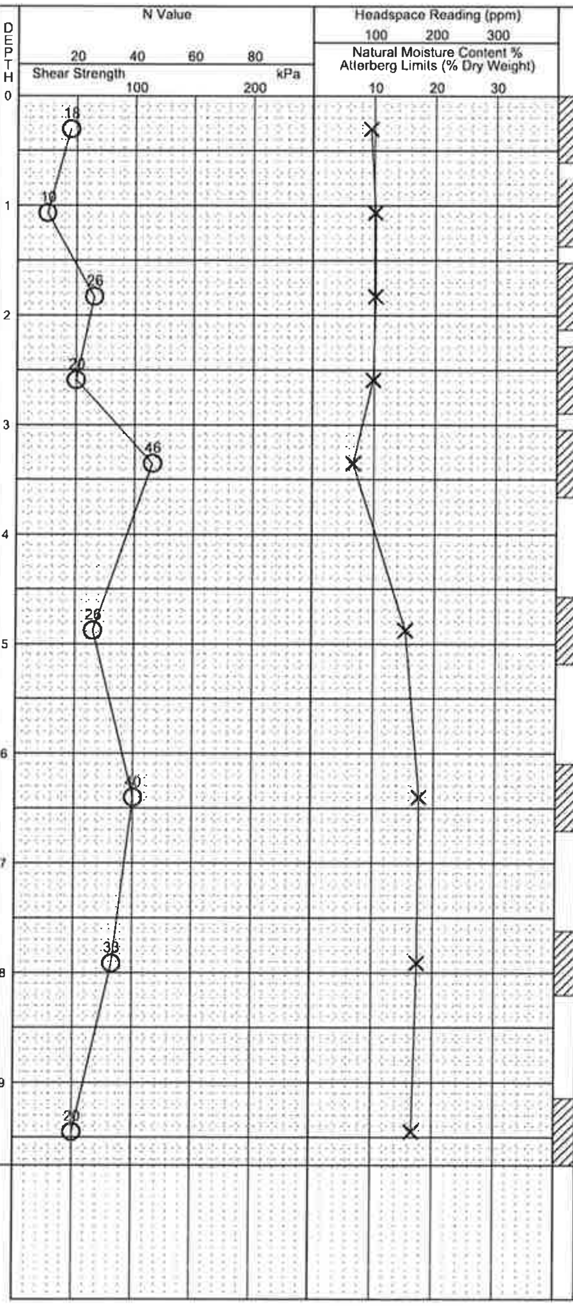
Date Drilled: 1/29/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Legend	Symbol	Legend	Symbol
Auger Sample	⊠	Headspace Reading (ppm)	●
SPT (N) Value	O ▨	Natural Moisture	X
Dynamic Cone Test	―	Plastic and Liquid Limit	├─┤
Shelby Tube	■	Unconfined Compression % Strain at Failure	⊗
Field Vane Test	✚ S	Penetrometer	▲

GWL	Symbol	Soil Description	ELEV. m	Depth (m)
		Ground Surface	304.83	0
		TOPSOIL	304.58	
		FILL - brown sand to silty sand, - minor topsoil or rootlets, - moist to very moist.	303.76	1
		SILTY SAND - compact, - brown, - some sandy silt, - very moist.	302.09	
▼		**SAND** - compact to dense, - brown to grey, - fine to medium grained, - some sandy silt, - trace gravel, - moist to wet.	299.04 / 295.08	
		END OF BOREHOLE **NOTE:** Upon completion of the drilling: - water level at 5.8m, - caved-in at 5.8m.		



Natural Unit Weight kN/m3

LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4649-18-GB

Log of Borehole BH-9

Dwg No. 10

Sheet No. 1 of 1

Project: Geothecnical Investigation

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

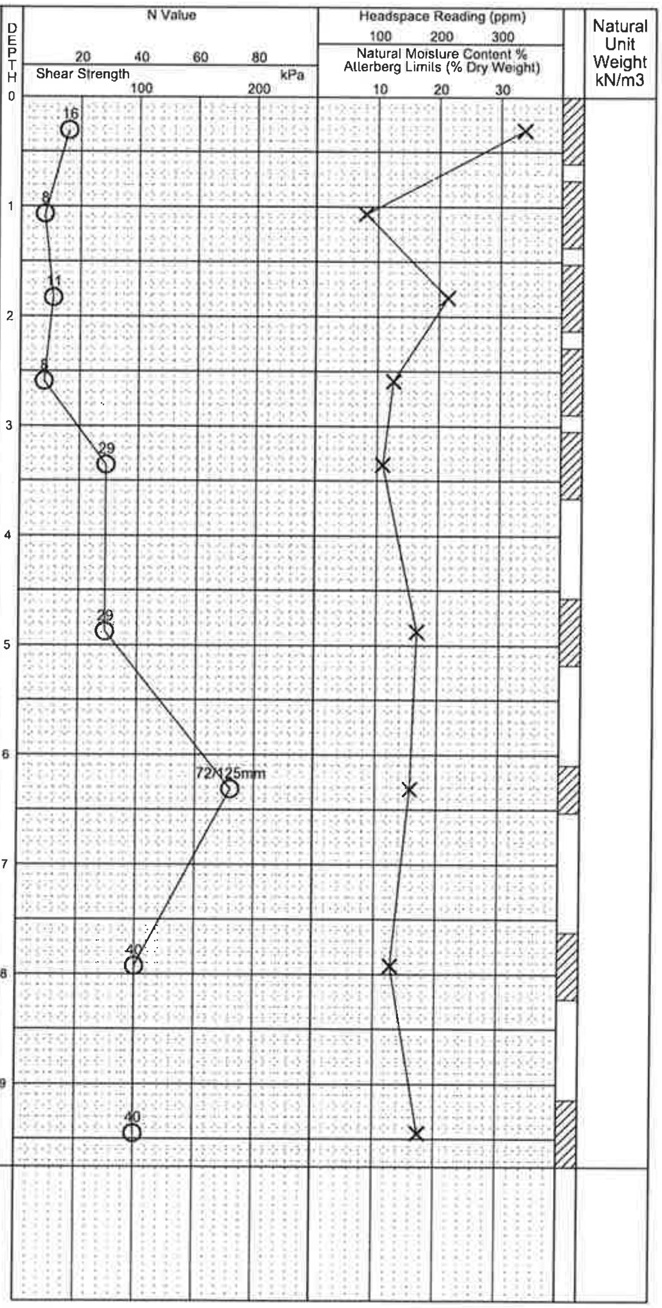
Date Drilled: 1/29/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Legend	Symbol
Auger Sample	⊠
SPT (N) Value	○ ▨
Dynamic Cone Test	——
Shelby Tube	■
Field Vane Test	S
Headspace Reading (ppm)	●
Natural Moisture	×
Plastic and Liquid Limit	├──┤
Unconfined Compression % Strain at Failure	⊗
Penetrometer	▲

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH
		Ground Surface	304.74	0
		TOPSOIL	304.53	
		FILL - dark brown to brown silty sand to sand, - minor topsoil, - moist to very moist.	303.52	1
		SANDY SILT - compact to loose, - brown, - a large of sand at 1.5m, - some silty sand, - trace gravel, - trace to some clayey silt, - very moist.	301.69	2, 3
▼		**SAND** - compact to very dense, - brown to grey, - fine to medium grained, - some silty sand, - trace to some gravel, - very moist to wet.	299.25 294.99	4, 5, 6, 7, 8, 9
		END OF BOREHOLE **NOTE:** Upon completion of the drilling: - water level at 5.5m, - caved-in at 5.5m.		



LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4649-18-GB

Log of Borehole BH-10

Dwg No. 11

Project: Geothecnical Investigation

Sheet No. 1 of 1

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

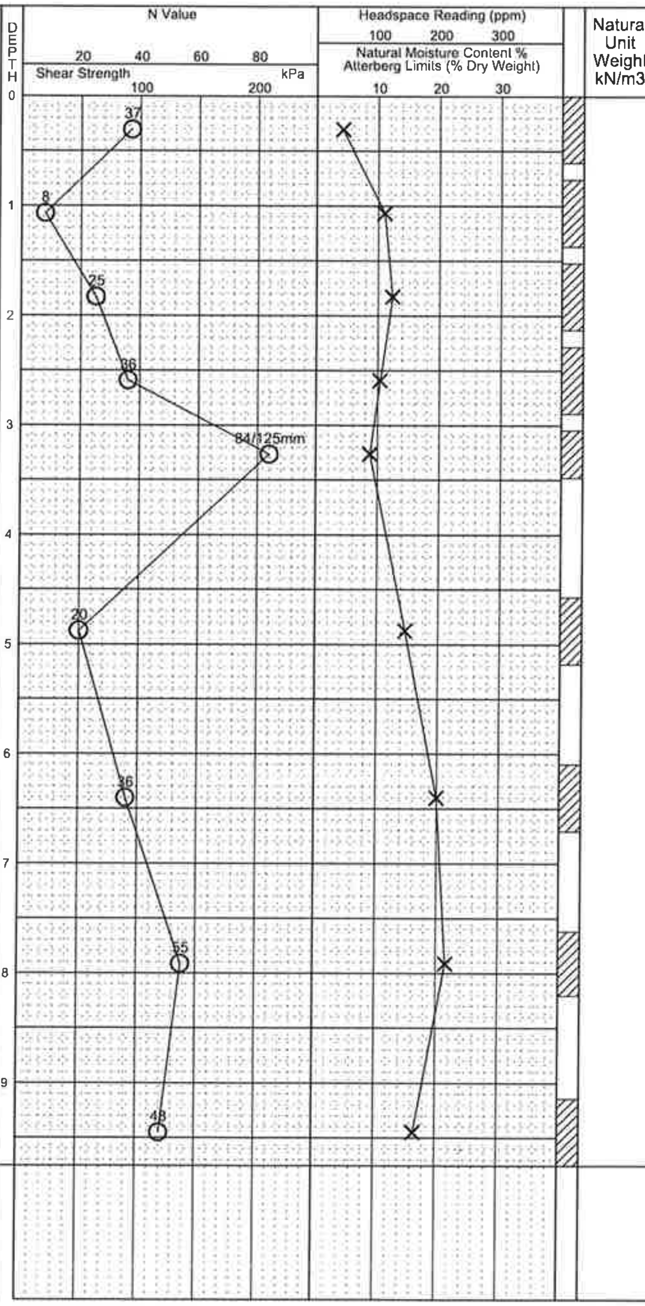
Date Drilled: 1/29/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Legend	Symbol
Auger Sample	⊠
SPT (N) Value	○ ▨
Dynamic Cone Test	—
Shelby Tube	■
Field Vane Test	S
Headspace Reading (ppm)	•
Natural Moisture	×
Plastic and Liquid Limit	├─┤
Unconfined Compression % Strain at Failure	⊗
Penetrometer	▲

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH
		Ground Surface	304.83	0
		TOPSOIL	304.43	
		FILL - brown sand, - some silty sand, - moist.	303.92	1
		SAND - loose to very dense, - brown to grey, - fine to medium grained, - thin layer of sandy silt at 2.3m, - some silty sand, - moist to wet.		2, 3, 4, 5, 6, 7, 8, 9
			295.08	
		END OF BOREHOLE **NOTE:** Upon completion of the drilling: - caved-in at 6.3m.		



LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4649-18-GB

Log of Borehole BH-11

Dwg No. 12

Sheet No. 1 of 1

Project: Geothecnical Investigation

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

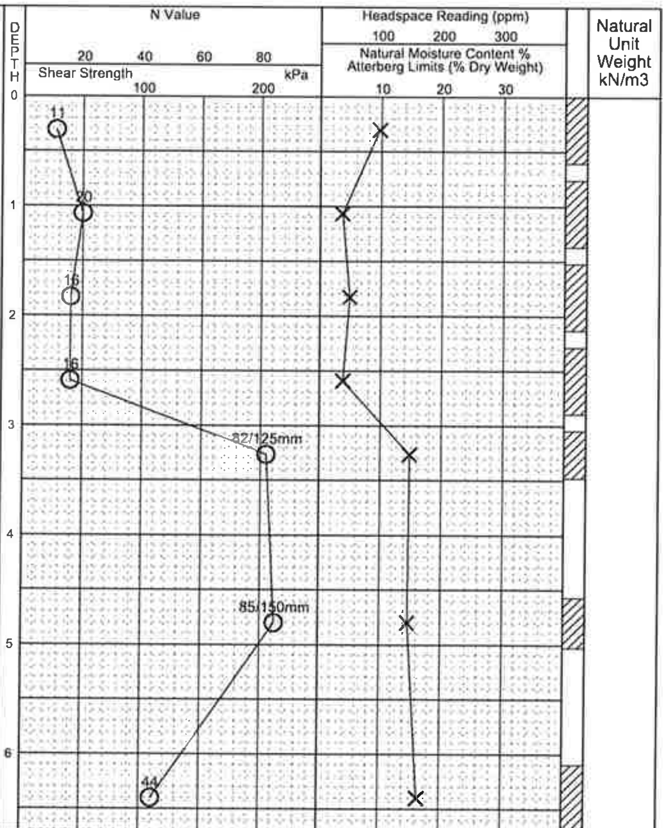
Date Drilled: 1/21/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Legend	Symbol
Auger Sample	⊠
SPT (N) Value	○ ⊘
Dynamic Cone Test	—
Shelby Tube	■
Field Vane Test	S
Headspace Reading (ppm)	•
Natural Moisture	×
Plastic and Liquid Limit	├─┤
Unconfined Compression % Strain at Failure	⊗
Penetrometer	▲

GWL	Soil Description	ELEV. m	DEPTH
	Ground Surface	305.20	0
	TOPSOIL	304.87	
	FILL - dark brown to brown sand, - some silty sand, - minor topsoil, - moist.	304.44	1
	SAND - compact to very dense, - brown, - fine to medium grained, - trace silt, - trace gravel, - moist to wet.		2, 3, 4, 5
▼		299.40	6
		298.49	
	END OF BOREHOLE **NOTE:** Upon completion of the drilling: - water level at 5.8m, - caved-in at 5.8m.		



LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4649-18-GB

Log of Borehole BH-12

Dwg No. 13

Sheet No. 1 of 1

Project: Geothecnical Investigation

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

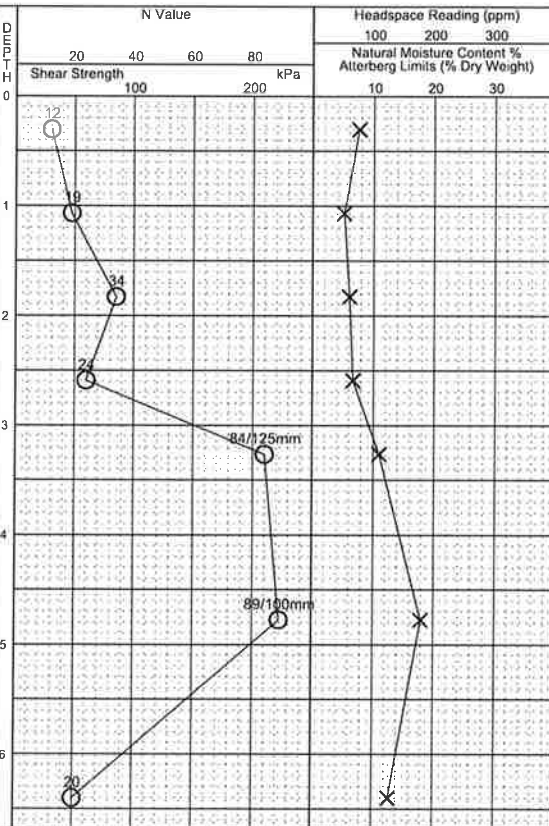
Date Drilled: 1/22/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Legend		Legend	
Auger Sample	⊠	Headspace Reading (ppm)	●
SPT (N) Value	○ ▨	Natural Moisture	×
Dynamic Cone Test	——	Plastic and Liquid Limit	├─┤
Shelby Tube	■	Unconfined Compression % Strain at Failure	⊗
Field Vane Test	S	Penetrometer	▲

GWL	Soil Description	ELEV. m	DEPTH
	Ground Surface	305.04	0
	TOPSOIL	304.68	
	FILL - dark brown to brown sand to silty sand, - very minor topsoil, - moist.	304.43	1
	SAND - compact to very dense, - brown, - fine to medium grained, - with coarse grained at 6.0m, - pockets of silty sand at 1.5m, - trace silt, - moist to wet.		2, 3, 4
▼		299.84	5, 6
		298.34	
	END OF BOREHOLE **NOTE:** Upon completion of the drilling: - water level at 5.2m, - caved-in at 5.2m.		



Natural Unit Weight kN/m3

LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4649-18-GB

Log of Borehole BH-13

Dwg No. 14

Sheet No. 1 of 1

Project: Geothecnical Investigation

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

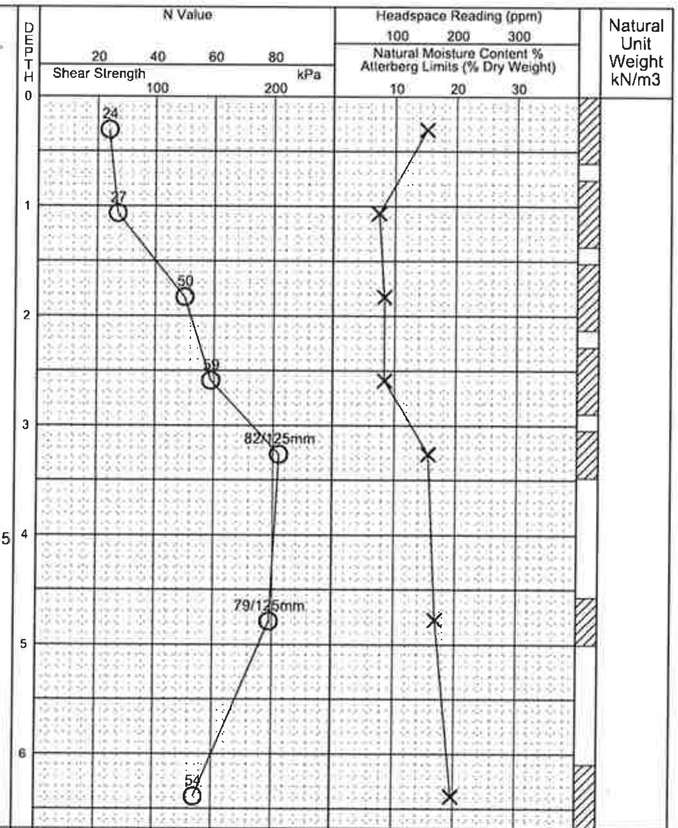
Date Drilled: 1/21/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Legend		Legend	
Auger Sample	⊠	Headspace Reading (ppm)	•
SPT (N) Value	O ▨	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	├─┤
Shelby Tube	■	Unconfined Compression % Strain at Failure	⊗
Field Vane Test	S	Penetrometer	▲

Soil Description	ELEV. m	DEPTH (m)
Ground Surface	305.55	0
TOPSOIL	305.42	
FILL - dark brown to brown sand, - some silty sand, - minor topsoil, - moist.	304.94	
SITLY SAND - compact to very dense, - brown, - some gravel, - some sandy silt, - moist to very moist.	302.81	
SAND - very dense, - brown, - fine to medium grained, - trace gravel, - trace silt, - very moist to wet.	301.45	4
	298.87	



END OF BOREHOLE

NOTE:

Upon completion of the drilling:
- water level at 5.5m,
- caved-in at 5.5m.

LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)
Jan 23, 2019	4.1m	
Jan 29, 2019	4.1m	

Project No. 4649-18-GB

Log of Borehole BH-14

Dwg No. 15

Project: Geothecnical Investigation

Sheet No. 1 of 1

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

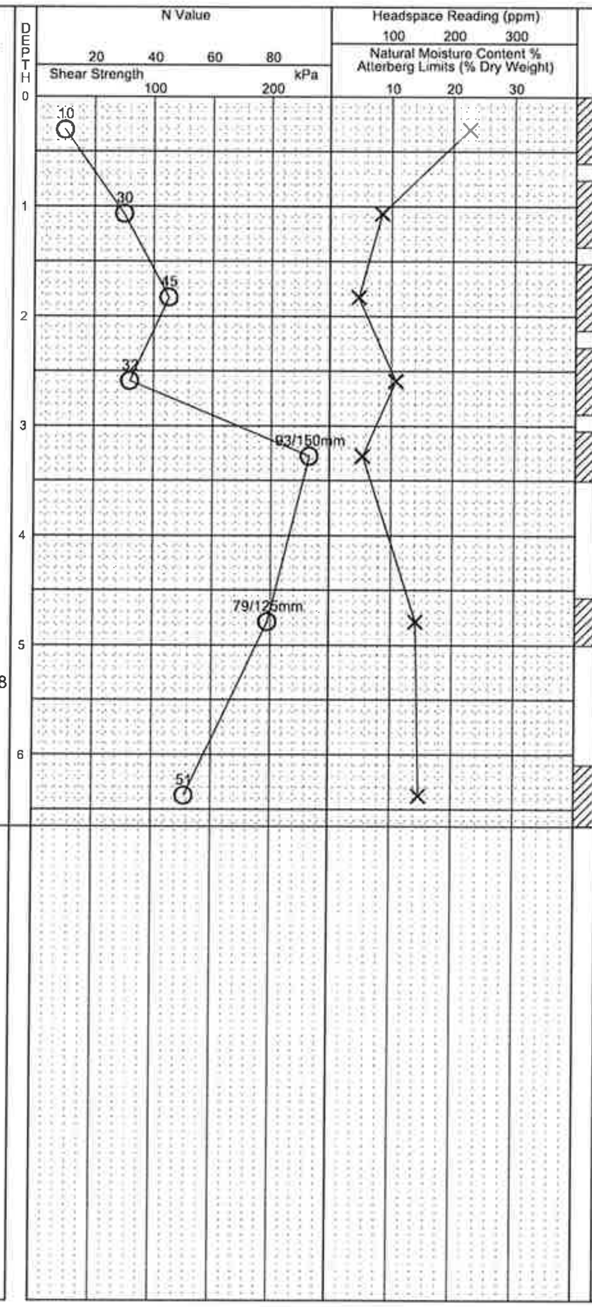
Date Drilled: 1/21/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Symbol		Symbol	
Auger Sample	⊠	Headspace Reading (ppm)	●
SPT (N) Value	○ ▨	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	├─┤
Shelby Tube	■	Unconfined Compression % Strain at Failure	⊗
Field Vane Test	S	Penetrometer	▲

GWL	SYMBOL	Soil Description	ELEV. m
		Ground Surface	305.18
		TOPSOIL	304.93
		FILL - dark brown to brown sand, - some silty sand, minor topsoil, - very moist to wet.	304.42
▼		**SAND** - dense to very dense, - brown, - fine to medium grained, - trace gravel, - trace to some silt, - moist to wet.	299.78 298.53
		END OF BOREHOLE **NOTE:** Upon completion of the drilling: - water level at 5.4m, - caved-in at 5.4m.	



Natural Unit Weight kN/m3

LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4649-18-GB

Log of Borehole BH-15

Dwg No. 16

Sheet No. 1 of 1

Project: Geothecnical Investigation

Location: 316, 326 and 336 Bryne Drive, Barrie, Ontario

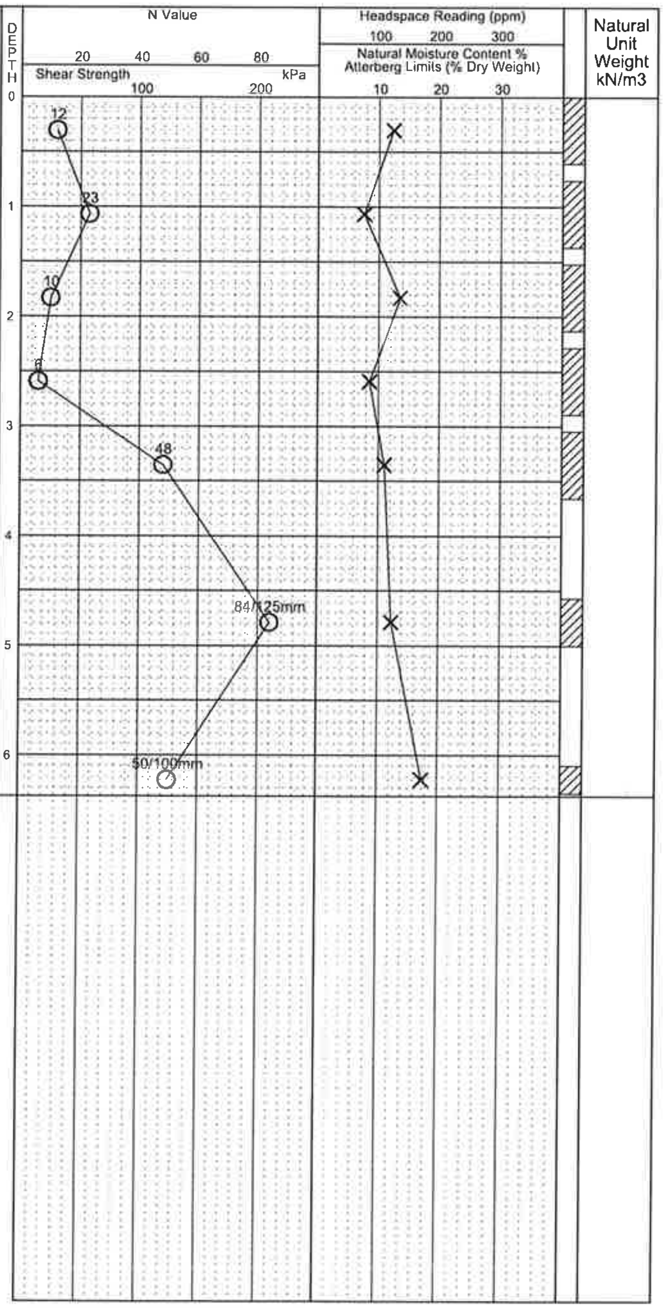
Date Drilled: 1/22/19

Drill Type: Track Mounted Drill Rig

Datum: Temporary

Legend		Legend	
Auger Sample	⊠	Headspace Reading (ppm)	●
SPT (N) Value	○ ▨	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	├─┤
Shelby Tube	■	Unconfined Compression % Strain at Failure	⊗
Field Vane Test	S	Penetrometer	▲

Soil Description	ELEV. m	DEPTH
Ground Surface	304.70	0
TOPSOIL	304.39	
FILL - dark brown to brown sand to silty sand, - some topsoil at 0.6m to 1.5m, - moist to very wet.	303.02	1
SAND - loose to very dense, - brown, - fine to medium grained, - pockets of silty sand, - trace gravel, - trace silt, - moist to wet.	300.70 298.35	2 3 4 5 6
END OF BOREHOLE **NOTE:** Upon completion of the drilling: - water level at 3.7m, - caved-in at 4.0m.		

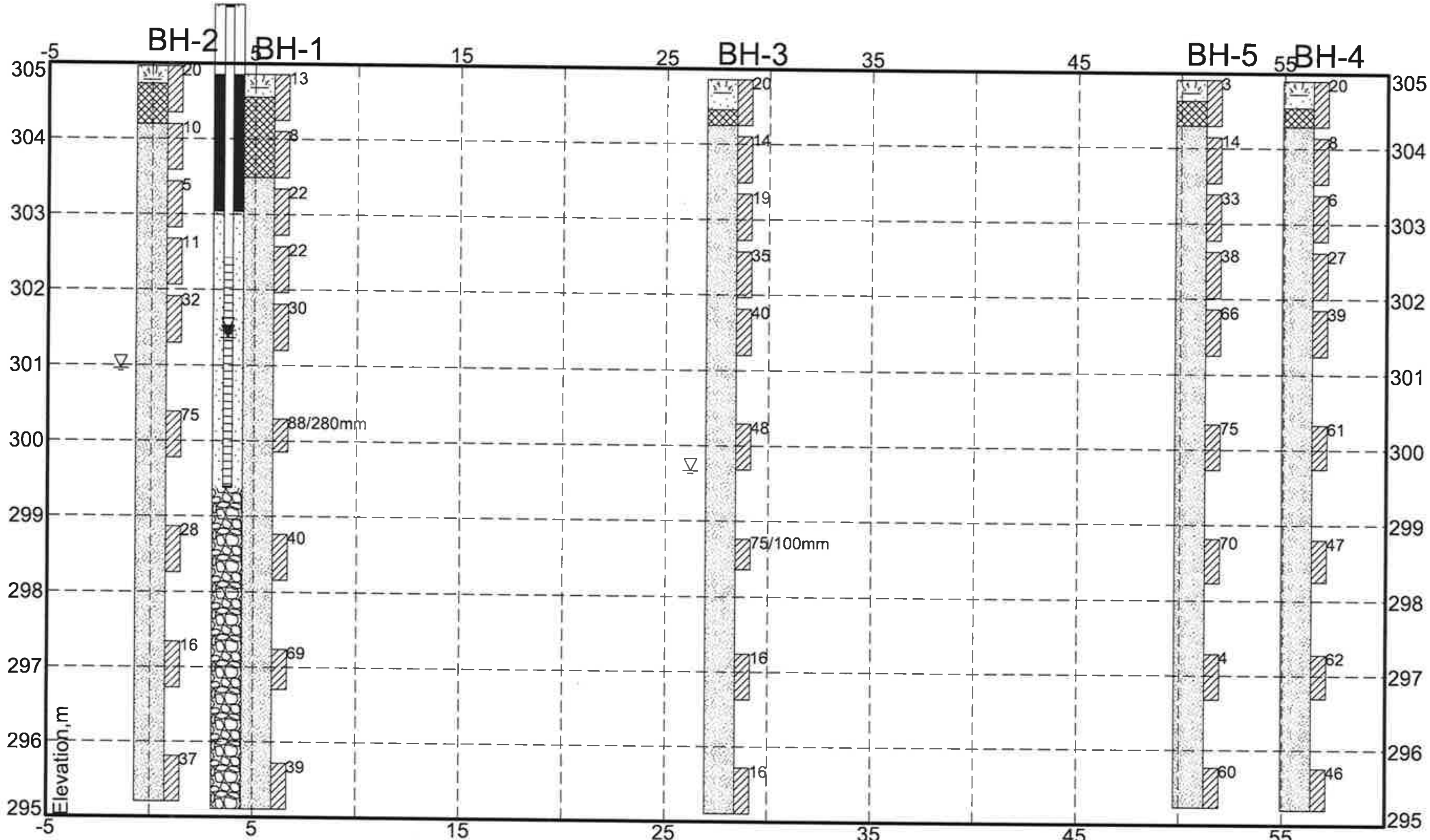


LGBE3 4649-18-GB.GPJ 2/25/19

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)
Jan 23, 2019	4.1m	
Jan 29, 2019	4.0m	



Borehole No	Elev.	Depth
BH-1	304.9	9.8
BH-2	305.0	9.8
BH-3	304.9	9.8
BH-4	304.9	9.7
BH-5	304.9	9.7

Toronto Inspection Ltd.

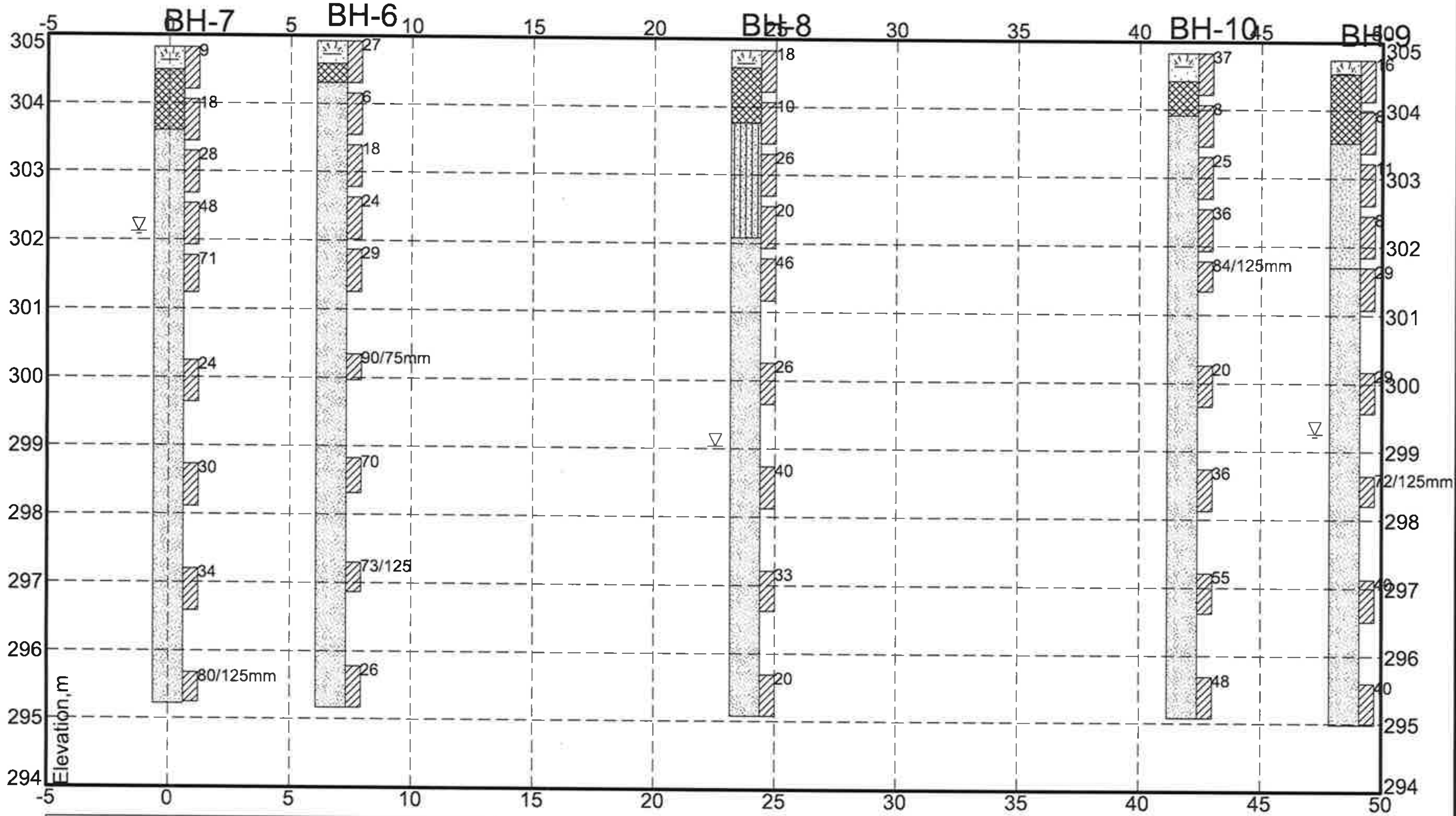
SUBSURFACE STRATIGRAPHY

Section (BH-1 to BH-5)

Geothecnical Investigation

316, 326 and 336 Bryne Drive, Barrie, Ontario

PROJECT #	DATE	DRAWING
4649-18-GB	Mar 19	17



Borehole No	Elev.	Depth
BH-10	304.8	9.8
BH-6	304.9	9.8
BH-7	304.8	9.6
BH-8	304.8	9.8
BH-9	304.7	9.8

Toronto Inspection Ltd.

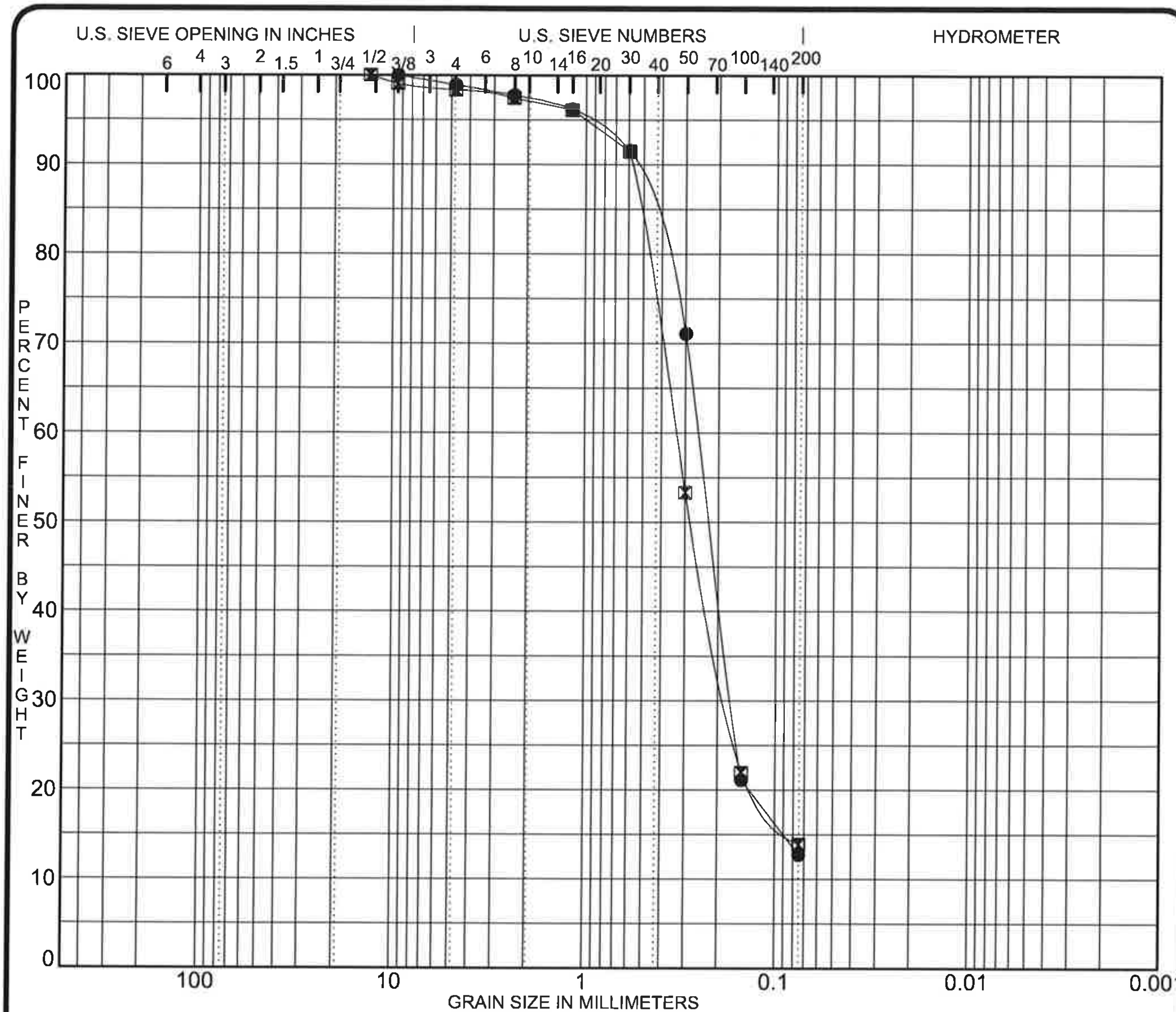
SUBSURFACE STRATIGRAPHY

Section (BH-6 to BH-10)

Geothecnical Investigation

316, 326 and 336 Bryne Drive, Barrie, Ontario

PROJECT #	DATE	DRAWING
4649-18-GB	Mar 19	18



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	**BH-2**	**0.9**							
⊠	**BH-7**	**1.5**							

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH-2**	**0.9**	**9.50**	**0.26**	**0.170**		**1.1**	**86.2**	**12.8**	
⊠	**BH-7**	**1.5**	**13.20**	**0.34**	**0.179**		**1.6**	**84.4**	**13.9**	

PROJECT **Geotechnical Investigation - 326 Bryne Drive, Barrie, Ontario**

JOB NO. **4649-18-GB**
DATE **2/4/19**

GRADATION CURVES

Toronto Inspection Ltd.

FIGURE NO. 1

Appendix D

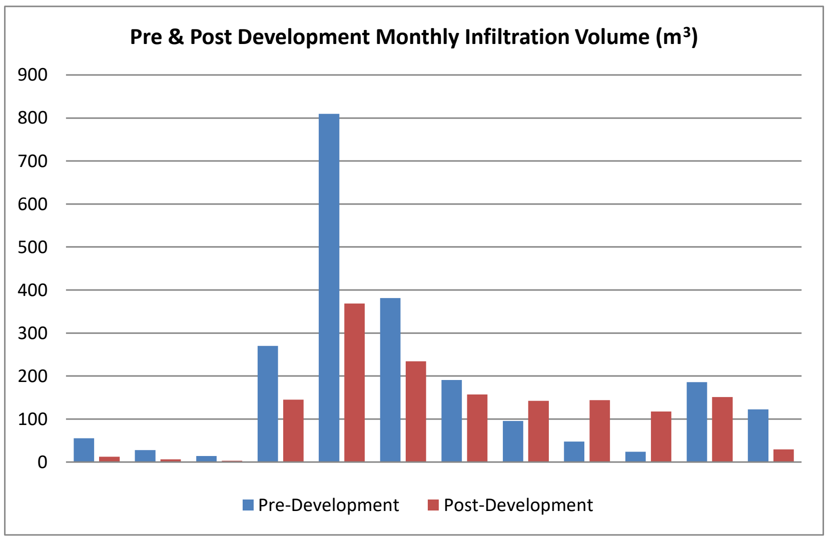
Water Balance Analysis

MTE

326 Bryne Drive - Barrie Holiday Inn Express
SITE WATER BUDGET (INFILTRATION) ANALYSIS
Barrie, Ontario

Project Number:	45303-100
Date:	July 17, 2020
Design By:	CAH
File:	Q:\45303\100\Water Balance\Monthly Balance\Water Balance (Thornthwaite-Mather)_2020-06-09.xlsx

Total Infiltration Volume (m^3)			
Pre-development	Post-development	Difference	Change %
55	13	-43	-77.3
28	6	-21	-77.3
14	3	-11	-77.3
270	145	-125	-46.2
810	369	-441	-54.4
381	234	-147	-38.5
191	157	-33	-17.4
95	142	47	49.5
48	144	96	201.9
24	117	94	393.2
186	151	-35	-18.7
122	29	-93	-76.1
2,223	1,512	-711	-32.0



326 Bryne Drive - Barrie Holiday Inn Express
SITE WATER BUDGET (INFILTRATION) ANALYSIS
Barrie, Ontario

Project Number:	45303-100
Date:	July 17, 2020
Design By:	CAH
File:	\\mte85.local\mte\DES\45303\100\Water Balance\Monthly Balance\Water Balance (Thornthwaite-Mather)_2020-06-09.xlsx

PRE-DEVELOPMENT CONDITION

Contributing Catchments:	301	Soil Type:	Sand	Runoff Factor:	0.20
Contributing Areas:	0.74 ha	Vegetation:	Pasture/Shrubs	Evapotranspiration Factor for Impervious Surfaces:	0.33
Percent Impervious	0.0 %	Topography:	Flat Land		
Weather Station:	Barrie WPCC	Soil Moisture Retention Capacity:	125 mm		

Month	Daily Average Temperature (C°)	Monthly Heat Index	Unadjusted Daily PE (mm)	Correction Factor	Adjusted PE (mm)	Average Precipitation (mm)	P-PE (mm)	Accum. Pot. Water Loss (mm)	Storage (mm)	ΔS (mm)	Pervious ET (mm)	Actual ET (mm)	Moisture Surplus (mm)	Water Runoff (mm)	Snow Melt Runoff (mm)	Total Recharge & Runoff (mm)	Total Recharge & Runoff (m^3)	Total Infiltration Depth (mm)	Total Infiltration Volume (m^3)	Actual Runoff (mm)	Runoff Volume (m^3)
Jan	-7.7	0.00	0.0	24.3	0.0	82.5	82.5	0.0	281.1	0.0	0.0	0.0	0.0	9.4	0.0	9.4	69	7.5	55	1.9	14
Feb	-6.6	0.00	0.0	24.5	0.0	61.8	61.8	0.0	342.9	0.0	0.0	0.0	0.0	4.7	0.0	4.7	35	3.8	28	0.9	7
Mar	-2.1	0.00	0.0	30.6	0.0	58.1	58.1	0.0	401.0	0.0	0.0	0.0	0.0	2.3	0.0	2.3	17	1.9	14	0.5	3
Apr	5.6	1.19	0.8	33.6	28.2	62.2	34.0	0.0	125.0	0.0	28.2	28.2	34.0	18.2	27.6	45.8	338	36.6	270	9.2	68
May	12.3	3.91	2.0	38.0	74.7	82.4	7.7	0.0	125.0	0.0	74.7	74.7	7.7	12.9	124.2	137.1	1,012	109.7	810	27.4	202
Jun	17.9	6.90	2.9	38.6	113.9	84.8	-29.1	-29.1	98.9	-26.1	110.9	110.9	0.0	2.4	62.1	64.5	476	51.6	381	12.9	95
Jul	20.8	8.66	3.5	38.9	135.0	77.2	-57.8	-86.8	61.8	-37.1	114.3	114.3	0.0	1.2	31.1	32.3	238	25.8	191	6.5	48
Aug	19.7	7.97	3.3	36.0	117.8	89.9	-27.9	-114.7	49.0	-12.8	102.7	102.7	0.0	0.6	15.5	16.1	119	12.9	95	3.2	24
Sep	15.3	5.44	2.5	31.2	77.7	94	16.3	0.0	65.3	16.3	77.7	77.7	0.0	0.3	7.8	8.1	60	6.5	48	1.6	12
Oct	8.7	2.31	1.4	28.5	38.6	77.5	38.9	0.0	104.3	38.9	38.6	38.6	0.0	0.2	3.9	4.0	30	3.2	24	0.8	6
Nov	2.7	0.39	0.4	24.2	9.2	88.9	79.7	0.0	125.0	20.7	9.2	9.2	58.9	29.5	1.9	31.5	232	25.2	186	6.3	46
Dec	-3.5	0.00	0.0	23.0	0.0	73.6	73.6	0.0	198.6	0.0	0.0	0.0	0.0	18.8	1.9	20.7	153	16.6	122	4.1	31
Total		36.8	16.7		595.1	**932.9**	**337.8**					**556.4**	**100.5**	**100.5**	**276.0**	**376.5**	**2,779**	**301.2**	**2,223**	**75.3**	**556**

Note: P - Precipitation, PE - Potential Evapotranspiration, ΔS- Change in Soil Moisture Storage, ET - Evapotranspiration

326 Bryne Drive - Barrie Holiday Inn Express
SITE WATER BUDGET (INFILTRATION) ANALYSIS
Barrie, Ontario

Project Number: 45303-100
Date: July 17, 2020
Design By: CAH
File: \\mte85.local\mte\DES\45303\100\Water Balance\Monthly Balance\Water Balance (Thornthwaite-Mather)_2020-06-09.xlsx

POST-DEVELOPMENT CONDITION

Contributing Catchments: 401,402,403,404,405
Contributing Areas: 0.74 ha
Percent Impervious 82.9 %
Weather Station: Barrie WPCC

Soil Type: Sand
Vegetation: Urban Lawn
Topography: Flat Land
Soil Moisture Retention Capacity 125 mm

Runoff Factor 0.86
Evapotranspiration Factor for Impervious Surfaces 0.33

Month	Daily Average Temperature (C°)	Monthly Heat Index	Unadjusted Daily PE (mm)	Correction Factor	Adjusted PE (mm)	Average Precipitation (mm)	P-PE (mm)	Accum. Pot. Water Loss (mm)	Storage (mm)	ΔS (mm)	Pervious ET (mm)	Actual ET (mm)	Moisture Surplus (mm)	Water Runoff (mm)	Snow Melt Runoff (mm)
Jan	-7.7	0.00	0.0	24.3	0.0	82.5	82.5	0.0	281.1	0.0	0.0	0.0	0.0	12.5	0.0
Feb	-6.6	0.00	0.0	24.5	0.0	61.8	61.8	0.0	342.9	0.0	0.0	0.0	0.0	6.2	0.0
Mar	-2.1	0.00	0.0	30.6	0.0	58.1	58.1	0.0	401.0	0.0	0.0	0.0	0.0	3.1	0.0
Apr	5.6	1.19	0.8	33.6	28.2	62.2	34.0	0.0	125.0	0.0	28.2	12.5	49.7	26.4	27.6
May	12.3	3.91	2.0	38.0	74.7	82.4	7.7	0.0	125.0	0.0	74.7	33.2	49.2	37.8	124.2
Jun	17.9	6.90	2.9	38.6	113.9	84.8	-29.1	-29.1	98.9	-26.1	110.9	49.3	61.6	49.7	62.1
Jul	20.8	8.66	3.5	38.9	135.0	77.2	-57.8	-86.8	61.8	-37.1	114.3	50.8	63.5	56.6	31.1
Aug	19.7	7.97	3.3	36.0	117.8	89.9	-27.9	-114.7	49.0	-12.8	102.7	45.6	57.1	56.8	15.5
Sep	15.3	5.44	2.5	31.2	77.7	94	16.3	0.0	65.3	16.3	77.7	34.5	43.2	50.0	7.8
Oct	8.7	2.31	1.4	28.5	38.6	77.5	38.9	0.0	104.3	38.9	38.6	17.1	21.4	35.7	3.9
Nov	2.7	0.39	0.4	24.2	9.2	88.9	79.7	0.0	125.0	20.7	9.2	4.1	64.1	49.9	1.9
Dec	-3.5	0.00	0.0	23.0	0.0	73.6	73.6	0.0	198.6	0.0	0.0	0.0	0.0	24.9	1.9
Total		36.8	16.7		595.1	**932.9**	**337.8**					**247.2**	**409.7**	**409.7**	**276.0**

Month	Total Recharge & Runoff (mm)	Total Recharge & Runoff (m^3)	Runoff before Enhanced Infiltration (mm)	Runoff before Enhanced Infiltration (m^3)	Total Enhanced Recharge* (m^3)	Total Enhanced Recharge (mm)	Recharge Pervious (m^3)	Recharge Pervious (mm)	Total Recharge (m^3)	Total Recharge (mm)	Acutal Runoff Volume (m^3)	Acutal Runoff (mm)
Jan	12.5	92	10.8	79	0	0	13	2	13	1.7	79	10.8
Feb	6.2	46	5.4	40	0	0	6	1	6	0.9	40	5.4
Mar	3.1	23	2.7	20	0	0	3	0	3	0.4	20	2.7
Apr	54.0	398	46.6	344	91	12	54	7	145	19.7	253	34.3
May	162.0	1,195	139.9	1,032	206	28	163	22	369	50.0	827	112.0
Jun	111.8	825	96.5	713	122	16	113	15	234	31.7	591	80.1
Jul	87.7	647	75.7	559	69	9	88	12	157	21.3	490	66.3
Aug	72.4	534	62.5	461	70	9	73	10	142	19.3	392	53.1
Sep	57.8	426	49.9	368	86	12	58	8	144	19.5	283	38.3
Oct	39.6	292	34.2	252	78	11	40	5	117	15.9	175	23.7
Nov	51.8	382	44.8	330	99	13	52	7	151	20.5	231	31.3
Dec	26.9	198	23.2	171	2	0	27	4	29	4.0	169	22.9
Total	**685.7**	**5,061**	**592.1**	**4,370**	**821**	**111**	**691**	**94**	**1,512**	**204.8**	**3,549**	**480.9**

Note: P - Precipitation, PE - Potential Evapotranspiration, ΔS- Change in Soil Moisture Storage, ET - Evapotranspiration
* Enhanced recharge volume was estimated by a continuous hydrologic model, based on the design of infiltration facility and condition of its contributing areas

Appendix E

Phosphorus Loading Calculations

BMP	Reduction Potential	BMP Description
Bioretention Systems	0.00%	
Constructed Wetlands	77.00%	
Dry Detention Ponds	10.00%	
NONE	0.00%	no BMP Applied
Hydrodynamic devices	0.00%	
Dry swales	0.00%	
Enhanced Grass/WQ Swales	0.00%	
Flow Balancing Systems	77.00%	
Green roofs	0.00%	
Other		please enter a reduction potential efficiency
Perforated Pipe Infiltration/Exfiltration Systems	87.00%	
Sand or Media Filters	45.00%	
Soakaways - Infiltration trenches	60.00%	
Sorbtive media interceptors	79.00%	
Underground Storage	25.00%	
Vegetated Filter Strips/Stream Buffers	65.00%	
Wet Detention Ponds	63.00%	
Treatment Train Approach		please enter a reduction potential efficiency

Ontario
MINISTRY OF THE ENVIRONMENT

Database Version: V 2.0 Release Update
Update Date: 30-Mar-12

Project DEVELOPMENT Summary

DEVELOPMENT: **Holiday Inn Express_Phase 1**
Subwatershed: **Barrie Creeks**

Total Pre-Development Area (ha):	**0.738**	Total Pre-Development Phosphorus Load (kg/yr):	**0.14**

Pre-Development Land Use	Area (ha)	P coeff. (kg/ha)	P Load (kg/yr)
Cropland	0.738	0.19	0.14

POST-DEVELOPMENT LOAD

Post-Development Land Use	Area (ha)	P coeff. (kg/ha)	Best Management Practice applied with P Removal Efficiency		P Load (kg/yr)
High Intensity - Comm/Industrial	0.63	1.82	Treatment Train Approach	83%	0.19
			Jellyfish Filter (49%) + Existing SWM Pond (63%) (Controlled Aspahlt, Sidewalks and Landsacpe Areas) *Infiltration Gallery (60%) + Existing SWM Pond (63%) (Building Rooftop)*		
Low Intensity Development	0.095	0.13	Vegetated Filter Strips/Stream Buffers	65%	0.00
			Uncontrolled Landscaped Area		

Post-Development Area Altered: **0.72**
Total Pre-Development Area: **0.74**
Unaffected Area: **0**

	P Load (kg/yr)
Pre-Development:	**0.14**
Post-Development:	**1.16**
Change (Pre - Post):	**-1.02**
727% Net Increase in Load	
Post-Development (with BMPs):	**0.20**
Change (Pre - Post):	**-0.06**
42.09% Net Increase in Load	

Appendix F

Lover's Creek SWM Report

The City of

BARRIE

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LOVER'S CREEK STORMWATER MANAGEMENT POND (LV14) RETROFIT

DETAILED DESIGN REPORT

ENGINEERING DEPARTMENT

November 2009

LOVER'S CREEK
STORMWATER MANAGEMENT POND
(LV14) RETROFIT

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION AND BACKGROUND

The City of Barrie is proposing to retrofit the existing Stormwater Management Pond located north-west of the Caplan Avenue and Bryne Drive intersection, in the City of Barrie. The pond, known as LV14, is located within the Lover's Creek Watershed, and is situated at the headwaters of a tributary to Lover's Creek. The location of the existing pond is shown on enclosed Figure 1 – Location Plan.

This report has been prepared to document the detailed design of the proposed retrofit of the LV14 Stormwater Management Pond and has been undertaken in accordance with the *Pond LV14 Stormwater Management Facility Retrofit Municipal Class Environmental Assessment,* prepared by the City of Barrie, February 2009.

1.1 Background Information and Previous Studies

In February 2009, the City of Barrie completed a Class Environmental Assessment (Class EA) for the retrofit of the existing LV14 Stormwater Management Pond. The Class EA study was undertaken in accordance with *Schedule "A+" Guidelines and Requirements of the June 2000 Municipal Class Environmental Assessment Document as amended in 2007.* The study examined different alternatives for retrofitting the existing pond and presented a preferred alternative based on an evaluation of physical, social, cultural, and economic environments specific to the project.

1.1.1 Preferred Alternative Solution

Through the Class EA study process the Preferred Alternative Solution for the retrofit of the existing Stormwater Management Pond is the creation of a wet pond with sediment forebays. The proposed wet pond is to provide sufficient permanent pool and active storage volume to meet current MOE requirements (March 2003) for "Enhanced Level" quality control protection.

The Preferred Alternative Solution, as adopted in the Class EA, involves the following:

- Converting a portion of the existing dry pond to a wet pond, including construction of two sediment forebays, the construction of a new outlet for water quality control and construction of a link channel between the new outlet and the existing Lover's Creek tributary; and,
- Improve aesthetics, nutrient uptake, and reduce temperature impacts on Lover's Creek through the pond landscaping and thermal protective vegetation.

2.0 EXPECTED REQUIREMENTS OF APPROVING AUTHORITIES

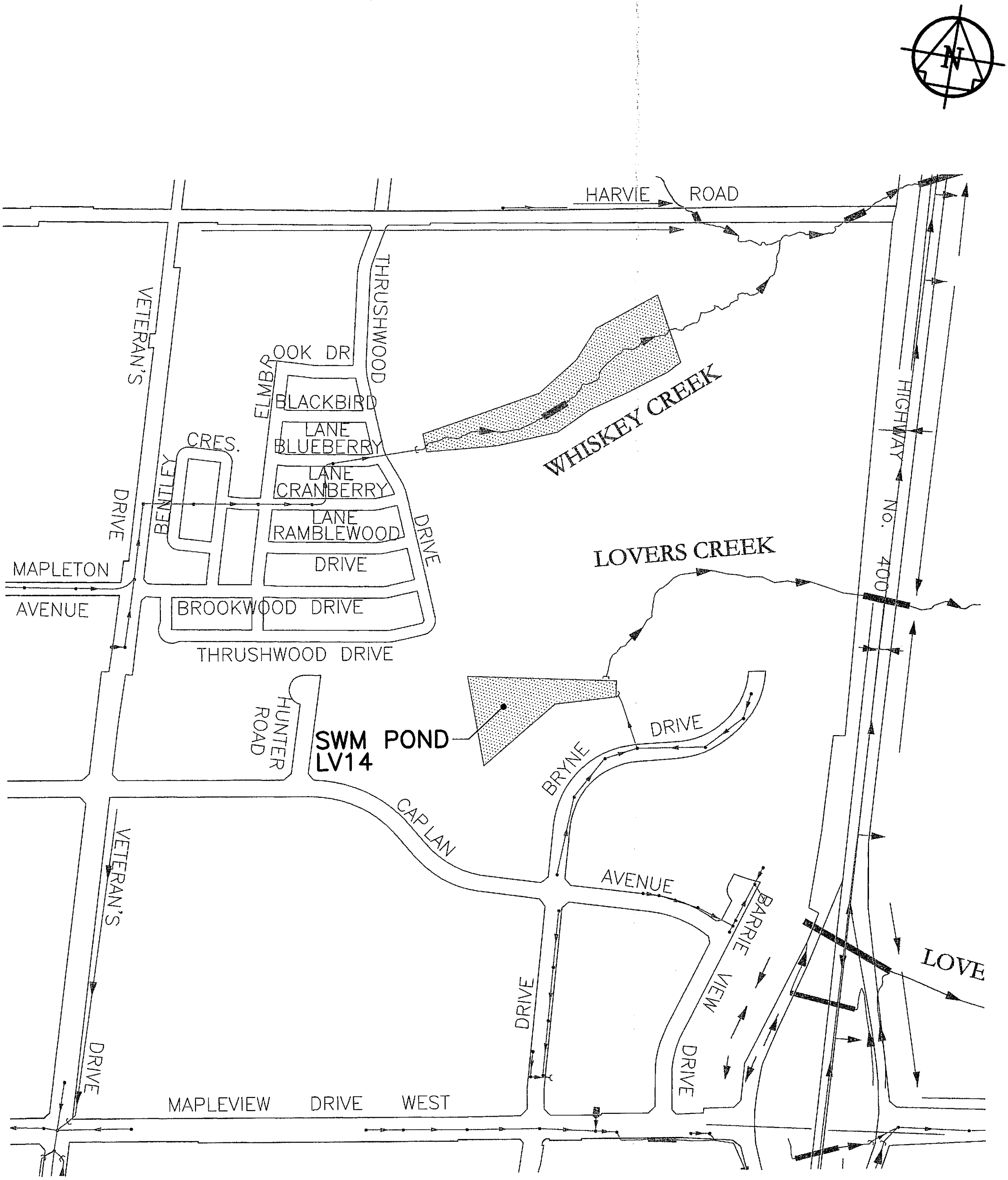
This project is subject to the policies and requirements of the Lake Simcoe Region Conservation Authority (LSRCA), and the Ministry of Environment (MOE) with respect to drainage and stormwater management.

2.1 Ministry of the Environment (MOE)

An amendment to the existing Certificate of Approval (C of A) (Number 3-1232-89-916) is required from the MOE for this retrofit project. This Detailed Design Report will be submitted to the MOE in support of an Application to amend the existing C of A.

2.2 Lake Simcoe Region Conservation Authority (LSRCA)

It is expected that the LSRCA will require a Stormwater Management Plan that conforms with their own development policies as well as to the recommendations of the *Pond LV14 Stormwater Management Facility Retrofit Class EA* and the MOE Stormwater Management Planning and Design Manual (March 2003).



CITY OF BARRIE *ENGINEERING DEPARTMENT*	FIGURE 1 – LOCATION PLAN LOVERS CREEK SWM POND (LV14)	*DATE: November 2009* *SCALE: NTS*

3.0 EXISTING CONDITIONS

3.1 General

The existing Stormwater Management Pond was first constructed in 1989 as part of the Barrie View Farms Subdivision and then later retrofitted in 1995 in conjunction with development within the Barrie View Subdivision by The Home Depot Canada Inc.

The design of the existing pond is detailed in the report *Stormwater Management Update Study Barrie View Subdivision, June 1995*, prepared by Skelton, Brumwell & Associates Inc. Excerpts of the report are included in Appendix 'A'.

3.2 Drainage Patterns and Land Use

The drainage patterns considered in the 1995 retrofit design are as shown on Figure 1 of that report (refer to Appendix 'A'), which was obtained from the original March 1989 report.

The existing pond consists of two main inlets. An open channel inlet at the west end of the pond that allows drainage from the west and south to enter overland, and a storm pipe and overland flow route inlet at the east end of the pond that captures drainage from the area to the east (Barrie View Farms Subdivision). A third inlet, located at the south end of the pond, allows drainage from 62 Caplan Avenue (Mapleview Self Storage Inc. – Mini Self-Storage Facility) to drain into the pond.

The existing pond was designed to provide controls for an area of 37.73ha.

3.3 Existing Stormwater Management Pond

The existing Stormwater Management Pond operates as a dry detention pond providing quantity control for all return period storm events (2-year to 100-year storms) and has a storage volume of approximately 27,400m^3 at an elevation of 303.30 metres. The top of the pond is at approximately elevation 303.50 metres. The existing pond design also provides 24-hour detention of runoff from a 25mm depth of rainfall for quality control.

Peak flows from the pond are controlled by a 600mm x 600mm concrete ditch inlet catchbasin structure and concrete weir structure situated within the ponds berm and located at the north-east end of the pond. The concrete ditch inlet structure consists of 5 – 100mm diameter orifice holes oriented vertically in the face of the structure, the lowest hole having an invert elevation of 300.20 metres, and a 300mm diameter discharge pipe that conveys flow from the ditch inlet catchbasin structure to the outlet channel. The weir structure is a two-stage weir consisting of a 0.45 metres wide weir at elevation 302.70 metres and a 4 metres wide weir at elevation 302.95 metres.

Table 2, in section 6.2, provides a summary of peak flows and performance characteristics of the existing pond.

4.0 PROPOSED CONDITIONS

4.1 Drainage Patterns and Land Use

A detailed review of the contributing drainage area was undertaken as part of the design process for retrofitting the existing pond in order to optimize the performance of the pond. The contributing drainage area is shown on drawing STM1, Storm Drainage Plan.

Based on a review of the drainage boundary and catchment areas, the drainage patterns were generally found to be similar to those described in the original report; however, the south-west boundary limit has been adjusted. The adjustment to the drainage boundary in this area was made in order to reflect the actual drainage patterns that currently exist. The need to revise the boundary is attributed to development occurring in the area that did not follow the drainage patterns used in the original report and pond design. The revised drainage area boundary is consistent with recent road reconstruction projects, in and adjacent to the drainage area, that have been undertaken by the City since the original construction of the LV14 pond in 1989 and the subsequent retrofit in 1995. These projects include the Veterans Drive Reconstruction from Harvie Road to

Mapleview Drive (completed in 2005, Contract 2004-13) and Caplan Avenue Urbanization (completed in 2008, Contract 2007-10). The storm drainage area plans for these projects are included in Appendix 'B'.

The net result of the changes to the drainage boundary is a reduction in the overall drainage area from 37.73ha to 33.40ha.

At present, all of the lands draining to the existing pond are zoned either Industrial or Commercial.

5.0 POND DESIGN FEATURES

The following sections summarize key features of the proposed retrofit design of the existing Stormwater Management Pond. A summary table of all the design criteria is provided in Appendix 'C'.

5.1 Design Criteria

The proposed retrofit of the existing Stormwater Management Pond has been designed to achieve the broad resource management goals, sub-goals and objectives set forth in the Ministry of the Environment's Stormwater Management Planning and Design Manual (March 2003), the City of Barrie Drainage and Storm Sewage Policies and Criteria (December 1983), and the *Pond LV14 SWM Facility Retrofit Class EA*.

The proposed Stormwater Management Pond is to be designed as an extended detention wet pond providing both quality and quantity control of stormwater runoff.

5.2 Pond Layout and Grading

The pond layout and grading has been established to meet the targets of the desired quality and quantity control objectives.

The retrofitted pond layout consists of two (2) sediment forebays, one located at either end of the pond, to capture runoff entering from the east and west inlets, and a main wet cell located between the two (2) forebays in the central portion of the pond. The forebays are separated from the main wet cell by 5 metres wide earth berms that also serve as access roads for maintenance purposes. The sediment forebays are connected to the main cell of the pond by an overflow weir set at the permanent pool elevation of 301.30 metres. The east forebay has been designed with a bottom elevation at 299.90 metres, providing a 1.40 metre depth of permanent water. The west forebay has been designed with a bottom elevation at 300.00 metres, providing a permanent pool depth of 1.30 metres. The minimum 1.30 metre depth provided in the forebays is a key design feature that will minimize re-suspension of solids and allow large particles to be captured and settled out within the forebays.

The main wet cell of the pond has a bottom elevation of 299.60 metres, thereby providing a 1.70 metre depth of permanent water to further enhance pollutant removal and capture of sediment prior to discharge from the pond.

The internal side slopes of the pond have been graded with a 6 metre wide, 7H:1V safety bench that extends 3.0 metres horizontally either side of the permanent pool level around the entire perimeter of the forebays and wet cell. Above the permanent pool elevation and beyond the limits of the 7H:1V safety bench, the side slopes have graded at 3H:1V. Below the permanent pool level and beyond the limits of the 7H:1V safety bench, the side slopes have been graded at 4H:1V.

The north berm of the pond, which is to be constructed with a minimum 3 metre top width will serve as an access road, providing access to all areas of the pond for maintenance and inspection purposes including the outlet control structure and sediment forebays.

5.3 Quality Control of Stormwater Runoff

The proposed retrofit has been designed to provide "Enhanced Level" water quality control. The MOE SWMPD Manual (March 2003) provides several guidelines for sizing a wet pond to provide "Enhanced Level" water quality control, including storage volume requirements and forebay design criteria, the details of which are outlined below. Detailed calculations are provided in Appendix 'D'.

Storage Volume Sizing

The size of the permanent pool for quality control purposes is a function of the tributary area and the areas imperviousness. For the proposed retrofit the imperviousness of the tributary area has been calculated at approximately 71%. Based on the MOE guidelines (Table 3.2), the required permanent pool storage volume for a wet pond providing "Enhanced Level" quality control, is as follows:

71% imperviousness = 186.5m^3/ha

Therefore the total permanent pool volume required is:

33.40ha x 186.5m^3/ha = 6,231m^3

The MOE guidelines also require that extended detention be provided for erosion control. The MOE guideline for extended detention is to provide storage at a rate of 40 m^3/ha. Therefore the minimum extended detention volume required is:

33.40ha x 40m^3/ha = 1,336m^3

However, the extended detention volume must be designed to attenuate the runoff volume from the 4-hour 25mm Chicago rainfall event over a minimum period of 24-hours. Based on the watershed characteristics and the OTTHYMO model (output appended), the required volume for extended detention is approximately 4,187m^3.

Therefore the required volumes for the pond are:

Permanent Pool = 6,231m^3
Extended Detention = 4,187m^3

Whereas the actual volumes to be provided are:

Permanent Pool = 7,143m^3
Extended Detention = 4,448m^3

The pond has been designed such that approximately 1,209m^3 of the permanent pool volume is provided within the forebays and approximately 5,934m^3 is provided in the main wet cell.

Drawdown Calculation

As noted previously, the extended detention storage volume must be adequately sized to attenuate the runoff volume from the 4-hour 25mm Chicago Storm event for a minimum of 24-hours. The extended detention zone is controlled using a 216mm (8.5 inch) diameter orifice at the outlet of a reverse slope pipe. The drawdown equation has been used to verify the detention time for the extended detention volume. The equation is given as follows:

$$t = \frac{2A_p}{CA_o(2g)^{0.5}}\left(h_1^{0.5} - h_2^{0.5}\right)$$

Where:

t	=	drawdown time (seconds)
A_p	=	surface area of the pond (m^2)
C	=	discharge coefficient (0.63)
A_o	=	cross-sectional area of the orifice (0.0366m^2)
g	=	gravitational acceleration constant (9.81m/s^2)
h_1	=	starting water elevation above the orifice (metre)
h_2	=	ending water elevation above the orifice (metre)

Given the above information, the actual extended detention storage time is estimated to be approximately 28-hours.

The extended detention outlet has been designed as a reverse slope (bottom draw) outlet pipe with a control orifice located inside of a maintenance hole structure (DDLV03422). Providing a reverse slope (bottom draw) outlet pipe forces the cooler water from the bottom of the pond to be released, thus minimizing the thermal impacts on the receiving watercourse.

Forebay Design

The retrofitted pond has been designed with two (2) sediment forebays and a separate wet cell component. The MOE manual provides guidelines for sizing and designing forebays to ensure that they operate effectively in removing and capturing larger particles near the inlet of the pond.

The permanent pool volume provided in the east forebay is approximately $344m^3$, whereas the volume provided in the west forebay is approximately $865m^3$, for a combined total of $1,209m^3$. The combined volume represents approximately 17% of the total permanent pool volume provided in the pond. The area of permanent pool provided in the two (2) forebays accounts for approximately 28% of the total permanent pool area. Both of these requirements fulfill the recommendations provided in the MOE SWMPD Manual for Wet Pond design.

A check of the other MOE design criteria guidelines for forebay settling length and dispersion length have been calculated as follows:

Settling Length

$$\text{Dist} = \sqrt{\frac{rQ_p}{V_s}} \qquad \textbf{(Equation 4.5)}$$

Where:

Dist	=	forebay length (metres)
r	=	length to width ratio of forebay
Q_p	=	peak flow rate from the pond during design quality storm (4-hr 25mm Chicago = $0.066m^3/s$)
V_s	=	settling velocity (m/s) (it is recommend that a value of 0.0003m/s be used)

Dispersion Length

$$\text{Dist} = \frac{8Q}{dV_f} \qquad \textbf{(Equation 4.6)}$$

Where:

Dist	=	length of dispersion (metres)
Q	=	inlet flow rate (m^3/s)
d	=	depth of permanent pool in the forebay
V_f	=	desired velocity in forebay (0.50 m/s)

For detailed calculations of the above refer to Appendix 'E'.

5.4 Quantity Control of Stormwater Runoff

The retrofitted pond will continue to provide quantity control of stormwater runoff from the 2-year thru 100-year return period storm events. The retrofitted pond has been designed to maintain or reduce the level of peak flows as compared to those currently released from the existing pond.

Outflow from the retrofitted pond will be controlled by three (3) physical features:

1) A 300mm diameter PVC reverse slope outlet pipe fitted with a 216mm (8.5 inch) diameter vertical plane orifice. The orifice consists of a 450mm x 450mm steel plate fastened to the inside wall of the central control structure (DDLV03422) over the outlet of 300mm diameter PVC pipe. The invert of the 216mm diameter control orifice is set to match the permanent pool elevation of 301.30 metres.
2) A 1200mm x 600mm Type 'A' concrete ditch inlet catchbasin (DICB) (per OPSD 705.040) with a horizontal top grate, a 280mm (11 inch) diameter vertical plane orifice cored in the front face of the structure, and 600mm diameter outlet pipe draining to the central control structure (DDLV03422). The 280mm diameter vertical plane orifice is set at elevation 301.85 metres (above the extended detention zone) and the grate elevation of the DICB is set at elevation 302.85 metres.
3) A 20 metre long emergency spillway weir is located within the ponds berm. The weir elevation is set 0.35 metres below the top of the pond at elevation 303.00 metres (above the 100-year controlled water elevation).

The stage-storage-discharge relationship table for the pond is included in Appendix 'D'.

5.5 Outlet Link Channel

In order to improve the overall function of the pond, primarily its water quality control capabilities, the outlet structure is to be relocated from its current location near the east end of the pond to a location in the central portion of the pond. Relocating the outlet structure will provide additional travel time between the east inlet and the pond outlet, thereby preventing short circuiting of the flows through the pond.

As a result of relocating the outlet structure a new link channel is required in order to connect the new outlet location to the existing receiving watercourse. This new link channel is to be constructed within an 8 metre wide easement on the adjacent SmartCentres property.

The proposed link channel has been designed to convey the controlled 100-year peak outflow from the pond. Supporting Calculations are provided in Appendix 'D'.

5.6 Vegatation Strategy

The selection of suitable native plant species for the retrofitted pond is a key factor in ensuring the long-term effectiveness of the pond. A planting plan has been prepared with objectives to provide shading, aesthetics, safety, and enhancement of pollutant removal. Refer to drawing L1, Landscaping Plan for details.

5.7 Phosphorous Reduction

An important issue in the Lake Simcoe Watershed is the reduction of Phosphorous loading to the Lake. The LSRCA has estimated that the average annual Total Phosphorous (TP) loading for a typical developed area is 1.3kg/ha. Based on the contributing drainage area of 33.40ha, the estimated annual TP loading for the existing condition is approximately 43.4kg. By implementing the proposed retrofit design, it is anticipated that the annual TP loading will be reduced by a approximately 50% for a detention time of approximately 28-hours, thereby reducing the average annual TP loading from the area to approximately 21.7kg or 0.65kg/ha.

6.0 ANALYSIS

6.1 Hydrologic Modeling

The hydrologic computer model Visual OTTHYMO V2.3 was used to compute the peak flows and analyze the operating characteristics of the proposed retrofitted pond.

The previous study analysis completed by Skelton, Brumwell & Associates Inc. used only rainfall data for the 4-hour Chicago distribution, as it was determined that the Chicago Storm Data produced the highest peak flows and the highest storage requirements. For analysis of the retrofitted pond it was determined that in addition to the 4-hour Chicago distribution, an analysis of the 24-hour SCS Type 2 distribution would also be undertaken as well as a 4-hour 25mm Chicago distribution to determine quality control requirements, and a Regional Storm event analysis utilizing the Hazel Regional Storm Event.

In order to accurately reflect the existing drainage patterns and analyze the function of the retrofitted pond, which will operate with two (2) sediment forebays, the drainage areas where adjusted from those used in Skelton, Brumwell's report.

The total catchment area draining to the pond was divided into four (4) separate catchments which are described as follows:

Catchment #100: Portion of Barrie View Subdivision with lots draining to Bryne Drive Storm Sewer which will have lot level controls limiting the outflow to 146L/s/ha. This is consistent with the previous study, which prescribed that all lots draining to the Storm Sewer on Bryne Drive are to implement lot level controls limiting runoff to a maximum of 146L/s/ha. Flows enter the pond via the east inlet.

Catchment #200: Portion of the Barrie View Subdivision which will not have lot level controls (i.e. Bryne Drive road allowance). Flows enter the pond via the east inlet.

Catchment #300: Portion of the City of Barrie Industrial Subdivision with sheet flow directly to the pond and the pond itself.

Catchment #400: Portion of the City of Barrie Industrial Subdivision entering the pond via the west inlet.

Table 1 indicates the main input parameters used for each catchment.

Table 1
Proposed Retrofit Condition
Hydrologic Model – Input Parameters

Catchment ID	Area (ha.)	Total Imperviousness (%)	Directly Connected Impervious (%)
100	6.1	0.85	0.85
200	1.4	0.60	0.60
300	5.8	0.60	0.50
400	20.1	0.72	0.50

As the entire catchment area is planned for or intended to be developed, each catchment area was modeled using the STANDHYD subroutine for urbanized areas.

A modified curve number of 62 was used for all catchments which is consistent with that used in the previous study.

To account for the controlled release rate of 146L/s/ha for catchment 100, the DIVERT HYD subroutine was used which splits the hydrograph into two separate hydrographs. One hydrograph has a maximum flow of 890L/s/ha (146L/s/ha over 6.10ha.) and is carried through to analyze the ponds operation. The second hydrograph represents the portion being stored on the roofs and parking lots on the individual lots.

Further details regarding the input data is provided in Appendix 'E'. This appendix also contains a model schematic as well as all input and output data for the modeling.

6.2 Peak Flows

As mentioned above, the peak flows for the Stormwater Management Pond retrofit design where calculated using the Visual OTTHYMO V2.3 computer modeling program.

Table 2 provides a summary of the peak flows reported in the previous pond design completed in 1995 and the estimated peak flows for the proposed retrofit design.

Table 2
Summary of Peak Flow Rates
and Stormwater Management Pond Characteristics

Storm Event	Existing Conditions[1]			Proposed Retrofit Condition		
	Peak Outflow from Pond[2] (m^3/s)	Active Storage Volume (m^3)	Ponding Elevation (m)	Peak Outflow from Pond (m^3/s)	Active Storage Volume (m^3)	Ponding Elevation[3] (m)
25mm 4-hr Chic.	0.10	4,800	301.49	0.07	4,187	301.82
2-Year Chic.	0.22	6,900	301.76	0.14	6,959	302.09
5-Year Chic.	0.28	13,450	302.50	0.24	12,771	302.59
10-Year Chic.	0.29	16,090	302.71	0.27	14,971	302.75
25-Year Chic.	0.34	18,630	302.85	0.32	17,173	302.88
100-Year Chic.	0.66	21,280	302.96	0.62	19,088	302.98
2-Year SCS*	0.20	6,236	-	0.13	6,740	302.07
5-Year SCS*	0.25	10,220	-	0.21	10,207	302.38
10-Year SCS*	0.27	13,280	-	0.24	12,714	302.58
25-Year SCS*	0.30	16,680	-	0.27	15,517	302.78
100-Year SCS*	0.63	21,060	-	0.61	19,070	302.98
Hazel Regional	-	-	-	4.10	23,186	302.19

* peak flows for the SCS storm were not calculated in the original report prepared by Skelton, Brumwell & Associates Inc.; the values indicated are derived from a re-created model representing the existing condition.

1 The existing condition is based on the Skelton, Brumwell & Associates, Stormwater Management Study Update Barrie View Subdivision, June 1995 report.

2 The existing peak outflows are used as the target flow rates for the retrofitted pond.

3 Elevations are approximate based on an interpolation of the storage requirements.

Comparing the data above, the proposed retrofit design will marginally reduce the peak outflows with little impact to the ponding elevations as compared to the existing pond. The greatest reduction in peak flows will occur during the more frequent storm events i.e. the 2-year peak flow is reduced from $0.22m^3/s$ to $0.14m^3/s$.

6.3 Hydraulic Grade-Line Analysis

Since the proposed retrofit will result in the east inlet being permanently submerged, a hydraulic grade-line analysis was undertaken to ensure that the existing Storm Sewer on Bryne Drive will continue to function under surcharged conditions.

The hydraulic grade-line analysis was completed using the PCSWMM software and the original design flow information for the Bryne Drive Storm Sewer.

Results of the hydraulic grade-line analysis indicate that Storm Sewer will continue to operate under the surcharged conditions. Details of the analysis are included in Appendix 'F'.

7.0 MONITORING, INSPECTION AND MAINTENANCE ACTIVITIES

This section outlines the inspection and maintenance activities that are to be completed as part of the Monitoring Program for this pond.

7.1 Inspection of the Stormwater Management Pond

In addition to providing an indicator of the performance of the Stormwater Management Pond, observations made during pond inspections will assist in identifying the need for maintenance. The following inspection activities have been included in the Monitoring Program for the Stormwater Management Pond:

i) During construction, inspections of the pond should be completed on a regular basis to assess any reduction in pond capacity due to sediment accumulation.

ii) Following construction, semi-annual inspections should be completed to assess:

- The health of vegetation in and surrounding the pond;
- The stability of the pond side slopes and the emergency overflow;
- The condition of the internal access roads;
- The structural condition of Storm Sewer inlet headwalls and components of the outlet structure;
- The established permanent pool elevation; and,
- The visible quality of water in the pond.

iii) Annual inspections of the ditch inlet outlet structure should be completed to identify the need for removal of sediment, debris, and/or biological accumulations.

7.2 Maintenance of the Stormwater Management Pond

Maintenance requirements will be identified and scheduled based on observations made during both scheduled inspections and visits to the pond to collect monitoring data. The types of maintenance activities needed and the frequency with which they are performed will provide the basis for scheduling long-term maintenance operations. Anticipated maintenance requirements have been classified as Routine Maintenance Operations and Major Maintenance Operations.

7.2.1 Routine Maintenance Operations

Routine Maintenance Operations are minor maintenance activities required to ensure that the pond remains an amenity to the surrounding area while providing the intended Stormwater Management Function. Maintenance activities classified as Routine Maintenance Operations include, but are not limited to:

- Removal of trash and debris from inside and surrounding the pond;
- Trimming and/or clearing of vegetation;
- Minor landscaping to restore seasonal vegetation loss, maintain desired planting densities along side slopes, remove undesirable plant species and improve aesthetics;
- Removal of sediment and biological accumulations from components of the outlet structure;
- Inspection of pond components to assess their condition and determine if repairs or replacement are required; and,
- Minor structural repairs to the pond inlets as well as components of the outlet structure.

7.2.2 Major Maintenance Operations

Major maintenance operations include Sediment Removal and Disposal Operations, and Remedial Works to repair failed components of the pond, and/or to alter pond performance.

The need for major maintenance will typically be identified by visual observations made during inspections. Visual indicators of the need for major maintenance could include slumping of pond side slopes, elevated permanent pool levels, biological or chemical "films" on the water surface, significant areas of dead vegetation inside the pond, sediment accumulations, excessive drain down times, frequent flooding of lands surrounding receiving drainage features, etc.

7.2.2.1 Sediment Removal and Disposal Operations

Periodically, accumulated sediment will have to be removed from the pond to ensure that the pond will continue to operate as designed. The frequency with which sediment will have to be removed will vary depending on the effectiveness of the erosion and sediment control measures implemented during construction, the frequency of winter sanding applications, the effectiveness of routine street cleaning, the frequency of rainfall events, etc.

Sediment accumulations will be removed to restore the original bottom elevation and will likely be completed using a small rubber-tired backhoe and a dump truck, or a vacuum truck. In order to facilitate sediment removal operations it may be necessary to lower or drain the permanent pool level in the pond. Due to topographic constraints and the design configuration of the pond, draining of the pond will need to be completed by means of pumping. Discharge from the pumping operations should be directed to the upstream limit of the outlet link channel and temporary controls implemented throughout the channel to capture any sediments prior to reaching the existing Lover's Creek tributary.

After the sediment removal operations have been completed and the sediment has been disposed of, the bottom of the pond and side slopes may need to be re-graded and/or re-vegetated to repair areas damaged during the removal operations. Vegetation should be selected based on the original landscaping plan prepared for the pond retrofit and should also consider the vegetation communities that have been established since its construction.

7.2.2.2 Remedial Works

Remedial Works are major maintenance activities completed to repair failed components of the pond, and/or to alter pond performance. They include, but are not limited to:

- Structural modifications to the outlet structure components to modify pond performance;
- Reconfiguration of the pond to increase storage;
- Restoration of severely eroded areas at the pond inlets and outlet;
- Significant re-planting to restore pond vegetation lost due to inundation;
- Re-vegetation and re-grading of failed basin side slopes;
- Re-surfacing of access roads; etc.

Information should be provided for any remedial works during the Stormwater Management Pond operation to clarify why the works are required, to present design alternatives, and to demonstrate that the proposed works will be effective. As well, additional monitoring events and/or an increase in inspection frequency may be required to verify the effectiveness of the proposed works.

8.0 SEDIMENT AND EROSION CONTROL

8.1 Sediment/Erosion Control Devices

Construction activities increase the potential for silt and sediment transport off site by surface drainage. In order to control silt and sediment transport off site during construction, typically various control measures are implemented. The following sections provide a brief description of each control device that is to be implemented during the construction of this project. The location of the proposed sediment/erosion control devices is identified on Sheet No. SC1.

8.1.1 Silt Control Fence

Silt Control Fencing is typically installed in areas where sheet flow can be expected prior to storm runoff exiting the site. Silt Control Fencing is to be installed along north and east limits of the site. The Silt Fence is to be erected in accordance with City of Barrie Standard BSD-23A.

8.1.2 Construction Entrance (Mud Mat)

A construction entrance consisting of a stone mud mat is designated for the site located off of Caplan Avenue. The proposed mud-mat will help to limit the amount of sediment transported off the site and on to the adjacent streets by construction vehicles. The mud mat is to be constructed in accordance with City of Barrie Standard BSD-23D.

8.1.3 Rock Check Dams

Rock check dams are often utilized in areas where storm run-off is concentrated (i.e. swales and ditches). A rock check dam is proposed at the end of the existing pond outlet and additional check dams may be implemented during construction as necessary. Rock check dams are to be constructed in accordance with BSD-23B.

8.2 <u>Maintenance of Erosion Control Devices</u>

Proper operation of siltation and sediment control devices is essential during construction of the pond. Erosion and sediment controls should be monitored regularly and repaired as necessary. All devices should be inspected after every rainfall event to ensure the controls are functioning properly.

9.0 <u>CONCLUSIONS</u>

The design of the proposed Stormwater Management Pond retrofit is in accordance with the Policies and Criteria of the MOE, The City of Barrie, and the *Pond LV14 SWM Facility Retrofit Municipal Class EA.*

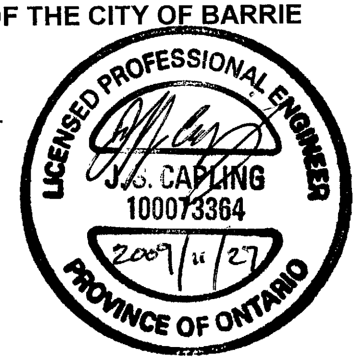
The retrofitted Stormwater Management Pond will provide a quality control level that meets the requirements for "Enhanced Level" protection based on the MOE Guidelines (SWMPD Manual, March 2003).

The retrofitted Stormwater Management Pond will maintain the release of peak flows from the facility at or below the levels currently provided by the existing facility.

Erosion and Sediment Control Measures will be implemented and maintained during construction to prevent silt from being conveyed off site.

All of which is respectfully submitted.

THE CORPORATION OF THE CITY OF BARRIE



J. S. Capling, P. Eng.
JSC/ac

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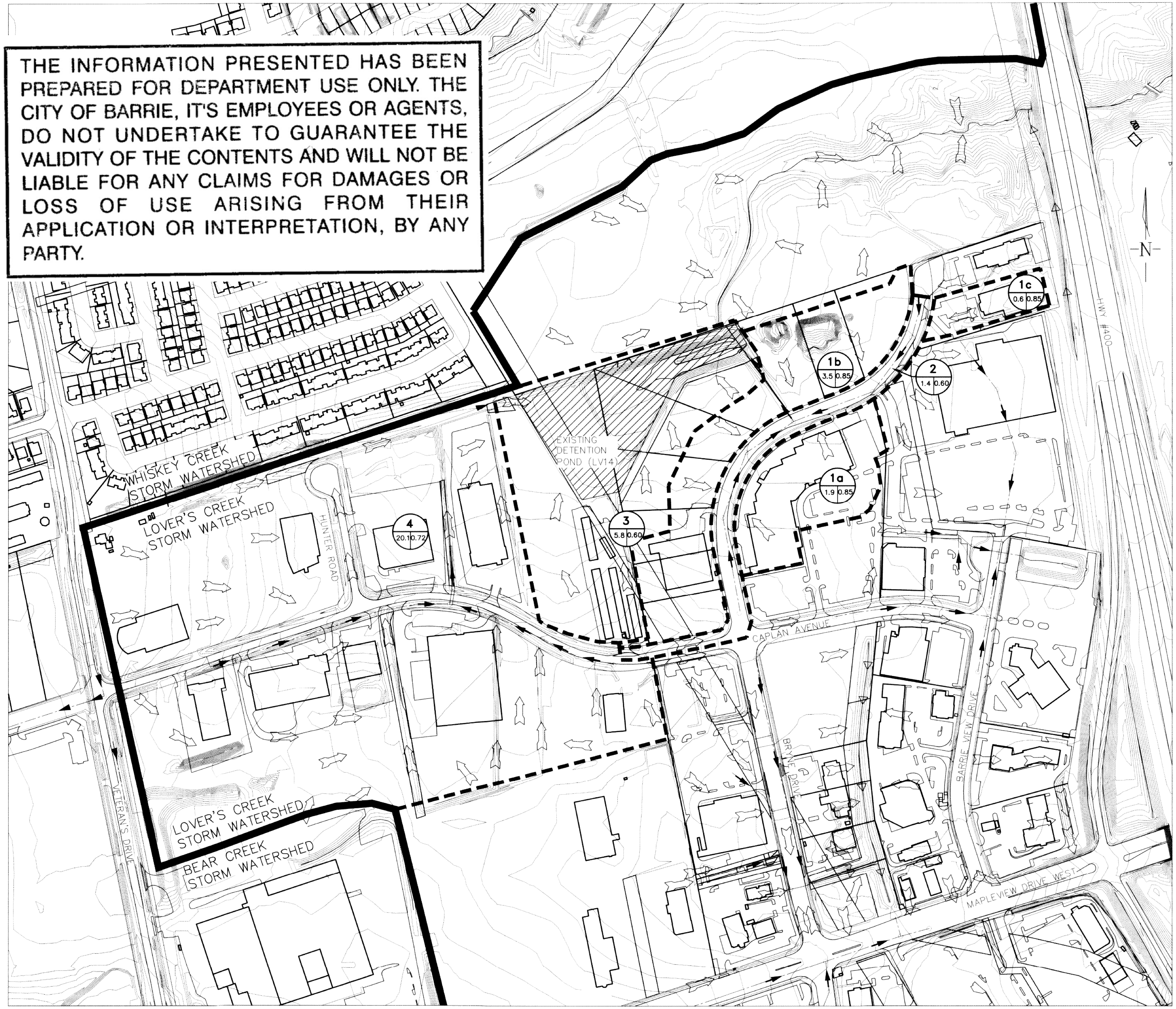

KEY PLAN
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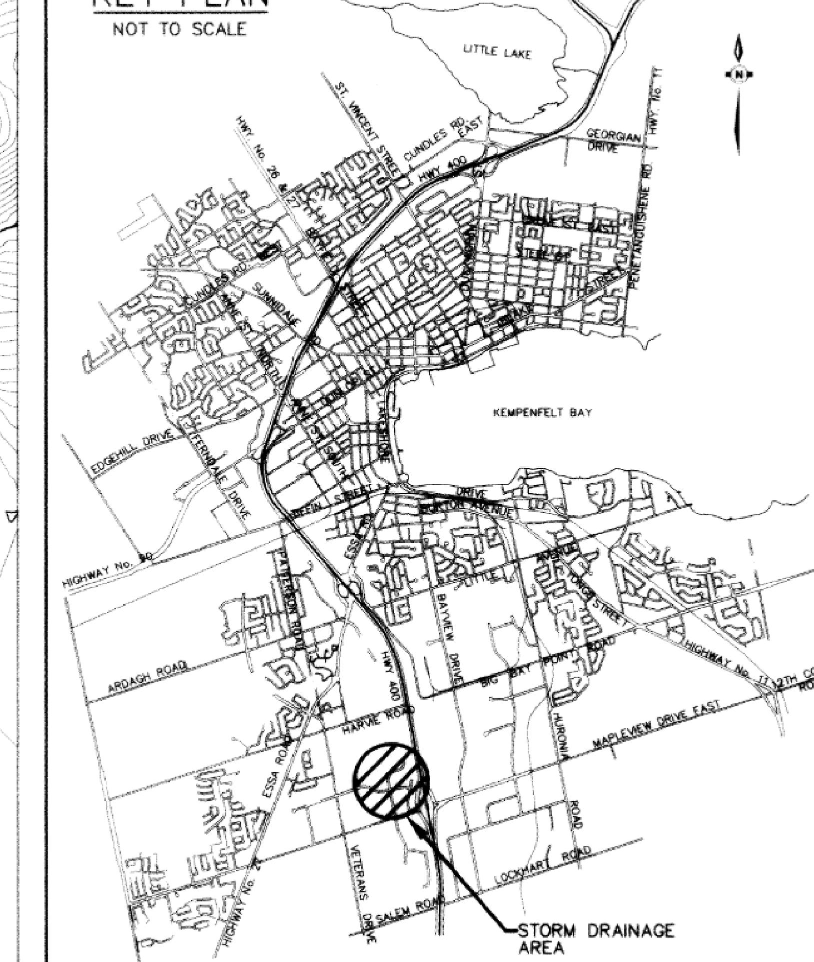

STORM LEGEND

WATERSHED BOUNDARY

CATCHMENT BOUNDARY

MAJOR SYSTEM FLOW

STORM SEWER SYSTEM FLOW

EXISTING STORM SEWER

LOVER'S CREEK TRIBUTARY

DITCH

EXISTING CONTOURS

1 — SUBCATCHMENT AREA
AREA (ha) 7.5 | 0.62 TOTAL IMPERVIOUS (TIMP)

SWM POND

NOTE:
SUBCATCHMENTS 1a, 1b, AND 1c ARE COMBINED AS ONE SUBCATCHMENT AREA IN THE HYDROLOGIC COMPUTER MODEL (AREA =6.10 HECTARES)

NO.	REVISIONS	DATE	APPROVED
1.	ISSUED FOR PERMIT	09/11/27	J.S.C.
2.	REVISED PER LSRCA COMMENTS	10/03/18	J.S.C.
3.	ISSUED FOR TENDER	10/04/09	J.S.C.

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CITY OF BARRIE
APPROVED
DATE 2010/04/07
for DIRECTOR OF MUNICIPAL WORKS

LICENSED PROFESSIONAL ENGINEER
J.S. CAPLING
100073364
2010/04/09
PROVINCE OF ONTARIO

LOVERS CREEK STORMWATER MANAGEMENT POND (LV14) RETROFIT

STORM DRAINAGE PLAN

CITY OF BARRIE INCORPORATED 1853

CITY of BARRIE
ENGINEERING DEPARTMENT

SCALE HOR. 1:2000	VERT. ---	DRAWING NO. 2010-007T
DESIGN T.F.	DRAWN T.F.	SHEET NO. STM1
REVIEWED J.S.C.	DATE 2009.11.27	

2010-007-002