S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Functional Servicing & Stormwater Management Report

4063 UPPER MIDDLE ROAD

CITY OF BURLINGTON

January 2017
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1.0 INTRODUCTION AND BACKGROUND

1.1 OVERVIEW

S. Llewellyn & Associates Limited has been retained by thinkGiraffe Environmental Design to provide Consulting Engineering services for the proposed development at 4063 Upper Middle Road in the City of Burlington (see Figure 1.0 for location plan). This report will outline the functional servicing and stormwater management strategy for the proposed development.

The proposed development consists of constructing a 8-storey residential apartment building. The 8-storey building will contain a total of 32 residential units and an underground parking structure.

This Functional Servicing Report will provide detailed information of the proposed servicing scheme for this development. Please refer to the preliminary site engineering plans prepared by S. Llewellyn and Associates Limited and the preliminary site plan prepared by thinkGiraffe Environmental Design for additional information.

1.2 BACKGROUND INFORMATION

The following documents were referenced in the preparation of this report:

Ref. 1: MOE Stormwater Management Practices Planning and Design Manual (Ministry of Environment, March 2003)

Ref. 2: City of Burlington Standard Drawings (City of Burlington, March 2004)

Ref. 3: Halton Region Water and Wastewater Linear Design Manual (Halton Region, May 2014)

Ref. 4: Erosion & Sediment Control Guidelines for Urban Construction (December 2006)

Ref. 5: Geotechnical Investigation (Soil-Mat Engineers & Consultants Ltd., May 16, 2013)

Ref. 6: Supplemental Hydrogeological Considerations (Soil-Mat Engineers & Consultants Ltd., January 9, 2020)



Figure 1.0 – Location Plan

2.0 STORMWATER MANAGEMENT

The following stormwater management (SWM) criteria will be applied to the site, in accordance with the City of Burlington:

Quantity Control

The stormwater discharge rate for the proposed site shall be controlled to the 5-year pre-development condition discharge rate for all storm events up to and including the 100-year event.

Quality Control

The stormwater runoff from the prosed condition site must meet Level 1 (Enhanced) stormwater quality control (80% TSS removal, 90% average annual runoff treatment).

Erosion Control

Erosion and sediment control measures will be implemented in accordance with the standards of the City of Burlington.

2.1 EXISTING CONDITIONS

In the existing conditions, the subject land is currently a residential lot with gravel, grassed areas and an existing 1-story dwelling. The site is bound by Upper Middle Road to the south, and existing residential units to the north, east and west. Approximately half of the existing site drains to the 900mmø storm sewer along Upper Middle Road and the remaining half drains to Shoreacres Creek at the northeast portion of the property.

Two catchment areas, Catchment 101 and 102 have been identified in the existing condition. Catchment 101 represents the existing conditions discharging to Upper Middle Road, Catchment 102 represents the existing conditions discharging to Shoreacres Creek. See Table 2.1 below and the Pre-Development Storm Drainage Area Plan in Appendix A for details.

Table 2.1- Pre-Development Catchment Areas

Catchment ID	Description	Area (ha)	% Imp.	Runoff Coefficient
101	To Upper Middle Road	0.31	21	0.39
102	To Shoreacres Creek	0.26	0	0.25

An analysis was performed on Catchment 101 using the SWMHYMO hydrologic modelling program developed by J.F. Sabourin & Associates for the 2-year to 100-year City of Burlington Design Storms. A summary of the results can be found in Table 2.2 below and the detailed SWMHYMO input/output information in Appendix B. Catchment 102 is not included in this analysis as it will remain unchanged from its existing condition.

Table 2.2 - Pre-Development Condition Site Discharge (Catchment 101)

Storm Event	Catchment 101 Discharge (m^3/s)
2-Yr Event	0.013
5-Yr Event	0.019
10-Yr Event	0.025
25-Yr Event	0.032
50-Yr Event	0.039
100-Yr Event	0.045

2.2 PROPOSED CONDITIONS

It is proposed to develop the site by constructing a 8-storey residential apartment building which will contain a total of 32 residential units and underground parking. It is proposed to service the site with a private storm sewer system, designed and constructed in accordance with the City of Burlington Standards.

Three catchment areas, Catchment 201, 202 and 203 have been identified in the proposed condition. Catchment 201 represents drainage that is captured from the roof of the proposed building, the asphalt parking and landscape area around the building by the proposed storm sewer system, which will discharge to the existing 900mmø storm sewer

along Upper Middle Road. Catchment 202 represents the existing conditions discharging to the creek that will remain unchanged. Catchment 203 represents the uncontrolled drainage at the frontage on the property that will drain to Upper Middle Road. See Table 2.3 below and the Post-Development Storm Drainage Area Plan in Appendix A for details.

Table 2.3- Post-Development Catchment Area				
Catchment ID	Description	Area (ha)	% Imp.	Runoff Coefficient
201	Controlled to Upper Middle Road	0.30	58	0.64
203	Uncontrolled to Upper Middle Road	0.01	10	0.31

Water Quantity Control

It is required to provide quantity control measures for the runoff from Catchment 201 by means of a 75mmø orifice pipe to restrict discharge from the area to 0.019m^3/s between storm MH1 and CBMH2. It is proposed to over control this area to include the runoff from Catchment 203. See Preliminary Site Servicing Plan for orifice pipe location.

With the installation of the quantity control measures, Catchment 201 will be required to provide stormwater storage during storm events. To provide the required storage for Catchment 201, it is proposed to install a StormTech MC-4500 tanks under the proposed asphalt parking area. It is determined that the tanks will provide a total of 92m^3 of storage volume which will accommodate the stormwater storage required during the 100-year event.

Details of the proposed storage tanks can be found in the Preliminary Site Servicing Plan. The stage-storage-discharge characteristics can be seen in Table 2.4 and Appendix A.

Table 2.4 - Post-Development Condition Stage-Storage-Discharge (Catchment 201)		
Elevation (m)	Underground Storage (m^3)	Discharge (m^3/s)
135.32 (Bottom of Stone)	0	0.0000
135.55 (Bottom of Tank)	7	0.0000
135.60 (Outlet Invert)	10	0.0000
135.90 (0.3m Depth)	18	0.0061
136.20 (0.6m Depth)	35	0.0080
136.50 (0.9m Depth)	51	0.0095
136.80 (1.2m Depth)	64	0.0108
137.08 (Top of Tank)	73	0.0119
137.38 (Top of Stone)	82	0.0129

An analysis was performed on Catchment 201 & 203 using the SWMHYMO hydrologic modelling program developed by J.F. Sabourin & Associates for the 2-year to 100-year City of Burlington Design Storms. A summary of the results can be found in Table 2.5

below and the detailed SWMHYMO input/output information in Appendix B. Catchment 202 is not included in this analysis as it will remain unchanged from its existing condition.

Table 2.5 - Post-Development Condition Site Discharge

Storm Event	Catchment 201 Discharge (m^3/s)	Catchment 203 Discharge (m^3/s)	Total Discharge (m^3/s)	Allowable Discharge Rate (Catchment 101) (m^3/s)	Required Storage (m^3)
2-Yr Event	0.007	0.000	0.007	0.019	28.3
5-Yr Event	0.008	0.000	0.009	0.019	40.2
10-Yr Event	0.009	0.001	0.010	0.019	49.1
25-Yr Event	0.010	0.001	0.011	0.019	60.1
50-Yr Event	0.011	0.001	0.012	0.019	69.7
100-Yr Event	0.013	0.001	0.013	0.019	78.5

This analysis determined the following:

- The proposed condition discharge rates will not exceed the existing 5-year discharge rate of $0.019m^3/s$ during the 2-year to 100-year design storms, with the installation of a 75mmø orifice pipe between storm MH1 and CBMH2.

- $78.5m^3$ of stormwater storage is required during the 100-year event, which can be accommodated by the proposed StormTech MC-4500 tanks.

Water Quality Control

The proposed development is required to achieve an "Enhanced" (80% TSS removal) level of water quality protection. To achieve this criteria, discharge from Catchment 201 will be subject to treatment from a Hydrostorm oil/grit separator before ultimately discharging to the existing 900mmø storm sewer along Upper Middle Road. The Hydrostorm sizing software was used to determine the required size of oil/grit separator unit for the site using the ETV particle sizes. It was determined that a Hydrostorm HS5 will provide 82% TSS removal and 97% average annual runoff treatment, which satisfies the requirements for an "Enhanced" level for quality control. See Hydrostorm unit sizing procedures in Appendix C for details.

Hydrostorm units require regular inspection and maintenance as per the manufacturer's specifications to ensure the unit operates properly. See Hydrostorm Maintenance Manual in Appendix C for details.

Groundwater Table and Dewatering

As illustrated within the Supplemental Hydrogeological Considerations Report dated January 9, 2020 prepared by Soil-Matt Engineers & Consultants Ltd., given the anticipated depths of construction and estimated water level as well as the proximity of the proposed structure from the existing creek and the low permeability of the clayey silt and shale bedrock, the static groundwater table is not anticipated to have a notable effect on the proposed excavation. In addition, there would not be any expected significant long-term dewatering controls required. Refer to the Geotechnical Investigation and the Supplemental Hydrogeological Considerations Report in Appendix E for details.

2.3 SEDIMENT AND EROSION CONTROL

In order to minimize erosion during the grading and site servicing period of construction, the following measures will be implemented:

- Install silt fencing along the outer boundary of the site to ensure that sediment does not migrate to the adjacent properties;
- Install sediment control (silt sacks) in the proposed catchbasins as well as the nearby existing catchbasins to ensure that no untreated runoff enters the existing conveyance system
- Stabilize all disturbed or landscaped areas with hydro seeding/sodding to minimize the opportunity for erosion.

To ensure and document the effectiveness of the erosion and sediment control structures, an appropriate inspection and maintenance program is necessary. The program will include the following activities:

- Inspection of the erosion and sediment controls (e.g. silt fences, sediment traps, outlets, vegetation, etc.) with follow up reports to the governing municipality; and
- The developer and/or his contractor shall be responsible for any costs incurred during the remediation of problem areas.

Details of the proposed erosion & sediment control measures will be provided on the Erosion and Sediment Control Plans, which will be provided upon final design.

3.0 SANITARY SEWER SERVICING

3.1 EXISTING CONDITIONS

The site is located on Upper Middle Road, north of Walkers Line with an existing 200mmø sanitary sewer located along the frontage of Upper Middle Road.

3.2 SANITARY DEMAND

Sanitary discharge from the site was estimated in accordance with the Halton Region Water and Wastewater Linear Design Manual (Ref. 3). Table 3.1 summarizes the sanitary sewer discharge rate from the subject lands.

Table 3.1 – Proposed Sanitary Sewer Discharge	
Site Area	0.31 ha
Population [A] (Apartment)	32 units x 2 bedroom units = 64 persons
Average Dry Weather Flow [B]	275 l/cap/day x 64 persons = 0.204 l/s
Harmon Peaking Factor [C]	4.29
Infiltration Allowance [D]	0.003 l/s/ha x 0.31 ha = 0.0009 l/s
Design Flow	(0.204 x 4.29) + 0.0009 = **0.876 l/s**
[A] Type of Development to be Apartment [B] Average demand = 275l/cap/day x population [C] Peaking Factor = $(1 + (14/(4 + P_e^{0.5})))$ with P_e being the equivalent tributary population in thousands [D] Infiltration based on 0.00318 l/s/ha infiltration rate	

3.3 PROPOSED SANITARY SERVICING AND CAPACITY ANALYSIS

The proposed apartment building will be serviced by a private 150mmø sanitary sewer system, designed and constructed in accordance with the Halton Region standards. Drainage from this sewer will discharge to the existing 200mmø sanitary sewer along Upper Middle Road.

The minimum grade of the proposed 150mmø sanitary will be 1.0%. At this minimum grade, the proposed sanitary sewer will have a capacity of 0.015 m^3/s (15 l/s). Therefore, the proposed 150mmø sanitary sewer at 1.0% grade is adequately sized to service the proposed development.

4.0 DOMESTIC AND FIRE WATER SUPPLY SERVICING

4.1 EXISTING CONDITIONS

The existing municipal water distribution system consists of a 400mmø and 600mmø distribution watermain located along Upper Middle Road. The nearest existing municipal fire hydrant is located at 4045 Upper Middle Road approximately 33m west of the proposed development.

4.2 DOMESTIC WATER DEMAND

Water demand for the site was estimated in accordance with the Halton Region Water and Wastewater Linear Design Manual (Ref.3). Table 4.1 summarizes the domestic water demand requirements for the Average Daily, Maximum Daily and Peaking Hourly demand scenarios.

Table 4.1 – Proposed Development Domestic Water Demand	
Total Population [A]	64 persons
Average Daily Demand [B]	0.204 l/s
Max. Daily Peaking Factor [C]	2.25
Max. Hourly Peaking Factor [C]	4.00
Max. Daily Demand	(0.204 L/s x 2.25) **= 0.459 L/s**
Max. Hourly Demand	(0.204 L/s x 4.00) **= 0.816 L/s**
[A] (32 units x 2 bedroom units) = 64 persons [B] Average Daily Demand = 275 l/cap/day x population [C] Max. Daily Peaking Factor = 2.25 (refer to sentence 2.4.1) [D] Max. Hourly Peaking Factor = 4.00 (refer to Table 2-2) [E] Max. Daily Demand = Average Daily Demand x Max. Daily Peaking Factor [F] Max. Hourly Demand = Average Daily Demand x Max. Hourly Peaking Factor	

4.3 FIRE FLOW DEMAND

Fire flow demands for development are governed by a number of guidelines and criteria, such as the Water Supply for Public Fire Protection (Fire Underwriters Survey, 1999), Ontario Building Code (OBC), and various codes and standards published by the National Fire Protection Association (NFPA).

At this stage of development it is understood that the proposed 8-storey apartment building will constructed of non-combustible construction (C=0.8), with limited combustible occupancy (-15% correction) and a sprinkler system (-40% correction).

Based on the FUS, the fire flow demand required for the proposed site is **11,000 l/min (183 l/s).** See Fire Flow Demand Requirements in Appendix D for calculations and details.

4.4 PROPOSED WATER SERVICING AND ANALYSIS

The proposed water servicing for the subject site consists of installing a 150mmø watermain which will be split at property line to provide a 100mmø domestic and 150mmø fire water service for the proposed development. Water services for the site are to be designed and constructed in accordance with the Halton Region standards.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information provided herein, it is concluded that the proposed development of 421 - 431 Brant Street can be constructed to meet the requirements of the City of Burlington and Halton Region. Therefore, it is recommended that:

- The development be graded and serviced in accordance with the Preliminary Grading Plan and the Preliminary Site Servicing Plan prepared by S.Llewellyn & Associates Limited;

- A 75mmø orifice pipe be installed as per the Preliminary Site Servicing Plan and this report to provide adequate quantity control;

- Stormtech MC-4500 tanks be installed as per the Preliminary Site Servicing Plan and this report to provide adequate stormwater storage during storm events;

- Erosion and sediment controls be installed as described in this report to meet City of Burlington requirements;

- The proposed sanitary and water servicing system be installed as per this report to adequately service the proposed development;

- This report be used as the basis for the servicing and stormwater management design. All design data, assumptions and calculations will be confirmed and/or updated as part of the future Site Plan Approval submission.

We trust the information enclosed herein is satisfactory. Should you have any questions please do not hesitate to contact our office.

Prepared by:
S. LLEWELLYN & ASSOCIATES LIMITED



M. Colosimo, Dipl.T.

S. Frankovich, P.Eng.

APPENDIX A
STORMWATER MANAGEMENT INFORMATION

S:\16115\WORKING\CURRENT\16115-DAPS.dwg

101
0.31
21
0.39

102
0.26
0
0.25

EX. FENCE
EX. HYDRO VAULT
EX. 2 STOREY TOWNHOUSE
EX. SHALE
EX. CONC. FENCE
EX. 3 STOREY TOWNHOUSE
EX.CB
EX.MH
EX. CURB
EX. ASPHALT (TO BE REMOVED)
EX. RET. WALL (TO BE REMOVED)
7.5m OFFSET FROM TOP OF BANK
LINE SHOWING APPROX. LOCATION OF DRIPLINE
LINE SHOWING APPROX. LOCATION OF 7.5M SETBACK FROM DRIPLINE
EX. 1 STOREY BRICK HOUSE No. 4063
CONC. SHED (TO BE REMOVED)
EX. WOOD SHED
EX. TOP OF BANK
EX. C/L OF CREEK
EX. WV
EX. SIDEWALK
EX. LS
EX. ASPHALT
EX.CB T/G 137.84
EX.CB T/G 137.29
EX.CB T/G 137.67
EX.MH T/G 138.31
EX.MH T/G 138.74
EX.SAN MH T/G 138.50 INV. 135.55±
EX.CB T/G 138.58
EX. HP
GW
EX.STM MH T/G 138.12 E.INV. 134.75± W.INV. 134.82±
EX.825mm STORM @ 0.40%
EX.900mm STORM @ 0.40%
EX. SIGN
EX. OVERHEAD WIRES
UPPER MIDDLE ROAD

LEGEND

DIRECTION OF SHEET FLOW

101
0.313
21
0.39

DRAINAGE AREA I.D.
DRAINAGE AREA (ha)
PERCENT IMPERVIOUS
RUNOFF COEFFICENT

FIGURE 1.0
PRE-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:400

PROJECT: 4063 UPPER MIDDLE ROAD
PROJECT No.: 16115

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201
0.30
58
0.64

202
0.26
0
0.25

203
0.01
10
0.31

#4063
8 STOREY
APARTMENT BUILDING
F.F.E = 138.60
B.F.E = 135.60

ROOF DRAINS & PROPOSED AREA DRAINS ARE TO CONNECT TO BUILDINGS INTERNAL MECHANICAL SYSTEM

DI1
(OPSD 705.030)
600X600
4H:1V
T/G 137.87

STORAGE TANK STORMTECH MC-4500
(c/w INSPECTION PORTS & ISOLATOR ROW)
TANK VOLUME = 92m³
TOP OF STONE = 137.38
TOP OF TANK = 137.08
BOTTOM OF TANK = 135.55
BOTTOM OF STONE = 135.32
(CONTRACTOR TO PROVIDE SHOP DWG'S)

T/G

3.0m-150mmø STM @ 1.0% TO CONNECT TO INTERNAL STORM SYSTEM

2.0m-150mmø STM @ 1.0% TO CONNECT TO INTERNAL STORM SYSTEM

COVERED PORCH

UNDERGROUND PARKING

2ND LEVEL PARKING

MAIN LEVEL PARKING

INV. 136.53

PROP. 58.0m SWALE @ 2.0%

EX. SWALE

EX. FENCE

EX. HYDRO VAULT

EX. LS

EX. CURB

EX. CB

EX. MH

17.0m-250mmø STM @ 0.50%

3.0m-300mmø STM @ 1.0%

2.0m-250mmø STM @ 1.0%

INV. 136.50
INV. 136.18
INV. 136.50
INV. 135.60

3.0m-450mmø STM @ 1.0%

MH3
(OPSD 701.010)
T/G 138.35

MH4
(OPSD 701.010)
T/G 138.40

3.0m-450mmø STM @ 1.0%

6.0m-250mmø STM @ 1.0%

CB3.1
(OPSD 705.010)
T/G 138.07

CBMH2
(OPSD 705.010)
T/G 138.30

5.0m-750mmø STM @ 1.0% (ORIFICE PIPE)

MH1
(HYDROSTORM HS5)
T/G 138.65

EX. TOP OF BANK

EX. C/L OF CREEK

EX. TOP OF BANK

EX. TOP OF BANK

EX. FENCE (TO BE REMOVED)

EX. WV

EX. SIDEWALK

EX. ASPHALT

EX. 400mm WTM

EX. CURB

EX. MH T/G 138.31

EX. MH T/G 138.74

EX. HP

GW

EX. SIDEWALK

EX. CB T/G 137.84

CONNECT TO EX. 900mmø STM
PROP. INV. 135.20
EX. INV. ±134.70
(BY HALTON REGION FORCES ONLY)

14.0m-250mmø STM @ 1.0%

EX. CB T/G 138.58

EX. CURB

EXIST 200mm SAN SEWER

EX. SAN MH T/G 138.50 INV. 135.55±

EX. OVERHEAD WIRES

EX. STM MH T/G 138.12 E/INV. 134.75± W/INV. 134.82±

EX. 825mm STORM @ 0.40%

EX. 900mm STORM @ 0.60%

EX. SIGN

EX. CURB

EX. 600mm WTM

EX. CURB

UPPER MIDDLE ROAD

N

LEGEND

DIRECTION OF SHEET FLOW

201
0.299
55
0.63

DRAINAGE AREA I.D.
DRAINAGE AREA (ha)
PERCENT IMPERVIOUS
RUNOFF COEFFICENT

FIGURE 2.0
POST-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:400

PROJECT: 4063 UPPER MIDDLE ROAD
PROJECT No.: 16115

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Rating Table Report
75mm dia. Orifice

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	135.60	137.38	0.01 m

HW Elev. (m)	Discharge (m³/s)
135.60	0.0035
135.61	0.0035
135.62	0.0037
135.63	0.0038
135.64	0.0039
135.65	0.0040
135.66	0.0041
135.67	0.0042
135.68	0.0043
135.69	0.0044
135.70	0.0045
135.71	0.0046
135.72	0.0047
135.73	0.0048
135.74	0.0048
135.75	0.0049
135.76	0.0050
135.77	0.0051
135.78	0.0052
135.79	0.0053
135.80	0.0054
135.81	0.0054
135.82	0.0055
135.83	0.0056
135.84	0.0057
135.85	0.0057
135.86	0.0058
135.87	0.0059
135.88	0.0060
135.89	0.0060
135.90	0.0061
135.91	0.0062
135.92	0.0063
135.93	0.0063
135.94	0.0064
135.95	0.0065
135.96	0.0065
135.97	0.0066
135.98	0.0067
135.99	0.0067
136.00	0.0068
136.01	0.0069
136.02	0.0069
136.03	0.0070
136.04	0.0071
136.05	0.0071
136.06	0.0072
136.07	0.0072
136.08	0.0073
136.09	0.0074
136.10	0.0074

Rating Table Report
75mm dia. Orifice

HW Elev. (m)	Discharge (m³/s)
136.11	0.0075
136.12	0.0075
136.13	0.0076
136.14	0.0077
136.15	0.0077
136.16	0.0078
136.17	0.0078
136.18	0.0079
136.19	0.0079
136.20	0.0080
136.21	0.0080
136.22	0.0081
136.23	0.0082
136.24	0.0082
136.25	0.0083
136.26	0.0083
136.27	0.0084
136.28	0.0084
136.29	0.0085
136.30	0.0085
136.31	0.0086
136.32	0.0086
136.33	0.0087
136.34	0.0087
136.35	0.0088
136.36	0.0088
136.37	0.0089
136.38	0.0089
136.39	0.0090
136.40	0.0090
136.41	0.0091
136.42	0.0091
136.43	0.0092
136.44	0.0092
136.45	0.0093
136.46	0.0093
136.47	0.0094
136.48	0.0094
136.49	0.0094
136.50	0.0095
136.51	0.0096
136.52	0.0096
136.53	0.0096
136.54	0.0097
136.55	0.0097
136.56	0.0098
136.57	0.0098
136.58	0.0099
136.59	0.0099
136.60	0.0100
136.61	0.0100
136.62	0.0100
136.63	0.0101
136.64	0.0101
136.65	0.0102

Rating Table Report
75mm dia. Orifice

HW Elev. (m)	Discharge (m³/s)
136.66	0.0102
136.67	0.0103
136.68	0.0103
136.69	0.0103
136.70	0.0104
136.71	0.0104
136.72	0.0105
136.73	0.0105
136.74	0.0105
136.75	0.0106
136.76	0.0106
136.77	0.0107
136.78	0.0107
136.79	0.0108
136.80	0.0108
136.81	0.0108
136.82	0.0109
136.83	0.0109
136.84	0.0110
136.85	0.0110
136.86	0.0110
136.87	0.0111
136.88	0.0111
136.89	0.0112
136.90	0.0112
136.91	0.0112
136.92	0.0113
136.93	0.0113
136.94	0.0114
136.95	0.0114
136.96	0.0114
136.97	0.0115
136.98	0.0115
136.99	0.0115
137.00	0.0116
137.01	0.0116
137.02	0.0117
137.03	0.0117
137.04	0.0117
137.05	0.0118
137.06	0.0118
137.07	0.0118
137.08	0.0119
137.09	0.0119
137.10	0.0120
137.11	0.0120
137.12	0.0120
137.13	0.0121
137.14	0.0121
137.15	0.0121
137.16	0.0122
137.17	0.0122
137.18	0.0122
137.19	0.0123
137.20	0.0123

Rating Table Report
75mm dia. Orifice

HW Elev. (m)	Discharge (m³/s)
137.21	0.0124
137.22	0.0124
137.23	0.0124
137.24	0.0125
137.25	0.0125
137.26	0.0125
137.27	0.0126
137.28	0.0126
137.29	0.0126
137.30	0.0127
137.31	0.0127
137.32	0.0127
137.33	0.0128
137.34	0.0128
137.35	0.0128
137.36	0.0129
137.37	0.0129
137.38	0.0129

4063 Upper Middle Rd
Burlington, Ontario

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

STAGE-STORAGE-DISCHARGE CALCULATIONS

Outlet Device No. 1 (Quantity)

Type:	Orifice Pipe
Diameter (mm)	100
Area (m^2)	0.00785
Invert Elev. (m)	135.48
C/L Elev. (m)	135.53

Number of Orifices: 1

		Underground Tank and Pipe Storage Volumes					Outlet No. 1		
	Elevation m	Tank 1 Area m^2	Dead Storage m^3	Incremental Live Storage m^3	Cumulative Live Volume m^3	**Total Active Storage Volume m^3**	H m	Discharge m^3/s	**Total Discharge m^3/s**
Orifice Pipe Invert	135.48	0	0						
Bottom of Stone	135.32	65	0						
Bottom of Tank	135.55	65	7						
Outlet Invert	135.60	65	10						
0.30m Depth	135.90	65		18	18	**18**	0.370	0.0125	**0.0061**
0.60m Depth	136.20	65		17	35	**35**	0.670	0.0165	**0.0080**
0.90m Depth	136.50	65		16	51	**51**	0.970	0.0197	**0.0095**
1.20m Depth	136.80	65		13	64	**64**	1.270	0.0225	**0.0108**
Top of Tank	137.08	65		10	73	**73**	1.550	0.0248	**0.0119**
Top of Stone	137.38	65		9	82	**82**	1.850	0.0271	**0.0129**

User Inputs

Chamber Model:	MC-4500
Outlet Control Structure:	No
Project Name:	4063 Upper Middle Road
Engineer:	Michael Colosimo
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	14.16 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	229 mm.
Stone Above Chambers:	305 mm.
Average Cover Over Chambers:	610 mm.
Design Constraint Dimensions:	(6.10 m. x 6.10 m.)

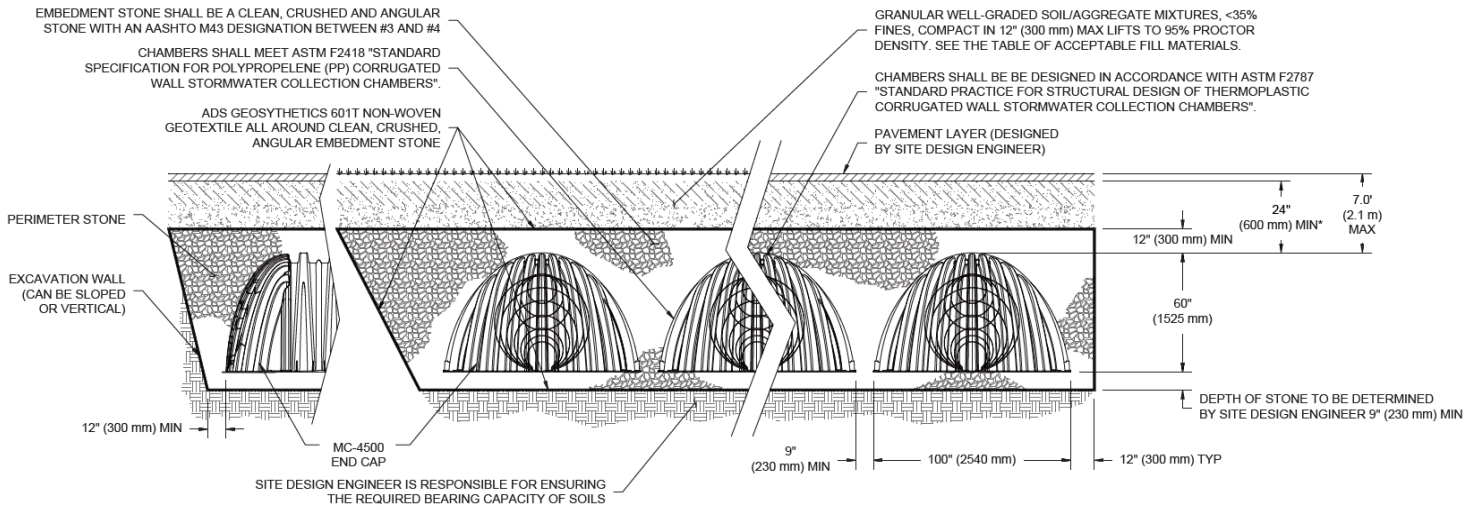
Results

System Volume and Bed Size

Installed Storage Volume:	92.06 cubic meters.
Storage Volume Per Chamber:	3.02 cubic meters.
Number Of Chambers Required:	17
Number Of End Caps Required:	2
Chamber Rows:	1
Maximum Length:	23.13 m.
Maximum Width:	3.15 m.
Approx. Bed Size Required:	72.86 square meters.

System Components

Amount Of Stone Required:	96.39 cubic meters
Volume Of Excavation (Not Including Fill):	149.89 cubic meters
Total Non-woven Geotextile Required:	304.62 square meters
Woven Geotextile Required (excluding Isolator Row):	0.00 square meters
Woven Geotextile Required (Isolator Row):	0.00 square meters
Total Woven Geotextile Required:	0.00 square meters



*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 30" (750 mm).

APPENDIX B
SWMHYMO INPUT/OUTPUT INFORMATION

```
2     Metric units
*#*************************************************************************|
*#  Project Name: 4063 UPPER MIDDLE ROAD
*#                BURLINGTON, ONTARIO
*#  JOB NUMBER  : 16115
*#       Date   : January 2017
*#    Revised   : October 2021
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 16115.DAT
*#*************************************************************************|
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[002]
                    BURL_002.stm
*
READ STORM          STORM_FILENAME "STORM.001"
*
*#*************************************************************************|
*#
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ==============================================
*#
**#*************************************************************************|
*# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD
*
CALIB STANDHYD      ID=[1], NHYD=["101"], DT=[1](min), AREA=[0.31](ha),
                    XIMP=[0.21], TIMP=[0.21], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[80],
                    Pervious   surfaces: IAper=[6.35](mm), SLPP=[1.5](%),
                                         LGP=[25](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.5](%),
                                         LGI=[18](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
**#*************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
*#
**#*************************************************************************|
*# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
*
CALIB STANDHYD      ID=[1], NHYD=["201"], DT=[1](min), AREA=[0.30](ha),
                    XIMP=[0.58], TIMP=[0.58], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[80],
                    Pervious   surfaces: IAper=[6.35](mm), SLPP=[3.0](%),
                                         LGP=[25](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[3.0](%),
                                         LGI=[15](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------|
ROUTE RESERVOIR     IDout=[2],   NHYD=["201"],  IDin=[1],
                    RDT=[1](min),
                          TABLE of ( OUTFLOW-STORAGE ) values
                                     (cms) - (ha-m)
                                      0.0     ,  0.0
                                      0.0061  ,  0.0018
                                      0.0080  ,  0.0035
                                      0.0095  ,  0.0051
                                      0.0108  ,  0.0064
                                      0.0119  ,  0.0073
                                      0.0129  ,  0.0082
                                        -1    ,  -1    (max twenty pts)
                          IDovf=[3], NHYDovf=["OVF"]
```

```
*%-----------------|---------------------------------------------------------|
*# CATCHMENT 203 - PROPOSED CONDITIONS (UNCONTROLLED TO UPPER MIDDLE ROAD)
CALIB NASHYD        ID=[4], NHYD=["203"], DT=[1]min, AREA=[0.01](ha),
                    DWF=[0](cms),  CN/C=[80], IA=[6.35](mm),
                    N=[3], TP=[0.1]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|---------------------------------------------------------|
ADD HYD             IDsum=[8], NHYD=["TOTAL"], IDs to add=[2, 3, 4 ]
**#*************************************************************************|
* RUN REMAINING DESIGN STORMS (TOWN OF EAST GWILLIMBURY 5 TO 100-YR)
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[005]
                    BURL_005.stm
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[010]
                    BURL_010.stm
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[025]
                    BURL_025.stm
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[050]
                    BURL_050.stm
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[100]
                    BURL_100.stm
*
*%-----------------|---------------------------------------------------------|
FINISH
```

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

   SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO       999    999    =========
   S      W W W  MM MM  H   H   Y Y   MM MM  O   O     9   9  9   9
   SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9   Ver  4.05
       S   W W   M   M  H   H    Y    M   M  O   O       9999   9999   Sept 2011
   SSSSS   W W   M   M  H   H    Y    M   M   OOO            9      9   =========
                                                          9   9  9   9   # 3902680
        StormWater Management HYdrologic Model            999    999    =========

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

 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++++ Licensed user: S. Llewellyn & Associates Ltd                +++++++++
 +++++++++                in any City           SERIAL#:3902680       +++++++++
 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

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


 **********************   D E T A I L E D   O U T P U T   **********************
 ********************************************************************************
 *         DATE: 2021-10-15     TIME: 16:21:25     RUN COUNTER: 000356          *
 ********************************************************************************
 * Input   filename: T:\PROJECTS\16115\SWMHYMO\16115.dat                        *
 * Output  filename: T:\PROJECTS\16115\SWMHYMO\16115.out                        *
 * Summary filename: T:\PROJECTS\16115\SWMHYMO\16115.sum                        *
 * User comments:                                                               *
 * 1:_____________________________________________________________________________*
 * 2:_____________________________________________________________________________*
 * 3:_____________________________________________________________________________*
 ********************************************************************************

--------------------------------------------------------------------------------
001:0001----------------------------------------------------------------------
*#*****************************************************************************|
*#  Project Name: 4063 UPPER MIDDLE ROAD
*#               BURLINGTON, ONTARIO
*#  JOB NUMBER  : 16115
*#       Date   : January 2017
*#    Revised   : October 2021
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 16115.DAT
*#*****************************************************************************|
*
  ** END OF RUN :   1

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




--------------------
| START            |  Project  dir.: T:\PROJECTS\16115\SWMHYMO\
--------------------  Rainfall dir.: T:\PROJECTS\16115\SWMHYMO\
    TZERO =   .00 hrs on      0
    METOUT=   2 (output = METRIC)
    NRUN  = 002
    NSTORM=   1
          #  1=BURL_002.stm
--------------------------------------------------------------------------------
002:0002----------------------------------------------------------------------
*#*****************************************************************************|
*#  Project Name: 4063 UPPER MIDDLE ROAD
*#               BURLINGTON, ONTARIO
*#  JOB NUMBER  : 16115
*#       Date   : January 2017
*#    Revised   : October 2021
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 16115.DAT
*#*****************************************************************************|
*
--------------------------------------------------------------------------------
002:0002----------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: 2-YR BURLINGTON CHICAGO STORM (4-HR DURA
| Ptotal=  32.34 mm|    Comments: 2-YR BURLINGTON CHICAGO STORM (4-HR DURA
--------------------
            TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
             hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
             .17   2.193 |   1.17  17.083 |   2.17   5.221 |   3.17   2.635
             .33   2.511 |   1.33  68.163 |   2.33   4.444 |   3.33   2.448
             .50   2.955 |   1.50  22.413 |   2.50   3.884 |   3.50   2.289
             .67   3.627 |   1.67  11.979 |   2.67   3.459 |   3.67   2.151
             .83   4.775 |   1.83   8.270 |   2.83   3.126 |   3.83   2.031
            1.00   7.239 |   2.00   6.374 |   3.00   2.857 |   4.00   1.925


--------------------------------------------------------------------------------
002:0003----------------------------------------------------------------------
*
*#*****************************************************************************|
*#
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ==============================================
*#
**#*****************************************************************************|
*# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .31
| 01:101    DT= 1.00 |   Total Imp(%)=   21.00   Dir. Conn.(%)=   21.00
----------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .07          .24
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.50         1.50
     Length            (m)=      18.00        25.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      68.16        10.24
               over (min)        1.00        15.00
     Storage Coeff.  (min)=        .88 (ii)   15.32 (ii)
     Unit Hyd. Tpeak (min)=       1.00        15.00
     Unit Hyd. peak  (cms)=       1.15          .07
                                                      *TOTALS*
     PEAK FLOW       (cms)=        .01          .00          .013 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.62         1.333
     RUNOFF VOLUME    (mm)=      31.34         7.55        12.546
     TOTAL RAINFALL   (mm)=      32.34        32.34        32.342
     RUNOFF COEFFICIENT   =        .97          .23          .388

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0004----------------------------------------------------------------------
**#*****************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
*#
**#*****************************************************************************|
*# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .30
| 01:201    DT= 1.00 |   Total Imp(%)=   58.00   Dir. Conn.(%)=   58.00
----------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .17          .13
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       3.00         3.00
     Length            (m)=      15.00        25.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      68.16        10.94
               over (min)        1.00        12.00
     Storage Coeff.  (min)=        .75 (ii)   12.17 (ii)
     Unit Hyd. Tpeak (min)=       1.00        12.00
     Unit Hyd. peak  (cms)=       1.25          .09
                                                      *TOTALS*
     PEAK FLOW       (cms)=        .03          .00          .034 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.52         1.333
     RUNOFF VOLUME    (mm)=      31.34         7.55        21.349
     TOTAL RAINFALL   (mm)=      32.34        32.34        32.342
     RUNOFF COEFFICIENT   =        .97          .23          .660

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0005----------------------------------------------------------------------
--------------------
| ROUTE RESERVOIR  |    Requested routing time step =  1.0 min.
|  IN>01:(201   )  |
| OUT<02:(201   )  |    =========  OUTLFOW STORAGE TABLE  =========
--------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00   |     .011  .6400E-02
                           .006  .1800E-02   |     .012  .7300E-02
                           .008  .3500E-02   |     .013  .8200E-02
                           .009  .5100E-02   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     -------------------        (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (201   )        .30      .034     1.333     21.349
     OUTFLOW<02: (201   )        .30      .007     1.683     21.349
    OVERFLOW<03: (OVF   )        .00      .000      .000       .000

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


                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   21.530
                    TIME SHIFT OF PEAK FLOW         (min)=    21.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.2830E-02

--------------------------------------------------------------------------------
002:0006----------------------------------------------------------------------
*# CATCHMENT 203 - PROPOSED CONDITIONS (UNCONTROLLED TO UPPER MIDDLE ROAD)
----------------------
| CALIB NASHYD       |   Area    (ha)=     .01   Curve Number   (CN)=80.00
| 04:203    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .100

     Unit Hyd Qpeak  (cms)=     .004

     PEAK FLOW       (cms)=     .000 (i)
     TIME TO PEAK    (hrs)=    1.417
     RUNOFF VOLUME    (mm)=    7.524
     TOTAL RAINFALL   (mm)=   32.342
     RUNOFF COEFFICIENT   =     .233

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0007----------------------------------------------------------------------
----------------------
| ADD HYD (TOTAL     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
                        ID1 02:201          .30      .007    1.68  21.35    .000
                       +ID2 03:OVF          .00      .000     .00    .00    .000
                       +ID3 04:203          .01      .000    1.42   7.52    .000
                        ==========================================================
                        SUM 08:TOTAL        .31      .007    1.53  20.90    .000
```

```
   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
002:0008----------------------------------------------------------------------
**#*****************************************************************************|
* RUN REMAINING DESIGN STORMS (TOWN OF EAST GWILLIMBURY 5 TO 100-YR)
*
  ** END OF RUN :   4

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




--------------------
| START            |  Project  dir.: T:\PROJECTS\16115\SWMHYMO\
--------------------  Rainfall dir.: T:\PROJECTS\16115\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 005
    NSTORM=   1
          #  1=BURL_005.stm
--------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
*#****************************************************************************|
*#  Project Name: 4063 UPPER MIDDLE ROAD
*#               BURLINGTON, ONTARIO
*#  JOB NUMBER  : 16115
*#       Date   : January 2017
*#    Revised   : October 2021
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 16115.DAT
*#****************************************************************************|
*
--------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: 5-YR BURLINGTON CHICAGO STORM (4-HR DURA
| Ptotal=  41.70 mm|    Comments: 5-YR BURLINGTON CHICAGO STORM (4-HR DURA
--------------------
             TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
              hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
              .17   2.963 |   1.17  21.285 |   2.17   6.805 |   3.17   3.535
              .33   3.374 |   1.33  88.094 |   2.33   5.834 |   3.33   3.293
              .50   3.946 |   1.50  27.774 |   2.50   5.128 |   3.50   3.087
              .67   4.803 |   1.67  15.072 |   2.67   4.590 |   3.67   2.908
              .83   6.247 |   1.83  10.561 |   2.83   4.165 |   3.83   2.751
             1.00   9.295 |   2.00   8.234 |   3.00   3.820 |   4.00   2.612

--------------------------------------------------------------------------------
005:0003----------------------------------------------------------------------
*
*#****************************************************************************|
*#
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ==============================================
*#
**#***************************************************************************|
*# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .31
| 01:101    DT= 1.00 |   Total Imp(%)=   21.00   Dir. Conn.(%)=   21.00
----------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .07          .24
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.50         1.50
     Length            (m)=      18.00        25.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      88.09        19.56
           over (min)            1.00        12.00
     Storage Coeff.  (min)=       .80 (ii)   11.94 (ii)
     Unit Hyd. Tpeak (min)=       1.00        12.00
     Unit Hyd. peak  (cms)=       1.22          .09
                                                    *TOTALS*
     PEAK FLOW       (cms)=        .02          .01          .019 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.52         1.333
     RUNOFF VOLUME    (mm)=      40.70        12.64        18.531
     TOTAL RAINFALL   (mm)=      41.70        41.70        41.696
     RUNOFF COEFFICIENT   =        .98          .30          .444

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0004----------------------------------------------------------------------
**#***************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
*#
**#***************************************************************************|
*# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .30
| 01:201    DT= 1.00 |   Total Imp(%)=   58.00   Dir. Conn.(%)=   58.00
----------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .17          .13
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       3.00         3.00
     Length            (m)=      15.00        25.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      88.09        22.49
           over (min)            1.00         9.00
     Storage Coeff.  (min)=       .67 (ii)    9.24 (ii)
     Unit Hyd. Tpeak (min)=       1.00         9.00
     Unit Hyd. peak  (cms)=       1.31          .12
                                                    *TOTALS*
     PEAK FLOW       (cms)=        .04          .00          .045 (iii)
     TIME TO PEAK    (hrs)=       1.32         1.45         1.333
     RUNOFF VOLUME    (mm)=      40.70        12.64        28.912
     TOTAL RAINFALL   (mm)=      41.70        41.70        41.696
     RUNOFF COEFFICIENT   =        .98          .30          .693

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0005----------------------------------------------------------------------
--------------------
| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>01:(201   )    |
| OUT<02:(201   )    |    =========  OUTLFOW STORAGE TABLE  =========
--------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00    |     .011  .6400E-02
                           .006  .1800E-02    |     .012  .7300E-02
                           .008  .3500E-02    |     .013  .8200E-02
                           .009  .5100E-02    |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     ---------------            (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (201   )        .30      .045     1.333     28.912
     OUTFLOW<02: (201   )        .30      .008     1.717     28.912
    OVERFLOW<03: (OVF   )        .00      .000      .000       .000

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


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   18.743
                   TIME SHIFT OF PEAK FLOW          (min)=    23.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.4016E-02

--------------------------------------------------------------------------------
005:0006----------------------------------------------------------------------
*# CATCHMENT 203 - PROPOSED CONDITIONS (UNCONTROLLED TO UPPER MIDDLE ROAD)
----------------------
| CALIB NASHYD       |   Area    (ha)=     .01   Curve Number   (CN)=80.00
| 04:203    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .100

     Unit Hyd Qpeak  (cms)=     .004

     PEAK FLOW       (cms)=     .000 (i)
     TIME TO PEAK    (hrs)=    1.400
     RUNOFF VOLUME    (mm)=   12.613
     TOTAL RAINFALL   (mm)=   41.696
     RUNOFF COEFFICIENT   =     .303

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0007----------------------------------------------------------------------
----------------------
| ADD HYD (TOTAL     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
----------------------                     (ha)     (cms)   (hrs)   (mm)   (cms)
                         ID1 02:201          .30     .008    1.72  28.91    .000
                        +ID2 03:OVF          .00     .000     .00    .00    .000
                        +ID3 04:203          .01     .000    1.40  12.61    .000
                         ==========================================================
                         SUM 08:TOTAL        .31     .009    1.67  28.39    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0008----------------------------------------------------------------------
**#***************************************************************************|
* RUN REMAINING DESIGN STORMS (TOWN OF EAST GWILLIMBURY 5 TO 100-YR)
*
--------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
*
  ** END OF RUN :   9

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




--------------------
| START            |  Project  dir.: T:\PROJECTS\16115\SWMHYMO\
--------------------  Rainfall dir.: T:\PROJECTS\16115\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 010
    NSTORM=   1
          #  1=BURL_010.stm
--------------------------------------------------------------------------------
010:0002----------------------------------------------------------------------
*#****************************************************************************|
*#  Project Name: 4063 UPPER MIDDLE ROAD
*#               BURLINGTON, ONTARIO
*#  JOB NUMBER  : 16115
*#       Date   : January 2017
*#    Revised   : October 2021
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 16115.DAT
*#****************************************************************************|
*
--------------------------------------------------------------------------------
010:0002----------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: 10-YR BURLINGTON CHICAGO STORM (4-HR DUR
| Ptotal=  48.00 mm|    Comments: 10-YR BURLINGTON CHICAGO STORM (4-HR DUR
--------------------
             TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
              hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
              .17   3.423 |   1.17  24.501 |   2.17   7.852 |   3.17   4.083
              .33   3.898 |   1.33 101.139 |   2.33   6.733 |   3.33   3.805
              .50   4.558 |   1.50  31.955 |   2.50   5.920 |   3.50   3.567
              .67   5.545 |   1.67  17.363 |   2.67   5.300 |   3.67   3.360
              .83   7.210 |   1.83  12.175 |   2.83   4.810 |   3.83   3.179
             1.00  10.719 |   2.00   9.497 |   3.00   4.413 |   4.00   3.019
```

```
------------------------------------------------------------------------------
010:0003----------------------------------------------------------------------
*
*#*************************************************************************|
*#
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ==============================================
*#
**#*************************************************************************|
*# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .31
| 01:101    DT= 1.00 |   Total Imp(%)=   21.00   Dir. Conn.(%)=   21.00
----------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .07          .24
     Dep. Storage     (mm)=      1.00         6.35
     Average Slope     (%)=      2.50         1.50
     Length            (m)=     18.00        25.00
     Mannings n           =      .015         .250

     Max.eff.Inten.(mm/hr)=    101.14        28.89
               over (min)        1.00        10.00
     Storage Coeff.  (min)=       .75 (ii)   10.29 (ii)
     Unit Hyd. Tpeak (min)=      1.00        10.00
     Unit Hyd. peak  (cms)=      1.25          .11
                                                    *TOTALS*
     PEAK FLOW       (cms)=       .02          .01          .025 (iii)
     TIME TO PEAK    (hrs)=      1.32         1.47         1.333
     RUNOFF VOLUME    (mm)=     47.00        16.50        22.906
     TOTAL RAINFALL   (mm)=     48.00        48.00        48.004
     RUNOFF COEFFICIENT   =       .98          .34          .477

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
010:0004----------------------------------------------------------------------
**#*************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
*#
**#*************************************************************************|
*# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .30
| 01:201    DT= 1.00 |   Total Imp(%)=   58.00   Dir. Conn.(%)=   58.00
----------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .17          .13
     Dep. Storage     (mm)=      1.00         6.35
     Average Slope     (%)=      3.00         3.00
     Length            (m)=     15.00        25.00
     Mannings n           =      .015         .250

     Max.eff.Inten.(mm/hr)=    101.14        32.26
               over (min)        1.00         8.00
     Storage Coeff.  (min)=       .64 (ii)    8.05 (ii)
     Unit Hyd. Tpeak (min)=      1.00         8.00
     Unit Hyd. peak  (cms)=      1.34          .14
                                                    *TOTALS*
     PEAK FLOW       (cms)=       .05          .01          .054 (iii)
     TIME TO PEAK    (hrs)=      1.32         1.43         1.333
     RUNOFF VOLUME    (mm)=     47.00        16.50        34.192
     TOTAL RAINFALL   (mm)=     48.00        48.00        48.004
     RUNOFF COEFFICIENT   =       .98          .34          .712

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
010:0005----------------------------------------------------------------------
----------------------
| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>01:(201   )    |
| OUT<02:(201   )    |    =========  OUTLFOW STORAGE TABLE  =========
----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00    |     .011  .6400E-02
                            .006  .1800E-02    |     .012  .7300E-02
                            .008  .3500E-02    |     .013  .8200E-02
                            .009  .5100E-02    |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (201   )        .30      .054     1.333     34.192
     OUTFLOW<02: (201   )        .30      .009     1.783     34.192
    OVERFLOW<03: (OVF   )        .00      .000      .000       .000

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


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   17.405
                   TIME SHIFT OF PEAK FLOW       (min)=    27.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.4907E-02

------------------------------------------------------------------------------
010:0006----------------------------------------------------------------------
*# CATCHMENT 203 - PROPOSED CONDITIONS (UNCONTROLLED TO UPPER MIDDLE ROAD)
----------------------
| CALIB NASHYD       |   Area    (ha)=     .01   Curve Number   (CN)=80.00
| 04:203    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .100

     Unit Hyd Qpeak  (cms)=     .004

     PEAK FLOW       (cms)=     .001 (i)
     TIME TO PEAK    (hrs)=    1.400
     RUNOFF VOLUME    (mm)=   16.474
     TOTAL RAINFALL   (mm)=   48.004
     RUNOFF COEFFICIENT   =     .343

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
010:0007----------------------------------------------------------------------
----------------------
| ADD HYD (TOTAL     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
                         ID1 02:201          .30     .009    1.78  34.19    .000
                        +ID2 03:OVF          .00     .000     .00    .00    .000
                        +ID3 04:203          .01     .001    1.40  16.47    .000
                         ============================================================
                         SUM 08:TOTAL        .31     .010    1.68  33.62    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
010:0008----------------------------------------------------------------------
**#*************************************************************************|
* RUN REMAINING DESIGN STORMS (TOWN OF EAST GWILLIMBURY 5 TO 100-YR)
*
------------------------------------------------------------------------------
010:0002----------------------------------------------------------------------
*
------------------------------------------------------------------------------
010:0002----------------------------------------------------------------------
*
  ** END OF RUN :  24

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




--------------------
| START            |  Project  dir.: T:\PROJECTS\16115\SWMHYMO\
--------------------  Rainfall dir.: T:\PROJECTS\16115\SWMHYMO\
    TZERO =   .00 hrs on       0
    METOUT=   2 (output = METRIC)
    NRUN  = 025
    NSTORM=   1
           #  1=BURL_025.stm
------------------------------------------------------------------------------
025:0002----------------------------------------------------------------------
*#*************************************************************************|
*#  Project Name: 4063 UPPER MIDDLE ROAD
*#                BURLINGTON, ONTARIO
*#  JOB NUMBER  : 16115
*#       Date   : January 2017
*#    Revised   : October 2021
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 16115.DAT
*#*************************************************************************|
*
------------------------------------------------------------------------------
025:0002----------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: 25-YR BURLINGTON CHICAGO STORM (4-HR DUR
| Ptotal=  56.03 mm|    Comments: 25-YR BURLINGTON CHICAGO STORM (4-HR DUR
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   4.010 |   1.17  28.592 |   2.17   9.185 |   3.17   4.782
               .33   4.566 |   1.33 117.720 |   2.33   7.879 |   3.33   4.457
               .50   5.337 |   1.50  37.274 |   2.50   6.929 |   3.50   4.178
               .67   6.491 |   1.67  20.279 |   2.67   6.204 |   3.67   3.937
               .83   8.435 |   1.83  14.230 |   2.83   5.632 |   3.83   3.725
              1.00  12.531 |   2.00  11.105 |   3.00   5.167 |   4.00   3.538

------------------------------------------------------------------------------
025:0003----------------------------------------------------------------------
*
*#*************************************************************************|
*#
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ==============================================
*#
**#*************************************************************************|
*# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .31
| 01:101    DT= 1.00 |   Total Imp(%)=   21.00   Dir. Conn.(%)=   21.00
----------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .07          .24
     Dep. Storage     (mm)=      1.00         6.35
     Average Slope     (%)=      2.50         1.50
     Length            (m)=     18.00        25.00
     Mannings n           =      .015         .250

     Max.eff.Inten.(mm/hr)=    117.72        41.87
               over (min)        1.00         9.00
     Storage Coeff.  (min)=       .71 (ii)    8.93 (ii)
     Unit Hyd. Tpeak (min)=      1.00         9.00
     Unit Hyd. peak  (cms)=      1.29          .13
                                                    *TOTALS*
     PEAK FLOW       (cms)=       .02          .02          .032 (iii)
     TIME TO PEAK    (hrs)=      1.32         1.45         1.333
     RUNOFF VOLUME    (mm)=     55.03        21.81        28.784
     TOTAL RAINFALL   (mm)=     56.03        56.03        56.030
     RUNOFF COEFFICIENT   =       .98          .39          .514

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
025:0004----------------------------------------------------------------------
**#*************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
```

```
*#
**#************************************************************************|
*# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
*
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .30
| 01:201    DT= 1.00 |   Total Imp(%)=   58.00   Dir. Conn.(%)=   58.00
---------------------
                         IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .17          .13
     Dep. Storage     (mm)=      1.00         6.35
     Average Slope     (%)=      3.00         3.00
     Length            (m)=     15.00        25.00
     Mannings n           =      .015         .250

     Max.eff.Inten.(mm/hr)=    117.72        45.86
               over (min)        1.00         7.00
     Storage Coeff.  (min)=       .60 (ii)    7.04 (ii)
     Unit Hyd. Tpeak (min)=      1.00         7.00
     Unit Hyd. peak  (cms)=      1.38          .16
                                                    *TOTALS*
     PEAK FLOW       (cms)=       .06          .01          .065 (iii)
     TIME TO PEAK    (hrs)=      1.32         1.42         1.333
     RUNOFF VOLUME    (mm)=     55.03        21.81        41.077
     TOTAL RAINFALL   (mm)=     56.03        56.03        56.030
     RUNOFF COEFFICIENT   =       .98          .39          .733

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
025:0005----------------------------------------------------------------------
---------------------
| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>01:(201   )    |
| OUT<02:(201   )    |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00    |     .011  .6400E-02
                           .006  .1800E-02    |     .012  .7300E-02
                           .008  .3500E-02    |     .013  .8200E-02
                           .009  .5100E-02    |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (201   )        .30      .065     1.333     41.077
     OUTFLOW<02: (201   )        .30      .010     1.833     41.077
    OVERFLOW<03: (OVF   )        .00      .000      .000      .000

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


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   16.198
                   TIME SHIFT OF PEAK FLOW       (min)=    30.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.6094E-02

------------------------------------------------------------------------------
025:0006----------------------------------------------------------------------
*# CATCHMENT 203 - PROPOSED CONDITIONS (UNCONTROLLED TO UPPER MIDDLE ROAD)
---------------------
| CALIB NASHYD       |   Area    (ha)=     .01   Curve Number   (CN)=80.00
| 04:203    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=    .100

     Unit Hyd Qpeak  (cms)=     .004

     PEAK FLOW       (cms)=     .001 (i)
     TIME TO PEAK    (hrs)=    1.400
     RUNOFF VOLUME    (mm)=   21.782
     TOTAL RAINFALL   (mm)=   56.030
     RUNOFF COEFFICIENT   =     .389

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
025:0007----------------------------------------------------------------------
----------------------
| ADD HYD (TOTAL     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
----------------------                     (ha)     (cms)   (hrs)   (mm)   (cms)
                        ID1 02:201            .30     .010    1.83  41.08    .000
                       +ID2 03:OVF            .00     .000     .00    .00    .000
                       +ID3 04:203            .01     .001    1.40  21.78    .000
                        ========================================================
                        SUM 08:TOTAL          .31     .011    1.68  40.45    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
025:0008----------------------------------------------------------------------
**#************************************************************************|
* RUN REMAINING DESIGN STORMS (TOWN OF EAST GWILLIMBURY 5 TO 100-YR)
*
------------------------------------------------------------------------------
025:0002----------------------------------------------------------------------
*
------------------------------------------------------------------------------
025:0002----------------------------------------------------------------------
*
------------------------------------------------------------------------------
025:0002----------------------------------------------------------------------
*
  ** END OF RUN :  49

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




--------------------
| START            |  Project  dir.: T:\PROJECTS\16115\SWMHYMO\
--------------------  Rainfall dir.: T:\PROJECTS\16115\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 050
    NSTORM=   1
            #  1=BURL_050.stm
------------------------------------------------------------------------------
050:0002----------------------------------------------------------------------
**#************************************************************************|
*#  Project Name: 4063 UPPER MIDDLE ROAD
*#                BURLINGTON, ONTARIO
*#  JOB NUMBER  : 16115
*#       Date   : January 2017
*#    Revised   : October 2021
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 16115.DAT
**#************************************************************************|
*
------------------------------------------------------------------------------
050:0002----------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: 50-YR BURLINGTON CHICAGO STORM (4-HR DUR
| Ptotal=  61.96 mm|    Comments: 50-YR BURLINGTON CHICAGO STORM (4-HR DUR
--------------------
             TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
              hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
              .17   4.451 |   1.17  31.613 |   2.17  10.180 |   3.17   5.306
              .33   5.067 |   1.33 129.819 |   2.33   8.734 |   3.33   4.946
              .50   5.921 |   1.50  41.194 |   2.50   7.683 |   3.50   4.637
              .67   7.198 |   1.67  22.439 |   2.67   6.881 |   3.67   4.369
              .83   9.350 |   1.83  15.757 |   2.83   6.247 |   3.83   4.135
             1.00  13.879 |   2.00  12.303 |   3.00   5.733 |   4.00   3.927

------------------------------------------------------------------------------
050:0003----------------------------------------------------------------------
*
**#************************************************************************|
*#
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ==============================================
*#
**#************************************************************************|
*# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD
*
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .31
| 01:101    DT= 1.00 |   Total Imp(%)=   21.00   Dir. Conn.(%)=   21.00
---------------------
                         IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .07          .24
     Dep. Storage     (mm)=      1.00         6.35
     Average Slope     (%)=      2.50         1.50
     Length            (m)=     18.00        25.00
     Mannings n           =      .015         .250

     Max.eff.Inten.(mm/hr)=    129.82        53.08
               over (min)        1.00         8.00
     Storage Coeff.  (min)=       .68 (ii)    8.16 (ii)
     Unit Hyd. Tpeak (min)=      1.00         8.00
     Unit Hyd. peak  (cms)=      1.31          .14
                                                    *TOTALS*
     PEAK FLOW       (cms)=       .02          .02          .039 (iii)
     TIME TO PEAK    (hrs)=      1.32         1.43         1.333
     RUNOFF VOLUME    (mm)=     60.96        25.96        33.314
     TOTAL RAINFALL   (mm)=     61.96        61.96        61.962
     RUNOFF COEFFICIENT   =       .98          .42          .538

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
050:0004----------------------------------------------------------------------
**#************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
*#
**#************************************************************************|
*# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
*
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .30
| 01:201    DT= 1.00 |   Total Imp(%)=   58.00   Dir. Conn.(%)=   58.00
---------------------
                         IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .17          .13
     Dep. Storage     (mm)=      1.00         6.35
     Average Slope     (%)=      3.00         3.00
     Length            (m)=     15.00        25.00
     Mannings n           =      .015         .250

     Max.eff.Inten.(mm/hr)=    129.82        55.25
               over (min)        1.00         7.00
     Storage Coeff.  (min)=       .58 (ii)    6.55 (ii)
     Unit Hyd. Tpeak (min)=      1.00         7.00
     Unit Hyd. peak  (cms)=      1.40          .17
                                                    *TOTALS*
     PEAK FLOW       (cms)=       .06          .01          .073 (iii)
     TIME TO PEAK    (hrs)=      1.30         1.40         1.333
     RUNOFF VOLUME    (mm)=     60.96        25.96        46.263
     TOTAL RAINFALL   (mm)=     61.96        61.96        61.962
     RUNOFF COEFFICIENT   =       .98          .42          .747

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
050:0005----------------------------------------------------------------------
---------------------
| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>01:(201   )    |
| OUT<02:(201   )    |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00    |     .011  .6400E-02
                           .006  .1800E-02    |     .012  .7300E-02
                           .008  .3500E-02    |     .013  .8200E-02
```

```
                          .009  .5100E-02   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (201   )        .30      .073     1.333     46.263
     OUTFLOW<02: (201   )        .30      .011     1.833     46.263
    OVERFLOW<03: (OVF   )        .00      .000      .000       .000

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


                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=   15.780
                  TIME SHIFT OF PEAK FLOW         (min)=    30.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.6973E-02

--------------------------------------------------------------------------------
050:0006----------------------------------------------------------------------
*# CATCHMENT 203 - PROPOSED CONDITIONS (UNCONTROLLED TO UPPER MIDDLE ROAD)
---------------------
| CALIB NASHYD      |   Area    (ha)=     .01   Curve Number   (CN)=80.00
| 04:203    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=    .100

     Unit Hyd Qpeak  (cms)=     .004

     PEAK FLOW       (cms)=     .001 (i)
     TIME TO PEAK    (hrs)=    1.383
     RUNOFF VOLUME    (mm)=   25.941
     TOTAL RAINFALL   (mm)=   61.962
     RUNOFF COEFFICIENT   =     .419

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0007----------------------------------------------------------------------
-----------------------
| ADD HYD (TOTAL     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
-----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
                        ID1 02:201           .30     .011    1.83  46.26    .000
                       +ID2 03:OVF           .00     .000     .00    .00    .000
                       +ID3 04:203           .01     .001    1.38  25.94    .000
                        ==========================================================
                        SUM 08:TOTAL         .31     .012    1.68  45.61    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
050:0008----------------------------------------------------------------------
**#*****************************************************************************|
* RUN REMAINING DESIGN STORMS (TOWN OF EAST GWILLIMBURY 5 TO 100-YR)
*
--------------------------------------------------------------------------------
050:0002----------------------------------------------------------------------
*
--------------------------------------------------------------------------------
050:0002----------------------------------------------------------------------
*
--------------------------------------------------------------------------------
050:0002----------------------------------------------------------------------
*
--------------------------------------------------------------------------------
050:0002----------------------------------------------------------------------
*
--------------------------------------------------------------------------------
050:0002----------------------------------------------------------------------
*
  ** END OF RUN :  99

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




--------------------
| START            |  Project  dir.: T:\PROJECTS\16115\SWMHYMO\
--------------------  Rainfall dir.: T:\PROJECTS\16115\SWMHYMO\
    TZERO =   .00 hrs on       0
    METOUT=   2 (output = METRIC)
    NRUN  = 100
    NSTORM=   1
           #  1=BURL_100.stm
--------------------------------------------------------------------------------
100:0002----------------------------------------------------------------------
*#*****************************************************************************|
*#  Project Name: 4063 UPPER MIDDLE ROAD
*#               BURLINGTON, ONTARIO
*#  JOB NUMBER  : 16115
*#       Date   : January 2017
*#    Revised   : October 2021
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 16115.DAT
*#*****************************************************************************|
*
--------------------------------------------------------------------------------
100:0002----------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: 100-YR BURLINGTON CHICAGO STORM (4-HR DU
| Ptotal=  67.72 mm|    Comments: 100-YR BURLINGTON CHICAGO STORM (4-HR DU
--------------------
            TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
             hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
             .17   4.865 |   1.17  34.553 |   2.17  11.126 |   3.17   5.800
             .33   5.538 |   1.33 141.892 |   2.33   9.547 |   3.33   5.406
             .50   6.472 |   1.50  45.024 |   2.50   8.397 |   3.50   5.068
             .67   7.868 |   1.67  24.526 |   2.67   7.521 |   3.67   4.776
             .83  10.219 |   1.83  17.223 |   2.83   6.828 |   3.83   4.519
            1.00  15.170 |   2.00  13.447 |   3.00   6.266 |   4.00   4.292

--------------------------------------------------------------------------------
100:0003----------------------------------------------------------------------
*
*#*****************************************************************************|
*#
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ==============================================
*#
**#****************************************************************************|
*# CATCHMENT 101 - EXISTING CONDITION (OUTLET TO UPPER MIDDLE ROAD
*
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .31
| 01:101    DT= 1.00 |   Total Imp(%)=   21.00   Dir. Conn.(%)=   21.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .07          .24
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.50         1.50
     Length            (m)=      18.00        25.00
     Mannings n             =      .015         .250

     Max.eff.Inten.(mm/hr)=     141.89        62.57
               over (min)        1.00         8.00
     Storage Coeff.  (min)=        .66 (ii)    7.66 (ii)
     Unit Hyd. Tpeak (min)=       1.00         8.00
     Unit Hyd. peak  (cms)=       1.33          .15
                                                      *TOTALS*
     PEAK FLOW       (cms)=        .03          .03          .045 (iii)
     TIME TO PEAK    (hrs)=       1.32         1.43         1.333
     RUNOFF VOLUME    (mm)=      66.72        30.16        37.842
     TOTAL RAINFALL   (mm)=      67.72        67.72        67.724
     RUNOFF COEFFICIENT   =        .99          .45          .559

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0004----------------------------------------------------------------------
**#*****************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
*#
**#****************************************************************************|
*# CATCHMENT 201 - PROPOSED CONDITION (CONTROLLED TO UPPER MIDDLE ROAD)
*
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .30
| 01:201    DT= 1.00 |   Total Imp(%)=   58.00   Dir. Conn.(%)=   58.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .17          .13
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       3.00         3.00
     Length            (m)=      15.00        25.00
     Mannings n             =      .015         .250

     Max.eff.Inten.(mm/hr)=     141.89        67.22
               over (min)        1.00         6.00
     Storage Coeff.  (min)=        .56 (ii)    6.08 (ii)
     Unit Hyd. Tpeak (min)=       1.00         6.00
     Unit Hyd. peak  (cms)=       1.42          .19
                                                      *TOTALS*
     PEAK FLOW       (cms)=        .07          .02          .082 (iii)
     TIME TO PEAK    (hrs)=       1.30         1.38         1.333
     RUNOFF VOLUME    (mm)=      66.72        30.16        51.369
     TOTAL RAINFALL   (mm)=      67.72        67.72        67.724
     RUNOFF COEFFICIENT   =        .99          .45          .759

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0005----------------------------------------------------------------------
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(201   )   |
| OUT<02:(201   )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00    |     .011  .6400E-02
                           .006  .1800E-02    |     .012  .7300E-02
                           .008  .3500E-02    |     .013  .8200E-02
                           .009  .5100E-02    |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (201   )        .30      .082     1.333     51.369
     OUTFLOW<02: (201   )        .30      .013     1.833     51.369
    OVERFLOW<03: (OVF   )        .00      .000      .000       .000

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


                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=   15.220
                  TIME SHIFT OF PEAK FLOW         (min)=    30.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.7853E-02

--------------------------------------------------------------------------------
100:0006----------------------------------------------------------------------
*# CATCHMENT 203 - PROPOSED CONDITIONS (UNCONTROLLED TO UPPER MIDDLE ROAD)
---------------------
| CALIB NASHYD      |   Area    (ha)=     .01   Curve Number   (CN)=80.00
| 04:203    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=    .100

     Unit Hyd Qpeak  (cms)=     .004

     PEAK FLOW       (cms)=     .001 (i)
     TIME TO PEAK    (hrs)=    1.383
     RUNOFF VOLUME    (mm)=   30.138
     TOTAL RAINFALL   (mm)=   67.724
     RUNOFF COEFFICIENT   =     .445

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0007----------------------------------------------------------------------
-----------------------
| ADD HYD (TOTAL     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
-----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
                        ID1 02:201           .30     .013    1.83  51.37    .000
```

```
                  +ID2 03:OVF             .00     .000     .00    .00    .000
                  +ID3 04:203             .01     .001    1.38  30.14    .000
                   ============================================================
                   SUM 08:TOTAL           .31     .013    1.68  50.68    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0008----------------------------------------------------------------------
**#*****************************************************************************|
* RUN REMAINING DESIGN STORMS (TOWN OF EAST GWILLIMBURY 5 TO 100-YR)
*
--------------------------------------------------------------------------------
100:0002----------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002----------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002----------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002----------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002----------------------------------------------------------------------
*
      FINISH
--------------------------------------------------------------------------------
********************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2021-10-15     at 16:21:27
================================================================================
```

APPENDIX C
HYDROSTORM INFORMATION

Hydroworks Sizing Summary

4063 Upper Middle Road

10-15-2021

Recommended Size: HS 5

A HydroStorm HS 5 is recommended to provide 80 % annual TSS removal based on a drainage area of 0.30 (ha) with an imperviousness of 58 % and Hamilton RBG, Ontario rainfall for the ETV Canada particle size distribution.

The recommended HydroStorm HS 5 treats 97 % of the annual runoff and provides 82 % annual TSS removal for the Hamilton RBG rainfall records and ETV Canada particle size distribution.

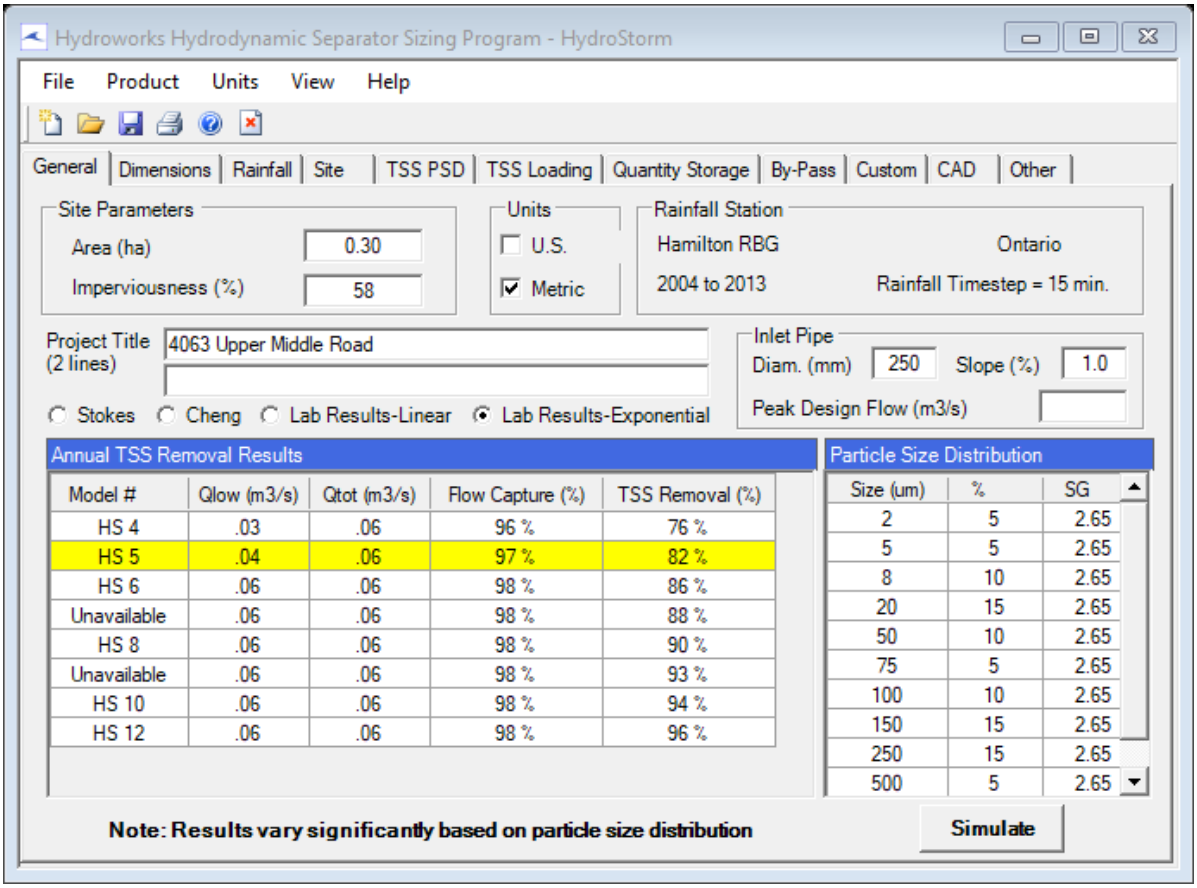
The HydroStorm has a headloss coefficient (K) of 1.04. Since a peak flow was not specified, headloss was calculated using the full pipe flow of .06 (m3/s) for the given 250 (mm) pipe diameter at 1% slope. The headloss was calculated to be 78 (mm) based on a flow depth of 250 (mm) (full pipe flow).

This summary report provides the main parameters that were used for sizing. These parameters are shown on the summary tables and graphs provided in this report.

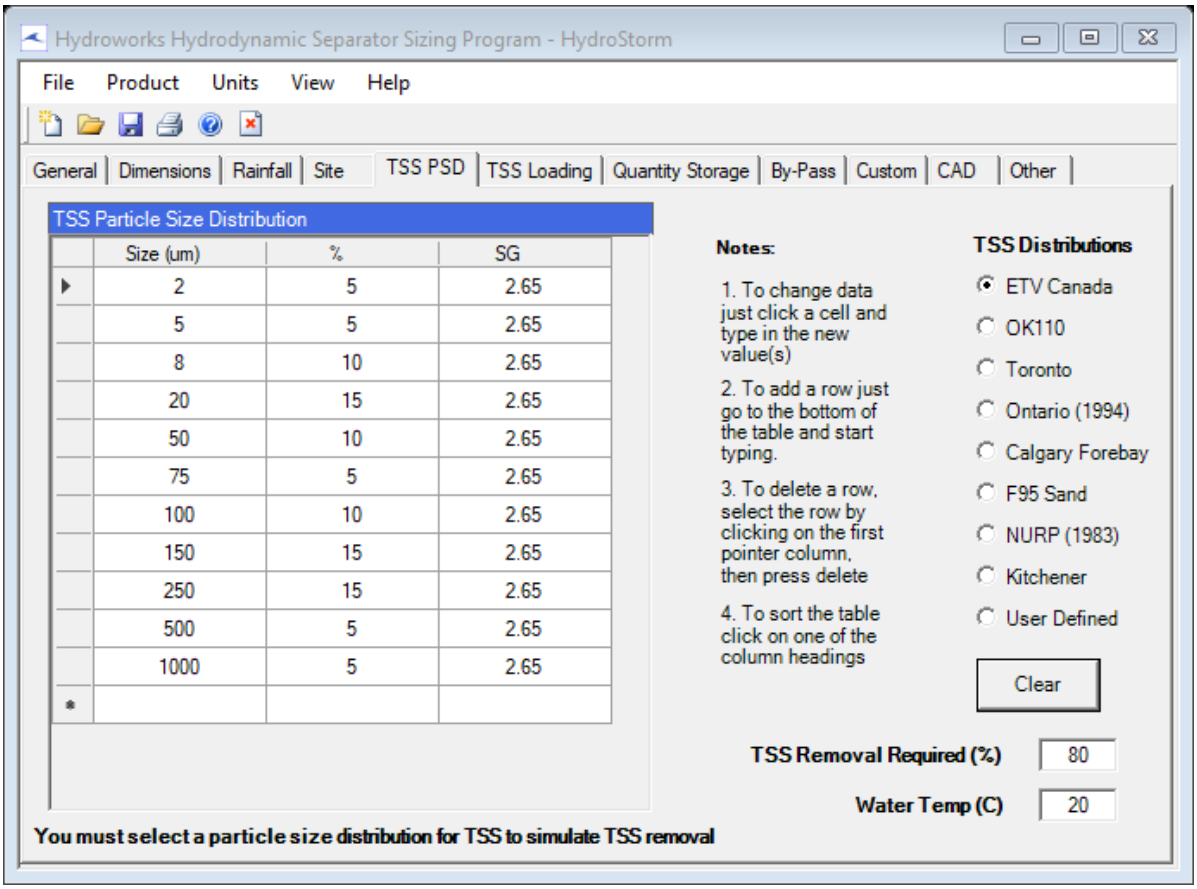
If you have any questions regarding this sizing summary please do not hesitate to contact Hydroworks at 888-290-7900 or email us at support@hydroworks.com.

The sizing program is for sizing purposes only and does not address any site specific parameters such as hydraulic gradeline, tailwater submergence, groundwater, soils bearing capacity, etc. Headloss calculations are not a hydraulic gradeline calculation since this requires a starting water level and an analysis of the entire system downstream of the HydroStorm . Design liability is only valid for lawsuits brought within the United States where Hydroworks has its corporate headquarters.

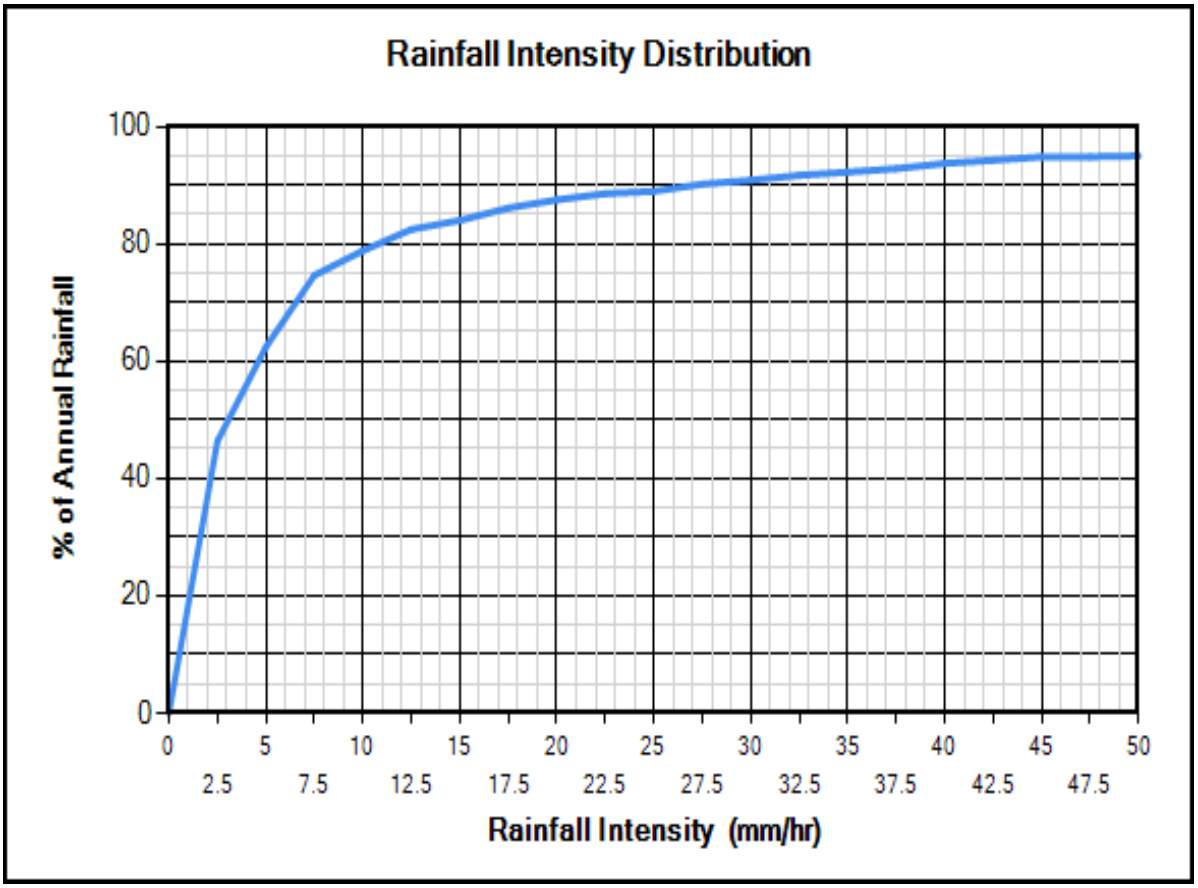
TSS Removal Sizing Summary



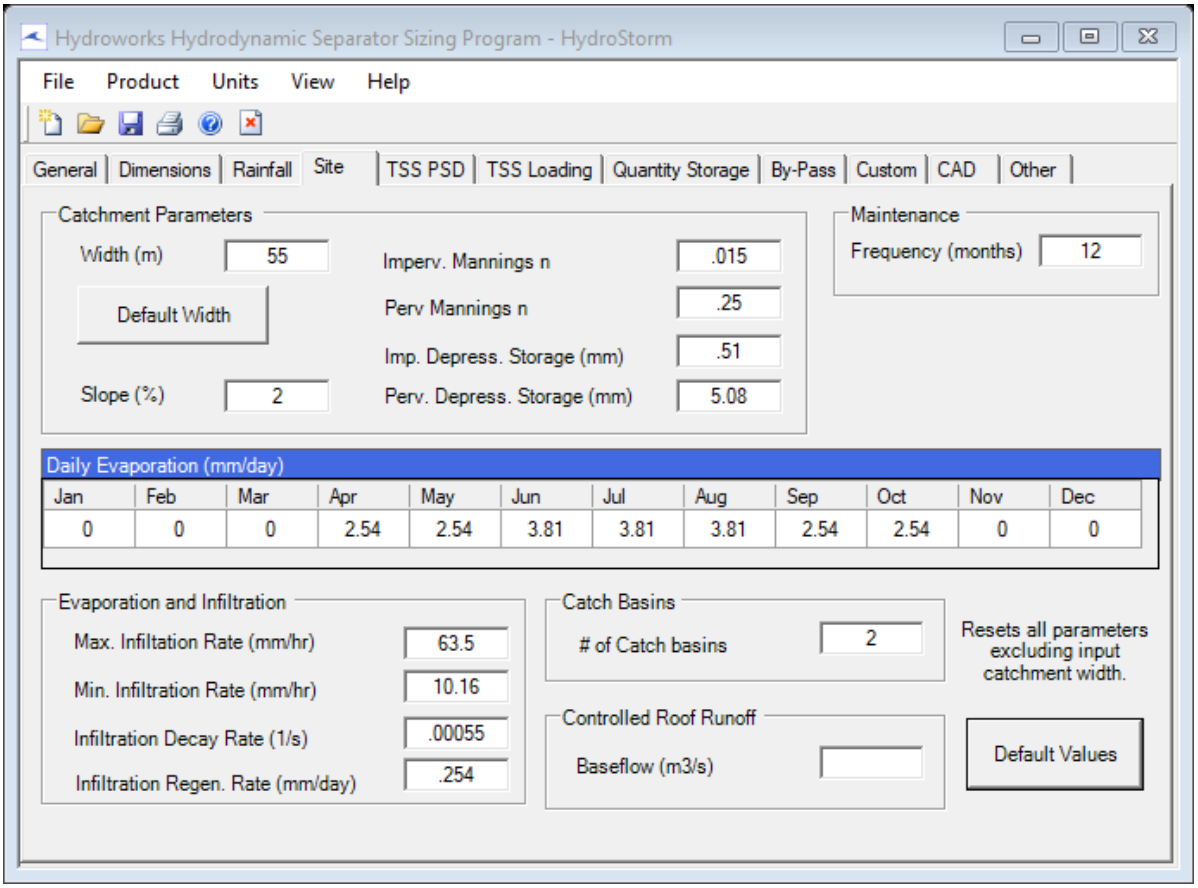
TSS Particle Size Distribution



Rainfall Station - Hamilton RBG, Ontario(2004 to 2013)



Site Physical Characteristics



Dimensions And Capacities

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units View Help

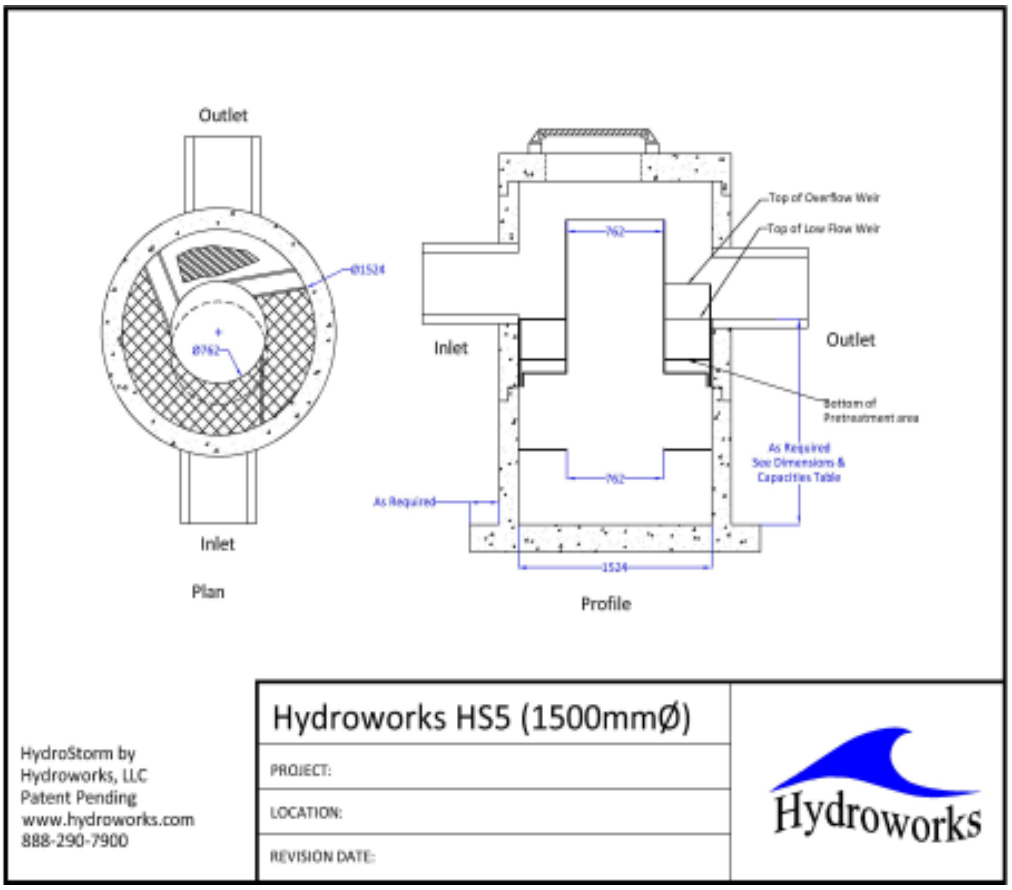
General | Dimensions | Rainfall | Site | TSS PSD | TSS Loading | Quantity Storage | By-Pass | Custom | CAD | Other

Dimensions and Capacities

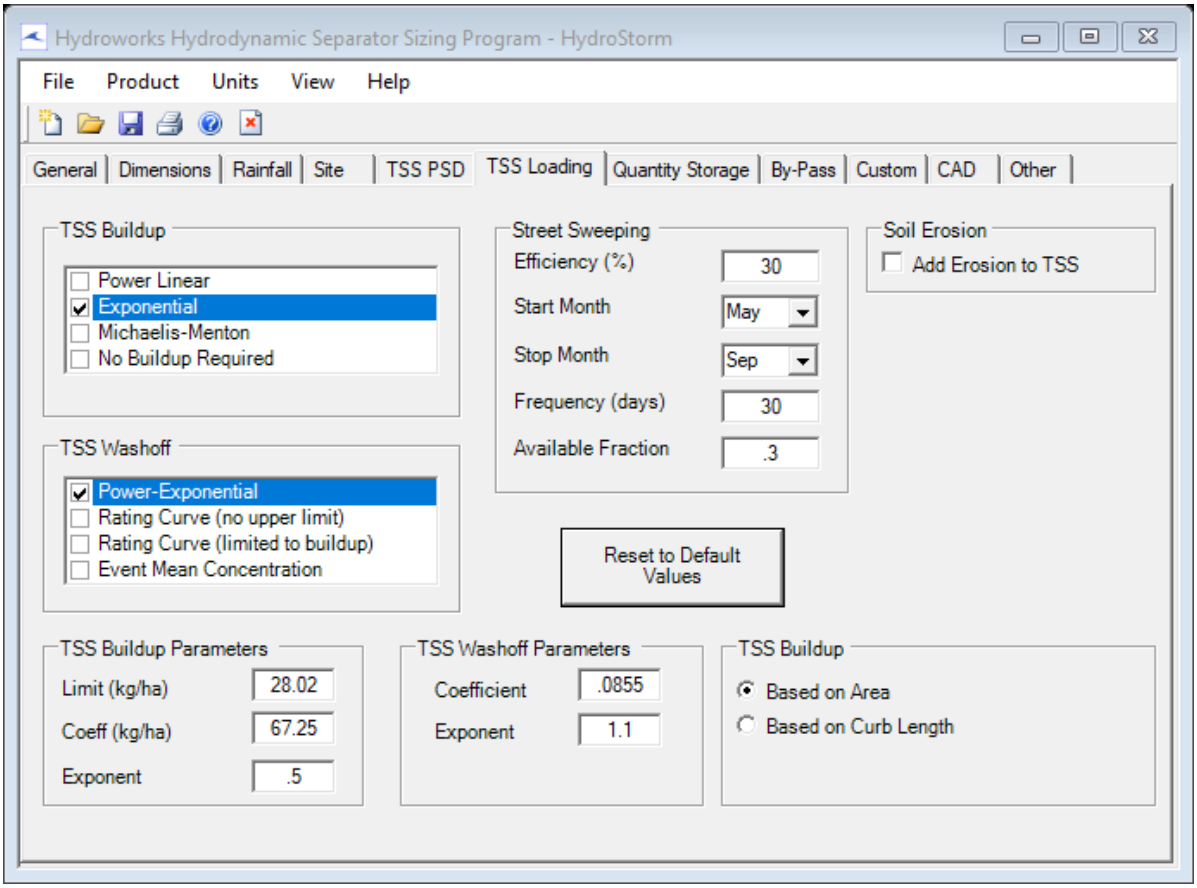
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HS 4	1.22	1.22	381	0.9	1.4
HS 5	1.52	1.52	642	1.8	2.8
HS 6	1.83	1.83	1041	3.2	4.8
HS 7	2.13	1.98	1575	4.6	7.1
HS 8	2.44	2.13	2354	6.3	10
HS 9	2.74	2.44	3242	9.3	14.4
HS 10	3.05	2.74	4327	13.2	20
HS 12	3.66	3.35	7164	23.8	35.2

Depth = Depth from outlet invert to inside bottom of tank

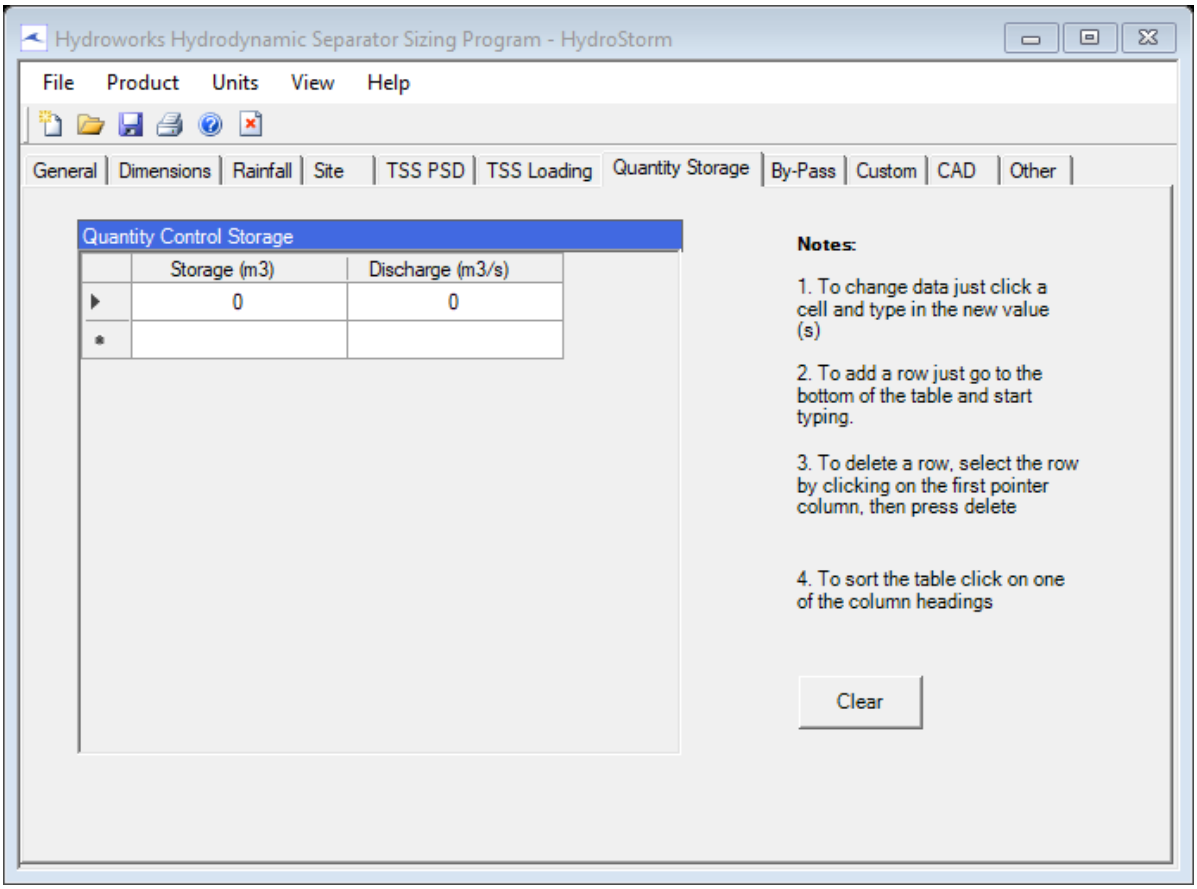
Generic HS 5 CAD Drawing



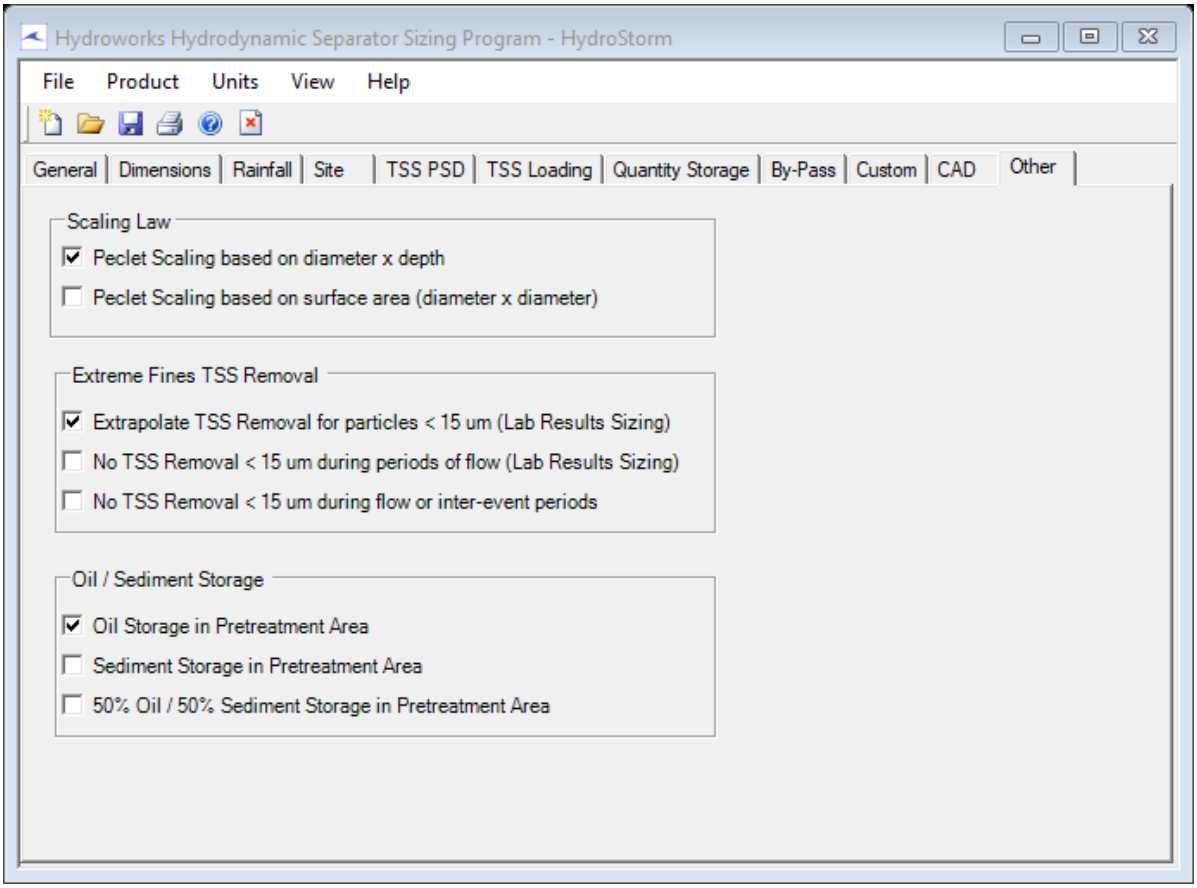
TSS Buildup And Washoff



Upstream Quantity Storage



Other Parameters



Hydroworks Sizing Program - Version 4.9
Copyright Hydroworks, LLC, 2019



Hydroworks® HydroStorm

Operations & Maintenance Manual

Version 1.0

Please call Hydroworks at 888-290-7900 or email us at support@hydroworks.com if you have any questions regarding the Inspection Checklist. Please fax a copy of the completed checklist to Hydroworks at 888-783-7271 for our records.

Introduction

The HydroStorm is a state of the art hydrodynamic separator. Hydrodynamic separators remove solids, debris and lighter than water (oil, trash, floating debris) pollutants from stormwater. Hydrodynamic separators and other water quality measures are mandated by regulatory agencies (Town/City, State, Federal Government) to protect storm water quality from pollution generated by urban development (traffic, people) as part of new development permitting requirements.

As storm water treatment structures fill up with pollutants they become less and less effective in removing new pollution. Therefore, it is important that storm water treatment structures be maintained on a regular basis to ensure that they are operating at optimum performance. The HydroStorm is no different in this regard and this manual has been assembled to provide the owner/operator with the necessary information to inspect and coordinate maintenance of their HydroStorm.

Hydroworks® HydroStorm Operation

The Hydroworks HydroStorm (HS) separator is a unique hydrodynamic by-pass separator. It incorporates a protected submerged pretreatment zone to collect larger solids, a treatment tank to remove finer solids, and a dual set of weirs to create a high flow bypass. High flows are conveyed directly to the outlet and do not enter the treatment area, however, the submerged pretreatment area still allows removal of coarse solids during high flows.

Under normal or low flows, water enters an inlet area with a horizontal grate. The area underneath the grate is submerged with openings to the main treatment area of the separator. Coarse solids fall through the grate and are either trapped in the pretreatment area or conveyed into the main treatment area depending on the flow rate. Fines are transported into the main treatment area. Openings and weirs in the pretreatment area allow entry of water and solids into the main treatment area and cause water to rotate in the main treatment area creating a vortex motion. Water in the main treatment area is forced to rise along the walls of the separator to discharge from the treatment area to the downstream pipe.

The vortex motion forces solids and floatables to the middle of the inner chamber. Floatables are trapped since the inlet to the treatment area is submerged. The design maximizes the retention of settled solids since solids are forced to the center of the inner chamber by the vortex motion of water while water must flow up the walls of the separator to discharge into the downstream pipe.

A set of high flow weirs near the outlet pipe create a high flow bypass over both the pretreatment area and main treatment chamber. The rate of flow into the treatment area is regulated by the number and size of openings into the treatment chamber and the height of by-pass weirs. High flows flow over the weirs directly to the outlet pipe preventing the scour and resuspension of any fines collected in the treatment chamber.

A central access tube is located in the structure to provide access for cleaning. The arrangement of the inlet area and bypass weirs near the outlet pipe facilitate the use of multiple inlet pipes.

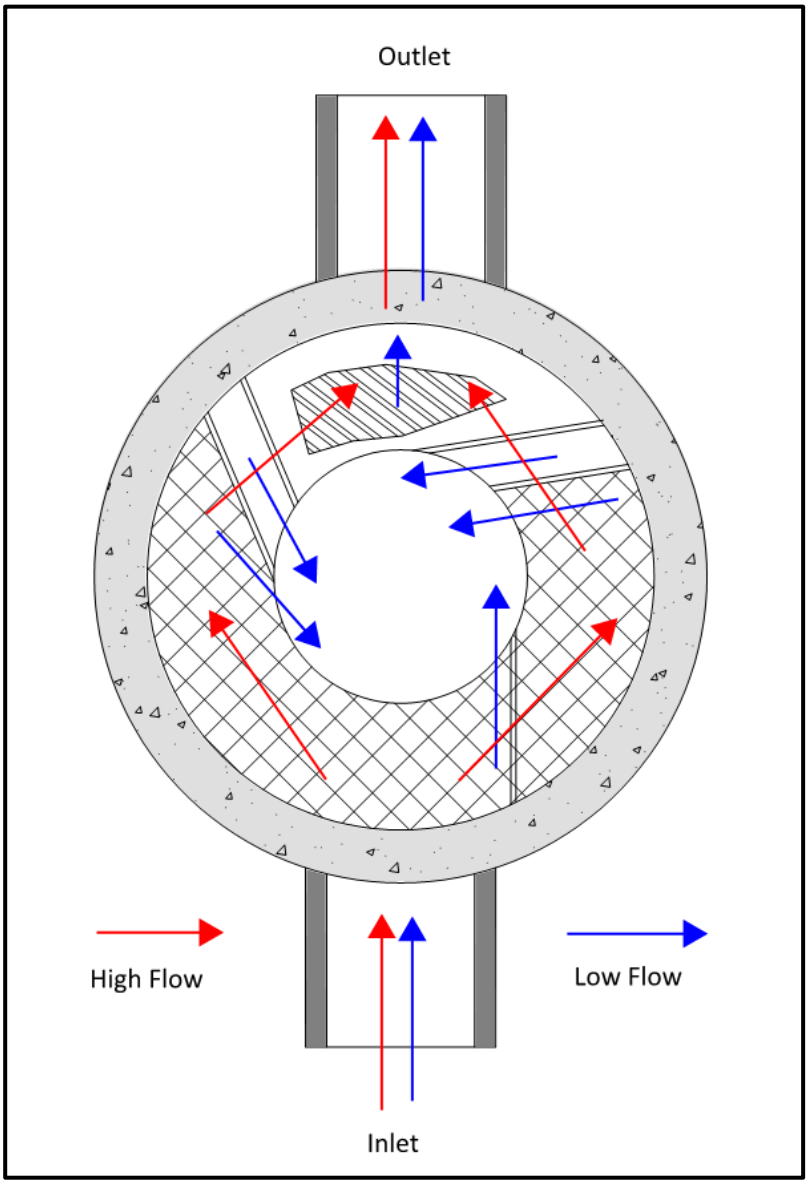


Figure 1. Hydroworks HydroStorm Operation – Plan View

Figure 2 is a profile view of the HydroStorm separator showing the flow patterns for low and high flows.

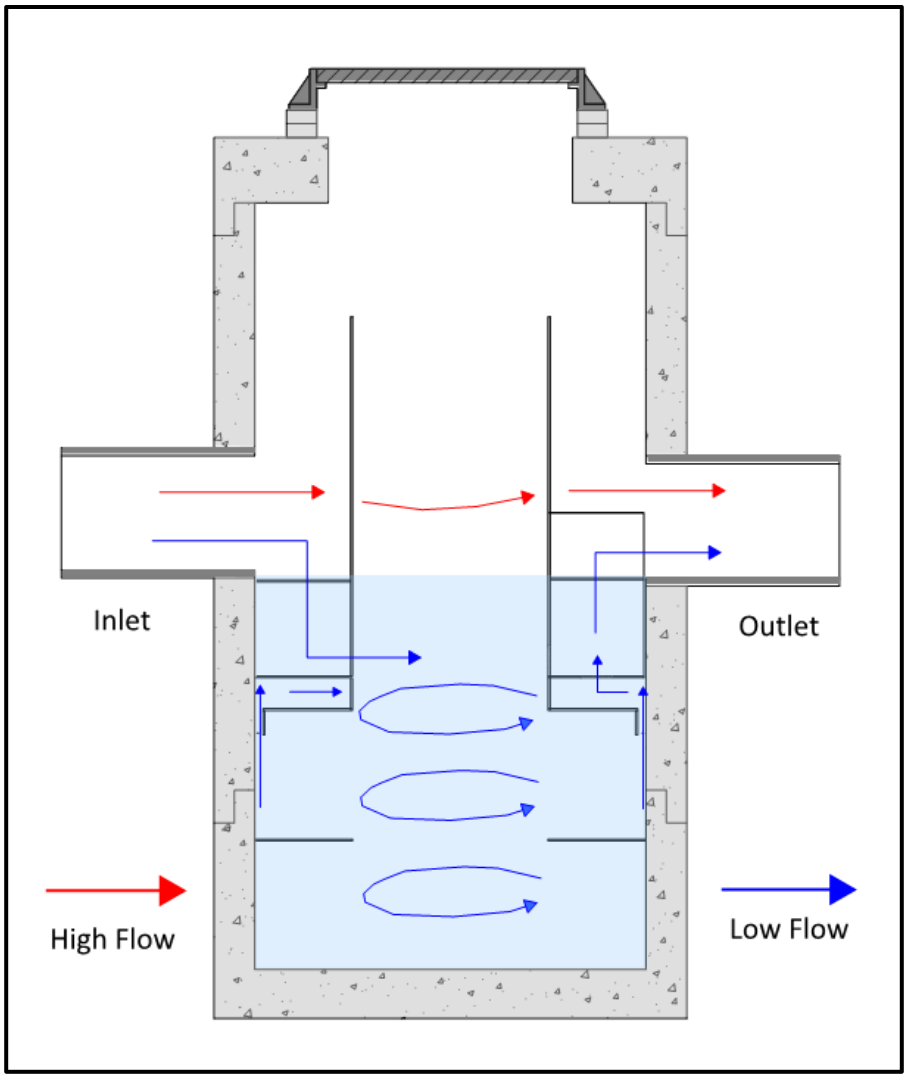


Figure 2. Hydroworks HydroStorm Operation – Profile View

The HS 4i is an inlet version of the HS 4 separator. There is a catch-basin grate on top of the HS 4i. A funnel sits sits underneath the grate on the frame and directs the water to the inlet side of the separator to ensure all lows flows are properly treated. The whole funnel is removed for inspection and cleaning.

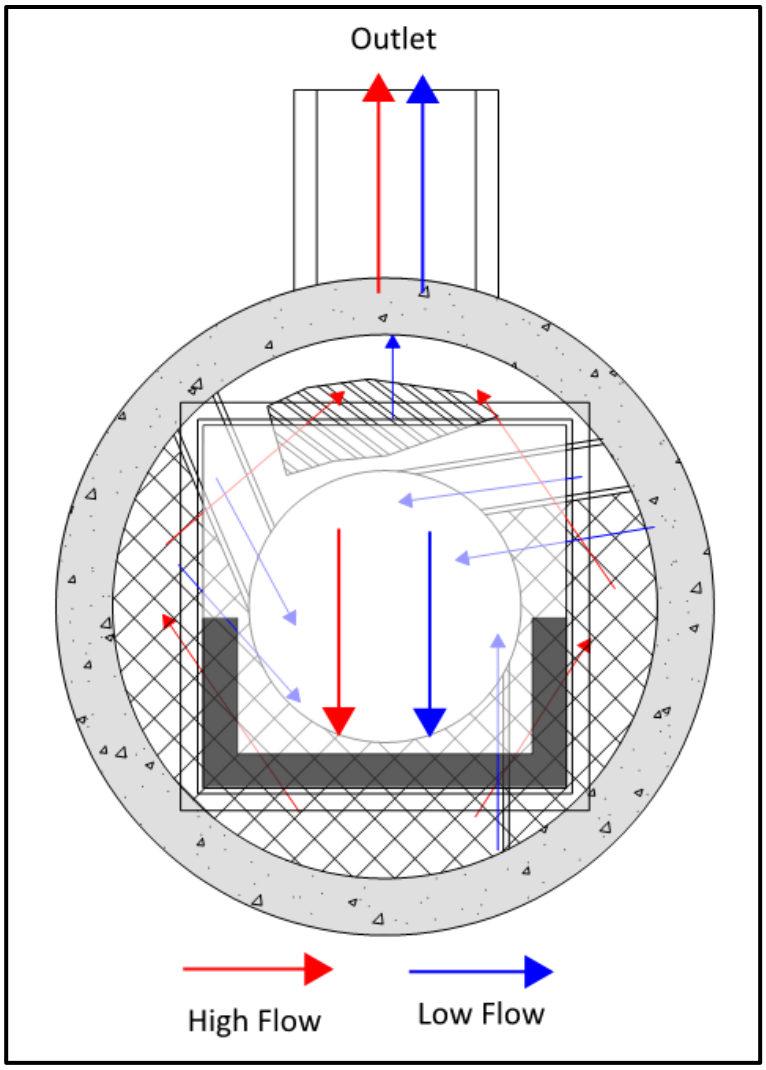


Figure 3. Hydroworks HS 4i Funnel

Inspection

Procedure

Floatables

A visual inspection can be conducted for floatables by removing the covers and looking down into the center access tube of the separator. Separators with an inlet grate (HS 4i or custom separator) will have a plastic funnel located under the grate that must be removed from the frame prior to inspection or maintenance. If you are missing a funnel please contact Hydroworks at the numbers provided at the end of this document.

Hydroworks

TSS/Sediment

Inspection for TSS build-up can be conducted using a Sludge Judge®, Core Pro®, AccuSludge® or equivalent sampling device that allows the measurement of the depth of TSS/sediment in the unit. These devices typically have a ball valve at the bottom of the tube that allows water and TSS to flow into the tube when lowering the tube into the unit. Once the unit touches the bottom of the device, it is quickly pulled upward such that the water and TSS in the tube forces the ball valve closed allowing the user to see a full core of water/TSS in the unit. The unit should be inspected for TSS through each of the access covers. Several readings (2 or 3) should be made at each access cover to ensure that an accurate TSS depth measurement is recorded.

Frequency

Construction Period

The HydroStorm separator should be inspected every four weeks and after every large storm (over 0.5" (12.5 mm) of rain) during the construction period.

Post-Construction Period

The Hydroworks HydroStorm separator should be inspected during the first year of operation for normal stabilized sites (grassed or paved areas). If the unit is subject to oil spills or runoff from unstabilized (storage piles, exposed soils) areas the HydroStorm separator should be inspected more frequently (4 times per year). The initial annual inspection will indicate the required future frequency of inspection and maintenance if the unit was maintained after the construction period.

Reporting

Reports should be prepared as part of each inspection and include the following information:

1. Date of inspection
2. GPS coordinates of Hydroworks unit
3. Time since last rainfall
4. Date of last inspection
5. Installation deficiencies (missing parts, incorrect installation of parts)
6. Structural deficiencies (concrete cracks, broken parts)
7. Operational deficiencies (leaks, blockages)
8. Presence of oil sheen or depth of oil layer
9. Estimate of depth/volume of floatables (trash, leaves) captured
10. Sediment depth measured
11. Recommendations for any repairs and/or maintenance for the unit
12. Estimation of time before maintenance is required if not required at time of inspection

A sample inspection checklist is provided at the end of this manual.

Maintenance

Procedure

The Hydroworks HydroStorm unit is typically maintained using a vacuum truck. There are numerous companies that can maintain the HydroStorm separator. Maintenance with a vacuum truck involves removing all of the water and sediment together. The water is then separated from the sediment on the truck or at the disposal facility.

A central access opening (24” or greater) is provided to the gain access to the lower treatment tank of the unit. This is the primary location to maintain by vacuum truck. The pretreatment area can also be vacuumed and/or flushed into the lower treatment tank of the separator for cleaning via the central access once the water level is lowered below the pretreatment floor.

In instances where a vacuum truck is not available other maintenance methods (i.e. clamshell bucket) can be used, but they will be less effective. If a clamshell bucket is used the water must be decanted prior to cleaning since the sediment is under water and typically fine in nature. Disposal of the water will depend on local requirements. Disposal options for the decanted water may include:

1. Discharge into a nearby sanitary sewer manhole
2. Discharge into a nearby LID practice (grassed swale, bioretention)
3. Discharge through a filter bag into a downstream storm drain connection

The local municipality should be consulted for the allowable disposal options for both water and sediments prior to any maintenance operation. Once the water is decanted the sediment can be removed with the clamshell bucket.

Disposal of the contents of the separator depend on local requirements. Maintenance of a Hydroworks HydroStorm unit will typically take 1 to 2 hours based on a vacuum truck and longer for other cleaning methods (i.e. clamshell bucket).

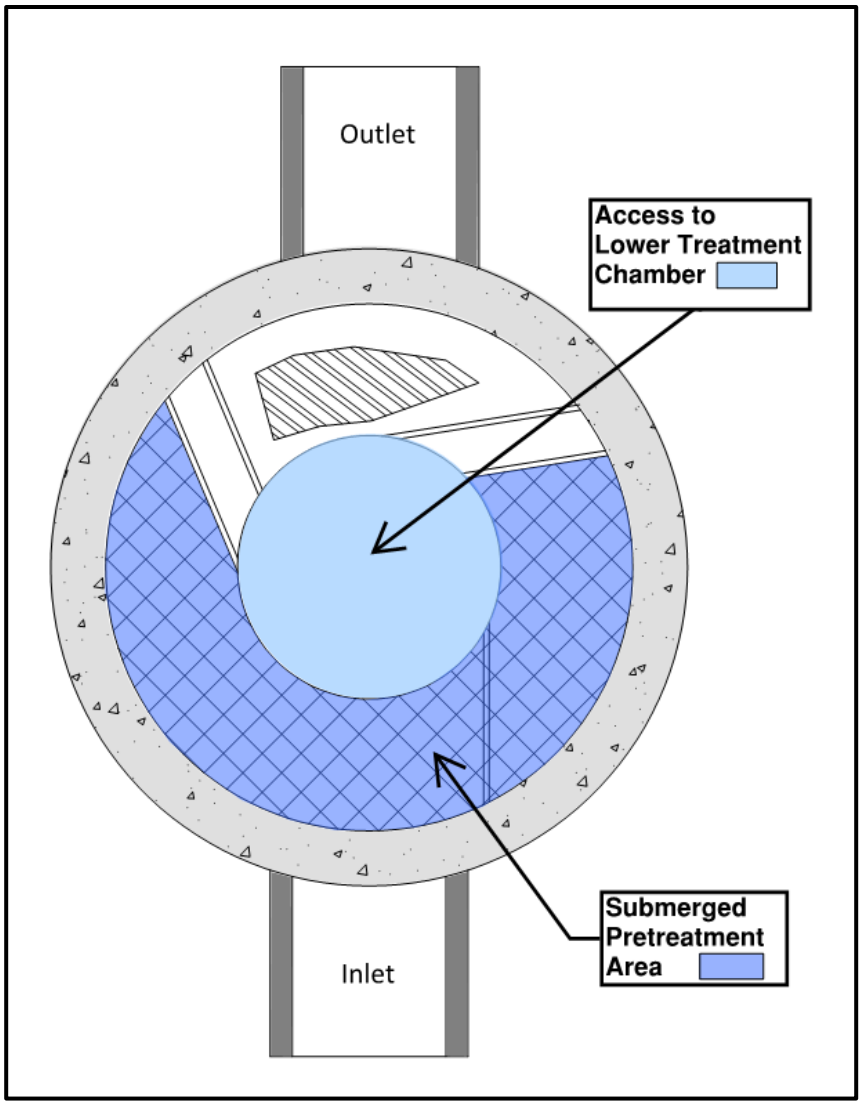


Figure 3. Maintenance Access

Frequency

Construction Period

A HydroStorm separator can fill with construction sediment quickly during the construction period. The HydroStorm must be maintained during the construction period when the depth of TSS/sediment reaches 24” (600 mm). It must also be maintained during the construction period if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the area of the separator

The HydroStorm separator should be maintained at the end of the construction period, prior to operation for the post-construction period.

Post-Construction Period

The HydroStorm was independently tested by Alden Research Laboratory in 2017. A HydroStorm HS 4 was tested for scour with a 50% sediment depth of 0.5 ft. Therefore, maintenance for sediment accumulation is required if the depth of sediment is 1 ft or greater in separators with standard water (sump) depths (Table 1).

There will be designs with increased sediment storage based on specifications or site-specific criteria. A measurement of the total water depth in the separator through the central access tube should be taken and compared to water depth given in Table 1. The standard water depth from Table 1 should be subtracted from the measured water depth and the resulting extra depth should be added to the 1 ft to determine the site-specific sediment maintenance depth for that separator.

For example, if the measured water depth in the HS-7 is 7 feet, then the sediment maintenance depth for that HS-7 is 2 ft (= 1 + 7 – 6) and the separator does not need to be cleaned for sediment accumulation until the measure sediment depth is 2 ft.

The HydroStorm separator must also be maintained if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the water surface of the separator.

Table 1 Standard Dimensions for Hydroworks HydroStorm Models

Model	Diameter (ft)	Total Water Depth (ft)	Sediment Maintenance Depth for Table 1 Total Water Depth(ft)
HS-3	3	3	1
HS-4	4	4	1
HS-5	5	4	1
HS-6	6	4	1
HS-7	7	6	1
HS-8	8	7	1
HS-9	9	7.5	1
HS-10	10	8	1
HS-11	11	9	1
HS-12	12	9.5	1

HYDROSTORM INSPECTION SHEET

Date _____
Date of Last Inspection _____

Site _____
City _____
State _____
Owner _____

GPS Coordinates _____

Date of last rainfall _____

Site Characteristics	**Yes**	**No**
Soil erosion evident	☐	☐
Exposed material storage on site	☐	☐
Large exposure to leaf litter (lots of trees)	☐	☐
High traffic (vehicle) area	☐	☐

HydroStorm	**Yes**	**No**
Obstructions in the inlet or outlet	☐ *	☐
Missing internal components	☐ **	☐
Improperly installed inlet or outlet pipes	☐ ***	☐
Internal component damage (cracked, broken, loose pieces)	☐ **	☐
Floating debris in the separator (oil, leaves, trash)	☐	☐
Large debris visible in the separator	☐ *	☐
Concrete cracks/deficiencies	☐ ***	☐
Exposed rebar	☐ **	☐
Water seepage (water level not at outlet pipe invert)	☐ ***	☐

Water level depth below outlet pipe invert _____“

Routine Measurements

Floating debris depth	**< 0.5” (13mm)**	☐	**>0.5” 13mm)**	☐ *
Floating debris coverage	**< 50% of surface area**	☐	**> 50% surface area**	☐ *
Sludge depth	**< 12” (300mm)**	☐	**> 12” (300mm)**	☐ ****

* Maintenance required
** Repairs required
*** Further investigation is required

Hydroworks

Other Comments:

Hydroworks

Hydroworks® HydroStorm

One Year Limited Warranty

Hydroworks, LLC warrants, to the purchaser and subsequent owner(s) during the warranty period subject to the terms and conditions hereof, the Hydroworks HydroStorm to be free from defects in material and workmanship under normal use and service, when properly installed, used, inspected and maintained in accordance with Hydroworks written instructions, for the period of the warranty. The standard warranty period is 1 year.

The warranty period begins once the separator has been manufactured and is available for delivery. Any components determined to be defective, either by failure or by inspection, in material and workmanship will be repaired, replaced or remanufactured at Hydroworks' option provided, however, that by doing so Hydroworks, LLC will not be obligated to replace an entire insert or concrete section, or the complete unit. This warranty does not cover shipping charges, damages, labor, any costs incurred to obtain access to the unit, any costs to repair/replace any surface treatment/cover after repair/replacement, or other charges that may occur due to product failure, repair or replacement.

This warranty does not apply to any material that has been disassembled or modified without prior approval of Hydroworks, LLC, that has been subjected to misuse, misapplication, neglect, alteration, accident or act of God, or that has not been installed, inspected, operated or maintained in accordance with Hydroworks, LLC instructions and is in lieu of all other warranties expressed or implied. Hydroworks, LLC does not authorize any representative or other person to expand or otherwise modify this limited warranty.

The owner shall provide Hydroworks, LLC with written notice of any alleged defect in material or workmanship including a detailed description of the alleged defect upon discovery of the defect. Hydroworks, LLC should be contacted at 136 Central Ave., Clark, NJ 07066 or any other address as supplied by Hydroworks, LLC. (888-290-7900).

This limited warranty is exclusive. There are no other warranties, express or implied, or merchantability or fitness for a particular purpose and none shall be created whether under the uniform commercial code, custom or usage in the industry or the course of dealings between the parties. Hydroworks, LLC will replace any goods that are defective under this warranty as the sole and exclusive remedy for breach of this warranty.

Subject to the foregoing, all conditions, warranties, terms, undertakings or liabilities (including liability as to negligence), expressed or implied, and howsoever arising, as to the condition, suitability, fitness, safety, or title to the Hydroworks HydroStorm are hereby negated and excluded and Hydroworks, LLC gives and makes no such representation, warranty or undertaking except as expressly set forth herein. Under no circumstances shall Hydroworks, LLC be liable to the Purchaser or to any third party for product liability claims; claims arising from the design, shipment, or installation of the HydroStorm, or the cost of other goods or services related to the purchase and installation of the HydroStorm. For this Limited Warranty to apply, the HydroStorm must be installed in accordance with all site conditions required by state and local codes; all other applicable laws; and Hydroworks' written installation instructions.

Hydroworks, LLC expressly disclaims liability for special, consequential or incidental damages (even if it has been advised of the possibility of the same) or breach of expressed or implied warranty. Hydroworks, LLC shall not be liable for penalties or liquidated damages, including loss of production and profits; labor and materials; overhead costs; or other loss or expense incurred by the purchaser or any third party. Specifically excluded from limited warranty coverage are damages to the HydroStorm arising from ordinary wear and tear; alteration, accident, misuse, abuse or neglect; improper maintenance, failure of the product due to improper installation of the concrete sections or improper sizing; or any other event not caused by Hydroworks, LLC. This limited warranty represents Hydroworks' sole liability to the purchaser for claims related to the HydroStorm, whether the claim is based upon contract, tort, or other legal basis.

◆ Verification Statement ◆ Verification Statement ◆ Verification Statement ◆

VERIFICATION STATEMENT

GLOBE Performance Solutions

Verifies the performance of

Hydroworks® HydroStorm (HS) Hydrodynamic Separator

Developed by Hydroworks, LLC
Clark, NJ, USA

In accordance with

ISO 14034:2016

Environmental management — Environmental technology verification (ETV)

John D. Wiebe, PhD
Executive Chairman
GLOBE Performance Solutions

May 15, 2018
Vancouver, BC, Canada

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

Technology description and application

The Hydroworks® HydroStorm (HS) Hydrodynamic Separator is a concrete cylindrical device with an annular pre-treatment channel, an inner chamber, and lower collection sump. A schematic of the HS 4 test unit is shown in Figure 1. The pre-treatment channel extends below the outlet pipe invert and contains three intermediate low-flow weirs (flush with the outlet invert), and two downstream higher bypass weirs that extend above the outlet invert. The higher weirs bypass high flows to prevent oil and solids from being scoured out of the separator.

As water enters the unit through one or more inlets, coarser solids immediately start to settle below a horizontal grate extending from the inlet to two sets of lower weirs near the outlet pipe. The grating is positioned over the pre-treatment channel to help displace the inflow turbulence and protect the captured sediment from scour. Openings are located on the horizontal plate upstream of each weir to allow the flow to be conveyed into the inner chamber and lower sump. The weirs are positioned to create a counter clockwise rotation of water in the inner chamber to minimize turbulence and maximize settling. After water spirals down the inner chamber to the main settling chamber towards the floor of the separator where it deposits suspended sediments, it flows upwards between the wall of the unit and the outer edge of the disk extended from the inner chamber and through an arced opening at the bottom of the pre-treatment disk, downstream of the bypass weirs, where it is conveyed into the outlet pipe. An annular secondary horizontal plate with 32% of open-perforations is located within the lower sump to protect the collected sediment from scour. Oil and light liquids enter the inner chamber through the holes, reaching the bottom of the pre-treatment area and rises to the top of the water level where they are trapped.

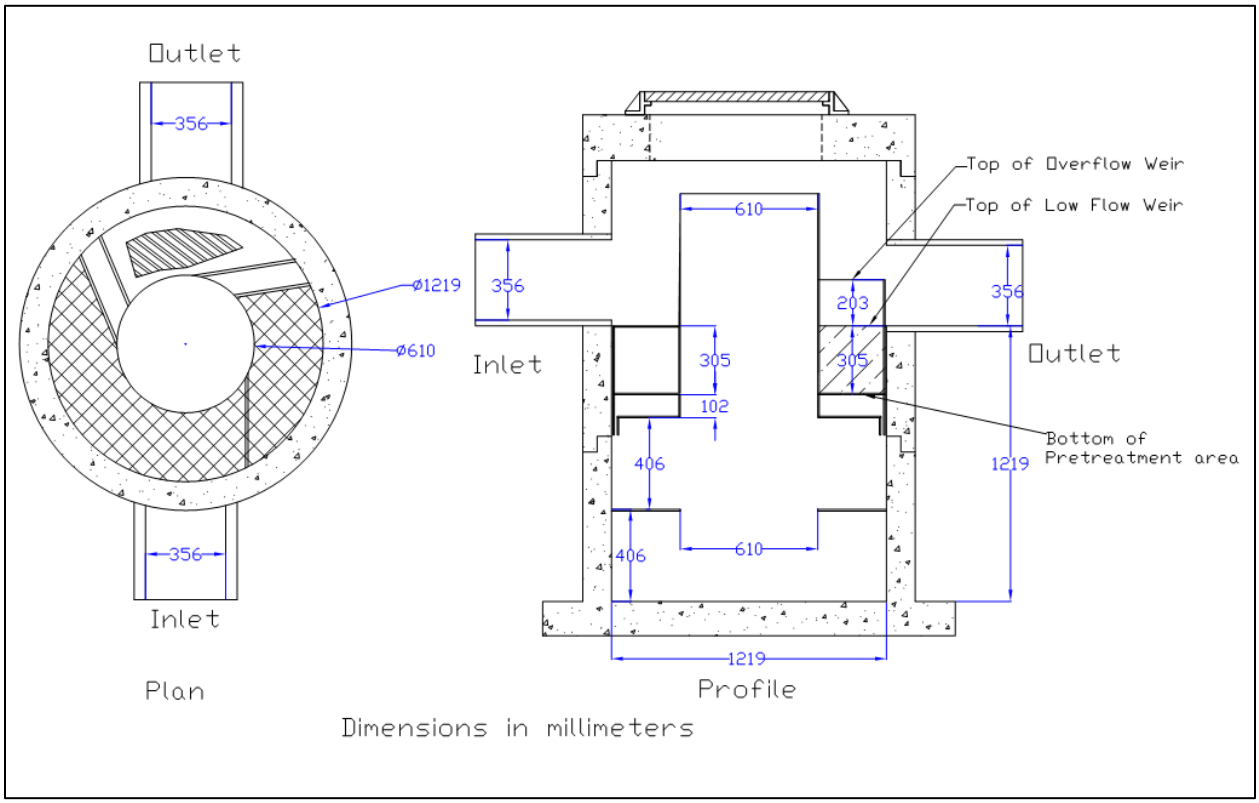


Figure 1: Schematic of the Hydroworks® HS4 Hydrodynamic Separator treatment unit tested as part of this verification.

Performance conditions

The data and results published in this Technology Fact Sheet were obtained from the testing program conducted on the Hydroworks® HS4 Hydrodynamic Separator, in accordance with the *Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014)*. The Procedure was prepared by the Toronto and Region Conservation Authority (TRCA) for the Canadian Environmental Technology Verification Program. A copy of the Procedure may be accessed on the Canadian ETV website at www.etvcanada.ca.

Performance claim(s)

Capture test[1]:

During the capture test, the Hydroworks® HS Hydrodynamic Separator, with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L, removes 69, 64, 60, 56, 46, 41, and 36 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, and 1400 L/min/m^2, respectively.

Scour test[1]:

During the scour test, the Hydroworks® HS Hydrodynamic Separator, with 10.2 cm (4 inches) of test sediment pre-loaded onto a false floor reaching 50% of the manufacturer's recommended maximum sediment sump storage depth and sediment loaded onto the pre-treatment channel emulating depositional pattern of the 40 L/min/m^2 capture test, generate corrected effluent concentrations of 22.4, 28.5, 20.0, 19.1, and 24.4 mg/L at 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m^2, respectively.

Light liquid re-entrainment test[1]:

During the light liquid re-entrainment test, the Hydroworks® HS Hydrodynamic Separator with surrogate low-density polyethylene beads preloaded within the inner chamber, representing a floating light liquid volume equal to a depth of 50.8 mm over the sedimentation area, retains 100, 99.9, 95.4, 95.7, and 97.5 percent of loaded beads by mass during the 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m^2, respectively.

Performance results

The test sediment consisted of ground silica (1 – 1000 micron) with a specific gravity of 2.65, uniformly mixed to meet the particle size distribution specified in the testing procedure. The *Procedure for Laboratory Testing of Oil Grit Separators* requires that the three sample average of the test sediment particle size distribution (PSD) meet the specified PSD percent less than values within a boundary threshold of 6%. The comparison of the average test sediment PSD to the CETV specified PSD in Figure 2indicates that the test sediment used for the capture and scour tests met this condition.

[1] The claim can be applied to other units smaller or larger than the tested unit as long as the untested units meet the scaling rule specified in the Procedure for Laboratory of Testing of Oil Grit Separators (Version 3.0, June 2014)

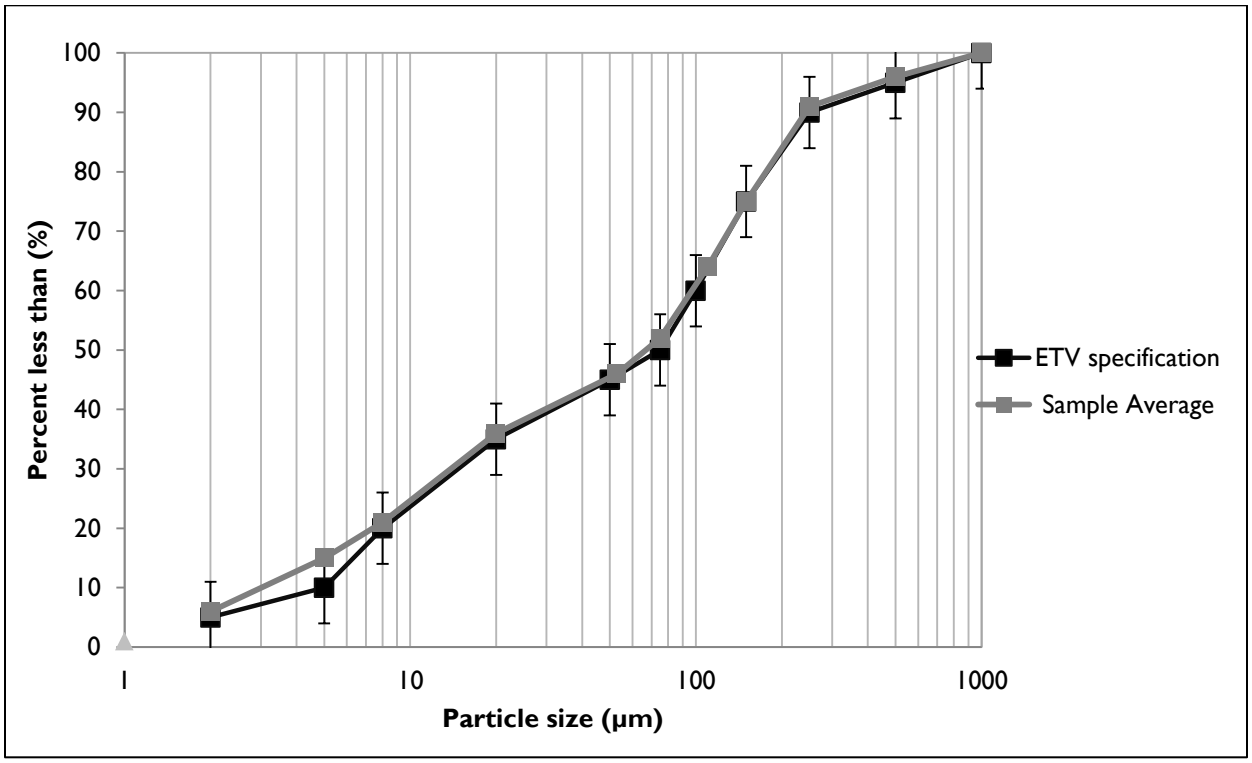


Figure 2. The three sample average particle size distribution (PSD) of the test sediment used for the capture and scour test compared to the specified PSD.

The capacity of the device to retain sediment was determined at seven surface loading rates using the modified mass balance method. This method involved measuring the mass and particle size distribution of the injected and retained sediment for each test run. Performance was evaluated with a false floor at 0.15 m from the bottom, simulating the technology filled to 50% of the manufacturer's recommended maximum sediment storage depth. The test was carried out with clean water that maintained a sediment concentration below 20 mg/L. Based on these conditions, removal efficiencies for individual particle size classes and for the test sediment as a whole were determined for each of the tested surface loading rates (Table 1).

In some instances, the removal efficiencies were above 100% for certain particle size fractions. These discrepancies are not unique to any one test laboratory and may be attributed to errors relating to the blending of sediment, collection of representative samples for laboratory submission, and laboratory analysis of PSD. Due to these errors, caution should be exercised in applying the removal efficiencies by particle size fraction for the purposes of sizing the tested device (see Bulletin # CETV 2016-11-0001). The results for "all particle sizes by mass balance" (see Table 1 and 2) are based on measurements of the total injected and retained sediment mass, and are therefore not subject to blending, sampling or PSD analysis errors.

Table 1. Removal efficiencies (%) of the HS4 unit at specified surface loading rates.

Particle size fraction (µm)	Surface loading rate (L/min/m²)						
	40	80	200	400	600	1000	1400
>500	73	100*	98	67	100*	100*	26
250 - 500	100	100*	92	64	100*	98	48
150 - 250	100*	75	89	72	89	60	69
105 - 150	94	100*	100*	100*	78	99	91
75 - 105	96	76	79	95	68	54	46
53 - 75	87	100*	100*	100*	56	69	65
20 - 53	71	54	46	44	19	14	10
8 - 20	38	23	15	8	2	2	2
5 – 8	13	6	1	1	0	0	0
<5	8	0	0	0	0	0	0
All particle sizes by mass balance	**68.6**	**64.0**	**60.0**	**56.1**	**46.1**	**41.2**	**35.7**

* Removal efficiencies were calculated to be above 100%. Calculated values ranged between 103 and 194% (average 128%). See text and Bulletin # CETV 2016-11-0001 for more information.

Figure 3 compares the particle size distribution (PSD) of the three sample average of the test sediment to the PSD of the sediment retained by the HS4 unit at each of the tested surface loading rates. As expected, the capture efficiency for fine particles in the unit was generally found to decrease as surface loading rates increased.

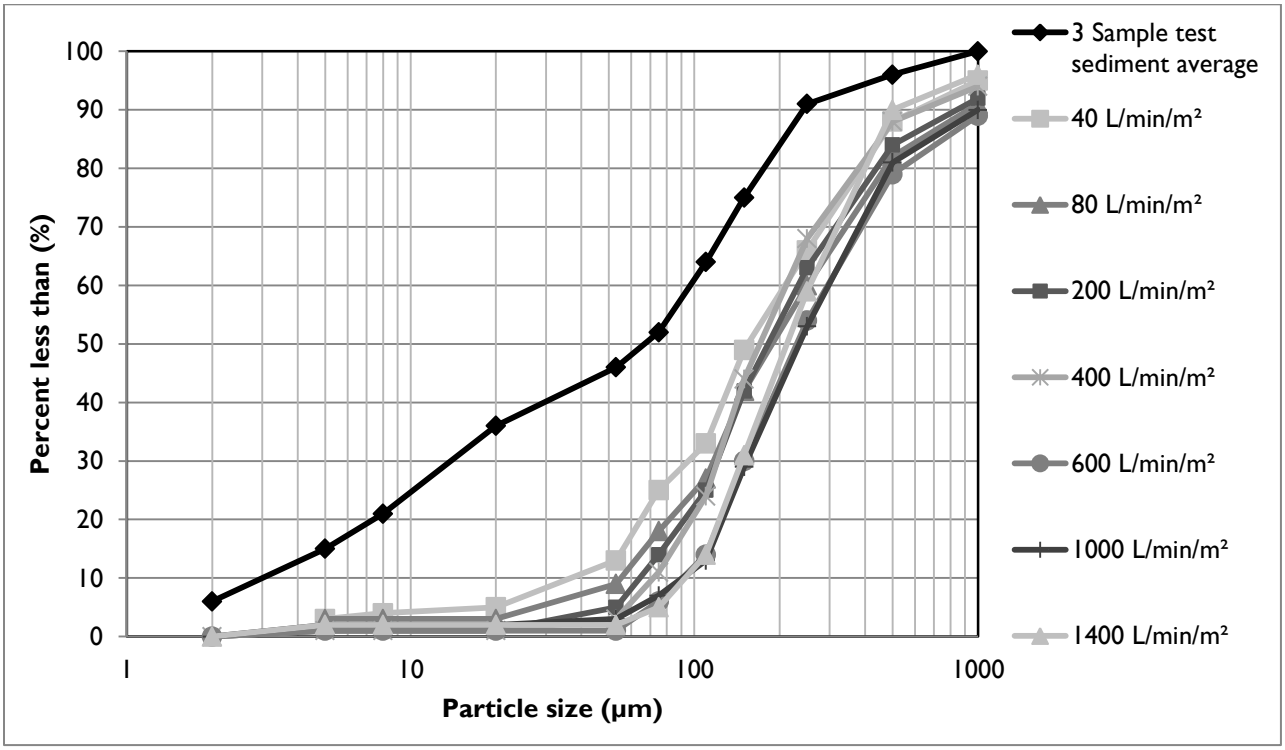


Figure 3. Particle size distribution of sediment retained in the HS4 unit in relation to the injected test sediment average.

For the sediment scour and re-suspension test, two tests were conducted. The first test was conducted with the secondary plate used in the capture tests. The second used a perforated secondary plate. Since sediment during the capture tests was found to settle in the pre-treatment channel, and in roughly the same quantities on the secondary plate and collection sump, all three of these surfaces were preloaded with sediment during the first test. The pre-treatment channel only captures coarse sediment. Therefore, this area was pre-loaded with sediment having a PSD similar to the PSD of the sediment that settled in this area during the 40 L/min/m^2 SLR sediment capture test. The pre-loaded sediment in the pre-treatment channel was shaped and leveled to correspond with sedimentation patterns and depths observed by the laboratory technician during the 40 L/min/m^2 SLR capture test. It should be noted that the actual sediment preloaded in this area was finer than the PSD of sediment captured in the same area during the 40 L/min/m^2 SLR capture test, particularly for particle sizes less than the median size. Both the sump and secondary plate were pre-loaded with the 1-1000 µm sediment mix to a depth of 10.2 cm. The preloaded sediment in the lower sump was placed on a false floor to mimic a device filled to 50% of the manufacturer's maximum recommended sediment storage depth.

After pre-loading the sediment, clean water was run through the device at five SLRs over a 25 minute period. At each SLR, five effluent samples were collected over a four minute interval (one per minute) with the first sample collected at the beginning of each flow rate, and the last collected just prior to the one minute transition to the next flow rate or end of the test. Effluent samples were analyzed for Suspended Sediment Concentration (SSC) and PSD by methods prescribed in the *Procedure*. The effluent samples were subsequently adjusted based on the background concentration of the influent water and the smallest 5% of particles captured during the 40 L/min/m^2 sediment capture test (7 um), as per the method described in Bulletin # CETV 2016-09-0001.

Measurements of sediment depths in the sump after the first test showed that most of the sediment from the secondary plate was carried into the lower sump. During this process, the fine sediment was likely re-suspended and carried out of the unit with the flow. The average adjusted effluent suspended sediment concentrations for each SLR ranged from 11.3 mg/L at the 200 L/min/m2 SLR to 196.7 mg/L at the 1400 L/min/m2 SLR. Effluent SSCs declined after the 1400 L/min/m2 SLR because the unit begins to bypass flow at this rate. It should be noted that this was a very conservative test as sediment was preloaded in three areas, rather than in the lower sump alone, and the preloaded sediment on the pre-treatment channel and secondary plate had a finer PSD than the sediment found to settle in these areas during the lowest SLR capture test.

The second sediment scour test was conducted on an identical unit but with a 32% open-area perforated secondary plate of the same size and orientation as the solid plate used in the first test. The perforated plate was intended to allow most of the sediment to settle in the lower sump, while still protecting against sediment scour, and not affecting the capacity of the unit to capture sediment. A second capture test was run at the 600 L/min/m^2 SLR to confirm that the perforated plate would have the same flow characteristics and removal efficiencies as the solid plate. Results of this comparison presented in Table 2 show that removal efficiencies were not affected and that the collection sump was receiving the majority of sediment transported into the lower chamber. Based on the observed sediment deposition zones, the second repeat test with the perforated plate had sediment preloaded in the pre-treatment channel and the lower collection sump only (*i.e.* the major deposition zones). The collection sump was preloaded with 10.2 cm of the 1- 1000 µm test sediment mix, as in the first test, and the pre-treatment channel was preloaded in much the same way as the first test, but with a sediment PSD that more closely mimicked the PSD of sediment observed to settle in this area during the 40 L/min/m^2 sediment capture test.

Table 2: Injected mass captured at the 600 L/min/m^2 SLR for two different configurations of the secondary plate

Secondary Plate type	Target Surface Loading Rate (L/min/m^2)	Tested Flow Rate (L/min)	Removal Efficiency (%)	Pre-treatment Channel (%)	Secondary Plate (%)	Outlet Dispersion Plate (%)	Collection Sump (%)
Solid Plate	600	736.2	46.1	24.7	8.5	3.1	9.9
Perforated Plate	600	740.9	45.9	25.8	2.7	3.0	14.5

Results of the second test are presented in Table 3. Background concentrations were maintained below 10.5 mg/L. The average adjusted effluent suspended sediment concentrations ranged from 19.1 to 28.5 mg/L. Since the commercially available unit will have a perforated secondary plate, these concentrations are the appropriate values to consider for approvals. The verifier acknowledges that the sediment capture removal efficiencies were not all tested with the perforated plate (see variance notes below), but that the repeat test results at the 600 L/min/m^2 SLR and a statement from the independent test laboratory were sufficient to provide reasonable confidence that the added perforations in the secondary plate would have negligible influence on sediment removal efficiencies.

Table 3. Scour test adjusted effluent sediment concentrations

Run	Surface loading rate (L/min/m^2)	Run time (min)	Background sample concentration (mg/L)[a]	Average adjusted effluent suspended sediment concentration (mg/L)[b]
1	200	5	3.6	22.4
2	800	5	8.9	28.5
3	1400	5	7.6	20.0
4	2000	5	10.4	19.1
5	2600	5	6.0	24.4

[a] Background concentrations shown here are approximate values based on graphical interpolation

[b] The adjusted effluent suspended sediment concentration represents the actual measured effluent concentration minus the background concentration. For more information see Bulletin # CETV 2016-09-0001. Adjusted concentrations were only calculated for the average of the five samples collected per surface loading rate.

The results of the light liquid re-entrainment test used to evaluate the unit's capacity to prevent re-entrainment of light liquids are reported in Table 4. The test involved preloading 58.3 L (corresponding to a 5 cm depth over the collection sump area of 1.17m^2) of surrogate low-density polyethylene beads (Dow Chemical Dowlex™ 2517) within the inner chamber and running clean water through the device continuously at five surface loading rates (200, 800, 1400, 2000, and 2600 L/min/m^2). Each flow rate was maintained for 5 minutes with approximately 1 minute transition time between flow rates (30 minutes total). The effluent flow was screened to capture all re-entrained pellets throughout the test. Results showed maximum re-entrainment of 4.6% at 1400 L/min/m^2, which is the highest SLR without bypass. Re-entrainment decreased at subsequent SLRs as bypass volumes increased.

Table 4. Light liquid re-entrainment test results for the HS4

Surface Loading Rate (L/min/m²)	Time Stamp (min)	Amount of Beads Re-entrained			
		Mass (g)	Volume (L)	% of Pre-loaded Mass Re-entrained	% of Pre-loaded Mass Retained
200	1:00 – 6:00	0	0	0.00	100
800	7:00 – 12:00	49	0.1	0.1	99.9
1400	13:00 – 18:00	1523	2.7	4.6	95.4
2000	19:00 – 24:00	1445	2.5	4.3	95.7
2600	25:00 – 30:00	847	1.5	2.5	97.5
Interim Collection Net		39	0.1	0.1	99.9
Total Re-entrained		3902	6.8	11.7	--
Total Retained		29,497	51.5	--	88.3
Total Loaded		33,399	58.3	--	--

Variances from testing Procedure

The following deviations from the *Procedure for Laboratory Testing of Oil-Grit Separators* (Version 3.0, June 2014) have been noted:

1. The Procedure stipulates that the tested device "must be a full scale, commercially available device with the same configuration and components that would be typical for an actual installation." As noted above, the sediment capture tests were conducted with a solid secondary plate. The solid secondary plate was later modified to a 32% open area perforated plate to reduce sediment settling on the plate, while continuing to provide scour prevention. As described above, the scour test was repeated with the perforated secondary plate, but the sediment capture test was only repeated at the 600 L/min/m² SLR (i.e. one of seven tested SLRs). Removal efficiency results for the repeat test showed very close correspondence with the earlier test using the solid plate and much of the sediment that previously settled on the secondary plate was deposited in the lower collection sump (see Table 2). The independent laboratory provided the following statement regarding the potential for the added perforations to affect sediment removal efficiencies: "Taking into account the close proximity of the plate to the collection sump, as well as our knowledge of sediment transport, it is expected that the deposited sediment would have settled in the lower sump, with no impact on removal efficiency, if the plate was removed." While the verifier acknowledges that stronger evidence would have been provided by additional repeat testing at a lower and higher SLR, the close correlation between the original and repeat test, combined with the statement from the lab were sufficient to provide reasonable confidence that adding the perforations would not likely have changed the capture test results significantly.

2. The repeat test at the 600 L/min/m² SLR had background concentrations exceeding the 20 mg/L threshold during the last half of the test. The exceedances occurred in 4 of the 8 samples collected, reaching a maximum of 28.4 mg/L. The experimental apparatus is a closed loop system. Therefore, the sediment in the background samples consists of fine particles not captured by the device, and would therefore not likely bias the mass balance results.

3. It was necessary to change flow meters during the sediment scour and light liquid re-entrainment test, as the required flows exceeded the minimum and/or maximum range of any single meter. When the flow capacity of the selected meter was reached, the flow was shut down over a period of approximately 10 seconds and all flow data saved. The next data acquisition file was executed and flow increased at a rate that corresponded to reaching each previous target flow after a period of 1-minute. This procedure was approved by CETV prior to testing, in recognition that most particles susceptible to scour at low flows would not be in the sump at higher flows. Similarly, re-entrainment of the oil beads was not expected to be significantly affected by the flow meter change.

4. As part of the capture test, evaluation of the 40 and 80 L/min/m^2 surface loading rate was split into 3 and 2 parts, respectively, due to the long duration needed to feed the required minimum of 11.3 kg of test sediment into the unit. At the end of the first and second parts of the test, the flow rates were gradually shutdown to prevent capture of particles that would have been washed out under normal circumstances. The amended procedure was reviewed and approved by the verifier prior to testing.

Verification

The verification was completed by the Verification Expert, Toronto and Region Conservation Authority, contracted by GLOBE Performance Solutions, using the International Standard ***ISO 14034:2016 Environmental management -- Environmental technology verification (ETV)***. Data and information provided by Hydroworks, LLC to support the performance claim included the following: Performance test report prepared by Alden Research Laboratory, Inc., and dated February 2018. This report is based on testing completed in accordance with the *Procedure for Laboratory Testing of Oil-Grit Separators* (Version 3.0, June 2014).

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

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

For more information on the Hydroworks® HS Hydrodynamic Separator please contact:

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

APPENDIX D
WATER ANALYSIS INFORMATION

FIRE FLOW DEMAND REQUIREMENTS - FIRE UNDERWRITERS SURVEY (FUS GUIDELINES)

Project Number: 16115
Project Name: 4063 Upper Middel Road
Date: 09-Jan-17

Fire flow demands for the FUS method is based on information and guidance provided in "Water Supply for Public Protection" (Fire Underwriters Survey, 1999).

An estimate of the fire flow required is given by the following formula:

$$F = 220\,C\sqrt{A} \qquad (1)$$

where:

F = the required fire flow in litres per minute
C = coefficient related to the type of construction
= 1.5 for wood frame construction (structure essentially all combustible).
= 1.0 for ordinary construction (brick or other masonry walls, combustible floor and interior)
= 0.8 for non-combustible construction (unprotected metal structural components, masonry or metal walls)
= 0.6 for fire-resistive construction (fully protected frame, floors, roof)
A = Total floor area in square metres

	Building Area				(1)		(2)			(3)		(4)		Final Adjusted Fire Flow	
Building / Location	Footprint Area (m^2)	# of Storeys	**Total GFA (m^2)**	Type of Construction	***Fire Flow "F"*** (l/min)	(l/s)	***Occupancy*** %	Adjustment (l/min)	**Adjusted Fire Flow (l/min)**	***Sprinkler*** %	Adjustment (l/min)	***Exposure*** %	Adjustment (l/min)	**(l/min)**	**(l/s)**
4063 Upper Middle Road	**7076**	**1**	**7076**	**0.8**	15000	250.0	**-15**	-2250.0	**12750.0**	**-40**	-5100.0	25	3187.5	**11000**	**183**

(2) Occupancy

Non-Combustible	-25%
Limited Combustible	-15%
Combustible	No charge
Free Burning	15%
Rapid Burning	25%

(3) Sprinkler

Minimum credit for systems designed to NFPA 13 is 30%.

If the domestic and fire services are supplied by the same municipal water system, then take an additional 10%.

If the sprinkler system is fully supervised (ie. annunciator panel that alerts the Fire Dept., such as a school), then an additional 10% can be taken. Maximum credit = 50%.

(4) Exposure

0 to 3m	25%	Calculate for all sides. Maximum charge shall not exceed 75%
3.1 to 10m	20%	
10.1 to 20m	15%	
20.1 to 30m	10%	
30.1 to 45m	5%	

Side	Exposure (m)	Charge (%)
North =	**22**	**10**
South =	**95**	**0**
East =	**none**	**0**
West =	**11**	**15**
Total Expoure =		***25***

APPENDIX E
REPORTS BY OTHERS

SOIL-MAT ENGINEERS & CONSULTANTS LTD.

130 LANCING DRIVE, HAMILTON, ONTARIO L8W 3A1
PHONE (905) 318-7440 FAX (905) 318-7455
E-MAIL: info@soil-mat.on.ca WEB SITE: www.soil-mat.on.ca

PROJECT NO.: SM 135055-G May 16, 2013

4063 Upper Middle Rd. Developments
c/o Ashenhurst Nouwens Ltd.
315 York Boulevard, Suite 2013
Hamilton, Ontario
L8R 3K5

Attention: Mr. Guido Consoli, C.L.S., O.L.S., O.L.I.P., B. Tech.

GEOTECHNICAL INVESTIGATION
PROPOSED EIGHT STOREY BUILDING
4063 UPPER MIDDLE ROAD, BURLINGTON, ONTARIO

Dear Mr. Consoli,

Further to your authorisation we have completed the fieldwork and laboratory testing, and report preparation, in connection with the above noted project. The fieldwork and laboratory testing was done in general accordance with our propose P-5022, dated April 10, 2013. Our comments and recommendations, based on our findings at the four borehole locations, are presented in the following paragraphs.

1. INTRODUCTION

We understand that the proposed project will include the construction of an eight to ten storey condominium building, with a single basement level, as well as the associated municipal services and asphalt paved driveway and parking lot areas. The purpose of this geotechnical investigation was to determine the subsurface conditions at four borehole locations and to interpret the results of this investigation with the respect to the design and construction of the foundations and related earthworks for this project.

This report is based on the above summarised project, and on the assumption that the design and construction will be performed in accordance with applicable codes and standards. Any significant deviations from the proposed project design may void the recommendations given in this report. If significant changes are made to the proposed design, this office must be consulted to review the new design with respect to the results of this investigation. The information contained in this report does not reflect upon the environmental aspects of the site and therefore have not been addressed in this document.

2. PROCEDURE

A total of four [4] sampled boreholes were advanced at the locations illustrated in the attached Drawing No. 1, Borehole Location Plan. The borings were advanced using solid stem continuous flight auger equipment on May 13, 2013 under the direction and supervision of a staff member of SOIL-MAT ENGINEERS & CONSULTANTS LTD. The boreholes were advanced using a track mounted drill rig to termination at depths of between about 3.3 and 6.2 metres below the existing surface, to practical auger and/or sampling spoon refusal on the underlying Queenston Shale. Upon completion of drilling, all of the boreholes were backfilled in general accordance with Ontario Regulation 903.

Representative samples of the subsoils were recovered from the borehole locations at selected depth intervals. After undergoing a general field examination, the soil samples were preserved and transported to the SOIL-MAT laboratory for visual, tactile, and olfactory classifications. Routine moisture content tests were performed on all soil samples recovered from the boreholes.

All boreholes were located in the field by a representative of SOIL-MAT ENGINEERS & CONSULTANTS LTD. The ground surface elevations were referenced to a site-specific benchmark described as the top of the top of the manhole grate located on the southern edge of the lot, immediately north of the sidewalk, in front of the existing house. This manhole grate was noted to have Elevation 138.31 metres, as seen on the survey plan provided to our office prepared by Ashenhurst Nouwens Limited dated January 24, 2013 [File No. 13006 TOPO+BLS].

3. SITE DESCRIPTION AND SUBSURFACE CONDITIONS

The subject site is located at 4063 Upper Middle Road in Burlington, Ontario. An abandoned single family dwelling currently occupies the south central portion of the lot, with the remainder being relatively forested and vegetated. The site is bounded to the south by Upper Middle Road and to the north and west by residential developments and to the east by a creek and forested lands beyond. The property slopes down from west to east towards the creek.

The subsurface conditions encountered at the borehole locations are summarised as follows:

Topsoil

A surficial veneer of topsoil of approximately 50 and 75 millimetres in thickness was encountered in Borehole Nos. 3 and 4, respectively. It is noted that the depth of topsoil may vary across the site and from the depths encountered at the borehole locations. It

is noted too that the term “topsoil” has been used from a geotechnical point of view and does not necessarily reflect the suitability of the material to support plant growth.

Sand and Gravel and Limestone Screenings Fill

A loose to compact sand and gravel material approximately 0.7 metres thick was encountered at the surface of Borehole No. 1 and compact limestone screenings approximately 75 millimetres thick in Borehole No. 2, as these borings were advanced through the driveway areas to the existing house.

Clayey Silt

A native brown to brownish grey clayey silt was encountered beneath the granular fill materials and the surficial topsoil at the borehole locations. This cohesive material was mottled and weathered, with organic staining in the upper levels and was found to contain a trace of sand, gravel and shale fragments. The clayey silt encountered in the boreholes was generally found to be very stiff to hard in consistency and described as having a ‘till-like’ structure. Hand penetrometer tests indicated unconfined compressive strengths consistently in excess of 4.5 kg / cm^2 [>4.5 tons/ft^2].

Queenston Shale Bedrock

Queenston Shale was encountered beneath the clayey silt at the borehole locations. The Queenston Shale bedrock encountered was red in colour with occasional more resistant grey layers, highly weathered in the upper levels, and was found to become sounder with depth. It should also be noted that where shale is encountered at shallower depths it is typically highly weathered and exhibits properties similar to hard soil making the transition from the hard overburden to weathered rock somewhat indistinct. Queenston Shale was encountered at depths ranging from about 2 to 4 metres beneath the existing ground surface. The bedrock was not cored as part of this investigation.

Groundwater Observations

All of the boreholes were noted to have been ‘dry’ on the completion of drilling. Given the low permeability of the clayey silt soils and the Queenston Shale bedrock, insufficient time would have passed for infiltrating groundwater to stabilise in the open boreholes. Some infiltration of groundwater from more permeable seams in the clayey silt and Queenston Shale must be anticipated by the contractor during the excavation operations. However the rate of infiltration from these seams is expected to be relatively low.

4. EXCAVATIONS

It is anticipated that the excavations for the proposed foundations and for the installation of underground services for the proposed high rise building will extend to the depths of up to 3 to 5 metres below the existing grade, into the very stiff to hard clayey silt and Queenston Shale bedrock. The sides of excavations into the soil and bedrock should remain stable at slopes of up to 60 degrees to the horizontal to near vertical. Nevertheless, all excavations must comply with the current Occupational Health and Safety Act and Regulations for Construction Projects. Excavation slopes steeper than those required in the Safety Act must be supported or a trench box must be provided, and a senior Geotechnical Engineer from this office should supervise the work. The contractor may encounter buried floor slabs, pits, foundations, etc. from the existing building on site which may slow their rate of excavation.

While the typical depths of construction are anticipated to be above the static groundwater level, some infiltration of groundwater through more permeable seams in the native soil and bedrock and from surface runoff should be anticipated. However, the rate of infiltration is anticipated to be relatively low, such that any water that may seem into the excavations could be removed using conventional construction 'dewatering' techniques, such as pumping from sumps and ditches. More water should be expected when connections are made with existing services. Surface water should be directed away from the excavations.

5. FOUNDATION CONSIDERATIONS

The soil conditions encountered in the boreholes are such that the proposed building may be supported on conventional spread footings founded in the native very stiff to hard clayey silt or Queenston Shale bedrock. Spread footings founded in the very stiff to hard clayey silt may be designed using a factored Ultimate Limit State [ULS] bearing capacity of 450 kPa [~9,000 psf]. The allowable bearing stress at Serviceability Limit State [SLS] should be limited to 300 kPa [~6,000 psf]. Where footings founded on the weathered Queenston Shale, within the upper one metre they may be designed on the basis of a factored ULS and SLS of 750 kPa [15,000 psf]. Where the footings extend into the more sound Queenston Shale, a minimum of one metre into the Queenston Shale bedrock, they may be designed using a factored Ultimate Limit State [ULS] bearing capacity 1,500 kPa [~30,000 psf]. The allowable bearing stress at Serviceability Limit State [SLS] will be controlled by the structure, as the bedrock would have to fail before the Service Limit deformations, typical for the type of building envisioned, would be realised. It is noted that higher bearing values may be available in the less weathered Queenston Shale at increased depth, however such increased values would require review and approval by this office, and possibly additional field investigations and coring of the bedrock.

It is noted that the SLS value represents the Serviceability Limit State, which is governed by the tolerable deflection [settlement] based on the proposed building type, using unfactored load combinations. The ULS value represents the Ultimate Limit State and is intended to reflect an upper limit of the available bearing capacity of the founding soils in terms of geotechnical design, using factored load combinations. There is no direct relationship between ULS and SLS; rather they are a function of the soil type and the tolerable deflections for serviceability, respectively. The above dissertation assumes a typical building. Evidently, the bearing capacity values would be lower for very settlement sensitive structures and larger for more flexible buildings.

In areas where it will be necessary to provide adjacent footings at different founding elevations, the lower footing should be constructed before the higher footing, if possible. To limit stress transfer from higher footings to lower footings, the higher footing should be set below an imaginary line drawn up from the edge of the lower footing at 10 horizontal to 7 vertical.

All footings exposed to the environment must be provided with a minimum of 1.2 metres of earth cover or equivalent insulation to protect against frost damage. This frost protection would also be required if construction were undertaken during the winter months. All footings and foundations should be designed and constructed in accordance with the current Ontario Building Code.

With foundations designed as outlined above and as required by the Building Code, and with careful attention paid to construction detail, total and differential settlements should be small, and within normally tolerated limits of 25 and 20 millimetres respectively, for the type of building and occupancy expected.

It is imperative that a soils engineer be retained from this office to provide geotechnical engineering services during the excavation and foundation construction phases of the project. This is to observe compliance with the design concepts and recommendations of this report and to allow changes to be made in the event that subsurface conditions differ from the conditions identified at the borehole locations.

6. SEISMIC DESIGN CONSIDERATIONS

The structure shall be designed according to Section 4.1.8 of the Ontario Building Code, Ontario Regulation 350/06. Based on the subsurface soil conditions encountered in this investigation, the applicable Site Classification for the seismic design is recommended as Site Class B – Rock.

The seismic data, from Supplementary Standard SB-1 of the Ontario Building Code, for Burlington are as follows:

$S_a(0.2)$	$S_a(0.5)$	$S_a(1.0)$	$S_a(2.0)$	PGA
0.36	0.180	0.063	0.020	0.270

7. BACKFILL CONSIDERATIONS

The majority of excavated materials will consist of the native brown clay silt and Queenston Shale bedrock encountered in the boreholes as described above. It is anticipated that a majority of the excavated material will be removed from the subject site to accommodate the basement level. We would recommend that any excavated Queenston Shale bedrock be excluded from re-use as service trench backfill on the project site. The clayey silt is considered suitable for use as backfill in the service trenches. Depending on the weather conditions at the time of construction, some moisture conditioning may be necessary of the on-site soils. It is noted that the on-site clayey silt soils are generally considered to be 'dry' of their optimum moisture content. The cohesive soils encountered are sensitive to moisture absorption and will become practically impossible to compact using conventional compaction equipment if they become wet/saturated during extended periods of precipitation. After a period of heavy precipitation, any near-surface wet or softened material should be allowed to air dry, or be removed and discarded. The clayey silt is not considered to be "free-draining" and should not be used where this characteristic is required.

The use of free draining, well-graded granular material, such as an Ontario Provincial Standard Specification [OPSS] Granular B, Type II, is recommended for use as backfill against foundation walls or to raise the interior grade to the design subgrade level. This material is more readily compacted in restricted access areas, and generally presents a more positive support condition for interior floor slabs and exterior concrete sidewalks, etc.

Any fill materials encountered during the excavation process at the existing building should be assessed for suitability for re-use on site or disposal, and dealt with accordingly.

We note that where backfill material is placed near or slightly above its optimum moisture content, the potential for long term settlements due to the ingress of groundwater and collapse of the fill structure is reduced. Correspondingly, the shear strength of any 'wet' backfill material is also lowered, thereby reducing its ability to support construction traffic and therefore impacting roadway construction. If the soil is well dry of its optimum value, it will appear to be very strong when compacted, but will tend to settle with time as the moisture content in the fill increased to equilibrium

condition. The clayey silt soils may require high compaction energy to achieve acceptable densities if the moisture content is not close to their standard Proctor optimum value. It is therefore very important that the placement moisture content of the backfill soils be within 3 percent of its standard Proctor optimum moisture content during placement and compaction.

All fill material should be conditioned to within 3 percent of its optimum moisture content, to achieve an efficient compaction operation and to minimise long term subsidence [settlement] of the fill mass. Any imported fill required in service trenches of to raise the subgrade elevation should have its moisture content within 3 percent of its optimum moisture content and meet the necessary environmental guidelines.

A representative of SOIL-MAT should be retained to monitor the backfilling and compaction operations to confirm uniform compaction of the backfill material to project specification requirements. Close supervision is prudent in areas that are not readily accessible to compaction equipment, such as near the end of compaction 'runs'. In service trenches, the backfill material should be compacted to 95 percent of its standard Proctor maximum dry density to within about one metre below final grade, and to 100 percent of its standard Proctor value above this level in exterior parking areas and to 100 percent within the building area.

7. LATERAL EARTH PRESSURES

The lateral earth pressure on the partial basement walls can be estimated on the basis of backfill [free draining granular material] unit weight, (γ), of 20 kN/m^3. The coefficient of lateral earth pressure may be taken as K_a = 0.35 if small lateral deformations are acceptable [active condition], or K_o = 0.5 in fill against rigid walls [at rest condition]. Any additional pressured due to surcharge loading, such as parked vehicles, floor slab loading, etc., must be included in the design.

8. FLOOR SLAB AND PERMANENT DRAINING

The basement floor slab may be constructed using conventional slab-on-grade techniques on a prepared subgrade. The exposed subgrade surface should be well compacted in the presence of a representative of SOIL-MAT. Any 'soft spots' delineated during this process must be sub-excavated and replaced with quality backfill material compacted to 100 percent of its standard Proctor maximum dry density. The subgrade level can then be raised to the design level with granular soils compacted to 100 percent standard Proctor density. As noted above granular fill is preferred due to its relative

insensitivity to weather conditions, its relative easy in achieving the required degree of compaction and its quick response to applied stresses.

As with all concrete floor slabs, there is a tendency for the floor slabs to crack. The slab thickness, concrete mix design, amount of steel and/or fibre reinforcement and/or wire mesh placed into the concrete slab, if any, will therefore be a function of the owner's tolerance for cracks in, and movements of, the slabs-on-grade, etc. The 'saw-cuts' in the concrete floors, for crack control, should extend to a minimum depth of 1/3 of the thickness of the slab.

A moisture barrier will be required under the floor slabs such as the placement of at least 200 millimetres of well-compacted 20 millimetre clear crushed stone. At a minimum, the moisture barrier should contain no more than 10 percent passing the No. 4 sieve.

Where 'non-damp' floor slabs are required, as for instance under sheet vinyl floor coverings, etc., extra efforts will be required to damp proof the floor slab, as with the additional provisions of a heavy 'poly' sheet, damp proofing sprays/membranes, drainage board products, etc. Where 'poly' sheets are used, care should be taken to prevent puncturing and tearing and/or sufficiently heavy gauge sheeting specified. Alternatively, a proprietary product such as Delta-MS Underslab or WR Meadows membrane may be considered in lieu of the 'poly' sheets.

Basement walls should be suitably damp-proofed and a permanent perimeter drainage system should be provided around the structure to prevent the build up of water under the slab-on-grade and against the foundation walls. The perimeter drainage system should consist of 150 mm diameter perforated pipe, surrounded with 200 mm of 20 mm clear stone, and the stone in turn surrounded by a heavy filter fabric. The suppliers of the filter fabric should be consulted as to the type best suited for this project. This office should examine the installation of the drains, as even a small break in the filtering materials could result in loss of fines into the drains with attendant performance difficulties, including settlements of the ground surface. The exterior grade around the structure should be sloped away from the structure to prevent the ponding of water against the foundation walls. The enclosed Drawing No. 2 shows schematics of the typical requirements for drainage and backfill of basement walls.

Curing of the slab-on-grade must be carefully specified to ensure that slab curl is minimised. This is especially critical during the hot summer months of the year when the surface of the slab tends to dry out quickly while high moisture conditions in the moisture barrier or water trapped on top of any 'poly' sheet at the saw cut joints and cracks, and at the edges of the slabs maintains the underside of the slab in a moist condition.

It is also important that the concrete mix design provide a limiting water/cement ratio and total cement content, which will mitigate moisture related problems with low permeance

floor coverings, such as debonding of vinyl and ceramic tile. It is equally important that excess free water not be added to the concrete during its placement as this could increase the potential for shrinkage cracking and curling of the slab.

9. PAVEMENT STRUCTURE DESIGN CONSIDERATIONS

All areas to be paved should be cleared and stripped and the exposed subgrade proofrolled with 3 to 4 passes of a loaded tandem truck (over the same wheel path) in the presence of a representative of SOIL-MAT IMMEDIATELY prior to the placement of the sub-base material. Any areas of distress revealed by this or other means should be subexcavated and replaced with suitable backfill material. Alternatively, the soft areas may be repaired by punching coarse aggregate, such as a 50 millimetre clear crushed stone, into the soft areas. The need for subexcavations of softened subgrade materials will be reduced if construction is undertaken during the dry summer months of the year and careful attention is paid to the compaction operations.

Good drainage provisions will optimise the long-term performance of the pavement structure. The subgrade must be properly crowned and shaped to promote drainage to the subdrain system. Subdrains should be installed to intercept excess subsurface water and to prevent softening of the subgrade material. Surface water should not be allowed to pond adjacent to the outer limits of the paved areas.

The most severe loading conditions on the subgrade typically occur during the course of construction. Therefore, precautionary measures may have to be taken to ensure that the subgrade is not unduly disturbed by construction traffic.

The suggested pavement structures outlined in Table A are based on subgrade parameters estimated on the basis of visual and tactile examinations of the on-site soils and past experience. The outlined pavement structure may be expected to have an approximate ten-year life, assuming that regular maintenance is performed. Should a more detailed pavement structure design be required, site specific traffic information would be needed, together with detailed laboratory testing of the subgrade soils. Although lighter pavement structures might suffice for the present, such lighter structures are expected to lead to premature pavement failures, etc.

Table A
Suggested Pavement Structure

Layer Description	Compaction Requirements	Light Duty Sections	Heavy Duty [truck route]
Asphaltic Concrete Wearing course OPSS HL 3 or HL 3A	97 percent Marshall	65 millimetres	40 millimetres
Binder Course OPSS HL 8	97 percent Marshall		65 millimetres
Base Course OPSS Granular A	100% SPMDD	150 millimetres	150 millimetres
Sub-base Course OPSS Granular B Type II	100% SPMDD	200 millimetres	350 millimetres

SPMDD denotes Standard Proctor Maximum Dry Density, ASTM-D698.

To minimise segregation of the finished asphalt mat, the asphalt temperature must be maintained uniform throughout the mat during placement and compaction. All too often, significant temperature gradients exist in the delivered and placed asphalt with the cooler portions of the mat resisting compaction and presenting a honeycomb surface. As the spreader moves forward, a responsible member of the paving crew should monitor the pavement surface, to ensure a smooth uniform surface. The contractor can mitigate the surface segregation by 'back-casting' or scattering shovels of the full mix material over the segregated areas and raking out the coarse particles during compaction operations. Of course, the above assumes that the asphalt mix is sufficiently hot to allow the 'back-casting' to be performed.

10. GENERAL COMMENTS

The comments provided in this document are intended only for the guidance of the design team. The subsoil descriptions and borehole information are intended to describe conditions at the borehole locations. Contractors tendering or undertaking this project should carry out due diligence in order to verify the results of this investigation and to determine how the subsurface conditions will effect their operations.

We trust that this geotechnical report is sufficient for your present requirements. Should you require any additional information or clarification as to the contents of this document, please do not hesitate to contact the undersigned.

Yours very truly,
SOIL-MAT ENGINEERS & CONSULTANTS LTD.

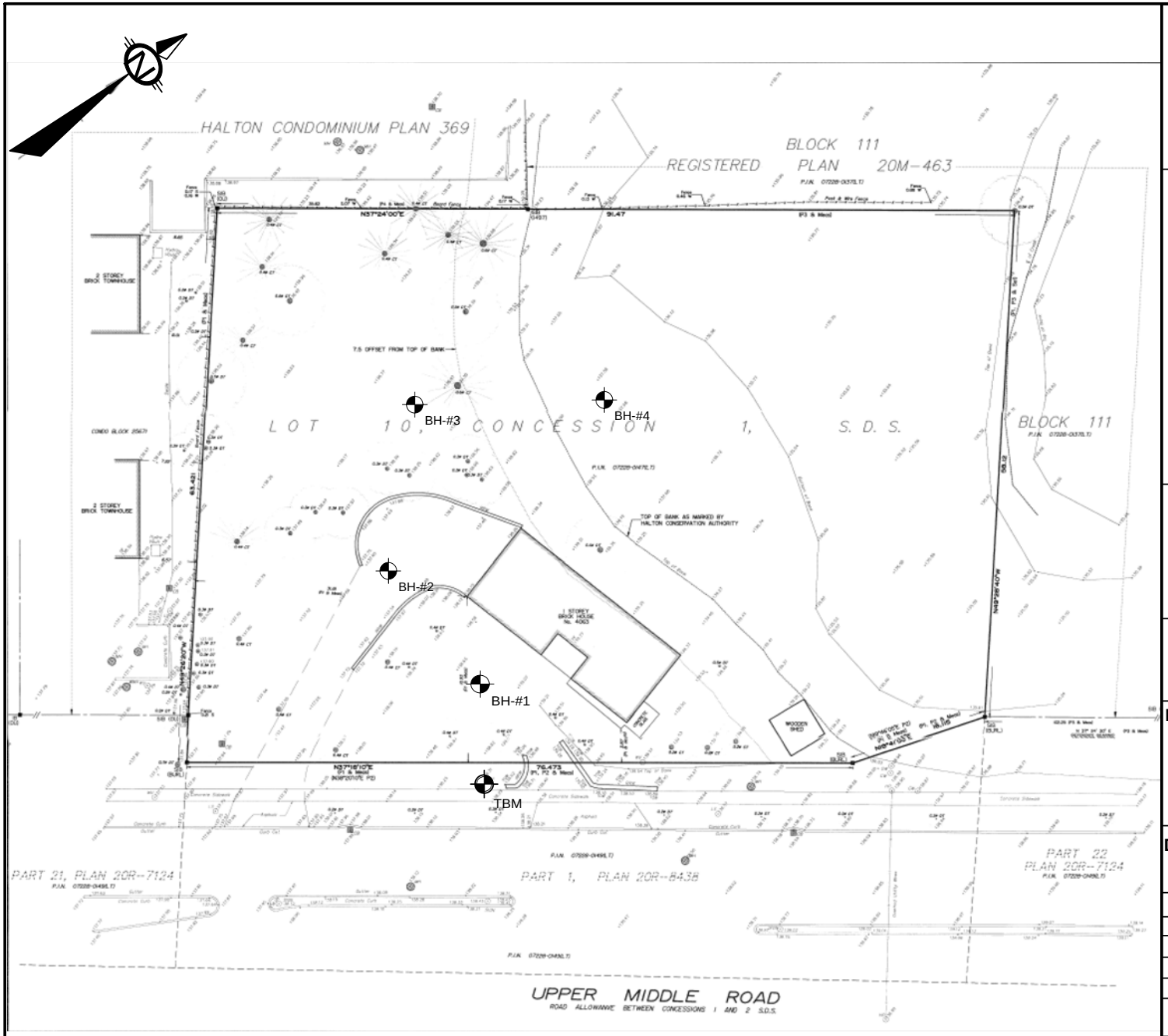
Kyle Richardson, B. Eng., EIT

John Monkman, P. Eng.
Project Engineer

Ian Shaw, P. Eng.
Review Engineer

Attachments: Drawing 1, Borehole Location Plan
Borehole Log Nos. 1 to 4, inclusive
Drawing 2: Typical Design Requirements, Drainage and Backfill of Basement Walls

Distribution: Ashenhurst Nouwens Ltd. [3 plus pdf copy]



LEGEND

BH-# Borehole

TBM Temporary Benchmark [Top of manhole grate immediately south of northern entrance to driveway, Elevation 138.31 metres.]

NOTES:

1. This drawing should be read in conjunction with Soil-Mat Engineers & Consultants Ltd. report number SM 135055-G.
2. Borehole locations are approximate.
3. Soil samples will be discarded after 3 months unless directed otherwise by client.
4. Image obtained from Google 2010 Digital Globe

Soil-Mat
Engineers & Consultants Ltd.

CLIENT
4063 Upper Middle Rd. Developments
C/O Ashenhurst Nouwens Ltd.

PROJECT TITLE
Geotechnical Investigation
Proposed Eight Storey Building
4063 Upper Middle Rd.
Burlington, Ontario

DRAWING TITLE
Borehole Location Plan

PROJECT No.	SM 135055-G
SCALE	N.T.S.
DATE	May 2013
CHECKED	JM
DRAWN	JM

FILENAME
135055-G Borehole Location Plan.kcw

DRAWING No. 1

Project No: SM 135055-G

Project: Proposed Eight Storey Building

Location: Burlington, Ontario

Client: 4063 Upper Middle Rd. Developments C/O Ashenhurst Nouwens Ltd.

Log of Borehole No. 1

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

Soil-Mat

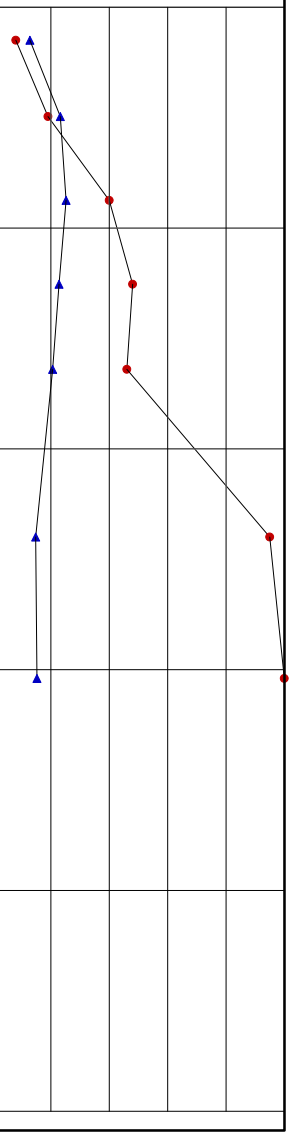
SUBSURFACE PROFILE

SAMPLE

Depth (ft)	Depth (m)	Elevation [m]	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
		138.87	Ground Surface								
0	0		**Sand and Gravel** Brown, fine to medium in gradation, loose to compact.		SS	1	4,5,3,4	8			
2		138.17									
4			**Clayey Silt** Brown, mottled and weathered, organic staining in upper level, trace of sand, fine to medium gravel, and shale fragments, 'till-like' structure, very stiff to hard.		AS	2	5,7,12	19			
6	2				SS	3	8,15,25	40		>4.5	
8					SS	4	8,20,28	48		>4.5	
10					SS	5	8,20,26	46		>4.5	
12		134.87									
14	4		**Queenston Shale** Red, severely weathered in upper levels, becoming more sound with depth, hard in terms of soil.								
16					SS	6	22,50,45	95			
18											
20	6	132.70			SS	7	50/3"	100			
22			End of Borehole								
24			NOTES:								
26	8		1. Borehole was advanced using solid stem auger equipment on May 13, 2013 to termination at a depth of 6.2 metres.								
28			2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.								
30			3. Soil samples will be discarded after 3 months unless otherwise directed by our client.								
32											

Moisture Content w% 10 20 30 40

Standard Penetration Test blows/300mm 20 40 60 80



Drill Method: Solid Stem Augers

Drill Date: May 13, 2013

Hole Size: 150mm

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Geodetic Benchmark

Checked by: JM

Sheet: 1 of 1

Project No: SM 135055-G

Project: Proposed Eight Storey Building

Location: Burlington, Ontario

Client: 4063 Upper Middle Rd. Developments C/O Ashenhurst Nouwens Ltd.

Log of Borehole No. 2

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

Soil-Mat

SUBSURFACE PROFILE

Depth ft	Depth m	Elevation [m]	Description
0	0	137.59	Ground Surface
			Limestone Screenings Approximately 75 millimeters of over
			Clayey Silt Brown, mottled and weathered, organic staining in upper level, traces of sand, fine to medium gravel, and shale fragments, 'till-like' structure, very stiff to hard.
6	2	135.46	***Queenston Shale*** Red, severely weathered in upper levels, becoming more sound with depth, hard in terms of soil.
10		134.26	End of Borehole

NOTES:

1. Borehole was advanced using solid stem auger equipment on May 13, 2013 to termination at a depth of 3.3 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

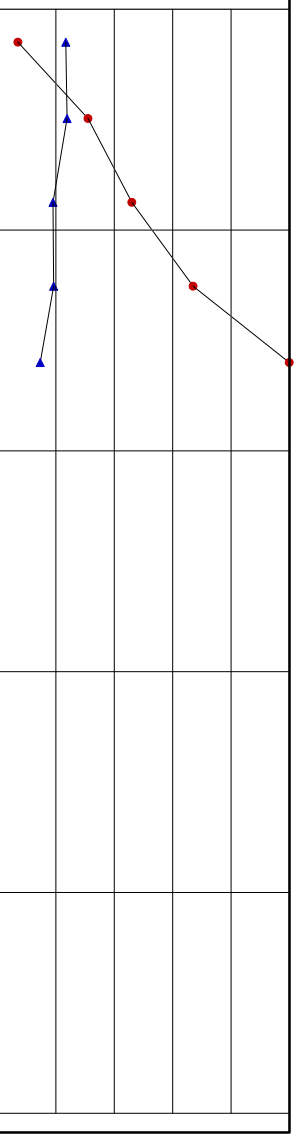
3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	4,4,3,5	7		1.5	
SS	2	8,12,19	31		>4.5	
SS	3	10,24,22	46		>4.5	
SS	4	11,27,40	67		>4.5	
SS	5	21,50/5"	100			

Moisture Content w% 10 20 30 40

Standard Penetration Test blows/300mm 20 40 60 80



Drill Method: Solid Stem Augers

Drill Date: May 13, 2013

Hole Size: 150mm

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Geodetic Benchmark

Checked by: JM

Sheet: 1 of 1

Project No: SM 135055-G

Project: Proposed Eight Storey Building

Location: Burlington, Ontario

Client: 4063 Upper Middle Rd. Developments C/O Ashenhurst Nouwens Ltd.

Log of Borehole No. 3

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

Soil-Mat

SUBSURFACE PROFILE

Depth ft	Depth m	Elevation [m]	Description
0	0	139.12	Ground Surface
			Topsoil Approximately 50 millimeters over
			Clayey Silt Brownish grey, mottled and weathered, organic staining in upper level, traces of sand, fine to medium gravel, and shale fragments, 'till-like' structure, very stiff to hard.
		135.12	
			Queenston Shale Red, severely weathered in upper levels, becoming more sound with depth, hard in terms of soil.
		132.97	
			End of Borehole

NOTES:

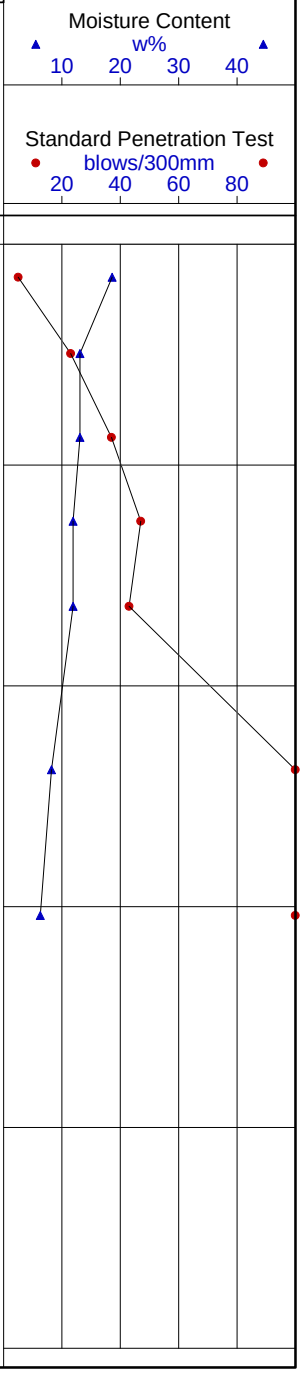
1. Borehole was advanced using solid stem auger equipment on May 13, 2013 to termination at a depth of 6.2 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	2,2,3,5	5		1.5	
SS	2	6,10,13	23		>4.5	
SS	3	9,15,22	37		>4.5	
SS	4	21,25,22	47		>4.5	
SS	5	9,18,25	43		>4.5	
SS	6	23,39,50/3"	100			
SS	7	50/2"	100			



Drill Method: Solid Stem Augers

Drill Date: May 13, 2013

Hole Size: 150mm

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Geodetic Benchmark

Checked by: JM

Sheet: 1 of 1

Project No: SM 135055-G

Project: Proposed Eight Storey Building

Location: Burlington, Ontario

Client: 4063 Upper Middle Rd. Developments C/O Ashenhurst Nouwens Ltd.

Log of Borehole No. 4

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

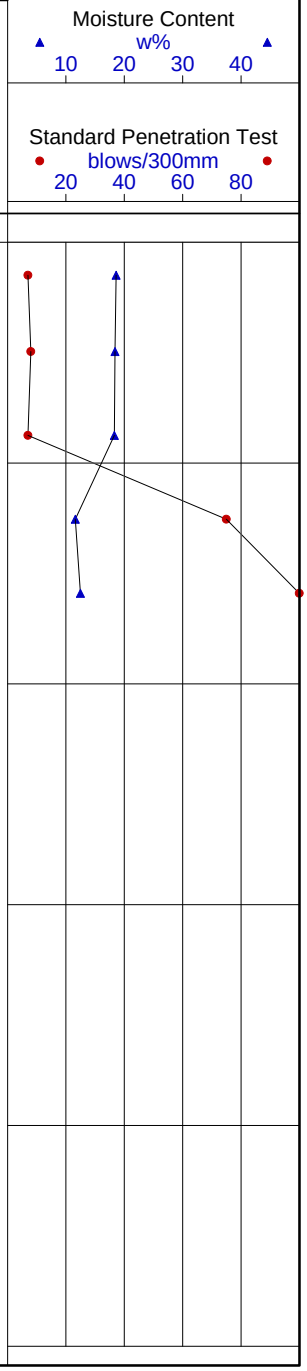
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SUBSURFACE PROFILE

Depth (ft)	Depth (m)	Elevation [m]	Symbol	Description	Well Data
0	0	136.70		Ground Surface	
0	0			**Topsoil** Approximately 75 millimeters over	
2				**Clayey Silt** Brown, mottled and weathered, organic staining in upper level, trace of sand, fine to medium gravel, and shale fragments, firm.	
6	2	134.57		**Queenston Shale** Red, severely weathered in upper levels, becoming more sound with depth, hard in terms of soil.	
10		133.40		End of Borehole	
				NOTES: 1. Borehole was advanced using solid stem auger equipment on December 13, 2013 to termination at a depth of 3.3 metres. 2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903. 3. Soil samples will be discarded after 3 months unless otherwise directed by our client.	
12	4				
14					
16					
18					
20	6				
22					
24					
26	8				
28					
30					
32					

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	2,3,4,4	7		1.5	
SS	2	2,3,5	8		>2.5	
SS	3	3,3,4	7		>1.5	
SS	4	18,25,50 Wet Spoon	75		>4.5	
SS	5	43,50/4" Wet Spoon	100		>4.5	



Drill Method: Solid Stem Augers

Drill Date: May 13, 2013

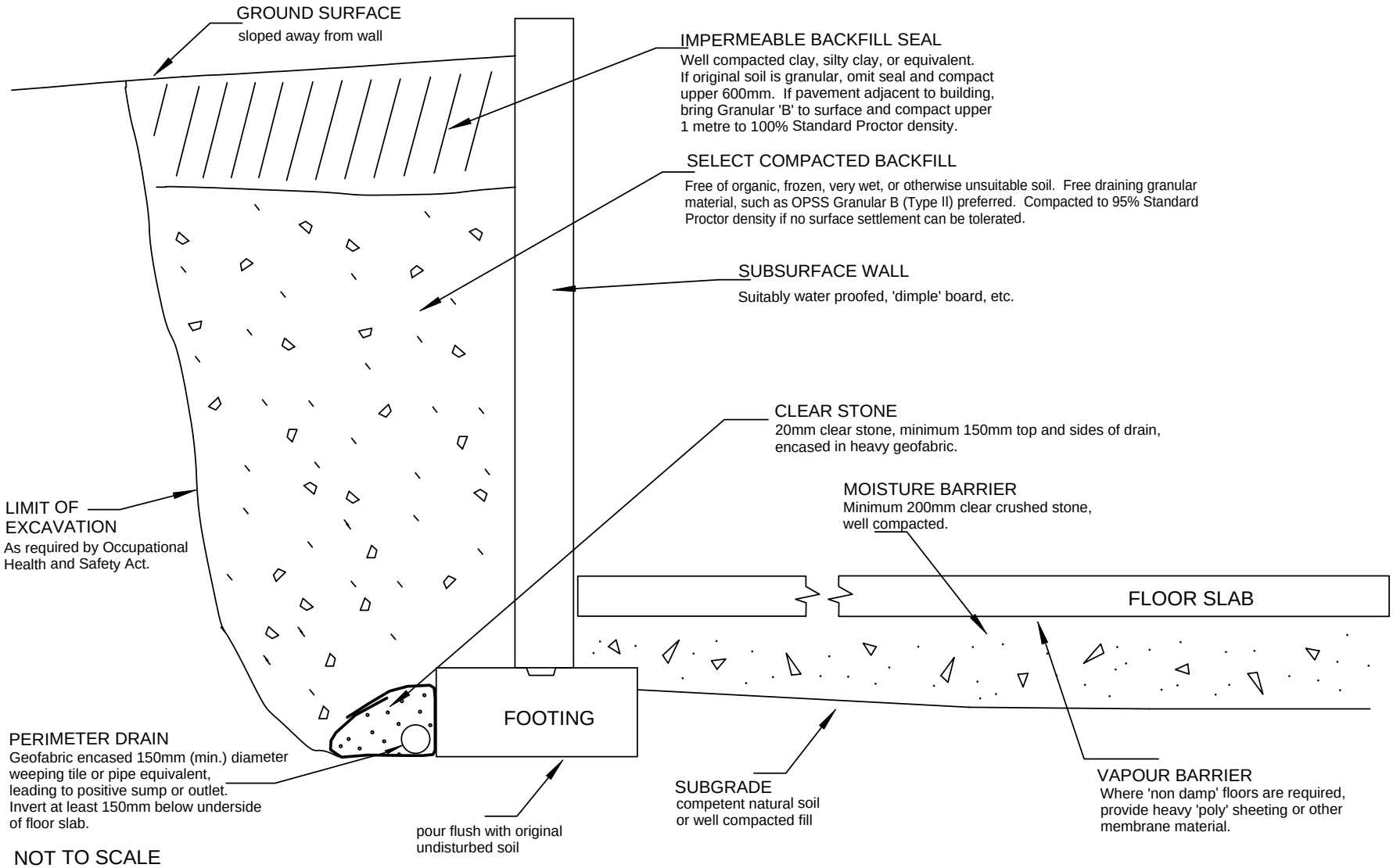
Hole Size: 150mm

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
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e-mail: info@soil-mat.on.ca

Datum: Geodetic Benchmark

Checked by: JM

Sheet: 1 of 1



NOT TO SCALE

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Soil-Mat Engineers & Consultants Ltd.

Typical Design Requirements
Drainage and Backfill for Basement Walls

Project No.:	SM 135055-G
Date:	May 2013

DRAWING No. 2

SOIL-MAT ENGINEERS & CONSULTANTS LTD.

www.soil-mat.ca info@soil-mat.ca TF: 800.243.1922

Hamilton: 130 Lancing Drive L8W 3A1 T: 905.318.7440 F: 905.318.7455
Milton: PO Box 40012 Derry Heights PO L9T 7W4 T: 800.243.1922

PROJECT NO.: SM 177692-G

January 9, 2020

GSP GROUP INC.
162 Locke Street South – Suite 200
Hamilton, Ontario
L8P 4A9

Attention: Nancy Frieday, MCIP, RPP
Senior Planner

SUPPLEMENTAL HYDROGEOLOGICAL CONSIDERATIONS
PROPOSED EIGHT STOREY RESIDENTIAL BUILDING
4063 UPPER MIDDLE ROAD
BURLINGTON, ONTARIO

Dear Ms. Frieday,

As requested, SOIL-MAT ENGINEERS has prepared this Supplemental Hydrogeological Considerations letter in connection with the above noted project. This letter report should be read in conjunction with our initial geotechnical investigation report, SM 135055-G dated May 16, 2013, and slope stability assessment report dated SM 177692-G, dated September 27, 2017.

We understand that the development will involve the construction of an eight storey residential building with one underground parking level. Based on the Preliminary Grading and Erosion Control Plan drawings prepared by S. Llewellyn & Associates, dated January 3, 2017, the proposed building will have a basement floor elevation of 135.60 metres, approximately 2 to 3.5 metres below the existing ground surface. The adjacent creek to the north was noted to have a water level at approximately 135.0 metres.

Given the anticipated depths of construction and estimated water level noted above, as well as the proximity of the proposed structure from the existing creek and the low permeability of the clayey silt overburden soils and Queenston shale bedrock encountered at the borehole locations, the static groundwater table is not anticipated to have an notable effect on the proposed excavations. Infiltration of groundwater would be expected to be generally limited to precipitation infiltrating through permeable seams as well as from surface runoff. Given the relatively low permeability of the subsurface soils, the rate of infiltration of such water into open excavations would be expected to be relatively low, and of relatively negligible volume. There would not be any expected

significant long-term dewatering control required. The total infiltration would be expected to be considerably less than 50,000 litres/day, such that a permit to take water [PTTW] would not be required.

With respect to construction of foundations and perimeter drainage, the recommendations provided in our geotechnical report would be considered valid and should be adhered to. The proposed construction would not be considered to have an effect on the existing groundwater level or flow. During construction, care should be taken to ensure drainage to the creek to the north is unaffected.

We trust that these supplemental hydrogeological comments are sufficient for your present requirements. Should you require any additional information or clarification as to the contents of this document, please do not hesitate to contact the undersigned.

Yours very truly,
SOIL-MAT ENGINEERS & CONSULTANTS LTD.



Kyle Richardson, P.Eng.
Project Engineer

Distribution: GSP Group Inc. [1, plus pdf]

APPENDIX F
PRELIMINARY ENGINEERING PLANS