PROPOSED RESIDENTIAL TOWNHOUSE DEVELOPMENT
521 & 525 ESSA ROAD – CITY OF BARRIE
STORM WATER MANAGEMENT REPORT

Prepared by:

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1.0 INTRODUCTION

1.1 General

The proposed development is located on lots 521 and 525 Essa Road approximately 250m north of the Essa Road and Mapleton Avenue intersection. The property is legally described as Part of Lot 10, Lot 11, and Lot 12 of Registered Plan 1080 in the City of Barrie.

The subject site is approximately 0.44 hectares (1.1 acres) in area and is currently occupied by two (2) single-family residential homes. Access to the site is provided directly from Essa Road by two (2) separate asphalt driveways. The site is bounded by Essa Road to the east, a multi-residential senior citizen development to the north, a commercial development to the south, and a residential subdivision to the west. The location of the subject site is illustrated on Figure 1.

The property owner is proposing to construct three (3) blocks of three-storey back to back townhouse units, consisting of 12 units per block, and 12 row townhouse units. Access to the development will be provided from Essa Road in the southeast corner of the site.

1.2 Purpose and Scope

Pinestone Engineering Ltd (PEL) has been retained by Encore Development Group to prepare a Storm Water Management Report in support of a Site Plan Approval. The report describes the storm water quality and quantity control strategy for the site.

2.0 REFERENCE REPORTS

The following reports and studies have been used for reference in the preparation of this Storm Water Management Report:

i) *City of Barrie Storm Drainage and Storm Water Management Policies and Design Guidelines, prepared by the City of Barrie Engineering Department, December 2017*
ii) *LSCRA Technical Guidelines for Storm Water Management Submissions, Effective Date: September 1, 2016*
iii) *Lake Simcoe Protection Plan, June 2009*
iv) *City of Barrie Development Manual, prepared by the City of Barrie Engineering Department, December 2017*
v) *Ministry of the Environment Storm Water Management Planning and Design Manual, March 2003.*
vi) *Low Impact Development Manual prepared by Credit Valley Conservation and Toronto and Region Conservation, 2010*
vii) *City of Barrie Infiltration Low Impact Development Screening Process, 2017*

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521-525 ESSA ROAD

LOCATION PLAN

DATE:	SCALE:	PROJECT No.	FIGURE No.
JUNE 2017	N.T.S.	17-11306B	FIGURE 1

3.0 EXISTING CONDITIONS

3.1 General

The site is currently occupied by two (2) detached single family residential dwellings. Access to both properties is provided directly from the recently reconstructed Essa Road. A 3m wide multi-use asphalt trail runs along the frontage of the property between Essa Road and the east property boundary. Tree stands exists along the south, and west property borders. The site is located within the City's urban servicing area and municipal services are available for connection along Essa Road. Existing services to the residential homes not being utilized for the proposed development will be removed.

3.2 Topography

Based on a review of the topographic survey provided by A. Aziz Surveyors, the property is relatively flat but generally slopes from a high point towards the west and eastern boundaries of the subject side. Elevations across the site range between 314.49m ASL at the northeast corner of the site to 313.71m ASL at the southwest corner.

3.3 Site Geology

A geotechnical investigation was completed by Peto MacCallum Ltd. In July 2018. Field work for this investigation consisted of 8 boreholes advanced to approximately 8m deep. Based on our review of their report, boreholes reveal top-soil was encountered over fill and native layers of clayey silty sand, and sand and silt till. Groundwater levels were recorded at each borehole numbers 1,4, and 7 and range from 1.1m to 2.3m below the ground surface.

Based on the existing clay soil condition encountered throughout the site, infiltration of storm water into underlying native soils is not recommended.

A copy of the geotechnical investigation prepared by Peto MacCallum Ltd. is included in Appendix A.

3.4 Drainage Conditions

Drainage from the site is conveyed in the form of overland sheet flow towards the existing ditch inlet catch basins located at the northwest, and southern property limits. A small portion of external drainage enters the site from the existing multi-residential development to the north as overland sheet flow.

A 750mm diameter storm sewer exists along the frontage of the subject site on Essa Road and conveys drainage southerly towards Mapleton Avenue. Drainage is conveyed easterly along Mapleton Avenue before ultimately discharging to the Whiskey Creek Park storm water management facility (City Pond WK-05). The site is not located within a Lake Simcoe Regional Conservation Authority (LSRCA) regulated area based on available mapping on their website.

4.0 PROPOSED DEVELOPMENT

The proposed development on the property consists of three (3) 12 unit, three-storey, back to back townhouses, and 12 standard townhouses with individual driveways for a total of 48 units. Parking for the back-to-back townhouses will be provided by at grade parking under the building. Two (2) shared terrace areas and a landscape amenity area are also proposed. Access to the development will be provided by one (1) asphalt driveway from Essa Road in the southeast corner of the site.

As part of the site plan submission requirements, a hydrant flow test was also completed by Troy Life and Fire Safety Ltd. on March 22nd, 2016. The results indicate a static pressure of 47 psi (324 kPa) and residual pressure of 38psi (262 kPa) at a flow rate of 1040 GPM (65 L/sec). The flow test results have been submitted under separate cover.

Catchment 201 consisting of drainage from the buildings and driveways will be directed to catch basins installed within the driveway. Storm water will outlet through a Jellyfish Filter treatment unit prior to discharging offsite via a storm sewer connection to the existing storm sewer network on Essa Road. Catchment 202 consisting of landscape areas around the perimeter of the development will flow offsite uncontrolled like pre-development conditions.

Water and sanitary servicing for the development will be provided from existing services along Essa Road. It is noted that there may be an existing well and septic system on the property. If encountered, the well should be abandoned in accordance with Ontario Regulation 903. Any septic / pump tank(s) should be pumped out, crushed in place and material disposed of off-site at an approved dumpsite. Leaching bed pipes should also be removed if encountered on site.

5.0 HYDROLOGY

5.1 Design Criteria

Based on a review of the City of Barrie's Storm Water Management (SWM) Guidelines, the following design criteria, in accordance with the current MOE SWM Planning and Design Manual (MOE, 2003) were established for the proposed development:

Quantity Control:

- Peak flow attenuation for the 2-year through 100-year storm events to pre-development rates based on the Rational Method using the City of Barrie's WPCC IDF parameters.

Quality Control:

- The City of Barrie in accordance with Ontario Regulation 219/09 regarding water quality and phosphorus loading to Lake Simcoe, requires that all new storm water management facilities provide as a minimum the "enhanced" level of protection in accordance with the MOE Storm Water Management Planning and Design Manual (MOE, 2003).

- Preparation of phosphorus and water balance calculations to meet City of Barrie requirements and the Lake Simcoe Protection Plan.

- Preparation of detailed erosion, sediment control and construction mitigation plan to be implemented as part of the construction program.

5.2 Design Storms

We have selected the following design storms as part of our evaluation:

- 2-year design storm
- 5-year design storm
- 10-year design storm
- 25-year design storm
- 50-year design storm
- 100-year design storm

Rainfall intensity - duration frequency (IDF) values for the Barrie Area were entered into an equation that expresses the time relationship intensity for specific frequency, in the form of:

$$i = \frac{a}{(t+b)^c}$$

where: i = intensity, mm/hr.
t = Time of concentration, minutes
a,b,c = constants developed to fit IDF curve

The design storm parameters are outlined in Table 1 below. A copy of the IDF values taken from the City's SWM guidelines is also included in Appendix B.

Table 1
Design Storm Parameters - Chicago Rainfall Distribution

Rainfall Event	Parameter		
	A	B	C
2 Yr	678.085	4.699	0.7810
5 Yr	853.608	4.699	0.7660
10 Yr	975.865	4.699	0.7600
25 Yr	1146.275	4.922	0.7570
50 Yr	1236.152	4.699	0.7510
100 Yr	1426.408	5.273	0.7590

5.3 Drainage Catchments

One (1) pre-development and two (2) post-development catchments have been delineated for the site in order to estimate the corresponding peak runoff rates for the site. The pre-

development catchment area represents the existing condition of the proposed development area, which consists of single-family residential development. The post development catchments represent the proposed grading concept for the development area. The pre-development and post-development catchment parameters are listed in Table 2.

Table 2
Sub-catchment Parameters

Catchments	Area (m^2)	Slope (%)	Composite Runoff Coefficient "C"
Pre-Development			
101	4428	0.5	0.34
Post-Development			
201	3283	1.5	0.86
202	1145	1.0	0.27

Pre-development and post development catchment areas are illustrated on drawings PRE-1 and POST-1 included in Appendix D (envelope at the rear of this report). Composition runoff values were increased for the 10 through 100-year storm events per Table 3.2 in the City's SWM guidelines.

5.4 Rational Method Results

The results from the 2 through 100-year peak storm events are listed in Table 3.

Table 3
Rational Method – Peak Flows

	2Yr	5Yr	10Yr	25Yr	50Yr	100Yr
Pre-Development (m^3/sec)						
Catchment 101	0.035	0.046	0.053	0.068	0.083	0.095
Total Pre-Development	**0.035**	**0.046**	**0.053**	**0.068**	**0.083**	**0.095**
Post Development (m^3/sec)						
Catchment 201	0.065	0.086	0.100	0.128	0.150	0.164
Catchment 202	0.007	0.009	0.011	0.014	0.017	0.019
Total Post Development	**0.072**	**0.095**	**0.110**	**0.142**	**0.166**	**0.183**

Based on the calculated results using the Rational Method, it is expected that post development flows directed to Essa Road will increase due to the proposed construction of the buildings and paved driveway. Rational Method design calculations are included in Appendix B.

6.0 STORM WATER MANAGEMENT PLAN

6.1 Quantity Control

As noted in the comparison of the pre-development and post development flows, an increase in run-off will occur due to the proposed construction of the buildings and paved access driveway. To satisfy the selected design criteria, peak flow attenuation of post development flows to pre-development levels for all storm events up to and including the 100-year storm event will be provided by directing roof drainage and driveway runoff to the proposed subsurface storage tanks located between the back to back town homes.

Peak flow attenuation for catchment 201 (buildings and asphalt driveway) will be achieved using an 81 cubic meter subsurface storage facility consisting of precast holding tanks (or equivalent). Peak flows will be controlled using a 130mm dia. orifice plate installed on the outlet pipe from CBMH#1 at an invert elevation of 311.78m. The maximum ponding elevation for the 5 year and 100-year events will be 312.58m and 313.43m respectively. This limits ponding below the surface of the proposed driveway. Major overland flow from catchment 201 will overflow out of the grate at CBMH#1 and will be directed to Essa Road through the entrance once ponding levels exceed 314.40m within the driveway.

Drainage from catchment 202 which includes the perimeter landscape areas will continue to drain offsite uncontrolled like pre-development conditions. The existing property line drainage swale along the north limit is proposed to be re-graded at 0.5-1.0% to encourage positive drainage to the existing rear yard catch basin located in the City's drainage easement in the northwest corner of the site. The swale design includes a perforated underdrain (french drain) that will be connected to the existing rear yard catch basin.

The stage-storage-discharge relationship of the proposed storage facilities is summarized in Table 4.

Table 4
Stage-Storage-Discharge Relationship of Storage Cells

	Description	Control Stage (m)	Elevation (m)	Volume (m3)	Discharge (m3)
Catchment 201: Storage Tanks (130mm dia. orifice at CBMH#1)	Orifice Invert	0.00	311.780	0	0.0000
	Tank Bottom	0.37	312.150	9.7	0.0209
	Contour	0.72	312.500	29.0	0.0301
	Contour	0.97	312.750	42.8	0.0352
	Contour	1.22	313.000	56.6	0.0396
	Contour	1.47	313.250	70.4	0.0436
	Tank Top	1.67	313.450	81.1	0.0465

Detailed Modified Rational Method calculations, including the control sizing for the orifice and weir are included in Appendix B. The location of the storm water management facilities and further design details are included on the engineering drawings included in Appendix D

(envelope at the rear of this report). The location of the storm water management facilities and details are identified on the engineering plans appended to this report.

Table 5 summarizes the effectiveness of the proposed storm water management attenuation feature based on the hydrologic model results.

Table 5
Model Results – Rational Method

	2Yr	5Yr	10Yr	25Yr	50Yr	100Yr
Pre-Development (m^3/sec)						
Catchment 101	0.035	0.046	0.053	0.068	0.083	0.095
Total Pre-Development	**0.035**	**0.046**	**0.053**	**0.068**	**0.083**	**0.095**
Post Development (m^3/sec)						
Catchment 201	0.065	0.086	0.100	0.128	0.150	0.164
Catchment 202	0.007	0.009	0.011	0.014	0.017	0.019
Total Post Development	**0.072**	**0.095**	**0.110**	**0.142**	**0.166**	**0.183**
Post Development with SWM (m^3/sec)						
Catchment 201 (controlled)	0.027	0.031	0.034	0.040	0.043	0.046
Catchment 202 (uncontrolled)	0.007	0.009	0.011	0.014	0.017	0.019
Total Post Development with SWM	**0.034**	**0.040**	**0.045**	**0.054**	**0.060**	**0.065**

6.2 Quality Control (Total Suspended Solids & Phosphorus Control)

The primary objective of the storm water management plan for this development is to maintain acceptable water quality within the receiving storm sewer and ultimate outfall, Lake Simcoe by maintaining existing site drainage patterns and flow rates. In order to provide water quality enhancement to an “enhanced” level of protection (80% TSS removal) for this development, we have incorporated a “treatment train” approach consisting of the following elements:

- The installation of a Jellyfish Offline Filter Unit-Model JF4-2-1-L1 (ETV verified to remove a minimum of 80% TSS and 59% TP) sized for 80% TSS removal and 90% runoff capture.

- Construction of a french drain swale design along the north property line to promote cleansing and infiltration of runoff.

The potential treatment alternatives have been evaluated with respect to their applicability for this development and implemented in a manner to achieve the best total suspended

solids (TSS) removal possible. Table 6 summarizes the proposed measures that in conglomeration will provide an overall TSS removal of greater than or equal to 80% which meets or exceeds the criteria outlined.

Table 6
Proposed Approach for Water Quality Treatment

Catchment	Method	Effective TSS	Area (m2)	% Area of Site	Overall TSS Removal
201 - Rooftops and asphalt driveway	Jellyfish Filter	80%	3283	74	59.2
202 - Perimeter uncontrolled landscape area	swale / vegetation – clean runoff	80%	1145	26	20.8
Total			**4428**	**100**	**80.0**

The Jellyfish Offline Filter Unit Model JF4-2-1-L1 design report, ETV verification, and the inspection and maintenance procedure are included in Appendix C.

The MOECC's P-Tool was utilized to determine pre and post development phosphorus loadings for the proposed development area. In the pre-development condition, low intensity residential development was used to determine the phosphorus loading. For the post development condition, high intensity residential development was assumed for most of the development area, except for the perimeter landscaping area where transitional land use was assumed. The calculated phosphorus loadings are illustrated on Table 7.

Table 7
Pre & Post Phosphorus Loading

	P Load (kg/yr)
Pre-Development	0.06
Post Development with no BMP's	0.44
Post Development with BMP's	0.18

Imbrium Systems was retained to detail that the proposed Jellyfish Filter Unit Model JF4-2-1-L1 will provide a 59% reduction in total phosphorus per the ETV verification. The Jellyfish unit utilizes membrane encased filter cartridges to provide phosphorus removal. The proposed infiltration French drain system also provides some phosphorus removal benefit. A 60% post development reduction can be achieved on the site when implementing best management practices when considering the poor soil conditions for the purposes of infiltration for further phosphorus removal.

Pre and post development phosphorus budget calculations are included in Appendix B. Sizing calculations and a design report for the proposed treatment unit is included in Appendix C.

6.3 Water Budget

As per City policy 4.1.3 of the Storm Water Policy and Design Guidelines, sites less than 5 ha shall minimize any anticipated changes in the water balance between pre-development and post development conditions and shall provide a minimum infiltration equivalent to the first 5mm of rainfall. Based on a total development area of 4,428m^2, the first 5mm of rainfall to be retained on the site for infiltration equates to 22.1m^3. Initial abstraction values provided in the City's SWM guidelines are shown in Table 8.

Table 8
Initial Abstraction Values

Cover	Initial Abstraction / Depression Storage (mm)
Woods	10
Meadows	8
Cultivated	7
Lawns	5
Impervious areas	3

Adapted from UNESCO, Manual on Drainage in Urbanized Areas, 1987

Using the values provided in Table 10 above, approximately 16.1m^3 of rainfall will be retained on the site through initial abstraction in the post re-development condition.

Based on a review of the geotechnical report prepared for the site, and the infiltration techniques outlined in the MOE SWM Manual (2003) and the LID Manual (2010), infiltration measures are not suitable for the site given the soils condition and development-built form. It is anticipated that the proposed french drain (along north property line) will provide partial water balance benefit as the swale is proposed with a subsurface infiltration trench and underdrain and will provide 6.2m3 of storage for infiltration below the invert of the subdrain (0.5mX0.5mX75m length X0.33 void ratio). The storm water volume retained in the sub-drain system will provide retention of the first 5mm of rainfall onsite when including the post development initial abstraction value of 16.1m^3.

7.0 EROSION AND SEDIMENT CONTROL

7.1 Mitigation Measures

Sedimentation and erosion control measures are required during construction and until such a time that site development has been completed and the driveway area has been paved.

The use of various siltation control measures will be implemented to protect the adjacent properties and receiving waterbodies from migrating sediments. These works include but may not be limited to:

- Installation of siltation fencing along perimeter of the development area.

- Filter cloth / silt sack placement over drains.

- Installation of vehicle tracking mud mat at the entrance to the site.

Prior to carrying out site grading the siltation barriers and mud mats shall be in place. Any onsite storm sewer works will not be permitted to outlet to the municipal sewers until the site has been stabilized. The filter cartridges in the proposed Jellyfish Filter should not be installed until the site has been stabilized.

Other temporary installations of silt fence or other appropriate measures may be required during grading to minimize silt migration from the site. The measures will need to be removed, replaced and relocated as required during the construction period until the site works have been completed and vegetation established. During construction, all stockpiled material will be placed up-gradient of the siltation controls with additional siltation fencing installation around the stock-piles.

7.2 Monitoring and Maintenance During Construction

It is the responsibility of the contractor and owner to maintain the siltation control devices until suitable grass cover has been established upon completion of construction.

A regular review of the facilities by the contractor should be carried out during the construction period to ensure that the facilities are being properly maintained, and if necessary, replaced. Inspection reports are to be completed monthly and distributed to the owner, contractor, and City.

If site works are to continue through the winter and spring the engineer should be contacted by the owner to review the measures in place with the contractor on a regular basis to ensure that the facilities are adequate and in good working order.

All reasonable methods to control erosion and sedimentation are to be taken during construction. The contractor should inspect the siltation devices immediately after each rainfall. Damaged devices should be repaired immediately, and additional devices installed if necessary. Silt should be removed from the fencing and related siltation devices when deposits are noticeable.

Should the erosion control measures fail, and sediment migrate beyond the limits of the control works, additional sedimentation facilities may need to be installed in the area of the migration and down gradient to contain the sediment.

8.0 SUMMARY AND CONCLUSIONS

The findings of this report are summarized as follows:

- Attenuation of peak post development flow rates to below pre-development levels will be provided by utilizing subsurface storage tanks located between the back to back

townhomes. A 130mm dia. orifice plate installed on the outlet pipe from CBMH#1 will control flows to or below pre-development levels.

- Quality control for the development will be provided by an Imbrium Jellyfish Offline Filter Unit (Model JF4-2-1-L1) sized to provide a minimum of 80% TSS removal and 59% removal of annual total phosphorus.

- Post development with BMP implementation phosphorus loadings for the site will be mitigated with the installation of an Imbrium Jellyfish Offline Filter Unit utilizing membrane filtration cartridges in combination with french drain system along the north property boundary.

- Suitable measures can be implemented during construction to protect the adjacent properties and receiving storm sewers from migrating sediments.

It is therefore recommended that:

1) This report and drawings be submitted to the City of Barrie for review and approval.

2) The construction mitigation measures outlined in this report are utilized as a guideline for construction mitigation measures for this site.

All of which is respectfully submitted.
PINESTONE ENGINEERING LTD.

Joe Voisin, P.Eng.
Project Engineer, Partner

APPENDIX A

Geotechnical Investigation – Peto MacCallum Ltd.

PEL
PINESTONE ENGINEERING LTD.

Peto MacCallum Ltd.
CONSULTING ENGINEERS

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
521 AND 525 ESSA ROAD
BARRIE, ONTARIO

for

ENCORE DEVELOPMENT GROUP

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PML Ref.: 18BF030
Report: 1
July 2018

Peto MacCallum Ltd.
CONSULTING ENGINEERS

July 12, 2018

PML Ref.: 18BF030
Report: 1

Mr. Bryan Toteda
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Dear Mr. Toteda

Geotechnical Investigation
Proposed Residential Development
521 and 525 Essa Road
Barrie, Ontario

Peto MacCallum Ltd. (PML) is pleased to present the results of the geotechnical investigation recently completed at the above noted project site. Authorization for the work described in this report was provided by Mr. B. Toteda in the signed Engineering Services Agreement dated April 23, 2018.

Three apartment buildings (about 450 m^2 each) and twelve townhouse units (about 480 m^2 total) are proposed for the property at 521 and 525 Essa Road in Barrie. All buildings will be slab-on-grade and four storeys. A parking garage is planned at the ground floor of the apartments, with three residential floors above the parking garage. Site servicing, paved parking and access are planned for the site. The current planned site configuration is shown on Drawing 1, appended. An existing residence currently occupies each site and both will be demolished prior to site development.

The purpose of this investigation was to assess the subsurface conditions at the site, and based on this information, provide comments and geotechnical engineering recommendations for building foundations, site servicing, and pavement design.

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

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

INVESTIGATION PROCEDURES

The field work for this investigation was conducted on June 11 and 12, 2018, and consisted of Boreholes 1 to 8 advanced to 5.0 m depth. Borehole locations are shown on Drawing 1, appended.

Boreholes locations were established in the field by PML based on a site concept plan provided by the Client and site access. Co-ordination of clearances of underground utilities was provided by PML with the aid of a sub-contracted private utility locating company. Boreholes were drilled cognizant of utility locates.

The boreholes were advanced using continuous flight solid stem augers, powered by a track mounted D-25 drill rig, equipped with a manual hammer, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of PML's engineering staff.

Topsoil encountered at the surface of the boreholes was measured and samples of the material were collected.

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

Piezometers comprised of 32 mm diameter PVC pipe (1.5 m of cut slots at the base), filter sand, bentonite seal and flush-mounted protective casing were installed in three boreholes to permit monitoring of the ground water table. Boreholes without piezometers were backfilled in accordance with O.Reg. 903. As per O.Reg. 903, piezometers become the property of the Owner and will have to be decommissioned when no longer required by the Owner. PML would be pleased to assist in this regard.

Ground surface elevations were referenced to the following Temporary Bench Mark (TBM) provided by the Client, as shown on Drawing 1, and described as follows:

TBM: Temporary Bench Mark
Top of Flange of Fire Hydrant No. 3986

Elevation 314.35 (metric, geodetic)

All recovered samples were returned to our laboratory for moisture content determination and detailed examination to confirm field classification. Grain size analyses were carried out on two samples of the major soil types. The results are presented in Figures 1 and 2, attached. Accompanying Atterberg Limits testing was also completed on one of the samples.

SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Log of Borehole sheets for details of the subsurface conditions, including soil classifications, inferred stratigraphy, Standard Penetration Test N values (N values), ground water observations, piezometer installation details and the results of laboratory moisture content determinations and Atterberg Limits testing.

Due to the soil sampling procedures and the limited size of samples, the depth/elevation demarcations on the borehole logs must be viewed as “transitional” zones, and cannot be construed as exact geologic boundaries between layers. PML should be retained to assist in defining the geological boundaries in the field during construction, if required.

Topsoil was encountered over fill and native layers of clayey silt, silty sand, and sand and silt till. A description of the distribution of the subsurface conditions encountered is provided below.

Topsoil was present at the surface of all boreholes, being 120 to 200 mm thick.

Below the topsoil, a fill unit composed of variable sand and silt content, with trace gravel and local trace organics noted, was observed in all boreholes with the exception of Borehole 1. The fill carried to 0.7 to 2.9 m depth (elevation 312.3 to 313.4). The layer was moist to very moist, with moisture contents of 3 to 25%. N Values were 4 to 26, typically less than 10, indicating variable conditions.

Underlying the fill or topsoil, a native clayey silt layer was encountered in Boreholes 1 to 3 and 5 to 7, carrying to 1.4 to 4.0 m depth (elevation 310.5 to 312.8). A sample of the material from Borehole 6 was submitted for grain size analysis and the results are presented on Figure 1, appended. Atterberg Limits testing showed the material to have a plastic limit of 17% and a liquid limit of 25%. The layer was firm to very stiff based on N Values of 4 to 22, and was about the plastic limit to wetter than plastic limit with moisture contents of 12 to 26%.

Beneath the native clayey silt layer in Borehole 2, a local silty sand layer was encountered to 2.1 m depth (elevation 312.0). The material was compact (N Value of 18) and was very moist with a moisture content of 21%.

A basal silt and sand till deposit was encountered below the upper soil units in all boreholes extending to the 5.0 m depth of exploration in all boreholes. The unit comprised silty sand to sandy silt with trace gravel. Cobbles and boulders were noted. A sample of the material was submitted for grain size analysis and the results are presented on Figure 2, appended. The relative density of the till unit was compact to very dense with N Values of 11 to 65. The till was moist to very moist, with local wet seams, and moisture contents of 7 to 12%.

A summary of the first water strike during drilling, the water/wet cave measurements conducted upon completion of the boreholes, and the water levels recorded in the piezometers on June 20, 2018 is summarized below:

BOREHOLE	FIRST WATER STRIKE DURING DRILLING		WATER LEVEL UPON COMPLETION OF AUGERING		WATER LEVEL IN PIEZOMETERS JUNE 20, 2018	
	Depth (m)	Elevation	Depth (m)	Elevation	Depth (m)	Elevation
1	3.4	310.8	3.7	310.5	1.1	313.1
2	4.6	309.5	No Water	No Water	--	--
3	4.6	310.0	4.0	310.6	--	--
4	4.6	310.2	4.1	310.7	2.3	312.5
5	3.7	310.8	4.0	310.5	--	--
6	4.6	309.9	4.0	310.5	--	--
7	4.0	311.2	4.1	311.1	2.3	312.9
8	4.6	310.2	4.4	310.4	--	--

Based on the above, ground water at the site is residing in wet seams within the till unit. Localized areas of perched water across the site are possible, especially above the till or clayey silt layer.

Ground water levels will fluctuate seasonally, and in response to variations in precipitation.

GEOTECHNCIAL ENGINEERING CONSIDERATIONS

General

Three apartment buildings (about 450 m^2 each) and twelve townhouse units (about 480 m^2 total) are proposed for the property at 521 and 525 Essa Road in Barrie. All buildings will be slab-on-grade and four storeys. A parking garage is planned at the ground floor of the apartments, with three residential floors above the parking garage. Site servicing, paved parking and access are planned for the site. The current planned site configuration is shown on Drawing 1, appended. An existing residence currently occupies each site and both will be demolished prior to site development.

Site Grading and Engineered Fill

The grading for the site has not been set however, for purposes of this report, it is assumed that the ground floor slab for the proposed buildings will be at about elevation 315.0, slightly above the existing site grades across the site. Based on this, exterior footings would normally be founded at about elevation 313.5, with interior footings at about elevation 314.4.

At these levels, the boreholes show the floor slabs and some footings would be founded on existing fill or firm portions of native clayey silt, which are unsuitable to support footings or floor slabs. As such it is recommended that existing fill be removed and grades raised with engineered fill. Both footings and floor slabs could then be supported on engineered fill, locally footings would be supported on native soils.

In the area of the existing houses, the in-situ fill and foundations will have to be removed, such that the extent of the excavation extends to native soil in all directions. It is noted that fill may be deeper around the existing houses than indicated at the borehole locations.

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

- Strip existing topsoil, fill, firm clayey silt (Borehole 1), and other deleterious materials down to native inorganic soil. The excavated soil should be segregated and stockpiled for reuse or disposal. Existing house foundations and associated fill will be removed and the excavation will have to extend to native soil in all directions;

- The clayey silt will typically be exposed as the subgrade soil may become sensitive to traffic if wet or allowed to get wet. Proofroll exposed subgrade, if not wet, using a heavy roller to targeted 100% Standard Proctor maximum dry density, under geotechnical review;

- Following geotechnical review and approval of the subgrade, spread approved material in maximum 200 mm thick lifts and uniformly compacted to 100% Standard Proctor maximum dry density in building areas and 95% Standard Proctor maximum dry density in pavement or site servicing areas. If

wet subgrade conditions are present the initial lift or two of engineered fill shall comprise Granular B Type II;

- Subject to geotechnical review during construction, the excavated sand to silty sand fill is only selectively suitable for reuse as engineered fill, subject to remove of organics, topsoil, oversized (over 150 mm) or otherwise deleterious material. A slight grade raise is anticipated at the site and as such imported fill is anticipated. Imported fill should be utilized under buildings or other structures, with on-site soils used in landscaped areas. Imported material should comprise OPSS Select Subgrade Material (SSM) or OPSS Granular B Type I. Other sources of imported material should be reviewed by our office to ensure suitability;

- The engineered fill pad must extend at least 1 m beyond the structure to be supported, then outwards and downwards at no steeper than 45° to the horizontal to meet the underlying approved native subgrade. In this regard, strict survey control and detailed documentation of the lateral and vertical extent of the engineered fill limits should be carried out to ensure that the engineered fill pad fully incorporates the structure to be supported;

- Engineered fill construction must be carried out under full time field review by PML, to approve sub-excavation and subgrade preparation, backfill materials, placement and compaction procedures, and to verify that the specified compaction standards are achieved throughout.

Foundations

As noted above, footings are anticipated at about elevation 314.4 and 313.5. At these levels, footings will be supported on engineered fill and locally the underlying native soil. Footings supported on native soil and/or engineered fill can be designed for a geotechnical bearing resistance at Serviceability Limit State (SLS) of 150 kPa, and a factored bearing resistance at Ultimate Limit State (ULS) of 225 kPa.

It is noted that in the area of the existing houses, fill will likely be present below the depths noted at the borehole locations. As such, as discussed above, existing fill and foundations once fully removed will have to be replaced with engineered fill.

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

Footings subject to frost action should be provided with a minimum 1.2 m of earth cover or equivalent.

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

Seismic Design

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

Floor Slab-on-Grade

Floor slab-on-grade construction is feasible on engineered fill, constructed as discussed earlier.

A minimum 200 mm thick base layer of crushed stone (nominal 20 mm size) is recommended directly beneath the floor slab. Where a vapour sensitive floor finish is to be used then the use of polyethylene sheeting or similar means should be incorporation as a vapour barrier.

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

Site Servicing

Design details were not finalized at the time of this report. For purposes of this report, inverts are assumed to be up to 3.0 m below existing grades.

Trench Excavation and Ground Water Control

Trench excavation and ground water control are described later in the report under Excavation and Ground Water Control.

Pipe Bedding

Engineered fill or native clayey silt, silty sand, or till is expected at invert levels which is considered satisfactory for pipe support.

Where existing fill or other deleterious material is encountered at the design invert level, such material should be sub-excavated and replaced with an increased thickness of bedding material, subject to geotechnical field review and approval.

Standard Granular A bedding, in accordance with OPSS, compacted to 95% Standard Proctor maximum dry density should be satisfactory. For flexible pipes, bedding and cover material should comprise OPSS Granular A. For rigid pipes, the bedding material should comprise OPSS Granular A and cover material may comprise select native soil free of oversized material.

Trench Backfill

Backfill in trenches should comprise select inorganics soil and be placed in maximum 200 mm thick loose lifts compacted to at least 95% Standard Proctor maximum dry density to minimize post construction settlement in the backfill. Topsoil, organic, excessively wet, frozen, oversized (greater than 200 mm), or otherwise deleterious material should not be incorporated as trench backfill. The moisture content of the trench backfill should be within 2% of the optimum moisture content in order to achieve the specified compaction and be close to optimum moisture content in the upper 1 m to prevent subgrade instability issues. Ideally the backfill should comprise excavated site soil, in order to minimize differential frost heave.

The excavated granular soils will comprise fill, native silty sand, and the till deposit. The native inorganic granular soil should generally be acceptable for reuse subject to geotechnical review during construction and moisture content control. The excavated clayey silt should be utilized in landscaped areas only.

Earthworks operations should be inspected by PML to verify subgrade preparation, backfill materials, placement and compaction efforts and ensure the specified degree of compaction is achieved throughout.

Excavation and Ground Water Control

It is anticipated that excavation for the engineered fill/apartment building foundations and site servicing will extend to about 3.0 m below existing grade possibly deeper in the area of the existing houses for removal of existing fill and foundations. Excavation will encounter fill and native clayey silt/silty sand/till. Harder digging and the presence of boulders should be expected within the till deposit.

Subject to the ground water control as discussed below, the site soils encountered at the site should be considered as Type 3 soil requiring excavation sidewalls to be constructed at no steeper than one horizontal to one vertical (1H:1V) from the base of the excavation in accordance with the Occupational Health and Safety Act.

The ground water table was generally encountered below the anticipated excavation depths noted above. Accordingly, it is expected that nuisance ground water seepage should be managed using conventional sump pumping techniques. The presence of perched water above the till or clayey silt should also be expected.

Water taking in Ontario is governed by the Ontario Water Resources Act (OWRA) and the Water Takings and Transfer Regulation O. Reg. 387/04. Section 34 of the OWRA requires anyone taking more than 50,000 L/d to notify the Ministry of the Environment and Climate Change (MOECC). This requirement applies to all withdrawals, whether for consumption, temporary construction dewatering, or permanent drainage improvements. Where it is assessed than more

than 50,000 L/d but less than 400,000 L/d of ground water taking is required, the Owner can register online via the Environmental Activity and Sector Registry (EASR) system. Where it is assessed that more than 400,000 L/d of ground water taking is required then a Category 3 Permit-to-Take-Water (PTTW) is required.

Based on the conditions revealed in the boreholes, a PTTW or registry on the EASR is not anticipated as the excavation will be above the ground water table. Excavation and ground water control requirements should be reviewed when design details are finalized.

Pavement Design and Construction

Based on the boreholes, it is anticipated that the pavement subgrade will comprise moderately frost susceptible sand/silt fills. Based on this, the following pavement structure thicknesses are recommended:

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

It is not intended to remove all of the existing fill from under the proposed pavement. However, in order to minimize potential settlement issues it is recommended that following rough grading to the subgrade level, subgrade preparation should include proofrolling and compacting the exposed subgrade with a heavy vibratory compactor to 95% Standard Proctor maximum dry density under geotechnical review. Any unstable zones identified during this process should be sub-excavated and replace with compacted select site material, subject to geotechnical field review.

Imported material for the granular base and subbase should conform to OPSS gradation specifications for Granular A and Granular B, and should be compacted to

100% Standard Proctor maximum dry density. Asphalt should be compacted in accordance with OPSS 310.

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

Geotechnical Review and Construction Inspection and Testing

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

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

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

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

CLOSURE

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

Sincerely

Peto MacCallum Ltd.

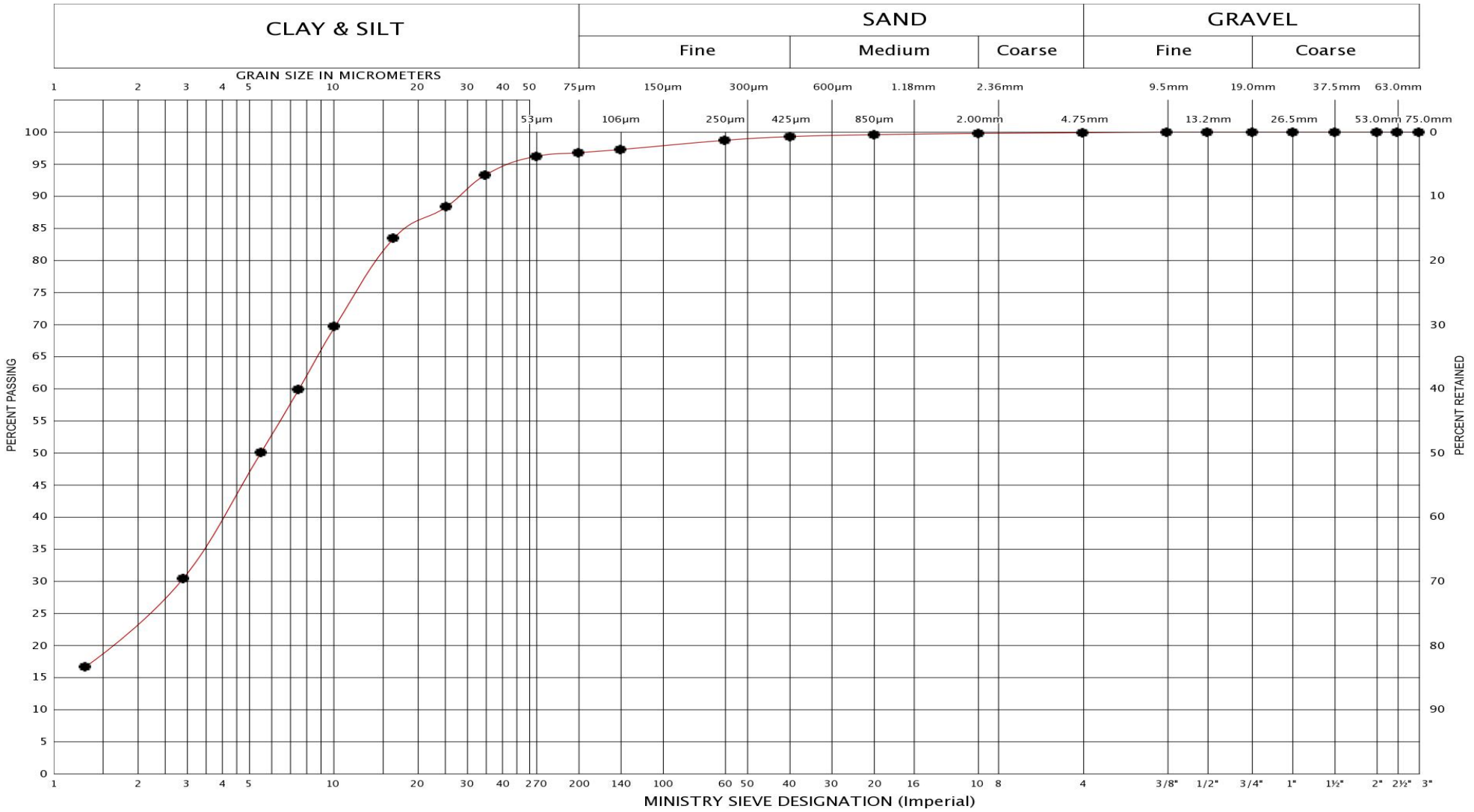
Richard Blair, P.Eng.
Project Engineer, Geotechnical Services

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

RB/GRW:jlb

Enclosures:
Figures 1 and 2 - Particle Size Distribution Charts
List of Abbreviations
Log of Borehole Nos. 1 to 8
Drawing 1 - Borehole Location Plan
Appendix A – Engineered Fill

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	6
	SAMPLE	4
	SYMBOL	●

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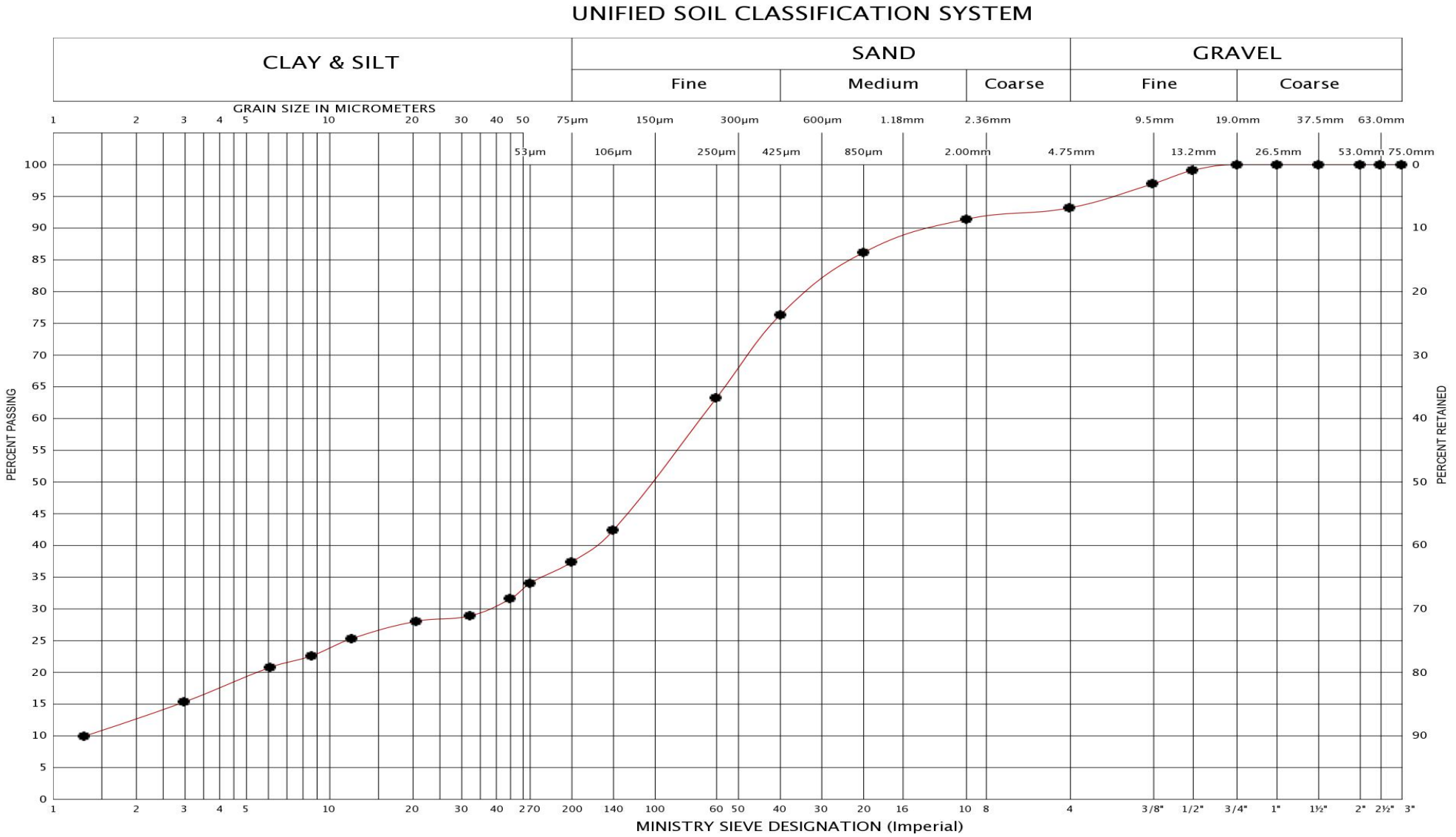
GRAIN SIZE DISTRIBUTION

CLAYEY SILT, Trace Sand; PL: 17%; LL: 25%

FIG No.: 1

Project No.: 18BF030



LEGEND	BH	4
	SAMPLE	4
	SYMBOL	●

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GRAIN SIZE DISTRIBUTION

TILL: Silty Sand, Trace Clay, Trace Gravel

FIG No.: 2

Project No.: 18BF030

LIST OF ABBREVIATIONS

PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

CONSISTENCY	N (blows/0.3 m)	c (kPa)	DENSENESS	N (blows/0.3 m)
Very Soft	0 - 2	0 - 12	Very Loose	0 - 4
Soft	2 - 4	12 - 25	Loose	4 - 10
Firm	4 - 8	25 - 50	Compact	10 - 30
Stiff	8 - 15	50 - 100	Dense	30 - 50
Very Stiff	15 - 30	100 - 200	Very Dense	> 50
Hard	> 30	> 200		

WTLL	Wetter Than Liquid Limit
WTPL	Wetter Than Plastic Limit
APL	About Plastic Limit
DTPL	Drier Than Plastic Limit

TYPE OF SAMPLE

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

PH	Sample Advanced Hydraulically
PM	Sample Advanced Manually

SOIL TESTS

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

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LOG OF BOREHOLE NO. 1

17T 602923E 4910588N

PROJECT Proposed Residential Development - 521 and 525 Essa Road
PML REF. 18BF030
LOCATION Barrie, Ontario
BORING DATE June 12, 2018
ENGINEER GW
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN AT

DEPTH (metres)	ELEV	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
		SURFACE ELEVATION 314.15				
0.0	314.15					
0.20	313.95	TOPSOIL: Dark brown, sandy silt, trace gravel, very moist		1	SS	4
1.0		CLAYEY SILT: Firm, brown to grey, clayey silt, trace sand, APL		2	SS	6
1.4	312.8	SILT AND SAND TILL: Compact to dense, brown, sandy silt to silty sand, trace gravel, cobbles and boulders, moist to very moist (wet seams)		3	SS	29
2.0				4	SS	35
3.0				5	SS	36
4.0						
5.0	309.2			6	SS	43
		BOREHOLE TERMINATED AT 5.0 m				

SHEAR STRENGTH (kPa)
+FIELD VANE △TORVANE ○ Qu
▲POCKET PENETROMETER ○ Q
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

ELEVATION SCALE: 314, 313, 312, 311, 310

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

GROUND WATER OBSERVATIONS AND REMARKS
GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL

Flushmount casing
Concrete
Bentonite seal
32 mm Slotted pipe
Filter sand
First water strike at 3.4 m

Upon completion of augering
Water at 3.7 m
Cave at 4.3 m
Water Level Readings:

Date	Depth	Elev.
2018-06-20	1.1	313.1

NOTES

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LOG OF BOREHOLE NO. 2

17T 602919E 4910569N

PROJECT Proposed Residential Development - 521 and 525 Essa Road
PML REF. 18BF030
LOCATION Barrie, Ontario
BORING DATE June 12, 2018
ENGINEER GW
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN AT

DEPTH (metres)	ELEV	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
		SURFACE ELEVATION 314.10				
0.18	313.92	TOPSOIL: Brown, silty sand, trace gravel, moist		1	SS	5
0.70	313.40	FILL: Brown, sand, trace gravel, trace silt, moist		2	SS	15
1.4	312.7	CLAYEY SILT: Stiff, brown to grey, clayey silt, trace sand, APL		3	SS	18
2.1	312.0	SILTY SAND: Compact, brown, silty sand, trace gravel, very moist		4	SS	36
		SILT AND SAND TILL: Dense to very dense, brown, sandy silt to silty sand, trace gravel, cobbles and boulders, moist to very moist (wet seams)		5	SS	44
5.0	309.1			6	SS	59
		BOREHOLE TERMINATED AT 5.0 m				

ELEVATION SCALE: 314, 313, 312, 311, 310

SHEAR STRENGTH (kPa)
+FIELD VANE △TORVANE ○ Qu
▲POCKET PENETROMETER ○ Q
50 100 150 200

DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

GROUND WATER OBSERVATIONS AND REMARKS

GRAIN SIZE DISTRIBUTION (%)
GR SA SI&CL

First water strike at 4.6 m

Upon completion of augering
No water
Cave at 2.1 m

NOTES

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LOG OF BOREHOLE NO. 3

17T 602952E 4910565N

PROJECT Proposed Residential Development - 521 and 525 Essa Road
PML REF. 18BF030
LOCATION Barrie, Ontario
BORING DATE June 12, 2018
ENGINEER GW
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN AT

DEPTH (metres)	ELEV	DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	SAMPLE TYPE	"N" VALUES	ELEVATION SCALE
		SURFACE ELEVATION 314.55					
0.0	314.40	TOPSOIL: Brown, sand, trace gravel, trace silt, wet		1	SS	7	314
0.15		FILL: Brown, sandy silt to silty sand, trace gravel, moist to very moist		2	SS	7	
1.0							
1.4	313.2	CLAYEY SILT: Stiff to very stiff, brown, clayey silt, trace sand, WTPL to APL		3	SS	8	313
2.0				4	SS	15	312
3.0				5	SS	22	311
4.0	310.6	SILT AND SAND TILL: Dense, grey, sandy silt to silty sand, trace gravel, cobbles and boulders, moist (wet seams)		6	SS	43	310
5.0	309.6	BOREHOLE TERMINATED AT 5.0 m					

SHEAR STRENGTH (kPa)
+FIELD VANE △TORVANE ○ Qu
▲POCKET PENETROMETER O Q
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

GROUND WATER OBSERVATIONS AND REMARKS
GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL

First water strike at 4.6 m

Upon completion of augering
Water at 4.0 m
Cave at 4.4 m

NOTES

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LOG OF BOREHOLE NO. 4

17T 602993E 4910561N

PROJECT Proposed Residential Development - 521 and 525 Essa Road
PML REF. 18BF030
LOCATION Barrie, Ontario
BORING DATE June 11, 2018
ENGINEER GW
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN AT

DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE
	SURFACE ELEVATION 314.75					
0.15 / 314.60	TOPSOIL: Brown, sand, trace gravel, trace silt, moist		1	SS	13	314
	FILL: Brown, silty sand, trace gravel, moist		2	SS	7	
1.4 / 313.4	SILT AND SAND TILL: Compact to dense, brown, sandy silt to silty sand, trace clay, trace gravel, cobbles and boulders, moist (wet seams)		3	SS	20	313
			4	SS	11	312
			5	SS	17	
4.6 / 310.2	Becoming grey		6	SS	38	311
5.0 / 309.8	BOREHOLE TERMINATED AT 5.0 m					310

SHEAR STRENGTH (kPa)
+ FIELD VANE △ TORVANE ○ Qu
▲ POCKET PENETROMETER ○ Q
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

GROUND WATER OBSERVATIONS AND REMARKS
GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL

Upon completion of augering
Water at 4.1 m
No cave
Water Level Readings:

Date	Depth	Elev.
2018-06-20	2.3	312.5

NOTES

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LOG OF BOREHOLE NO. 5

17T 602977E 4910538N

PROJECT Proposed Residential Development - 521 and 525 Essa Road
PML REF. 18BF030
LOCATION Barrie, Ontario
BORING DATE June 11, 2018
ENGINEER GW
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN AT

DEPTH (metres)	ELEV	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH (kPa) / DYNAMIC CONE PENETRATION / STANDARD PENETRATION TEST	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT kN/m³	GROUND WATER OBSERVATIONS AND REMARKS / GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
		SURFACE ELEVATION 314.50									
0.15	314.35	TOPSOIL: Brown, sand, some silt, trace gravel, moist		1	SS	7	314				
		FILL: Brown, sandy silt, trace gravel, trace organics, moist		2	SS	9					
1.4	313.1	CLAYEY SILT: Very stiff, brown to grey, clayey silt, trace sand, trace gravel, APL		3	SS	20	313				
2.1	312.4	SILT AND SAND TILL: Compact to dense, brown, sandy silt to silty sand, trace gravel, cobbles and boulders, moist to very moist (wet seams)		4	SS	16	312				
				5	SS	24	311				First water strike at 3.7 m
4.6	309.9	Becoming grey		6	SS	30	310				
5.0	309.5	BOREHOLE TERMINATED AT 5.0 m									Upon completion of augering Water at 4.0 m Cave at 4.3 m

SHEAR STRENGTH (kPa): + FIELD VANE △ TORVANE ○ Qu ▲ POCKET PENETROMETER O Q (50 100 150 200)
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ● (20 40 60 80)
WATER CONTENT (%) (10 20 30 40)

NOTES

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LOG OF BOREHOLE NO. 6

17T 602922E 4910537N

PROJECT Proposed Residential Development - 521 and 525 Essa Road
PML REF. 18BF030
LOCATION Barrie, Ontario
BORING DATE June 12, 2018
ENGINEER GW
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN AT

DEPTH (metres)	ELEV	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	SHEAR STRENGTH (kPa) + FIELD VANE △ TORVANE ○ Qu ▲ POCKET PENETROMETER ○ Q / DYNAMIC CONE PENETRATION × STANDARD PENETRATION TEST ●	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT kN/m³	GROUND WATER OBSERVATIONS AND REMARKS / GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
		SURFACE ELEVATION 314.50						50 100 150 200 / 20 40 60 80	10 20 30 40		
0.16	314.34	TOPSOIL: Brown, silty sand, trace gravel, moist		1	SS	9	314				
		FILL: Brown, silty sand, trace gravel, moist		2	SS	14					
1.4	313.1	CLAYEY SILT: Stiff to very stiff, brown to grey, clayey silt, trace sand, trace gravel, APL to WTPL		3	SS	10	313				
				4	SS	13	312				
				5	SS	17	311				
4.0	310.5	SILT AND SAND TILL: Very dense, brown, sandy silt to silty sand, trace gravel, cobbles and boulders, very moist (wet seams)		6	SS	65	310				First water strike at 4.6 m
5.0	309.5	BOREHOLE TERMINATED AT 5.0 m									Upon completion of augering Water at 4.0 m Cave at 4.4 m

NOTES

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CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 7

17T 602964E 4910525N

PROJECT Proposed Residential Development - 521 and 525 Essa Road
PML REF. 18BF030
LOCATION Barrie, Ontario
BORING DATE June 11, 2018
ENGINEER GW
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN AT

DEPTH (metres)	ELEV	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES
		SURFACE ELEVATION 315.15				
0.0	315.03	TOPSOIL: Brown, sand, trace gravel, trace silt, moist		1	SS	4
0.12		FILL: Brown, sand trace gravel, trace silt, moist to very moist		2	SS	5
1.0				3	SS	15
2.0	313.1	Becoming silty sand		4	SS	26
2.1						
2.9	312.3	CLAYEY SILT: Very stiff, brown, clayey silt, trace sand, WTPL		5	SS	21
3.0						
4.0	311.2	SILT AND SAND TILL: Compact, grey, sandy silt to silty sand, trace gravel, cobbles and boulders, very moist (wet seams)		6	SS	15
4.0						
5.0	310.2	BOREHOLE TERMINATED AT 5.0 m				

SHEAR STRENGTH (kPa)
+ FIELD VANE △ TORVANE ○ Qu
▲ POCKET PENETROMETER ○ Q
50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
20 40 60 80

ELEVATION SCALE: 315, 314, 313, 312, 311

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

GROUND WATER OBSERVATIONS AND REMARKS
GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL

Flushmount casing
Concrete
Bentonite seal
32 mm Slotted pipe
Filter sand
First water strike at 4.0 m

Upon completion of augering
Water at 4.1 m
No cave
Water Level Readings:

Date	Depth	Elev.
2018-06-20	2.3	312.9

NOTES

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 8

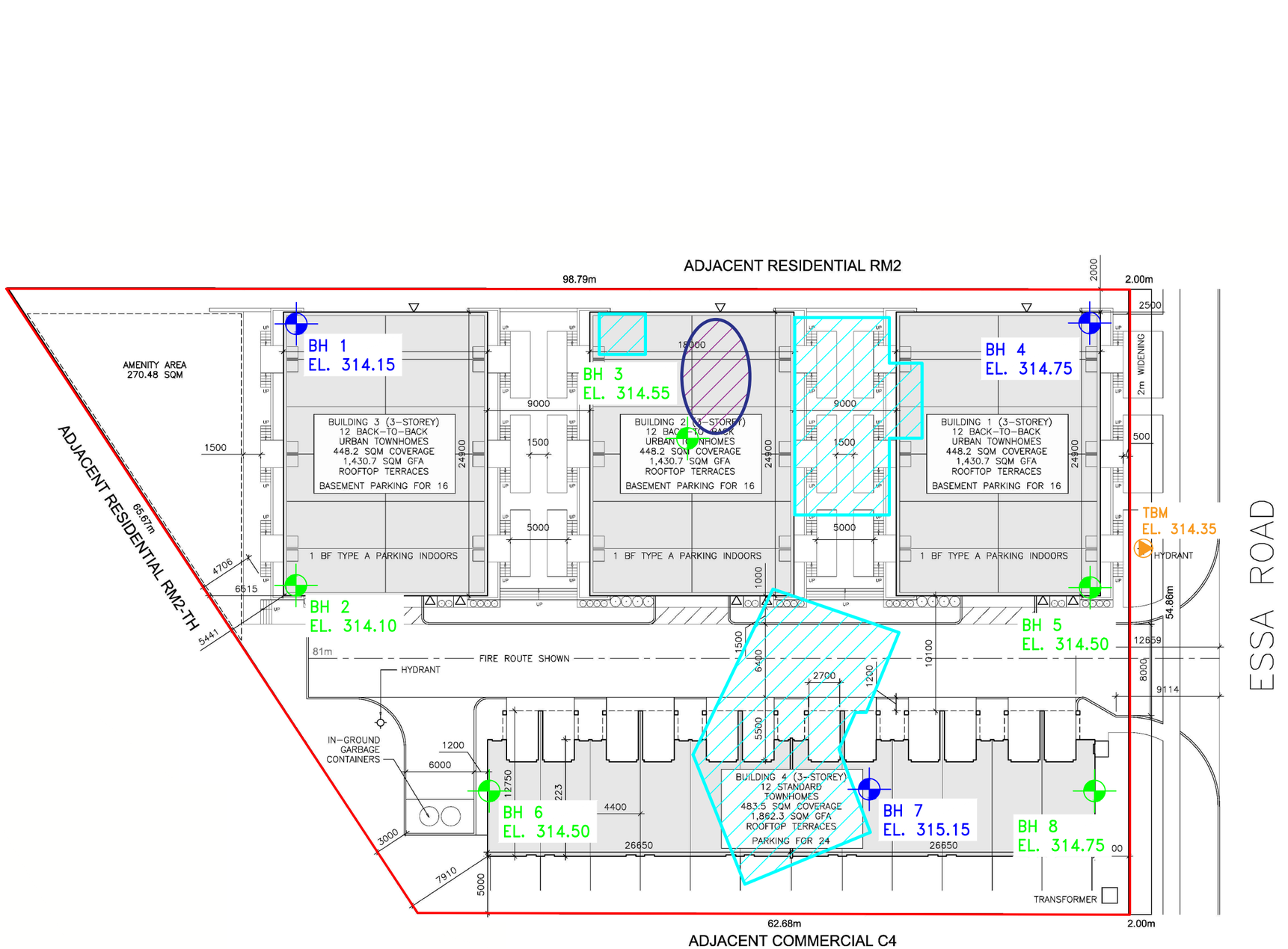
17T 602975E 4910529N

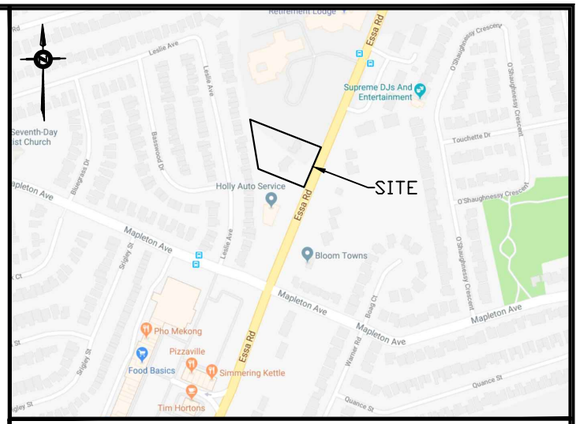
PROJECT Proposed Residential Development - 521 and 525 Essa Road
PML REF. 18BF030
LOCATION Barrie, Ontario
BORING DATE June 11, 2018
ENGINEER GW
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN AT

DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH (kPa) / DYNAMIC CONE PENETRATION	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT kN/m³	GROUND WATER OBSERVATIONS AND REMARKS / GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
	SURFACE ELEVATION 314.75									
0.18 314.57	TOPSOIL: Dark brown, silty sand, trace gravel, moist FILL: Brown, sandy silt, trace gravel, wood pieces, very moist		1	SS	4	314				
			2	SS	8					
			3	SS	5	313				
2.1 312.7	SILT AND SAND TILL: Compact to dense, brown to grey, sandy silt to silty sand, trace gravel, cobbles and boulders, moist (wet seams)		4	SS	26	312				
			5	SS	22					
						311				
5.0 309.8	BOREHOLE TERMINATED AT 5.0 m		6	SS	47	310				First water strike at 4.6 m Upon completion of augering Wet cave at 4.4 m

SHEAR STRENGTH (kPa): + FIELD VANE △ TORVANE ○ Qu ▲ POCKET PENETROMETER ○ Q; 50 100 150 200
DYNAMIC CONE PENETRATION × STANDARD PENETRATION TEST ●: 20 40 60 80
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%): 10 20 30 40

NOTES





KEY PLAN
BARRIE, ONTARIO

LEGEND:

- SITE LIMITS
- APPROXIMATE LOCATION OF EXISTING BUILDINGS TO BE DEMOLISHED
- APPROXIMATE LOCATION OF EXISTING ABOVE GRADE POOL TO BE REMOVED
- BH 1 EL. 314.15 — BOREHOLE 1 (WITH PIEZOMETER) SURFACE ELEVATION
- BH 2 EL. 314.10 — BOREHOLE 2 SURFACE ELEVATION
- TBM EL. 314.35 — TEMPORARY BENCH MARK TOP OF FLANGE OF FIRE HYDRANT #3986 ELEVATON 314.35 (METRIC, GEODETIC)

REFERENCE:

BASE PLAN PROVIDED BY CLIENT.

0m 5 10 15 20 25

SCALE

BOREHOLE LOCATION PLAN

PROPOSED RESIDENTIAL DEVELOPMENT
521 AND 525 ESSA ROAD
BARRIE, ONTARIO

Peto MacCallum Ltd.
CONSULTING ENGINEERS

		DATE	SCALE	PML REF.	DRAWING NO.
DRAWN	RB	JULY 2018	AS SHOWN	18BF030	1
CHECKED	GW				
APPROVED	GW				

APPENDIX A

Engineered Fill

ENGINEERED FILL

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

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

1. Purpose

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

2. Minimum Extent

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

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

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

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

3. Survey Control

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

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

4. Subsurface Preparation

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

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

5. Suitable Fill Materials

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

6. Test Section

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

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

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

7. Inspection and Testing

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

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

8. Protection of Fill

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

9. Construction Delay Time Considerations

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

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

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

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

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

10. Approved Fill Pad Surveillance

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

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

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

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

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

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

11. Unusual Working Conditions

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

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

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

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

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

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

APPENDIX B

Storm Water Management Calculations

PINESTONE ENGINEERING LTD.

3.2.1 *Service Area*

The drainage system shall be designed to accommodate all upstream drainage areas plus any external area tributary to the system for the existing, interim and ultimate development conditions, as determined by the delineation of appropriate topographic mapping and the preparation of drainage plans.

3.2.2 *Design Flow*

Storm sewer systems with a drainage area ≤ 50 ha shall be designed to convey the 1:5 year (minimum) design storm using the Rational Method and the City's IDF regression equation for rainfall intensity unless otherwise approved or directed by the City. Storm sewer systems with a drainage area > 50 ha shall be designed using an approved computer program and verified with the Rational Method. The storm sewer design shall be based on the larger of the two flows calculated using the computer model and the Rational Method. Under no circumstances shall the storm system be designed in a surcharged condition.

The design of the storm sewers shall be computed using the City of Barrie's Storm Sewer Design Sheet as provided in **Appendix A.**

All storm sewers shall be designed according to the Rational Formula where:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

Q = the design flow in (m^3/s)
C = the site specific runoff coefficient
A = the drainage area (ha)
i = rainfall intensity (mm/hr)

The rainfall intensity shall be calculated in accordance with the following table and equation:

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

Parameter	Return Period					
	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
A	678.085	853.608	975.865	1146.275	1236.152	1426.408
B	4.699	4.699	4.699	4.922	4.699	5.273
C	0.781	0.766	0.760	0.757	0.751	0.759

Rainfall Intensity, I (mm/hr) = $A/(t+B)^C$, where t is time duration in minutes
Parameters based on rain gauge data for the period 1979 – 2003 for the Barrie WPCC Station #6110557
Based on a review of the literature, the IDF intensity values for Barrie WPCC Station were increased by 15% before calculating a, b, c values to account for climate change

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

where,

i = the rainfall intensity (mm/hr)
t_d = the storm duration (minutes)
A, B, C = a function of the local intensity-duration data.

The storm duration is set to the time of concentration (i.e. the sewer inlet time plus the time of travel in the pipe or channel) for the total cumulative drainage area to the node of interest. The maximum inlet time for the first pipe of a storm sewer system is 10 minutes.

The runoff coefficient shall be calculated in accordance with the following table:

Table 3.2: Runoff Coefficients (Rational *C*) (5-yr to 10-yr) Based on Hydrologic Soil Group

Land Use	Runoff Coefficient "C"		
	A-AB	B-BC	C-D
Cultivated Land, 0 - 5% grade	0.22	0.35	0.55
Cultivated Land, 5 - 10% grade	0.30	0.45	0.60
Cultivated Land, 10 - 30% grade	0.40	0.65	0.70
Pasture Land, 0 - 5% grade	0.10	0.28	0.40
Pasture Land, 5 - 10% grade	0.15	0.35	0.45
Pasture Land, 10 - 30% grade	0.22	0.40	0.55
Woodlot or Cutover, 0 – 5% grade	0.08	0.25	0.35
Woodlot or Cutover, 5 - 10% grade	0.12	0.30	0.42
Woodlot or Cutover, 10 - 30% grade	0.18	0.35	0.52
Lakes and Wetlands	0.05	0.05	0.05
Impervious Area (i.e., buildings, roads, parking lots, etc.)	0.95	0.95	0.95
Gravel (not to be used for proposed parking or storage areas)	0.40	0.50	0.60
Residential – Single Family	0.30	0.40	0.50
Residential – Multiple (i.e., semi, townhouse, apartment)	0.50	0.60	0.70
Industrial – light	0.55	0.65	0.75
Industrial – heavy	0.65	0.75	0.85
Commercial	0.60	0.70	0.80
Unimproved Areas	0.10	0.20	0.30
Lawn, < 2% grade	0.05	0.11	0.17
Lawn, 2 - 7% grade	0.10	0.16	0.22
Lawn, > 7% grade	0.15	0.25	0.35

Adapted from Design Chart 1.07, Ontario Ministry of Transportation, "MTO Drainage Management Manual," MTO (1997)

An approximation of the runoff coefficient can be calculated based on the following relationship with:

$$c = (0.7)(TIMP) + 0.2$$

where,

c = the runoff coefficient

TIMP = total impervious fraction (dimensionless)

The runoff coefficient shall be adjusted for return period events greater than the 10-yr storm per the following table:

Table 3.3: Runoff Coefficient Adjustment for 25-yr to 100-yr Storms

Return Period	Runoff Coefficient "C"
25 years	$C_{25} = 1.1*C_5$
50 years	$C_{50} = 1.2*C_5$
100 years	$C_{100} = 1.25*C_5$

Adapted from Design Chart 1.07, Ontario Ministry of Transportation, "MTO Drainage Management Manual," MTO, (1997).
Note: When applying the runoff coefficient adjustment, the maximum c-value should not exceed 1.0.

Given that the direct connection of foundation drains to the storm sewer is not permitted, a detailed HGL analysis is typically not required unless deemed otherwise by the City due to special circumstances. Refer to **Section 7.3** for details regarding HGL analysis requirements.

The calculation of total percent impervious (TIMP) values for modeling shall be in accordance with **Section 7.2.5** (**Table 7.6**).

3.2.3 Pipe Capacity and Size

The storm sewer capacity shall be calculated using the Manning's equation assuming the pipe is flowing full as follows:

$$Q=\left[\frac{1}{n}\right]A(R)^{\frac{2}{3}}(S)^{\frac{1}{2}}$$

where,

Q = the pipe capacity (m3/s)
n = the Manning roughness value
R = the hydraulic radius (m)
S = the sewer pipe slope (m/m).

A maximum inlet time of 10 minutes shall be used for the first pipe of a storm sewer system.

The velocity of flow in the storm sewer (assuming pipe flowing full) shall be calculated as follows:

$$v=\left[\frac{Q}{A}\right]$$

where,

Q = flow in the pipe when flowing full (m3/s)
A = cross sectional area of the pipe (m2)

The appropriate roughness coefficients shall be used as identified in **Table 3.4**.
The minimum size for a storm sewer (within a street) shall be 300 mm in diameter. No decrease of pipe size from a larger size upstream to a smaller size downstream shall be allowed regardless of the increase in grade.

3.2.4 Roughness Coefficients

The following roughness coefficients shall be used for hydraulic calculations of storm sewers:

521-525 Essa Road

MODIFIED RATIONAL METHOD - PRE-DEVELOPMENT CATCHMENT 101

City of Barrie

Project Number: 17-11306.1B
Date: November 6, 2018
Design By: JHV
File: Z:\Project Documents\11306B 521&525 Essa Road\11306.1B SITE PLAN APPROVAL\SWM\MRM SWM Calculations - JHV Final.xls

IDF Curve Parameters				Intensity
Storm Event	A	B	C	(mm/hr)
2 year	678.085	4.699	0.7810	83.11
5 year	853.608	4.699	0.7660	108.92
10 year	975.865	4.699	0.7600	126.55
25 year	1146.275	4.922	0.7570	148.15
50 year	1236.152	4.699	0.7510	164.22
100 year	1426.408	5.273	0.7590	180.15

Tc = 10.0 minutes

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

I = average rainfall intensity (mm/hr)
A,B,C, = the IDF equation coefficients (dimensionless)
T_c = time of concentration (min)

Runoff Coefficients	
Land Use	"C"
Unimproved Area	0.30
Pasture Land	0.40
Woodlot	0.35
Lakes / Swamps	0.05
Impervious Area	0.95
Building Area	0.95
Gravel	0.60
Lawn	0.17
X	0.00
Y	0.00
Z	0.00

Time of Concentration Calculations:

Catchment Parameters			
Catchment ID	=	101	
Catchment Area	=	0.4428	ha
Flow Length	=	35	m
Slope	=	0.005	m/m
Weighted Runoff Coefficient	=	0.34	

Pre-Development Runoff Coefficients:

Catchment	Total Area (m^2)	Unimproved Area (m^2)	Pasture Area (m^2)	Woodlot Area (m^2)	Lakes/Swamps Area (m^2)	Impervious Area (m^2)	Building Area (m^2)	Gravel Area (m^2)	Lawn Area (m^2)	X Area (m^2)	Y Area (m^2)	Z Area (m^2)	Weighted C
101	4,428			95			950		3,383				0.34

Runoff Coefficient Adjustment for 25-100 yr Storm Events:

Catchment	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
101	0.34	0.34	0.34	0.38	0.41	0.43

Pre-Development Peak Flow Rates:

Catchment	2-Year (m^3/s)	5-Year (m^3/s)	10-Year (m^3/s)	25-Year (m^3/s)	50-Year (m^3/s)	100-Year (m^3/s)
101	0.035	0.046	0.053	0.068	0.083	0.095

Notes:

1) Runoff coefficients from City of Barrie Storm Drainage and SWM Policies and Design Guidelines Table 3.2
2) Runoff coefficients for events greater than the 10 year storm have been adjusted as per City Policies and Guidelines Table 3.3

521-525 Essa Road

MODIFIED RATIONAL METHOD - POST DEVELOPMENT CATCHMENT 201

City of Barrie

Project Number: 17-11306.1B
Date: November 6, 2018
Design By: JHV
File: Z:\Project Documents\11306B 521&525 Essa Road\11306.1B SITE PLAN APPROVAL\SWM\MRM SWM Calculations - JHV Final.xls

IDF Curve Parameters				Intensity
Storm Event	A	B	C	(mm/hr)
2 year	678.085	4.699	0.7810	83.11
5 year	853.608	4.699	0.7660	108.92
10 year	975.865	4.699	0.7600	126.55
25 year	1146.275	4.922	0.7570	148.15
50 year	1236.152	4.699	0.7510	164.22
100 year	1426.408	5.273	0.7590	180.15

Tc = 10.0 minutes

$$i = \frac{A}{(t_c + B)^c}$$

I = average rainfall intensity (mm/hr)
A,B,C, = the IDF equation coefficients (dimensionless)
T_c = time of concentration (min)

Runoff Coefficients	
Land Use	"C"
Unimproved Area	0.30
Pasture Land	0.40
Woodlot	0.35
Lakes / Swamps	0.05
Impervious Area	0.95
Building Area	0.95
Gravel	0.60
Lawn	0.17
X	0.00
Y	0.00
Z	0.00

Time of Concentration Calculations:

Catchment Parameters			
Catchment ID	=	201	
Catchment Area	=	0.3283	ha
Flow Length	=	20	m
Slope	=	0.015	m/m
Weighted Runoff Coefficient	=	0.86	

Pre-Development Runoff Coefficients:

Catchment	Total Area (m^2)	Unimproved Area (m^2)	Pasture Area (m^2)	Woodlot Area (m^2)	Lakes/Swamps Area (m^2)	Impervious Area (m^2)	Building Area (m^2)	Gravel Area (m^2)	Lawn Area (m^2)	X Area (m^2)	Y Area (m^2)	Z Area (m^2)	Weighted C
201	3,283						2,918		365				0.86

Runoff Coefficient Adjustment for 25-100 yr Storm Events:

Catchment	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
201	0.86	0.86	0.86	0.95	1.00	1.00

Post-Development Peak Flow Rates:

Catchment	2-Year (m^3/s)	5-Year (m^3/s)	10-Year (m^3/s)	25-Year (m^3/s)	50-Year (m^3/s)	100-Year (m^3/s)
201	0.065	0.086	0.100	0.128	0.150	0.164

Notes:

1) Runoff coefficients from City of Barrie Storm Drainage and SWM Policies and Design Guidelines Table 3.2
2) Runoff coefficients for events greater than the 10 year storm have been adjusted as per City Policies and Guidelines Table 3.3

521-525 Essa Road

MODIFIED RATIONAL METHOD - POST DEVELOPMENT CATCHMENT 202

City of Barrie

Project Number: 17-11306.1B
Date: November 6, 2018
Design By: JHV
File: Z:\Project Documents\11306B 521&525 Essa Road\11306.1B SITE PLAN APPROVAL\SWM\MRM SWM Calculations - JHV Final.xls

IDF Curve Parameters				Intensity
Storm Event	A	B	C	(mm/hr)
2 year	678.085	4.699	0.7810	83.11
5 year	853.608	4.699	0.7660	108.92
10 year	975.865	4.699	0.7600	126.55
25 year	1146.275	4.922	0.7570	148.15
50 year	1236.152	4.699	0.7510	164.22
100 year	1426.408	5.273	0.7590	180.15

Tc = 10.0 minutes

$$i = \frac{A}{(t_c + B)^c}$$

I = average rainfall intensity (mm/hr)
A,B,C, = the IDF equation coefficients (dimensionless)
T_c = time of concentration (min)

Runoff Coefficients	
Land Use	"C"
Unimproved Area	0.30
Pasture Land	0.40
Woodlot	0.35
Lakes / Swamps	0.05
Impervious Area	0.95
Building Area	0.95
Gravel	0.60
Lawn	0.17
X	0.00
Y	0.00
Z	0.00

Time of Concentration Calculations:

Catchment Parameters			
Catchment ID	=	202	
Catchment Area	=	0.1145	ha
Flow Length	=	30	m
Slope	=	0.01	m/m
Weighted Runoff Coefficient	=	0.27	

Pre-Development Runoff Coefficients:

Catchment	Total Area (m^2)	Unimproved Area (m^2)	Pasture Area (m^2)	Woodlot Area (m^2)	Lakes/Swamps Area (m^2)	Impervious Area (m^2)	Building Area (m^2)	Gravel Area (m^2)	Lawn Area (m^2)	X Area (m^2)	Y Area (m^2)	Z Area (m^2)	Weighted C
202	1,145					140			1,005				0.27

Runoff Coefficient Adjustment for 25-100 yr Storm Events:

Catchment	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
202	0.27	0.27	0.27	0.29	0.32	0.33

Post-Development Peak Flow Rates:

Catchment	2-Year (m^3/s)	5-Year (m^3/s)	10-Year (m^3/s)	25-Year (m^3/s)	50-Year (m^3/s)	100-Year (m^3/s)
202	0.007	0.009	0.011	0.014	0.017	0.019

Notes:

1) Runoff coefficients from City of Barrie Storm Drainage and SWM Policies and Design Guidelines Table 3.2
2) Runoff coefficients for events greater than the 10 year storm have been adjusted as per City Policies and Guidelines Table 3.3

521-525 Essa Road

MODIFIED RATIONAL METHOD - PRE TO POST DEVELOPMENT FLOW SUMMARY

City of Barrie

PINESTONE ENGINEERING LTD.

Project Number:	17-11306.1B
Date:	November 6, 2018
Design By:	JHV
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Storm Event	2 Year (m^3/s)	5 Year (m^3/s)	10 Year (m^3/s)	25 Year (m^3/s)	50 Year (m^3/s)	100 Year (m^3/s)
Pre-Development Catchment 101	0.035	0.046	0.053	0.068	0.083	0.095
Total Pre-Development Flow	0.035	0.046	0.053	0.068	0.083	0.095
Post Development Catchment 201 (controlled)	0.065	0.086	0.100	0.128	0.150	0.164
Post Development Catchment 202 (uncontrolled)	0.007	0.009	0.011	0.014	0.017	0.019
Total Post Development Flow	0.072	0.095	0.110	0.142	0.166	0.183
Total Difference from Post to Pre	**0.038**	**0.049**	**0.057**	**0.074**	**0.084**	**0.089**
Allowable Post Development flow from Catchment 201	**0.028**	**0.037**	**0.042**	**0.055**	**0.066**	**0.076**

521-525 Essa Road

Quantity Control Storage Calculations - Catchment 201

City of Barrie

Project Number: 17-11306.1B
Date: November 6, 2018
Design By: JHV
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2 Year Storm Event

Total Area	0.3283 ha.		
Runoff Coefficient	0.86		
Release Rate	27.0 l/sec <= allowable of	0.028	(m3/sec)
Tc	10.0		

Time (mins.)	Intensity (mm/hr)	Peak Inflow (m^3/sec)	Release Rate (m^3/sec)	Required Storage Volume (m^3)	
10.0	83.1	0.066	0.027	23.34987542	
11	78.9	0.063	0.027	23.50396366	
12	75.2	0.060	0.027	23.51699455	<- Required Volume
13	71.9	0.057	0.027	23.40906774	
14	68.9	0.055	0.027	23.19640547	
15	66.1	0.052	0.027	22.89226908	
16	63.6	0.050	0.027	22.50762353	
17	61.3	0.049	0.027	22.05162812	
18	59.2	0.047	0.027	21.53200454	
19	57.2	0.045	0.027	20.95531699	
20	55.4	0.044	0.027	20.32718818	
21	53.7	0.043	0.027	19.65246785	
22	52.1	0.041	0.027	18.93536574	
23	50.7	0.040	0.027	18.17955747	
24	49.3	0.039	0.027	17.3882697	
25	48.0	0.038	0.027	16.56434921	
26	46.8	0.037	0.027	15.71031927	
27	45.6	0.036	0.027	14.82842617	
28	44.5	0.035	0.027	13.92067767	
29	43.5	0.034	0.027	12.98887516	
30	42.5	0.034	0.027	12.03464057	
31	41.6	0.033	0.027	11.05943914	
32	40.7	0.032	0.027	10.06459871	
33	39.8	0.032	0.027	9.051326119	
34	39.0	0.031	0.027	8.020721352	
35	38.3	0.030	0.027	6.973789598	
36	37.5	0.030	0.027	5.911451729	
37	36.8	0.029	0.027	4.834553368	
38	36.1	0.029	0.027	3.743872785	
39	35.5	0.028	0.027	2.640127791	
40	34.9	0.028	0.027	1.523981777	
41	34.3	0.027	0.027	0.396049036	
42	33.7	0.027	0.027	-0.743100562	
43	33.1	0.026	0.027	-1.892937415	
44	32.6	0.026	0.027	-3.052968521	
45	32.1	0.025	0.027	-4.222734203	
46	31.6	0.025	0.027	-5.401805195	
47	31.1	0.025	0.027	-6.58978004	
48	30.7	0.024	0.027	-7.78628275	
49	30.2	0.024	0.027	-8.990960713	
50	29.8	0.024	0.027	-10.2034828	
51	29.4	0.023	0.027	-11.42353769	

Control Flow:

Orifice Flow

Orifice Diameter	=	0.13
Orifice Area	=	0.0133
Orifice Centroid	=	311.85

Storage Elevation (m)	Hydraulic Head (m)	Flow (m3/sec)	Flow (L/sec)
312.4	0.55	0.0270	27.0

*Orifice Flow = C * Area * (2*9.81 * Hydraulic Head) ^0.5*
where C = 0.62, A = area of the orifice and H = hydraulic head

5 Year Storm Event

Total Area	0.3283	ha.	
Runoff Coefficient	0.86		
Release Rate	31.1	l/sec <= allowable of	0.037 (m3/sec)
Tc	10.0		

Time (mins.)	Intensity (mm/hr)	Peak Inflow (m^3/sec)	Release Rate (m^3/sec)	Required Storage Volume (m^3)	
10.0	108.9	0.086	0.031	33.17525931	
11	103.6	0.082	0.031	33.68793571	
12	98.8	0.078	0.031	34.01658275	
13	94.5	0.075	0.031	34.18712137	
14	90.6	0.072	0.031	34.22050682	<- Required Volume
15	87.0	0.069	0.031	34.13389671	
16	83.8	0.067	0.031	33.94149919	
17	80.8	0.064	0.031	33.65519998	
18	78.1	0.062	0.031	33.28503335	
19	75.5	0.060	0.031	32.83954097	
20	73.2	0.058	0.031	32.32604894	
21	71.0	0.056	0.031	31.75088424	
22	69.0	0.055	0.031	31.11954555	
23	67.0	0.053	0.031	30.43683962	
24	65.2	0.052	0.031	29.70699089	
25	63.6	0.050	0.031	28.9337306	
26	62.0	0.049	0.031	28.12036955	
27	60.5	0.048	0.031	27.26985819	
28	59.0	0.047	0.031	26.38483639	
29	57.7	0.046	0.031	25.46767497	
30	56.4	0.045	0.031	24.52051069	
31	55.2	0.044	0.031	23.54527566	
32	54.0	0.043	0.031	22.54372244	
33	52.9	0.042	0.031	21.51744532	
34	51.9	0.041	0.031	20.46789867	
35	50.9	0.040	0.031	19.39641268	
36	49.9	0.040	0.031	18.30420699	
37	49.0	0.039	0.031	17.19240245	
38	48.1	0.038	0.031	16.06203151	
39	47.3	0.038	0.031	14.91404711	
40	46.5	0.037	0.031	13.74933065	
41	45.7	0.036	0.031	12.56869888	
42	44.9	0.036	0.031	11.37291006	
43	44.2	0.035	0.031	10.16266936	
44	43.5	0.035	0.031	8.93863369	
45	42.8	0.034	0.031	7.70141597	
46	42.2	0.033	0.031	6.451588955	
47	41.6	0.033	0.031	5.189688653	
48	41.0	0.033	0.031	3.916217391	
49	40.4	0.032	0.031	2.631646566	
50	39.8	0.032	0.031	1.336419124	
51	39.3	0.031	0.031	0.030951797	

Control Flow:

Orifice Flow

Orifice Diameter	=	0.13
Orifice Area	=	0.0133
Orifice Centroid	=	311.85

Storage Elevation (m)	Hydraulic Head (m)	Flow (m3/sec)	Flow (L/sec)
312.58	0.73	0.0311	31.1

*Orifice Flow = C * Area * (2*9.81 * Hydraulic Head) ^0.5*
where C = 0.62, A = area of the orifice and H = hydraulic head

10 Year Storm Event

Total Area	0.3283 ha		
Runoff Coefficient	0.86		
Release Rate	34.2 l/sec <= allowable of	0.042	(m3/sec)
Tc	10.0		

Time (mins.)	Intensity (mm/hr)	Peak Inflow (m^3/sec)	Release Rate (m^3/sec)	Required Storage Volume (m^3)	
10.0	126.5	0.100	0.034	39.73678389	
11	120.4	0.096	0.034	40.47665289	
12	114.9	0.091	0.034	41.00314084	
13	109.9	0.087	0.034	41.34616413	
14	105.4	0.084	0.034	41.52992402	
15	101.3	0.080	0.034	41.57424829	<- Required Volume
16	97.6	0.077	0.034	41.49556617	
17	94.1	0.075	0.034	41.30762938	
18	91.0	0.072	0.034	41.02205397	
19	88.0	0.070	0.034	40.64873338	
20	85.3	0.068	0.034	40.19615756	
21	82.8	0.066	0.034	39.67166219	
22	80.4	0.064	0.034	39.08162576	
23	78.2	0.062	0.034	38.43162666	
24	76.1	0.060	0.034	37.72656976	
25	74.1	0.059	0.034	36.97078913	
26	72.3	0.057	0.034	36.1681322	
27	70.6	0.056	0.034	35.32202898	
28	68.9	0.055	0.034	34.43554968	
29	67.4	0.053	0.034	33.51145272	
30	65.9	0.052	0.034	32.55222507	
31	64.5	0.051	0.034	31.56011641	
32	63.1	0.050	0.034	30.53716805	
33	61.9	0.049	0.034	29.48523762	
34	60.6	0.048	0.034	28.40602033	
35	59.5	0.047	0.034	27.30106713	
36	58.4	0.046	0.034	26.17180053	
37	57.3	0.045	0.034	25.0195283	
38	56.3	0.045	0.034	23.84545537	
39	55.3	0.044	0.034	22.65069427	
40	54.3	0.043	0.034	21.43627429	
41	53.4	0.042	0.034	20.20314951	
42	52.6	0.042	0.034	18.95220594	
43	51.7	0.041	0.034	17.68426779	
44	50.9	0.040	0.034	16.40010307	
45	50.1	0.040	0.034	15.10042855	
46	49.4	0.039	0.034	13.78591421	
47	48.7	0.039	0.034	12.45718721	
48	48.0	0.038	0.034	11.11483544	
49	47.3	0.038	0.034	9.75941075	
50	46.6	0.037	0.034	8.391431791	
51	46.0	0.036	0.034	7.011386642	

Control Flow:

Orifice Flow

Orifice Diameter	=	0.13
Orifice Area	=	0.0133
Orifice Centroid	=	311.85

Storage Elevation (m)	Hydraulic Head (m)	Flow (m3/sec)	Flow (L/sec)
312.73	0.88	0.0342	34.2

*Orifice Flow = C * Area * (2*9.81 * Hydraulic Head) ^0.5*
where C = 0.62, A = area of the orifice and H = hydraulic head

25 Year Storm Event

Total Area	0.3283	ha	
Runoff Coefficient	0.95		
Release Rate	39.8	l/sec <= allowable of	0.055 (m3/sec)
Tc	10.0		

Time (mins.)	Intensity (mm/hr)	Peak Inflow (m^3/sec)	Release Rate (m^3/sec)	Required Storage Volume (m^3)	
10.0	148.2	0.129	0.040	53.73525094	
11	141.1	0.123	0.040	55.01892284	
12	134.7	0.118	0.040	56.02568378	
13	129.0	0.113	0.040	56.79388051	
14	123.8	0.108	0.040	57.35462074	
15	119.0	0.104	0.040	57.73345336	
16	114.7	0.100	0.040	57.95159431	
17	110.7	0.097	0.040	58.02683643	<- Required Volume
18	107.0	0.093	0.040	57.97423552	
19	103.6	0.090	0.040	57.80663481	
20	100.5	0.088	0.040	57.53507117	
21	97.5	0.085	0.040	57.16909328	
22	94.8	0.083	0.040	56.71701354	
23	92.2	0.080	0.040	56.18610946	
24	89.8	0.078	0.040	55.58278617	
25	87.5	0.076	0.040	54.91270852	
26	85.3	0.074	0.040	54.1809094	
27	83.3	0.073	0.040	53.39187918	
28	81.4	0.071	0.040	52.54964001	
29	79.6	0.069	0.040	51.65780792	
30	77.8	0.068	0.040	50.71964515	
31	76.2	0.067	0.040	49.73810428	
32	74.6	0.065	0.040	48.71586587	
33	73.1	0.064	0.040	47.65537048	
34	71.7	0.063	0.040	46.55884628	
35	70.3	0.061	0.040	45.42833275	
36	69.0	0.060	0.040	44.2657012	
37	67.8	0.059	0.040	43.07267265	
38	66.6	0.058	0.040	41.85083336	
39	65.4	0.057	0.040	40.60164843	
40	64.3	0.056	0.040	39.32647377	
41	63.3	0.055	0.040	38.02656661	
42	62.2	0.054	0.040	36.70309478	
43	61.3	0.053	0.040	35.35714495	
44	60.3	0.053	0.040	33.98972996	
45	59.4	0.052	0.040	32.60179528	
46	58.5	0.051	0.040	31.19422488	
47	57.6	0.050	0.040	29.7678464	
48	56.8	0.050	0.040	28.32343582	
49	56.0	0.049	0.040	26.86172168	
50	55.2	0.048	0.040	25.38338882	
51	54.5	0.048	0.040	23.88908183	

Control Flow:

Orifice Flow

Orifice Diameter	=	0.13
Orifice Area	=	0.0133
Orifice Centroid	=	311.85

Storage Elevation (m)	Hydraulic Head (m)	Flow (m3/sec)	Flow (L/sec)
313.04	1.19	0.0398	39.8

*Orifice Flow = C * Area * (2*9.81 * Hydraulic Head) ^0.5*
where C = 0.62, A = area of the orifice and H = hydraulic head

50 Year Storm Event

Total Area	0.3283	ha	
Runoff Coefficient	1.00		
Release Rate	43.3	l/sec <= allowable of	0.066 (m3/sec)
Tc	10.0		

Time (mins.)	Intensity (mm/hr)	Peak Inflow (m^3/sec)	Release Rate (m^3/sec)	Required Storage Volume (m^3)	
10.0	164.2	0.151	0.043	64.60680722	
11	156.3	0.144	0.043	66.26236946	
12	149.2	0.137	0.043	67.59817689	
13	142.8	0.131	0.043	68.65874969	
14	137.1	0.126	0.043	69.48013841	
15	131.8	0.121	0.043	70.09190658	
16	127.0	0.117	0.043	70.5185725	
17	122.6	0.113	0.043	70.78067634	
18	118.5	0.109	0.043	70.89558276	<- Required Volume
19	114.7	0.105	0.043	70.87809316	
20	111.2	0.102	0.043	70.74091891	
21	108.0	0.099	0.043	70.49505144	
22	104.9	0.096	0.043	70.15005477	
23	102.0	0.094	0.043	69.71429909	
24	99.4	0.091	0.043	69.19514893	
25	96.8	0.089	0.043	68.59911606	
26	94.5	0.087	0.043	67.93198471	
27	92.2	0.085	0.043	67.19891479	
28	90.1	0.083	0.043	66.40452765	
29	88.1	0.081	0.043	65.55297777	
30	86.2	0.079	0.043	64.64801293	
31	84.3	0.078	0.043	63.69302515	
32	82.6	0.076	0.043	62.69109395	
33	81.0	0.074	0.043	61.64502323	
34	79.4	0.073	0.043	60.55737299	
35	77.9	0.072	0.043	59.43048661	
36	76.4	0.070	0.043	58.2665144	
37	75.1	0.069	0.043	57.06743418	
38	73.7	0.068	0.043	55.83506909	
39	72.5	0.067	0.043	54.57110321	
40	71.2	0.065	0.043	53.27709531	
41	70.1	0.064	0.043	51.95449092	
42	68.9	0.063	0.043	50.60463296	
43	67.8	0.062	0.043	49.22877123	
44	66.8	0.061	0.043	47.82807076	
45	65.8	0.060	0.043	46.4036193	
46	64.8	0.060	0.043	44.95643401	
47	63.9	0.059	0.043	43.48746736	
48	63.0	0.058	0.043	41.99761257	
49	62.1	0.057	0.043	40.48770835	
50	61.2	0.056	0.043	38.95854329	
51	60.4	0.056	0.043	37.41085972	

Control Flow:

Orifice Flow

Orifice Diameter	=	0.13
Orifice Area	=	0.0133
Orifice Centroid	=	311.85

Storage Elevation (m)	Hydraulic Head (m)	Flow (m3/sec)	Flow (L/sec)
313.26	1.41	0.0433	43.3

*Orifice Flow = C * Area * (2*9.81 * Hydraulic Head) ^0.5*
where C = 0.62, A = area of the orifice and H = hydraulic head

100 Year Storm Event

Total Area	0.3283	ha	
Runoff Coefficient	1.00		
Release Rate	45.8	l/sec <= allowable of	0.076 (m3/sec)
Tc	10.0		

Time (mins.)	Intensity (mm/hr)	Peak Inflow (m^3/sec)	Release Rate (m^3/sec)	Required Storage Volume (m^3)	
10.0	180.2	0.166	0.046	71.87170397	
11	171.7	0.158	0.046	73.92222058	
12	164.1	0.151	0.046	75.61356948	
13	157.2	0.145	0.046	76.99478029	
14	151.0	0.139	0.046	78.10576978	
15	145.3	0.134	0.046	78.97942417	
16	140.1	0.129	0.046	79.6431269	
17	135.3	0.124	0.046	80.11989831	
18	130.9	0.120	0.046	80.42925873	
19	126.7	0.117	0.046	80.58789105	
20	122.9	0.113	0.046	80.61015557	<- Required Volume
21	119.4	0.110	0.046	80.50849463	
22	116.0	0.107	0.046	80.29375399	
23	112.9	0.104	0.046	79.97544034	
24	109.9	0.101	0.046	79.56192959	
25	107.2	0.099	0.046	79.06063668	
26	104.6	0.096	0.046	78.47815495	
27	102.1	0.094	0.046	77.82037153	
28	99.8	0.092	0.046	77.09256333	
29	97.5	0.090	0.046	76.2994774	
30	95.4	0.088	0.046	75.44539874	
31	93.4	0.086	0.046	74.53420758	
32	91.5	0.084	0.046	73.56942823	
33	89.7	0.082	0.046	72.55427082	
34	88.0	0.081	0.046	71.49166717	
35	86.3	0.079	0.046	70.38430169	
36	84.7	0.078	0.046	69.23463822	
37	83.2	0.076	0.046	68.0449433	
38	81.7	0.075	0.046	66.81730648	
39	80.3	0.074	0.046	65.55365814	
40	79.0	0.073	0.046	64.25578512	
41	77.7	0.071	0.046	62.92534448	
42	76.4	0.070	0.046	61.56387571	
43	75.2	0.069	0.046	60.17281148	
44	74.1	0.068	0.046	58.75348724	
45	72.9	0.067	0.046	57.30714978	
46	71.9	0.066	0.046	55.83496487	
47	70.8	0.065	0.046	54.33802405	
48	69.8	0.064	0.046	52.81735082	
49	68.8	0.063	0.046	51.27390611	
50	67.9	0.062	0.046	49.70859329	
51	67.0	0.062	0.046	48.12226262	

Control Flow:

Orifice Flow

Orifice Diameter	=	0.13
Orifice Area	=	0.0133
Orifice Centroid	=	311.85

Storage Elevation (m)	Hydraulic Head (m)	Flow (m3/sec)	Flow (L/sec)
313.43	1.58	0.046	45.8

*Orifice Flow = C * Area * (2*9.81 * Hydraulic Head) ^0.5*
where C = 0.62, A = area of the orifice and H = hydraulic head

521-525 Essa Road
STAGE STORAGE DISCHARGE RELATIONSHIP
City of Barrie

Project Number: 17-11306.1B
Date: November 6, 2018
File: Z:\Project Documents\11306B 521&525 Essa Road\11306.1B SITE PLAN APPROVAL\SWM\MRM SWM Calculations - JHV Final.xls

Orifice Calculations $Q_o=C_d*A_o*(2*g*H_o)^{0.5}$			
	Orifice 1	**Orifice 2**	**Orifice 3**
C_d	0.62	0	0
Centroid (m)	311.85	1000	1000
Width (m)	0.000	0.000	0.000
Diameter/Height (m)	0.130	0.000	0.00
Type (H/V)	V	V	V

Cd	Description
0.62	Orifice Plate
0.8	Orifice Tube

Weir Calculations $Q_w=C_w*(H_w)^{1.5}*((L-0.2*H_w)+(0.8*TAN(THETA)*H_w))$	
Cw	1.60
Invert (m)	314.4
Length (m)	8
Side Slope (H:V)	1
Side Slope (rad)	0.785

Stage Discharge Relationship for Retention Tank

Stage	Active Volume	Orifice 1									Weir Flow	Total Flow	Comments
		Area	H_o	Flow									
m	m^3	m^2	m	m^3/s							m^3/s	m^3/s	
311.78	0	0.0133	0.00	0.0000							0.0000	0.0000	Orifice Invert
311.80	0.1	0.0133	0.00	0.0000							0.0000	0.0000	
311.82	0.2	0.0133	0.00	0.0000							0.0000	0.0000	
311.84	0.3	0.0133	0.02	0.0052							0.0000	0.0052	Orifice Centroid
311.86	0.5	0.0133	0.04	0.0073							0.0000	0.0073	
311.88	0.6	0.0133	0.06	0.0089							0.0000	0.0089	
311.90	0.8	0.0133	0.08	0.0103							0.0000	0.0103	
311.92	1	0.0133	0.10	0.0115							0.0000	0.0115	
311.94	2	0.0133	0.12	0.0126							0.0000	0.0126	
311.96	3	0.0133	0.14	0.0136							0.0000	0.0136	
311.98	4.1	0.0133	0.16	0.0146							0.0000	0.0146	
312.00	5	0.0133	0.18	0.0155							0.0000	0.0155	
312.05	6.2	0.0133	0.23	0.0175							0.0000	0.0175	
312.10	7.5	0.0133	0.28	0.0193							0.0000	0.0193	
312.15	9.7	0.0133	0.33	0.0209							0.0000	0.0209	Tank Bottom
312.2	12.459	0.0133	0.38	0.0225							0.0000	0.0225	
312.25	15.218	0.0133	0.43	0.0239							0.0000	0.0239	
312.3	17.977	0.0133	0.48	0.0253							0.0000	0.0253	
312.35	20.736	0.0133	0.53	0.0265							0.0000	0.0265	
312.4	23.495	0.0133	0.58	0.0278							0.0000	0.0278	
312.45	26.254	0.0133	0.63	0.0289							0.0000	0.0289	
312.5	29.013	0.0133	0.68	0.0301							0.0000	0.0301	
312.55	31.772	0.0133	0.73	0.0311							0.0000	0.0311	
312.6	34.531	0.0133	0.78	0.0322							0.0000	0.0322	
312.65	37.29	0.0133	0.83	0.0332							0.0000	0.0332	
312.7	40.049	0.0133	0.88	0.0342							0.0000	0.0342	
312.75	42.808	0.0133	0.93	0.0352							0.0000	0.0352	
312.8	45.567	0.0133	0.98	0.0361							0.0000	0.0361	
312.85	48.326	0.0133	1.03	0.0370							0.0000	0.0370	
312.9	51.085	0.0133	1.08	0.0379							0.0000	0.0379	
312.95	53.844	0.0133	1.13	0.0387							0.0000	0.0387	
313	56.603	0.0133	1.18	0.0396							0.0000	0.0396	
313.05	59.362	0.0133	1.23	0.0404							0.0000	0.0404	
313.1	62.121	0.0133	1.28	0.0412							0.0000	0.0412	
313.15	64.88	0.0133	1.33	0.0420							0.0000	0.0420	
313.2	67.639	0.0133	1.38	0.0428							0.0000	0.0428	
313.25	70.398	0.0133	1.43	0.0436							0.0000	0.0436	
313.3	73.157	0.0133	1.48	0.0443							0.0000	0.0443	
313.35	75.916	0.0133	1.53	0.0451							0.0000	0.0451	
313.4	78.675	0.0133	1.58	0.0458							0.0000	0.0458	
313.45	81.054	0.0133	1.63	0.0465							0.0000	0.0465	U/S Tank

521-525 Essa Road

Storage Volume Calculations

City of Barrie

PINESTONE ENGINEERING LTD.

Project Number: 17-11306.1B
Date: November 6, 2018
Design By: JHV
File: Z:\Project Documents\11306B 521&525 Essa Road\11306.1B SITE PLAN APPROVAL\SWM\MRM SWM Calculations - JHV Final.xls

300mm dia. STM Sewer = 66.5m

Area of pipe = 0.0707m2
Volume = 4.7m3
Volume of Structures = 5m3

Storage Tank (25,000 L)
Area = 18.79m2
Volume per 5cm = 0.9395m3

Tank Height 1.3m
Total Tank Storage = 24.4m3
(Using 2 tanks = 48.8)

Storage Tank (11,200 L)
Volume per 5cm = 0.44m3
(Volume = 22.5m3 using 2 tanks)

Total storage with pipes and tank = 81m3

	Stage	(25000 Tanks) Volume (m3)	(11200 Tanks) Volume (m3)	Total With Pipes
Storage Tank Bottom	312.15	0	0.000	9.700
	312.2	1.879	0.880	12.459
	312.25	3.758	1.760	15.218
	312.3	5.637	2.640	17.977
	312.35	7.516	3.520	20.736
	312.4	9.395	4.400	23.495
	312.45	11.274	5.280	26.254
	312.5	13.153	6.160	29.013
	312.55	15.032	7.040	31.772
	312.6	16.911	7.920	34.531
	312.65	18.79	8.800	37.290
	312.7	20.669	9.680	40.049
	312.75	22.548	10.560	42.808
	312.8	24.427	11.440	45.567
	312.85	26.306	12.320	48.326
	312.9	28.185	13.200	51.085
	312.95	30.064	14.080	53.844
	313	31.943	14.960	56.603
	313.05	33.822	15.840	59.362
	313.1	35.701	16.720	62.121
	313.15	37.58	17.600	64.880
	313.2	39.459	18.480	67.639
	313.25	41.338	19.360	70.398
	313.3	43.217	20.240	73.157
	313.35	45.096	21.120	75.916
	313.4	46.975	22.000	78.675
U/S Tank	313.45	48.854	22.500	81.054

521-525 Essa Road

FLOW SUMMARY WITH SWM IN EFFECT

City of Barrie

PINESTONE ENGINEERING LTD.

Project Number: 17-11306.1B
Date: November 6, 2018
Design By: JHV
File: Z:\Project Documents\113068 521&525 Essa Road\11306 1B SITE PLAN APPROVAL\SWM\MRM SWM Calculations - JHV Final.xls

Storm Event	2 Year (m^3/s)	5 Year (m^3/s)	10 Year (m^3/s)	25 Year (m^3/s)	50 Year (m^3/s)	100 Year (m^3/s)
Pre-Development Catchment 101	0.035	0.046	0.053	0.068	0.083	0.095
Total Pre-Development Flow	0.035	0.046	0.053	0.068	0.083	0.095
Post Development Catchment 201 (controlled)	0.027	0.031	0.034	0.040	0.043	0.046
Post Development Catchment 202 (uncontrolled)	0.007	0.009	0.011	0.014	0.017	0.019
Total Post Development Flow (with SWM)	0.034	0.040	0.045	0.054	0.060	0.065

25,000 LITRE PRECAST CONCRETE WATER HOLDING TANK MODEL H25.1L

WILKINSON HEAVY PRECAST LIMITED
DUNDAS, ONTARIO 1-800-263-8503
www.wilkinsonheavyprecast.com

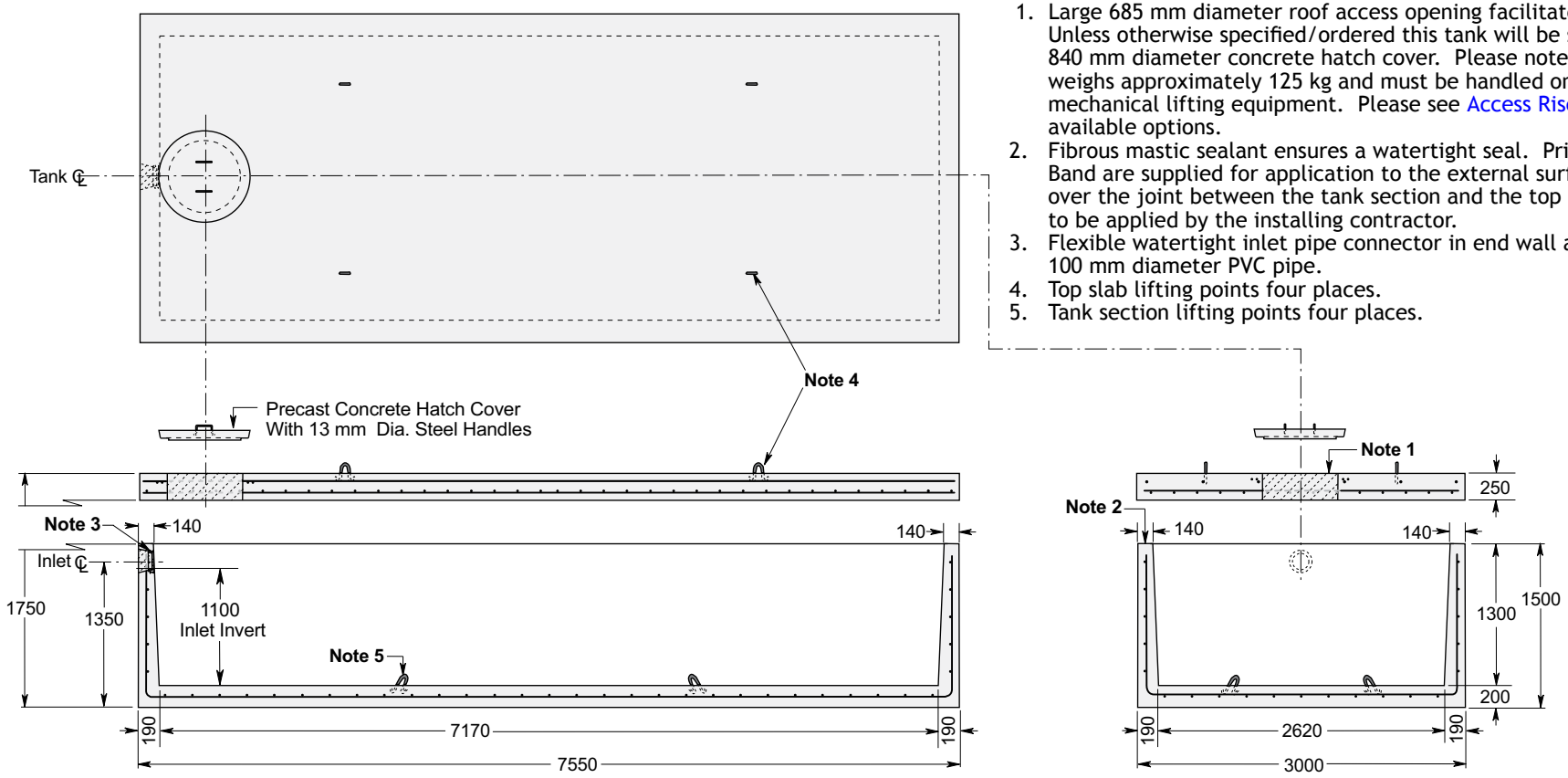
LOW PROFILE

CONSTRUCTION DETAILS *

Concrete: 35 MPa at 28 Days, 5 to 8% Air Entrainment.
Reinforcing: 15 M bars at 250 mm centres each way in walls and floor.
2 Mats of Bars in top slab.
Top Mat - Six 20 M bars evenly spaced (Long Direction)
Bottom Mat - 15 M bars at 200 mm centres each way.
Eight extra 15 M bars around roof access opening.
Minimum cover over reinforcing steel - 25 mm.

Weight:
Top Slab	14,060 kg
Tank Section	22,000 kg
Total	36,060 kg

Actual Capacity: 19,277 Litres Per Vertical Metre.
25,060 Litres to Underside of Roof.



NOTES

1. Large 685 mm diameter roof access opening facilitate tank maintenance. Unless otherwise specified/ordered this tank will be shipped with a 840 mm diameter concrete hatch cover. Please note that the cover weighs approximately 125 kg and must be handled only with suitable mechanical lifting equipment. Please see Access Riser section for available options.
2. Fibrous mastic sealant ensures a watertight seal. Primer and Mastic Band are supplied for application to the external surface of the tank over the joint between the tank section and the top slab. This band is to be applied by the installing contractor.
3. Flexible watertight inlet pipe connector in end wall accommodates 100 mm diameter PVC pipe.
4. Top slab lifting points four places.
5. Tank section lifting points four places.

Dimensions in mm
N.T.S.

*Product designed for a **Maximum 1.2 Metre** burial over the top slab in firm soil away from any area of vehicular traffic.

For recommended installation procedures refer to Wilkinson Installation Guidelines.

WARNING! IMPROPER INSTALLATION ESPECIALLY IN UNSTABLE SOIL CAN RESULT IN THE STRUCTURAL FAILURE OF THIS PRODUCT

11,200 LITRE PRECAST CONCRETE WATER HOLDING TANK MODEL H11.2L

WILKINSON HEAVY PRECAST LIMITED
DUNDAS, ONTARIO 1-800-263-8503
www.wilkinsonheavyprecast.com

LOW PROFILE

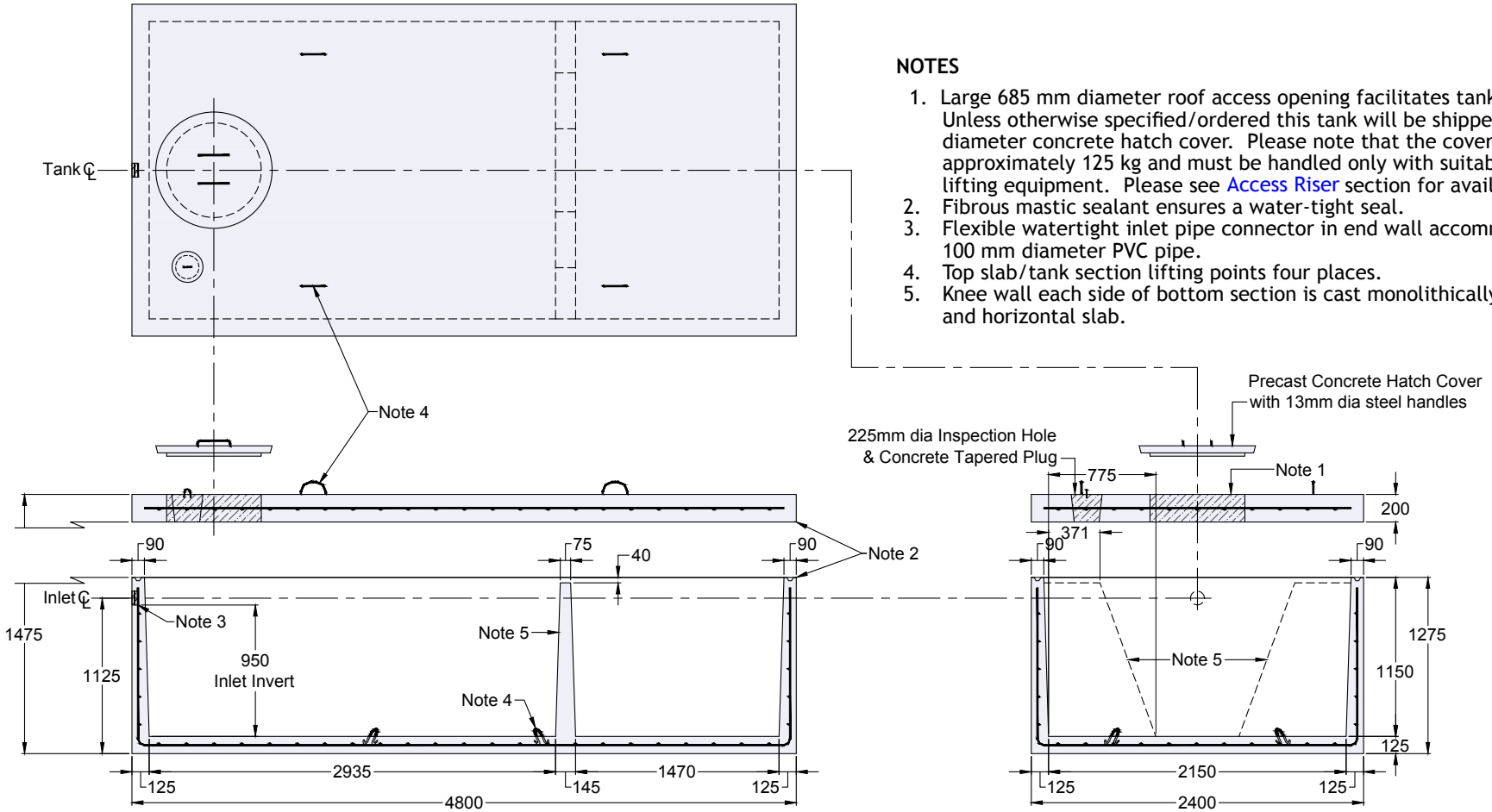
CONSTRUCTION DETAILS *

Concrete: 35 MPa at 28 Days, 5 to 8% Air Entrainment.

Reinforcing: 10 M bars at 300 mm centres each way in walls and floor.
10 M bars at 200 mm centres each way in top slab.
Four extra 15 M bars around roof access opening.
Minimum cover over reinforcing steel - 25 mm.

Weight: Top Slab 5620 kg
Tank Section 8100 kg
Total 13,720 kg

Actual Capacity: 9778 Litres Per Vertical Metre.
11,245 Litres to Underside of Roof Slab.



NOTES

1. Large 685 mm diameter roof access opening facilitates tank maintenance. Unless otherwise specified/ordered this tank will be shipped with 840 mm diameter concrete hatch cover. Please note that the cover weighs approximately 125 kg and must be handled only with suitable mechanical lifting equipment. Please see Access Riser section for available options.
2. Fibrous mastic sealant ensures a water-tight seal.
3. Flexible watertight inlet pipe connector in end wall accommodates 100 mm diameter PVC pipe.
4. Top slab/tank section lifting points four places.
5. Knee wall each side of bottom section is cast monolithically with the walls and horizontal slab.

Dimensions in mm
N.T.S.

*Product designed for a **Maximum 1 Metre** burial over the top slab in firm soil beneath an area of vehicular traffic.

For recommended installation procedures refer to Wilkinson Installation Guidelines.

WARNING! IMPROPER INSTALLATION ESPECIALLY IN UNSTABLE SOIL CAN RESULT IN THE STRUCTURAL FAILURE OF THIS PRODUCT

Ontario

MINISTRY OF THE ENVIRONMENT

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

PRE-DEVELOPMENT Phosphorus LOAD

DEVELOPMENT: 521-525 Essa Road
Subwatershed: Barrie Creeks

Land Use	Area (ha)	P coeff. (kg/ha)	P Load (kg/yr)
Low Intensity Development	0.4428	0.13	0.06
TOTALS:	**0.4428**		**0.06**

Ontario

MINISTRY OF THE ENVIRONMENT

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

POST-DEVELOPMENT Phosphorus LOAD - BMPs applied

Subwatershed: **Barrie Creeks**

Land Use	Area (ha)	P coeff. (kg/ha)	Best Management Practice applied with P Removal Efficiency		BMP P Load (kg/yr)
DEVELOPMENT: **521-525 Essa Road**					
High Intensity - Residential	0.33	1.32	Other	59%	0.18
					JellyFish
Transition	0.06	0.06	NONE	0%	0.00
					landscape area
Transition	0.05	0.06	Soakaways - Infiltration trenches	60%	0.00
					french drain system

Post-Development Area Altered:	**0.44**
Total Pre-Development Area:	**0.44**
Unaffected Area:	**0**

	P Load (kg/yr)
Pre-Development:	**0.06**
Post-Development Load:	**0.44**
Change (Pre- Post):	**-0.38**
664% Net Increase in Load	
Post-Development (with BMP):	**0.18**
Change (Pre-Post):	**-0.12**
217% Net Increase in Load	

APPENDIX C

Jellyfish Filter Unit Sizing Report
ETV Approval
Jellyfish Filter Inspection and Maintenance Procedures

PINESTONE ENGINEERING LTD.

ON-LINE
Jellyfish Filter Sizing Report

Project Information

Date	Tuesday, November 06, 2018
Project Name	Barrie Site
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 JF4-2-1-L1 is recommended to meet the water quality objective by treating a flow of 12.6 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 Jellyfish Model has a Peak Flow Capacity of 83.4 L/s. This model has a sediment capacity of 142 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)	Peak Capacity (L/s)	Bypass MAW	Sediment Capacity (kg)
JF4-2-1-L1	2	1	1.2	12.6	83.4	Yes	142

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 maintenance is necessary to assure proper functioning of the Jellyfish Filter. The maintenance inverval is designed to be a minimum of 12 months, but this will vary significantly with on-line desings based on storm event conditions, 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:

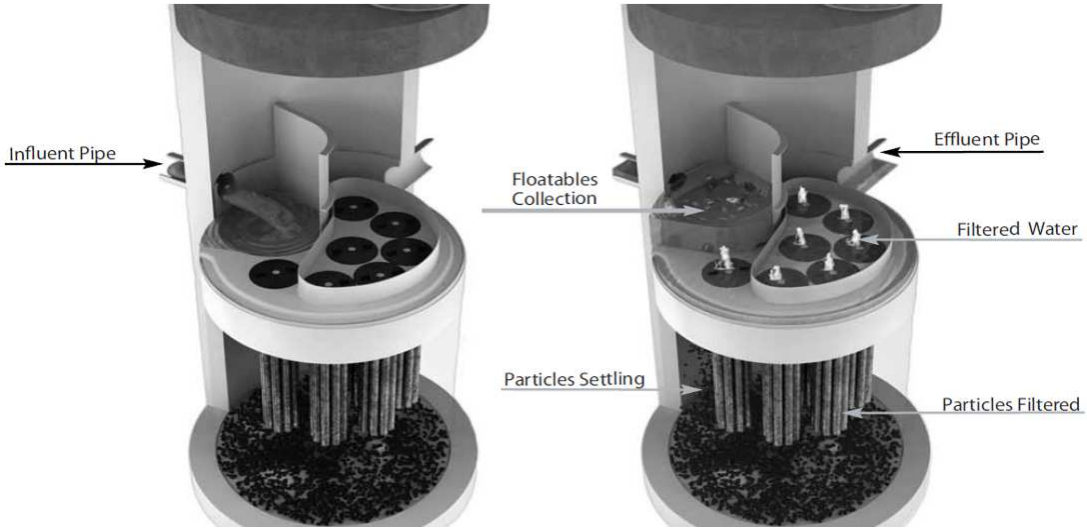
- ☑ 89% of the total suspended solids (TSS) load, including particles less than 5 microns
- ☑ 59% TP removal & 51% TN removal
- ☑ 90% Total Copper, 81% Total Lead, 70% Total Zinc
- ☑ Particulate-bound pollutants such as nutrients, toxic metals, hydrocarbons and bacteria
- ☑ Free oil, Floatable trash 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:	Tuesday, November 06, 2018
Project Name:	Barrie Site
Project Number:	
Location:	Barrie

Designer Information

Company:	Pinestone Engineering
Contact:	Joe Voisin
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:	0.33 ha
Imperviousness:	94.3%

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:	**8.6 L/s**
Sediment Loading	Treating 90% of the average annual runoff volume, 914 m³, with a suspended sediment concentration of 100 mg/L.	**91 kg**
Peak Flow	The flow which must pass through the unit, includes treatment flow	**45.8 L/s**

Recommendation

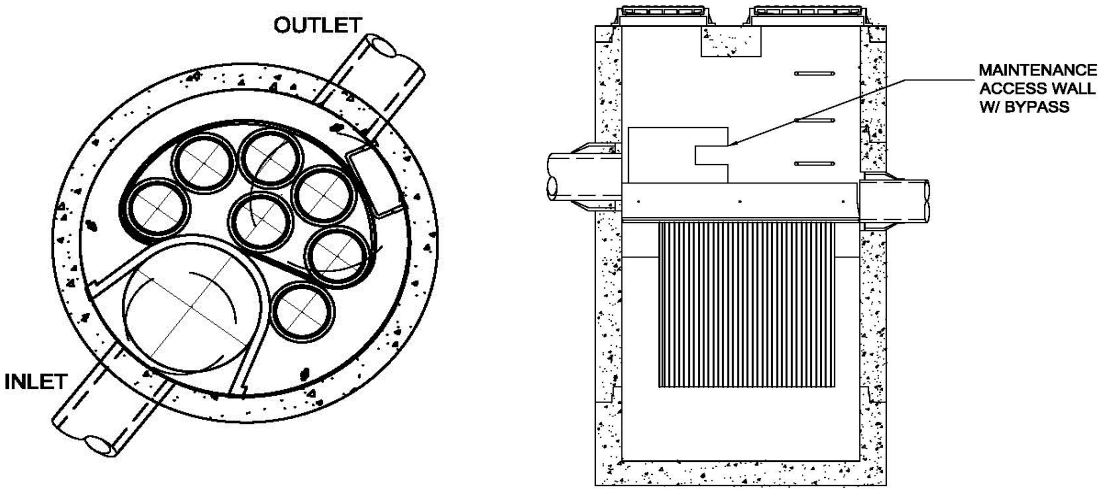
The Jellyfish Filter model JF4-2-1-L1 is recommended to meet the water quality objective by treating a flow of 12.6 L/s, which meets or exceeds 90% of the average annual rainfall runoff volume based on 36 years of BARRIE WPCC rainfall data for this site. This Jellyfish Model has a Peak Flow Capacity of 83.4 L/s. This model has a sediment capacity of 142 kg, which meets or exceeds the estimated average annual sediment load.

Jellyfish Model	Number of High-Flo Cartridges	Number of Draindown Cartridges	Bypass MAW	Addt'l Sump (ft)	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-L0	1	1	No	0	1.2	2313	0.34	379	7.6	85
JF4-1-1-L1	1	1	Yes	1	1.2	2661	0.34	379	7.6	85
JF4-2-1-L0	2	1	No	0	1.2	2313	0.34	379	12.6	142
JF4-2-1-L1	**2**	**1**	**Yes**	**1**	**1.2**	**2661**	**0.34**	**379**	**12.6**	**142**
JF6-3-1-L0	3	1	No	0	1.8	5205	0.79	848	17.7	199
JF6-3-1-L1	3	1	Yes	1	1.8	6003	0.79	848	17.7	199
JF6-4-1-L0	4	1	No	0	1.8	5205	0.79	848	22.7	256
JF6-4-1-L1	4	1	Yes	1	1.8	6003	0.79	848	22.7	256
JF6-5-1-L0	5	1	No	0	1.8	5205	0.79	848	27.8	313
JF6-5-1-L1	5	1	Yes	1	1.8	6003	0.79	848	27.8	313
JF6-6-1-L0	6	1	No	0	1.8	5205	0.79	848	28.6	370
JF6-6-1-L1	6	1	Yes	1	1.8	6003	0.79	848	28.6	370
JF8-6-2-L0	6	2	No	0	2.4	9252	1.42	1469	35.3	398
JF8-6-2-L1	6	2	Yes	1	2.4	10675	1.42	1469	35.3	398
JF8-7-2-L0	7	2	No	0	2.4	9252	1.42	1469	40.4	455
JF8-7-2-L1	7	2	Yes	1	2.4	10675	1.42	1469	40.4	455
JF8-8-2-L0	8	2	No	0	2.4	9252	1.42	1469	45.4	512
JF8-8-2-L1	8	2	Yes	1	2.4	10675	1.42	1469	45.4	512
JF8-9-2-L0	9	2	No	0	2.4	9252	1.42	1469	50.5	569
JF8-9-2-L1	9	2	Yes	1	2.4	10675	1.42	1469	50.5	569
JF8-10-2-L0	10	2	No	0	2.4	9252	1.42	1469	50.5	626
JF8-10-2-L1	10	2	Yes	1	2.4	10675	1.42	1469	50.5	626
JF10-11-3-L0	11	3	No	0	3.0	14456	2.21	2302	63.1	711
JF10-11-3-L1	11	3	Yes	1	3.0	16678	2.21	2302	63.1	711
JF10-12-3-L0	12	3	No	0	3.0	14456	2.21	2302	68.2	768
JF10-12-3-L1	12	3	Yes	1	3.0	16678	2.21	2302	68.2	768
JF10-12-4-L0	12	4	No	0	3.0	14456	2.21	2302	70.7	796
JF10-12-4-L1	12	4	Yes	1	3.0	16678	2.21	2302	70.7	796

JF10-13-4-L0	13	4	No	0	3.0	14456	2.21	2302	75.7	853
JF10-13-4-L1	13	4	Yes	1	3.0	16678	2.21	2302	75.7	853
JF10-14-4-L0	14	4	No	0	3.0	14456	2.21	2302	78.9	910
JF10-14-4-L1	14	4	Yes	1	3.0	16678	2.21	2302	78.9	910
JF10-15-4-L0	15	4	No	0	3.0	14456	2.21	2302	78.9	967
JF10-15-4-L1	15	4	Yes	1	3.0	16678	2.21	2302	78.9	967
JF10-16-4-L0	16	4	No	0	3.0	14456	2.21	2302	78.9	1024
JF10-16-4-L1	16	4	Yes	1	3.0	16678	2.21	2302	78.9	1024
JF10-17-4-L0	17	4	No	0	3.0	14456	2.21	2302	78.9	1081
JF10-17-4-L1	17	4	Yes	1	3.0	16678	2.21	2302	78.9	1081
JF10-18-4-L0	18	4	No	0	3.0	14456	2.21	2302	78.9	1138
JF10-18-4-L1	18	4	Yes	1	3.0	16678	2.21	2302	78.9	1138
JF10-19-4-L0	19	4	No	0	3.0	14456	2.21	2302	78.9	1195
JF10-19-4-L1	19	4	Yes	1	3.0	16678	2.21	2302	78.9	1195
JF12-20-5-L0	20	5	No	0	3.6	20820	3.2	2771	113.6	1280
JF12-20-5-L1	20	5	Yes	1	3.6	24012	3.2	2771	113.6	1280
JF12-21-5-L0	21	5	No	0	3.6	20820	3.2	2771	113.7	1337
JF12-21-5-L1	21	5	Yes	1	3.6	24012	3.2	2771	113.7	1337
JF12-22-5-L0	22	5	No	0	3.6	20820	3.2	2771	113.7	1394
JF12-22-5-L1	22	5	Yes	1	3.6	24012	3.2	2771	113.7	1394
JF12-23-5-L0	23	5	No	0	3.6	20820	3.2	2771	113.7	1451
JF12-23-5-L1	23	5	Yes	1	3.6	24012	3.2	2771	113.7	1451
JF12-24-5-L0	24	5	No	0	3.6	20820	3.2	2771	113.7	1508
JF12-24-5-L1	24	5	Yes	1	3.6	24012	3.2	2771	113.7	1508
JF12-25-5-L0	25	5	No	0	3.6	20820	3.2	2771	113.7	1565
JF12-25-5-L1	25	5	Yes	1	3.6	24012	3.2	2771	113.7	1565
JF12-26-5-L0	26	5	No	0	3.6	20820	3.2	2771	113.7	1622
JF12-26-5-L1	26	5	Yes	1	3.6	24012	3.2	2771	113.7	1622
JF12-27-5-L0	27	5	No	0	3.6	20820	3.2	2771	113.7	1679
JF12-27-5-L1	27	5	Yes	1	3.6	24012	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 that 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 Online 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. Alternative driving head values are only possible with off-line configuration.
- Typically, the Jellyfish Filter is designed with the inlet pipe configured 6 inches (150 mm) above the outlet invert elevation.
- The Jellyfish Filter can not accommodate multiple inlet pipes in an on-line configuration.
- Typical systems conform to the following pipe orientations:

Model Diameter (m)	Minimum Angle Inlet / Outlet Pipes	Minimum Inlet Pipe Diameter (mm)	Maximum Inlet Pipe Diameter (mm)
1.2	**62º**	**150**	**300**
1.8	59º	200	300
2.4	52º	250	375
3.0	48º	300	450
3.6	40º	300	450

- Outlet pipes to be one size larger than inlet pipes on new projects.
- 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/ft² (0.142 lps/m²).

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

GENERAL NOTES:
1. ALL DIMENSIONS INDICATED ARE IN MILLIMETERS (INCHES) UNLESS OTHERWISE SPECIFIED.
2. JELLYFISH STRUCTURE INLET AND OUTLET PIPE SIZE AND ORIENTATION SHOWN FOR INFORMATIONAL PURPOSES ONLY.
3. UNLESS OTHERWISE NOTED, BYPASS INFRASTRUCTURE, SUCH AS ALL UPSTREAM DIVERSION STRUCTURES, CONNECTING STRUCTURES, OR PIPE CONDUITS CONNECTING TO COMPLETE THE JELLYFISH SYSTEM SHALL BE PROVIDED AND ADDRESSED SEPARATELY.
4. DRAWING FOR INFORMATION PURPOSES ONLY. REFER TO ENGINEER'S SITE/UTILITY PLAN FOR STRUCTURE ORIENTATION.
5. NO PRODUCT SUBSTITUTIONS SHALL BE ACCEPTED UNLESS SUBMITTED 10 DAYS PRIOR TO PROJECT BID DATE, OR AS DIRECTED BY THE ENGINEER OF RECORD.

JELLYFISH STRUCTURE & DESIGN NOTES:
1. 457 MM Ø (18") MAINTENANCE ACCESS WALL TO BE USED FOR CLEANOUT AND ACCESS BELOW CARTRIDGE DECK.
2. CASTINGS OR DOORS OF THE JELLYFISH MANHOLE STRUCTURE TO EXTEND TO DESIGN FINISH GRADE. DEPTHS IN EXCESS OF 3.65 M (12') MAY REQUIRE THE DESIGN AND INSTALLATION OF INTERMEDIATE SAFETY GRATES OR OTHER STRUCTURAL ELEMENTS.
3. CASTINGS AND GRADE RINGS, OR DOORS AND DOOR RISERS, OR BOTH, SHALL BE GROUTED FOR WATERTIGHTNESS.
   STRUCTURE SHALL MEET AASHTO HS-20, ASSUMING EARTH COVER OF 0' - 3', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 LOAD RATING AND BE CAST WITH THE IMBRIUM LOGO.
4. ALL STRUCTURAL SECTIONS AND PARTS TO MEET OR EXCEED ASTM C-478, ASTM C-443, AND ASTM D-4097 CORRESPONDING TO AASHTO SPECIFICATIONS, AND ANY OTHER SITE OR LOCAL STANDARDS.
5. CONCRETE RISER SECTIONS FROM BOTTOM TO TOP WILL BE ADDED AS REQUIRED INCLUDING TRANSITION PIECES TO SMALLER DIAMETER RISERS FOR SURFACE ACCESSES WHERE WARRANTED BY SERVICING DEPTH.
6. IF MINIMUM DEPTH FROM TOP OF CARTRIDGE DECK TO BOTTOM OF STRUCTURAL TOP SLAB CANNOT BE ACHIEVED DUE TO PIPING INVERT ELEVATIONS OR OTHER SITE CONSTRAINTS. ALTERNATIVE HATCH CONFIGURATIONS MAY BE AVAILABLE. HATCH DOORS SHOULD BE SIZED TO PROVIDE FULL ACCESS ABOVE THE CARTRIDGES TO ACCOMMODATE MAINTENANCE.
7. STEPS TO BE APPROXIMATELY 330 MM (13") APART AND DIMENSIONS MUST MEET LOCAL STANDARDS. STEPS MUST BE INSTALLED AFTER CARTRIDGE DECK IS IN PLACE.
8. CONFIGURATION OF INLET AND OUTLET PIPE CAN VARY TO MEET SITE'S NEEDS.
9. IT IS THE RESPONSIBILITY OF OTHERS TO PROPERLY PROTECT THE TREATMENT DEVICE, AND KEEP THE DEVICE OFFLINE DURING CONSTRUCTION. FILTER CARTRIDGES SHALL NOT BE INSTALLED UNTIL THE PROJECT SITE IS CLEAN AND FREE OF DEBRIS, BY OTHERS. THE PROJECT SITE INCLUDES ANY SURFACE THAT CONTRIBUTES STORM DRAINAGE TO THE TREATMENT DEVICE. CARTRIDGES SHALL BE FURNISHED NEW, AT THE TIME OF FINAL ACCEPTANCE.
10. THIS DRAWING MUST BE VIEWED IN CONJUNCTION WITH THE STANDARD JELLYFISH SPECIFICATION, AND STORMWATER QUALITY FILTER TREATMENT JELLYFISH DOCUMENTS.

PEAK DIVERSION JELLYFISH DESIGN NOTES:
1. STRUCTURE SHALL MEET AASHTO HS-20 OR PER APPROVING JURISDICTION REQUIREMENTS; WHICHEVER IS MORE STRINGENT, ASSUMING EARTH COVER OF 0' - 3', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 LOAD RATING AND BE CAST WITH THE IMBRIUM LOGO.
2. STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.
3. INLET HGL NOT TO EXCEED 6" BELOW THE TOP OF THE M.A.W. DURING THE PEAK DESIGN STORM, OR 10-YEAR STORM (WHICHEVER IS GREATER).
4. INLET PIPE INVERT ELEVATION VARIES FROM 1" TO 6" MAXIMUM ABOVE THE OUTLET PIPE INVERT.
5. OUTLET PIPE INVERT IS EQUAL TO THE CARTRIDGE DECK ELEVATION.
6. THE OUTLET PIPE DIAMETER FOR NEW INSTALLATIONS IS TO BE ONE PIPE SIZE LARGER THAN THE INLET PIPE AT EQUAL OR GREATER SLOPE.
7. THE DIFFERENCE IN THE INLET AND OUTLET PIPE ELEVATIONS FOR RETROFIT INSTALLATIONS TO EXISTING STORM DRAIN PIPES SHALL BE EQUAL TO THE SLOPE OVER THE DIAMETER OF THE MANHOLE; NOT THE EXCEED 6" IN VERTICAL DIFFERENTIAL BETWEEN INLET AND OUTLET PIPES.

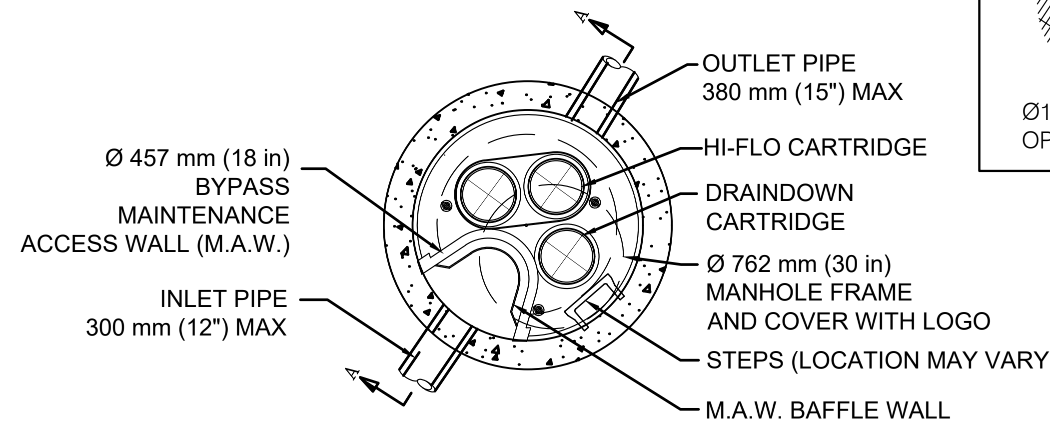
INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STRUCTURE (LIFTING CLUTCHES PROVIDED)
C. CONTRACTOR WILL INSTALL AND LEVEL THE STRUCTURE, SEALING THE JOINTS, LINE ENTRY AND EXIT POINTS (NON-SHRINK GROUT WITH APPROVED WATERSTOP OR FLEXIBLE BOOT)
D. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.
E. CARTRIDGE INSTALLATION, BY IMBRIUM, SHALL OCCUR ONLY AFTER SITE HAS BEEN STABILIZED AND THE JELLYFISH UNIT IS CLEAN AND FREE OF DEBRIS. CONTACT IMBRIUM TO COORDINATE CARTRIDGE INSTALLATION WITH SITE STABILIZATION.

PEAK DIVERSION JELLYFISH RECOMMENDED PIPE DIAMETERS

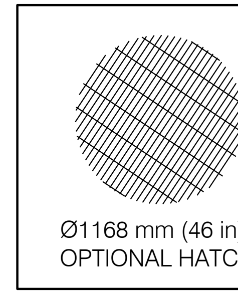
MODEL DIAMETER (m)	MINIMUM ANGLE INLET/OUTLET PIPES	MINIMUM INLET PIPE DIAMETER (mm)	MAXIMUM INLET PIPE DIAMETER (mm)
1.2	62	150	300
1.8	59	200	300
2.4	52	250	375
3.0	48	300	450
3.6	40	300	450
CONTACT IMBRIUM SYSTEMS FOR ALTERNATE PIPE DIAMETERS			

FOR SITE SPECIFIC DRAWINGS PLEASE CONTACT YOUR LOCAL JELLYFISH FILTER REPRESENTATIVE. SITE SPECIFIC DRAWINGS ARE BASED ON THE BEST AVAILABLE INFORMATION AT THE TIME. SOME FIELD REVISIONS TO THE SYSTEM LOCATION OR CONNECTION PIPING MAY BE NECESSARY BASED ON AVAILABLE SPACE OR SITE CONFIGURATION REVISIONS. ELEVATIONS SHOULD BE MAINTAINED EXCEPT WHERE NOTED ON BYPASS STRUCTURE.

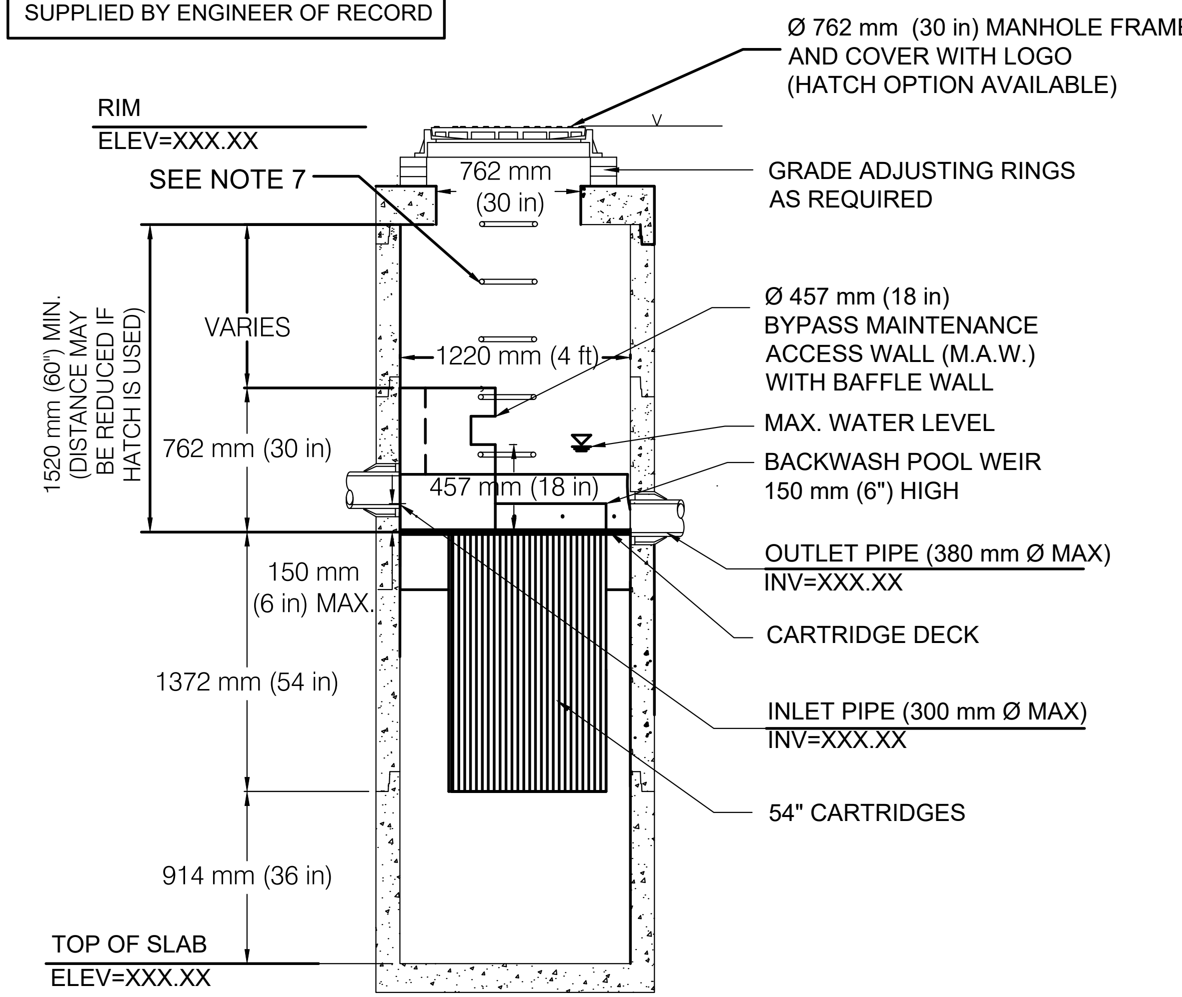
DRAWING NOT TO BE USED FOR CONSTRUCTION



JF4 (PEAK DIVERSION) PLAN VIEW



XXX.XX INFORMATION TO BE SUPPLIED BY ENGINEER OF RECORD



JELLYFISH CROSS SECTION A-A

JELLYFISH DESIGN NOTES

JELLYFISH TREATMENT CAPACITY IS A FUNCTION OF THE CARTRIDGE SELECTION AND THE NUMBER OF CARTRIDGES. THE STANDARD MANHOLE STYLE IS SHOWN. Ø1220 mm (48") MANHOLE JELLYFISH PEAK TREATMENT CAPACITY IS 12.7 L/s (0.54 CFS), AND MAXIMUM BYPASS CAPACITY IS 70.8 L/s (2.50 CFS). IF THE SITE CONDITIONS EXCEED TOTAL CAPACITY, AN UPSTREAM BYPASS STRUCTURE IS REQUIRED. TREATMENT FLOW RATE IS BASED ON 457 mm (18") OF HEAD PRESSURE.

CARTRIDGE SELECTION				
CARTRIDGE DEPTH	54"	40"	27"	15"
OUTLET INVERT TO STRUCTURE BASE SLAB	90"	76"	63"	51"
FLOW RATE HIGH-FLO / DRAINDOWN (L/s) (per cart)	5.09 / 2.55	3.68 / 1.84	2.55 / 1.27	1.41 / 0.71
SEDIMENT CAPACITY HIGH-FLO / DRAINDOWN (kg) (per cart)	57 / 28	42 / 21	28 / 14	16 / 8
MAX. CARTS HIGH-FLO/DRAINDOWN	2 / 1			
MAX. BYPASS (L/s)	70.8			
MAX. SEDIMENT CAPACITY (kg)	142	105	70	40
MAX. TREATMENT (L/s)	12.7	9.3	6.2	3.4
MAX. TREATMENT AND BYPASS (L/s) (PEAK CAPACITY)	83.5	80.1	77.0	74.2

SITE SPECIFIC DATA REQUIREMENTS

JELLYFISH MODEL	*
STRUCTURE ID	*
WATER QUALITY FLOW RATE (L/s)	*
BYPASS FLOW RATE (L/s)	*
PEAK FLOW RATE (L/s)	*
RETURN PERIOD OF PEAK FLOW (yrs)	*
# OF CARTRIDGES REQUIRED (HF / DD)	*
CARTRIDGE SIZE (inches)	*
MAX ALLOWABLE BYPASS FLOW RATE (L/s)	70.8

PIPE DATA:	I.E.	MAT'L	DIA	SLOPE %	HGL
INLET #1	*	*	*	*	*
INLET #2	*	*	*	*	*
OUTLET	*	*	*	*	*

* PER ENGINEER OF RECORD

MARK	DATE	REVISION DESCRIPTION	BY
#	#	#	#
#	#	#	#
#	#	#	#
#	#	#	#
0	04/15/2015	INTIAL RELEASE	BSF

Jellyfish®

JF4 PEAK DIVERSION

Scale = 1:50

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USA 888-279-8826 CA 800-565-4801 INTL +1-416-960-9900

Jellyfish® Filter

THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING AUS NO. 2008/286748, U.S.A. NO. US 8,287,726, US 8,221,618, US 8,123,935, CA 2,696,482, CA, 2,834,542, KR 10-1287539, NZ 583461, NZ 604227, ZA 2010/01068; OTHER INTERNATIONAL PATENTS PENDING

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SHEET: 1 OF 2	

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JELLYFISH® FILTER - SPECIFICATIONS

GENERAL

A. WORK INCLUDED: SPECIFIES REQUIREMENTS FOR CONSTRUCTION AND PERFORMANCE OF AN UNDERGROUND STORMWATER QUALITY, MEMBRANE FILTRATION, AND TREATMENT DEVICE THAT REMOVES POLLUTANTS FROM STORMWATER RUNOFF THROUGH THE UNIT OPERATIONS OF SEDIMENTATION, FLOATATION, AND MEMBRANE FILTRATION.

B. 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 990:	SPECIFICATION FOR JOINTS FOR CONCRETE MANHOLES USING PREFORMED FLEXIBLE JOINT SEALANTS
ASTM D 4101:	SPECIFICATION FOR COPOLYMER STEPS CONSTRUCTION

C. 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 PRECAST CONCRETE AND CALL OUT OR NOTE THE FIBERGLASS (FRP) INTERNALS/COMPONENTS.

D. 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.

E. HANDLING AND STORAGE: PREVENT DAMAGE TO MATERIALS DURING STORAGE AND HANDLING.

PRODUCTS

A. 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.

B. THE CYLINDRICAL CONCRETE DEVICE SHALL INCLUDE A FIBERGLASS CARTRIDGE DECK INSERT. THE RECTANGULAR CONCRETE DEVICE SHALL INCLUDE A COATED ALUMINUM INSERT. IN EITHER INSTANCE, THE INSERT SHALL BE BOLTED AND SEALED WATERTIGHT INSIDE THE PRECAST CONCRETE CHAMBER. THE INSERT 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); (D) A CONDUIT FOR CONVEYANCE OF TREATED WATER TO THE EFFLUENT PIPE.

C. MEMBRANE 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) OR GREATER 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 FLUX RATE SHALL BE 0.21 GPM/FT2 (0.142 LPS/M2). EACH MEMBRANE FILTER CARTRIDGE SHALL ALLOW FOR MANUAL INSTALLATION AND REMOVAL.

D. 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.

E. ACCESS SHALL HAVE A MINIMUM CLEAR HEIGHT OF 60" OVER ALL OF THE FILTER CARTRIDGES, OR BE ACCESSIBLE BY A HATCH OR OTHER MECHANISM THAT PROVIDES MINIMUM 60" 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.

F. 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" MAY HAVE AN IMPACT ON THE TOTAL PERFORMANCE AND/OR LONGEVITY BETWEEN CARTRIDGE MAINTENANCE/REPLACEMENT OF THE DEVICE.

G. 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.

H. GASKETS AND/OR SEALANTS TO PROVIDE WATER TIGHT SEAL BETWEEN CONCRETE JOINTS. JOINTS SHALL BE SEALED WITH PREFORMED JOINT SEALING COMPOUND CONFORMING TO ASTM C 990.

I. 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.

J. DOOR AND HATCHES, IF PROVIDED SHALL MEET DESIGNATED LOADING REQUIREMENTS OR AT A MINIMUM FOR INCIDENTAL VEHICULAR TRAFFIC.

K. ALL CONCRETE COMPONENTS SHALL BE MANUFACTURED ACCORDING TO LOCAL SPECIFICATIONS AND SHALL MEET THE REQUIREMENTS OF ASTM C 478.

L. 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.

M. 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.

N. 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.

PERFORMANCE

A. THE STORMWATER QUALITY FILTER TREATMENT DEVICE SHALL FUNCTION TO REMOVE POLLUTANTS BY THE FOLLOWING UNIT TREATMENT PROCESSES; SEDIMENTATION, FLOATATION, AND MEMBRANE FILTRATION.

B. 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.

C. 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 PASS WATER OVER THE CARTRIDGE DECK, AND AVOID PASSAGE THROUGH THE SUMP AND/OR CARTRIDGE FILTRATION ZONE.

D. THE STORMWATER QUALITY FILTER TREATMENT DEVICE SHALL TREAT 100% OF THE REQUIRED WATER QUALITY TREATMENT FLOW BASED ON A MAXIMUM TREATMENT FLUX RATE (SURFACE LOADING RATE) ACROSS THE MEMBRANE FILTER CARTRIDGES NOT TO EXCEED 0.21 GPM/FT2 (0.142 LPS/M2).

E. AT A MINIMUM, THE STORMWATER QUALITY FILTER DEVICE SHALL HAVE BEEN FIELD TESTED AND VERIFIED WITH A MINIMUM 25 QUALIFYING STORM EVENTS AND FIELD MONITORING CONDUCTED ACCORDING TO THE TARP TIER II OR TAPE FIELD TEST PROTOCOL, AND HAVE RECEIVED NJCAT VERIFICATION.

F. 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%.

G. 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 D50 OF 15 MICRONS OR LOWER FOR ALL MONITORED STORM EVENTS, AND AN EFFLUENT TURBIDITY OF 15 NTUS OR LOWER.

H. 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%.

I. THE STORMWATER QUALITY FILTER TREATMENT DEVICE SHALL HAVE DEMONSTRATED A MINIMUM MEDIAN TOTAL ZINC REMOVAL OF 50%, AND A MINIMUM MEDIAN TOTAL COPPER REMOVAL OF 75%.

INSPECTION AND MAINTENANCE

A. 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.

B. 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).

C. 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.

D. 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.

E. MAINTENANCE ACCESS SHALL HAVE A MINIMUM CLEAR HEIGHT OF 60" OVER ALL OF THE FILTER CARTRIDGES, OR BE ACCESSIBLE BY A HATCH OR OTHER MECHANISM THAT PROVIDES MINIMUM 60" 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.

F. FILTER CARTRIDGES SHALL BE ABLE TO BE MAINTAINED WITHOUT THE USE OF ADDITIONAL LIFTING EQUIPMENT.

EXECUTION

A. 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.

B. 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

C. 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.

D. 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.

E. 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.

F. FILTER CARTRIDGES SHALL BE INSTALLED IN THE CARTRIDGE DECK AFTER THE CONSTRUCTION SITE IS FULLY STABILIZED AND IN ACCORDANCE WITH THE MANUFACTURERS 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.

G. 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.

H. THE MANUFACTURER SHALL PROVIDE AN OWNER'S MANUAL UPON REQUEST.

I. 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.

J. 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

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JELLYFISH FILTER SPECIFICATIONS

Jellyfish®

JF4 ONLINE

Scale = 1:50

www.imbriumsystems.com info@imbriumsystems.com

imbrium®
7037 Ridge Road, Suite 350, Hanover, MD 21076
USA 888-279-8826 CA 800-565-4801 INTL +1-416-960-9900

Jellyfish® Filter

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◆ 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

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.

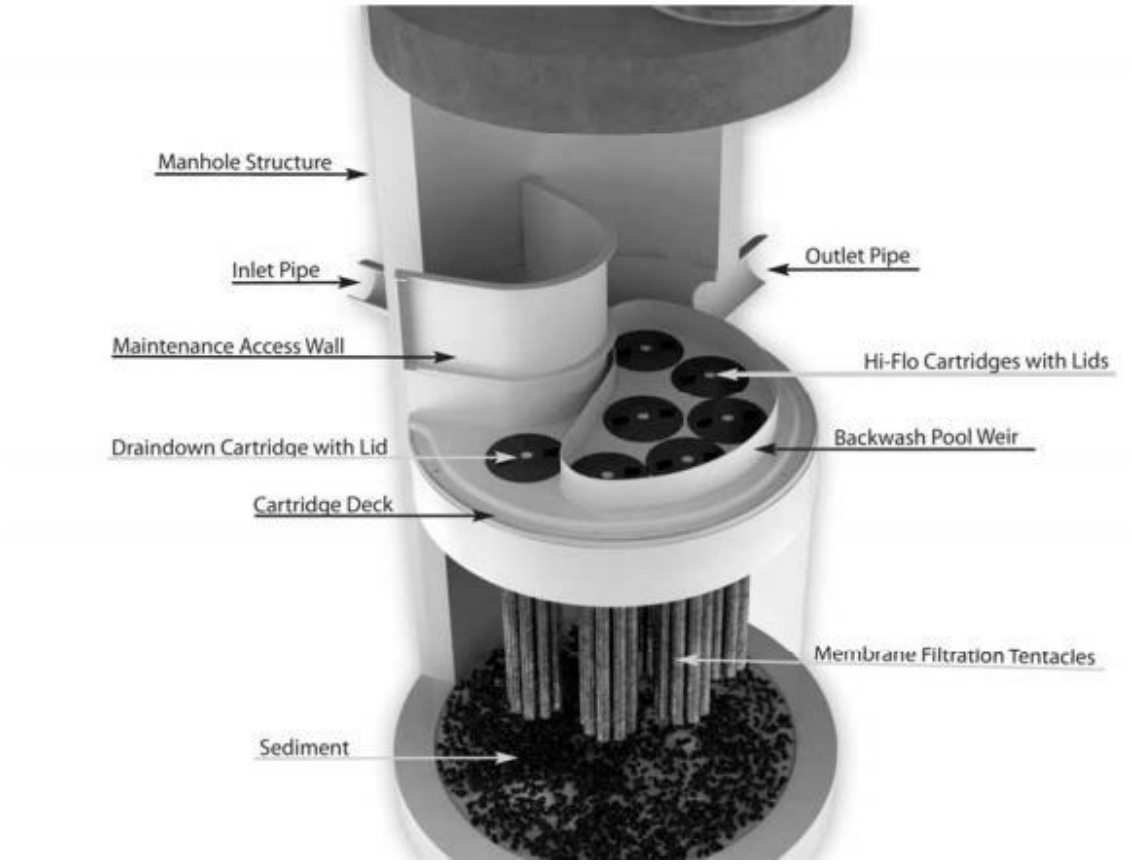


Figure 1. Cut-away graphic of a Jellyfish® Filter manhole with 6 hi-flo cartridges and 1 draindown cartridge

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.

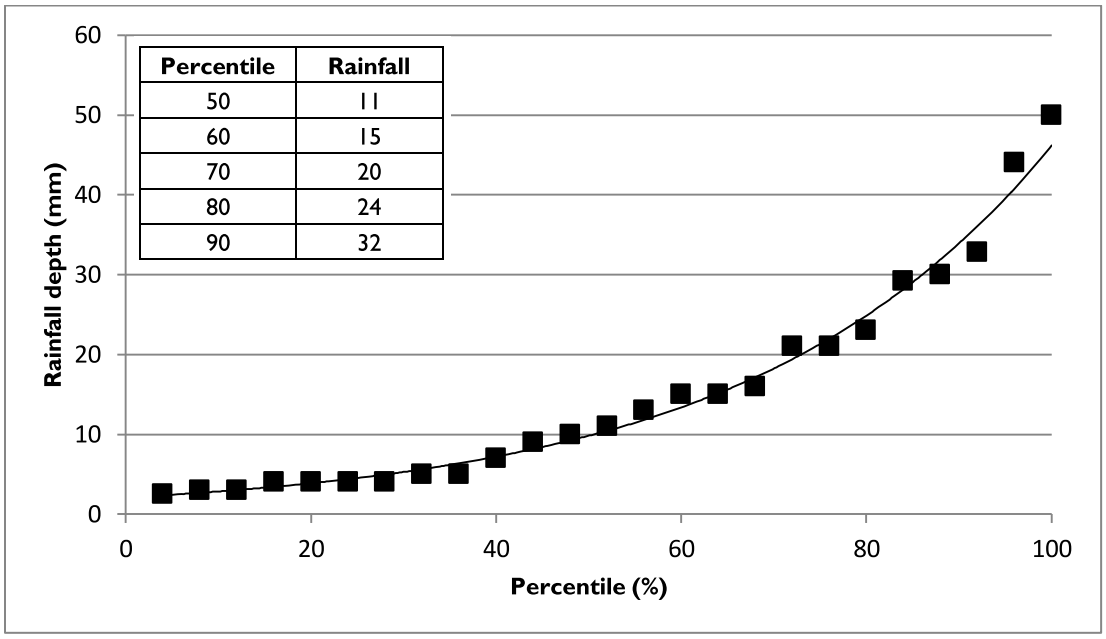


Figure 2. Rainfall depth frequency curve

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.

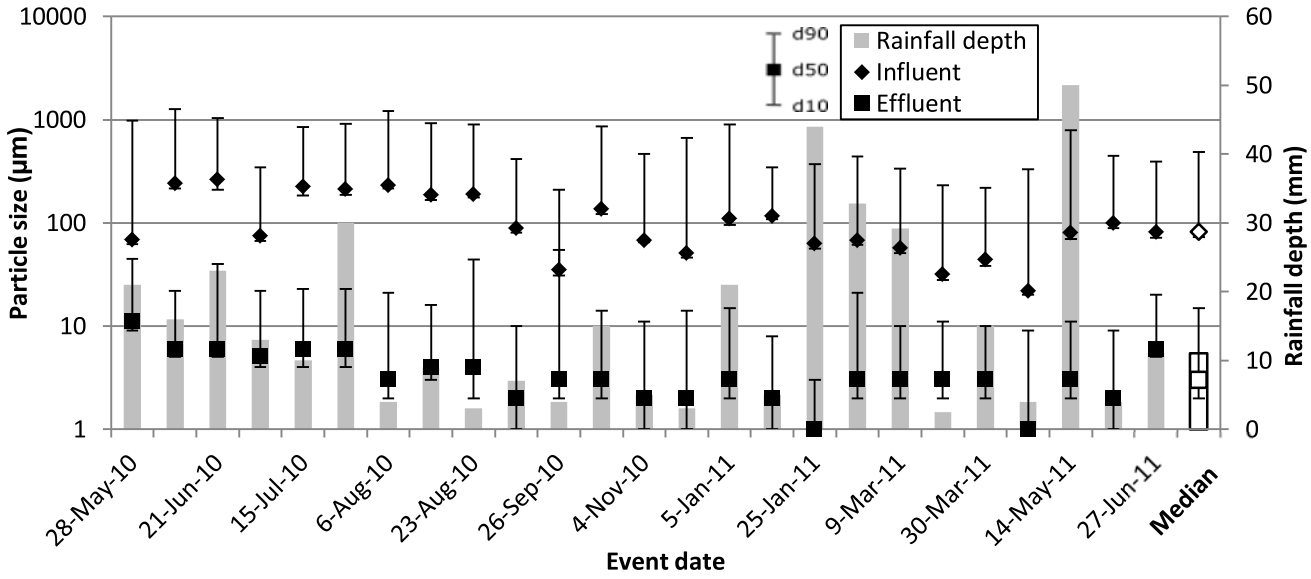


Figure 3. The rainfall depth and d10, d50, and d90 particle sizes of the influent and effluent composite samples for each monitored storm event over the 13-month testing period

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	

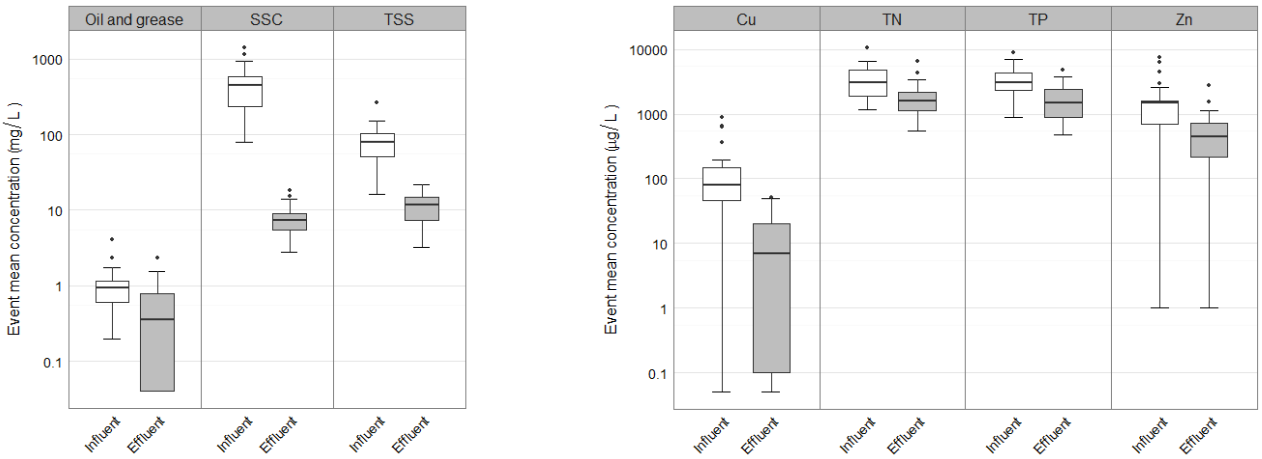


Figure 4. Boxplots showing the distribution of influent and effluent event mean concentrations (EMC) for selected stormwater constituents over the study period

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.

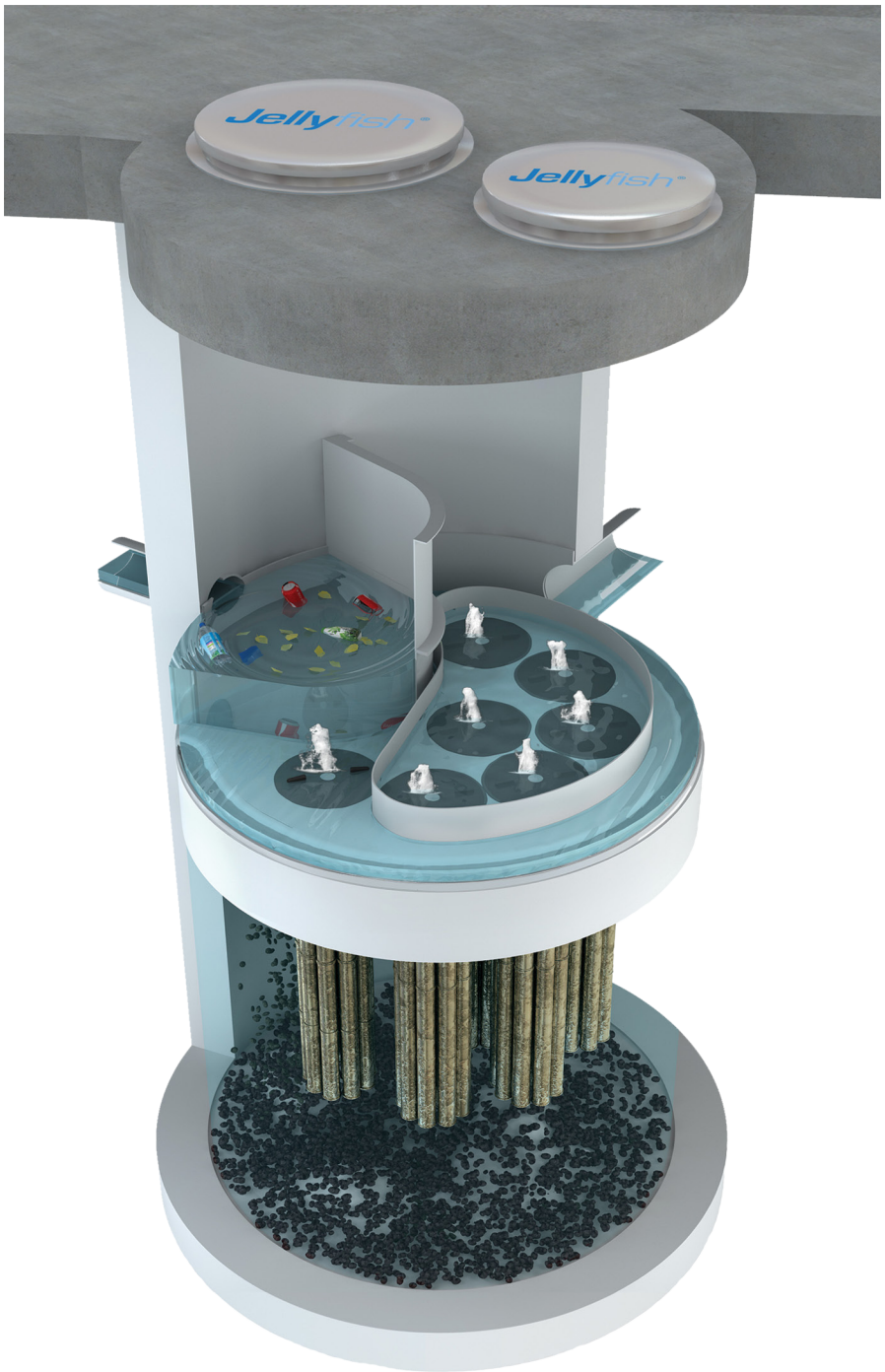
For more information on the Jellyfish® Filter please contact:

Imbrium Systems, Inc.
407 Fairview Drive
Whitby, ON
L1N 3A9, Canada
Tel: 416-960-9900
info@imbriumsystems.com

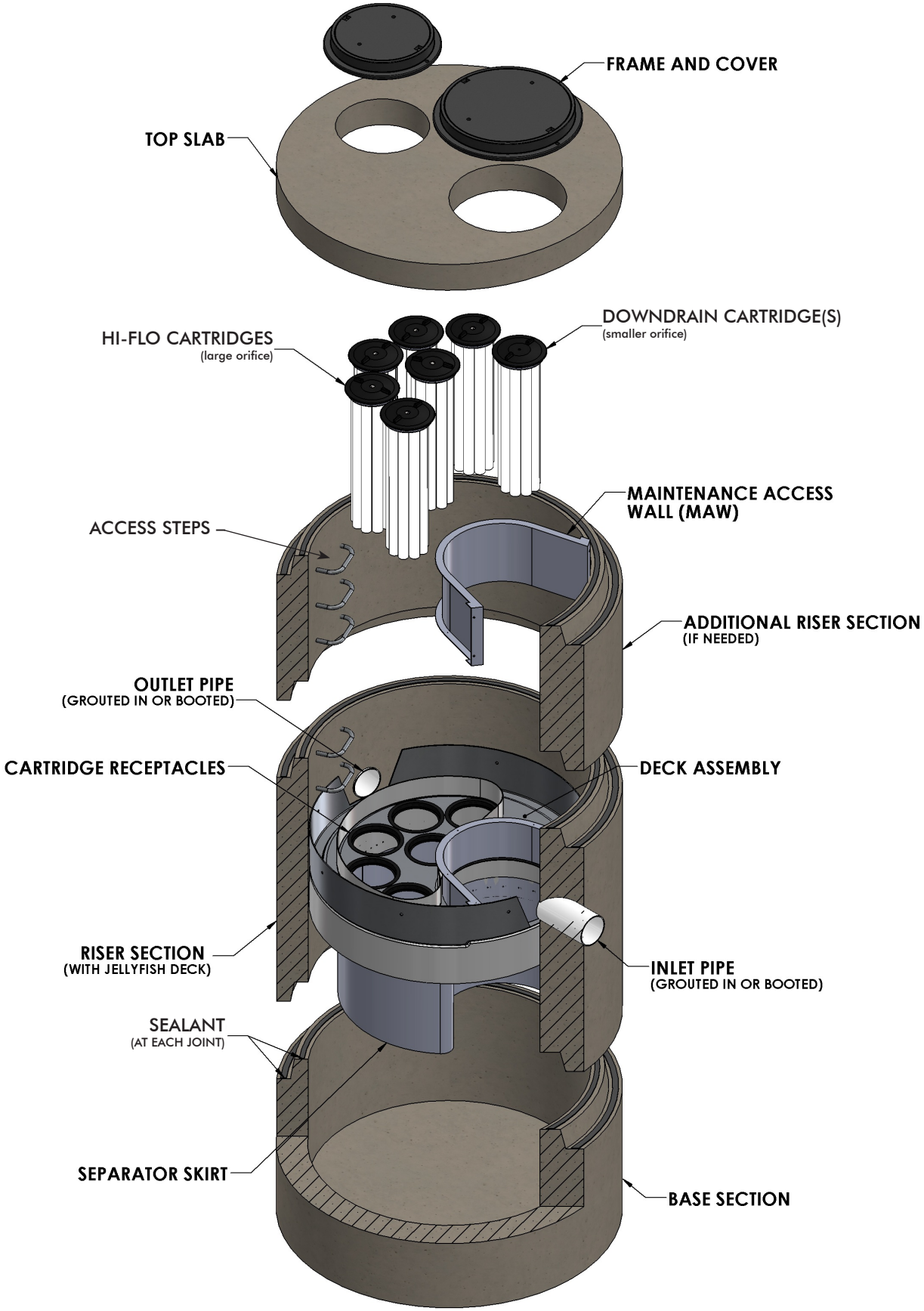
For more information on ISO 14034:2016 / ETV please contact:

GLOBE Performance Solutions
World Trade Centre
404 – 999 Canada Place
Vancouver, BC
V6C 3E2 Canada
Tel: 604-695-5018 / Toll Free: 1-855-695-5018
etv@globeperformance.com

Jellyfish® Filter
Owner's Manual



imbrium®


FRAME AND COVER
TOP SLAB
DOWNDRAIN CARTRIDGE(S)
(smaller orifice)
HI-FLO CARTRIDGES
(large 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.

Imbrium Systems
USA: 301.279.8827 | 888.279.8826
CAD: 416.960.9900 | 800.565.4801
INT'L: +1.416.960.9900

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.

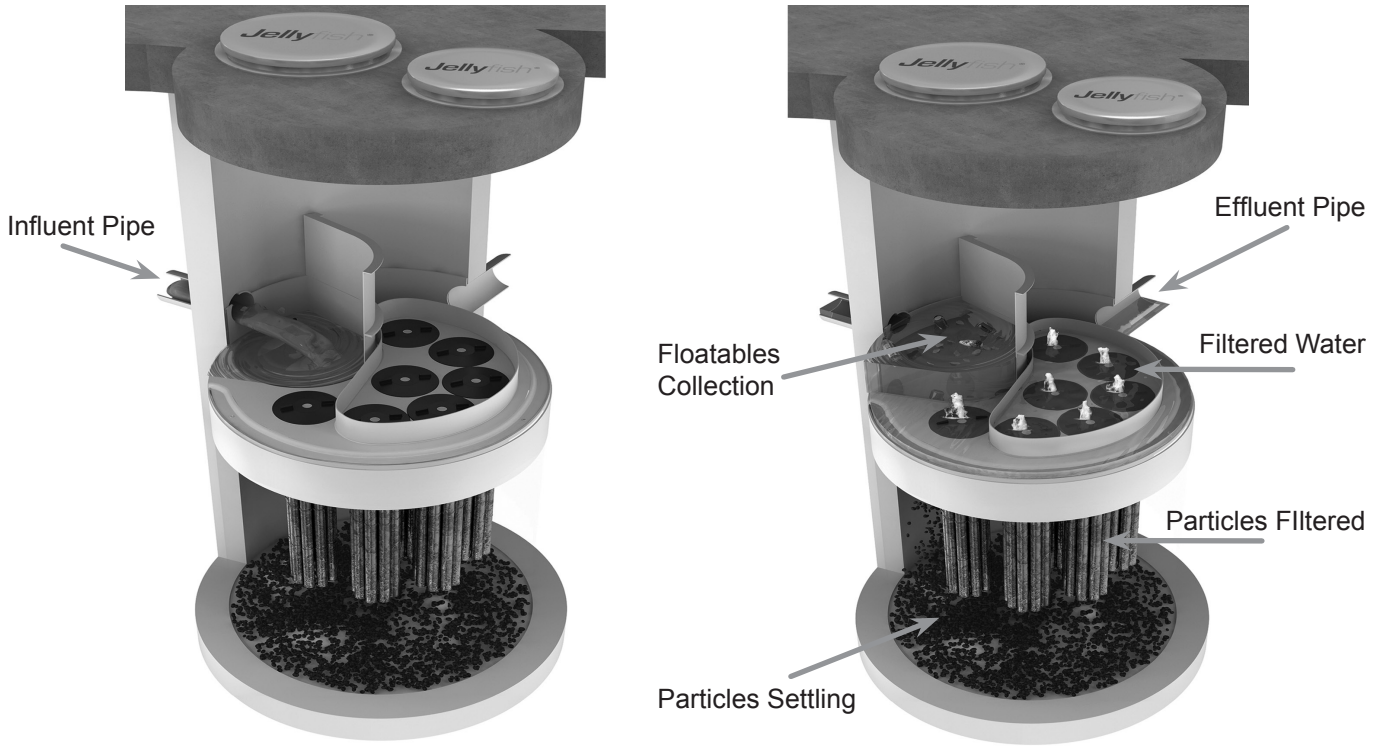
The Jellyfish Filter functions are depicted in **Figure 1** below.

FIGURE 1

Jellyfish Filter Treatment Functions

Membrane Filtration

Section View with Maintenance Access Wall (MAW) Cutaway



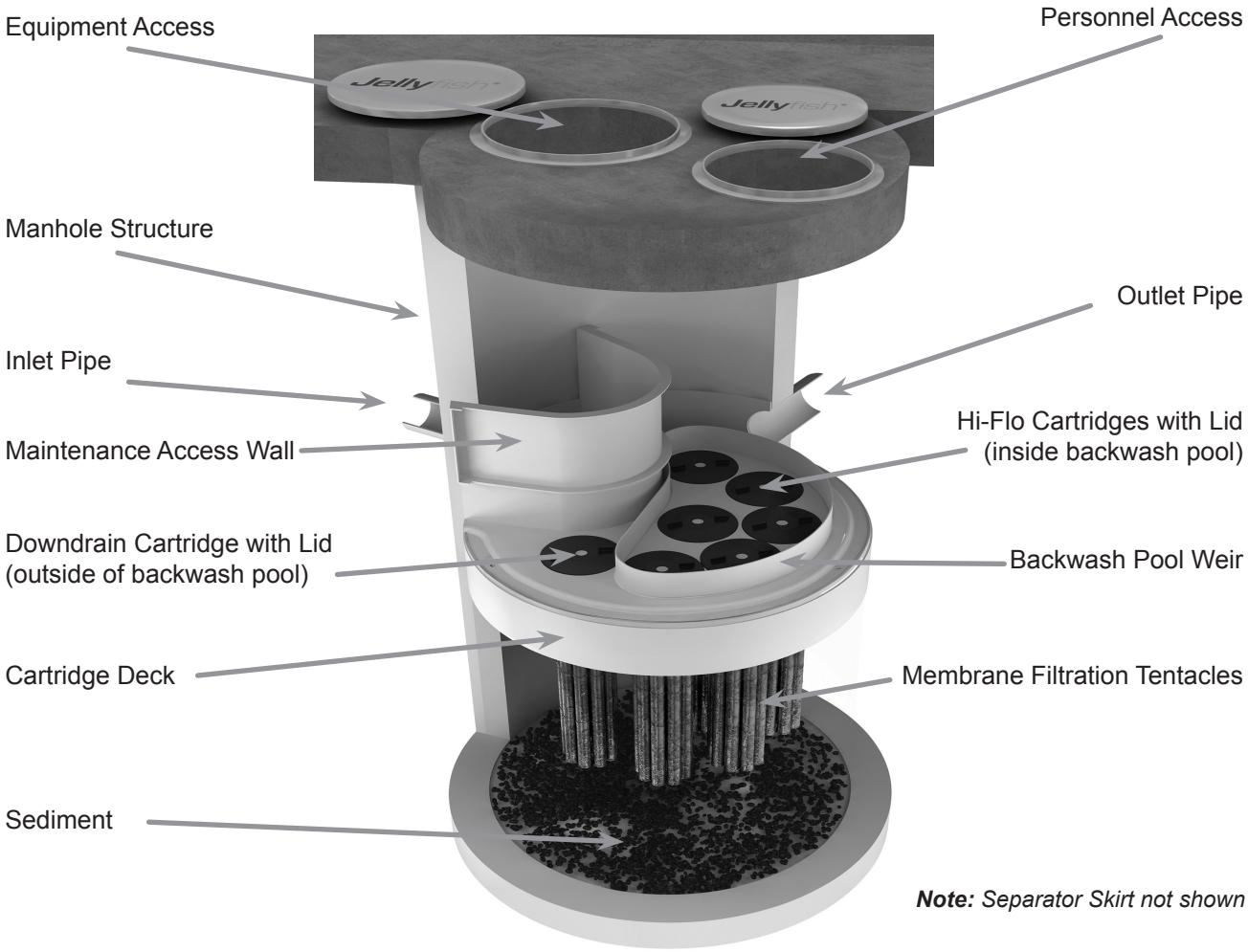
Jellyfish Filter cartridges are backwashed after each peak storm event, which removes accumulated sediment from the membranes. This backwash process extends the service life of the cartridges and increases the time between maintenance events.

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.
- **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.

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.

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.

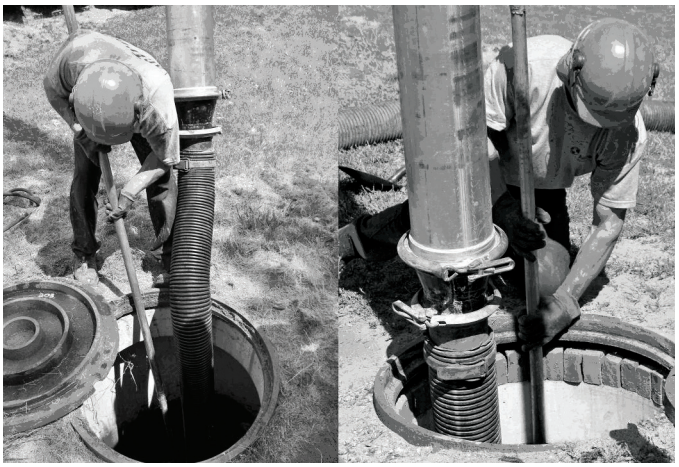
- Remove rinse water from rinse tub or garbage can using a vacuum hose as needed.
- Slip the o-ring over the tentacle nipple and reassemble onto the cartridge head plate; hand-tighten.
- If rinsing is ineffective in removing sediment from the tentacles, or if tentacles are damaged, provisions must be 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.

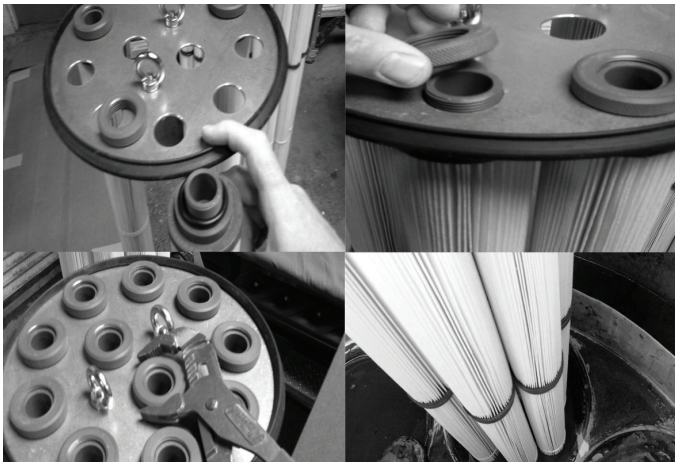
3.2.6 – Chemical Spills

- **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 D

Drawings (in envelope at rear of report)

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PINESTONE ENGINEERING LTD.