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FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT REPORT

FOR

THEBERGE HOMES DEVELOPMENT 21 WITHROW AVENUE

CITY OF OTTAWA

PROJECT NO.: 17-931

JUNE 2018 – REV 3

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1.0 INTRODUCTION

David Schaeffer Engineering Ltd. (DSEL) has been retained by Theberge Homes Development to prepare a Functional Servicing and Stormwater Management Report in support of the Plan of Subdivision, Zoning By-Law Amendment (ZBLA) for the proposed development at 21 Withrow Avenue. Additionally, this report and the accompanying drawing package also support the Consent for Severance application for the residential units fronting Withrow Avenue.

The subject property is located within the City of Ottawa urban boundary, in the College ward. As illustrated in ***Figure 1***, the subject property is bounded by existing residences and Tower Road to the north, St. Helen's Place to the east, Withrow Avenue to the south and existing residences and Rita Avenue to the west. The subject property measures approximately ***0.82ha*** and is designated Residential First Density Zone (R1FF) under the current City of Ottawa zoning by-law.

Figure 1: Site Location

The proposed development involves the construction of 13 single family homes and a detached garage for the existing residence on the property. A copy of the proposed site plan is included in ***Drawings/Figures***. The single parcel is proposed to be subdivided into 4 units fronting onto Withrow Avenue, with the remaining main property subdivided in accordance with the ***Legal Plan*** provided in ***Drawings/Figures.***

The objective of this report is to support the application for Plan of Subdivision and ZBLA by providing sufficient detail to demonstrate that the proposed development is supported by existing and proposed municipal servicing infrastructure and that the site design conforms to current City of Ottawa design standards. Please refer to the associated drawing package to support the Consent for Severance Application for the units fronting Withrow Avenue.

1.1 Existing Conditions

The subject site currently consists of one single family home and garage, which are surrounded by grassy areas and a few trees.

Sewer system and watermain distribution mapping collected from the City of Ottawa indicate that the following services exist across the property frontages within the adjacent municipal right-of-ways:

St. Helen's Place

- 150mm diameter watermain
- 200mm diameter sanitary sewer

Withrow Avenue

- 150mm diameter watermain
- 200mm diameter sanitary sewer

Cleto Avenue

- 150mm diameter watermain
- 200mm diameter sanitary sewer
- 300mm diameter storm sewer

Rita Avenue

- 150mm diameter watermain
- 200mm diameter sanitary sewer

1.2 Required Permits / Approvals

Development of the site is subject to the City of Ottawa Planning and Development Approvals process. The City of Ottawa must approve detailed engineering design drawings and reports, prepared to support the proposed development plan.

The subject property contains existing trees. Development, which may require removal of existing trees, maybe subject to the City of Ottawa Urban Tree Conservation By-law No. 2009-200.

It is proposed that multiple property will be serviced by a single stormwater management system. As such, it is anticipated that an Environmental Compliance Approval (ECA) through a direct submission to the Ministry of the Environment and Climate Change (MOECC) will be required.

1.3 Pre-consultation

Pre-consultation correspondence and the servicing guidelines checklist are located in ***Appendix A***.

The pre-consultation notes indicate the City requires separate stormwater requirements for the proposed 4 lots fronting Withrow Avenue and the remaining property being serviced by a private roadway. The lots fronting Withrow Avenue will be subject to a Consent of Severance Application and it is required that these units be serviced independently and directly from Withrow Avenue. It is proposed to have drainage from the 4 units fronting Withrow Avenue to be directed to the subdivision to the north, therefore, the units have been reviewed in the interim and ultimate condition with the stormwater management plan for the subdivision.

Sanitary and water servicing described in the pre-consultation notes were based on an outdated concept plan. The current plan shows only a road connection to St. Helen's Place, therefore water and sanitary servicing proposed is different than described in the pre-consultation notes.

City of Ottawa staff have indicated the importance of retaining the landscaping edge condition at the property line and on the adjacent property. The plan and reports have been prepared in consideration of retaining the edge condition and landscaping on the adjacent property.

2.0 GUIDELINES, PREVIOUS STUDIES, AND REPORTS

2.1 Existing Studies, Guidelines, and Reports

The following studies were utilized in the preparation of this report:

- **Ottawa Sewer Design Guidelines**,
  City of Ottawa, *SDG002**,*** October 2012.
  (City Standards)

  - **Technical Bulletin ISDTB-2014-01**
    City of Ottawa, February 5, 2014.
    (ITSB-2014-01)

  - **Technical Bulletin PIEDTB-2016-01**
    City of Ottawa, September 6, 2016.
    (PIEDTB-2016-01)

  - **Technical Bulletin ISTB-2018-01**
    City of Ottawa, March 21, 2018.
    (ISTB-2018-01)

- **Ottawa Design Guidelines – Water Distribution**
  City of Ottawa, October 2012.
  (Water Supply Guidelines)

  - **Technical Bulletin ISD-2010-2**
    City of Ottawa, December 15, 2010.
    (*ISD-2010-2*)

  - **Technical Bulletin ISDTB-2014-02**
    City of Ottawa, May 27, 2014.
    (*ISDTB-2014-02*)

  - **Technical Bulletin ISDTB-2018-02**
    City of Ottawa, March 21, 2018.
    (ISDTB-2018-02)

- **Stormwater Planning and Design Manual,**
  Ministry of the Environment, March 2003.
  (SWMP Design Manual)

- **Ontario Building Code Compendium**
  Ministry of Municipal Affairs and Housing Building Development Branch, January 1, 2010 Update.
  (OBC)

- **Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems**
  National Fire Protection Association
  2014 Edition.
  (NFPA 25)

- **Merivale Road Sewer Investigation and Hydraulic Assessment Study- Final Report**
  Delcan Corporation
  January 2000.
  (Merivale Road Sewer Investigation)

- **Water Supply for Public Fire Protection**
  Fire Underwriters Survey, 1999.
  (FUS)

- **Drainage Management Manual**
  Ministry of Transportation of Ontario (MTO), 1997.
  (MTO Drainage Manual)

- **Low Impact Development Stormwater Management Planning and Design Guide**
  Credit Valley Conservation & Toronto and Region Conservation, 2010.
  (LID Guide)

3.0 WATER SUPPLY SERVICING

3.1 Existing Water Supply Services

The subject property lies within the City of Ottawa 2W pressure zone, as shown by the Pressure Zone map in ***Appendix B.*** Based on further correspondence with the City of Ottawa, the site is serviced by the ME pressure zone and therefore is part of this pressure zone. Watermains exist within St. Helen's Place, Withrow Avenue, Cleto Avenue and Rita Avenue.

3.2 Water Supply Servicing Design

The subject property is proposed to be serviced through a connection to the existing 150mm municipal watermain within St. Helen's Place. It is proposed to service the site with a ***200mm*** watermain up to the proposed private hydrant, after which a ***50mm*** water service will service the remaining development. It is proposed that ***19mm*** water service will service the individual units. The proposed hydrant is located a maximum of ***85m*** from the furthest unit, in accordance with the ***OBC***.

Water servicing for the units fronting the private site was analyzed for pressure and fire flow.

Table 1 summarizes the ***Water Supply Guidelines*** employed in the preparation of the water demand estimate.

Table 1
Water Supply Design Criteria

Design Parameter	Value
Residential Demand	350 L/p/d
Residential Maximum Daily Demand	4.9 x Average Daily *
Residential Maximum Hourly	7.4 x Average Daily *
Minimum Watermain Size	150mm diameter
Minimum Depth of Cover	2.4m from top of watermain to finished grade
During normal operating conditions desired operating pressure is within	350kPa and 480kPa
During normal operating conditions pressure must not drop below	275kPa
During normal operating conditions pressure shall not exceed	552kPa
During fire flow operating pressure must not drop below	140kPa
** Residential Max. Daily and Max. Hourly peaking factors per MOE Guidelines for Drinking-Water Systems Table 3-3 for 0 to 500 persons.* *** Table updated to reflect ISD-2018-2*	

Table 2 summarizes the anticipated water demand and boundary conditions for the proposed development, calculated using the ***Water Supply Guidelines.***

Table 2
Proposed Water Demand

Design Parameter	Anticipated Demand[1] (L/min)	Boundary Conditions[2] ($m\ H_2O$ / kPa)	
Average Daily Demand	11.7	66.0	647.5
Max Day + Fire Flow	57.2 + 6,000	41.5	407.1
Peak Hour	86.3	60.9	597.4

1) Water demand calculation per ***Water Supply Guidelines***. See ***Appendix B*** for detailed calculations.
2) Boundary conditions supplied by the City of Ottawa for the demands indicated in the correspondence; assumed ground elevation 97.5m at the connection to the municipal watermain. See ***Appendix B.***

The Required Fire Flow (RFF) was estimated in accordance with **ISTB-2018-02.** The maximum RFF required was found to be ***6,000 L/min***, at house 2 and house 4. Refer to ***Appendix B*** for calculations.

The City provided both the anticipated minimum and maximum water pressures, as well as, the estimated water pressure during fire flow, as indicated by the correspondence in ***Appendix A***.

3.3 Watermain Modelling

EPANet was utilized to determine the availability of pressures throughout the system during average day, max day plus fire flow, and peak hour demands. This static model determines pressures based on the available head obtained from the boundary conditions provided by the City of Ottawa.

The model utilizes the Hazen-Williams equation to determine pressure drop, while the pipe properties have been selected in accordance with ***Water Supply Guidelines***. The model was prepared to assess the available pressure at the finished first floor of each building, as well as, the pressures the watermain provides to fire hydrants during fire flow conditions.

The critical zones of the development are considered to be at House 1 and House 4, as both are located at the end of dead end mains. As per **ISTB-2018-02,** a minimum pressure of 140 kPa was maintained while 5,700 L/min was applied to the proposed hydrant. Note that the proposed hydrant is within 75 m of the critical zones. 3,500 L/min was applied to the existing hydrant at St. Helen Place and Cleto Avenue, as it is greater than 75 m away from the critical areas but within 150m of the subject property. The fire flow simulated in this scenario exceeds requirements for the development and resulted in a minimum pressure of ***330.6 kPa*** at node 3.

The maximum required fire flow of ***6,000 L/min*** was also simulated through the proposed hydrant alone. This scenario resulted in a minimum pressure of ***321.1 kPa*** at node 3. The internal hydrant can provide the required fire flow while maintaining minimum pressures described in ***Table 1***. ***Appendix B*** contains a model sketch showing the node locations, fire demand assigned to the hydrant and resulting pressures.

Table 3
Model Simulation Output Summary

Location	Average Day (kPa)	Max Day + Fire Flow (kPa)	Peak Hour (kPa)
Node 2	669.3	403.2	619.3
Node 3 (Hydrant)	668.2	321.1	618.1
Node 4	667.6	401.3	617.5
Node 5	667.1	400.8	617.0
Node 6	667.6	401.3	617.5

As demonstrated in ***Table 3***, the anticipated pressures during the average day and peak hour simulations are higher than allowable pressures in ***Table 1***. Pressure reducing valves are recommended. The recommended pressures from the ***Water Supply Guidelines*** are respected during the max day + fire flow scenario. ***Appendix B*** contains output reports and model schematics for each scenario.

The model predicted that water will flow in all areas of the system and no 'dead' zones were found. ***Appendix B*** contains output reports and model schematics for each scenario.

3.4 Water Supply Conclusion

It is proposed to service the private development from one connection to the existing 150mm watermain within St. Helen's Place.

The anticipated water demand was submitted to the City of Ottawa for establishing boundary conditions.

Based on the EPANET model, pressures during max day + fire flow respect the requirements of the ***Water Supply Guidelines***. Pressures during the average day and peak hour scenario are higher than allowable pressure in ***Table 1***; thus, pressure reducing valves are recommended.

The design of the water distribution system conforms to all relevant City Guidelines and Policies.

4.0 WASTEWATER SERVICING

4.1 Existing Wastewater Services

The subject property lies within the Viewmount Drive Trunk sewer catchment area and on the border of the Lynwood Trunk Sewer, as shown by the ***Trunk Sanitary Sewers and Collection Areas Map*** included in ***Appendix C***. There are existing sanitary sewers within St. Helen's Place, Withrow Avenue, Cleto Avenue and Rita Avenue. The existing site consists of a single residential unit, and anticipated wastewater flow is summarized in ***Table 4,*** below:

Table 4
Summary of Existing Wastewater Flows

Design Parameter	Anticipated Sanitary Flow[1] (L/s)
Average Dry Weather Flow Rate	0.01
Peak Dry Weather Flow Rate	0.05
Peak Wet Weather Flow Rate	0.32
1) Based on criteria shown in ***Table 5***	

Based on the ***Merivale Road Sewer Investigation*** the most restrictive leg of sewer up to the 450mm diameter trunk sewer within Merivale, is between Node 920 and 220 on St. Helen's Place with a residual capacity of ***12.8 L/s***. Refer to ***Appendix C*** for sanitary drainage figure and sanitary design sheet extracted from the ***Merivale Road Sewer Investigation***.

4.2 Wastewater Design

It is anticipated that the proposed development will be serviced via a connection to the existing 200mm sanitary sewer within St. Helen's Place. Refer to the drawing ***SSP-1*** in ***Drawings/Figures*** for sanitary servicing layout.

Table 5 summarizes the ***City Standards*** employed in the calculation of wastewater flow rates for the proposed development.

Table 5
Wastewater Design Criteria

Design Parameter	Value
Residential Demand	280 L/p/d
Peaking Factor	Harmon's Peaking Factor. Max 3.8, Min 2.0
Infiltration and Inflow Allowance	0.33L/s/ha
Sanitary sewers are to be sized employing the Manning's Equation	$Q = \frac{1}{n} AR^{2/3} S^{1/2}$
Minimum Sanitary Sewer Lateral	135mm diameter
Minimum Manning's 'n'	0.013
Minimum Depth of Cover	2.5m from crown of sewer to grade
Minimum Full Flowing Velocity	0.6m/s
Maximum Full Flowing Velocity	3.0m/s
Extracted from Sections 4 and 6 of the City of Ottawa Sewer Design Guidelines, October 2012.	

Table 6 demonstrates the anticipated peak flow from the proposed development to the sanitary connection within St. Helen's Place. See ***Appendix C*** for associated calculations.

Table 6
Summary of Proposed Wastewater Flows

Design Parameter	Anticipated Sanitary Flow[1] (L/s)
Average Dry Weather Flow Rate	0.16
Peak Dry Weather Flow Rate	0.59
Peak Wet Weather Flow Rate	0.86
1) Based on criteria shown in ***Table 5***	

The estimated sanitary flow based on the ***Site Plan*** provided in ***Drawings/Figures,*** anticipates a peak wet weather flow of ***0.86L/s*** to the St. Helen's Place sanitary connection. This results in an increase of ***0.54 L/s*** compared to existing conditions.

Based on the ***Merivale Road Sewer Investigation***, the most restrictive leg of sewer up to the trunk sewer within Merivale has an available capacity of ***12.8L/s***, therefore, the increase can be accommodated in the downstream system.

4.3 Wastewater Servicing Conclusions

The site is tributary to the Viewmount Drive Trunk sewer and currently the site consists of a single residential unit. Sufficient capacity is available to accommodate the anticipated ***0.54L/s*** peak wet weather flow increase from the proposed development to the downstream system.

The proposed wastewater design conforms to all relevant ***City Standards***.

5.0 STORMWATER MANAGEMENT

A stormwater management strategy has been developed to ensure there is no increased risk of flooding to the surrounding residential neighbourhood due to the development. Hydraulic and hydrological models have been generated to analyze the existing, interim and proposed conditions.

5.1 Model Summary

The hydrology and hydraulics of the proposed stormwater management system were analyzed in EPASWMM using the Dynamic Wave Routing Model.

The following assumptions were made in the preparation for the EPASWMM model:

Hydrology

- Initial abstraction parameters per City of Ottawa standards;
- Horton's infiltration for soil loss, per City guidelines;
- Calculated % impervious area;
- Sub-catchment width measured as perpendicular area to catch basins for longest distance of travel.

- Hydraulics
  - Storage Nodes represent both surface and subsurface components. Each node is assigned an invert elevation that corresponds with the tributary catch basin;
  - "Regular" Node represent either connections to the sewer main or strategic maintenance hole locations. Not all structures have been included in model;
  - All conduits have been assigned a Mannings n = 0.013 except CSP assigned Mannings n = 0.024
  - Orifices are all side mounted, circular and have a 0.61 discharge coefficient.

Refer to a summary of the hydrological parameters used for each sub catchment in the tables below:

Table 7
Summary of Hydrologic Parameters Existing, Interim & Proposed

Drainage Area ID	Total Area (ha)	% Impervious	Width (m)	Slope (%)	Manning's N – Pervious	Manning's N – Impervious	Initial Abstraction – Pervious	Initial Abstraction – Impervious
Existing Condition								
EX12	0.198	57	99	2	0.013	0.25	1.57	4.67
EX13	0.559	57	223.6	2	0.013	0.25	1.57	4.67
EX15	0.063	86	3	2	0.013	0.25	1.57	4.67
EX1-EX2-A1, EX3	0.893	21	60	2	0.013	0.25	1.57	4.67
A2	0.194	13	40	2	0.013	0.25	1.57	4.67
Proposed Condition								
D1-D6	0.701	54	50	2	0.013	0.25	1.57	4.67
EX2	0.041	29	27	2	0.013	0.25	1.57	4.67
EX1, EX3	0.268	47	92	2	0.013	0.25	1.57	4.67
U2	0.075	9	100	2	0.013	0.25	1.57	4.67
Interim Condition								
A1, A3, EX1, EX2	0.894	29	60	2	0.013	0.25	1.57	4.67
All Drainage Areas use Horton's Infiltration Parameters as per the ***City Standard***								

5.2 Existing Stormwater Services

Stormwater runoff from the subject property is tributary to the City of Ottawa sewer system and is located within the Ottawa Central sub-watershed. As such, approvals for proposed developments within this area are under the approval authority of the City of Ottawa.

Flows that influence the watershed in which the subject property is located are further reviewed by the principal authority. The subject property is located within the Ottawa River watershed and is therefore subject to review by the Rideau Valley Conservation Authority (RVCA).

The existing runoff from the subject site is directed to 2 separate outlets; Tower Road and St. Helen's Place. The majority of flow is directed to St. Helen's Place where flow continues north to Tower Road. Both outlets are conveyed through a series of undefined ditch systems, which are generally draining north through the existing residential neighborhood.

DSEL identified three external areas tributary to the development and are identified as EX-1, EX-2 and EX-3 on drawing ***SWM-1***. EX-1 is located west of the subject lands on Withrow Avenue and includes runoff from the residential properties fronting Withrow Avenue as well as the rear yards of Rita Avenue. EX-2 is limited to the surface runoff from the rear yard of 33 St. Helen's Place. EX-3 includes a portion of Withrow Avenue along the south edge of the subject site. Drainage from external areas is directed through the subject site via sheet flow outleting to St. Helen's Place and conveyed to Tower Road.

The external and internal drainage directed to Tower Road results in localized ponding approximately 100m west of the intersection of St. Helen's Place and Tower Road. Based on visual inspection of the area, there are existing catch basins within the southern boulevard of Tower Road at the low point of the road. Information received from the City of Ottawa on the existing sewers within Tower Road indicate no evidence of storm sewers along Tower Road to service the existing CB. The existing CB may pick up flow from smaller storm event, but it is anticipated that major overland flow would be conveyed through the 23 Tower Road property to the north, as indicated on drawing ***SWM-1*** included in ***Drawings/Figures***.

An analysis of varying storm events was conducted to determine the critical event in the existing condition, summarized in ***Table 8*** below:

Table 8
Existing Flow from Subject Site, 100-year Storm Varying Storm Distribution

Storm Distribution	Total Flow to Tower Road (Area A2, A1, EX1, EX2, EX3) (1.087 Ha) (L/s)
3 Hr Chicago	119.1
4 Hr Chicago	124.8
6 Hr Chicago	132.6
12 Hr SCS	129.3

As shown in ***Table 8*** above, the 6 Hr Chicago Distribution results in the highest flow from the site to Tower Road, and therefore, will be used in the existing conditions analysis.

Table 9, below, summarizes the flow from the subject property and adjacent external areas directed to Tower Road & St Helen's Place, refer to ***Appendix D*** for EPASWMM output summary.

Table 9
Existing Flow from Subject Site, 6-Hr Chicago Distribution

	Flow to St. Helen's Place from Area EX1, EX2, EX3, A1 (0.893 Ha)		Flow to Tower Road Flow from Area A2 (0.194 Ha)	
Storm Event	**Flow (L/s)**	**Runoff Volume (cu.m)**	**Flow (L/s)**	**Runoff Volume (cu.m)**
2-Year	6.9	10	6.3	10
5-Year	25.0	60	13.0	20
100-Year	97.8	270	41.7	70

An analysis of peak flow and spill was completed for the existing 300mm CSP within Cleto Avenue. It is anticipated this sewer could be used as potential outlet from the proposed subdivision, therefore, the analysis of the pre-development condition will help inform the design. The 300mm CSP currently receives flow from the front yards of the residential units on the north side of Cleto Ave, approximately ***0.198 Ha***, through a series of landscaped drains. Refer to Drawing ***SWM-1*** in ***Drawings/Figures*** for drainage area directed to the storm sewer within Cleto Avenue.

The capture rate of the existing landscape drains was analyzed assuming a maximum ponding depth of 10cm, using modification to Design Chart 4.19 of the ***MTO Drainage Manual***. The max flow rate per drain is equal to ***12 L/s*** and a total capture of ***60 L/s*** for the 5 drains, refer to ***Appendix D*** for area drain capture calculation. The capture rate has been accounted for in the model with a depth vs flow rating curve, restricting flow to the storm sewer to maximum of ***60 L/s***.

Based on the size (300mm), slope (0.70%) and Manning's N (0.24 per ***MTO Drainage Manual***) of the existing sewer on Cleto Ave., there is a free flowing capacity of ***43.8 L/s***.

A boundary condition equal ground surface at the outlet of the receiving sewer was accounted for in the existing conditions analysis, a conservative approach, assuming that the downstream sewer within Merivale Road is surcharged and spilling to the surface.

The existing 300mm CSP storm sewer was analyzed during the 2, 5 and 100-year events using a 6-hour Chicago distribution. ***Table 10,*** below, summarizes the flow and surcharge at each node analyzed up to Merivale Road.

Table 10
Existing Flow in Cleto Ave Sewer, 6-Hr Chicago Distribution

Storm Event	**2-Year Storm**		**5-Year Storm**		**100-Year Storm**	
Node ID	**Flow (L/s)**	**Surcharge (L/s)**	**Flow (L/s)**	**Node ID**	**Flow (L/s)**	**Surcharge (L/s)**
AD	31.8	5.2	49.9	**AD**	31.8	5.2
STM12	159.2	149.7	159.2	**STM12**	159.2	149.7
STM13	218.0	174.9	218.0	**STM13**	218.0	174.9
STM15	218.0	0	218.0	**STM15**	218.0	0

The inlet capacity of the area drains, which convey flow from Area EX12 to the existing 300mm CSP sewer, were analyzed. As illustrated above, surcharge occurs at nodes STM12 and STM13 during the 100-year storm event. Node flooding also occurs upstream of node AD due to the restriction of ***60 L/s*** from the area drain, noted as AD-D in the EPASWMM model schematic.

Please refer to existing model schematic below for more detail.

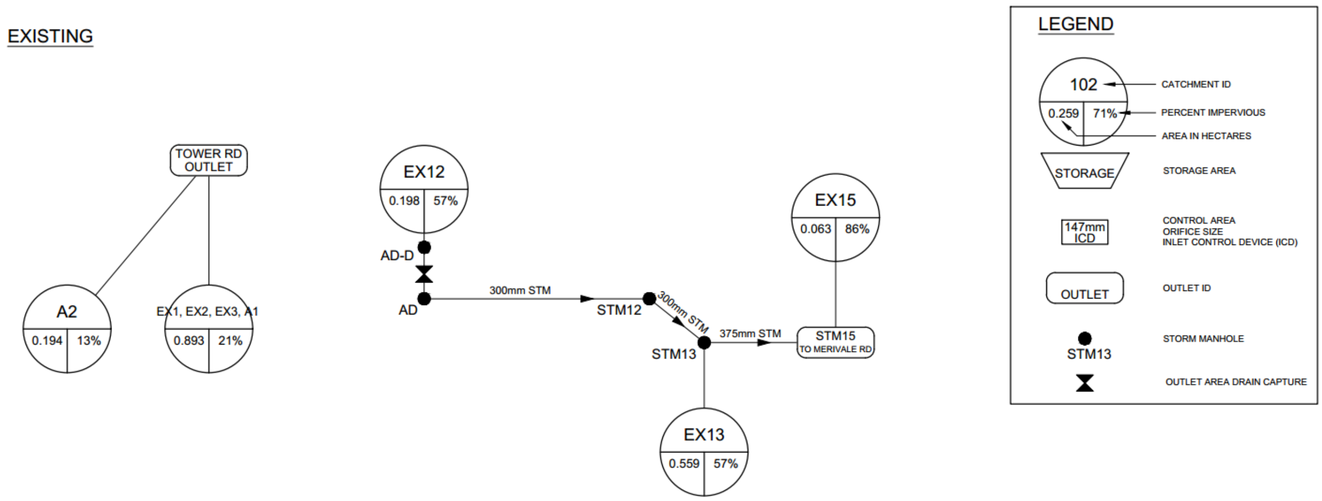

Figure 2: Existing Condition EPASWMM Node Diagram

5.3 Post-development Stormwater Management Targets

Stormwater management requirements for the proposed development were reviewed with the City of Ottawa, and are summarized below:

- Attenuate to a target release rate based on a calculated Rational Method Coefficient no more than 0.5, employing the City of Ottawa IDF parameters for a 2-year storm with a calculated time of concentration equal to or greater than 10 minutes;
- Time of concentration calculated using the Federal Aviation Administration method, slope and length based on the longest flow path to the lowest point within the subject site;
- Flow attenuation is required up to and including the 100-year storm event;
- Ensure no negative impacts to downstream stormwater network from the proposed development;
- Areas to be retained as existing to ensure the edge condition and adjacent landscaping is maintained and will continue to drain as existing thus ensuring no increase in peak flow compared to the existing condition;
- External areas directed to the site are to be accommodated in the stormwater conveyance system.

Based on the drainage area in the proposed condition of ***0.701 ha, 0.29 RC*** and a calculated time of concentration of ***21.2 minutes***, a target release rate of ***28.3 L/s*** is determined, refer to calculation in ***Appendix D*** for details. Based on the analysis of the existing 300mm CSP, proposed to be used as the outlet from the site, the target release rate may be further reduced to ensure no negative impacts to the downstream storm sewer system.

5.4 Proposed Stormwater Management System

5.4.1 Stormwater Management Overview

The stormwater management system is proposed to collect runoff through a series of internal swales and culverts crossing driveways and internal access roads. The ditches and majority of culverts have been sized to convey up to the 100-year storm event. Culverts on south side of the private access road and the culvert crossing under the access road near House 9 will overtop the road in the 100-year storm event and be collected by the roadside ditch on the north side of the road. Storm events in excess of the 100-year storm will utilize the private access road as an overland flow route directed to St. Helen's Place.

The internal roadside ditches are directed to a proposed Ditch Inlet Catch Basin (DICB) at the east edge of the property, adjacent to St. Helen's Place. A storm sewer connection is proposed crossing St. Helen's place, connecting to the existing Area Drain (AD) and existing 300mm CSP storm sewer within Cleto Avenue. An inlet control device (ICD) is proposed at the outlet side of the DICB to control flow to the existing storm sewer. Attenuation is provided to ensure there is not an increase in peak flow or spill within the existing 300mm CSP sewer compared to the existing condition, described in ***Section 5.2***.

The inlet control device will act attenuate runoff in the site within underground storage and surface ponding.

External area draining to the site in the existing condition will continue to drain to the site and be captured by the internal swales system. The swales have been sized to convey the 100-year storm event from the external and internal area, refer to ***Appendix D*** for swale capacity calculations.

It is proposed to service the foundation drainage from the units through the use of sump pumps discharging to surface.

5.4.2 On-Site Quantity Control Analysis

The DICB has been sized to convey the uncontrolled 100-year flow of ***246.9 L/s*** with a maximum head of ***0.22m*** or an elevation of ***97.17m***, refer to calculations in ***Appendix D***. A spill point exists at ***97.35m*** which allows for emergency flow and overflow equal to the external flow into the site to release in the 100-year event.

A ***111mm*** circular inlet control device (ICD) is proposed to control flow from the subject site to the release rate at a high-water level of ***97.42m*** or equal to ***0.88m*** of head above the ICD with a total flow of ***23.7 L/s***.

Underground storage is required to control flow to the allowable release rate. Underground storage is proposed to be provided by Brentwood Storm Tank model numbers ST-18 & ST-30 where cover allows (or equivalent approved by the City of Ottawa Planning Staff). The tanks have been broken up into 4 separate areas summarized below:

Table 11
Storage Tank Summary

Tank Detail	Tank # 1	Tank # 2	Tank # 3	Tank # 4
Length (m) x Width (m)	59 x 3	22.3 x 2.1	8 x 10	6 x 6
Model #	ST-18	ST-18	ST-30	ST-30
Invert (m)	96.59	96.59	96.59	96.59
Obvert (m)	97.05	97.05	97.35	97.35
Minimum Cover (mm)	530	540	650	650
Provided Storage (m^3)	109.8	30.6	73.3	34.2

Further details on the storage capacity and cross sections for the underground storage tanks are included in ***Appendix D.***

In addition to underground storage, surface storage is provided on-site. A total of ***12m³*** of surface ponding is available, surface ponding in rear yards is not accounted for in this calculation.

As discussed in ***Section 1.3***, the City of Ottawa has stressed the importance of retaining the existing edge condition on the adjacent property. To ensure no impact to adjacent landscaping, the grading of the north-west edge of the site has been retained as existing. Alternatively, if this area is re-graded to fully capture stormwater in the on-site system, a retaining wall would be required along the north-west edge impacting the existing edge condition and off-site mature trees.

An analysis of varying storm events was conducted to determine the critical event in the existing condition, summarized in ***Table 12*** below:

Table 12
Proposed Flow from Subject Site, 100-year Storm Varying Storm Distribution

Storm Distribution	Total Flow to Internal Storage (Area D1-D6, EX1, EX2, EX3) (1.01 Ha) (L/s)	Total Storage Required (m^3)
3 Hr Chicago	230.0	259
4 Hr Chicago	237.6	260
6 Hr Chicago	246.9	260
12 Hr SCS	183.3	259

As shown in the above, the 6 Hr Chicago Distribution results in the highest peak flow and storage requirement, and therefore, will be used in the proposed condition analysis.

The storage requirements and flow are summarized in ***Table 13*** below, refer to ***Appendix D*** for EPASWMM output summary.

Table 13
Proposed Storage and Flow from Subject Site, 6-Hr Chicago Distribution

Storm Event	Flow from External Area (EX1, EX2, EX3 0.309 Ha) (L/s)	Flow from ICD (EX1, EX2, EX3, A1, 1.01 Ha) (L/s)	Required Storage (cu.m)	Flow to Tower Road (Area U2, 0.075 Ha)	Flow to St. Helen's (L/s)
2-Year	4.87	8.3	46	3.3	0
5-Year	19.4	12.9	109	11.5	0
100-Year	77.4	23.7	260	31.2	71.5

During the 100-year storm event a storage of ***260m³*** is required to control to a release rate of ***23.7 L/s.***

During storm events up to the 100-year event, the external drainage will be captured and controlled by the ICD. In the 100-year storm event and greater spill will occur to St. Helen's Place. Spill will occur at a rate of ***71.5 L/s*** to St. Helen's place at a maximum head of ***7cm***, the spill is less than the runoff from EX1, EX2 and EX3 of ***77.3 L/s***.

To determine impacts of the proposed flow form the subject site being directed to the existing 300mm CSP storm sewer within Cleto Avenue, an analysis of peak flow and spill was completed for the existing sewer.

5.4.3 External Sewer Analysis

The existing stormwater system was analyzed including the contribution from the subject property and is summarized in ***Table 14,*** below.

Table 14
Proposed Flow in Cleto Ave Sewer, 6-Hr Chicago Distribution

Storm Event	2-Year Storm		5-Year Storm		100-Year Storm	
Node ID	Flow (L/s)	Surcharge (L/s)	Flow (L/s)	Surcharge (L/s)	Flow (L/s)	Surcharge (L/s)
AD	34.09	0	49.9	0	66.9	20.60
STM12	159.2	149.7	159.2	149.7	159.2	152.8
STM13	218.0	174.9	218.0	174.9	259.6	174.9
STM15	218.0	0	218.0	0	218.0	0

Comparing ***Table 14*** to ***Table 10*** there is no change flow to the Merivale Road Sewer at STM15 in the 100-year event. There is no increase in surcharge in the proposed condition at either node AD or STM12 or STM13 in the 100-year storm event.

Please refer to proposed model schematic below for more detail.

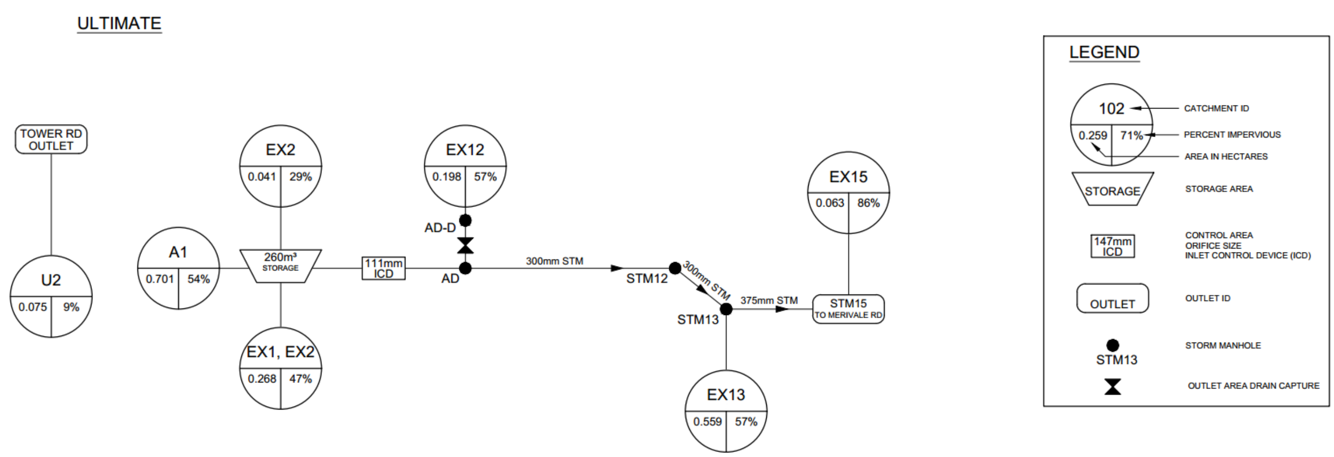

Figure 3: Proposed Condition EPASWMM Node Diagram

5.4.4 Quality Control Requirements

The development employs a rural cross section and an enhanced grass swale as a best management practice, per the ***LID Guide***. The swales have been designed with a minimal slope of 0.50%, which reduces flow velocities within the swale and promotes on-site TSS removal and infiltration. The swale does not employ a perforated pipe subdrain to allow for the maximum infiltration, in accordance with the ***LID Guide.*** Refer to extracted pages from the ***LID Guide*** in ***Appendix D*** which describes design guidance, operation and maintenance and site considerations for the enhanced swale.

Swales have been sized to convey the 100-year event, refer to sizing included in ***Appendix D***.

Full quality controls will be provided by an external facility, per the RVCA correspondence in ***Appendix A***.

5.4.5 Summary of Results

The stormwater management plan is proposed to re-direct flow away from Tower Road and to Cleto Avenue. This results in a reduced peak flow and runoff volume to Tower Road and provides a benefit to residents on Tower Road that currently would have issues with surface ponding and overland flow through their private property.

It is proposed to direct flow from the subject site to the existing 300mm CSP sewer within Cleto Avenue.

The flow to the existing Cleto Avenue storm sewer from the proposed development and runoff from EX12 is summarized graphically below, for the 100-year storm event.

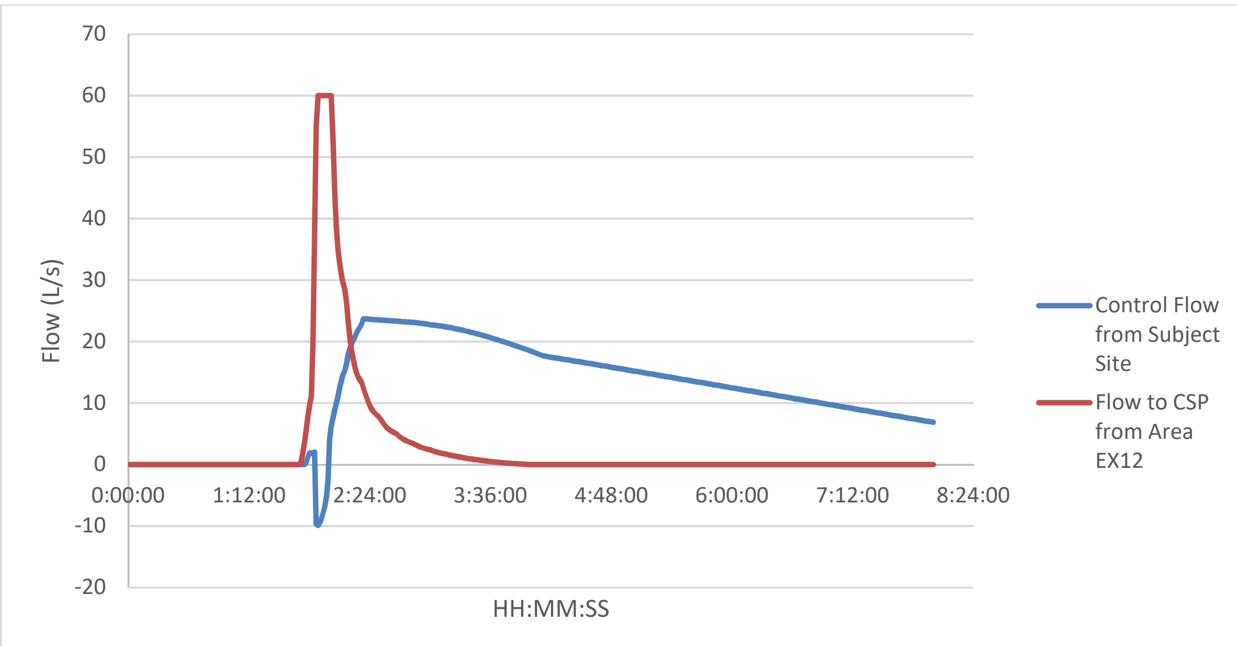

Figure 4: Flow from Subject Site, Runoff from Area EX12, 100-year Storm event 6 Hr Chicago distribution

The above figure shows the flow from EX12 to the existing 300mm CSP. The flow to the sewer is constrained to ***60 L/s,*** equal to the capture rate of the existing area drains. The controlled from the site shows a brief negative inflow. This represents the backwater from the existing system entering the proposed stormwater management system and underground storage chambers. The inflow from the existing system is accounted for in the dynamic model and in the required storage on-site and release rate from the ICD.

5.5 Interim Stormwater Servicing Strategy

It is proposed to develop the site in phases with the 4 units fronting Withrow Ave proceeding before the remainder of the site connected to the private road. It is proposed to provide grading such that the front portion of the units will drain to the Withrow Ave

ROW and the roof and rear yard area will drain south to the future subdivision. It is proposed to provide an interim ditch with a total storage of ***69m³*** to provide quantity control for the increase in imperviousness proposed by the units fronting Withrow Avenue. A triangular outlet in the ditch will detain flow before using existing drainange patterns to discharge to St. Helen's Place. Refer to ***SWM-3*** in ***Drawings/Figures*** for interim drainage areas and interim stormwater management plan and ***Appendix D*** for interim model output files.

The flows in the interim condition are summarized below:

Table 15
Flow during Interim Condition, 6-Hr Chicago Distribution

Storm Event	Flow to St. Helen's Place from Area EX1, EX2, EX3, A1 (0.894 Ha)	
	Flow (L/s)	**Interim Storage Volume (m^3)**
2-Year	4.2	16
5-Year	21.9	32
100-Year	94.3	69

As shown in ***Table 15*** above, no increase to flow to St. Helen's Place will result due to the construction of the 4 lots fronting Withrow Avenue.

Please refer to interim model schematic below for more detail.

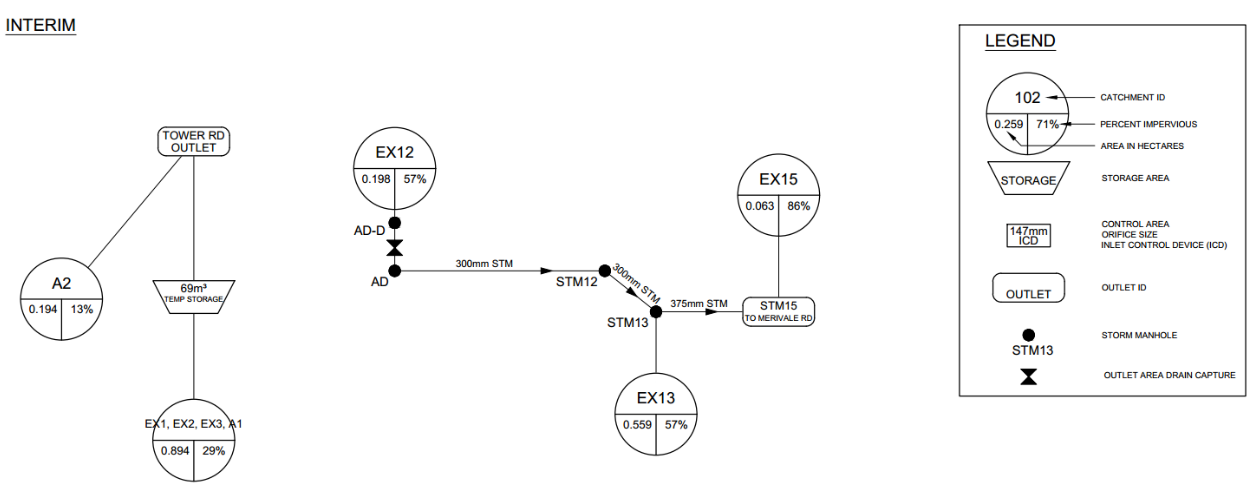

Figure 5: Interim Condition EPASWMM Node Diagram

5.6 Stormwater Servicing Conclusions

Existing conditions result in flow from the subject property to Tower Road and St. Helen's Place. A target release rate of ***28.3 L/s*** was established based on the quantity control criteria from City of Ottawa pre-consultation. Existing areas to be retained to ensure the edge condition and adjacent landscaping is maintained will continue to drain as existing. An external capacity analysis was completed for the adjacent Cleto Avenue storm sewer.

Proposed runoff to the Cleto Avenue storm sewer will be controlled through the use of a ***111mm*** inlet control device to control flow to a release rate of ***23.7 L/s***. The reduced release rate compared to the allowable is required to ensure no negative impacts to the downstream 300mm CSP sewer within Cleto Avenue due to the increase in flow from the subject site. Underground and surface storage is proposed to meet the required ***260m^3*** of storage to attenuate flow.

The flow from the site can discharge to the existing sewer within Cleto Ave without any increase in risk of flooding to the downstream system.

Best management practices in the form of enhanced grassed swales are provided on-site to promote TSS removal and infiltration.

The proposed stormwater design conforms to all relevant ***City Standards*** and Policies for approval.

6.0 UTILITIES

Utility servicing will be coordinated with the individual utility companies prior to site development.

7.0 EROSION AND SEDIMENT CONTROL

Soil erosion occurs naturally and is a function of soil type, climate and topography. The extent of erosion losses is exaggerated during construction where vegetation has been removed and the top layer of soil becomes agitated.

Prior to topsoil stripping, earthworks or underground construction, erosion and sediment controls will be implemented and will be maintained throughout construction.

Silt fence will be installed around the perimeter of the site and will be cleaned and maintained throughout construction. Silt fence will remain in place until the working areas have been stabilized and re-vegetated.

Catch basins will have SILTSACKs installed under the grate during construction to protect from silt entering the storm sewer system.

A mud mat will be installed at the construction access, in order to prevent mud tracking onto adjacent roads.

Erosion and sediment controls must be in place during construction. The following recommendations to the contractor will be included in contract documents:

- Limit extent of exposed soils at any given time;
- Re-vegetate exposed areas as soon as possible;
- Minimize the area to be cleared and grubbed;
- Protect exposed slopes with plastic or synthetic mulches;
- Install silt fence to prevent sediment from entering existing ditches;
- No refueling or cleaning of equipment near existing watercourses;
- Provide sediment traps and basins during dewatering;
- Install filter cloth between catch basins and frames;
- Plan construction at proper time to avoid flooding;
- Establish material stockpiles away from watercourses, so that barriers and filters may be installed.

The contractor will, at every rainfall, complete inspections and guarantee proper performance. The inspection is to include:

- Verification that water is not flowing under silt barriers;
- Clean and change filter cloth at catch basins.

8.0 CONCLUSION AND RECOMMENDATIONS

David Schaeffer Engineering Ltd. (DSEL) has been retained to prepare a Functional Servicing and Stormwater Management Report in support of the Zoning By-Law Amendment and Plan of Subdivision at 21 Withrow Avenue. The preceding report outlines the following:

- Based on boundary conditions provided by the City, the existing municipal water infrastructure is capable of providing the proposed development with water within the City's required pressure range;
- The EPANET water distribution model confirmed adequate pressure exists within fire hydrants during fire flow, and within the system for the Average Day, Max Day + Fire Flow and Peak Hour scenarios;
- The proposed development is anticipated to have a peak wet weather flow of ***0.86 L/s*** directed to the St. Helen's Place sanitary sewer. Based on the sanitary analysis that was conducted, the existing municipal sewer infrastructure has sufficient capacity to support the development;
- Based on the ***City Standards***, the proposed development will attenuate flow to a release rate of ***23.7 L/s*** and will not have an impact on peak flows to the storm sewer within Cleto Ave;
- It is proposed to attenuate flow through underground and surface storage. It is anticipated that ***260m³*** of onsite storage will be required to attenuate flow to the established release rate above;
- Grassed swales will be provided to promote TSS removal and infiltration, full quality controls will be provided by off-site infrastructure, per RVCA correspondence.

Prepared by,
David Schaeffer Engineering Ltd.

Per: Steven L. Merrick, P.Eng.

Reviewed by,
David Schaeffer Engineering Ltd.

Per: Adam D. Fobert, P.Eng.

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APPENDIX A

Pre-Consultation

Genavieve Melatti

From:	Genavieve Melatti
Sent:	Thursday, June 7, 2018 10:52 AM
To:	Genavieve Melatti
Subject:	FW: 21 WIthrow - Boundary condition request
Attachments:	21 Withrow May 2018.pdf

From: Schaeffer, Gabrielle [mailto:gabrielle.schaeffer@Ottawa.ca]
Sent: Thursday, May 31, 2018 9:21 AM
To: Steve Merrick <SMerrick@dsel.ca>
Subject: RE: 21 WIthrow - Boundary condition request

Hi Steve,

The following are boundary conditions, HGL, for hydraulic analysis 21 Withrow (zone ME), assumed to be connected to the 152mm on St-Helens (see attached PDF for location).

Minimum HGL = 158.4m

Maximum HGL = 163.5m; the maximum pressure is estimated to be above 80 psi. A pressure check at completion of construction is recommended to determine if pressure control is required.

Max Day + Fire Flow (100 L/s) = 139.0m

These are for current conditions and are based on computer model simulation.

Disclaimer: The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions. The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation.

Regards,
Gabrielle

From: Schaeffer, Gabrielle
Sent: Wednesday, May 30, 2018 9:22 AM
To: 'Steve Merrick' <SMerrick@dsel.ca>
Subject: RE: 21 WIthrow - Boundary condition request

No, that technical memo only applies to the sewer design guidelines. No memo has been issued regarding this topic for the water distribution guidelines.
I will send the boundary conditions request with this information below:

	L/min	L/s
Avg. Daily	11.7	0.20
Max Day	57.2	0.95
Peak Hour	86.3	1.44

RFF = 6000 L/min

Regards,
Gabrielle

From: Steve Merrick <SMerrick@dsel.ca>
Sent: Wednesday, May 30, 2018 8:55 AM
To: Schaeffer, Gabrielle <gabrielle.schaeffer@Ottawa.ca>
Subject: RE: 21 WIthrow - Boundary condition request

Good question, our unit counts have not changed, however, the revised technical memo to the sewer design guidelines indicates 280 L/p/day for residential demand. Should the same be applied to water demand? Could you confirm what the City would like to see going forward?

Thanks!

Steve Merrick, P.Eng.
Project Manager / Intermediate Designer

DSEL
david schaeffer engineering ltd.

120 Iber Road, Unit 103
Stittsville, ON K2S 1E9

phone: (613) 836-0856 ext. 561
cell: (613) 222-7816
email: smerrick@DSEL.ca

From: Schaeffer, Gabrielle [mailto:gabrielle.schaeffer@Ottawa.ca]
Sent: Wednesday, May 30, 2018 8:48 AM
To: Steve Merrick <SMerrick@dsel.ca>
Subject: RE: 21 WIthrow - Boundary condition request

Hi Steve,

Attached is Cleto's P&P.

I needed the RFF before asking for revised boundary conditions. I assume the domestic demands remain the same in table below from your previous email?

	L/min	L/s
Avg. Daily	11.7	0.20
Max Day	57.2	0.95

Peak Hour	86.3	1.44

Regards,
Gabrielle

From: Steve Merrick <SMerrick@dsel.ca>
Sent: Tuesday, May 29, 2018 5:20 PM
To: Schaeffer, Gabrielle <gabrielle.schaeffer@Ottawa.ca>
Subject: RE: 21 WIthrow - Boundary condition request

Hi Gabrielle,

I wanted to follow up on my original request earlier this month, did you receive anything back from the water resources group?

Thank you for the copy of the revised guidelines. Based on the updated clarification that if the building exceeds 67% brick/masonary veneer that ordinary construction can be contemplated for the FUS. This clarification results in the new and existing buildings to be classified as ordinary construction and therefore the 3.0m separation would not apply. Based on this a revised FUS calculation, the highest fire flow resulted in 6,000 L/min maximum fire flow. We will ensure we follow the guide which outlines hydrant spacing for dead end connections and the max flow from each hydrant which you have indicated below.

As discussed in the meeting may you please forward on the as-built information for Cleto Ave and specifically the CSP as when we tried to request this information from the Information Centre we were told it was not available.

Thanks in advance,

Steve Merrick, P.Eng.
Project Manager / Intermediate Designer

DSEL
david schaeffer engineering ltd.

120 Iber Road, Unit 103
Stittsville, ON K2S 1E9

phone: (613) 836-0856 ext. 561
cell: (613) 222-7816
email: smerrick@DSEL.ca

From: Schaeffer, Gabrielle [mailto:gabrielle.schaeffer@Ottawa.ca]
Sent: Monday, May 7, 2018 10:41 AM

To: Steve Merrick <SMerrick@dsel.ca>
Subject: RE: 21 WIthrow - Boundary condition request

Hi Steve,

I've passed your request along to our water group. Please provide me with your FUS calcs.

Note, a more recent technical bulletin came out providing guidance on FUS calculations and other water related items. I've attached it for you read through and apply to this file. One item to note is that the maximum flow from one hydrant is about 95 L/s. Please review the FUS guidance before providing your FUS calcs.

Thanks,
Gabrielle

From: Steve Merrick <SMerrick@dsel.ca>
Sent: Monday, May 07, 2018 9:25 AM
To: Schaeffer, Gabrielle <gabrielle.schaeffer@Ottawa.ca>
Subject: FW: 21 WIthrow - Boundary condition request

Hi Gabrielle,

Thank you for meeting with us last week. See below our first boundary condition request sent to the City. A subsequent boundary condition request was made to determine pressure at 8,000L/min.

As shown below the pressure provided at minimum pressure was less than 10,000 L/min. Can you confirm that these boundary conditions are still valid for the area? I have summarized demand and fire flow below:

	L/min	L/s
Avg. Daily	11.7	0.20
Max Day	57.2	0.95
Peak Hour	86.3	1.44

Fire flow = 10,000 L/min

Steve Merrick, P.Eng.
Project Manager / Intermediate Designer

DSEL
david schaeffer engineering ltd.

120 Iber Road, Unit 103
Stittsville, ON K2S 1E9

phone: (613) 836-0856 ext. 561
cell: (613) 222-7816
email: smerrick@DSEL.ca

From: Balima, Nadege <Nadege.Balima@ottawa.ca>
Sent: September 11, 2017 9:17 AM
To: Brandon Chow <BChow@dsel.ca>
Subject: RE: 21 WIthrow - Boundary condition request

Good morning Brandon,
As per our phone conversation last week, the watermain on Rita and St Helen are in two different watermain pressure zones and cannot be interconnected. Below/attached are therefore the results of your request for option 1 only. I'm also providing a snapshot of the pressure zones limits in that area for your information (the blue area is the 2W zone and the purple area is the Meadowlands Zone).

The following are boundary conditions, HGL, for hydraulic analysis 21 Withrow (zone ME), assumed to be connected to the 152mm on St-Helens (see attached PDF for location).

Minimum HGL = 158.4m

Maximum HGL = 163.5m; the maximum pressure is estimated to be above 80 psi. A pressure check at completion of construction is recommended to determine if pressure control is required.

Available Flow = 155 L/s assuming a residual of 20 psi and a ground elevation of 97.5m

These are for current conditions and are based on computer model simulation.

Disclaimer: The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions. The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation.

Please let me know if you have questions.
Regards,

Nadège Balima, P.Eng., M.P.M., LEED Green Assoc.
Project Manager, Infrastructure Approvals
Development Review Services (West)
613.580.2424 ext. 13477

From: Brandon Chow [mailto:BChow@dsel.ca]
Sent: Thursday, August 31, 2017 5:43 PM
To: Balima, Nadege <Nadege.Balima@ottawa.ca>
Subject: 21 WIthrow - Boundary condition request

Hi Nadege,

We would like to request boundary conditions for 2 options for the proposed development at 21 Withrow Ave. The proposed development will consist of 14 single family homes. 10 units will be serviced from a proposed 150mm watermain within the site and 4 units will be serviced from the existing 150mm watermain within Withrow Ave.
See attached figures of the 2 options for connection point(s).

We hope that you can provide the maximum flow from the 150mm watermain in St. Helene's Place and in Rita Avenue using a fire flow of 10,000 L/m.

The anticipated water demands are summarized below:

	L/min	L/s
Avg. Daily	11.7	0.20
Max Day	57.2	0.95
Peak Hour	86.3	1.44

Thank you,

Brandon Chow
Project Coordinator / Junior Designer

DSEL
david schaeffer engineering ltd.

120 Iber Road, Unit 103
Stittsville, ON K2S 1E9

phone: (613) 836-0856 ext.532
fax: (613) 836-7183
email: bchow@DSEL.ca

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Boundary Condition for 21 Withrow

Hannah Pepper

Subject: FW: 21 Withrow - Infrastructure Follow up

From: Bill Holzman [mailto:b.holzman@holzmanconsultants.com]
Sent: Wednesday, June 28, 2017 9:21 AM
To: joeytheberge@thebergehomes.com
Cc: Reid Shepherd <r.shepherd@holzmanconsultants.com>; Adam Fobert <AFobert@dsel.ca>
Subject: Fwd: 21 Withrow - Infrastructure Follow up

fyi,
Bill

Begin forwarded message:

From: "Dickinson, Mary" <mary.dickinson@ottawa.ca>
Subject: FW: 21 Withrow - Infrastructure Follow up
Date: June 28, 2017 at 8:32:55 AM EDT
To: Bill Holzman <b.holzman@holzmanconsultants.com>

Bill
Please see below the detailed civil notes that make up part of the pre-consultation follow up for 21 Withrow.
Please let Nadege and/or me know if you have any questions.
Thanks
Mary

Mary Dickinson, MCIP, RPP
Planner
Development Review West
Urbaniste
Examen des demandes d'aménagement ouest

City of Ottawa | Ville d'Ottawa
613.580.2424 ext./poste 13923
ottawa.ca/planning / ottawa.ca/urbanisme

From: Balima, Nadege
Sent: Tuesday, June 27, 2017 4:47 PM
To: Dickinson, Mary
Subject: 21 Withrow - Infrastructure Follow up

Hi Mary,
As discussed, please find below my notes on the site at 21 Withrow.

1. The proponent may proceed with severance of lots along Withrow while ensuring that each lot:
    a) Maintains a size and imperviousness similar to what was originally planned in the subdivision for this area;
    b) Can be serviced independently for water and sanitary;
    c) Is graded to provide positive drainage and can be drained while following existing grading and drainage with no adverse effects on neighboring lots.
2. A preliminary high level stormwater analysis should be performed prior to the severance to ensure that development of the site (subdivision) can occur as planned in the future without any adverse impacts on neighboring properties. The following should be considered for storm flows:
    a) The pre-development runoff coefficient or a maximum equivalent 'C' of 0.5, whichever is less (§ 8.3.7.3 of the Ottawa Sewer Design Guidelines).
    b) A calculated time of concentration (Cannot be less than 10 minutes)
    c) Flows from the site can be accommodated by the roadside ditches without adverse impact on neighboring properties
    d) Post-development flows should be controlled to pre-developed flows for both the 2 and 100 year events. (Note that although a storm water management pond is not expected for the site, best management practices to minimize the amount of flow from the site should be incorporated in the design;)
    e) Both the interim (severance only) and the ultimate (severance and subdivision on private street) can function independently without adverse impacts on the neighboring properties and existing outlets/ditches;
3. A servicing plan, grading and drainage plan, erosion and sediment control plan as well as the high level stormwater analysis will need to be provided at the time of application for severance;
4. In addition to the information in point 3 for the subdivision, a geotechnical report, servicing and stormwater management brief will need to be submitted as part of the subdivision application;
5. If the rural type cross-section is maintained for the private street, this should also be discussed in the stormwater analysis to be submitted at the time of severance;
6. Note that water looping will likely be required due to low pressure in the area and district metering area chamber may be required on the private street;
7. The sanitary sewer connection for the future subdivision may come from Rita Avenue;
8. Keep in mind that for the private road, MOECC environmental compliance approval may be required if the lots are under different ownership (no condominium ownership).
9. With regards to the watermain analysis, you may request water boundary conditions for your watermain calculations. Requests must include the location of the service and the expected loads required by the proposed development. The following information is required:
    i. Location of service (on a plan)
    ii. Type of development and amount of fire flow required (as per FUS, 1999).
    iii. Average daily demand: ___ l/s.
    iv. Maximum daily demand: ___l/s.
    v. Maximum hourly daily demand: ___ l/s.

You may also wish to check the City's record drawings and utility plans in case there is additional plans or reports available. To purchase available documentation, please contact the City's Information Centre by email at InformationCentre@ottawa.ca or by phone at (613) 580-2424 x.44455.

Please let me know if you have any further questions.
Regards,

Nadège Balima, P.Eng., M.P.M., LEED Green Assoc.
Project Manager, Infrastructure Approvals
Development Review Services (West)
Gestionnaire de Projet, Approbation des demandes en Infrastructures
Services d'examen des demandes d'aménagement (Ouest)
Planning, Infrastructure and Economic Development Department
Service de planification, d'Infrastructure et de Développement économique
City of Ottawa | Ville d'Ottawa
613.580.2424 ext.| poste 13477
ottawa.ca/planning | ottawa.ca/urbanisme

" Nous n'héritons pas de la terre de nos ancêtres, nous l' empruntons à nos enfants". Saint-Exupéry
" We do not inherit the land from our forefathers, we borrow it from our children". Saint-Exupéry

Hannah Pepper

Subject: FW: Stormwater Quality Controls - 21 Withrow Avenue

From: Eric Lalande [mailto:eric.lalande@rvca.ca]
Sent: October 13, 2017 4:24 PM
To: Hannah Pepper <HPepper@dsel.ca>
Subject: RE: Stormwater Quality Controls - 21 Withrow Avenue

Hi Hanna,

The RVCA is looking for 80% TSS removal as part of quality control for the project. This can be accomplished either through on-site controls or off site systems prior to releasing in to a watercourse. Please outline if any quality controls are proposed to be implemented on-site. The intervening pond in Gibley Park outlets back into the municipal sewer system connecting to the Rideau River. While the travel distance should be sufficient to handle quality control for the proposal, best management practices are encouraged, where feasible.

Thanks,

Eric Lalande, MCIP, RPP
Planner, Rideau Valley Conservation Authority
613-692-3571 x1137

From: Jamie Batchelor
Sent: Wednesday, October 11, 2017 2:34 PM
To: Eric Lalande <eric.lalande@rvca.ca>
Subject: FW: Stormwater Quality Controls - 21 Withrow Avenue

From: Hannah Pepper [mailto:HPepper@dsel.ca]
Sent: Wednesday, October 11, 2017 1:55 PM
To: Jamie Batchelor <jamie.batchelor@rvca.ca>
Subject: FW: Stormwater Quality Controls - 21 Withrow Avenue

Hi Jamie,

Just wanted to follow up on the below?

Thanks!

Hannah Pepper, EIT.
Project Coordinator / Junior Designer

DSEL
david schaeffer engineering ltd.

120 Iber Road, Unit 103
Stittsville, ON K2S 1E9

phone: (613) 836-0856 ext. 569
fax: (613) 836-7183
email: hpepper@DSEL.ca

From: Hannah Pepper
Sent: October 4, 2017 11:24 AM
To: 'jamie.batchelor@rvca.ca' <jamie.batchelor@rvca.ca>
Subject: Stormwater Quality Controls - 21 Withrow Avenue

Hi Jamie,

Could you please confirm if stormwater quality controls would be necessary for a contemplated development with the following details?

The property is located at 21 Withrow Avenue and would include the construction of 13 townhome units, with the retention of one existing single family townhome. This is outlined in the attached site plan.

Stormwater from the new buildings will discharge into proposed ditches and then to existing sewers within Cleto Avenue, which drains to storm sewers within Merivale Road and then to a pond in Gibley Park. Total flow path to the pond is about 900m; please see the attached figure.

Stormwater storage onsite would be through underground storage. There is no proposed underground parking and there will be surface parking from proposed driveways for each home.

Thanks!

Hannah Pepper, EIT.
Project Coordinator / Junior Designer

DSEL
david schaeffer engineering ltd.

120 Iber Road, Unit 103
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Steve Merrick

From: Schaeffer, Gabrielle <gabrielle.schaeffer@Ottawa.ca>
Sent: Monday, February 12, 2018 2:13 PM
To: Steve Merrick
Cc: Dickinson, Mary
Subject: RE: 21 Withrow - Comments

Hi Steve,

I don't have the file in front of me today, but to answer your question now instead of wait, here is my review of my comments and the applicable changes. These changes are based on an internal discussion regarding the severance lots and their relation to the subdivision lots.

Since the Withrow lots are not part of the subdivision development:

- Comment #8 does not apply
- Change comment #58 to read "Add existing storm infrastructure within St. Helen's Place, Cleto and Tower ROWs (i.e. swale, culverts, etc) if not already done so."
- Delete the general section comment of comment #82
- Change comment #82a to read: "A discussion is required regarding how flows from the property (external tributary areas and subdivision lots) can be accommodated by the sewers and/or roadside ditches without adverse impact on neighbouring properties."
- Change comment #82b to read: "Part of neighbouring severance lots are to drain onto subdivision property, specifically roof and rear yard drainage. Discuss how interim conditions (i.e. developed severance lots while subdivision lots have not) will function without causing any adverse impacts to neighbouring properties and existing outlets/ditches. Also, discuss how the ultimate design (i.e. severance lots and subdivision lots both developed) will function without causing any adverse impacts to neighbouring properties and existing outlets/ditches.
- Change comment #82c to read: "A downstream analysis of the connecting STM sewer systems is to be provided." "The Withrow STM system is to be assessed for any impacts caused by the proposed severance lots" sentence can be deleted.

After our conversation last week and re-reading the comments, please make the additional changes to my comments:

- Change comment #53 to: Edit the text to 'or equivalent approved by City of Ottawa Planning Staff'.
- Change comment #66 to "Submit a revised request for Boundary Conditions once comments #64 and #65 have been addressed."
- Change comment #92 to read "External drainage entering the proposed storm system is to be accounted for in the design and calculations. Either a full by-pass system (i.e. dedicated swale and outlet) or a release of the external drainage from the proposed system to the existing drainage path is required. An additional option would be to outlet through the proposed connection to the Cleto storm sewer system ensuring to adverse impacts downstream."

Regards,
Gabrielle

From: Steve Merrick [mailto:SMerrick@dsel.ca]
Sent: Monday, February 12, 2018 9:00 AM
To: Schaeffer, Gabrielle <gabrielle.schaeffer@Ottawa.ca>
Subject: 21 Withrow - Comments

Hi Gabrielle,

Good to chat with you on Friday about some of the attached comments. I recall you discussing some of the comments may not be applicable after your meeting with Justin Armstrong. Can you indicate which of these comments are no longer applicable?

Let me know if you find out anything about recent flooding in this area so we can be prepared for the meeting on Thursday. See you then.

Thanks!

Steve Merrick, P.Eng.
Project Manager / Intermediate Designer

DSEL
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APPENDIX B

Water Supply

Water Demand Design Flows per Unit Count
City of Ottawa - Water Distribution Guidelines, July 2010

Domestic Demand

Type of Housing	Per / Unit	Units	Pop
Single Family	3.4	1	4
Semi-detached	2.7		0
Townhouse	2.7		0
Apartment			0
Bachelor	1.4		0
1 Bedroom	1.4		0
2 Bedroom	2.1		0
3 Bedroom	3.1		0
Average	1.8		0

	Pop	Avg. Daily		Max Day		Peak Hour	
		m^3/d	L/min	m^3/d	L/min	m^3/d	L/min
Total Domestic Demand	4	1.4	1.0	13.3	9.2	20.0	13.9

Institutional / Commercial / Industrial Demand

Property Type	Unit Rate		Units	Avg. Daily		Max Day		Peak Hour	
				m^3/d	L/min	m^3/d	L/min	m^3/d	L/min
Commercial floor space	2.5	$L/m^2/d$		0.00	0.0	0.0	0.0	0.0	0.0
Office	75	$L/9.3m^2/d$		0.00	0.0	0.0	0.0	0.0	0.0
Industrial - Light	35,000	L/gross ha/d		0.00	0.0	0.0	0.0	0.0	0.0
Industrial - Heavy	55,000	L/gross ha/d		0.00	0.0	0.0	0.0	0.0	0.0
			Total I/CI Demand	0.0	0.0	0.0	0.0	0.0	0.0
			Total Demand	**1.4**	**1.0**	**13.3**	**9.2**	**20.0**	**13.9**

Water Demand Design Flows per Unit Count
City of Ottawa - Water Distribution Guidelines, July 2010

Domestic Demand

Type of Housing	Per / Unit	Units	Pop
Single Family	3.4	14	48
Semi-detached	2.7		0
Townhouse	2.7		0
Apartment			0
Bachelor	1.4		0
1 Bedroom	1.4		0
2 Bedroom	2.1		0
3 Bedroom	3.1		0
Average	1.8		0

	Pop	Avg. Daily		Max Day		Peak Hour	
		m^3/d	L/min	m^3/d	L/min	m^3/d	L/min
Total Domestic Demand	48	16.8	11.7	82.3	57.2	124.3	86.3

Institutional / Commercial / Industrial Demand

Property Type	Unit Rate		Units	Avg. Daily m^3/d	Avg. Daily L/min	Max Day m^3/d	Max Day L/min	Peak Hour m^3/d	Peak Hour L/min
Commercial floor space	2.5	$L/m^2/d$		0.00	0.0	0.0	0.0	0.0	0.0
Office	75	$L/9.3m^2/d$		0.00	0.0	0.0	0.0	0.0	0.0
Industrial - Light	35,000	L/gross ha/d		0.00	0.0	0.0	0.0	0.0	0.0
Industrial - Heavy	55,000	L/gross ha/d		0.00	0.0	0.0	0.0	0.0	0.0
			Total I/CI Demand	0.0	0.0	0.0	0.0	0.0	0.0
			Total Demand	**16.8**	**11.7**	**82.3**	**57.2**	**124.3**	**86.3**

Fire Flow Estimation per Fire Underwriters Survey
Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C 1 *Type of Construction Coefficient per FUS Part II, Section 1*
A 345.0 m^2 *Total floor area based on FUS Part II section 1*

Fire Flow 4086.3 L/min
4000.0 L/min *rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible -15%

Fire Flow **3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered 0%

Reduction **0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	3.1m-10m	18.36	2	37	16%
S	Ordinary - Unprotected Openings	10.1m-20m	18.93	2	38	11%
E	Ordinary - Unprotected Openings	10.1m-20m	10.79	2	22	10%
W	Ordinary - Unprotected Openings	30.1m-45m	8.3	2	17	5%
		% Increase				**42%** *value not to exceed 75%*

Increase **1428.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow 4828.0 L/min *fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
5000.0 L/min *rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey
Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C 1 *Type of Construction Coefficient per FUS Part II, Section 1*
A 374.1 m^2 *Total floor area based on FUS Part II section 1*

Fire Flow 4255.1 L/min
4000.0 L/min *rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible -15%

Fire Flow **3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered 0%

Reduction **0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	3.1m-10m	13.88	2	28	15%
S	Ordinary - Unprotected Openings	0m-3m	15.03	2	31	22%
E	Ordinary - Unprotected Openings	10.1m-20m	14.42	2	29	10%
W	Ordinary - Unprotected Openings	10.1m-20m	14.24	2	29	10%
		% Increase				**57%** *value not to exceed 75%*

Increase **1938.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow 5338.0 L/min *fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
5000.0 L/min *rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey
Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C	1		*Type of Construction Coefficient per FUS Part II, Section 1*
A	292.7	m^2	*Total floor area based on FUS Part II section 1*

Fire Flow	3764.0 L/min	
	4000.0 L/min	*rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible	-15%
Fire Flow	**3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered	0%
Reduction	**0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	0m-3m	15.34	2	31	22%
S	Ordinary - Unprotected Openings	0m-3m	14.24	2	29	21%
E	Ordinary - Unprotected Openings	10.1m-20m	9.8	2	20	10%
W	Ordinary - Unprotected Openings	10.1m-20m	10.97	2	22	10%
		% Increase				**63%** *value not to exceed 75%*

Increase	**2142.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow	5542.0 L/min	*fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
	6000.0 L/min	*rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey

Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C	1		*Type of Construction Coefficient per FUS Part II, Section 1*
A	341.7	m^2	*Total floor area based on FUS Part II section 1*

Fire Flow	4066.6 L/min	
	4000.0 L/min	*rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible	-15%
Fire Flow	**3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered	0%
Reduction	**0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	0m-3m	20.34	2	41	22%
S	Ordinary - Unprotected Openings	10.1m-20m	18.64	2	38	11%
E	Ordinary - Unprotected Openings	3.1m-10m	8.25	2	17	15%
W	Ordinary - Unprotected Openings	10.1m-20m	9.93	2	20	10%
		% Increase				**58%** *value not to exceed 75%*

Increase	**1972.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow	5372.0 L/min	*fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
	5000.0 L/min	*rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey
Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C	1		*Type of Construction Coefficient per FUS Part II, Section 1*
A	453.3	m^2	*Total floor area based on FUS Part II section 1*

Fire Flow	4683.8	L/min	
	5000.0	**L/min**	*rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible -15%

Fire Flow	**4250.0**	**L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered 0%

Reduction	**0**	**L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	20.1m-30m	18.49	2	37	7%
S	Ordinary - Unprotected Openings	20.1m-30m	19.38	2	39	7%
E	Ordinary - Unprotected Openings	3.1m-10m	13.43	2	27	15%
W	Ordinary - Unprotected Openings	3.1m-10m	12.12	2	25	15%
		% Increase				**44%** *value not to exceed 75%*

Increase	**1870.0**	**L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow	6120.0	L/min	*fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
	6000.0	**L/min**	*rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey

Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C	1		*Type of Construction Coefficient per FUS Part II, Section 1*
A	300.3	m^2	*Total floor area based on FUS Part II section 1*

Fire Flow	3812.7 L/min	
	4000.0 L/min	*rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible -15%

Fire Flow **3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered 0%

Reduction **0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	20.1m-30m	10.99	2	22	6%
S	Ordinary - Unprotected Openings	10.1m-20m	9.73	2	20	10%
E	Ordinary - Unprotected Openings	0m-3m	15.82	2	32	22%
W	Ordinary - Unprotected Openings	0m-3m	14.76	2	30	21%
		% Increase				**59%** *value not to exceed 75%*

Increase **2006.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow	5406.0 L/min	*fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
	5000.0 L/min	*rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey
Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C	1		*Type of Construction Coefficient per FUS Part II, Section 1*
A	300.3	m^2	*Total floor area based on FUS Part II section 1*

Fire Flow	3812.7 L/min	
	4000.0 L/min	*rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible -15%

Fire Flow	**3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered 0%

Reduction	**0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	20.1m-30m	10.99	2	22	6%
S	Ordinary - Unprotected Openings	10.1m-20m	9.73	2	20	10%
E	Ordinary - Unprotected Openings	0m-3m	15.82	2	32	22%
W	Ordinary - Unprotected Openings	0m-3m	14.76	2	30	21%
		% Increase				**59%** *value not to exceed 75%*

Increase	**2006.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow	5406.0 L/min	*fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
	5000.0 L/min	*rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey

Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C 1 *Type of Construction Coefficient per FUS Part II, Section 1*
A 292.6 m^2 *Total floor area based on FUS Part II section 1*

Fire Flow	3763.5 L/min	
	4000.0 L/min	*rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible -15%

Fire Flow	**3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered 0%

Reduction	**0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	20.1m-30m	10.99	2	22	6%
S	Ordinary - Unprotected Openings	10.1m-20m	9.73	2	20	10%
E	Ordinary - Unprotected Openings	0m-3m	14.76	2	30	21%
W	Ordinary - Unprotected Openings	0m-3m	15.82	2	32	22%
		% Increase				**59%** *value not to exceed 75%*

Increase	**2006.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow	5406.0 L/min	*fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
	5000.0 L/min	*rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey
Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C	1		*Type of Construction Coefficient per FUS Part II, Section 1*
A	300.3	m^2	*Total floor area based on FUS Part II section 1*

Fire Flow	3812.7 L/min	
	4000.0 L/min	*rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible -15%

Fire Flow **3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered 0%

Reduction **0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	20.1m-30m	10.99	2	22	6%
S	Ordinary - Unprotected Openings	10.1m-20m	9.73	2	20	10%
E	Ordinary - Unprotected Openings	0m-3m	15.82	2	32	22%
W	Ordinary - Unprotected Openings	0m-3m	14.76	2	30	21%
		% Increase				**59%** *value not to exceed 75%*

Increase **2006.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow	5406.0 L/min	*fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
	5000.0 L/min	*rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey
Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C 1 *Type of Construction Coefficient per FUS Part II, Section 1*
A 292.6 m^2 *Total floor area based on FUS Part II section 1*

Fire Flow	3763.5 L/min	
	4000.0 L/min	*rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible -15%

Fire Flow	**3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered 0%

Reduction	**0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	20.1m-30m	10.99	2	22	6%
S	Ordinary - Unprotected Openings	10.1m-20m	9.73	2	20	10%
E	Ordinary - Unprotected Openings	0m-3m	14.76	2	30	21%
W	Ordinary - Unprotected Openings	0m-3m	15.82	2	32	22%
		% Increase				**59%** *value not to exceed 75%*

Increase	**2006.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow	5406.0 L/min	*fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
	5000.0 L/min	*rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey

Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C	1		*Type of Construction Coefficient per FUS Part II, Section 1*
A	350.2	m^2	*Total floor area based on FUS Part II section 1*

Fire Flow	4117.2 L/min	
	4000.0 L/min	*rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible -15%

Fire Flow	**3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered 0%

Reduction	**0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC	
N	Ordinary - Unprotected Openings	10.1m-20m	13.21	2	27	10%	
S	Ordinary - Unprotected Openings	30.1m-45m	14.56	2	30	5%	
E	Ordinary - Unprotected Openings	3.1m-10m	14.42	2	29	15%	
W	Ordinary - Unprotected Openings	3.1m-10m	13.84	2	28	15%	
		% Increase				**45%**	*value not to exceed 75%*

Increase	**1530.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow	4930.0 L/min	*fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section*
	5000.0 L/min	*rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey

Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C	1		*Type of Construction Coefficient per FUS Part II, Section 1*
A	342.2	m^2	*Total floor area based on FUS Part II section 1*

Fire Flow	4069.9 L/min	
	4000.0 L/min	*rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible -15%

Fire Flow **3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered 0%

Reduction **0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	10.1m-20m	13.19	2	27	10%
S	Ordinary - Unprotected Openings	30.1m-45m	13.21	2	27	5%
E	Ordinary - Unprotected Openings	0m-3m	13.89	2	28	21%
W	Ordinary - Unprotected Openings	3.1m-10m	13.82	2	28	15%
		% Increase				**51%** *value not to exceed 75%*

Increase **1734.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow	5134.0 L/min	*fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
	5000.0 L/min	*rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey

Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C	1		*Type of Construction Coefficient per FUS Part II, Section 1*
A	350.2	m^2	*Total floor area based on FUS Part II section 1*

Fire Flow	4117.2 L/min	
	4000.0 L/min	*rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible -15%

Fire Flow	**3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered 0%

Reduction	**0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	10.1m-20m	13.21	2	27	10%
S	Ordinary - Unprotected Openings	30.1m-45m	14.56	2	30	5%
E	Ordinary - Unprotected Openings	0m-3m	14.42	2	29	21%
W	Ordinary - Unprotected Openings	3.1m-10m	13.84	2	28	15%
		% Increase				**51%** *value not to exceed 75%*

Increase	**1734.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

Fire Flow	5134.0 L/min	*fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
	5000.0 L/min	*rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II

Fire Flow Estimation per Fire Underwriters Survey
Water Supply For Public Fire Protection - 1999

Fire Flow Required

1. Base Requirement

$F = 220C\sqrt{A}$ L/min — *Where **F** is the fire flow, **C** is the Type of construction and **A** is the Total floor area*

Type of Construction: Ordinary Construction

C	1		*Type of Construction Coefficient per FUS Part II, Section 1*
A	342.2	m^2	*Total floor area based on FUS Part II section 1*

Fire Flow 4069.9 L/min
4000.0 L/min *rounded to the nearest 1,000 L/min*

Adjustments

2. Reduction for Occupancy Type

Limited Combustible -15%

Fire Flow **3400.0 L/min**

3. Reduction for Sprinkler Protection

Non-Sprinklered 0%

Reduction **0 L/min**

4. Increase for Separation Distance

	Cons. of Exposed Wall	S.D	Lw	Ha	LH	EC
N	Ordinary - Unprotected Openings	10.1m-20m	13.19	2	27	10%
S	Ordinary - Unprotected Openings	30.1m-45m	13.21	2	27	5%
E	Ordinary - Unprotected Openings	0m-3m	13.89	1	14	21%
W	Ordinary - Unprotected Openings	3.1m-10m	13.82	2	28	15%
		% Increase				**51%** *value not to exceed 75%*

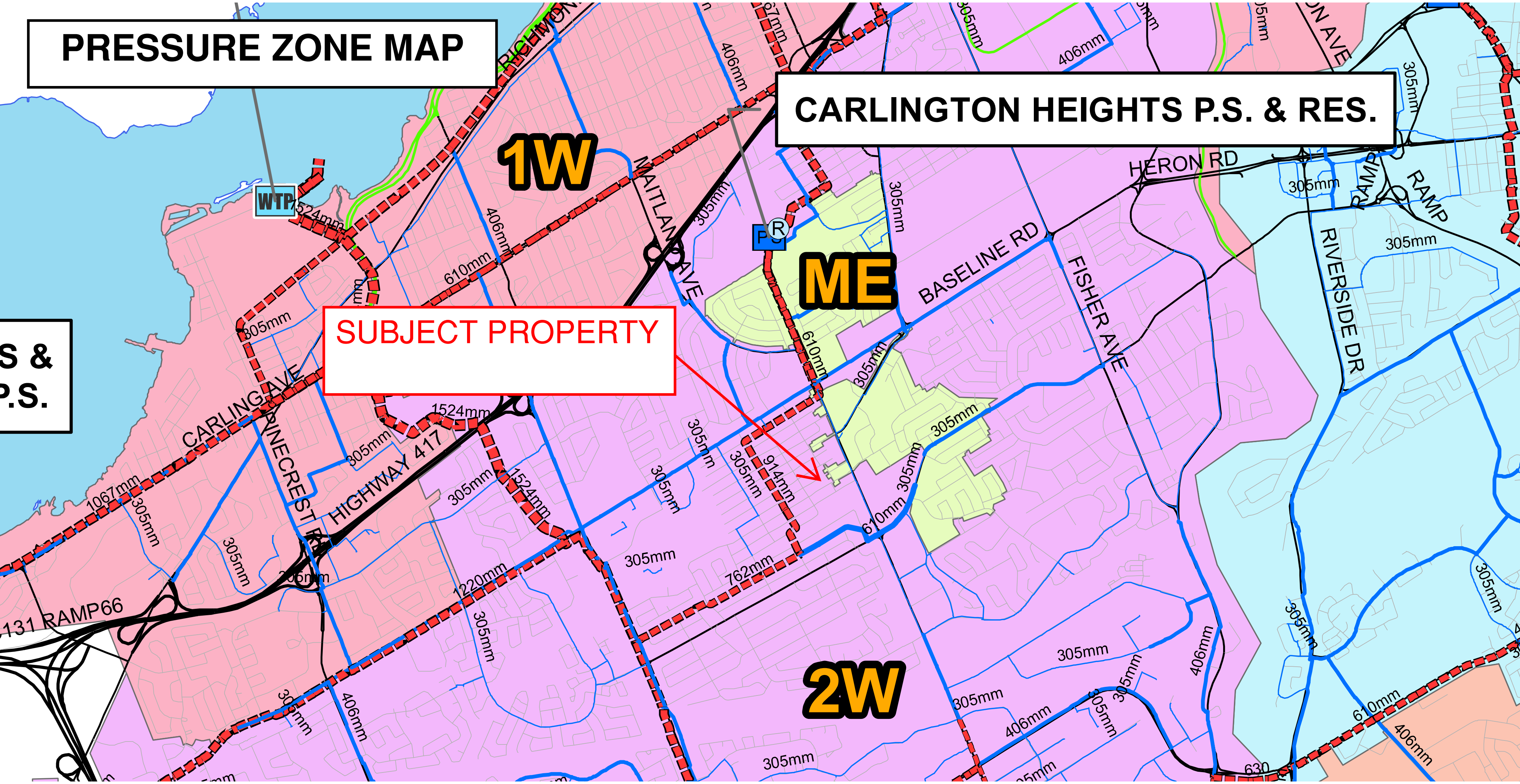
Increase **1734.0 L/min**

Lw = Length of the Exposed Wall
Ha = number of storeys of the adjacent structure
LH = Length-height factor of exposed wall. Value rounded up.
EC = Exposure Charge

Total Fire Flow

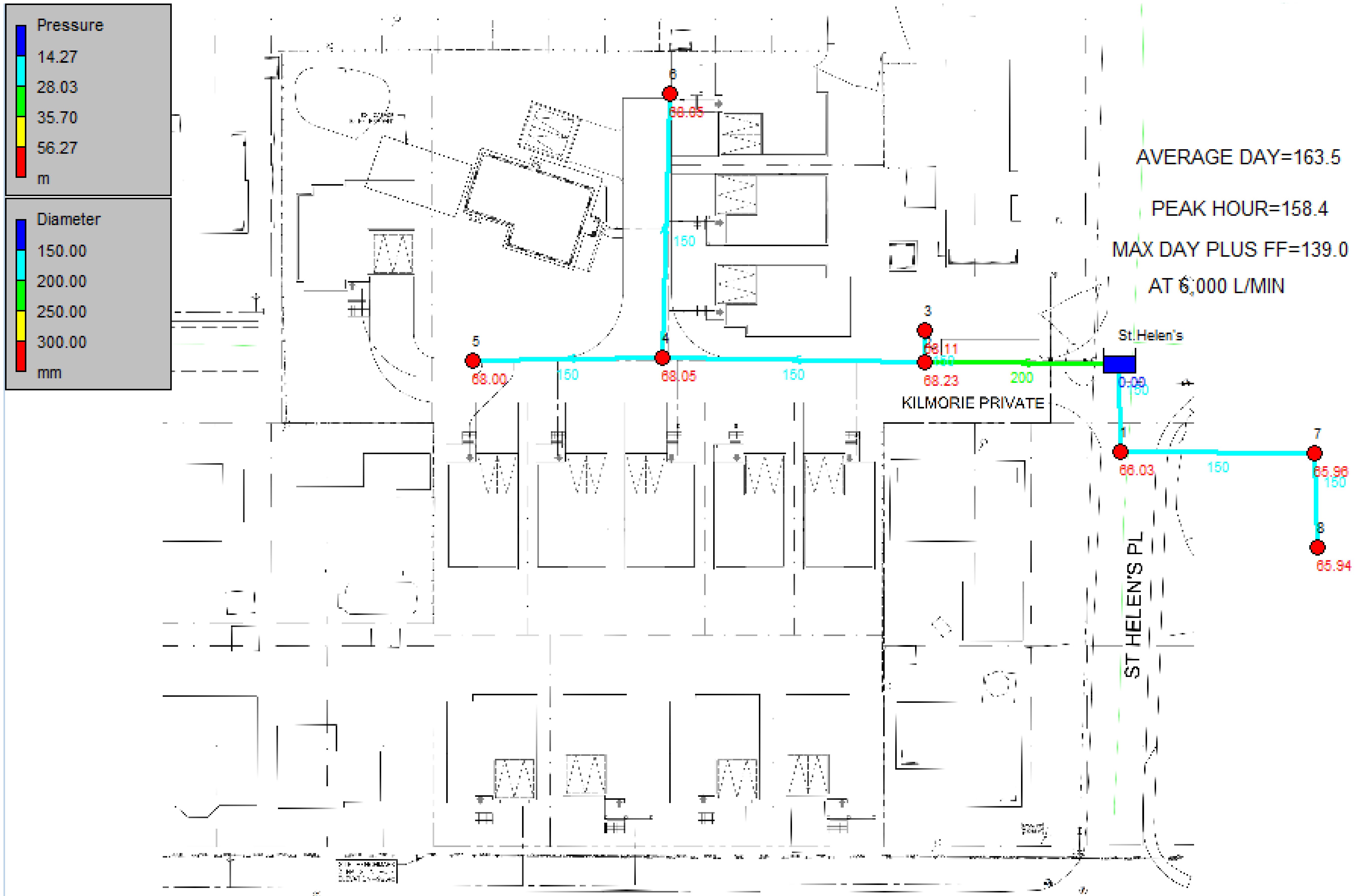
Fire Flow 5134.0 L/min *fire flow not to exceed 45,000 L/min nor be less than 2,000 L/min per FUS Section 4*
5000.0 L/min *rounded to the nearest 1,000 L/min*

Notes:
-Type of construction, Occupancy Type and Sprinkler Protection information provided by Theberge Homes.
-Calculations based on Fire Underwriters Survey - Part II



PRESSURE ZONE MAP
CARLINGTON HEIGHTS P.S. & RES.
SUBJECT PROPERTY
1W
ME
2W
WTP
CARLING AVE
PINECREST RD
HIGHWAY 417
MAITLAND AVE
BASELINE RD
FISHER AVE
HERON RD
RIVERSIDE DR
RAMP
RICHMOND
RAMP66
1067mm
1524mm
1220mm
914mm
762mm
610mm
406mm
305mm

AVERAGE DAY SCHEMATIC



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**********************************************************************
*                           E P A N E T                              *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                          Version 2.0                               *
**********************************************************************
```

Input File: 2018-05-14_931_wtr_ggm.net

Link - Node Table:

Link ID	Start Node	End Node	Length m	Diameter mm
1	6	4	38.3	150
2	4	5	23.3	150
3	4	2	40	150
4	2	St.Helen's	23	200
5	2	3	1.9	150
6	St.Helen's	1	2.67	150
7	1	7	16.21	150
8	7	8	3.12	150

Node Results:

Node ID	Demand LPM	Head m	Pressure m	Quality	
2	2.92	163.50	68.23	0.00	
3	0.00	163.50	68.11	0.00	
4	2.92	163.50	68.05	0.00	
5	2.92	163.50	68.00	0.00	
6	2.92	163.50	68.05	0.00	
1	0.00	163.50	66.03	0.00	
7	0.00	163.50	65.96	0.00	
8	0.00	163.50	65.94	0.00	
St.Helen's	-11.68	163.50	0.00	0.00	Reservoir

Link Results:

Link ID	Flow LPM	VelocityUnit m/s	Headloss m/km	Status
1	-2.92	0.00	0.00	Open
2	2.92	0.00	0.00	Open

3	-8.76	0.01	0.00	Open
4	-11.68	0.01	0.00	Open
5	0.00	0.00	0.00	Open
6	0.00	0.00	0.00	Open
7	0.00	0.00	0.00	Open
8	0.00	0.00	0.00	Open

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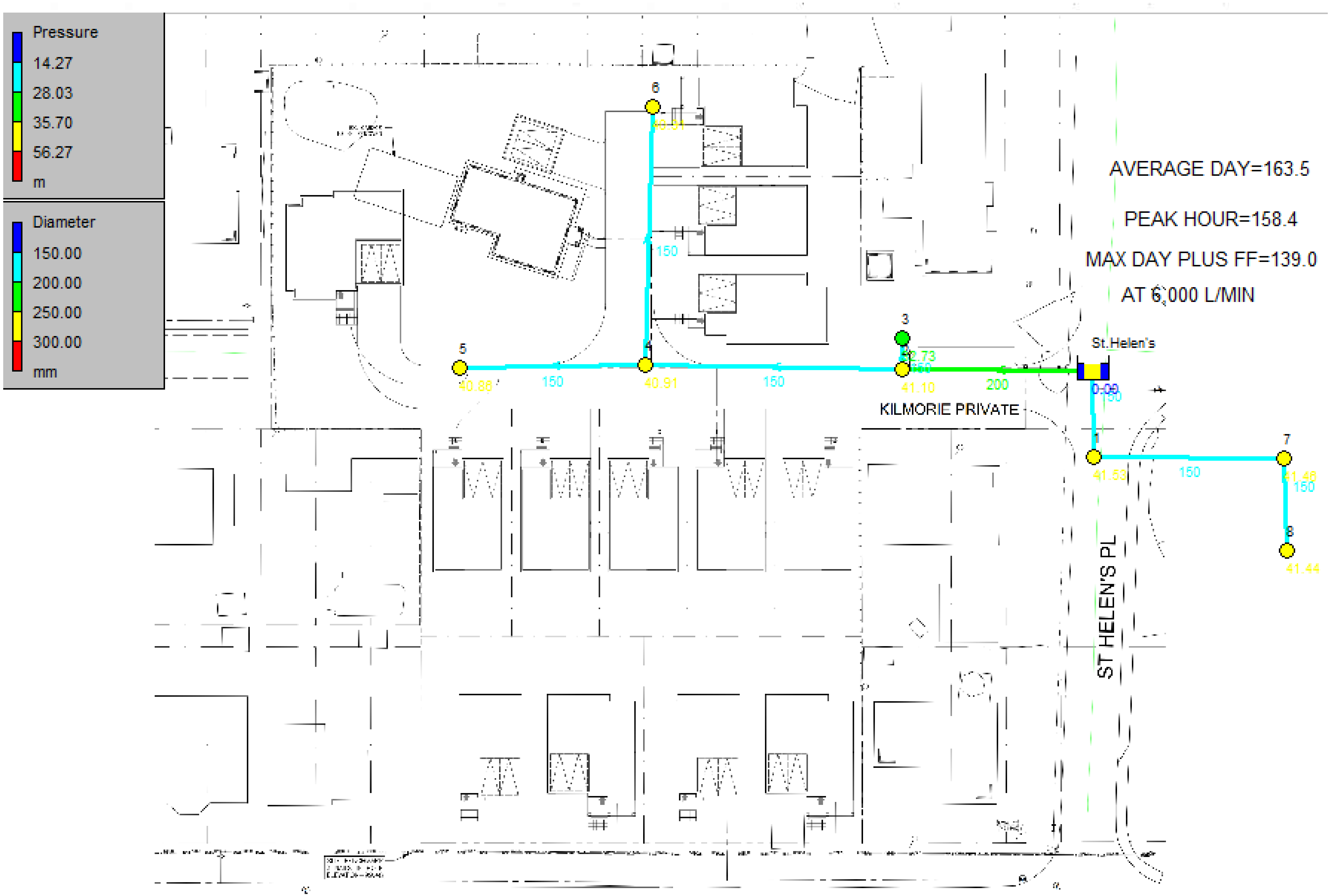
Page 2

MAX DAY + FIRE FLOW SCENARIO (6,000 L/min through Proposed Hydrant)



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**********************************************************************
*                             E P A N E T                            *
*                    Hydraulic and Water Quality                     *
*                    Analysis for Pipe Networks                      *
*                           Version 2.0                              *
**********************************************************************
```

Input File: 2018-06-05_931_wtr_ggm-ff.net

Link - Node Table:

Link ID	Start Node	End Node	Length m	Diameter mm
1	6	4	38.3	150
2	4	5	23.3	150
3	4	2	40	150
4	2	St.Helen's	23	200
5	2	3	1.9	150
6	St.Helen's	1	2.67	150
7	1	7	16.21	150
8	7	8	3.12	150

Node Results:

Node ID	Demand LPM	Head m	Pressure m	Quality	
2	14.29	136.37	41.10	0.00	
3	6000.00	128.12	32.73	0.00	
4	14.29	136.36	40.91	0.00	
5	14.29	136.36	40.86	0.00	
6	14.29	136.36	40.91	0.00	
1	0.00	139.00	41.53	0.00	
7	0.00	139.00	41.46	0.00	
8	0.00	139.00	41.44	0.00	
St.Helen's	-6057.16	139.00	0.00	0.00	Reservoir

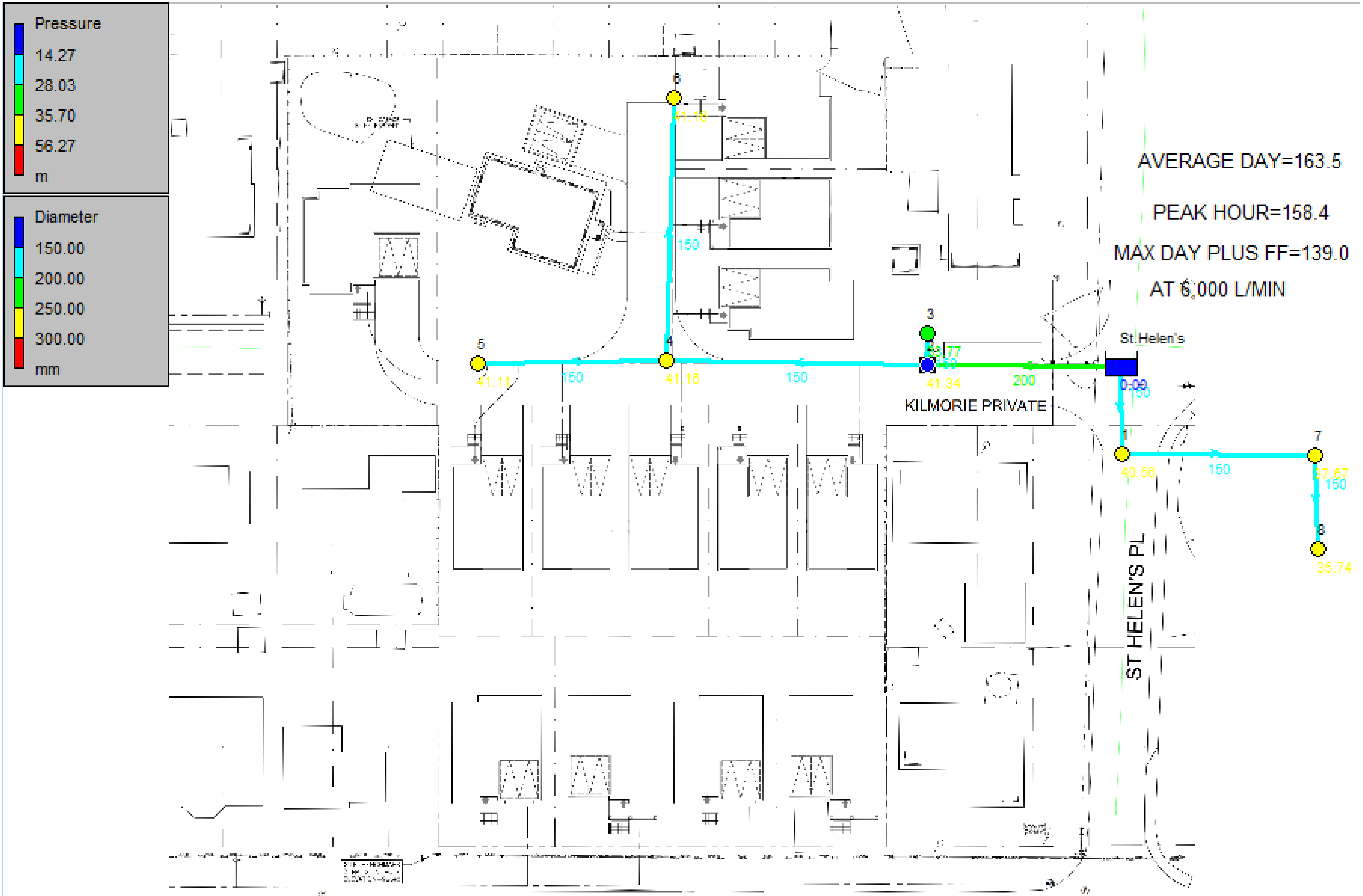
Link Results:

Link ID	Flow LPM	VelocityUnit m/s	Headloss m/km	Status
1	-14.29	0.01	0.00	Open
2	14.29	0.01	0.00	Open

3	-42.87	0.04	0.04	Open
4	-6057.16	3.21	114.54	Open
5	6000.00	5.66	4340.79	Open
6	0.00	0.00	0.00	Open
7	0.00	0.00	0.00	Open
8	0.00	0.00	0.00	Open

Page 2

MAX DAY + FIRE FLOW SCENARIO (5,300 L/min through Proposed Hydrant and 3,500 L/min through Existing Hydrant on Cleto Ave.)



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******************************************************************
*                         E P A N E T                            *
*                  Hydraulic and Water Quality                   *
*                  Analysis for Pipe Networks                    *
*                         Version 2.0                            *
******************************************************************
```

Input File: 2018-06-05_931_wtr_ggm-ff.net

Link - Node Table:

Link ID	Start Node	End Node	Length m	Diameter mm
1	6	4	38.3	150
2	4	5	23.3	150
3	4	2	40	150
4	2	St.Helen's	23	200
5	2	3	1.9	150
6	St.Helen's	1	2.67	150
7	1	7	16.21	150
8	7	8	3.12	150

Node Results:

Node ID	Demand LPM	Head m	Pressure m	Quality	
2	14.29	136.61	41.34	0.00	
3	5700.00	129.16	33.77	0.00	
4	14.29	136.61	41.16	0.00	
5	14.29	136.61	41.11	0.00	
6	14.29	136.61	41.16	0.00	
1	0.00	138.03	40.56	0.00	
7	0.00	135.21	37.67	0.00	
8	3500.00	133.30	35.74	0.00	
St.Helen's	-9257.16	139.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow LPM	VelocityUnit m/s	Headloss m/km	Status
1	-14.29	0.01	0.00	Open
2	14.29	0.01	0.00	Open

3	-42.87	0.04	0.04	Open
4	-5757.16	3.05	103.91	Open
5	5700.00	5.38	3919.67	Open
6	3500.00	3.30	362.13	Open
7	3500.00	3.30	174.30	Open
8	3500.00	3.30	610.79	Open

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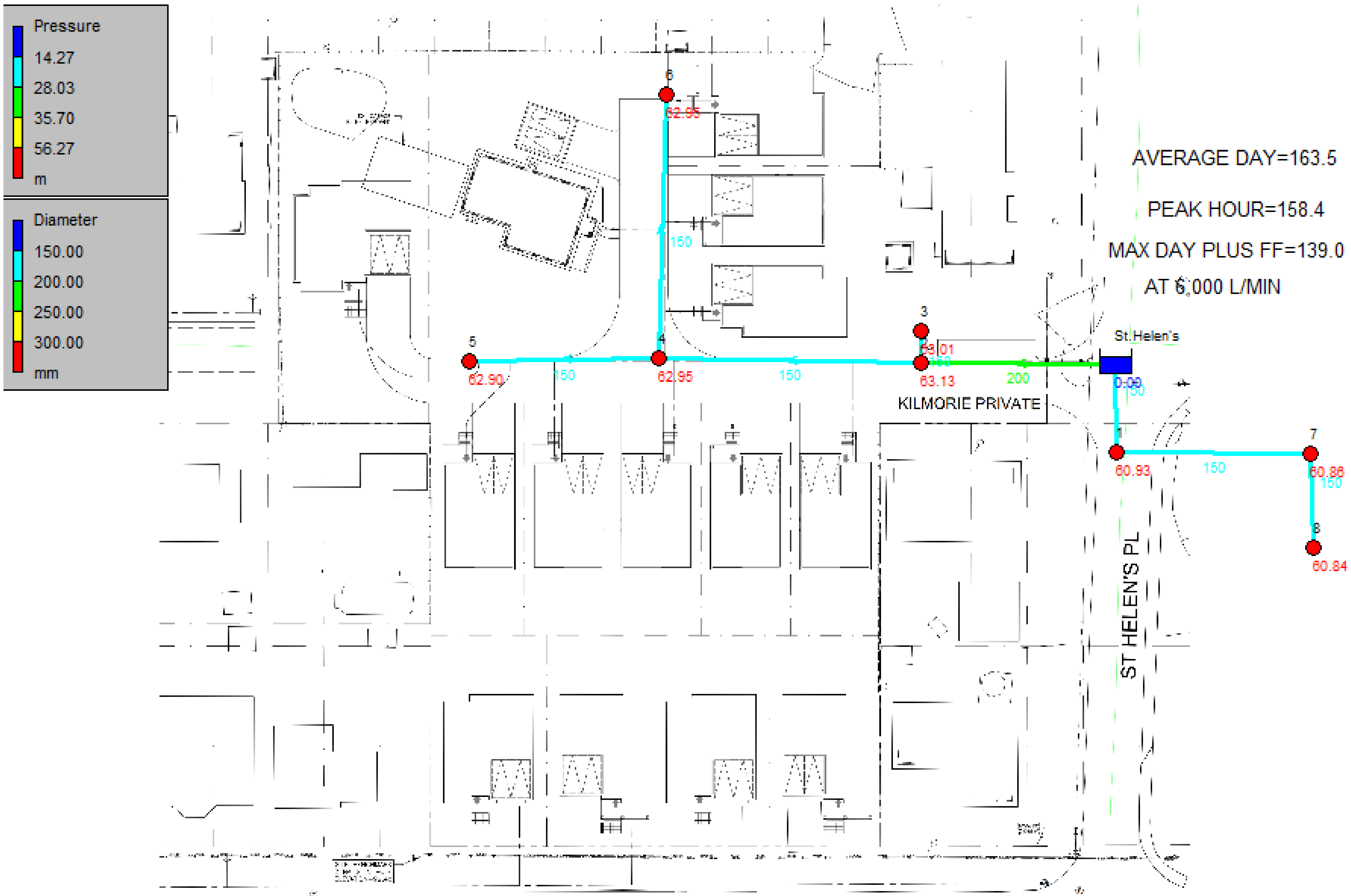
Page 2

PEAK HOUR SCHEMATIC



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**********************************************************************
*                           E P A N E T                              *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                         Version 2.0                                *
**********************************************************************
```

Input File: 2018-05-14_931_wtr_ggm.net

Link - Node Table:

Link ID	Start Node	End Node	Length m	Diameter mm
1	6	4	38.3	150
2	4	5	23.3	150
3	4	2	40	150
4	2	St.Helen's	23	200
5	2	3	1.9	150
6	St.Helen's	1	2.67	150
7	1	7	16.21	150
8	7	8	3.12	150

Node Results:

Node ID	Demand LPM	Head m	Pressure m	Quality	
2	21.58	158.40	63.13	0.00	
3	0.00	158.40	63.01	0.00	
4	21.58	158.40	62.95	0.00	
5	21.58	158.40	62.90	0.00	
6	21.58	158.40	62.95	0.00	
1	0.00	158.40	60.93	0.00	
7	0.00	158.40	60.86	0.00	
8	0.00	158.40	60.84	0.00	
St.Helen's	-86.32	158.40	0.00	0.00	Reservoir

Link Results:

Link ID	Flow LPM	Velocity m/s	Unit Headloss m/km	Status
1	-21.58	0.02	0.01	Open
2	21.58	0.02	0.01	Open

3	-64.74	0.06	0.08	Open
4	-86.32	0.05	0.03	Open
5	0.00	0.00	0.00	Open
6	0.00	0.00	0.00	Open
7	0.00	0.00	0.00	Open
8	0.00	0.00	0.00	Open

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APPENDIX C

Wastewater Collection

Wastewater Design Flows per Unit Count
City of Ottawa Sewer Design Guidelines, 2004

Site Area		0.82	**ha**
Extraneous Flow Allowances			
	Infiltration / Inflow	**0.27**	**L/s**

Domestic Contributions

Unit Type	**Unit Rate**	**Units**	**Pop**
Single Family	3.4	1	4
Semi-detached and duplex	2.7		0
Townhouse	2.7		0
Stacked Townhouse (Duplex)	2.3		0
Apartment			
Bachelor	1.4		0
1 Bedroom	1.4		0
2 Bedroom	2.1		0
3 Bedroom	3.1		0
Average	1.8		0
Type of Housing	**Per/Bed**	**Beds**	**Pop**
Boarding*	1		0

Total Pop	**4**	
Average Domestic Flow	**0.01**	**L/s**
Peaking Factor	**3.80**	
Peak Domestic Flow	**0.05**	**L/s**

Institutional / Commercial / Industrial Contributions

Property Type	**Unit Rate**		**No. of Units**	**Avg Wastewater (L/s)**
Water Closets **	150	L/hr		0.00
Restaurant***	125	L/seat/d		0.00
Commercial floor space*	5	$L/m^2/d$		0.00
Hospitals	900	L/bed/d		0.00
School	70	L/student/d		0.00
Industrial - Light**	35,000	L/gross ha/d		0.00
Industrial - Heavy**	55,000	L/gross ha/d		0.00

Average I/C/I Flow	**0.00**
Peak Institutional / Commercial Flow	0.00
Peak Industrial Flow**	0.00
Peak I/C/I Flow	**0.00**

** assuming a 12 hour commercial operation*
*** peak industrial flow per City of Ottawa Sewer Design Guidelines Appendix 4B*

Total Estimated Average Dry Weather Flow Rate	**0.01**	**L/s**
Total Estimated Peak Dry Weather Flow Rate	**0.05**	**L/s**
Total Estimated Peak Wet Weather Flow Rate	**0.32**	**L/s**

* Based on a daily demand of 200L/day per person as identified by Appendix 4-A of the Sewer design guidelines
** Water closets demand of 150 L/hour from Appendix 4-A of the Sewer design guidelines, assuming a 12 hour operation
***Assuming 1 seat is approximately equal to 9.3 m²

Wastewater Design Flows per Unit Count
City of Ottawa Sewer Design Guidelines, 2004

Site Area 0.82 **ha**

Extraneous Flow Allowances

Infiltration / Inflow	**0.27**	**L/s**

Domestic Contributions

Unit Type	**Unit Rate**	**Units**	**Pop**
Single Family	3.4	14	48
Semi-detached and duplex	2.7		0
Townhouse	2.7		0
Stacked Townhouse (Duplex)	2.3		0
Apartment			
Bachelor	1.4		0
1 Bedroom	1.4		0
2 Bedroom	2.1		0
3 Bedroom	3.1		0
Average	1.8		0
Type of Housing	**Per/Bed**	**Beds**	**Pop**
Boarding*	1		0

Total Pop	**48**	
Average Domestic Flow	**0.16**	**L/s**
Peaking Factor	**3.80**	
Peak Domestic Flow	**0.59**	**L/s**

Institutional / Commercial / Industrial Contributions

Property Type	**Unit Rate**		**No. of Units**	**Avg Wastewater (L/s)**
Water Closets	150	L/hr		0.00
Restaurant	125	L/seat/d		0.00
Commercial floor space*	5	$L/m^2/d$		0.00
Laundry*	1,200	L/machine/d		0.00
Hospitals	900	L/bed/d		0.00
School	70	L/student/d		0.00

Average I/C/I Flow	**0.00**
Peak Institutional / Commercial Flow	0.00
Peak Industrial Flow**	0.00
Peak I/C/I Flow	**0.00**

** assuming a 12 hour commercial operation*

Total Estimated Average Dry Weather Flow Rate	**0.16**	**L/s**
Total Estimated Peak Dry Weather Flow Rate	**0.59**	**L/s**
Total Estimated Peak Wet Weather Flow Rate	**0.86**	**L/s**

* Based on a daily demand of 200L/day per person as identified by Appendix 4-A of the Sewer design guidelines

SANITARY SEWER CALCULATION SHEET - EXISTING CONDITIONS

PROJECT: **Theberge Homes**
LOCATION: **21 Withrow Avenue**
FILE REF: **17-931**
DATE: **6-Jun-18**

DESIGN PARAMETERS

Avg. Daily Flow Res.	280 L/p/d	Peak Fact Res. Per Harmons: Min = 2.0, Max =3.8				Infiltration / Inflow	0.33 L/s/ha
Avg. Daily Flow Comm.	28,000 L/ha/d	Peak Fact. Comm. If (Q_I/Q_{TOTAL}>20%)	1.5	Peak Fact. Comm.	1	Min. Pipe Velocity	0.60 m/s full flowing
Avg. Daily Flow Instit.	28,000 L/ha/d	Peak Fact. Instit. If (Q_I/Q_{TOTAL}>20%)	1.5	Peak Fact. Instit.	1	Max. Pipe Velocity	3.00 m/s full flowing
Avg. Daily Flow Indust.	35,000 L/ha/d	Peak Fact. Indust. per MOE graph				Mannings N	0.013
		Correction Factor K	0.8				

Location			Residential Area and Population										Commercial		Institutional		Industrial	
Area ID	Up	Down	Area (ha)	Number of Units by type: Singles	Semi's	Town's	Apt's	Pop.	Cumulative Area (ha)	Cumulative Pop.	Peak. Fact. (-)	Q_{res} (L/s)	Area (ha)	Accu. Area (ha)	Area (ha)	Accu. Area (ha)	Area (ha)	Accu. Area (ha)
A	A	B	1.14	9				31.0	1.1	31.0	3.68	0.37	0.00	0.00	0.00	0.00	0.00	0.00
B	B	C	0.48	5				17.0	1.62	48.0	3.65	0.57		0.00		0.00		0.00
C	C	F	0.49	1				3.0	2.110	51.0	3.65	0.60		0.00	0.17	0.17		0.00
F	D	G	2.71	6				20.0	2.71	20.0	3.70	0.24	0.17	0.17		0.17		0.00
G	H	I	4.90	14				48.0	9.72	119.0	3.58	1.38	0.12	0.29	0.32	0.49		0.00
i	i	TRUNK SAN	4.70					0.0	14.42	119.0	3.58	1.38	1.12	1.41		0.49		0.00

Area ID	Infiltration				Pipe Data									
	Q_{C+I+I} (L/s)	Total Area (ha)	Accu. Area (ha)	Infiltration Flow (L/s)	Total Flow (L/s)	DIA (mm)	Slope (%)	Length (m)	$A_{hydraulic}$ (m^2)	R (m)	Velocity (m/s)	Q_{cap} (L/s)	Q / Q full (-)	Qresidual (L/s)
A	0.0	1.140	1.140	0.376	0.75	200	0.65	117.5	0.031	0.050	0.84	26.4	0.03	
B	0.0	0.480	1.620	0.535	1.10	200	0.3	74.7	0.031	0.050	0.59	18.6	0.06	17.5
C	0.1	0.660	2.280	0.752	1.44	200	0.3	77.6	0.031	0.050	0.59	18.6	0.08	17.1
F	0.2	2.880	2.880	0.950	1.36	250	0.7	68.0	0.049	0.063	0.99	48.7	0.03	47.3
G	0.4	5.340	10.500	3.465	5.22	250	4.4	57.0	0.049	0.063	2.54	124.6	0.04	119.4
i	0.9	5.820	16.320	5.386	7.69	250	2.5	97.0	0.049	0.063	1.90	93.5	0.08	85.8

*No sanitary asbuilts were available to obtain slopes as constructed, so minimum slopes were assumed

SANITARY SEWER CALCULATION SHEET - EXISTING CONDITIONS

*

*

LEGEND

- South Merivale Sanitary Basin
- Clyde Avenue Sanitary Basin
- North Merivale Sanitary Basin

DELCAN

NEPEAN

Sanitary Drainage Basins

Date: January 2000

Figure 1.2

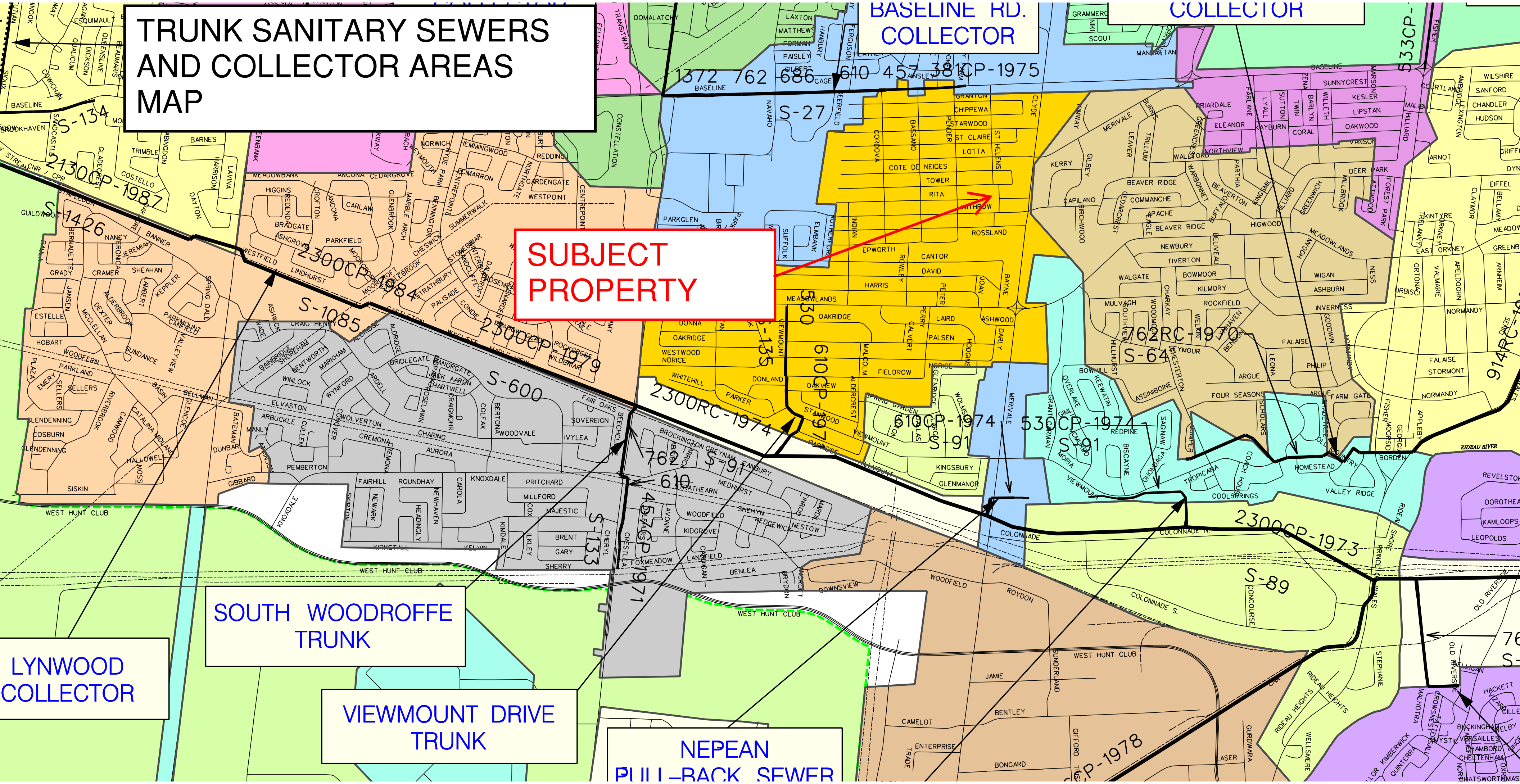
SOUTH MERIVALE SANITARY SEWER DESIGN SHEET: Theoretical Design Flows

commercial flow (_ L/1000 sqm/d) 5000
q = average daily per capita flow (_ L/cap,d) 350
persons per dwelling 3.31
I = unit of peak extraneous flow (_ L/ha,s) 0.28
M = peaking factor
Q (p) = peak population flow (L/s)
Q (I) = peak extraneous flow (L/s)
Q (d) = peak design flow

M = 1 + 14/(4+sqrtP) where P is population in 1000's
Q(p) = PqM/86.4 (L/s)
Q (I) = IA (L/s) where A = area in hectares
Q (d) = Q (p) + Q (I) (L/s)

Location			Residential Flow Calculations				Commercial Flow Calculations				Catchment Area I/I Flow Calculations				Existing Sewer (n = 0.013)						
Street	From MH	To MH	Individual Population	Cumulative Population	Peaking factor M	Residential Flow Q(p) (L/s)	Individual Building Area (1000 m²)	Cumulative Building Area	Peaking factor	Commercial Flow (L/s)	Individual Area (ha)	Cumultaive Area (ha)	Peak extraneous flow Q(I) (L/s)	Peak design flow Q (d) (L/s)	Length (m)	Pipe Size (mm)	Type of pipe	Grade %	Capacity (L/s)	Full flow velocity (m/s)	Residual Capacity (L/s)
Merivale	120	130	0.0	0	4.0	0.0	8.8	8.8	1.5	0.8	2.170	2.17	0.61	1.4	70.9	203	CP	0.33	19.41	0.6	18.0
Rita	120	110	19.9	20	4.0	0.3	0.0	0.0	1.5	0.0	0.452	0.45	0.13	0.4	62.3	203	AC	0.60	26.17	0.8	25.7
	110	130	0.0	20	4.0	0.3	0.0	0.0	1.5	0.0	0.180	0.63	0.18	0.5	66.5	203	AC	0.20	15.11	0.5	14.6
Merivale	130	134	0.0	20	4.0	0.3	0.0	8.8	1.5	0.8	0.137	2.94	0.82	1.9	15.5	254	AC	0.10	19.44	0.4	17.5
	134	136	0.0	20	4.0	0.3	0.6	9.4	1.5	0.8	0.198	3.14	0.88	2.0	9.3	254	AC	0.69	51.06	1.0	49.0
	136	140	0.0	20	4.0	0.3	0.4	9.8	1.5	0.9	0.293	3.43	0.96	2.1	43.9	254	AC	0.45	41.24	0.8	39.1
St Helen's	910	920	6.6	7	4.0	0.1	0.0	0.0	1.5	0.0	0.296	0.30	0.08	0.2	55.0	203	AC	0.24	16.55	0.5	16.4
	920	220	3.3	10	4.0	0.2	0.0	0.0	1.5	0.0	0.205	0.50	0.14	0.3	54.3	203	AC	0.15	13.09	0.4	12.8
Withrow	230	226	16.6	17	4.0	0.3	0.0	0.0	1.5	0.0	0.664	0.66	0.19	0.5	42.0	203	AC	1.50	41.38	1.3	40.9
	226	220	13.2	30	4.0	0.5	0.0	0.0	1.5	0.0	0.408	1.07	0.30	0.8	61.5	203	AC	2.13	49.31	1.5	48.5
	220	210	9.9	50	4.0	0.8	0.0	0.0	1.5	0.0	0.760	2.33	0.65	1.5	80.1	203	AC	0.36	20.27	0.6	18.8
	210	140	3.3	53	4.0	0.9	3.5	3.5	1.5	0.3	0.314	2.65	0.74	1.9	78.0	203	AC	0.40	21.37	0.7	19.5
Merivale	140	150	0.0	73	4.0	1.2	3.5	16.8	1.5	1.5	1.346	7.42	2.08	4.7	78.7	254	AC	0.64	49.18	1.0	44.5
Rossland	330	326	23.2	23	4.0	0.4	0.0	0.0	1.5	0.0	0.650	0.65	0.18	0.6	116.5	203	AC	1.12	35.76	1.1	35.2
	326	320	6.6	30	4.0	0.5	0.0	0.0	1.5	0.0	0.882	1.53	0.43	0.9	88.0	203	AC	1.67	43.67	1.3	42.8
	320	310	3.3	33	4.0	0.5	0.0	0.0	1.5	0.0	0.652	2.18	0.61	1.1	62.5	203	AC	1.07	34.95	1.1	33.8
	310	150	0.0	33	4.0	0.5	0.0	0.0	1.5	0.0	0.277	2.46	0.69	1.2	60.5	203	AC	0.94	32.76	1.0	31.5
Merivale	150	160	0.0	106	4.0	1.7	19.8	36.6	1.5	3.2	2.867	12.75	3.57	8.5	78.4	254	AC	0.54	45.17	0.9	36.7
	160	170	0.0	106	4.0	1.7	0.4	36.9	1.5	3.2	1.917	14.67	4.11	9.0	73.7	254	AC	0.47	42.14	0.8	33.1
Easement	410	170	0.0	0	4.0	0.0	1.0	1.0	1.5	0.1	0.716	0.72	0.20	0.3	95.5	203	AC	0.39	21.10	0.7	20.8
Merivale	170	180	0.0	106	4.0	1.7	0.2	38.2	1.5	3.3	1.351	16.74	4.69	9.7	74.5	457	AC	0.36	176.97	1.1	167.3
	180	190	0.0	106	4.0	1.7	16.6	54.8	1.5	4.8	1.994	18.73	5.24	11.7	120.3	533	AC	0.18	188.70	0.8	177.0
	190	300	0.0	106	4.0	1.7	10.8	65.6	1.5	5.7	1.416	20.15	5.64	13.0	120.3	457	AC	0.29	158.83	1.0	145.8
Meadwlands	340	336	29.8	30	4.0	0.5	0.0	0.0	1.5	0.0	0.731	0.73	0.20	0.7	54.5	203	AC	2.00	47.79	1.5	47.1
	336	330	13.2	43	4.0	0.7	0.0	0.0	1.5	0.0	0.435	1.17	0.33	1.0	84.0	203	AC	1.13	35.92	1.1	34.9
	330	320	26.5	70	4.0	1.1	0.0	0.0	1.5	0.0	0.806	1.97	0.55	1.7	112.5	203	AC	0.39	21.10	0.7	19.4
	320	310	23.2	172	4.0	2.8	0.0	0.0	1.5	0.0	0.745	5.64	1.58	4.4	109.0	203	AC	0.61	26.39	0.8	22.0
	310	300	0.0	367	4.0	6.0	0.0	0.0	1.5	0.0	0.428	12.86	3.60	9.6	92.0	203	AC	0.40	21.37	0.7	11.8
Harris	750	740	16.6	17	4.0	0.3	0.0	0.0	1.5	0.0	0.867	0.87	0.24	0.5	69.5	203	AC	4.10	68.42	2.1	67.9
	740	730	33.1	50	4.0	0.8	0.0	0.0	1.5	0.0	0.757	1.62	0.45	1.3	69.0	203	AC	0.41	21.64	0.7	20.4
	730	720	16.6	66	4.0	1.1	0.0	0.0	1.5	0.0	0.688	2.31	0.65	1.7	69.0	203	AC	0.41	21.64	0.7	19.9
	720	710	6.6	73	4.0	1.2	0.0	0.0	1.5	0.0	0.423	2.74	0.77	1.9	45.5	203	AC	0.33	19.41	0.6	17.5
	710	320	6.6	79	4.0	1.3	0.0	0.0	1.5	0.0	0.186	2.92	0.82	2.1	47.5	203	AC	0.63	26.82	0.8	24.7

residual capacity is based on gravity flow



TRUNK SANITARY SEWERS
AND COLLECTOR AREAS
MAP
SUBJECT
PROPERTY
BASELINE RD.
COLLECTOR
COLLECTOR
SOUTH WOODROFFE
TRUNK
LYNWOOD
COLLECTOR
VIEWMOUNT DRIVE
TRUNK
NEPEAN
PULL-BACK SEWER
S-134
2130CP-1987
S-1426
2300CP-1984
S-1085
2300CP-1979
S-600
1372 762 686 610 457 381CP-1975
S-27
2300RC-1974
610CP-1971
S-133
457CP-1971
762 S-91
610
610CP-1974
S-91
530CP-1974
762RC-1970
S-64
2300CP-1973
S-89

SANITARY SEWER CALCULATION SHEET - PROPOSED CONDITIONS

PROJECT: **Theberge Homes**
LOCATION: **21 Withrow Avenue**
FILE REF: **17-931**
DATE: **29-Mar-18**

DESIGN PARAMETERS

Avg. Daily Flow Res. 350 L/p/d
Peak Fact Res. Per Harmons: Min = 2.0, Max =4.0
Peak Fact. Comm. 1.5
Peak Fact. Instit. 1.5
Peak Fact. Indust. per MOE graph
Infiltration / Inflow 0.28 L/s/ha
Min. Pipe Velocity 0.60 m/s full flowing
Max. Pipe Velocity 3.00 m/s full flowing
Mannings N 0.013

Location				Residential Area and Population										Commercial		Institutional		Industrial		Infiltration				Pipe Data									
Street Name	Area ID	Up	Down	Area (ha)	Number of Units by type: Singles	Semi's	Town's	Apt's**	Pop.	Cumulative Area (ha)	Cumulative Pop.	Peak. Fact. (-)	Q_{res} (L/s)	Area (ha)	Accu. Area (ha)	Area (ha)	Accu. Area (ha)	Area (ha)	Accu. Area (ha)	Q_{C+I+I^*} (L/s)	Total Area (ha)	Accu. Area (ha)	Infiltration Flow (L/s)	Total Flow (L/s)	DIA (mm)	Slope (%)	Length (m)	$A_{hydraulic}$ (m^2)	R (m)	Velocity (m/s)	Q_{cap} (L/s)	Q / Q full (-)	Qresidual (L/s)
Kilmorie Private	A2	SAN4	SAN2	0.170	4				14.0	0.170	14.0	4.00	0.23		0.00		0.00		0.00	0.0	0.170	0.170	0.048	0.27	200	0.35	36.6	0.031	0.050	0.62	19.4	0.01	19.1
Kilmorie Private	A3	SAN3	SAN3	0.322	4				14.0	0.322	14.0	4.00	0.23		0.00		0.00		0.00	0.0	0.322	0.322	0.090	0.32	200	0.35	20.0	0.031	0.050	0.62	19.4	0.02	19.1
Kilmorie Private	A1	SAN2	SAN1	0.218	2				7.0	0.540	35.0	4.00	0.57		0.00		0.00		0.00	0.0	0.218	0.710	0.199	0.77	200	0.35	61.4	0.031	0.050	0.62	19.4	0.04	18.6

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APPENDIX D

Stormwater Management

Estimated Peak Stormwater Flow Rate
City of Ottawa Sewer Design Guidelines, 2012

Drainage Area A1 to St Helen's Place
Existing Drainage Charateristics From Internal Site - East

Area	0.62	ha
C	0.29	Rational Method runoff coefficient
L	90	m
Up Elev	98.85	m
Dn Elev	97.37	m
Slope	1.6	%
Tc	21.23	min

1) Time of Concentration per Federal Aviation Administration

$$t_c = \frac{1.8(1.1-C)L^{0.5}}{S^{0.333}}$$

tc, in minutes
C, rational method coefficient, (-)
L, length in ft
S, average watershed slope in %

Stormwater - Proposed Development
City of Ottawa Sewer Design Guidelines, 2012

Target Flow Rate

Area	0.70	ha
C	0.29	Rational Method runoff coefficient
t_c	21.2	min

	2-year	
i	50.2	mm/hr
Q	28.3	L/s

Estimated Post Development Peak Flow from Attenuated Areas

Area ID A1
Available Sub-surface Storage
Maintenance Structures

Sewers

ID	**U/G STORG.**	**U/G STORG.**
Storage Pipe Dia (mm)	ST-18	ST-30
Height (mm)	457	762
V_{sewer} (m^3)	140.4	107.5

*Top of lid or max ponding elevation = ____ 97.42

Total Subsurface Storage (m^3) 247.9

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Stage Attenuated Areas Storage Summary

		Surface Storage				**Surface and Subsurface Storage**		
	Stage	**Ponding**	**h_o**	**delta d**	**V***	**V_{acc}****		
	(m)	**(m^2)**	**(m)**	**(m)**	**(m^3)**	**(m^3)**		
Orifice INV	96.54	-	0.00			0.0		
U/G STORAGE INV	96.59	-	0.05	0.05	0.0	0.0		
DICB T/L	96.95	0.36	0.41	0.36	160.8	160.8		
Storage Tank #1, #2 OBV	97.05	10.00	0.51	0.10	45.1	205.9		
IAX PONDING / Top of Storage Tank 3	97.35	50.00	0.81	0.30	50.7	256.5		
Top of Spillway	97.42	50.0	0.88	0.07	3.5	260.0		

* V=Incremental storage volume
**V_{acc}=Total surface and sub-surface

Theberge Homes
21 Withrow Avenue
Ditch Calculation Sheet - 100 Year Storm

									Ditch Data												
	Area	**Area**	**C**	**Indiv AxC**	**Acc AxC**	**T_C**	**I**	**Q**	**depth**	**Side Slope**	**Bot. Width**	**Mannings**	**Slope**	**Length**	**A_{flow}**	**Wet. Per.**	**R**	**Velocity**	**Qcap**	**Time Flow**	**Q / Q full**
		(ha)	**(-)**			**(min)**	**(mm/hr)**	**(L/s)**	**(mm)**	**(X:1)**	**(m)**	**n**	**(%)**	**(m)**	**(m^2)**	**(m)**	**(m)**	**(m/s)**	**(L/s)**	**(min)**	**(-)**
	EX1	0.139	0.47	0.07	0.07																
	D1	0.386	0.57	0.22	0.29	10.0	178.6	141.5	400	2	0	0.03	0.50	79.8	0.320	1.789	0.18	0.75	239.5	1.8	0.59
						11.8															
	EX3	0.129	0.61	0.08	0.08	10.0	178.6	39.0	300	2	0	0.03	0.50	61	0.180	1.342	0.13	0.62	111.2	1.6	0.35
						11.6															
	D2	0.141	0.59	0.08	0.08	10.0	178.6	41.3	360	2	0	0.03	0.50	72.9	0.259	1.610	0.16	0.70	180.8	1.7	0.23
						11.7															
	D3	0.055	0.75	0.04	0.04	10.0	178.6	20.5	400	2	0	0.03	0.50	47.5	0.320	1.789	0.18	0.75	239.5	1.1	0.09
						11.1															
	D4	0.034	0.80	0.03	0.15	11.7	164.1	69.1	370	2	0	0.03	0.80	25.7	0.274	1.655	0.17	0.90	246.0	0.5	0.28
						12.2															
	EX2	0.041	0.4	0.02	0.02																
	D5	0.052	0.41	0.02	0.04	10.0	178.6	18.7	330	2	0	0.03	0.50	39.3	0.218	1.476	0.15	0.66	143.4	1.0	0.13
						11.0															
	D6	0.033	0.44	0.01	0.57	12.2	160.5	253.3	500	2	0	0.03	0.50	18.8	0.500	2.236	0.22	0.87	434.2	0.4	0.58
						12.6	158.0														

* Side slopes of 2:1 used as this represents the worst case scenario for ditch flow capacity

Theberge Homes
21 Withrow Avenue
Culvert/Sewer Calculation Sheet - 100 Year Storm

								Sewer Data								
Area ID	**Area**	**C**	**Indiv AxC**	**Acc AxC**	**T_{C**}**	**I**	**Q**	**DIA**	**Slope**	**Length**	**$A_{hydraulic}$**	**R**	**Velocity**	**Qcap**	**Time Flow**	**Q / Q full**
	(ha)	**(-)**			**(min)**	**(mm/hr)**	**(L/s)**	**(mm)**	**(%)**	**(m)**	**(m^2)**	**(m)**	**(m/s)**	**(L/s)**	**(min)**	**(-)**
EX1	0.139	0.47	0.07	0.07												
D1	0.386	0.57	0.22	0.29	11.8	163.8	129.8	400	0.50	9.7	0.126	0.100	0.63	79.8	0.3	1.63
EX3	0.129	0.61	0.08	0.36	11.8	163.8	165.6	400	0.50	10.5	0.126	0.100	0.63	79.8	0.3	2.08
D2	0.141	0.59	0.08	0.08	11.7	164.1	37.9	300	0.50	16.9	0.071	0.075	0.97	68.4	0.3	0.55
D3	0.055	0.75	0.04	0.04	11.1	169.4	19.4	300	0.50	10.4	0.071	0.075	0.97	68.4	0.2	0.28
D4	0.034	0.80	0.03	0.15	12.2	160.5	67.6									
EX2	0.041	0.40	0.02	0.02												
D5	0.052	0.41	0.02	0.04	11.0	169.9	17.8									
D6	0.033	0.44	0.01	0.85	12.6	158.0	374.4									
DICB101*	0.000	0.00	0.00	0.85	12.6	158.0	40.8	300	0.35	30.9	0.071	0.075	0.81	57.2	0.6	0.71
AD102	0.000	0.00	0.00	0.00	13.2	153.7	40.8	300	0.35	9.7	0.071	0.075	0.81	57.2	0.2	0.71

*Pipe sized for the proposed controlled elease rate

STORMTANK® Module Volume Calculator

Inputs

Project Name:	21 Withrow Avenue - Storage Tank #1		
Engineer:		Date:	10/31/2017
Units:	SI	Shape:	Square/Rectangle
Liner:	No	Location:	N/A
Stacking:	Single	Height:	457.2
Stone Storage:	All	Porosity:	40%

Dimensions

Module		
Length:	59	m
Width:	3	m
Excavation		
Length:	59.6	m
Width:	3.6	m
Stone		
Leveling Bed:	0	m
Top Backfill:	0.3	m
Compacted Fill:	0.3	m

Results

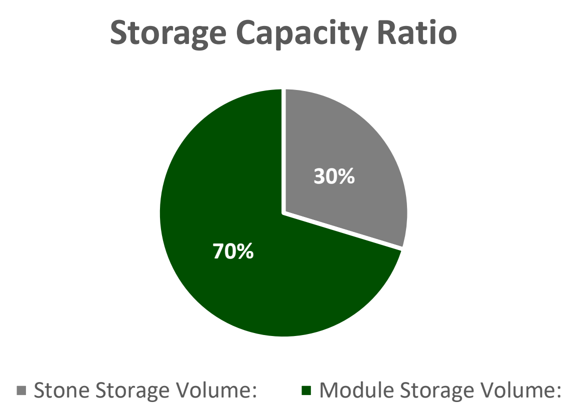
Capacity:

Stone Storage Volume:	32.62	m^3
Module Storage Volume:	77.22	m^3
Total Storage Volume:	109.83	m^3

Quantities:

Required Excavation:	226.83	m^3
Required Stone Volume:	81.54	m^3
Estimated Geotextile:	1,039.47	m^2
Estimated Liner:	0.00	m^2

(Estimations include 10% for scrap and overlap)

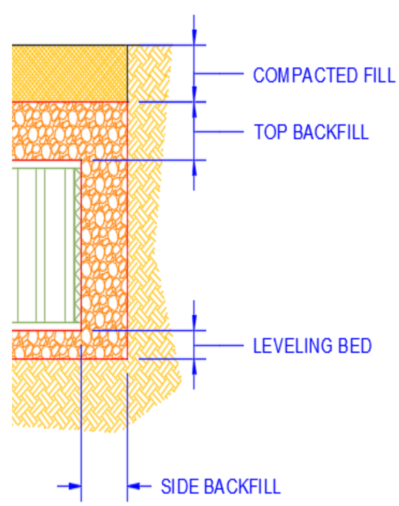


Basin Detail

Component Quantities:

	Bottom Layer	Top Layer	Total
Height	457.2	N/A	457.2
# of Modules	423	N/A	423
# of Platens	847	N/A	847
# of Side Panels	271	N/A	271
# of Columns	3,387	N/A	3,387
# of Stacking Pins	0	N/A	0

Cross-Section:



STORMTANK® Module Volume Calculator

Inputs

Project Name: 21 Withrow Avenue - Storage Tank #2

Engineer: ______ Date: 10/31/2017

Units: SI Shape: Square/Rectangle

Liner: No Location: N/A

Stacking: Single Height: 457.2

Stone Storage: All Porosity: 40%

Dimensions

Module
Length: 22.3 m
Width: 2.1 m

Excavation
Length: 22.9 m
Width: 2.7 m

Stone
Leveling Bed: 0 m
Top Backfill: 0.3 m
Compacted Fill: 0.3 m

Results

Capacity:

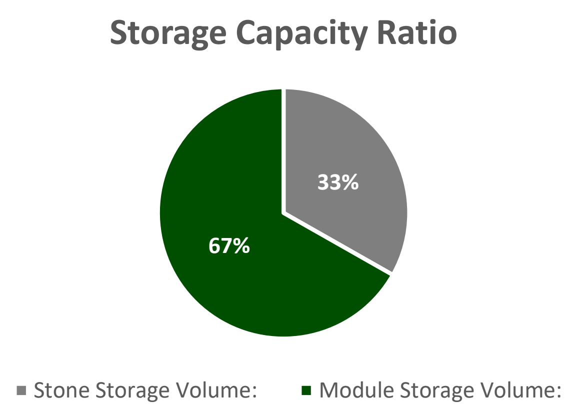
Stone Storage Volume: 10.16 m^3
Module Storage Volume: 20.43 m^3
Total Storage Volume: 30.59 m^3

Quantities:

Required Excavation: 65.37 m^3
Required Stone Volume: 25.41 m^3

Estimated Geotextile: 309.33 m^2
Estimated Liner: 0.00 m^2

(Estimations include 10% for scrap and overlap)

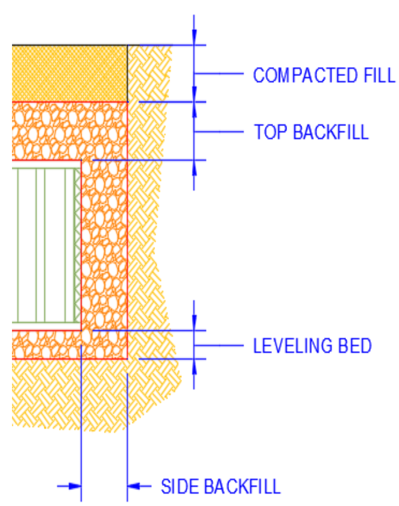


Basin Detail

Component Quantities:

	Bottom Layer	Top Layer	Total
Height	457.2	N/A	457.2
# of Modules	112	N/A	112
# of Platens	224	N/A	224
# of Side Panels	107	N/A	107
# of Columns	896	N/A	896
# of Stacking Pins	0	N/A	0

Cross-Section:



STORMTANK® Module Volume Calculator

Inputs

Project Name:	21 Withrow Avenue - Storage Tank #3		
Engineer:		Date:	2018-06-06
Units:	SI	Shape:	Square/Rectangle
Liner:	No	Location:	N/A
Stacking:	Single	Height:	762
Stone Storage:	All	Porosity:	40%

Dimensions

Module		
Length:	8	m
Width:	10	m
Excavation		
Length:	8.6	m
Width:	10.6	m
Stone		
Leveling Bed:	0	m
Top Backfill:	0.3	m
Compacted Fill:	0.3	m

Results

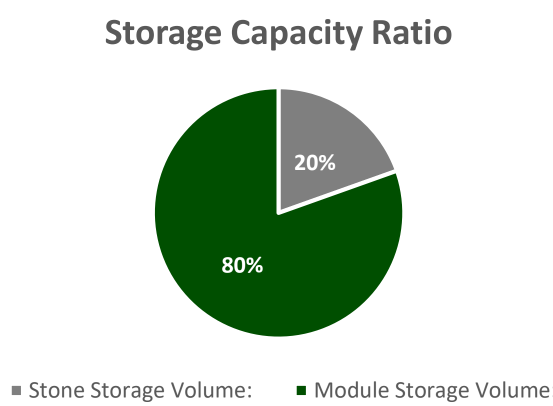
Capacity:

Stone Storage Volume:	14.34	m^3
Module Storage Volume:	59.01	m^3
Total Storage Volume:	73.35	m^3

Quantities:

Required Excavation:	124.16	m^3
Required Stone Volume:	35.85	m^3
Estimated Geotextile:	456.15	m^2
Estimated Liner:	0.00	m^2

(Estimations include 10% for scrap and overlap)

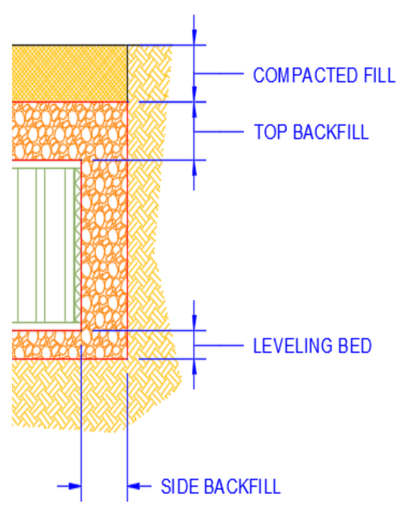


Basin Detail

Component Quantities:

	Bottom Layer	Top Layer	Total
Height	762.0	N/A	762.0
# of Modules	191	N/A	191
# of Platens	383	N/A	383
# of Side Panels	79	N/A	79
# of Columns	1,531	N/A	1,531
# of Stacking Pins	0	N/A	0

Cross-Section:



STORMTANK® Module Volume Calculator

Inputs

Project Name:	21 Withrow Avenue - Storage Tank #4		
Engineer:		Date:	6/6/2018
Units:	SI	Shape:	Square/Rectangle
Liner:	No	Location:	N/A
Stacking:	Single	Height:	762
Stone Storage:	All	Porosity:	40%

Dimensions

Module		
Length:	6	m
Width:	6	m
Excavation		
Length:	6.62	m
Width:	6.62	m
Stone		
Leveling Bed:	0	m
Top Backfill:	0.3	m
Compacted Fill:	0.3	m

Results

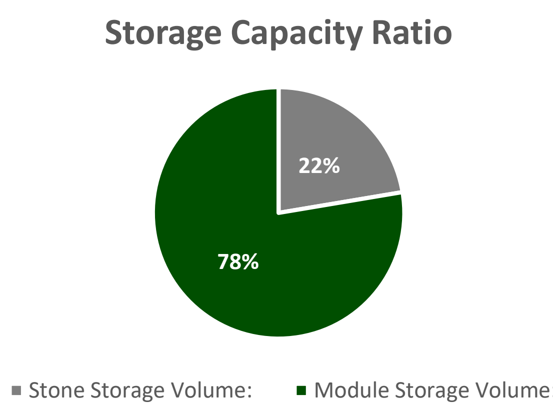
Capacity:

Stone Storage Volume:	7.64	m^3
Module Storage Volume:	26.55	m^3
Total Storage Volume:	34.20	m^3

Quantities:

Required Excavation:	59.69	m^3
Required Stone Volume:	19.11	m^3
Estimated Geotextile:	228.95	m^2
Estimated Liner:	0.00	m^2

(Estimations include 10% for scrap and overlap)

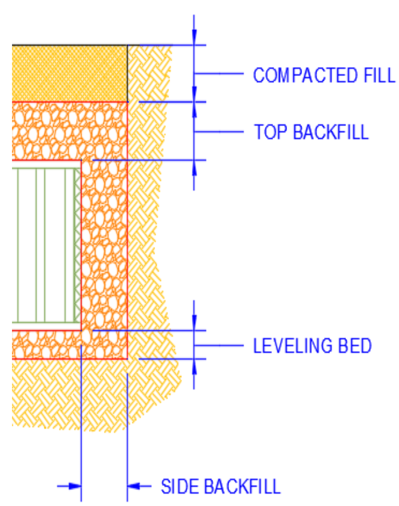


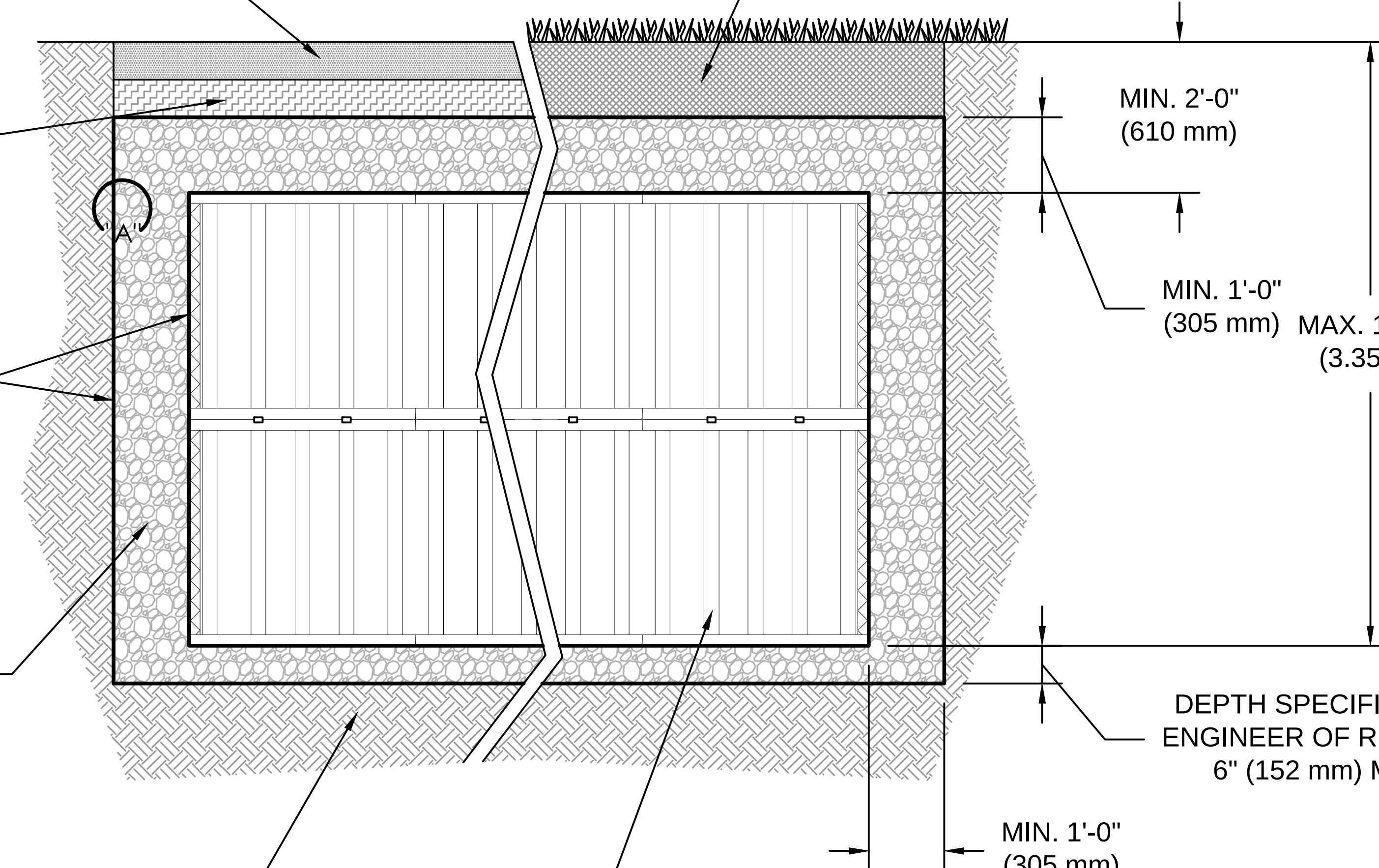
Basin Detail

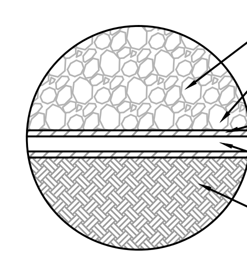
Component Quantities:

	Bottom Layer	Top Layer	Total
Height	762.0	N/A	762.0
# of Modules	86	N/A	86
# of Platens	172	N/A	172
# of Side Panels	52	N/A	52
# of Columns	689	N/A	689
# of Stacking Pins	0	N/A	0

Cross-Section:







DETAIL "A"

NOTES:

a. REFERENCE CURRENT INSTALLATION INSTRUCTIONS FOR PROPER INSTALLATION PRACTICES.

b. IMPERMEABLE LINER IS REQUIRED TO BE INSTALLED AROUND BOTTOM AND SIDES OF EXCAVATION ONLY

REV.	DATE	RECORD OF CHANGES	BY	APPRV.
D	11/10/14	GEOTEXTILE PRODUCT SPECIFIED	CGB	
C	9/9/13	NOTE REVISION, FORMATTING UPDATE & DWG. NO. UPDATE	JKB	JKB
B	7/6/12	FORMATTING & DWG. NO. UPDATE	JKB	FK
A	1/10/12	INITIAL RELEASE	BLL	FK

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Reading, PA 19611 U.S.A.
Phone: (610) 374-5109
Fax: (610) 376-6022
www.brentwoodindustries.com

Project Name
TYPICAL DOUBLE STK. DETENTION BASIN CROSS-SECTION DETAIL

Title
STORMTANK®
MODULE

Drawn By	Date
B.LINE	1/10/12

Drawing No.	Sheet	Scale
STM-001-03	1 of 1	NTS

DESIGN GUIDE

STORMTANK® Module

BRENTWOOD®

Contents

General Notes

1. Brentwood recommends that the installing contractor contact either Brentwood or the local distributor prior to installation of the system to schedule a pre-construction meeting. This meeting will ensure that the installing contractor has a firm understanding of the installation instructions.
2. All systems must be designed and installed to meet or exceed Brentwood's minimum requirements. Although Brentwood offers support during the design, review, and construction phases of the Module system, it is the ultimate responsibility of the Engineer of Record to design the system in full compliance with all applicable engineering practices, laws, and regulations.
3. Brentwood requires a minimum cover of 24" (610 mm) and/or a maximum Module invert of 11' (3.35 m). Additionally, a minimum 6" (152 mm) leveling bed, 12" (305 mm) side backfill, and 12" (305 mm) top backfill are required on every system.
4. Brentwood recommends a minimum bearing capacity and subgrade compaction for all installations. If site conditions are found not to meet any design requirements during installation, the Engineer of Record must be contacted immediately.
5. All installations require a minimum two layers of geotextile fabric. One layer is to be installed around the Modules, and another layer is to be installed between the stone/soil interfaces.
6. Stone backfilling is to follow all requirements of the most current installation instructions.
7. The installing contractor must apply all protective measures to prevent sediment from entering the system during and after installation per local, state, and federal regulations.
8. The StormTank® Module carries a Limited Warranty, which can be accessed at www.brentwoodindustries.com.

1.0 Introduction

About Brentwood

Brentwood is a global manufacturer of custom and proprietary products and systems for the construction, consumer, medical, power, transportation, and water industries. A focus on plastics innovation, coupled with diverse production capabilities and engineering expertise, has allowed Brentwood to build a strong reputation for thermoplastic molding and solutions development.

Brentwood's product and service offerings continue to grow with an ever-increasing manufacturing presence. By emphasizing customer service and working closely with clients throughout the design, engineering, and manufacturing phases of each project, Brentwood develops forward-thinking strategies to create targeted, tailored solutions.

StormTank® Module

The StormTank Module is a strong, yet lightweight, alternative to other subsurface systems and offers the largest void space (up to 97%) of any subsurface stormwater storage unit on the market. The Modules are simple to assemble on site, limiting shipping costs, installation time, and labor. Their structural PVC columns pressure fit into the polypropylene top/bottom platens, with side panels inserted around the perimeter of the system. This open design and lack of internal walls make the Module system easy to clean compared to other subsurface box structures. When properly designed, applied, installed, and maintained, the Module system has been engineered to achieve a 50-year lifespan.

Technical Support

Brentwood's knowledgeable distributor network and in-house associates emphasize customer service and support by partering with customers to extend the process beyond physical material supply. These trained specialists are available to assist in the review of proposed systems, conversions of alternatively designed systems, or to resolve any potential concerns before, during, and after the design process. To provide the best assistance, it is recommended that associates be provided with a site plan and cross-sections that include grading, drainage structures, dimensions, etc.

2.0 Product Information

Applications

The Module system can be utilized for detention, infiltration, capture and reuse, and specialty applications across a wide range of industries, including the commercial, residential, and recreational segments. The product's modular design allows the system to be configured in almost any shape (even around utilities) and to be located under almost any pervious or impervious surface.

Module Selection

Brentwood manufactures the Module in five different heights (Table 1) that can be stacked uniformly up to two Modules high. This allows for numerous height configurations up to 6' (1.83 m) tall. The Modules can be buried up to a maximum invert of 11' (3.35 m) and require a minimum cover of 24" (610 mm) for load rating. When selecting the proper Module, it is important to consider the minimum required cover, any groundwater or limiting zone restrictions, footprint requirements, and all local, state, and federal regulations.

Table 1: Nominal StormTank® Module Specificiations

	ST-18	ST-24	ST-30	ST-33	ST-36
Height	18" (457 mm)	24" (610 mm)	30" (762 mm)	33" (838 mm)	36" (914 mm)
Void Space	95.5%	96.0%	96.5%	96.9%	97.0%
Module Storage Capacity	6.54 ft^3 (0.18 m^3)	8.64 ft^3 (0.24 m^3)	10.86 ft^3 (0.31 m^3)	11.99 ft^3 (0.34 m^3)	13.10 ft^3 (0.37 m^3)
Min. Installed Capacity*	9.15 ft^3 (0.26 m^3)	11.34 ft^3 (0.32 m^3)	13.56 ft^3 (0.38 m^3)	14.69 ft^3 (0.42 m^3)	15.80 ft^3 (0.45 m^3)
Weight	22.70 lbs (10.30 kg)	26.30 lbs (11.93 kg)	29.50 lbs (13.38 kg)	31.3 lbs (14.20 kg)	33.10 lbs (15.01 kg)

Min. Installed Capacity includes the leveling bed, Module, and top backfill storage capacity for one Module. Stone storage capacity is based on 40% void space.* ***Side backfill storage is not included.*

3.0 Manufacturing Standards

Brentwood selects material based on long-term performance needs. To ensure long-term performance and limit component deflection over time (creep), Brentwood selected polyvinyl chloride (PVC) for the Module's structural columns and a virgin polypropylene (PP) blend for the top/bottom and side panels. PVC provides the largest creep resistance of commonly available plastics, and therefore, provides the best performance under loading conditions. Materials like polyethylene (HDPE) and recycled PP have lower creep resistance and are not recommended for load-bearing products and applications.

Materials:

Brentwood's proprietary PVC and PP copolymer resins have been chosen specifically for utilization in the StormTank® Module. The PVC is blended in house by experts and is a 100% blend of post-manuacturing/pre-consumer recycled material. Both materials exhibit structural resilience and naturally resist the chemicals typically found in stormwater runoff.

Methods:

Injection Molding

The Module's top/bottom platens and side panels are injection molded, using proprietary molds and materials. This allows Brentwood to manufacture a product that meets structural requirements while maintaining dimensional control, molded-in traceability, and quality control.

Extrusion

Brentwood's expertise in PVC extrusion allows the structural columns to be manufactured in house. The column extrusion includes the internal structural ribs required for lateral support.

Quality Control

Brentwood maintains strict quality control in order to ensure that materials and the final product meet design requirments. This quality assurance program includes full material property testing in accordance with American Society for Testing and Materials (ASTM) standards, full-part testing, and process testing in order to quantify product performance during manufacturing. Additionally, Brentwood conducts secondary finshed-part testing to verify that design requirements continue to be met post-manufacturing.

All Module parts are marked with traceability information that allows for tracking of manufacturing. Brentwood maintains equipment at all manufacturing locations, as well as at its corporate testing lab, to ensure all materials and products meet all requirements.

4.0 Structural Response

Structural Design

The Module has been designed to resist loads calculated in accordance with the American Association of State Highway and Transportation Official's (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design manual. This fully factored load includes a multiple presence factor, dynamic load allowance, and live load factor to account for real-world situations. This loading was considered when Brentwood developed both the product and installation requirements. The developed minimum cover ensures the system maintains an adequate resistance factor for the design truck (HS-20) and HS-25 loads.

Full-Scale Product Testing

Engineers at Brentwood's in-house testing facility have completed full-scale vertical and lateral tests on the Module to evaluate product response. To date, Brentwood continues in-house testing in order to evaluate long-term creep effects.

Fully Installed System Testing

Brentwood's dedication to providing a premier product extends to fully installed testing. Through a partnership with Queen's University's GeoEngineering Centre in Kingston, Ontario, Brentwood has conducted full-scale installation tests of single- and double-stacked Module systems to analyze short- and long-term performance. Testing includes short-term ultimate limit state testing under fully factored AASHTO loads and minimum installation cover, lateral load testing, long-term performance and lifecycle testing utilizing time-temperature superposition, and load resistance development. Side backfill material tests were also performed to compare the usage of sand, compacted stone, and uncompacted stone.

5.0 Foundation

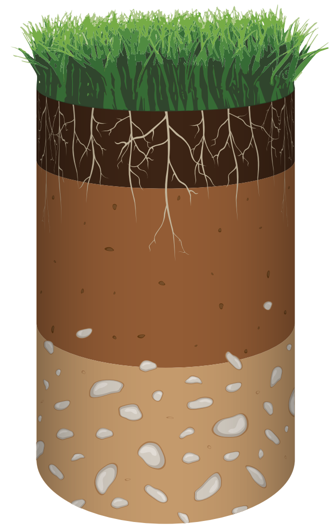
The foundation (subgrade) of the subsurface storage structure may be the most important part of the Module system installation as this is the location where the system applies the load generated at the surface. If the subgrade lacks adequate support or encounters potential settlement, the entire system could be adversely affected. Therefore, when implementing an underground storage solution, it is imperative that a geotechnical investigation be performed to ensure a strong foundation.

Considerations & Requirements:

<u>Bearing Capacity</u>

The bearing capacity is the ability of the soil to resist settlement. In other words, it is the amount of weight the soil can support. This is important versus the native condition because the system is replacing earth, and even though the system weighs less than the earth, the additional load displacement of the earth is not offset by the difference in weight.

Using the Loading and Resistance Factor Design (LRFD) calculation for bearing capacity, Brentwood has developed a conservative minimum bearing capacity table (see Appendix). The Engineer of Record shall reference this table to assess actual cover versus the soil bearing required for each unit system.



Soil Profile

<u>Limiting Zones</u>

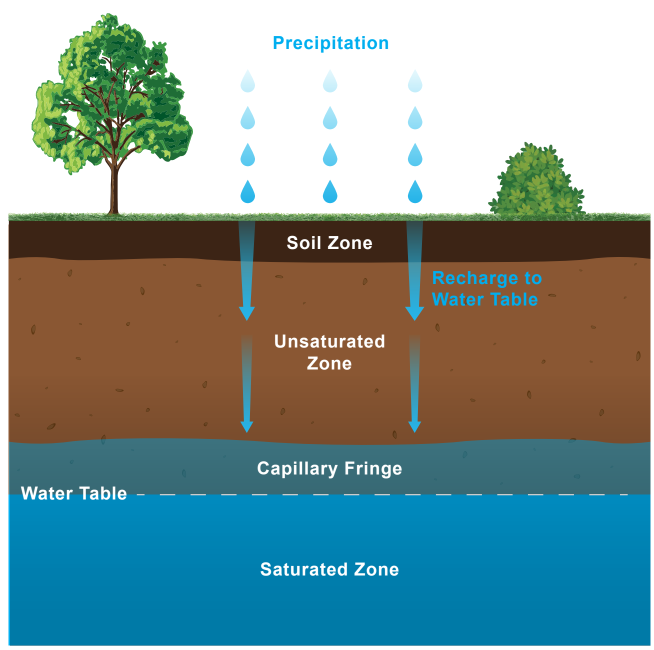
Limiting zones are conditions in the underlying soils that can affect the maximum available depth for installation and can reduce the strength and stability of the underlying subgrade. The three main forms of limiting zones are water tables, bedrock, and karst topography. It is recommended that a system be offset a minimum of 12" (305 mm) from any limiting zones.

<u>Compaction</u>

Soil compaction occurs as the soil particles are pressed together and pore space is eliminated. By compacting the soils to 95% (as recommended by Brentwood), the subgrade strength will increase, in turn limiting both the potential for the soil to move once installed and for differential settlement to occur throughout the system. If designing the specific compaction requirement, settlement should be limited to less than 1" (25 mm) through the entire subgrade and should not exceed a 1/2" (13 mm) of differential settlement between any two adjacent units within the system over time.

<u>Mitigation</u>

If a minimum subgrade bearing capacity cannot be achieved because of weak soil, a suitable design will need to be completed by a Geotechnical Engineer. This design may include the over-excavation of the subgrade and an engineered fill or slurry being placed. Additional material such as geogrid or other products may also be required. Please contact a Geotechnical Engineer prior to selecting products or designing the subgrade.



Water Table Zones

6.0 System Materials

Geotextile Fabric

The 6-ounce geotextile fabric is recommended to be installed between the soil and stone interfaces around the Modules to prevent soil migration.

Leveling Bed

The leveling bed is constructed of 6"-thick (152 mm) angular stone (Table 2). The bed has not been designed as a structural element but is utilized to provide a level surface for the installation of the system and provide an even distribution of load to the subgrade.

Stone Backfill

The stone backfill is designed to limit the strain on the product through displacement of load and ensure the product's longevity. Therefore, a minimum of 12"-wide (305 mm) angular stone must be placed around all sides of the system. In addition, a minimum layer of 12" (305 mm) angular stone is required on top of the system. All material is to be placed evenly in 12" (305 mm) lifts around and on top of the system and aligned with a vibratory plate compactor.

Table 2: Approved Backfill Material

Material Location	Description	AASHTO M43 Designation	ASTM D2321 Class	Compaction/Density
Finished Surface	Topsoil, hardscape, stone, concrete, or asphalt per Engineer of Record	N/A	N/A	Prepare per engineered plans
Suitable Compactable Fill	Well-graded granular soil/aggregate, typically road base or earthen fill (maximum 4" particle size)	56, 57, 6, 67, 68	I & II III (Earth Only)	Place in maximum 12" lifts to a minimum 90% standard proctor density
Top Backfill	Crushed angular stone placed between Modules and road base or earthen fill	56, 57, 6, 67, 68	I & II	Plate vibrate to provide evenly distributed layers
Side Backfill	Crushed angular stone placed between earthen wall and Modules	56, 57, 6, 67, 68	I & II	Place and plate vibrate in uniform 12" lifts around the system
Leveling Bed	Crushed angular stone placed to provide level surface for installation of Modules	56, 57, 6, 67, 68	I & II	Plate vibrate to achieve level surface

Impermeable Liner

In designs that prevent runoff from infiltrating into the surrounding soil (detention or reuse applications) or groundwater from entering the system, an impermeable liner is required. When incorporating a liner as part of the system, Brentwood recommends using a manufactured product such as a PVC liner. This can be installed around the Modules themselves or installed around the excavation (to gain the benefit of the void space in the stone) and should include an underdrain system to ensure the basin fully drains. This liner is installed with a layer of geotextile fabric on both sides to prevent puncture, in accordance with manufacturer recommendations.

7.0 Connections

Stormwater runoff must be able to move readily in and out of the StormTank® Module system. Brentwood has developed numerous means of connecting to the system, including inlet/outlet ports and direct abutment to a catch basin or endwall. All methods of connection should be evaluated as each one may offer a different solution. Brentwood has developed drawings to assist with specific installation methods, and these are available at www.brentwoodindustries.com.

Inlet/Outlet and Pipe Connections

To facilitate easy connection to the system, Brentwood manufactures two inlet/outlet ports. They are 12" (305 mm) and 14" (356 mm), respectfully, and utilize a flexible coupling connection to the adjoining pipe.

Another common installation method is to directly connect the pipe to the system. In order to do this, an opening is cut into the side panels, the pipe is inserted, and then the system is wrapped in geotextile fabric. When utilizing this connection method, the pipe must be located a minimum of 3" (76 mm) from the bottom of the system. This provides adequate clearance for the bottom platen and the required strength in the remaining side panel. To maintain the required clearances or reduce pipe size, it may be necessary to connect utilizing a manifold system.

Direct Abutment

The system can also be connected by directly abutting Modules to a concrete catch basin or endwall. This allows for a seamless connection of structures in close proximity to the system and eliminates the need for numerous pipe connections. When directly abutting one of these structures, remove any side panels that fully abut the structure, and make sure it is flush with the system to prevent material migration into the structure.

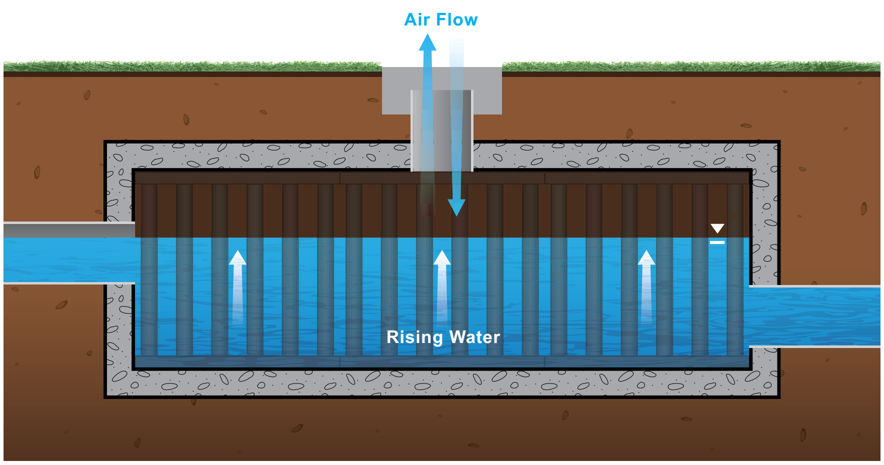
Underdrain

Underdrains are typically utilized in detention applications to ensure the system fully drains since infiltration is limited or prohibited. The incorporation of an underdrain in a detention application will require an impermeable liner between the stone-soil interface.

Cleanout Ports

Brentwood understands the necessity to inspect and clean a subsurface system and has designed the Module without any walls to allow full access. Brentwood offers three different cleanout/observation ports for utilization with the system. The ports are made from PVC, provide an easy means of connection, and are available in 6" (152 mm), 8" (203 mm) and 10" (254 mm) diameters. The 10" (254 mm) port is sized to allow access to the system by a vacuum truck suction hose for easy debris removal.

It is recommended that ports be located a maximum of 30' (9.14 m) on center to provide adequate access, ensure proper airflow, and allow the system to completely fill.



Ventilation and Air Flow

8.0 Pretreatment

Removing pollutants from stormwater runoff is an important component of any stormwater management plan. Pretreatment works to prevent water quality deterioration and also plays an integral part in allowing the system to maintain performance over time and increase longevity. Treatment products vary in complexity, design, and effectiveness, and therefore, should be selected based on specific project requirements.

Typical Stormwater System

Catch Basin → Inlet Piping → Pretreatment → Storage Basin → Outlet Structure

Pretreatment: STORMTANK® Shield

Storage Basin: STORMTANK® Module, STORMTANK® Pack

StormTank® Shield

Brentwood's StormTank Shield provides a low-cost solution for stormwater pretreatment. Designed to improve sumped inlet treatment, the Shield reduces pollutant discharge through gross sediment removal and oil/water separation. For more information, please visit www.brentwoodindustries.com.

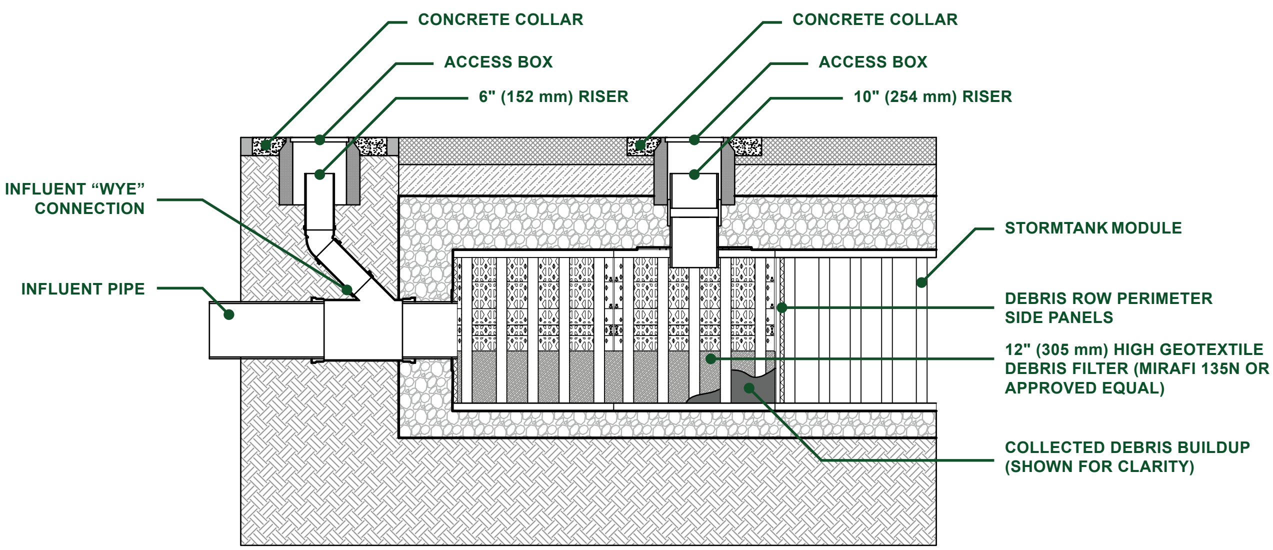
Debris Row (Easy Cleanout)

An essential step of designing, installing, and maintaining a subsurface system is preventing debris from entering the storage. This can be done by incorporating debris rows (or bays) at the inlets of the system to prevent debris from entering the rest of the system.

The debris row is built into the system utilizing side panels with a 12" (305 mm) segment of geotextile fabric. This allows for the full basin capacity to be utilized while storing any debris in an easy-to-remove location. To calculate the number of side panels required to prevent backing up, the opening area of the side panels on the area above the geotextile fabric has been calculated and compared to the inflow pipe diameter.

Debris row cleanout is made easy by including 10" (254 mm) suction ports, based on the length of the row, and a 6" (152 mm) saddle connection to the inflow pipe. If the system is directly abutting a catch basin, the saddle connection is not required, and the flush hose can be inserted through the catch basin. Debris is then flushed from the inlet toward the suction ports and removed.

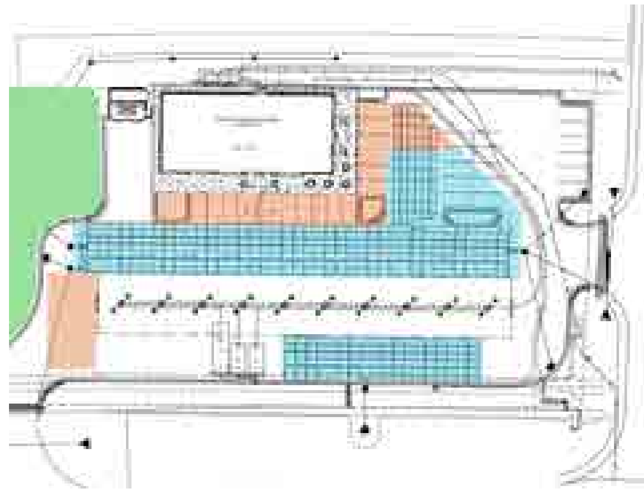
Brentwood has developed drawings and specifications that are available at www.brentwoodindustries.com to illustrate the debris row configuration and layouts.



Debris Row Section Detail

9.0 Additional Considerations

Many variable factors, such as the examples below, must be taken into consideration when designing a StormTank® Module system. As these considerations require complex calculations and proper planning, please contact Brentwood or your local distributor to discuss project-specific requirements.



Site Plan Module Layout Adaptability
(StormTank Modules shown in blue)

Adaptability

The Modules can be arranged in custom configurations to meet tight site constraints and to provide different horizontal and edge configurations. Modules can also be stacked, to a maximum 2 units tall, to meet capacity needs and can be buried to a maximum invert of 11' (3.35 m) to allow for a stacked system or deeper burial.

Adjacent Structures

The location of adjacent structures, especially the location of footings and foundations, must be taken into consideration as part of system design. The foundation of a building or retaining wall produces a load that is transmitted to a footing and then applied to the surface below. The footing is intended to distribute the line load of the wall over a larger area without increasing the larger wall's thickness. The reason this is important is because the load the footing is applying to the earth is distributed through the earth and could potentially affect a subsurface system as either a vertical load to the top of the Module or a lateral load to the side of the Module.

Based on this increased loading, it is recommended that the subsurface system either maintain a distance away from the foundation, footing equal to the height between the Module invert and structure invert of the system, or the foundation or footing extend at a minimum to the invert of the subsurface system. By locating the foundation away from the system or equal to the invert, the loading generated by the structure does not get transferred onto the system. It is recommended that all adjacent structures be completed prior to the installation of the Modules to prevent construction loads from being imparted on the system.

Adjacent Excavation

The subsurface system must be protected before, during, and after the installation. Once a system is installed, it is important to remember that excavation adjacent to the system could potentially cause the system to become unstable. The uniform backfilling will evenly distribute the lateral loads to the system and prohibit the system from becoming unstable and racking from unequal loads. However, it is recommended that any excavation adjacent to a system remain a minimum distance away from the system equal to the invert. This will provide a soil load that is equal to the load applied by the opposite side of the installation. If the excavation is to exceed the invert of the system, additional analysis may be necessary.

Sloped Finished Grade

Much like adjacent excavation, a finished grade with a differential cover could potentially cause a subsurface system to become disproportionately loaded. For example, if one side of the system has 10' (3.05 m) of cover and the adjacent side has 24" (610 mm) of cover, the taller side will generate a higher lateral load, and the opposite side may not have an equal amount of resistance to prevent a racking of the system. Additional evaluation may be required when working on sites where the final grade around a system exceeds 5%.

10.0 Inspection & Maintenance

Description

Proper inspection and maintenance of a subsurface stormwater storage system are vital to ensuring proper product functioning and system longevity. It is recommended that during construction the contractor takes the necessary steps to prevent sediment from entering the subsurface system. This may include the installation of a bypass pipe around the system until the site is stabilized. The contractor should install and maintain all site erosion and sediment per Best Management Practices (BMP) and local, state, and federal regulations.

Once the site is stabilized, the contractor should remove and properly dispose of erosion and sediment per BMP and all local, state, and federal regulations. Care should be taken during removal to prevent collected sediment or debris from entering the stormwater system. Once the controls are removed, the system should be flushed to remove any sediment or construction debris by following the maintenance procedure outlined below.

During the first service year, a visual inspection should be completed during and after each major rainfall event, in addition to semi-annual inspections, to establish a pattern of sediment and debris buildup. Each stormwater system is unique, and multiple criteria can affect maintenance frequency. For example, whether or not a system design includes inlet protection or a pretreatment device has a substantial effect on the system's need for maintenance. Other factors include where the runoff is coming from (hardscape, gravel, soil, etc.) and seasonal changes like autumn leaves and winter salt.

During and after the second year of service, an established annual inspection frequency, based on the information collected during the first year, should be followed. At a minimum, an inspection should be performed semi-annually. Additional inspections may be required at the change of seasons for regions that experience adverse conditions (leaves, cinders, salt, sand, etc).

Maintenance Procedures

Inspection:

1. Inspect all observation ports, inflow and outflow connections, and the discharge area.
2. Identify and log any sediment and debris accumulation, system backup, or discharge rate changes.
3. If there is a sufficient need for cleanout, contact a local cleaning company for assistance.

Cleaning:

1. If a pretreatment device is installed, follow manufacturer recommendations.
2. Using a vacuum pump truck, evacuate debris from the inflow and outflow points.
3. Flush the system with clean water, forcing debris from the system.
4. Repeat steps 2 and 3 until no debris is evident.

11.0 System Sizing

System Sizing Calculation

This section provides a brief description of the process required to size the StormTank® Module system. If you need additional assistance in determining the required number of Modules or assistance with the proposed configuration, it is recommended that you contact Brentwood or your local distributor. Additionally, Brentwood's volume calculator can help you to estimate the available storage volumes with and without stone storage. This tool is available at www.brentwoodindustries.com.

1. Determine the required storage volume (Vs):
It is the sole responsibility of the Engineer of Record to calculate the storage volume in accordance with all local, state, and federal regulations.

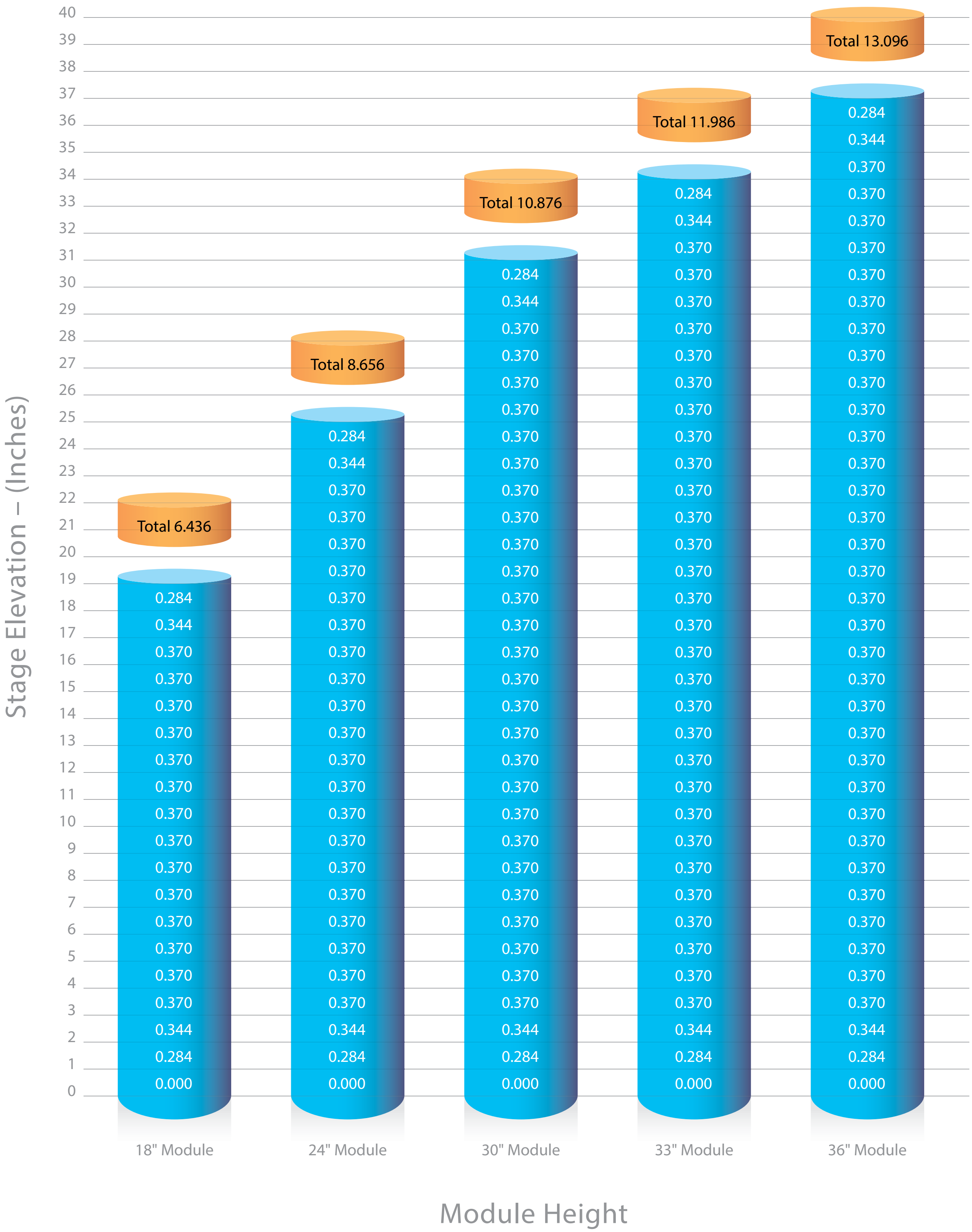
2. Determine the required number of Modules (N):
If the storage volume does not include stone storage, take the total volume divided by the selected Module storage volume. If the stone storage is to be included, additional calculations will be required to determine the available stone storage for each configuration.

3. Determine the required volume of stone (Vstone):
The system requires a minimum 6" (152 mm) leveling bed, 12" (305 mm) backfill around the system, and 12" (305 mm) top backfill utilizing 3/4" (19 mm) angular clean stone. Therefore, take the area of the system times the leveling bed and the top backfill. Once that value is determined, add the volume based on the side backfill width times the height from the invert of the Modules to the top of the Modules.

4. Determine the required excavation volume (Vexcv):
Utilizing the area of the system, including the side backfill, multiply by the depth of the system including the leveling bed. It is noted that this calculation should also include any necessary side pitch or benching that is required for local, state, or federal safety standards.

5. Determine the required amount of geotextile (G):
The system utilizes a multiple layer system of geotextile fabric. Therefore, two calculations are required to determine the necessary amount of geotextile. The first layer surrounds the entire system (including all backfill), and the second layer surrounds the Module system only. It is recommended that an additional 20% be included for waste and overlap.

11.1 Storage Volume



11.2 Material Quantity Worksheet

Project Name: ______________________ By: __________

Location: ______________________ Date: __________

System Requirements

Required Storage		ft^3 (m^3)
Number of Modules		Each
Module Storage		ft^3 (m^3)
Stone Storage		ft^3 (m^3)
Module Footprint		ft^2 (m^2) Number of Modules x 4.5 ft^2 (0.42 m^2)
System Footprint w/ Stone		ft^2 (m^2) Module Footprint + 1 ft (0.3048 m) to each edge
Stone		Tons (kg) Leveling Bed + Side Backfill + Top Backfill
Volume of Excavation		yd^3 (m^3) System Footprint w/ Stone x Total Height
Area of Geotextile		yd^2 (m^2) Wrap around Modules + Wrap around Stone/Soil Interface

System Cost

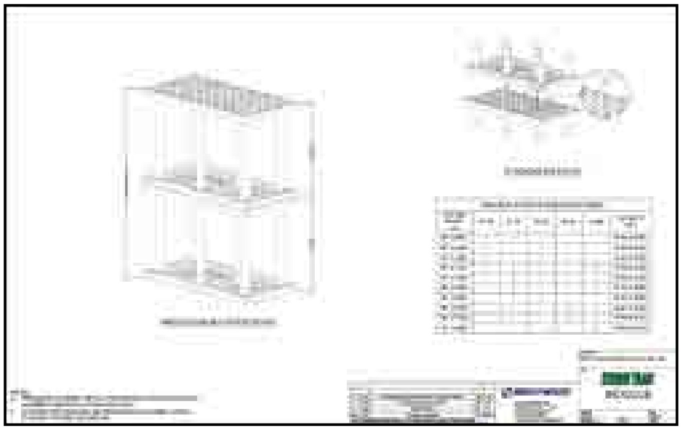
	Quantity			**Unit Price**			**Total**
Modules		ft^3 (m^3)	**X**	$	ft^3 (m^3)	=	$
Stone		Tons (kg)	**X**	$	Tons (kg)	=	$
Excavation		yd^3 (m^3)	**X**	$	yd^3 (m^3)	=	$
Geotextile		yd^2 (m^2)	**X**	$	yd^2 (m^2)	=	$
						Subtotal =	$
						Tons =	$

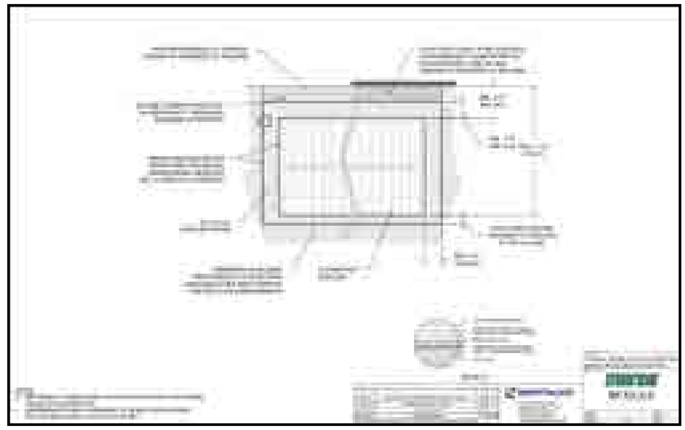
Material costs may not include freight.

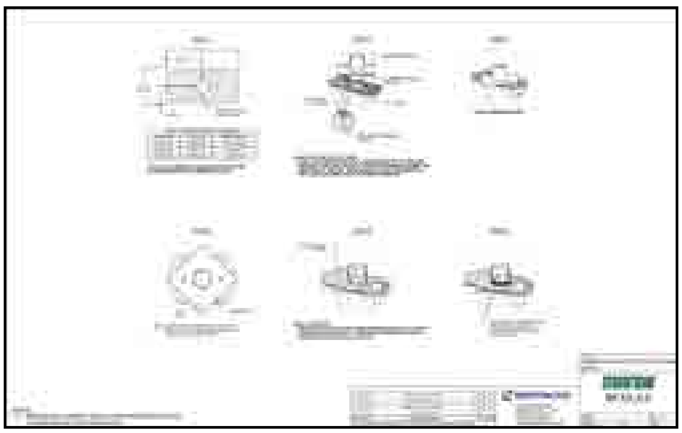
Please contact Brentwood or your local distributor for this information.

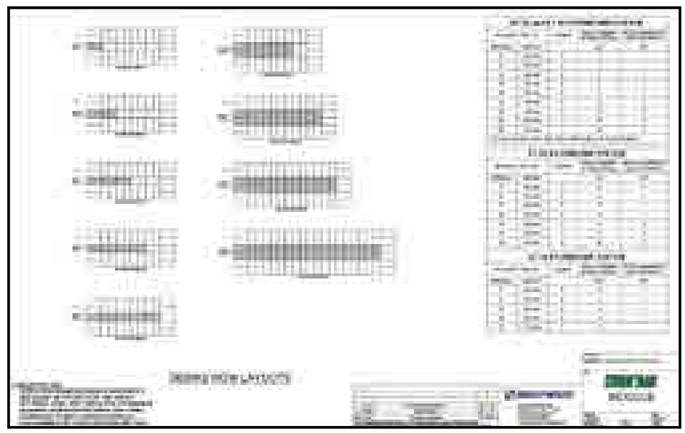
12.0 Detail Drawings

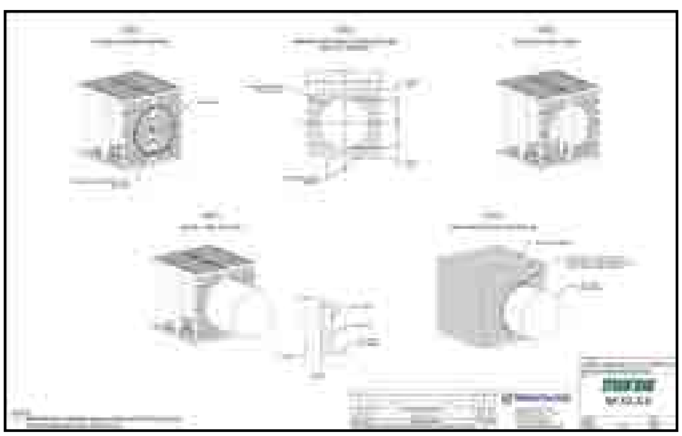
Brentwood has developed numerous drawings for utilization when specifying a StormTank® Module system. Below are some examples of drawings available at www.brentwoodindustries.com.

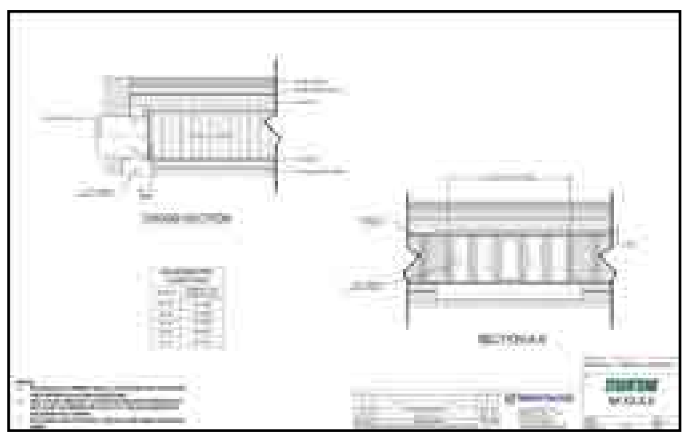












13.0 Specifications

1) General

a) This specification shall govern the implementation, performance, material, and fabrication pertaining to the subsurface stormwater storage system. The subsurface stormwater storage system shall be manufactured by Brentwood Industries, Inc., 500 Spring Ridge Drive, Reading, PA 19610 (610.374.5109), and shall adhere to the following specification at the required storage capacities.

b) All work is to be completed per the design requirements of the Engineer of Record and to meet or exceed the manufacturer's design and installation requirements.

2) Subsurface Stormwater Storage System Modules

a) The subsurface stormwater storage system shall be constructed from virgin polypropylene and 100% recycled PVC to meet the following requirements:

i) High-Impact Polypropylene Copolymer Material

(1) Injection molded, polypropylene, top/bottom platens and side panels formed to a dimension of 36" (914 mm) long by 18" (457 mm) wide [nominal].

ii) 100% Recycled PVC Material

(1) PVC conforming to ASTM D-1784 Cell Classification 12344 b-12454 B.

(2) Extruded, rigid, and 100% recycled PVC columns sized for applicable loads as defined by Section 3 of the AASHTO LRFD Bridge Design Specifications and manufactured to the required length per engineer-approved drawings.

iii) Platens and columns are assembled on site to create Modules, which can be uniformly stacked up to two Modules high, in vertical structures of variable height (custom for each project).

iv) Modular stormwater storage units must have a minimum 95% void space and be continuously open in both length and width, with no internal walls or partitions.

3) Submittals

a) Only systems that are approved by the engineer will be allowed.

b) At least 10 days prior to bid, submit the following to the engineer to be considered for pre-qualification to bid:

i) A list of materials to be provided for work under this article, including the name and address of the materials producer and the location from which the materials are to be obtained.

ii) Three hard copies of the following:

(1) Shop drawings.

(2) Specification sheets.

(3) Installation instructions.

(4) Maintenance guidelines.

c) Subsurface Stormwater Storage System Component Samples for review:

i) Subsurface stormwater storage system Modules provide a single 36" (914 mm) long by 18" (457 mm) wide, height as specified, unit of the product for review.

ii) Sample to be retained by owner.

d) Manufacturers named as acceptable herein are not required to submit samples.

4) Structural Design

a) The structural design, backfill, and installation requirements shall ensure the loads and load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 3 are met.

b) Product shall be tested under minimum installation criteria for short-duration live loads that are calculated to include a 20% increase over the AASHTO Design Truck standard with consideration for impact, multiple vehicle presences, and live load factor.

c) Product shall be tested under maximum burial criteria for long-term dead loads.

d) The engineer may require submission of third-party test data and results in accordance with items 4b and 4c to ensure adequate structural design and performance.

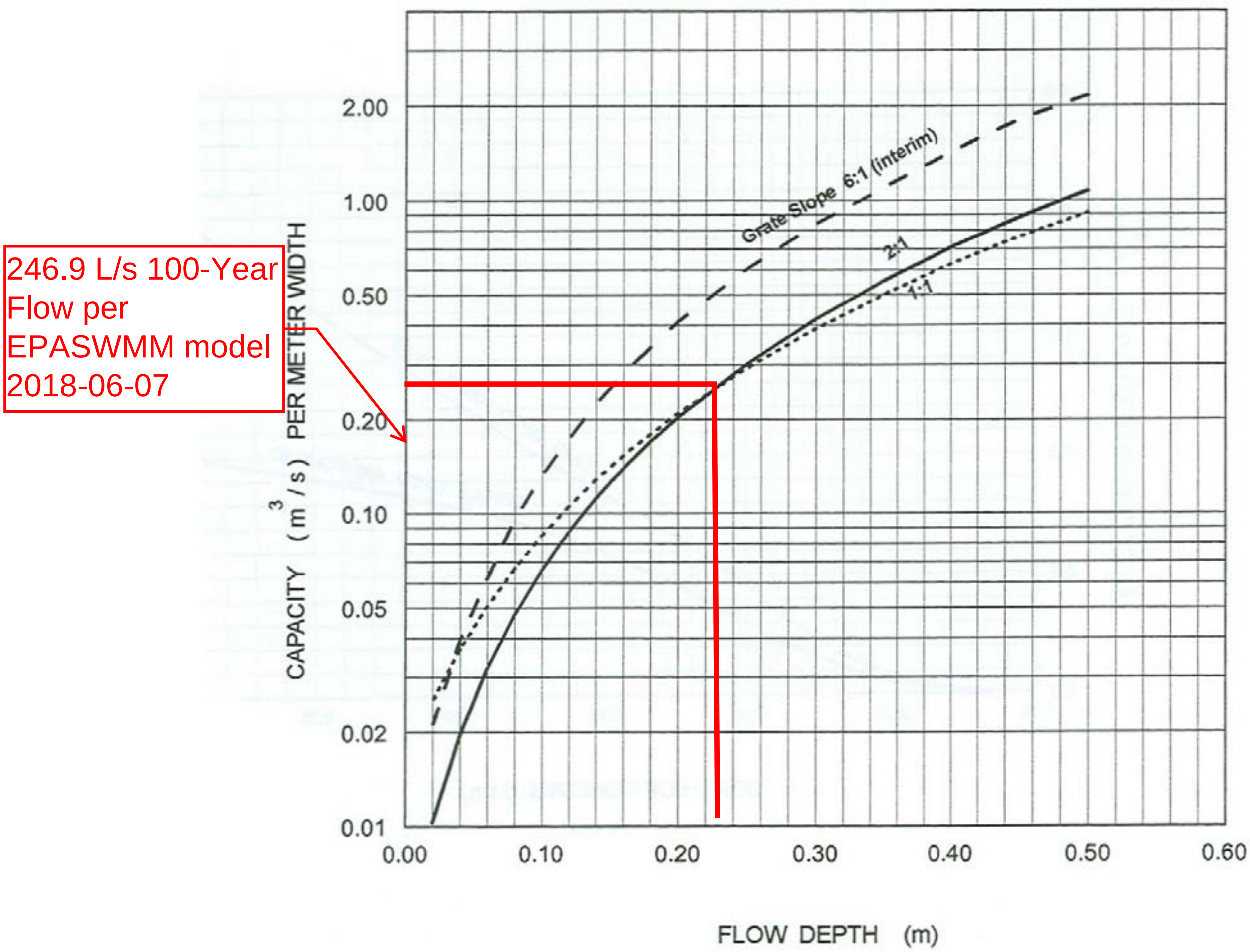
14.0 Appendix - Bearing Capacity Tables

Cover		HS-25 (Unfactored)		HS-25 (Factored)	
English (in)	Metric (mm)	English (ksf)	Metric (kPa)	English (ksf)	Metric (kPa)
24	610	1.89	90.45	4.75	227.43
25	635	1.82	86.96	4.53	216.90
26	660	1.75	83.78	4.34	207.80
27	686	1.69	80.88	4.16	199.18
28	711	1.63	78.24	3.99	191.04
29	737	1.58	75.82	3.84	183.86
30	762	1.54	73.62	3.70	177.16
31	787	1.50	71.60	3.57	170.93
32	813	1.46	69.75	3.45	165.19
33	838	1.42	68.06	3.34	159.92
34	864	1.39	66.51	3.24	155.13
35	889	1.36	65.10	3.14	150.34
36	914	1.33	63.80	3.05	146.03
37	940	1.31	62.62	2.97	142.20
38	965	1.29	61.54	2.90	138.85
39	991	1.26	60.55	2.83	135.50
40	1,016	1.25	59.65	2.76	132.15
41	1,041	1.23	58.54	2.70	129.28
42	1,067	1.21	58.09	2.67	127.84
43	1,092	1.20	57.42	2.60	124.49
44	1,118	1.19	56.81	2.55	122.09
45	1,143	1.18	56.26	2.50	119.70
46	1,168	1.16	55.77	2.46	117.79
47	1,194	1.16	55.33	2.42	115.87
48	1,219	1.15	54.94	2.39	114.43
49	1,245	1.14	54.59	2.36	113.00
50	1,270	1.13	54.29	2.33	111.56
51	1,295	1.13	54.03	2.30	110.12
52	1,321	1.12	53.80	2.27	108.69
53	1,346	1.12	53.62	2.25	107.73
54	1,372	1.12	53.46	2.23	106.77
55	1,397	1.11	53.34	2.21	105.82
56	1,422	1.11	53.24	2.19	104.86
57	1,448	1.11	53.18	2.17	103.90
58	1,473	1.11	53.14	2.16	103.42
59	1,499	1.11	53.12	2.14	102.46
60	1,524	1.11	53.13	2.13	101.98
61	1,549	1.11	53.16	2.12	101.51
62	1,575	1.11	53.21	2.11	101.03
63	1,600	1.11	53.28	2.10	100.55
64	1,626	1.11	53.37	2.09	100.07
65	1,651	1.12	53.48	2.08	99.59
66	1,676	1.12	53.61	2.08	99.59
67	1,702	1.12	53.75	2.07	99.11
68	1,727	1.13	53.91	2.07	99.11
69	1,753	1.13	54.08	2.06	98.63

Cover		HS-25 (Unfactored)		HS-25 (Factored)	
English (in)	Metric (mm)	English (ksf)	Metric (kPa)	English (ksf)	Metric (kPa)
70	1,778	1.13	54.26	2.06	98.63
71	1,803	1.14	54.46	2.06	98.63
72	1,829	1.14	54.67	2.06	98.63
73	1,854	1.15	54.90	2.06	98.63
74	1,880	1.15	55.13	2.06	98.63
75	1,905	1.16	55.38	2.06	98.63
76	1,930	1.16	55.64	2.06	98.63
77	1,956	1.17	55.90	2.06	98.63
78	1,981	1.17	56.18	2.06	98.63
79	2,007	1.18	56.46	2.07	99.11
80	2,032	1.19	56.76	2.07	99.11
81	2,057	1.19	57.06	2.07	99.11
82	2,083	1.20	57.37	2.08	99.59
83	2,108	1.20	57.69	2.08	99.59
84	2,134	1.21	58.02	2.09	100.07
85	2,159	1.22	58.35	2.09	100.07
86	2,184	1.23	58.69	2.10	100.55
87	2,210	1.23	59.04	2.11	101.03
88	2,235	1.24	59.39	2.11	101.03
89	2,261	1.25	59.75	2.12	101.51
90	2,286	1.26	60.11	2.13	101.98
91	2,311	1.26	60.48	2.13	101.98
92	2,337	1.27	60.86	2.14	102.46
93	2,362	1.28	61.24	2.15	102.94
94	2,388	1.29	61.62	2.16	103.42
95	2,413	1.30	62.01	2.17	103.90
96	2,438	1.30	62.41	2.18	104.38
97	2,464	1.31	62.81	2.19	104.86
98	2,489	1.32	63.21	2.20	105.34
99	2,515	1.33	63.62	2.21	105.82
100	2,540	1.34	64.03	2.22	106.29
101	2,565	1.35	64.45	2.23	106.77
102	2,591	1.35	64.87	2.24	107.25
103	2,616	1.36	65.29	2.25	107.73
104	2,642	1.37	65.72	2.27	108.69
105	2,667	1.38	66.15	2.28	109.17
106	2,692	1.39	66.58	2.29	109.65
107	2,718	1.40	67.02	2.30	110.12
108	2,743	1.41	67.45	2.31	110.60
109	2,769	1.42	67.90	2.33	111.56
110	2,794	1.43	68.34	2.34	112.04
111	2,819	1.44	68.79	2.35	112.52
112	2,845	1.45	69.24	2.36	113.00
113	2,870	1.46	69.69	2.38	113.96
114	2,896	1.47	70.15	2.39	114.43

BRENTWOOD INDUSTRIES, INC.
brentwoodindustries.com
stormtank@brentw.com
+1.610.374.5109

Design Chart 4.20: Ditch Inlet Capacity



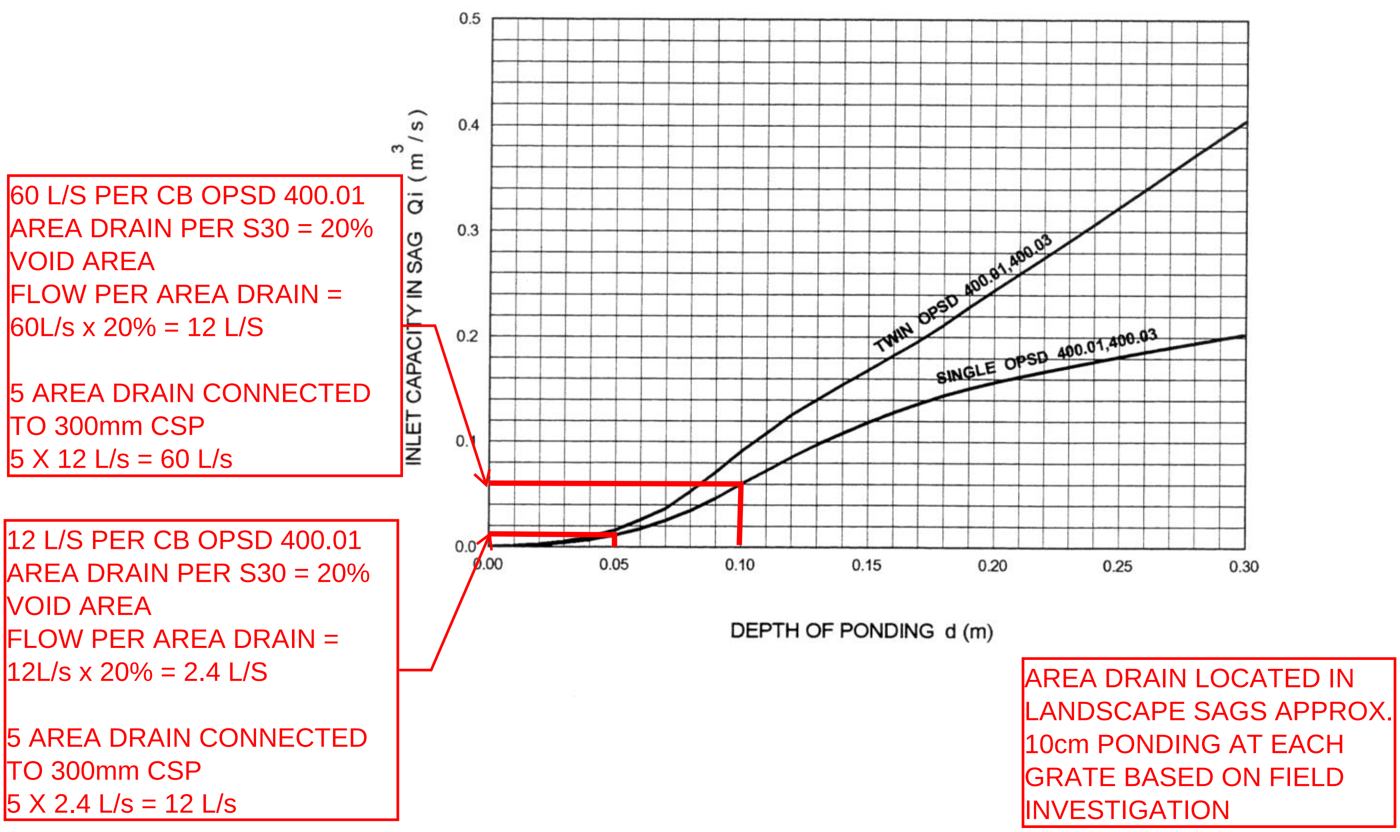
Notes:

1. Curves apply to grate Type 403.01, but may be used for straight - bar inlets without significant loss of accuracy.
2. Capacities given by curves are for unobstructed grates only. For design use working capacity ≯ 0.5 x unobstructed capacity.
3. Capacities of grates operating in high velocity flows are less than indicated.

Surface Inlet Capacity At Road Sags[8]

Design Charts

Design Chart 4.19: Inlet Capacity at Road Sag



103

[8] From the *MTO Drainage Management Manual*

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... LPS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Starting Date ............ JAN-01-2000 00:01:00
Ending Date .............. JAN-02-2000 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:01:00
Dry Time Step ............ 00:01:00
Routing Time Step ........ 2.00 sec


WARNING 03: negative offset ignored for Link 4

**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.157        82.291
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.080        41.755
Surface Runoff ...........         0.076        40.020
Final Surface Storage ....         0.001         0.575
Continuity Error (%) .....        -0.072


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.076         0.763
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.170         1.703
External Outflow .........         0.049         0.494
Internal Outflow .........         0.195         1.948
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.000         0.001
Final Stored Volume ......         0.001         0.008
Continuity Error (%) .....         0.737
```

****
Highest Continuity Errors
****
Node AD (1.53%)

****
Time-Step Critical Elements
****
None

****
Highest Flow Instability Indexes
****
All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	1.83 sec
Average Time Step	:	2.00 sec
Maximum Time Step	:	2.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.01

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
EX12	82.29	0.00	0.00	31.62	49.89	0.10	93.22	0.606
EX13	82.29	0.00	0.00	31.69	49.82	0.28	259.72	0.605
EX15	82.29	0.00	0.00	7.63	73.33	0.05	27.80	0.891
EX1-EX2-EX3-A1	82.29	0.00	0.00	51.29	30.69	0.27	97.80	0.373
A2	82.29	0.00	0.00	48.28	33.84	0.07	41.65	0.411

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min
STM12	JUNCTION	0.81	0.81	96.01	0 00:00
STM13	JUNCTION	0.94	1.17	96.25	0 00:00
AD	JUNCTION	0.12	0.85	96.75	0 01:51
STM15	OUTFALL	1.06	1.06	96.02	0 00:00
5	OUTFALL	0.00	0.00	0.00	0 00:00
AD-D	STORAGE	0.00	0.10	96.85	0 01:52

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr
STM12	JUNCTION	0.00	159.19	0 00:00	0.000	1.933
STM13	JUNCTION	259.63	259.63	0 01:59	0.278	1.982
AD	JUNCTION	0.00	60.00	0 01:52	0.000	0.089
STM15	OUTFALL	27.78	217.95	0 00:00	0.046	1.857
5	OUTFALL	132.60	132.60	0 01:59	0.340	0.340
AD-D	STORAGE	93.19	93.19	0 01:58	0.099	0.099

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
STM12	JUNCTION	23.97	0.510	0.000
STM13	JUNCTION	23.98	0.785	0.000
AD	JUNCTION	0.33	0.550	0.000
AD-D	STORAGE	23.98	0.101	0.000

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate LPS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
STM12	23.97	152.83	0 01:59	1.927	0.81
STM13	0.01	174.93	0 00:00	0.001	1.17
AD	0.19	20.69	0 01:51	0.008	0.85

AD-D	0.15	33.18	0 01:59	0.012	0.10

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	E&I Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
AD-D	0.000	3	0	0.000	100	0 01:52	60.00

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow LPS	Max. Flow LPS	Total Volume 10^6 ltr
STM15	100.00	21.51	217.95	1.857
5	23.25	16.92	132.60	0.340
System	61.62	38.43	313.44	2.197

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
1	CONDUIT	46.23	0 01:54	0.65	1.03	1.00
2	CONDUIT	159.19	0 00:00	2.73	1.93	1.00
3	CONDUIT	217.95	0 00:00	2.01	1.65	1.00
4	DUMMY	60.00	0 01:52			

****
Flow Classification Summary
****

		--- Fraction of Time in Flow Class ----								
Conduit	Adjusted /Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0001
2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0001
3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0001

****

Conduit Surcharge Summary
****

Conduit	Hours Full Both Ends	Hours Full Upstream	Hours Full Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
1	0.33	0.33	0.33	0.19	0.19
2	23.97	23.97	23.97	0.13	0.01
3	23.98	23.98	23.98	0.10	0.09

Analysis begun on: Thu Jun 07 07:55:01 2018
Analysis ended on: Thu Jun 07 07:55:01 2018
Total elapsed time: < 1 sec

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... LPS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Starting Date ............ JAN-01-2000 00:01:00
Ending Date .............. JAN-02-2000 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:01:00
Dry Time Step ............ 00:01:00
Routing Time Step ........ 2.00 sec


WARNING 03: negative offset ignored for Link 13

WARNING 03: negative offset ignored for Link 4

**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.157        82.292
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.069        36.080
Surface Runoff ...........         0.087        45.552
Final Surface Storage ....         0.001         0.729
Continuity Error (%) .....        -0.084


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.087         0.868
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.170         1.703
External Outflow .........         0.024         0.238
Internal Outflow .........         0.231         2.308
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.000         0.001
```

```
  Final Stored Volume ......         0.001         0.008
  Continuity Error (%) .....         0.702


  ***************************
  Time-Step Critical Elements
  ***************************
  None


  ********************************
  Highest Flow Instability Indexes
  ********************************
  All links are stable.


  *************************
  Routing Time Step Summary
  *************************
  Minimum Time Step           :     1.83 sec
  Average Time Step           :     2.00 sec
  Maximum Time Step           :     2.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     2.01


  ***************************
  Subcatchment Runoff Summary
  ***************************
```

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
EX12	82.29	0.00	0.00	31.62	49.89	0.10	93.22	0.606
EX13	82.29	0.00	0.00	31.69	49.82	0.28	259.72	0.605
EX15	82.29	0.00	0.00	7.63	73.33	0.05	27.80	0.891
D1-D6	82.29	0.00	0.00	34.58	46.90	0.33	172.95	0.570
EX2	82.29	0.00	0.00	42.92	39.00	0.02	17.33	0.474
EX1,EX3	82.29	0.00	0.00	54.32	27.99	0.08	60.02	0.340
U2	82.29	0.00	0.00	49.57	32.66	0.02	31.22	0.397

```
  ******************
  Node Depth Summary
  ******************

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

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min
AD	JUNCTION	0.15	0.85	96.75	0 01:51
STM12	JUNCTION	0.81	0.81	96.01	0 00:00
STM13	JUNCTION	0.94	1.17	96.25	0 00:00
STM15	OUTFALL	1.06	1.06	96.02	0 00:00
1	OUTFALL	0.00	0.00	97.00	0 00:00
DICB101	STORAGE	0.12	0.88	97.42	0 02:20
AD-D	STORAGE	0.00	0.10	96.85	0 01:52

****

Node Inflow Summary

****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr
AD	JUNCTION	0.00	66.86	0 02:01	0.000	0.454
STM12	JUNCTION	0.00	159.19	0 00:00	0.000	2.296
STM13	JUNCTION	259.63	259.63	0 01:59	0.278	1.982
STM15	OUTFALL	27.78	217.95	0 00:00	0.046	1.857
1	OUTFALL	31.20	74.45	0 02:20	0.024	0.084
DICB101	STORAGE	244.48	246.94	0 01:59	0.420	0.423
AD-D	STORAGE	93.19	93.19	0 01:58	0.099	0.099

****

Node Surcharge Summary

****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
AD	JUNCTION	1.41	0.550	0.000
STM12	JUNCTION	23.97	0.510	0.000
STM13	JUNCTION	23.98	0.785	0.000
AD-D	STORAGE	23.98	0.101	0.000

****

Node Flooding Summary

****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate LPS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
AD	0.22	20.60	0 02:01	0.007	0.85

STM12	23.97	152.83	0 01:59	2.288	0.81
STM13	0.01	174.93	0 00:00	0.001	1.17
AD-D	0.15	33.18	0 01:59	0.012	0.10

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	E&I Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
DICB101	0.039	15	0	0.260	100	0 02:20	95.19
AD-D	0.000	3	0	0.000	100	0 01:52	60.00

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow LPS	Max. Flow LPS	Total Volume 10^6 ltr
STM15	100.00	21.51	217.95	1.857
1	4.82	20.26	74.45	0.084
System	52.41	41.77	217.95	1.941

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
1	CONDUIT	46.23	0 01:54	0.65	1.03	1.00
2	CONDUIT	159.19	0 00:00	2.73	1.93	1.00
3	CONDUIT	217.95	0 00:00	2.01	1.65	1.00
14	CONDUIT	71.47	0 02:20	0.56	0.92	0.96
13	ORIFICE	23.72	0 02:20			1.00
4	DUMMY	60.00	0 01:52			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	--- Fraction of Time in Flow Class ---- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.03	0.0001

2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0001
3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0001
14	1.00	0.97	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.0000

****
Conduit Surcharge Summary
****

Conduit	Hours Full Both Ends	Hours Full Upstream	Hours Full Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
1	1.41	1.41	1.41	0.24	0.24
2	23.97	23.97	23.97	0.13	0.01
3	23.98	23.98	23.98	0.10	0.09

Analysis begun on: Thu Jun 07 07:57:26 2018
Analysis ended on: Thu Jun 07 07:57:27 2018
Total elapsed time: 00:00:01

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... LPS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Starting Date ............ JAN-01-2000 00:01:00
Ending Date .............. JAN-02-2000 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:01:00
Dry Time Step ............ 00:01:00
Routing Time Step ........ 2.00 sec


WARNING 03: negative offset ignored for Link 4

**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.157        82.291
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.076        39.922
Surface Runoff ...........         0.080        41.796
Final Surface Storage ....         0.001         0.634
Continuity Error (%) .....        -0.074


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.080         0.797
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.078         0.780
Internal Outflow .........         0.001         0.013
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.001         0.005
Continuity Error (%) .....        -0.009
```

```
  ***************************
  Time-Step Critical Elements
  ***************************
  Link 13 (27.94%)


  ********************************
  Highest Flow Instability Indexes
  ********************************
  All links are stable.


  *************************
  Routing Time Step Summary
  *************************
  Minimum Time Step           :     0.50 sec
  Average Time Step           :     1.58 sec
  Maximum Time Step           :     2.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     2.01


  ***************************
  Subcatchment Runoff Summary
  ***************************
```

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
EX12	82.29	0.00	0.00	31.62	49.89	0.10	93.22	0.606
EX13	82.29	0.00	0.00	31.69	49.82	0.28	259.72	0.605
EX15	82.29	0.00	0.00	7.63	73.33	0.05	27.80	0.891
EX1-EX2-EX3-A1	82.29	0.00	0.00	47.37	34.49	0.31	116.62	0.419
A2	82.29	0.00	0.00	48.28	33.84	0.07	41.65	0.411

```
  ******************
  Node Depth Summary
  ******************
```

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min
AD	JUNCTION	0.01	0.40	96.80	0 01:57
STM12	JUNCTION	0.02	0.81	96.01	0 01:52

STM13	JUNCTION	0.05	0.91	95.99	0	01:59
STM15	OUTFALL	0.03	0.38	95.34	0	01:55
5	OUTFALL	0.07	0.30	0.30	0	02:15
1	STORAGE	0.16	0.40	0.40	0	02:15
AD-D	STORAGE	0.00	0.00	96.75	0	00:00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr
AD	JUNCTION	93.21	93.21	0 01:59	0.099	0.099
STM12	JUNCTION	0.00	87.73	0 01:59	0.000	0.098
STM13	JUNCTION	259.71	296.33	0 01:59	0.279	0.365
STM15	OUTFALL	27.80	324.13	0 01:59	0.046	0.411
5	OUTFALL	41.64	112.03	0 02:13	0.066	0.369
1	STORAGE	116.62	116.62	0 02:02	0.308	0.308
AD-D	STORAGE	0.00	0.00	0 00:00	0.000	0.000

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
AD	JUNCTION	0.04	0.100	0.000
STM12	JUNCTION	0.19	0.510	0.000
STM13	JUNCTION	0.19	0.524	0.261
AD-D	STORAGE	23.98	0.000	0.101

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate LPS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
AD	0.03	8.50	0 01:57	0.000	0.40
STM12	0.11	51.10	0 01:59	0.012	0.81

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	E&I Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
1	0.015	22	0	0.069	99	0 02:15	94.31
AD-D	0.000	0	0	0.000	0	0 00:00	0.00

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow LPS	Max. Flow LPS	Total Volume 10^6 ltr
STM15	42.84	26.74	324.13	0.411
5	62.30	20.42	112.03	0.369
System	52.57	47.16	377.11	0.780

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
1	CONDUIT	87.73	0 01:59	1.29	0.81	1.00
2	CONDUIT	84.83	0 02:00	1.20	1.03	1.00
3	CONDUIT	296.33	0 01:59	2.68	2.24	1.00
13	CONDUIT	94.31	0 02:15	3.18	0.98	0.99
4	DUMMY	0.00	0 00:00			

****
Flow Classification Summary
****

	Adjusted	--- Fraction of Time in Flow Class ----							Avg.	Avg.
	/Actual		Up	Down	Sub	Sup	Up	Down	Froude	Flow
Conduit	Length	Dry	Dry	Dry	Crit	Crit	Crit	Crit	Number	Change
1	1.00	0.06	0.00	0.00	0.74	0.20	0.00	0.00	0.31	0.0000
2	1.00	0.06	0.00	0.00	0.94	0.00	0.00	0.00	0.14	0.0001
3	1.00	0.06	0.00	0.00	0.78	0.17	0.00	0.00	0.31	0.0001
13	1.00	0.06	0.00	0.00	0.00	0.94	0.00	0.00	1.74	0.0000

****
Conduit Surcharge Summary
****

Conduit	Hours Full Both Ends	Hours Full Upstream	Hours Full Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
1	0.04	0.04	0.04	0.01	0.01
2	0.19	0.19	0.19	0.01	0.01
3	0.06	0.06	0.06	0.25	0.06

Analysis begun on: Wed Jun 06 18:14:00 2018
Analysis ended on: Wed Jun 06 18:14:01 2018
Total elapsed time: 00:00:01

ENHANCED GRASS SWALES

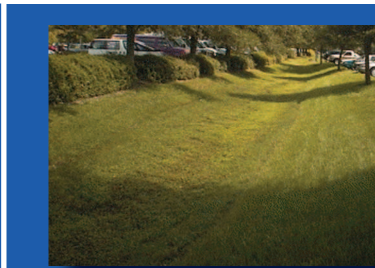
CVC/TRCA LOW IMPACT DEVELOPMENT PLANNING AND DESIGN GUIDE - FACT SHEET

Source: Delaware Department of Transportation

Source: Seattle Public Utilities

Source: Thomas Engineering

Source: Sue Donaldson



Source: CVP

GENERAL DESCRIPTION

Enhanced grass swales are vegetated open channels designed to convey, treat and attenuate stormwater runoff (also referred to as enhanced vegetated swales). Check dams and vegetation in the swale slows the water to allow sedimentation, filtration through the root zone and soil matrix, evapotranspiration, and infiltration into the underlying native soil. Simple grass channels or ditches have long been used for stormwater conveyance, particularly for roadway drainage. Enhanced grass swales incorporate design features such as modified geometry and check dams that improve the contaminant removal and runoff reduction functions of simple grass channel and roadside ditch designs.

Where development density, topography and depth to water table permit, enhanced grass swales are a preferred alternative to both curb and gutter and storm drains as a stormwater conveyance system. When incorporated into a site design, they can reduce impervious cover, accent the natural landscape, and provide aesthetic benefits.

DESIGN GUIDANCE

GEOMETRY AND SITE LAYOUT

- Shape: Should be designed with a trapezoidal or parabolic cross section. Trapezoidal swales will generally evolve into parabolic swales over time, so the initial trapezoidal cross-section design should be checked for capacity and conveyance assuming it is a parabolic cross-section. Swale length between culverts should be 5 metres or greater.
- Bottom Width: Should be designed with a bottom width between 0.75 and 3.0 metres. Should allow for shallow flows and adequate water quality treatment, while preventing flows from concentrating and creating gullies.
- Longitudinal Slope: Slopes should be between 0.5% and 4%. Check dams should be incorporated on slopes greater than 3%.
- Length: When used to convey and treat road runoff, the length simply parallels the road, and therefore should be equal to, or greater than the contributing roadway length.
- Flow Depth: A maximum flow depth of 100 mm is recommended during a 4 hour, 25 mm Chicago storm event.
- Side Slopes: Should be as flat as possible to aid in providing pretreatment for lateral incoming flows and to maximize the swale filtering surface. Steeper side slopes are likely to have erosion gullying from incoming lateral flows. A maximum slope of 2.5:1 (H:V) is recommended and a 4:1 slope is preferred where space permits.

PRE-TREATMENT

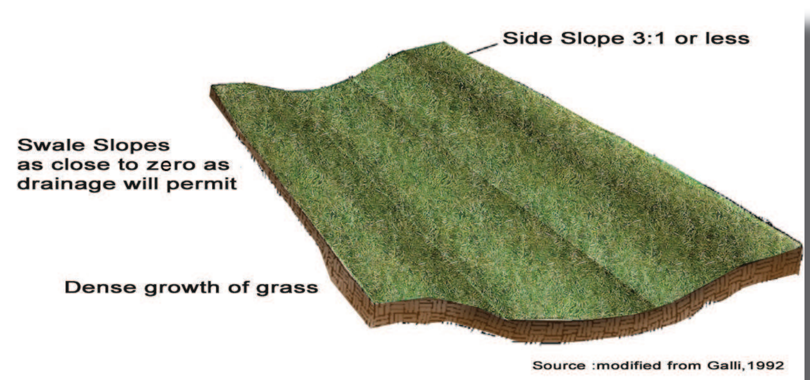
A pea gravel diaphragm located along the top of each bank can be used to provide pretreatment of any runoff entering the swale laterally along its length. Vegetated filter strips or mild side slopes (3:1) also provide pretreatment for any lateral sheet flow entering the swale. Sedimentation forebays at inlets to the swale are also a pretreatment option.

CONVEYANCE AND OVERFLOW

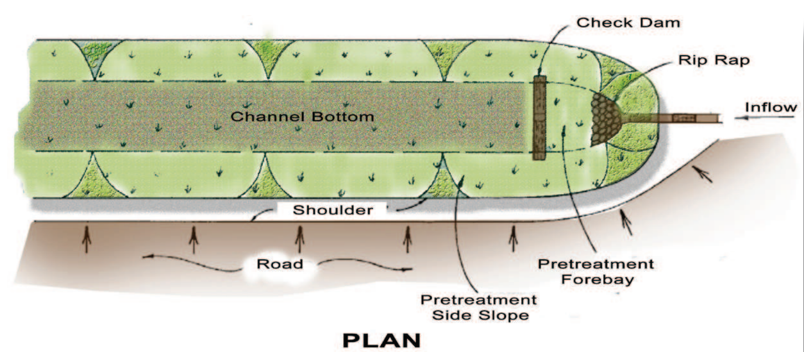
Grass swales must be designed for a maximum velocity of 0.5 m/s or less for the 4 hour 25 mm Chicago storm event. The swale should also convey the locally required design storm (usually the 10 year storm) at non-erosive velocities.

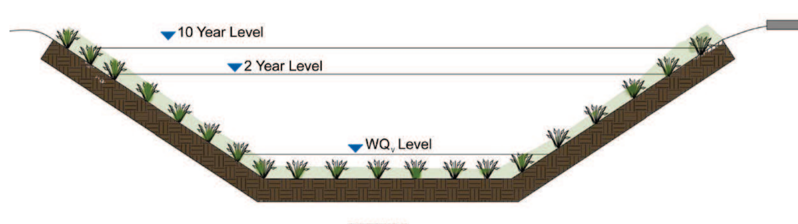
SOIL AMENDMENTS

If soils along the location of the swale are highly compacted, or of such low fertility that vegetation cannot become established, they should be tilled to a depth of 300 mm and amended with compost to achieve an organic content of 8 to 15% by weight or 30 to 40% by volume.



PLAN VIEW OF A GRASS SWALE





PLAN AND PROFILE VIEWS

ABILITY TO MEET SWM OBJECTIVES

BMP	Water Balance Benefit	Water Quality Improvement	Stream Channel Erosion Control Benefit
Enhanced Grass Swale	Partial - depends on soil infiltration rate	Yes, if design velocity is 0.5 m/s or less for a 4 hour, 25 mm Chicago storm	Partial - depends on soil infiltration rate

GENERAL SPECIFICATIONS

Component	Specification	Quantity
Check Dams	Constructed of a non-erosive material such as suitably sized aggregate, wood, gabions, riprap, or concrete. All check dams should be underlain with geotextile filter fabric. Wood used for check dams should consist of pressure treated logs or timbers, or water-resistant tree species such as cedar, hemlock, swamp oak or locust.	Spacing should be based on the longitudinal slope and desired ponding volume.
Gravel Diaphragm	Washed stone between 3 and 10 mm in diameter.	Minimum of 300 mm wide and 600 mm deep.

CONSTRUCTION CONSIDERATIONS

Grass swales should be clearly marked before site work begins to avoid disturbance during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within the swale site. Any accumulation of sediment that does occur within the swale must be removed during the final stages of grading to achieve the design cross-section. Final grading and planting should not occur until the adjoining areas draining into the swale are stabilized. Flow should not be diverted into the swale until the banks are stabilized.

Preferably, the swale should be planted in the spring so that the vegetation can become established with minimal irrigation. Installation of erosion control matting or blanketing to stabilize soil during establishment of vegetation is highly recommended. If sod is used, it should be placed with staggered ends and secured by rolling the sod. This helps to prevent gullies.

OPERATION AND MAINTENANCE

Generally, routine maintenance will be the same as for any other landscaped area; weeding, pruning, and litter removal. Grassed swales should be mown at least twice yearly to maintain grass height between 75 and 150 mm. The lightest possible mowing equipment should be used to prevent soil compaction. Routine roadside ditch maintenance practices such as scraping and re-grading should be avoided. Regular watering may be required during the first two years until vegetation is established. Routine inspection is very important to ensure that dense vegetation cover is maintained and inlets and pretreatment devices are free of debris.

For the first two years following construction the swale should be inspected at least quarterly and after every major storm event (> 25 mm). Subsequently, inspections should be conducted in the spring and fall of each year and after major storm events. Inspect for vegetation density (at least 80% coverage), damage by foot or vehicular traffic, accumulation of debris, trash and sediment, and structural damage to pretreatment devices.

Trash and debris should be removed from pretreatment devices and the surface of the swale at least twice annually. Other maintenance activities include weeding, replacing dead vegetation, repairing eroded areas, dethatching and aerating as needed. Remove accumulated sediment on the swale surface when dry and exceeding 25 mm depth.

SITE CONSIDERATIONS

Available Space
Grass swales usually consume about 5 to 15% of their contributing drainage area. A width of at least 2 metres is needed.

Site Topography
Site topography constrains the application of grass swales. Longitudinal slopes between 0.5 and 6% are allowable. This prevents ponding while providing residence time and preventing erosion. On slopes steeper than 3%, check dams should be used.

Drainage Area & Runoff Volume
The conveyance capacity should match the drainage area. Sheet flow to the grass swale is preferable. If drainage areas are greater than 2 hectares, high discharge through the swale may not allow for filtering and infiltration, and may create erosive conditions. Typical ratios of impervious drainage area to treatment facility area range from 5:1 to 10:1.

Soil
Grass swales can be applied on sites with any type of soils.

Pollution Hot Spot Runoff
To protect groundwater from possible contamination, source areas where land uses or human activities have the potential to generate highly contaminated runoff (e.g., vehicle fueling, servicing and demolition areas, outdoor storage and handling areas for hazardous materials and some heavy industry sites) should not be treated by grass swales.

Proximity to Underground Utilities
Utilities running parallel to the grass swale should be offset from the centerline of the swale. Underground utilities below the bottom of the swale are not a problem.

Water Table
The bottom of the swale should be separated from the seasonally high water table or top of bedrock elevation by at least one (1) metre.

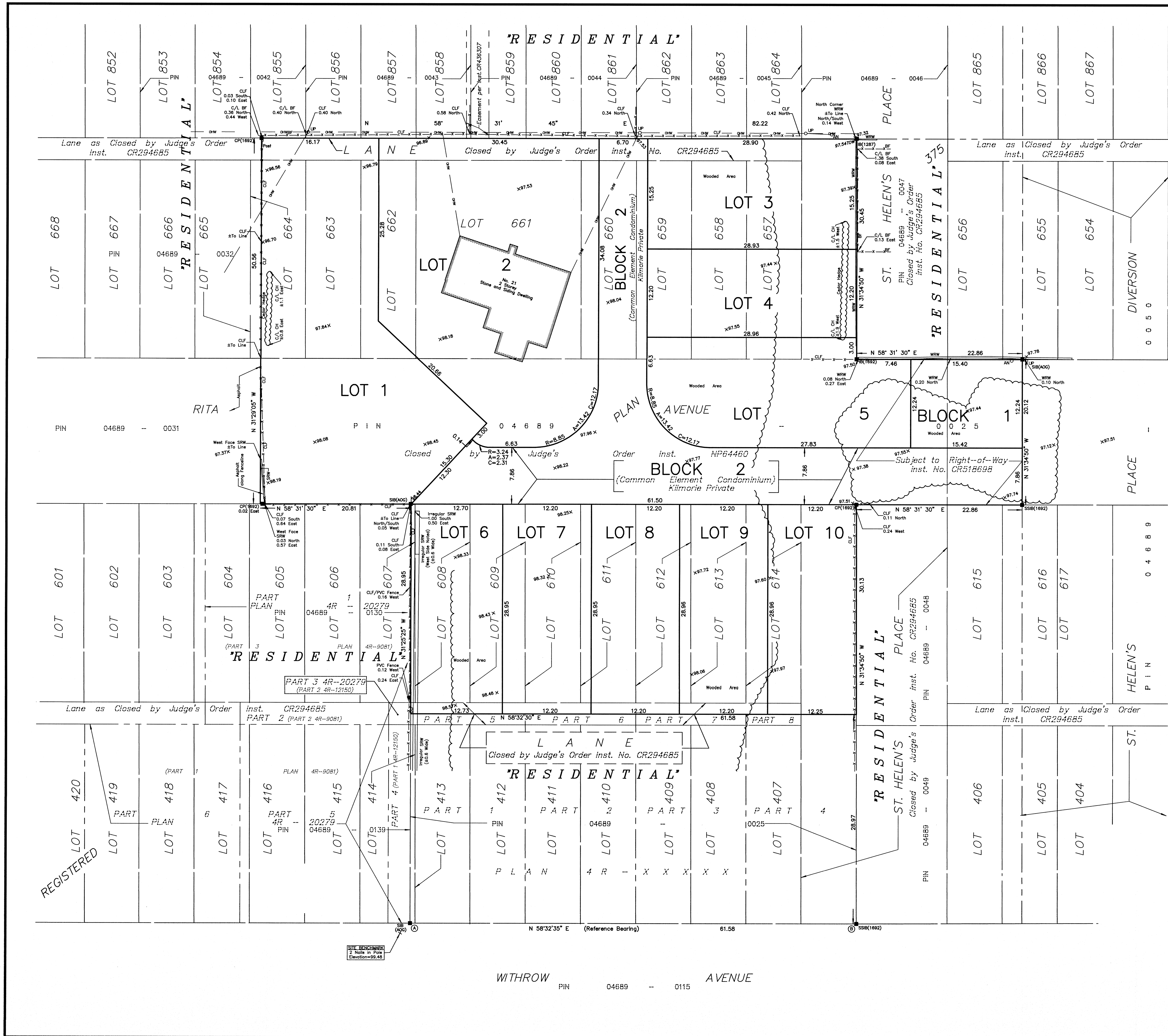
Setback from Buildings
Should be located a minimum of four (4) metres from building foundations to prevent water damage.

TORONTO AND REGION Conservation for The Living City

CVC CREDIT VALLEY CONSERVATION

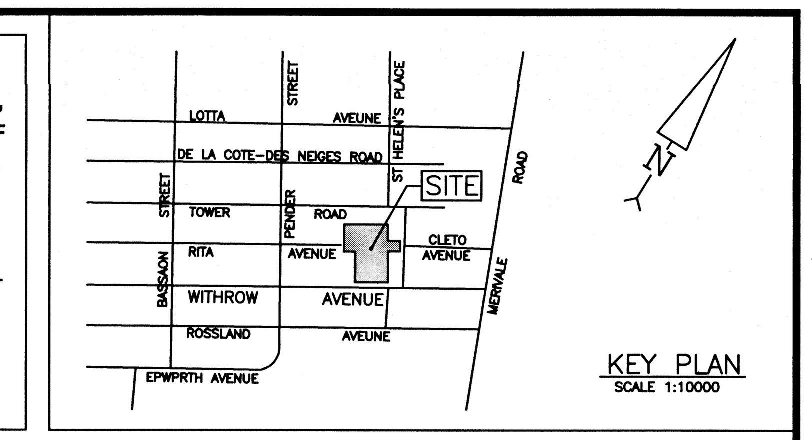
FOR FURTHER DETAILS SEE SECTION 4.8 OF THE CVC/TRCA LID SWM GUIDE

DRAWINGS / FIGURES



SUBJECT TO THE CONDITIONS, IF ANY, SET FORTH IN OUR LETTER DATED ______________, THIS DRAFT PLAN IS APPROVED BY THE CITY OF OTTAWA UNDER SECTION 51 OF THE PLANNING ACT THIS ______ DAY OF ________, 2017.

Don Herweyer, MCIP, RPP, ACTING Manager
Development Review, Urban Services
Planning, Infrastructure and Economic Development Department, City of Ottawa



DRAFT PLAN OF SUBDIVISION OF

LOTS 608, 609, 610, 611, 612, 613, 614, 657, 658, 659, 660, 661, 662, 663 AND PART OF LOTS 607, 664 AND PART OF THE ADJACENT LANES (Closed by Judge's Order Inst.CR294685) AND PART OF RITA AVENUE (Closed by Judge's Order Inst. NP64460) AND PART OF ST.HELENS'S PLACE (Closed by Judge's Order Inst. CR294685) REGISTERED PLAN 375 CITY OF OTTAWA

FARLEY, SMITH & DENIS SURVEYING LTD. 2017

Scale 1: 250

0 2.5 5 7.5 10 12.5 15 20 25 metres

Metric Note

Distances and coordinates on this plan are in metres and can be converted to feet by dividing by 0.3048.

Bearing Note

Bearings hereon are grid bearings and are referred to the Northerly limit of Withrow Avenue as shown on a Surveyor's Real Property Report by Farley, Smith & Denis Surveying Ltd. dated November 11, 2015, being N 58°32'35" E.

Elevation Note

Elevations are geodetic.

CO-ORDINATES WERE DERIVED FROM SMART-NET REAL TIME NETWORK OBSERVATIONS, MTM, N.A.D. 1983 (ORIGINAL) ZONE 9.

POINT ID	NORTHING	EASTING
(A)	5024100.09	364422.83
(B)	5024132.26	364475.42
01919680005	5027191.26	361496.76
01919750705	5016816.93	360806.84

CO-ORDINATES ARE MTM, N.A.D. 1983 (ORIGINAL) ZONE 9, TO URBAN ACCURACY PER SEC. 14 (2) OF O.REG. 216/10, AND CANNOT, IN THEMSELVES, BE USED TO RE-ESTABLISH CORNERS OR BOUNDARIES SHOWN ON THIS PLAN.

Owner's Certificate

I hereby authorize Farley, Smith & Denis Surveying Ltd. to submit this draft plan of subdivision on our behalf.

November 1, 2017
Date

Joey Theberge
Theberge Homes Ltd.

Surveyor's Certificate

I certify that :
The boundaries of the lands to be subdivided and their relationship to adjoining lands are accurately can correctly shown.

November 1, 2017
Date

Ronald A. Denis
Ontario Land Surveyor

Additional Information

(a) See Plan
(b) See Key Plan
(c) See Plan
(d) Residential
(e) See Plan
(f) See Plan
(g) See Plan
(h) Municipal Water
(i) See Soil Report
(j) See Plan
(k) All Municipal Services
(l) See Plan

Notes & Legend

—□—	Denotes	Survey Monument Planted
—■—	"	Survey Monument Found
SIB	"	Standard Iron Bar
IB	"	Iron Bar
SSIB	"	Short Standard Iron Bar
CP	"	Concrete Pin
1692/1287	"	Farley, Smith & Denis Surveying Ltd.
AOG	"	Annis, O'Sullivan & Goltz Ltd.
—— OHW ——	"	Overhead Wires
OUP	"	Utility Pole
O AN	"	Anchor
BF	"	Board Fence
CLF	"	Chain Link Fence
PVC	"	Plastic Fence
CRW	"	Concrete Retaining Wall
SRW	"	Stone Retaining Wall
WRW	"	Wood Retaining Wall
C/L	"	Centreline
Ø	"	Diameter
+ 65.00	"	Location of Elevations

FARLEY, SMITH & DENIS SURVEYING LTD.

ONTARIO LAND SURVEYORS
CANADA LAND SURVEYORS

190 COLONNADE ROAD, OTTAWA, ONTARIO K2E 7J5
TEL. (613) 727-8226 FAX. (613) 727-1826

FILE No. : J-1199

J:\J-files\J-1199_21 Withrow Ave_Subd\Final\J-1199_21 Withrow Ave_Lts407-413 608-614 657-664 RP375_Plan of Sub_F.dwg

SuB 24X36