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STORMWATER MANGEMENT REPORT

Proposed Condominium Apartment Development

681 & 685 Yonge Street
N/E Corner of Yonge Street / Ashford Drive
City of Barrie

May 2019
Revision 1: September 2019
Revision 2: November 2019

Prepared For: **Queensgate Homes (Barrie) Inc.**

File: **19112**

VALDOR WATER RESOURCES

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1.0 INTRODUCTION

Valdor Engineering Inc. has been retained by the Queensgate Homes (Barrie) Inc. to provide consulting engineering services for the proposed development on their lands located at the northeast corner of Yonge Street and Ashford Drive in the City of Barrie as indicated in **Figure 1.** The property is known municipally as 681 & 685 Yonge Street and is approximately 0.557 hectares in size.

1.1 Existing Conditions

The subject site is an assembly of two properties, each containing detached dwellings, driveways patio areas and lawns. The subject site is bound to the west by Yonge Street, to the south by Ashford Drive and to the north and east by lots containing detached dwellings. The lands slope from an elevation of 257.81 at the south east corner down to 255.33m at the northwest corner with an elevation differential of approximately 2.5m equating to an average slope of 2.2%.

1.2 Proposed Development

The proposed development consists of a 183 unit 7 storey condominium apartment building with driveway access off Ashford Drive and a surface parking lot with the balance of the site to be landscaped. A one level underground parking lot extends across the limits of the site. Based on a future 3.0m road widening which will eventually to be conveyed along the frontage of Yonge Street, the developable area of the site is 0.533 hectares. A copy of the architectural site plan is included in **Appendix "A"**.

1.3 Watershed Description

The subject site is located in the Lake Simcoe watershed which covers 3,400 square kilometres and encompasses 20 municipalities. The watershed extends from the Oak Ridges Moraine in the south to the Oro Moraine in the north, through York and Durham regions, Simcoe County and the cities of Kawartha Lakes, Barrie and Orillia. The lake itself covers 20 percent of the area and is fed by 18 sub-watersheds. Of the various sub-watersheds, the subject site drains to Lovers Creek. This creek has a drainage area of approximately 60 square kilometers, which covers parts of the City of Barrie and the Town of Innisfil and outlets to Kempenfelt Bay. The Lake Simcoe Region Conservation Authority (LSRCA) is responsible for the 18 sub-watersheds. A review of the LSRCA's mapping indicates that the subject site is not located in an area that is regulated by their office. A map of the various watersheds in LSRCA's jurisdiction and the regulation mapping is contained in **Appendix "B"**.

1.4 Purpose of Report

This report has been prepared in conjunction with a site plan application for the proposed development and is based on a review of the topographic survey, background studies, municipal servicing plans for the site and a visit to the property. The purpose of this detailed report is to describe the existing and proposed storm drainage, assess the impact of the proposed development and recommend stormwater management mitigation measures for the subject site which are necessary to achieve compliance with the municipal storm drainage criteria.

2.0 DESIGN CRITERIA

In accordance with the municipal standards, the storm drainage system for the subject site is to be designed as follows:

- A storm sewer system sized for the 5 year storm design event to convey the minor flows.
- An overland flow route is to be provided for flows in excess of the 100 year storm event.
- Stormwater quantity control is to be implemented such that the post development peak flows are controlled to pre-development rates for rainfall events from the 2 year storm up to and including the 100 year storm.
- Stormwater quality control is to be provided for “Enhanced” Protection (Level 1 Treatment).
- Water balance is to be addressed in accordance with the requirements of the City of Barrie and the LSRCA.
- Phosphorous loading is to be addressed in accordance with the requirements of the LSRCA.

The rainfall intensity values, *I*, for the 2, 5 and 100 year return periods are calculated in accordance with the City of Barrie standards using a 10 minute time of concentration as follows.

$$I_2 = \frac{678.085}{(t+4.699)^{0.781}} = 83.1 mm/hr \quad I_5 = \frac{853.608}{(t+4.699)^{0.766}} = 108.9 mm/hr \quad I_{100} = \frac{1426.408}{(t+5.273)^{0.759}} = 180.2 mm/hr$$

A copy of the City’s intensity / duration / frequency (IDF) data is included in **Appendix “C”**.

3.0 STORMWATER MANAGEMENT

The following sections provide an analysis of the stormwater management measures.

3.1 Quantity Control

3.1.1 Pre-Development Condition

The subject site is occupied by two detached dwelling with driveways and grassed lawn areas as depicted in **Figure 2**. Based on the various surface types the pre-development composite runoff coefficient was calculated to be 0.32. The pre-development peak flows are calculated in **Table D1** contained in **Appendix “D”** and summarized in the first row of **Table 1**.

Table 1: Summary of Peak Flow Rates

Condition	**Runoff Coefficient**	**Peak Flows (L/s)**	
		2 Year	100 Year
Pre-Development	0.32	39.3	85.2
Post-Development - Unmitigated	0.82	81.2	161.3
Post-Development - Mitigated	0.82	20.8	39.3

3.1.2 Post-Development Condition: Un-Mitigated

Based on a review of the Architect's site plan, the post-development storm drainage areas and composite runoff coefficients for the subject site were delineated and summarized in **Figure 3**. The surfaces include the parking lot area and the roof area of the building. The balance of the proposed development is comprised of the relatively small area associated with landscaped strips along the perimeter of the site.

Based on these surfaces, the proposed development has a higher level of imperviousness than the pre-development condition and the post-development runoff coefficient was calculated to be 0.82. The post-development unmitigated peak flow calculation is provided in **Table D2** contained in **Appendix "D"** ad summarized in the second row of **Table 1**.

3.1.3 Post-Development Condition: Mitigated

A comparison of the first and third rows of **Table 1** indicates that an increase in peak flows is anticipated and therefore stormwater mitigation measures are to be implemented. Given that drainage from the site will discharge directly to the municipal storm sewer, the 100 year post development-peak flow is to be controlled to the 2 year pre-development rate. In this regard, discharge is to be restricted to 39.3 L/s.

In order to achieve the controlled discharge, it is proposed to install an orifice restrictor and to provide on-site detention. In this regard, the detention system will be comprised of a tank which will be constructed on the P1 level of the underground parking garage to provide the required storage with an orifice to control the discharge. Ground surface detention and roof top detention is not required.

The stormwater quantity control was modelled using the modified rational method. This method calculates the storage volume using the composite runoff coefficient and the allowable release rate based on rainfall intensities using the City standard IDF data. Through an iterative process, a combination of orifice diameters, high water levels (HWL) and detention volumes, was analyzed to optimize the SWM system.

Using an orifice diameter of 120 mm, the post-development 100 year peak flow can be controlled to 39.3 L/s, as indicated in the third row of **Table 1,** which matches the allowable release rate. Based on this rate the required detention volume is 136.5 m^3. The stormwater detention calculations are provided in **Table D3** to **Table D7**, all of which are contained in **Appendix "D"** together with the summary **Table D**. The location of the detention tank and the control device are illustrated in **Figure 4**.

3.2 Phosphorous Loading

Lake Simcoe is enriched by nutrients from land use activities in its watershed and has, for many years, been the focus of efforts to protect and restore its water quality. In 2009 the Lake Simcoe Protection Plan (LSPP) was approved to regulate inputs of nutrients (specifically phosphorus) to Lake Simcoe.

The intent of policies in the LSPP is that new development in the Lake Simcoe watershed adopts BMP and LID techniques and innovative stormwater management techniques to achieve sustainable development practices that will reduce the phosphorus loading from new urban development. In this regard the policy requires that post-development loadings on any major development site be reduced from pre-development loadings.

In order to establish a method to quantify and compare pre- and post-development phosphorus loadings which reflects differing precipitation patterns, soils and slopes that occur across the Lake Simcoe watershed, the MOE released the *Phosphorus Budget Guidance Tool to Guide New Development in the Lake Simcoe Watershed* in 2012. This "Tool" uses estimates of phosphorus export that were developed for specific land uses coupled to standard estimates of phosphorus reduction efficiencies for various BMPs and LID techniques. The following is a summary of the phosphorus analysis for the site using the Tool.

3.2.1 Pre-Development Loading

Under pre-development conditions, based on the land use categories of the Tool, the 0.533 Ha site area is considered to be "High Intensity Development (Residential)". Based on this category, the Tool indicates that the pre-development phosphorus loading is 0.70 kg/year as summarized in **Table 2**.

The Tool output for the pre-development loading is provided in **Appendix "E"** together with tables listing the various export coefficients and land use categories.

Table 2: Phosphorus Loading summary

Land Use	**Area** (ha)	**Phosphorus Coefficient** (kg/ha)	**Phosphorus Load** (kg/yr)
Pre-Development			
High Intensity Development (Residential)	0.533	1.32	0.70
Post-Development - Unmitigated			
High Intensity Development (Residential)	0.533	1.32	0.70
Total: (Net Increase)			**+0.00**
Post-Development - Mitigated			
High Intensity Development (Residential)	0.533	1.32	0.27
Total: (Net Reduction)			**-0.43**

3.2.2 Post-Development Loading

Under post-development conditions, based on the land use categories of the Tool, the site is considered “High Intensity Development (Residential)”. Based on this category, the Tool indicates that the post-development phosphorus loading is 0.70 kg/year. Based on a review of the results summarized in **Table 2**, it has been determined that there will be no net annual increase in phosphorus loading (no change in land use). The Tool output for the post-development loading is provided in **Appendix “E”**.

3.2.3 Mitigation Measures

As per the *LSRCA Technical Guidelines for Stormwater Management Submissions*, 80% of the total annual post-development phosphorus load is to be removed. A suitable best-efforts approach is to be demonstrated if achieving 80% total phosphorus load is not possible.

In order to reduce phosphorus loading, a variety of measures were reviewed and assessed based on their documented removal efficiency. Given that the underground parking garage extends under virtually the entire site area, infiltration measures are not feasible.

In this regard a treatment train approach has been utilized to combine the benefits of the proposed stormwater detention tank (credited with 25% phosphorus removal efficiency) with a phosphorus removal treatment unit, operating in series.

The proposed commercially available treatment unit is known as the Up-Flo® Filter, manufactured by Hydro International. This is an advanced stormwater treatment system that is credited with a phosphorus removal efficiency of 48%

(refer to *Technical Bulletin - Up-Flo Filter - Field Evaluation of Phosphorus Removal* (Hydro International Plc., 2006), included in **Appendix E**).

The Up-Flo® Filter will be housed in a pre-cast concrete vault to contain the filter modules. It is designed with a treatment train concept that incorporates gravitational separation of floating and settling materials, screening, and filtration of stormwater flows. A filtered drain down prevents media from remaining saturated after storm events and becoming anaerobic. Operation of the Up-Flo® Filter is initiated during a rainfall event when controlled discharge is conveyed into the chamber from the detention tank. As flow enters the chamber, internal components act as baffles to slow down flows and encourage gross debris and sediment to settle into the sump and floating debris to rise to the surface. Depending on the runoff rate entering the chamber, a water column builds above the top of the media until it reaches the bypass weir elevation. This water column provides the driving head to convey flow upward through an angled screen and media pack into a conveyance slot where filtered flow is discharged into the outlet module.

When operating as a treatment train, the stormwater detention tank and Up-Flo® Filter will have a total phosphorus efficiency of 61% (refer to **Table E.1** in **Appendix E** for details), which represents a best-efforts approach for this development, given the site constraints.

Based on the incorporation of this treatment unit, the Tool indicates that the post-development phosphorus loading will be 0.27 kg/year, for a net annual decrease of 0.43 kg/year, as summarized in **Table 2.**

The location of the Up-Flo® Filter is indicated in **Figure 4**. The Tool output as well as the sizing calculations and a detail of the Up-Flo® Filter is included in **Appendix "E"**.

As per the *Phosphorus Offsetting Policy* (LSRCA, September 2017), a phosphorus loading offset payment is required to offset any remaining phosphorus loading if 100% of phosphorus can't be removed. The offset payment is calculated using the following formula:

Offset Payment = Offset Ratio x P Load x Offset Value

Where:
Offset Ratio = 2.5
Offset Value = $35,000/kg/yr
P Load = 0.27 kg/yr

The calculated offset payment value is therefore $24,009:

Offset Payment = 2.5 x 0.27 kg/yr x $35,000/kg/yr = $24,009

As per LSRCA policy, where a development requires a cash-in-lieu payment for the *Phosphorus Offsetting Policy* (LSRCA, September 2017), and for *Section 8.0*

– *Recharge Compensation Program* of the *Lake Simcoe Protection Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP* (LSRCA, November 2018), only the larger of the two payments must be made. This is because the remediation measures these payments are used for tend to provide both phosphorus and water balance benefits. As described in Section 3.4.2 of this report, the cash-in-lieu payment for water balance for this development is $245,784. Given that the cash-in-lieu payment for water balance is greater than the phosphorus payment, the $24,009 phosphorus payment is not required.

3.3 Quality Treatment

Based on the City criteria, storm water quality control for the subject site is to be designed to achieve “Enhanced” protection level (Level 1 treatment) which entails 80% total suspended solids (TSS) removal. Based on a review of the capabilities of the Up-Flo® Filter that is being utilized for phosphorus removal, this unit is also designed to provide the required 80% TSS removal rate. The quality treatment sizing is based on the quality design flow of 14.88 L/s (refer to **Tables D4-3 & D5-3**, provided in **Appendix D**).

Table 3: Quality Treatment Summary

TSS Removal Rate Required (%)	**TSS Removal Rate Provided** (%)	**Mitigation Measure**
80	80	Up-Flo® Filter

The location of the Up-Flo® Filter treatment unit is provided in **Figure 4**. The sizing calculations and a detail of the Up-Flo® Filter is included in **Appendix “E”**.

3.4 Stormwater Retention & Water Balance

The objective of water balance is to capture and manage annual rainfall on-site to preserve the pre-development hydrology. Water balance consists of runoff, infiltration and evapotranspiration.

3.4.1 Stormwater Retention (City of Barrie Criteria)

Based on the City’s criteria, infiltration of a minimum of 5mm rainfall depth is required. The runoff volume is calculated based on the site area with an adjustment for initial abstraction for the various site surface types. The runoff volume required to be retained on site is calculated as follows:

$$V = A \times (D - Ia)$$

where: V = runoff volume (cu.m.)
A = site area (sq.m)
D = rainfall depth (0.005m)
I = Initial Abstraction

$$V = 5{,}330\ m^2 \times (0.005m - 0.001488m)$$

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$V = 18.7\ m^3$

Based on the above and site area, the volume required to achieve water balance is 18.7 m^3 as summarized in **Table 3**.

Table 4: Water Balance Summary

Required Volume to be Retained (m^3)	Retention Volume Provided (m^3)	Mitigation Measure
18.7	83.1	Landscape Irrigation

Unfortunately, a review of the architect's site plan indicates that there is no opportunity to introduce infiltration measures given that the underground parking garage extends virtually across the entire site area.

Therefore, it is proposed to make a cash-in-lieu payment to the LSRCA, so that they can install infiltration measures elsewhere in the area to address the water balance.

3.4.2 Water Balance Assessment (LSRCA Criteria)

The objective of the LSRCA's water balance criterion is to capture and manage annual rainfall on-site to preserve the pre-development hydrology. In accordance with the requirements of the LSRCA, a water balance assessment based on the MOE methodology was undertaken for the site. The assessment was completed for the site using soils and land use information to calculate weighted evapotranspiration values. Weighted water surplus quantities were then calculated for the site as well. Per the MOE methodology, a weighted infiltration factor was calculated and surplus quantities were then split into runoff and infiltration components for existing and proposed conditions.

The existing land use is primarily residential, with the pervious areas consisting of primarily urban lawns, and the soil texture is classified as primarily Bondhead sandy loam (HSG "AB") based on the Soil Map of Simcoe County, South Sheet (Ontario Soil Survey Report No. 29). The proposed land use is residential and the pervious areas will be landscaped (i.e., lawn). The water balance calculations including the water holding capacity assessment, infiltration factor selection, and evapotranspiration analysis are provided in **Tables F2** to **F5** contained in **Appendix "F"**.

Pre-Development Infiltration Volume

The results of the annual water balance analysis for existing conditions, including pervious and impervious areas for the site, are presented in **Table F2**. Based on a total average annual precipitation of 932.9 mm (Barrie WPCC Climate Normals, 1981 – 2010 data, Environment Canada), approximately 1,235 m^3/yr of water infiltrates the ground under existing conditions. This is the target infiltration rate that is to be maintained under post-development conditions.

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Post-Development Infiltration Volume

Under proposed conditions without implementing any infiltration best management practices (BMPs), approximately 182 m^3/yr of water will infiltrate the ground. This represents 14.7 % of the existing infiltration volume, or an infiltration deficit of 1,053 m^3/yr, as summarized in **Table F2**.

As discussed in *Section 3.4.1*, above, there is no opportunity to introduce infiltration measures given that the underground parking garage extends virtually across the entire site area.

As per *Section 8.0 – Recharge Compensation Program* of the *Lake Simcoe Protection Plan Water Budget Policy for LSPP 4.8-DP and 6.40-DP* (LSRCA, November 2018), a compensation payment is required if pre-development infiltration rates cannot be maintained under post-development conditions. The compensation payment is calculated based on \$52.80/m^3 of deficit.

As per the analysis above, the annual infiltration deficit for the subject site is 1,053 m^3. In addition to the annual infiltration deficit, the LSRCA requires that the annual long-term foundation dewatering volume be included in the cash-in-lieu payment calculation. As per the *Hydrogeological Assessment Proposed Residential Development 681 Yonge Street* (Soil Engineers Ltd. November 2019), the daily long-term foundation dewatering rate is 9,867.32 L/day. This equates to an annual foundation dewatering volume of 3,602 m^3. Therefore the total volume for the compensation payment is 4,655 $m^{3.}$ The required compensation payment to LSRCA is therefore \$245,784.00:

$$\text{Compensation Payment} = \$52.80/m^3 \times 4,655\ m^3 = \$245,784.00$$

Excerpts from the *Hydrogeological Assessment Proposed Residential Development 681 Yonge Street* have been included in **Appendix "F"**.

4.0 STORM DRAINAGE

In accordance with City standards, a major / minor system storm conveyance concept has been incorporated into the servicing design for the subject development. The following sections provide a brief summary of the storm drainage components:

4.1 Minor System Design

In accordance with the municipal standards, the development will be serviced with a minor storm sewer system consisting of catchbasins to capture runoff and a storm sewer to convey flow to the outlet. The minor system has been designed to convey runoff from the 5 year storm event using the rational method based on the City's intensity duration frequency (IDF) data. This system will discharge to the existing storm sewer on Yonge Street with a manhole to be located at the property line. The configuration of the minor system is illustrated in **Figure 4**.

4.2 Major System Design

In accordance with the municipal requirements an overland flow route will be provided within the site to direct runoff in excess of the 100 year storm to a safe outlet. In this regard, the site grading and catchbasin placement was coordinated to create an overland flow route directing major flows to the adjacent road allowance. The major system flow route is illustrated in **Figure 4**.

4.3 Foundation Drainage

Based on the architectural plans, the proposed building will have an underground parking garage which will require a foundation drainage system. This foundation drainage system will drain to a sump pit. A sump pump in this pit will pump flow to the stormwater detention tank. As per the *Hydrogeological Assessment Proposed Residential Development 681 Yonge Street* (Soil Engineers Ltd. November 2019), the daily long-term foundation dewatering rate is 9,867.32 L/day. This foundation drainage rate has been incorporated in the stormwater detention tank sizing calculations.

4.4 Roof Drainage

The proposed building will have flat roof design that will require roof drains. These roof drains will be collected by the building's internal storm drain system which will discharge to the site storm sewer system. The roof drain system is to be designed by the mechanical engineer and indicated on the mechanical plans at the building permit design stage. Roof top stormwater detention is not proposed.

5.0 SWM INSPECTION & MAINTENANCE

The proposed stormwater management system requires regular inspection and maintenance to ensure the infrastructure functions as designed. The suggested inspection and maintenance procedures are as follows:

5.1 Catchbasins & Area Drains

Catchbasins and area drains accumulate debris which is washed off the site surfaces. The grates for these structures should be inspected regularly to ensure that they are not blocked. These structures also have sumps which are designed to capture silt and debris and prevent this material from entering the storm sewer system.

The catchbasin sumps are to be cleaned using a vacuum truck when the sump becomes 50% full. Maintenance should be preformed immediately if abnormality is observed such as a slow catchbasin draining rate.

5.2 Detention Tank & Orifice Device

The orifice devices in detention tanks typically have small diameters and can be susceptible to blockage. The orifice device should be inspected periodically to ensure that it is clear of debris. Maintenance should be preformed immediately if abnormality is observed such as slow catchbasin draining rate, excessive drain down time or excessive detention depth of the parking lot surface stormwater storage.

5.3 TSS / Phosphorus Treatment Unit

Maintenance is an integral component of a treatment unit's ability to operate as designed and without regular maintenance, the effectiveness will gradually diminish. The location of this treatment unit is indicated on the Site Servicing Plan and will be easily identifiable on site by the access lid which is to be stamped with the manufacturer's name. The maintenance and inspection requirements for the Up-Flo® Filter treatment unit are provided in the manual which is contained in **Appendix "E"**.

6.0 EROSION & SEDIMENT CONTROL DURING CONSTRUCTION

Construction activity, especially operations involving the handling of earthen material, dramatically increases the availability of particulate matter for erosion and transport by surface drainage. In order to mitigate the adverse environmental impacts caused by the release of silt-laden stormwater runoff into receiving watercourses, measures for erosion and sediment control are required for construction sites.

The impact of construction on the environment is recognized by the Greater Golden Horseshoe Area Conservation Authorities. In December 2006 they released their document titled "Erosion & Sediment Control Guidelines for Urban Construction". This document provides guidance for the preparation of effective erosion and sediment control plans.

Control measures must be selected that are appropriate for the erosion potential of the site and it is important that they be implemented and modified on a staged basis to reflect the site activities. Furthermore, their effectiveness decreases with sediment loading and therefore inspection and maintenance is required. The selection, implementation, inspection and maintenance of the control features are summarized as follows:

6.1 Control Measures

On relatively small sites, measures for erosion and sediment control (ESC) typically include the use of silt fencing, a mud mat and sediment traps. The following is a description of the sediment controls to be implemented on the subject site:

- **Silt Fences** are to be installed adjacent to all property limits subject to drainage from the development area prior to topsoil stripping and in other locations, such as at the bases of topsoil stockpiles.
- **Mud Mat** is to be installed at the construction entrance prior to commencing earthworks to minimize the tracking of mud onto municipal roads.
- **Sediment Traps** are to be installed at all catchbasin and area drain locations once the storm sewer system has been constructed to prevent silt laden runoff from entering the municipal storm sewer system.

6.2 Construction Sequencing

The following is the scheduling of construction activities with respect to sediment controls:

1. Installation of all silt fences prior to any other activities on the site.
2. Construct temporary mud mat for construction access.
3. Install shoring and excavate for the construction of the underground parking lot. Dispose surplus material off site.
4. Construct the parking garage.
5. Install the site servicing and all underground utilities.
6. Construct the sediment traps.
7. Construct the superstructure.
8. Construct the driveway and surface parking lot.
9. Restore / re-vegetate all disturbed areas either with temporary measures such as mulch or seeding or with final landscape and paving materials.
10. Upon stabilization of all disturbed areas, remove sediment controls.

6.3 ESC Inspection & Maintenance

In order to ensure that the erosion and sediment control measures operate effectively, they are to be regularly monitored and they will require periodic cleaning (e.g., removal of accumulated silt), maintenance and/or re-construction.

Inspections of all of the erosion and sediment controls on the construction site should be undertaken with the following frequency:

- On a weekly basis
- After every rainfall event
- After significant snow melt events
- Prior to forecasted rainfall events

If damaged control measures are found they should be repaired and/or replaced within 48 hours. Site inspection staff and construction managers should refer to the Erosion and Sediment Control Inspection Guide (2008) prepared by the Greater Golden Horseshoe Area Conservation Authorities. This Inspection Guide provides information related to the inspection reporting, problem response and proper installation techniques.

7.0 SUMMARY

Based on the analysis contained in this report, the subject site can be serviced with a stormwater management system in accordance with the standards of the City of Barrie and the Lake Simcoe Region Conservation Authority (LSRCA). The proposed storm drainage system, detention area, orifice location, as well as erosion and sediment control measures are illustrated on the Site Servicing & Grading Plans. The system is summarized as follows:

Storm Drainage

- Storm drainage from the subject site currently sheet flows off the site to Yonge Street. In accordance with City standards the subject site will be serviced with an on-site storm sewer system discharging to the existing municipal storm sewer on Yonge Street.
- An overland flow route will be provided within the site to direct runoff, in excess of the 100 year storm event, to the adjacent road allowances.

Quantity Control

- Discharge is to be controlled to the 2 year pre-development rate by implementing an on-site stormwater detention system. Through the implementation of a detention tank on the P1 level of the underground parking garage the post-development 100 year rate will be controlled to the 2 year pre-development rate of 39.3 L/s using a 120 mm diameter orifice and providing the required 136.5 m^3 of detention volume. Ground surface detention and roof top detention is not required. Foundation drainage will discharge to the detention tank and is included in the tank sizing calculations.

Phosphorus Removal

- Based on the requirements of the LSRCA, phosphorus removal will be provided by a Up-Flo® Filter treatment unit manufactured by Hydro International. This unit together with the benefits of the stormwater detention tank provides a phosphorus removal rate of 61%. Based on the LSRCA policy an offset payment in the amount of $24,009.00 will be required to compensate for the remaining phosphorus load. Because the water balance cash-in-lieu payment is greater than the phosphorus offset payment, the phosphorus payment is not required.

Quality Treatment

- Quality treatment will be provided by the same unit that will address phosphorus removal. In this regard the Up-Flo® Filter treatment unit has the capability to provide a TSS removal rate of 80%.

Water Balance

- Infiltration measures are not feasible due to the extent of the underground parking garage and therefore pre-development infiltration rates cannot be maintained. Based on the foregoing, in accordance with the LSRCA policy a compensation payment in the amount of $245,784.00 will be required.

Inspection & Maintenance

- The stormwater management system is to be inspected and maintained in accordance with the recommendations contained in this report.

Erosion & Sediment Control

- Erosion and sediment control measures are to be implemented during construction to prevent silt laden runoff downstream in accordance with the Erosion & Sediment Control Guidelines for Urban Construction (December 2006).

8.0 REFERENCES & BIBLIOGRAPHY

- City of Barrie, **Storm Drainage & Stormwater Management Policies & Design Guidelines**, November 30, 2009
- City of Barrie, **Site Plan Application Manual**, February 2010.
- City of Barrie, **City Standards Drawing Details**, February 2006.
- Lake Simcoe Region Conservation Authority, **Technical Guidelines for Stormwater Management Submissions**, June 24, 2016.
- Ministry of Environment, **Stormwater Management Planning & Design Manual**, March 2003.
- Greater Golden Horseshoe Area Conservation Authorities, **Erosion & Sediment Control Guidelines for Urban Construction**, December 2006.
- Soil Engineers Ltd., **Hydrogeological Assessment Proposed Residential Development 681 Yonge Street**, November 2019.

Respectfully Submitted,

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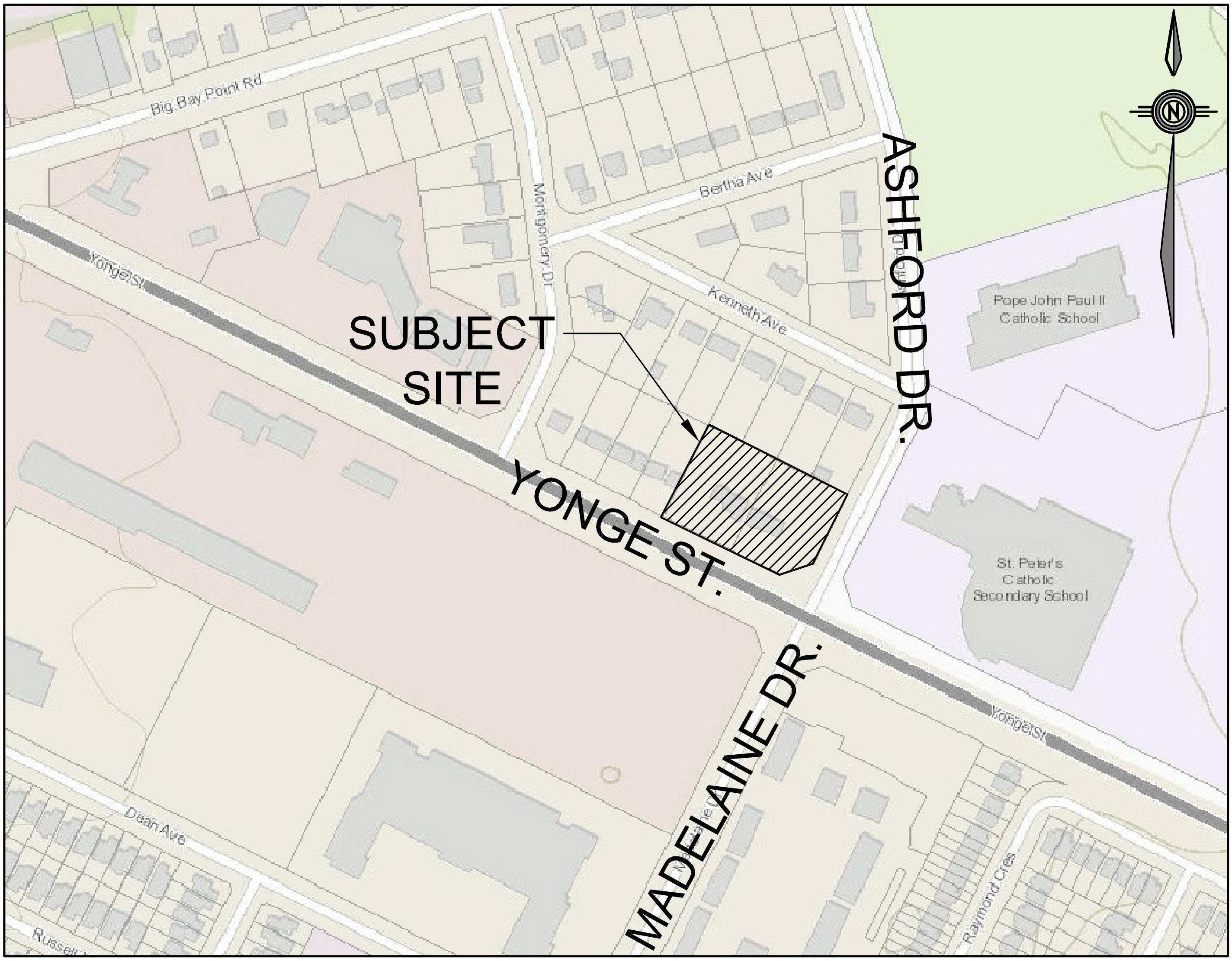

PROJECT
PROPOSED CONDOMINIUM BUILDING
681 & 685 YONGE ST, BARRIE

TITLE
LOCATION PLAN

VALDOR ENGINEERING INC.
Consulting Engineers - Project Managers
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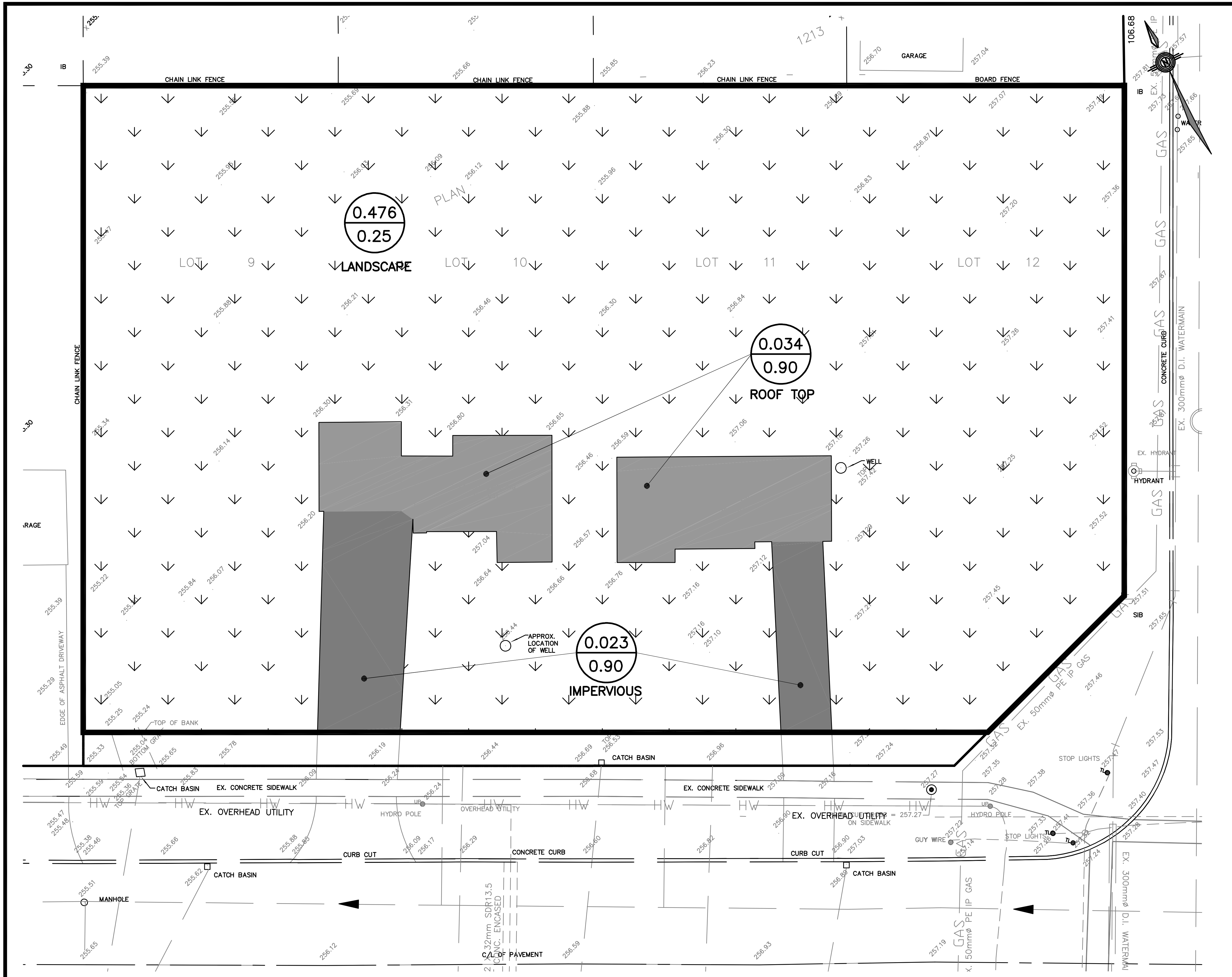
PREPARED BY P.Y.	CKD. BY D.G.
SCALE NTS	DATE NOV 2019
PROJECT 19112	DWG. FIGURE 1



LEGEND:

BUILDING SURFACE

LANDSCAPE SURFACE

PAVED SURFACE

DRAINAGE BOUNDARY

PRE-DEVELOPMENT AREA SUMMARY

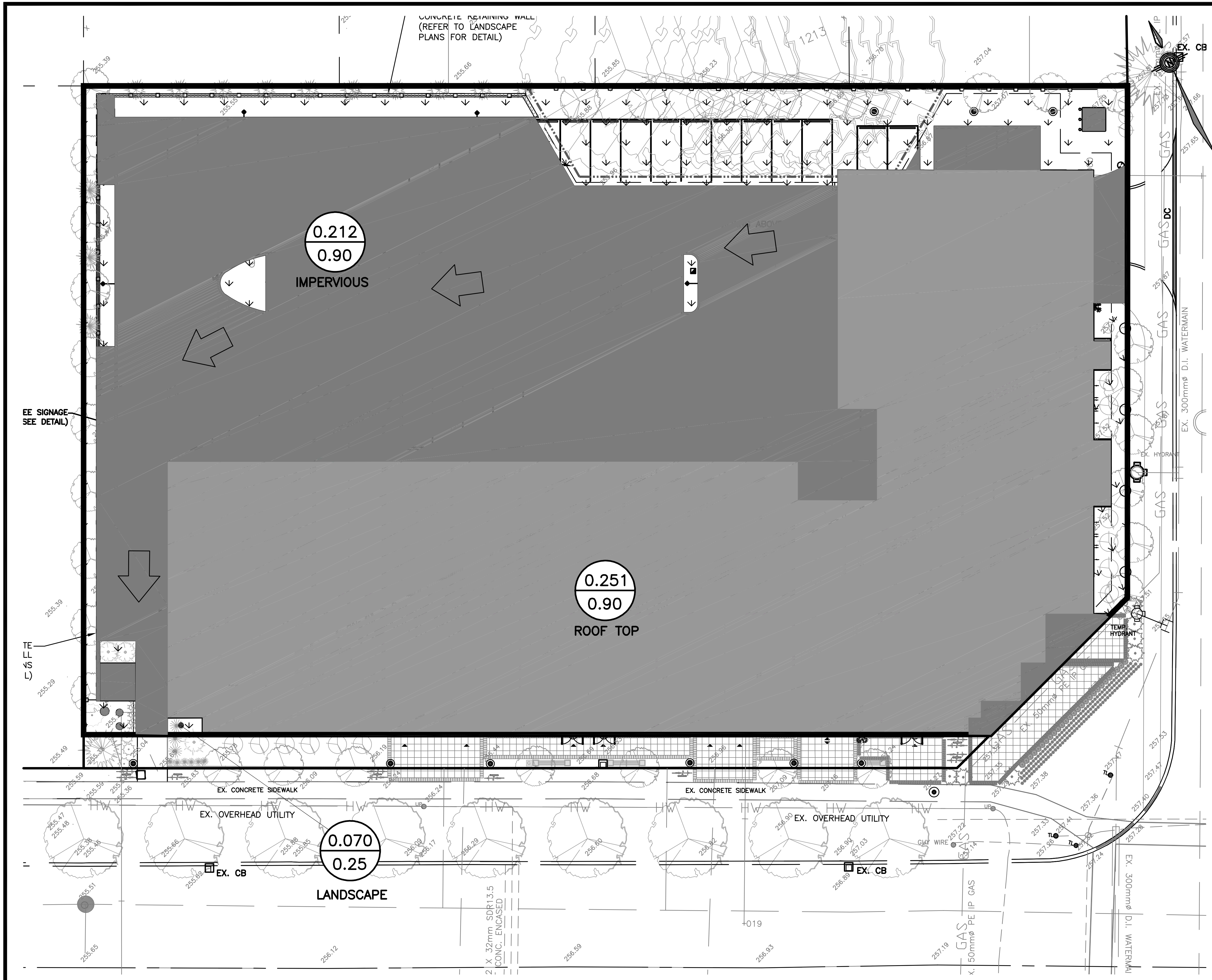
LANDUSE	AREA (Ha.)	RC	COMPOSITE RC
LANDSCAPE	0.476	0.25	0.32
ROOF TOP	0.034	0.90	
IMPERVIOUS	0.023	0.90	
TOTAL	0.533		

PROJECT
PROPOSED CONDOMINIUM BUILDING
681 & 685 YONGE ST, BARRIE

TITLE
PRE-DEVELOPMENT STORM DRAINAGE CONDITIONS

VALDOR ENGINEERING INC.
Consulting Engineers - Project Managers
741 ROWNTREE DAIRY ROAD, SUITE 2, WOODBRIDGE, ONTARIO, L4L 5T9
TEL (905)264-0054, FAX (905)264-0069
E-MAIL: info@valdor-engineering.com
www.valdor-engineering.com

PREPARED BY P.Y.	CKD. BY D.G.
SCALE NTS	DATE NOV 2019
PROJECT 19112	DWG. FIGURE 2



LEGEND:

- BUILDING SURFACE
- LANDSCAPE SURFACE
- PAVED SURFACE
- DRAINAGE BOUNDARY
- OVERLAND FLOW

POST-DEVELOPMENT AREA SUMMARY

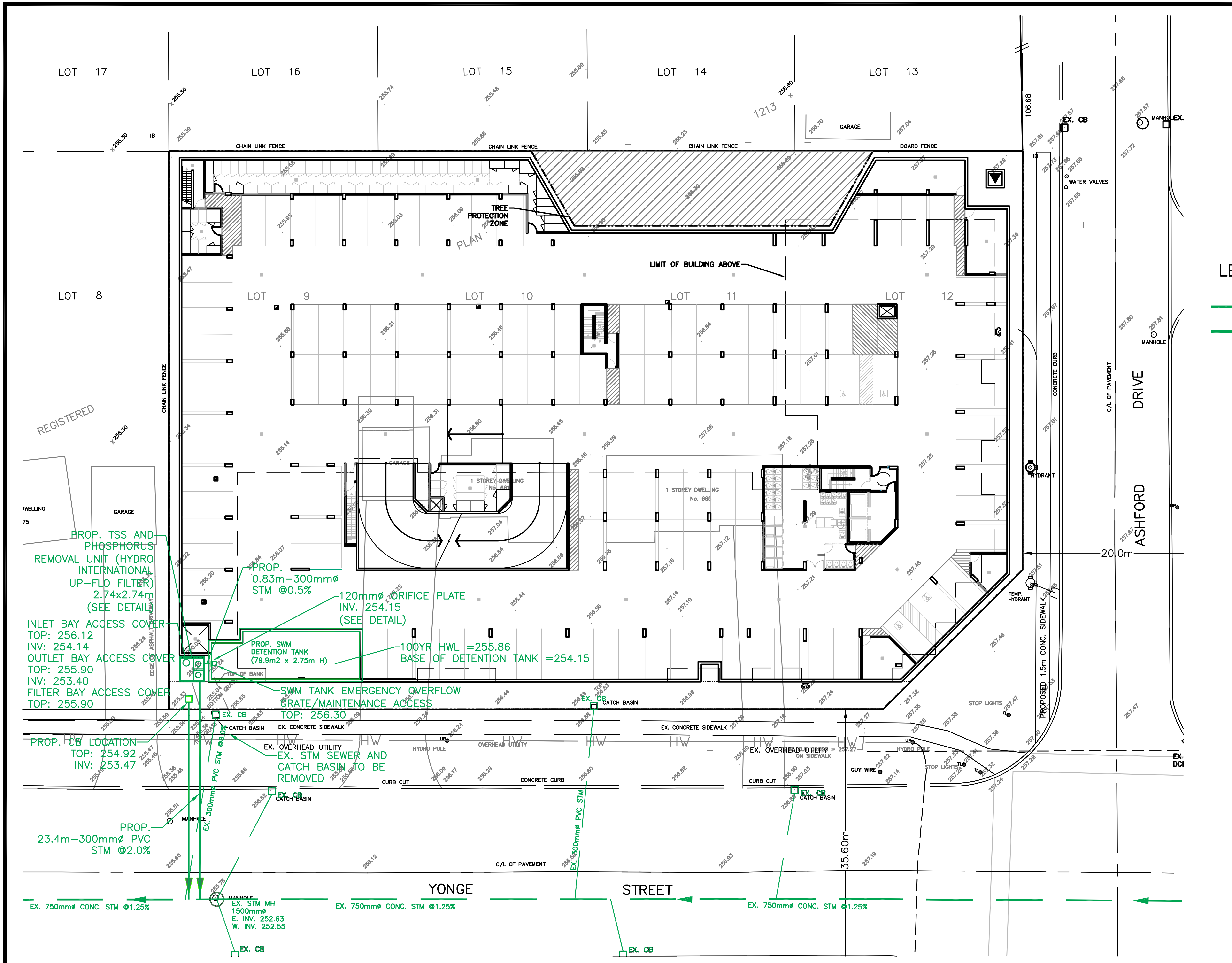
LANDUSE	AREA (Ha.)	RC	COMPOSITE RC
LANDSCAPE	0.070	0.25	0.82
IMPERVIOUS	0.212	0.90	
ROOF TOP	0.251	0.90	
TOTAL	0.533		

PROJECT
PROPOSED CONDOMINIUM BUILDING
681 & 685 YONGE ST, BARRIE

TITLE
POST-DEVELOPMENT STORM DRAINAGE CONDITIONS

VALDOR ENGINEERING INC.
Consulting Engineers - Project Managers
741 ROWNTREE DAIRY ROAD, SUITE 2, WOODBRIDGE, ONTARIO, L4L 5T9
TEL (905)264-0054, FAX (905)264-0069
E-MAIL: info@valdor-engineering.com
www.valdor-engineering.com

PREPARED BY	P.Y.	CKD. BY	D.G.
SCALE	NTS	DATE	NOV 2019
PROJECT	19112	DWG.	FIGURE 3



PROJECT
PROPOSED CONDOMINIUM BUILDING
681 & 685 YONGE ST, BARRIE

TITLE
STORM SERVICING PLAN

VALDOR ENGINEERING INC.
Consulting Engineers - Project Managers
741 ROWNTREE DAIRY ROAD, SUITE 2, WOODBRIDGE, ONTARIO, L4L 5T9
TEL (905)264-0054, FAX (905)264-0069
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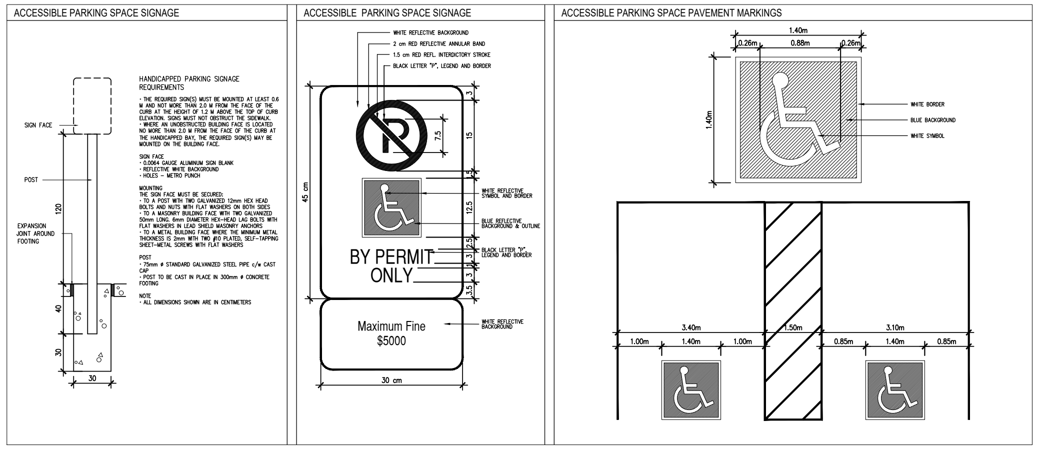
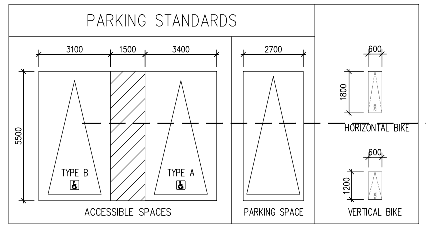
PREPARED BY	P.Y.	CKD. BY	D.G.
SCALE	NTS	DATE	NOV 2019
PROJECT	19112	DWG.	FIGURE 4

APPENDIX “A”

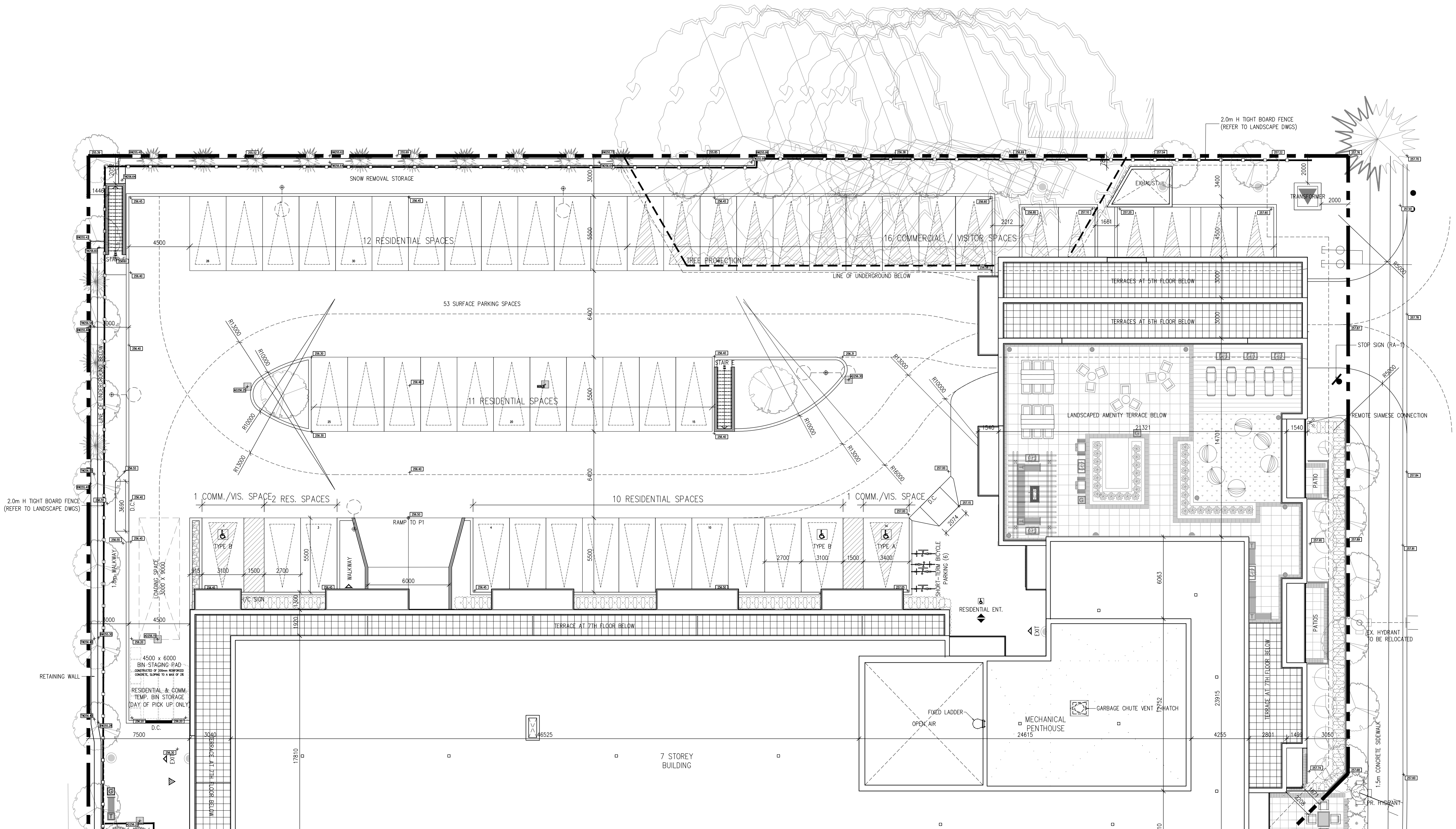
Architectural Site Plan

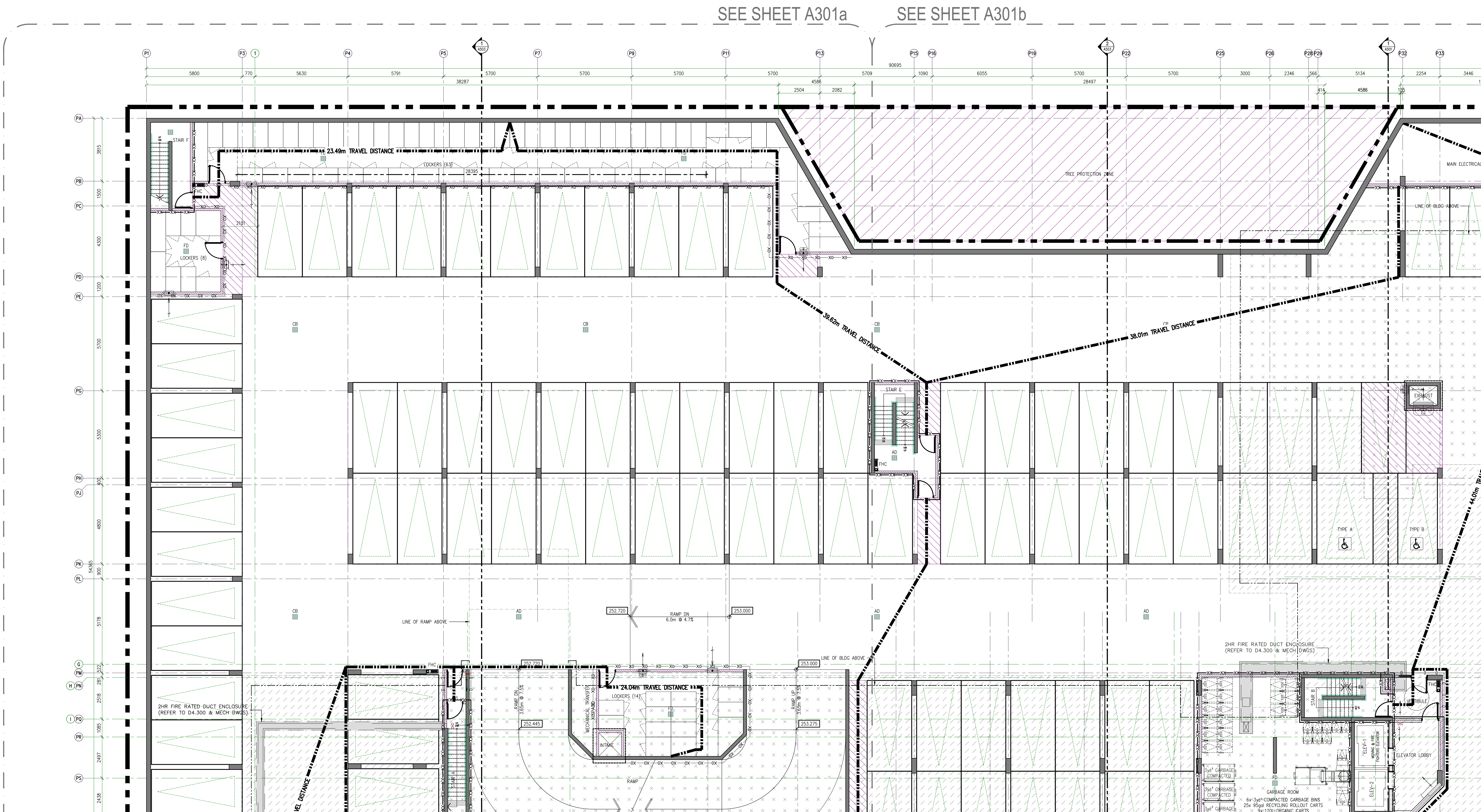




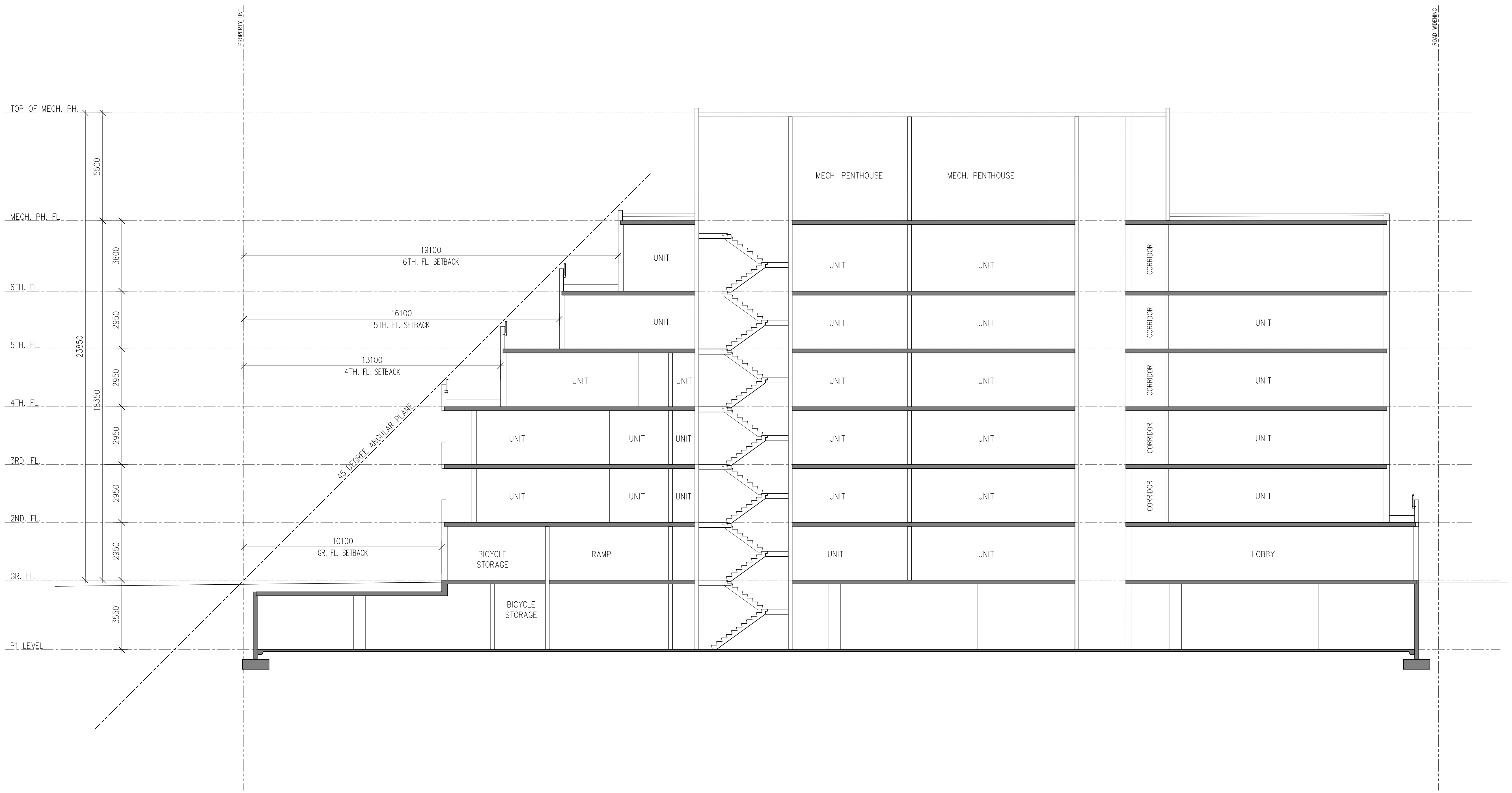
LEGEND

000.000	FINISH ELEVATION	▲	DENOTES BUILDING ENTRANCE	C.B.	CATCH BASIN
+123.18	EXISTING ELEVATION	▽	DENOTES BUILDING EXIT		MAINTENANCE HOLE COVER
	HANDICAPPED PARKING SPACE	△	DENOTES BUILDING SERVICE ENTRANCE	D.C.	DEPRESSED CURB
	SIAMESE CONNECTION		FIRE HYDRANT		SITE LIGHTING (REFER TO LANDSCAPE DWGS)





SEE SHEET A301a
SEE SHEET A301b
23.49m TRAVEL DISTANCE
LOCKERS (63)
STAIR F
FHC
LOCKERS (8)
TREE PROTECTION ZONE
MAIN ELECTRICAL
LINE OF BLDG ABOVE
39.62m TRAVEL DISTANCE
38.01m TRAVEL DISTANCE
STAIR E
EXHAUST
TYPE A
TYPE B
LINE OF RAMP ABOVE
RAMP DN
6.0m @ 4.7%
LINE OF BLDG ABOVE
2HR FIRE RATED DUCT ENCLOSURE
(REFER TO D4.300 & MECH DWGS)
24.04m TRAVEL DISTANCE
LOCKERS (14)
MECHANICAL TRANSFER
INTAKE
RAMP
STAIR B
VESTIBULE
ELEVATOR LOBBY
GARBAGE ROOM
6x 3yd³ COMPACTED GARBAGE BINS
25x 95gal RECYCLING ROLLOUT CARTS



These Contract Documents are the property of the architect. The architect bears no responsibility for the interpretation of these documents by the Contractor. Upon written application the architect will provide written/graphic clarification or supplementary information regarding the intent of the Contract Documents. The architect will review Shop Drawings submitted by the Contractor for design conformance only.

Drawings are not to be scaled for construction. Contractor to verify all existing conditions and dimensions required to perform the work and report any discrepancies with the Contract Documents to the architect before commencing work.

Positions of exposed or finished mechanical or electrical devices, fittings, and fixtures are indicated on architectural drawings. The locations shown on the architectural drawings govern over the Mechanical and Electrical drawings. Those items not clearly located will be located as directed by the architect.

These drawings are not to be used for construction unless noted below as "Issued for Construction"

All work to be carried out in conformance with the Code and bylaws of the authorities having jurisdiction.

The Designer of these plans and specifications gives no warranty or representation to any party about the constructability of the represented by them. all contractors or subcontractors must satisfy themselves when bidding and at all times that they can properly construct the work represented by these plans.

notes:

architectureunfolded

219 dufferin street, suite 201b, toronto, on, m6k3j1 tel: (416)601.5416 info@unfolded.ca

revisions:

architectural team :

mark zwicker
artem ponomarenko

planning:

structural:

electrical:

mechanical:

landscape:

site services:

project:
681 Yonge st
barrie, ontario

section

january 8.2019	date:
1:150	scale:
18-34	project:
ap	drawing by:

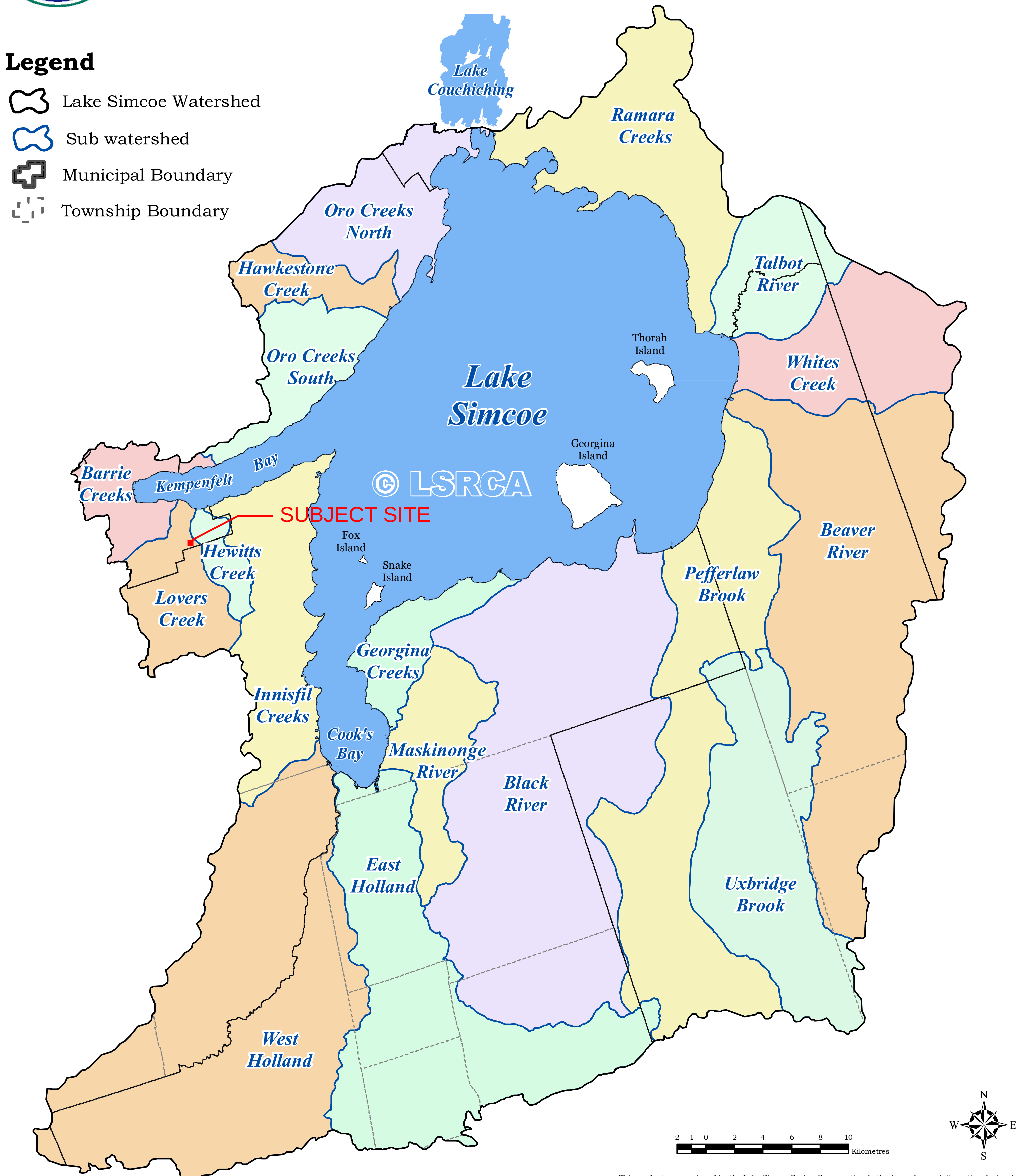
north

drawing number:
A501

APPENDIX “B”

LSRCA Watershed Map / Regulation Mapping

Lake Simcoe Region Conservation Authority
Sub - Watersheds



This product was produced by the Lake Simcoe Region Conservation Authority and some information depicted on this map may have been compiled from various sources.
While every effort has been made to accurately depict the information, data / mapping errors may exist.
This map has been produced for illustrative purposes only.
LSRCA GIS Services DRAFT printed July 2008.

Lake Simcoe Region
conservation authority

Features

- Regulation Map Index
- LSRCA Watershed Boundary
- Lake Simcoe
- Watercourse
- Regulated Area Boundary
- Regulated Area
- Lot and Concession
- Roads
  - Hwy 400 Series
  - Highway, Arterials
  - Local Road
- Railway

Printed On:
3/31/2019

WGS_1984_Web_Mercator_
Auxiliary_Sphere

Mapped By:

Scale 1: 42,769

Meters

2,173 0 1,086 2,173

APPENDIX "C"

Municipal Intensity / Duration Frequency Data

VALDOR

7.0 GUIDELINES FOR HYDROLOGIC AND HYDRAULIC ANALYSES

The guidelines in this section provide some direction for completing hydrologic and hydraulic studies for submission to and review by the City of Barrie. Prior to undertaking hydrology and hydraulic modeling work, the City of Barrie Engineering Department shall be contacted to confirm the use of an approved and appropriate software package. A number of relevant sample problems and calculations are provided in **Appendix C**.

7.1 Rainfall Data

7.1.1 City of Barrie IDF Curves

Until the Regional Intensity-Duration-Frequency (IDF) curves are available, stormwater management facilities should be designed based on the most current IDF tables developed by Environment Canada for Barrie including a 15% increase in rainfall intensity data to account for impacts due to climate change. The Chicago distribution parameters for different return periods provided in **Table 7.1** should be used for modeling purposes.

Table 7.1: 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.

7.1.2 Return Period Design Storms and Regional Storm

1: 2 year, 1:5 year, 1:10 year, 1:25 year, 1:50 year, 1:100 year and the Regional Storms shall be applied for quantity control and the 25 mm 4-hour Chicago storm shall be applied for erosion control as required. In order to determine the critical design storms, the SCS Type II (6-hr, 12-hr and 24-hr durations) and the 4-hour Chicago storm distributions for the 1:2 year through 1:100 year return period shall be applied.

Unless otherwise directed by the City, Hurricane Hazel shall be applied throughout the City as the Regional storm for the sizing of municipal infrastructure associated with storm drainage and stormwater management. It should be noted, however, that either the Timmins storm or Hurricane Hazel shall be used as the Regional storm within the respective jurisdictions of the NVCA and the LSRCA for the preparation of floodplain mapping where applicable. In addition, watershed and subwatershed hydrology models within the City that lie within the NVCA jurisdiction must include the Timmins storm such that appropriate peak flow information is available as required (*e.g.* for either floodplain mapping or culvert/bridge designs on a watercourse where applicable.

City approved design storm hyetographs for computer modeling (adjusted to account for climate change) are provided in **Appendix B** and on CD in **Appendix I**. An analysis of design storm durations for use within the City of Barrie is provided in **Appendix H**. A map delineating the flood hazard criteria zone boundaries (*i.e.* where to apply Hurricane Hazel and the Timmins storm) within the City of Barrie is provided in **Appendix B**.

APPENDIX "D"

Stormwater Quantity Control Calculations

VALDOR ENGINEERING INC.

File: 19112

Date: November 2019

TABLE 1: PEAK FLOW SUMMARY

Condition	Runoff Coefficient	Peak Flow (L/s)	
		2 Year	100 year
Pre-Development (Detached Dwelling)	0.32	39.3	85.2
Post-Development Un-Mitigated (Condo)	0.81	81.2	176.1
Post-Development Mitigated (Condo)	0.81	20.9	39.3

VALDOR ENGINEERING INC.

File: 19112

Date: November 2019

TABLE D1

TABLE D1: STORAGE AND DISCHARGE SUMMARY

PROJECT: **681 Yonge Street, Barrie**

AREA No.	DESCRIPTION	DRAINAGE AREA (Ha)	2 YR HWL (m)	100 YR HWL (m)	ORIFICE LOCATION	ORIFICE INVERT (m)	ORIFICE DIAMETER (mm)	ORIFICE 2 YEAR RELEASE (L/s)	ORIFICE 100 YEAR RELEASE (L/s)	STORAGE REQUIRED 2 YR (cu.m.)	STORAGE REQUIRED 100 YR (cu.m.)	STORAGE 0.2511 0.07 0.2116
1	Subject Site	0.533	254.68	255.86	SWM TANK	254.15	120	20.9	39.3	41.6	136.5	23.2
	TOTAL AREA	**0.533**										
	ACTUAL RELEASE							**20.9**	**39.3**			
	ALLOWABLE RELEASE							**39.3**	**39.3**			

VALDOR ENGINEERING INC.

File: 19112

Date: November 2019

TABLE D2

PROJECT: 681 Yonge Street, Barrie

PRE-DEVELOPMENT PEAK FLOW CALCULATION

2 Year Peak Flow

I = 678.085 / (Tc+4.699)^0.781
I = Rainfall Rate (mm/hr)

T = 10 minutes

253.42

I = 83.1 mm/hr

255.22

A = 0.53 Ha

R = 0.32

N = 2.778

Q = R x A x I x N 2 year **Q** = **39.3** L/s

100 Year Peak Flow

I = 1426.408 / (Tc+5.273)^0.759
I = Rainfall Rate (mm/hr)

T = 10 minutes

I = 180.2 mm/hr

A = 0.53 Ha

R = 0.32

N = 2.778

Q = R x A x I x N 100 year **Q** = **85.2** L/s

VALDOR ENGINEERING INC.

File: 19112

TABLE D3

Date: November 2019

PROJECT: **681 Yonge Street, Barrie**

POST-DEVELOPMENT PEAK FLOW CALCULATION (UNMITIGATED)

2 Year Peak Flow

I = 678.085 / (Tc+4.699)^0.781
I = Rainfall Rate (mm/hr)

T =	10	minutes	
			253.42
I =	83.1	mm/hr	
			255.22
A =	0.53	Ha	
R =	0.66		
N =	2.778		

Q = R x A x I x N   2 year **Q** = **81.2** L/s

100 Year Peak Flow

I = 1426.408 / (Tc+5.273)^0.759
I = Rainfall Rate (mm/hr)

T =	10	minutes
I =	180.2	mm/hr
A =	0.53	Ha
R =	0.66	
N =	2.778	

Q = R x A x I x N   100 year **Q** = **176.1** L/s

VALDOR ENGINEERING INC. **TABLE D4-1**

File: 19112
Date: November 2019

CONTROL ORIFICE DESIGN
2 Year Storm

Orifice Pipe Location	=	SWM TANK		
Orifice Coefficient (C)	=	0.61	(Plate)	
Acceleration due to gravity (g)	=	9.81	(m/s/s)	
Orifice Invert	=	254.15	(m)	
High Water Level	=	254.68	(m)	2 Year
Orifice diameter	=	120	(mm)	
Cross section area of orifice (A)	=	0.0113	(sq.m.)	
Head (H)	=	0.47	(m)	
Actual Discharge (Q) (C x A x (2 x g x H)^0.5)	=	20.95	(L/s)	

VALDOR ENGINEERING INC. **TABLE D4-2**

File: 19112

Date: November 2019

CONTROL ORIFICE DESIGN
100 Year Storm

Orifice Pipe Location	=	SWM TANK		
Orifice Coefficient (C)	=	0.61	(Plate)	
Acceleration due to gravity (g)	=	9.81	(m/s/s)	
Orifice Invert	=	254.15	(m)	
High Water Level	=	255.86	(m)	100 Year
Orifice diameter	=	120	(mm)	
Cross section area of orifice (A)	=	0.0113	(sq.m.)	
Head (H)	=	1.65	(m)	
Actual Discharge (Q) (C x A x (2 x g x H)^0.5)	=	39.25	(L/s)	

VALDOR ENGINEERING INC. **TABLE D4-3**

File: 19112
Date: November 2019

CONTROL ORIFICE DESIGN
25mm Chicago Storm

Orifice Pipe Location	=	SWM TANK		
Orifice Coefficient (C)	=	0.61	(Plate)	
Acceleration due to gravity (g)	=	9.81	(m/s/s)	
Orifice Invert	=	254.15	(m)	
High Water Level	=	254.45	(m)	25mm
Orifice diameter	=	120	(mm)	
Cross section area of orifice (A)	=	0.0113	(sq.m.)	
Head (H)	=	0.24	(m)	
Actual Discharge (Q) (C x A x (2 x g x H)^0.5)	=	14.97	(L/s)	

VALDOR ENGINEERING INC.

File: 19112 **TABLE D5-1**

Date: November 2019

Storage Volume Calculations - Rational Method

2-year Storm - City of Barrie

PROJECT: **681 Yonge St. Condo**

Drainage Area	Area	Coefficient
Landscape Area	0.070	0.25
Roof Area	0.251	0.90
Impervious Area	0.212	0.90
Total Area (ha)	0.533	

Runoff Coefficient	0.81
Maximum Discharge Through Orifice (L/s)	20.9
Discharged Volume per 5 min Interval (cu.m)	6.3

Time (min)	Intensity (mm/hr)	Runoff Volume (cu.m)	Discharged Volume (cu.m)	Storage Volume (cu.m)
0	0.0	0.000	0.000	0.000
5	2.6	0.940	0.940	0.000
10	2.8	1.027	1.027	0.000
15	3.1	1.135	1.135	0.000
20	3.5	1.269	1.269	0.000
25	4.0	1.446	1.446	0.000
30	4.7	1.685	1.685	0.000
35	5.6	2.029	2.029	0.000
40	7.1	2.557	2.557	0.000
45	9.6	3.471	3.471	0.000
50	15.0	5.435	5.435	0.000
55	33.3	12.052	6.285	5.767
60	84.6	30.588	6.285	24.303
65	42.1	15.216	6.285	8.932
70	24.6	8.899	6.285	2.614
75	17.1	6.180	6.180	0.000
80	13.0	4.701	4.701	0.000
85	10.5	3.786	3.786	0.000
90	8.8	3.168	3.168	0.000
95	7.5	2.727	2.727	0.000
100	6.6	2.394	2.394	0.000
105	5.9	2.133	2.133	0.000
110	5.3	1.927	1.927	0.000
115	4.9	1.757	1.757	0.000
120	4.5	1.620	1.620	0.000
125	4.2	1.501	1.501	0.000
130	3.9	1.399	1.399	0.000
135	3.6	1.313	1.313	0.000
140	3.4	1.233	1.233	0.000
145	3.2	1.168	1.168	0.000
150	3.1	1.107	1.107	0.000
155	2.9	1.052	1.052	0.000
160	2.8	1.005	1.005	0.000
165	2.7	0.962	0.962	0.000
170	2.6	0.922	0.922	0.000
175	2.5	0.886	0.886	0.000
180	2.4	0.850	0.850	0.000

Total Storage Volume Required (cu.m) **41.6**

VALDOR ENGINEERING INC.

File: 19112

Date: November 2019

TABLE D5-2

Storage Volume Calculations - Rational Method

100-year Storm - City of Barrie

PROJECT: **681 Yonge St. Condo**

Surface Type	Area	Coefficient
Landscape Area	0.070	0.25
Roof Area	0.251	0.90
Impervious Area	0.212	0.90
Total Area (ha)	0.533	

Composite Runoff Coefficient	0.81
Maximum Discharge Through Orifice (L/s)	39.3
Groundwater Discharge Rate (L/s)	0.11
Discharged Volume per 5 min Interval (cu.m)	11.8

Time (min)	Intensity (mm/hr)	Groundwater Discharge (cu.m)	Runoff Volume (cu.m)	Discharged Volume (cu.m)	Storage Volume (cu.m)
0	0.0	0.034	0.000	0.034	0.000
5	7.7	0.034	2.833	2.867	0.000
10	8.4	0.034	3.065	3.099	0.000
15	9.2	0.034	3.347	3.381	0.000
20	10.1	0.034	3.701	3.735	0.000
25	11.4	0.034	4.149	4.184	0.000
30	13.0	0.034	4.746	4.780	0.000
35	15.4	0.034	5.585	5.619	0.000
40	18.9	0.034	6.854	6.888	0.000
45	24.8	0.034	9.013	9.047	0.000
50	37.5	0.034	13.580	11.776	1.838
55	82.7	0.034	29.947	11.776	18.205
60	243.4	0.034	88.061	11.776	76.319
65	105.4	0.034	38.133	11.776	26.392
70	60.2	0.034	21.799	11.776	10.058
75	42.3	0.034	15.316	11.776	3.574
80	32.7	0.034	11.873	11.776	0.132
85	26.9	0.034	9.747	9.781	0.000
90	22.9	0.034	8.304	8.339	0.000
95	20.0	0.034	7.259	7.293	0.000
100	17.8	0.034	6.467	6.502	0.000
105	16.1	0.034	5.842	5.876	0.000
110	14.7	0.034	5.343	5.377	0.000
115	13.5	0.034	4.927	4.961	0.000
120	12.6	0.034	4.580	4.614	0.000
125	11.8	0.034	4.283	4.317	0.000
130	11.0	0.034	4.026	4.061	0.000
135	10.4	0.034	3.802	3.836	0.000
140	9.9	0.034	3.607	3.641	0.000
145	9.4	0.034	3.430	3.464	0.000
150	9.0	0.034	3.274	3.309	0.000
155	8.6	0.034	3.133	3.168	0.000
160	8.2	0.034	3.007	3.041	0.000
165	7.9	0.034	2.887	2.922	0.000
170	7.6	0.034	2.782	2.817	0.000
175	7.3	0.034	2.685	2.719	0.000
180	7.1	0.034	2.594	2.629	0.000

Total Storage Volume Required (cu.m) **136.5**

VALDOR ENGINEERING INC.

File: 19112 **TABLE D5-3**

Date: November 2019

Storage Volume Calculations - Rational Method

25mm Quality Design Storm (Chicago Distribution)

PROJECT: **681 Yonge St. Condo**

Surface Type	Area	Coefficient
Landscape Area	0.070	0.25
Roof Area	0.251	0.90
Impervious Area	0.212	0.90
Total Area (ha)	0.533	

Composite Runoff Coefficient	0.81
Maximum Discharge Through Orifice (L/s)	15.0
Discharged Volume per 5 min Interval (cu.m)	4.5

Time (min)	Intensity (mm/hr)	Runoff Volume (cu.m)	Discharged Volume (cu.m)	Storage Volume (cu.m)
0	2.17	0.785	0.785	0.000
5	2.17	0.785	0.785	0.000
10	2.38	0.861	0.861	0.000
15	2.38	0.861	0.861	0.000
20	2.66	0.962	0.962	0.000
25	2.66	0.962	0.962	0.000
30	3.03	1.096	1.096	0.000
35	3.03	1.096	1.096	0.000
40	3.58	1.295	1.295	0.000
45	3.58	1.295	1.295	0.000
50	4.47	1.616	1.616	0.000
55	4.47	1.616	1.616	0.000
60	6.20	2.242	2.242	0.000
65	6.20	2.242	2.242	0.000
70	12.18	4.404	4.404	0.000
75	12.18	4.404	4.404	0.000
80	41.67	15.068	4.491	10.577
85	41.67	15.068	4.491	10.577
90	15.28	5.525	4.491	1.034
95	15.28	5.525	4.491	1.034
100	9.22	3.334	3.334	0.000
105	9.22	3.334	3.334	0.000
110	6.88	2.488	2.488	0.000
115	6.88	2.488	2.488	0.000
120	5.62	2.032	2.032	0.000
125	5.62	2.032	2.032	0.000
130	4.80	1.736	1.736	0.000
135	4.80	1.736	1.736	0.000
140	4.21	1.522	1.522	0.000
145	4.21	1.522	1.522	0.000
150	3.78	1.367	1.367	0.000
155	3.78	1.367	1.367	0.000
160	3.45	1.248	1.248	0.000
165	3.45	1.248	1.248	0.000
170	3.18	1.150	1.150	0.000
175	3.18	1.150	1.150	0.000
180	2.95	1.067	1.067	0.000
185	2.95	1.067	1.067	0.000
190	2.76	0.998	0.998	0.000
195	2.76	0.998	0.998	0.000
200	2.62	0.947	0.947	0.000
205	2.62	0.947	0.947	0.000
210	2.47	0.893	0.893	0.000
215	2.47	0.893	0.893	0.000
220	2.35	0.850	0.850	0.000
225	2.35	0.850	0.850	0.000
230	2.23	0.806	0.806	0.000
235	2.23	0.806	0.806	0.000

Total Storage Volume Required (cu.m) **23.2**

VALDOR ENGINEERING INC. **TABLE D6**

File: 19112

Date: November 2019

AVAILABLE DETENTION STORAGE VOLUME

UNDERGROUND STORAGE

		INV. ELEV. (m)	HIGH WATER ELEV. (m)	PONDING DEPTH (m)	TANK SIZE (sq.m.)	STORAGE AREA (sq.m.)	STORAGE VOLUME (cu.m)
SWM TANK	2 yr	254.15	254.68	0.53	79.90	79.9	42.3
	100 yr	254.15	255.86	1.71		79.9	136.6
	25mm	254.15	254.45	0.30		79.9	24.0

2-yr	**STORAGE PROVIDED:**	**42.3**
	STORAGE REQUIRED:	**41.6**

100-yr	**STORAGE PROVIDED:**	**136.6**
	STORAGE REQUIRED:	**136.5**

25mm	**STORAGE PROVIDED:**	**24.0**
	STORAGE REQUIRED:	**23.2**

APPENDIX "E"

Stormwater Quality / Phosphorus Calculations

VALDOR ENGINEERING INC.
File: 19112
Date: November 2019

Table E.1: Phosphorus Loading Calculations

A [1]NON-POINT SOURCE P LOADING

LAND USE	[1]LOADING RATE (kg/yr/ha)	PRE-DEVELOPMENT		POST-DEVELOPMENT (UNMITIGATED)		P LOAD
		AREA (ha)	LOAD (kg/yr)	AREA (ha)	LOAD (kg/yr)	NET CHANGE (kg/yr)
High Intensity Development (Residential)	1.32	0.533	0.70	0.530	0.70	0.00
TOTAL		0.533	**0.70**	0.530	**0.70**	**0.00**

B [2]P LOAD REDUCTION TARGET

Post-Development (Unmitigated) P Load (kg/yr):	0.70
Target P Load Reduction Rate Required (%):	80%
Target Post-Development P Load Reduction Required (kg/yr):	**0.56**

C [3]MITIGATION BMPs

Assumed underground storage P removal rate (%):	25%
[4]Assumed Up-Flo Filter P removal rate (%):	48%

Treatment Trains:

Underground storage & Up-Flo Filter P removal rate (%):	61%

LAND USE AND MITIGATION BMP	LOADING RATE (Kg/Yr/Ha)	POST-DEVELOPMENT (UNMITIGATED)		P REMOVAL RATE (%)	P REMOVAL TOTAL (Kg/Year)	POST-DEVELOPMENT (MITIGATED) (Kg/Year)
		AREA (Ha)	LOAD (Kg/Year)			
High Intensity Residential BMP: Underground Storage & Up-Flo Filter	1.32	0.533	0.70	61%	0.43	0.27
TOTAL		**0.533**	**0.70**		**0.43**	**0.27**

C [5]P LOAD REDUCTION ACHIEVED

Post-Development (Unmitigated) P Load (kg/yr):	0.70
Post-Development (Mitigated) P Load (kg/yr):	0.27
Total P Load Reduction Rate (%):	**61%**

D [6]P LOAD OFFSET

Post-Development (Mitigated) P Load (kg/yr):	0.27
P Offset Ratio:	2.50
P Offset Value ($/kg/yr):	$ 35,000.00
Total P Offset Amount ($):	**$ 24,008.99**

Notes:
1) Only non-point sources were considered in this analysis, as wastewater from this area does not contribute to the Lake Simcoe watershed.
2) As per section *2.3.2 Phosphorus* of the *LSRCA Technical Guidelines for Stormwater Management Submission* (LSRCA, June 24, 2016), 80% removal of the total annual phosphorus loading from the post-development area is required.
3) Phosphorus loading rate values were determined from the average loading rates by land use for the East Holland River as per the *Phosphorus Budget Tool in Support of Sustainable Development for the Lake Simcoe Watershed* by Hutchinson Environmental Sciences Ltd. (Prepared for Ontario Ministry of the Environment), March 30, 2012.
4) The Up-Flo Filter has a P removal efficiency of 48%, as documented in *Verification Statement Hydro International Up-Flo® Filter with CPZ™ Media* (VerifiGlobal, 2019), included in **Appendix E**.
5) The achieved phosphorus loading reduction rate (79%) is slightly less than the target rate (80%). However, the proposed BMPs represent a best-efforts approach to reduce phosphorus loading to the greatest extent possible.
6) As per *Section 4.4.3* of the *Phosphorus Offsetting Policy* (LSRCA, September 2017), a phosphorus loading offset payment is required to offset any remaining phosphorus loading if 100% of phosphorus can't be removed.

Ontario

MINISTRY OF THE ENVIRONMENT

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

Project DEVELOPMENT Summary

DEVELOPMENT: 681 & 685 Yonge St., Barrie
Subwatershed: Lovers Creek

Total Pre-Development Area (ha):	**0.533**	Total Pre-Development Phosphorus Load (kg/yr):	**0.70**

Pre-Development Land Use	Area (ha)	P coeff. (kg/ha)	P Load (kg/yr)
High Intensity - Residential	0.533	1.32	0.70

POST-DEVELOPMENT LOAD

Post-Development Land Use	Area (ha)	P coeff. (kg/ha)	Best Management Practice applied with P Removal Efficiency		P Load (kg/yr)
High Intensity - Residential	0.533	1.32	Treatment Train Approach	61%	0.27

Hydro International Up-Flo Filter is credited with 48% P removal. Underground storage is credited with 25% P removal. When operating in series as a treatment train, they will achieve 61% P removal.

Post-Development Area Altered: **0.53**
Total Pre-Development Area: **0.53**
Unaffected Area: **0**

	P Load (kg/yr)
Pre-Development:	**0.70**
Post-Development:	**0.70**
Change (Pre - Post):	**0.00**
	0% Net Reduction in Load
Post-Development (with BMPs):	**0.27**
Change (Pre - Post):	**0.43**
	61% Net Reduction in Load

DEVELOPMENT: 681 & 685 Yonge St., Barrie
Subwatershed: Lovers Creek

CONSTRUCTION PHASE LOAD

SUMMARY WITH IMPLEMENTATION OF BMPs	P Load (kg/yr)
Pre-Development:	**0.70**
Construction Phase Amortized Over 8 Years :	to be determined
Post-Development:	**0.27**
Post-Development + Amortized Construction:	**to be determined**
Pre-Development Load - Post-Development Load:	**0.43**
Conclusion:	**61% Reduction in Load**
Pre-Development Load - (Post-Development + Amortized Construction Load):	**to be determined**
Conclusion:	**to be determined**

Based on a comparison of Pre-Development and Post-Development loads, and in consideration of Construction Phase loads, the Ministry would encourage the Municipality to:

Hutchinson
Environmental Sciences Ltd.

Phosphorus Budget Tool in Support of Sustainable Development for the Lake Simcoe Watershed

Prepared By: **Hutchinson Environmental Sciences Ltd.**
Greenland International Consulting Ltd. and
Stoneleigh Associates Inc.

Prepared For: **Ontario Ministry of the Environment**

Date: March 30, 2012

Version 2 Report

3-1 Taylor Road, Bracebridge, ON P1L 1S6 ph: 705 645 0021

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

Berger (2010) Land Use	Included LSRCA Land Use(s)	Land Use Description
Hay / Pasture	Non-intensive Agriculture	Hay and pasture fields, including the related agricultural buildings such as barns, silos and the farm residence. Fields are dominated with herbaceous vegetation and grasses with an understory of similar material in a state of decay. Weedy hay and/or pasture covers more than 50% of the area.
Crop Land	Intensive Agriculture	Cultivated row crops, including the related agricultural buildings (e.g., barns, silos and the farm residence), producing crops in varying degrees (e.g., corn and wheat) and includes specialty agriculture (i.e., orchards, market gardens, Christmas tree plantations and nurseries).
Sod Farm / Golf Course	Sod Farm	Sod farms.
	Golf Course	Golf courses, including lane ways, but not the isolated woodlots within, unless the area of the woodlots is < 0.5 ha.
Low Intensity Development	Estate Residential	A home including the manicured area around the home and driveway, within a natural heritage feature. The natural heritage feature is not included in the Estate Residential land use classification.
	Manicured Open Space	Cleared areas with a low density of trees, including lawns and landscaping. Land use is dominated by gardens, parkland and lawns, e.g., cemeteries, urban parks, ski hills and residential/industrial open space with a minimum size of 2 ha.
	Rail	Rail lines and the associated cleared adjacent areas.
	Rural Development	Properties not directly associated with an agricultural operation and that contain residential, commercial or other buildings, as well as a manicured open space, within a natural heritage or agricultural feature (e.g., estate residential or service station). On developed portions, these properties are under intensive use. Based on canopy cover, these areas will often appear as Cultural Savannah or Cultural Woodland in aerial photographs or satellite imagery. However, the presence of buildings and manicured lands identify the properties as Rural Development.
High Intensity Development[1] (Commercial /Industrial)	Commercial	Impervious properties that contain a building and an adjacent parking lot (e.g., shopping and strip malls, power centres, scrap yards). Excludes green land areas such as parks or river valleys.
	Industrial	Impervious properties that are not commercial and include industrial operations e.g., factories, manufacturing facilities, processing facilities, bulk fuel storage. Excludes green land areas such as parks or river valleys.
	Institutional	Schools, hospitals and other institutional structures. May include large storm water management ponds. Excludes green land areas such as parks or river valleys.
High Intensity Development[1] (Residential)	Urban	Urban related land uses including continuous ribbon development. Interpreted from aerial photographs or satellite imagery by many roof tops and/or groupings of 5 or more residential properties with a combined area of ≥ 2 ha. Residential properties include single and semi-detached dwellings, apartment buildings and associated out-buildings, driveways and parking lots. Excludes green land areas such as parks or river valleys.
Quarry	Active Aggregate	Areas that are currently being excavated or have recently been excavated. Identified by pits, extraction machinery, unvegetated landscape and/or piles of extracted materials. Active aggregate areas may contain open water.
	Inactive Aggregate	Former aggregate sites that have been recently revegetated; vegetation is established and growing. Depending on their characteristics, in aerial photographs or satellite imagery, these properties may appear to be comparable to an abandoned field or forming wetland.
Road	Road	Unpaved roads, including the shoulder. Does not include driveways.

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

Berger (2010) Land Use	Included Ecological Land Classifications (ELC(s))	Land Use Description
	Meadow Marsh	Dominated by emergent hydrophytic aquatic plants (grow wholly or partially in water); tree and shrub cover ≤25%. Variable flooding regimes and water depth 2m.
	Shallow Marsh	Emergent hydrophytic aquatic plant cover ≥ 25%, tree and shrub cover ≤ 25% of the area. Water up to 2 m deep; standing or flowing water for much or all of the growing season.
Wetland[3]	Floating-Leaved Shallow Aquatic	Floating leaved aquatic vegetation covers > 25% of the area; no tree or shrub cover. Water up to 2 m deep; standing water is always present.
	Mixed Shallow Aquatic	A mixture of submerged and floating leaved aquatic vegetation covers > 25% of the area; no tree or shrub cover. Water up to 2 m deep; standing water is always present.
	Submerged Shallow Aquatic	Submerged aquatic vegetation covers > 25% of the area; no tree or shrub cover. Water up to 2 m deep; standing water is always present.
	Coniferous Swamp	Tree cover is > 25% of the area with trees > 5 m tall, and coniferous trees > 75% of the canopy area. Water depth is < 2 m with variable flooding regimes; standing water or spring (vernal) pooling covers > 20% of the ground.
	Deciduous Swamp	Tree cover is > 25% of the area with trees > 5 m tall, and deciduous trees > 75% of the canopy area. Water depth is < 2 m with variable flooding regimes; standing water or spring (vernal) pooling covers > 20% of the ground.
	Mixed Swamp	Tree cover is > 25% of the area with trees > 5 m tall; coniferous trees > 25% of the canopy area and deciduous trees > 25% of the canopy area. Water depth is < 2 m with variable flooding regimes; standing water or spring (vernal) pooling covers > 20% of the ground.
	Thicket Swamp	Tree or shrub cover > 25%, dominated by hydrophytic shrub and tree species (grow wholly or partially in water); tree cover ≤ 25%, hydrophytic shrub cover > 25%. Water depth is < 2 m with variable flooding regimes; standing water or spring (vernal) pooling covers > 20% of the ground.
Open Water[4]		Lakes, rivers and ponds including stormwater management ponds.

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

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

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

Table 3. Phosphorus Removal Efficiencies for Major Classes of BMPs Using the Decision Tree (Figure 5).

BMP Class	Reference IDs[1]	Reported Phosphorus Removal Efficiency (%)		Relevant to Ontario?	Range <40%?	Are Non-Ontario values acceptable?	Possible design criteria?	Median % Removal Efficiency
		Min	Max					
Post-development BMPs								
Bioretention Systems	8-10, 12,13, 34-38, 40	-1552	80	no	no	no	No	none
Constructed Wetlands	104, 106, 109	72	87	yes	yes			77
Dry Detention Ponds	104, 109	0	20	no	yes	yes		10
Dry Swales	24, 26-32	-216	94	no	no	no	possible	none
Enhanced Grass/Water Quality Swales	21, 104	34	55	no	yes	no	No	none
Flow Balancing Systems	106	77		no	?	yes	Min data	77
Green Roofs	2	-248		no	no	no	No	none
Hydrodynamic Devices	109	-8		no	?	yes		none
Perforated Pipe Infiltration/Exfiltration Systems	7, 4	81	93	yes	yes			87
Sand or Media Filters	104, 109	30	59	no	yes	yes		45
Soakaways - Infiltration Trenches	6, 104	50	70	no	yes	yes		60
Sorbtive Media Interceptors	111	78	80	no	yes	yes		79
Underground Storage	106	25		no	?	yes	Min data	25
Vegetated Filter Strips/Stream Buffers	6, 42, 104	60	70	no	yes	yes	Yes	65
Wet Detention Ponds	104-106, 109	42	85	yes	yes			63

Notes: [1]References associated with IDs are provided in Appendix 7.

Module 4 – Examines the potential for erosion and sediment loss during the construction phase on the basis of the Universal Soil Loss Equation and provides guidance to the user on appropriate BMPs that can be implemented during this phase to minimize sediment loss and resultant phosphorus export. The module calculates loads for the entire construction phase, but pro-rates this one-time load to annual loads to account for the eight-year hydraulic residence time in Lake Simcoe. The quantification of expected soil and phosphorus loss from a construction site is an uncertain process, even under ideal conditions. Determining expected loss reductions from the use of various on-site BMPs adds to the uncertainty. Even with

Up-Flo® Filter

Sizing Calculator v3.0

Hydro International

Today's Date: 2019-09-12

Click to Check for Newer Version

HELP

STEP 1. Enter Project and Contact Information in YELLOW Cells

Project Name:	Valdor File: 19112
Location:	Barrie, Ontario
Development Type:	New Development

Contact Name:	Oliver Beaudin
Company:	Valdor Engineering Inc.
Phone:	647-632-1391
E-mail:	obeaudin@valdor-engineering.com

STEP 2. Select Sizing Methodology

Select Sizing Methodology from Drop Down:

Hydro Int'l Default Sizing (0.056 cfs/Filter Module)

The Filtration System Must be Offline (Yes/No)

Yes

STEP 3. Enter Project Flow Rate Info

Water Quality Flow Rate = 0.525 cfs

Peak Flow Rate = 1.38 cfs

STEP 4. Enter Site Values

Invert Elev of Storm Drain Pipe = 833.82 -ft.

Pipe Diameter of Storm Drain Pipe = 12 -in.

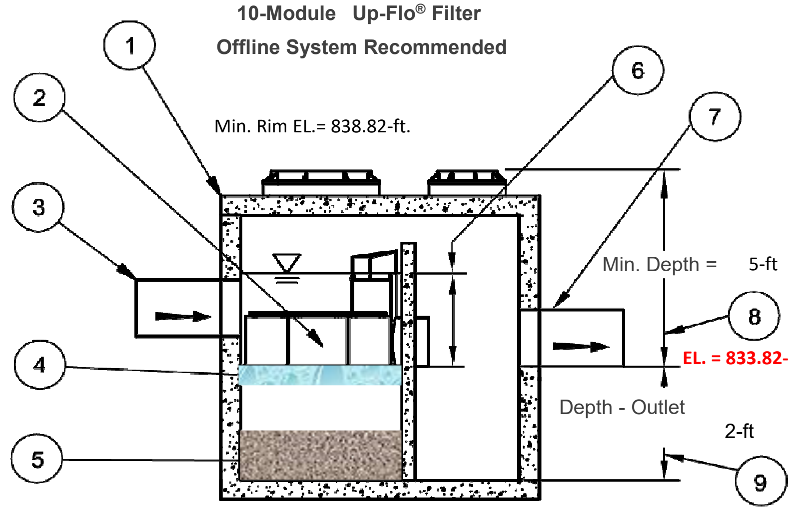
Rim Elevation = 839 -ft.

STEP 5. Check Output: Sizing Recommendation and Design Parameters

*****Peak Flow Note*****
Offline System Recommended
Use "DWG 8-19 Modules (On or Offline)" on Worksehet 3c.

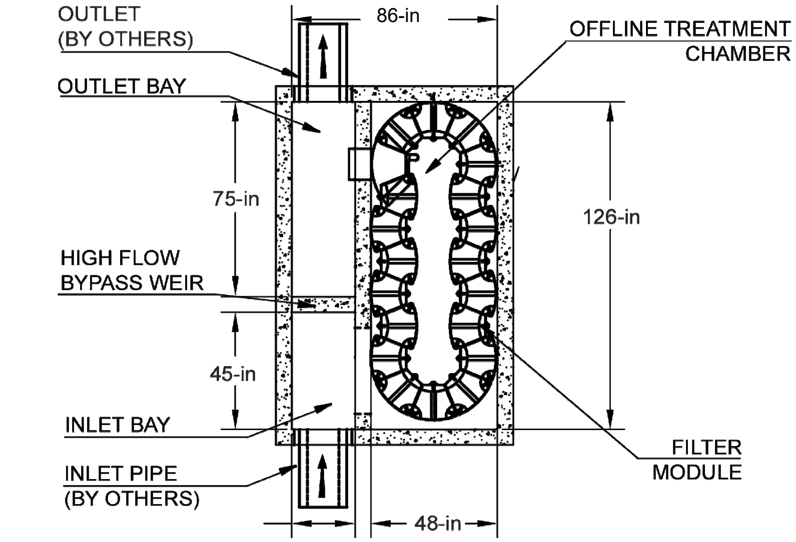
1	Number of Filter Modules Req'd	10-Module
2	Typical Filter Chamber Size	86-in x 126-in
3	Maximum Inlet Pipe Diameter	36-in
4	Oil Storage Capacity	209-gal
5	Sediment Storage Capacity	55.9 cu-ft
6	Operating Head	29.5-in
7	Max Outlet Pipe Diameter	36-in
8	Minimum Stormdrain Depth (Final Grade to Outlet Invert)	5-ft
9	Standard Depth - Outlet Invert to Sump	2-ft

10-Module Up-Flo® Filter
Offline System Recommended

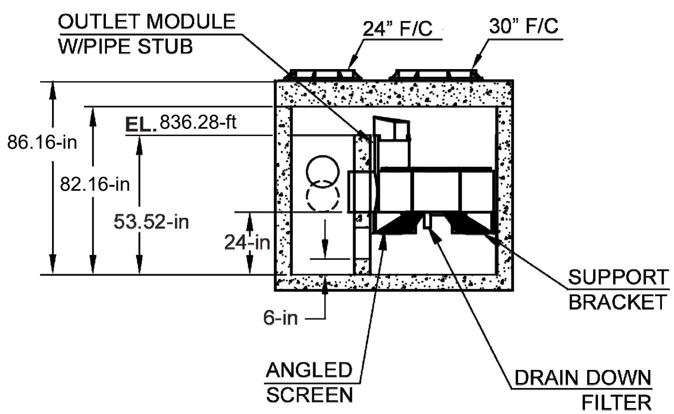


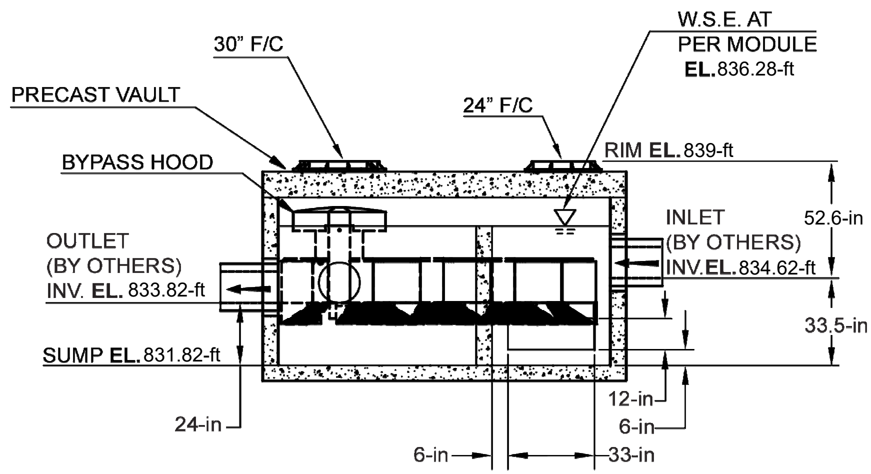
Click to Submit Your Design for a Price Estimate and a Complimentary Technical Review

94 Hutchins Drive, Portland, Maine 04102 t:(207) 756-6200 f:(207) 756-6212 www.hydro-int.com



Treatment System Specifications	
Filtration Chamber Dimensions	**86-in x 126-in**
No. Filter Modules	**8 to 19**
Max.Filtration Rate per Filter Module	**0.056-cfs**
Peak Internal Bypass Flow Rate	**Varies**
Operating Head at Max. Filtration Rate	**29.5-in**
Sediment Storage	**55.9 cu-ft**
Oil Storage	**209-gal**
Outlet / Inlet Pipe Diameter (Max.36-in)	**12-in**





CAPACITIES:
1. Minimum performance: 80% removal of Sil-Co-Sil 106 (d50=22 microns) at the max. filtration rate.
2. Maximum number of modules for vault size: 19*
3. Peak treatment flow: 1.064-cfs

ADDITIONAL DESIGN INFORMATION:
1. Normal operating W.S.E. is 29.5” (2.46’) above the outlet invert at the max. filtration rate. For a given flow the head requirement can be reduced by adding additional Filter Modules.
2. *Treatment flows that require more modules will require a larger vault design.
3. Drop required from inlet pipe invert to outlet pipe invert is 9”.
4. Filter Media: CPZ Mix Media

Notes

1. THIS IS A STANDARD DETAIL AND IS NOT SITE SPECIFIC. ACTUAL INLET PIPE DIAMETER AND ANGLE MAY BE DIFFERENT
2. REFER TO SUBMITTAL OR FABRICATION DRAWINGS FOR FINAL RIM AND INVERT ELEVATIONS.
3. CONTACT HYDRO INTERNATIONAL FOR SITE SPECIFIC DRAWINGS AND INSTALLATION REQUIREMENTS.

REVISION HISTORY

REV	BY	DATE	DESCRIPTION
A	JL	5/23/13	PARTS LIST

Date	Scale
02/28/13	NTS

Drawn	Checked	Approved
JLL3		

OFF-LINE UP-FLO® FILTER
8-19 MODULES
86-in x 126-in VAULT
Valdor File: 19112

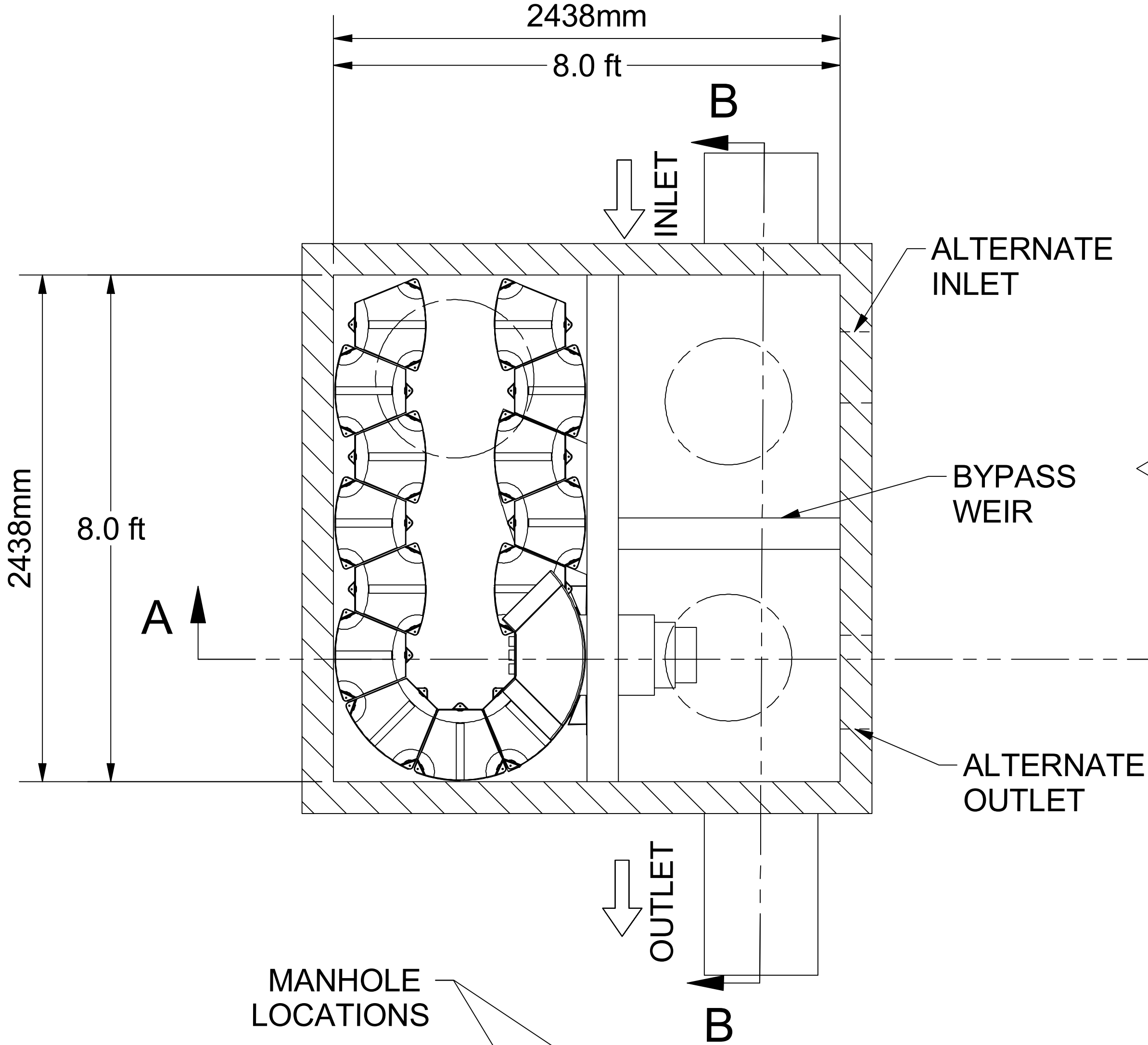
Barrie, Ontario

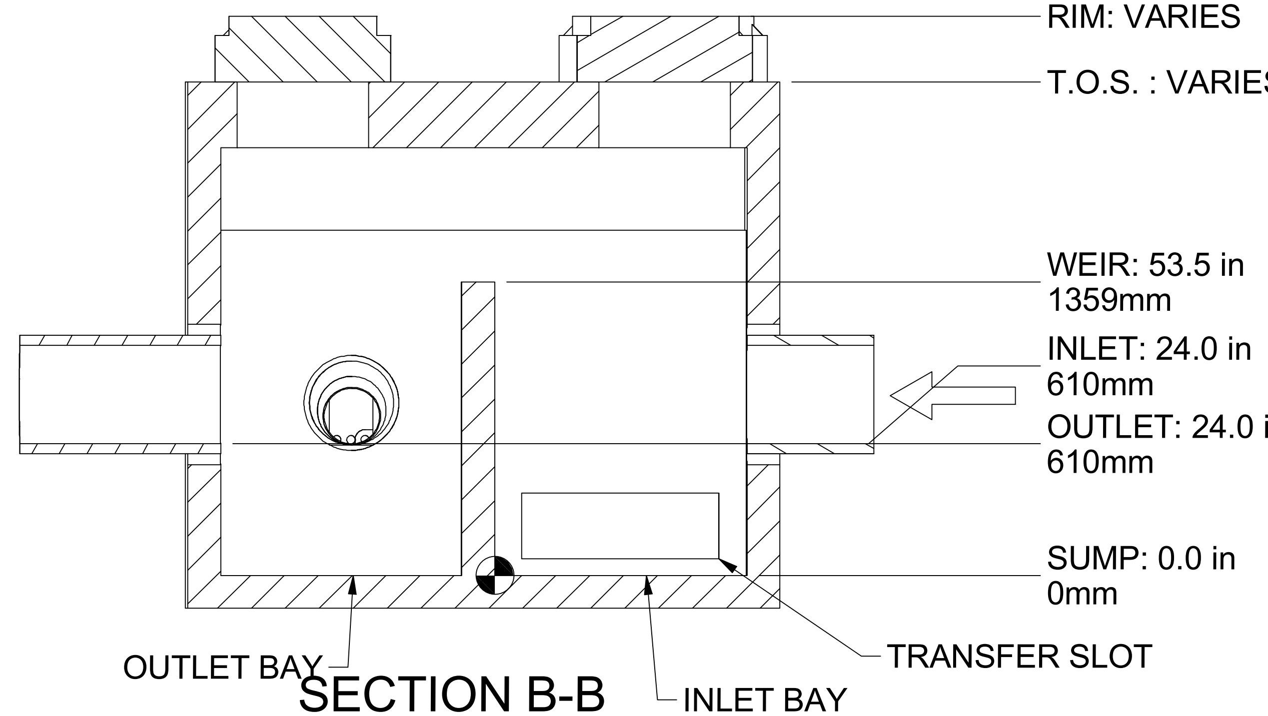
Hydro International

Stormwater Solutions
94 Hutchins Drive
Portland, Maine 04102
Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

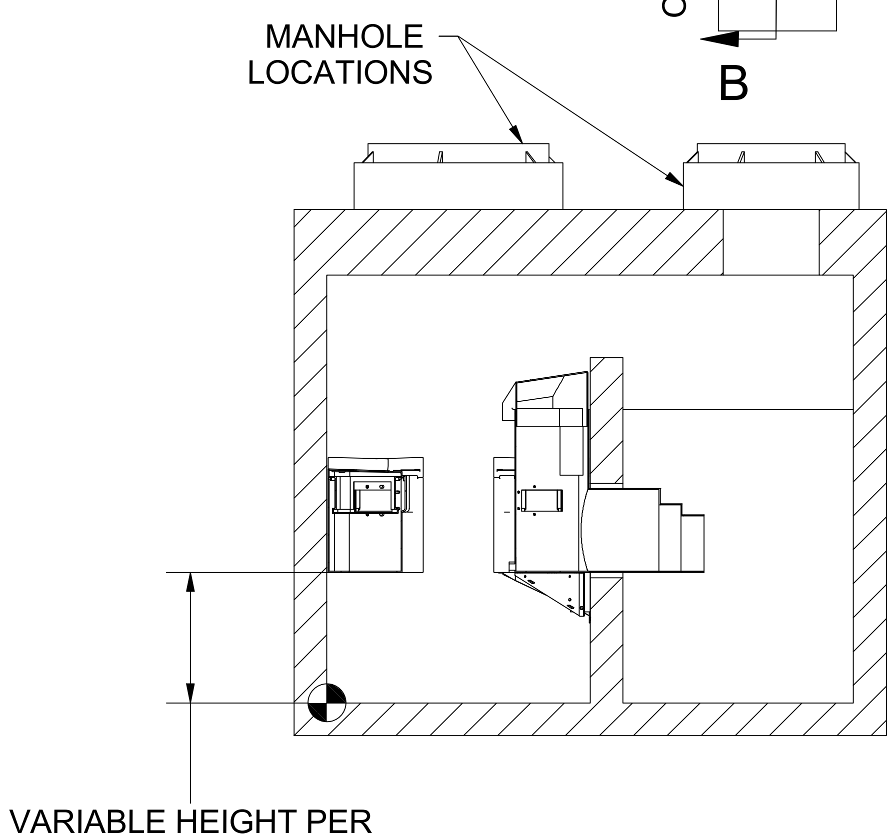
DO NOT USE FOR CONSTRUCTION OR FABRICATION

CAD Ref: SIZING CALC DWG
Project No.
DrawingNo. Rev. A

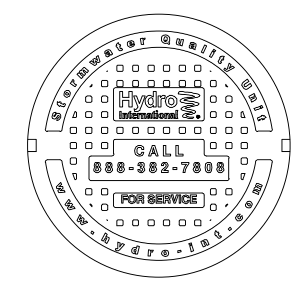




SECTION B-B



SECTION A-A



CAPACITIES:

- Minimum performance: 80% removal. Washington DOE/NJCAT verified at the peak treatment flow.
- Peak treatment flow:
  .033 CFS (0.9 LPS) (15 GPM) per module (Ribbons)
  .022 CFS (0.6 LPS) (10 GPM) per module (Long Ribbons)
  .056 CFS (1.6 LPS) (25 GPM) per module (CPZ)
- Maximum number of ribbon modules per outlet module: 36
- Maximum number of CPZ modules per outlet module: 18 (contract Hydro if more are required)

ADDITIONAL DESIGN INFORMATION:

- Normal operating W.S.E. is 26-30" (660-762mm) above the outlet invert
- Media Types Available: Ribbons, CPZ

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.

TOLERENCES ARE:
FRACTIONS ± 1/16
DECIMALS:
X.X ± .06
X.XX ± .03
X.XXX ± .015
ANGLES: ± .5°

PROJECTION

COMMENTS:
1. STRUCTURE WALL AND SLAB THICKNESSES ARE NOT TO SCALE
2. CONTACT HYDRO INTERNATIONAL FOR A BOTTOM OF STRUCTURE ELEVATION PRIOR TO SETTING THE STRUCTURE
3. NOT FOR CONSTURCION CONTACT HYDRO FOR SITE SPECIFIC DRAWING
4. NOT ALL SIZES AVAILABLE IN ALL AREAS
5. SUMP DEPTH AVAILABLE IN 24" (610mm) CPZ, RIBBONS AND 36" (914mm) LONG RIBBONS DEPTH

REVISION HISTORY

REV	BY	DESCRIPTION	DATE
-	ER	FIRST RELEASE	3/8/2019

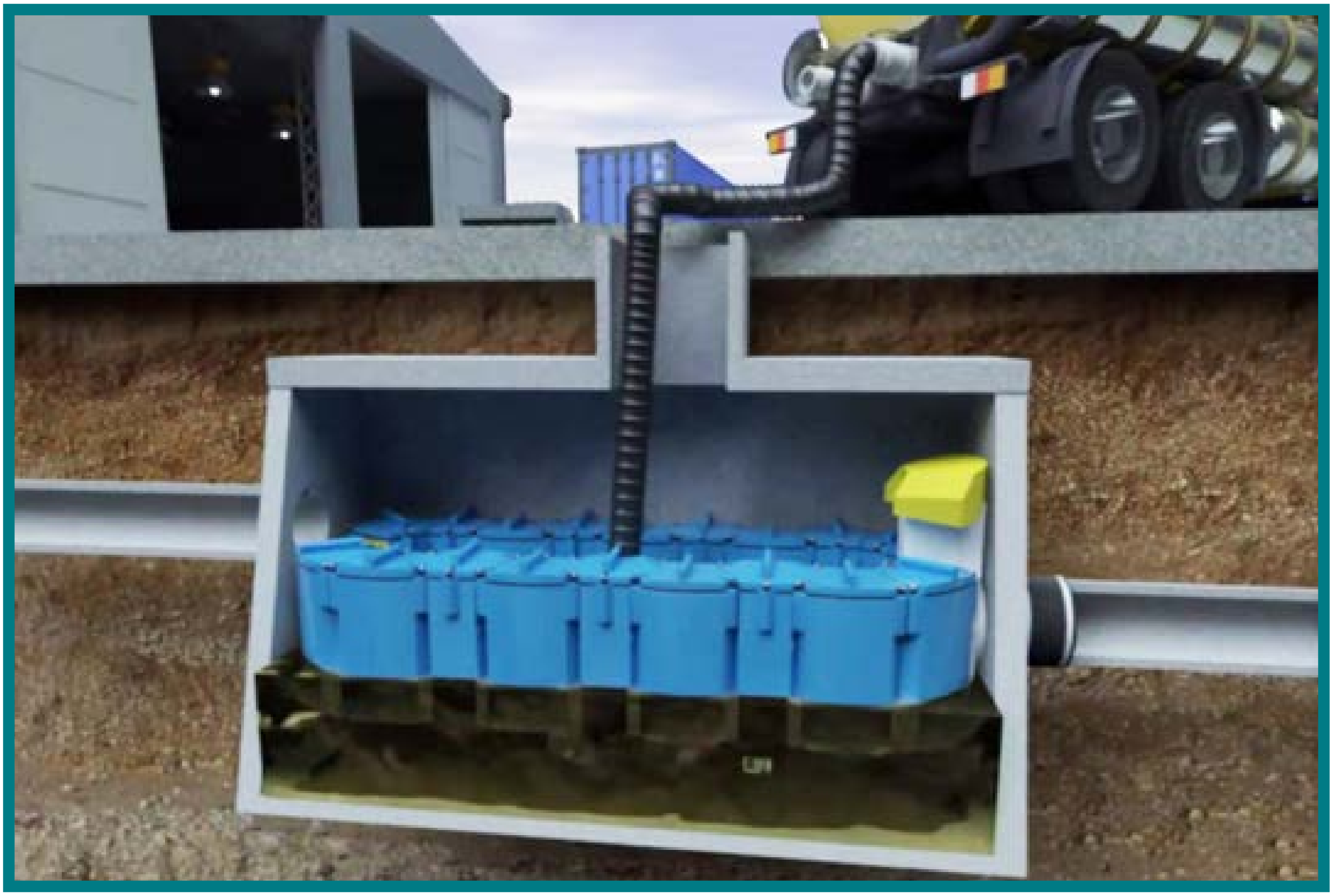
DATE: 3/8/2019	SCALE: 1:35	
DRAWN BY: ER	CHECKED BY:	APPROVED BY

Title
UP-FLO FILTER
8ft (2438mm) X 8ft (2438mm)

14 MODULES MAX

Hydro International
94 Hutchins Drive
Portland, ME 04102
Tel: +1 (207) 756-6200
Fax: +1 (207) 756-6212
hydro-int.com

WEIGHT: N/A	MATERIAL:	
NEXT ASSEMBLY: 8x8-1		
DRAWING NO.: 8x8-UFF-1		
SHEET SIZE: B	SHEET: 1 OF 1	Rev: -



Operation and Maintenance Manual

Stormwater Solutions

94 Hutchins Drive
Portland, ME 04102

Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

www.hydro-int.com

Up-Flo® Filter

Filtration System for Stormwater Treatment

Table of Contents

IMPORTANT - ORDER REPLACEMENT PARTS FOR MAINTENANCE - **IMPORTANT**

Annual maintenance requires replacement of the Media Packs and the Drain Down Filter. Contact Hydro International to order replacements. Allow 2-4 weeks for delivery.

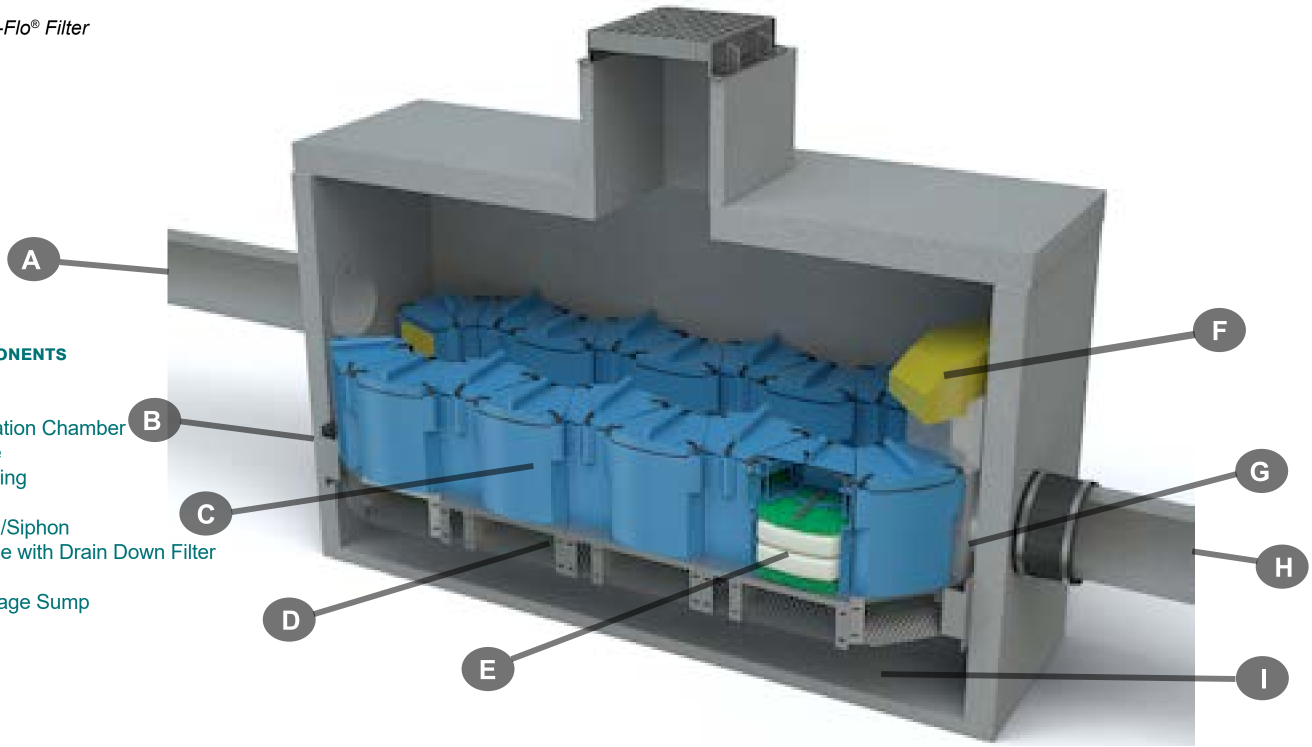
Office hours Monday thru Friday 8:00 A.M. to 5:00 P.M. EST
Toll free: 1-888-382-7808
Phone: 207-756-6200
Fax: 207-756-6212
Email: services@hydro-int.com

Overview & Product Description

The Up-Flo® Filter is a modular high-rate stormwater filtration device designed to capture trash, oil, sediment and remove fine pollutants such as dissolved and particulate metals and nutrients from stormwater runoff. Designed with efficiency, longevity and upkeep in mind, this high performance, low maintenance filter option that offers higher loading rates and longer media life for higher quality stormwater for longer periods between servicings.

In general, a minimum of two inspections are required per year to monitor sediment and gross pollutant accumulations. In order to achieve an annual TSS removal rate of 80% for the Up-Flo® Filter, the minimum maintenance frequency specified in the maintenance section for replacement of the Media Pack and removal of accumulated sediment from the sump is mandatory.

Fig.1 *The Up-Flo® Filter*



System Components

A. Inlet Pipe
B. Precast Filtration Chamber
C. Filter Module
D. 4mm Screening
E Media bag
F. Bypass Hood/Siphon
G. Outlet Module with Drain Down Filter
H. Outlet pipe
I. Pollutant Storage Sump

Product Configurations

a. Manhole

b. Vault

Fig.2 *The Up-Flo® Filter is installed in a) 4-ft (1.2m) round manholes or b) in rectangular precast vaults. Both configurations have a wide central opening in the Up-Flo® Filter.*

Hydro Maintenance Services

Hydro International has been engineering stormwater treatment systems for over 30 years. We understand the mechanics of removing pollutants from stormwater and how to keep systems running at an optimal level.

Nobody Knows our Systems Better than we do

Avoid Service Negligence

Sanitation services providers not intimately familiar with stormwater treatment systems are at risk of the following:

- Inadvertently breaking parts or failing to clean/replace system components appropriately.
- Charging you for more frequent maintenance because they lacked the tools to service your system properly in the first place.
- Billing you for replacement parts that might have been covered under your Hydro warranty plan
- Charging for maintenance that may not yet have been required.

Leave the Dirty Work to us

Trash, sediment and polluted water is stored inside treatment systems until they are removed by our team with a vactor truck. Sometimes teams must physically enter the system chambers in order to prepare the system for maintenance and install any replacement parts. Services include are are not limited to:

- Solids removal
- Removal of liquid pollutants
- Replacement media installation (when applicable)

Better Tools, Better Results

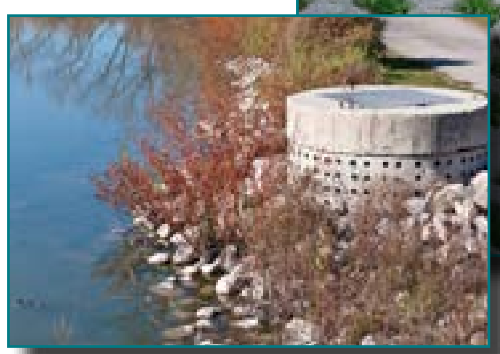
Not all vactor trucks are created equal. Appropriate tools and suction power are needed to service stormwater systems appropriately. Companies who don't specialize in stormwater treatment won't have the tools to properly clean systems or install new parts.

Service Warranty

Make sure you're not paying for service that is covered under your warranty plan. Only Hydro International's service teams can identify tune-ups that should be on us, not you.

Treatment Systems Serviced by Hydro:

- Stormwwater filters
- Stormwater separators
- Baffle boxes
- Biofilters/biorention systems
- Storage structures
- Catch basins
- Stormwater ponds
- Permeable pavement



SAVE TIME & MONEY: CALL HYDRO FOR A QUOTE

1 (800) 382-7808

LEARN MORE AT HYDRO-INT.COM/SERVICE

Operation

Introduction

The Up-Flo® Filter operates on simple fluid hydraulics. It is self-activating, has no moving parts, no external power requirements and is fabricated with durable non-corrosive components. Personnel are not required to operate the unit and maintenance is limited to periodic inspections, sediment and floatables removal, Media Pack replacement and Drain Down Filter replacement.

Pollutant Capture

The Up-Flo® Filter is designed to operate as a "treatment train" by incorporating multiple treatment technologies into a single device. Trash and gross debris are removed by sedimentation and screening before they are introduced to the filtration media, preventing surface blinding of the filter media. The Up-Flo® Filter is a wet-sump device. Between storm events, oil and floatables are stored on the water surface separate from the sediment storage volume in the sump (see **Fig.1**). The high-capacity bypass siphon acts as a floatables baffle to prevent washout of captured floatable pollutants during high intensity events.

Reduced Clogging

The Up-Flo® Filter has been designed to minimize the occurrence of clogging and blinding and employs a unique Drain Down Filter that allows the water level in the chamber to drop below the filter media between events. The Drain Down Filter mechanism creates a reverse flow that flushes captured pollutants off the surface of the Media Bag, helping to prevent blinding. By allowing the water to drain out, the Drain Down Filter also reduces the weight of the Media Bags. This makes the bags easier and safer to remove during maintenance operations.

Overflow Protection

The Angled Screens are designed to prevent ragging and blinding and are situated below the Filter Modules, sheltering them from the direct path of the influent. Coarse debris settles in the sump before the runoff flows up through the screens, protecting them from blinding. In the unlikely event of a blockage, the high capacity siphonic Bypass Hood is designed to convey high enough flow to minimize the risk of large storm creating upstream flooding.

Best Practices

Good housekeeping upstream of the Up-Flo® Filter can significantly extend Media Bag life. For example, sweeping paved surfaces, collecting leaves and grass trimmings, and protecting bare ground from erosion will reduce loading to the system. Media Packs should not be installed in the Filter Modules until construction activities are complete and site stabilization is effective.

Damage Due to Lack of Maintenance

Delayed maintenance would result in clogged Media Bags and/or blinded Angled Screens. In that situation, the Up-Flo® Filter would go into bypass and there would be no treatment of the incoming stormwater. Because the Bypass Weir can easily convey all of the flow to the Outlet Module, there would be no lasting damage to the system. Replacement of the Media Bags and removal of sediment from the sump would restore the Up-Flo® Filter to its original treatment efficiency. Establishing and adhering to a regular maintenance schedule ensures optimal performance of the system.

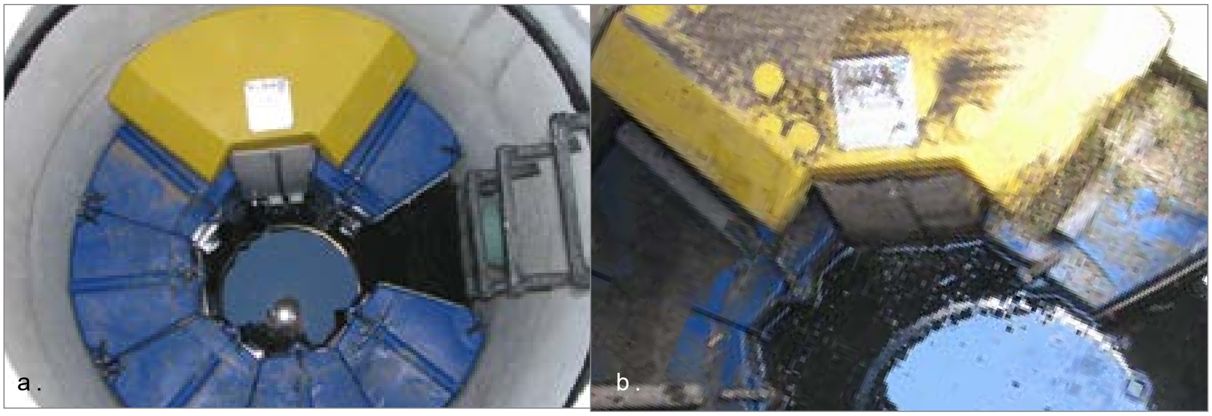


Fig.3 a) The water level in a properly functioning Up-Flo® Filter will drain down to the base of the Filter Modules. b) When the Drain Down Filter becomes clogged, the base of the Filter Modules will be submerged in standing water. Note, above right, that the Drain Down Filter is submerged in standing water.

Inspection & Maintenance

Overview

The Up-Flo® Filter protects the environment by removing a wide range of pollutants from stormwater runoff. Periodic removal of these captured pollutants is essential to the proper functioning of the Up-Flo® Filter.

Maintenance activities can be categorized as those that may be performed from outside the Up-Flo® vessel and those that are performed inside the vessel. Maintenance performed from outside the modules includes removal of floatables and oils that have accumulated on the water surface and removal of sediment from the sump. Maintenance performed inside the vessel includes removal and replacement of Media Bags, Flow Distribution Media and the Drain Down Filter. A vactor truck is required for removal of oils, water, sediment, and to completely pump out the vessel to allow for maintenance inside. If you are not using Hydro Internatioanl or a trained servcie provider you must follow OSHA Confined Space Entry procedures when entering the Up-Flo® vessel.

The Up-Flo® Filter design has a wide central opening between the Filter Modules for easy access to all of the components (see **Fig.3**). In the case of inspection and floatables removal, a vactor truck is not required. Otherwise, a vactor truck is normally required for oil removal, removal of sediment from the sump, and replacement of the Media Packs and Drain Down Filter. In most cases, entry into the Up-Flo® Filter vessel is required for replacement of the Media Packs and Drain Down Filter.

The minimum required frequency for replacement of the Media Pack is annually, whereas the minimum required frequency for removal of accumulated sediment from the sump is dependent on the Up-Flo® Filter configuration. Configurations with a larger sediment storage volume per module will require less frequent removal of accumulated sediment. Regardless, whenever sediment depth in the sump is found to be greater than 16 inches, sediment removal is required.

Fig.4 a) A new Media Bag of Hydro Filter Sand. b) A spent media bag of Hydro Filter Sand.

At a minimum, media bags must be replaced at least once a year.

Make Sure your System was Installed Correctly

First Year Inspection and Maintenance

The frequency of inspection and maintenance can be determined in the field after installation. The frequency of ongoing maintenance needs is based on site characteristics such as contributing area, types of surfaces (e.g., paved and/or landscaped), site activities (e.g., short-term or long-term parking), and other site maintenance (e.g., sanding and sweeping). At a minimum, inspection and maintenance should be conducted at intervals of no more than six months during the first year of operation. Maintenance personnel should observe and record pollutant accumulations during the first year of service in order to benchmark the maintenance intervals that will later be established for the site. Pollutant accumulations should be measured or monitored using the following procedures:

- Measurement of sediment depth in the sump: A minimum of 8 inches (20 cm) should separate the Drain Down Filter inlet from stored sediment in the sump in order to minimize sediment migration into the Drain Down Filter. A simple probe, such as the Sludge-Judge®, can be used to determine the depth of the solids in the sump. In a typical 4-ft (1.2m) diameter manhole installation, the sediment depth should be no more than 16 inches (41 cm).

- Maintenance personnel should then enter the structure, remove the Media Pack from one of the Filter Modules, and weigh the Media Bags. Media Bags with a wet weight of approximately 40 lbs (18 kg) or more are an indication that the filter media has become full and that the Media Packs in all of the Filter Modules will require replacement (Fig.4). Minimum filtration rate is generally reached when the Media Bags have accumulated approximately 20 lbs (9 kg) of sediment. Determining the amount of accumulated sediment will be accomplished by removing both of the Media Bags from one of the Media Packs and weighing the bags separately. Since a new Media Bag weighs approximately 30 lbs (14 kg) wet, the difference in weight will approximately equal the weight of solids that have accumulated in the bag. A spent Media Bag weighs approximately 50 lbs (23 kg) wet.

- Measurement of oil layer on water surface: Since water in the Up-Flo® vessel drains down to an elevation below the bottom of the Filter Modules when the system is idle, the amount of accumulated oil must be minimized so that oil is not entrained in the Media Pack when stormwater begins to fill the vessel at the start of a storm event. Oil accumulation should be limited to 1.5 inches (4 cm) or less. Probes can be used to measure oil thickness.

- Monitoring for Drain Down Filter clogging: The water level in the Up-Flo® Filter should be monitored to ensure that the Drain Down Filter is operating properly. The Drain Down Filter is designed to lower the water level in the Up-Flo® vessel to an elevation below the bottom of the Filter Modules between storm events. Periodically conduct an inspection one to two days after a storm event during the first year of operation. Approximately 36 hours after a 1-in (2.5-cm) rainfall, the water level inside the vessel should have dropped to a point where it is equal with the base of the Filter Modules. If the water level has not reached that point, then the Drain Down Filter has either become clogged or blinded by trash or debris (Fig.5 a and b). If there is no evidence of trash or debris around the Drain Down Filter inlet, then it has likely become clogged with particles.

- Monitoring for slime and debris covering the Flow Distribution Media or Angled Screens: After removal of the Media Bags, the bottom Flow Distribution Media should be removed and inspected to determine if it is coated with slime or debris. Similarly, the Angled Screen should be inspected for blockages and ragging.

Find out how Frequently your System Needs Maintenance

Monitoring for floatables on the water surface: Similar to oil, the amount of accumulated floatables must be minimized to prevent trash and loose debris from becoming trapped on the Angled Screens when stormwater begins to fill the Up-Flo® vessel at the start of a storm event. Visual inspection is adequate to determine the amount of floatables. Floatables should be removed before they form a mat on the surface of the water.

The solids loading rate in the sump will be calculated by measuring the sediment depth in the sump and dividing the depth by the correlating interval of time since the sump was last cleaned. Similarly, starting with fresh Media Bags, the solids loading rate in the Media Packs will be calculated by weighing the Media Bags and dividing the weights by the correlating interval of time since they were installed. The wet weight of the heaviest bag will be used to determine the loading rate. As previously mentioned, a spent Media Bag weighs approximately 50 lbs (23 kg) wet. The spent Media Bag weight estimate was based on calculations of sediment loading in an Up-Flo® Filter that was run to exhaustion during laboratory testing.

The rate of oil accumulation will be calculated by measuring the thickness of the oil layer and dividing the thickness by the correlating interval of time since the sump was last cleaned. Ordinarily, oil thickness will not be measurable unless a spill has occurred. Consequently, any oil will typically be removed along with water when cleaning the sump.

Monitoring the Drain Down Filter for clogging, monitoring the Flow Distribution Media and Angled Screens for slime and debris, and monitoring the accumulation of floatables will provide an estimate of how long the Up-Flo® Filter can operate before its performance can become impaired by one of these factors.

Routine Inspection and Maintenance

After completion of the first year of operation, determining and then following the established inspection and maintenance intervals will keep pollutant loadings within their respective limits. Removal of oils and floatables, replacement of the Drain Down Filter, replacement of Flow Distribution Media (see Fig.9, pg 11), and cleaning of Angled Screens will occur at the same frequency as cleaning of the sump and replacement of Media Bags unless the first year of operation indicates otherwise. Keeping to the established maintenance intervals will keep treatment flow rates at, or above, the design flow rate. Typically, annual maintenance is adequate.

In addition to scheduled maintenance, occasional checks for Up-Flo® Filter clogging can be performed by removing the manhole cover during a storm, monitoring the water level in the manhole or vault, and determining whether the filter is in bypass. A properly-sized filter (on-line or off-line) that is in bypass during a storm that is producing runoff at, or below, the filter's design filtration rate needs maintenance.

Inspection & Maintenance

Routine Inspection

Inspection is a simple process that requires monitoring pollutant accumulations. Maintenance crews should be familiar with the Up-Flo® Filter and its components prior to inspection.

The following instructions are intended for non-Hydro maintenance service providers and/or those intending to maintain thier own Up-Flo® Filter:

Scheduling

- Inspection may be conducted during any season of the year but should occur shortly after a predicted rainfall to ensure components are operating properly.

Necessary Equipment

- Safety Equipment and Personal Protective Equipment (traffic cones, work gloves, etc.)
- Scale to measure the weight of the Media Bags
- Crow bar to remove grate or lid
- Pole with skimmer or net
- Sediment probe (such as a Sludge-Judge®)
- Hydro International Up-Flo® Filter Maintenance Log
- Trash bags for removed floatables

Routine Inspection Procedures

1. Set up any necessary safety equipment (such as traffic cones) to provide access to the Up-Flo® Filter. Safety equipment should notify passing pedestrian and road traffic that work is being done.
2. Remove the grate or lid to the manhole or vault.
3. Without entering the vessel, look down into the chamber to inspect the inside and to determine whether the high-water level indicator has been activated. Make note of any irregularities. See Fig.6 for a typical Inspection View.
4. Without entering the vessel, use the pole with the skimmer net to remove floatables and loose debris from the chamber.
5. Using a sediment probe such as a Sludge-Judge®, measure the depth of sediment that has collected in the sump of the vessel. Maximum sediment depth is 16 inches (41 cm).
6. If the high-water level indicator has been activated after two consecutive storms, remove the Filter Module lid by turning the cam latch and remove the Filter Media Pack (*refer to page 11 Replacement Procedures*). Weigh the Media Bags from one or two modules. Media Bags should be replaced if the wet weight exceeds 40 lbs (18 kg).
7. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components or a high standing water level (see Fig.6 for the standard standing water level).
8. Securely replace the grate or lid.
9. Remove safety equipment.
10. Contact Hydro International at (800) 848-2706 to discuss any irregularities noted during inspection.

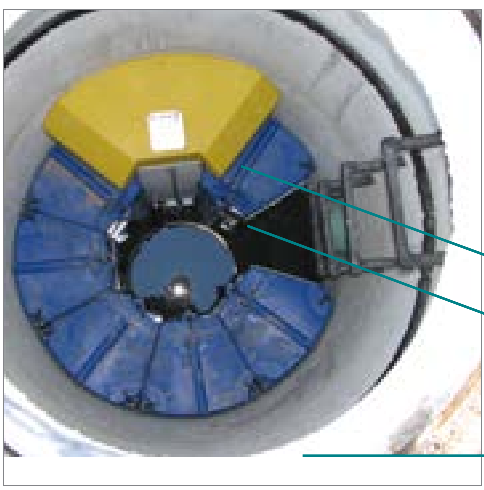


Fig.6 Inspection view of the Up-Flo® Filter.

Routine Maintenance

Maintenance activities are grouped into two categories:

- *Activities **Not Requiring** Man Entry Into the Up-Flo® Filter*
  These activities include floatables removal, oil removal and removal of sediment from the sump.
- *Activities **Requiring** Man Entry Into the Up-Flo® Filter*
  Media Pack replacement and Drain Down Filter replacement.

Maintenance intervals are determined from monitoring the Up-Flo® Filter during its first year of operation. Depending on the site, some maintenance activities may have to be performed on a more frequent basis than others. In the case of floatables removal, a vactor truck is not required. Floatables and loose debris can be netted with a skimmer and pole.

A vactor truck is normally required for oil removal, removal of sediment from the sump, and to dewater the vessel for replacement of the Media Packs and Drain Down Filter (Fig.7). All inspection and maintenance activities would be recorded in an Inspection and Maintenance Log.

Completion of all the maintenance activities for a typical 4-ft (1.2m) diameter manhole installation takes less than one hour. Approximately 360 gallons of water and up to 0.6 yd^3 (0.5 m^3) of sediment may be removed in the process. In an installation equipped with six Filter Modules, 12 Media Bags (2 bags per module) would be removed and replaced. Assuming a spent Media Bag weight of 50 lbs (23 kg), up to 600 lbs (272 kg) of spent Media Bags would be removed. All consumables, including Media Bags, Flow Distribution Media, and replacement Drain Down Filters are supplied by Hydro International.

The access port located at the top of the manhole provides unobstructed access for a vactor hose and/or skimmer pole to be lowered to the base of the sump.

Maintenance Activities Not Requiring Man Entry

These activities include floatables removal, oil removal and removal of sediment from the sump.

Scheduling

- Floatables and sump cleanout may typically be done during any season of the year - before and after rainy season
- Floatables and sump cleanout should occur as soon as possible following a contaminated spill in the contributing drainage area

Recommended Equipment

- Safety Equipment (traffic cones, etc)
- Crow bar to remove grate or lid
- Pole with skimmer or net (if only floatables are being removed)
- Sediment probe (such as a Sludge-Judge®)
- Vactor truck (flexible hose preferred)
- Pressure nozzle attachment or other screen-cleaning device

Fig.7 Sediment is removed from the sump with a vactor hose. Man entry is not required for this step.

No Man Entry Required: Floatables, Oil and Sediment:

1. Set up any necessary safety equipment (such as traffic cones) around the access of the Up-Flo® Filter. Safety equipment should notify passing pedestrian and road traffic that work is being done.
2. Remove the grate or lid to the manhole or vault.
3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities.
4. If the standing water level in the sump is above the base of the Filter Modules (see Fig.8), tug the Pull Chain(s) to release the Drain Down Filter plug(s). Allow the excess water to drain out of the chamber.
5. Use the skimmer pole to fit the Drain Down Filter plug back into the open port.
6. Once all floatables and oil have been removed, drop the vactor hose to the base of the sump. Vactor out the sediment and gross debris from the sump floor. Up to 0.3 yd^3 (0.2 m^3) of sediment and 360 gallons (1,363 L) of water will be removed from a typical manhole Up-Flo® Filter during this process.
7. Retract the vactor hose from the vessel.
8. Inspect the Angled Screens for blockages and ragging. If present, remove the obstruction or ragging materials from the surface using a hose or other screen-cleaning device.
9. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables, oils, and gross debris removed, and the depth of sediment measured. Note any apparent irregularities such as damaged components or blockages.
10. Securely replace the grate or lid. Remove safety equipment.
11. Dispose of sediment and gross debris following local regulations.
12. Dispose of oil and sump water at a licensed water treatment facility or following local regulations.
13. Contact Hydro International at (800) 848-2706 to discuss any irregularities noted during cleanout.

Maintenance Activities Requiring Man Entry

These activities include replacement of the Media Packs and Drain Down Filter.

Unless the Up-Flo® Filter has been installed as a very shallow unit, it is necessary to have an OSHA-confined space entry trained person enter the vessel to replace Media Packs.

The access port located at the top of the manhole or vault provides access to the Up-Flo® vessel for maintenance personnel to enter the vessel and remove and replace Media Packs. The same access would be used for maintenance personnel working from the surface to net or skim debris and floatables or to vactor out sediment, oil, and water. Unless the Up-Flo® Filter has been installed in a very shallow configuration, it is necessary to have personnel with OSHA Confined Space Entry training performing the maintenance that occurs inside the vessel.

Scheduling

- Call Hydro International to order replacement Media Packs and Drain Down Filter prior to scheduling maintenance.
- Because Media Pack replacement requires entry into the Up-Flo® chamber, maintenance events should be scheduled during dry weather.
- Media Pack replacement should occur immediately after a contaminated spill in the contributing drainage area.

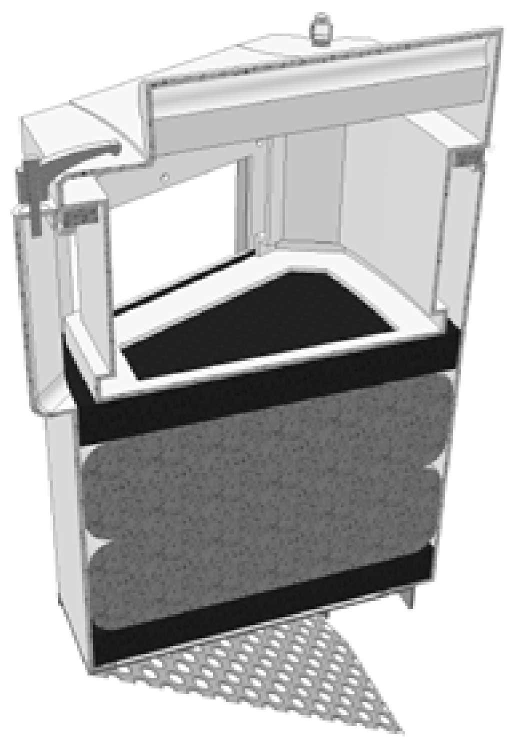


Fig.8 Cutaway view of the Filter Module

Recommended Equipment

- Safety Equipment (traffic cones, etc.)
- Crow bar to remove grate or lid
- Pole with skimmer or net (if floatables removal is not to be done with vactor hose)
- Sediment probe (such as a Sludge-Judge®)
- Vactor truck (flexible hose preferred)
- OSHA Confined Space Entry Equipment
- Up-Flo® Filter Replacement Media Packs (available from Hydro International)
- Hydro International Up-Flo® Filter Maintenance Log
- Screwdriver (flat head)
- Replacement Drain Down Filter components supplied by Hydro International

Man Entry Required: Media Pack and Drain Down Filter

1. Follow Floatables and Sump Cleanout Procedures, 1 – 13.
2. Following OSHA Confined Space Entry procedures, enter the Up-Flo® Filter Chamber.
3. Open the Filter Module by turning the three cam latches on the front and sides of the module. Remove the lid 1 to gain access to the Media Pack (Fig.9).
4. Remove and discard the spent Media Pack. The Media Pack contents include:
   - A top layer of A Flow Distributing Sheets
   - Two (2) Media Bags B equipped with nylon handles.
   - A bottom layer of A Flow Distributing Media.
5. Insert a new Media Pack, supplied by Hydro International.
   - First, insert a bottom layer of green Flow Distributing Media. Be sure that the media sits snugly and level at the bottom of the Filter Module.
   - Next, insert the first of two (2) replacement Media Bags. Smooth the bag out with your hands to make sure that the bag extends snugly to the walls and corners of the Filter Module.
   - Insert the second Media Bag, following the same procedure.
   - Insert the top layer of green Flow Distributing Media.

1. Filter Module Cover and Media Restraint

2. Replaceable Media Pack:
   a) Flow distribution sheets
   b) Filter Media Bags

3. Cam Latch

4. Conveyance Channel

5. Filter Module

6. Support Bracket / Angled Screen

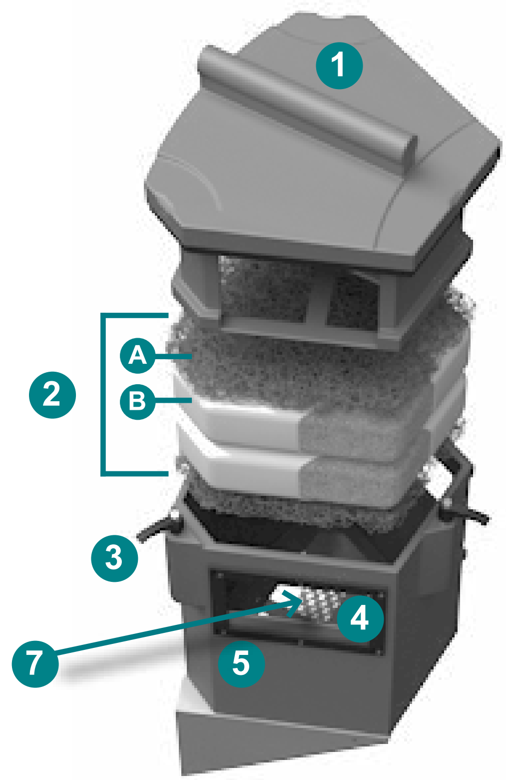


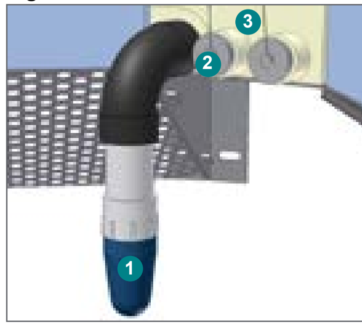
Fig.9 The Filter Module houses the Media Restraint and the Media Pack.

Be sure that the piece fits snugly against the walls and corners of the Filter Module.

- Put the lid on and secure the three latches. Check to make sure that the latches are closed properly.

6. Use a screwdriver to unscrew the Drain Down Filter from the face of the Outlet Module (see Fig.10). DO NOT DISCARD THIS PIECE.
7. Install new Drain Down Filter supplied by Hydro International.
8. Exit the Up-Flo® Filter chamber and securely replace the grate or lid.
9. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables, oil and gross debris removed, and the depth of sediment measured. Note the number of Media Packs replaced. Note any irregularities such as damaged components or blockages.

Fig.10 *The Drain Down Filter.*



1. Drain Down Filter
2. Drain Down Plug
3. Pull Chain for Drain Down

10. Remove safety equipment.
11. Dispose of spent media packs at your local landfill, following local regulations.
12. Return the spent Drain Down Filter to Hydro International.
13. Contact Hydro International to discuss any irregularities noted during annual maintenance.

Solids Disposal

Sediment, floatables, gross debris, and spent Media Bags can generally be disposed of at the local landfill in accordance with local regulations. The toxicity of the residues captured will depend on the activities in the contributing drainage area, and testing of the residues may be required if they are considered potentially hazardous.

Sump water can generally be disposed of at a licensed water treatment facility but the local sewer authority should be contacted for permission prior to discharging the liquid. Significant accumulations of oil removed separately from sump water should be transported to a licensed hazardous waste treatment facility for treatment or disposal. **In all cases, local regulators should be contacted about disposal requirements.**

Maintenance at a Glance

Activity	Frequency
Inspection	- Regularly during first year of installation - Every 6 months after the first year of installation
Floatables/Oils Removal	- Twice per year or as needed - Following a contaminated spill in the drainage area
Sediment Removal	- Every six to 12 months, depending on the Up-Flo® Filter Configuration - The maximum allowable sediment depth in any Up-Flo Filter configuration is 16 inches (41 cm) - Following a contaminated spill in the drainage area
Media Pack Replacement	- Once per year - Replacement is required anytime inspection reveals that the high-water level indicator has been activated after two consecutive storms and the subsequent weighing of the Media Bags shows a wet weight greater than 40 lbs - Following a contaminated spill in the drainage area
Drain Down Filter Replacement	- Once per year with Media Pack replacement - Replacement is required anytime inspection reveals that the water level inside the vessel has not reached a level equal with the base of the Filter Modules approximately 36 hours after a 1-inch (2.5 cm) rainfall - As needed, in the event of continuous base flow conditions

Up-Flo® Filter Installation Log

SITE REFERENCE NAME OR NUMBER FOR THIS UP-FLO® FILTER LOCATION:	
SITE NAME:	
SITE LOCATION:	
OWNER:	**SITE CONTRACTOR:**
CONTACT NAME:	**CONTACT NAME:**
COMPANY NAME:	**COMPANY NAME:**
ADDRESS:	**ADDRESS:**
TELEPHONE:	**TELEPHONE:**
FAX:	**FAX:**

INSTALLATION DATE: / /

CONFIGURATION (CIRCLE ONE): **MANHOLE** **VAULT SYSTEM**

TOTAL NUMBER OF UP-FLO® FILTER MODULES: ________________

Hydro International®

UP-FLO® FILTER INSPECTION LOG

Site Name: ______________________________ Owner Change since last inspection? Y N

Location: ______________________________

Owner Name: ______________________________

Address: ______________________________ Phone Number: ______________

Site Status: ______________________________

Date: ____________ Time: ____________ Site conditions*: ______________________________

(Stable, Under Construction, Needing Maintenance, etc.)

Inspection Frequency Key: A=annual; M=monthly; S=after major storms

Inspection Items	Inspection Frequency	Inspected? (Yes/No)	Maintenance Needed? (Yes/No)	Comments/Description
Debris Removal				
Adjacent area free of debris?	M			
Inlets and Outlets free of debris?	M			
Facility (internally) free of debris?	M			
Vegetation				
Surrounding area fully stabilized? (no evidence of eroding material into Up-Flo® Filter)	A			
Grass mowed?	M			
Water retention where required				
Water holding chamber(s) at normal pool?	A			
Evidence of erosion?	A			
Sediment Deposition				
Filtration Chamber free of sediments?	A			
Sedimentation sump not more than 50% full?	A			
Structural Components				
Any evidence of structural deterioration?	A			
Grates in good condition?	A			
Spalling or cracking of structural parts?	A			
Outlet/Overflow Spillway	A			
Other				
Noticeable odors?	A			
Any evidence of filter(s) clogging?	M			
Evidence of flow bypassing facility?	A			

Inspector Comments: ____

____

____

____

Overall Condition of Up-Flo® Filter**: ☐ Acceptable ☐ Unacceptable

***"Acceptable" would mean properly functioning; "unacceptable" would mean damaged or required further maintenance.*

If any of the above Inspection Items are checked "Yes" for "Maintenance Needed", list Maintenance actions and their completion dates below or on the Maintenance Log provided on page 15 of the Up-Flo® Filter Operation & Maintenance Manual:

Maintenance Action Needed	Due Date

The next routine inspection is schedule for approximately: (date) ________________________

Inspected by: (signature) ____

Inspected by: (printed) ____

Hydro International

Up-Flo® Filter Maintenance Log

Site Name: ____ Owner Change since last inspection? Y N

Location: ____

Owner Name: ____

Address: ____ Phone Number: ______________________

Site Status: ____

Date: ____________ Time: ____________ Site conditions: ____
(Stable, Under Construction, Needing Maintenance, etc.)

Estimated volume of oil/floatable trash removed: ____

Sediment depth measured in sump prior to removal: ____

Number of Filter Modules fitted with new media packs: ____

Inspector Comments: ____

____

____

____

Overall Condition of Up-Flo® Filter: ☐ Acceptable ☐ Unacceptable
***"Acceptable" would mean properly functioning; "unacceptable" would mean damaged or required further maintenance.*

Maintained by: (signature) ____

Maintained by: (printed) ____

Do it Right the First Time

Learn more at hydro-int.com/service

CALL **1 (888) 382-7808** TO SCHEDULE AN INSPECTION

Stormwater Solutions

94 Hutchins Drive
Portland, ME 04102

Tel: (207) 756-6200
Fax: (207) 756-6212
stormwaterinquiry@hydro-int.com

www.hydro-int.com

Turning Water Around...®

UFF_OMM_D1608

Verification Statement

Hydro International Up-Flo® Filter with CPZ™ Media

Registration number: (V-2019-06-01)
Date of issue: (2019-June-28)

Technology type	Stormwater Filtration Device		
Application	Technology to remove sediment, nutrients and metals from stormwater runoff		
Company	Hydro International	**Website**	https://www.hydro-int.com
Address	94 Hutchins Drive, Portland, Maine USA 04102		
E-mail	TechSupport@hydro-int.com	**Phone**	+1-207-756 6200

This Verification Statement was prepared by VerifiGlobal to summarize the results reported in the Verification Report for the Hydro International Up-Flo® Filter with CPZ™ Media, dated June 26, 2019. The Verification Report was prepared by Good Harbour Laboratories Inc. (GHL) for VerifiGlobal in accordance with the requirements of the International Organization for Standardization (ISO) 14034 Environmental Technology Verification (ETV) standard and the VerifiGlobal Performance Verification Protocol. All the information provided in this Statement are based on the independent, third-party review and verification of technical information, performance test reports, performance data and specific performance claims documented in the Verification Report.

Technology Description

The *Up-Flo® Filter with CPZ™ Media* is a stormwater remedial device that incorporates gravitational separation of floating and settling materials, screening, and filtration of polluted stormwater to offer treatment train capabilities in a standalone device. Each Up-Flo® Filter consists of a highly configurable array of modules that are typically supplied as a complete system housed in a 4-ft (1.2 m) diameter manhole or precast vault. Manhole configurations consist of a single ring assembly containing one to six modules. Vaulted systems are highly configurable and may contain single or multiple arrays each consisting of one to 18 Filter Modules depending on availability of vault sizes.

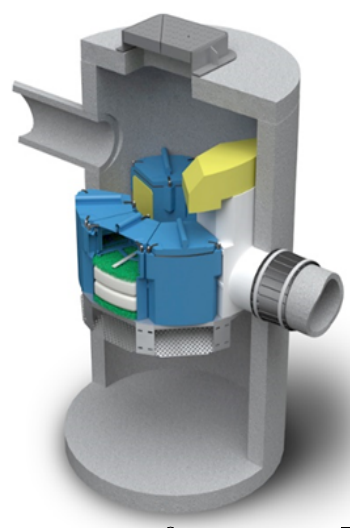


Figure 1: Up-Flo® Filter with CPZ™ Media

Verified Performance Claims

Verification of the Hydro International Up-Flo® Filter with CPZ™ Media is based on existing performance test data from two different locations with different rainfall characteristics, catchment areas and pollutant loadings. Supporting data were obtained from three independent perfomance monitoring studies. One was conducted by Engineering School of Sustainable Infrastructure and Environment (ESSIE) at the University of Florida (UF) under the supervision of Dr. John Sansalone and two were conducted by Department of Civil, Construction, and Environmental Engineering (CCEE) at the University of Alabama (UA) under the supervision of Dr. Bob Pitt.

All three studies were guided by the New Jersey Department of Environmental Protection (NJDEP) Technology Acceptance Reciprocity Partnership (TARP) Tier II Protocol for Stormwater Best Management Practice Demonstrations (2003) and its 2006 and 2009 amendments. In total, there were 66[1] storms assessed to verify that an Up-Flo® Filter with CPZ™ Media achieves the performance listed in Tables 1 and 2, when designed to the following parameters:

- System hydraulic loading rate of 25 gpm (1.58 L/s) per filter module, with bypass of higher flows.
- Filter flux rate of 22.7 gpm/ft2 (15.4 L/s/m2)
- Operating head of ≤30 in. (76.2 cm)
- Effective Sedimentation/ Filtration Treatment Area (ESA/EFTA) –12.6/6.6 (1.91)
- Maximum sediment storage volume of 16.8 ft3 (0.476 m3) at a sediment depth of 16 inches (0.41m).

Table 1. Up-Flo® Filter with CPZ™ Media – Verified Concentration Removal Efficiency

Constituent	Lower 95% Confidence Interval	Median	Upper 95% Confidence Interval
SSC *	85.9%	92.8%	94.7%
SSC **	73.9%	82.8%	86.3%
TSS *	79.0%	89.2%	91.0%
TSS **	72.0%	78.3%	85.2%
TN *	9.0%	28.5%	64.7%
TP *	33.8%	43.9%	50.9%
Zn **	39.4%	50.0%	62.1%
Cu **	72.6%	80.7%	85.2%
* Based on ESSIE (UF) Performance monitoring results ** Based on CCEE (UA) Performance monitoring results			

Table 2. Up-Flo® Filter with CPZ™ Media – Verified Flow Weighted Mass Removal Efficiency

Constituent	ESSIE (UF) Performance monitoring results		CCEE (UA) Performance monitoring results
	6-month	12-month	12-month
SSC	93%	92%	86%
TSS*	89%	87%	87%
TN **	68%	39%	***
TP **	48%	48%	***
Zn	***	***	59%
Cu	***	***	70%
* TSS results for UF are a function of SSC. ** TN and TP load data was time dependent after 6-months *** No data submitted			

[1]Of the total 66 storms (16 storms from UF and 50 storms from UA), 62 were identified as qualifying events having quality data for TSS, and 59 for SSC. Fewer events with metals detected in the runoff limited the metals data sets. There were a total of 28 and 17 storms for Zn and Cu, respectively, solely from the UA data. Total Nitrogen and Total Phosphorous claims were based on the 16 storms recorded solely from the UF data.

Description of Test Procedure

Table 3 shows the target criteria as outlined by the TARP and TAPE programs as well as the results achieved at the two locations. Table 4 provides a more detailed description of the observed operating conditions over the testing period. At the time of testing, the TARP and TAPE programs both allowed for field testing data to be used to obtain certification in participating states. They were the most widely used protocols and were generally accepted as industry standards. The TARP program has since stopped accepting field data, but the TAPE program remains in effect and is currently referenced to benchmark the quality of data obtained from stormwater monitoring programs.

Table 3. Up-Flo® Filter with CPZ™ Media Performance Testing - Specified TARP & TAPE criteria, and achieved results, for storm selection and sampling

Description	TARP Criteria	TAPE Criteria	Achieved value	
			ESSIE - UF	CCEE - UA
Total rainfall/storm	≥2.5 mm (0.1")	≥3.81 mm (0.15")	>2.5 mm (0.1")	≥4.6 mm (0.18")
Minimum inter-event period	6 h	6 h	≥ 6 h	≥ 6 h
Minimum flow-weighted composite sample storm coverage	70% including as much of the first 20% of the storm	75% including as much of the first 20% of the storm	100%	87.6%
Minimum influent/effluent samples	10, but a minimum of 5 subsamples for composite samples	12, but a minimum of 10 subsamples for composite samples	5, whole manual samples	11
Total sampled rainfall	≥ 381 mm (15")	NA	195 mm (7.66")	765 mm (30.07")
Total sampled storms	≥ 20	≥ 12	16	29

Table 4. Up-Flo® Filter with CPZ™ Media Performance Testing - Observed operational conditions for events monitored over each performance test period

Operating parameter	Observed range	
	ESSIE - UF	CCEE - UA Total*
Storm duration	0.35-5.78 h	0.67-64.7 h
Previous dry hours**	6-213	> 6 hrs for the 20 storms in 1st study and 12-632 hrs for 30 storms in second study
Rainfall depth	0.10-1.64 in	0.18-2.44 in
Runoff volume	223-4095 gal (0.84-15.5 m^3)	2,065-61,131 gal(7.82-231 m^3)
Peak rainfall intensity (5 min)	1.2-5.4 in/h (3.0-13.7 cm)	0.24-4.68 in/h (0.61-11.9 cm)
Peak runoff flow rate	27.7-233 gpm (1.75-14.7 L/s)	68-1023 gpm (4.29-64.5 L/s)
Event median flow rate	2.4-21.4 gpm (0.15-1.35 L/s)	28-175 gpm (1.75-11.0 L/s)

* The UA data ranges cover the storms for both studies; ranges for individual studies might be narrower.
** This is the same as the time period between events, or time since it last rained a qualifying event.

For the UF study, performance monitoring was conducted at the Reitz Union surface parking lot, which had a drainage area of 0.12-0.20 acres (0.049-0.081 ha),which was 76% impervious, depending on storm intensity and wind direction. The area generated a flow rate in excess of the 150 gpm (9.55 L/s) maximum treatment flow rate (MTFR) in 3 of the 16 storms. The 4-ft diameter (1.2 m) test unit was installed above ground in a temporary installation at the bottom of a hill sloping down from the lot. An inlet catch basin conveyed runoff from the parking lot through a Pashall flume into the filter. Monitoring occurred over a period of 12 months and the UF team recovered the captured mass at the end of the perfomance monitoring study. No maintenance was required or conducted during the year long monitoring period from 12 September 2015 through 1 September 2016.

The UA perfomance monitoring studies covered a total of 50 storms, but not all of them yielded useful data for all parameters. The site used in both cases was the Riverwalk parking lot near the Bama Belle in Tuscaloosa, Alabama. The drainage area was about 0.9 acres (0.36 ha), 68% impervious. The unit was installed in a 4 ft. (1.2 m) diameter below-grade catch basin inlet manhole on the site. Monitoring occurred in two stages of approximately 12 months each over a total of 32 months. The first round of testing occurred from July 16, 2010 to April 11, 2011 and the second from May 31st, 2012 to March 30th, 2013.

The UA perfomance monitoring study used autosamplers to generate the flow-weighted composite samples and the event mean concentration data. This data was used to calculate removal efficiencies. However, in the UF performance monitoring study, sediment removal performance was assessed by taking full cross section samples of the influent and effluent streams at regular intervals for the duration of the storm and combining the samples into flow-weighted composites. The data was converted into event mean concentrations for the purposes of calculating removals.

The following approved analytical methods were used:

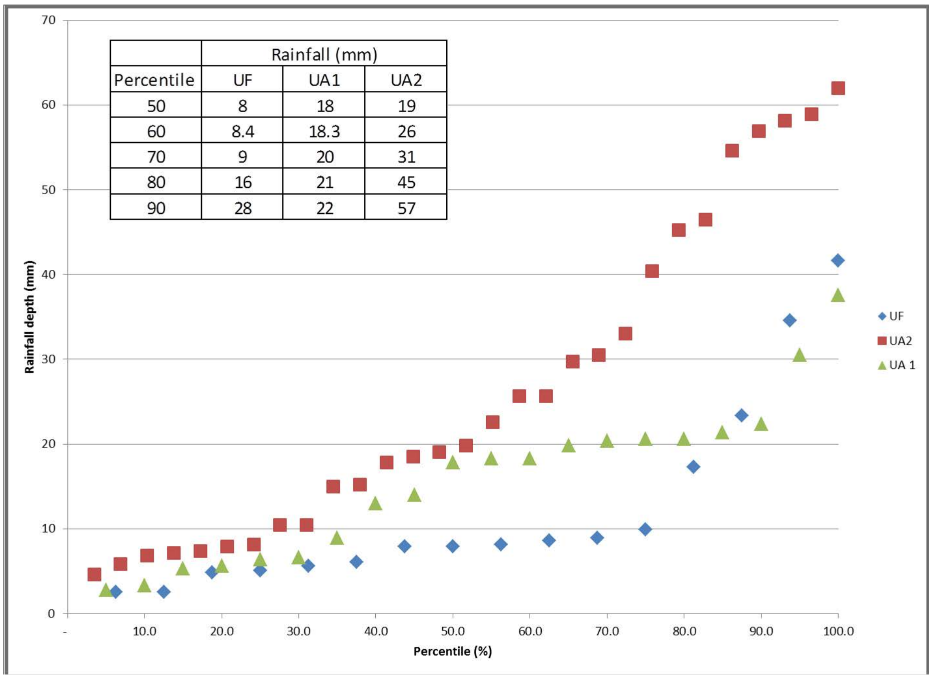
- TSS – ASTM D2540
- SSC – ASTM D3977-97(2013) Standard Test Methods for Determining Sediment Concentration in Water Samples
- PSD – ASTM D422 – 63 Standard Test Method for Particle-Size Analysis of Soils and ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- PSD – ASTM 2560- C, D (UF used 2560D laser diffraction or light-scattering method and UA used 2560C Coulter Counter or light-blocking method)
- TP – S.M.4500-P-B Acid Hydrolysis
- TN – Persulfate Digestion Method
- Cu – EPA 200.8 Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry
- Zn - EPA 200.8 Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry

As part of the mass balance measurements, the UF team allowed all samples to sit for an hour and reported concentrations of suspended solids, measured using ASTM 2540D, as TSS, in addition to the usual SSC measurement using SM3977. In order to be able to report a TSS comparable to other perfomance monitoring studies, Dr. Sansalone developed a correlation equation for TSS* = f(SSC) as well as equations for the 95% confidence limits of TSS*.

Summary of Verification Results

The cumulative frequency of rainfall depths monitored during the three perfomance monitoring studies is presented in Figure 2. The median rainfall depths in the three perfomance monitoring studies were 0.31, 0.71, and 0.75 inches (8, 18 & 19 mm) while the 90th percentile rainfall depths were 1.1, 0.9 and 2.2 inches (28, 22 and 57 mm). Thus the data presented covers a comparatively wide range of rain events.

Figure 2. Rainfall depth frequency curves



	Rainfall (mm)		
Percentile	UF	UA1	UA2
50	8	18	19
60	8.4	18.3	26
70	9	20	31
80	16	21	45
90	28	22	57

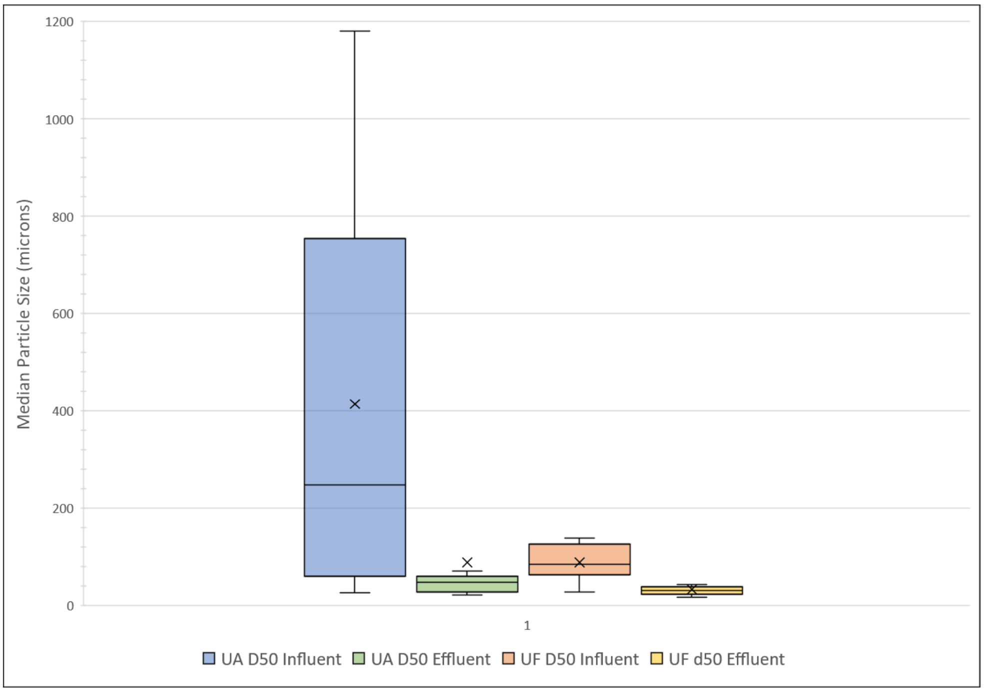
For UF monitoring, a total of 16 storm events, with varying rainfall intensity and runoff volume from event to event, were monitored. The cumulative rainfall depth was 7.66 inches (195 mm) and the cumulative influent runoff volume was 20,022 gallons (7.65 m^3). The entire volume was treated by the Up-Flo® Filter system. Of the 16 storms treated, three storms generated flow rates exceeding the MTFR of 150 gpm (9.55 L/s) but there was no bypass, because the excess was not sufficient to top the overflow weir, and all sampled flows passed through the filtration media. Median driving head difference for an event never exceeded 13.1 inches (33.3 cm) and peak driving head difference never exceeded 27.1 inches (68.8 cm), which indicates the media was not occluded.

For the UA site, all of the storm events from May 31st, 2012 to March 30th, 2013 were monitored for flow but only 30 events were sampled. The total rainfall depth for this period was 49 inches (124.5 cm) or 982,192 gal. (3,718 m^3) of runoff volume that was routed through the filter. Actual storm data from the monitoring period showed about 624,503 gal. (2,364 m^3) of runoff (from about 30 inches or 76.2 cm of rainfall) was treated by the media filter system. This included about 28.5 % of bypass flow volume, which was sampled and included in the performance results. Given that the total bypassed volume was almost three times the expected bypass volume at the UA site, the UA results are considered conservative.

Influent particle sizes varied considerably between the two monitored locations and between storm events. Catchment characteristics and available sources, sampling methods (auto sampling vs. grab sampling), storm intensities, duration and volumes all influence the particle size range. The particle size analyses were completed for just the median particle size for each storm. A comparison of statistical descriptive values for influent and effluent median particle sizes for the two monitored sites is illustrated with the Whisker-Box-Plot shown in Figure 3.

Due to larger storm events and curbside erosion, the median UA influent particle size range and d_{50} were substantially the larger of the two monitored sites. The interquartile range for the influent median particles sizes was 659 µm for UA compared to 59 µm for UF and the UA d50 was 247 µm compared to 85 µm for UF. However, despite the influent particle size differences between locations, the median UA and UF effluent particle size range and d50 were similar. The interquartile range for the effluent median particles sizes was 33 µm for UA compared to 13 µm for UF and the UA d50 was 48 µm compared to 30 µm for UF.

Figure 3. UF and UA Summary of Influent and Effluent Median Particle Sizes



Summary statistics for the influent and effluent concentration removal efficiencies as well as the overall mass load reductions are shown in Table 4 and Table 5 for UF and UA, respectively.

While the flow weighted removal efficiency for TP and TN were 48% and 39%, respectively, TP and TN reduction tended to decrease with the overall volume treated. Results showed that if the filter maintnenance cycle is limited to 6-8 months, the long-term load reduction for TP and TN would have been 50% and 70%, respectively.

Table 4: Up-Flo® Filter with CPZ™ Media Performance Testing - Summary statistics for influent and effluent event mean concentrations (EMCs) and the overall mass load reductions for selected constituents (UF Test)

Parameter	Sample Location	Min	Max	Median	SD	Mass Load Reduction
SSC	Influent	146	1584	487	360	92%
	Effluent	19.9	96.5	43.25	20.2	
TSS*	Influent	93.3	870	277	194	87%
	Effluent	25.0	66.4	37.6	10.9	
TP	Influent	0.79	6.05	1.9	1.70	48%
	Effluent	.56	2.19	1.1	0.56	
TN	Influent	.41	7.89	2.1	2.18	39%
	Effluent	.52	3.84	1.2	1.21	

Table 5. Up-Flo® Filter with CPZ™ Media Performance Testing - Summary statistics for influent and effluent event mean concentrations (EMCs) and the overall mass load reductions for selected constituents (UA Tests)

Parameter	Sample Location	Min	Max	Median	SD	Mass Load Reduction
SSC (mg/L)	Influent	23	879	88	166	86%
	Effluent	3	69	17	18	
TSS (mg/L)	Influent	11	571	89	128	87%
	Effluent	3	64	19	22	
Total Zn (µg/L)	Influent	7.0	157	22.0	0.71	59%
	Effluent	2.5*	72	14.0	0.68	
Total Cu (µg/L)	Influent	6	181	9	42	70%
	Effluent	1.3**	42	1.3	20.9	

* There was a single effluent value that was non-detect (ND). Since it was only 1 value ½ the detection limit 1.3 µg/L, was substituted when calculating statistics.
**The Cu data was highly censored (many non-detect, ND, effluents). Statistics were calculated by substituting ½ the detection limit, 1.3 µg/L, for all ND data then bootstrapping as usual.

As the independent verifier, GHL has confirmed that

- The Hydro International Up-Flo® Filter with CPZ™ Media is based on sound scientific and engineering principles, providing a net environmental benefit.
- Performance testing of the Hydro International Up-Flo® Filter with CPZ™ Media was based on defined parameters and quality-assured performance test results.
- Performance testing of the Hydro International Up-Flo® Filter with CPZ™ Media was performed by a qualified testing organization.
- Sample analyses were carried out as part of the test plan by a third-party analytical laboratory in a manner that meets the quality requirements of ISO 17025. Operating conditions and performance during each testing run were documented.
- Frequency of sampling and duration of each performance test were determined based on the specifications in a credible test plan and the requirements to produce sufficient data to support the performance claim at a 95% confidence level.
- Performance measurements and calculations were based on the technology application and relevant performance parameters as outlined in the Verification Plan.
- Performance calculations were done according to generally accepted test methods described in the test design, including the applicable mathematical and statistical principles and procedures.
- Data storage, transfer and control were adequate, carried out in accordance with the intent of ISO 9001 enabling control and retrieval of documents and records.
- Quality assurance requirements were addressed throughout the performance testing process and in the generation of performance test results. This confirmation included reviewing all data sheets and data downloads, as well as overall management of test system quality.

Quality Assurance

Performance testing and verification of the Hydro International Up-Flo® Filter with CPZ™ Media were performed in accordance with the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. The verifier, Good Harbour Laboratories, has confirmed that quality assurance requirements were addressed throughout the performance testing process and in the generation of performance test results. This includes reviewing all data sheets and data downloads, as well as overall management of the test system, quality control and data integrity.

References

Technology Acceptance Reciprocity Partnership (TARP) Protocol and New Jersey Department of Environmental Protection (NJDEP amendments to the TARP Protocol, dated August 5, 2009 and Revised December 5th, 2009

"Development and Testing of Protocols for Evaluating Emerging Technologies for the treatment of Stormwater", Noboru Togawa, Dissertation, Department of Civil, Construction, Construction, and Environmental Engineering, Graduate School of the University Of Alabama, Tuscaloosa, Alabama, 2011.

"Up-Flo® Filter Verification Testing, Quality Assurance Project Plan, Bama Belle Field Verification Test Site", Tuscaloosa, AL, Hydro International, July 2012.

"Full-Scale Up-Flo® Filter Field Performance Verification Tests", Department of Civil, Construction, and Environmental Engineering University of Alabama, Tuscaloosa, AL 35487 USA - December 26, 2013.

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Up-Flo® Filter with CPZ™ Media - Performance Claims submitted by Hydro International, 2018-05-15.

"Physical Model Testing and Monitoring of a Hydro International (HI) Up-Flo® Filter Subject to Rainfall-Runoff Loading Events", University of Florida Engineering School of Sustainable Infrastructure and Environment (ESSIE), University of Florida, Gainesville, FL 32611 USA - Version 7-12-17.

Particulate Matter Fraction Analyses. (Sansalone & Kim: Transport of Particulate Matter Fractions in Runoff, Journal of Environmental Quality • Volume 37 • September–October 2008)

New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device, January 2013

2009 Urban Stormwater BMP Performance Monitoring Guidelines
http://www.bmpdatabase.org/contacts.html

Description of Up-Flo® Filter

Up-Flo® Filter Design Manual https://www.hydroint.com/sites/default/files/uff_dg_nashville_f1504.pdf

Up-Flo® Filter Verification Brochure

ISO/IEC 14034, Environmental management – Environmental technology verification

ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories

ISO/IEC 9001, Quality Management Systems.

VerifiGlobal Performance Verification Protocol (Applying ISO 14034:2016)

VerifiGlobal Test Body Assessment – Guidance (2018)

What is ISO 14034?

The purpose of environmental technology verification is to provide a credible and impartial account of the performance of environmental technologies. Environmental technology verification is based on a number of principles to ensure that verifications are performed and reported accurately, clearly, unambiguously and objectively. The International Organization for Standardization (ISO) standard for environmental technology verification (ETV) is ISO 14034, which was published in November 2016.

Benefits of ETV

ETV contributes to protection and conservation of the environment by promoting and facilitating market uptake of innovative environmental technologies, especially those that perform better than relevant alternatives. ETV is particularly applicable to those environmental technologies whose innovative features or performance cannot be fully assessed using existing standards. Through the provision of objective evidence, ETV provides an independent and impartial confirmation of the performance of an environmental technology based on reliable test data. ETV aims to strengthen the credibility of new, innovative technologies by supporting informed decision-making among interested parties.

For more information on the Hydro International Up-Flo® Filter, contact:	For more information on VerifiGlobal, contact:
Hydro International 94 Hutchins Drive, Portland, ME USA 04102 t +1-207-756 6200 e: TechSupport@hydro-int.com w: www.hydro-int.com	VerifiGlobal c/o ETA-Danmark A/S Göteborg Plads 1, DK-2150 Nordhaven t +45 7224 5900 e: info@verifiglobal.com w: www.verifiglobal.com
Signed for Hydro International: *Original signed by:* Dave Scott David Scott Technical Product Manager, Americas Stormwater	Signed for VerifiGlobal: *Original signed by:* Thomas Bruun Thomas Bruun, Managing Director *Original signed by:* John Neate John Neate, Managing Director

APPENDIX “F”

Water Balance Calculations

VALDOR ENGINEERING INC.

File: 19112

November 2019

TABLE: F1

WATER BALANCE CALCULATION

1. INITIAL ABSTRACTION

Surface Type	Area (Ha)	Runoff Coefficient	Init. Abstract. (mm)
Impervious (Roof, Pavement)	0.4680	0.90	1.000
Pervious (Landscape)	0.0650	0.25	5.000
Total	**0.5330**	**0.82**	**1.488**

2. VOLUME TO INFILTRATE

A = Area =	0.5330	ha.
Depth of Rain to Retain (D) =	5.000	mm
Initial Abstractions (I) =	1.488	mm
Volume =	A x (D - I)	
VOLUME REQUIRED =	**18.72**	cu.m.

VALDOR ENGINEERING INC.
File: 19112
Date: September 2019

Table F.2: Site Water Balance Calculations (Annual)

Condition	Site Area (ha)	Water Balance Components	Pervious Area Without Infiltration BMP's	Impervious Area Without Infiltration BMP's	Impervious Area With Basic Infiltration BMP's	TOTAL SITE VOLUMES Precipitation (m^3)	Evapotranspiration (m^3)	Surplus (m^3)	Runoff (m^3)	Infiltration (m^3)	Percent of Existing Infiltration (%)
Existing	**0.533**	Area (ha)	0.476	0.057	0.000	4,972	2,465	2,507	1,273	1,235	100.0
		HSG	AB	n/a	AB						
		Weighted WHC (mm)	63	n/a	63						
		Infiltration Factor	0.625	0.00	0.494						
		Precipitation (mm)	932.9	932.9	932.9						
		Evapotranspiration (mm)	517.9	0.0	525.3						
		Surplus (mm)	415.0	932.9	358.7						
		Infiltration (mm)	259.4	0.0	177.1						
		Runoff (mm)	155.6	932.9	181.6						
Proposed (No Infiltration BMPs)	**0.533**	Area (ha)	0.070	0.463	0.000	4,972	363	4,610	4,428	182	14.7
		HSG	AB	n/a	AB						
		Weighted WHC (mm)	63	n/a	63						
		Infiltration Factor	0.625	0.00	0.494						
		Precipitation (mm)	932.9	932.9	932.9						
		Evapotranspiration (mm)	517.9	0.0	525.3						
		Surplus (mm)	415.0	932.9	358.7						
		Infiltration (mm)	259.4	0.0	177.1						
		Runoff (mm)	155.6	932.9	181.6						

Notes:
1. Site water balance calculations based on methodology per the **Stormwater Management Planning and Design Manual** (MOE, March 2003).

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Table F.3: Water Holding Capacity (WHC) Calculations

Per MOE Methodology (SWM Planning & Design Manual, MOE, March 2003)

Existing Conditions (Pervious Area)			
Land Use	**Area (ha)**	**HSG**	**WHC**
Urban lawns	0.476	AB	63
Total (Area-Weighted):	0.476		**63**

Proposed Conditions (Pervious Area)			
Land Use	**Area (ha)**	**HSG**	**WHC**
Urban Lawns	0.07	AB	63
Total (Area-Weighted):	-		**63**

Table 3.1: Hydrologic Cycle Component Values

	Water Holding Capacity mm	Hydrologic Soil Group	Precipitation mm	Evapo-transpiration mm	Runoff mm	Infiltration* mm
Urban Lawns/Shallow Rooted Crops (spinach, beans, beets, carrots)						
Fine Sand	50	A	940	515	149	276
Fine Sandy Loam	75	B	940	525	187	228
Silt Loam	125	C	940	536	222	182
Clay Loam	100	CD	940	531	245	164
Clay	75	D	940	525	270	145
Moderately Rooted Crops (corn and cereal grains)						
Fine Sand	75	A	940	525	125	291
Fine Sandy Loam	150	B	940	539	160	241
Silt Loam	200	C	940	543	199	199
Clay Loam	200	CD	940	543	218	179
Clay	150	D	940	539	241	160
Pasture and Shrubs						
Fine Sand	100	A	940	531	102	307
Fine Sandy Loam	150	B	940	539	140	261
Silt Loam	250	C	940	546	177	217
Clay Loam	250	CD	940	546	197	197
Clay	200	D	940	543	218	179
Mature Forests						
Fine Sand	250	A	940	546	79	315
Fine Sandy Loam	300	B	940	548	118	274
Silt Loam	400	C	940	550	156	234
Clay Loam	400	CD	940	550	176	215
Clay	350	D	940	549	196	196

Notes: Hydrologic Soil Group A represents soils with low runoff potential and Soil Group D represents soils with high runoff potential. The evapotranspiration values are for mature vegetation. Streamflow is composed of baseflow and runoff.

** This is the total infiltration of which some discharges back to the stream as base flow. The infiltration factor is determined by summing a factor for topography, soils and cover.*

Topography	Flat Land, average slope < 0.6 m/km	0.3
	Rolling Land, average slope 2.8 m to 3.8 m/km	0.2
	Hilly Land, average slope 28 m to 47 m/km	0.1
Soils	Tight impervious clay	0.1
	Medium combinations of clay and loam	0.2
	Open Sandy loam	0.4
Cover	Cultivated Land	0.1
	Woodland	0.2

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Table F.4: Infiltration Factor Calculations
Per MOE Methodology (SWM Planning & Design Manual, MOE, March 2003)

Topography	
0.3	Flat Land (avg slope < 0.06%)
0.225	0.06% to 0.27%
0.15	Rolling Land (avg slope between 0.28% and 0.38%)
0.125	0.39% to 2.7%
0.1	Hilly Land (avg slope between 2.8% and 4.7%)
Soils	
0.4	HSG A - open sandy loam
0.35	HSG AB
0.3	HSG B
0.27	HSG BC
0.23	HSG C
0.2	HSG CD - medium combinations of clay and loam
0.1	HSG D - tight impervious clay
Cover	
0.1	cultivated land (crops)
0.15	pasture, lawns
0.2	woodland (forest)

Infiltration Factor Calculations

Existing Conditions

0.125	Topography
0.35	Soils
0.15	Cover
0.625	Total Infiltration Factor (Existing Conditions)

Proposed Conditions

0.125	Topography
0.35	Soils
0.15	Cover
0.625	Total Infiltration Factor (Proposed Conditions)

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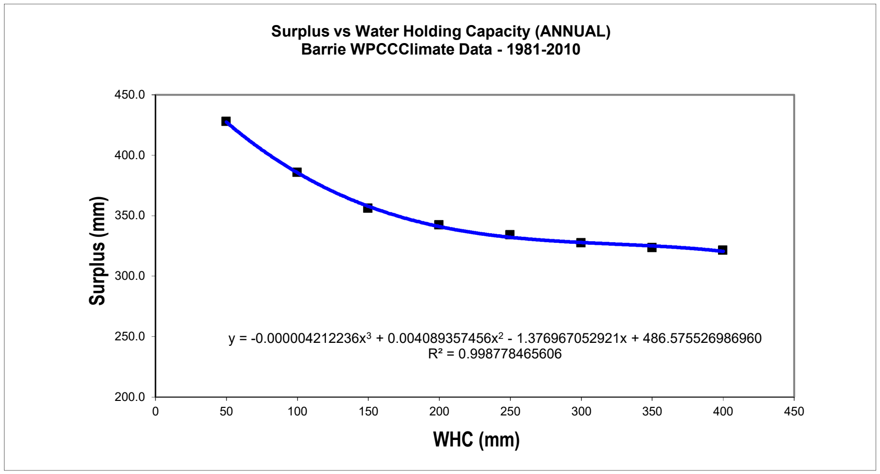
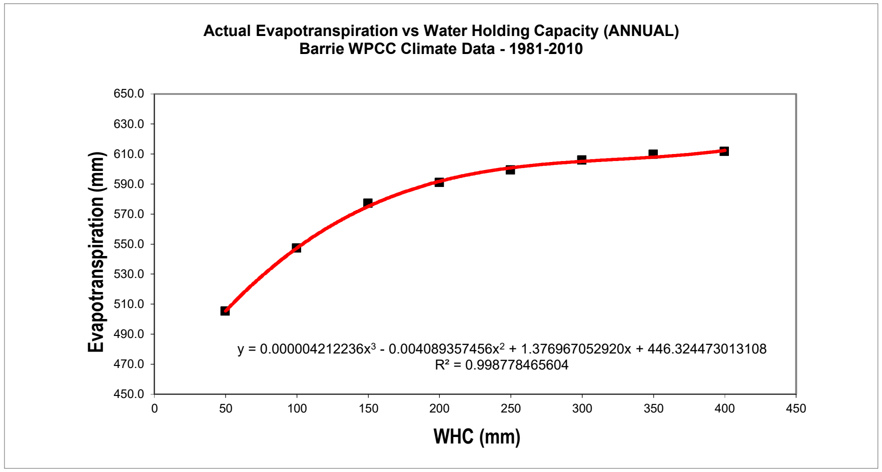
Table F.5: Surplus and Actual Evapotranspiration vs Water Holding Capacity (WHC) Regression Analysis

AES Water Balance Model Results for a Range of WHC
Barrie WPCC Climate Data (1981-2010)

Existing Condition

Trendline			AES Model Results	
Surplus (mm)	AE (mm)	WHC (mm)	Surplus (mm)	AE (mm)
427	505	50	427.8	505.1
386	547	100	385.7	547.2
358	575	150	355.8	577.1
341	592	200	342.2	590.7
332	601	250	333.8	599.1
328	605	300	327.2	605.7
325	608	350	323.4	609.5
321	612	400	321.3	611.6
415.0	517.9	63	TOTAL SITE	





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681 Yonge Street Weekly Plant Water Use Calculation

July Eto = 138.2 mm

Irrigation Water Requirement for July

Planting Description		Area (m2)	Species Factor	Density Factor	Microclimate Factor	Landscape Coefficient	Landscape ET (mm)	Irrigation Efficiency (%)	Gross Monthly Water Requirement (Litres)
Turfgrass		0	0.7	1.0	1.2	0.84	116.1	0.63	**0**
Trees		338	0.5	1.0	1.4	0.70	96.7	0.63	**51,902**
Shrub (Drought Tolerant)		571	0.2	1.0	1.3	0.26	35.9	0.90	**22,797**
Green Roof		0	0.2	1.0	1.3	0.26	35.9	0.90	**0**

Total Monthly Water Use= 74,699

Monthly Water Requirement

Month	Eto (mm)	Days Per Month	Volume (L)	Volume (m3)
May	110.6	31	59,759	59.8
June	124.4	30	67,229	67.2
July	138.2	31	74,699	74.7
August	110.6	31	59,759	59.8
September	82.9	30	44,819	44.8
Total	**566.6**	**153**		
Annual Water Use			**306,264**	**306.3**
Average Daily Water Use (153 Days)			**2,002**	**2.0**
Average Weekly Water Use			**14,012**	**14.0**

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A REPORT TO
QUEENSGATE HOMES BARRIE INC.

PRELIMINARY HYDROGEOLOGICAL ASSESSMENT
PROPOSED RESIDENTIAL DEVELOPMENT
681 YONGE STREET

CITY OF BARRIE

REFERENCE NO. 1909-W019

NOVEMBER 2019

DISTRIBUTION

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A long-term foundation drainage network designated to minimize or eliminate TSS from the disposal discharge would likely minimize any further effluent treatment requirements for the effluent to meet the City of Toronto Barrie Storm Sewer standards.

For temporary construction dewatering a settlement tank can likely be user to minimize TSS from the dewatering effluent prior to its disposal to the city sewer system.

For the long-term foundation drainage effluent management, the final design for drainage system to minimize the generation of the TSS will be the responsibility of the mechanical engineer responsible for the design of a long-term foundation drainage system.

7.6 Ground Settlement

The maximum zone of influence could extend to 24.4 m from the development footprint. It is recommended that a geotechnical engineer confirm if there are any potential ground settlement concerns to existing structures within the zone of influence for any construction dewatering prior to proposed earthworks.

7.7 Long-Term Foundation Drainage Assessment

The proposed development plans indicate that a 7-storey high residential mixed-use, residential building which will be constructed at the site, having a common, 1.5-level underground parking structure having a variable basement floor elevation including an underground water storage tank and elevator pits. An average grading elevation of 257.35 masl was considered to accommodate the proposed 1.5-level underground parking structure. The proposed elevator shaft under-slab structure will be built at the lowest considered elevation of 247.87 masl, while the basement under-slab for inner underground structure was considered at elevation of 249.72 masl, and the basement slab for the outer underground structure was considered at a base elevation 252.72 masl. The highest shallow groundwater level elevation of 253.30 masl, which is about 5.43 m above the base for the proposed elevator pit structure, 0.6 m above the outer basement slab structure and 3.58 m above the inner under-slab basement structure. The proposed elevator shaft structure will be waterproofed.

Given the lot to moderate anticipated groundwater seepage rate estimates for long-term foundation drainage, a conventionally shored excavation, using pile and lagging methods can be designed and completed for the construction of the proposed underground parking level structure. A standard Mira Drainage network can be included with the design of a conventionally shored excavation along with a simple basement under-slab drainage network to address any long-term seepage into the excavation and completed underground structure. These systems can be drained to separate sump pits. The drainage network should be designed by a qualified mechanical engineer, having experience with the designs for under-slab and Mira drainage networks.

The drainage networks should have separate connections to the proposed sump pits, with one pit connected to the Mira drainage network for the shore walls and a second pit connected to the under-slab floor drainage network.

In order to estimate the long-term foundation drainage needs for the Mira perimeter foundation drainage network and to the under-slab floor basement drainage systems at the constructed site, Darcy's Equation was used, as described below:

$$Q = KiA$$

Where:

Q = Estimated foundation drainage rate (m^3/day)

K = 1.6×10^{-6} m/sec (highest hydraulic conductivity (K) assessed for the screened subsoil and shale units encountered beneath the site)

A = 180.2 m^2 for the saturated Mira Drain foundation walls area around the outer underground structure, 492.3 m^2 around the inner underground structure. A total area of 295.04 m^2 was considered for the under-slab floor drainage network which is the approximate total surface areas for weeper tiles used to estimate groundwater seepage to the basement under-slab drainage network, below the water table (cross-sectional area of flow) (m^2)

iv = the vertical groundwater hydraulic gradient varies between 0.052 to 0.09 [unitless], considered for the under-slab basement drainage system

ih = 0.048 [unitless], Horizontal Hydraulic Gradient for groundwater considered for the perimeter, shore wall, mira drainage system.

For the proposed inner and outer underground parking structure, the total long-term foundation seepage drainage rate to the Mira perimeter drainage network for a conventionally shored excavation is 4,460.97 L/day. The long-term, average seepage drainage rate to the under-slab basement floor drainage networks for these structures is 472.69 L/day. The combined, long-term seepage drainage rate to both the Mira drain, perimeter system for the shore walls, and from the under-slab drainage networks is estimated at 4,933.67 L/day. By applying a safety factor of two (2), the combined seepage flow drainage rate is estimated at 9,867.32 L/day. It should be noted that these estimates are all be below the MECP threshold of 50,000 L/day for a groundwater taking approval for long-term foundation drainage which is not anticipated following construction.

The pumping facility and sump systems should be designed for the maximum expected drainage seepage rate. The drainage piping should be properly constructed using weeper tiles surrounded by filter cloth, in turn surrounded by bedding stone or concrete sand to minimize potential losses of fines and to prevent silt from clogging of weeper tiles. Over time, the foundation drainage flows to the underground basement structure may diminish to a lower, or possibly negligible steady state rate, but more likely to a steady state rate that will remain relatively constant over time.

8.0 CONCLUSION

1. The subject site is located within the physiographic region of Southern Ontario known as the known as the Peterborough Drumlin Field.
2. Based on review of the surface geological map of Ontario, the subject site is located on the Newmarket Till unit material, consisting of sandy silt to silt matrix, having moderate to high matrix carbonate content with moderate to high clast content.
3. A review of the local topography shows that the site is relatively flat, exhibiting a gentle decline in elevation relief towards the site's west limits.
4. The subject site is located within the Hewitt's Creek sub watershed of the Lake Simcoe Watershed.
5. The findings from the current study have disclosed that beneath a layer of topsoil and earth fill, the native soil underlying the subject site consist of silty sand till, and sandy silt till extending to the termination depth of 15.5 m below the exiting site grades.
6. The findings show that the average of groundwater levels ranges from El. 252.09 to 253.3 masl (3.16 to 4.11 mbgl) as recorded during the preliminary monitoring period, with shallow groundwater interpreted as flowing in a westerly direction.
7. The single well response tests yielded an estimated K values in the range of 6.6×10^{-7} m/sec and 1.6×10^{-6} m/sec for the sandy silt till at the depths of the well screen, suggesting low to moderate anticipated seepage rates into open excavations below the water table during construction.
8. Since the shallow groundwater level elevation is above the lowest basemen floor elevation for the proposed multi storey residential building, temporary construction dewatering is anticipated to facilitate safe stable subsoil conditions for earthworks excavations for construction of the proposed underground structure and associated services. The temporary construction dewatering flows to build the proposed underground structures will range from 12,510.80 to 181,135.23 L/day with application of a 3 x safety factor these flows could reach daily maximums of 37,532.41 L/day up 543,405.69 L/day. The high end of the anticipated daily flows is above the MECP approval threshold limit of 50,000 L/day whereby the approval for proposed groundwater taking is by means of an EASR with the EASR filed through the MECP.
9. The combined long-term foundation drainage estimates for the completed underground structure is 4,460.97 L/day for the shore wall perimeter mira drainage network and is 472.69 L/day for the basement under-slab drainage network. The combined drainage rate for both systems is 4,933.67 L/day, with application of a 2x safety factor the combined drainage rate could reach 9,867.32 L/day. The high end of the drainage flow estimate is below the MECP groundwater taking threshold

approval requirement with no MECP approval being anticipated.

10. The anticipated maximum zone of influence for temporary construction dewatering is 24.4 m away from the dewatering alignments around the excavation footprints. Based on the records review, there are no records for natural heritage features within the anticipate zones of influence for temporary construction dewatering. The surrounding area is serviced with municipal water with no nearby private wells still being used. It is recommended that any existing supply wells on site, if encountered be decommissioned prior to earth works if they are no longer needed. A geotechnical has determined that there are no ground settlement concerns to any existing structures or infrastructure associated with the proposed development.
11. Results of the groundwater quality analysis indicate that the groundwater quality is acceptable for disposal to the Barrie storm sewer system as long as total suspended solids in any dewatering effluent is lowered to meet Barrie's storm sewer use standards.

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