S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Functional Servicing & Stormwater Management Report

4063 UPPER MIDDLE ROAD

CITY OF BURLINGTON

January 2017
Revised August 2018
Revised May 2020
SLA File: 16115

3228 South Service Road, Suite 105, East Wing Burlington, Ontario L7N 3H8
Tel. (905) 631-6978 Fax (905) 631-8927

TABLE OF CONTENTS

Page

1.0 INTRODUCTION AND BACKGROUND 1
1.1 OVERVIEW 1
1.2 BACKGROUND INFORMATION 1

2.0 STORMWATER MANAGEMENT 2
2.1 EXISTING CONDITIONS 3
2.2 PROPOSED CONDITIONS 3
2.3 SEDIMENT AND EROSION CONTROL 6

3.0 SANITARY SEWER SERVICING 6
3.1 EXISTING CONDITIONS 6
3.2 SANITARY DEMAND 6
3.3 PROPOSED SANITARY SERVICING AND CAPACITY ANALYSIS 7

4.0 DOMESTIC AND FIRE WATER SUPPLY SERVICING 7
4.1 EXISTING CONDITIONS 7
4.2 DOMESTIC WATER DEMAND 7
4.3 FIRE FLOW DEMAND 8
4.4 PROPOSED WATER SERVICING AND ANALYSIS 8

5.0 CONCLUSIONS AND RECOMMENDATIONS 8

TABLES

2.1 Pre-Development Condition Catchment Areas 3
2.2 Pre-Development Condition Discharge (Catchment 101) 3
2.3 Post-Development Condition Catchment Area 4
2.4 Post-Development Condition Stage-Storage Discharge (Catchment 201) 4
2.5 Post-Development Condition Site Discharge 5
3.1 Post-Development Sanitary Sewer Discharge 7
4.1 Post-Development Domestic Water Demand 8

FIGURES

1.0 Location Plan 2

APPENDICES

Appendix A – Stormwater Management Information ..... Encl.
Appendix B – SWMHYMO Input/Output Information ..... Encl.
Appendix C – Hydroguard Information ..... Encl.
Appendix D – Water Analysis Information ..... Encl.
Appendix E – Reports By Others ..... Encl.
Appendix F – Preliminary Engineering Plans ..... Encl.

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 a 3-level 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	0.29	57	0.64
203	Uncontrolled to Upper Middle Road	0.02	34	0.47

Water Quantity Control

It is required to provide quantity control measures for the runoff from Catchment 201 by means of a 100mmø orifice pipe to restrict discharge from the area to 0.019m^3/s between storm MH1 and MH2. 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 70m^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)
135.35 (Orifice Invert)	0	0.0000
135.59 (Bottom of Tank)	0	0.0029
136.09 (0.5m Depth)	23	0.0094
136.59 (1.0m Depth)	46	0.0135
137.12 (Top of Tank)	70	0.0162

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	0.009	0.001	0.009	0.019	20.4
5-Yr Event	0.011	0.002	0.012	0.019	29.6
10-Yr Event	0.012	0.003	0.013	0.019	37.0
25-Yr Event	0.014	0.003	0.015	0.019	46.9
50-Yr Event	0.014	0.004	0.016	0.019	54.6
100-Yr Event	0.015	0.005	0.018	0.019	62.8

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 100mmø orifice pipe between storm MH1 and MH2.

- $62.8m^3$ 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 Hydroguard oil/grit separator before ultimately discharging to the existing 900mmø storm sewer along Upper Middle Road. The Hydroguard sizing software was used to determine the required size of oil/grit separator unit for the site. It was determined that a Hydroguard HG4 will provide 99% TSS removal and 99% average annual runoff treatment, which satisfies the requirements for an "Enhanced" level for quality control. See Hydroguard unit sizing procedures in Appendix C for details.

Hydroguard units require regular inspection and maintenance as per the manufacturer's specifications to ensure the unit operates properly. See Hydroguard 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 100mmø 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

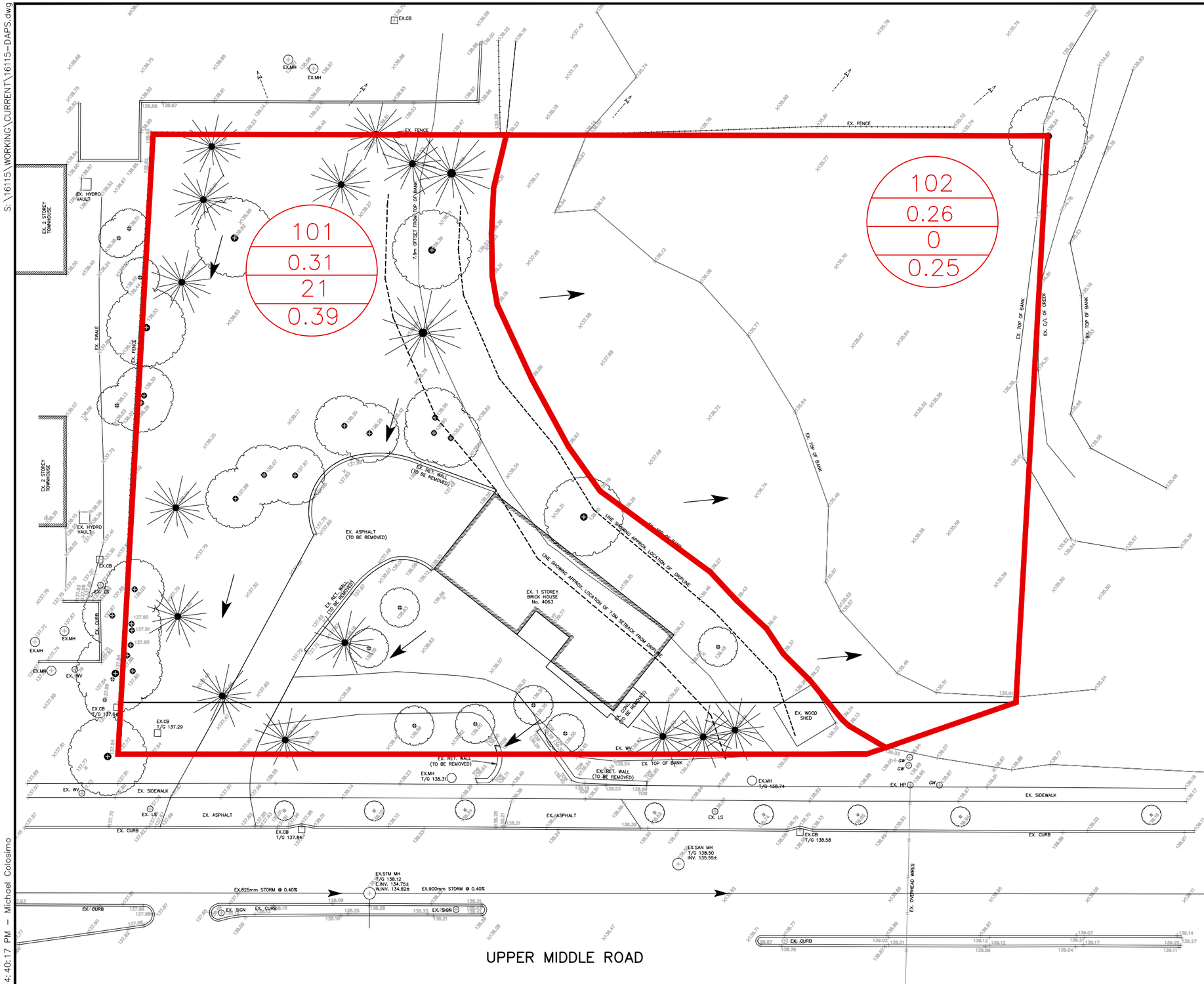


M. Colosimo, Dipl.T.

S. Frankovich, P.Eng.

APPENDIX A
STORMWATER MANAGEMENT INFORMATION

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



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
POST-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:400

PROJECT: 4063 UPPER MIDDLE ROAD
PROJECT No.: 16115

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Tel. (905) 631-6978
Fax (905) 631-8927
email: info@sla.on.ca

3228 South Service Road, Suite #105 East Wing, Burlington, Ont., L7N 3H8

8/11/2018 4:40:17 PM - Michael Colosimo

C:\Users\Michael\Desktop\16115\16115 CAD\WORKING\CURRENT\16115-DAPS.dwg

5/5/2020 8:24:49 AM - Michael Colosimo

EX.CB
EX.MH
EX.MH
EX. FENCE
EX. FENCE
EX. HYDRO VAULT
PROP. 58.0m SWALE @ 2.0%
EX. SWALE
EX. FENCE
201
0.29
57
0.64
ROOF DRAINS AND AREA DRAINS TO CONNECT TO BUILDINGS INTERNAL MECHANICAL SYSTEM
AREA DRAIN T/G 138.45
3.0m-150mmø STM @ 1.0% TO CONNECT TO INTERNAL STORM SYSTEM
AREA DRAIN T/G 138.28
2.0m-150mmø STM @ 1.0% TO CONNECT TO INTERNAL STORM SYSTEM
TD1.3 (KLASSIK DRAIN K200) T/G 135.60 (TO BE CONNECTED TO INTERNAL MECHANICAL SYSTEM)
EX. HYDRO VAULT
DI1 (OPSD 705.030) 600X600 4H:1V T/G 137.70
EX.CB
STORAGE TANK STORMTECH MC-4500 (c/w INSPECTION PORTS & ISOLATOR ROW) TANK VOLUME = 70m³ TOP OF TANK = 137.12 BOTTOM OF TANK = 135.59 (CONTRACTOR TO PROVIDE SHOP DWG'S)
10.0m-250mmø STM @ 1.0%
2ND LEVEL PARKING
MAIN LEVEL PARKING
2.0m-300mmø STM @ 1.0%
EX.MH
EX.MH
EX. WV
COVERED PORCH
CB1.2 (OPSD 705.010) T/G 138.25
2.0m-600mmø STM @ 1.0%
10.5m-250mmø STM @ 2.0%
1.5m-300mmø STM @ 1.0%
17.0m-100mmø STM ORIFICE PIPE @ 0.8%
EX.CB T/G 137.54
EX.CB T/G 137.29
CBMH2 (OPSD 701.010) T/G 138.20
MH3 (OPSD 701.010) T/G 138.30
MH1 HYDROGUARD HG4 T/G 138.30
EX.MH T/G 138.31
EX. WV
EX. SIDEWALK
EX. LS
EX. ASPHALT
EX. 400mm WTM
EX.CB T/G 137.84
EX. CURB
CONNECT INTO EX. 900mmø STM. EX. INV. ±134.70 PROP. INV. 135.20 (BY HALTON REGION FORCES ONLY)
19.5m-250mmø STM @ 0.8%
EXIST 200mm SAN SEWER
EX.825mm STORM @ 0.40%
EX.STM MH T/G 138.12 E.INV. 134.75± W.INV. 134.82±
EX.900mm STORM @ 0.80%
EX. SIGN
EX. CURB
EX. SIGN
EX. 600mm WTM
203
0.02
34
0.47
UPPER MIDDLE ROAD
202
0.26
0
0.25
EX. TOP OF BANK
EX. C/L OF CREEK
EX. TOP OF BANK
EX. TOP OF BANK
BY OTHERS TO BE REMOVED
EX. WV
EX. TOP OF BANK
EX.MH T/G 138.74
GW
GW
EX. HP
GW
EX. SIDEWALK
EX. CURB
EX.CB T/G 138.58
EX.SAN MH T/G 138.50 INV. 135.55±
EX. OVERHEAD WIRES
EX. CURB

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

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Tel. (905) 631-6978
Fax (905) 631-8927
email: info@sla.on.ca

3228 South Service Road, Suite #105 East Wing, Burlington, Ont., L7N 3H8

4063 Upper Middle Rd
Burlington, Ontario

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

STAGE-STORAGE-DISCHARGE CALCULATIONS

Outlet Device No. 1 (Quantity)

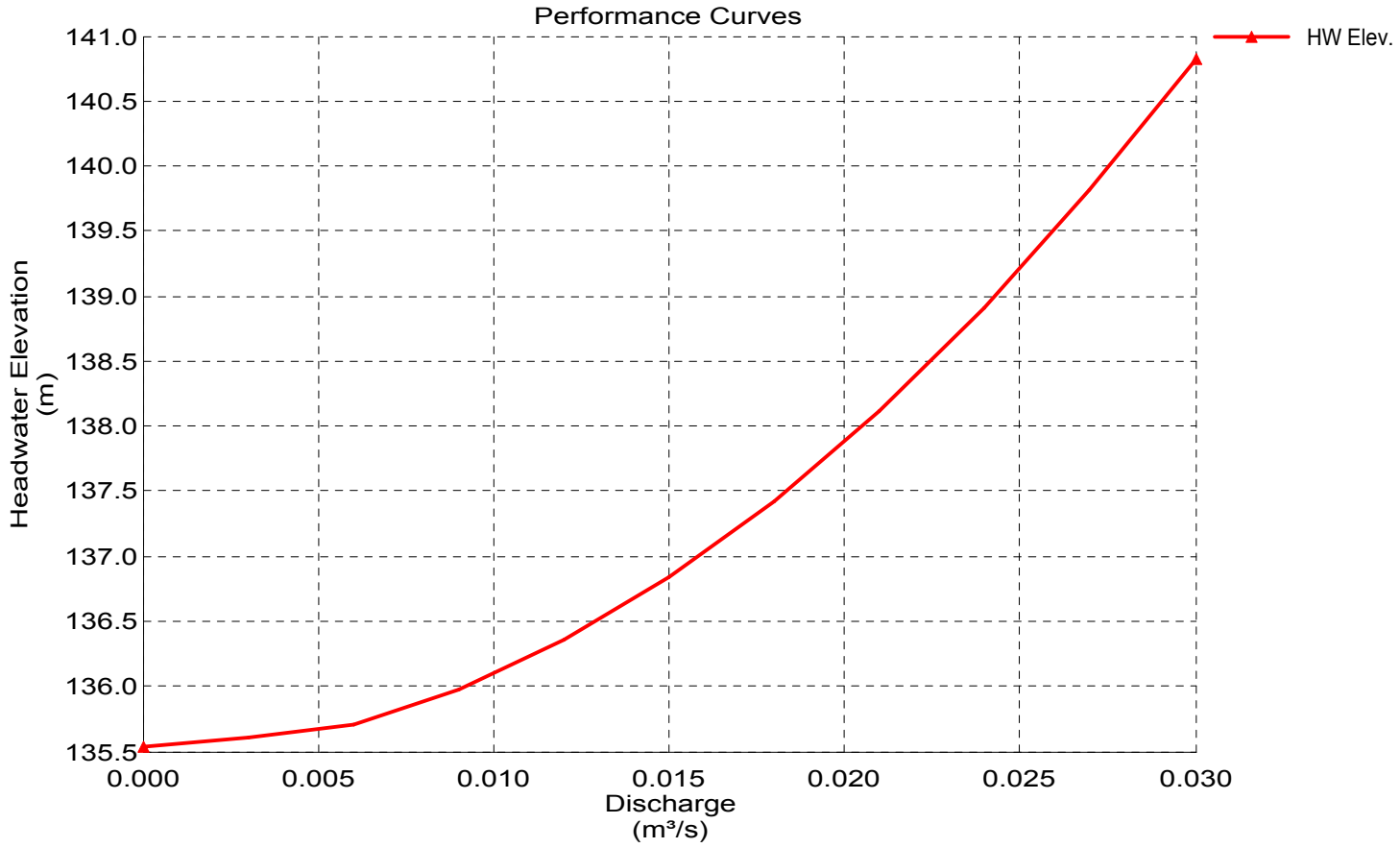
Type:	Orifice Pipe
Diameter (mm)	100
Area (m^2)	0.00785
Invert Elev. (m)	135.35
C/L Elev. (m)	135.40

Number of Orifices: 1

		Underground Tank and Pipe Storage Volumes						Outlet No. 1		
	Elevation m	Tank 1 Area m^2	Tank 1 Increm. Volume m^3	Additional Incremental Surface m^3	Cumulative Volume m^3	Pipe Storage Volume m^3	**Total Active Storage Volume m^3**	H m	Discharge m^3/s	**Total Discharge m^3/s**
Orifice Pipe Invert	135.35	0	0	0	0	0	**0**	0.000	0.0000	**0.0000**
Bottom of Tank	135.59	0	0	0	0	0	**0**	0.190	0.0029	**0.0029**
0.5m Depth	136.09	91	23	0	23	0	**23**	0.690	0.0094	**0.0094**
1.0m Depth	136.59	91	46	0	46	0	**46**	1.190	0.0135	**0.0135**
Top of Tank	137.12	91	70	0	70	0	**70**	1.720	0.0162	**0.0162**

Performance Curves Report
Worksheet-1

Range Data:				
	Minimum	Maximum	Increment	
Discharge	0.0000	0.0300	0.0030	m³/s



User Inputs

Chamber Model	MC-4500
Outlet Control Structure	Yes (Outlet)
Project Name	4063 Upper Middle Road
Project Location	Burlington Ontario
Project Date	01/06/2017
Engineer	Michael
Measurement Type	Metric
Required Storage Volume	66 cubic meters
Stone Porosity	40%
Stone Above Chamber	305 mm
Stone Foundation Depth	229 mm
Average Cover Over Chambers	610 mm
Design Constraint	WIDTH
Design Constraint Dimension	3.5 meters

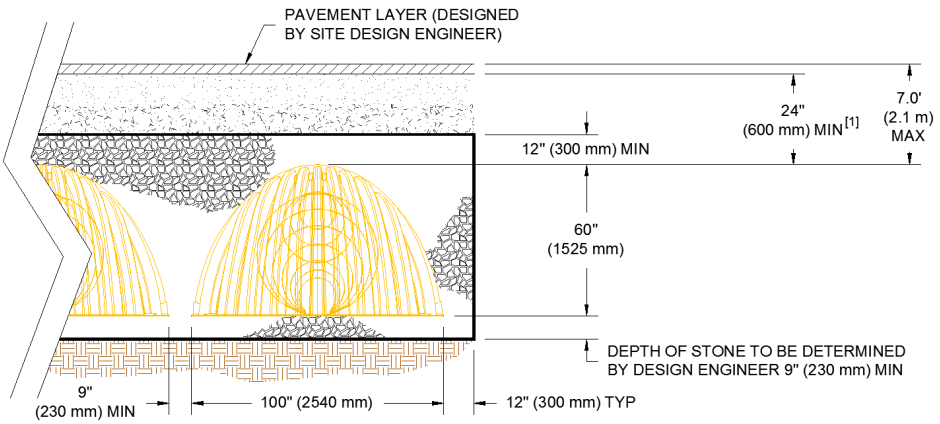
Results

System Volume and Bed Size

Installed Storage Volume	70 cubic meters
Storage Volume Per Chamber	4.6 cubic meters
Storage Volume Per End Cap	3.0 cubic meters
Number Of Chambers Required	14 each
Number Of End Caps Required	2 each
Rows/Chambers	1 row(s) of 14 chamber(s)
Maximum Length	20.44 meters
Maximum Width	3.33 meters
Approx. Bed Size Required	65 square meters

System Components

Amount Of Stone Required	90 cubic meters
Volume Of Excavation (Not Including Fill)	134 cubic meters
Non-woven Filter Fabric Required	223 square meters
Length Of Isolator Row	19.3 meters
Woven Isolator Row Fabric	121 square meters



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

© ADS StormTech 2015

APPENDIX B
SWMHYMO INPUT/OUTPUT INFORMATION

```
2     Metric units
*#*************************************************************************|
*#  Project Name: 4063 UPPER MIDDLE ROAD
*#                BURLINGTON, ONTARIO
*#  JOB NUMBER  : 16115
*#       Date   : January 2017
*#    Revised   : August 2018
*#    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=[2], NHYD=["201"], DT=[1](min), AREA=[0.29](ha),
                    XIMP=[0.57], TIMP=[0.57], 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=[3],   NHYD=["201"],  IDin=[2],
                    RDT=[1](min),
                          TABLE of ( OUTFLOW-STORAGE ) values
                                   (cms) - (ha-m)
                                    0.0     ,  0.0
                                    0.0029  ,  0.0
                                    0.0094  ,  0.0023
                                    0.0135  ,  0.0046
                                    0.0162  ,  0.0070
                                       -1   ,  -1    (max twenty pts)
                          IDovf=[4], NHYDovf=["OVF"]
*%-----------------|-------------------------------------------------------|
*# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
```

```
*
CALIB STANDHYD      ID=[5], NHYD=["203"], DT=[1](min), AREA=[0.02](ha),
                    XIMP=[0.34], TIMP=[0.34], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[80],
                    Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.0](%),
                                         LGP=[12](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
                                         LGI=[12](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------------|
ADD HYD             IDsum=[8], NHYD=["TOTAL"], IDs to add=[3, 4, 5]
**#**************************************************************************|
* 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                +++++++++
 +++++++++                Burlington            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: 2018-08-11     TIME: 15:47:58     RUN COUNTER: 001013          *
 ********************************************************************************
 * 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   : August 2018
*#    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   : August 2018
*#    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)=     .29
| 02:201    DT= 1.00 |   Total Imp(%)=   57.00   Dir. Conn.(%)=   57.00
----------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .17          .12
     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          .032 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.52         1.333
     RUNOFF VOLUME    (mm)=      31.34         7.55        21.111
     TOTAL RAINFALL   (mm)=      32.34        32.34        32.342
     RUNOFF COEFFICIENT   =        .97          .23          .653

       (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>02:(201   )  |
| OUT<03:(201   )  |    =========  OUTLFOW STORAGE TABLE  =========
--------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00   |     .014  .4600E-02
                           .003  .0000E+00   |     .016  .7000E-02
                           .009  .2300E-02   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     ---------------            (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (201   )        .29      .032     1.333     21.111
     OUTFLOW<03: (201   )        .29      .009     1.533     21.124
    OVERFLOW<04: (OVF   )        .00      .000      .000       .000

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


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   27.093
                   TIME SHIFT OF PEAK FLOW         (min)=    12.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.2044E-02

--------------------------------------------------------------------------------
002:0006----------------------------------------------------------------------
*# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .02
| 05:203    DT= 1.00 |   Total Imp(%)=   34.00   Dir. Conn.(%)=   34.00
----------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .01          .01
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      12.00        12.00
     Mannings n            =       .015         .250

     Max.eff.Inten.(mm/hr)=      68.16        12.26
                  over (min)        1.00         9.00
     Storage Coeff.  (min)=        .74 (ii)    8.67 (ii)
     Unit Hyd. Tpeak (min)=       1.00         9.00
     Unit Hyd. peak  (cms)=       1.26          .13
                                                      *TOTALS*
     PEAK FLOW       (cms)=        .00          .00          .001 (iii)
     TIME TO PEAK    (hrs)=       1.28         1.47         1.333
     RUNOFF VOLUME    (mm)=      31.34         7.55        15.638
     TOTAL RAINFALL   (mm)=      32.34        32.34        32.342
     RUNOFF COEFFICIENT   =        .97          .23          .484

       (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.

------------------------------------------------------------------------------
002:0007----------------------------------------------------------------------
-------------------------
| ADD HYD (TOTAL     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
-----------------------  --------------- (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 03:201            .29     .009    1.53  21.12    .000
                      +ID2 04:OVF            .00     .000     .00    .00    .000
                      +ID3 05:203            .02     .001    1.33  15.64    .000
                       ============================================================
                       SUM 08:TOTAL          .31     .009    1.50  20.77    .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   : August 2018
*#    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)=     .29
| 02:201    DT= 1.00 |   Total Imp(%)=   57.00   Dir. Conn.(%)=   57.00
----------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .17          .12
     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          .043 (iii)
     TIME TO PEAK    (hrs)=     1.32         1.45         1.333
     RUNOFF VOLUME    (mm)=    40.70        12.64        28.632
     TOTAL RAINFALL   (mm)=    41.70        41.70        41.696
     RUNOFF COEFFICIENT   =      .98          .30          .687

       (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>02:(201   )   |
| OUT<03:(201   )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00   |     .014  .4600E-02
                           .003  .0000E+00   |     .016  .7000E-02
                           .009  .2300E-02   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     ---------------            (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (201   )        .29      .043     1.333     28.632
     OUTFLOW<03: (201   )        .29      .011     1.650     28.638
    OVERFLOW<04: (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](%)=   24.551
                    TIME SHIFT OF PEAK FLOW         (min)=    19.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.2964E-02

------------------------------------------------------------------------------
005:0006----------------------------------------------------------------------
*# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .02
| 05:203    DT= 1.00 |   Total Imp(%)=   34.00   Dir. Conn.(%)=   34.00
----------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .01          .01
     Dep. Storage     (mm)=      1.00         6.35
     Average Slope     (%)=      2.00         2.00
     Length            (m)=     12.00        12.00
     Mannings n             =      .015         .250

     Max.eff.Inten.(mm/hr)=     88.09        25.23
               over (min)        1.00         7.00
     Storage Coeff.  (min)=      .67 (ii)    6.61 (ii)
     Unit Hyd. Tpeak (min)=     1.00         7.00
     Unit Hyd. peak  (cms)=     1.32          .17
                                                      *TOTALS*
     PEAK FLOW       (cms)=      .00          .00          .002 (iii)
     TIME TO PEAK    (hrs)=     1.28         1.42         1.333
     RUNOFF VOLUME    (mm)=    40.69        12.64        22.178
     TOTAL RAINFALL   (mm)=    41.70        41.70        41.696
     RUNOFF COEFFICIENT   =      .98          .30          .532

       (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.

------------------------------------------------------------------------------
005:0007----------------------------------------------------------------------
-----------------------
| ADD HYD (TOTAL     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
-----------------------  --------------- (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 03:201            .29     .011    1.65  28.64    .000
                      +ID2 04:OVF            .00     .000     .00    .00    .000
                      +ID3 05:203            .02     .002    1.33  22.18    .000
                       ============================================================
                       SUM 08:TOTAL          .31     .012    1.33  28.22    .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   : August 2018
*#    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)=     .29
| 02:201    DT= 1.00 |   Total Imp(%)=   57.00   Dir. Conn.(%)=   57.00
----------------------
                         IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .17          .12
     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          .051 (iii)
     TIME TO PEAK    (hrs)=      1.32         1.43         1.333
     RUNOFF VOLUME    (mm)=     47.00        16.50        33.887
     TOTAL RAINFALL   (mm)=     48.00        48.00        48.004
     RUNOFF COEFFICIENT   =       .98          .34          .706

       (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>02:(201   )  |
| OUT<03:(201   )  |    =========  OUTLFOW STORAGE TABLE  =========
--------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00   |     .014  .4600E-02
                           .003  .0000E+00   |     .016  .7000E-02
                           .009  .2300E-02   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     ---------------            (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (201   )        .29      .051     1.333     33.887
     OUTFLOW<03: (201   )        .29      .012     1.667     33.913
    OVERFLOW<04: (OVF   )        .00      .000      .000       .000

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


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   23.308
                   TIME SHIFT OF PEAK FLOW         (min)=    20.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.3704E-02

-------------------------------------------------------------------------------
010:0006-------------------------------------------------------------------------
*# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .02
| 05:203    DT= 1.00 |   Total Imp(%)=   34.00   Dir. Conn.(%)=   34.00
----------------------
                         IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .01          .01
     Dep. Storage     (mm)=      1.00         6.35
     Average Slope     (%)=      2.00         2.00
     Length            (m)=     12.00        12.00
     Mannings n           =      .015         .250

     Max.eff.Inten.(mm/hr)=    101.14        35.40
               over (min)       1.00         6.00
     Storage Coeff.  (min)=      .63 (ii)    5.82 (ii)
     Unit Hyd. Tpeak (min)=      1.00         6.00
     Unit Hyd. peak  (cms)=      1.35          .19
                                                    *TOTALS*
     PEAK FLOW       (cms)=       .00          .00          .003 (iii)
     TIME TO PEAK    (hrs)=      1.28         1.40         1.333
     RUNOFF VOLUME    (mm)=     47.00        16.50        26.871
     TOTAL RAINFALL   (mm)=     48.00        48.00        48.004
     RUNOFF COEFFICIENT   =       .98          .34          .560

       (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.

-------------------------------------------------------------------------------
010:0007-------------------------------------------------------------------------
----------------------
| ADD HYD (TOTAL     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
----------------------                     (ha)     (cms)   (hrs)   (mm)   (cms)
                         ID1 03:201          .29     .012    1.67  33.91    .000
                        +ID2 04:OVF          .00     .000     .00    .00    .000
                        +ID3 05:203          .02     .003    1.33  26.87    .000
                         ========================================================
                         SUM 08:TOTAL        .31     .013    1.33  33.46    .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   : August 2018
*#    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)=     .29
| 02:201    DT= 1.00 |   Total Imp(%)=   57.00   Dir. Conn.(%)=   57.00
----------------------
                          IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .17          .12
     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)=        .05           .01          .062 (iii)
     TIME TO PEAK    (hrs)=       1.32         1.42         1.333
     RUNOFF VOLUME    (mm)=      55.03        21.81        40.744
     TOTAL RAINFALL   (mm)=      56.03        56.03        56.030
     RUNOFF COEFFICIENT   =        .98          .39          .727

       (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>02:(201    )   |
| OUT<03:(201    )   |    =========  OUTLFOW STORAGE TABLE  =========
----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00    |     .014  .4600E-02
                            .003  .0000E+00    |     .016  .7000E-02
                            .009  .2300E-02    |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (201   )        .29      .062     1.333     40.744
     OUTFLOW<03: (201   )        .29      .014     1.683     40.754
    OVERFLOW<04: (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](%)=   21.980
                   TIME SHIFT OF PEAK FLOW         (min)=    21.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.4689E-02

-------------------------------------------------------------------------------
025:0006---------------------------------------------------------------------
*# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .02
| 05:203    DT= 1.00 |   Total Imp(%)=   34.00   Dir. Conn.(%)=   34.00
----------------------
                          IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .01          .01
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      12.00        12.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     117.72        49.45
                  over (min)       1.00         5.00
     Storage Coeff.  (min)=        .59 (ii)    5.14 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=       1.38          .22
                                                      *TOTALS*
     PEAK FLOW       (cms)=        .00           .00          .003 (iii)
     TIME TO PEAK    (hrs)=       1.30         1.38         1.333
     RUNOFF VOLUME    (mm)=      55.03        21.81        33.103
     TOTAL RAINFALL   (mm)=      56.03        56.03        56.030
     RUNOFF COEFFICIENT   =        .98          .39          .591

       (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.

-------------------------------------------------------------------------------
025:0007---------------------------------------------------------------------
----------------------
| ADD HYD (TOTAL     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
----------------------                     (ha)     (cms)   (hrs)   (mm)   (cms)
                        ID1 03:201            .29     .014    1.68  40.75    .000
                       +ID2 04:OVF            .00     .000     .00    .00    .000
                       +ID3 05:203            .02     .003    1.33  33.10    .000
                        ==========================================================
                        SUM 08:TOTAL          .31     .015    1.50  40.26    .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   : August 2018
*#    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)=     .29
| 02:201    DT= 1.00 |   Total Imp(%)=   57.00   Dir. Conn.(%)=   57.00
---------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .17          .12
     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          .070 (iii)
     TIME TO PEAK    (hrs)=      1.30         1.40         1.333
     RUNOFF VOLUME    (mm)=     60.96        25.96        45.913
     TOTAL RAINFALL   (mm)=     61.96        61.96        61.962
     RUNOFF COEFFICIENT   =       .98          .42          .741

       (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>02:(201   )    |
| OUT<03:(201   )    |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00    |     .014  .4600E-02
                           .003  .0000E+00    |     .016  .7000E-02
                           .009  .2300E-02    |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     -------------------        (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (201   )        .29      .070     1.333     45.913
     OUTFLOW<03: (201   )        .29      .014     1.683     45.920
    OVERFLOW<04: (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](%)=   20.781
                  TIME SHIFT OF PEAK FLOW         (min)=    21.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.5463E-02

------------------------------------------------------------------------------
050:0006----------------------------------------------------------------------
*# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
*
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .02
| 05:203    DT= 1.00 |   Total Imp(%)=   34.00   Dir. Conn.(%)=   34.00
---------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .01          .01
     Dep. Storage     (mm)=      1.00         6.35
     Average Slope     (%)=      2.00         2.00
     Length            (m)=     12.00        12.00
     Mannings n           =      .015         .250

     Max.eff.Inten.(mm/hr)=    129.82        59.24
               over (min)        1.00         5.00
     Storage Coeff.  (min)=       .57 (ii)    4.80 (ii)
     Unit Hyd. Tpeak (min)=      1.00         5.00
     Unit Hyd. peak  (cms)=      1.40          .23
                                                    *TOTALS*
     PEAK FLOW       (cms)=       .00          .00          .004 (iii)
     TIME TO PEAK    (hrs)=      1.27         1.37         1.333
     RUNOFF VOLUME    (mm)=     60.96        25.96        37.863
     TOTAL RAINFALL   (mm)=     61.96        61.96        61.962
     RUNOFF COEFFICIENT   =       .98          .42          .611

       (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.

------------------------------------------------------------------------------
050:0007----------------------------------------------------------------------
-----------------------
| ADD HYD (TOTAL     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
-----------------------                    (ha)     (cms)   (hrs)   (mm)    (cms)
                    ID1 03:201             .29      .014    1.68   45.92    .000
                   +ID2 04:OVF             .00      .000     .00     .00    .000
                   +ID3 05:203             .02      .004    1.33   37.86    .000
                    ===========================================================
                    SUM 08:TOTAL           .31      .016    1.33   45.40    .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----------------------------------------------------------------------
*
  ** 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   : August 2018
*#    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          .25
                                                    *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)=     .29
| 02:201    DT= 1.00 |   Total Imp(%)=   57.00   Dir. Conn.(%)=   57.00
---------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .17          .12
     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          .079 (iii)
     TIME TO PEAK    (hrs)=       1.30         1.38         1.333
     RUNOFF VOLUME    (mm)=      66.72        30.16        51.003
     TOTAL RAINFALL   (mm)=      67.72        67.72        67.724
     RUNOFF COEFFICIENT   =        .99          .45          .753

       (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>02:(201   )   |
| OUT<03:(201   )   |    =========  OUTLFOW STORAGE TABLE  =========
--------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00   |     .014  .4600E-02
                           .003  .0000E+00   |     .016  .7000E-02
                           .009  .2300E-02   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     -------------------        (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (201   )        .29      .079     1.333     51.003
     OUTFLOW<03: (201   )        .29      .015     1.683     51.024
    OVERFLOW<04: (OVF   )        .00      .000      .000       .000

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


                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   19.565
                    TIME SHIFT OF PEAK FLOW         (min)=    21.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.6276E-02

--------------------------------------------------------------------------------
100:0006--------------------------------------------------------------------------
*# CATCHMENT 203 - PROPOSED CONDITION (UNCONTROLLED TO UPPER MIDDLE ROAD)
*
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .02
| 05:203    DT= 1.00 |   Total Imp(%)=   34.00   Dir. Conn.(%)=   34.00
---------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .01          .01
     Dep. Storage     (mm)=      1.00         6.35
     Average Slope     (%)=      2.00         2.00
     Length            (m)=     12.00        12.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     141.89        71.35
               over (min)         1.00         4.00
     Storage Coeff.  (min)=        .55 (ii)    4.47 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.42          .26
                                                    *TOTALS*
     PEAK FLOW       (cms)=        .00          .00          .005 (iii)
     TIME TO PEAK    (hrs)=       1.27         1.37         1.333
     RUNOFF VOLUME    (mm)=      66.72        30.16        42.594
     TOTAL RAINFALL   (mm)=      67.72        67.72        67.724
     RUNOFF COEFFICIENT   =        .99          .45          .629

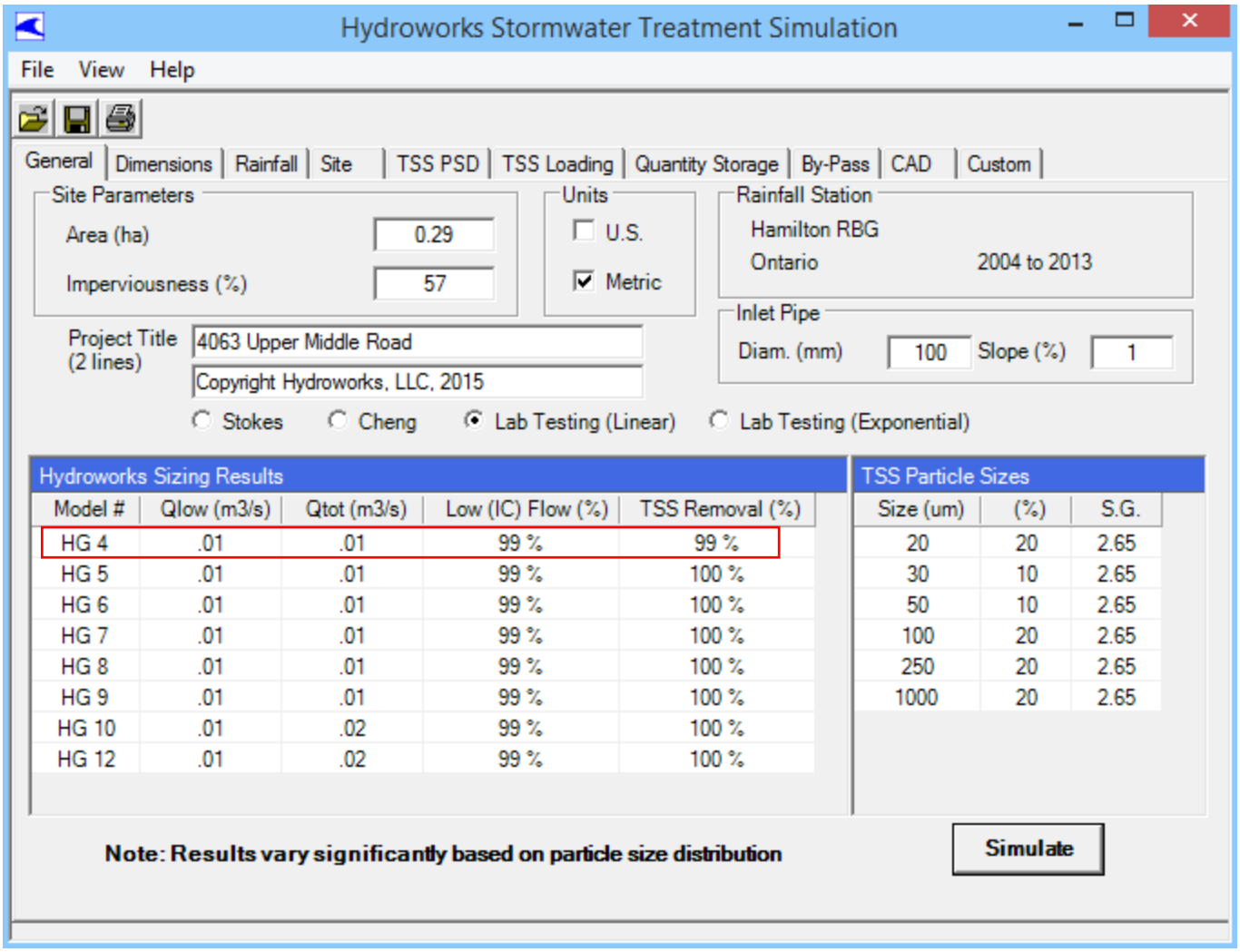
       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0007--------------------------------------------------------------------------
-----------------------
| ADD HYD (TOTAL     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
-----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
                      ID1 03:201             .29     .015    1.68  51.02    .000
                     +ID2 04:OVF             .00     .000     .00    .00    .000
                     +ID3 05:203             .02     .005    1.33  42.59    .000
                      ============================================================
                      SUM 08:TOTAL           .31     .018    1.33  50.48    .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--------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002--------------------------------------------------------------------------
*
      FINISH
--------------------------------------------------------------------------------
********************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2018-08-11     at 15:47:59
================================================================================
```

APPENDIX C
HYDROGUARD INFORMATION


Hydroworks Stormwater Treatment Simulation
File View Help
General Dimensions Rainfall Site TSS PSD TSS Loading Quantity Storage By-Pass CAD Custom
Site Parameters
Area (ha) 0.29
Imperviousness (%) 57
Units
U.S.
Metric
Rainfall Station
Hamilton RBG
Ontario 2004 to 2013
Inlet Pipe
Diam. (mm) 100 Slope (%) 1
Project Title (2 lines)
4063 Upper Middle Road
Copyright Hydroworks, LLC, 2015
Stokes Cheng Lab Testing (Linear) Lab Testing (Exponential)
Hydroworks Sizing Results
Model # Qlow (m3/s) Qtot (m3/s) Low (IC) Flow (%) TSS Removal (%)
HG 4 .01 .01 99 % 99 %
HG 5 .01 .01 99 % 100 %
HG 6 .01 .01 99 % 100 %
HG 7 .01 .01 99 % 100 %
HG 8 .01 .01 99 % 100 %
HG 9 .01 .01 99 % 100 %
HG 10 .01 .02 99 % 100 %
HG 12 .01 .02 99 % 100 %
TSS Particle Sizes
Size (um) (%) S.G.
20 20 2.65
30 10 2.65
50 10 2.65
100 20 2.65
250 20 2.65
1000 20 2.65
Note: Results vary significantly based on particle size distribution
Simulate



Hydroworks® Hydroguard

Maintenance Manual

Version 1.3

Introduction

The Hydroguard 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 Hydroguard 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 Hydroguard.

Hydroworks® HG Operation

The Hydroworks HG separator is unique since it treats both high and low flows in one device, but maintains separate flow paths for low and high flows. Accordingly, high flows do not scour out the fines that are settled in the low flow path since they are treated in a separate area of the device as shown in Figure 1.

The HG separator consists of three chambers:

1. an inner chamber that treats low or normal flows
2. a middle chamber that treats high flows
3. an outlet chamber where water is discharged to the downstream storm system

Under normal or low flows, water enters the middle chamber and is conveyed into the inner chamber by momentum. Since the inner chamber is offset to one side of the structure the water strikes the wall of the inner chamber at a tangent creating a vortex within the inner chamber. The vortex motion forces solids and floatables to the middle of the inner chamber. The water spirals down the inner chamber to the outlet of the inner chamber which is located below the inlet of the inner chamber and adjacent to the wall of the structure but above the floor of the structure. Floatables are trapped since the outlet of the inner chamber 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 the outlet of the inner chamber draws water from the wall of the inner chamber.

The water leaving the inner chamber continues into the middle chamber, again at a tangent to the wall of the structure. The water is then conveyed through an outlet baffle wall (high and low baffle). This enhances the collection of any floatables or solids not removed by the inner chamber. Water flowing through the baffles then enters the outlet chamber and is discharged into the downstream storm drain.

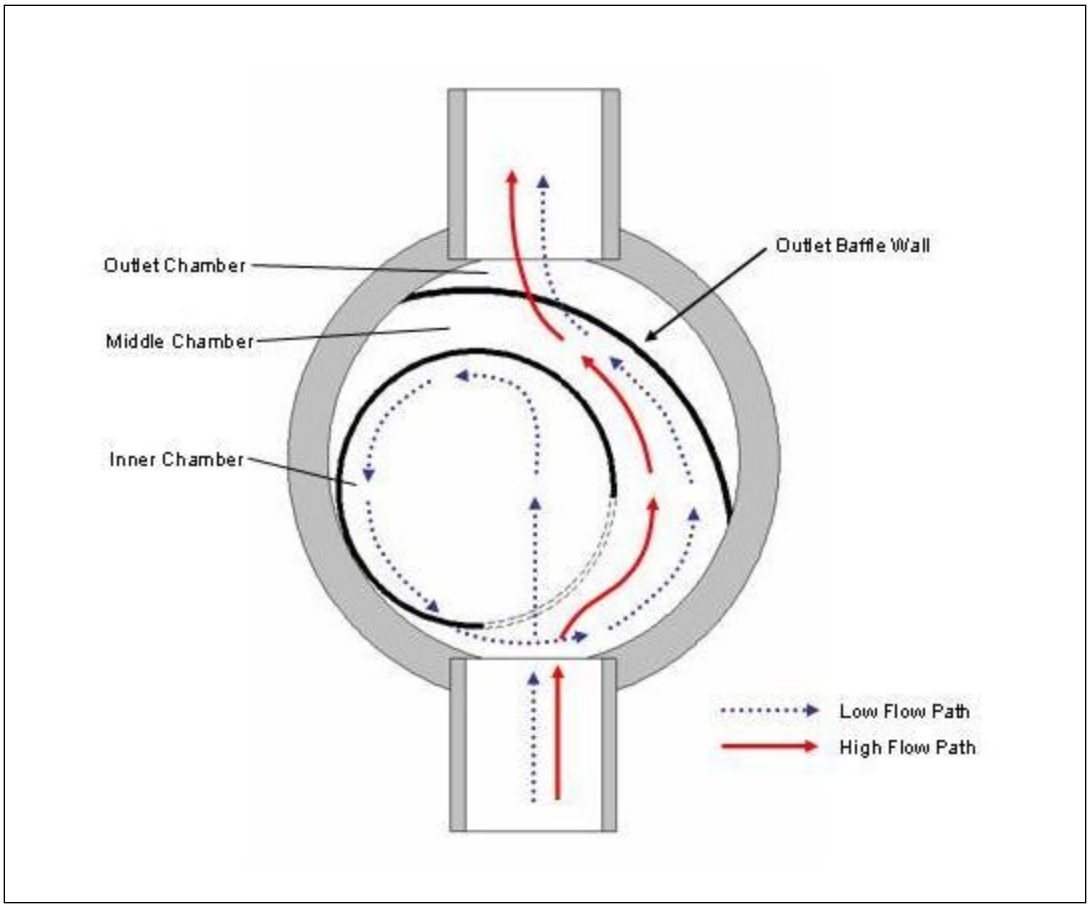


Figure 1. Hydroworks HG Operation – Plan View

During high flows, the flow rate entering the inner chamber is restricted by the size of the inlet opening to the inner chamber. This restriction of flow rate into the inner chamber prevents scour and re-suspension of solids from the inner chamber during periods of high flow. This is important since fines, which are typically considered highly polluted, are conveyed during low/normal flows.

The excess flow is conveyed directly into the middle chamber where it receives treatment for floatables and solids via the baffle system. This treatment of the higher flow rates is important since trash and heavier solids are typically conveyed during periods of higher flow rates. The Hydroworks HG separator is revolutionary since it incorporates low and high flow treatment in one device while maintaining separate low and high flow paths to prevent the scour and re-suspension of fines.

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

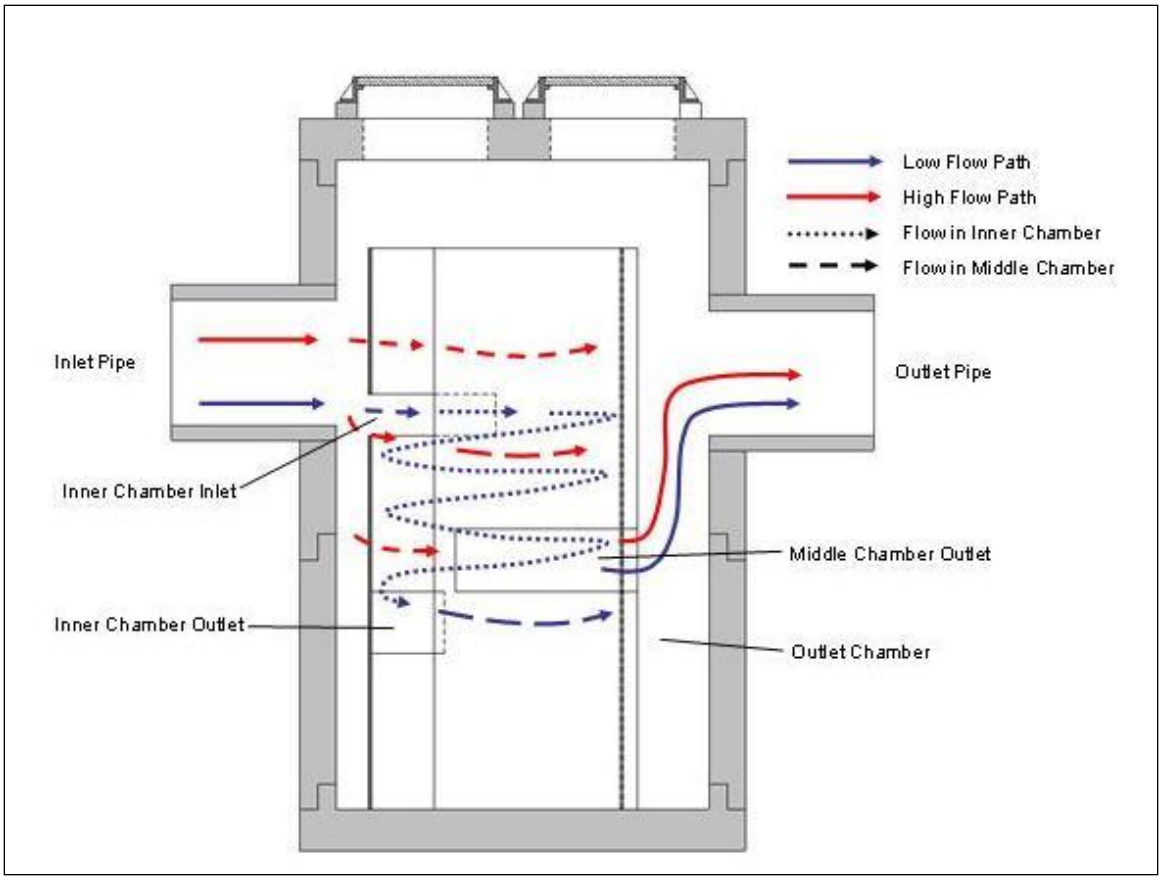
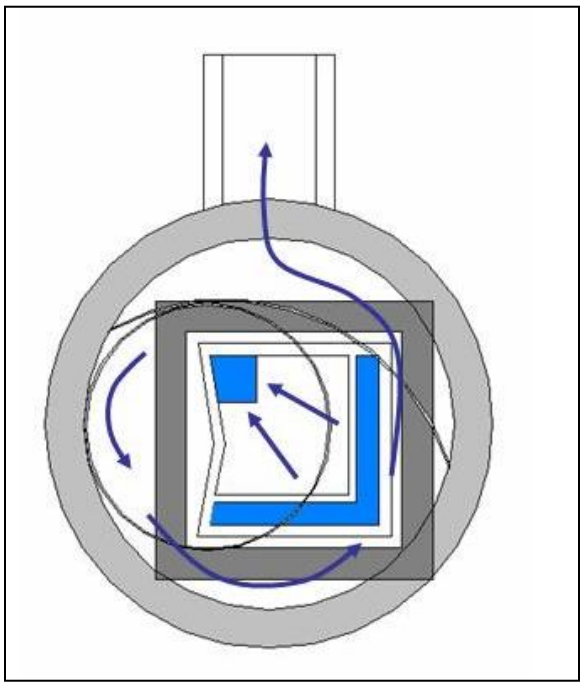


Figure 2. Hydroworks HG Operation – Profile View

The HG 4i is an inlet version of the HG 4 separator. There is a catch-basin grate on top of the HG 4i. Water flows directly into the inner chamber of the HG 4i through the catch-basin grate on top of the structure. The grate is oversized to allow maintenance of the entire structure. A funnel that sits underneath the grate on the top cap of the concrete itself directs the water into the inner chamber during normal flows and the middle chamber during high flows. Figures 3 and 4 show the flow paths for the HG 4i separator.

The inlet funnel is sloped towards the corner inlet and hence the wall of the inner chamber. Water moves in a circular direction in the inner chamber since water enters tangentially along the wall of the inner chamber due to the sloping funnel.

Water continues moving in a circular motion (vortex) through the rest of the structure (through the middle chamber and baffle wall) until it is discharged from the separator.



During periods of peak flow the water will back up from the corner inlet and overflow into two side overflow troughs which discharge directly into the middle chamber. These overflow troughs are covered from the surface such that water cannot directly fall through them (i.e. water must back up to enter the overflow troughs).

Accordingly this funnel provides the same separate flow paths for low and high flow as the other Hydroguard separators.

The whole funnel is removed for inspection and cleaning providing.

Figure 3. Hydroworks Hydroguard HG 4i Normal Flow Path

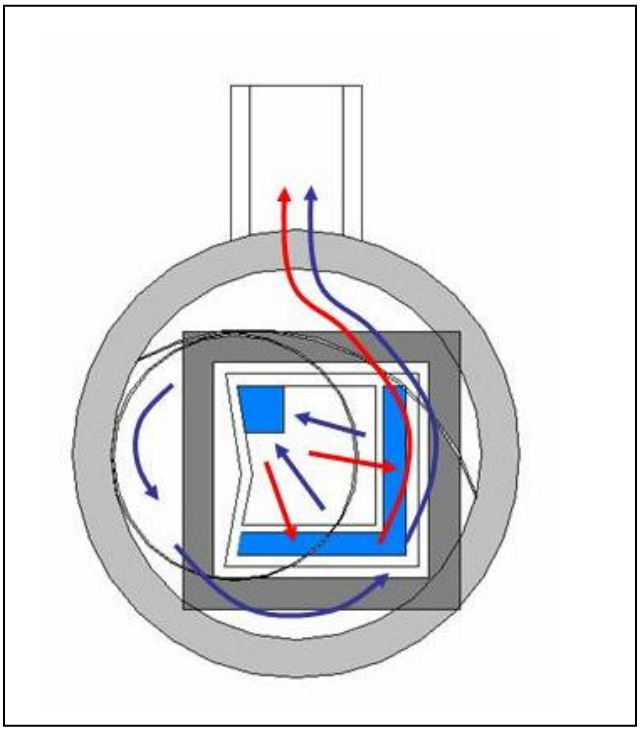


Figure 4. Hydroworks Hydroguard HG 4i Peak Flow Path

Inspection

Procedure

Although all parts of the Hydroguard should be inspected, inspection and maintenance should focus on the inner and middle chambers since this is where the pollutants (floatable and sinking) will accumulate.

Floatables

A visual inspection can be conducted for floatables by removing the covers and looking down into the separator. Multiple covers are provided on Hydroworks HG units to access all areas of the separator (The HG 4 may have a single larger 32” (800mm) cover due to the lack of space for multiple 24” (600mm) covers).

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 HG separator should be inspected every two weeks and after every large storm (over 0.5” (12.5 mm) of rain) during the construction period.

Post-Construction Period

The Hydroworks HG separator should be inspected once per year 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 HG separator should be inspected more frequently (4 times per year). An initial annual inspection will indicate the required future frequency of 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 HG unit is typically maintained using a vactor truck or clam shell bucket. There are numerous companies that can maintain the HG separator. Envirocalm, LLC, an affiliate company of Hydroworks offers inspection and maintenance services and can inspect and maintain the HG separator. (www.envirocalm.com).

Disposal of the contents of the separator depend on local requirements. Maintenance of a Hydroworks HG unit will typically take 1 to 2 hours.

Frequency

Construction Period

A HG separator can fill with construction sediment quickly during the construction period. The construction sediment will have a much coarser particle size distribution than the suspended solids during the post-development period. Accordingly, scour is not so much of a concern during the construction period compared to the separator filling up with solids. The Hydroguard must be maintained during the construction period when the depth of TSS/sediment reaches 27” (675 mm). This represents 75% of the maximum sediment storage capacity. 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 open water surface on the inlet side of the outlet baffle wall.

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

Post-Construction Period

The Hydroguard was independently tested by Alden Research Laboratory in 2008. A HG6 was tested for scour with initial sediment loads of 4.6 ft^3 and 9.3 ft^3. The results from these tests were almost identical. Therefore, the 9.3 ft^3 sediment load was used as 50% of the maximum sediment depth for maintenance in the calculation of the maintenance interval for the HG6 separator based on the NJDEP maintenance interval equation.

Maintenance Interval (months) = 3.565 x (Sediment Storage) / (MTFR x TSS Removal)

Maintenance Interval (HG6) = 3.565 x 9.3 / (1.67x 0.55) = 36 months

All values (flow, sediment storage) can be scaled by the surface area making the sediment depths and maintenance intervals equal for all separators.

The separator was loaded with the sediment in the inner chamber and middle chamber with the majority of sediment (80%) located in the inner chamber. The inner chamber for area represents approximately 44% of the separator surface area. The inner chamber is 4 ft (1200 mm) in diameter in the HG6. Therefore the 50% sediment depth for the HG6 in the inner chamber would be:

9.3 ft^3 x 0.80 / (3.14 x 4 ft^2) x 12 in/ft = 7.1 inches (175 mm)

Accordingly the 100% sediment volume would represent 14.2” (350 mm) of sediment depth in the inner chamber.

The HG separator must 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 open water surface on the inlet side of the outlet baffle wall. It should also be maintained once the accumulated TSS/sediment depths are greater than 14” (350 mm) in the inner chamber. For typical stabilized post-construction sites (parking lots, streets) it is anticipated that maintenance will be required annually or once every two years. More frequent or less frequent maintenance will be required depending on individual site conditions (traffic use, stabilization, storage piles, etc.). The long term maintenance frequency can be established based on the maintenance requirements during the first several years of operation if site conditions do not change.

HYDROGUARD 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	☐	☐

Hydroguard	**Yes**	**No**
Incorrect access orientation	☐ ***	☐
Obstructions in the inlet or outlet	☐ *	☐
Missing internal components	☐ **	☐
Improperly installed 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	**< 25% of surface area**	☐	**> 25% surface area**	☐ *
Sludge depth	**< 14" (350mm)**	☐	**> 14" (350mm)**	☐ *****

Other Comments: _____
_____
_____

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

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.

Hydroworks® Hydroguard

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 Hydroguard 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 50 S 21st St., Kenilworth, NJ 07033 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 Hydroguard 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 Hydroguard, or the cost of other goods or services related to the purchase and installation of the Hydroguard. For this Limited Warranty to apply, the Hydroguard 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 Hydroguard 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 Hydroguard, whether the claim is based upon contract, tort, or other legal basis.

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.

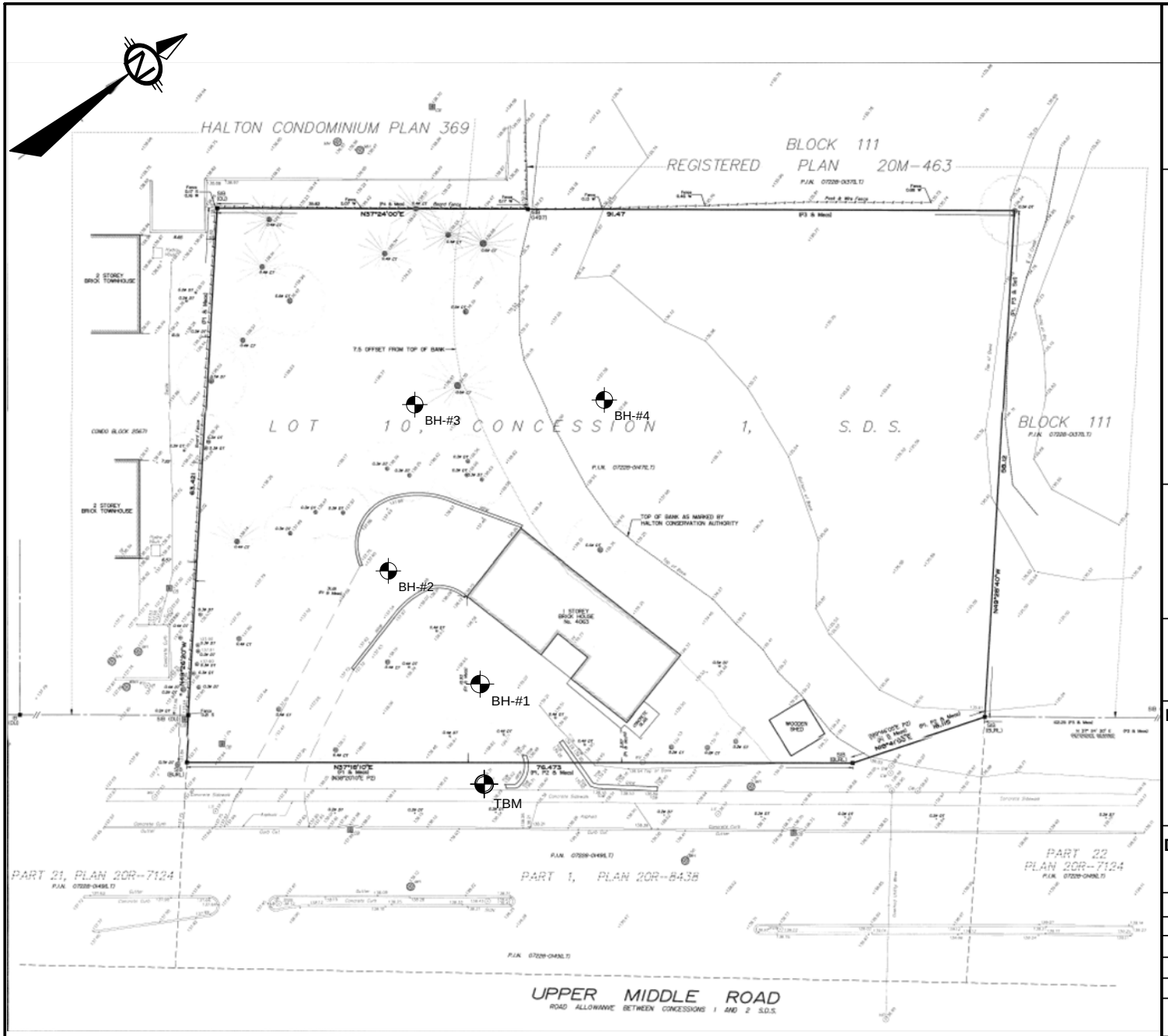
Kyle Richardson, B. Eng., EIT

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

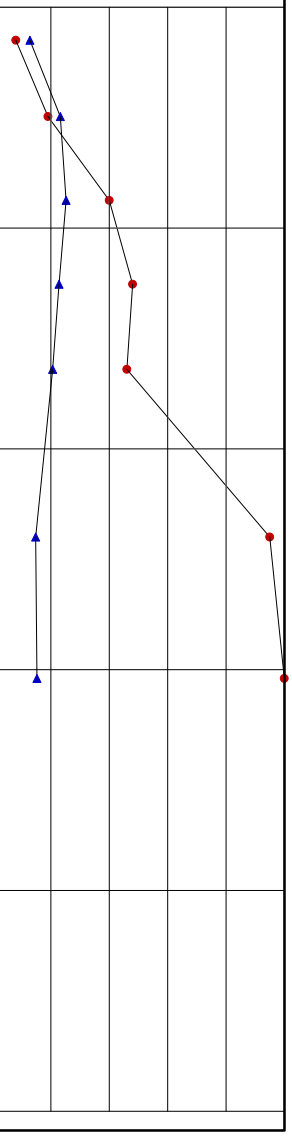
SUBSURFACE PROFILE

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.

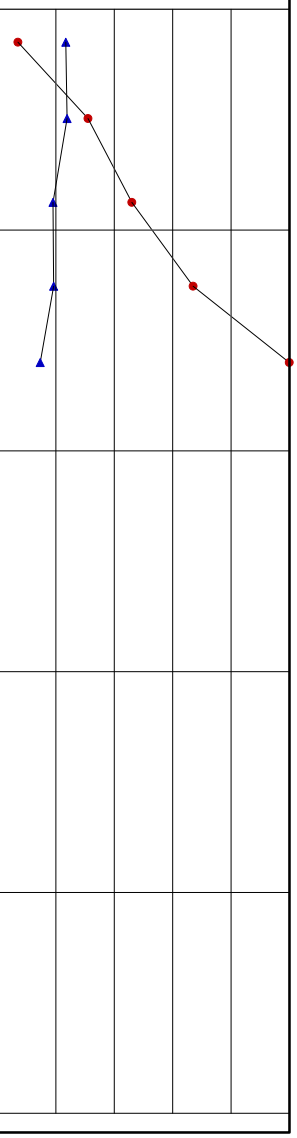
3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

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:

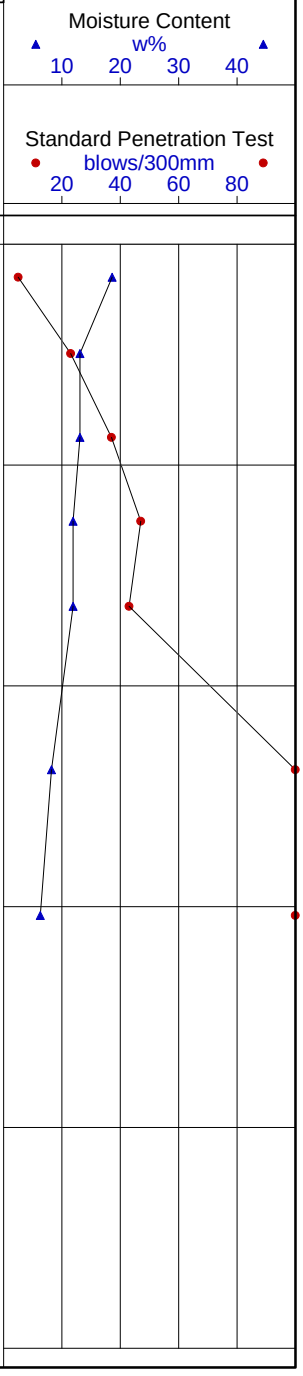
1. Borehole was advanced using solid stem auger equipment on May 13, 2013 to termination at a depth of 6.2 metres.

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

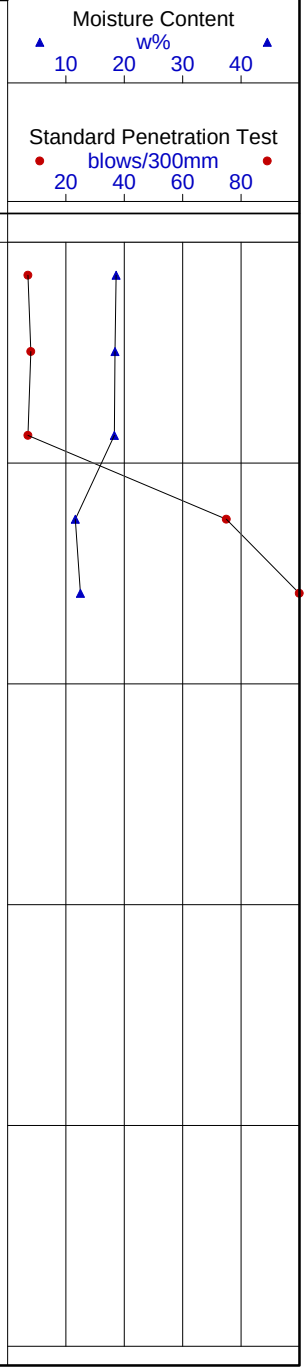
Soil-Mat

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

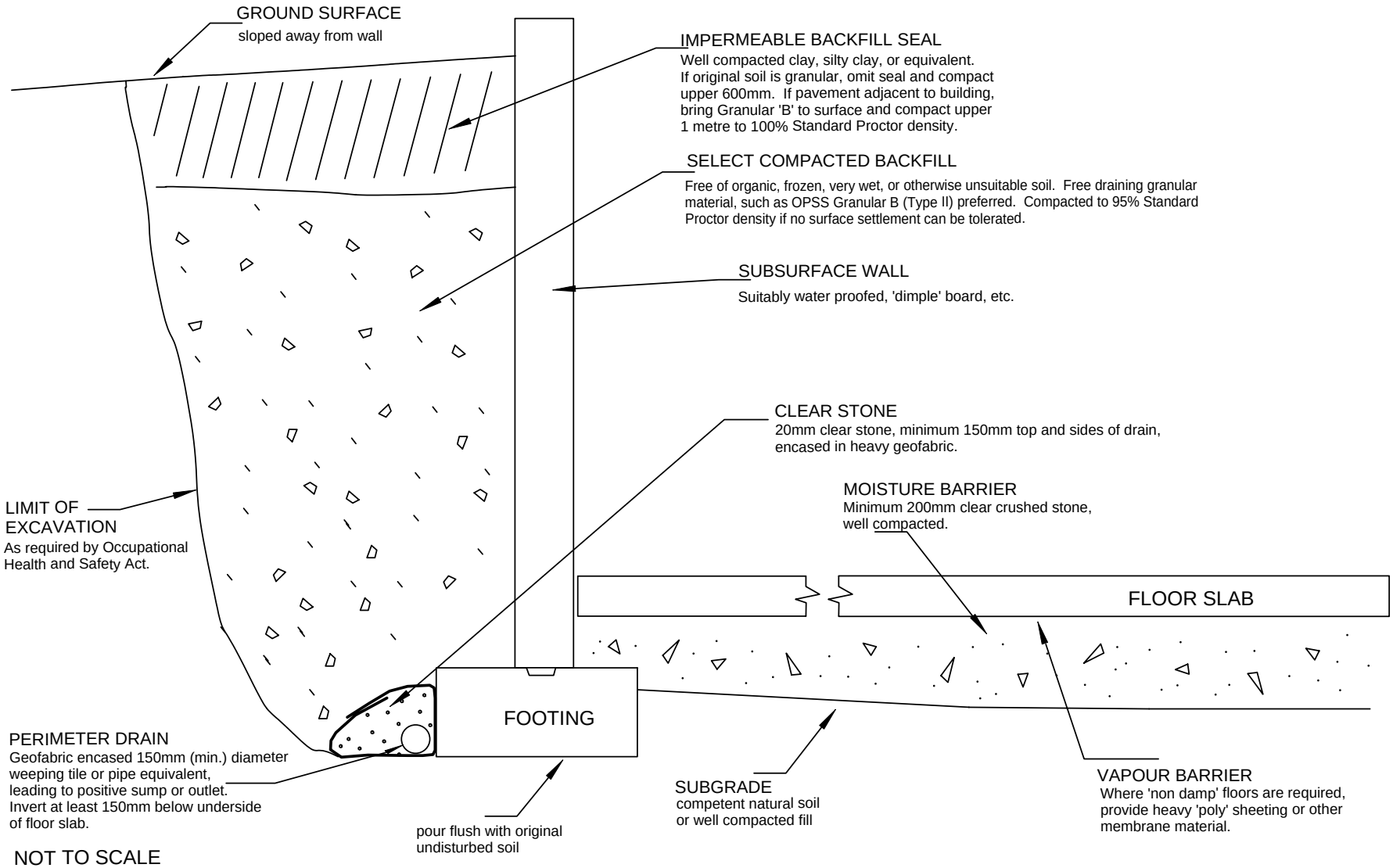
Hole Size: 150mm

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
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



NOT TO SCALE

Soil-Mat

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