S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Functional Servicing and Stormwater Management Report

747 & 761 BRANT STREET

(PHASE 3 OF 3)

PROPOSED MIX-USE BUILDING

CITY OF BURLINGTON

JUNE 2021

Revised November 2022

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3228 South Service Road, Suite 105, East Wing Burlington, Ontario L7N 3H8
Tel. (905) 631-6978 www.sla.on.ca

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1.0 INTRODUCTION AND BACKGROUND

1.1 OVERVIEW

S. Llewellyn & Associates Limited has been retained by Molinaro Group to provide consulting engineering services for the proposed development located at the NW, NE and SE corners of the intersection at Brant Street and Ghent Avenue in the City of Burlington. This report will outline the functional servicing strategy for Phase 3 of the proposed development (see Figure 1.0 for location plan).

The proposed Phase 3 development consists of constructing an 8-storey mix-use building, with a total of 120 residential units and 545m^2 of commercial area. The proposed site will also include 2 levels of underground parking, concrete curbing/sidewalk, asphalt drive aisle and landscaped areas.

This Functional Servicing Report will provide detailed information of the proposed servicing scheme for Phase 3 of this development. Please refer to the site engineering plans prepared by S. Llewellyn and Associates Limited and the site plan prepared by Graziani and Corazza Architects Inc. 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: Erosion & Sediment Control Guidelines for Urban Construction (December 2006)

Ref. 3: Low Impact Development Stormwater Management Planning and Design Guide (Toronto and Region Conservation Authority & Credit Valley Conservation, 2010)

Ref. 4: Water and Wastewater Linear Design Manual (Regional Municipality of Halton, October 2019)

Ref. 5: Hydrogeological Investigation (Landtek Limited, May 2022)

Ref. 6: Stormwater Management Design Guidelines (City of Burlington, May 5, 2021)



Figure 1.0 - Location Plan

2.0 HYDROGEOLOGICAL INVESTIGATION

A hydrogeological investigation was prepared by Landtek Limited dated May 17, 2022. Three (3) boreholes were drilled at the site between August 31 and September 2, 2020 to approximate depths ranging between 6.0 and 9.3m below grade. Asphalt and topsoil were encountered overlain fill at a thickness of 3.0m below grade. Native soils of clayey silt till were encountered within Borehole 9 at a thickness of 0.5m underlaying the fill soils. Shale bedrock was encountered in all three boreholes at depths ranging from 3.0 to 3.5m below grade.

Groundwater was encountered at depths between 1.00 and 3.15m below grade (elevations of 90.13 to 88.15m). Temporary construction dewatering will be required and the dewatering flow outside periods of active precipitation is approximately 6,044 l/day (0.07 l/s) to 70,016 l/day (0.81l/s) (FS 1.3) which is less than the 5-year allowable discharge rate of 26 l/s to Ghent Avenue (see Table 3.2 of this report). A permit to take water (PTTW) is required for this volume of water taking, as the estimated discharge rate is more than 50,000 l/day. Long-term dewatering will not be required for the site, as the developer has proposed to waterproof the below grade structure to prevent inflow of groundwater into the subsurface parking structures and foundation.

The groundwater quality was analysed and found that the levels of total suspended solids, total chromium, total copper, total manganese, total nickel and total zinc exceed the City of Burlington Municipal Storm Sewer Discharge Limits Guidelines. Based on these results, pre-treatment of the

groundwater will be required prior to discharging to the storm sewer system during temporary dewatering at the construction stage.

Groundwater levels are continued to being monitored to determine the seasonal high groundwater level and the report will be updated upon completion of the groundwater monitoring program. For additional information, refer to the Hydrogeological Investigation in Appendix D.

3.0 STORMWATER MANAGEMENT

The following stormwater management (SWM) criteria will be applied to the site, through pre-consultation comments (dated June 17, 2020) from the City of Burlington, Halton Region and Conservation Halton staff:

Quantity Control

The post-development stormwater discharge rates shall be controlled to the 5-year pre-development discharge rate from site for all storm events (2 to 100-year storm events). The overland flow route is to flow to Brant Street. Additionally, the maximum pre-development imperviousness of 36% is to be used the pre-development calculations, as per City of Burlington Standards.

Quality Control

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

Water Balance

It is recommended to retain/infiltrate the first 5mm on site.

Erosion Control

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

3.1 EXISTING CONDITIONS

In the existing conditions, the approximate 0.40ha site consists of a commercial and a residential building with associated parking lots and landscaped areas. The site is bound by Ghent Avenue to the northwest, Brant Street to the southwest, and existing residential lands to the northeast and southeast. A 1500mmø storm sewer exists on Brant Street flowing southeast and a 525mmø storm sewer exists on Ghent Avenue flowing southwest.

The topography of the existing site generally slopes from northwest to southeast with the majority of the site being collected an off-site rear lot catchbasin which ultimately outlets to the storm sewer on Brant Street. A portion of the site is collected by an on-site catchbasin which ultimately outlets to the storm sewer on Ghent Avenue. The remaining site area sheet drains to Brant Street and Ghent Avenue where it is collected by existing catchbasins within the right-of-way.

Four (4) catchment areas, Catchment 101, 102, 103 and 104 have been identified in the existing condition. See Table 3.1 and the Pre-Development Storm Drainage Area Plan in Appendix A for details.

Catchment 101 represents the existing conditions discharge from the subject site draining towards Brant Street where it is captured by street catchbasins and conveyed to the existing 1500mmø storm sewer on Brant Street.

Catchment 102 represents the existing conditions drainage from the subject site draining towards an existing catchbasin within the on-site parking lot and the roof area, which ultimately discharges the existing 525mmø storm sewer on Ghent Avenue.

Catchment 103 represents the existing conditions drainage from the subject site draining towards an existing rear lot catchbasin south-east of the site within the rear yard of 2024 Grovetree Lane, where the minor flows are conveyed to the existing 1500mmø storm sewer on Brant Street.

Catchment 104 represents the external drainage from the residential lands to the east of the site which drains towards an existing rear lot catchbasin south-east of the site, ultimately discharging to the existing 1500mmø storm sewer along Brant Street.

Table 3.1 – Existing Conditions Catchment Areas

Catchment ID	Description	Area (ha)	% Impervious	Runoff Coefficient (C)
101	Drainage from subject lands towards Brant Street	0.11	36	0.50
102	Drainage from subject lands towards Ghent Avenue	0.10	90	0.88
103	Drainage from subject lands towards off-site rear lot catchbasin	0.19	47	0.58
104	External drainage from residential lands towards off-site rear lot catchbasin	0.06	0	0.25

The post development flow rates shall be controlled to pre-development flow rates for the 2-year to 100-year storm events. However, the maximum pre-development imperviousness of 36% will be used for the pre-development calculations since the existing conditions site is greater than 36% impervious. The allowable discharge rates for the 2-year to 100-year storm events have been calculated using the SWMHYMO Hydrologic Modelling Program. A summary of the results can be found in Table 3.2.

Table 3.2 – Allowable Discharge from Site

Storm Event	Discharge to Brant Street (m^3/s)	Discharge to Ghent Avenue (m^3/s)	Discharge to Off-Site Catchbasin (m^3/s)
2-year	0.011	0.010	0.020
5-year	**0.016**	**0.015**	**0.030**
10-year	0.020	0.018	0.037
25-year	0.025	0.023	0.047
50-year	0.029	0.026	0.054
100-year	0.033	0.030	0.061

3.2 PROPOSED CONDITIONS

It is proposed to develop the site by constructing a 8-storey mix-use building containing a total of 120 residential units, 545m^2 of retail area and 2 levels of underground parking. The proposed site

will also include concrete curbing/sidewalk, asphalt parking lot and drive aisle, and landscaped areas. It is proposed to service the site with a private storm sewer system designed and constructed in accordance with the standards and specifications of the City of Burlington, directing all captured stormwater runoff to the 525mmø storm sewer located within Ghent Avenue. Allocating all stormwater runoff to this location will limit the number of quantity and quality control facilities to one location.

Four (4) catchment areas, Catchment 201, 202, 203 and 204, have been identified in the proposed condition. Refer to Table 3.3 and the Proposed Condition Drainage Area Plan in Appendix A for details.

Catchment 201 represents the drainage area for the portion of the site which will sheet drain uncontrolled to Brant Street, ultimately discharging to the existing 1500mmø storm sewer along Brant Street.

Catchment 202 represents the drainage area for the portion of the site which will be captured via on-site storm network and controlled by the proposed stormwater management tank which will ultimately discharge to the existing 525mmø storm sewer along Ghent Avenue.

Catchment 203 represents the drainage area for the portion of the site which will sheet drain uncontrolled to Ghent Avenue, ultimately discharging to the existing 525mmø storm sewer along Ghent Avenue.

Catchment 204 represents the external drainage from the residential lands to the east of the site which drains towards an existing rear lot catchbasin south-east of the site, ultimately discharging to the existing 1500mmø storm sewer along Brant Street.

Table 3.3 – Proposed Condition Catchment Areas

Catchment ID	Description	Area (ha)	% Impervious	Run-off Coefficient (C)
201	Uncontrolled site drainage to Brant Street	0.03	54	0.63
202	Controlled site drainage to Ghent Avenue	0.35	94	0.91
203	Uncontrolled site drainage to Ghent Avenue	0.01	60	0.67
204	Uncontrolled external drainage from residential lands towards off-site rear lot catchbasin	0.05	0	0.25

Water Quantity Control

It is proposed to apply quantity control measures to the runoff from Catchment 202 by means of an 100mmø orifice pipe installed between the SWM tank and MH3, to restrict discharge from the site to the allowable 5-year pre-development discharge rate.

With the installation of on-site quantity control measures for Catchment 202, it will be required to provide stormwater storage during storm events up to and including the 100-year event. To provide the required storage, a cast-in-place storage vault within the underground parking structure with approximately 273m^3 of storage will be provided.

The proposed storage vault will be designed with an upper and lower section. The upper section of the vault will drain via gravity through the orifice pipe to MH3. Once the upper vault storage

volume is full, stormwater will spill over the weir, filling up the lower section of the vault which will be equipped with a pump capable of pumping 10.8 l/s. Once the water level drops below the weir elevation, stormwater will be pumped from the lower level of the tank to the upper level where it will drain via gravity through the orifice pipe to MH3 until the lower level is empty. Additionally, the tank will have an emergency overflow outlet (AD1) above the tank which will sheet drain to the Brant Street right-of-way. The proposed pump will also be connected to the building emergency backup power.

Preliminary details of the proposed stormwater management tank can be found on the Preliminary Grading and Servicing Plans. The stage-storage-discharge characteristics can be seen in Table 3.4 and Appendix A for details.

Table 3.4 – Proposed Condition Stage-Storage-Discharge

Elevation (m)	Storage (m^3)	Discharge (m^3/s)	Comments
90.25	0	0.0000	Bottom of Upper Section and Invert of 100mmø Orifice Pipe
90.35	4	0.0062	0.1m ponding
90.45	8	0.0108	Top of Weir
84.40	8	0.0108	Bottom of Lower Section
85.40	49	0.0108	1.0m ponding
86.40	91	0.0108	2.0m ponding
87.40	131	0.0108	3.0m ponding
88.40	172	0.0108	4.0m ponding
90.25	248	0.0108	Top of Lower Section
90.45	248	0.0108	Top of Weir
91.05	273	0.0241	Top of Tank

An analysis was performed on the Proposed Condition site using the SWMHYMO hydrologic modeling program to determine the required volume of stormwater storage during the 2-year to 100-year City of Burlington design storms. A summary of the results can be found in Table 3.5 and the detailed SWMHYMO input/output information can be found in Appendix B.

Table 3.5 – Proposed Condition Stormwater Discharge and Storage Volumes to Ghent Avenue

Storm Event	202 (Controlled) (m^3/s)[1]	203 (Uncontrolled) (m^3/s)[1]	Total Discharge (m^3/s)[1]	Allowable Discharge (m^3/s)[2]	Required Storage (m^3)[1]	Storage Provided (m^3)[3]
2-Year	0.011	0.001	0.012	0.015	56.07	273
5-Year	0.011	0.002	0.013		78.84	
10-Year	0.011	0.002	0.013		95.70	
25-Year	0.011	0.003	0.014		118.30	
50-Year	0.011	0.003	0.014		135.60	
100-Year	0.011	0.004	0.015		153.10	

[1] Based on SWMHYMO Output. Refer to Appendix A for details.
[2] Refer to Table 3.2.

[3] Refer to Table 3.4.

Table 3.6 – Proposed Condition Stormwater Discharge to Brant Street and Ex. RLCB

Storm Event	201 (Uncontrolled) (m^3/s)[1]	Allowable Discharge (m^3/s)[2]	205 (Uncontrolled) (m^3/s)[1]	Allowable Discharge (m^3/s)[2]
2-Year	0.004	0.016	0.002	0.030
5-Year	0.006		0.003	
10-Year	0.007		0.004	
25-Year	0.008		0.005	
50-Year	0.009		0.006	
100-Year	0.010		0.007	

[1] Based on SWMHYMO Output. Refer to Appendix A for details.
[2] Refer to Table 3.2.
[3] Refer to Table 3.4.

This analysis determined the following:

- The proposed condition discharge rates will not exceed the allowable 5-year pre-development flow rates from the site.
- Catchment 202 will require 153.10m^3 of stormwater storage during the 100-year event, which can be accommodated within the proposed storage tank, having a volume of 273m^3.

Water Quality Control

The proposed development is required to achieve an "Enhanced" (80% TSS removal) level of water quality protection. To achieve this criterion, discharge from Catchment 202 will be subject to a treatment from a Hydro International Up-Flo Filter before ultimately discharging to the ultimately discharging to the existing 525mmø storm sewer within Ghent Avenue.

The Up-Flo Filter manufacturer has provided sizing information and determined the filter unit for Catchment 201 will require 5 filter modules and be housed in a 1.8m x 2.4m vault. See the Up-Flo filter sizing procedures in Appendix C for details. The Up-Flo Filter has been certified under the ETV for 82.1% removal efficiency. Based on the information provided to S.Llewellyn and Associates it is our opinion that the Up-Flo filters have been sized to be in conformance with the water quality targets for this site.

As part of a treatment train approach, area drains within the proposed asphalt parking lot will be fitted with ADS Flexstorm Pure permanent inlet filters. The installation of the inlet filters will contribute to the removal of TSS and the capture of floatable within the area drains. The units also provide scout protection and reduce resuspension of solids during heavy rain events which would otherwise enter the storm system.

Up-Flo filter units and Flexstorm inlet filters require regular inspection and maintenance as per the manufacturer's specifications to ensure the unit operates properly. See the Up-Flo filter and Flexstorm Operation and Maintenance Manuals in Appendix B for details.

Water Balance

The proposed development is recommended to retain or infiltrate the first 5mm of every rainfall on site. Due to the nature of the development having an underground parking garage which spans

the majority of the site, retaining and infiltrating any amount of water is not feasible. This has been discussed in preliminary conversations with City of Burlington staff and will be confirmed at the detailed design stage.

3.3 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 area drains as well as the nearby existing catchbasins to ensure that no untreated runoff enters the existing conveyance system; and
- 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.

For details on the proposed erosion and sediment control for the proposed site, see the Preliminary Grading & Erosion Control Plan included in the engineering drawings.

3.4 FLOOD SPILL CONTROL

The City of Burlington will be completing a Phase 2 study intended to confirm the extent of the flood hazard within the site area and further discuss policy and mitigation measures in this area. Once this study is complete and provided to S. Llewellyn and Associates Ltd., the site will be reviewed to ensure all requirements with respect to the spill hazards are met.

4.0 SANITARY SEWER SERVICING

4.1 EXSTING CONDITIONS

The site is located at 774-782 Brant Street with an existing 450mmø sanitary sewer on Brant Street flowing southeast and a 250mmø sanitary sewer on Ghent Avenue flowing southwest.

4.2 SANITARY DEMAND

The proposed development consists of a 8-storey mix-use building containing a total of 120 residential units and 545m^2 of retail floor area. Wastewater generation for the site was calculated based on the Ontario Building Code (OBC) and Tables 3-1 Residential Dry Weather Flow and 3-2 Commercial, Industrial, and Community Dry Weather Flow of the 2019 Regional Municipality of Halton Water and Wastewater Linear Design Manual.

Table 4.1 summarizes population and Table 4.2 summarizes the sanitary sewer discharge rates from the proposed site.

Table 4.1 – Proposed Population

Occupancy Type	No. of Beds [A]	Gross Floor Area (m^2)	Population Density [B]	Population
Residential	202	---	2 per/bed	404
Commercial	---	545	3.7m^2/per	148
			Total Population:	**552**

[A] Information from site plan prepared by Graziana & Corazza Architects Inc., dated October 11, 2022.
[B] Residential population density per OBC 3.1.17.1.1(b).

Table 4.2 – Proposed Sanitary Sewer Discharge

Site Area (ha)	Population [A]	Avg. Demand [B] (l/s)	Peak Factor [C]	Infiltration [D] (l/s)	Peak Flow [E] (l/s)
0.39	552	1.76	3.95	0.11	**7.06**

[A] From Table 3.1.
[B] Based on a unit sewage flow of 0.275m^3pcd (as per Table 3-1 of the Regional Municipality of Halton Water and Wastewater Linear Design Manual).
[C] Based on the modified Harmon Formula (as per section 3.2.3 of the Regional Municipality of Halton Water and Wastewater Linear Design Manual).
Peak Factor, $M = 1 + [14 / (4+P^{0.5})]$, where P is in thousands
[D] Based on an infiltration rate of 0.286 l/ha/s (as per Section 3.2.4 of the Regional Municipality of Halton Water and Wastewater Linear Design Manual).
[E] Peak Flow = (Avg. Demand x Peak Factor) + Infiltration

Based on the above, the estimate of sanitary demand for the townhouse development is:

7.06 L/s

4.3 PROPOSED SANITARY SERVICING AND CAPACITY ANALYSIS

The proposed mix-use building will be serviced by a 200mmø sanitary sewer, designed and constructed in accordance with the City of Burlington standards. Drainage from this sewer will discharge to the existing 250mmø sanitary sewer along Ghent Avenue.

The minimum grade of the proposed 200mmø sanitary sewer will be 1.0%. At this minimum grade, the proposed sanitary sewer will have a capacity of 0.033 m^3/s (33 l/s). Therefore, the proposed 200mmø sanitary sewer at 1.0% grade is adequately sized to service the proposed development.

5.0 DOMESTIC AND FIRE WATER SUPPLY SERVICING

5.1 EXISTING CONDITIONS

The existing municipal water distribution system consists of a 150mmø watermain located on Ghent Avenue and a 200mmø and 400mmø watermain located on Brant Street. An existing fire hydrant is located within the west boulevard of Ghent Avenue, in front of 761 Brant Street and within the south boulevard of Brant Street, in front of 747 Brant Street.

5.2 DOMESTIC WATER DEMAND

The following is an estimate of the water usage for the proposed building. Water usage for the site was calculated based on the “Fixture Unit Method” as per Table 7.6.3.2.A. forming part of sentences 7.6.3.1(1) to (3) and 7.6.3.4.(2), (3) and (5) of the 2012 Ontario Building Code. See Table 5.1 for fixture unit (FU) calculations.

Table 5.1 – Domestic Water Demand

Component	No. of Fixtures	FU/ Fixture	Total FU
Lavatory (8.3L/min or less per head) (Private)[1,3]	191	0.7	133.7
Shower Head (9.5L/min or less per head) (Private)[1]	190	1.4	266.0
Water Closet (6 LPF or less with flush tank) (Private)[1,3]	191	2.2	420.2
Sink (kitchen, domestic, 8.3 L/min or less) (public)[2,3]	121	4	484.0
Dishwasher (domestic)[2,3]	121	1.4	169.4
Clothes Washer (3.5 kg) (private)[2]	120	1.4	168.0
Mop Sink[4]	2	3	6
		Total FU:	**1,647.3**
		Water Usage (l/s):	**17.5**

[1] Each 1-bedroom unit was assumed to have one fill bathroom and each 2 and 3-bedroom unit was assumed to have two full bathrooms
[2] Each unit was assumed to have one kitchen with dishwasher and one washing machine
[3] The building was assumed to have one common room that includes a kitchen (with dishwasher) and a half bathroom
[3] The building was assumed to have one mop sink per parking level

Total peak water usage for the site was derived below from the fixture unit count as per Table 7.4.10.5 of the Ontario Building Code.

Total Fixture Unit Count = 1,647.3 FU

Water Usage: 231.0 IGPM (17.5 l/s)

5.3 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, 2020), the Ontario Building Code (OBC), and various codes and standards published by the National Fire Protection Association (NFPA). Since FUS criteria provides adjustments for sprinklered buildings (OBC does not), the FUS method was used to determine the fire flow demand for the proposed development.

The proposed development consists of constructing a 8-storey mix-use building containing a total of 120 residential units and 2 levels of underground parking. Existing hydrants are located at 2047 Ghent Avenue and at 760 Brant Street. Both hydrants are within the required 90m separation to the building face (as per Sentence 3.2.5.7 of the Ontario Building Code).

Proposed building is fire-resistive construction (C=0.6), with limited combustible occupancy (-15% correction) and a fully supervised sprinkler system (-50% correction). Exposure components are based on the following:

North Face: 20.1 to 30m (10% correction)
South Face: 3.1 to 10m (20% correction)
East Face: 20.1 to 30m (10% correction)
West Face: >30m (0% correction)

It is estimated that the required fire flow for the proposed development will be **167 l/s**. See the Fire Flow Demand Requirements in Appendix C for details.

Hydrant flow tests were performed by Jackson Waterworks on the two municipal hydrants closest to the site to determine the performance of the existing water distribution system. The following hydrant flow test data has been analyzed to determine if the municipal system adjacent to the site is adequate to provide the required fire flow, with a minimum pressure of 20 psi. Table 5.2 summarizes the hydrant flow data provided by Jackson Waterworks.

Table 5.2 – Hydrant Flow Test Data

Hydrant ID	H9419
Location	2047 Ghent Avenue
Static Pressure	60 psi
Residual Pressure During Test Flow	55 psi
Test Flow Rate	1,776 USGPM (112 l/s)
Theoretical Flow @ 20 psi	**5,737 USGPM (362 l/s)**
Hydrant ID	H20649
Location	760 Brant Street
Static Pressure	60 psi
Residual Pressure During Test Flow	55 psi
Test Flow Rate	1,986 USGPM (125 l/s)
Theoretical Flow @ 20 psi	**5,982 USGPM (377 l/s)**

Based on the above hydrant flow test data, the theoretical maximum available flow rate from the hydrant is **362 l/s**, while the maximum required fire flow for the proposed development is only **167l/s**. Therefore, the water distribution system has adequate pressure and capacity to service the subject site.

5.4 PROPOSED WATER SERVICING AND ANALYSIS

Proposed water servicing for the site consists of connecting a 150mmø water service off of the existing 150mmø watermain adjacent to the site on Ghent Avenue. The proposed 150mmø water service will provide domestic and fire water service for the proposed. Water services for the site are to be designed and constructed in accordance with City of Burlington standards.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information provided herein, it is concluded that the proposed development at 741 & 746 Brant Street can be constructed to meet the requirements of the City of Burlington and Region of Halton. Therefore, it is recommended that:

- The development be graded and serviced in accordance with the Preliminary Grading, Servicing & Erosion Control Plan prepared by S. Llewellyn & Associates Limited;
- A 100mmø orifice pipe be installed as per the Preliminary Grading, Servicing & Erosion Control Plan and this report to provide adequate quantity control;
- A two level underground storage vault, complete with pump system for lower level dewatering, be installed within the underground parking garage as per the Preliminary Grading, Servicing & Erosion Control Plan and this report to provide effective stormwater storage during storm events;

- Erosion and sediment controls be installed as described in this report to meet City of Burlington requirements;
- Up-Flow Filter unit be installed to provide Enhanced (80% TSS Removal) quality control for the subject site;
- Short-term dewatering be addressed at a discharge rate of 0.07 l/s to 0.81l/s and be filtered prior to discharging to the existing storm sewer system as per this report; and
- The proposed sanitary and water servicing system be installed as per the Preliminary Grading, Servicing & Erosion Control Plan and this report to adequately service the proposed development.

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

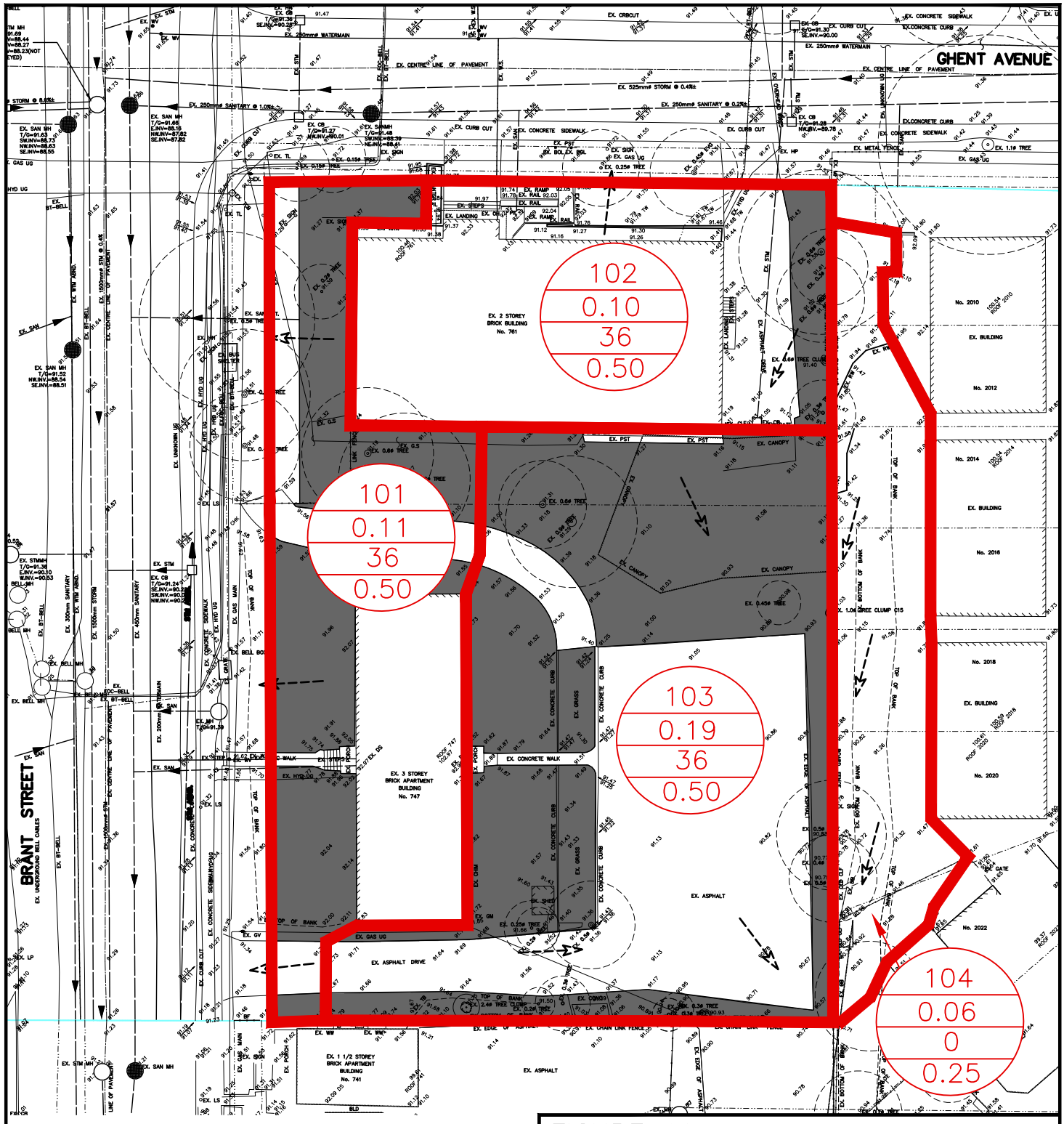


B. Henderson, Dipl.T.

S. Frankovich, P.Eng.

APPENDIX A

STORMWATER MANAGEMENT INFORMATION



LEGEND:

- CATCHMENT AREA BOUNDARY
- PERVIOUS AREA
- 101 / 0.018 / 100 / 0.90 — DRAINAGE AREA ID / DRAINAGE AREA (ha) / PERCENT IMPERVIOUS / RUNOFF COEFFICIENT
- EXISTING DIRECTION OF DRAINAGE

FIGURE A1
PRE-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:500

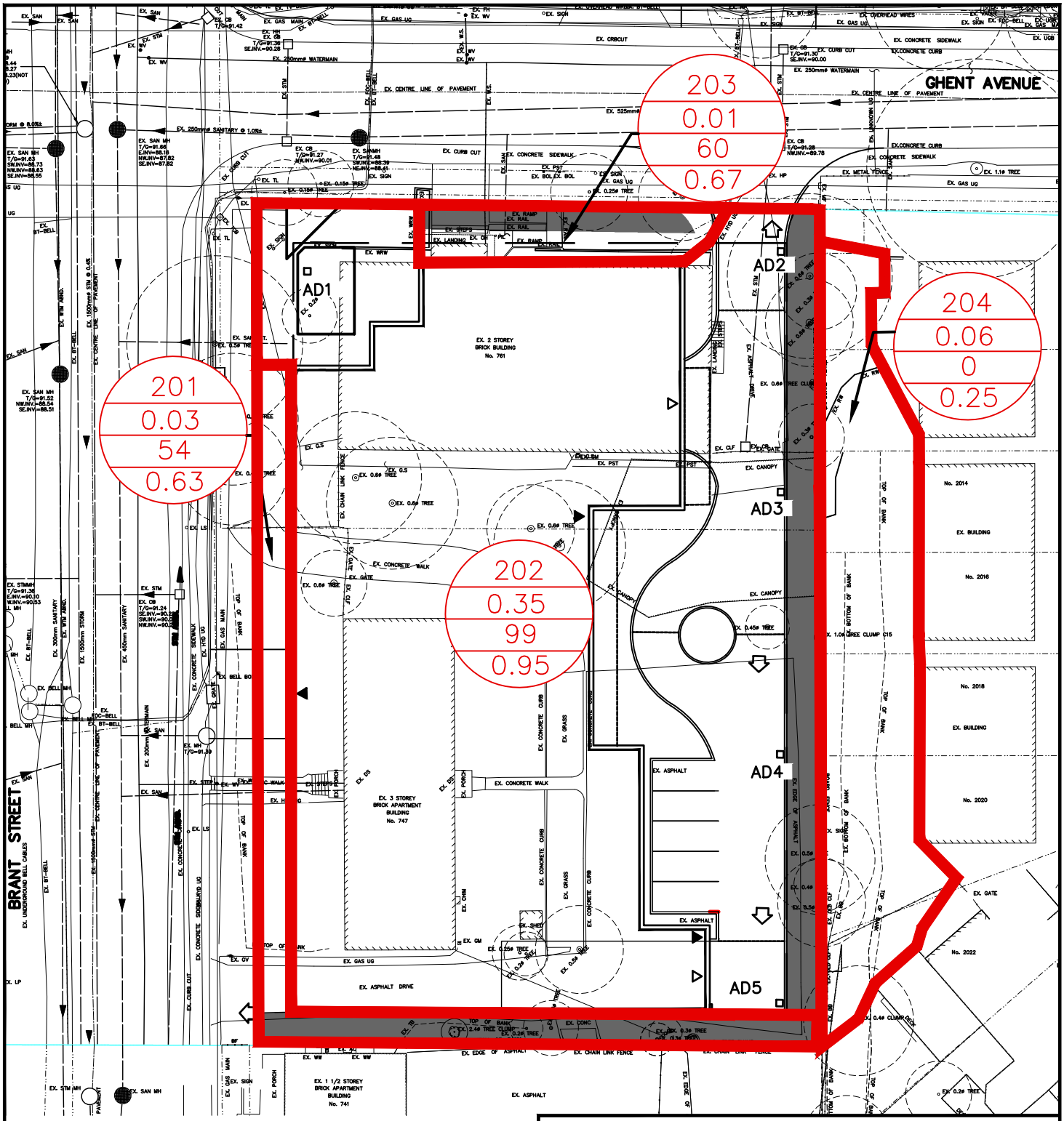
PROJECT: 747&761 BRANT STREET, BURLINGTON
PROJECT No.: 20062

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Tel. (905) 631-6978
Website: www.sla.on.ca
email: info@sla.on.ca

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

S:\20062\WORKING\CURRENT\20062 - DAPs.dwg
11/11/2022 2:00:46 PM - Blair Henderson



LEGEND:

- CATCHMENT AREA BOUNDARY
- PERVIOUS AREA
- 101 / 0.04 / 25 / 0.41 — DRAINAGE AREA ID / DRAINAGE AREA (ha) / PERCENT IMPERVIOUS / RUNOFF COEFFICIENT
- PROPOSED OVERLAND FLOW ROUTE

FIGURE A2
POST-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:500

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

S:\20062\WORKING\CURRENT\20062 - DAPs.dwg
11/11/2022 2:15:30 PM - Blair Henderson

747 761 Brant Street
City of Burlington

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)	90.25
C/L Elev. (m)	90.30
Disch. Coeff. (C_d)	0.8
Discharge (Q) =	See Orifice Report
Number of Orifices:	1

		SWM Tank Volumes					Outlet No. 1	
	Elevation m	Area m^2	Tank Incremental Volume	Cumulative Tank Volume m^3	Cumulative Pipe/Structure Storage Vol. m^3	Active Storage Volume m^3	H m	Discharge m^3/s
Orifice Invert	90.25	0	0	0	0	0.0	0.000	0.0000
Bottom of Upper Section	90.25	41.0	0	0	0	0.0	0.000	0.0000
	90.35	41.0	4	4	0	4.1	0.050	0.0062
Top of Weir	90.45	41.0	4	8	0	8.2	0.150	0.0108
Bottom of Tank	84.40	41.0	0	8	0	8.2	0.000	0.0108
	85.40	41.0	41	49	0	49.2	0.000	0.0108
	86.40	42.0	42	91	1	92.2	1.000	0.0108
	87.40	41.0	82	131	0	131.2	0.000	0.0108
	88.40	41.0	41	172	0	172.2	0.000	0.0108
Top of Lower Section	90.25	41.0	76	248	0	248.1	0.000	0.0108
Top of Weir	90.45	41.0	0	248	0	248.1	0.150	0.0108
Top of Tank	91.05	41.0	25	273	0	272.7	0.750	0.0241

```
2     Metric units
*#**************************************************************************|
*#  Project Name: 774-782 BRANT STREET
*#               BURLINGTON, ONTARIO
*#  JOB NUMBER  : 20062
*#       Date   : MAY 2021
*#    Revised   :
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 20062C.DAT
*#**************************************************************************|
*
START                TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[002]
                     BUR6_002.stm
*
READ STORM           STORM_FILENAME "STORM.001"
*
*#**************************************************************************|
*#
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
*#        ========================================================
*#
*#**************************************************************************|
*# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
*
CALIB STANDHYD       ID=[1], NHYD=["101"], DT=[1](min), AREA=[0.11](ha),
                     XIMP=[0.36], TIMP=[0.36], DWF=[0](cms), LOSS=[2],
                     SCS curve number CN=[80],
                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.5](%),
                                          LGP=[10](m), MNP=[0.250], SCP=[0](min),
                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
                                          LGI=[20](m), MNI=[0.013], SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------|
*# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
*
CALIB STANDHYD       ID=[2], NHYD=["102"], DT=[1](min), AREA=[0.10](ha),
                     XIMP=[0.36], TIMP=[0.36], DWF=[0](cms), LOSS=[2],
                     SCS curve number CN=[80],
                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.5](%),
                                          LGP=[10](m), MNP=[0.250], SCP=[0](min),
                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
                                          LGI=[20](m), MNI=[0.013], SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------|
*# CATCHMENT 103 -  EXISTING DRAINAGE TO EX. REAR LOT CB
*
CALIB STANDHYD       ID=[3], NHYD=["103"], DT=[1](min), AREA=[0.19](ha),
                     XIMP=[0.36], TIMP=[0.36], DWF=[0](cms), LOSS=[2],
                     SCS curve number CN=[80],
                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.5](%),
                                          LGP=[10](m), MNP=[0.250], SCP=[0](min),
                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
                                          LGI=[20](m), MNI=[0.013], SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------|
*# CATCHMENT 104 - EXTERNAL DRAINAGE TO EX. REAR LOT CB
*
CALIB NASHYD         ID=[4], NHYD=["104"], DT=[1]min, AREA=[0.06](ha),
                     DWF=[0](cms),  CN/C=[80], IA=[6.35](mm),
                     N=[3], TP=[0.18]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-------------------------------------------------------|
*# TOTAL EX. REAR LOT CB
ADD HYD              IDsum=[5], NHYD=["EX.CB"], IDs to add=[4,3]
*%-----------------|-------------------------------------------------------|
*# TOTAL EX. FROM SITE
ADD HYD              IDsum=[10], NHYD=["EX.P3"], IDs to add=[1,2,3,4]
*%-----------------|-------------------------------------------------------|
*#**************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
*#        =========================================================
*#
**#**************************************************************************|
*# CATCHMENT 202 - CONTROLLED DISCHARGE TO GHENT AVENUE
*
CALIB STANDHYD       ID=[1], NHYD=["202"], DT=[1](min), AREA=[0.35](ha),
                     XIMP=[0.95], TIMP=[0.95], DWF=[0](cms), LOSS=[2],
                     SCS curve number CN=[80],
                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.0](%),
                                          LGP=[10](m), MNP=[0.250], SCP=[0](min),
                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
                                          LGI=[20](m), MNI=[0.013], SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------|
*# ROUTE CATCHMENT 202 THROUGH ORIFICE PIPE
*
ROUTE RESERVOIR      IDout=[2],  NHYD=["202_CTL"],  IDin=[1],
                     RDT=[1](min),
                          TABLE of ( OUTFLOW-STORAGE ) values
                                    (cms) - (ha-m)
  0.0000     0.0000
  0.0062     0.0004
  0.0108     0.0008
  0.0108     0.0008
  0.0108     0.0049
  0.0108     0.0092
  0.0108     0.0131
  0.0108     0.0172
  0.0108     0.0248
  0.0108     0.0248
  0.0241     0.0273

                                   -1  ,  -1    (max twenty pts)
                          IDovf=[3], NHYDovf=["202_OVF"]
*%-----------------|-------------------------------------------------------|
*# CATCHMENT 201 - UNCONTROLLED DISCHARGE TO BRANT STREET
*
CALIB STANDHYD       ID=[4], NHYD=["201"], DT=[1](min), AREA=[0.03](ha),
                     XIMP=[0.54], TIMP=[0.54], DWF=[0](cms), LOSS=[2],
                     SCS curve number CN=[80],
                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.0](%),
                                          LGP=[10](m), MNP=[0.250], SCP=[0](min),
                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
                                          LGI=[20](m), MNI=[0.013], SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------|
*# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
*
CALIB STANDHYD       ID=[5], NHYD=["203"], DT=[1](min), AREA=[0.01](ha),
                     XIMP=[0.60], TIMP=[0.60], DWF=[0](cms), LOSS=[2],
                     SCS curve number CN=[80],
                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.0](%),
                                          LGP=[5](m), MNP=[0.250], SCP=[0](min),
                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
                                          LGI=[10](m), MNI=[0.013], SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------|
*# CATCHMENT 204 - UNCONTROLLED EXTERNAL DRAINAGE TO EX. REAR LOT CB
*
CALIB NASHYD         ID=[6], NHYD=["204"], DT=[1]min, AREA=[0.05](ha),
                     DWF=[0](cms),  CN/C=[80], IA=[6.35](mm),
                     N=[3], TP=[0.18]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-------------------------------------------------------|
*# ADD TOTAL FLOWS TO GHENT
ADD HYD              IDsum=[7], NHYD=["GHENT"], IDs to add=[2,3,5]
*%-----------------|-------------------------------------------------------|
*# ADD TOTAL FLOWS FROM SITE
ADD HYD              IDsum=[8], NHYD=["TOTAL.P3"], IDs to add=[4,7]
*%-----------------|-------------------------------------------------------|
*# AREA CHECK
ADD HYD              IDsum=[9], NHYD=["CHECK"], IDs to add=[10,8]
*%-----------------|-------------------------------------------------------|
**#**************************************************************************|
* RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
*
START                TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[005]
                     BUR6_005.stm
*
START                TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[010]
                     BUR6_010.stm
*
START                TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[025]
                     BUR6_025.stm
*
START                TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[050]
                     BUR6_050.stm
*
START                TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[100]
                     BUR6_100.stm
*%-----------------|-------------------------------------------------------|
FINISH
```

```
00001> ================================================================================
00002>
00003>   SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999    =========
00004>   S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
00005>   SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9   Ver  4.05
00006>       S  W W W  M   M  H   H    Y    M   M  O   O       9999   9999   Sept 2011
00007>   SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9    =========
00008>                                                          9   9  9   9   # 3902680
00009>         StormWater Management HYdrologic Model            999    999    =========
00010>
00011>  ********************************************************************************
00012>  ************************** SWMHYMO Ver/4.05  ***************************
00013>  *********  A single event and continuous hydrologic simulation model  *********
00014>  *********     based on the principles of HYMO and its successors      *********
00015>  *********                  OTTHYMO-83 and OTTHYMO-89.                  *********
00016>  ********************************************************************************
00017>  ******** Distributed by:  J.F. Sabourin and Associates Inc.           *********
00018>  *********                  Ottawa,  Ontario: (613) 836-3884           *********
00019>  *********                  Gatineau, Quebec: (819) 243-6858           *********
00020>  *********                  E-Mail: swmhymo@jfsa.Com                   *********
00021>  ********************************************************************************
00022>
00023>  ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
00024>  +++++++++ Licensed user: S. Llewellyn & Associates Ltd                +++++++++
00025>  +++++++++                  Burlington          SERIAL#:3902680       +++++++++
00026>  ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
00027>
00028>  ********************************************************************************
00029>  *********           ++++++ PROGRAM ARRAY DIMENSIONS ++++++             *********
00030>  *********           Maximum value for ID numbers  :     10            *********
00031>  *********           Max. number of rainfall points: 105408            *********
00032>  *********           Max. number of flow points    : 105408            *********
00033>  ********************************************************************************
00034>
00035>
00036>  **********************   D E T A I L E D   O U T P U T   **********************
00037>  ********************************************************************************
00038>  *         DATE: 2022-11-11     TIME: 14:11:40     RUN COUNTER: 000237         *
00039>  ********************************************************************************
00040>  * Input   filename: T:\PROJECTS\20062\SWMHYMO\20062C.dat                       *
00041>  * Output  filename: T:\PROJECTS\20062\SWMHYMO\20062C.out                       *
00042>  * Summary filename: T:\PROJECTS\20062\SWMHYMO\20062C.sum                       *
00043>  * User comments:                                                              *
00044>  * 1:_____________________________________________________________________________*
00045>  * 2:_____________________________________________________________________________*
00046>  * 3:_____________________________________________________________________________*
00047>  ********************************************************************************
00048>
00049> --------------------------------------------------------------------------------
00050> 001:0001--------------------------------------------------------------------------
00051> *#*****************************************************************************|
00052> *#  Project Name: 774-782 BRANT STREET
00053> *#               BURLINGTON, ONTARIO
00054> *#  JOB NUMBER  : 20062
00055> *#       Date   : MAY 2021
00056> *#    Revised   :
00057> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00058> *#       File   : 20062C.DAT
00059> *#*****************************************************************************|
00060> *
00061>   ** END OF RUN :   1
00062>
00063> ********************************************************************************
00064>
00065>
00066>
00067>
00068>
00069> --------------------
00070> | START            |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
00071> --------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
00072>     TZERO =   .00 hrs on       0
00073>     METOUT=   2 (output = METRIC)
00074>     NRUN  = 002
00075>     NSTORM=   1
00076>           #  1=BUR6_002.stm
00077> --------------------------------------------------------------------------------
00078> 002:0002--------------------------------------------------------------------------
00079> *#*****************************************************************************|
00080> *#  Project Name: 774-782 BRANT STREET
00081> *#               BURLINGTON, ONTARIO
00082> *#  JOB NUMBER  : 20062
00083> *#       Date   : MAY 2021
00084> *#    Revised   :
00085> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00086> *#       File   : 20062C.DAT
00087> *#*****************************************************************************|
00088> *
00089> --------------------------------------------------------------------------------
00090> 002:0002--------------------------------------------------------------------------
00091> *
00092> --------------------
00093> | READ STORM       |    Filename: Burlington 2-yr 6hr CHICAGO  (A=681.52,
00094> | Ptotal=  40.93 mm|    Comments: Burlington 2-yr 6hr CHICAGO  (A=681.52,
00095> --------------------
00096>                TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00097>                 hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
00098>                 .17   1.715 |   1.67   8.325 |   3.17   4.467 |   4.67   2.213
00099>                 .33   1.858 |   1.83  19.646 |   3.33   3.978 |   4.83   2.105
00100>                 .50   2.032 |   2.00  78.391 |   3.50   3.595 |   5.00   2.008
00101>                 .67   2.247 |   2.17  25.776 |   3.67   3.286 |   5.17   1.920
00102>                 .83   2.522 |   2.33  13.777 |   3.83   3.030 |   5.33   1.841
00103>                1.00   2.888 |   2.50   9.511 |   4.00   2.815 |   5.50   1.769
00104>                1.17   3.399 |   2.67   7.331 |   4.17   2.632 |   5.67   1.703
00105>                1.33   4.172 |   2.83   6.005 |   4.33   2.474 |   5.83   1.642
00106>                1.50   5.492 |   3.00   5.111 |   4.50   2.335 |   6.00   1.586
00107>
00108> --------------------------------------------------------------------------------
00109> 002:0003--------------------------------------------------------------------------
00110> *
00111> *#*****************************************************************************|
00112> *#
00113> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
00114> *#        ============================================================
00115> *#
00116> *#*****************************************************************************|
00117> *# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
00118> *
00119> ----------------------
00120> | CALIB STANDHYD     |   Area    (ha)=     .11
00121> | 01:101    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
00122> ----------------------
00123>                                IMPERVIOUS    PERVIOUS (i)
00124>      Surface Area     (ha)=        .04          .07
00125>      Dep. Storage     (mm)=       1.00         6.35
00126>      Average Slope     (%)=       2.00         2.50
00127>      Length            (m)=      20.00        10.00
00128>      Mannings n            =       .013         .250
00129>
00130>      Max.eff.Inten.(mm/hr)=      78.39        22.56
00131>                 over (min)        1.00         6.00
00132>      Storage Coeff.  (min)=         .87 (ii)    6.08 (ii)
00133>      Unit Hyd. Tpeak (min)=        1.00         6.00
00134>      Unit Hyd. peak  (cms)=        1.16          .19
00135>                                                          *TOTALS*
00136>      PEAK FLOW       (cms)=         .01          .00          .011 (iii)
00137>      TIME TO PEAK    (hrs)=        2.00         2.07         2.000
00138>      RUNOFF VOLUME    (mm)=       39.93        12.19        22.179
00139>      TOTAL RAINFALL   (mm)=       40.93        40.93        40.933
00140>      RUNOFF COEFFICIENT   =         .98          .30          .542
00141>
00142>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00143>            CN* =  80.0    Ia = Dep. Storage  (Above)
00144>         (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00145>              THAN THE STORAGE COEFFICIENT.
00146>        (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00147>
00148> --------------------------------------------------------------------------------
00149> 002:0004--------------------------------------------------------------------------
00150> *# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
00151> *
00152> ----------------------
00153> | CALIB STANDHYD     |   Area    (ha)=     .10
00154> | 02:102    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
00155> ----------------------
00156>                                IMPERVIOUS    PERVIOUS (i)
00157>      Surface Area     (ha)=        .04          .06
00158>      Dep. Storage     (mm)=       1.00         6.35
00159>      Average Slope     (%)=       2.00         2.50
00160>      Length            (m)=      20.00        10.00
00161>      Mannings n            =       .013         .250
00162>
00163>      Max.eff.Inten.(mm/hr)=      78.39        22.56
00164>                 over (min)        1.00         6.00
00165>      Storage Coeff.  (min)=         .87 (ii)    6.08 (ii)
00166>      Unit Hyd. Tpeak (min)=        1.00         6.00
00167>      Unit Hyd. peak  (cms)=        1.16          .19
00168>                                                          *TOTALS*
00169>      PEAK FLOW       (cms)=         .01          .00          .010 (iii)
00170>      TIME TO PEAK    (hrs)=        2.00         2.07         2.000
00171>      RUNOFF VOLUME    (mm)=       39.93        12.19        22.179
00172>      TOTAL RAINFALL   (mm)=       40.93        40.93        40.933
00173>      RUNOFF COEFFICIENT   =         .98          .30          .542
00174>
00175>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00176>            CN* =  80.0    Ia = Dep. Storage  (Above)
00177>         (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00178>              THAN THE STORAGE COEFFICIENT.
00179>        (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00180>
00181> --------------------------------------------------------------------------------
00182> 002:0005--------------------------------------------------------------------------
00183> *# CATCHMENT 103 -  EXISTING DRAINAGE TO EX. REAR LOT CB
00184> *
00185> ----------------------
00186> | CALIB STANDHYD     |   Area    (ha)=     .19
00187> | 03:103    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
00188> ----------------------
00189>                                IMPERVIOUS    PERVIOUS (i)
00190>      Surface Area     (ha)=        .07          .12
00191>      Dep. Storage     (mm)=       1.00         6.35
00192>      Average Slope     (%)=       2.00         2.50
00193>      Length            (m)=      20.00        10.00
00194>      Mannings n            =       .013         .250
00195>
00196>      Max.eff.Inten.(mm/hr)=      78.39        22.56
00197>                 over (min)        1.00         6.00
00198>      Storage Coeff.  (min)=         .87 (ii)    6.08 (ii)
00199>      Unit Hyd. Tpeak (min)=        1.00         6.00
00200>      Unit Hyd. peak  (cms)=        1.16          .19
00201>                                                          *TOTALS*
00202>      PEAK FLOW       (cms)=         .01          .01          .019 (iii)
00203>      TIME TO PEAK    (hrs)=        2.00         2.07         2.000
00204>      RUNOFF VOLUME    (mm)=       39.93        12.19        22.179
00205>      TOTAL RAINFALL   (mm)=       40.93        40.93        40.933
00206>      RUNOFF COEFFICIENT   =         .98          .30          .542
00207>
00208>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00209>            CN* =  80.0    Ia = Dep. Storage  (Above)
00210>         (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00211>              THAN THE STORAGE COEFFICIENT.
00212>        (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00213>
00214> --------------------------------------------------------------------------------
00215> 002:0006--------------------------------------------------------------------------
00216> *# CATCHMENT 104 - EXTERNAL DRAINAGE TO EX. REAR LOT CB
00217> *
00218> ----------------------
00219> | CALIB NASHYD       |   Area    (ha)=     .06   Curve Number   (CN)=80.00
00220> | 04:104    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
00221> ----------------------   U.H. Tp(hrs)=    .180
00222>
00223>      Unit Hyd Qpeak  (cms)=     .013
00224>
00225>      PEAK FLOW       (cms)=     .002 (i)
00226>      TIME TO PEAK    (hrs)=    2.200
00227>      RUNOFF VOLUME    (mm)=   12.187
00228>      TOTAL RAINFALL   (mm)=   40.933
00229>      RUNOFF COEFFICIENT   =     .298
00230>
00231>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00232>
00233> --------------------------------------------------------------------------------
00234> 002:0007--------------------------------------------------------------------------
00235> *# TOTAL EX. REAR LOT CB
00236> ------------------------
00237> | ADD HYD (EX.CB     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00238> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00239>                        ID1 04:104          .06      .002    2.20  12.19     .000
00240>                       +ID2 03:103          .19      .019    2.00  22.18     .000
00241>                        ========================================================
00242>                        SUM 05:EX.CB         .25      .020    2.00  19.78     .000
00243>
00244>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00245>
00246> --------------------------------------------------------------------------------
00247> 002:0008--------------------------------------------------------------------------
00248> *# TOTAL EX. FROM SITE
00249> ------------------------
00250> | ADD HYD (EX.P3     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00251> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00252>                        ID1 01:101          .11      .011    2.00  22.18     .000
00253>                       +ID2 02:102          .10      .010    2.00  22.18     .000
00254>                       +ID3 03:103          .19      .019    2.00  22.18     .000
00255>                       +ID4 04:104          .06      .002    2.20  12.19     .000
00256>                        ========================================================
00257>                        SUM 10:EX.P3         .46      .041    2.00  20.88     .000
00258>
00259>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00260>
00261> --------------------------------------------------------------------------------
00262> 002:0009--------------------------------------------------------------------------
00263> *#*****************************************************************************|
00264> *#
00265> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
00266> *#        ============================================================
00267> *#
00268> **#*****************************************************************************|
00269> *# CATCHMENT 202 - CONTROLLED DISCHARGE TO GHENT AVENUE
00270> *
```

```
00271> ----------------------
00272> | CALIB STANDHYD     |   Area    (ha)=     .35
00273> | 01:202    DT= 1.00 |   Total Imp(%)=   95.00   Dir. Conn.(%)=   95.00
00274> ----------------------
00275>                              IMPERVIOUS    PERVIOUS (i)
00276>      Surface Area     (ha)=        .33          .02
00277>      Dep. Storage     (mm)=       1.00         6.35
00278>      Average Slope     (%)=       2.00         2.00
00279>      Length            (m)=      20.00        10.00
00280>      Mannings n             =       .013         .250
00281>
00282>      Max.eff.Inten.(mm/hr)=      78.39        22.56
00283>                 over (min)        1.00         6.00
00284>      Storage Coeff.  (min)=        .87 (ii)    6.44 (ii)
00285>      Unit Hyd. Tpeak (min)=       1.00         6.00
00286>      Unit Hyd. peak  (cms)=       1.16          .18
00287>                                                          *TOTALS*
00288>      PEAK FLOW       (cms)=        .07          .00          .073 (iii)
00289>      TIME TO PEAK    (hrs)=       2.00         2.07         2.000
00290>      RUNOFF VOLUME    (mm)=      39.93        12.19        38.546
00291>      TOTAL RAINFALL   (mm)=      40.93        40.93        40.933
00292>      RUNOFF COEFFICIENT   =        .98          .30          .942
00293>
00294>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00295>            CN* =  80.0    Ia = Dep. Storage  (Above)
00296>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00297>            THAN THE STORAGE COEFFICIENT.
00298>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00299>
00300> ------------------------------------------------------------------------------
00301> 002:0010----------------------------------------------------------------------
00302> *# ROUTE CATCHMENT 202 THROUGH ORIFICE PIPE
00303> *
00304> ----------------------
00305> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
00306> |  IN>01:(202   )    |
00307> | OUT<02:(202_CT)    |    =========  OUTLFOW STORAGE TABLE  =========
00308> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
00309>                             (cms)     (ha.m.)   |    (cms)    (ha.m.)
00310>                              .000  .0000E+00    |     .011  .1310E-01
00311>                              .006  .4000E-03    |     .011  .1720E-01
00312>                              .011  .8000E-03    |     .011  .2480E-01
00313>                              .011  .8000E-03    |     .011  .2480E-01
00314>                              .011  .4900E-02    |     .024  .2730E-01
00315>                              .011  .9200E-02    |     .000  .0000E+00
00316>
00317>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
00318>      --------------------       (ha)     (cms)     (hrs)       (mm)
00319>      INFLOW >01: (202   )        .35      .073     2.000      38.546
00320>      OUTFLOW<02: (202_CT)        .35      .011     1.800      38.546
00321>     OVERFLOW<03: (202_OV)        .00      .000      .000       .000
00322>
00323>                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
00324>                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
00325>                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
00326>
00327>
00328>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   14.802
00329>                    TIME SHIFT OF PEAK FLOW       (min)=   -12.00
00330>                    MAXIMUM  STORAGE   USED       (ha.m.)=.5607E-02
00331>
00332> ------------------------------------------------------------------------------
00333> 002:0011----------------------------------------------------------------------
00334> *# CATCHMENT 201 - UNCONTROLLED DISCHARGE TO BRANT STREET
00335> *
00336> ----------------------
00337> | CALIB STANDHYD     |   Area    (ha)=     .03
00338> | 04:201    DT= 1.00 |   Total Imp(%)=   54.00   Dir. Conn.(%)=   54.00
00339> ----------------------
00340>                              IMPERVIOUS    PERVIOUS (i)
00341>      Surface Area     (ha)=        .02          .01
00342>      Dep. Storage     (mm)=       1.00         6.35
00343>      Average Slope     (%)=       2.00         2.00
00344>      Length            (m)=      20.00        10.00
00345>      Mannings n             =       .013         .250
00346>
00347>      Max.eff.Inten.(mm/hr)=      78.39        22.56
00348>                 over (min)        1.00         6.00
00349>      Storage Coeff.  (min)=        .87 (ii)    6.44 (ii)
00350>      Unit Hyd. Tpeak (min)=       1.00         6.00
00351>      Unit Hyd. peak  (cms)=       1.16          .18
00352>                                                          *TOTALS*
00353>      PEAK FLOW       (cms)=        .00          .00          .004 (iii)
00354>      TIME TO PEAK    (hrs)=       1.98         2.07         2.000
00355>      RUNOFF VOLUME    (mm)=      39.93        12.19        27.172
00356>      TOTAL RAINFALL   (mm)=      40.93        40.93        40.933
00357>      RUNOFF COEFFICIENT   =        .98          .30          .664
00358>
00359>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00360>            CN* =  80.0    Ia = Dep. Storage  (Above)
00361>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00362>            THAN THE STORAGE COEFFICIENT.
00363>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00364>
00365> ------------------------------------------------------------------------------
00366> 002:0012----------------------------------------------------------------------
00367> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
00368> *
00369> ----------------------
00370> | CALIB STANDHYD     |   Area    (ha)=     .01
00371> | 05:203    DT= 1.00 |   Total Imp(%)=   60.00   Dir. Conn.(%)=   60.00
00372> ----------------------
00373>                              IMPERVIOUS    PERVIOUS (i)
00374>      Surface Area     (ha)=        .01          .00
00375>      Dep. Storage     (mm)=       1.00         6.35
00376>      Average Slope     (%)=       2.00         2.00
00377>      Length            (m)=      10.00         5.00
00378>      Mannings n             =       .013         .250
00379>
00380>      Max.eff.Inten.(mm/hr)=      78.39        24.53
00381>                 over (min)        1.00         4.00
00382>      Storage Coeff.  (min)=        .57 (ii)    4.13 (ii)
00383>      Unit Hyd. Tpeak (min)=       1.00         4.00
00384>      Unit Hyd. peak  (cms)=       1.40          .28
00385>                                                          *TOTALS*
00386>      PEAK FLOW       (cms)=        .00          .00          .001 (iii)
00387>      TIME TO PEAK    (hrs)=       1.93         2.03         2.000
00388>      RUNOFF VOLUME    (mm)=      39.93        12.19        28.836
00389>      TOTAL RAINFALL   (mm)=      40.93        40.93        40.933
00390>      RUNOFF COEFFICIENT   =        .98          .30          .704
00391>
00392>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00393>            CN* =  80.0    Ia = Dep. Storage  (Above)
00394>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00395>            THAN THE STORAGE COEFFICIENT.
00396>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00397>
00398> ------------------------------------------------------------------------------
00399> 002:0013----------------------------------------------------------------------
00400> *# CATCHMENT 204 - UNCONTROLLED EXTERNAL DRAINAGE TO EX. REAR LOT CB
00401> *
00402> ----------------------
00403> | CALIB NASHYD       |   Area    (ha)=     .05   Curve Number   (CN)=80.00
00404> | 06:204    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
00405> ----------------------   U.H. Tp(hrs)=    .180
00406>
00407>      Unit Hyd Qpeak  (cms)=     .011
00408>
00409>      PEAK FLOW       (cms)=     .002 (i)
00410>      TIME TO PEAK    (hrs)=    2.200
00411>      RUNOFF VOLUME    (mm)=   12.186
00412>      TOTAL RAINFALL   (mm)=   40.933
00413>      RUNOFF COEFFICIENT   =     .298
00414>
00415>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00416>
00417> ------------------------------------------------------------------------------
00418> 002:0014----------------------------------------------------------------------
00419> *# ADD TOTAL FLOWS TO GHENT
00420> ----------------------
00421> | ADD HYD (GHENT     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00422> ----------------------                   (ha)     (cms)   (hrs)   (mm)    (cms)
00423>                        ID1 02:202_CTL       .35     .011    1.80  38.55    .000
00424>                       +ID2 03:202_OVF       .00     .000     .00    .00    .000
00425>                       +ID3 05:203           .01     .001    2.00  28.84    .000
00426>                        ========================================================
00427>                        SUM 07:GHENT          .36     .012    2.00  38.28    .000
00428>
00429>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00430>
00431> ------------------------------------------------------------------------------
00432> 002:0015----------------------------------------------------------------------
00433> *# ADD TOTAL FLOWS FROM SITE
00434> ----------------------
00435> | ADD HYD (TOTAL.P3  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00436> ----------------------                   (ha)     (cms)   (hrs)   (mm)    (cms)
00437>                        ID1 04:201            .03     .004    2.00  27.17    .000
00438>                       +ID2 07:GHENT         .36     .012    2.00  38.28    .000
00439>                        ========================================================
00440>                        SUM 08:TOTAL.P3       .39     .016    2.00  37.42    .000
00441>
00442>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00443>
00444> ------------------------------------------------------------------------------
00445> 002:0016----------------------------------------------------------------------
00446> *# AREA CHECK
00447> ----------------------
00448> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00449> ----------------------                   (ha)     (cms)   (hrs)   (mm)    (cms)
00450>                        ID1 10:EX.P3          .46     .041    2.00  20.88    .000
00451>                       +ID2 08:TOTAL.P3       .39     .016    2.00  37.42    .000
00452>                        ========================================================
00453>                        SUM 09:CHECK          .85     .057    2.00  28.47    .000
00454>
00455>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00456>
00457> ------------------------------------------------------------------------------
00458> 002:0017----------------------------------------------------------------------
00459> **#*************************************************************************|
00460> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00461> *
00462>   ** END OF RUN :   4
00463>
00464> ********************************************************************************
00465>
00466>
00467>
00468>
00469>
00470> --------------------
00471> | START            |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
00472> --------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
00473>     TZERO =   .00 hrs on      0
00474>     METOUT=   2 (output = METRIC)
00475>     NRUN  = 005
00476>     NSTORM=   1
00477>          #  1=BUR6_005.stm
00478> ------------------------------------------------------------------------------
00479> 005:0002----------------------------------------------------------------------
00480> *#*************************************************************************|
00481> *#  Project Name: 774-782 BRANT STREET
00482> *#               BURLINGTON, ONTARIO
00483> *#  JOB NUMBER  : 20062
00484> *#       Date   : MAY 2021
00485> *#    Revised   :
00486> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00487> *#       File   : 20062C.DAT
00488> *#*************************************************************************|
00489> *
00490> ------------------------------------------------------------------------------
00491> 005:0002----------------------------------------------------------------------
00492> *
00493> --------------------
00494> | READ STORM       |    Filename: Burlington 5-yr 6hr CHICAGO    (A=802.04
00495> | Ptotal=  53.05 mm|    Comments: Burlington 5-yr 6hr CHICAGO    (A=802.04
00496> --------------------
00497>                TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00498>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
00499>                .17   2.348 |   1.67  10.690 |   3.17   5.897 |   4.67   3.004
00500>                .33   2.537 |   1.83  24.479 |   3.33   5.279 |   4.83   2.862
00501>                .50   2.766 |   2.00 101.312 |   3.50   4.790 |   5.00   2.734
00502>                .67   3.048 |   2.17  31.941 |   3.67   4.394 |   5.17   2.619
00503>                .83   3.407 |   2.33  17.333 |   3.83   4.065 |   5.33   2.514
00504>               1.00   3.881 |   2.50  12.145 |   4.00   3.788 |   5.50   2.419
00505>               1.17   4.539 |   2.67   9.469 |   4.17   3.550 |   5.67   2.331
00506>               1.33   5.523 |   2.83   7.826 |   4.33   3.344 |   5.83   2.251
00507>               1.50   7.185 |   3.00   6.709 |   4.50   3.164 |   6.00   2.176
00508>
00509> ------------------------------------------------------------------------------
00510> 005:0003----------------------------------------------------------------------
00511> *
00512> *#*************************************************************************|
00513> *#
00514> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
00515> *#        ======================================================
00516> *#
00517> *#*************************************************************************|
00518> *# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
00519> *
00520> ----------------------
00521> | CALIB STANDHYD     |   Area    (ha)=     .11
00522> | 01:101    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
00523> ----------------------
00524>                              IMPERVIOUS    PERVIOUS (i)
00525>      Surface Area     (ha)=        .04          .07
00526>      Dep. Storage     (mm)=       1.00         6.35
00527>      Average Slope     (%)=       2.00         2.50
00528>      Length            (m)=      20.00        10.00
00529>      Mannings n             =       .013         .250
00530>
00531>      Max.eff.Inten.(mm/hr)=     101.31        39.72
00532>                 over (min)        1.00         5.00
00533>      Storage Coeff.  (min)=        .79 (ii)    4.94 (ii)
00534>      Unit Hyd. Tpeak (min)=       1.00         5.00
00535>      Unit Hyd. peak  (cms)=       1.22          .23
00536>                                                          *TOTALS*
00537>      PEAK FLOW       (cms)=        .01          .01          .016 (iii)
00538>      TIME TO PEAK    (hrs)=       1.98         2.03         2.000
00539>      RUNOFF VOLUME    (mm)=      52.05        19.79        31.406
00540>      TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
```

```
00541>      RUNOFF COEFFICIENT   =       .98          .37          .592
00542>
00543>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00544>            CN* =  80.0    Ia = Dep. Storage  (Above)
00545>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00546>            THAN THE STORAGE COEFFICIENT.
00547>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00548>
00549> ---------------------------------------------------------------------------
00550> 005:0004----------------------------------------------------------------------
00551> *# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
00552> *
00553> ----------------------
00554> | CALIB STANDHYD     |   Area    (ha)=     .10
00555> | 02:102    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
00556> ----------------------
00557>                               IMPERVIOUS    PERVIOUS (i)
00558>      Surface Area     (ha)=        .04          .06
00559>      Dep. Storage     (mm)=       1.00         6.35
00560>      Average Slope     (%)=       2.00         2.50
00561>      Length            (m)=      20.00        10.00
00562>      Mannings n             =      .013         .250
00563>
00564>      Max.eff.Inten.(mm/hr)=     101.31        39.72
00565>                    over (min)        1.00         5.00
00566>      Storage Coeff.  (min)=        .79 (ii)    4.94 (ii)
00567>      Unit Hyd. Tpeak (min)=       1.00         5.00
00568>      Unit Hyd. peak  (cms)=       1.22          .23
00569>                                                          *TOTALS*
00570>      PEAK FLOW       (cms)=        .01          .01          .015 (iii)
00571>      TIME TO PEAK    (hrs)=       1.98         2.03         2.000
00572>      RUNOFF VOLUME    (mm)=      52.05        19.79        31.406
00573>      TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
00574>      RUNOFF COEFFICIENT   =        .98          .37          .592
00575>
00576>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00577>            CN* =  80.0    Ia = Dep. Storage  (Above)
00578>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00579>            THAN THE STORAGE COEFFICIENT.
00580>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00581>
00582> ---------------------------------------------------------------------------
00583> 005:0005----------------------------------------------------------------------
00584> *# CATCHMENT 103 -  EXISTING DRAINAGE TO EX. REAR LOT CB
00585> *
00586> ----------------------
00587> | CALIB STANDHYD     |   Area    (ha)=     .19
00588> | 03:103    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
00589> ----------------------
00590>                               IMPERVIOUS    PERVIOUS (i)
00591>      Surface Area     (ha)=        .07          .12
00592>      Dep. Storage     (mm)=       1.00         6.35
00593>      Average Slope     (%)=       2.00         2.50
00594>      Length            (m)=      20.00        10.00
00595>      Mannings n             =      .013         .250
00596>
00597>      Max.eff.Inten.(mm/hr)=     101.31        39.72
00598>                    over (min)        1.00         5.00
00599>      Storage Coeff.  (min)=        .79 (ii)    4.94 (ii)
00600>      Unit Hyd. Tpeak (min)=       1.00         5.00
00601>      Unit Hyd. peak  (cms)=       1.22          .23
00602>                                                          *TOTALS*
00603>      PEAK FLOW       (cms)=        .02          .01          .028 (iii)
00604>      TIME TO PEAK    (hrs)=       1.98         2.03         2.000
00605>      RUNOFF VOLUME    (mm)=      52.05        19.79        31.406
00606>      TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
00607>      RUNOFF COEFFICIENT   =        .98          .37          .592
00608>
00609>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00610>            CN* =  80.0    Ia = Dep. Storage  (Above)
00611>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00612>            THAN THE STORAGE COEFFICIENT.
00613>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00614>
00615> ---------------------------------------------------------------------------
00616> 005:0006----------------------------------------------------------------------
00617> *# CATCHMENT 104 - EXTERNAL DRAINAGE TO EX. REAR LOT CB
00618> *
00619> ----------------------
00620> | CALIB NASHYD       |   Area    (ha)=     .06   Curve Number    (CN)=80.00
00621> | 04:104    DT= 1.00 |   Ia        (mm)=   6.350   # of Linear Res.(N)= 3.00
00622> ----------------------   U.H. Tp(hrs)=    .180
00623>
00624>      Unit Hyd Qpeak  (cms)=     .013
00625>
00626>      PEAK FLOW       (cms)=     .003 (i)
00627>      TIME TO PEAK    (hrs)=    2.183
00628>      RUNOFF VOLUME    (mm)=   19.786
00629>      TOTAL RAINFALL   (mm)=   53.053
00630>      RUNOFF COEFFICIENT   =     .373
00631>
00632>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00633>
00634> ---------------------------------------------------------------------------
00635> 005:0007----------------------------------------------------------------------
00636> *# TOTAL EX. REAR LOT CB
00637> ------------------------
00638> | ADD HYD (EX.CB     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00639> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00640>                       ID1 04:104           .06     .003    2.18  19.79    .000
00641>                      +ID2 03:103           .19     .028    2.00  31.41    .000
00642>                       ========================================================
00643>                       SUM 05:EX.CB          .25     .030    2.00  28.62    .000
00644>
00645>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00646>
00647> ---------------------------------------------------------------------------
00648> 005:0008----------------------------------------------------------------------
00649> *# TOTAL EX. FROM SITE
00650> ------------------------
00651> | ADD HYD (EX.P3     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00652> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00653>                       ID1 01:101           .11     .016    2.00  31.41    .000
00654>                      +ID2 02:102           .10     .015    2.00  31.41    .000
00655>                      +ID3 03:103           .19     .028    2.00  31.41    .000
00656>                      +ID4 04:104           .06     .003    2.18  19.79    .000
00657>                       ========================================================
00658>                       SUM 10:EX.P3          .46     .060    2.00  29.89    .000
00659>
00660>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00661>
00662> ---------------------------------------------------------------------------
00663> 005:0009----------------------------------------------------------------------
00664> *#*************************************************************************|
00665> *#
00666> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
00667> *#        ================================================
00668> *#
00669> **#************************************************************************|
00670> *# CATCHMENT 202 - CONTROLLED DISCHARGE TO GHENT AVENUE
00671> *
00672> ----------------------
00673> | CALIB STANDHYD     |   Area    (ha)=     .35
00674> | 01:202    DT= 1.00 |   Total Imp(%)=   95.00   Dir. Conn.(%)=   95.00
00675> ----------------------
00676>                               IMPERVIOUS    PERVIOUS (i)
00677>      Surface Area     (ha)=        .33          .02
00678>      Dep. Storage     (mm)=       1.00         6.35
00679>      Average Slope     (%)=       2.00         2.00
00680>      Length            (m)=      20.00        10.00
00681>      Mannings n             =      .013         .250
00682>
00683>      Max.eff.Inten.(mm/hr)=     101.31        39.72
00684>                    over (min)        1.00         5.00
00685>      Storage Coeff.  (min)=        .79 (ii)    5.23 (ii)
00686>      Unit Hyd. Tpeak (min)=       1.00         5.00
00687>      Unit Hyd. peak  (cms)=       1.22          .22
00688>                                                          *TOTALS*
00689>      PEAK FLOW       (cms)=        .09          .00          .095 (iii)
00690>      TIME TO PEAK    (hrs)=       2.00         2.05         2.000
00691>      RUNOFF VOLUME    (mm)=      52.05        19.79        50.440
00692>      TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
00693>      RUNOFF COEFFICIENT   =        .98          .37          .951
00694>
00695>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00696>            CN* =  80.0    Ia = Dep. Storage  (Above)
00697>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00698>            THAN THE STORAGE COEFFICIENT.
00699>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00700>
00701> ---------------------------------------------------------------------------
00702> 005:0010----------------------------------------------------------------------
00703> *# ROUTE CATCHMENT 202 THROUGH ORIFICE PIPE
00704> *
00705> ----------------------
00706> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
00707> |  IN>01:(202   )    |
00708> | OUT<02:(202_CT)    |    =========  OUTLFOW STORAGE TABLE  =========
00709> ----------------------    OUTFLOW     STORAGE   |  OUTFLOW     STORAGE
00710>                             (cms)      (ha.m.)   |    (cms)     (ha.m.)
00711>                              .000  .0000E+00    |     .011  .1310E-01
00712>                              .006  .4000E-03    |     .011  .1720E-01
00713>                              .011  .8000E-03    |     .011  .2480E-01
00714>                              .011  .8000E-03    |     .011  .2480E-01
00715>                              .011  .4900E-02    |     .024  .2730E-01
00716>                              .011  .9200E-02    |     .000  .0000E+00
00717>
00718>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
00719>      --------------------       (ha)     (cms)     (hrs)        (mm)
00720>      INFLOW >01: (202   )        .35      .095     2.000      50.440
00721>      OUTFLOW<02: (202_CT)        .35      .011     1.750      50.440
00722>     OVERFLOW<03: (202_OV)        .00      .000      .000       .000
00723>
00724>                     TOTAL NUMBER OF SIMULATED OVERFLOWS  =         0
00725>                     CUMULATIVE TIME OF OVERFLOWS  (hours)=       .00
00726>                     PERCENTAGE OF TIME OVERFLOWING    (%)=       .00
00727>
00728>
00729>                     PEAK   FLOW   REDUCTION [Qout/Qin](%)=   11.393
00730>                     TIME SHIFT OF PEAK FLOW          (min)=   -15.00
00731>                     MAXIMUM  STORAGE   USED       (ha.m.)=.7884E-02
00732>
00733> ---------------------------------------------------------------------------
00734> 005:0011----------------------------------------------------------------------
00735> *# CATCHMENT 201 - UNCONTROLLED DISCHARGE TO BRANT STREET
00736> *
00737> ----------------------
00738> | CALIB STANDHYD     |   Area    (ha)=     .03
00739> | 04:201    DT= 1.00 |   Total Imp(%)=   54.00   Dir. Conn.(%)=   54.00
00740> ----------------------
00741>                               IMPERVIOUS    PERVIOUS (i)
00742>      Surface Area     (ha)=        .02          .01
00743>      Dep. Storage     (mm)=       1.00         6.35
00744>      Average Slope     (%)=       2.00         2.00
00745>      Length            (m)=      20.00        10.00
00746>      Mannings n             =      .013         .250
00747>
00748>      Max.eff.Inten.(mm/hr)=     101.31        39.72
00749>                    over (min)        1.00         5.00
00750>      Storage Coeff.  (min)=        .79 (ii)    5.23 (ii)
00751>      Unit Hyd. Tpeak (min)=       1.00         5.00
00752>      Unit Hyd. peak  (cms)=       1.22          .22
00753>                                                          *TOTALS*
00754>      PEAK FLOW       (cms)=        .00          .00          .006 (iii)
00755>      TIME TO PEAK    (hrs)=       1.98         2.05         2.000
00756>      RUNOFF VOLUME    (mm)=      52.05        19.79        37.213
00757>      TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
00758>      RUNOFF COEFFICIENT   =        .98          .37          .701
00759>
00760>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00761>            CN* =  80.0    Ia = Dep. Storage  (Above)
00762>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00763>            THAN THE STORAGE COEFFICIENT.
00764>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00765>
00766> ---------------------------------------------------------------------------
00767> 005:0012----------------------------------------------------------------------
00768> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
00769> *
00770> ----------------------
00771> | CALIB STANDHYD     |   Area    (ha)=     .01
00772> | 05:203    DT= 1.00 |   Total Imp(%)=   60.00   Dir. Conn.(%)=   60.00
00773> ----------------------
00774>                               IMPERVIOUS    PERVIOUS (i)
00775>      Surface Area     (ha)=        .01          .00
00776>      Dep. Storage     (mm)=       1.00         6.35
00777>      Average Slope     (%)=       2.00         2.00
00778>      Length            (m)=      10.00         5.00
00779>      Mannings n             =      .013         .250
00780>
00781>      Max.eff.Inten.(mm/hr)=     101.31        42.29
00782>                    over (min)        1.00         3.00
00783>      Storage Coeff.  (min)=        .52 (ii)    3.38 (ii)
00784>      Unit Hyd. Tpeak (min)=       1.00         3.00
00785>      Unit Hyd. peak  (cms)=       1.45          .35
00786>                                                          *TOTALS*
00787>      PEAK FLOW       (cms)=        .00          .00          .002 (iii)
00788>      TIME TO PEAK    (hrs)=       1.93         2.02         2.000
00789>      RUNOFF VOLUME    (mm)=      52.05        19.79        39.148
00790>      TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
00791>      RUNOFF COEFFICIENT   =        .98          .37          .738
00792>
00793>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00794>            CN* =  80.0    Ia = Dep. Storage  (Above)
00795>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00796>            THAN THE STORAGE COEFFICIENT.
00797>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00798>
00799> ---------------------------------------------------------------------------
00800> 005:0013----------------------------------------------------------------------
00801> *# CATCHMENT 204 - UNCONTROLLED EXTERNAL DRAINAGE TO EX. REAR LOT CB
00802> *
00803> ----------------------
00804> | CALIB NASHYD       |   Area    (ha)=     .05   Curve Number    (CN)=80.00
00805> | 06:204    DT= 1.00 |   Ia        (mm)=   6.350   # of Linear Res.(N)= 3.00
00806> ----------------------   U.H. Tp(hrs)=    .180
00807>
00808>      Unit Hyd Qpeak  (cms)=     .011
00809>
00810>      PEAK FLOW       (cms)=     .003 (i)
```

```
00811>      TIME TO PEAK    (hrs)=    2.183
00812>      RUNOFF VOLUME    (mm)=   19.784
00813>      TOTAL RAINFALL   (mm)=   53.053
00814>      RUNOFF COEFFICIENT   =     .373
00815>
00816>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00817>
00818> ---------------------------------------------------------------------------
00819> 005:0014-----------------------------------------------------------------------
00820> *# ADD TOTAL FLOWS TO GHENT
00821> ----------------------
00822> | ADD HYD (GHENT     ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
00823> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
00824>                       ID1 02:202_CTL         .35     .011    1.75  50.44    .000
00825>                      +ID2 03:202_OVF         .00     .000     .00    .00    .000
00826>                      +ID3 05:203             .01     .002    2.00  39.15    .000
00827>                       ============================================================
00828>                       SUM 07:GHENT           .36     .013    2.00  50.13    .000
00829>
00830>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00831>
00832> ---------------------------------------------------------------------------
00833> 005:0015-----------------------------------------------------------------------
00834> *# ADD TOTAL FLOWS FROM SITE
00835> ----------------------
00836> | ADD HYD (TOTAL.P3  ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
00837> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
00838>                       ID1 04:201             .03     .006    2.00  37.21    .000
00839>                      +ID2 07:GHENT           .36     .013    2.00  50.13    .000
00840>                       ============================================================
00841>                       SUM 08:TOTAL.P3        .39     .018    2.00  49.13    .000
00842>
00843>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00844>
00845> ---------------------------------------------------------------------------
00846> 005:0016-----------------------------------------------------------------------
00847> *# AREA CHECK
00848> ----------------------
00849> | ADD HYD (CHECK     ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
00850> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
00851>                       ID1 10:EX.P3           .46     .060    2.00  29.89    .000
00852>                      +ID2 08:TOTAL.P3        .39     .018    2.00  49.13    .000
00853>                       ============================================================
00854>                       SUM 09:CHECK           .85     .079    2.00  38.72    .000
00855>
00856>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00857>
00858> ---------------------------------------------------------------------------
00859> 005:0017-----------------------------------------------------------------------
00860> **#*************************************************************************|
00861> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00862> *
00863> ---------------------------------------------------------------------------
00864> 005:0002-----------------------------------------------------------------------
00865> *
00866>   ** END OF RUN :   9
00867>
00868> ***************************************************************************
00869>
00870>
00871>
00872>
00873>
00874> --------------------
00875> | START            |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
00876> --------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
00877>     TZERO =   .00 hrs on       0
00878>     METOUT=  2 (output = METRIC)
00879>     NRUN  = 010
00880>     NSTORM=  1
00881>              #  1=BUR6_010.stm
00882> ---------------------------------------------------------------------------
00883> 010:0002-----------------------------------------------------------------------
00884> *#*************************************************************************|
00885> *#  Project Name: 774-782 BRANT STREET
00886> *#                BURLINGTON, ONTARIO
00887> *#  JOB NUMBER  : 20062
00888> *#       Date   : MAY 2021
00889> *#    Revised   :
00890> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00891> *#       File   : 20062C.DAT
00892> *#*************************************************************************|
00893> *
00894> ---------------------------------------------------------------------------
00895> 010:0002-----------------------------------------------------------------------
00896> *
00897> --------------------
00898> | READ STORM       |    Filename: Burlington 10-yr 6hr CHICAGO     (A=918.
00899> | Ptotal=  61.10 mm|    Comments: Burlington 10-yr 6hr CHICAGO     (A=918.
00900> --------------------
00901>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00902>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
00903>                .17   2.714 |   1.67  12.326 |   3.17   6.808 |   4.67   3.472
00904>                .33   2.933 |   1.83  28.176 |   3.33   6.095 |   4.83   3.308
00905>                .50   3.197 |   2.00 116.310 |   3.50   5.532 |   5.00   3.161
00906>                .67   3.523 |   2.17  36.748 |   3.67   5.075 |   5.17   3.027
00907>                .83   3.937 |   2.33  19.967 |   3.83   4.696 |   5.33   2.907
00908>               1.00   4.483 |   2.50  14.001 |   4.00   4.376 |   5.50   2.796
00909>               1.17   5.242 |   2.67  10.921 |   4.17   4.102 |   5.67   2.695
00910>               1.33   6.377 |   2.83   9.030 |   4.33   3.864 |   5.83   2.602
00911>               1.50   8.291 |   3.00   7.743 |   4.50   3.656 |   6.00   2.516
00912>
00913> ---------------------------------------------------------------------------
00914> 010:0003-----------------------------------------------------------------------
00915> *
00916> *#*************************************************************************|
00917> *#
00918> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
00919> *#        ========================================================
00920> *#
00921> *#*************************************************************************|
00922> *# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
00923> *
00924> ----------------------
00925> | CALIB STANDHYD     |   Area    (ha)=     .11
00926> | 01:101     DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
00927> ----------------------
00928>                                IMPERVIOUS    PERVIOUS (i)
00929>      Surface Area     (ha)=        .04          .07
00930>      Dep. Storage     (mm)=       1.00         6.35
00931>      Average Slope     (%)=       2.00         2.50
00932>      Length            (m)=      20.00        10.00
00933>      Mannings n            =       .013         .250
00934>
00935>      Max.eff.Inten.(mm/hr)=     116.31        53.05
00936>                    over (min)       1.00         4.00
00937>      Storage Coeff.  (min)=        .74 (ii)    4.45 (ii)
00938>      Unit Hyd. Tpeak (min)=       1.00         4.00
00939>      Unit Hyd. peak  (cms)=       1.26          .26
00940>                                                          *TOTALS*
00941>      PEAK FLOW       (cms)=        .01          .01          .020 (iii)
00942>      TIME TO PEAK    (hrs)=       1.98         2.03         2.000
00943>      RUNOFF VOLUME    (mm)=      60.10        25.35        37.861
00944>      TOTAL RAINFALL   (mm)=      61.10        61.10        61.101
00945>      RUNOFF COEFFICIENT   =        .98          .41          .620
00946>
00947>       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00948>           CN* =  80.0    Ia = Dep. Storage  (Above)
00949>      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00950>           THAN THE STORAGE COEFFICIENT.
00951>     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00952>
00953> ---------------------------------------------------------------------------
00954> 010:0004-----------------------------------------------------------------------
00955> *# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
00956> *
00957> ----------------------
00958> | CALIB STANDHYD     |   Area    (ha)=     .10
00959> | 02:102     DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
00960> ----------------------
00961>                                IMPERVIOUS    PERVIOUS (i)
00962>      Surface Area     (ha)=        .04          .06
00963>      Dep. Storage     (mm)=       1.00         6.35
00964>      Average Slope     (%)=       2.00         2.50
00965>      Length            (m)=      20.00        10.00
00966>      Mannings n            =       .013         .250
00967>
00968>      Max.eff.Inten.(mm/hr)=     116.31        53.05
00969>                    over (min)       1.00         4.00
00970>      Storage Coeff.  (min)=        .74 (ii)    4.45 (ii)
00971>      Unit Hyd. Tpeak (min)=       1.00         4.00
00972>      Unit Hyd. peak  (cms)=       1.26          .26
00973>                                                          *TOTALS*
00974>      PEAK FLOW       (cms)=        .01          .01          .018 (iii)
00975>      TIME TO PEAK    (hrs)=       1.98         2.03         2.000
00976>      RUNOFF VOLUME    (mm)=      60.10        25.35        37.861
00977>      TOTAL RAINFALL   (mm)=      61.10        61.10        61.101
00978>      RUNOFF COEFFICIENT   =        .98          .41          .620
00979>
00980>       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00981>           CN* =  80.0    Ia = Dep. Storage  (Above)
00982>      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00983>           THAN THE STORAGE COEFFICIENT.
00984>     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00985>
00986> ---------------------------------------------------------------------------
00987> 010:0005-----------------------------------------------------------------------
00988> *# CATCHMENT 103 -  EXISTING DRAINAGE TO EX. REAR LOT CB
00989> *
00990> ----------------------
00991> | CALIB STANDHYD     |   Area    (ha)=     .19
00992> | 03:103     DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
00993> ----------------------
00994>                                IMPERVIOUS    PERVIOUS (i)
00995>      Surface Area     (ha)=        .07          .12
00996>      Dep. Storage     (mm)=       1.00         6.35
00997>      Average Slope     (%)=       2.00         2.50
00998>      Length            (m)=      20.00        10.00
00999>      Mannings n            =       .013         .250
01000>
01001>      Max.eff.Inten.(mm/hr)=     116.31        53.05
01002>                    over (min)       1.00         4.00
01003>      Storage Coeff.  (min)=        .74 (ii)    4.45 (ii)
01004>      Unit Hyd. Tpeak (min)=       1.00         4.00
01005>      Unit Hyd. peak  (cms)=       1.26          .26
01006>                                                          *TOTALS*
01007>      PEAK FLOW       (cms)=        .02          .01          .035 (iii)
01008>      TIME TO PEAK    (hrs)=       2.00         2.03         2.000
01009>      RUNOFF VOLUME    (mm)=      60.10        25.35        37.861
01010>      TOTAL RAINFALL   (mm)=      61.10        61.10        61.101
01011>      RUNOFF COEFFICIENT   =        .98          .41          .620
01012>
01013>       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01014>           CN* =  80.0    Ia = Dep. Storage  (Above)
01015>      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01016>           THAN THE STORAGE COEFFICIENT.
01017>     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01018>
01019> ---------------------------------------------------------------------------
01020> 010:0006-----------------------------------------------------------------------
01021> *# CATCHMENT 104 - EXTERNAL DRAINAGE TO EX. REAR LOT CB
01022> *
01023> ----------------------
01024> | CALIB NASHYD       |   Area    (ha)=     .06   Curve Number    (CN)=80.00
01025> | 04:104     DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
01026> ----------------------  U.H. Tp(hrs)=    .180
01027>
01028>      Unit Hyd Qpeak  (cms)=     .013
01029>
01030>      PEAK FLOW       (cms)=     .004 (i)
01031>      TIME TO PEAK    (hrs)=    2.183
01032>      RUNOFF VOLUME    (mm)=   25.344
01033>      TOTAL RAINFALL   (mm)=   61.101
01034>      RUNOFF COEFFICIENT   =     .415
01035>
01036>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01037>
01038> ---------------------------------------------------------------------------
01039> 010:0007-----------------------------------------------------------------------
01040> *# TOTAL EX. REAR LOT CB
01041> ----------------------
01042> | ADD HYD (EX.CB     ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
01043> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
01044>                       ID1 04:104             .06     .004    2.18  25.34    .000
01045>                      +ID2 03:103             .19     .035    2.00  37.86    .000
01046>                       ============================================================
01047>                       SUM 05:EX.CB           .25     .037    2.00  34.86    .000
01048>
01049>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01050>
01051> ---------------------------------------------------------------------------
01052> 010:0008-----------------------------------------------------------------------
01053> *# TOTAL EX. FROM SITE
01054> ----------------------
01055> | ADD HYD (EX.P3     ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
01056> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
01057>                       ID1 01:101             .11     .020    2.00  37.86    .000
01058>                      +ID2 02:102             .10     .018    2.00  37.86    .000
01059>                      +ID3 03:103             .19     .035    2.00  37.86    .000
01060>                      +ID4 04:104             .06     .004    2.18  25.34    .000
01061>                       ============================================================
01062>                       SUM 10:EX.P3           .46     .076    2.00  36.23    .000
01063>
01064>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01065>
01066> ---------------------------------------------------------------------------
01067> 010:0009-----------------------------------------------------------------------
01068> *#*************************************************************************|
01069> *#
01070> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
01071> *#        =========================================================
01072> *#
01073> **#************************************************************************|
01074> *# CATCHMENT 202 - CONTROLLED DISCHARGE TO GHENT AVENUE
01075> *
01076> ----------------------
01077> | CALIB STANDHYD     |   Area    (ha)=     .35
01078> | 01:202     DT= 1.00 |   Total Imp(%)=   95.00   Dir. Conn.(%)=   95.00
01079> ----------------------
01080>                                IMPERVIOUS    PERVIOUS (i)
```

```
01081>      Surface Area     (ha)=        .33          .02
01082>      Dep. Storage     (mm)=       1.00         6.35
01083>      Average Slope     (%)=       2.00         2.00
01084>      Length            (m)=      20.00        10.00
01085>      Mannings n            =       .013         .250
01086>
01087>      Max.eff.Inten.(mm/hr)=     116.31        51.53
01088>                 over (min)        1.00         5.00
01089>      Storage Coeff.  (min)=        .74 (ii)    4.75 (ii)
01090>      Unit Hyd. Tpeak (min)=       1.00         5.00
01091>      Unit Hyd. peak  (cms)=       1.26          .23
01092>                                                          *TOTALS*
01093>      PEAK FLOW       (cms)=        .11          .00          .109 (iii)
01094>      TIME TO PEAK    (hrs)=       2.00         2.03         2.000
01095>      RUNOFF VOLUME    (mm)=      60.10        25.35        58.364
01096>      TOTAL RAINFALL   (mm)=      61.10        61.10        61.101
01097>      RUNOFF COEFFICIENT   =        .98          .41          .955
01098>
01099>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01100>            CN* =  80.0    Ia = Dep. Storage  (Above)
01101>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01102>            THAN THE STORAGE COEFFICIENT.
01103>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01104>
01105> ---------------------------------------------------------------------------
01106> 010:0010-----------------------------------------------------------------------
01107> *# ROUTE CATCHMENT 202 THROUGH ORIFICE PIPE
01108> *
01109> ----------------------
01110> | ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
01111> |  IN>01:(202   )   |
01112> | OUT<02:(202_CT)   |    =========  OUTLFOW STORAGE TABLE  =========
01113> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
01114>                             (cms)     (ha.m.)  |    (cms)     (ha.m.)
01115>                             .000  .0000E+00    |     .011  .1310E-01
01116>                             .006  .4000E-03    |     .011  .1720E-01
01117>                             .011  .8000E-03    |     .011  .2480E-01
01118>                             .011  .8000E-03    |     .011  .2480E-01
01119>                             .011  .4900E-02    |     .024  .2730E-01
01120>                             .011  .9200E-02    |     .000  .0000E+00
01121>
01122>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
01123>      ---------------------      (ha)     (cms)     (hrs)       (mm)
01124>      INFLOW >01: (202   )        .35      .109     2.000     58.364
01125>      OUTFLOW<02: (202_CT)        .35      .011     1.717     58.364
01126>     OVERFLOW<03: (202_OV)        .00      .000      .000      .000
01127>
01128>                     TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
01129>                     CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
01130>                     PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
01131>
01132>
01133>                     PEAK   FLOW   REDUCTION [Qout/Qin](%)=    9.897
01134>                     TIME SHIFT OF PEAK FLOW         (min)=   -17.00
01135>                     MAXIMUM  STORAGE   USED       (ha.m.)=.9570E-02
01136>
01137> ---------------------------------------------------------------------------
01138> 010:0011-----------------------------------------------------------------------
01139> *# CATCHMENT 201 - UNCONTROLLED DISCHARGE TO BRANT STREET
01140> *
01141> ----------------------
01142> | CALIB STANDHYD     |   Area    (ha)=     .03
01143> | 04:201     DT= 1.00 |   Total Imp(%)=   54.00   Dir. Conn.(%)=   54.00
01144> ----------------------
01145>                              IMPERVIOUS    PERVIOUS (i)
01146>      Surface Area     (ha)=        .02          .01
01147>      Dep. Storage     (mm)=       1.00         6.35
01148>      Average Slope     (%)=       2.00         2.00
01149>      Length            (m)=      20.00        10.00
01150>      Mannings n            =       .013         .250
01151>
01152>      Max.eff.Inten.(mm/hr)=     116.31        51.53
01153>                 over (min)        1.00         5.00
01154>      Storage Coeff.  (min)=        .74 (ii)    4.75 (ii)
01155>      Unit Hyd. Tpeak (min)=       1.00         5.00
01156>      Unit Hyd. peak  (cms)=       1.26          .23
01157>                                                          *TOTALS*
01158>      PEAK FLOW       (cms)=        .01          .00          .007 (iii)
01159>      TIME TO PEAK    (hrs)=       2.00         2.03         2.000
01160>      RUNOFF VOLUME    (mm)=      60.10        25.35        44.115
01161>      TOTAL RAINFALL   (mm)=      61.10        61.10        61.101
01162>      RUNOFF COEFFICIENT   =        .98          .41          .722
01163>
01164>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01165>            CN* =  80.0    Ia = Dep. Storage  (Above)
01166>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01167>            THAN THE STORAGE COEFFICIENT.
01168>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01169>
01170> ---------------------------------------------------------------------------
01171> 010:0012-----------------------------------------------------------------------
01172> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
01173> *
01174> ----------------------
01175> | CALIB STANDHYD     |   Area    (ha)=     .01
01176> | 05:203     DT= 1.00 |   Total Imp(%)=   60.00   Dir. Conn.(%)=   60.00
01177> ----------------------
01178>                              IMPERVIOUS    PERVIOUS (i)
01179>      Surface Area     (ha)=        .01          .00
01180>      Dep. Storage     (mm)=       1.00         6.35
01181>      Average Slope     (%)=       2.00         2.00
01182>      Length            (m)=      10.00         5.00
01183>      Mannings n            =       .013         .250
01184>
01185>      Max.eff.Inten.(mm/hr)=     116.31        54.51
01186>                 over (min)        1.00         3.00
01187>      Storage Coeff.  (min)=        .49 (ii)    3.07 (ii)
01188>      Unit Hyd. Tpeak (min)=       1.00         3.00
01189>      Unit Hyd. peak  (cms)=       1.48          .37
01190>                                                          *TOTALS*
01191>      PEAK FLOW       (cms)=        .00          .00          .002 (iii)
01192>      TIME TO PEAK    (hrs)=       1.93         2.02         2.000
01193>      RUNOFF VOLUME    (mm)=      60.10        25.35        46.201
01194>      TOTAL RAINFALL   (mm)=      61.10        61.10        61.101
01195>      RUNOFF COEFFICIENT   =        .98          .41          .756
01196>
01197>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01198>            CN* =  80.0    Ia = Dep. Storage  (Above)
01199>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01200>            THAN THE STORAGE COEFFICIENT.
01201>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01202>
01203> ---------------------------------------------------------------------------
01204> 010:0013-----------------------------------------------------------------------
01205> *# CATCHMENT 204 - UNCONTROLLED EXTERNAL DRAINAGE TO EX. REAR LOT CB
01206> *
01207> ----------------------
01208> | CALIB NASHYD       |   Area    (ha)=     .05   Curve Number   (CN)=80.00
01209> | 06:204     DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
01210> ----------------------  U.H. Tp(hrs)=    .180
01211>
01212>      Unit Hyd Qpeak  (cms)=     .011
01213>
01214>      PEAK FLOW       (cms)=     .004 (i)
01215>      TIME TO PEAK    (hrs)=    2.183
01216>      RUNOFF VOLUME    (mm)=   25.342
01217>      TOTAL RAINFALL   (mm)=   61.101
01218>      RUNOFF COEFFICIENT   =     .415
01219>
01220>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01221>
01222> ---------------------------------------------------------------------------
01223> 010:0014-----------------------------------------------------------------------
01224> *# ADD TOTAL FLOWS TO GHENT
01225> ------------------------
01226> | ADD HYD (GHENT     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01227> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
01228>                        ID1 02:202_CTL      .35     .011    1.72  58.36    .000
01229>                       +ID2 03:202_OVF      .00     .000     .00    .00    .000
01230>                       +ID3 05:203          .01     .002    2.00  46.20    .000
01231>                        ========================================================
01232>                        SUM 07:GHENT        .36     .013    2.00  58.03    .000
01233>
01234>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01235>
01236> ---------------------------------------------------------------------------
01237> 010:0015-----------------------------------------------------------------------
01238> *# ADD TOTAL FLOWS FROM SITE
01239> ------------------------
01240> | ADD HYD (TOTAL.P3  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01241> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
01242>                        ID1 04:201          .03     .007    2.00  44.12    .000
01243>                       +ID2 07:GHENT        .36     .013    2.00  58.03    .000
01244>                        ========================================================
01245>                        SUM 08:TOTAL.P3     .39     .020    2.00  56.96    .000
01246>
01247>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01248>
01249> ---------------------------------------------------------------------------
01250> 010:0016-----------------------------------------------------------------------
01251> *# AREA CHECK
01252> ------------------------
01253> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01254> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
01255>                        ID1 10:EX.P3        .46     .076    2.00  36.23    .000
01256>                       +ID2 08:TOTAL.P3     .39     .020    2.00  56.96    .000
01257>                        ========================================================
01258>                        SUM 09:CHECK        .85     .096    2.00  45.74    .000
01259>
01260>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01261>
01262> ---------------------------------------------------------------------------
01263> 010:0017-----------------------------------------------------------------------
01264> **#*****************************************************************************|
01265> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
01266> *
01267> ---------------------------------------------------------------------------
01268> 010:0002-----------------------------------------------------------------------
01269> *
01270> ---------------------------------------------------------------------------
01271> 010:0002-----------------------------------------------------------------------
01272> *
01273>   ** END OF RUN :  24
01274>
01275> *****************************************************************************
01276>
01277>
01278>
01279>
01280>
01281> --------------------
01282> | START            |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
01283> --------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
01284>     TZERO =   .00 hrs on        0
01285>     METOUT=   2 (output = METRIC)
01286>     NRUN  = 025
01287>     NSTORM=   1
01288>               #  1=BUR6_025.stm
01289> ---------------------------------------------------------------------------
01290> 025:0002-----------------------------------------------------------------------
01291> *#*****************************************************************************|
01292> *#  Project Name: 774-782 BRANT STREET
01293> *#               BURLINGTON, ONTARIO
01294> *#  JOB NUMBER  : 20062
01295> *#       Date   : MAY 2021
01296> *#    Revised   :
01297> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
01298> *#       File   : 20062C.DAT
01299> *#*****************************************************************************|
01300> *
01301> ---------------------------------------------------------------------------
01302> 025:0002-----------------------------------------------------------------------
01303> *
01304> --------------------
01305> | READ STORM       |    Filename: Burlington 25-yr 6hr CHICAGO      (A=106
01306> | Ptotal=  71.35 mm|    Comments: Burlington 25-yr 6hr CHICAGO      (A=106
01307> --------------------
01308>                TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
01309>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
01310>                .17   3.182 |   1.67  14.410 |   3.17   7.968 |   4.67   4.068
01311>                .33   3.437 |   1.83  32.881 |   3.33   7.135 |   4.83   3.876
01312>                .50   3.746 |   2.00 135.380 |   3.50   6.477 |   5.00   3.704
01313>                .67   4.128 |   2.17  42.866 |   3.67   5.943 |   5.17   3.548
01314>                .83   4.612 |   2.33  23.321 |   3.83   5.499 |   5.33   3.407
01315>               1.00   5.251 |   2.50  16.365 |   4.00   5.125 |   5.50   3.278
01316>               1.17   6.138 |   2.67  12.771 |   4.17   4.805 |   5.67   3.160
01317>               1.33   7.465 |   2.83  10.563 |   4.33   4.527 |   5.83   3.051
01318>               1.50   9.700 |   3.00   9.061 |   4.50   4.284 |   6.00   2.950
01319>
01320> ---------------------------------------------------------------------------
01321> 025:0003-----------------------------------------------------------------------
01322> *
01323> *#*****************************************************************************|
01324> *#
01325> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
01326> *#        ======================================================
01327> *#
01328> *#*****************************************************************************|
01329> *# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
01330> *
01331> ----------------------
01332> | CALIB STANDHYD     |   Area    (ha)=     .11
01333> | 01:101     DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
01334> ----------------------
01335>                              IMPERVIOUS    PERVIOUS (i)
01336>      Surface Area     (ha)=        .04          .07
01337>      Dep. Storage     (mm)=       1.00         6.35
01338>      Average Slope     (%)=       2.00         2.50
01339>      Length            (m)=      20.00        10.00
01340>      Mannings n            =       .013         .250
01341>
01342>      Max.eff.Inten.(mm/hr)=     135.38        69.33
01343>                 over (min)        1.00         4.00
01344>      Storage Coeff.  (min)=        .70 (ii)    4.03 (ii)
01345>      Unit Hyd. Tpeak (min)=       1.00         4.00
01346>      Unit Hyd. peak  (cms)=       1.29          .28
01347>                                                          *TOTALS*
01348>      PEAK FLOW       (cms)=        .01          .01          .025 (iii)
01349>      TIME TO PEAK    (hrs)=       1.98         2.02         2.000
01350>      RUNOFF VOLUME    (mm)=      70.35        32.88        46.366
```

```
01351>      TOTAL RAINFALL   (mm)=      71.35        71.35         71.347
01352>      RUNOFF COEFFICIENT   =        .99          .46           .650
01353>
01354>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01355>            CN* =  80.0    Ia = Dep. Storage  (Above)
01356>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01357>            THAN THE STORAGE COEFFICIENT.
01358>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01359>
01360> ---------------------------------------------------------------------------
01361> 025:0004----------------------------------------------------------------------
01362> *# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
01363> *
01364> ---------------------
01365> | CALIB STANDHYD     |   Area    (ha)=     .10
01366> | 02:102    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
01367> ---------------------
01368>                                IMPERVIOUS    PERVIOUS (i)
01369>      Surface Area     (ha)=        .04          .06
01370>      Dep. Storage     (mm)=       1.00         6.35
01371>      Average Slope     (%)=       2.00         2.50
01372>      Length            (m)=      20.00        10.00
01373>      Mannings n            =       .013         .250
01374>
01375>      Max.eff.Inten.(mm/hr)=     135.38        69.33
01376>                  over (min)        1.00         4.00
01377>      Storage Coeff.  (min)=        .70 (ii)     4.03 (ii)
01378>      Unit Hyd. Tpeak (min)=       1.00         4.00
01379>      Unit Hyd. peak  (cms)=       1.29          .28
01380>                                                          *TOTALS*
01381>      PEAK FLOW       (cms)=        .01          .01          .023 (iii)
01382>      TIME TO PEAK    (hrs)=       1.98         2.02         2.000
01383>      RUNOFF VOLUME    (mm)=      70.35        32.88        46.366
01384>      TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
01385>      RUNOFF COEFFICIENT   =        .99          .46           .650
01386>
01387>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01388>            CN* =  80.0    Ia = Dep. Storage  (Above)
01389>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01390>            THAN THE STORAGE COEFFICIENT.
01391>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01392>
01393> ---------------------------------------------------------------------------
01394> 025:0005----------------------------------------------------------------------
01395> *# CATCHMENT 103 -  EXISTING DRAINAGE TO EX. REAR LOT CB
01396> *
01397> ---------------------
01398> | CALIB STANDHYD     |   Area    (ha)=     .19
01399> | 03:103    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
01400> ---------------------
01401>                                IMPERVIOUS    PERVIOUS (i)
01402>      Surface Area     (ha)=        .07          .12
01403>      Dep. Storage     (mm)=       1.00         6.35
01404>      Average Slope     (%)=       2.00         2.50
01405>      Length            (m)=      20.00        10.00
01406>      Mannings n            =       .013         .250
01407>
01408>      Max.eff.Inten.(mm/hr)=     135.38        69.33
01409>                  over (min)        1.00         4.00
01410>      Storage Coeff.  (min)=        .70 (ii)     4.03 (ii)
01411>      Unit Hyd. Tpeak (min)=       1.00         4.00
01412>      Unit Hyd. peak  (cms)=       1.29          .28
01413>                                                          *TOTALS*
01414>      PEAK FLOW       (cms)=        .03          .02          .043 (iii)
01415>      TIME TO PEAK    (hrs)=       1.98         2.02         2.000
01416>      RUNOFF VOLUME    (mm)=      70.35        32.88        46.366
01417>      TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
01418>      RUNOFF COEFFICIENT   =        .99          .46           .650
01419>
01420>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01421>            CN* =  80.0    Ia = Dep. Storage  (Above)
01422>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01423>            THAN THE STORAGE COEFFICIENT.
01424>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01425>
01426> ---------------------------------------------------------------------------
01427> 025:0006----------------------------------------------------------------------
01428> *# CATCHMENT 104 - EXTERNAL DRAINAGE TO EX. REAR LOT CB
01429> *
01430> ---------------------
01431> | CALIB NASHYD       |   Area    (ha)=     .06   Curve Number   (CN)=80.00
01432> | 04:104    DT= 1.00 |   Ia      (mm)=    6.350   # of Linear Res.(N)= 3.00
01433> ---------------------   U.H. Tp(hrs)=    .180
01434>
01435>      Unit Hyd Qpeak  (cms)=     .013
01436>
01437>      PEAK FLOW       (cms)=     .006 (i)
01438>      TIME TO PEAK    (hrs)=    2.167
01439>      RUNOFF VOLUME    (mm)=   32.870
01440>      TOTAL RAINFALL   (mm)=   71.347
01441>      RUNOFF COEFFICIENT   =     .461
01442>
01443>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01444>
01445> ---------------------------------------------------------------------------
01446> 025:0007----------------------------------------------------------------------
01447> *# TOTAL EX. REAR LOT CB
01448> ------------------------
01449> | ADD HYD (EX.CB     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01450> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
01451>                       ID1 04:104           .06      .006    2.17  32.87    .000
01452>                      +ID2 03:103           .19      .043    2.00  46.37    .000
01453>                       ========================================================
01454>                       SUM 05:EX.CB          .25      .047    2.00  43.13    .000
01455>
01456>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01457>
01458> ---------------------------------------------------------------------------
01459> 025:0008----------------------------------------------------------------------
01460> *# TOTAL EX. FROM SITE
01461> ------------------------
01462> | ADD HYD (EX.P3     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01463> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
01464>                       ID1 01:101           .11      .025    2.00  46.37    .000
01465>                      +ID2 02:102           .10      .023    2.00  46.37    .000
01466>                      +ID3 03:103           .19      .043    2.00  46.37    .000
01467>                      +ID4 04:104           .06      .006    2.17  32.87    .000
01468>                       ========================================================
01469>                       SUM 10:EX.P3          .46      .095    2.00  44.61    .000
01470>
01471>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01472>
01473> ---------------------------------------------------------------------------
01474> 025:0009----------------------------------------------------------------------
01475> *#*****************************************************************************|
01476> *#
01477> *#       POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
01478> *#       ========================================================
01479> *#
01480> **#*****************************************************************************|
01481> *# CATCHMENT 202 - CONTROLLED DISCHARGE TO GHENT AVENUE
01482> *
01483> ---------------------
01484> | CALIB STANDHYD     |   Area    (ha)=     .35
01485> | 01:202    DT= 1.00 |   Total Imp(%)=   95.00   Dir. Conn.(%)=   95.00
01486> ---------------------
01487>                                IMPERVIOUS    PERVIOUS (i)
01488>      Surface Area     (ha)=        .33          .02
01489>      Dep. Storage     (mm)=       1.00         6.35
01490>      Average Slope     (%)=       2.00         2.00
01491>      Length            (m)=      20.00        10.00
01492>      Mannings n            =       .013         .250
01493>
01494>      Max.eff.Inten.(mm/hr)=     135.38        69.33
01495>                  over (min)        1.00         4.00
01496>      Storage Coeff.  (min)=        .70 (ii)     4.26 (ii)
01497>      Unit Hyd. Tpeak (min)=       1.00         4.00
01498>      Unit Hyd. peak  (cms)=       1.29          .27
01499>                                                          *TOTALS*
01500>      PEAK FLOW       (cms)=        .13          .00          .128 (iii)
01501>      TIME TO PEAK    (hrs)=       2.00         2.02         2.000
01502>      RUNOFF VOLUME    (mm)=      70.35        32.88        68.473
01503>      TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
01504>      RUNOFF COEFFICIENT   =        .99          .46           .960
01505>
01506>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01507>            CN* =  80.0    Ia = Dep. Storage  (Above)
01508>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01509>            THAN THE STORAGE COEFFICIENT.
01510>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01511>
01512> ---------------------------------------------------------------------------
01513> 025:0010----------------------------------------------------------------------
01514> *# ROUTE CATCHMENT 202 THROUGH ORIFICE PIPE
01515> *
01516> ---------------------
01517> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
01518> |  IN>01:(202    )   |
01519> | OUT<02:(202_CT)    |    =========  OUTLFOW STORAGE TABLE  =========
01520> ---------------------    OUTFLOW     STORAGE   |  OUTFLOW     STORAGE
01521>                            (cms)     (ha.m.)   |    (cms)     (ha.m.)
01522>                             .000  .0000E+00    |     .011  .1310E-01
01523>                             .006  .4000E-03    |     .011  .1720E-01
01524>                             .011  .8000E-03    |     .011  .2480E-01
01525>                             .011  .8000E-03    |     .011  .2480E-01
01526>                             .011  .4900E-02    |     .024  .2730E-01
01527>                             .011  .9200E-02    |     .000  .0000E+00
01528>
01529>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
01530>      ---------------            (ha)     (cms)     (hrs)       (mm)
01531>      INFLOW >01: (202    )       .35       .128     2.000     68.473
01532>      OUTFLOW<02: (202_CT)        .35       .011     1.683     68.473
01533>     OVERFLOW<03: (202_OV)        .00       .000      .000       .000
01534>
01535>                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
01536>                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
01537>                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
01538>
01539>
01540>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=    8.467
01541>                    TIME SHIFT OF PEAK FLOW          (min)=   -19.00
01542>                    MAXIMUM  STORAGE   USED       (ha.m.)=.1183E-01
01543>
01544> ---------------------------------------------------------------------------
01545> 025:0011----------------------------------------------------------------------
01546> *# CATCHMENT 201 - UNCONTROLLED DISCHARGE TO BRANT STREET
01547> *
01548> ---------------------
01549> | CALIB STANDHYD     |   Area    (ha)=     .03
01550> | 04:201    DT= 1.00 |   Total Imp(%)=   54.00   Dir. Conn.(%)=   54.00
01551> ---------------------
01552>                                IMPERVIOUS    PERVIOUS (i)
01553>      Surface Area     (ha)=        .02          .01
01554>      Dep. Storage     (mm)=       1.00         6.35
01555>      Average Slope     (%)=       2.00         2.00
01556>      Length            (m)=      20.00        10.00
01557>      Mannings n            =       .013         .250
01558>
01559>      Max.eff.Inten.(mm/hr)=     135.38        69.33
01560>                  over (min)        1.00         4.00
01561>      Storage Coeff.  (min)=        .70 (ii)     4.26 (ii)
01562>      Unit Hyd. Tpeak (min)=       1.00         4.00
01563>      Unit Hyd. peak  (cms)=       1.29          .27
01564>                                                          *TOTALS*
01565>      PEAK FLOW       (cms)=        .01          .00          .008 (iii)
01566>      TIME TO PEAK    (hrs)=       1.97         2.02         2.000
01567>      RUNOFF VOLUME    (mm)=      70.35        32.88        53.110
01568>      TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
01569>      RUNOFF COEFFICIENT   =        .99          .46           .744
01570>
01571>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01572>            CN* =  80.0    Ia = Dep. Storage  (Above)
01573>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01574>            THAN THE STORAGE COEFFICIENT.
01575>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01576>
01577> ---------------------------------------------------------------------------
01578> 025:0012----------------------------------------------------------------------
01579> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
01580> *
01581> ---------------------
01582> | CALIB STANDHYD     |   Area    (ha)=     .01
01583> | 05:203    DT= 1.00 |   Total Imp(%)=   60.00   Dir. Conn.(%)=   60.00
01584> ---------------------
01585>                                IMPERVIOUS    PERVIOUS (i)
01586>      Surface Area     (ha)=        .01          .00
01587>      Dep. Storage     (mm)=       1.00         6.35
01588>      Average Slope     (%)=       2.00         2.00
01589>      Length            (m)=      10.00         5.00
01590>      Mannings n            =       .013         .250
01591>
01592>      Max.eff.Inten.(mm/hr)=     135.38        71.01
01593>                  over (min)        1.00         3.00
01594>      Storage Coeff.  (min)=        .46 (ii)     2.79 (ii)
01595>      Unit Hyd. Tpeak (min)=       1.00         3.00
01596>      Unit Hyd. peak  (cms)=       1.50          .39
01597>                                                          *TOTALS*
01598>      PEAK FLOW       (cms)=        .00          .00          .003 (iii)
01599>      TIME TO PEAK    (hrs)=       1.93         2.00         2.000
01600>      RUNOFF VOLUME    (mm)=      70.35        32.88        55.359
01601>      TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
01602>      RUNOFF COEFFICIENT   =        .99          .46           .776
01603>
01604>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01605>            CN* =  80.0    Ia = Dep. Storage  (Above)
01606>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01607>            THAN THE STORAGE COEFFICIENT.
01608>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01609>
01610> ---------------------------------------------------------------------------
01611> 025:0013----------------------------------------------------------------------
01612> *# CATCHMENT 204 - UNCONTROLLED EXTERNAL DRAINAGE TO EX. REAR LOT CB
01613> *
01614> ---------------------
01615> | CALIB NASHYD       |   Area    (ha)=     .05   Curve Number   (CN)=80.00
01616> | 06:204    DT= 1.00 |   Ia      (mm)=    6.350   # of Linear Res.(N)= 3.00
01617> ---------------------   U.H. Tp(hrs)=    .180
01618>
01619>      Unit Hyd Qpeak  (cms)=     .011
01620>
```

```
      PEAK FLOW       (cms)=     .005 (i)
      TIME TO PEAK    (hrs)=    2.167
      RUNOFF VOLUME    (mm)=   32.869
      TOTAL RAINFALL   (mm)=   71.347
      RUNOFF COEFFICIENT   =     .461

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

--------------------------------------------------------------------------------
025:0014--------------------------------------------------------------------------
*# ADD TOTAL FLOWS TO GHENT
----------------------
| ADD HYD (GHENT     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 02:202_CTL        .35     .011    1.68  68.47    .000
                      +ID2 03:202_OVF        .00     .000     .00    .00    .000
                      +ID3 05:203            .01     .003    2.00  55.36    .000
                       ========================================================
                       SUM 07:GHENT           .36     .014    2.00  68.11    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0015--------------------------------------------------------------------------
*# ADD TOTAL FLOWS FROM SITE
------------------------
| ADD HYD (TOTAL.P3  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 04:201            .03     .008    2.00  53.11    .000
                      +ID2 07:GHENT          .36     .014    2.00  68.11    .000
                       ========================================================
                       SUM 08:TOTAL.P3        .39     .022    2.00  66.95    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0016--------------------------------------------------------------------------
*# AREA CHECK
------------------------
| ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 10:EX.P3           .46     .095    2.00  44.61    .000
                      +ID2 08:TOTAL.P3        .39     .022    2.00  66.95    .000
                       ========================================================
                       SUM 09:CHECK           .85     .116    2.00  54.86    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0017--------------------------------------------------------------------------
**#*************************************************************************|
* RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
*
--------------------------------------------------------------------------------
025:0002--------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
025:0002--------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
025:0002--------------------------------------------------------------------------
*
  ** END OF RUN :  49

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



--------------------
| START            |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
--------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 050
    NSTORM=   1
            #  1=BUR6_050.stm
--------------------------------------------------------------------------------
050:0002--------------------------------------------------------------------------
*#*************************************************************************|
*#  Project Name: 774-782 BRANT STREET
*#               BURLINGTON, ONTARIO
*#  JOB NUMBER  : 20062
*#       Date   : MAY 2021
*#    Revised   :
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 20062C.DAT
*#*************************************************************************|
*
--------------------------------------------------------------------------------
050:0002--------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: Burlington 50-yr 6hr CHICAGO     (A=1172
| Ptotal=  78.93 mm|    Comments: Burlington 50-yr 6hr CHICAGO     (A=1172
--------------------
               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   3.533 |   1.67  15.961 |   3.17   8.836 |   4.67   4.516
               .33   3.817 |   1.83  36.356 |   3.33   7.913 |   4.83   4.304
               .50   4.160 |   2.00 149.296 |   3.50   7.185 |   5.00   4.113
               .67   4.582 |   2.17  47.374 |   3.67   6.593 |   5.17   3.940
               .83   5.119 |   2.33  25.806 |   3.83   6.102 |   5.33   3.783
              1.00   5.827 |   2.50  18.121 |   4.00   5.688 |   5.50   3.640
              1.17   6.809 |   2.67  14.149 |   4.17   5.333 |   5.67   3.509
              1.33   8.278 |   2.83  11.707 |   4.33   5.025 |   5.83   3.388
              1.50  10.753 |   3.00  10.045 |   4.50   4.755 |   6.00   3.277

--------------------------------------------------------------------------------
050:0003--------------------------------------------------------------------------
*
*#*************************************************************************|
*#
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
*#        ========================================================
*#
*#*************************************************************************|
*# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .11
| 01:101    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .04          .07
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.00         2.50
     Length            (m)=      20.00        10.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     149.30        81.82
                   over (min)        1.00         4.00
     Storage Coeff.  (min)=        .67 (ii)     3.79 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.31          .29
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .02          .01          .029 (iii)
     TIME TO PEAK    (hrs)=       1.98         2.02         2.000
     RUNOFF VOLUME    (mm)=      77.93        38.71        52.832
     TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
     RUNOFF COEFFICIENT   =        .99          .49          .669

       (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--------------------------------------------------------------------------
*# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .10
| 02:102    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .04          .06
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.00         2.50
     Length            (m)=      20.00        10.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     149.30        81.82
                   over (min)        1.00         4.00
     Storage Coeff.  (min)=        .67 (ii)     3.79 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.31          .29
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .01          .01          .026 (iii)
     TIME TO PEAK    (hrs)=       1.98         2.02         2.000
     RUNOFF VOLUME    (mm)=      77.93        38.71        52.832
     TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
     RUNOFF COEFFICIENT   =        .99          .49          .669

       (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--------------------------------------------------------------------------
*# CATCHMENT 103 -  EXISTING DRAINAGE TO EX. REAR LOT CB
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .19
| 03:103    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .07          .12
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.00         2.50
     Length            (m)=      20.00        10.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     149.30        81.82
                   over (min)        1.00         4.00
     Storage Coeff.  (min)=        .67 (ii)     3.79 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.31          .29
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .03          .02          .050 (iii)
     TIME TO PEAK    (hrs)=       1.98         2.02         2.000
     RUNOFF VOLUME    (mm)=      77.93        38.71        52.832
     TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
     RUNOFF COEFFICIENT   =        .99          .49          .669

       (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.

--------------------------------------------------------------------------------
050:0006--------------------------------------------------------------------------
*# CATCHMENT 104 - EXTERNAL DRAINAGE TO EX. REAR LOT CB
*
----------------------
| CALIB NASHYD       |   Area    (ha)=     .06   Curve Number   (CN)=80.00
| 04:104    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .180

     Unit Hyd Qpeak  (cms)=     .013

     PEAK FLOW       (cms)=     .007 (i)
     TIME TO PEAK    (hrs)=    2.167
     RUNOFF VOLUME    (mm)=   38.707
     TOTAL RAINFALL   (mm)=   78.932
     RUNOFF COEFFICIENT   =     .490

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

--------------------------------------------------------------------------------
050:0007--------------------------------------------------------------------------
*# TOTAL EX. REAR LOT CB
------------------------
| ADD HYD (EX.CB     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 04:104            .06     .007    2.17  38.71    .000
                      +ID2 03:103            .19     .050    2.00  52.83    .000
                       ========================================================
                       SUM 05:EX.CB           .25     .054    2.00  49.44    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
050:0008--------------------------------------------------------------------------
*# TOTAL EX. FROM SITE
------------------------
| ADD HYD (EX.P3     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 01:101            .11     .029    2.00  52.83    .000
                      +ID2 02:102            .10     .026    2.00  52.83    .000
                      +ID3 03:103            .19     .050    2.00  52.83    .000
                      +ID4 04:104            .06     .007    2.17  38.71    .000
                       ========================================================
                       SUM 10:EX.P3           .46     .109    2.00  50.99    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
050:0009--------------------------------------------------------------------------
*#*************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
*#        =========================================================
*#
**#*************************************************************************|
```

```
*# CATCHMENT 202 - CONTROLLED DISCHARGE TO GHENT AVENUE
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .35
| 01:202    DT= 1.00 |   Total Imp(%)=   95.00   Dir. Conn.(%)=   95.00
----------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .33          .02
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      20.00        10.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     149.30        81.82
                   over (min)        1.00         4.00
     Storage Coeff.  (min)=        .67 (ii)     4.00 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.31          .28
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .14          .00          .141 (iii)
     TIME TO PEAK    (hrs)=       2.00         2.02         2.000
     RUNOFF VOLUME    (mm)=      77.93        38.71        75.971
     TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
     RUNOFF COEFFICIENT   =        .99          .49          .962

       (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.

-------------------------------------------------------------------------------
050:0010-----------------------------------------------------------------------
*# ROUTE CATCHMENT 202 THROUGH ORIFICE PIPE
*
----------------------
| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>01:(202   )    |
| OUT<02:(202_CT)    |    =========  OUTLFOW STORAGE TABLE  =========
----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00    |     .011  .1310E-01
                            .006  .4000E-03    |     .011  .1720E-01
                            .011  .8000E-03    |     .011  .2480E-01
                            .011  .8000E-03    |     .011  .2480E-01
                            .011  .4900E-02    |     .024  .2730E-01
                            .011  .9200E-02    |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (202   )        .35      .141     2.000     75.971
     OUTFLOW<02: (202_CT)        .35      .011     1.633     75.971
    OVERFLOW<03: (202_OV)        .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](%)=    7.662
                    TIME SHIFT OF PEAK FLOW         (min)=   -22.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.1356E-01

-------------------------------------------------------------------------------
050:0011-----------------------------------------------------------------------
*# CATCHMENT 201 - UNCONTROLLED DISCHARGE TO BRANT STREET
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .03
| 04:201    DT= 1.00 |   Total Imp(%)=   54.00   Dir. Conn.(%)=   54.00
----------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .02          .01
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      20.00        10.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     149.30        81.82
                   over (min)        1.00         4.00
     Storage Coeff.  (min)=        .67 (ii)     4.00 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.31          .28
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .01          .00          .009 (iii)
     TIME TO PEAK    (hrs)=       1.97         2.02         2.000
     RUNOFF VOLUME    (mm)=      77.93        38.71        59.891
     TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
     RUNOFF COEFFICIENT   =        .99          .49          .759

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

-------------------------------------------------------------------------------
050:0012-----------------------------------------------------------------------
*# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .01
| 05:203    DT= 1.00 |   Total Imp(%)=   60.00   Dir. Conn.(%)=   60.00
----------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .01          .00
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00         5.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     149.30        83.65
                   over (min)        1.00         3.00
     Storage Coeff.  (min)=        .44 (ii)     2.62 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.52          .41
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .00          .00          .003 (iii)
     TIME TO PEAK    (hrs)=       1.92         2.00         2.000
     RUNOFF VOLUME    (mm)=      77.93        38.71        62.244
     TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
     RUNOFF COEFFICIENT   =        .99          .49          .789

       (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.

-------------------------------------------------------------------------------
050:0013-----------------------------------------------------------------------
*# CATCHMENT 204 - UNCONTROLLED EXTERNAL DRAINAGE TO EX. REAR LOT CB
*
----------------------
| CALIB NASHYD       |   Area    (ha)=     .05   Curve Number   (CN)=80.00
| 06:204    DT= 1.00 |   Ia      (mm)=    6.350   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=     .180

     Unit Hyd Qpeak  (cms)=      .011

     PEAK FLOW       (cms)=      .006 (i)
     TIME TO PEAK    (hrs)=     2.167
     RUNOFF VOLUME    (mm)=    38.706
     TOTAL RAINFALL   (mm)=    78.932
     RUNOFF COEFFICIENT   =      .490

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

-------------------------------------------------------------------------------
050:0014-----------------------------------------------------------------------
*# ADD TOTAL FLOWS TO GHENT
------------------------
| ADD HYD (GHENT     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)    (cms)
                        ID1 02:202_CTL       .35     .011    1.63  75.97    .000
                       +ID2 03:202_OVF       .00     .000     .00    .00    .000
                       +ID3 05:203           .01     .003    2.00  62.24    .000
                        ==========================================================
                        SUM 07:GHENT         .36     .014    2.00  75.59    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
050:0015-----------------------------------------------------------------------
*# ADD TOTAL FLOWS FROM SITE
------------------------
| ADD HYD (TOTAL.P3  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)    (cms)
                        ID1 04:201           .03     .009    2.00  59.89    .000
                       +ID2 07:GHENT         .36     .014    2.00  75.59    .000
                        ==========================================================
                        SUM 08:TOTAL.P3      .39     .023    2.00  74.38    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
050:0016-----------------------------------------------------------------------
*# AREA CHECK
------------------------
| ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)    (cms)
                        ID1 10:EX.P3         .46     .109    2.00  50.99    .000
                       +ID2 08:TOTAL.P3      .39     .023    2.00  74.38    .000
                        ==========================================================
                        SUM 09:CHECK         .85     .132    2.00  61.72    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
050:0017-----------------------------------------------------------------------
**#*****************************************************************************|
* RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
*
-------------------------------------------------------------------------------
050:0002-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
050:0002-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
050:0002-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
050:0002-----------------------------------------------------------------------
*
   ** END OF RUN :  99

*******************************************************************************
----------------------
| START              |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
----------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 100
    NSTORM=   1
             #  1=BUR6_100.stm
-------------------------------------------------------------------------------
100:0002-----------------------------------------------------------------------
*#*****************************************************************************|
*#  Project Name: 774-782 BRANT STREET
*#               BURLINGTON, ONTARIO
*#  JOB NUMBER  : 20062
*#       Date   : MAY 2021
*#    Revised   :
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 20062C.DAT
*#*****************************************************************************|
*
-------------------------------------------------------------------------------
100:0002-----------------------------------------------------------------------
*
----------------------
| READ STORM         |    Filename: Burlington 100-yr 6hr CHICAGO        (A=
| Ptotal=  86.27 mm  |    Comments: Burlington 100-yr 6hr CHICAGO        (A=
----------------------
                TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
                 hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
                 .17   3.862 |   1.67  17.445 |   3.17   9.657 |   4.67   4.936
                 .33   4.172 |   1.83  39.736 |   3.33   8.649 |   4.83   4.704
                 .50   4.546 |   2.00 163.177 |   3.50   7.853 |   5.00   4.495
                 .67   5.008 |   2.17  51.779 |   3.67   7.206 |   5.17   4.306
                 .83   5.595 |   2.33  28.205 |   3.83   6.670 |   5.33   4.135
                1.00   6.369 |   2.50  19.806 |   4.00   6.217 |   5.50   3.979
                1.17   7.443 |   2.67  15.465 |   4.17   5.829 |   5.67   3.835
                1.33   9.048 |   2.83  12.795 |   4.33   5.492 |   5.83   3.703
                1.50  11.752 |   3.00  10.979 |   4.50   5.197 |   6.00   3.581

-------------------------------------------------------------------------------
100:0003-----------------------------------------------------------------------
*
*#*****************************************************************************|
*#
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
*#        ========================================================
*#
*#*****************************************************************************|
*# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .11
| 01:101    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
----------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .04          .07
     Dep. Storage     (mm)=       1.00         6.35
```

```
02161>      Average Slope     (%)=       2.00        2.50
02162>      Length            (m)=      20.00       10.00
02163>      Mannings n            =       .013        .250
02164>
02165>      Max.eff.Inten.(mm/hr)=     163.18       94.55
02166>                    over (min)        1.00        4.00
02167>      Storage Coeff.  (min)=        .65 (ii)    3.59 (ii)
02168>      Unit Hyd. Tpeak (min)=       1.00        4.00
02169>      Unit Hyd. peak  (cms)=       1.33         .30
02170>                                                        *TOTALS*
02171>      PEAK FLOW       (cms)=        .02         .02          .033 (iii)
02172>      TIME TO PEAK    (hrs)=       1.97        2.02         2.000
02173>      RUNOFF VOLUME    (mm)=      85.27       44.54        59.200
02174>      TOTAL RAINFALL   (mm)=      86.27       86.27        86.271
02175>      RUNOFF COEFFICIENT   =        .99         .52          .686
02176>
02177>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02178>            CN* =  80.0    Ia = Dep. Storage  (Above)
02179>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02180>            THAN THE STORAGE COEFFICIENT.
02181>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02182>
02183> -------------------------------------------------------------------------------
02184> 100:0004-------------------------------------------------------------------------
02185> *# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
02186> *
02187> ----------------------
02188> | CALIB STANDHYD     |   Area    (ha)=     .10
02189> | 02:102    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
02190> ----------------------
02191>                                IMPERVIOUS    PERVIOUS (i)
02192>      Surface Area     (ha)=        .04          .06
02193>      Dep. Storage     (mm)=       1.00         6.35
02194>      Average Slope     (%)=       2.00         2.50
02195>      Length            (m)=      20.00        10.00
02196>      Mannings n            =       .013         .250
02197>
02198>      Max.eff.Inten.(mm/hr)=     163.18       94.55
02199>                    over (min)        1.00        4.00
02200>      Storage Coeff.  (min)=        .65 (ii)    3.59 (ii)
02201>      Unit Hyd. Tpeak (min)=       1.00        4.00
02202>      Unit Hyd. peak  (cms)=       1.33         .30
02203>                                                        *TOTALS*
02204>      PEAK FLOW       (cms)=        .02         .01          .030 (iii)
02205>      TIME TO PEAK    (hrs)=       1.97        2.02         2.000
02206>      RUNOFF VOLUME    (mm)=      85.27       44.54        59.200
02207>      TOTAL RAINFALL   (mm)=      86.27       86.27        86.271
02208>      RUNOFF COEFFICIENT   =        .99         .52          .686
02209>
02210>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02211>            CN* =  80.0    Ia = Dep. Storage  (Above)
02212>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02213>            THAN THE STORAGE COEFFICIENT.
02214>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02215>
02216> -------------------------------------------------------------------------------
02217> 100:0005-------------------------------------------------------------------------
02218> *# CATCHMENT 103 -  EXISTING DRAINAGE TO EX. REAR LOT CB
02219> *
02220> ----------------------
02221> | CALIB STANDHYD     |   Area    (ha)=     .19
02222> | 03:103    DT= 1.00 |   Total Imp(%)=   36.00   Dir. Conn.(%)=   36.00
02223> ----------------------
02224>                                IMPERVIOUS    PERVIOUS (i)
02225>      Surface Area     (ha)=        .07          .12
02226>      Dep. Storage     (mm)=       1.00         6.35
02227>      Average Slope     (%)=       2.00         2.50
02228>      Length            (m)=      20.00        10.00
02229>      Mannings n            =       .013         .250
02230>
02231>      Max.eff.Inten.(mm/hr)=     163.18       94.55
02232>                    over (min)        1.00        4.00
02233>      Storage Coeff.  (min)=        .65 (ii)    3.59 (ii)
02234>      Unit Hyd. Tpeak (min)=       1.00        4.00
02235>      Unit Hyd. peak  (cms)=       1.33         .30
02236>                                                        *TOTALS*
02237>      PEAK FLOW       (cms)=        .03         .03          .057 (iii)
02238>      TIME TO PEAK    (hrs)=       1.98        2.02         2.000
02239>      RUNOFF VOLUME    (mm)=      85.27       44.54        59.200
02240>      TOTAL RAINFALL   (mm)=      86.27       86.27        86.271
02241>      RUNOFF COEFFICIENT   =        .99         .52          .686
02242>
02243>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02244>            CN* =  80.0    Ia = Dep. Storage  (Above)
02245>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02246>            THAN THE STORAGE COEFFICIENT.
02247>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02248>
02249> -------------------------------------------------------------------------------
02250> 100:0006-------------------------------------------------------------------------
02251> *# CATCHMENT 104 - EXTERNAL DRAINAGE TO EX. REAR LOT CB
02252> *
02253> ----------------------
02254> | CALIB NASHYD       |   Area    (ha)=     .06   Curve Number    (CN)=80.00
02255> | 04:104    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
02256> ----------------------   U.H. Tp(hrs)=    .180
02257>
02258>      Unit Hyd Qpeak  (cms)=     .013
02259>
02260>      PEAK FLOW       (cms)=     .008 (i)
02261>      TIME TO PEAK    (hrs)=    2.167
02262>      RUNOFF VOLUME    (mm)=   44.530
02263>      TOTAL RAINFALL   (mm)=   86.271
02264>      RUNOFF COEFFICIENT   =     .516
02265>
02266>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02267>
02268> -------------------------------------------------------------------------------
02269> 100:0007-------------------------------------------------------------------------
02270> *# TOTAL EX. REAR LOT CB
02271> ------------------------
02272> | ADD HYD (EX.CB     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02273> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
02274>                       ID1 04:104           .06      .008    2.17   44.53    .000
02275>                      +ID2 03:103           .19      .057    2.00   59.20    .000
02276>                       ========================================================
02277>                       SUM 05:EX.CB          .25      .061    2.00   55.68    .000
02278>
02279>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02280>
02281> -------------------------------------------------------------------------------
02282> 100:0008-------------------------------------------------------------------------
02283> *# TOTAL EX. FROM SITE
02284> ------------------------
02285> | ADD HYD (EX.P3     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02286> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
02287>                       ID1 01:101           .11      .033    2.00   59.20    .000
02288>                      +ID2 02:102           .10      .030    2.00   59.20    .000
02289>                      +ID3 03:103           .19      .057    2.00   59.20    .000
02290>                      +ID4 04:104           .06      .008    2.17   44.53    .000
02291>                       ========================================================
02292>                       SUM 10:EX.P3          .46      .124    2.00   57.29    .000
02293>
02294>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02295>

02296> -------------------------------------------------------------------------------
02297> 100:0009-------------------------------------------------------------------------
02298> *#*****************************************************************************|
02299> *#
02300> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 3)
02301> *#        ========================================================
02302> *#
02303> **#*************************************************************************|
02304> *# CATCHMENT 202 - CONTROLLED DISCHARGE TO GHENT AVENUE
02305> *
02306> ----------------------
02307> | CALIB STANDHYD     |   Area    (ha)=     .35
02308> | 01:202    DT= 1.00 |   Total Imp(%)=   95.00   Dir. Conn.(%)=   95.00
02309> ----------------------
02310>                                IMPERVIOUS    PERVIOUS (i)
02311>      Surface Area     (ha)=        .33          .02
02312>      Dep. Storage     (mm)=       1.00         6.35
02313>      Average Slope     (%)=       2.00         2.00
02314>      Length            (m)=      20.00        10.00
02315>      Mannings n            =       .013         .250
02316>
02317>      Max.eff.Inten.(mm/hr)=     163.18       94.55
02318>                    over (min)        1.00        4.00
02319>      Storage Coeff.  (min)=        .65 (ii)    3.79 (ii)
02320>      Unit Hyd. Tpeak (min)=       1.00        4.00
02321>      Unit Hyd. peak  (cms)=       1.33         .29
02322>                                                        *TOTALS*
02323>      PEAK FLOW       (cms)=        .15         .00          .154 (iii)
02324>      TIME TO PEAK    (hrs)=       2.00        2.02         2.000
02325>      RUNOFF VOLUME    (mm)=      85.27       44.54        83.234
02326>      TOTAL RAINFALL   (mm)=      86.27       86.27        86.271
02327>      RUNOFF COEFFICIENT   =        .99         .52          .965
02328>
02329>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02330>            CN* =  80.0    Ia = Dep. Storage  (Above)
02331>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02332>            THAN THE STORAGE COEFFICIENT.
02333>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02334>
02335> -------------------------------------------------------------------------------
02336> 100:0010-------------------------------------------------------------------------
02337> *# ROUTE CATCHMENT 202 THROUGH ORIFICE PIPE
02338> *
02339> ----------------------
02340> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
02341> |  IN>01:(202    )   |
02342> | OUT<02:(202_CT)    |    =========  OUTFLOW STORAGE TABLE  =========
02343> ----------------------    OUTFLOW     STORAGE    |  OUTFLOW     STORAGE
02344>                             (cms)     (ha.m.)    |    (cms)     (ha.m.)
02345>                              .000  .0000E+00     |     .011  .1310E-01
02346>                              .006  .4000E-03     |     .011  .1720E-01
02347>                              .011  .8000E-03     |     .011  .2480E-01
02348>                              .011  .8000E-03     |     .011  .2480E-01
02349>                              .011  .4900E-02     |     .024  .2730E-01
02350>                              .011  .9200E-02     |     .000  .0000E+00
02351>
02352>      ROUTING RESULTS             AREA     QPEAK     TPEAK       R.V.
02353>      -------------------         (ha)     (cms)     (hrs)       (mm)
02354>      INFLOW >01: (202    )        .35      .154     2.000     83.234
02355>      OUTFLOW<02: (202_CT)         .35      .011     1.583     83.234
02356>     OVERFLOW<03: (202_OV)         .00      .000      .000       .000
02357>
02358>                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
02359>                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
02360>                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
02361>
02362>
02363>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=    6.997
02364>                    TIME SHIFT OF PEAK FLOW         (min)=   -25.00
02365>                    MAXIMUM  STORAGE   USED       (ha.m.)=.1531E-01
02366>
02367> -------------------------------------------------------------------------------
02368> 100:0011-------------------------------------------------------------------------
02369> *# CATCHMENT 201 - UNCONTROLLED DISCHARGE TO BRANT STREET
02370> *
02371> ----------------------
02372> | CALIB STANDHYD     |   Area    (ha)=     .03
02373> | 04:201    DT= 1.00 |   Total Imp(%)=   54.00   Dir. Conn.(%)=   54.00
02374> ----------------------
02375>                                IMPERVIOUS    PERVIOUS (i)
02376>      Surface Area     (ha)=        .02          .01
02377>      Dep. Storage     (mm)=       1.00         6.35
02378>      Average Slope     (%)=       2.00         2.00
02379>      Length            (m)=      20.00        10.00
02380>      Mannings n            =       .013         .250
02381>
02382>      Max.eff.Inten.(mm/hr)=     163.18       94.55
02383>                    over (min)        1.00        4.00
02384>      Storage Coeff.  (min)=        .65 (ii)    3.79 (ii)
02385>      Unit Hyd. Tpeak (min)=       1.00        4.00
02386>      Unit Hyd. peak  (cms)=       1.33         .29
02387>                                                        *TOTALS*
02388>      PEAK FLOW       (cms)=        .01         .00          .010 (iii)
02389>      TIME TO PEAK    (hrs)=       1.97        2.02         2.000
02390>      RUNOFF VOLUME    (mm)=      85.27       44.54        66.533
02391>      TOTAL RAINFALL   (mm)=      86.27       86.27        86.271
02392>      RUNOFF COEFFICIENT   =        .99         .52          .771
02393>
02394>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02395>            CN* =  80.0    Ia = Dep. Storage  (Above)
02396>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02397>            THAN THE STORAGE COEFFICIENT.
02398>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02399>
02400> -------------------------------------------------------------------------------
02401> 100:0012-------------------------------------------------------------------------
02402> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
02403> *
02404> ----------------------
02405> | CALIB STANDHYD     |   Area    (ha)=     .01
02406> | 05:203    DT= 1.00 |   Total Imp(%)=   60.00   Dir. Conn.(%)=   60.00
02407> ----------------------
02408>                                IMPERVIOUS    PERVIOUS (i)
02409>      Surface Area     (ha)=        .01          .00
02410>      Dep. Storage     (mm)=       1.00         6.35
02411>      Average Slope     (%)=       2.00         2.00
02412>      Length            (m)=      10.00         5.00
02413>      Mannings n            =       .013         .250
02414>
02415>      Max.eff.Inten.(mm/hr)=     163.18       98.36
02416>                    over (min)        1.00        2.00
02417>      Storage Coeff.  (min)=        .43 (ii)    2.47 (ii)
02418>      Unit Hyd. Tpeak (min)=       1.00        2.00
02419>      Unit Hyd. peak  (cms)=       1.53         .49
02420>                                                        *TOTALS*
02421>      PEAK FLOW       (cms)=        .00         .00          .004 (iii)
02422>      TIME TO PEAK    (hrs)=       1.92        2.00         2.000
02423>      RUNOFF VOLUME    (mm)=      85.27       44.54        68.977
02424>      TOTAL RAINFALL   (mm)=      86.27       86.27        86.271
02425>      RUNOFF COEFFICIENT   =        .99         .52          .800
02426>
02427>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02428>            CN* =  80.0    Ia = Dep. Storage  (Above)
02429>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02430>            THAN THE STORAGE COEFFICIENT.
```

```
02431>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02432>
02433> ---------------------------------------------------------------------------
02434> 100:0013-----------------------------------------------------------------------
02435> *# CATCHMENT 204 - UNCONTROLLED EXTERNAL DRAINAGE TO EX. REAR LOT CB
02436> *
02437> ----------------------
02438> | CALIB NASHYD       |   Area    (ha)=     .05   Curve Number   (CN)=80.00
02439> | 06:204    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
02440> ----------------------   U.H. Tp(hrs)=    .180
02441>
02442>      Unit Hyd Qpeak  (cms)=     .011
02443>
02444>      PEAK FLOW       (cms)=     .007 (i)
02445>      TIME TO PEAK    (hrs)=    2.167
02446>      RUNOFF VOLUME    (mm)=   44.529
02447>      TOTAL RAINFALL   (mm)=   86.271
02448>      RUNOFF COEFFICIENT   =     .516
02449>
02450>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02451>
02452> ---------------------------------------------------------------------------
02453> 100:0014-----------------------------------------------------------------------
02454> *# ADD TOTAL FLOWS TO GHENT
02455> ------------------------
02456> | ADD HYD (GHENT     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02457> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
02458>                       ID1 02:202_CTL        .35     .011    1.58  83.23    .000
02459>                      +ID2 03:202_OVF        .00     .000     .00    .00    .000
02460>                      +ID3 05:203            .01     .004    2.00  68.98    .000
02461>                       ========================================================
02462>                       SUM 07:GHENT          .36     .015    2.00  82.84    .000
02463>
02464>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02465>
02466> ---------------------------------------------------------------------------
02467> 100:0015-----------------------------------------------------------------------
02468> *# ADD TOTAL FLOWS FROM SITE
02469> ------------------------
02470> | ADD HYD (TOTAL.P3  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02471> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
02472>                       ID1 04:201            .03     .010    2.00  66.53    .000
02473>                      +ID2 07:GHENT          .36     .015    2.00  82.84    .000
02474>                       ========================================================
02475>                       SUM 08:TOTAL.P3       .39     .025    2.00  81.58    .000
02476>
02477>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02478>
02479> ---------------------------------------------------------------------------
02480> 100:0016-----------------------------------------------------------------------
02481> *# AREA CHECK
02482> ------------------------
02483> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02484> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
02485>                       ID1 10:EX.P3          .46     .124    2.00  57.29    .000
02486>                      +ID2 08:TOTAL.P3       .39     .025    2.00  81.58    .000
02487>                       ========================================================
02488>                       SUM 09:CHECK          .85     .149    2.00  68.43    .000
02489>
02490>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02491>
02492> ---------------------------------------------------------------------------
02493> 100:0017-----------------------------------------------------------------------
02494> **#*************************************************************************|
02495> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
02496> *
02497> ---------------------------------------------------------------------------
02498> 100:0002-----------------------------------------------------------------------
02499> *
02500> ---------------------------------------------------------------------------
02501> 100:0002-----------------------------------------------------------------------
02502> *
02503> ---------------------------------------------------------------------------
02504> 100:0002-----------------------------------------------------------------------
02505> *
02506> ---------------------------------------------------------------------------
02507> 100:0002-----------------------------------------------------------------------
02508> *
02509> ---------------------------------------------------------------------------
02510> 100:0002-----------------------------------------------------------------------
02511>      FINISH
02512> ---------------------------------------------------------------------------
02513> ***************************************************************************
02514>      WARNINGS / ERRORS / NOTES
02515>      -------------------------
02516>    Simulation ended on 2022-11-11     at 14:11:44
02517> ===========================================================================
02518>
02519>
```

APPENDIX B

QUALITY CONTROL INFORMATION

May 2, 2022

ADS UFF Sizing Summary

Project Name: 747 - 761 Brant Street
Consulting Engineer: S. Llewellyn & Associates Limited
Location: Burlington, ON
Sizing Completed By: Haider Nasrullah **Email:** haider.nasrullah@ads-pipe.com

Recommended Unit	
Recommended Model:	UFF-5
TSS Removal Percentage:	82.1%
Total Site Volume Treated:	91.1%

Site Details	
Site Area:	0.34 ha
% Impervious:	100%
Rational C:	0.95
Rainfall Station:	Hamilton, ONT
Particle Size Distribution:	ETV

Unit Specifications:	
Number of Filter Modules:	5
Maximum Treatment Flowrate:	8 L/s
Inlet - Outlet Drop:	240 mm*
Max. Pipe Diameter:	600 mm
Operating Head:	760 mm

* Drop across unit can be reduced when required.

Site Elevations:	
Rim Elevation:	-
Inlet Pipe Elevation:	-
Outlet Pipe Elevation:	-

Consult approved shop drawings for final elevations. Riser sections (and/or grade rings) may be required to reach final grade on site.

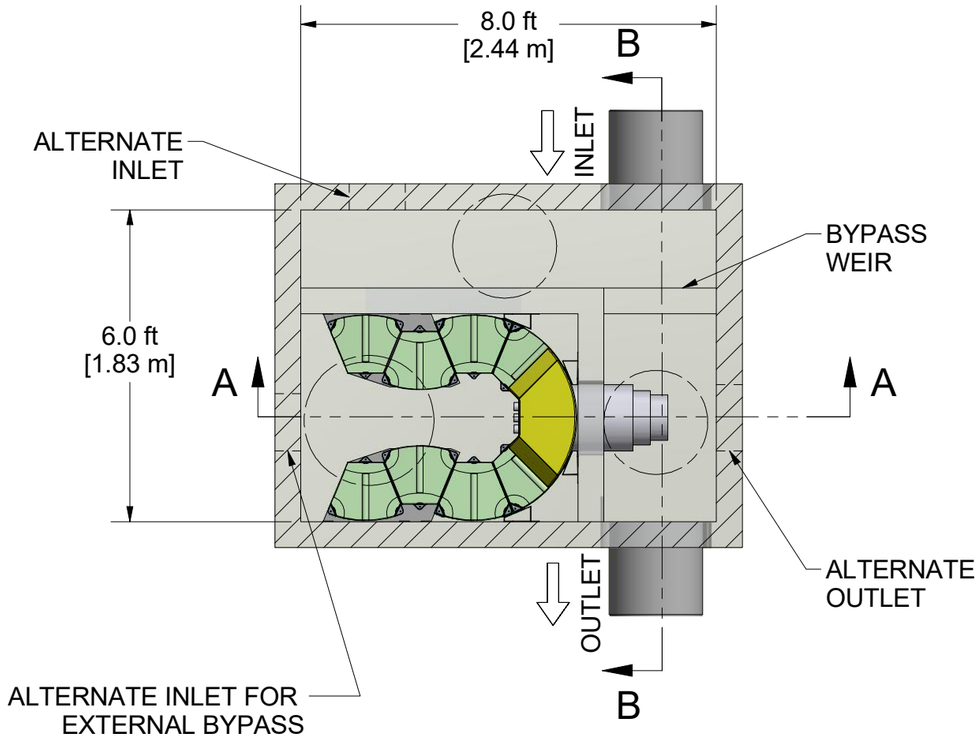
Rainfall Intensity[1]	Fraction of Rainfall[1]	Removal Efficiency[2]	Weighted Net-Annual Removal Efficiency
mm/hr	%	%	%
0.50	0.4%	92.3%	0.3%
1.00	18.8%	91.5%	17.2%
1.50	10.9%	90.6%	9.9%
2.00	13.9%	89.7%	12.4%
2.50	4.5%	88.9%	4.0%
3.00	2.7%	88.0%	2.4%
3.50	7.8%	87.1%	6.8%
4.00	4.2%	86.3%	3.6%
4.50	2.2%	85.4%	1.9%
5.00	4.7%	84.5%	3.9%
6.00	4.2%	82.8%	3.4%
7.00	4.2%	81.1%	3.4%
8.00	3.2%	79.3%	2.6%
9.00	1.9%	77.6%	1.5%
10.00	2.6%	75.9%	2.0%
20.00	9.2%	58.6%	5.4%
30.00	2.3%	41.3%	0.9%
40.00	1.1%	23.9%	0.3%
50.00	0.5%	6.6%	0.0%
100.00	0.6%	0.0%	0.0%
150.00	0.1%	0.0%	0.0%
Net Annual Treatment			**82.1%**
Total Runoff Volume Treated:			**91.1%**

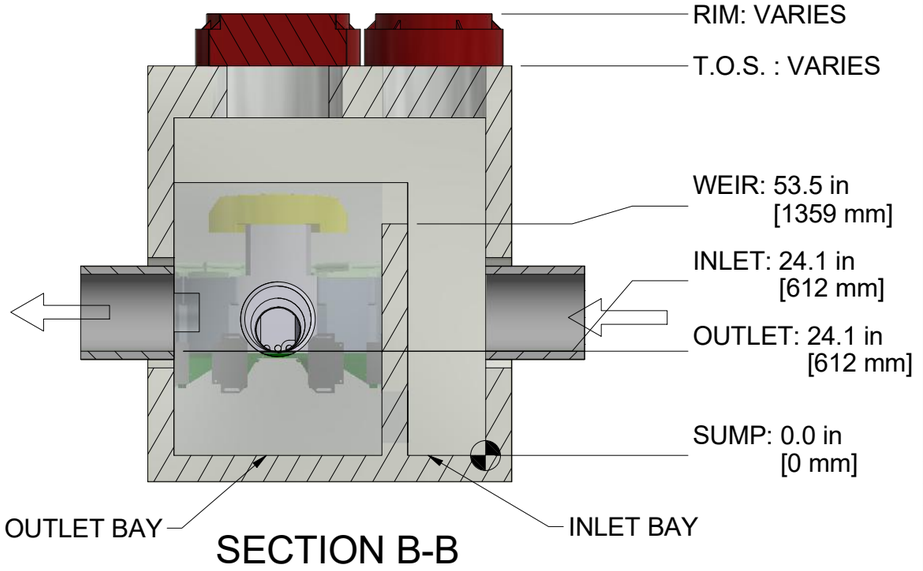
Rainfall Data: 1970:2007, HLY03, Hamilton, ON, 6153194.

Notes:

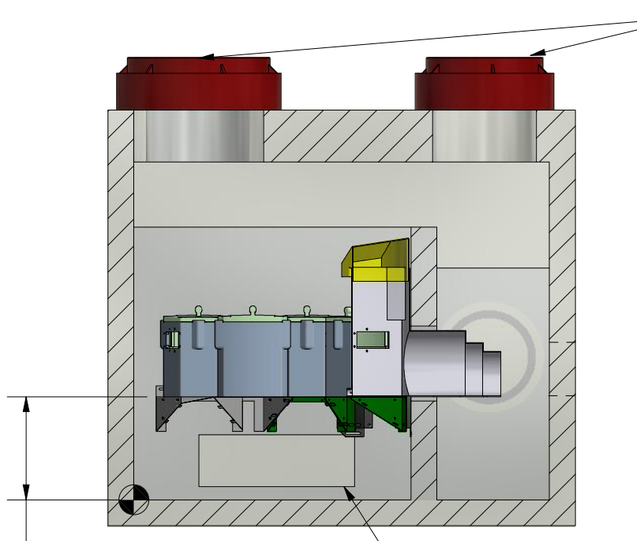
Removal efficiencies are based on NJDEP Test Protocols and independently verified.

All units supplied by ADS have numerous local, provincial, and international certifications (copies of which can be provided upon request). The design engineer is responsible for ensuring compliance with applicable regulations.





SECTION B-B



SECTION A-A

CAPACITIES:

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

ADDITIONAL DESIGN INFORMATION:

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

ANY WARRANTY GIVEN BY HYDRO INTERNATIONAL WILL APPLY ONLY TO THOSE ITEMS SUPPLIED BY IT. ACCORDINGLY HYDRO INTERNATIONAL CANNOT ACCEPT ANY RESPONSIBILITY FOR ANY STRUCTURE, PLANT, OR EQUIPMENT, (OR THE PERFORMANCE THERE OF) DESIGNED, BUILT, MANUFACTURED, OR SUPPLIED BY ANY THIRD PARTY. HYDRO INTERNATIONAL HAVE A POLICY OF CONTINUOUS DEVELOPMENT AND RESERVE THE RIGHT TO AMEND THE SPECIFICATION. HYDRO INTERNATIONAL CANNOT ACCEPT LIABILITY FOR PERFORMANCE OF ITS EQUIPMENT, (OR ANY PART THEREOF), IF THE EQUIPMENT IS SUBJECT TO CONDITIONS OUTSIDE ANY DESIGN SPECIFICATION. HYDRO INTERNATIONAL OWNS THE COPYRIGHT OF THIS DRAWING, WHICH IS SUPPLIED IN CONFIDENCE. IT MUST NOT BE USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS SUPPLIED AND MUST NOT BE REPRODUCED, IN WHOLE OR IN PART, WITHOUT PRIOR PERMISSION IN WRITING FROM HYDRO INTERNATIONAL.
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DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.

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

PROJECTION

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

REVISION HISTORY

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

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

Title
UP-FLO FILTER
6ft (1829mm) X 8ft (2438mm)

8 MODULES MAX

Hydro International

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

WEIGHT: N/A
MATERIAL:
NEXT ASSEMBLY: 6x8-1
DRAWING NO.: 6x8-UFF-1
SHEET SIZE: B
SHEET: 1 OF 1
Rev: -

Verification Statement



Hydro International Up-Flo® Filter with CPZ™ Media

Registration number: (V-2019-06-01)
Date of issue: (2019-November-27)

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

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

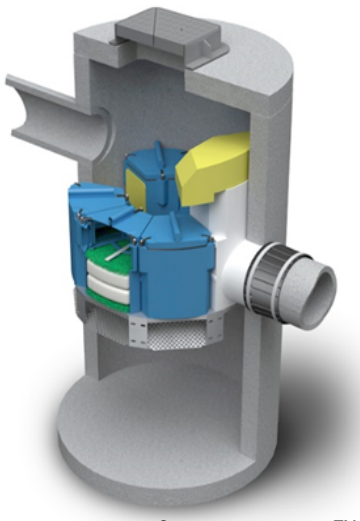


Figure 1: Up-Flo® Filter with CPZ™ Media

Technology Description

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

Verified Performance Claims

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

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

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

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

Constituent	Lower 95% Confidence Interval	Median	Upper 95% Confidence Interval
SSC *	85.9%	92.8%	94.7%
SSC **	73.9%	82.8%	86.3%
TSS *	79.0%	89.2%	91.0%
TSS **	72.0%	78.3%	85.2%
TN *	90.0%	43.9%	50.9%
TP *	33.8%	28.5%	64.7%
Zn **	39.4%	50.0%	62.1%
Cu **	72.6%	80.7%	85.2%
* Based on ESSIE (UF) Performance monitoring results ** Based on CCEE (UA) Performance monitoring results			

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

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

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

Description of Test Procedure

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

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

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

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

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

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

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

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

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

The following approved analytical methods were used:

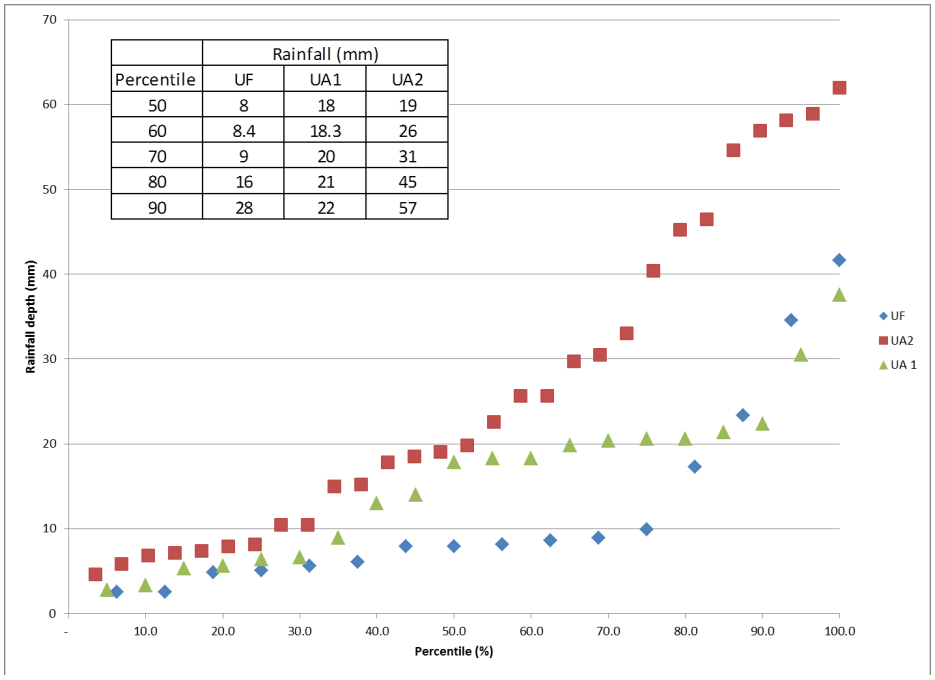
- TSS – ASTM D2540
- SSC – ASTM D3977-97(2013) Standard Test Methods for Determining Sediment Concentration in Water Samples
- PSD – ASTM D422 – 63 Standard Test Method for Particle-Size Analysis of Soils and ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- PSD – ASTM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

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

Summary of Verification Results

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

Figure 2. Rainfall depth frequency curves



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

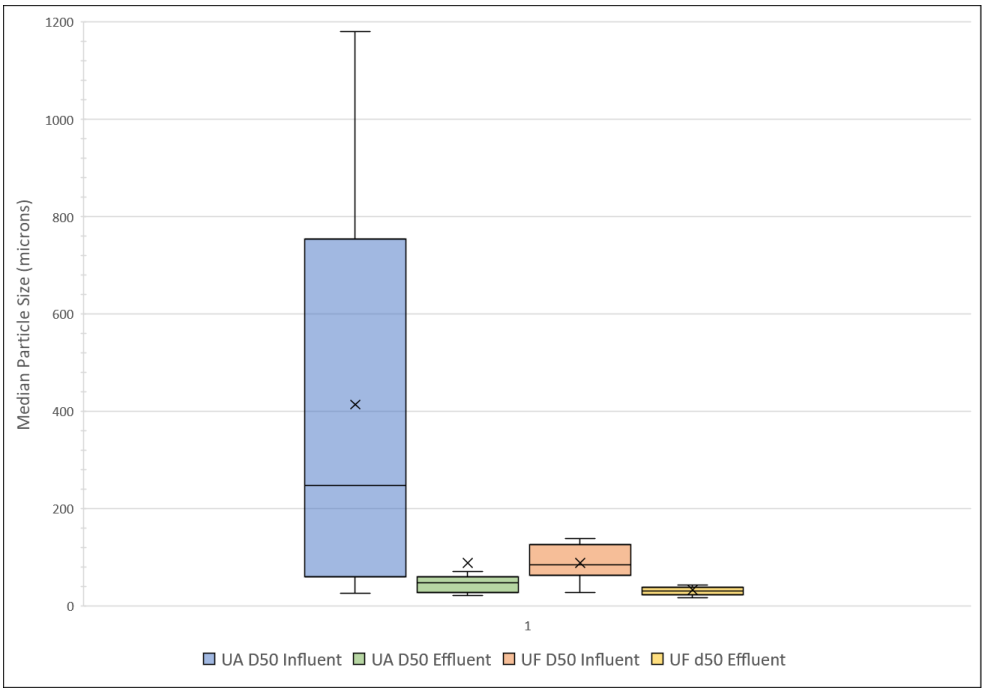
For UF monitoring, a total of 16 storm events, with varying rainfall intensity and runoff volume from event to event, were monitored. The cumulative rainfall depth was 7.66 inches (195 mm) and the cumulative influent runoff volume was 20,022 gallons (7.65 m^3). The entire volume was treated by the Up-Flo®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

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

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

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

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



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

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

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

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

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

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

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

As the independent third-party verifier, following the requirements of ISO 14034, GHL has confirmed that:

- The Hydro International Up-Flo® Filter with CPZ™ Media is based on sound scientific and engineering principles, providing a net environmental benefit.
- Performance testing of the Hydro International Up-Flo® Filter with CPZ™ Media was based on defined parameters and was conducted following the requirements of the NJDEP TARP Tier II Protocol for Stormwater Best Management Practice Demonstrations (2003) and its 2006 and 2009 amendments.
- Performance testing of the Hydro International Up-Flo® Filter with CPZ™ Media was performed by a qualified testing organization.
- Sample analyses were carried out as part of the test plan by a third-party analytical laboratory in a manner that meets the quality requirements of ISO 17025. Operating conditions and performance during each testing run were documented.
- Frequency of sampling and duration of each performance test were determined based on the specifications in a credible test plan and the requirements to produce sufficient data to support the performance claim at a 95% confidence level.
- Performance measurements and calculations were based on the technology application and relevant performance parameters as outlined in the Verification Plan.
- Performance calculations were done according to generally accepted test methods described in the test design, including the applicable mathematical and statistical principles and procedures.
- Data storage, transfer and control were adequate, carried out in accordance with the intent of ISO 9001 enabling control and retrieval of documents and records.
- Quality assurance requirements were addressed throughout the performance testing process and in the generation of performance test results. This confirmation included reviewing all data sheets and data downloads, as well as overall management of test system quality.

Quality Assurance

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

References

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

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

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

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

"NJCAT Technology Verification Up-Flo® Filter", January 2015.

Hydro International Up-Flo® Filter with CPZ™ Media Specifications, Hydro International.

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

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

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

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

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

Description of Up-Flo® Filter

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

Up-Flo® Filter Verification Brochure

ISO/IEC 14034, Environmental management – Environmental technology verification

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

ISO/IEC 9001, Quality Management Systems.

VerifiGlobal Performance Verification Protocol (Applying ISO 14034:2016)

VerifiGlobal Test Body Assessment – Guidance (2018)

What is ISO 14034?

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

Benefits of ETV

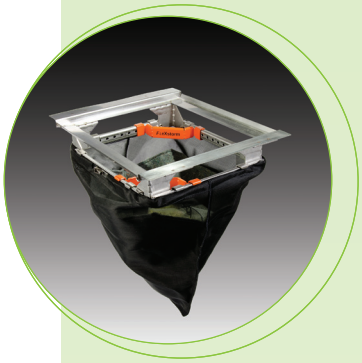
ETV contributes to protection and conservation of the environment by promoting and facilitating market uptake of innovative environmental technologies, especially those that perform better than relevant alternatives. ETV is particularly applicable to those environmental technologies whose innovative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

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

NOTICE: Verifications are based on an evaluation of technology performance under specific, predetermined operational conditions and parameters and the appropriate quality assurance procedures. VerifiGlobal and the Verification Expert, Good Harbour Laboratories, make no expressed or implied warranties as to the performance of the technology and do not certify that a technology will always operate as verified. The end user is solely responsible for complying with any and all applicable regulatory requirements. Mention of commercial product names does not imply endorsement.

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FLEXSTORM® PURE PERMANENT INLET PROTECTION



SPECIFY WITH CONFIDENCE

State DOTs and municipalities across the country now have a universal structural BMP to address the issue of storm sewer inlet protection: FLEXSTORM PURE Inlet Filters.

The FLEXSTORM PURE system is the preferred choice for permanent inlet protection and storm water runoff control. Constructed of versatile stainless steel, FLEXSTORM PURE Inlet Filters will fit any drainage structure and are available with site-specific filter bags providing various levels of filtration. Whether you're the specifier or the user, it's clear to see how FLEXSTORM PURE Inlet Filters outperform the competition.

APPLICATIONS:

Car Washes	Gas Stations
Commercial	Parking Lots
Loading Ramps	Dock Drains
Industrial	Maintenance

FEATURES:

- Stainless Steel filter framing is custom configured to fit perfectly into any drainage structure, whether a standard design or obstructed inlet opening
- Filtered Flow Rates and Ultimate Bypass Rates are designed to meet your specific inlet requirements
- Multiple Filter Bags are available targeting site specific removal of trash, litter, leaves, or small particles, oil and grease
- Filters work below grade with an ultimate bypass allowing inlet area to drain with a full bag
- Units install in seconds and are easily maintained with the FLEXSTORM Universal Removal Tool (no heavy machinery required)

FEATURES:

- Receive payback on your investment: durable stainless steel framing provides extended service life while replaceable filter bags handle loads with a safety factor of 5
- Meets stringent removal requirements:
  - FX filter bags are rated for >80% removal efficiency of street sweep-size particles
  - PC/PC+ filter bags have been tested to 99% TSS removal of OK-110 US Silica Sand and 97% TPH (total petroleum hydrocarbon) removal
- Help prevent fines: FLEXSTORM Inlet Filters comply with EPA NPDES initiatives as a temporary or permanent BMP
- If not in stock, orders up to 100 pieces can ship within 48 hours



ADS Service: ADS representatives are committed to providing you with the answers to all your questions, including selecting the proper filter, specifications, installation and more. Also try the ADS FLEXSTORM Online Product Configurator at www.inletfilters.com

FLEXSTORM PURE INLET FILTERS SPECIFICATION

IDENTIFICATION

The installer shall inspect the plans and/or worksite to determine the quantity of each drainage structure casting type. The foundry casting number, exact grate size and clear opening size, or other information will be necessary to finalize the FLEXSTORM part number and dimensions. The units are shipped to the field configured precisely to fit the identified drainage structure.

MATERIAL AND PERFORMANCE

The FLEXSTORM Inlet Filter system is comprised of a corrosion resistant steel frame and a replaceable geotextile filter bag attached to the frame with a stainless steel locking band. The filter bag hangs suspended at a distance below the grate that shall allow full water flow into the drainage structure if the bag is completely filled with sediment. The standard Woven Polypropylene FX filter bags are rated for 200 gpm/sqft with a removal efficiency of 82% when filtering a USDA Sandy Loam sediment load. The Post Construction PC filter bags are rated for 137 gpm/sqft and have been 3rd party tested at 99% TSS removal to 110 micron and 97% TPH removal of used motor oil hydrocarbon mix.

INSTALLATION

Remove the grate from the casting or concrete drainage structure. Clean the ledge (lip) of the casting frame or drainage structure to ensure it is free of stone and dirt. Drop in the FLEXSTORM Inlet Filter through the clear opening and be sure the suspension hangers rest firmly on the inside ledge (lip) of the casting. Replace the grate and confirm it is elevated no more than 1/8", which is the thickness of the steel hangers. For wall mount units, follow instructions for attaching the stainless steel mounting brackets using the provided concrete fasteners.

INSPECTION FREQUENCY

Construction site inspection should occur following each ½" or more rain event. Post Construction inspections should occur three times per year (every four months) in areas with mild year round rainfall and four times per year (every three months Feb–Nov) in areas with summer rains and before and after the winter snowfall season. Industrial application site inspections (loading ramps, wash racks, maintenance facilities) should occur on a regularly scheduled basis no less than three times per year.

MAINTENANCE GUIDELINES

Empty the filter bag if more than half filled with sediment and debris, or as directed by the engineer. Remove the grate, engage the lifting bars or handles with the FLEXSTORM Removal Tool, and lift from the drainage structure. Dispose of the sediment or debris as directed by the engineer or maintenance contract in accordance with EPA guidelines.

As an alternative, an industrial vacuum may be used to collect the accumulated sediment. Remove any caked-on silt from the sediment bag and reverse flush the bag with medium spray for optimal filtration. Replace the bag if torn or punctured to ½" diameter or greater on the lower half of the bag. Post Construction PC/PC+ Bags should be maintained prior to 50% oil saturation. The average 2' x 2' PC filter bag will retain approx. 96 oz (5.4 lbs) of oil at which time it should be serviced or replaced. It can be centrifuged or passed through a wringer to recover the oils, and the fabric reused with 85% to 90% efficacy. It may also be recycled for its fuel value through waste to energy incineration. When utilizing the Cleartec Rubberizer Pouches in the + bags, note that these oil skimmers will gradually turn brown and solidify as they become saturated, indicating time for replacement. Each pouch will absorb approximately 62 oz (4 lbs) of oil before requiring replacement. The spent media may also be recycled for its fuel value through waste to energy incineration. Dispose of all oil contaminated products in accordance with EPA guidelines.

FILTER BAG REPLACEMENT

Remove the bag by loosening or cutting off the clamping band. Take the new filter bag, which is equipped with a stainless steel worm drive clamping band, and use a screw driver to tighten the bag around the frame channel. Ensure the bag is secure and that there is no slack around the perimeter of the band.

Lift Handles ease installation and maintenance

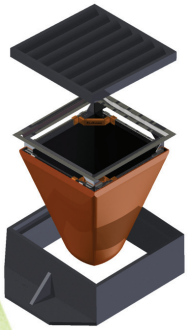


Replaceable Sediment Bag

1/8" thick steel hangers & channels; precision stampings **configured to fit each individual casting**



CAD drawings, work instructions and test reports on website: ***www.inletfilters.com***



For more information on FLEXSTORM Inlet Filters and other ADS products, please contact our Customer Service Representatives at 1-800-821-6710
Try the ADS FLEXSTORM Online Product Configurator at www.inletfilters.com.

ADS "Terms and Conditions of Sale" are available on the ADS website, www.ads-pipe.com
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APPENDIX C

WATER ANALYSIS INFORMATION

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

Project Number: **20062**
Project Name: **747 & 761 Brant Street**
Date: **07-May-21**

Fire flow demands for the FUS method is based on information and guidance provided in "Water Supply for Public Protection" (Fire Underwriters Survey, 2020).

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

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

where:

F = the required fire flow in litres per minute
C = coefficient related to the type of construction
= 1.5 for Type V wood frame construction (structure essentially all combustible)
= 0.8 for Type IV-A mass timber construction (encapsulated mass timber)
= 0.9 for Type IV-B mass timber construction (rated mass timber)
= 1.0 for Type IV-C mass timber construction (ordinary mass timber)
= 1.5 for Type IV-D mass timber construction (un-rated mass timber)
= 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 / Location	Building Area: Footprint Area (m^2)	Building Area: # of Storeys	Building Area: **Total GFA (m^2)**	Type of Construction	(1) *Fire Flow "F"*: (l/min)	(1) *Fire Flow "F"*: (l/s)	(2) *Occupancy*: %	(2) *Occupancy*: Adjustment (l/min)	(2) *Occupancy*: **Adjusted Fire Flow (l/min)**	(3) *Sprinkler*: %	(3) *Sprinkler*: Adjustment (l/min)	(4) *Exposure*: %	(4) *Exposure*: Adjustment (l/min)	**Final Adjusted Fire Flow**: **(l/min)**	**Final Adjusted Fire Flow**: **(l/s)**
Mix-use Building	**9085.5**	**1**	**9085.5**	**0.6**	13000	216.7	**-15**	-1950.0	**11050.0**	**-50**	-5525.0	40	4420.0	**10000**	**167**

(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%	
3.1 to 10m	20%	Calculate for all
10.1 to 20m	15%	sides. Maximum
20.1 to 30m	10%	charge shall not
> 30m	0%	exceed 75%

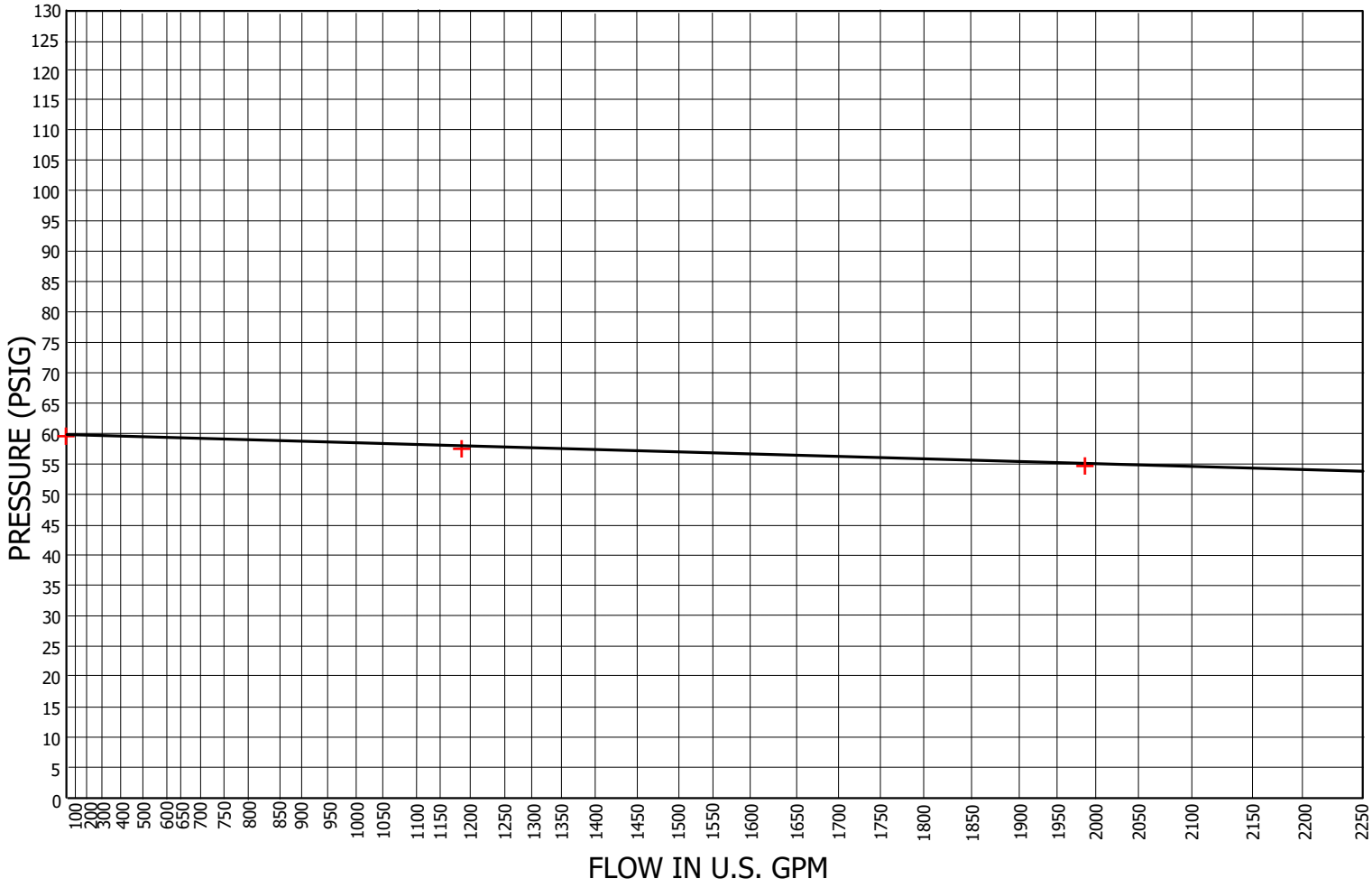
Block 1

Side	Exposure (m)	Charge (%)
North =	**20.1 to 30**	**10**
South =	**3.1 to 10**	**20**
East =	**20.1 to 30**	**10**
West =	**> 30m**	**0**
Total Exposure =		***40***

Total Area Calculatio

Two largest ajoining floors plus 50% of any floors immediately above them up to eight floors

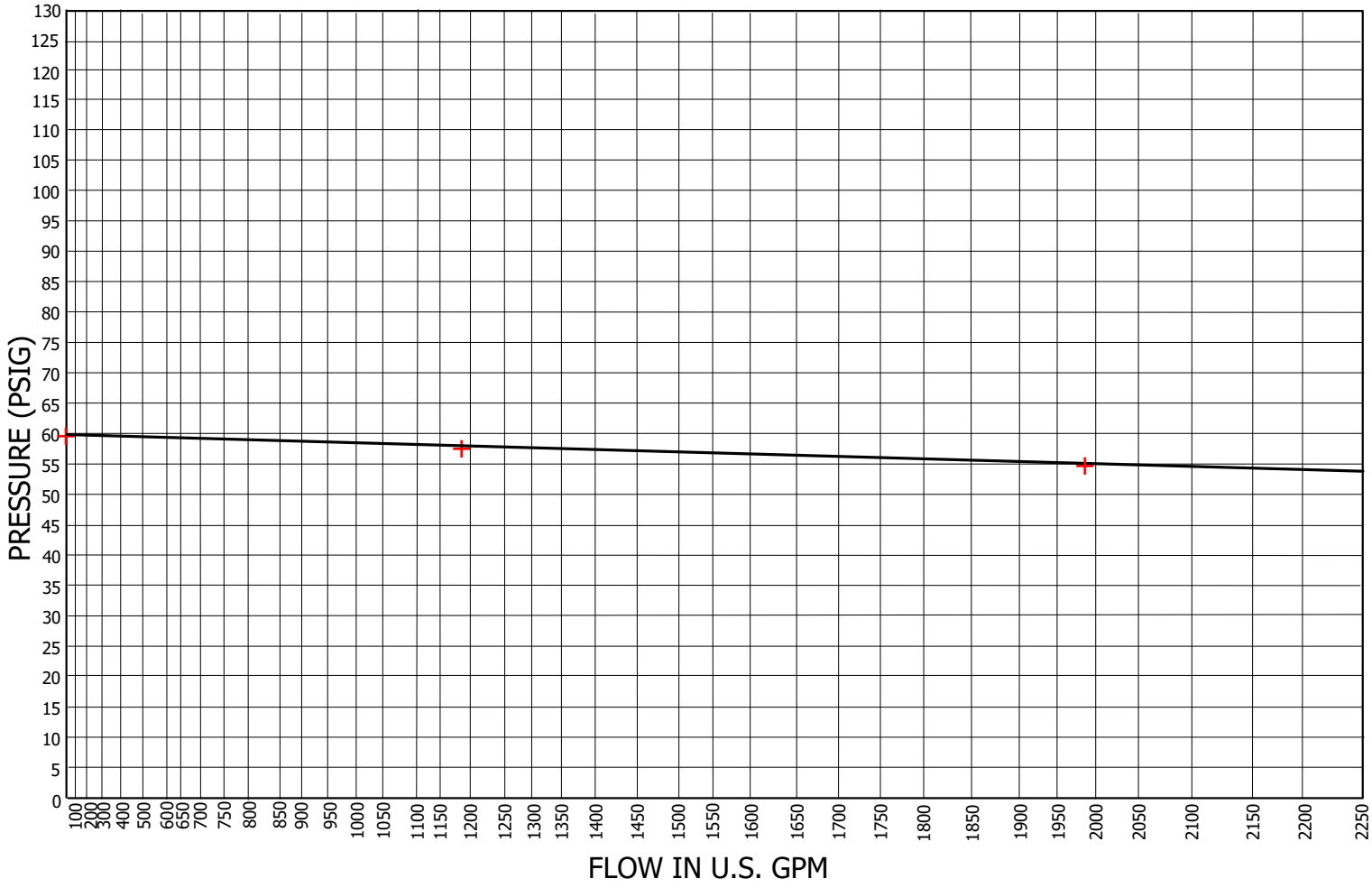
Floor	Area	Tot. Area	Cumm. Area
1	2304	2304	2304
2	2323	2323	4627
3	2373	1187	5814
4	1630	815	6629
5	1686	843	7472
6	1614	807	8279
7	1614	807	9086
8		0	9086
9		0	9086
10		0	**9086**



# of Ports	PORT DIA. (in/mm)	PITOT (psig)	FLOW (usgpm)	RESIDUAL (psig)
1	2.50/63	50	1186	58
2	2.50/63	35/35	1986	55
THEORETICAL FLOW @ 20psi			5982	

General Data	
Test Date	23 October 2020
Test Time	09:00am
Pipe Dia.	16"
Static	60

Site Information	
Site or Developer Name	S. Llewellyn & Associates
Site Address/Municipality	Brant Street, Burlington
Location of Test Hydrant	Front of 760 Brant Street
Location of Base Hydrant	Near 730 Brant Street
Technician's Comments	No conversion factor used for flow calculation based on round and flush internal nozzle
	configuration. Flow testing has been conducted in accrodance with NFPA 291 guidelines
	wherever possible. Refer to attached report for further information.
	Verified By: Mark Schmidt



# of Ports	PORT DIA. (in/mm)	PITOT (psig)	FLOW (usgpm)	RESIDUAL (psig)
1	2.50/63	46	1138	58
2	2.50/63	28/28	1776	55
THEORETICAL FLOW @ 20psi			5737	

General Data	
Test Date	23 October 2020
Test Time	09:30am
Pipe Dia.	10"
Static	60

Site Information	
Site or Developer Name	S. Llewellyn & Associates
Site Address/Municipality	Brant Street, Burlington
Location of Test Hydrant	Near 2047 Ghent Avenue
Location of Base Hydrant	Ghent Avenue, 1st East of Brant Street
Technician's Comments	No conversion factor used for flow calculation based on round and flush internal nozzle
	configuration. Flow testing has been conducted in accrodance with NFPA 291 guidelines
	wherever possible. Refer to attached report for further information.
	Verified By: Mark Schmidt

APPENDIX D

HYDROGEOLOGICAL INVESTIGATION

LANDTEK LIMITED
Consulting Engineers
205 Nebo Road, Unit 3
Hamilton, Ontario
Canada
L8W 2E1
Phone: 905-383-3733
Fax: 905-383-8433
engineering@landteklimited.com
www.landteklimited.com

Hydrogeological Investigation
Proposed Development
Phase 3 – Lot C
747 & 761 Brant Street (Phase 3)
Burlington, Ontario

Prepared for:

Brant Street Joint Venture
c/o Molinaro Group
472 Brock Avenue, Unit 103
Burlington, Ontario
L7S 1N1

Landtek File: 20255-C
May 17, 2022

■ FOUNDATION INVESTIGATIONS ■ ENVIRONMENTAL SITE ASSESSMENTS AND CLEANUP ■ GROUNDWATER STUDIES ■ SLOPE STABILITY STUDIES
■ ASPHALT TECHNOLOGY ■ ASPHALT MIX DESIGNS ■ PAVEMENT PERFORMANCE ANALYSIS ■ CONSTRUCTION MATERIALS TESTING & INSPECTION
■ ANALYSIS OF SOIL CORROSION POTENTIAL ■ PAVEMENT REHABILITATION & TENDER SPECIFICATIONS ■ CONCRETE QUALITY ASSURANCE TESTING
■ ROOF INSPECTIONS ■ INFRASTRUCTURE NEEDS STUDIES ■ FAILURE ANALYSIS AND EXPERT WITNESS SERVICES ■ AGGREGATE EVALUATION

EXECUTIVE SUMMARY

SCOPE OF SERVICES

Proposed Development	Brant Street Joint Venture is intending to develop the site identified as civic addresses 747 and 761 Brant Street in Burlington, Ontario for a primarily residential and limited commercial use. Based on the Proposed Site Plan provided to Landtek, as developed by Graziani + Corazza Architects Inc., the proposed structure is to comprise of an 8-storey tower with a surrounding three to seven storey podium. The structure will include a maximum of two levels of basement parking. The footprint of the proposed structure is to cover the full site area.
Report Deliverables	The Hydrogeological Investigation is required to assess the current site groundwater conditions, determine potential development/post development effects of the proposed development; and provide monitoring and mitigation plans for the development.

SITE DETAILS AND SETTING

Coordinates	596634, 4798498	**Site Area (approx.)**	3,831 m^2 (0.95 acres)
Site Description	The site is situated in a developed predominantly mixed commercial and residential area and is bounded by Ghent Avenue to the northwest and Brant Street to the southwest. Residential and commercial premises bound the site to the northeast and southeast respectively. The site consists of a three-storey apartment brick building and a two-storey building. The remainder of the site is covered by an asphalt paved parking lot and access route and maintained landscaped areas.		
Geology	Topsoil and asphalt were encountered at the ground level. Underlying the surface material is fill material. The fill extends to depths of approximately 3.0 m below existing ground level. Underlying the fill is clayey silt till and red shale. Red shale bedrock was encountered underlying the till.		
Groundwater	Depths to groundwater in all monitoring wells were obtained manually from September 2020 to August 2021. It was determined that that depth to groundwater ranged from 1.00 to 3.15 metres below ground surface.		

DEWATERING CONSIDERATIONS

Short Term	Dewatering rate will range from 6,044 (0.07 L/s) to 70,016 L/day (0.81 L/s) outside periods of active precipitation; while Dewatering during Spring/active precipitation period: is estimated to be approximately 70,016 L/day (radial flow into excavation) + 383,100 L/day (direct precipitation) = 453,116 L/day (5.24 L/s). Normal condition is considered to be weather conditions that should be expected during the operation of the construction dewatering but excludes extreme weather events.
Long Term	The basement parking will be waterproofed to prevent inflow of groundwater into the subsurface parking structures and foundation, post construction. As a result, long term dewatering will not be required at the Site.
Monitoring and Mitigation Plans	Monitoring and mitigation plans are provided. These include dewatering abstraction and settlement monitoring and responses; and limiting adverse dewatering related settlement and adverse effects on surface water bodies.

PERMIT CONSIDERATIONS

PTTW	Construction dewatering will be required only during the construction phase of the project, as it is proposed that the underground parking be waterproofed to prevent inflow of groundwater into the subsurface parking structures and foundation, post construction. This consideration is based on a 100 year-storm event for the City of Burlington. As a result, the maximum dewatering rate of groundwater for the proposed excavation is estimated to be approximately 453,116 L/day or ~5.24 L/s(radial inflow and direct precipitation). A permit to take water (PTTW) is required for this volume of water taking, as the estimated water taking is more than 400,000 L/day.

WATER BALANCE

Maintenance of Groundwater Recharge	The site is considered to have low groundwater recharge due to the relatively low impermeable soils encountered at surface at the site. In addition, there no natural area for infiltration is proposed for the development. As a result, infiltration value is expected to decrease from 147 to 68 m^3/year based on the water balance calculations. This decrease in infiltration indicates that approximately 4% of the roof runoff from the proposed buildings must be re-directed towards overland flow or infiltration facilities to match the pre-development infiltration rates.

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1.0 INTRODUCTION

1.1 Background

Landtek Limited (Landtek) was retained by Molinaro Group to complete a Hydrogeological Investigation for the proposed development at 747 & 761 Brant Street (Phase 3) in Burlington, Ontario (the 'site' or 'development property').

The Site is rectangular in shape and comprises an area of approximately 3,833 m^2 (0.95 acres) of developed land located to the east corner area of the intersection of the Brant Street and Ghent Avenue in Burlington, north of Brant Street. The Site is bound by Brant Street to the south, Ghent Avenue to the West, and developed properties to the North and East.

It is understood that the proposed development is to consist of three, five, six, seven and eight-storey buildings, with two-level of basement parking across the full site area.

A site location plan showing the Study Area for this investigation is presented on Figure 1 in Appendix A. The proposed Siteplan is shown on Figure 2 in Appendix A.

The purpose of the Hydrogeological Investigation is to evaluate the current conditions of the Site, delineate possible development/post-development effects, and suggest mitigation measures to minimize the effects to the shallow groundwater system post-development. Specifically, the report provides the following:

- A description of the hydrogeologic setting of the property and a summary of the existing soil and groundwater conditions at the Site.
- Identification of hydrogeologic features such as zones of significant groundwater recharge and discharge.
- Assessment of the requirement for groundwater control during construction, if any.
- A detailed water budget for the Site based on the current and proposed Site development plans and recommendations for mitigation measures in order to maintain groundwater infiltration and aquifer recharge in the area.

1.2 Work Scope and Report Organization

The scope of work for this investigation includes the following:

- *Review of available background information.* A review of published works was done of available geologic and hydrogeologic information for the site including topographic and geologic maps. Meteorological data was reviewed to assess the local climate and to use the information for water balance calculations.
- *Site Assessment.* A detailed visual inspection of the site and surrounding area was completed to identify and document local topography, surface water drainage features, and the potential presence of significant hydrogeologic features such as closed depressions (areas of ground water recharge), seeps, springs, or the presence of phreatophytic vegetation.

- *A subsurface investigation.* Boreholes were drilled at the site and completed as monitoring wells. The subsurface investigation of the property was done to characterize the overburden stratigraphy at the property as well as assess the site-specific groundwater conditions.

- *Water Balance.* A water balance of pre and post-development scenarios for the site was completed, including suggestions for mitigation measures that could be implemented in order to maintain shallow groundwater recharge conditions.

- *Hydraulic Conductivity Tests.* In-situ rising head tests were completed in all monitoring wells to assess overburden permeability.

- *Groundwater Monitoring.* Groundwater level monitoring was conducted in all installed monitoring wells in order to assess the depth in groundwater levels across the site.

The report is organized as follows:

Section 1 contains a brief introduction to the project and the scope of work undertaken by Landtek.

Section 2 outlines the methodologies followed during completion of the desktop study and the field investigation.

Section 3 summarizes the findings of the investigation. It includes:
- a description of the physical setting
- the results of the field investigation

Section 4 provides Water Taking Evaluation and Impact Assessment

Section 5 provides Monitoring Plan.

Section 6 provides Mitigation Plan.

Section 7 provides Site Development, Hydrogeology and Water Balance.

Section 8 provides Summary and Conclusions.

Section 9 provides Recommendations.

Section 10 provides Closure.

Section 11 provides References.

Section 12 provides Limitations.

2.0 METHODOLOGY

2.1 Desktop Study

A review of published works, existing site reports and available geologic and hydrogeological information for the site including topographic and geologic maps was completed.

Climate data for the period of 1981 to 2010 was obtained from Environment Canada publications and from the Hamilton A station (Hamilton Airport) to assess the local climate and to use the information for water balance calculations.

The MECP water well database for the local area was also accessed and the individual well records were obtained for wells that are located in the Study Area. The Study Area is defined, as an area extending 500 m outward from the edge of the excavation for the proposed basement parking levels.

2.2 Site Inspection to Assess Hydrogeologic Features

A detailed site inspection was conducted on August 24, 2020 to assess the presence of features which may be of Hydrogeologic significance. In particular, the site was inspected to assess the following:

- The presence of closed drainage features, depressions, or sandy areas which may allow for ponding and significant or enhanced infiltration of water.
- Assessment of the presence of phreatophytic vegetation which may indicate seasonally high groundwater levels and/or groundwater discharge and seepage.
- Identification of any zones of visible seepage or groundwater discharge.

2.3 Field Investigation

2.3.1 Drilling and Well Installation

Drilling: Landtek's investigation involved the advancement of a total of eleven (11) boreholes at the site project area on August 31 to September 2, 2020; three at the Site, four at the west adjacent property across Ghent Avenue (769-789 Brant Street & 2023-2031 Ghent Avenue); and two at the property located at the west corner area of the intersection of Brant Street and Ghent Avenue (774-782 Brant Street). All three properties are concomitantly connected hydrogeologically. The boreholes were drilled to log the stratigraphy and collect samples for laboratory testing. Six (6) of the boreholes BH1, BH4, BH5, BH8, BH9, and BH11 were completed as a monitoring wells MW1, MW4, MW5, MW8, MW9, and MW11, respectively to depths ranging from 9.1 to 18.4 meter below ground surface (mbgs). The boreholes were advanced by Pontil Drilling. and were drilled using a CME 75 track-mounted drill rig, with hollow stem augers [150 mm outer diameter (OD) and 100 mm inner diameter (ID)]. Representative soil samples were retained for logging purposes and for subsequent grain-size composition analysis.

The drilling was supervised by an experienced Landtek soil technician, who also prepared borehole logs. The borehole logs are included in Appendix B of this report.

The monitoring wells installed in MW1, MW4, MW5, MW8, MW9, and MW11 were constructed with 50 mm inner diameter, Schedule 40 machine slotted PVC screens equipped with a bottom cap, and machine threaded riser pipe. The screen length and slot size are 3.0 m, and 0.10-inch, respectively.

The annular space between the PVC riser pipes and each borehole wall was backfilled to at least 0.3 m above the top of the screen with silica sand (No. 2). A bentonite seal was placed immediately above the sand pack to a height just below grade. Each monitoring well was finished with a protective steel casing, which was cemented in-place.

The boreholes and monitoring well locations are shown on Figure 3 in Appendix A, and well construction details are provided below in Table 1.

Table 1. Well Construction Details

Well ID	Ground Surface Elevation [masl*]	Well Diameter [mm]	Well Depth [mbgs]	Well UTMs**		Bentonite Seal Depth [masl]		Well Screen Depth [masl]	
				Easting	Northing	Top	Bottom	Top	Bottom
BH/MW1	92.80	50	18.4	596475.6	4798472.4	92.25	77.70	77.40	74.40
BH/MW4	91.53	50	18.4	596530.5	4798499.0	91.23	76.43	76.13	73.13
BH/MW5	91.77	50	12.1	596534.0	4798599.9	91.47	82.97	82.67	79.67
BH/MW8	91.74	50	12.1	596692.2	4798628.5	91.44	82.94	82.64	79.64
BH/MW9	91.44	50	9.1	596633.3	4798530.9	91.14	85.64	85.34	82.34
BH/MW11	91.13	50	9.3	596662.9	4798494.0	90.83	85.13	84.83	81.83

masl* = meters above sea level based on Topographical Survey completed by A.T. McLaren Limited for the site.
mm = millimetre
mbgs = metre below ground surface
UTMs**: +/- 4.0 m Error.

Well Development: All monitoring wells were developed to remove any sediment that may have been introduced during drilling/installation and to improve the hydraulic properties of the formation against which the wells were screened. This work was completed by Landtek staff on September 17, 2020. Development employed an electric well pump and/or Waterra Tubing with Foot Valve. Each well was pumped until a visible decrease in turbidity was observed.

Groundwater Sampling: On September 22, 2020, ground water samples were collected from monitoring wells MW9 and MW11 and submitted to ALS laboratories in Mississauga, Ontario for the City of Burlington Storm Water Discharge Parameters Limits analysis and e-coli.

2.3.2 Hydraulic Conductivity Tests

Hydraulic Conductivity Testing: Five (5) installed monitoring wells (MW1, MW4, MW5, MW8 and MW11) in the project area were tested to provide estimates of the hydraulic conductivity for the zones against which the screens for the wells were set. Rising head tests were conducted by Landtek on September 24, 2020. The tests involved the extraction of a known volume to displace the water level. A datalogger programed at 2 seconds intervals was used to record the water level response during the tests.

Data Analysis: The rising head test data were analyzed using AqteSolve Professional Version 4.5 software package developed by Glenn M. Duffield of HydroSOLVE Inc. applying the Hvorslev analysis solutions, depending on hydrogeology.

3.0 FINDINGS

3.1 Site Topography, Drainage and Hydrology

The Site is developed and flat-lying at approximately 91 to 92 masl. Rambo Creek is located approximately 77 m east of the Site while Lake Ontario is located approximately 1.4 km southeast of the site. It is expected that the direction of groundwater flow at the site is southeast towards Lake Ontario.

3.2 Physiography

The Site is located in the Iroquois Plains physiographic region, as defined by Chapman and Putnam (1984). The Iroquois Plains extends 305 km along the western part of Lake Ontario, with varying conditions from the Niagara River to the Trent River. In more detail, Chapman and Putnam (1984) subdivided the Iroquois Plains into smaller areas to account for the varying conditions along this region. The Site and its surrounding area are described as being situated in a former gravel bar (extending between Hamilton and Toronto), with the nearby shoreline consisting of distinct bluff cuts into the red shale of the Queenston Formation.

3.3 Climate

The climate in the study area is largely influenced by Lake Ontario. The general climate data presented below in Table 2 was obtained from Environment Canada publications and from the Environment Canada online database. Average climate data was taken from Hamilton A station Airport (Hamilton Airport) for the period of 1981 to 2010.

Table 2. 1981 to 2010 Climate Normals for Hamilton A Station (as averages)

	Daily Average Temperature (°C)	Average Rainfall (mm)	Average Snowfall (cm)	Average Precipitation (mm)
January	-5.5	29.7	40.8	64.0
February	-4.6	28.2	35.1	57.8
March	-0.1	42.6	26.5	68.4
April	6.7	71.3	8.4	79.1
May	12.8	78.7	0.5	79.4
June	18.3	84.9	0.0	84.9
July	20.9	100.7	0.0	100.7
August	20.0	79.2	0.0	79.2
September	15.8	81.9	0.0	81.9
October	9.3	76.5	0.7	77.4
November	3.7	74.4	11.0	84.3
December	-2.3	43.8	33.5	73.0
Year	7.9	791.7	156.5	929.8

3.4 Regional Geology

The surficial geology of the Site and the surrounding area is mapped as sand and is shown on Figure 2. Ministry of Natural Resources mapping (accessed via Ontario Geological Survey (OGS) OGS Earth published by the Ontario Ministry of Natural Development, Mines and Forestry), indicates the regional surficial geology on the Site is comprised of coarse-textured glacio-lacustrine deposits of sand, gravel, minor silt and clay.

According to bedrock mapping provided by the OGS Earth website, bedrock in the area of the Site and the Study Area is identified as the Queenston Formation consisting of shale, limestone, dolostone, and siltstone.

The Site is generally flat with a slight slope from the northwest to southeast. Based on groundwater levels measured at the Site, the inferred shallow groundwater flow direction is southeasterly.

3.5 Regional Hydrogeology

The Halton Till unit, underlying the Site and its vicinity, is generally regarded as an aquitard. The range of indicated hydraulic conductivity values for the Halton Till is from 7 x 10-10 m/s (Gartner Lee, 1983) to 4.8 x 10-5 m/s (Ostry, 1979). Ostry (1979) also calculated hydraulic conductivities for Peel Plain sediments as ranging from 4.0 x 10-5 m/s to 5.0 x 10-6 m/s as far as to east and middle areas of the Town of Oakville. As such, the shallow overburden materials (Halton Till and Peel Plain sediments) are considered aquitards.

The underlying Queenston Formation shale bedrock, particularly the upper, weathered portion, is regarded as a poor aquifer, however the upper 3 to 6 m of weathered bedrock typically provides sufficient water supplies to meet domestic requirements (Ostry, 1979). The bedrock porosity is low as a result of the compaction and consolidation of these fine-grained rocks since their deposition. Groundwater does, however, flow within joints, fractures, cleavage planes and faults within the shale bedrock (which generally become tighter and fewer with increasing depth). Well yields from the Queenston Formation shale bedrock in Halton Region are generally low. Very few wells yield 276,480 L/day (3.2 L/s) or more, and a yield of approximately 13,824 L/day (0.16 L/s) is generally expected (Gore & Storrie et al., 1995).

A regional summary of hydraulic conductivity values derived from consulting work conducted throughout Halton Region, by Holysh, April 1997 are presented. The indicated hydraulic conductivity values for the Halton Till range from 7 x 10-10 (Gartner Lee, 1983) to 4.8 x 10-5 m/s (Ostry, 1979). The range of indicated values for the Queenston Formation is from 1 x 10-8 m/s (Gartner Lee, 1983) to 3.2 x 10-5 m/s (Ostry, 1979).

3.6 Groundwater Resources/Well Survey

The site is located in the Halton Region Source Protection Area and is classified as a Highly Vulnerable Aquifer area with score of 6 and an Intake Protection Zone 2 with a score of 5.6. The source water protection details for the site were referenced from the Ministry of the Environment, Conservation and Park (MECP) website on Source Water Protection for the Province of Ontario (MECP, 2020). Observed evidence of karstification was not observed due to the character of bedrock, lack of outcrop and/or relative thickness of overburden.

Well records were downloaded from the MECP water well database for a radius of approximately 500 m from the proposed development. A total of 42 well records were identified within the search radius.

The well records were reviewed to assess the general nature and use of the groundwater resource in the area and to characterize local hydrogeologic conditions; and determine the type of well. A summary of the data obtained from this review is presented on the following page.

Well Construction

- Wells terminated in bedrock 9
- Wells terminated in overburden 28
- No information (assumed to be overburden).....5
- **Total.....42**

Well Uses

- Domestic 0
- Observation Wells 16
- Test Holes/Monitoring Wells 20
- Abandoned.....4
- No Information.....2
- **Total.....42**

Well Depth

- Less than 15 m 35
- 15 to 30 m 3
- Abandoned.....4
- **Total.....42**

The locations of all the MECP wells are plotted on Figure 4 in Appendix A, and the Well Records are included in Appendix C.

Based on the well records, it was determined that there are no water wells within 500 m of the site.

3.7 Local Geology and Hydrogeology

Based on the results of the Geotechnical and Hydrogeological Investigations carried out at the Site, a brief description of the general surficial geology of the Site, in order of depth is summarized in the following sections. Boreholes BH9, BH10 and BH11 were completed at the Site and sampled as part of the investigation on the Site and completed at depths ranging from approximately 7.6 to 18.4 mbgs (Appendix B).

The borehole information is generally consistent with the geological data. The lithologies encountered by the boreholes are discussed further in the following sections.

Fill

A layer of fill of 3.0 m in thickness was encountered in all the boreholes at the ground surface overlying clayey silt in BH9, and bedrock in BH10 and BH11.

Clayey Silt

A layer of fill of 0.5 m in thickness was encountered below the fill in BH9, overlying shale bedrock.

Bedrock

Shale bedrock was encountered below the clayey silt in BH1; and fill in BH10 and BH11 at depths ranging from 3.0 to 3.5 mbgs. The boreholes were terminated in bedrock at the maximum depth of approximately 9.3 mbgs.

3.8 Groundwater Monitoring

Depths to groundwater in all monitoring wells were obtained manually by Landtek staff on September 21 and 24, 2020, January 14, February 23, March 17, April 12 and April 22, 2021. The readings are presented below in Table 3.

Table 3. Monitoring Well Details

Monitoring Well ID	Ground Surface Elevation (masl)*	Date	Stick-up	Water Strike Depth (mbgs)	Water Level (mbgs)	Water Level Elevation (masl)	Screened Material
MW1	92.80	21-Sep-20	0.85	1.50	3.02	89.78	Bedrock
		24-Sep-20			2.99	89.81	
		14-Jan-21			2.78	90.02	
		23-Feb-21			2.85	89.95	
		17-Mar-21			2.81	89.99	
		12-Apr-21			2.76	90.04	
		10-May-21			2.77	90.03	
		10-Jun-21			2.80	90.00	
		19-Jul-21			2.82	89.98	
		31-Aug-21			2.80	90.00	
MW4	91.53	21-Sep-20	0.91	3.50	2.61	88.92	Bedrock
		24-Sep-20			2.57	88.96	
		14-Jan-21			2.43	89.10	
		23-Feb-21			2.56	88.97	
		17-Mar-21			2.49	89.04	
		12-Apr-21			2.50	89.03	
		10-May-21			2.54	88.99	
		10-Jun-21			2.64	88.89	
		19-Jul-21			2.64	88.89	
		31-Aug-21			2.75	88.78	
MW5	91.77	21-Sep-20	Flush mount	7.60	2.33	89.44	Bedrock
		24-Sep-20			2.20	89.57	
		14-Jan-21			2.11	89.66	
		23-Feb-21			2.20	89.57	
		17-Mar-21			2.13	89.64	
		12-Apr-21			2.07	89.70	
		22-Apr-21			2.09	89.68	
		10-May-21			2.06	89.71	
		10-Jun-21			1.98	89.79	
		19-Jul-21			2.16	89.61	
		31-Aug-21			2.16	89.61	
MW8	91.74	21-Sep-20	Flush mount	1.5	2.34	89.40	Bedrock
		24-Sep-20			1.85	89.89	
		14-Jan-21			1.72	90.02	
		23-Feb-21			1.82	89.92	
		17-Mar-21			1.68	90.06	
		12-Apr-21			UW**	NA**	
		22-Apr-21			1.63	90.11	
		10-May-21			1.65	90.09	
		10-Jun-21			1.98	89.76	
		19-Jul-21			1.66	90.08	
		31-Aug-21			Dest***	NA	

MW9	91.30	21-Sep-20	Flush mount	None	3.13	88.17	Bedrock
		24-Sep-20			3.15	88.15	
		14-Jan-21			2.83	88.47	
		23-Feb-21			2.92	88.38	
		17-Mar-21			2.54	88.76	
		12-Apr-21			2.56	88.74	
		10-May-21			2.53	88.77	
		10-Jun-21			2.76	88.54	
		19-Jul-21			2.72	88.58	
		31-Aug-21			2.85	88.80	
MW11	91.13	21-Sep-20	Flush mount	None	2.00	89.13	Bedrock
		24-Sep-20			1.95	89.18	
		14-Jan-21			1.29	89.84	
		23-Feb-21			1.35	89.78	
		17-Mar-21			1.19	89.94	
		12-Apr-21			1.00	90.13	
		10-May-21			1.36	89.77	
		10-Jun-21			1.52	88.61	
		19-Jul-21			1.43	89.70	
		31-Aug-21			1.36	89.77	

Notes:
masl* = meters above sea level based on Topographical Survey completed by A.T. McLaren Limited for the site.
mbgs = meters below ground surface
mbtoc = meters below top of casing
[**] = under water/flooded

3.9 Hydraulic Gradients and Flow

Groundwater typically follows the general path of the surface water courses and flows to low lying and major surface water features from areas of higher gradients to areas of relative lower gradients.

The groundwater flow regime for the Site was determined by using the groundwater elevations recorded in monitoring wells MW8, MW9, and MW11. The water table contours lines were completed by using triangulation with linear interpolation. The arrow, perpendicular to the contours, indicates the direction of groundwater flow was southeast on December 3, 2018 as shown on Figure 5 in Appendix A. The horizontal hydraulic gradient across the Site was approximately 0.043 m/m southwest toward Lake Ontario.

3.10 Estimated Hydraulic Conductivity

3.10.1 Hydraulic Conductivity Tests

The estimated hydraulic conductivity values are provided below in Table 4, and normalized head vs. time curves for each hydraulic conductivity test is provided in Appendix D.

It should be noted that the tested monitoring wells are enough to characterize the hydraulic conductivity of the Site, as a result MW9 was not tested.

Table 4. Estimated Hydraulic Conductivity

Monitoring Well	Hydraulic Conductivity (m/s)	Well Screened Material
MW1	1.847×10^{-5}	Bedrock
MW4	8.12×10^{-8}	Bedrock
MW5	1.871×10^{-5}	Bedrock
MW8	8.538×10^{-8}	Bedrock

MW11	1.597 x 10^{-7}	Bedrock

Note:
[1] A regional summary of hydraulic conductivity values derived from consulting work conducted throughout Halton Region, by Holysh, April 1997 is presented in Appendix E. The indicated hydraulic conductivity values for the Queenston Formation range from 1 x 10^{-8} m/s (Gartner Lee, 1983) to 3.2 10^{-5} m/s (Ostry, 1979).

[2] Based on the hydraulic conductivity values in Table 4 above, the geometric mean of the hydraulic conductivity values was determined to be 8.252 x 10^{-7} m/s. As a result, the value of 8.252 x 10^{-7} m/s was adopted in estimating the potential dewatering requirement at the Site.

3.11 Groundwater Quality

Copies of the laboratory Certificates of Analysis are provided in Appendix F.

Sewer Discharge Analysis

The laboratory results for the analyzed groundwater samples collected from monitoring wells MW9 and MW11 were compared to the City of Burlington Municipal Storm Sewer Discharge Limits Guidelines. The parameters that exceeded the Limits Guidelines are highlighted on the table presented below.

Sample Date: October 22, 2020

Parameter	G/S (mg/L)	MW9	MW11
		Lab Result (mg/L)	Lab Result (mg/L)
pH	6.5-8.5*	7.76	7.72
BOD	15	<2	<2
Total Cyanide	0.02	<0.002	<0.002
Phenols	0.008	<0.002	0.005
Total Phosphorus	0.4	0.10	**2.75**
Total Suspended Solids	15	**39**	**202**
Total Arsenic	0.02	<0.015	<0.030
Total Cadmium	0.008	<0.005	<0.010
Total Chromium	0.08	<0.020	**0.086**
Chromium VI	0.04	<0.005	<0.005
Total Copper	0.04	<0.020	**0.068**
Total Lead	0.12	<0.020	<0.040
Total Manganese	0.05	**0.164**	**3.45**
Total Mercury	0.0004	<0.0002	<0.0002
Total Nickel	0.08	<0.030	**0.115**
Total Selenium	0.02	<0.020	<0.040
Total Silver	0.12	<0.020	<0.040
Total Zinc	0.04	<0.020	**0.238**
E. Coli	200**	ND	ND
Methylene Chloride	0.0052	<0.0003	<0.0003

trans-1,3-Dichloropropylene	0.0056	<0.0003	<0.0003
cis-1,2-Dichloroetylene	0.0056	<0.0002	<0.0002
Chloroform	0.002	<0.0002	<0.0002
Benzene	0.002	<0.0002	0.0002
Trichloroethylene	0.0076	0.0002	0.0002
Toluene	0.002	<0.0002	<0.0002
Tetrachloroethylene	0.0044	<0.0001	<0.0001
Ethylbenzene	0.002	<0.0002	<0.0002
1,1,2,2-Tetrachloroethane	0.017	<0.0002	<0.0002
1,2-Dichlorobenzene	0.0056	<0.0002	<0.0002
1,4-Dichlorobenzene	0.0068	<0.0002	<0.0002
Total Xylenes	0.0044	<0.0002	<0.0002
PCBs	0.0004	<0.0002	<0.0002
Pentachlorophenol	0.002	<0.0005	<0.0005
Di-n-butyl phthalate	0.015	<0.0005	<0.0005
3,3'-dichlorobenzidine	0.0008	<0.0001	<0.0001
Bis(2-Ethylhexyl)phthalate	0.0088	<0.0005	<0.0005
Total PAHs	0.002	<0.0003	<0.0003
Total Nonylphenol	0.001	<0.001	<0.001
NP1E0	None	<0.001	<0.001
NP2E0	None	<0.0003	<0.0003
Total Nonylphenol Ethoxylates	0.01	<0.001	<0.001

[*] pH Units
[**] CFU/100ml
[*] Exceedance
[ND] – Not Detected

An application for a proposed groundwater dewatering discharge into the City of Burlington Storm Water System should be submitted for approval. The application should include a dewatering plan by dewatering contractor specifying a treatment system for identified exceedances proposed by the retained dewatering contractor.

According to AGAT Laboratories, Temperature is more of a field parameter that is determined on a case-by-case basis during period of dewatering before discharge. Temperature analysis is not included in AGAT Laboratory package for the City of Burlington Storm Discharge. The temperature value of underground water is usually ambient, and the dewatering contractor should incorporate a system to have the temperature of discharge groundwater <30^{o} C before discharge

3.12 Site Inspection to Assess Hydrogeologic Features

Significant hydrogeologic features were not identified at the site during the inspection.

4.0 WATER TAKING EVALUATION & IMPACT ASSESSMENT

The Molinaro Group proposes to develop the property to comprise of an 8-storey tower with a surrounding three to seven storey podium. The structure will include a maximum of two levels of basement parking. The footprint of the proposed structure is to cover the full site area.

4.1 Estimating Construction Dewatering Rate

It is assumed that the underground levels will be installed in a supported open excavation. The excavation area estimated from the Site Plan provided by Graziani + Corazza Architects Inc. is approximated to be: ~ 75.1 m x 51.0 m = ~3831 m^2.

There will be two levels of underground parking. As a result, the maximum depth of the underground parking is estimated to be 7.1 mbgs (Level 1 = 4.1 m, and Level 2 = 3.0 m). An elevator shaft extension is assumed to be 1.5 m. Therefore, a total excavation depth of 8.6 mbgs is required for the construction. A dewatering depth of approximately 0.5 m below the excavation bottom (9.1 mbgs) is assumed in order to keep the bottom of the excavation dry during construction.

Basement Excavation

The potential groundwater flow rate to the underground parking excavation was estimated using the dewatering equation for a fully penetrated well of confined aquifer fed by circular source:

$$Q = 2\pi kD\,(H-h_w)/(\ln R_o/r_e)$$

Where: Q = pumping rate [m^3/s]
k = hydraulic conductivity [m/s]
D = aquifer thickness [m]
H = height of piezometer level above base of aquifer before dewatering [m]
h_w = height of water after dewatering [m]
R_o. = radius of influence [m]
r_e = equivalent radius [m]

The radius of cone of depression R can be estimated using:

$$R_o = Ch*Sqrt(K)$$

Where: C = is a factor equal to 3000 for radial flow to a pumping well

h = H- h_w = required drawdown [m]
K = hydraulic conductivity [m/s]

Dewatering of a rectangular area can be accomplished by using an equivalent radius (r_e) to assess drawdown where r_e is given by the following equation:

r_e = Sqrt (length*width/π) (applies when a/b>1.5 and $R_o << r_e$)
r_e = (length + width)/π (applies when a/b,1.5 and $R_o >> r_e$)

Static Water Levels

Depths to groundwater in all monitoring wells were obtained manually by Landtek staff on September 21 and 24, 2020, January 14, February 23, March 17, and April 12, 2021. The readings are presented in Table 3. Based on the groundwater levels recorded in monitoring MW9 and MW11 located at the Site, it was determined that depth to groundwater ranged from 1.00 mbgs to 3.15 mbgs. The highest ground water level was determined to be 1.00 mbgs. The data were recorded in September, and it should be noted that depths groundwater vary seasonally, and the water table is typically elevated during spring and periods of active precipitation.

Radial Flow into Excavation

The total amount of groundwater required to be pumped for dewatering the excavation associated with the underground level construction assuming there is no rainfall and applying a factor of safety of 1.5 will be ~70,016 L/day (0.81 L/s). These calculations and associated assumptions are provided in Table 1, Appendix G.

4.2 Dewatering Considerations

4.2.1 Estimating Dewatering Volume

The dewatering rate for the proposed excavation must also consider management of direct precipitation input. As a result, dewatering volume is estimated from the following two contributions:

- Radial flow into an excavation under a water table condition (Section 4.1).
- Direct precipitation

Direct Precipitation

Note: Radial flow into an excavation under a water table condition estimate does not take into account storm water management from rainfall events. Additional volume generated from a 100 year-storm event for the City of Burlington of 100 mm (from Extreme Rainfall Intensity-Duration-Frequency [IDF] Curve for the City of Burlington) rainfall event is estimated as follows:

Direct Precipitation into the proposed excavation = A (m^2) *rainfall (m) = (3,831)*0.100 m = 383.1 m^3/day = 383,100 L/day

Contingencies should be made by the dewatering contractor to handle the estimated volume during active of active precipitation.

4.2.2 Short Term Dewatering Volume

- Dewatering rate outside periods of active precipitation: ~70,016 L/day (~0.81 L/s)
- Dewatering during Spring/active precipitation period: ~~70,016 L/day (radial flow into excavation) + 383,100 L/day (direct precipitation) = 453,116 L/day or ~5.2 L/s.

Normal condition is considered to be weather conditions that should be expected during the operation of the construction dewatering. Normal operation does not include extreme weather events. Dewatering requirements less precipitation is estimated to be approximately 60,680 L/day = ~61 m^3/day.

4.2.3 Long Term Groundwater Control (Post Construction)

Long term dewatering is not required at the Site as the proposed underground parking levels and structures will be designed to be fully waterproofed in accordance regulatory requirements.

4.2.4 Permit to Take Water

The maximum dewatering rate of groundwater for the proposed excavation is estimated to be approximately 453,116 or ~5.2 L/s (radial inflow and direct precipitation). A permit to take water (PTTW) is required for this volume of water taking, as the estimated water taking is more than 400,000 L/day.

4.2.5 Dewatering Volume Plan for Construction

A regional summary of hydraulic conductivity values derived from consulting work conducted throughout Halton Region, by Holysh, April 1997 is presented in Appendix E. The indicated hydraulic conductivity values for the Queenston Formation range from 1×10^{-8} m/s to 1×10^{-6} m/s (Gartner Lee, 1983).

The excavation dewatering volume was also estimated based on the low-end value of hydraulic conductivity for the Burlington Shale of 1×10^{-8} m/s above; and was determined to be approximately 6,044 L/day withr a factor of safety of 1.5. These calculations and associated assumptions are provided in Table 2, Appendix G.

Based on the above, it is recommended that the Dewatering Volume Plan should provide for dewatering volumes ranging from 6,044 L/day or 0.07 l/s (determined using the low-end value of hydraulic conductivity value for Burlington shale) to 453,116 L/day or ~5.2 L/s (radial inflow [determined with the geometric mean of the field determined hydraulic conductivity values] + direct precipitation).

4.2.6 Dewatering Procedure

Based on the results of the hydraulic conductivity tests, seepage through the overburden/bedrock beneath the Site should be feasible to be handled by a sump and/or well point dewatering system. The type of dewatering system to be used should be discussed with a dewatering contractor and be evaluated based on anticipated low and high volumes estimates.

The following general construction practices can be implemented to minimize the volume of water to be extracted:

- Schedule construction outside the spring period when the water table is typically elevated and avoid constructing during period of active precipitation.
- It is recommended that any excavations should be staged or constructed in such a manner to be able to manage dewatering volume conveniently.
- Reduce the length of time during which the open cut remains open.

4.2.7 Water Management and Discharge Plan

The City of Burlington is currently reviewing the Municipal Storm Sewer Discharge By-Law. The City advises that the requirements of the by-law in place should be adhered to at the time of excavation.

4.3 Assessment of Potential Impacts and Water Management

4.3.1 Impact to Existing Groundwater Users

A search of the Ontario Ministry of the Environment Water Well Records for an area extending about 500 m outward from the edge of the excavation was completed, identifying no Water wells in the database. As a result, it is not anticipated that there will be any impact to the existing water wells.

4.3.2 Impact to Surface Water and Natural Functions of the Ecosystem

Rambo Creek is located approximately 77 m east of the Site, Lake Ontario is located approximately 1.4 km southeast of the site. The groundwater dewatering activities will result in localized depression of the groundwater table, and it is anticipated that there will be impact within the radius of influence of approximately 22 m calculated in Table 1, Appendix G.

4.3.3 Contaminants Impacts

This occurs when pre-existing ground or groundwater contamination is mobilised and transported where transmission pathways are created.

Based on the environmental site assessments completed by Landtek, there are no known sources of contamination in groundwater at the Site. As a result, there is no potential for mobilization of contaminants or creation of transmission pathways during the planned groundwater dewatering activities.

4.3.4 Geotechnical Impacts

Geotechnical impacts occur where the geotechnical properties or state of the ground are changed by groundwater control activities. The most common type of impact in this category is ground settlement, with the corresponding risk of distortion and damage to structures, services and other sensitive infrastructure.

Ground settlement can be caused by two principal mechanisms:

- Increases in effective stress as a result of lowering of groundwater levels, resulting in compression and consolidation of the ground. Such settlements are an unavoidable consequence of lowering of groundwater levels.
- Removal of fine particles from the ground (loss of fines) which can occur when poorly controlled sump pumping draws out soil particles with the pumped water. With good design and implementation, loss of fines (and the associated settlement risk) can be avoided.

The Site is located to the east corner area of the intersection of the Brant Street and Ghent Avenue in Burlington, east of Ghent Avenue. The Site is bound by Brant Street to the south, Ghent Avenue to the West, and developed properties to the North and East. It is anticipated that there will be impact within the radius of influence of approximately 22 m calculated in Table 1, Appendix G.

Dewatering could be handled by pumping from a sump/well point dewatering system. The well sump/point system used for lowering the water table within the excavation must be properly screened and installed to ensure that pumping will not remove sediment from the low permeability overburden aquifer. Removal of significant fines may result in the formation of voids and the loss of ground.

Based on the above, potential geotechnical impacts are anticipated during dewatering at the Site. Surrounding buildings and roads should be monitored by geotechnical instrumentation to determine impact, if any.

The proposed monitoring and mitigation plans are presented in Sections 5 and 6, respectively.

5.0 MONITORING PLAN

5.1 Construction Monitoring

Once construction dewatering is initiated it will be difficult to stop pumping or significantly reduce the rate of pumping without disrupting construction activities. It will however be possible to monitor the drawdown response at the construction site and to adjust the pumping rate to optimize drawdown and the associated pumping rate.

5.2 Management of Dewatering Abstraction

5.2.1 Monitoring, Trigger Levels and Management Responses

Abstraction management is critical to ensure target water levels within the construction zone are met, but that over-pumping does not occur.

Target groundwater levels in- and outside excavations will be set individually for each dewatering monitoring well based on location, aquifer and construction requirements, in-line with stated dewatering aims above.

Trigger levels for wells will typically be set 0.5 m above the dewatering target and 1.0 m below the dewatering target to give a 1.5 m target operational zone. These targets may be reviewed and adjusted to decrease size of the operational target zone and increase the factor of safety.

If monitoring indicates that dewatering zone groundwater levels exceed the upper trigger levels (i.e. required drawdown is not being achieved or maintained) management actions are available (in order of preference):

- Adjust automatic pump start and stop water levels.
- Increase pumping rates within the constraints of the system; and/or
- Install additional abstraction capacity (well points, spears or sump pumps).

If monitoring indicates that excavation zone groundwater levels are below the lower trigger levels (i.e. excessive drawdown) management actions available are (in order of preference):

- Adjust automatic pump start and stop water levels; and/or
- Decrease pumping rates; and/or
- Reduce the number of pumps operating.

5.2.2 Contingency Responses

If management responses prove to be insufficient to achieve and maintain the target levels, excavations may be slowed or suspended to enable contingencies to be implemented. Available contingency measures that will be assessed include (in order of preference):

- Construction of additional dewatering wells, spears or sumps.
- Construction of additional drains or groundwater control structures.

Excavation would resume when the required drawdown is able to be reliably obtained.

5.2.3 Settlement Monitoring

Ground settlement can be caused by two principal mechanisms:

- Increases in effective stress as a result of lowering of groundwater levels, resulting in compression and consolidation of the ground. Such settlements are the unavoidable consequence of lowering of groundwater level
- Removal of fine particles from the ground (loss of fines) which can occur when poorly controlled sump pumping draws out soil particles with the pumped water. With good design and implementation, loss of fines (and the associated settlement risk) can be avoided.

Implementation of a settlement monitoring plan should be completed within an approximate radius of influence of 22.0 m of the Site, the estimated radius of influence from dewatering. Prior to commencing dewatering, condition surveys of adjacent properties that could potentially be affected by dewatering, considering anticipated effects and specific dewatering design, should be completed.

Temporary access permit should be obtained from properties and utilities owners with the estimated radius of influence of the Site on a case-by-case basis prior to construction

The following monitoring measures are recommended to be carried out before and during the temporary dewatering:

- Complete a pre-excavation condition survey and install settlement monitoring monuments and or markers at the existing buildings and roadways within the estimated zone of influence. This should be done to document existing ground elevations and building/structure conditions. In addition, buried infrastructure and utilities should be identified and surveyed by ground penetrating radar.

- The settlement monitoring monuments (markers) should be surveyed prior to the dewatering to establish a baseline and surveyed on a daily basis during the dewatering.

- A typical settlement monitoring system should comprise a series of settlement markers sited at various distances beyond and at the site, within the zone of influence of groundwater drawdown. Monitoring points should be surveyed to an accuracy of +/-2 mm. Note that the reference benchmark must be located beyond the extent of the anticipated influence of groundwater drawdown. For very high-risk projects, incorporation of piezometer standpipes will allow confirmation of the field groundwater drawdown and will enable calibration of field settlement observation with theoretical assessments.

- Condition of buried infrastructure and utilities should be monitored on regular basis.

- Alert and Action settlement thresholds should be set, selected through theoretical assessment of anticipated settlements and review of sensitivity of adjacent structures and infrastructures. It is prudent to implement staged groundwater drawdown, providing holding points to allow adequate time to enable observation of the delayed settlement response of the ground.

- The monitoring program will include review and alert levels. If instrument readings exceed “review” levels, the Proponent and its Contractor will jointly assess the necessity of altering the method, rate, or sequence of construction.
- The survey results should be provided to the project geotechnical engineer for evaluation. The estimated potential and actual settlements should also be reviewed by a structural engineer to assess the potential damage to the existing structures.

6.0 MITIGATION PLAN

The groundwater dewatering activities will result in localized depression of the groundwater table, and it is not anticipated that there will impact beyond the radius of influence of 22.0 m.

Mitigation would involve the reduction or elimination of the impacts induced by construction dewatering. As noted above, the potential exists for dewatering to cause ground settlement, with the corresponding risk of distortion and damage to structures, services and other sensitive infrastructure.

Methods to limit adverse dewatering settlement should include the following:

- Settlement associated with loss of fines should be mitigated through appropriate design of the dewatering system to control flow velocity and provide screens and/or filters matched to the grading of the in-situ soils. Entrainment of fines must be monitored during construction; actions could include analysis of TSS in discharge water and/or monitoring of accumulation of sediment in sedimentation tanks.

- Drawdown-induced ground settlement should be mitigated though pre-construction estimation of groundwater drawdown and settlement coefficients to identify risk prior to drawing the groundwater down, and water level monitoring in monitoring wells to check that larger drawdown than anticipated at distance from the excavation are not occurring.

- Differential settlement is most problematic. This should be reduced by managing the rate of drawdown and understanding where clear changes in soil type occur. Should potentially damaging settlement be indicated, these can be mitigated by installing groundwater cut-offs to stem or restrict groundwater flow and limit drawdown beyond the site.

- Sufficient temporary support should be provided for excavations to maintain stability, where seeps might otherwise induce progressive collapse of the sides of the excavation.

- During dewatering, staged drawdowns (where appropriate) should be implemented and field settlement and water level changes beyond the immediate site monitored, comparing against theoretical settlements and water levels to allow warning of potential dewatering settlement issues.

At “alert” levels during monitoring, the dewatering should be reduced to a lower rate or ceased temporarily, and alternative measures considered for the excavation, which should be approved by the project geotechnical engineer and project team.

If the settlement monitoring indicates an undesirable deformation, the project manager should order construction operations to cease until the necessary mitigation measures are undertaken.

In the event that a property or infrastructure owner submits a claim for damages, the Developer should conduct further investigations and, if appropriate, negotiate a settlement.

7.0 SITE DEVELOPMENT, HYDROGEOLOGY and WATER BALANCE

The following discussion and recommendations are based on the data gathered for the study and are presented for site planning purposes.

7.1 Site Development Concept

It is understood that the proposed development is to comprise of an 8-storey tower with a surrounding three to seven storey podium. The structure will include a maximum of two levels of basement parking. The footprint of the proposed structure is to cover the full site area.

The following summarizes the proposed approximate land coverage areas for the development:

- Building roof area ..... 0.229 ha
- Parking Areas, Roadways, and other impervious Areas..... 0.087 ha
- Green space, SWMP, natural areas..... 0.068 ha
- **Total Area ..... 0.383 ha**

7.2 Principal Hydrogeologic Features and Functions

The results of the study indicate that the site hydrogeologic characteristics can be summarized as follows:

- Generally, the site stratigraphy consists of fill/clayey silt to depths varying from 3.0-3.5 mbgs, over bedrock. Drilling was terminated at a maximum depth of approximately 9.3 mbgs in bedrock.
- The water table recorded at the site ranges from 1.95 mbgs to 3.15 mbgs.
- There will be two levels of underground parking. As a result, the maximum depth of the underground parking is estimated to be 7.1 mbgs (Level 1 = 4.1 m, Level 2 = 3.0 m). An elevator shaft extension is assumed to be 1.5 m. Therefore, a total excavation depth of mbgs is required for the construction. A dewatering depth of approximately 0.5 m below the excavation bottom (9.1 mbgs) is assumed in order to keep the bottom of the excavation dry during construction.
- The Site is generally flat with a slight slope from the northeast to southwest. Based on groundwater levels measured at the Site, the inferred shallow groundwater flow direction is southwesterly.

The above noted hydrogeological characteristics should be considered in conjunction with the requirement for site development plans and in particular storm water management practices at the site. Further information regarding water balance at the site is presented in the following section.

Based on the above information, the following considerations should be made with respect to maintenance of hydrogeologic functions and hydrogeologic conditions at the site:

- The site consists of fill/clayey silt overlying shale bedrock and would not be well suited to groundwater recharge due to the relatively high hydraulic conductivity of the subsurface strata. Engineered infiltration methods, other Best Management Practices and low impact development methods should be implemented accordingly.

7.3 Water Balance

The proposed site development plan will result in the construction of buildings, parking areas, and roadways. Without mitigation, this will lead to a decrease in infiltration and groundwater recharge.

The surface soils at the site will provide relatively high water recharge into the shallow groundwater system. This is a result of the relatively high permeable silty sand/sandy silt soil encountered below ground surface across the site. Based on the subsurface investigation completed for the site, no enhanced zones of groundwater flow or transmission were identified across the site.

Notwithstanding the above, one of the objectives during development should be to ensure that the overall volume of groundwater recharge is not significantly impacted. A water balance for the site was prepared to assess the distribution of precipitation, evapotranspiration, infiltration and runoff for existing (pre-development) conditions as well as post-development conditions. The water balance calculations are detailed in Appendix H.

Evapotranspiration represents the transport of water from the earth back to the atmosphere and is an important component to a water balance calculation. The Thornthwaite method was used to calculate potential evapotranspiration typical for the region. By using equations 8, 9, and 10 in Thornthwaite (1948), the potential evapotranspiration for the region was found to be 609 mm/year. The calculation is included in Appendix H.

As was presented in Table 2, the annual total precipitation was taken from the Hamilton Airport climate station for the period of 1981 to 2010. Total annual precipitation for the area is 930 mm/year and mean daily temperature is 7.9 °C.

In summary, the total shallow groundwater recharge rate for the site is estimated to be 175 mm/year. This recharge was referenced from the MOE Table 2 and Table 3 approach in the Technical Information Requirements for Land Development Applications (MOE, 1995). The post-development water budget was calculated and is presented in Appendix H. A recharge rate of 100 mm/year was assumed for the silty sand/sandy silt beneath the site.

The water balance (pre- and post-development) is summarized in Table 5 from Appendix H.

Table 5. Comparison of Pre- and Post-Development Water Balance

Development	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Pre-Development	3,563	897	147	2,518
Post-Development	3,565	413	68	3,084

The increase in run-off from 2,518 m^3 to 3,084 m^3 is the result of developing and installing hard surfaced or impermeable areas across the site. The post-development impermeable areas also result in the decrease of evapotranspiration and infiltration across the site.

The above-noted values and associated calculations found in Appendix H are considered to be conservative and are based on the following assumptions:

- No infiltration will occur beneath the internal roads, walkways, buildings or driveways.
- No evapotranspiration will occur from the internal roads, walkways, buildings or parking areas.

7.4 Mitigating Measures to Maintain Hydrogeological Functions

7.4.1 Maintenance of Groundwater Recharge

The site is considered to have significant amounts of groundwater recharge due to the relatively high permeable soils encountered at surface at the site. There is no natural area for infiltration proposed for the development. However, infiltration value is expected to decrease from 147 to 68 m^3/year based on the water balance calculations outlined in Appendix H. This decrease in infiltration indicates that approximately 4% of the roof runoff from the proposed buildings must be re-directed towards overland flow or infiltration facilities in order to match the pre-development infiltration rates.

It is recommended that development planners collaborate with storm water specialists or engineers to be able to maintain pre-development water balance and recharge at the site through storm water management design techniques. Perhaps Low Impact Development techniques would be applicable for this site.

7.4.2 Maintenance of Groundwater Transmission Pathways

As referenced from the Graziani & Corazza Architects Inc. drawings provided by Molinaro Group, it is understood that the earthworks and servicing will be completed within the clayey silt and bedrock beneath the Site. The overall continuity of the groundwater flow at the site should be maintained, where practical. Generally, any groundwater transmission pathways encountered can be maintained through the following means:

- The excavation of any underground services or utilities across more permeable layers may interrupt the groundwater flow. As good practice, it is recommended that trench backfilling operations be carried out with materials that are similar to the materials that have been excavated. In particular, if any more permeable sand zones are encountered, they must not be truncated by backfilling of the excavation or trench using lower permeability materials (such as the silty sand/sandy silt identified at the subject site).

8.0 SUMMARY AND CONCLUSIONS

The following summarizes the results of the investigation:

- Generally, the site stratigraphy consists of fill/clayey silt to depths varying from 3.0-3.5 mbgs, which overlies bedrock. Drilling was terminated at a maximum depth of approximately 9.3 mbgs in bedrock.
- Lake Ontario is located approximately 1.4 km southeast of the site. The direction of groundwater flow at the site is southwest towards.
- Groundwater contour plot from groundwater monitoring levels recorded on September 24, 2020 indicates the direction of groundwater flow was southwest. The horizontal hydraulic gradient across the Site, was approximately 0.043 m/m southwest.
- The water table present within the shale bedrock at the site ranges from 1.0 meters mbgs to 3.15 mbgs.
- There will be two levels of underground parking. As a result, the maximum depth of the underground parking is estimated to be 7.1 mbgs (Level 1 = 4.1 m, and Level 2 = 3.0 m). A dewatering depth of approximately 0.5 m below the excavation bottom (7.6 mbgs) is assumed in order to keep the bottom of the excavation dry during construction.
- The maximum short term dewatering rate of groundwater for the proposed excavation under normal operation which does not include extreme weather events is estimated to be approximately 70,016 L/day = ~0.81 L/s.
- Long term dewatering is not required at the Site as the proposed underground parking levels and structures will be designed to be fully waterproofed in accordance regulatory requirements.
- The maximum dewatering rate of groundwater for the proposed excavation is estimated to be approximately 453,116 L/day or ~5.2 L/s (radial inflow and direct precipitation).
- A permit to take water (PTTW) is required for above volume of water taking, as the estimated water taking is more than 400,000 L/day.
- A Dewatering Volume Plan for construction should provide for dewatering volumes ranging from 6,044 L/day or 0.07 L/s (determined using the low-end value of hydraulic conductivity value for Burlington shale) to 453,116 or ~5.2 L/s (radial inflow [determined with the geometric mean of the field determined hydraulic conductivity values] + direct precipitation).
- Water extracted during construction dewatering is required to be discharged into an approved combined storm sewer near the Site.
- As per the Sewers ByLaw, in order to issue a discharge approval, information relating to the quality and quantity of the discharge must be provided to City of Burlington. It is strongly recommended that the applicant provide this information eight to twelve weeks prior to the proposed start of discharge.
- Geotechnical and surface water impacts are anticipated during groundwater dewatering within a radius of approximately 22 m outside the Site boundaries.

9.0 RECOMMENDATIONS

The following general construction practices are recommended to minimize the volume of water to be extracted:

- Schedule construction outside the spring period when the water table is typically elevated and avoid constructing during period of active precipitation.
- Reduce the length of time during which the open cut remains open.
- Install valves on the individual well point to allow for the flow adjustment.

The City of Burlington is currently reviewing the Municipal Storm Sewer Discharge By-Law. The City advises that at the time of excavation the requirements of the by-law in place should be adhered to.

An application for a Permit to Take Water (PTTW) should be completed for the potential groundwater dewatering requirement at the Site.

10.0 CLOSURE

We trust this report is satisfactory for you purposes. If you have any questions regarding our submission, please do not hesitate to contact this office.

Yours truly,

Landtek Limited



Henry Erebor, M.Sc., P.Geo.,

11.0 REFERENCES

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Ontario Geological Survey, OGS Earth. Quaternary Geology of Ontario

Ontario Geological Survey, OGS Earth. Bedrock Geology of Ontario.

12.0 LIMITATIONS

The conclusions and recommendations given in this report are based on information determined at the borehole locations. Subsurface and ground water conditions between and beyond the boreholes may be different from those encountered at the borehole locations, and conditions may become apparent during construction that could not be detected or anticipated at the time of the geotechnical investigation. It is recommended practice that Landtek be retained during construction to confirm that the subsurface conditions throughout the site are consistent with the conditions encountered in the boreholes.

The comments made in this report on potential construction problems and possible remedial methods are intended only for the guidance of the designer. The number of boreholes may not be sufficient to determine all the factors that may influence construction methods and costs. For example, the thickness and quality of surficial topsoil or fill layers may vary markedly and unpredictably. Contractors bidding on the project, or undertaking construction on the site should make their own interpretation of the factual borehole information, and establish their own conclusions as to how the subsurface conditions may affect their work.

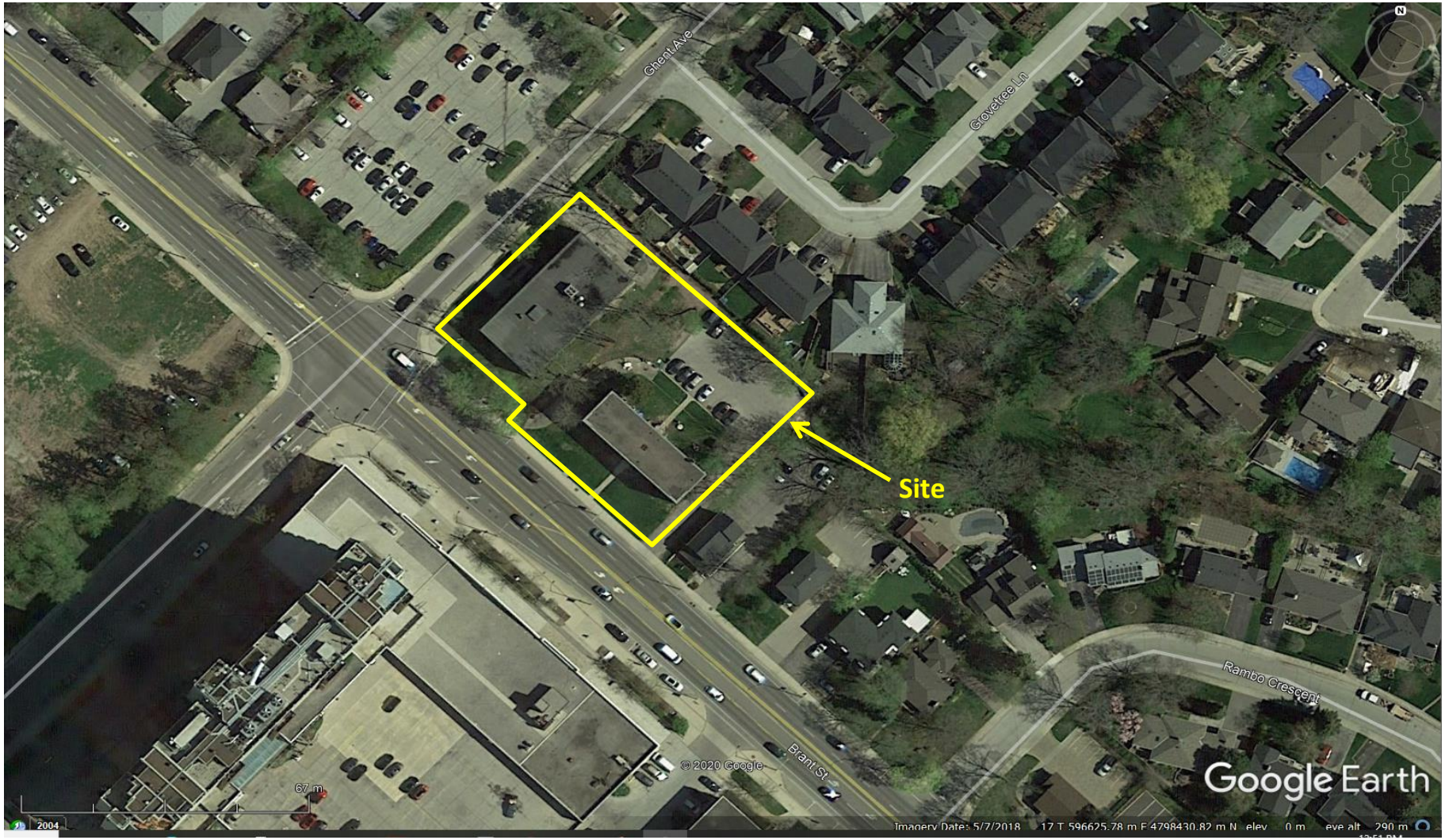
The survey elevations in the report were obtained by Landtek or others, and are strictly for use by Landtek in the preparation of the geotechnical report. The elevations should not be used by any other parties for any other purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Landtek accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

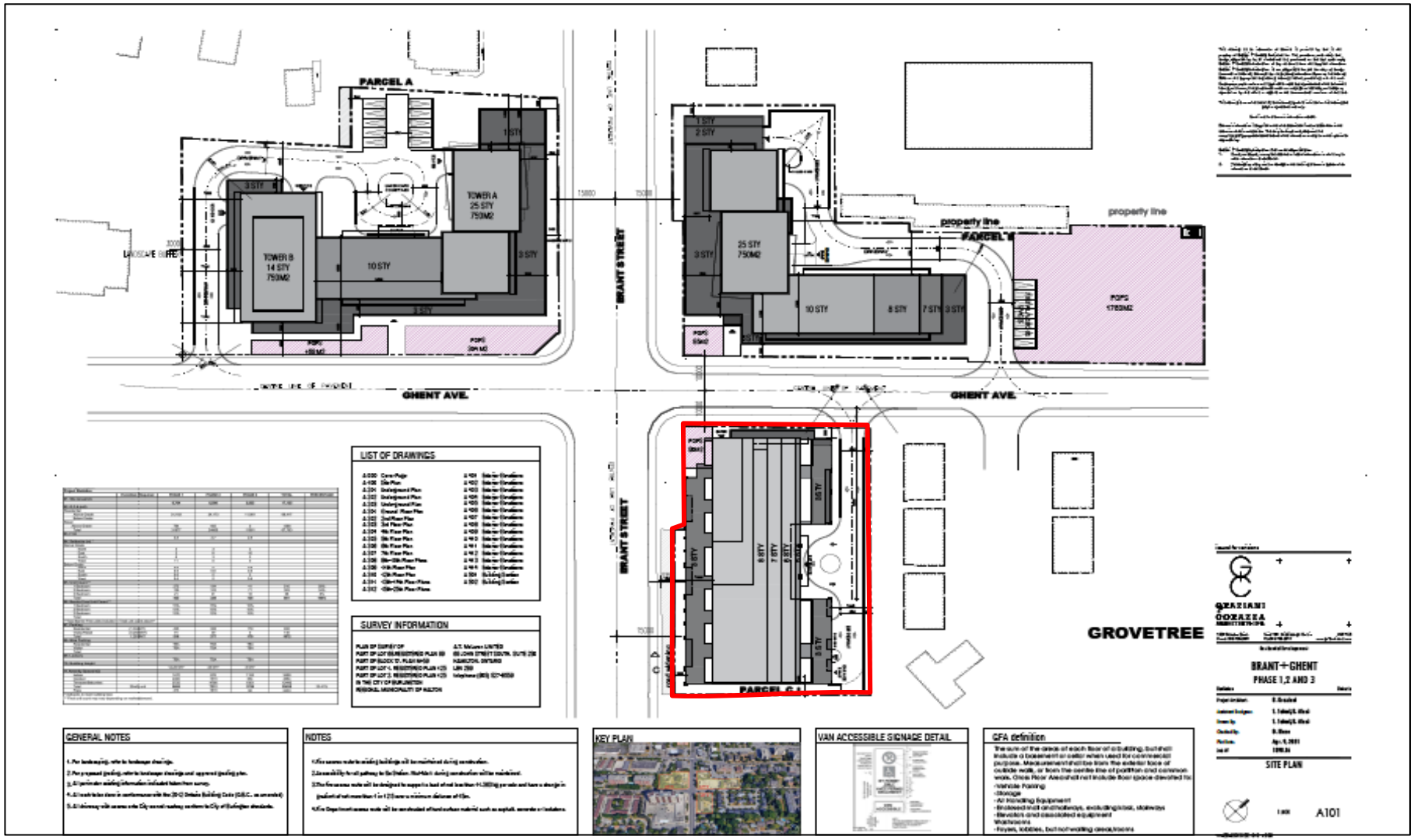
This report does not reflect environmental issues or concerns related to the property unless otherwise stated in the report. The design recommendations given in the report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, it is recommended that Landtek be retained during the final design stage to verify that the design is consistent with the report recommendations, and that the assumptions made in the report are still valid.

APPENDIX A

FIGURES

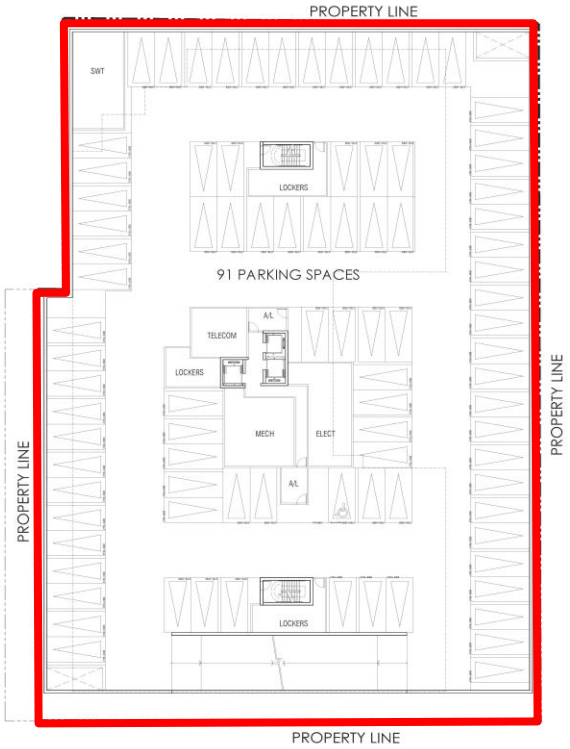


LANDTEK LIMITED ***CONSULTING ENGINEERS*** **205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1**	
Scale: See Map	Date: September 2020
Project:	Hydrogeological Investigation 747 and 761 Brant Street Burlington, Ontario
Title:	Figure 1: Site Location
Project No.	20255C



Site

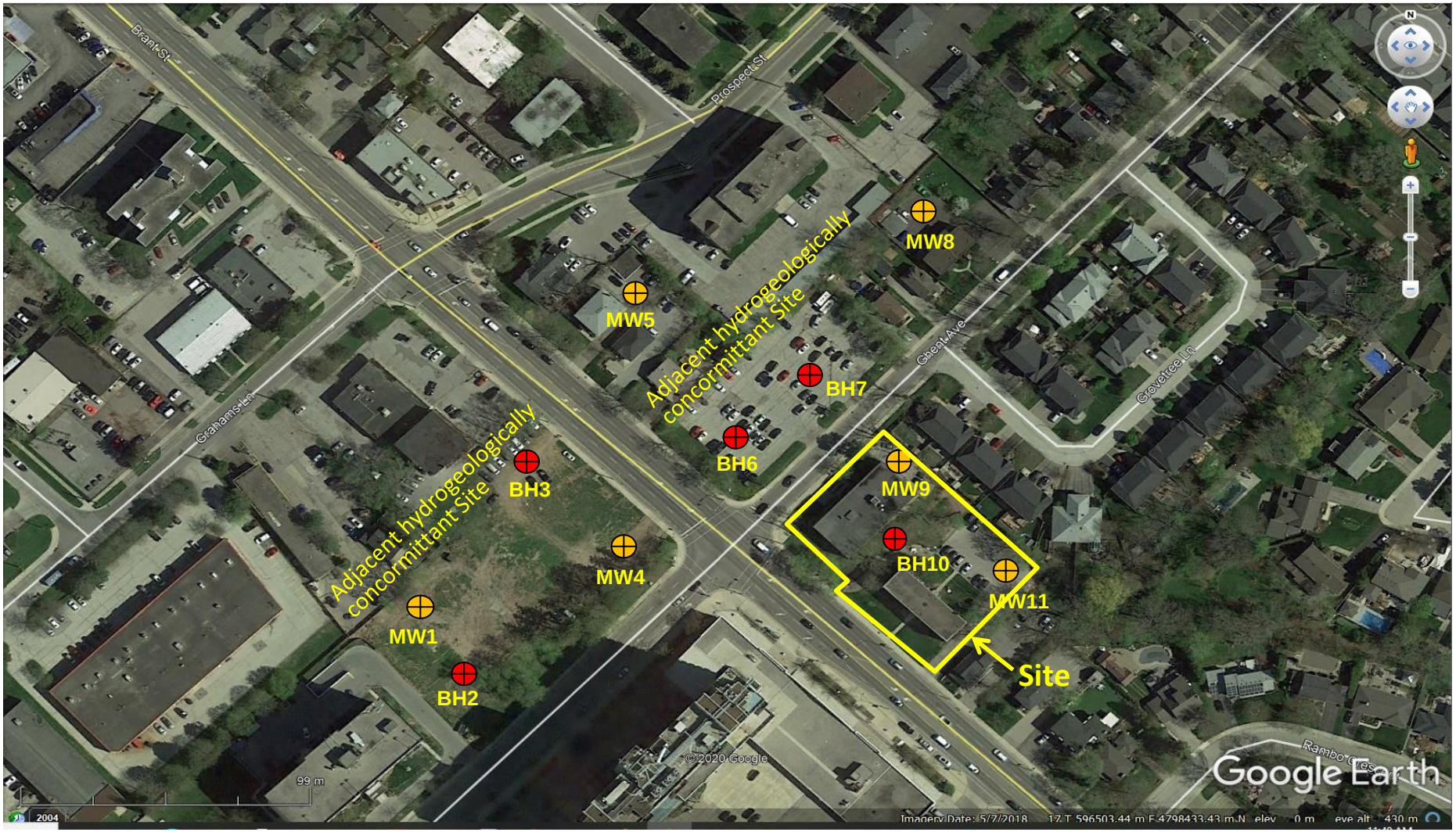
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Scale: On Plan	Date: May 2021
Project:	Hydrogeological Investigation 774-782 Brant Street Burlington, Ontario
Title:	Figure 2: Site Plan
Project No.	20255A







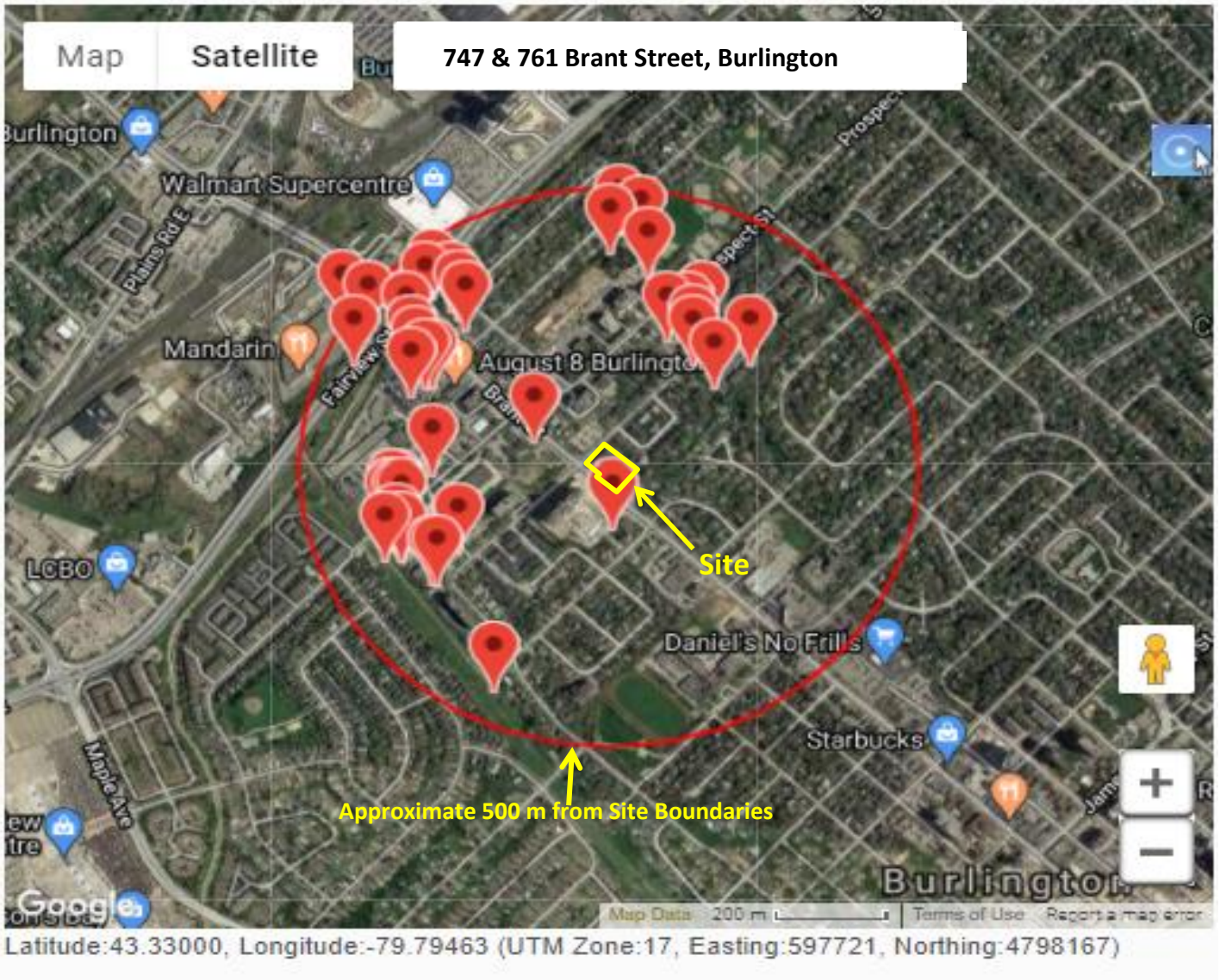
	LANDTEK LIMITED ***CONSULTING ENGINEERS*** **205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1**
Scale: On Plan	Date: May 2022
Project:	Hydrogeological Investigation Hydrogeological Investigation 774-782 Brant Street
Title:	Figure 3: Underground Parking Plan
Project No.	20255C



Monitoring Well Location

Borehole Location

LANDTEK LIMITED *CONSULTING ENGINEERS* 205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1	
Scale: See Map	Date: September 2020
Project:	Hydrogeological Investigation 747 and 761 Brant Street Burlington, Ontario
Title:	Figure 4: Boreholes and Monitoring Wells Locations
Project No.	20255C



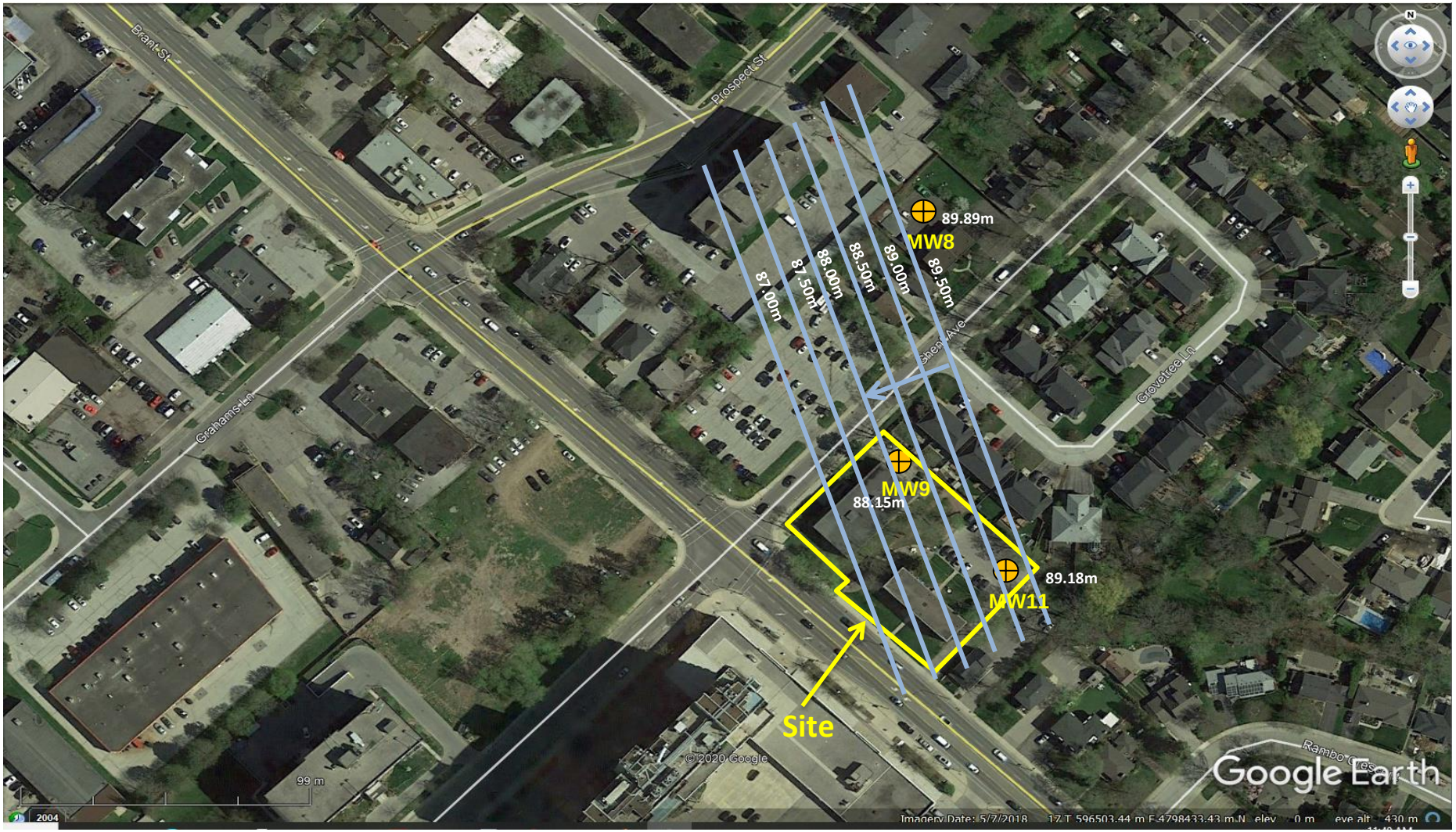
MECP Wells Locations

LANDTEK LIMITED

CONSULTING ENGINEERS

205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

	Scale: See Map	Date: September 2020
Project:	Hydrogeological Investigation 747 and 761 Brant Street Burlington, Ontario	
Title:	Figure 5: MECP Wells Locations	
Project No.	20255	



LEGEND

- Borehole/Monitoring Well
- Groundwater Flow Direction
- 90.00 m — Groundwater Level Contour

	LANDTEK LIMITED *CONSULTING ENGINEERS* **205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1**
Scale: See Map	Date: September 2020
Project:	Hydrogeological Investigation 747 and 761 Brant Street Burlington, Ontario
Title:	Figure 6: Monitoring Wells Locations
Project No.	20255C

APPENDIX B

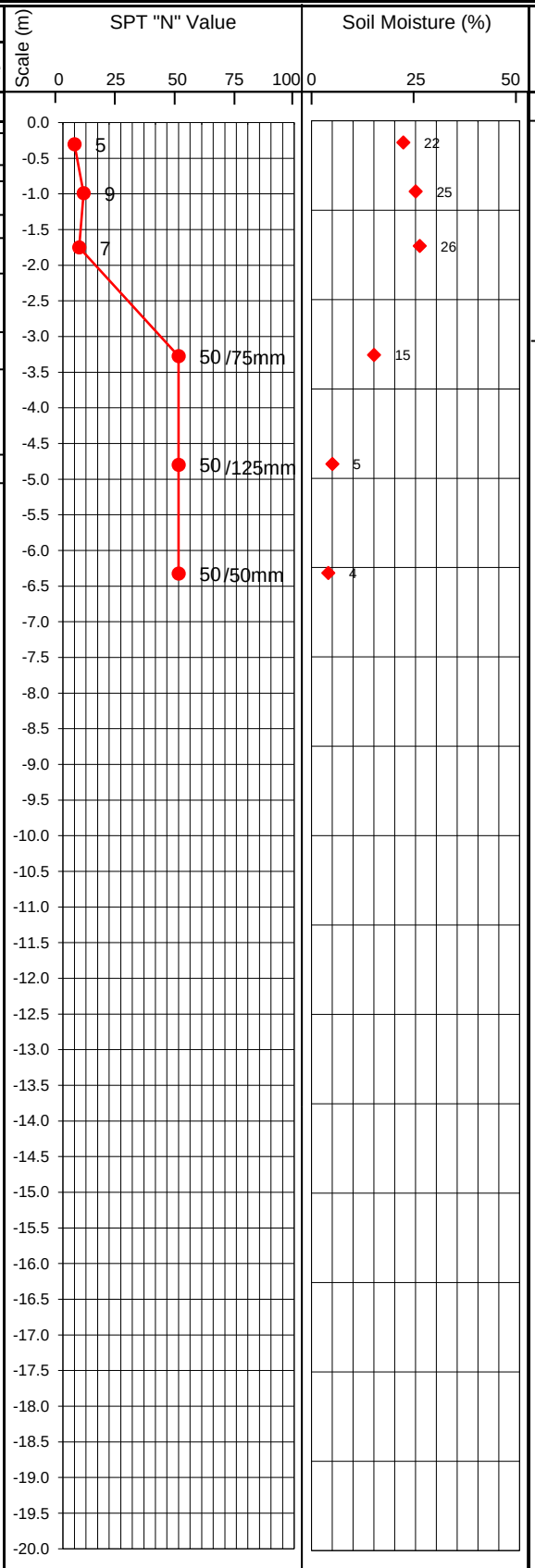
BOREHOLES & MONITORING WELLS LOGS

Landtek Limited

BH 9

Project No.:	20255C	Drill Date:	August 31, 2020
Project:	Hydrogeological Investigation	Drill Method:	[ ] solid stem [x] hollow stem [ ] Coring
Location:	Brant Street and Ghent Avenue, Burlington, Ontario	Datum:	Geodetic (Approximate)

Material Description	Elev. Depth	Samples No.	Type	Test Data
Ground Surface	91.3			Flush mount
±50 mm of asphalt	0.0	1	SS	
± 200 mm of crushed limestone				
FILL: clayey silt, trace gravel, dark brown, firm, moist		2	SS	
		3	SS	
	88.3			
CLAYEY SILT TILL: trace gravel, trace shale, brownish grey, very stiff, moist	3.0	4	SS	
	3.5			
SHALE BEDROCK (Queenston Formation) very weak to weak, highly weathered, red, moist		5	SS	
	82.2			
	9.1			
AUGER REFUSAL **BOREHOLE TERMINATED**				



Notes:
1. Groundwater not encountered during drilling
2. Water level reading: 3.15 m on September 24, 2020

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

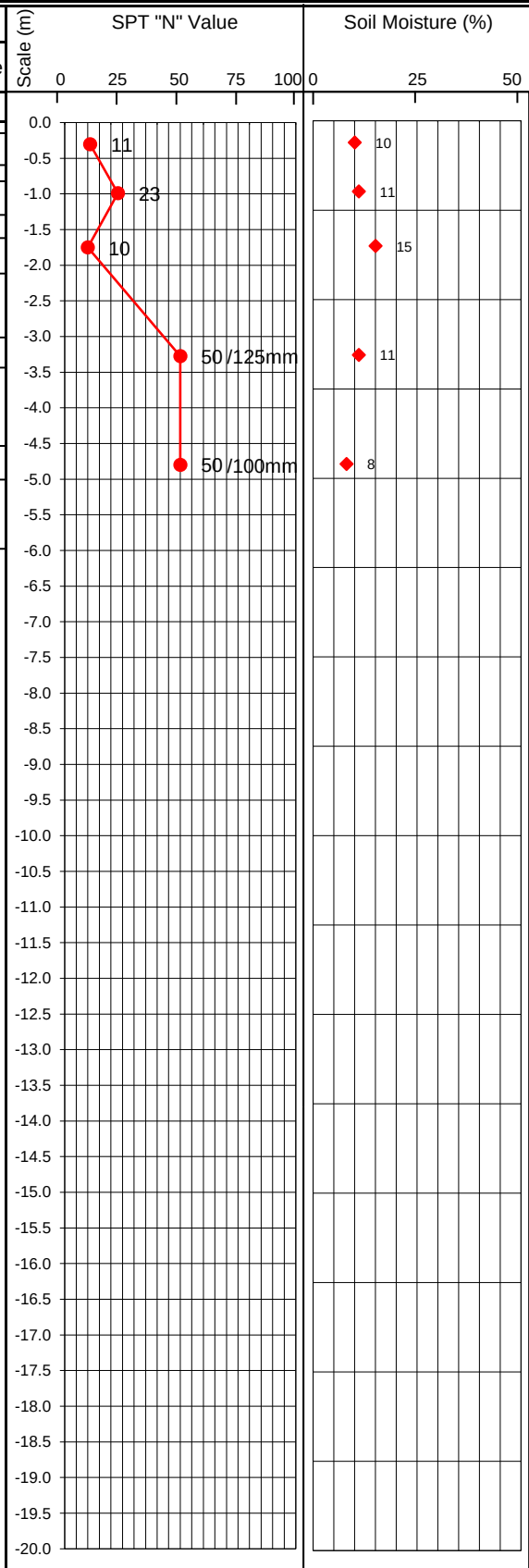
Landtek Limited
205 Nebo Road, Unit 3
Hamilton, Ontario, Canada, L8W 2E1
Ph: (905) 383-3733 Fax: (905) 383-8433
www.landteklimited.com

Landtek Limited

BH 10

Project No.:	20255C	Drill Date:	August 31, 2020
Project:	Hydrogeological Investigation	Drill Method:	[ ] solid stem [x] hollow stem [ ] Coring
Location:	Brant Street and Ghent Avenue, Burlington, Ontario	Datum:	Geodetic (Approximate)

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	Test Data
Ground Surface		91.3			
±50 mm of Topsoil		0.0			
FILL: clayey silt, trace gravel, trace iron staining, stiff to very stiff, moist			1	SS	
			2	SS	
			3	SS	
SHALE BEDROCK (Queenston Formation) very weak to weak, highly weathered, red, moist		3.0	4	SS	
			5	SS	
AUGER REFUSAL **BOREHOLE TERMINATED**		6.0			



GWL | Monitor Details | Test Data

Notes: 1. Groundwater not encountered during drilling

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

Landtek Limited
205 Nebo Road, Unit 3
Hamilton, Ontario, Canada, L8W 2E1
Ph: (905) 383-3733 Fax: (905) 383-8433
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BH/MW 11

Project No.:	20255C	Drill Date:	August 31, 2020
Project:	Hydrogeological Investigation	Drill Method:	[ ] solid stem [x] hollow stem [x] Coring
Location:	Brant Street and Ghent Avenue, Burlington, Ontario	Datum:	Geodetic (Approximate)

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	Scale (m)
Ground Surface		91.1			
±50 mm of asphalt ± 100 mm of crushed limestone **FILL:** clayey silt, trace gravel, trace iron staining, soft to stiff, very moist to wet		0.0	1 2 3	SS SS SS	
		88.1			
SHALE BEDROCK (Queenston Formation) very weak to weak, highly weathered, red, moist 7.6 m to 9.3 m: slightly weathered to fresh, medium strong		3.0 83.5	4 5	SS SS	63 mm Dia. Core
Recovery = 100 %; RQD = 83 % ∂ = 25.7 kN/m³; UCS strength = 27.3 MPa		7.6	RUN #1		
Recovery = 100 %; RQD = 100 % ∂ = 25.7 kN/m³; UCS strength = 39.5 MPa		8.5 81.8	RUN #2		
BOREHOLE TERMINATED		9.3			

SPT "N" Value: 9, 8, 3, 50/125 mm, 50/75 mm

Soil Moisture (%): 27, 22, 22, 19, 5

GWL: WL = 1.95 m Sept. 24, 2020

Monitor Details: Flush mount; bentonite backfill to 0.3 m below existing pavement surface; sand backfill to 6.0 m; 6.3 m; 3.0 m of slotted 50 mm dia. PVC pipe; 9.3 m

Notes:
1. Groundwater not encountered during drilling
2. Water level reading: 1.95 m on September 24, 2020

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

Landtek Limited
205 Nebo Road, Unit 3
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Ph: (905) 383-3733 Fax: (905) 383-8433
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APPENDIX C

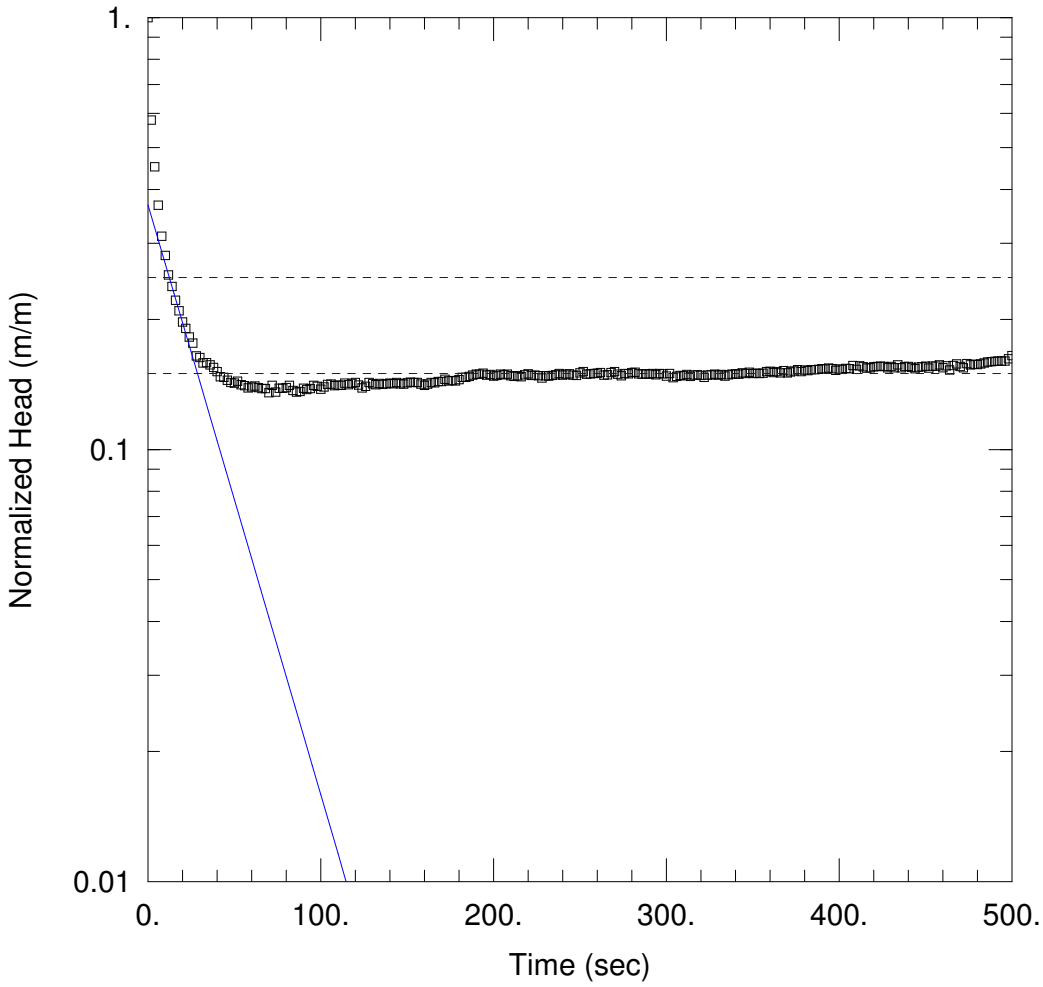
SUMMARY OF MECP WELL RECORDS

906 Main Street West, Hamilton

Well #	WELL_ID	DATE_COMPLETED	DATE_RECEIVED	EAST83	NORTH83	WATER_FOUND_ DEPTH (FT)	Static Water Level (ft)	KIND	FINAL_STATUS	USE_1ST	DEPTH_TO (ft)	DEPTH_TO (m)	Well Construction	STREET	CITY
1	2810171	09-Feb-05	10-Mar-05	596252	4798292	11.5	NA	Fresh	Observation Well	Observation Well	14.8	4.51	Overburden	1380 Grahams Lane	BURLINGTON
2	2810214	21-Mar-05	26-Apr-05	596212	4798276	6.6	NA	NA	Observation Well	NA	14.8	4.51	Overburden	NA	BURLINGTON
3	2810308	16-May-05	03-Aug-05	596240	4798302	8.2	NA	Fresh	Observation Well	Observation Well	15.1	4.60	Overburden	1380 Grahams Lane	BURLINGTON
4	7042731	03-Apr-07	17-Apr-07	596361	4798305	NA	NA	NA	Observation Well	Monitoring Well	13.1	3.99	Overburden	802 Hager Avenue	BURLINGTON
5	7128794	09-Jan-08	01-Sep-09	596186	4798748	NA	NA	NA	Abandoned	Monitoring Well	22.3	6.80	Overburden	2075 Fairview Street	BURLINGTON
6	7179514	09-Jan-12	17-Apr-12	596238	4798370	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	16.73	5.10	Overburden	1380 Grahams Lane	BURLINGTON
7	7179515	19-Jan-12	17-Apr-12	596232	4798362	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	16.73	5.10	Overburden	1380 Grahams Lane	BURLINGTON
8	7179516	19-Jan-12	17-Apr-12	596245	4798354	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	16.73	5.10	Overburden	1380 Grahams Lane	BURLINGTON
9	7179605	19-Jan-12	17-Apr-12	596248	4798355	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	18	5.49	Overburden	1380 Grahams Lane	BURLINGTON
10	7187211	NA	17-Sep-12	596799	4798762	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Bedrock	2096 Hent Avenue	BURLINGTON
11	7187212	NA	17-Sep-12	596775	4798734	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Bedrock	2084 Ghgnt Avenue	BURLINGTON
12	7220604	21-Apr-14	20-May-14	596782	4798703	NA	NA	NA	Monitoring Well	Monitoring Well	17	5.18	Bedrock	2702 Ghent Avenue	BURLINGTON
13	7220605	21-Apr-14	20-May-14	596782	4798703	NA	NA	NA	Abandoned	NA	20	6.10	NA	2702 Ghent Avenue	BURLINGTON
14	7244979	03-Jun-15	21-Jul-15	596883	4798686	7	NA	NA	Abandoned	NA	NA	NA	NA	2086 Grant Avenue	BURLINGTON
15	7244980	03-Jun-15	21-Jul-15	596883	4798686	NA	NA	NA	Observation Well	Monitoring Well	18	5.5	Bedrock	2086 Grant Avenue	BURLINGTON
16	7244981	03-Jun-15	21-Jul-15	596883	4798686	NA	NA	NA	Observation Well	NA	18	5.49	Bedrock	2086 Grant Avenue	BURLINGTON
17	7244982	03-Jun-15	21-Jul-15	596825	4798636	NA	NA	NA	Abandoned	NA	NA	NA	NA	2086 Grant Avenue	BURLINGTON
18	7251865	11-Sep-15	10-Nov-15	596782	4798684	NA	NA	NA	Monitoring Well	Monitoring Well	20	6.10	Bedrock	2068 Ghent Avenue	BURLINGTON
19	7252011	04-Sep-15	10-Nov-15	596736	4798745	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Bedrock	2071 Ghent Avenue	BURLINGTON
20	7283351	04-Nov-16	17-Mar-17	596640	4798358	NA	NA	NA	Monitoring and Test hole	Test Hole	20	6.10	Overburden	730 Brant Street	BURLINGTON
21	7284939	07-Mar-17	10-Apr-17	596319	4798254	NA	NA	NA	Monitoring and Test hole	Test Hole	15	4.57	Bedrock	770 Haggar Avenue East	BURLINGTON
22	7284940	07-Mar-17	10-Apr-17	596309	4798244	NA	NA	NA	Monitoring and Test hole	Test Hole	15	4.57	Bedrock	770 Haggar Avenue East	BURLINGTON
23	7290057	26-May-17	07-Jul-17	596301	4798815	NA	NA	NA	Observation Well	Test Hole	20	6.10	Overburden	833 Brant Street	BURLINGTON
24	7290058	26-May-17	07-Jul-17	596289	4798790	NA	NA	NA	Observation Well	Test Hole	20	6.10	Overburden	855 Brant Street	BURLINGTON
25	7291911	12-Jun-17	02-Aug-17	596224	4798347	NA	NA	NA	NA	NA	NA	NA	NA	NA	BURLINGTON
26	7292314	21-Jun-17	11-Aug-17	596336	4798785	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Overburden	849 Brant Street	BURLINGTON
27	7292315	21-Jun-17	11-Aug-17	596336	4798786	NA	NA	NA	Observation Well	Monitoring Well	30	9.15	Overburden	849 Brant Street	BURLINGTON
28	7292316	21-Jun-17	11-Aug-17	596361	4798743	NA	NA	NA	Observation Well	Monitoring Well	18	5.49	Overburden	849 Brant Street	BURLINGTON
29	7292317	21-Jun-17	11-Aug-17	596352	4798776	NA	NA	NA	Observation Well	Monitoring Well	18	5.49	Overburden	849 Brant Street	BURLINGTON
30	7314898	04-Jul-18	19-Jul-18	596295	4798451	NA	NA	NA	Observation Well	Monitoring Well	15	4.57	Overburden	1416 Graham Lane	BURLINGTON
31	7320914	22-Aug-18	18-Oct-18	596673	4798937	NA	NA	NA	Test Hole	Test Hole	65.6	20.00	Overburden	2087 Prospect Street	BURLINGTON
32	7320915	22-Aug-18	18-Oct-18	596624	4798918	NA	NA	NA	Test Hole	Test Hole	65.6	20.00	Overburden	2087 Prospect Street	BURLINGTON
33	7320916	22-Aug-18	18-Oct-18	596697	4798876	NA	NA	NA	Test Hole	Test Hole	65.6	20.00	Overburden	2087 Prospect Street	BURLINGTON
34	7323581	05-Oct-18	06-Dec-18	596643	4798961	NA	NA	NA	Test Hole	Test Hole	20	6.10	Overburden	2103 Prospect Street	BURLINGTON
35	7330854	14-Feb-19	01-Apr-19	596270	4798655	NA	NA	NA	Observation Well	Monitoring Well	13	3.96	Overburden	850 Brant Street	BURLINGTON
36	7330855	14-Feb-19	01-Apr-19	596305	4798644	NA	NA	NA	Observation Well	Monitoring Well	15.6	4.76	Overburden	850 Brant Street	BURLINGTON
37	7330856	15-Feb-19	01-Apr-19	596261	4798608	NA	NA	NA	Monitoring and Test hole	Monitoring Well	15.6	4.76	Overburden	850 Brant Street	BURLINGTON
38	7330857	15-Feb-19	01-Apr-19	596254	4798731	NA	NA	NA	Monitoring and Test hole	Monitoring Well	15.6	4.76	Overburden	850 Brant Street	BURLINGTON
39	7330858	15-Feb-19	01-Apr-19	596259	4798693	NA	NA	NA	Monitoring and Test hole	Monitoring Well	15.6	4.76	Overburden	850 Brant Street	BURLINGTON
40	7330859	14-Feb-19	01-Apr-19	596288	4798651	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Overburden	850 Brant Street	BURLINGTON
41	7331850	23-Aug-18	23-Apr-19	596494	4798533	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Overburden	280 Brant Street	BURLINGTON
42	7332300	NA	08-May-19	596425	4798027	NA	NA	NA	NA	NA	NA	NA	NA	NA	BURLINGTON

APPENDIX D

HYDRAULIC CONDUCTIVITY TESTING ANALYSIS RESULTS



HYDRGEOLOGICAL INVESTIGATION

Data Set: F:\...\MW1-update.aqt
Date: 10/07/20 Time: 09:51:07

PROJECT INFORMATION

Company: Landtek Limited
Client: Milinaro Group
Project: 20255-A
Location: 774-780 Brant Street E.
Test Well: MW1
Test Date: September 24, 2020

AQUIFER DATA

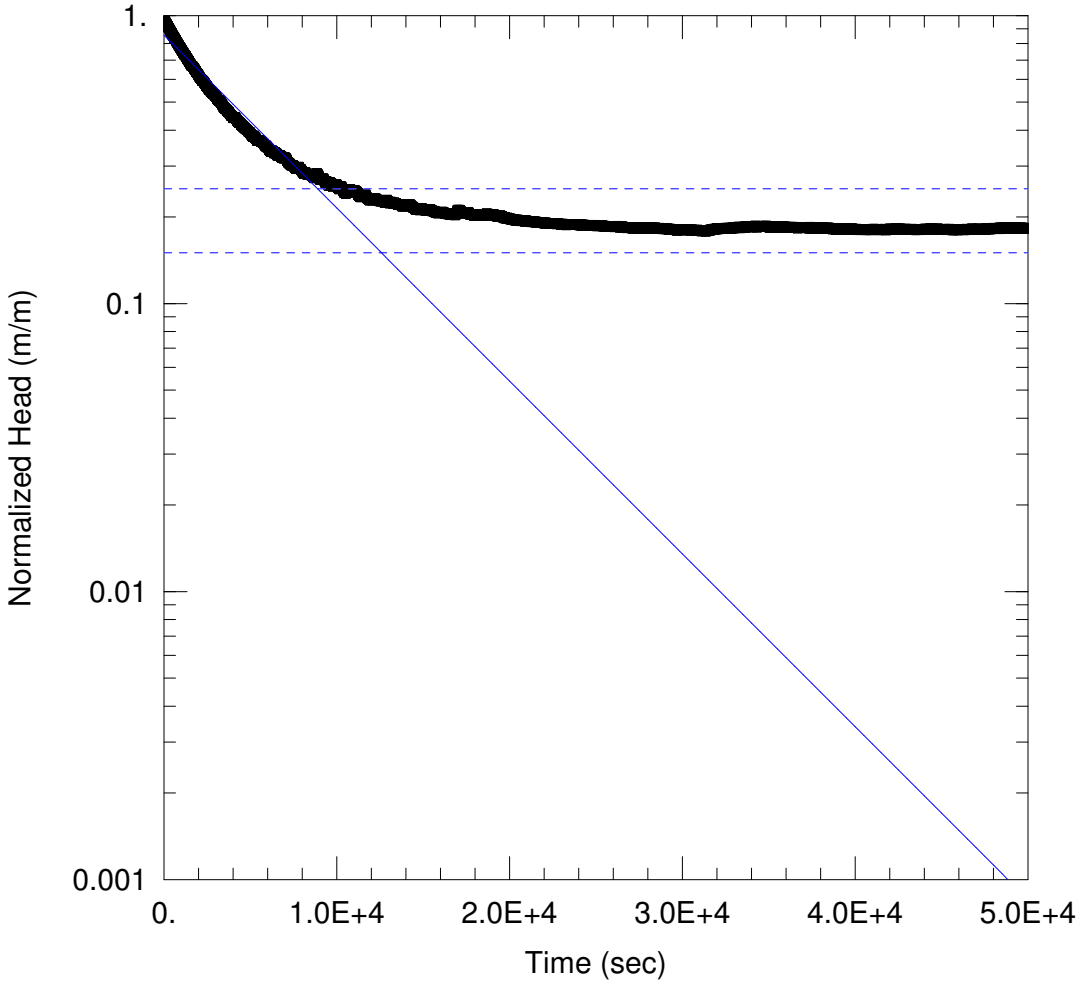
Saturated Thickness: 15.4 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW1)

Initial Displacement: 0.311 m
Total Well Penetration Depth: 18.4 m
Casing Radius: 0.0254 m
Static Water Column Height: 15.4 m
Screen Length: 3. m
Well Radius: 0.0254 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 1.847E-5 m/sec
y0 = 0.1147 m



HYDRGEOLOGICAL INVESTIGATION

Data Set: F:\...\MW4.aqt
Date: 10/07/20 Time: 09:04:22

PROJECT INFORMATION

Company: Landtek Limited
Client: Milinaro Group
Project: 20255-A
Location: 774-780 Brant Street E.
Test Well: MW4
Test Date: September 24, 2020

AQUIFER DATA

Saturated Thickness: 14.4 m Anisotropy Ratio (Kz/Kr): 1.

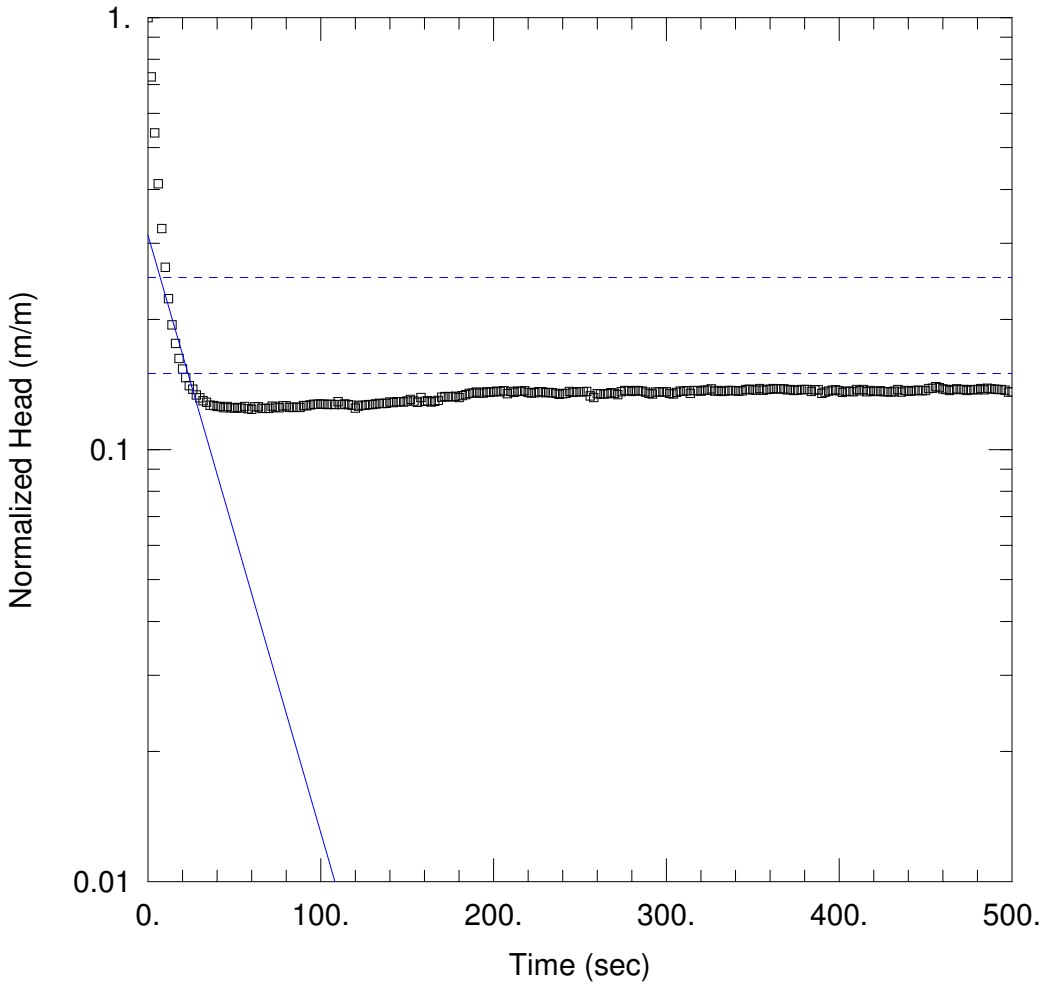
WELL DATA (MW4)

Initial Displacement: 0.5121 m
Total Well Penetration Depth: 18.4 m
Casing Radius: 0.0254 m
Static Water Column Height: 14.92 m
Screen Length: 3. m
Well Radius: 0.0254 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 8.12E-8 m/sec y0 = 0.4371 m



HYDRGEOLOGICAL INVESTIGATION

Data Set: F:\...\MW5.aqt
Date: 10/07/20 Time: 09:07:35

PROJECT INFORMATION

Company: Landtek Limited
Client: Milinaro Group
Project: 20255-B
Location: 769-789 Brant St.
Test Well: MW5
Test Date: September 24, 2020

AQUIFER DATA

Saturated Thickness: 6.5 m Anisotropy Ratio (Kz/Kr): 1.

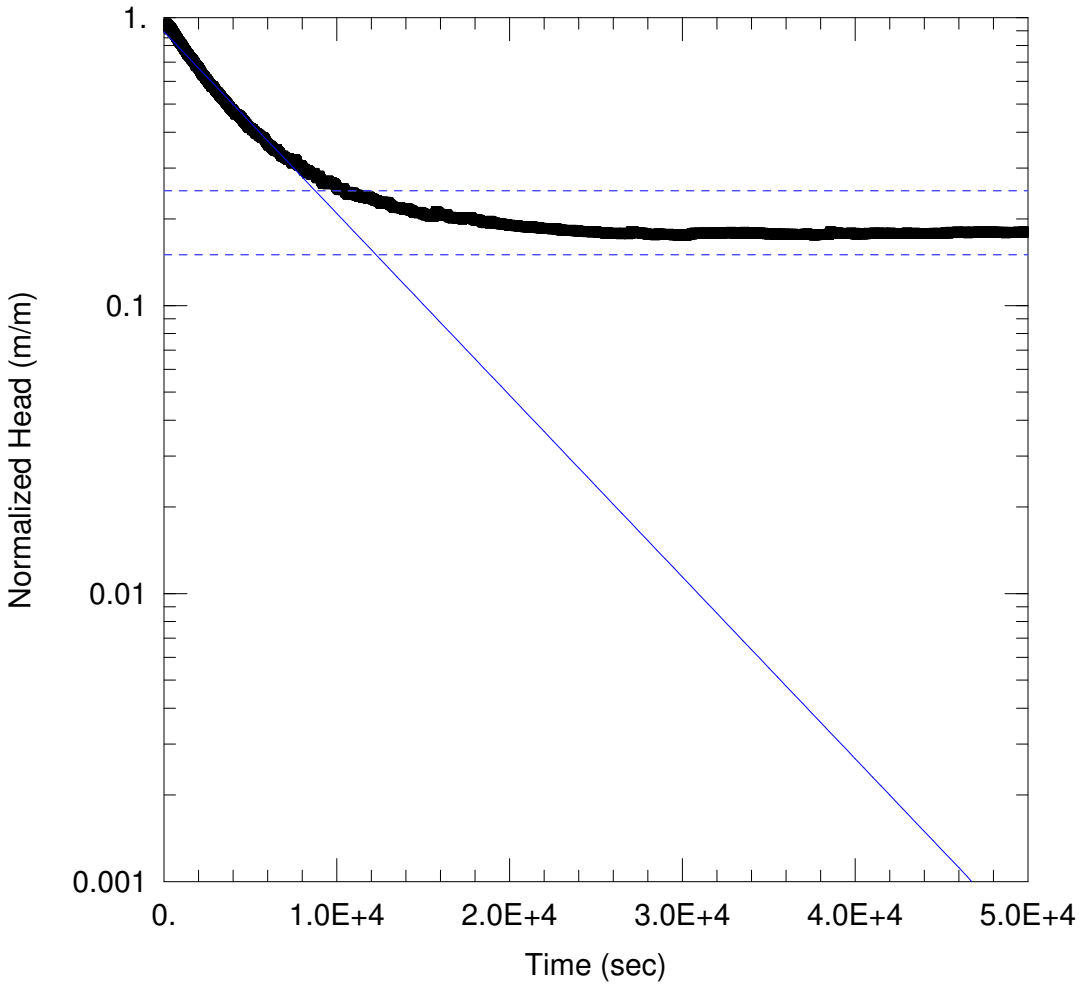
WELL DATA (MW5)

Initial Displacement: 0.4104 m
Total Well Penetration Depth: 9.9 m
Casing Radius: 0.0254 m
Static Water Column Height: 9.9 m
Screen Length: 3. m
Well Radius: 0.0254 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 1.871E-5 m/sec y0 = 0.1285 m



HYDRGEOLOGICAL INVESTIGATION

Data Set: F:\...\MW8.aqt
Date: 10/07/20 Time: 09:09:17

PROJECT INFORMATION

Company: Landtek Limited
Client: Milinaro Group
Project: 20255-B
Location: 769-789 Brant Street
Test Well: MW8
Test Date: September 24, 2020

AQUIFER DATA

Saturated Thickness: 9.6 m Anisotropy Ratio (Kz/Kr): 1.

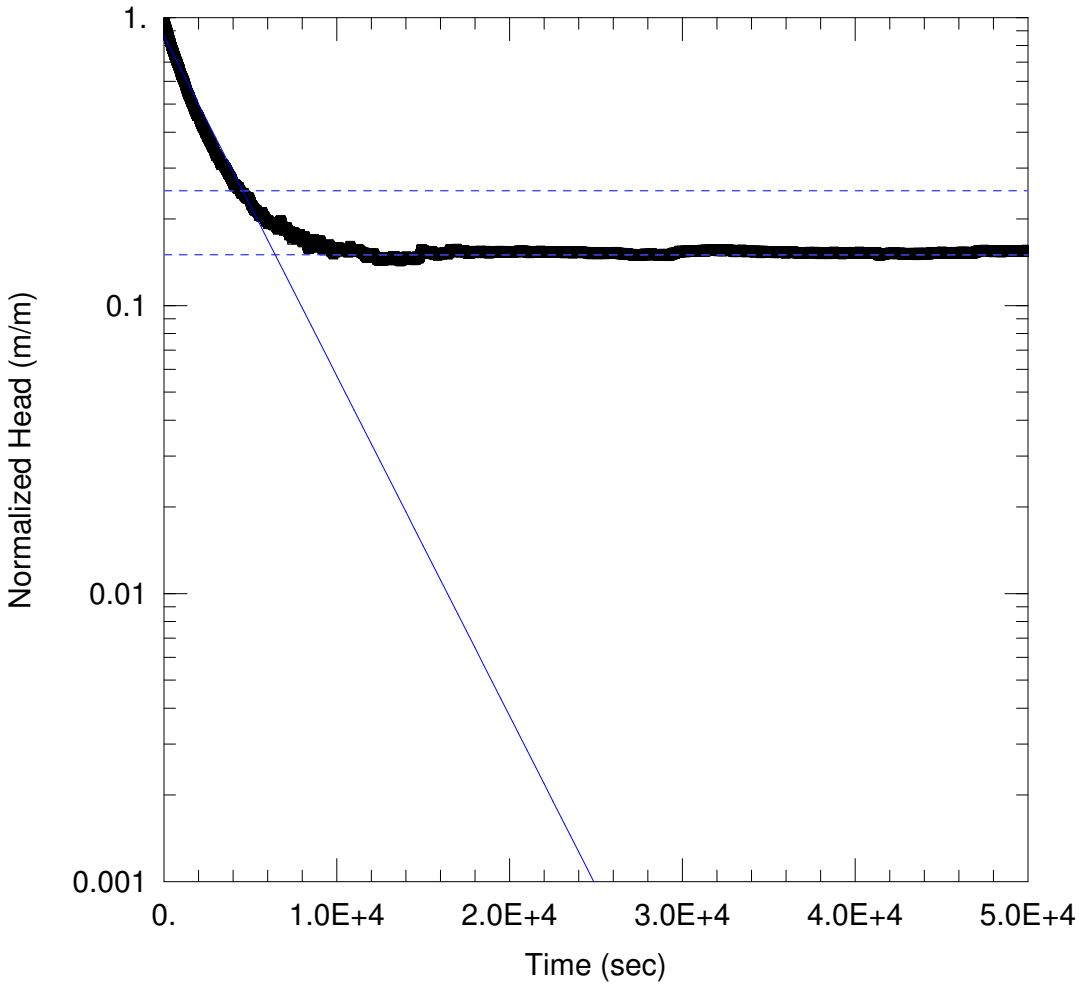
WELL DATA (MW8)

Initial Displacement: 0.4756 m
Total Well Penetration Depth: 10.25 m
Casing Radius: 0.0254 m
Static Water Column Height: 10.25 m
Screen Length: 3. m
Well Radius: 0.0254 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 8.538E-8 m/sec y0 = 0.4245 m



HYDRGEOLOGICAL INVESTIGATION

Data Set: F:\...\MW11.aqt
Date: 10/07/20 Time: 09:10:53

PROJECT INFORMATION

Company: ppppppp
Client: Milinaro Group
Project: 20255-C
Location: 747 & 761 Brant Street
Test Well: MW11
Test Date: September 24, 2020

AQUIFER DATA

Saturated Thickness: 6.8 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW11)

Initial Displacement: 0.4362 m
Total Well Penetration Depth: 7.35 m
Casing Radius: 0.0254 m
Static Water Column Height: 7.35 m
Screen Length: 3. m
Well Radius: 0.0254 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 1.597E-7 m/sec
y0 = 0.3765 m

APPENDIX E

SUMMARY OF HYDRAULIC CONDUCTIVITY RESULTS FROM PREVIOUS INVESTIGATIONS

Appendix G
Summary of Hydraulic Conductivity Results from Previous Investigations

Location	Author	Unit	K - Hydraulic Conductivity (m/sec)	
			Low	High
Various	Gartner Lee Ltd (1978)	Halton Till	1×10^{-9}	
Various	Gartner Lee Ltd (1978)	Queenston Shale	8.10×10^{-7}	
Various	Gartner Lee Ltd (1978)	Lacustrine Clay Silt (Peel Plain)	1×10^{-8}	
Georgetown	Gartner Lee Ltd. (1993)	Queenston Shale	1×10^{-6}	
Burlington	Gartner Lee Ltd. (1983)	Shale	1×10^{-8}	1×10^{-6}
Oakville (East)	MOE (1979)	Peel Plain	5×10^{-6}	4×10^{-5}
Oakville (East)	MOE (1979)	Queenston Shale	3.2×10^{-5}	2.3×10^{-6}
Oakville (East)	MOE (1979)	Georgian Bay Shale	5.1×10^{-6}	
Milton	International Water Consultants (1977)	Upper Sand and Gravel	2.83×10^{-3}	
Mississauga	Conestoga Rovers and Associates (2013)	Shale	2.4×10^{-5}	

Geometric Mean	K (m/sec)
Halton Till	1×10^{-9}
Peel Plain	2.5×10^{-6}
Sand/Gravel	2.83×10^{-3}
Queenston Shale	1.1×10^{-5}
Georgian Bay Shale	5.1×10^{-6}

Source: Holysh (1997)

APPENDIX F

LABORATORY CERTIFICATE OF ANALYSIS

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: LANDTEK LTD.
205 NEBO ROAD, UNIT 3
HAMILTON, ON L8W2E1
(905) 383-3733
ATTENTION TO: Henry Erebor
PROJECT: 20255C
AGAT WORK ORDER: 20T653959
MICROBIOLOGY ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer
TRACE ORGANICS REVIEWED BY: Pinkal Patel, Report Reviewer
ULTRA TRACE REVIEWED BY: Philippe Morneau, chimiste
WATER ANALYSIS REVIEWED BY: Yris Verastegui, Report Reviewer
DATE REPORTED: Oct 02, 2020
PAGES (INCLUDING COVER): 16
VERSION*: 2

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

VERSION 2:Version 2 supersedes work order 20T653959, Version 1, issued October 1, 2020. Complete.

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Environmental Services Association of Alberta (ESAA)

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CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
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Certificate of Analysis

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

E. Coli (Using MI Agar)

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

		SAMPLE DESCRIPTION:		**MW9**		**MW11**
		SAMPLE TYPE:		**Water**		**Water**
		DATE SAMPLED:		**2020-09-22 11:27**		**2020-09-22 12:15**
Parameter	**Unit**	**G / S**	**RDL**	**1468718**	**RDL**	**1468726**
Escherichia coli	CFU/100mL	200	1	ND	2	ND

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to ON Burlington Storm 086-2002
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

1468718 ND - Not Detected.

1468726 ND - Not Detected.
Presence of sediments was observed upon receipt.
If RDL >1 indicates dilutions of the sample.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



Results relate only to the items tested. Results apply to samples as received.

AGAT Laboratories

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CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
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Certificate of Analysis

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Burlington Storm Sewer - Organics

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

		SAMPLE DESCRIPTION:		MW9	MW11
		SAMPLE TYPE:		Water	Water
		DATE SAMPLED:		2020-09-22 11:27	2020-09-22 12:15
Parameter	Unit	G / S	RDL	1468718	1468726
Methylene Chloride	mg/L	0.0052	0.0003	<0.0003	<0.0003
trans-1,3-Dichloropropylene	mg/L	0.0056	0.0003	<0.0003	<0.0003
cis- 1,2-Dichloroethylene	mg/L	0.0056	0.0002	<0.0002	<0.0002
Chloroform	mg/L	0.002	0.0002	<0.0002	<0.0002
Benzene	mg/L	0.002	0.0002	<0.0002	0.0002
Trichloroethylene	mg/L	0.0076	0.0002	0.0002	0.0002
Toluene	mg/L	0.002	0.0002	<0.0002	<0.0002
Tetrachloroethylene	mg/L	0.0044	0.0001	<0.0001	<0.0001
Ethylbenzene	mg/L	0.002	0.0002	<0.0002	<0.0002
1,1,2,2-Tetrachloroethane	mg/L	0.017	0.0002	<0.0002	<0.0002
1,2-Dichlorobenzene	mg/L	0.0056	0.0002	<0.0002	<0.0002
1,4-Dichlorobenzene	mg/L	0.0068	0.0002	<0.0002	<0.0002
Xylenes (Total)	mg/L	0.0044	0.0002	<0.0002	<0.0002
PCBs	mg/L	0.0004	0.0002	<0.0002	<0.0002
Pentachlorophenol	mg/L	0.002	0.0005	<0.0005	<0.0005
Di-n-butyl phthalate	mg/L	0.015	0.0005	<0.0005	<0.0005
3,3'-Dichlorobenzidine	mg/L	0.0008	0.0001	<0.0001	<0.0001
Bis(2-Ethylhexyl)phthalate	mg/L	0.0088	0.0005	<0.0005	<0.0005
Total PAHs	mg/L	0.002	0.0003	<0.0003	<0.0003

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to ON Burlington Storm 086-2002
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Pinkal Patel

Results relate only to the items tested. Results apply to samples as received.

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MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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Certificate of Analysis

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Nonylphenol and Nonylphenol Ethoxylates (Ontario, mg/L)

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

				SAMPLE DESCRIPTION:	MW9	MW11
				SAMPLE TYPE:	Water	Water
				DATE SAMPLED:	2020-09-22 11:27	2020-09-22 12:15
Parameter	Unit	G / S	RDL		1468718	1468726
Total Nonylphenol	mg/L	0.001	0.001		<0.001	<0.001
NP1EO	mg/L		0.001		<0.001	<0.001
NP2EO	mg/L		0.0003		<0.0003	<0.0003
Total Nonylphenol Ethoxylates	mg/L	0.01	0.001		<0.001	<0.001

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to ON Burlington Storm 086-2002
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Analysis performed at AGAT Montreal (unless marked by *)

Certified By:

Results relate only to the items tested. Results apply to samples as received.

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
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Certificate of Analysis

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

BOD-Toronto

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

				SAMPLE DESCRIPTION:	MW9	MW11
				SAMPLE TYPE:	Water	Water
				DATE SAMPLED:	2020-09-22 11:27	2020-09-22 12:15
Parameter	Unit	G / S	RDL		1468718	1468726
Biochemical Oxygen Demand, Total	mg/L	15	2		<2	<2

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to ON Burlington Storm 086-2002
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By: Iris Verástegui

Results relate only to the items tested. Results apply to samples as received.

AGAT Laboratories

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MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Burlington Storm Sewer Use By-law - Inorganics

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

				SAMPLE DESCRIPTION:		MW11
				SAMPLE TYPE:		Water
				DATE SAMPLED:		2020-09-22 12:15
Parameter	Unit	G / S	RDL	1468718	RDL	1468726
pH	pH Units	6.5 - 8.5	NA	7.76	NA	7.72
Total Suspended Solids	mg/L	15	10	**39**	10	**202**
Total Cyanide	mg/L	0.02	0.002	<0.002	0.002	<0.002
Phenols	mg/L	0.008	0.002	<0.002	0.002	0.005
Total Phosphorus	mg/L	0.4	0.02	0.10	0.2	**2.75**
Total Arsenic	mg/L	0.02	0.015	<0.015	**0.030**	<0.030
Total Cadmium	mg/L	0.008	0.005	<0.005	**0.010**	<0.010
Total Chromium	mg/L	0.08	0.020	<0.020	0.040	**0.086**
Chromium VI	mg/L	0.04	0.005	<0.005	0.005	<0.005
Total Copper	mg/L	0.04	0.020	<0.020	0.040	**0.068**
Total Lead	mg/L	0.12	0.020	<0.020	0.040	<0.040
Total Manganese	mg/L	0.05	0.020	**0.164**	0.040	**3.45**
Total Mercury	mg/L	0.0004	0.0002	<0.0002	0.0002	<0.0002
Total Nickel	mg/L	0.08	0.030	<0.030	0.060	**0.115**
Total Selenium	mg/L	0.02	0.020	<0.020	**0.040**	<0.040
Total Silver	mg/L	0.12	0.020	<0.020	0.040	<0.040
Total Zinc	mg/L	0.04	0.020	<0.020	0.040	**0.238**

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to ON Burlington Storm 086-2002
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

1468726 Dilution required, RDL has been increased accordingly.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Iris Verástegui

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Exceedance Summary

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erebor

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
1468718	MW9	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Manganese	mg/L	0.05	0.164
1468718	MW9	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Suspended Solids	mg/L	15	39
1468726	MW11	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Chromium	mg/L	0.08	0.086
1468726	MW11	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Copper	mg/L	0.04	0.068
1468726	MW11	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Manganese	mg/L	0.05	3.45
1468726	MW11	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Nickel	mg/L	0.08	0.115
1468726	MW11	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Phosphorus	mg/L	0.4	2.75
1468726	MW11	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Suspended Solids	mg/L	15	202
1468726	MW11	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Zinc	mg/L	0.04	0.238

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Quality Assurance

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Microbiology Analysis

RPT Date: Oct 02, 2020			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
E. Coli (Using MI Agar)															
Escherichia coli	1468036		ND	ND	NA	< 1									

Comments: ND - Not Detected, NA - % RPD Not Applicable

Certified By:



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Quality Assurance

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Trace Organics Analysis

RPT Date: Oct 02, 2020			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Burlington Storm Sewer - Organics															
Methylene Chloride	1467084		< 0.0003	< 0.0003	NA	< 0.0003	85%	60%	130%	103%	60%	130%	97%	60%	130%
trans-1,3-Dichloropropylene	1467084		< 0.0003	< 0.0003	NA	< 0.0003	83%	50%	140%	81%	60%	130%	77%	50%	140%
cis- 1,2-Dichloroethylene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	99%	60%	130%	106%	60%	130%	114%	60%	130%
Chloroform	1467084		< 0.0002	< 0.0002	NA	< 0.0002	96%	50%	140%	105%	60%	130%	112%	50%	140%
Benzene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	88%	50%	140%	110%	60%	130%	115%	50%	140%
Trichloroethylene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	99%	50%	140%	114%	60%	130%	117%	50%	140%
Toluene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	102%	50%	140%	102%	60%	130%	92%	50%	140%
Tetrachloroethylene	1467084		< 0.0001	< 0.0001	NA	< 0.0001	103%	50%	140%	98%	60%	130%	102%	50%	140%
Ethylbenzene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	107%	50%	140%	105%	60%	130%	113%	50%	140%
1,1,2,2-Tetrachloroethane	1467084		< 0.0002	< 0.0002	NA	< 0.0002	114%	50%	140%	102%	60%	130%	96%	50%	140%
1,2-Dichlorobenzene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	96%	50%	140%	89%	60%	130%	105%	50%	140%
1,4-Dichlorobenzene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	103%	50%	140%	98%	60%	130%	102%	50%	140%
PCBs	1470537		< 0.0002	< 0.0002	NA	< 0.0002	107%	60%	130%	87%	60%	130%	87%	60%	130%
Pentachlorophenol	1466584		< 0.0001	< 0.0001	NA	< 0.0005	85%	50%	140%	80%	50%	140%	85%	50%	140%
Di-n-butyl phthalate	1466584		< 0.0005	< 0.0005	NA	< 0.0005	88%	50%	140%	99%	50%	140%	89%	50%	140%
3,3'-Dichlorobenzidine	1466584		< 0.0005	< 0.0005	NA	< 0.0001	84%	30%	130%	95%	30%	130%	96%	30%	130%
Bis(2-Ethylhexyl)phthalate	1466584		< 0.0005	< 0.0005	NA	< 0.0005	71%	50%	140%	102%	50%	140%	99%	50%	140%
Total PAHs	1466584		< 0.0003	< 0.0003	NA	< 0.0003	70%	60%	130%	100%	60%	130%	80%	60%	130%

Comments: When the average of the sample and duplicate results is less than 5x the RDL, the Relative Percent Difference (RPD) will be indicated as Not Applicable (NA).

Certified By:



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CANADA L4Z 1Y2
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Quality Assurance

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Ultra Trace Analysis

RPT Date: Oct 02, 2020			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Nonylphenol and Nonylphenol Ethoxylates (Ontario, mg/L)															
Total Nonylphenol	1	1468783	< 0.001	< 0.001	0.0%	< 0.001	90%	60%	140%	NA	60%	140%	NA	60%	140%
NP1EO	1	1468783	< 0.001	< 0.001	0.0%	< 0.001	49%	60%	140%	NA	60%	140%	NA	60%	140%
NP2EO	1	1468783	< 0.0003	< 0.0003	0.0%	< 0.0003	88%	60%	140%	NA	60%	140%	NA	60%	140%

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Quality Assurance

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Water Analysis

RPT Date: Oct 02, 2020			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Burlington Storm Sewer Use By-law - Inorganics															
pH	1472945		7.07	7.00	1.0%	NA	100%	90%	110%						
Total Suspended Solids	1489514		<10	<10	NA	< 10	98%	80%	120%						
Total Cyanide	1468718	1468718	<0.002	<0.002	NA	< 0.002	90%	70%	130%	101%	80%	120%	100%	70%	130%
Phenols	1468787		<0.002	<0.002	NA	< 0.002	103%	90%	110%	94%	90%	110%	94%	80%	120%
Total Phosphorus	1466850		0.02	0.03	NA	< 0.02	100%	70%	130%	102%	80%	120%	97%	70%	130%
Total Arsenic	1453842		<0.015	<0.015	NA	< 0.015	99%	70%	130%	103%	80%	120%	102%	70%	130%
Total Cadmium	1453842		<0.005	<0.005	NA	< 0.005	100%	70%	130%	104%	80%	120%	102%	70%	130%
Total Chromium	1453842		<0.020	<0.020	NA	< 0.020	98%	70%	130%	104%	80%	120%	106%	70%	130%
Chromium VI	1468718	1468718	<0.005	<0.005	NA	< 0.005	100%	70%	130%	100%	80%	120%	97%	70%	130%
Total Copper	1453842		<0.020	<0.020	NA	< 0.020	100%	70%	130%	102%	80%	120%	102%	70%	130%
Total Lead	1453842		<0.020	<0.020	NA	< 0.020	94%	70%	130%	88%	80%	120%	88%	70%	130%
Total Manganese	1453842		<0.020	<0.020	NA	< 0.020	96%	70%	130%	102%	80%	120%	104%	70%	130%
Total Mercury	1472485		<0.0002	<0.0002	NA	< 0.0002	103%	70%	130%	96%	80%	120%	97%	70%	130%
Total Nickel	1453842		<0.030	<0.030	NA	< 0.030	99%	70%	130%	102%	80%	120%	102%	70%	130%
Total Selenium	1453842		<0.020	<0.020	NA	< 0.020	96%	70%	130%	99%	80%	120%	98%	70%	130%
Total Silver	1453842		<0.020	<0.020	NA	< 0.020	95%	70%	130%	100%	80%	120%	95%	70%	130%
Total Zinc	1453842		<0.020	<0.020	NA	< 0.020	101%	70%	130%	115%	80%	120%	117%	70%	130%

Comments: NA signifies Not Applicable.
If the RPD value is NA, the results of the duplicates are under 5X the RDL and will not be calculated.

BOD-Toronto

Biochemical Oxygen Demand, Total	1470130	76	73	4.0%	< 2	91%	70%	130%	

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By: Iris Verástegui

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MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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QA Violation

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

ATTENTION TO: Henry Erebor

RPT Date: Oct 02, 2020			REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Sample Id	Sample Description	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
				Lower	Upper		Lower	Upper		Lower	Upper
Nonylphenol and Nonylphenol Ethoxylates (Ontario, mg/L)											
NP1EO	1468783	MW9	49%	60%	140%	NA	60%	140%	NA	60%	140%

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Method Summary

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Microbiology Analysis			
Escherichia coli	MIC-93-7010	EPA 1604	Membrane Filtration
Trace Organics Analysis			
Methylene Chloride	VOL-91-5001	EPA SW-846 5030B & 8260B	(P&T)GC/MS
trans-1,3-Dichloropropylene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
cis- 1,2-Dichloroethylene	VOL-91-5001	EPA SW-846 5030B & 8260B	(P&T)GC/MS
Chloroform	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
Benzene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
Trichloroethylene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
Toluene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
Tetrachloroethylene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
Ethylbenzene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
1,1,2,2-Tetrachloroethane	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
1,2-Dichlorobenzene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
1,4-Dichlorobenzene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
Xylenes (Total)	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
PCBs	ORG-91-5112	EPA SW-846 3510C & 8082A	GC/ECD
Pentachlorophenol	ORG-91-5114	EPA SW-846 3510C & 8270E	GC/MS
Di-n-butyl phthalate	ORG-91-5114	EPA SW-846 3510C & 8270E	GC/MS
3,3'-Dichlorobenzidine	ORG-91-5114	EPA SW-846 3510C & 8270E	GC/MS
Bis(2-Ethylhexyl)phthalate	ORG-91-5114	EPA SW-846 3510C & 8270E	GC/MS
Total PAHs	ORG-91-5114	EPA SW-846 3510C & 8270E	GC/MS
Ultra Trace Analysis			
Total Nonylphenol	NA	ASTM D7065-6	LC/MS/MS
NP1EO	NA	ASTM D7065-6	LC/MS/MS
NP2EO	NA	ASTM D7065-6	LC/MS/MS
Total Nonylphenol Ethoxylates	NA	ASTM D7065-6	LC/MS/MS

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Method Summary

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653959

PROJECT: 20255C

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Biochemical Oxygen Demand, Total	INOR-121-6023	SM 5210 B	INCUBATOR
pH	INOR-93-6000	modified from SM 4500-H+ B	PC TITRATE
Total Suspended Solids	INOR-93-6028	modified from EPA 1684,ON MOECC E3139,SM 2540C,D	BALANCE
Total Cyanide	INOR-93-6051	modified from MOECC E3015; SM 4500-CN- A, B, & C	TECHNICON AUTO ANALYZER
Phenols	INOR-93-6050	MOE ROPHEN-E3179 & SM 5530 D	TECHNICON AUTO ANALYZER
Total Phosphorus	INOR-93-6022	modified from SM 4500-P B and SM 4500-P E	SPECTROPHOTOMETER
Total Arsenic	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Cadmium	MET -93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Chromium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Chromium VI	INOR-93-6034	modified from SM 3500-CR B	SPECTROPHOTOMETER
Total Copper	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Lead	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Manganese	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Mercury	MET-93-6100	modified from EPA 245.2 and SM 3112 B	CVAAS
Total Nickel	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Selenium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Silver	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Zinc	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS

Results relate only to the items tested. Results apply to samples as received.

AGAT Laboratories
5835 Coopers Avenue
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Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: Landtek Limited
Contact: Henry Ereba
Address: 205 Nebo Rd, Hamilton ON L8W 2E1
Phone: 289-880-3992 Fax:
Reports to be sent to:
1. Email: henry@landtek.ca
2. Email:

Project Information:

Project: 20255C
Site Location: ~~747~~ and 761 ~~Ghent~~ Ghent Ave. Burlington
Sampled By: LB and HE
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☑ No ☐
Company:
Contact:
Address:
Email:

Regulatory Requirements:

(Please check all applicable boxes)

☐ Regulation 153/04
Table _____ *Indicate One*
☐ Ind/Com
☐ Res/Park
☐ Agriculture
Soil Texture *(Check One)*
☐ Coarse
☐ Fine

☐ Excess Soils R406
Table _____ *Indicate One*
☐ Regulation 558
☐ CCME

☐ Sewer Use ☐ Sanitary ☑ Storm
_____ *Region*
☐ Prov. Water Quality Objectives (PWQO)
☐ Other
_____ *Indicate One*

Is this submission for a **Record of Site Condition?** ☐ Yes ☑ No

Report Guideline on *Certificate of Analysis* ☑ Yes ☐ No

Laboratory Use Only

Work Order #: 20T653959
Cooler Quantity:
Arrival Temperatures: 6.2 | 6 | 6.2 / 6 | 6 | 6.4
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes: Ice

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

For 'Same Day' analysis, please contact your AGAT CPM

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI, DOC Y/N	O. Reg 153: Metals & Inorganics	Metals - CrVI, Hg, HWSB	BTEX, F1-F4 PHCs Analyze F4G if required ☐ Yes ☐ No	PAHs	PCBs	VOC	O. Reg 558: Landfill Disposal Characterization TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	O. Reg 406: Excess Soils SPLP Rainwater Leach SPLP: ☐ Metals ☐ VOCs ☐ SVOCs	Excess Soils Characterization Package pH, ICPMS Metals, BTEX, F1-F4	Salt - EC/SAR		Sewer Use	City of Burlington	Storm Sewer Discharge	& E. Coli			Potentially Hazardous or High Concentration (Y/N)
MW9	29-Sep-20	11:27 AM PM				N												✓	✓					
MW11	"	12:15 AM PM				N												✓	✓					
		AM PM																						
		AM PM																						
		AM PM																						
		AM PM																						
		AM PM																						
		AM PM																						
		AM PM																						
		AM PM																						
		AM PM																						

Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time
K Urshot	Sept 22/20	2:00 pm	John Chyrycka	Sept 22	1:45
					Page ____ of ____
	Date	Time	Samples Received By (Print Name and Sign):	Date	Time
			John Chyrycka	Sept 22	4:30

No: 109218

AGAT Laboratories

Sample Temperature Log

Client: Landtek

# of Coolers: 8

COC# or Work Order #: 20T653959

# of Submissions:

Arrival Temperatures - Branch/Driver

Cooler #1:	6.2	6	6.2
Cooler #2:	6.6	6.6	6.8
Cooler #3:	6	6.2	6
Cooler #4:	6.4	6	6.4
Cooler #5:	6.4	6.4	6.4
Cooler #6:	6.2	6.2	6.2
Cooler #7:	7.2	7	7.2
~~Cooler #8~~	7.1	7.4	7.5
Cooler #9:			
Cooler #10:			

IR Gun ID:

Taken By: John Chypyha

Date (yyyy/mm/dd): Sept 22 Time: 1:45 AM / PM

Arrival Temperatures - Laboratory

Cooler #1:	6	6	6.4
Cooler #2:	6.8	6.6	7
Cooler #3:	6.6	6.6	6.8
Cooler #4:	6.6	6.8	6.8
Cooler #5:	7	6.8	7
Cooler #6:	6.4	6.6	6.6
Cooler #7:	7.4	7.6	7.8
Cooler #8	7.8	7.6	7.6
Cooler #9:			
Cooler #10:			

IR Gun ID:

Taken By: John Chypyha

Date (yyyy/mm/dd): Sept 22 Time: 4:30 AM / ~~PM~~

Instructions for use of this form: 1) complete all fields of info including total # of coolers and # of submissions rec'd, 2) photocopy and place in each submission prior to giving a WO#, 3) Proceed as normal, write the WO# and scan (please make sure to scan along with the COC)

Document ID: SR-78-0511.003
Date Issued: 2017-2-23

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APPENDIX G

DEWATERING ASSUMPTIONS & CALCULATIONS – BASEMENT PARKING LEVELS

Table 1 – Basement Excavation Dewatering Calculations-Scenario Based on Field Hydraulic Conductivity Tests

$$Q = 2\pi kD\,(H - h_w)/\ln\,(R_o/r_e)$$

Equation 1: The potential groundwater flow rate to the excavation was estimated using equation for full penetration by single well of confined aquifer (artesian conditions) fed by a circular source.

Where: Q = discharge rate (m^3/s)
K = hydraulic conductivity (m/s)
D = Aquifer thickness (m)
H = height of piezometer level above based of aquifer (m)
h_w = height of water at outside edge of pumping wells after drawdown (m)
R = radius of influence (m)
r_e = equivalent radius (m)
C = 3000
D = 6.3 m

$R = C*(H - h)*\sqrt{(K)}$ Radius of Influence - Sichardt's equation

$r_e = \sqrt{(L * B)}/\pi$ (applies when a/b>1.5 and R0 << rs)

$r_e = (L + B)/\pi$ (applies when a/b<1.5 and R0 >> rs)

Basement + Elevator Shaft	H (m)	h_w (m)	R (m)	r_e (m)	Q L/day	Q L/day (1.5 Factor of Safety
	9.0	0.9	~22.1	~35.0	~46,677 (5.40 x 10-4 m3/s)	~ 70,016

Assumptions for hydrogeological setting:

1. A confined aquifer is presumed to exist locally with a water table determined to be 1.0 mbgs at MW11 on April 12, 2021 and extending to an estimated depth of approximately 10.0 mbgl.
2. The maximum dewatering depth of construction activities is assumed to be 9.1 mbgl (0.5 m below Excavation).
3. It is assumed that as a requirement of the proposed construction activities the excavation will be pumped dry.
4. The hydraulic conductivity values for the bedrock beneath the site was determined to be 8.252×10^{-7} m/s

Table 2 – Basement Excavation Dewatering Calculations-Scenario Based on Low Hydraulic Conductivity Values from Previous Investigations in Burlington Shale (Holysh, 1997)

$$Q = 2\pi kD\,(H - h_w)/\ln(R_o/r_e)$$

Equation 1: The potential groundwater flow rate to the excavation was estimated using equation for full penetration by single well of confined aquifer (artesian conditions) fed by a circular source.

Where: Q = discharge rate (m^3/s)
K = hydraulic conductivity (m/s)
D = Aquifer thickness (m)
H = height of piezometer level above based of aquifer (m)
h_w = height of water at outside edge of pumping wells after drawdown (m)
R = radius of influence (m)
r_e = equivalent radius (m)
C = 3000
D = 6.3 m

R = C*(H – h)*√(K) Radius of Influence - Sichardt's equation

r_e = √(L * B)/π (applies when a/b>1.5 and R0 << rs)

r_e = (L + B)/π (applies when a/b<1.5 and R0 >> rs)

Basement + Elevator Shaft	H (m)	h_w (m)	R (m)	r_e (m)	Q L/day	Q L/day (1.5 Factor of Safety
	9.0	2.4	~2.43	~35.0	~4,029 (4.78 x 10-5 m3/s)	~ 6,044

Assumptions for hydrogeological setting:

1. A confined aquifer is presumed to exist locally with a water table determined to be 1.0 mbgs at MW11 on April 12, 2021 and extending to an estimated depth of approximately 10.0 mbgl.
2. The maximum dewatering depth of construction activities is assumed to be 9.1 mbgl (0.5 m below Excavation).
3. It is assumed that as a requirement of the proposed construction activities the excavation will be pumped dry.
4. The hydraulic conductivity values for the bedrock beneath the site was determined to be 1.0×10^{-8} m/s

APPENDIX H

WATER BALANCE

APPENDIX H: D ETAILED WATER BALANCE - 747 and 761 Brant Street (Phase 3), Burlington, ON.

1. Climate Information

Precipitation (collected from Env. Canada data)	930	mm/a
Evapotranspiration (calculated by Thornthwaite method	609	mm/a
Water Surplus	321	mm/a

2. Infiltration Rates

Infiltration Factors (Table 2)

Flat Land (average slope not exceeding 0.6 m per km)	0.3
Medium combinations of clay and loam	0.2
Cultivated Lands	0.1
TOTAL	0.6

Infiltration	193	mm/a
Run-off	128	mm/a

Typical Recharge Rates (Table 3)

Clayey Silt/Clayey Silt	100	mm/a
Silt	125-150	mm/a
silty sand to sandy silt	150-200	mm/a

Site development area is underlain by silty sand to sandy silt.

Based on the above, the recharge rate is approximately	100	mm/a
with runoff of	221	mm/a

3. Site Statistics

Pre-Development:

Building roofs	0.086	ha	863	m^2
Parking Areas, Roadways, Other impervious Areas	0.149	ha	1,495	m^2
Green space, open space, natural areas	0.147	ha	1,473	m^2
TOTAL	0.383	ha	3,831	m^2

Post-Development:

Building Roof	0.229	ha	2,289	m^2
Parking Areas, Roadways, Other impervious Areas	0.087	ha	866	m^2
Green space, SWMP, natural areas	0.068	ha	678	m^2
TOTAL	0.383	ha	3,833	m^2

Industrial Buildings

Landscape coverage (17.7%)	0.068	ha	678	m^2
Parking/Roadway coverage (22.6%)	0.087	ha	866	m^2
Building (59.7%)	0.229	ha	2,289	m^2

4. Annual Pre-Development Water Balance

Land Use	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Building Roofs	863	803	-	-	803
Green Space	1,473	1,370	897	147	326
Roads, Other impervious	1,495	1,390	-	-	1,390
TOTAL	3,831	3,563	897	147	2,518

5. Annual Post-Development Water Balance

Land Use	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Building Roofs	2,289	2,129	-	-	2,129
Roads, Other impervious	866	805	-	-	805
Green space, open space, natural areas	678	631	413	68	150
TOTAL	3,833	3,565	413	68	3,084

6. Comparison of Pre-Development and Post-Development

		Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Pre-Development		3,563	897	147	2,518
Post-Development		3,565	413	68	3,084

7. Post development infiltration measures

Post-development infiltration volume	68	m^3
Pre-development infiltration volume	147	m^3
Deficit from pre to post-development infiltration	79	m^3
Percentage of water collected from roof area required to match pre-development infiltration	4	%

APPENDIX H: Thornthwaite Method For Calculating Evapotranspiration

Thornthwaite method for determining potential evapotranspiration

A monthly index is obtained from the equation:

$i = (t/5)^{1.514}$

Summation of the 12 monthly values gives an appropriate heat index, I.

To calculate a, the expression is:

$a = 0.000000675I^3 - 0.0000771I^2 + 0.01792I + 0.49239$

From these relations, a general equation for potential evapotranspiration is obtained. It is:

$$e = 1.6\left(\frac{10t}{I}\right)^a$$

in which a has the value given in the equation above.

APPENDIX H: Thornthwaite Method For Calculating Evapotranspiration

Hamilton Airport Climate Data

	Daily Average Temp (C^o)	Monthly index (i)	Potential Evapotranspiration (cm)	Adjusted Potential Evaportranspiration (cm)
Jan	-5.5			0
Feb	-4.6			0
Mar	-0.1			0
April	6.7	1.557530876	2.946791827	3.300406846
May	12.8	4.150260027	6.038429267	7.608420877
June	18.3	7.13034204	8.973741023	11.48638851
July	20.9	8.718883818	10.39718	13.4123622
August	20	8.156781464	9.902149829	11.88257979
September	15.8	5.708555702	7.625570812	7.930593644
October	9.3	2.558836857	4.238152363	4.026244745
November	3.7	0.633894267	1.526004012	1.236063249
Dec	-2.3			0
	HEAT INDEX (I) =	38.61508505		**60.88 cm/year**
				608.83 mm/year
	a =	1.108273042		

