S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Functional Servicing and Stormwater Management Report

774 – 782 BRANT STREET

(PHASE 1 of 3)

PROPOSED MIX-USE BUILDING

CITY OF BURLINGTON

JUNE 2021

Revised November 2022

SLA File: 20062

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 1 of the proposed development (see Figure 1.0 for location plan).

The proposed Phase 1 development consists of constructing a mix use building including a 3-storey podium and two residential towers, one 14-storey and one 25-storey, with a total of 444 residential units and 794m^2 of commercial area. The proposed site will also include 3 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 1 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. Four (4) boreholes were drilled at the site between August 31 and September 2, 2020 to approximate depths ranging between 7.6 and 18.4m below grade. Topsoil was encountered overlain fill ranging in thickness from 0.7 to 1.4m below grade. A layer of sand of 0.8 to 1.8m in thickness was encountered in Boreholes 1 and 2. Native soils of clayey silt were encountered within all boreholes ranging in thickness from 2.0 to 3.1m underlaying the fill soils. Shale bedrock was encountered in all boreholes at depths ranging from 3.5 to 5.6m below grade.

Groundwater was encountered at depths between 2.43 and 3.02m below grade (elevations of 89.10 to 89.78m). Temporary construction dewatering will be required and the dewatering flow outside periods of active precipitation is approximately 214,100 l/day (2.48 l/s) (FS 1.3) which is less than the 5-year allowable discharge rate of 78 l/s to Brant Street (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 substructure and foundation.

The groundwater quality was analyzed and found that the levels of total suspended soils, total manganese and total selenium exceed the City of Burlington Municipal Storm Sewer Discharge Limit 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 0.67ha site consists of a vacant sodded lot with a gravel driveway. The site is bound by Brant Street to the northeast, Ghent Avenue to the southeast, existing commercial lands to the northwest, and existing residential lands to the southwest. There exists a 1500mmø storm sewer on Brant Street adjacent to the property, at 0.25% flowing southeast and a 600mmø storm sewer on Ghent Avenue adjacent to the property, flowing northeast.

The topography of the existing site generally slopes from southwest to northeast with the majority of the site sheet draining to Brant Street where it is collected by exiting catchbasins within the right-of-way. The remaining site area sheet drains to Ghent Avenue where it is collected by existing catchbasins within the right-of-way.

Two (2) catchment areas, Catchment 101 and 102, 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 the existing 1500mmø storm sewer on Brant Street.

Catchment 102 represents the existing conditions discharge from the subject site draining towards the existing 600mmø storm sewer on Ghent Avenue.

Table 3.1 – Existing Conditions Catchment Areas

Catchment ID	Description	Area (ha)	% Impervious	Runoff Coefficient (C)
101	Drainage from subject lands to Brant Street	0.597	28	0.45
102	Drainage from subject lands to Ghent Avenue	0.077	0	0.25

An analysis was performed on Catchments 101 and 102 using the SWMHYMO hydrologic modelling program developed by J.F. Sabourin & Associates for the 2 to 100-year City of Burlington 6-hour Chicago Design Storms. A summary of the results can be found in Table 3.2 and the detailed SWMHYMO input/output information in Appendix A.

Table 3.2 – Allowable Discharge from Site

Storm Event	Discharge to Brant Street (m^3/s)	Discharge to Ghent Avenue (m^3/s)
2-year	0.051	0.005
5-year	**0.078**	**0.008**
10-year	0.099	0.011
25-year	0.126	0.014
50-year	0.146	0.017
100-year	0.166	0.019

3.2 PROPOSED CONDITIONS

It is proposed to develop the site by constructing a mix-use building containing a total of 444 residential units, 794m^2 of retail area and 3 levels of underground parking. The proposed site will also include concrete curbing/sidewalk, asphalt parking spaces 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 1500mmø storm sewer located within Brant Street. Allocating all stormwater runoff to this location will limit the number of quantity and quality control facilities to one location.

Three (3) catchment areas, Catchment 201, 202 and 203, have been identified in the proposed condition. Refer to Table 3.3 below 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 be captured via on-site storm network and controlled by the proposed stormwater management tank which will ultimately discharge to the existing 1500mmø storm sewer along Brant Street.

Catchment 202 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 on Brant Street.

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 600mmø storm sewer on Ghent Avenue.

Table 3.3 – Proposed Condition Catchment Areas

Catchment ID	Description	Area (ha)	% Impervious	Run-off Coefficient (C)
201	Controlled drainage to Brant Street	0.646	97	0.93
202	Uncontrolled drainage to Brant Street	0.025	98	0.94
203	Uncontrolled drainage to Ghent Avenue	0.003	90	0.88

Water Quantity Control

It is proposed to apply quantity control measures to the runoff from Catchment 201 by means of a 150mmø orifice pipe installed between the SWM tank and MH2, 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 201, it will be required to provide stormwater storage during storm events up to and including the 100-year storm event. To provide the required storage, a cast-in-place storage vault within the underground parking structure with approximately 228m^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 MH1. 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 51.4 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 MH1, until the lower level is empty. Additionally, the tank will have an emergency overflow outlet (AD13) 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
90.00	0	0.0000	Bottom of Upper Section and Invert of 150mmø Orifice Pipe
90.50	40	0.0408	0.5m ponding
90.75	60	0.0514	Top of Weir
88.50	60	0.0514	Bottom of Lower Section
89.00	100	0.0514	0.5m ponding
89.50	140	0.0514	1.0m ponding
90.00	180	0.0514	Top of Lower Section
90.75	180	0.0514	Top of Weir
91.35	228	0.0707	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 Brant Street

Storm Event	201 (Controlled) (m^3/s)[1]	202 (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	0.051	0.005	0.057	0.078	73.5	228
5-Year	0.051	0.007	0.058		104.6	
10-Year	0.051	0.008	0.059		128.6	
25-Year	0.051	0.009	0.061		159.5	
50-Year	0.051	0.010	0.062		182.7	
100-Year	0.057	0.011	0.063		204.9	

[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 Ghent Avenue

Storm Event	203 (Uncontrolled) (m^3/s)[1]	Allowable Discharge (m^3/s)[2]
2-Year	0.001	0.008
5-Year	0.001	
10-Year	0.001	
25-Year	0.001	
50-Year	0.001	
100-Year	0.001	

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

This analysis determined the following:

- The proposed condition discharge rates will not exceed the 5-year allowable pre-development flow rates from the site.
- Catchment 201 will require 219.9m^3 of stormwater storage during the 100-year event, which can be accommodated within the proposed storage tank, having a volume of 228m^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 201 will be subject to a treatment from a Hydro International Up-Flo Filter before ultimately discharging to the ultimately discharging to the existing 1500mmø storm sewer within Brant Street.

The Up-Flo Filter manufacturer has provided sizing information and determined the filter unit for Catchment 201 will require 8 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 80.4% 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 200mmø sanitary sewer on Ghent Avenue flowing northeast and a 300mmø and 450mmø sanitary sewer on Brant Street flowing southeast.

4.2 SANITARY DEMAND

The proposed development consists of a 14 to 25-storey mix-use building containing a total of 444 residential units and 794m^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) [A]	Population Density [B]	Population
Residential	623	---	2 per/bed	1,246
Commercial	---	794	3.7m^2/per	215
			Total Population [C]:	**1,461**

[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); commercial population density as per OBC Table 3.1.13.1 (5).
[C] Total population = Residential Population + Commercial Population

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)
0.67	1,461	4.64	3.68	0.19	**17.27**

[A] From Table 3.1.
[B] Based on a unit sewage flow of 0.275m^{3}pcd (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:

17.27 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 200mmø 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 250mmø watermain located on Ghent Avenue and existing 200mmø and 400mmø watermains located on Brant Street. Existing fire hydrants are located in front of 786 Brant Street and in front of 1426 Ghent Avenue.

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]	624	0.7	436.8
Shower Head (9.5L/min or less per head) (Private)[1]	623	1.4	872.2
Water Closet (6 LPF or less with flush tank) (Private)[1,3]	624	2.2	1372.8
Sink (kitchen, domestic, 8.3 L/min or less) (Private)[2,3]	445	4	1,780.0
Dishwasher (Domestic)[2,3]	445	1.4	623.0
Clothes Washer (3.5 kg) (Private)[2]	444	1.4	621.6
Mop Sink[4]	3	3	9
		Total FU:	**5,715.4**
		Water Usage (l/s):	**43.04**

[1] Each 1-bedroom unit was assumed to have one full 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
[4] 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 = 5,379.8 FU

Water Usage: 550.38 IGPM (41.70 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, 1999), 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 14 to 25-storey mix-use building containing a total of 444 residential units, 794m^2 of commercial area and 3 levels of underground parking. Existing hydrants are located at 786 Brant Street and 1426 Ghent Avenue. 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: >30m (0% correction)
East Face: >30m (0% correction)
West Face: 20.1 to 30m (10% 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	H20737
Location	786 Brant Street
Static Pressure	62 psi
Residual Pressure During Test Flow	57 psi
Test Flow Rate	2,014 USGPM (127.1 l/s)
Theoretical Flow @ 20 psi	**7,355 USGPM (464 l/s)**
Hydrant ID	H3714
Location	1426 Ghent Avenue
Static Pressure	60 psi
Residual Pressure During Test Flow	55 psi
Test Flow Rate	1,776 USGPM (112.0 l/s)
Theoretical Flow @ 20 psi	**5,675 USGPM (358 l/s)**

Based on the above hydrant flow test data, the theoretical maximum available flow rate from the hydrant is **358 l/s**, while the maximum required fire flow for the proposed development is only **167 l/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 development. 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 774 to 782 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 150mmø orifice pipe be installed as per 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 2.48 l/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 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

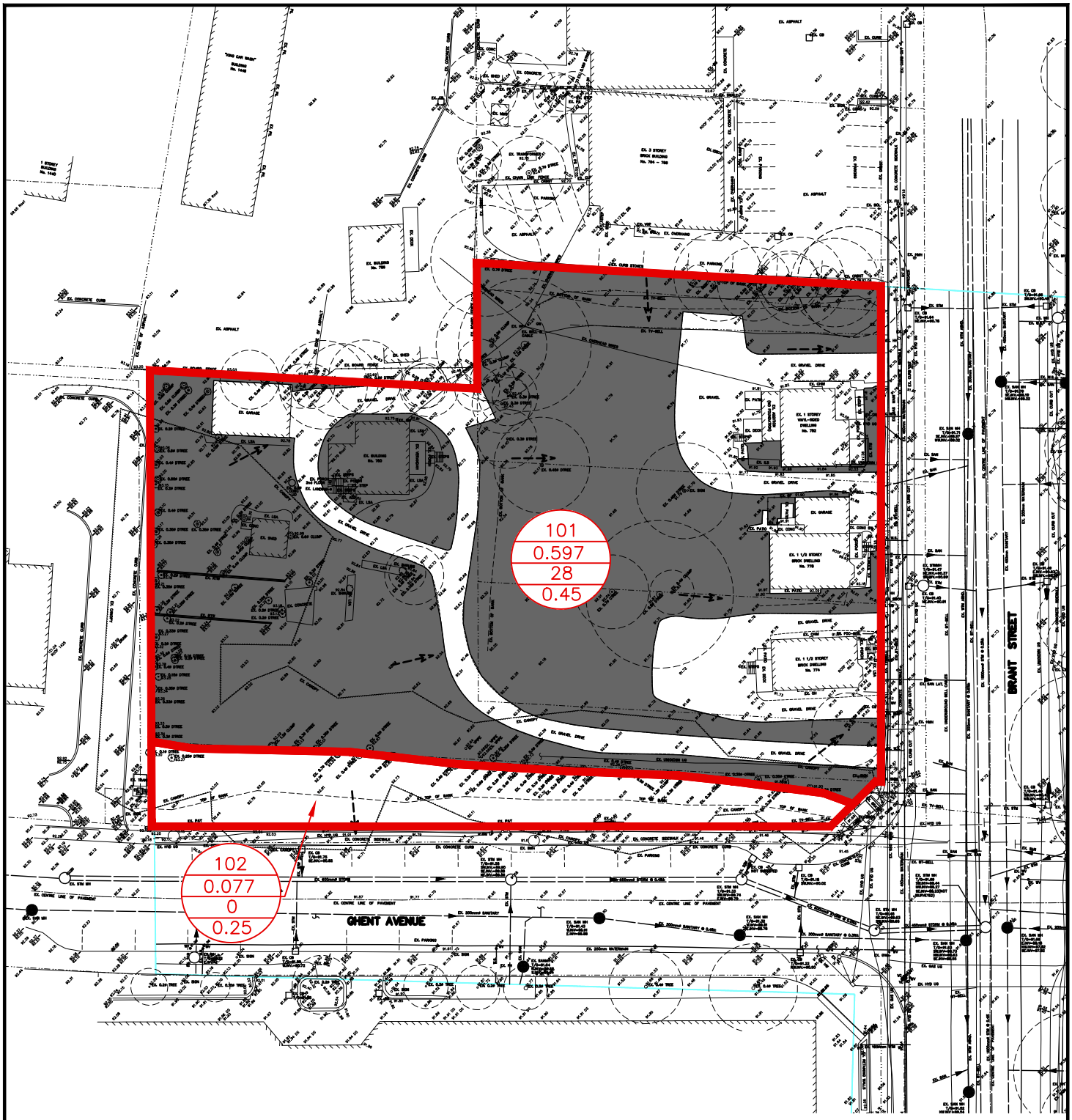


B. Henderson, Dipl.T.

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: 1:750

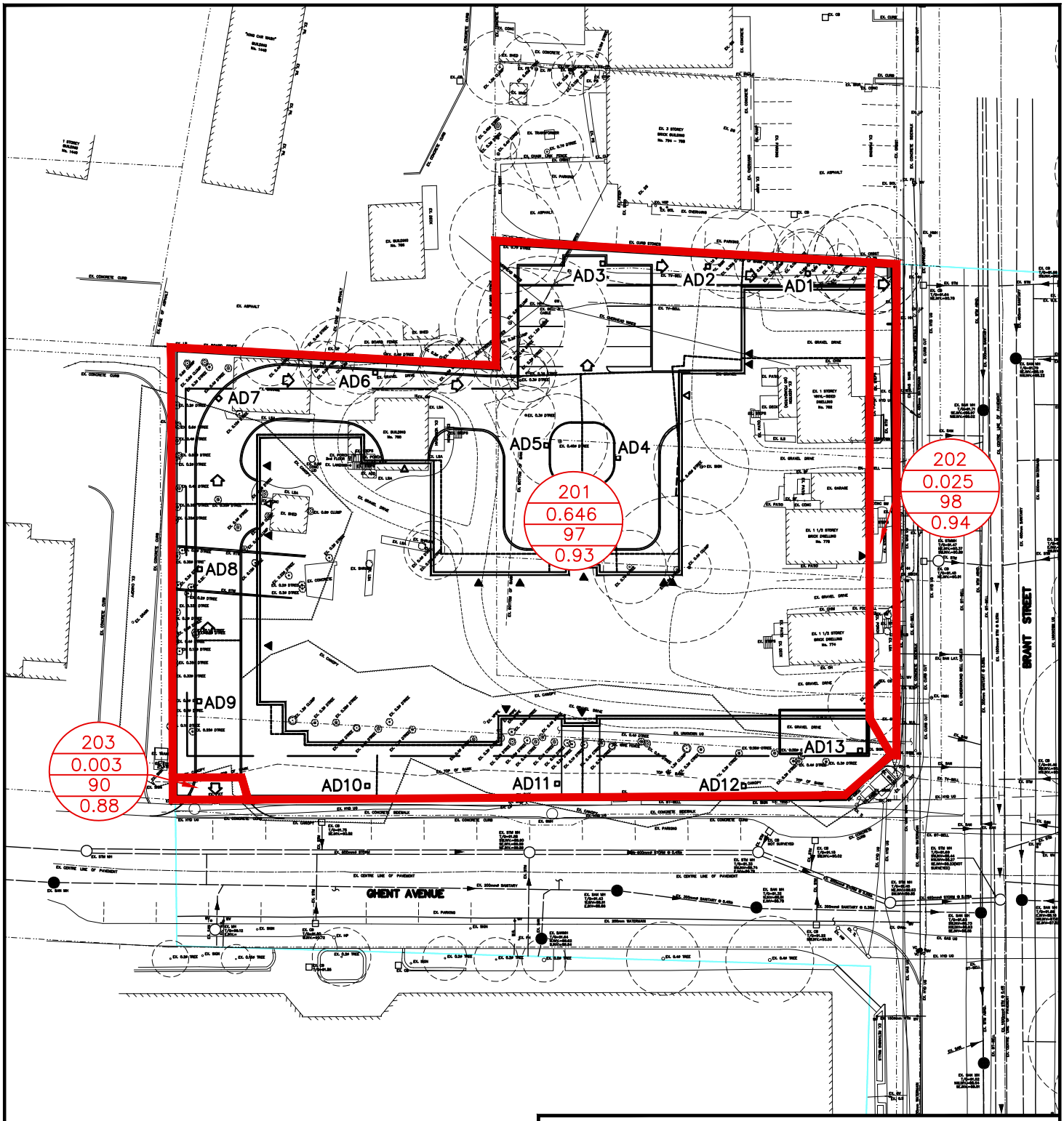
PROJECT: 774-782 BRANT STREET, BURLINGTON
PROJECT No.: 20062

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

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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: 1:750

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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 1:58:11 PM - Blair Henderson

774-782 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)	**150**
Area (m^2)	0.01767
Invert Elev. (m)	90.00
C/L Elev. (m)	90.08
Disch. Coeff. (C_d)	0.8
Discharge (Q) =	$C_d A (2 g H)^{0.5}$
Number of Orifices:	1

		SWM Tank Volumes				Outlet No. 1	
	Elevation m	Area m^2	Tank Incremental Volume	Cumulative Tank Volume m^3	Active Storage Volume m^3	H m	Discharge m^3/s
Bottom of Upper Section	90.00	80.0	0	0	0.0	0.000	0.0000
	90.50	80.0	40	40	40.0	0.425	0.0408
Top of Weir	90.75	80.0	20	60	60.0	0.675	0.0514
Bottom of Tank	88.50	80.0	0	60	60.0	0.000	0.0514
	89.00	80.0	40	100	100.0	0.000	0.0514
	89.50	80.0	40	140	140.0	0.000	0.0514
Top of Lower Section	90.00	80.0	40	180	180.0	0.000	0.0514
Top of Weir	90.75	80.0	0	180	180.0	0.675	0.0514
Top of Tank	91.35	80.0	48	228	228.0	1.275	0.0707

```
00001> 2     Metric units
00002> *#************************************************************************|
00003> *#  Project Name: BRANT & GHENT (PHASE 1)
00004> *#               BURLINGTON, ONTARIO
00005> *#  JOB NUMBER  : 20062
00006> *#       Date   : JUNE 2021
00007> *#    Revised   :
00008> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00009> *#       File   : 20071A.DAT
00010> *#************************************************************************|
00011> *
00012> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[002]
00013>                     BUR6_002.stm
00014> *
00015> READ STORM          STORM_FILENAME "STORM.001"
00016> *
00017> *#************************************************************************|
00018> *#
00019> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
00020> *#        ============================================================
00021> *#
00022> *#************************************************************************|
00023> *# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
00024> *
00025> CALIB STANDHYD      ID=[1], NHYD=["101"], DT=[1](min), AREA=[0.597](ha),
00026>                     XIMP=[0.28], TIMP=[0.28], DWF=[0](cms), LOSS=[2],
00027>                     SCS curve number CN=[80],
00028>                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.5](%),
00029>                                          LGP=[10](m), MNP=[0.250], SCP=[0](min),
00030>                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
00031>                                          LGI=[20](m), MNI=[0.013], SCI=[0](min),
00032>                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
00033> *%-----------------|-------------------------------------------------------|
00034> *# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
00035> *
00036> CALIB NASHYD        ID=[2], NHYD=["102"], DT=[1]min, AREA=[0.077](ha),
00037>                     DWF=[0](cms),  CN/C=[80], IA=[6.35](mm),
00038>                     N=[3], TP=[0.04]hrs,
00039>                     RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
00040> *%-----------------|-------------------------------------------------------|
00041> * ADD TOTAL EX. FLOWS FROM PHASE 1
00042> ADD HYD             IDsum=[10], NHYD=["EX.P1"], IDs to add=[1,2]
00043> *%-----------------|-------------------------------------------------------|
00044> *#************************************************************************|
00045> *#
00046> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
00047> *#        ============================================================
00048> *#
00049> **#***********************************************************************|
00050> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO BRANT STREET
00051> *
00052> CALIB STANDHYD      ID=[1], NHYD=["201"], DT=[1](min), AREA=[0.646](ha),
00053>                     XIMP=[0.97], TIMP=[0.97], DWF=[0](cms), LOSS=[2],
00054>                     SCS curve number CN=[80],
00055>                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.0](%),
00056>                                          LGP=[20](m), MNP=[0.250], SCP=[0](min),
00057>                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[1.5](%),
00058>                                          LGI=[20](m), MNI=[0.013], SCI=[0](min),
00059>                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
00060> *%-----------------|-------------------------------------------------------|
00061> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE AND TANK
00062> *
00063> ROUTE RESERVOIR     IDout=[2],  NHYD=["201.CTL"],  IDin=[1],
00064>                     RDT=[1](min),
00065>                          TABLE of ( OUTFLOW-STORAGE ) values
00066>                                   (cms) - (ha-m)
00067>  0.0000     0.0000
00068>  0.0408     0.0035
00069>  0.0514     0.0053
00070>  0.0514     0.0053
00071>  0.0514     0.0123
00072>  0.0514     0.0158
00073>  0.0514     0.0193
00074>  0.0514     0.0193
00075>  0.0707     0.0235
00076>                                  -1  ,  -1    (max twenty pts)
00077>                          IDovf=[3], NHYDovf=["201.OVF"]
00078> *%-----------------|-------------------------------------------------------|
00079> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
00080> *
00081> CALIB STANDHYD      ID=[1], NHYD=["202"], DT=[1](min), AREA=[0.025](ha),
00082>                     XIMP=[0.98], TIMP=[0.98], DWF=[0](cms), LOSS=[2],
00083>                     SCS curve number CN=[80],
00084>                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.0](%),
00085>                                          LGP=[10](m), MNP=[0.250], SCP=[0](min),
00086>                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[3.0](%),
00087>                                          LGI=[10](m), MNI=[0.013], SCI=[0](min),
00088>                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
00089> *%-----------------|-------------------------------------------------------|
00090> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
00091> *
00092> CALIB STANDHYD      ID=[4], NHYD=["203"], DT=[1](min), AREA=[0.003](ha),
00093>                     XIMP=[0.90], TIMP=[0.90], DWF=[0](cms), LOSS=[2],
00094>                     SCS curve number CN=[80],
00095>                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.0](%),
00096>                                          LGP=[10](m), MNP=[0.250], SCP=[0](min),
00097>                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
00098>                                          LGI=[10](m), MNI=[0.013], SCI=[0](min),
00099>                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
00100> *%-----------------|-------------------------------------------------------|
00101> * ADD TOTAL FLOWS TO BRANT STREET
00102> ADD HYD             IDsum=[5], NHYD=["BRANT"], IDs to add=[2,3,1]
00103> *%-----------------|-------------------------------------------------------|
00104> * ADD TOTAL FLOWS FROM PHASE 1 SITE
00105> ADD HYD             IDsum=[9], NHYD=["TOTAL.P1"], IDs to add=[4,5]
00106> *%-----------------|-------------------------------------------------------|
00107> * AREA CHECK
00108> ADD HYD             IDsum=[1], NHYD=["CHECK"], IDs to add=[10,9]
00109> *%-----------------|-------------------------------------------------------|
00110> **#***********************************************************************|
00111> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00112> *
00113> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[005]
00114>                     BUR6_005.stm
00115> *
00116> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[010]
00117>                     BUR6_010.stm
00118> *
00119> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[025]
00120>                     BUR6_025.stm
00121> *
00122> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[050]
00123>                     BUR6_050.stm
00124> *
00125> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[100]
00126>                     BUR6_100.stm
00127> *
00128> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[200]
00129>                     hazel.stm
00130> *
00131> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[300]
00132>                     MTHP25MM.stm
00133> *%-----------------|-------------------------------------------------------|
00134> FINISH
00135>
00136>
00137>
00138>
00139>
00140>
00141>
00142>
00143>
00144>
00145>
00146>
00147>
00148>
00149>
00150>
00151>
00152>
00153>
00154>
00155>
00156>
```

```
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: 2022-11-01     TIME: 13:01:22     RUN COUNTER: 000192         *
00039>  ********************************************************************************
00040>  * Input   filename: T:\PROJECTS\20062\SWMHYMO\20062A.dat                       *
00041>  * Output  filename: T:\PROJECTS\20062\SWMHYMO\20062A.out                       *
00042>  * Summary filename: T:\PROJECTS\20062\SWMHYMO\20062A.sum                       *
00043>  * User comments:                                                              *
00044>  * 1:_____________________________________________________________________     *
00045>  * 2:_____________________________________________________________________     *
00046>  * 3:_____________________________________________________________________     *
00047>  ********************************************************************************
00048>
00049> --------------------------------------------------------------------------------
00050> 001:0001--------------------------------------------------------------------------
00051> *#*****************************************************************************|
00052> *#  Project Name: BRANT & GHENT (PHASE 1)
00053> *#               BURLINGTON, ONTARIO
00054> *#  JOB NUMBER  : 20062
00055> *#       Date   : JUNE 2021
00056> *#    Revised   :
00057> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00058> *#       File   : 20071A.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: BRANT & GHENT (PHASE 1)
00081> *#               BURLINGTON, ONTARIO
00082> *#  JOB NUMBER  : 20062
00083> *#       Date   : JUNE 2021
00084> *#    Revised   :
00085> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00086> *#       File   : 20071A.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 1)
00114> *#        ============================================================
00115> *#
00116> *#*****************************************************************************|
00117> *# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
00118> *
00119> ----------------------
00120> | CALIB STANDHYD     |   Area    (ha)=     .60
00121> | 01:101    DT= 1.00 |   Total Imp(%)=   28.00   Dir. Conn.(%)=   28.00
00122> ----------------------
00123>                                IMPERVIOUS    PERVIOUS (i)
00124>      Surface Area     (ha)=        .17          .43
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)=        .04          .02          .051 (iii)
00137>      TIME TO PEAK    (hrs)=       2.00         2.07         2.000
00138>      RUNOFF VOLUME    (mm)=      39.93        12.19        19.960
00139>      TOTAL RAINFALL   (mm)=      40.93        40.93        40.933
00140>      RUNOFF COEFFICIENT   =        .98          .30          .488
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 NASHYD       |   Area    (ha)=     .08   Curve Number   (CN)=80.00
00154> | 02:102    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
00155> ----------------------   U.H. Tp(hrs)=    .040
00156>
00157>      Unit Hyd Qpeak  (cms)=     .074
00158>
00159>      PEAK FLOW       (cms)=     .005 (i)
00160>      TIME TO PEAK    (hrs)=    2.000
00161>      RUNOFF VOLUME    (mm)=   12.193
00162>      TOTAL RAINFALL   (mm)=   40.933
00163>      RUNOFF COEFFICIENT   =     .298
00164>
00165>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00166>
00167> --------------------------------------------------------------------------------
00168> 002:0005--------------------------------------------------------------------------
00169> * ADD TOTAL EX. FLOWS FROM PHASE 1
00170> ------------------------
00171> | ADD HYD (EX.P1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00172> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00173>                       ID1 01:101           .60     .051    2.00  19.96    .000
00174>                      +ID2 02:102           .08     .005    2.00  12.19    .000
00175>                       ==========================================================
00176>                       SUM 10:EX.P1          .67     .055    2.00  19.07    .000
00177>
00178>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00179>
00180> --------------------------------------------------------------------------------
00181> 002:0006--------------------------------------------------------------------------
00182> *#*****************************************************************************|
00183> *#
00184> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
00185> *#        ========================================================
00186> *#
00187> **#****************************************************************************|
00188> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO BRANT STREET
00189> *
00190> ----------------------
00191> | CALIB STANDHYD     |   Area    (ha)=     .65
00192> | 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
00193> ----------------------
00194>                                IMPERVIOUS    PERVIOUS (i)
00195>      Surface Area     (ha)=        .63          .02
00196>      Dep. Storage     (mm)=       1.00         6.35
00197>      Average Slope     (%)=       1.50         2.00
00198>      Length            (m)=      20.00        20.00
00199>      Mannings n             =       .013         .250
00200>
00201>      Max.eff.Inten.(mm/hr)=      78.39        18.32
00202>                  over (min)        1.00        10.00
00203>      Storage Coeff.  (min)=        .95 (ii)   10.13 (ii)
00204>      Unit Hyd. Tpeak (min)=       1.00        10.00
00205>      Unit Hyd. peak  (cms)=       1.11          .11
00206>                                                          *TOTALS*
00207>      PEAK FLOW       (cms)=        .14          .00          .137 (iii)
00208>      TIME TO PEAK    (hrs)=       2.00         2.15         2.000
00209>      RUNOFF VOLUME    (mm)=      39.93        12.19        39.100
00210>      TOTAL RAINFALL   (mm)=      40.93        40.93        40.933
00211>      RUNOFF COEFFICIENT   =        .98          .30          .955
00212>
00213>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00214>            CN* =  80.0    Ia = Dep. Storage  (Above)
00215>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00216>            THAN THE STORAGE COEFFICIENT.
00217>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00218>
00219> --------------------------------------------------------------------------------
00220> 002:0007--------------------------------------------------------------------------
00221> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE AND TANK
00222> *
00223> ----------------------
00224> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
00225> |  IN>01:(201    )   |
00226> | OUT<02:(201.CT)    |    =========  OUTFLOW STORAGE TABLE  =========
00227> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
00228>                             (cms)     (ha.m.)  |    (cms)    (ha.m.)
00229>                             .000  .0000E+00    |     .051  .1580E-01
00230>                             .041  .3500E-02    |     .051  .1930E-01
00231>                             .051  .5300E-02    |     .051  .1930E-01
00232>                             .051  .5300E-02    |     .071  .2350E-01
00233>                             .051  .1230E-01    |     .000  .0000E+00
00234>
00235>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
00236>      --------------------       (ha)     (cms)     (hrs)       (mm)
00237>      INFLOW >01: (201    )       .65      .137     2.000     39.100
00238>      OUTFLOW<02: (201.CT)        .65      .051     1.950     39.100
00239>     OVERFLOW<03: (201.OV)        .00      .000      .000       .000
00240>
00241>                     TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
00242>                     CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
00243>                     PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
00244>
00245>
00246>                     PEAK   FLOW   REDUCTION [Qout/Qin](%)=   37.585
00247>                     TIME SHIFT OF PEAK FLOW          (min)=    -3.00
00248>                     MAXIMUM  STORAGE   USED       (ha.m.)=.7350E-02
00249>
00250> --------------------------------------------------------------------------------
00251> 002:0008--------------------------------------------------------------------------
00252> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
00253> *
00254> ----------------------
00255> | CALIB STANDHYD     |   Area    (ha)=     .03
00256> | 01:202    DT= 1.00 |   Total Imp(%)=   98.00   Dir. Conn.(%)=   98.00
00257> ----------------------
00258>                                IMPERVIOUS    PERVIOUS (i)
00259>      Surface Area     (ha)=        .02          .00
00260>      Dep. Storage     (mm)=       1.00         6.35
00261>      Average Slope     (%)=       3.00         2.00
00262>      Length            (m)=      10.00        10.00
00263>      Mannings n             =       .013         .250
00264>
00265>      Max.eff.Inten.(mm/hr)=      78.39        22.56
00266>                  over (min)        1.00         6.00
00267>      Storage Coeff.  (min)=        .51 (ii)    6.08 (ii)
00268>      Unit Hyd. Tpeak (min)=       1.00         6.00
00269>      Unit Hyd. peak  (cms)=       1.46          .19
00270>                                                          *TOTALS*
```

```
00271>      PEAK FLOW       (cms)=        .01          .00           .005 (iii)
00272>      TIME TO PEAK    (hrs)=       1.93         2.07          2.000
00273>      RUNOFF VOLUME    (mm)=      39.93        12.19         39.378
00274>      TOTAL RAINFALL   (mm)=      40.93        40.93         40.933
00275>      RUNOFF COEFFICIENT   =        .98          .30           .962
00276>
00277>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00278>            CN* =  80.0    Ia = Dep. Storage  (Above)
00279>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00280>            THAN THE STORAGE COEFFICIENT.
00281>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00282>
00283> ---------------------------------------------------------------------------
00284> 002:0009----------------------------------------------------------------------
00285> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
00286> *
00287> ----------------------
00288> | CALIB STANDHYD     |   Area    (ha)=     .00
00289> | 04:203    DT= 1.00 |   Total Imp(%)=   90.00   Dir. Conn.(%)=   90.00
00290> ----------------------
00291>                            IMPERVIOUS    PERVIOUS (i)
00292>      Surface Area     (ha)=        .00          .00
00293>      Dep. Storage     (mm)=       1.00         6.35
00294>      Average Slope     (%)=       2.00         2.00
00295>      Length            (m)=      10.00        10.00
00296>      Mannings n             =       .013         .250
00297>
00298>      Max.eff.Inten.(mm/hr)=      78.39        22.56
00299>                  over (min)        1.00         6.00
00300>      Storage Coeff.  (min)=        .57 (ii)    6.15 (ii)
00301>      Unit Hyd. Tpeak (min)=       1.00         6.00
00302>      Unit Hyd. peak  (cms)=       1.40          .19
00303>                                                          *TOTALS*
00304>      PEAK FLOW       (cms)=        .00          .00           .001 (iii)
00305>      TIME TO PEAK    (hrs)=       1.93         2.07          2.000
00306>      RUNOFF VOLUME    (mm)=      39.93        12.19         37.158
00307>      TOTAL RAINFALL   (mm)=      40.93        40.93         40.933
00308>      RUNOFF COEFFICIENT   =        .98          .30           .908
00309>
00310>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00311>            CN* =  80.0    Ia = Dep. Storage  (Above)
00312>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00313>            THAN THE STORAGE COEFFICIENT.
00314>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00315>
00316> ---------------------------------------------------------------------------
00317> 002:0010----------------------------------------------------------------------
00318> * ADD TOTAL FLOWS TO BRANT STREET
00319> ------------------------
00320> | ADD HYD (BRANT     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00321> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00322>                        ID1 02:201.CTL       .65     .051    1.95  39.10    .000
00323>                       +ID2 03:201.OVF       .00     .000     .00    .00    .000
00324>                       +ID3 01:202           .03     .005    2.00  39.38    .000
00325>                        ========================================================
00326>                        SUM 05:BRANT          .67     .057    2.00  39.11    .000
00327>
00328>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00329>
00330> ---------------------------------------------------------------------------
00331> 002:0011----------------------------------------------------------------------
00332> * ADD TOTAL FLOWS FROM PHASE 1 SITE
00333> ------------------------
00334> | ADD HYD (TOTAL.P1  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00335> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00336>                        ID1 04:203            .00     .001    2.00  37.16    .000
00337>                       +ID2 05:BRANT          .67     .057    2.00  39.11    .000
00338>                        ========================================================
00339>                        SUM 09:TOTAL.P1       .67     .057    2.00  39.10    .000
00340>
00341>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00342>
00343> ---------------------------------------------------------------------------
00344> 002:0012----------------------------------------------------------------------
00345> * AREA CHECK
00346> ------------------------
00347> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00348> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00349>                        ID1 10:EX.P1          .67     .055    2.00  19.07    .000
00350>                       +ID2 09:TOTAL.P1       .67     .057    2.00  39.10    .000
00351>                        ========================================================
00352>                        SUM 01:CHECK         1.35     .113    2.00  29.09    .000
00353>
00354>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00355>
00356> ---------------------------------------------------------------------------
00357> 002:0013----------------------------------------------------------------------
00358> **#*************************************************************************|
00359> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00360> *
00361>   ** END OF RUN :   4
00362>
00363> ***************************************************************************
00364>
00365>
00366>
00367>
00368>
00369> --------------------
00370> | START            |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
00371> --------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
00372>     TZERO =   .00 hrs on       0
00373>     METOUT=   2 (output = METRIC)
00374>     NRUN  = 005
00375>     NSTORM=   1
00376>                #  1=BUR6_005.stm
00377> ---------------------------------------------------------------------------
00378> 005:0002----------------------------------------------------------------------
00379> *#*************************************************************************|
00380> *#  Project Name: BRANT & GHENT (PHASE 1)
00381> *#               BURLINGTON, ONTARIO
00382> *#  JOB NUMBER  : 20062
00383> *#       Date   : JUNE 2021
00384> *#    Revised   :
00385> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00386> *#       File   : 20071A.DAT
00387> *#*************************************************************************|
00388> *
00389> ---------------------------------------------------------------------------
00390> 005:0002----------------------------------------------------------------------
00391> *
00392> --------------------
00393> | READ STORM       |    Filename: Burlington 5-yr 6hr CHICAGO    (A=802.04
00394> | Ptotal=  53.05 mm|    Comments: Burlington 5-yr 6hr CHICAGO    (A=802.04
00395> --------------------
00396>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00397>               hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
00398>               .17   2.348 |  1.67  10.690 |  3.17   5.897 |  4.67   3.004
00399>               .33   2.537 |  1.83  24.479 |  3.33   5.279 |  4.83   2.862
00400>               .50   2.766 |  2.00 101.312 |  3.50   4.790 |  5.00   2.734
00401>               .67   3.048 |  2.17  31.941 |  3.67   4.394 |  5.17   2.619
00402>               .83   3.407 |  2.33  17.333 |  3.83   4.065 |  5.33   2.514
00403>              1.00   3.881 |  2.50  12.145 |  4.00   3.788 |  5.50   2.419
00404>              1.17   4.539 |  2.67   9.469 |  4.17   3.550 |  5.67   2.331
00405>              1.33   5.523 |  2.83   7.826 |  4.33   3.344 |  5.83   2.251
00406>              1.50   7.185 |  3.00   6.709 |  4.50   3.164 |  6.00   2.176
00407>
00408> ---------------------------------------------------------------------------
00409> 005:0003----------------------------------------------------------------------
00410> *
00411> *#*************************************************************************|
00412> *#
00413> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
00414> *#        ============================================================
00415> *#
00416> *#*************************************************************************|
00417> *# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
00418> *
00419> ----------------------
00420> | CALIB STANDHYD     |   Area    (ha)=     .60
00421> | 01:101    DT= 1.00 |   Total Imp(%)=   28.00   Dir. Conn.(%)=   28.00
00422> ----------------------
00423>                            IMPERVIOUS    PERVIOUS (i)
00424>      Surface Area     (ha)=        .17          .43
00425>      Dep. Storage     (mm)=       1.00         6.35
00426>      Average Slope     (%)=       2.00         2.50
00427>      Length            (m)=      20.00        10.00
00428>      Mannings n             =       .013         .250
00429>
00430>      Max.eff.Inten.(mm/hr)=     101.31        39.72
00431>                  over (min)        1.00         5.00
00432>      Storage Coeff.  (min)=        .79 (ii)    4.94 (ii)
00433>      Unit Hyd. Tpeak (min)=       1.00         5.00
00434>      Unit Hyd. peak  (cms)=       1.22          .23
00435>                                                          *TOTALS*
00436>      PEAK FLOW       (cms)=        .05          .03           .078 (iii)
00437>      TIME TO PEAK    (hrs)=       2.00         2.03          2.000
00438>      RUNOFF VOLUME    (mm)=      52.05        19.79         28.825
00439>      TOTAL RAINFALL   (mm)=      53.05        53.05         53.053
00440>      RUNOFF COEFFICIENT   =        .98          .37           .543
00441>
00442>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00443>            CN* =  80.0    Ia = Dep. Storage  (Above)
00444>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00445>            THAN THE STORAGE COEFFICIENT.
00446>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00447>
00448> ---------------------------------------------------------------------------
00449> 005:0004----------------------------------------------------------------------
00450> *# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
00451> *
00452> ----------------------
00453> | CALIB NASHYD       |   Area    (ha)=     .08   Curve Number   (CN)=80.00
00454> | 02:102    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
00455> ----------------------   U.H. Tp(hrs)=    .040
00456>
00457>      Unit Hyd Qpeak  (cms)=     .074
00458>
00459>      PEAK FLOW       (cms)=     .008 (i)
00460>      TIME TO PEAK    (hrs)=    2.000
00461>      RUNOFF VOLUME    (mm)=   19.791
00462>      TOTAL RAINFALL   (mm)=   53.053
00463>      RUNOFF COEFFICIENT   =     .373
00464>
00465>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00466>
00467> ---------------------------------------------------------------------------
00468> 005:0005----------------------------------------------------------------------
00469> * ADD TOTAL EX. FLOWS FROM PHASE 1
00470> ------------------------
00471> | ADD HYD (EX.P1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00472> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00473>                        ID1 01:101            .60     .078    2.00  28.83    .000
00474>                       +ID2 02:102            .08     .008    2.00  19.79    .000
00475>                        ========================================================
00476>                        SUM 10:EX.P1          .67     .086    2.00  27.79    .000
00477>
00478>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00479>
00480> ---------------------------------------------------------------------------
00481> 005:0006----------------------------------------------------------------------
00482> *#*************************************************************************|
00483> *#
00484> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
00485> *#        ============================================================
00486> *#
00487> **#*************************************************************************|
00488> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO BRANT STREET
00489> *
00490> ----------------------
00491> | CALIB STANDHYD     |   Area    (ha)=     .65
00492> | 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
00493> ----------------------
00494>                            IMPERVIOUS    PERVIOUS (i)
00495>      Surface Area     (ha)=        .63          .02
00496>      Dep. Storage     (mm)=       1.00         6.35
00497>      Average Slope     (%)=       1.50         2.00
00498>      Length            (m)=      20.00        20.00
00499>      Mannings n             =       .013         .250
00500>
00501>      Max.eff.Inten.(mm/hr)=     101.31        35.40
00502>                  over (min)        1.00         8.00
00503>      Storage Coeff.  (min)=        .86 (ii)    7.91 (ii)
00504>      Unit Hyd. Tpeak (min)=       1.00         8.00
00505>      Unit Hyd. peak  (cms)=       1.17          .14
00506>                                                          *TOTALS*
00507>      PEAK FLOW       (cms)=        .18          .00           .177 (iii)
00508>      TIME TO PEAK    (hrs)=       2.00         2.10          2.000
00509>      RUNOFF VOLUME    (mm)=      52.05        19.79         51.085
00510>      TOTAL RAINFALL   (mm)=      53.05        53.05         53.053
00511>      RUNOFF COEFFICIENT   =        .98          .37           .963
00512>
00513>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00514>            CN* =  80.0    Ia = Dep. Storage  (Above)
00515>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00516>            THAN THE STORAGE COEFFICIENT.
00517>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00518>
00519> ---------------------------------------------------------------------------
00520> 005:0007----------------------------------------------------------------------
00521> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE AND TANK
00522> *
00523> ----------------------
00524> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
00525> |  IN>01:(201    )   |
00526> | OUT<02:(201.CT)    |    =========  OUTFLOW STORAGE TABLE  =========
00527> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
00528>                             (cms)    (ha.m.)   |    (cms)    (ha.m.)
00529>                              .000  .0000E+00    |     .051  .1580E-01
00530>                              .041  .3500E-02    |     .051  .1930E-01
00531>                              .051  .5300E-02    |     .051  .1930E-01
00532>                              .051  .5300E-02    |     .071  .2350E-01
00533>                              .051  .1230E-01    |     .000  .0000E+00
00534>
00535>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
00536>      ---------------------       (ha)     (cms)     (hrs)       (mm)
00537>      INFLOW >01: (201    )        .65      .177     2.000     51.085
00538>      OUTFLOW<02: (201.CT)         .65      .051     1.917     51.085
00539>     OVERFLOW<03: (201.OV)         .00      .000      .000       .000
00540>
```

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


                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   29.008
                    TIME SHIFT OF PEAK FLOW         (min)=    -5.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.1046E-01

--------------------------------------------------------------------------------
005:0008--------------------------------------------------------------------------
*# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .03
| 01:202    DT= 1.00 |   Total Imp(%)=   98.00   Dir. Conn.(%)=   98.00
----------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .02          .00
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       3.00         2.00
     Length            (m)=      10.00        10.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     101.31        39.72
                  over (min)        1.00         5.00
     Storage Coeff.  (min)=        .46 (ii)    4.90 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=       1.51          .23
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .01          .00          .007 (iii)
     TIME TO PEAK    (hrs)=       1.93         2.03         2.000
     RUNOFF VOLUME    (mm)=      52.05        19.79        51.408
     TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
     RUNOFF COEFFICIENT   =        .98          .37          .969

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

--------------------------------------------------------------------------------
005:0009--------------------------------------------------------------------------
*# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .00
| 04:203    DT= 1.00 |   Total Imp(%)=   90.00   Dir. Conn.(%)=   90.00
----------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .00          .00
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00        10.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     101.31        39.72
                  over (min)        1.00         5.00
     Storage Coeff.  (min)=        .52 (ii)    4.96 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=       1.45          .23
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .00          .00          .001 (iii)
     TIME TO PEAK    (hrs)=       1.92         2.03         2.000
     RUNOFF VOLUME    (mm)=      52.05        19.79        48.824
     TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
     RUNOFF COEFFICIENT   =        .98          .37          .920

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

--------------------------------------------------------------------------------
005:0010--------------------------------------------------------------------------
* ADD TOTAL FLOWS TO BRANT STREET
------------------------
| ADD HYD (BRANT     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                      ID1 02:201.CTL        .65      .051    1.92   51.09    .000
                     +ID2 03:201.OVF        .00      .000     .00     .00    .000
                     +ID3 01:202            .03      .007    2.00   51.41    .000
                      ========================================================
                      SUM 05:BRANT          .67      .058    2.00   51.10    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0011--------------------------------------------------------------------------
* ADD TOTAL FLOWS FROM PHASE 1 SITE
------------------------
| ADD HYD (TOTAL.P1  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                      ID1 04:203            .00      .001    2.00   48.82    .000
                     +ID2 05:BRANT          .67      .058    2.00   51.10    .000
                      ========================================================
                      SUM 09:TOTAL.P1       .67      .059    2.00   51.09    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0012--------------------------------------------------------------------------
* AREA CHECK
------------------------
| ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                      ID1 10:EX.P1          .67      .086    2.00   27.79    .000
                     +ID2 09:TOTAL.P1       .67      .059    2.00   51.09    .000
                      ========================================================
                      SUM 01:CHECK         1.35      .145    2.00   39.44    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0013--------------------------------------------------------------------------
**#*************************************************************************|
* RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
*
--------------------------------------------------------------------------------
005:0002--------------------------------------------------------------------------
*
  ** END OF RUN :   9

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




----------------------
| START            |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
----------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
    TZERO =   .00 hrs on        0

    METOUT=   2 (output = METRIC)
    NRUN  = 010
    NSTORM=   1
           #  1=BUR6_010.stm
--------------------------------------------------------------------------------
010:0002--------------------------------------------------------------------------
*#*************************************************************************|
*#  Project Name: BRANT & GHENT (PHASE 1)
*#               BURLINGTON, ONTARIO
*#  JOB NUMBER  : 20062
*#       Date   : JUNE 2021
*#    Revised   :
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 20071A.DAT
*#*************************************************************************|
*
--------------------------------------------------------------------------------
010:0002--------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: Burlington 10-yr 6hr CHICAGO      (A=918.
| Ptotal=  61.10 mm|    Comments: Burlington 10-yr 6hr CHICAGO      (A=918.
--------------------
               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   2.714 |   1.67  12.326 |   3.17   6.808 |   4.67   3.472
               .33   2.933 |   1.83  28.176 |   3.33   6.095 |   4.83   3.308
               .50   3.197 |   2.00 116.310 |   3.50   5.532 |   5.00   3.161
               .67   3.523 |   2.17  36.748 |   3.67   5.075 |   5.17   3.027
               .83   3.937 |   2.33  19.967 |   3.83   4.696 |   5.33   2.907
              1.00   4.483 |   2.50  14.001 |   4.00   4.376 |   5.50   2.796
              1.17   5.242 |   2.67  10.921 |   4.17   4.102 |   5.67   2.695
              1.33   6.377 |   2.83   9.030 |   4.33   3.864 |   5.83   2.602
              1.50   8.291 |   3.00   7.743 |   4.50   3.656 |   6.00   2.516

--------------------------------------------------------------------------------
010:0003--------------------------------------------------------------------------
*
*#*************************************************************************|
*#
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
*#        ========================================================
*#
*#*************************************************************************|
*# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .60
| 01:101    DT= 1.00 |   Total Imp(%)=   28.00   Dir. Conn.(%)=   28.00
----------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .17          .43
     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)=     116.31        53.05
                  over (min)        1.00         4.00
     Storage Coeff.  (min)=        .74 (ii)    4.45 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.26          .26
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .05          .05          .099 (iii)
     TIME TO PEAK    (hrs)=       2.00         2.03         2.000
     RUNOFF VOLUME    (mm)=      60.10        25.35        35.081
     TOTAL RAINFALL   (mm)=      61.10        61.10        61.101
     RUNOFF COEFFICIENT   =        .98          .41          .574

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

--------------------------------------------------------------------------------
010:0004--------------------------------------------------------------------------
*# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
*
----------------------
| CALIB NASHYD       |   Area    (ha)=     .08   Curve Number   (CN)=80.00
| 02:102    DT= 1.00 |   Ia      (mm)=    6.350   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=     .040

     Unit Hyd Qpeak  (cms)=     .074

     PEAK FLOW       (cms)=     .011 (i)
     TIME TO PEAK    (hrs)=    2.000
     RUNOFF VOLUME    (mm)=   25.349
     TOTAL RAINFALL   (mm)=   61.101
     RUNOFF COEFFICIENT   =     .415

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

--------------------------------------------------------------------------------
010:0005--------------------------------------------------------------------------
* ADD TOTAL EX. FLOWS FROM PHASE 1
------------------------
| ADD HYD (EX.P1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                      ID1 01:101            .60      .099    2.00   35.08    .000
                     +ID2 02:102            .08      .011    2.00   25.35    .000
                      ========================================================
                      SUM 10:EX.P1          .67      .110    2.00   33.97    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0006--------------------------------------------------------------------------
*#*************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
*#        =========================================================
*#
**#*************************************************************************|
*# CATCHMENT 201 - CONTROLLED DISCHARGE TO BRANT STREET
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .65
| 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
----------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .63          .02
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       1.50         2.00
     Length            (m)=      20.00        20.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     116.31        48.24
                  over (min)        1.00         7.00
     Storage Coeff.  (min)=        .81 (ii)    7.04 (ii)
     Unit Hyd. Tpeak (min)=       1.00         7.00
     Unit Hyd. peak  (cms)=       1.20          .16
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .20          .00          .204 (iii)
```

```
00811>      TIME TO PEAK    (hrs)=       2.00         2.07          2.000
00812>      RUNOFF VOLUME    (mm)=      60.10        25.35         59.059
00813>      TOTAL RAINFALL   (mm)=      61.10        61.10         61.101
00814>      RUNOFF COEFFICIENT   =        .98          .41           .967
00815>
00816>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00817>            CN* =  80.0    Ia = Dep. Storage  (Above)
00818>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00819>            THAN THE STORAGE COEFFICIENT.
00820>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00821>
00822> ---------------------------------------------------------------------------
00823> 010:0007-----------------------------------------------------------------
00824> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE AND TANK
00825> *
00826> ---------------------
00827> | ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
00828> |  IN>01:(201   )   |
00829> | OUT<02:(201.CT)   |    =========  OUTLFOW STORAGE TABLE  =========
00830> ---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
00831>                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
00832>                             .000  .0000E+00    |     .051  .1580E-01
00833>                             .041  .3500E-02    |     .051  .1930E-01
00834>                             .051  .5300E-02    |     .051  .1930E-01
00835>                             .051  .5300E-02    |     .071  .2350E-01
00836>                             .051  .1230E-01    |     .000  .0000E+00
00837>
00838>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
00839>      --------------------       (ha)     (cms)     (hrs)       (mm)
00840>      INFLOW >01: (201   )        .65      .204     2.000     59.059
00841>      OUTFLOW<02: (201.CT)        .65      .051     1.900     59.059
00842>     OVERFLOW<03: (201.OV)        .00      .000      .000       .000
00843>
00844>                     TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
00845>                     CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
00846>                     PERCENTAGE OF TIME OVERFLOWING     (%)=     .00
00847>
00848>
00849>                     PEAK   FLOW   REDUCTION [Qout/Qin](%)=   25.222
00850>                     TIME SHIFT OF PEAK FLOW          (min)=    -6.00
00851>                     MAXIMUM  STORAGE   USED       (ha.m.)=.1286E-01
00852>
00853> ---------------------------------------------------------------------------
00854> 010:0008-----------------------------------------------------------------
00855> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
00856> *
00857> ---------------------
00858> | CALIB STANDHYD     |   Area    (ha)=     .03
00859> | 01:202    DT= 1.00 |   Total Imp(%)=   98.00   Dir. Conn.(%)=   98.00
00860> ---------------------
00861>                              IMPERVIOUS    PERVIOUS (i)
00862>      Surface Area     (ha)=        .02          .00
00863>      Dep. Storage     (mm)=       1.00         6.35
00864>      Average Slope     (%)=       3.00         2.00
00865>      Length            (m)=      10.00        10.00
00866>      Mannings n             =       .013         .250
00867>
00868>      Max.eff.Inten.(mm/hr)=     116.31        53.05
00869>                 over (min)        1.00         4.00
00870>      Storage Coeff.  (min)=        .43 (ii)    4.39 (ii)
00871>      Unit Hyd. Tpeak (min)=       1.00         4.00
00872>      Unit Hyd. peak  (cms)=       1.53          .27
00873>                                                          *TOTALS*
00874>      PEAK FLOW       (cms)=        .01          .00          .008 (iii)
00875>      TIME TO PEAK    (hrs)=       1.93         2.03         2.000
00876>      RUNOFF VOLUME    (mm)=      60.10        25.35        59.406
00877>      TOTAL RAINFALL   (mm)=      61.10        61.10        61.101
00878>      RUNOFF COEFFICIENT   =        .98          .41          .972
00879>
00880>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00881>            CN* =  80.0    Ia = Dep. Storage  (Above)
00882>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00883>            THAN THE STORAGE COEFFICIENT.
00884>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00885>
00886> ---------------------------------------------------------------------------
00887> 010:0009-----------------------------------------------------------------
00888> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
00889> *
00890> ---------------------
00891> | CALIB STANDHYD     |   Area    (ha)=     .00
00892> | 04:203    DT= 1.00 |   Total Imp(%)=   90.00   Dir. Conn.(%)=   90.00
00893> ---------------------
00894>                              IMPERVIOUS    PERVIOUS (i)
00895>      Surface Area     (ha)=        .00          .00
00896>      Dep. Storage     (mm)=       1.00         6.35
00897>      Average Slope     (%)=       2.00         2.00
00898>      Length            (m)=      10.00        10.00
00899>      Mannings n             =       .013         .250
00900>
00901>      Max.eff.Inten.(mm/hr)=     116.31        53.05
00902>                 over (min)        1.00         4.00
00903>      Storage Coeff.  (min)=        .49 (ii)    4.45 (ii)
00904>      Unit Hyd. Tpeak (min)=       1.00         4.00
00905>      Unit Hyd. peak  (cms)=       1.48          .27
00906>                                                          *TOTALS*
00907>      PEAK FLOW       (cms)=        .00          .00          .001 (iii)
00908>      TIME TO PEAK    (hrs)=       1.92         2.03         2.000
00909>      RUNOFF VOLUME    (mm)=      60.10        25.35        56.624
00910>      TOTAL RAINFALL   (mm)=      61.10        61.10        61.101
00911>      RUNOFF COEFFICIENT   =        .98          .41          .927
00912>
00913>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00914>            CN* =  80.0    Ia = Dep. Storage  (Above)
00915>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00916>            THAN THE STORAGE COEFFICIENT.
00917>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00918>
00919> ---------------------------------------------------------------------------
00920> 010:0010-----------------------------------------------------------------
00921> * ADD TOTAL FLOWS TO BRANT STREET
00922> ------------------------
00923> | ADD HYD (BRANT     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00924> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00925>                       ID1 02:201.CTL        .65     .051    1.90   59.06    .000
00926>                      +ID2 03:201.OVF        .00     .000     .00     .00    .000
00927>                      +ID3 01:202            .03     .008    2.00   59.41    .000
00928>                       ============================================================
00929>                       SUM 05:BRANT          .67     .059    2.00   59.07    .000
00930>
00931>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00932>
00933> ---------------------------------------------------------------------------
00934> 010:0011-----------------------------------------------------------------
00935> * ADD TOTAL FLOWS FROM PHASE 1 SITE
00936> ------------------------
00937> | ADD HYD (TOTAL.P1  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00938> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00939>                       ID1 04:203            .00     .001    2.00   56.62    .000
00940>                      +ID2 05:BRANT          .67     .059    2.00   59.07    .000
00941>                       ============================================================
00942>                       SUM 09:TOTAL.P1       .67     .060    2.00   59.06    .000
00943>
00944>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00945>
00946> ---------------------------------------------------------------------------
00947> 010:0012-----------------------------------------------------------------
00948> * AREA CHECK
00949> ------------------------
00950> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00951> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00952>                       ID1 10:EX.P1          .67     .110    2.00   33.97    .000
00953>                      +ID2 09:TOTAL.P1       .67     .060    2.00   59.06    .000
00954>                       ============================================================
00955>                       SUM 01:CHECK         1.35     .170    2.00   46.51    .000
00956>
00957>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00958>
00959> ---------------------------------------------------------------------------
00960> 010:0013-----------------------------------------------------------------
00961> **#*************************************************************************|
00962> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00963> *
00964> ---------------------------------------------------------------------------
00965> 010:0002-----------------------------------------------------------------
00966> *
00967> ---------------------------------------------------------------------------
00968> 010:0002-----------------------------------------------------------------
00969> *
00970>   ** END OF RUN :  24
00971>
00972> ***************************************************************************
00973>
00974>
00975>
00976>
00977>
00978> --------------------
00979> | START              |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
00980> --------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
00981>     TZERO =   .00 hrs on        0
00982>     METOUT=   2 (output = METRIC)
00983>     NRUN  = 025
00984>     NSTORM=   1
00985>               #  1=BUR6_025.stm
00986> ---------------------------------------------------------------------------
00987> 025:0002-----------------------------------------------------------------
00988> *#*************************************************************************|
00989> *#  Project Name: BRANT & GHENT (PHASE 1)
00990> *#               BURLINGTON, ONTARIO
00991> *#  JOB NUMBER   : 20062
00992> *#      Date     : JUNE 2021
00993> *#    Revised    :
00994> *#    Company    : S. LLEWELLYN AND ASSOCIATES LTD.
00995> *#       File    : 20071A.DAT
00996> *#*************************************************************************|
00997> *
00998> ---------------------------------------------------------------------------
00999> 025:0002-----------------------------------------------------------------
01000> *
01001> --------------------
01002> | READ STORM        |    Filename: Burlington 25-yr 6hr CHICAGO      (A=106
01003> | Ptotal=  71.35 mm|    Comments: Burlington 25-yr 6hr CHICAGO      (A=106
01004> --------------------
01005>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
01006>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
01007>                .17   3.182 |   1.67  14.410 |   3.17   7.968 |   4.67   4.068
01008>                .33   3.437 |   1.83  32.881 |   3.33   7.135 |   4.83   3.876
01009>                .50   3.746 |   2.00 135.380 |   3.50   6.477 |   5.00   3.704
01010>                .67   4.128 |   2.17  42.866 |   3.67   5.943 |   5.17   3.548
01011>                .83   4.612 |   2.33  23.321 |   3.83   5.499 |   5.33   3.407
01012>               1.00   5.251 |   2.50  16.365 |   4.00   5.125 |   5.50   3.278
01013>               1.17   6.138 |   2.67  12.771 |   4.17   4.805 |   5.67   3.160
01014>               1.33   7.465 |   2.83  10.563 |   4.33   4.527 |   5.83   3.051
01015>               1.50   9.700 |   3.00   9.061 |   4.50   4.284 |   6.00   2.950
01016>
01017> ---------------------------------------------------------------------------
01018> 025:0003-----------------------------------------------------------------
01019> *
01020> *#*************************************************************************|
01021> *#
01022> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
01023> *#        ======================================================
01024> *#
01025> *#*************************************************************************|
01026> *# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
01027> *
01028> ----------------------
01029> | CALIB STANDHYD     |   Area    (ha)=     .60
01030> | 01:101    DT= 1.00 |   Total Imp(%)=   28.00   Dir. Conn.(%)=   28.00
01031> ----------------------
01032>                              IMPERVIOUS    PERVIOUS (i)
01033>      Surface Area     (ha)=        .17          .43
01034>      Dep. Storage     (mm)=       1.00         6.35
01035>      Average Slope     (%)=       2.00         2.50
01036>      Length            (m)=      20.00        10.00
01037>      Mannings n             =       .013         .250
01038>
01039>      Max.eff.Inten.(mm/hr)=     135.38        69.33
01040>                 over (min)        1.00         4.00
01041>      Storage Coeff.  (min)=        .70 (ii)    4.03 (ii)
01042>      Unit Hyd. Tpeak (min)=       1.00         4.00
01043>      Unit Hyd. peak  (cms)=       1.29          .28
01044>                                                          *TOTALS*
01045>      PEAK FLOW       (cms)=        .06          .07          .126 (iii)
01046>      TIME TO PEAK    (hrs)=       2.00         2.02         2.000
01047>      RUNOFF VOLUME    (mm)=      70.35        32.88        43.368
01048>      TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
01049>      RUNOFF COEFFICIENT   =        .99          .46          .608
01050>
01051>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01052>            CN* =  80.0    Ia = Dep. Storage  (Above)
01053>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01054>            THAN THE STORAGE COEFFICIENT.
01055>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01056>
01057> ---------------------------------------------------------------------------
01058> 025:0004-----------------------------------------------------------------
01059> *# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
01060> *
01061> ----------------------
01062> | CALIB NASHYD       |   Area     (ha)=     .08   Curve Number   (CN)=80.00
01063> | 02:102    DT= 1.00 |   Ia       (mm)=   6.350   # of Linear Res.(N)= 3.00
01064> ----------------------   U.H. Tp(hrs)=    .040
01065>
01066>      Unit Hyd Qpeak  (cms)=     .074
01067>
01068>      PEAK FLOW       (cms)=     .014 (i)
01069>      TIME TO PEAK    (hrs)=    2.000
01070>      RUNOFF VOLUME    (mm)=   32.876
01071>      TOTAL RAINFALL   (mm)=   71.347
01072>      RUNOFF COEFFICIENT   =     .461
01073>
01074>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01075>
01076> ---------------------------------------------------------------------------
01077> 025:0005-----------------------------------------------------------------
01078> * ADD TOTAL EX. FLOWS FROM PHASE 1
01079> ------------------------
01080> | ADD HYD (EX.P1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
```

```
01081> ------------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
01082>                       ID1 01:101             .60     .126    2.00  43.37    .000
01083>                      +ID2 02:102             .08     .014    2.00  32.88    .000
01084>                       ============================================================
01085>                       SUM 10:EX.P1           .67     .140    2.00  42.17    .000
01086>
01087>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01088>
01089> ---------------------------------------------------------------------------------
01090> 025:0006-----------------------------------------------------------------------------
01091> *#*****************************************************************************|
01092> *#
01093> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
01094> *#        ========================================================
01095> *#
01096> **#*************************************************************************|
01097> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO BRANT STREET
01098> *
01099> ----------------------
01100> | CALIB STANDHYD     |   Area    (ha)=     .65
01101> | 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
01102> ----------------------
01103>                              IMPERVIOUS    PERVIOUS (i)
01104>      Surface Area     (ha)=        .63          .02
01105>      Dep. Storage     (mm)=       1.00         6.35
01106>      Average Slope     (%)=       1.50         2.00
01107>      Length            (m)=      20.00        20.00
01108>      Mannings n             =      .013         .250
01109>
01110>      Max.eff.Inten.(mm/hr)=     135.38        65.70
01111>                    over (min)        1.00         6.00
01112>      Storage Coeff.  (min)=        .76 (ii)    6.27 (ii)
01113>      Unit Hyd. Tpeak (min)=       1.00         6.00
01114>      Unit Hyd. peak  (cms)=       1.24          .18
01115>                                                          *TOTALS*
01116>      PEAK FLOW       (cms)=        .24          .00          .238 (iii)
01117>      TIME TO PEAK    (hrs)=       2.00         2.05         2.000
01118>      RUNOFF VOLUME    (mm)=      70.35        32.88        69.223
01119>      TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
01120>      RUNOFF COEFFICIENT   =        .99          .46          .970
01121>
01122>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01123>            CN* =  80.0    Ia = Dep. Storage  (Above)
01124>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01125>            THAN THE STORAGE COEFFICIENT.
01126>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01127>
01128> ---------------------------------------------------------------------------------
01129> 025:0007-----------------------------------------------------------------------------
01130> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE AND TANK
01131> *
01132> ----------------------
01133> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
01134> |  IN>01:(201   )    |
01135> | OUT<02:(201.CT)    |    =========  OUTLFOW STORAGE TABLE  =========
01136> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
01137>                             (cms)    (ha.m.)   |    (cms)    (ha.m.)
01138>                              .000  .0000E+00    |     .051  .1580E-01
01139>                              .041  .3500E-02    |     .051  .1930E-01
01140>                              .051  .5300E-02    |     .051  .1930E-01
01141>                              .051  .5300E-02    |     .071  .2350E-01
01142>                              .051  .1230E-01    |     .000  .0000E+00
01143>
01144>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
01145>      --------------------       (ha)     (cms)     (hrs)       (mm)
01146>      INFLOW >01: (201   )        .65      .238     2.000     69.223
01147>      OUTFLOW<02: (201.CT)        .65      .051     1.883     69.222
01148>     OVERFLOW<03: (201.OV)        .00      .000      .000       .000
01149>
01150>                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
01151>                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
01152>                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
01153>
01154>
01155>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   21.621
01156>                    TIME SHIFT OF PEAK FLOW          (min)=    -7.00
01157>                    MAXIMUM  STORAGE   USED       (ha.m.)=.1595E-01
01158>
01159> ---------------------------------------------------------------------------------
01160> 025:0008-----------------------------------------------------------------------------
01161> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
01162> *
01163> ----------------------
01164> | CALIB STANDHYD     |   Area    (ha)=     .03
01165> | 01:202    DT= 1.00 |   Total Imp(%)=   98.00   Dir. Conn.(%)=   98.00
01166> ----------------------
01167>                              IMPERVIOUS    PERVIOUS (i)
01168>      Surface Area     (ha)=        .02          .00
01169>      Dep. Storage     (mm)=       1.00         6.35
01170>      Average Slope     (%)=       3.00         2.00
01171>      Length            (m)=      10.00        10.00
01172>      Mannings n             =      .013         .250
01173>
01174>      Max.eff.Inten.(mm/hr)=     135.38        69.33
01175>                    over (min)        1.00         4.00
01176>      Storage Coeff.  (min)=        .41 (ii)    3.97 (ii)
01177>      Unit Hyd. Tpeak (min)=       1.00         4.00
01178>      Unit Hyd. peak  (cms)=       1.55          .29
01179>                                                          *TOTALS*
01180>      PEAK FLOW       (cms)=        .01          .00          .009 (iii)
01181>      TIME TO PEAK    (hrs)=       1.93         2.02         2.000
01182>      RUNOFF VOLUME    (mm)=      70.35        32.88        69.597
01183>      TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
01184>      RUNOFF COEFFICIENT   =        .99          .46          .975
01185>
01186>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01187>            CN* =  80.0    Ia = Dep. Storage  (Above)
01188>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01189>            THAN THE STORAGE COEFFICIENT.
01190>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01191>
01192> ---------------------------------------------------------------------------------
01193> 025:0009-----------------------------------------------------------------------------
01194> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
01195> *
01196> ----------------------
01197> | CALIB STANDHYD     |   Area    (ha)=     .00
01198> | 04:203    DT= 1.00 |   Total Imp(%)=   90.00   Dir. Conn.(%)=   90.00
01199> ----------------------
01200>                              IMPERVIOUS    PERVIOUS (i)
01201>      Surface Area     (ha)=        .00          .00
01202>      Dep. Storage     (mm)=       1.00         6.35
01203>      Average Slope     (%)=       2.00         2.00
01204>      Length            (m)=      10.00        10.00
01205>      Mannings n             =      .013         .250
01206>
01207>      Max.eff.Inten.(mm/hr)=     135.38        69.33
01208>                    over (min)        1.00         4.00
01209>      Storage Coeff.  (min)=        .46 (ii)    4.02 (ii)
01210>      Unit Hyd. Tpeak (min)=       1.00         4.00
01211>      Unit Hyd. peak  (cms)=       1.50          .28
01212>                                                          *TOTALS*
01213>      PEAK FLOW       (cms)=        .00          .00          .001 (iii)
01214>      TIME TO PEAK    (hrs)=       1.92         2.02         2.000
01215>      RUNOFF VOLUME    (mm)=      70.34        32.88        66.598
01216>      TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
01217>      RUNOFF COEFFICIENT   =        .99          .46          .933
01218>
01219>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01220>            CN* =  80.0    Ia = Dep. Storage  (Above)
01221>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01222>            THAN THE STORAGE COEFFICIENT.
01223>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01224>
01225> ---------------------------------------------------------------------------------
01226> 025:0010-----------------------------------------------------------------------------
01227> * ADD TOTAL FLOWS TO BRANT STREET
01228> ----------------------
01229> | ADD HYD (BRANT     ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
01230> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
01231>                       ID1 02:201.CTL        .65      .051    1.88  69.22    .000
01232>                      +ID2 03:201.OVF        .00      .000     .00    .00    .000
01233>                      +ID3 01:202            .03      .009    2.00  69.60    .000
01234>                       ============================================================
01235>                       SUM 05:BRANT          .67      .061    2.00  69.24    .000
01236>
01237>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01238>
01239> ---------------------------------------------------------------------------------
01240> 025:0011-----------------------------------------------------------------------------
01241> * ADD TOTAL FLOWS FROM PHASE 1 SITE
01242> ----------------------
01243> | ADD HYD (TOTAL.P1  ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
01244> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
01245>                       ID1 04:203            .00      .001    2.00  66.60    .000
01246>                      +ID2 05:BRANT          .67      .061    2.00  69.24    .000
01247>                       ============================================================
01248>                       SUM 09:TOTAL.P1       .67      .062    2.00  69.22    .000
01249>
01250>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01251>
01252> ---------------------------------------------------------------------------------
01253> 025:0012-----------------------------------------------------------------------------
01254> * AREA CHECK
01255> ----------------------
01256> | ADD HYD (CHECK     ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
01257> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
01258>                       ID1 10:EX.P1          .67      .140    2.00  42.17    .000
01259>                      +ID2 09:TOTAL.P1       .67      .062    2.00  69.22    .000
01260>                       ============================================================
01261>                       SUM 01:CHECK         1.35      .201    2.00  55.70    .000
01262>
01263>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01264>
01265> ---------------------------------------------------------------------------------
01266> 025:0013-----------------------------------------------------------------------------
01267> **#*************************************************************************|
01268> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
01269> *
01270> ---------------------------------------------------------------------------------
01271> 025:0002-----------------------------------------------------------------------------
01272> *
01273> ---------------------------------------------------------------------------------
01274> 025:0002-----------------------------------------------------------------------------
01275> *
01276> ---------------------------------------------------------------------------------
01277> 025:0002-----------------------------------------------------------------------------
01278> *
01279>   ** END OF RUN :  49
01280>
01281> ********************************************************************************
01282>
01283>
01284>
01285>
01286>
01287> --------------------
01288> | START            |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
01289> --------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
01290>     TZERO =   .00 hrs on        0
01291>     METOUT=   2 (output = METRIC)
01292>     NRUN  = 050
01293>     NSTORM=   1
01294>             #  1=BUR6_050.stm
01295> ---------------------------------------------------------------------------------
01296> 050:0002-----------------------------------------------------------------------------
01297> *#*************************************************************************|
01298> *#  Project Name: BRANT & GHENT (PHASE 1)
01299> *#                BURLINGTON, ONTARIO
01300> *#  JOB NUMBER  : 20062
01301> *#       Date   : JUNE 2021
01302> *#    Revised   :
01303> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
01304> *#       File   : 20071A.DAT
01305> *#*************************************************************************|
01306> *
01307> ---------------------------------------------------------------------------------
01308> 050:0002-----------------------------------------------------------------------------
01309> *
01310> --------------------
01311> | READ STORM       |    Filename: Burlington 50-yr 6hr CHICAGO     (A=1172
01312> | Ptotal=  78.93 mm|    Comments: Burlington 50-yr 6hr CHICAGO     (A=1172
01313> --------------------
01314>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
01315>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
01316>                .17   3.533 |   1.67  15.961 |   3.17   8.836 |   4.67   4.516
01317>                .33   3.817 |   1.83  36.356 |   3.33   7.913 |   4.83   4.304
01318>                .50   4.160 |   2.00 149.296 |   3.50   7.185 |   5.00   4.113
01319>                .67   4.582 |   2.17  47.374 |   3.67   6.593 |   5.17   3.940
01320>                .83   5.119 |   2.33  25.806 |   3.83   6.102 |   5.33   3.783
01321>               1.00   5.827 |   2.50  18.121 |   4.00   5.688 |   5.50   3.640
01322>               1.17   6.809 |   2.67  14.149 |   4.17   5.333 |   5.67   3.509
01323>               1.33   8.278 |   2.83  11.707 |   4.33   5.025 |   5.83   3.388
01324>               1.50  10.753 |   3.00  10.045 |   4.50   4.755 |   6.00   3.277
01325>
01326> ---------------------------------------------------------------------------------
01327> 050:0003-----------------------------------------------------------------------------
01328> *
01329> *#*************************************************************************|
01330> *#
01331> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
01332> *#        ========================================================
01333> *#
01334> *#*************************************************************************|
01335> *# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
01336> *
01337> ----------------------
01338> | CALIB STANDHYD     |   Area    (ha)=     .60
01339> | 01:101    DT= 1.00 |   Total Imp(%)=   28.00   Dir. Conn.(%)=   28.00
01340> ----------------------
01341>                              IMPERVIOUS    PERVIOUS (i)
01342>      Surface Area     (ha)=        .17          .43
01343>      Dep. Storage     (mm)=       1.00         6.35
01344>      Average Slope     (%)=       2.00         2.50
01345>      Length            (m)=      20.00        10.00
01346>      Mannings n             =      .013         .250
01347>
01348>      Max.eff.Inten.(mm/hr)=     149.30        81.82
01349>                    over (min)        1.00         4.00
01350>      Storage Coeff.  (min)=        .67 (ii)    3.79 (ii)
```

```
01351>      Unit Hyd. Tpeak (min)=       1.00         4.00
01352>      Unit Hyd. peak  (cms)=       1.31          .29
01353>                                                        *TOTALS*
01354>      PEAK FLOW       (cms)=        .07          .08          .146 (iii)
01355>      TIME TO PEAK    (hrs)=       2.00         2.02         2.000
01356>      RUNOFF VOLUME    (mm)=      77.93        38.71        49.694
01357>      TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
01358>      RUNOFF COEFFICIENT   =        .99          .49          .630
01359>
01360>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01361>            CN* =  80.0     Ia = Dep. Storage  (Above)
01362>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01363>            THAN THE STORAGE COEFFICIENT.
01364>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01365>
01366> ------------------------------------------------------------------------------
01367> 050:0004--------------------------------------------------------------------
01368> *# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
01369> *
01370> ----------------------
01371> | CALIB NASHYD       |   Area    (ha)=     .08   Curve Number    (CN)=80.00
01372> | 02:102    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
01373> ----------------------  U.H. Tp(hrs)=    .040
01374>
01375>      Unit Hyd Qpeak  (cms)=     .074
01376>
01377>      PEAK FLOW       (cms)=     .016 (i)
01378>      TIME TO PEAK    (hrs)=    2.000
01379>      RUNOFF VOLUME    (mm)=   38.712
01380>      TOTAL RAINFALL   (mm)=   78.932
01381>      RUNOFF COEFFICIENT   =     .490
01382>
01383>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01384>
01385> ------------------------------------------------------------------------------
01386> 050:0005--------------------------------------------------------------------
01387> * ADD TOTAL EX. FLOWS FROM PHASE 1
01388> ----------------------
01389> | ADD HYD (EX.P1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01390> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
01391>                        ID1 01:101          .60     .146    2.00  49.69    .000
01392>                       +ID2 02:102          .08     .016    2.00  38.71    .000
01393>                        ============================================================
01394>                        SUM 10:EX.P1         .67     .162    2.00  48.44    .000
01395>
01396>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01397>
01398> ------------------------------------------------------------------------------
01399> 050:0006--------------------------------------------------------------------
01400> *#*************************************************************************|
01401> *#
01402> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
01403> *#        ============================================================
01404> *#
01405> **#************************************************************************|
01406> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO BRANT STREET
01407> *
01408> ----------------------
01409> | CALIB STANDHYD     |   Area    (ha)=     .65
01410> | 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
01411> ----------------------
01412>                              IMPERVIOUS    PERVIOUS (i)
01413>      Surface Area     (ha)=        .63          .02
01414>      Dep. Storage     (mm)=       1.00         6.35
01415>      Average Slope     (%)=       1.50         2.00
01416>      Length            (m)=      20.00        20.00
01417>      Mannings n             =      .013         .250
01418>
01419>      Max.eff.Inten.(mm/hr)=     149.30        77.86
01420>                 over (min)        1.00         6.00
01421>      Storage Coeff.  (min)=        .73 (ii)    5.88 (ii)
01422>      Unit Hyd. Tpeak (min)=       1.00         6.00
01423>      Unit Hyd. peak  (cms)=       1.26          .19
01424>                                                        *TOTALS*
01425>      PEAK FLOW       (cms)=        .26          .00          .262 (iii)
01426>      TIME TO PEAK    (hrs)=       2.00         2.05         2.000
01427>      RUNOFF VOLUME    (mm)=      77.93        38.71        76.755
01428>      TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
01429>      RUNOFF COEFFICIENT   =        .99          .49          .972
01430>
01431>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01432>            CN* =  80.0     Ia = Dep. Storage  (Above)
01433>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01434>            THAN THE STORAGE COEFFICIENT.
01435>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01436>
01437> ------------------------------------------------------------------------------
01438> 050:0007--------------------------------------------------------------------
01439> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE AND TANK
01440> *
01441> ----------------------
01442> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
01443> |  IN>01:(201    )   |
01444> | OUT<02:(201.CT)    |    =========  OUTLFOW STORAGE TABLE  =========
01445> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
01446>                             (cms)    (ha.m.)   |    (cms)    (ha.m.)
01447>                              .000  .0000E+00    |     .051  .1580E-01
01448>                              .041  .3500E-02    |     .051  .1930E-01
01449>                              .051  .5300E-02    |     .051  .1930E-01
01450>                              .051  .5300E-02    |     .071  .2350E-01
01451>                              .051  .1230E-01    |     .000  .0000E+00
01452>
01453>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
01454>      ---------------------      (ha)     (cms)     (hrs)        (mm)
01455>      INFLOW >01: (201    )       .65      .262     2.000      76.755
01456>      OUTFLOW<02: (201.CT)        .65      .051     1.883      76.755
01457>     OVERFLOW<03: (201.OV)        .00      .000      .000        .000
01458>
01459>                     TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
01460>                     CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
01461>                     PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
01462>
01463>
01464>                     PEAK   FLOW   REDUCTION [Qout/Qin](%)=   19.584
01465>                     TIME SHIFT OF PEAK FLOW         (min)=    -7.00
01466>                     MAXIMUM  STORAGE   USED       (ha.m.)=.1827E-01
01467>
01468> ------------------------------------------------------------------------------
01469> 050:0008--------------------------------------------------------------------
01470> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
01471> *
01472> ----------------------
01473> | CALIB STANDHYD     |   Area    (ha)=     .03
01474> | 01:202    DT= 1.00 |   Total Imp(%)=   98.00   Dir. Conn.(%)=   98.00
01475> ----------------------
01476>                              IMPERVIOUS    PERVIOUS (i)
01477>      Surface Area     (ha)=        .02          .00
01478>      Dep. Storage     (mm)=       1.00         6.35
01479>      Average Slope     (%)=       3.00         2.00
01480>      Length            (m)=      10.00        10.00
01481>      Mannings n             =      .013         .250
01482>
01483>      Max.eff.Inten.(mm/hr)=     149.30        81.82
01484>                 over (min)        1.00         4.00
01485>      Storage Coeff.  (min)=        .39 (ii)    3.72 (ii)
01486>      Unit Hyd. Tpeak (min)=       1.00         4.00
01487>      Unit Hyd. peak  (cms)=       1.57          .30
01488>                                                        *TOTALS*
01489>      PEAK FLOW       (cms)=        .01          .00          .010 (iii)
01490>      TIME TO PEAK    (hrs)=       1.93         2.02         2.000
01491>      RUNOFF VOLUME    (mm)=      77.93        38.71        77.148
01492>      TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
01493>      RUNOFF COEFFICIENT   =        .99          .49          .977
01494>
01495>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01496>            CN* =  80.0     Ia = Dep. Storage  (Above)
01497>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01498>            THAN THE STORAGE COEFFICIENT.
01499>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01500>
01501> ------------------------------------------------------------------------------
01502> 050:0009--------------------------------------------------------------------
01503> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
01504> *
01505> ----------------------
01506> | CALIB STANDHYD     |   Area    (ha)=     .00
01507> | 04:203    DT= 1.00 |   Total Imp(%)=   90.00   Dir. Conn.(%)=   90.00
01508> ----------------------
01509>                              IMPERVIOUS    PERVIOUS (i)
01510>      Surface Area     (ha)=        .00          .00
01511>      Dep. Storage     (mm)=       1.00         6.35
01512>      Average Slope     (%)=       2.00         2.00
01513>      Length            (m)=      10.00        10.00
01514>      Mannings n             =      .013         .250
01515>
01516>      Max.eff.Inten.(mm/hr)=     149.30        81.82
01517>                 over (min)        1.00         4.00
01518>      Storage Coeff.  (min)=        .44 (ii)    3.77 (ii)
01519>      Unit Hyd. Tpeak (min)=       1.00         4.00
01520>      Unit Hyd. peak  (cms)=       1.52          .30
01521>                                                        *TOTALS*
01522>      PEAK FLOW       (cms)=        .00          .00          .001 (iii)
01523>      TIME TO PEAK    (hrs)=       1.92         2.02         2.000
01524>      RUNOFF VOLUME    (mm)=      77.93        38.71        74.009
01525>      TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
01526>      RUNOFF COEFFICIENT   =        .99          .49          .938
01527>
01528>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01529>            CN* =  80.0     Ia = Dep. Storage  (Above)
01530>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01531>            THAN THE STORAGE COEFFICIENT.
01532>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01533>
01534> ------------------------------------------------------------------------------
01535> 050:0010--------------------------------------------------------------------
01536> * ADD TOTAL FLOWS TO BRANT STREET
01537> ----------------------
01538> | ADD HYD (BRANT     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01539> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
01540>                        ID1 02:201.CTL       .65     .051    1.88  76.76    .000
01541>                       +ID2 03:201.OVF       .00     .000     .00    .00    .000
01542>                       +ID3 01:202           .03     .010    2.00  77.15    .000
01543>                        ============================================================
01544>                        SUM 05:BRANT         .67     .062    2.00  76.77    .000
01545>
01546>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01547>
01548> ------------------------------------------------------------------------------
01549> 050:0011--------------------------------------------------------------------
01550> * ADD TOTAL FLOWS FROM PHASE 1 SITE
01551> ----------------------
01552> | ADD HYD (TOTAL.P1  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01553> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
01554>                        ID1 04:203           .00     .001    2.00  74.01    .000
01555>                       +ID2 05:BRANT         .67     .062    2.00  76.77    .000
01556>                        ============================================================
01557>                        SUM 09:TOTAL.P1      .67     .063    2.00  76.76    .000
01558>
01559>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01560>
01561> ------------------------------------------------------------------------------
01562> 050:0012--------------------------------------------------------------------
01563> * AREA CHECK
01564> ----------------------
01565> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01566> ----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
01567>                        ID1 10:EX.P1         .67     .162    2.00  48.44    .000
01568>                       +ID2 09:TOTAL.P1      .67     .063    2.00  76.76    .000
01569>                        ============================================================
01570>                        SUM 01:CHECK        1.35     .225    2.00  62.60    .000
01571>
01572>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01573>
01574> ------------------------------------------------------------------------------
01575> 050:0013--------------------------------------------------------------------
01576> **#************************************************************************|
01577> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
01578> * *
01579> ------------------------------------------------------------------------------
01580> 050:0002--------------------------------------------------------------------
01581> *
01582> ------------------------------------------------------------------------------
01583> 050:0002--------------------------------------------------------------------
01584> *
01585> ------------------------------------------------------------------------------
01586> 050:0002--------------------------------------------------------------------
01587> *
01588> ------------------------------------------------------------------------------
01589> 050:0002--------------------------------------------------------------------
01590> *
01591>  ** END OF RUN :  99
01592>
01593> ********************************************************************************
01594>
01595>
01596>
01597>
01598>
01599> ---------------------
01600> | START             |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
01601> ---------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
01602>     TZERO =   .00 hrs on       0
01603>     METOUT=   2 (output = METRIC)
01604>     NRUN  = 100
01605>     NSTORM=   1
01606>            #  1=BUR6_100.stm
01607> ------------------------------------------------------------------------------
01608> 100:0002--------------------------------------------------------------------
01609> *#*************************************************************************|
01610> *#  Project Name: BRANT & GHENT (PHASE 1)
01611> *#               BURLINGTON, ONTARIO
01612> *#  JOB NUMBER  : 20062
01613> *#        Date  : JUNE 2021
01614> *#    Revised   :
01615> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
01616> *#       File   : 20071A.DAT
01617> *#*************************************************************************|
01618> *
01619> ------------------------------------------------------------------------------
01620> 100:0002--------------------------------------------------------------------
```

```
01621> *
01622> --------------------
01623> | READ STORM       |    Filename: Burlington 100-yr 6hr CHICAGO        (A=
01624> | Ptotal=  86.27 mm|    Comments: Burlington 100-yr 6hr CHICAGO        (A=
01625> --------------------
01626>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
01627>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
01628>                .17   3.862 |   1.67  17.445 |   3.17   9.657 |   4.67   4.936
01629>                .33   4.172 |   1.83  39.736 |   3.33   8.649 |   4.83   4.704
01630>                .50   4.546 |   2.00 163.177 |   3.50   7.853 |   5.00   4.495
01631>                .67   5.008 |   2.17  51.779 |   3.67   7.206 |   5.17   4.306
01632>                .83   5.595 |   2.33  28.205 |   3.83   6.670 |   5.33   4.135
01633>               1.00   6.369 |   2.50  19.806 |   4.00   6.217 |   5.50   3.979
01634>               1.17   7.443 |   2.67  15.465 |   4.17   5.829 |   5.67   3.835
01635>               1.33   9.048 |   2.83  12.795 |   4.33   5.492 |   5.83   3.703
01636>               1.50  11.752 |   3.00  10.979 |   4.50   5.197 |   6.00   3.581
01637>
01638> ------------------------------------------------------------------------------
01639> 100:0003--------------------------------------------------------------------
01640> *
01641> *#*************************************************************************|
01642> *#
01643> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
01644> *#        ======================================================
01645> *#
01646> *#*************************************************************************|
01647> *# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
01648> *
01649> ----------------------
01650> | CALIB STANDHYD     |   Area    (ha)=     .60
01651> | 01:101    DT= 1.00 |   Total Imp(%)=   28.00   Dir. Conn.(%)=   28.00
01652> ----------------------
01653>                              IMPERVIOUS    PERVIOUS (i)
01654>      Surface Area     (ha)=        .17          .43
01655>      Dep. Storage     (mm)=       1.00         6.35
01656>      Average Slope     (%)=       2.00         2.50
01657>      Length            (m)=      20.00        10.00
01658>      Mannings n            =       .013         .250
01659>
01660>      Max.eff.Inten.(mm/hr)=     163.18        94.55
01661>                    over (min)        1.00         4.00
01662>      Storage Coeff.  (min)=        .65 (ii)    3.59 (ii)
01663>      Unit Hyd. Tpeak (min)=       1.00         4.00
01664>      Unit Hyd. peak  (cms)=       1.33          .30
01665>                                                          *TOTALS*
01666>      PEAK FLOW       (cms)=        .08          .09          .166 (iii)
01667>      TIME TO PEAK    (hrs)=       1.98         2.02         2.000
01668>      RUNOFF VOLUME    (mm)=      85.27        44.54        55.942
01669>      TOTAL RAINFALL   (mm)=      86.27        86.27        86.271
01670>      RUNOFF COEFFICIENT   =        .99          .52          .648
01671>
01672>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01673>            CN* =  80.0    Ia = Dep. Storage  (Above)
01674>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01675>            THAN THE STORAGE COEFFICIENT.
01676>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01677>
01678> ------------------------------------------------------------------------------
01679> 100:0004--------------------------------------------------------------------
01680> *# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
01681> *
01682> ----------------------
01683> | CALIB NASHYD       |   Area    (ha)=     .08   Curve Number    (CN)=80.00
01684> | 02:102    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
01685> ----------------------   U.H. Tp(hrs)=    .040
01686>
01687>      Unit Hyd Qpeak  (cms)=     .074
01688>
01689>      PEAK FLOW       (cms)=     .019 (i)
01690>      TIME TO PEAK    (hrs)=    2.000
01691>      RUNOFF VOLUME    (mm)=   44.534
01692>      TOTAL RAINFALL   (mm)=   86.271
01693>      RUNOFF COEFFICIENT   =     .516
01694>
01695>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01696>
01697> ------------------------------------------------------------------------------
01698> 100:0005--------------------------------------------------------------------
01699> * ADD TOTAL EX. FLOWS FROM PHASE 1
01700> -------------------------
01701> | ADD HYD (EX.P1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01702> -------------------------  (ha)     (cms)   (hrs)   (mm)   (cms)
01703>                      ID1 01:101          .60     .166    2.00  55.94    .000
01704>                    +ID2 02:102           .08     .019    2.00  44.53    .000
01705>                     ========================================================
01706>                     SUM 10:EX.P1          .67     .186    2.00  54.64    .000
01707>
01708>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01709>
01710> ------------------------------------------------------------------------------
01711> 100:0006--------------------------------------------------------------------
01712> *#*************************************************************************|
01713> *#
01714> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
01715> *#        ========================================================
01716> *#
01717> **#************************************************************************|
01718> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO BRANT STREET
01719> *
01720> ----------------------
01721> | CALIB STANDHYD     |   Area    (ha)=     .65
01722> | 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
01723> ----------------------
01724>                              IMPERVIOUS    PERVIOUS (i)
01725>      Surface Area     (ha)=        .63          .02
01726>      Dep. Storage     (mm)=       1.00         6.35
01727>      Average Slope     (%)=       1.50         2.00
01728>      Length            (m)=      20.00        20.00
01729>      Mannings n            =       .013         .250
01730>
01731>      Max.eff.Inten.(mm/hr)=     163.18        90.27
01732>                    over (min)        1.00         6.00
01733>      Storage Coeff.  (min)=        .71 (ii)    5.56 (ii)
01734>      Unit Hyd. Tpeak (min)=       1.00         6.00
01735>      Unit Hyd. peak  (cms)=       1.29          .20
01736>                                                          *TOTALS*
01737>      PEAK FLOW       (cms)=        .28          .00          .287 (iii)
01738>      TIME TO PEAK    (hrs)=       2.00         2.05         2.000
01739>      RUNOFF VOLUME    (mm)=      85.27        44.54        84.049
01740>      TOTAL RAINFALL   (mm)=      86.27        86.27        86.271
01741>      RUNOFF COEFFICIENT   =        .99          .52          .974
01742>
01743>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01744>            CN* =  80.0    Ia = Dep. Storage  (Above)
01745>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01746>            THAN THE STORAGE COEFFICIENT.
01747>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01748>
01749> ------------------------------------------------------------------------------
01750> 100:0007--------------------------------------------------------------------
01751> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE AND TANK
01752> *
01753> ----------------------
01754> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
01755> |  IN>01:(201   )    |
01756> | OUT<02:(201.CT)    |    =========  OUTFLOW STORAGE TABLE  =========
01757> ----------------------    OUTFLOW    STORAGE    |  OUTFLOW    STORAGE
01758>                             (cms)     (ha.m.)    |    (cms)    (ha.m.)
01759>                              .000  .0000E+00     |     .051  .1580E-01
01760>                              .041  .3500E-02     |     .051  .1930E-01
01761>                              .051  .5300E-02     |     .051  .1930E-01
01762>                              .051  .5300E-02     |     .071  .2350E-01
01763>                              .051  .1230E-01     |     .000  .0000E+00
01764>
01765>      ROUTING RESULTS             AREA     QPEAK     TPEAK       R.V.
01766>      ----------------------       (ha)     (cms)     (hrs)       (mm)
01767>      INFLOW >01: (201   )          .65      .287     2.000     84.049
01768>      OUTFLOW<02: (201.CT)          .65      .057     2.200     84.049
01769>     OVERFLOW<03: (201.OV)          .00      .000      .000      .000
01770>
01771>                     TOTAL NUMBER OF SIMULATED OVERFLOWS  =         0
01772>                     CUMULATIVE TIME OF OVERFLOWS  (hours)=       .00
01773>                     PERCENTAGE OF TIME OVERFLOWING    (%)=       .00
01774>
01775>
01776>                     PEAK   FLOW   REDUCTION [Qout/Qin](%)=   19.782
01777>                     TIME SHIFT OF PEAK FLOW         (min)=     12.00
01778>                     MAXIMUM  STORAGE   USED       (ha.m.)=.2049E-01
01779>
01780> ------------------------------------------------------------------------------
01781> 100:0008--------------------------------------------------------------------
01782> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
01783> *
01784> ----------------------
01785> | CALIB STANDHYD     |   Area    (ha)=     .03
01786> | 01:202    DT= 1.00 |   Total Imp(%)=   98.00   Dir. Conn.(%)=   98.00
01787> ----------------------
01788>                              IMPERVIOUS    PERVIOUS (i)
01789>      Surface Area     (ha)=        .02          .00
01790>      Dep. Storage     (mm)=       1.00         6.35
01791>      Average Slope     (%)=       3.00         2.00
01792>      Length            (m)=      10.00        10.00
01793>      Mannings n            =       .013         .250
01794>
01795>      Max.eff.Inten.(mm/hr)=     163.18        94.55
01796>                    over (min)        1.00         4.00
01797>      Storage Coeff.  (min)=        .38 (ii)    3.52 (ii)
01798>      Unit Hyd. Tpeak (min)=       1.00         4.00
01799>      Unit Hyd. peak  (cms)=       1.58          .31
01800>                                                          *TOTALS*
01801>      PEAK FLOW       (cms)=        .01          .00          .011 (iii)
01802>      TIME TO PEAK    (hrs)=       1.92         2.02         2.000
01803>      RUNOFF VOLUME    (mm)=      85.27        44.54        84.456
01804>      TOTAL RAINFALL   (mm)=      86.27        86.27        86.271
01805>      RUNOFF COEFFICIENT   =        .99          .52          .979
01806>
01807>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01808>            CN* =  80.0    Ia = Dep. Storage  (Above)
01809>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01810>            THAN THE STORAGE COEFFICIENT.
01811>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01812>
01813> ------------------------------------------------------------------------------
01814> 100:0009--------------------------------------------------------------------
01815> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
01816> *
01817> ----------------------
01818> | CALIB STANDHYD     |   Area    (ha)=     .00
01819> | 04:203    DT= 1.00 |   Total Imp(%)=   90.00   Dir. Conn.(%)=   90.00
01820> ----------------------
01821>                              IMPERVIOUS    PERVIOUS (i)
01822>      Surface Area     (ha)=        .00          .00
01823>      Dep. Storage     (mm)=       1.00         6.35
01824>      Average Slope     (%)=       2.00         2.00
01825>      Length            (m)=      10.00        10.00
01826>      Mannings n            =       .013         .250
01827>
01828>      Max.eff.Inten.(mm/hr)=     163.18        94.55
01829>                    over (min)        1.00         4.00
01830>      Storage Coeff.  (min)=        .43 (ii)    3.57 (ii)
01831>      Unit Hyd. Tpeak (min)=       1.00         4.00
01832>      Unit Hyd. peak  (cms)=       1.53          .31
01833>                                                          *TOTALS*
01834>      PEAK FLOW       (cms)=        .00          .00          .001 (iii)
01835>      TIME TO PEAK    (hrs)=       1.92         2.02         2.000
01836>      RUNOFF VOLUME    (mm)=      85.27        44.54        81.197
01837>      TOTAL RAINFALL   (mm)=      86.27        86.27        86.271
01838>      RUNOFF COEFFICIENT   =        .99          .52          .941
01839>
01840>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01841>            CN* =  80.0    Ia = Dep. Storage  (Above)
01842>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01843>            THAN THE STORAGE COEFFICIENT.
01844>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01845>
01846> ------------------------------------------------------------------------------
01847> 100:0010--------------------------------------------------------------------
01848> * ADD TOTAL FLOWS TO BRANT STREET
01849> -------------------------
01850> | ADD HYD (BRANT     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01851> -------------------------  (ha)     (cms)   (hrs)   (mm)   (cms)
01852>                      ID1 02:201.CTL        .65     .057    2.20  84.05    .000
01853>                    +ID2 03:201.OVF         .00     .000     .00   .00    .000
01854>                    +ID3 01:202             .03     .011    2.00  84.46    .000
01855>                     ========================================================
01856>                     SUM 05:BRANT          .67     .063    2.00  84.06    .000
01857>
01858>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01859>
01860> ------------------------------------------------------------------------------
01861> 100:0011--------------------------------------------------------------------
01862> * ADD TOTAL FLOWS FROM PHASE 1 SITE
01863> -------------------------
01864> | ADD HYD (TOTAL.P1  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01865> -------------------------  (ha)     (cms)   (hrs)   (mm)   (cms)
01866>                      ID1 04:203            .00     .001    2.00  81.20    .000
01867>                    +ID2 05:BRANT           .67     .063    2.00  84.06    .000
01868>                     ========================================================
01869>                     SUM 09:TOTAL.P1       .67     .064    2.00  84.05    .000
01870>
01871>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01872>
01873> ------------------------------------------------------------------------------
01874> 100:0012--------------------------------------------------------------------
01875> * AREA CHECK
01876> -------------------------
01877> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01878> -------------------------  (ha)     (cms)   (hrs)   (mm)   (cms)
01879>                      ID1 10:EX.P1          .67     .186    2.00  54.64    .000
01880>                    +ID2 09:TOTAL.P1        .67     .064    2.00  84.05    .000
01881>                     ========================================================
01882>                     SUM 01:CHECK         1.35     .249    2.00  69.34    .000
01883>
01884>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01885>
01886> ------------------------------------------------------------------------------
01887> 100:0013--------------------------------------------------------------------
01888> **#************************************************************************|
01889> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
01890> *
```

```
01891> ------------------------------------------------------------------------------
01892> 100:0002-------------------------------------------------------------------------
01893> *
01894> ------------------------------------------------------------------------------
01895> 100:0002-------------------------------------------------------------------------
01896> *
01897> ------------------------------------------------------------------------------
01898> 100:0002-------------------------------------------------------------------------
01899> *
01900> ------------------------------------------------------------------------------
01901> 100:0002-------------------------------------------------------------------------
01902> *
01903> ------------------------------------------------------------------------------
01904> 100:0002-------------------------------------------------------------------------
01905> *
01906>   ** END OF RUN : 199
01907>
01908> ********************************************************************************
01909>
01910>
01911>
01912>
01913>
01914> --------------------
01915> | START            |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
01916> --------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
01917>     TZERO =   .00 hrs on        0
01918>     METOUT=   2 (output = METRIC)
01919>     NRUN  = 200
01920>     NSTORM=   1
01921>              #  1=hazel.stm
01922> ------------------------------------------------------------------------------
01923> 200:0002-------------------------------------------------------------------------
01924> *#*****************************************************************************|
01925> *#  Project Name: BRANT & GHENT (PHASE 1)
01926> *#                BURLINGTON, ONTARIO
01927> *#  JOB NUMBER  : 20062
01928> *#       Date   : JUNE 2021
01929> *#    Revised   :
01930> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
01931> *#       File   : 20071A.DAT
01932> *#*****************************************************************************|
01933> *
01934> ------------------------------------------------------------------------------
01935> 200:0002-------------------------------------------------------------------------
01936> *
01937> --------------------
01938> | READ STORM       |    Filename: Regional - Hurricane Hazel
01939> | Ptotal= 284.97 mm|    Comments: Regional - Hurricane Hazel
01940> --------------------
01941>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
01942>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
01943>               1.00   2.027 |  13.00   2.027 |  25.00   2.027 |  37.00   6.000
01944>               2.00   2.027 |  14.00   2.027 |  26.00   2.027 |  38.00   4.000
01945>               3.00   2.027 |  15.00   2.027 |  27.00   2.027 |  39.00   6.000
01946>               4.00   2.027 |  16.00   2.027 |  28.00   2.027 |  40.00  13.000
01947>               5.00   2.027 |  17.00   2.027 |  29.00   2.027 |  41.00  17.000
01948>               6.00   2.027 |  18.00   2.027 |  30.00   2.027 |  42.00  13.000
01949>               7.00   2.027 |  19.00   2.027 |  31.00   2.027 |  43.00  23.000
01950>               8.00   2.027 |  20.00   2.027 |  32.00   2.027 |  44.00  13.000
01951>               9.00   2.027 |  21.00   2.027 |  33.00   2.027 |  45.00  13.000
01952>              10.00   2.027 |  22.00   2.027 |  34.00   2.027 |  46.00  53.000
01953>              11.00   2.027 |  23.00   2.027 |  35.00   2.027 |  47.00  38.000
01954>              12.00   2.027 |  24.00   2.027 |  36.00   2.027 |  48.00  13.000
01955>
01956> ------------------------------------------------------------------------------
01957> 200:0003-------------------------------------------------------------------------
01958> *
01959> *#*****************************************************************************|
01960> *#
01961> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
01962> *#        ============================================================
01963> *#
01964> *#*****************************************************************************|
01965> *# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
01966> *
01967> ----------------------
01968> | CALIB STANDHYD     |   Area    (ha)=     .60
01969> | 01:101    DT= 1.00 |   Total Imp(%)=   28.00   Dir. Conn.(%)=   28.00
01970> ----------------------
01971>                              IMPERVIOUS    PERVIOUS (i)
01972>      Surface Area     (ha)=        .17          .43
01973>      Dep. Storage     (mm)=       1.00         6.35
01974>      Average Slope     (%)=       2.00         2.50
01975>      Length            (m)=      20.00        10.00
01976>      Mannings n            =       .013         .250
01977>
01978>      Max.eff.Inten.(mm/hr)=      53.00        50.44
01979>                    over (min)        1.00         5.00
01980>      Storage Coeff.  (min)=       1.02 (ii)    4.80 (ii)
01981>      Unit Hyd. Tpeak (min)=       1.00         5.00
01982>      Unit Hyd. peak  (cms)=       1.06          .23
01983>                                                          *TOTALS*
01984>      PEAK FLOW       (cms)=        .02          .06          .085 (iii)
01985>      TIME TO PEAK    (hrs)=      45.45        46.00        46.000
01986>      RUNOFF VOLUME    (mm)=     283.96       226.89       242.888
01987>      TOTAL RAINFALL   (mm)=     284.97       284.97       284.973
01988>      RUNOFF COEFFICIENT   =       1.00          .80          .852
01989>
01990>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01991>            CN* =  80.0    Ia = Dep. Storage  (Above)
01992>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01993>            THAN THE STORAGE COEFFICIENT.
01994>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01995>
01996> ------------------------------------------------------------------------------
01997> 200:0004-------------------------------------------------------------------------
01998> *# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
01999> *
02000> ----------------------
02001> | CALIB NASHYD       |   Area    (ha)=     .08   Curve Number    (CN)=80.00
02002> | 02:102    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
02003> ----------------------   U.H. Tp(hrs)=    .040
02004>
02005>      Unit Hyd Qpeak  (cms)=     .074
02006>
02007>      PEAK FLOW       (cms)=     .011 (i)
02008>      TIME TO PEAK    (hrs)=   46.000
02009>      RUNOFF VOLUME    (mm)=  226.909
02010>      TOTAL RAINFALL   (mm)=  284.973
02011>      RUNOFF COEFFICIENT   =     .796
02012>
02013>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02014>
02015> ------------------------------------------------------------------------------
02016> 200:0005-------------------------------------------------------------------------
02017> * ADD TOTAL EX. FLOWS FROM PHASE 1
02018> ------------------------
02019> | ADD HYD (EX.P1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02020> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
02021>                       ID1 01:101           .60     .085   46.00 242.89    .000
02022>                      +ID2 02:102           .08     .011   46.00 226.91    .000
02023>                       ============================================================
02024>                       SUM 10:EX.P1          .67     .096   46.00 241.06    .000
02025>
02026>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02027>
02028> ------------------------------------------------------------------------------
02029> 200:0006-------------------------------------------------------------------------
02030> *#*****************************************************************************|
02031> *#
02032> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
02033> *#        ============================================================
02034> *#
02035> **#****************************************************************************|
02036> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO BRANT STREET
02037> *
02038> ----------------------
02039> | CALIB STANDHYD     |   Area    (ha)=     .65
02040> | 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
02041> ----------------------
02042>                              IMPERVIOUS    PERVIOUS (i)
02043>      Surface Area     (ha)=        .63          .02
02044>      Dep. Storage     (mm)=       1.00         6.35
02045>      Average Slope     (%)=       1.50         2.00
02046>      Length            (m)=      20.00        20.00
02047>      Mannings n            =       .013         .250
02048>
02049>      Max.eff.Inten.(mm/hr)=      53.00        50.42
02050>                    over (min)        1.00         7.00
02051>      Storage Coeff.  (min)=       1.11 (ii)    7.23 (ii)
02052>      Unit Hyd. Tpeak (min)=       1.00         7.00
02053>      Unit Hyd. peak  (cms)=       1.01          .16
02054>                                                          *TOTALS*
02055>      PEAK FLOW       (cms)=        .09          .00          .095 (iii)
02056>      TIME TO PEAK    (hrs)=      45.45        46.00        46.000
02057>      RUNOFF VOLUME    (mm)=     283.97       226.90       282.263
02058>      TOTAL RAINFALL   (mm)=     284.97       284.97       284.973
02059>      RUNOFF COEFFICIENT   =       1.00          .80          .990
02060>
02061>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02062>            CN* =  80.0    Ia = Dep. Storage  (Above)
02063>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02064>            THAN THE STORAGE COEFFICIENT.
02065>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02066>
02067> ------------------------------------------------------------------------------
02068> 200:0007-------------------------------------------------------------------------
02069> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE AND TANK
02070> *
02071> ----------------------
02072> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
02073> |  IN>01:(201    )   |
02074> | OUT<02:(201.CT)    |    =========  OUTLFOW STORAGE TABLE  =========
02075> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
02076>                             (cms)     (ha.m.)   |    (cms)    (ha.m.)
02077>                             .000  .0000E+00   |     .051  .1580E-01
02078>                             .041  .3500E-02   |     .051  .1930E-01
02079>                             .051  .5300E-02   |     .051  .1930E-01
02080>                             .051  .5300E-02   |     .071  .2350E-01
02081>                             .051  .1230E-01   |     .000  .0000E+00
02082>
02083>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
02084>      ---------------------       (ha)     (cms)     (hrs)       (mm)
02085>      INFLOW >01: (201   )        .65      .095    46.000    282.263
02086>      OUTFLOW<02: (201.CT)        .65      .064    47.000    282.262
02087>     OVERFLOW<03: (201.OV)        .00      .000      .000       .000
02088>
02089>                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
02090>                    CUMULATIVE TIME OF OVERFLOWS  (hours)=       .00
02091>                    PERCENTAGE OF TIME OVERFLOWING    (%)=       .00
02092>
02093>
02094>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   67.084
02095>                    TIME SHIFT OF PEAK FLOW         (min)=   60.00
02096>                    MAXIMUM  STORAGE   USED       (ha.m.)=.2199E-01
02097>
02098> ------------------------------------------------------------------------------
02099> 200:0008-------------------------------------------------------------------------
02100> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
02101> *
02102> ----------------------
02103> | CALIB STANDHYD     |   Area    (ha)=     .03
02104> | 01:202    DT= 1.00 |   Total Imp(%)=   98.00   Dir. Conn.(%)=   98.00
02105> ----------------------
02106>                              IMPERVIOUS    PERVIOUS (i)
02107>      Surface Area     (ha)=        .02          .00
02108>      Dep. Storage     (mm)=       1.00         6.35
02109>      Average Slope     (%)=       3.00         2.00
02110>      Length            (m)=      10.00        10.00
02111>      Mannings n            =       .013         .250
02112>
02113>      Max.eff.Inten.(mm/hr)=      53.00        50.44
02114>                    over (min)        1.00         5.00
02115>      Storage Coeff.  (min)=        .59 (ii)    4.63 (ii)
02116>      Unit Hyd. Tpeak (min)=       1.00         5.00
02117>      Unit Hyd. peak  (cms)=       1.38          .24
02118>                                                          *TOTALS*
02119>      PEAK FLOW       (cms)=        .00          .00          .004 (iii)
02120>      TIME TO PEAK    (hrs)=      45.45        46.00        46.000
02121>      RUNOFF VOLUME    (mm)=     283.96       226.91       282.832
02122>      TOTAL RAINFALL   (mm)=     284.97       284.97       284.973
02123>      RUNOFF COEFFICIENT   =       1.00          .80          .992
02124>
02125>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02126>            CN* =  80.0    Ia = Dep. Storage  (Above)
02127>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02128>            THAN THE STORAGE COEFFICIENT.
02129>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02130>
02131> ------------------------------------------------------------------------------
02132> 200:0009-------------------------------------------------------------------------
02133> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
02134> *
02135> ----------------------
02136> | CALIB STANDHYD     |   Area    (ha)=     .00
02137> | 04:203    DT= 1.00 |   Total Imp(%)=   90.00   Dir. Conn.(%)=   90.00
02138> ----------------------
02139>                              IMPERVIOUS    PERVIOUS (i)
02140>      Surface Area     (ha)=        .00          .00
02141>      Dep. Storage     (mm)=       1.00         6.35
02142>      Average Slope     (%)=       2.00         2.00
02143>      Length            (m)=      10.00        10.00
02144>      Mannings n            =       .013         .250
02145>
02146>      Max.eff.Inten.(mm/hr)=      53.00        50.44
02147>                    over (min)        1.00         5.00
02148>      Storage Coeff.  (min)=        .67 (ii)    4.71 (ii)
02149>      Unit Hyd. Tpeak (min)=       1.00         5.00
02150>      Unit Hyd. peak  (cms)=       1.32          .24
02151>                                                          *TOTALS*
02152>      PEAK FLOW       (cms)=        .00          .00          .000 (iii)
02153>      TIME TO PEAK    (hrs)=      45.45        46.00        46.000
02154>      RUNOFF VOLUME    (mm)=     283.96       226.91       278.266
02155>      TOTAL RAINFALL   (mm)=     284.97       284.97       284.973
02156>      RUNOFF COEFFICIENT   =       1.00          .80          .976
02157>
02158>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02159>            CN* =  80.0    Ia = Dep. Storage  (Above)
02160>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
```

```
02161>           THAN THE STORAGE COEFFICIENT.
02162>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02163>
02164> ---------------------------------------------------------------------------
02165> 200:0010-----------------------------------------------------------------
02166> * ADD TOTAL FLOWS TO BRANT STREET
02167> ------------------------
02168> | ADD HYD (BRANT     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02169> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
02170>                        ID1 02:201.CTL       .65     .064   47.00 282.26    .000
02171>                       +ID2 03:201.OVF       .00     .000     .00    .00    .000
02172>                       +ID3 01:202           .03     .004   46.00 282.83    .000
02173>                        ========================================================
02174>                        SUM 05:BRANT          .67     .066   47.00 282.28    .000
02175>
02176>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02177>
02178> ---------------------------------------------------------------------------
02179> 200:0011-----------------------------------------------------------------
02180> * ADD TOTAL FLOWS FROM PHASE 1 SITE
02181> ------------------------
02182> | ADD HYD (TOTAL.P1  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02183> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
02184>                        ID1 04:203           .00     .000   46.00 278.27    .000
02185>                       +ID2 05:BRANT         .67     .066   47.00 282.28    .000
02186>                        ========================================================
02187>                        SUM 09:TOTAL.P1       .67     .067   47.00 282.26    .000
02188>
02189>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02190>
02191> ---------------------------------------------------------------------------
02192> 200:0012-----------------------------------------------------------------
02193> * AREA CHECK
02194> ------------------------
02195> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02196> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
02197>                        ID1 10:EX.P1          .67     .096   46.00 241.06    .000
02198>                       +ID2 09:TOTAL.P1      .67     .067   47.00 282.26    .000
02199>                        ========================================================
02200>                        SUM 01:CHECK         1.35     .151   46.00 261.66    .000
02201>
02202>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02203>
02204> ---------------------------------------------------------------------------
02205> 200:0013-----------------------------------------------------------------
02206> **#*************************************************************************|
02207> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
02208> *
02209> ---------------------------------------------------------------------------
02210> 200:0002-----------------------------------------------------------------
02211> *
02212> ---------------------------------------------------------------------------
02213> 200:0002-----------------------------------------------------------------
02214> *
02215> ---------------------------------------------------------------------------
02216> 200:0002-----------------------------------------------------------------
02217> *
02218> ---------------------------------------------------------------------------
02219> 200:0002-----------------------------------------------------------------
02220> *
02221> ---------------------------------------------------------------------------
02222> 200:0002-----------------------------------------------------------------
02223> *
02224> ---------------------------------------------------------------------------
02225> 200:0002-----------------------------------------------------------------
02226> *
02227>   ** END OF RUN : 299
02228>
02229> ***************************************************************************
02230>
02231>
02232>
02233>
02234>
02235> --------------------
02236> | START            |  Project  dir.: T:\PROJECTS\20062\SWMHYMO\
02237> --------------------  Rainfall dir.: T:\PROJECTS\20062\SWMHYMO\
02238>     TZERO =   .00 hrs on       0
02239>     METOUT=   2 (output = METRIC)
02240>     NRUN  = 300
02241>     NSTORM=   1
02242>               #  1=MTHP25MM.stm
02243> ---------------------------------------------------------------------------
02244> 300:0002-----------------------------------------------------------------
02245> *#*************************************************************************|
02246> *#  Project Name: BRANT & GHENT (PHASE 1)
02247> *#               BURLINGTON, ONTARIO
02248> *#  JOB NUMBER  : 20062
02249> *#       Date   : JUNE 2021
02250> *#    Revised   :
02251> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
02252> *#       File   : 20071A.DAT
02253> *#*************************************************************************|
02254> *
02255> ---------------------------------------------------------------------------
02256> 300:0002-----------------------------------------------------------------
02257> *
02258> --------------------
02259> | READ STORM       |    Filename: 25mm 4-HOUR (A=555 B=5.89 C=0.813)
02260> | Ptotal=  25.27 mm|    Comments: 25mm 4-HOUR (A=555 B=5.89 C=0.813)
02261> --------------------
02262>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
02263>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
02264>                .17   1.491 |   1.17  13.390 |   2.17   3.748 |   3.17   1.810
02265>                .33   1.720 |   1.33  58.584 |   2.33   3.156 |   3.33   1.675
02266>                .50   2.045 |   1.50  17.849 |   2.50   2.734 |   3.50   1.560
02267>                .67   2.542 |   1.67   9.118 |   2.67   2.417 |   3.67   1.460
02268>                .83   3.408 |   1.83   6.129 |   2.83   2.170 |   3.83   1.374
02269>               1.00   5.319 |   2.00   4.638 |   3.00   1.973 |   4.00   1.299
02270>
02271> ---------------------------------------------------------------------------
02272> 300:0003-----------------------------------------------------------------
02273> *
02274> *#*************************************************************************|
02275> *#
02276> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
02277> *#        ========================================================
02278> *#
02279> *#*************************************************************************|
02280> *# CATCHMENT 101 -  EXISTING DRAINAGE TO BRANT STREET
02281> *
02282> ----------------------
02283> | CALIB STANDHYD     |   Area    (ha)=     .60
02284> | 01:101    DT= 1.00 |   Total Imp(%)=   28.00   Dir. Conn.(%)=   28.00
02285> ----------------------
02286>                              IMPERVIOUS    PERVIOUS (i)
02287>      Surface Area     (ha)=        .17          .43
02288>      Dep. Storage     (mm)=       1.00         6.35
02289>      Average Slope     (%)=       2.00         2.50
02290>      Length            (m)=      20.00        10.00
02291>      Mannings n            =       .013         .250
02292>
02293>      Max.eff.Inten.(mm/hr)=      58.58         7.26
02294>                    over (min)       1.00         9.00
02295>      Storage Coeff.  (min)=        .98 (ii)    9.18 (ii)
02296>      Unit Hyd. Tpeak (min)=       1.00         9.00
02297>      Unit Hyd. peak  (cms)=       1.09          .12
02298>                                                          *TOTALS*
02299>      PEAK FLOW       (cms)=        .03          .01          .029 (iii)
02300>      TIME TO PEAK    (hrs)=       1.33         1.47         1.333
02301>      RUNOFF VOLUME    (mm)=      24.27         4.34         9.921
02302>      TOTAL RAINFALL   (mm)=      25.27        25.27        25.268
02303>      RUNOFF COEFFICIENT   =        .96          .17          .393
02304>
02305>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02306>            CN* =  80.0    Ia = Dep. Storage  (Above)
02307>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02308>            THAN THE STORAGE COEFFICIENT.
02309>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02310>
02311> ---------------------------------------------------------------------------
02312> 300:0004-----------------------------------------------------------------
02313> *# CATCHMENT 102 -  EXISTING DRAINAGE TO GHENT AVENUE
02314> *
02315> ----------------------
02316> | CALIB NASHYD       |   Area    (ha)=     .08   Curve Number   (CN)=80.00
02317> | 02:102    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
02318> ----------------------   U.H. Tp(hrs)=    .040
02319>
02320>      Unit Hyd Qpeak  (cms)=     .074
02321>
02322>      PEAK FLOW       (cms)=     .002 (i)
02323>      TIME TO PEAK    (hrs)=    1.350
02324>      RUNOFF VOLUME    (mm)=    4.341
02325>      TOTAL RAINFALL   (mm)=   25.268
02326>      RUNOFF COEFFICIENT   =     .172
02327>
02328>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02329>
02330> ---------------------------------------------------------------------------
02331> 300:0005-----------------------------------------------------------------
02332> * ADD TOTAL EX. FLOWS FROM PHASE 1
02333> ------------------------
02334> | ADD HYD (EX.P1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02335> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
02336>                        ID1 01:101            .60     .029    1.33   9.92    .000
02337>                       +ID2 02:102            .08     .002    1.35   4.34    .000
02338>                        ========================================================
02339>                        SUM 10:EX.P1          .67     .031    1.33   9.28    .000
02340>
02341>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02342>
02343> ---------------------------------------------------------------------------
02344> 300:0006-----------------------------------------------------------------
02345> *#*************************************************************************|
02346> *#
02347> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 1)
02348> *#        ========================================================
02349> *#
02350> **#************************************************************************|
02351> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO BRANT STREET
02352> *
02353> ----------------------
02354> | CALIB STANDHYD     |   Area    (ha)=     .65
02355> | 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
02356> ----------------------
02357>                              IMPERVIOUS    PERVIOUS (i)
02358>      Surface Area     (ha)=        .63          .02
02359>      Dep. Storage     (mm)=       1.00         6.35
02360>      Average Slope     (%)=       1.50         2.00
02361>      Length            (m)=      20.00        20.00
02362>      Mannings n            =       .013         .250
02363>
02364>      Max.eff.Inten.(mm/hr)=      58.58         6.19
02365>                    over (min)       1.00        15.00
02366>      Storage Coeff.  (min)=       1.07 (ii)   15.24 (ii)
02367>      Unit Hyd. Tpeak (min)=       1.00        15.00
02368>      Unit Hyd. peak  (cms)=       1.03          .07
02369>                                                          *TOTALS*
02370>      PEAK FLOW       (cms)=        .10          .00          .102 (iii)
02371>      TIME TO PEAK    (hrs)=       1.33         1.65         1.333
02372>      RUNOFF VOLUME    (mm)=      24.27         4.34        23.670
02373>      TOTAL RAINFALL   (mm)=      25.27        25.27        25.268
02374>      RUNOFF COEFFICIENT   =        .96          .17          .937
02375>
02376>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02377>            CN* =  80.0    Ia = Dep. Storage  (Above)
02378>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02379>            THAN THE STORAGE COEFFICIENT.
02380>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02381>
02382> ---------------------------------------------------------------------------
02383> 300:0007-----------------------------------------------------------------
02384> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE AND TANK
02385> *
02386> ----------------------
02387> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
02388> |  IN>01:(201    )   |
02389> | OUT<02:(201.CT)    |    =========  OUTFLOW STORAGE TABLE  =========
02390> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
02391>                             (cms)     (ha.m.)   |    (cms)    (ha.m.)
02392>                             .000  .0000E+00   |     .051  .1580E-01
02393>                             .041  .3500E-02   |     .051  .1930E-01
02394>                             .051  .5300E-02   |     .051  .1930E-01
02395>                             .051  .5300E-02   |     .071  .2350E-01
02396>                             .051  .1230E-01   |     .000  .0000E+00
02397>
02398>      ROUTING RESULTS             AREA     QPEAK     TPEAK        R.V.
02399>      ---------------             (ha)     (cms)     (hrs)        (mm)
02400>      INFLOW >01: (201    )        .65      .102     1.333      23.670
02401>      OUTFLOW<02: (201.CT)         .65      .050     1.367      23.670
02402>     OVERFLOW<03: (201.OV)         .00      .000      .000       .000
02403>
02404>                     TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
02405>                     CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
02406>                     PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
02407>
02408>
02409>                     PEAK   FLOW   REDUCTION [Qout/Qin](%)=   48.623
02410>                     TIME SHIFT OF PEAK FLOW          (min)=     2.00
02411>                     MAXIMUM  STORAGE   USED        (ha.m.)=.5016E-02
02412>
02413> ---------------------------------------------------------------------------
02414> 300:0008-----------------------------------------------------------------
02415> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
02416> *
02417> ----------------------
02418> | CALIB STANDHYD     |   Area    (ha)=     .03
02419> | 01:202    DT= 1.00 |   Total Imp(%)=   98.00   Dir. Conn.(%)=   98.00
02420> ----------------------
02421>                              IMPERVIOUS    PERVIOUS (i)
02422>      Surface Area     (ha)=        .02          .00
02423>      Dep. Storage     (mm)=       1.00         6.35
02424>      Average Slope     (%)=       3.00         2.00
02425>      Length            (m)=      10.00        10.00
02426>      Mannings n            =       .013         .250
02427>
02428>      Max.eff.Inten.(mm/hr)=      58.58         7.26
02429>                    over (min)       1.00         9.00
02430>      Storage Coeff.  (min)=        .57 (ii)    9.34 (ii)
```

```
02431>      Unit Hyd. Tpeak (min)=       1.00         9.00
02432>      Unit Hyd. peak  (cms)=       1.40          .13
02433>                                                          *TOTALS*
02434>      PEAK FLOW       (cms)=        .00          .00          .004 (iii)
02435>      TIME TO PEAK    (hrs)=       1.28         1.47         1.333
02436>      RUNOFF VOLUME    (mm)=      24.27         4.34        23.869
02437>      TOTAL RAINFALL   (mm)=      25.27        25.27        25.268
02438>      RUNOFF COEFFICIENT   =        .96          .17          .945
02439>
02440>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02441>            CN* =  80.0    Ia = Dep. Storage  (Above)
02442>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02443>            THAN THE STORAGE COEFFICIENT.
02444>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02445>
02446> ----------------------------------------------------------------------------
02447> 300:0009----------------------------------------------------------------------
02448> *# CATCHMENT 203 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
02449> *
02450> ----------------------
02451> | CALIB STANDHYD     |   Area    (ha)=     .00
02452> | 04:203    DT= 1.00 |   Total Imp(%)=   90.00   Dir. Conn.(%)=   90.00
02453> ----------------------
02454>                              IMPERVIOUS    PERVIOUS (i)
02455>      Surface Area     (ha)=        .00          .00
02456>      Dep. Storage     (mm)=       1.00         6.35
02457>      Average Slope     (%)=       2.00         2.00
02458>      Length            (m)=      10.00        10.00
02459>      Mannings n           =       .013         .250
02460>
02461>      Max.eff.Inten.(mm/hr)=      58.58         7.26
02462>                 over (min)        1.00         9.00
02463>      Storage Coeff.  (min)=        .65 (ii)    9.42 (ii)
02464>      Unit Hyd. Tpeak (min)=       1.00         9.00
02465>      Unit Hyd. peak  (cms)=       1.34          .13
02466>                                                          *TOTALS*
02467>      PEAK FLOW       (cms)=        .00          .00          .000 (iii)
02468>      TIME TO PEAK    (hrs)=       1.27         1.47         1.333
02469>      RUNOFF VOLUME    (mm)=      24.27         4.34        22.273
02470>      TOTAL RAINFALL   (mm)=      25.27        25.27        25.268
02471>      RUNOFF COEFFICIENT   =        .96          .17          .881
02472>
02473>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02474>            CN* =  80.0    Ia = Dep. Storage  (Above)
02475>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02476>            THAN THE STORAGE COEFFICIENT.
02477>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02478>
02479> ----------------------------------------------------------------------------
02480> 300:0010----------------------------------------------------------------------
02481> * ADD TOTAL FLOWS TO BRANT STREET
02482> ------------------------
02483> | ADD HYD (BRANT     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02484> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
02485>                       ID1 02:201.CTL        .65     .050    1.37  23.67    .000
02486>                      +ID2 03:201.OVF        .00     .000     .00    .00    .000
02487>                      +ID3 01:202            .03     .004    1.33  23.87    .000
02488>                       ========================================================
02489>                       SUM 05:BRANT          .67     .052    1.33  23.68    .000
02490>
02491>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02492>
02493> ----------------------------------------------------------------------------
02494> 300:0011----------------------------------------------------------------------
02495> * ADD TOTAL FLOWS FROM PHASE 1 SITE
02496> ------------------------
02497> | ADD HYD (TOTAL.P1  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02498> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
02499>                       ID1 04:203            .00     .000    1.33  22.27    .000
02500>                      +ID2 05:BRANT          .67     .052    1.33  23.68    .000
02501>                       ========================================================
02502>                       SUM 09:TOTAL.P1       .67     .053    1.33  23.67    .000
02503>
02504>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02505>
02506> ----------------------------------------------------------------------------
02507> 300:0012----------------------------------------------------------------------
02508> * AREA CHECK
02509> ------------------------
02510> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02511> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
02512>                       ID1 10:EX.P1          .67     .031    1.33   9.28    .000
02513>                      +ID2 09:TOTAL.P1       .67     .053    1.33  23.67    .000
02514>                       ========================================================
02515>                       SUM 01:CHECK         1.35     .084    1.33  16.48    .000
02516>
02517>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02518>
02519> ----------------------------------------------------------------------------
02520> 300:0013----------------------------------------------------------------------
02521> **#*************************************************************************|
02522> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
02523> *
02524> ----------------------------------------------------------------------------
02525> 300:0002----------------------------------------------------------------------
02526> *
02527> ----------------------------------------------------------------------------
02528> 300:0002----------------------------------------------------------------------
02529> *
02530> ----------------------------------------------------------------------------
02531> 300:0002----------------------------------------------------------------------
02532> *
02533> ----------------------------------------------------------------------------
02534> 300:0002----------------------------------------------------------------------
02535> *
02536> ----------------------------------------------------------------------------
02537> 300:0002----------------------------------------------------------------------
02538> *
02539> ----------------------------------------------------------------------------
02540> 300:0002----------------------------------------------------------------------
02541> *
02542> ----------------------------------------------------------------------------
02543> 300:0002----------------------------------------------------------------------
02544>       FINISH
02545> ----------------------------------------------------------------------------
02546> ****************************************************************************
02547>      WARNINGS / ERRORS / NOTES
02548>      -------------------------
02549>    Simulation ended on 2022-11-01     at 13:01:27
02550> ============================================================================
02551>
02552>
```

APPENDIX B

QUALITY CONTROL INFORMATION

May 2, 2022

ADS UFF Sizing Summary

Project Name: 774-782 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-8
TSS Removal Percentage:	80.4%
Total Site Volume Treated:	89.6%

Site Details	
Site Area:	0.646 ha
% Impervious:	97%
Rational C:	0.93
Rainfall Station:	Hamilton, ONT
Particle Size Distribution:	ETV

Unit Specifications:	
Number of Filter Modules:	8
Maximum Treatment Flowrate:	12.8 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.

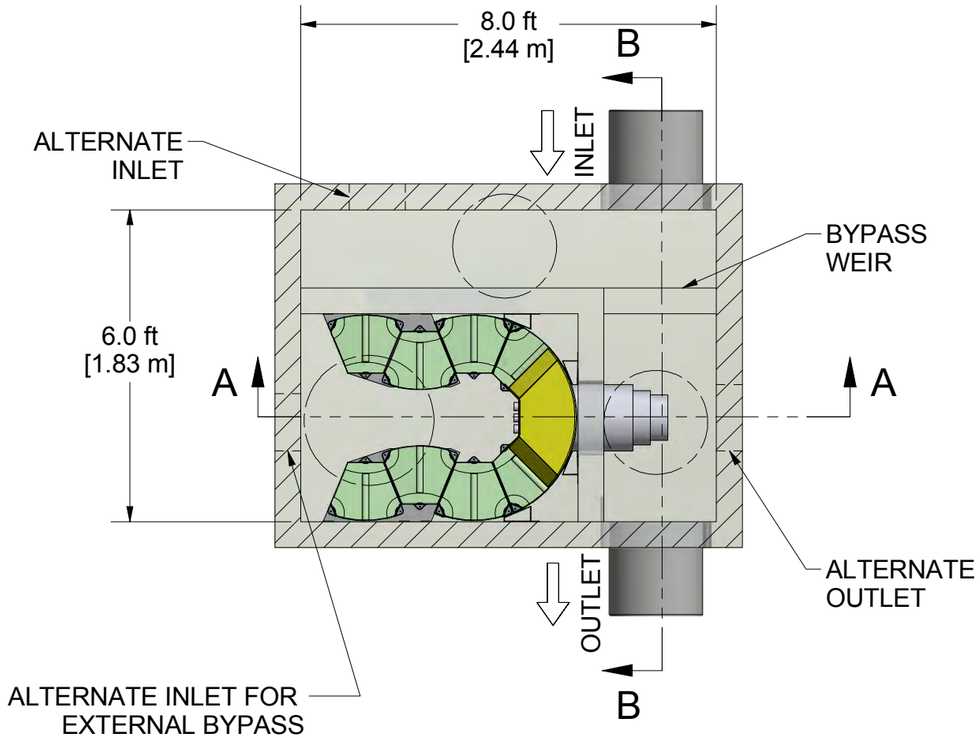
Rainfall Intensity[1]	Fraction of Rainfall[1]	Removal Efficiency[2]	Weighted Net-Annual Removal Efficiency
mm/hr	%	%	%
0.50	0.4%	92.2%	0.3%
1.00	18.8%	91.2%	17.2%
1.50	10.9%	90.2%	9.9%
2.00	13.9%	89.2%	12.4%
2.50	4.5%	88.2%	4.0%
3.00	2.7%	87.2%	2.4%
3.50	7.8%	86.2%	6.7%
4.00	4.2%	85.1%	3.6%
4.50	2.2%	84.1%	1.8%
5.00	4.7%	83.1%	3.9%
6.00	4.2%	81.1%	3.4%
7.00	4.2%	79.1%	3.4%
8.00	3.2%	77.1%	2.5%
9.00	1.9%	75.1%	1.5%
10.00	2.6%	73.1%	1.9%
20.00	9.2%	52.9%	4.9%
30.00	2.3%	32.8%	0.7%
40.00	1.1%	12.7%	0.1%
50.00	0.5%	0.0%	0.0%
100.00	0.6%	0.0%	0.0%
150.00	0.1%	0.0%	0.0%
Net Annual Treatment			**80.4%**
Total Runoff Volume Treated:			**89.6%**

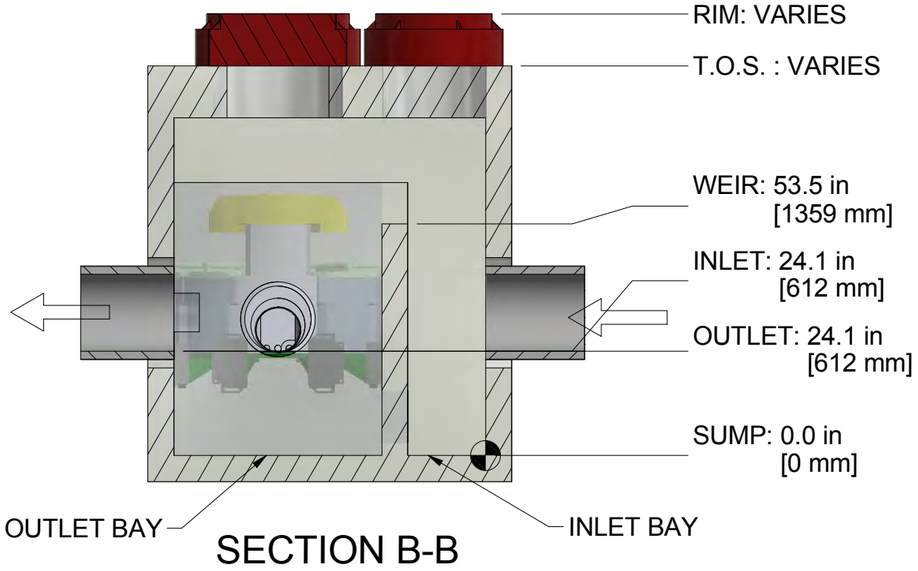
Rainfall Data: 1970:2007, HLY03, Hamilton, ON, 6153194.

Notes:

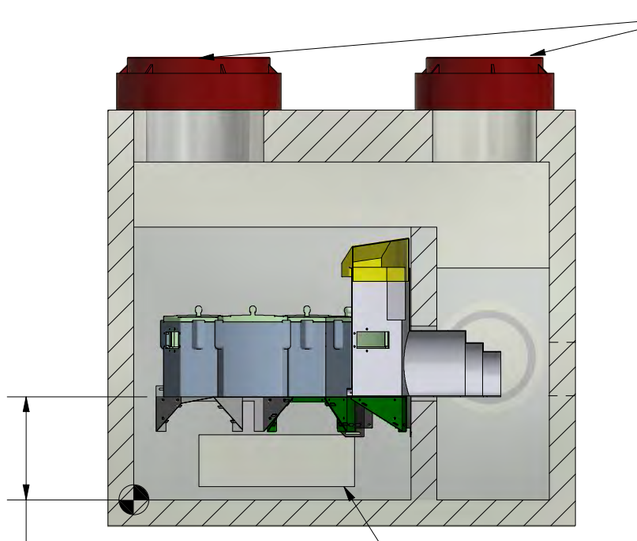
Removal efficiencies are based on NJDEP Test Protocols and independently verified.

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.

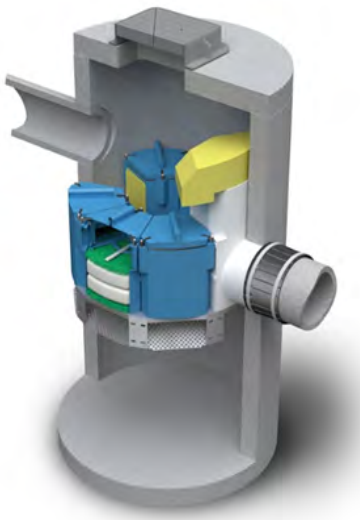


Figure 1: Up-Flo® Filter with CPZ™ Media

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:

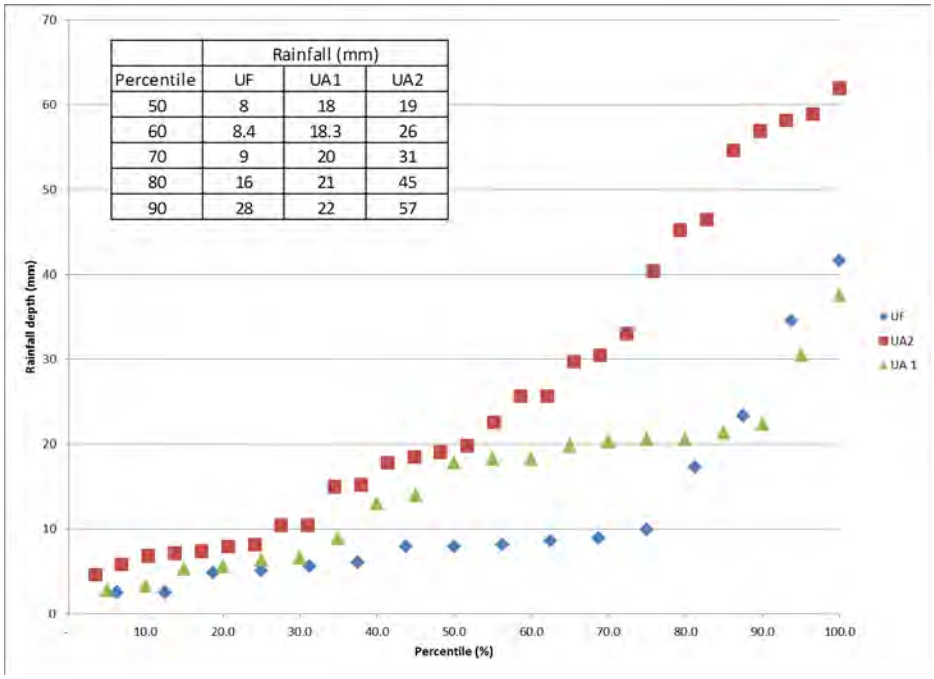
- TSS – ASTM D2540
- SSC – ASTM D3977-97(2013) Standard Test Methods for Determining Sediment Concentration in Water Samples
- PSD – ASTM D422 – 63 Standard Test Method for Particle-Size Analysis of Soils and ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- PSD – ASTM 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



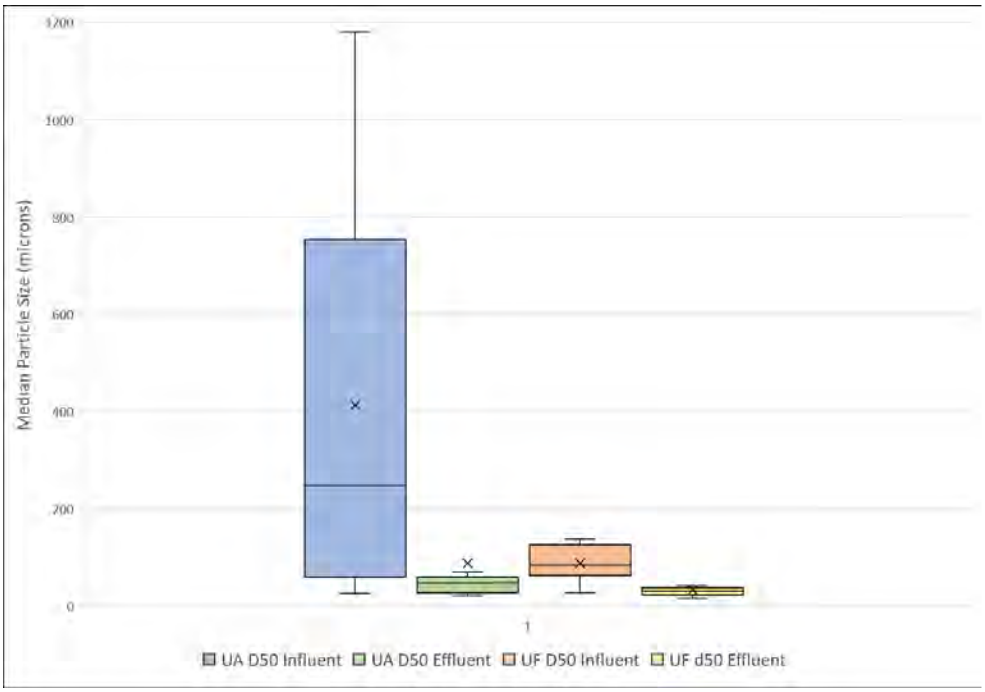
For UF monitoring, a total of 16 storm events, with varying rainfall intensity and runoff volume from event to event, were monitored. The cumulative rainfall depth was 7.66 inches (195 mm) and the cumulative influent runoff volume was 20,022 gallons (7.65 m^3). The entire volume was treated by the Up-Flo® 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

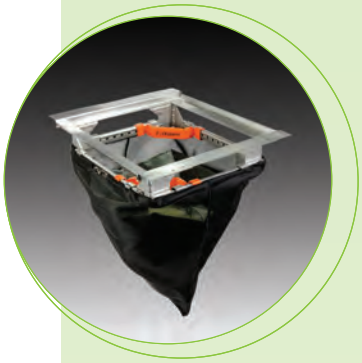
ETV contributes to protection and conservation of the environment by promoting and facilitating market uptake of innovative environmental technologies, especially those that perform better than relevant alternatives. ETV is particularly applicable to those environmental technologies whose innovative 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

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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: **774-782 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	**14540.5**	**1**	**14540.5**	**0.6**	16000	266.7	**-15**	-2400.0	**13600.0**	**-50**	-6800.0	20	2720.0	**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%

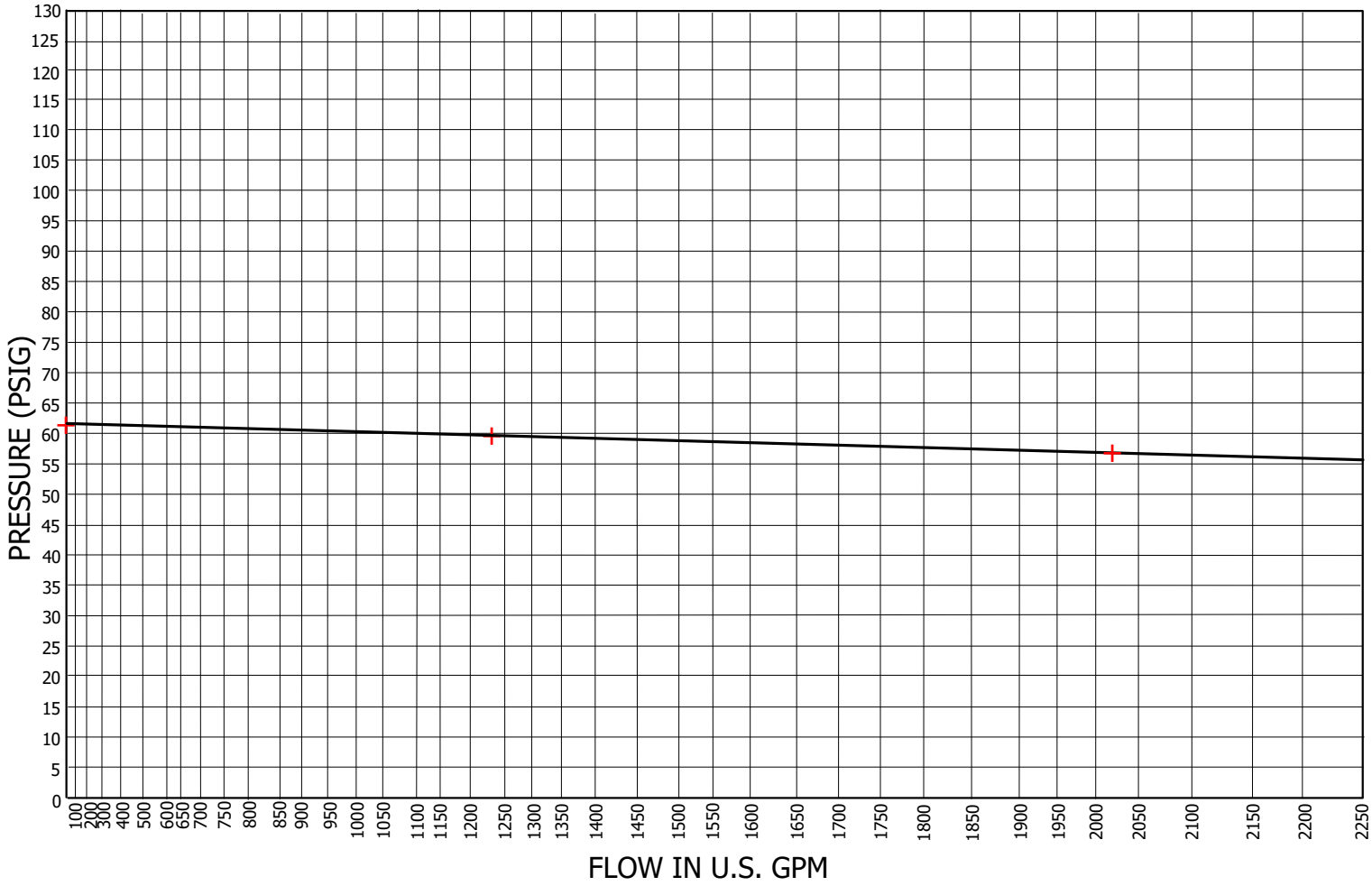
Block 1

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

Total Area Calculatio

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

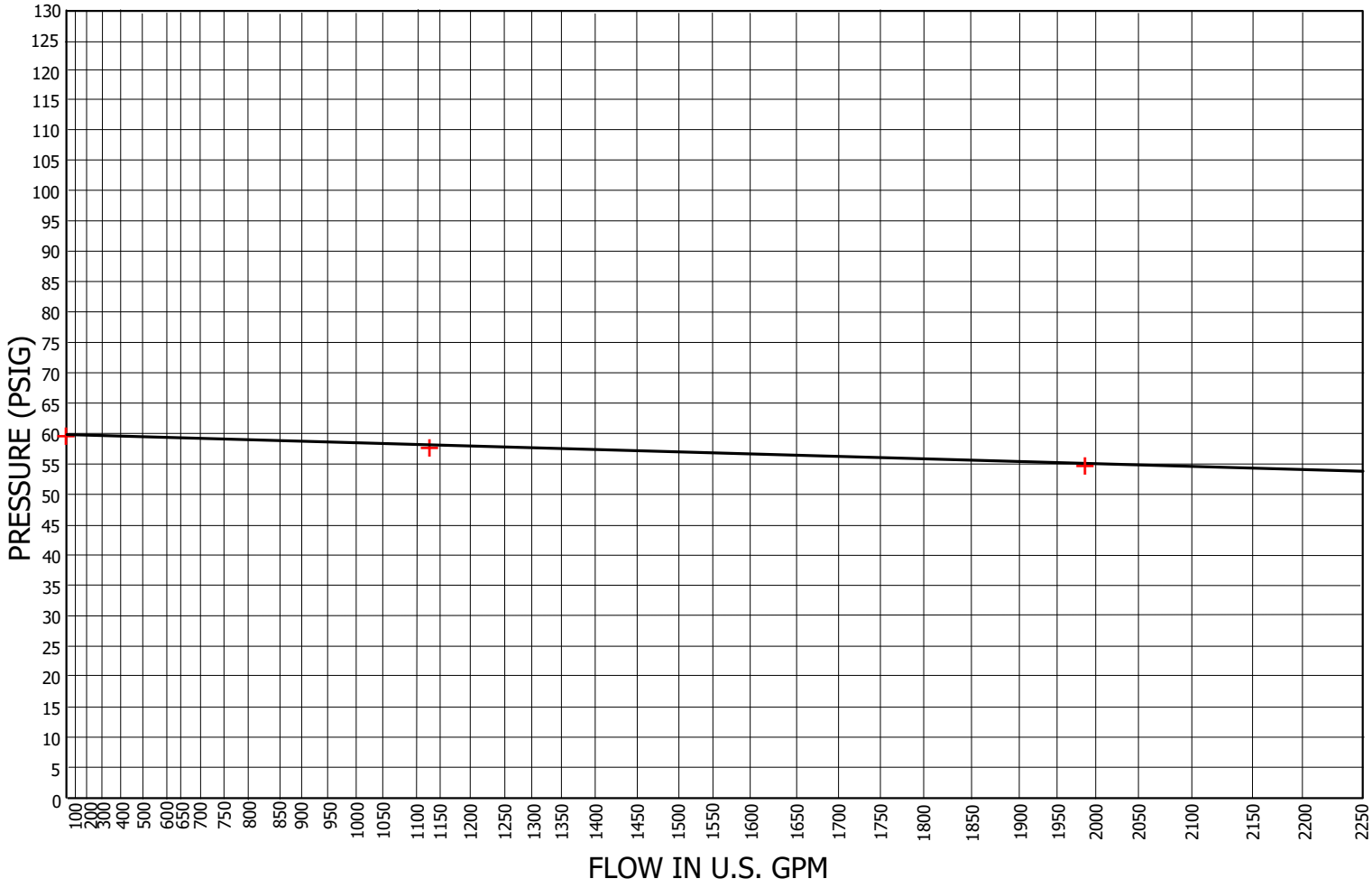
Floor	Area	Tot. Area	Cumm. Area
1	2960	2960	2960
2	2938	2938	5898
3	2695	1348	7246
4	2100	1050	8296
5	1955	978	9273
6	2107	1054	10327
7	2107	1054	11380
8	2107	1054	12434
9	2107	1054	13487
10	2107	1054	**14541**



# of Ports	PORT DIA. (in/mm)	PITOT (psig)	FLOW (usgpm)	RESIDUAL (psig)
1	2.50/63	54	1233	60
2	2.50/63	36/36	2014	57
THEORETICAL FLOW @ 20psi			7355	

General Data	
Test Date	23 October 2020
Test Time	08:30am
Pipe Dia.	16"
Static	62

Site Information	
Site or Developer Name	S. Llewellyn & Associates
Site Address/Municipality	Brant Street, Burlington
Location of Test Hydrant	Front of 786 Brant Street
Location of Base Hydrant	Front of 760 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	45	1126	58
2	2.50/63	28/28	1776	55
THEORETICAL FLOW @ 20psi			5675	

General Data	
Test Date	23 October 2020
Test Time	09:15am
Pipe Dia.	10"
Static	60

Site Information	
Site or Developer Name	S. Llewellyn & Associates
Site Address/Municipality	Brant Street, Burlington
Location of Test Hydrant	Front of 1426 Ghent Avenue
Location of Base Hydrant	Ghent Avenue, 1st West 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 1 – Lot A
774-782 Brant Street
Burlington, Ontario

Prepared for:

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

Landtek File: 20255-A
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 774, 778, 780, and 782 Brant Street in Burlington, Ontario. The proposed development is to comprise of a 14-storey and 25-storey towers connected by a three- and ten-storey podium, with three (3) levels of basement parking across 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	596497, 4798487	**Site Area (approx.)**	6,700 m^2 (1.66 acres)
Site Description	The site is situated in a developed predominantly commercial area and is bounded by Brant Street to the northeast and Ghent Avenue to the southeast. Commercial and residential premises bound the site to the northwest and southwest respectively. The site is currently undeveloped and covered mainly by unmaintained grasses and copse of trees, located along Ghent Avenue.		
Geology	Underlying the topsoil encountered at the surface is fill comprising of either sand or silt. The fill extends to depths of between 0.7 m and 1.5 m. Underlying the fill is a veneer of silty sand and sandy silt. Clayey silt till was encountered underlying the silty sand and sandy silt. The till extends to depths of between 3.5 m and 5.6 m below existing ground level. Red shale bedrock was encountered underlying the till.		
Groundwater	Depths to groundwater in monitoring wells installed at the Site were obtained manually from September 2020 to August 2021. It was determined that depth to groundwater ranged from 2.43 to 3.02 metres below ground surface.		

DEWATERING CONSIDERATIONS

Short Term	Dewatering rate will range from 18,914 (0.22 L/s) to 214,100 L/day (2.48 L/s) outside periods of active precipitation; while Dewatering during Spring/active precipitation period: is estimated to be approximately 214,100 L/day (radial flow into excavation) + 670,400 L/day (direct precipitation) = 884,500 L/day (10.24 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 884,500 L/day or ~10.24 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 not to have significant amounts of 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 670 to 168 m^3/year based on the water balance calculations. This decrease in infiltration indicates that approximately 17% 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 774-782 Brant Street in Burlington, Ontario (the 'site' or 'development property').

The Site is irregular in shape and comprises an area of approximately 6,704 m^2 (1.66 acres) of undeveloped largely naturally vegetated land with bare areas located to the west corner area of the intersection of the Brant Street and Ghent Avenue, south of Brant Street in Burlington. The Site is bound by Brant Street to the north, Ghent Avenue to the east, and developed properties to the west and south.

It is understood that the proposed development is to consist of a 14-storey and 25-storey towers connected by a three- and ten-storey podium, with three (3) levels 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 site plan 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. Previous investigations completed on the property were reviewed including the results of the Preliminary Geotechnical Investigation and Phase Two Environmental Site Assessment by Landtek in September 2018. 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 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.

Previous investigations completed on the property were reviewed including the results of the Preliminary Geotechnical Investigation and Phase Two Environmental Site Assessment by Landtek in September 2018.

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; four at the Site, four at the north adjacent property across Brant Street (769, 779, 783, and 789 Brant Street and 2023, 2027, and 2031 Ghent Avenue); and two at the property located at the east corner area of the intersection of Brant Street and Ghent Avenue (747 and 761 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 provided in Appendix B of this report.

The monitoring wells MW1, MW4, MW5, MW8, MW9, and MW11 at the Site and adjacent area 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 lengths 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 21, 2020, ground water samples were collected from on-site monitoring wells MW1 and MW4 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 undeveloped largely naturally vegetated land with bare areas at 92 to 93 masl. Rambo Creek is located approximately 188 m northeast of the Site while Lake Ontario is located approximately 1.5 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 in areas as far as 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 MOE water well database for a radius of approximately 500 m from the proposed development. A total of 47 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 below.

Well Construction

- Wells terminated in bedrock 11
- Wells terminated in overburden 30
- Unknown 6
- **Total 47**

Well Uses

- Domestic 0
- Observation Wells 23
- Test Holes/Monitoring Wells 17
- Abandoned 4
- Unknown 3
- **Total 47**

Well Depth

- Less than 15 m 39
- 15 to 30 m 3
- Greater than 30 m 0
- No Data 5
- **Total 47**

The locations of all the MOE 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 BH1, BH2, BH3 and BH4 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 ground lithologies encountered by the boreholes are discussed further in the following sections.

Fill

A layer of fill ranging from 0.7 to 1.4 m in thickness was encountered in all the boreholes at the ground surface overlying sand in BH1 and BH2, and silty clay in BH3 and BH4.

Sand

A layer of sand of 0.8 to 1.8 m in thickness was encountered in BH 1 and BH2 overlying clayey silt.

Clayey Silt

A layer of clayey silt ranging from 2.0 to 3.1 m in thickness was encountered in all the boreholes overlying bedrock.

Bedrock

Shale bedrock was encountered below the clayey silt in all boreholes at depths ranging from 3.5 to 5.6 mbgs; and below silt in BH4 at 4.0 mbgs. The boreholes were terminated in bedrock at the maximum depth of approximately 18.4 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
[***] = destroyed

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 direction for the Site was determined by using the groundwater elevations recorded in monitoring wells MW1, MW4, and MW5. 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 September 24, 2020 as shown on Figure 5 in Appendix A. The horizontal hydraulic gradient across the Site was approximately 0.016 m/m southeast toward Lake Ontario.

3.10 Estimated Hydraulic Conductivity

3.10.1 Hydraulic Conductivity Tests

The estimated hydraulic conductivity values for the Site and adjacent area are provided on the following page 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	1.597×10^{-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 1×10^{-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 8.252×10^{-7} m/s. As a result, the value of 8.252×10^{-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 MW1 and MW4 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: September 21, 2020

Parameter	G/S (mg/L)	MW1	MW4
		Lab Result (mg/L)	Lab Result (mg/L)
pH	6.5-8.5*	6.73	6.92
BOD	15	<2	<2
Total Cyanide	0.02	<0.002	<0.002
Phenols	0.008	<0.002	<0.002
Total Phosphorus	0.4	0.02	0.04
Total Suspended Solids	15	**19**	**25**
Total Arsenic	0.02	<0.015	<0.015
Total Cadmium	0.008	<0.005	<0.005
Total Chromium	0.08	<0.020	<0.020
Chromium VI	0.04	<0.005	<0.005
Total Copper	0.04	<0.020	<0.020
Total Lead	0.12	<0.020	<0.020
Total Manganese	0.05	**0.757**	**0.447**
Total Mercury	0.0004	<0.0002	<0.0002
Total Nickel	0.08	<0.030	<0.030

Total Selenium	0.02	**0.066**	**0.041**
Total Silver	0.12	<0.020	<0.020
Total Zinc	0.04	<0.020	<0.020
E. Coli	200**	2	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	0.0004	0.0004
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 a 14-storey and 25-storey towers connected by a three- and ten-storey podium, with three (3) levels of basement parking across 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: ~ 97.5 m x 68.8 m = ~6,704 m2.

There will be three levels of underground parking. As a result, the maximum depth of the underground parking is estimated to be 10.1 mbgs (Level 1 = 4.1 m, Level 2 = 3.0 m, and Level 3 = 3.0 m). An elevator shaft extension is assumed to be 1.5 m. Therefore, a total excavation depth of 12.1 mbgs is required for the construction. A dewatering depth of approximately 0.5 m below the excavation bottom (12.1 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)

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, April 12, April 22, and May 10, 2021. The readings are presented in Table 3.

Based on the groundwater levels recorded in monitoring wells MW1 and MW4 located at the Site, it was determined that depth to groundwater ranged from 2.43 mbgs to 3.02 mbgs. The highest ground water level was determined to be 2.43 mbgs. Depth groundwater varies 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 214,100 L/day (2.48 L/s). These calculations and associated assumptions are provided in Table 1, Appendix F.

4.2 Dewatering Considerations

4.2.1 Estimating Total 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) = (97.5 m x 68.8 m) *0.100 m = 670.4 m^3/day = 670,400 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: ~ 214,100 L/day (2.48 L/s)
- Dewatering during Spring/active precipitation period: ~214,100 L/day (radial flow into excavation) + 670,400 L/day (direct precipitation) = 884,500 L/day or ~10.24 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 214,100 L/day = 2.48 L/s.

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 should 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 884,500 L/day or ~10.24 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.

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 Burlington Shale range from 1 x 10^{-8} m/s to 1 x 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 x 10^{-8} m/s above; and was determined to be approximately 18,914 L/day (0.22 L/s) after 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 18,914 L/day or 0.22 L/s (determined using the low-end value of hydraulic conductivity value for Burlington shale) to 884,500 L/day or ~10.24 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 188 m northeast of the Site. Lake Ontario is located approximately 1.5 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 only within the radius of influence of approximately 27 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 west corner area of the intersection of the Brant Street and Ghent Avenue in Burlington. The Site is bound by Brant Street to the north, Ghent Avenue to the East, and developed properties to the West and South. It is anticipated that there will be impact within the radius of influence of approximately 27 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 27.0 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 within the estimated dewatering 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 of 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 Project Manager and its Contractor will jointly assess the necessity of altering the method, rate, or sequence of construction. Underground infrastructure should also be reviewed.

- 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 27.0 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 consist of two 25-storey towers connected by three- and six-storey podiums, with four levels of basement parking across the full site area.

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

- Building roof area ..... 0.312 ha
- Parking Areas, Roadways, and other impervious Areas..... 0.191 ha
- Green space, SWMP, natural areas..... 0.168 ha
- **Total Area ..... 0.670 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 silt/sandy silt to depths varying from 2.5-4.0 mbgs, over clayey silt, which overlies bedrock, except in BH4 with the silt/sandy silt overlying bedrock directly. Drilling was terminated at a maximum depth of approximately 18.4 mbgs in bedrock.
- The water table recorded at the site ranges from 2.57 mbgs to 2.99 mbgs.
- There will be three levels of underground parking. As a result, the maximum depth of the underground parking is estimated to be 10.1 mbgs (Level 1 = 4.1 m, Level 2 = 3.0 m, and Level 3 = 3.0 m). An elevator shaft extension is assumed to be 1.5 m. Therefore, a total excavation depth of 12.1 mbgs is required for the construction. A dewatering depth of approximately 0.5 m below the excavation bottom (12.1 mbgs) is assumed in order to keep the bottom of the excavation dry during construction.
- Groundwater flow direction within the bedrock at the site is interpreted to be towards the southeast.
- 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.

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 mainly 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 clayey silt beneath the site.

The water balance (pre- and post-development) is summarized in Table 5 below 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	6,235	4,083	670	1,482
Post-Development	6,235	1,020	168	5,047

The increase in run-off from 1,482 m^3 to 5,047 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 670 to 168 m^3/year based on the water balance calculations outlined in Appendix H. This decrease in infiltration indicates that approximately 17% 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 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 silt/clayey silt to depths varying from 3.5-5.6 mbgs, which overlies bedrock. Drilling was terminated at a maximum depth of approximately 18.4 mbgs in bedrock.
- Lake Ontario is located approximately 1.5 km southeast of the site. The direction of groundwater flow at the site is southeast towards Lake Ontario.
- Groundwater contour plot from groundwater monitoring levels recorded on September 24, 2020 indicates the direction of groundwater flow was southeast. The horizontal hydraulic gradient across the Site, was approximately 0.016 m/m southeast.
- The water table present within the shale bedrock at the site ranges from 2.43 meters mbgs to 3.02 mbgs.
- There will be three levels of underground parking. As a result, the maximum depth of the underground parking is estimated to be 10.1 mbgs (Level 1 = 4.1 m, Level 2 = 3.0 m, and Level 3 = 3.0 m). A dewatering depth of approximately 0.5 m below the excavation bottom (10.6 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 214,100 L/day = ~2.48 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.
- Long term dewatering is not required at the Site as the proposed underground parking levels and structures should be designed to be fully waterproofed in accordance regulatory requirements.
- A permit to take water (PTTW) is required for the above volume of water taking, as the estimated water taking is more than 400,000 L/day.
- A Short-term Dewatering Volume Plan should provide for dewatering volumes ranging from 18,914 L/day or 0.22 L/s (determined using the low-end value of hydraulic conductivity value for Burlington shale) to 884,500 L/day or ~10.24 m^3/day (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 27 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 your 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. 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.

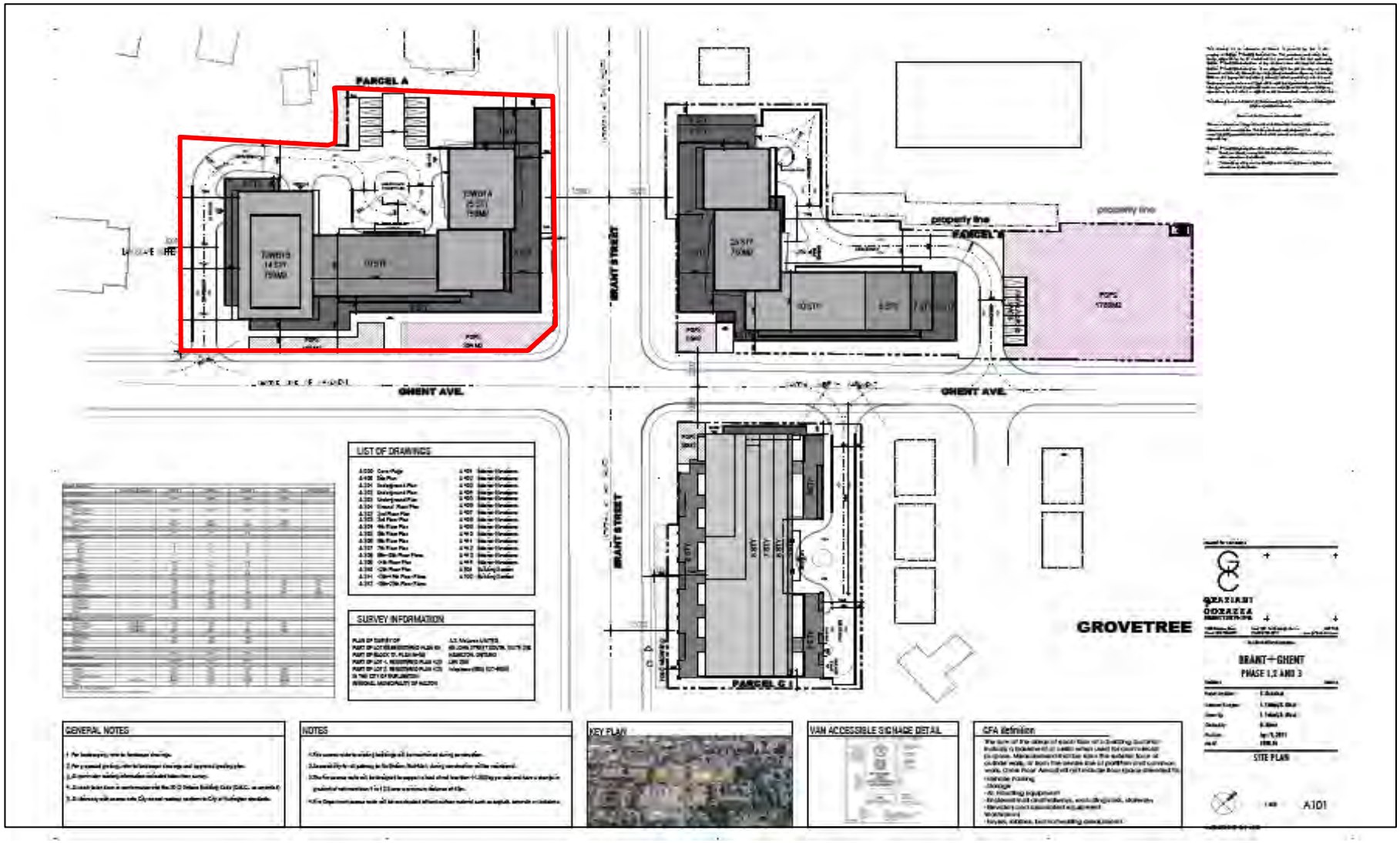
This report does not reflect environmental issues or concerns related to the property unless otherwise stated in the report. The design recommendations given in the report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details 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

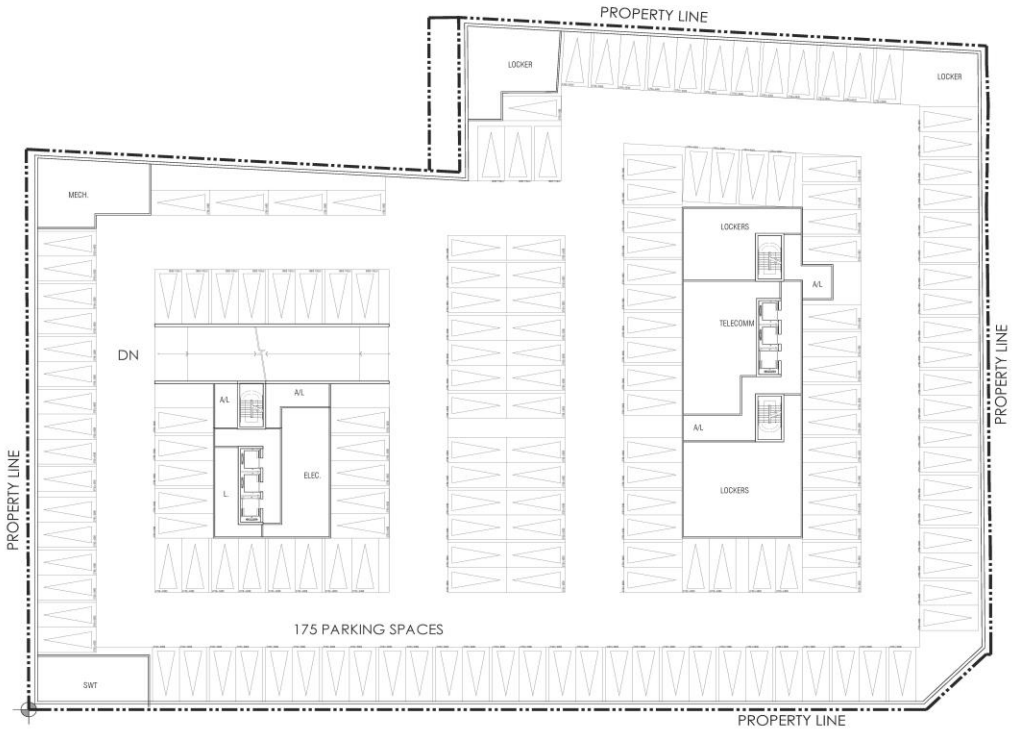


LANDTEK LIMITED ***CONSULTING ENGINEERS*** **205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1**	
Scale: See Map	Date: September 2020
Project:	Hydrogeological Investigation 774-782 Brant Street Burlington, Ontario
Title:	Figure 1: Site Location
Project No.	20255A



Site

LANDTEK LIMITED *CONSULTING ENGINEERS* **205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1**	
Scale: On Plan	Date: May 2021
Project:	Hydrogeological Investigation 774-782 Brant Street Burlington, Ontario
Title:	Figure 2: Site Plan
Project No.	20255A



This drawing, as an instrument of service, is provided by and is the property of Graziani + Corazza Architects Inc. The contractor must verify and accept responsibility for all dimensions and conditions on site and must notify Graziani + Corazza Architects Inc. of any variations from the supplied information. Graziani + Corazza Architects Inc. is not responsible for the accuracy of survey, site or existing building information provided by consultants or others. It is the client's responsibility to retain the appropriate engineering consultants to provide the necessary engineering drawings before proceeding with the work. Construction must conform to all applicable codes and requirements of the authorities having jurisdiction. Unless otherwise noted, no investigation has been undertaken or reported on by this office in regards to the environmental condition of this site.

This drawing is not to be scaled. All architectural symbols indicated on this drawing are graphic representations only.

Conditions for electronic information transfer

Electronic information is supplied to the other associated firms to assist them in the execution of their work/services. The recipient firms must determine the completeness/appropriateness/relevance of the information in respect to their particular responsibility.

Graziani + Corazza Architects Inc. shall not be responsible for:
1. Errors, omissions, inconsistencies that in loss of information in whole or part when information is transferred.
2. Transmission of any virus or damage to the receiving electronic system when information is transferred.

Issued for revisions

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ONTARIO ASSOCIATION OF ARCHITECTS
BENVENUTO E. GRAZIANI
LICENCE
4684

1320 Glenora Drive, Suite 100, Mississauga, Ontario, L4W 1Z3
Phone: 905.796.7601 Fax: 905.796.7848 www.gc-architects.com

Residential Development

BRANT+GHENT
PHASE 1- LOT "A"

Burlington	Ontario
Project Architect:	B. Graziani
Assistant Designer:	S.Safari
Drawn By:	S. Safari
Checked By:	D. Biase
Plot Date:	Mar. 27, 2020
Job #	1398.16

P1 LEVEL

1:200 A201

TITLEBLOCK SIZE: 810 x 600

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



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 774-782 Brant Street Burlington, Ontario
Title:	Figure 4: Boreholes and Monitoring Wells Locations
Project No.	20255A



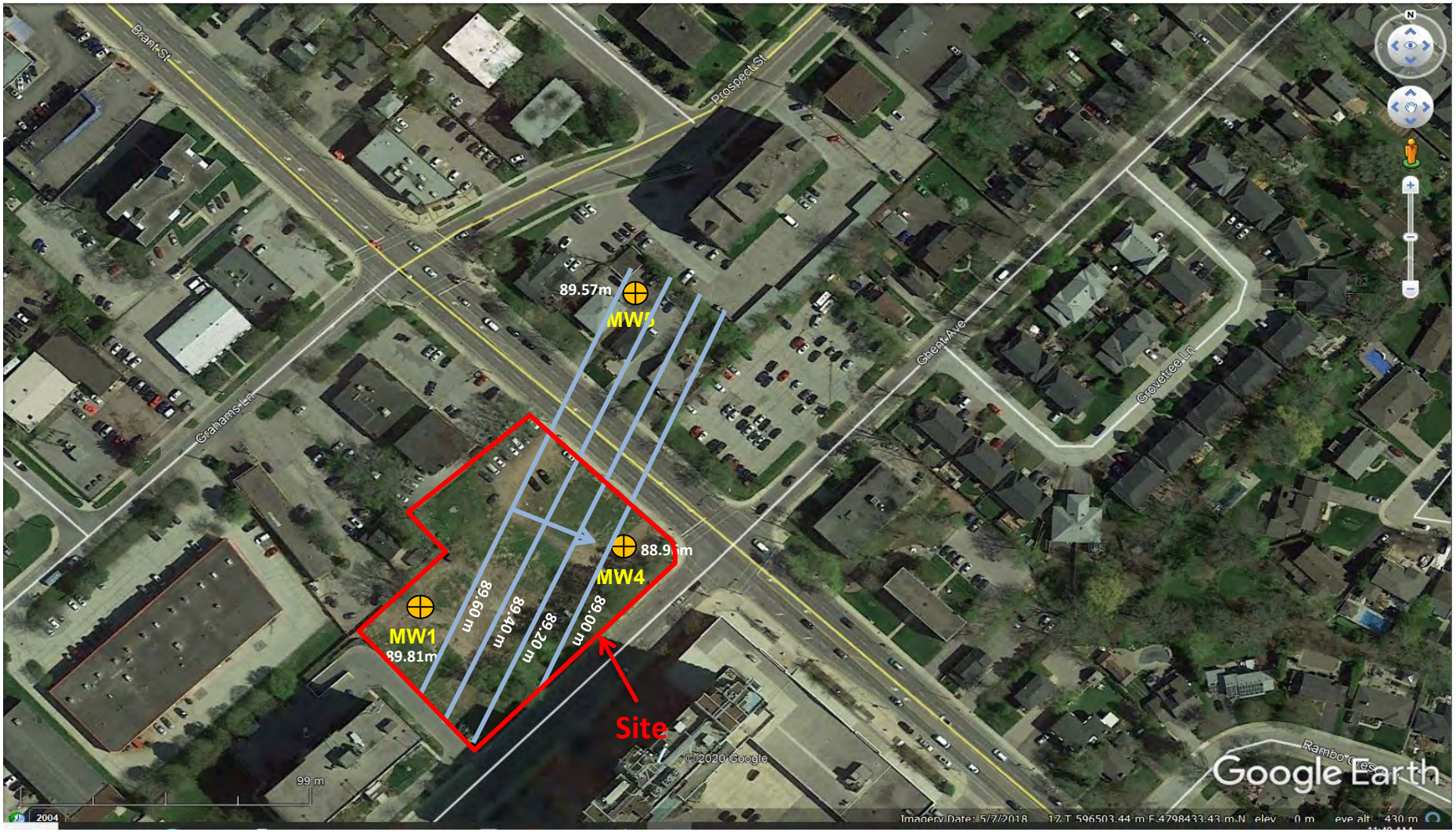
MOE Wells Locations

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205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

	Scale: See Map	Date: September 2020
Project:	Hydrogeological Investigation 774-782 Brant Street Burlington, Ontario	
Title:	Figure 5: MOE Wells Locations	
Project No.	20255A	



LEGEND

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

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Scale: See Map	Date: September 2020
Project:	Hydrogeological Investigation 774-782 Brant Street Burlington, Ontario
Title:	Figure 6: Groundwater Contour Diagram
Project No.	20255A

APPENDIX B

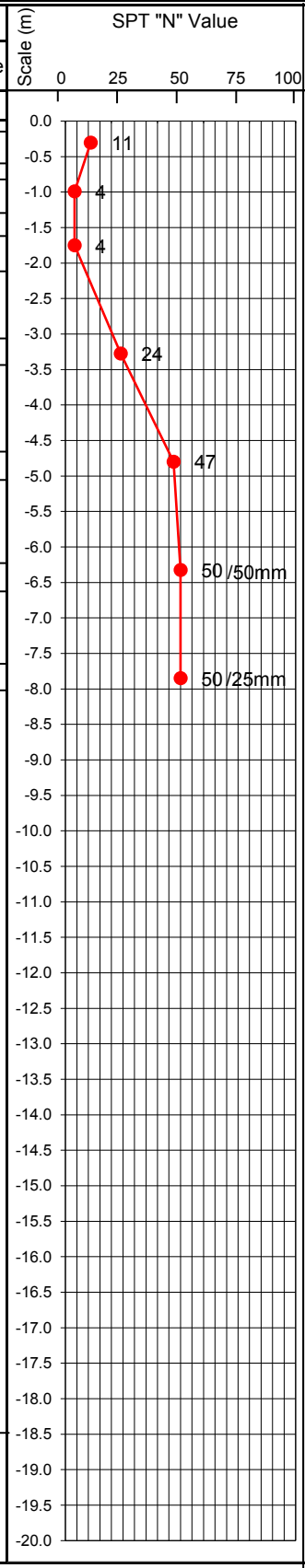
BOREHOLES & MONITORING WELLS LOGS

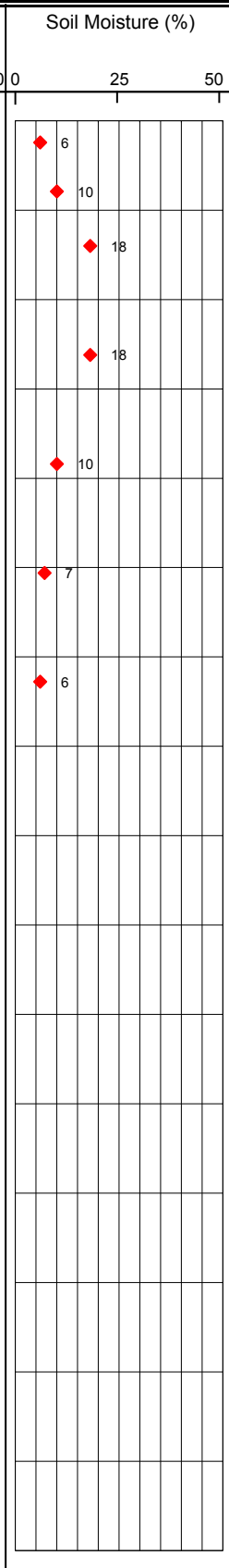
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BH/MW 1

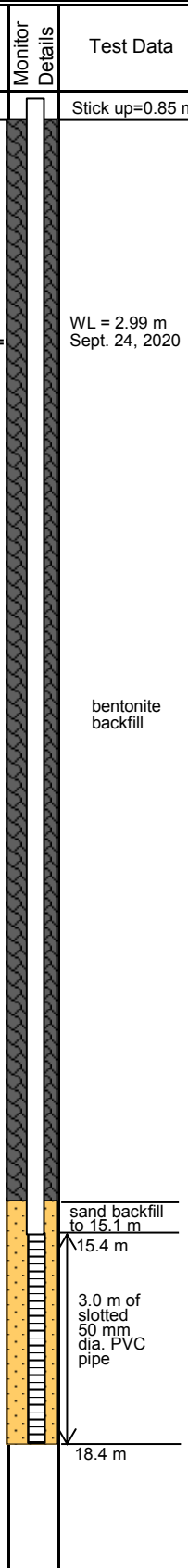
Project No.:	20255A	Drill Date:	August 31, 2020
Project:	Hydrogeological Investigation	Drill Method:	[ ] solid stem [x] hollow stem [x] Coring
Location:	Brant Street and Ghent Avenue, Burlington, Ontario	Datum:	Geodetic (Approximate)

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	Scale (m)
Ground Surface		92.8			
±130 mm of Topsoil		0.0	1	SS	
FILL: sand, trace gravel, brown, compact					
SILTY SAND: fine to medium grained, trace gravel, brown, loose, moist		0.7	2	SS	
SANDY SILT: fine to medium grained sand, brown, loose, wet		1.5	3	SS	
		90.3			
CLAYEY SILT TILL: trace gravel, trace shale, brownish grey, very stiff, moist		2.5	4	SS	
4.5 m to 5.6 m: reddish brown, hard, moist			5	SS	
		87.2			
SHALE BEDROCK (Queenston Formation) very weak to weak, highly weathered, red, moist		5.6	6	SS	
		84.8	7	SS	
slightly weathered to fresh, red and grey, medium strong Recovery = 100 %; RQD = 80 %		8.0	CORE RUN #1	63 mm Dia. Core	
slightly weathered to fresh, red, strong Recovery = 100 %; RQD = 100 % ∂ = 25.5 kN/m³; UCS strength = 72.7 MPa		9.3	CORE RUN #2		
slightly weathered to fresh, red and grey, medium strong Recovery = 100 %; RQD = 99 %		10.8	CORE RUN #3		
fresh, red and grey, medium strong Recovery = 100 %; RQD = 97 % ∂ = 25.5 kN/m³; UCS strength = 44.3 MPa		12.2	CORE RUN #4		
fresh, red and grey, medium strong Recovery = 100 %; RQD = 100 %		13.7	CORE RUN #5		
fresh, red and grey, medium strong Recovery = 100 %; RQD = 88 %		15.4	CORE RUN #6		
fresh, red and grey, medium strong Recovery = 100 %; RQD = 100 %		16.9	CORE RUN #7		
		74.4			
BOREHOLE TERMINATED		18.4			









Notes:
1. Wet soils encountered at 1.5 m
2. Water level reading: 2.99 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

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BH 2

Project No.:	20255A	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	Sample No.	Sample Type	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface		93.3							
±50 mm of Topsoil		0.0	1	SS	8	6			
FILL: sand, brown, compact, moist		92.6							
SILTY SAND: fine to medium grained, trace gravel, brown, loose, moist		0.7	2	SS	6	11			
1.5 m to 2.5 m: wet			3	SS	5	19			
		90.8							
CLAYEY SILT TILL: trace gravel, trace shale, brownish grey, very stiff, moist		2.5	4	SS	18	17			
4.5 m to 5.0 m: hard		88.3	5	SS	46	7			
		5.0							
SHALE BEDROCK (Queenston Formation) very weak to weak, highly weathered, red, moist			6	SS	50/50mm	6			
		85.7	7	SS	50/25mm				
AUGER REFUSAL **BOREHOLE TERMINATED**		7.6							

SPT "N" Value scale: 0 25 50 75 100 (Scale (m): 0.0 to -20.0)

Soil Moisture (%) scale: 0 25 50

Notes: 1. Wet soils encountered at 1.5 m

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

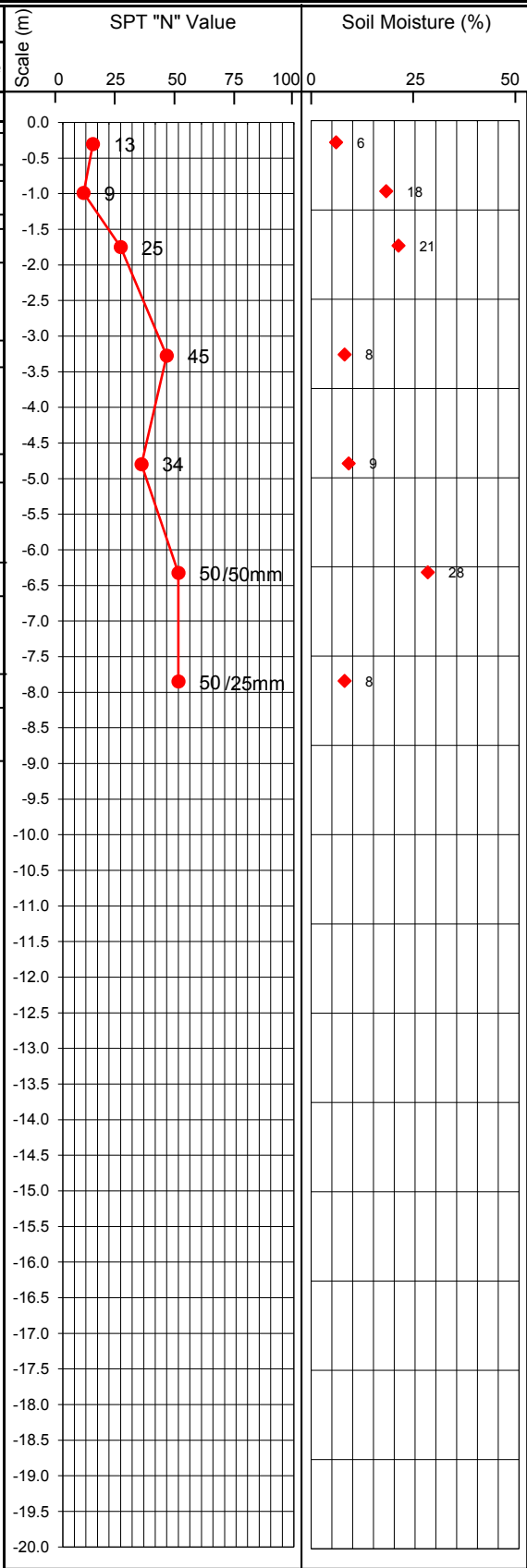
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205 Nebo Road, Unit 3
Hamilton, Ontario, Canada, L8W 2E1
Ph: (905) 383-3733 Fax: (905) 383-8433
www.landteklimited.com

Landtek Limited

BH 3

Project No.:	20255A	Drill Date:	September 1, 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	Sample No.	Sample Type	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface		91.9							
±50 mm of Topsoil		0.0							
FILL: clayey silt, trace iron staining, brown, stiff, moist			1	SS	13	6			
			2	SS	9	18			
		90.4							
CLAYEY SILT TILL: trace gravel, trace shale, brownish grey, very stiff, moist		1.5	3	SS	25	21			
3.0 m to 4.0 m: reddish brown, hard			4	SS	45	8			
		87.9							
SHALE BEDROCK (Queenston Formation) very weak to weak, highly weathered, red, moist		4.0	5	SS	34	9			
4.3 m to 8.0 m: wet			6	SS	50/50mm	28			
8.0 m to 9.1 m: slightly weathered to fresh			7	SS	50/25mm	8			
		82.8							
		9.1							
AUGER REFUSAL **BOREHOLE TERMINATED**									



Notes: 1. Groundwater encountered at 4.3 m depth 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
www.landteklimited.com

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BH/MW 4

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

Material Description	Elev. / Depth	Sample No.	Sample Type	SPT "N" Value (Scale (m))	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface	91.5							Stick up=0.91 m
±50 mm of Topsoil	0.0							
FILL: silty sand and silt, trace iron staining, brown, loose to compact, moist		1	SS	11, 7	12, 11			
	90.0	2	SS					
CLAYEY SILT TILL: trace gravel, trace shale, brownish grey, very stiff, moist	1.5	3	SS	20	24			
3.0 m to 3.5 m: wet	88.0	4	SS	50/100 mm	12	WL = 2.57 m Sept. 24, 2020		
SHALE BEDROCK (Queenston Formation) very weak to weak, highly weathered, red, moist	3.5	5	SS	50/100 mm	3			bentonite backfill
		6	SS	50/50mm	2			
slightly weathered to fresh, red and grey, medium strong	8.0		TRICONE DRILLING					
	73.1							sand backfill to 15.1 m
								15.4 m
								3.0 m of slotted 50 mm dia. PVC pipe
BOREHOLE TERMINATED	18.4							18.4 m

Notes: 1. Wet soils encountered at 3.5 m 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
www.landteklimited.com

APPENDIX C

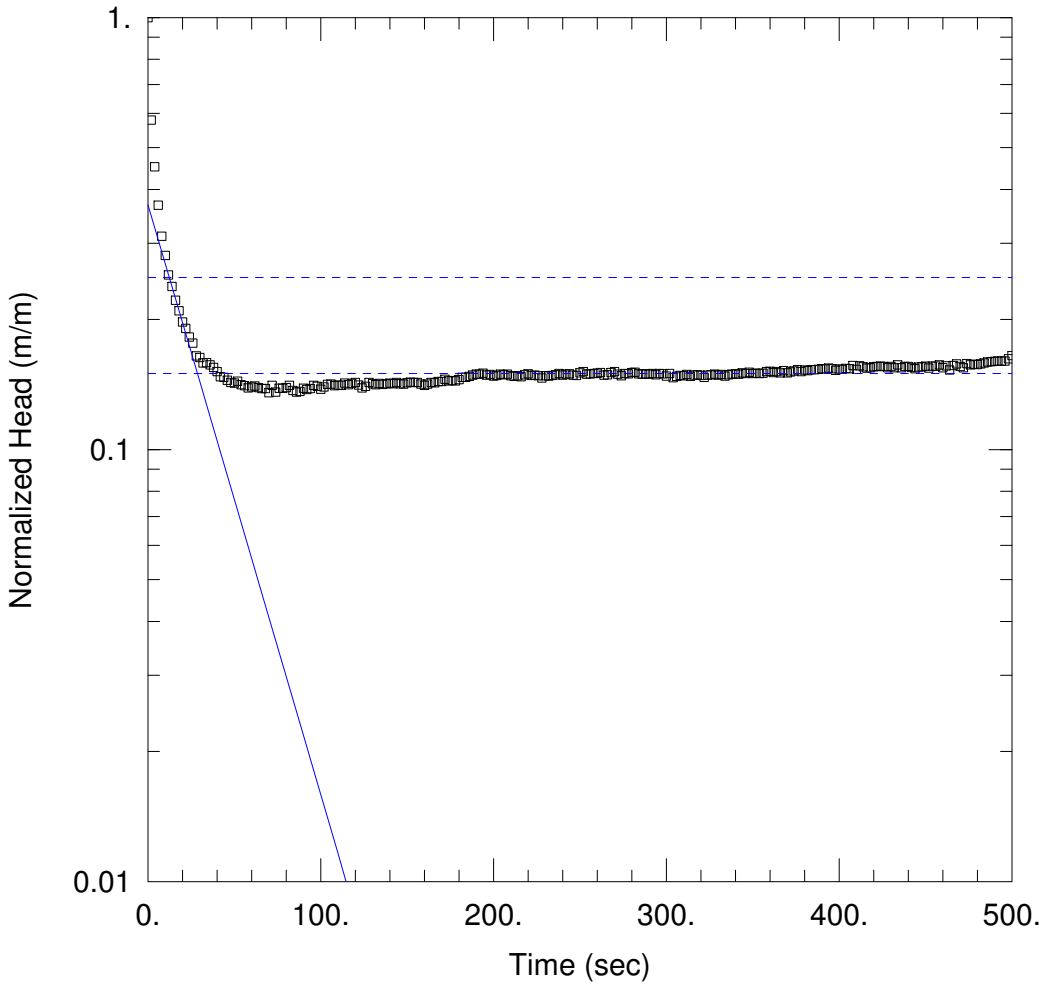
SUMMARY OF MOE WELL RECORDS

774-782 Brant Street, Burlington

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	2810058	05-Jul-04	23-Sep-04	596231	4798928	NA	NA	NA	Observation Well	Observation Well	24.93	7.60	Bedrock	903 Brant Street	BURLINGTON
2	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
3	2810214	21-Mar-05	26-Apr-05	596212	4798276	6.6	NA	NA	Observation Well	NA	14.8	4.51	Overburden	NA	BURLINGTON
4	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
5	6715010	06-Jul-04	31-Aug-04	596235	4798927	10.5	NA	Fresh	Observation Well	Monitoring Well	14.8	4.51	Overburden	131 Ontario Street	BURLINGTON
6	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
7	7047125	04-Jun-07	26-Jul-07	596126	4798177	9.8	NA	NA	Observation Well	Observation Well	11.8	3.60	Overburden	1380 Grahams Lane	BURLINGTON
8	7128794	09-Jan-08	01-Sep-09	596186	4798748	NA	NA	NA	Abandoned	Monitoring Well	22.3	6.80	Overburden	2075 Fairview Street	BURLINGTON
9	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
10	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
11	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
12	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
13	7187211	NA	17-Sep-12	596799	4798762	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Bedrock	2096 Hent Avenue	BURLINGTON
14	7187212	NA	17-Sep-12	596775	4798734	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Bedrock	2084 Ghgnt Avenue	BURLINGTON
15	7220604	21-Apr-14	20-May-14	596782	4798703	NA	NA	NA	Monitoring Well	Monitoring Well	17	5.18	Bedrock	2702 Ghent Avenue	BURLINGTON
16	7220605	21-Apr-14	20-May-14	596782	4798703	NA	NA	NA	Abandoned	NA	20	6.10	NA	2702 Ghent Avenue	BURLINGTON
17	7243101	29-Apr-15	16-Jun-15	596193	4798975	NA	NA	NA	Monitoring Well	Monitoring Well	25	7.62	Bedrock	923 Brant Street	BURLINGTON
18	7244979	03-Jun-15	21-Jul-15	596883	4798686	7	NA	NA	Abandoned	NA	NA	NA	NA	2086 Grant Avenue	BURLINGTON
19	7244980	03-Jun-15	21-Jul-15	596883	4798686	NA	NA	NA	Observation Well	Monitoring Well	18	5.5	Bedrock	2086 Grant Avenue	BURLINGTON
20	7244981	03-Jun-15	21-Jul-15	596883	4798686	NA	NA	NA	Observation Well	NA	18	5.49	Bedrock	2086 Grant Avenue	BURLINGTON
21	7244982	03-Jun-15	21-Jul-15	596825	4798636	NA	NA	NA	Abandoned	NA	NA	NA	NA	2086 Grant Avenue	BURLINGTON
22	7251865	11-Sep-15	10-Nov-15	596782	4798684	NA	NA	NA	Monitoring Well	Monitoring Well	20	6.10	Bedrock	2068 Ghent Avenue	BURLINGTON
23	7252011	04-Sep-15	10-Nov-15	596736	4798745	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Bedrock	2071 Ghent Avenue	BURLINGTON
24	7265586	10-Mar-16	24-Jun-16	596019	4798801	NA	NA	NA	NA	NA	NA	NA	NA	NA	BURLINGTON
25	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
26	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
27	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
28	7290057	26-May-17	07-Jul-17	596301	4798815	NA	NA	NA	Observation Well	Test Hole	20	6.10	Overburden	833 Brant Street	BURLINGTON
29	7290058	26-May-17	07-Jul-17	596289	4798790	NA	NA	NA	Observation Well	Test Hole	20	6.10	Overburden	855 Brant Street	BURLINGTON
30	7291911	12-Jun-17	02-Aug-17	596224	4798347	NA	NA	NA	NA	NA	NA	NA	NA	NA	BURLINGTON
31	7292314	21-Jun-17	11-Aug-17	596336	4798785	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Overburden	849 Brant Street	BURLINGTON
32	7292315	21-Jun-17	11-Aug-17	596336	4798786	NA	NA	NA	Observation Well	Monitoring Well	30	9.15	Overburden	849 Brant Street	BURLINGTON
33	7292316	21-Jun-17	11-Aug-17	596361	4798743	NA	NA	NA	Observation Well	Monitoring Well	18	5.49	Overburden	849 Brant Street	BURLINGTON
34	7292317	21-Jun-17	11-Aug-17	596352	4798776	NA	NA	NA	Observation Well	Monitoring Well	18	5.49	Overburden	849 Brant Street	BURLINGTON
35	7314898	04-Jul-18	19-Jul-18	596295	4798451	NA	NA	NA	Observation Well	Monitoring Well	15	4.57	Overburden	1416 Graham Lane	BURLINGTON
36	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
37	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
38	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
39	7323581	05-Oct-18	06-Dec-18	596643	4798961	NA	NA	NA	Test Hole	Test Hole	20	6.10	Overburden	2103 Prospect Street	BURLINGTON
40	7330854	14-Feb-19	01-Apr-19	596270	4798655	NA	NA	NA	Observation Well	Monitoring Well	13	3.96	Overburden	850 Brant Street	BURLINGTON
41	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
42	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
43	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
44	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
45	7330859	14-Feb-19	01-Apr-19	596288	4798651	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Overburden	850 Brant Street	BURLINGTON
46	7331850	23-Aug-18	23-Apr-19	596494	4798533	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Overburden	280 Brant Street	BURLINGTON
47	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

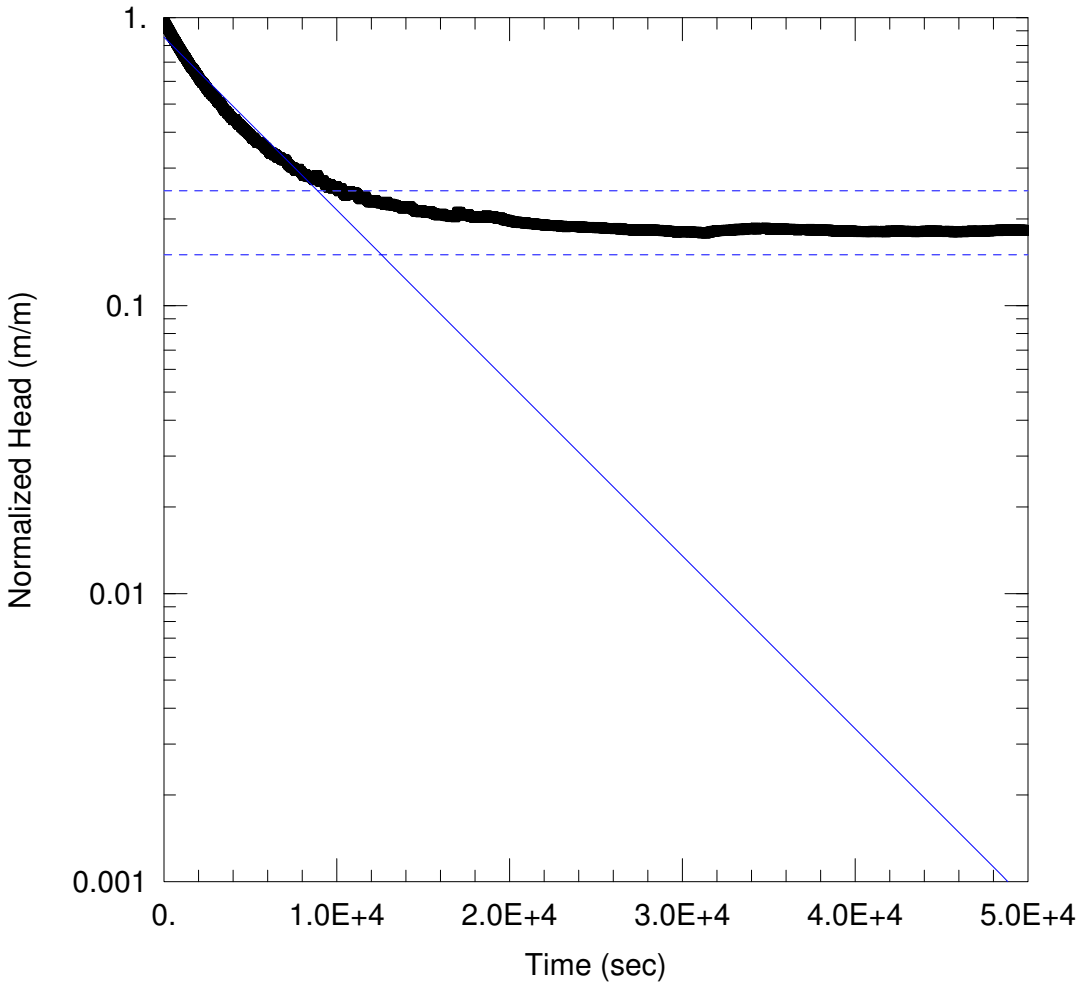
Saturated Thickness: 15.4 m
Anisotropy Ratio (Kz/Kr): 1.

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.

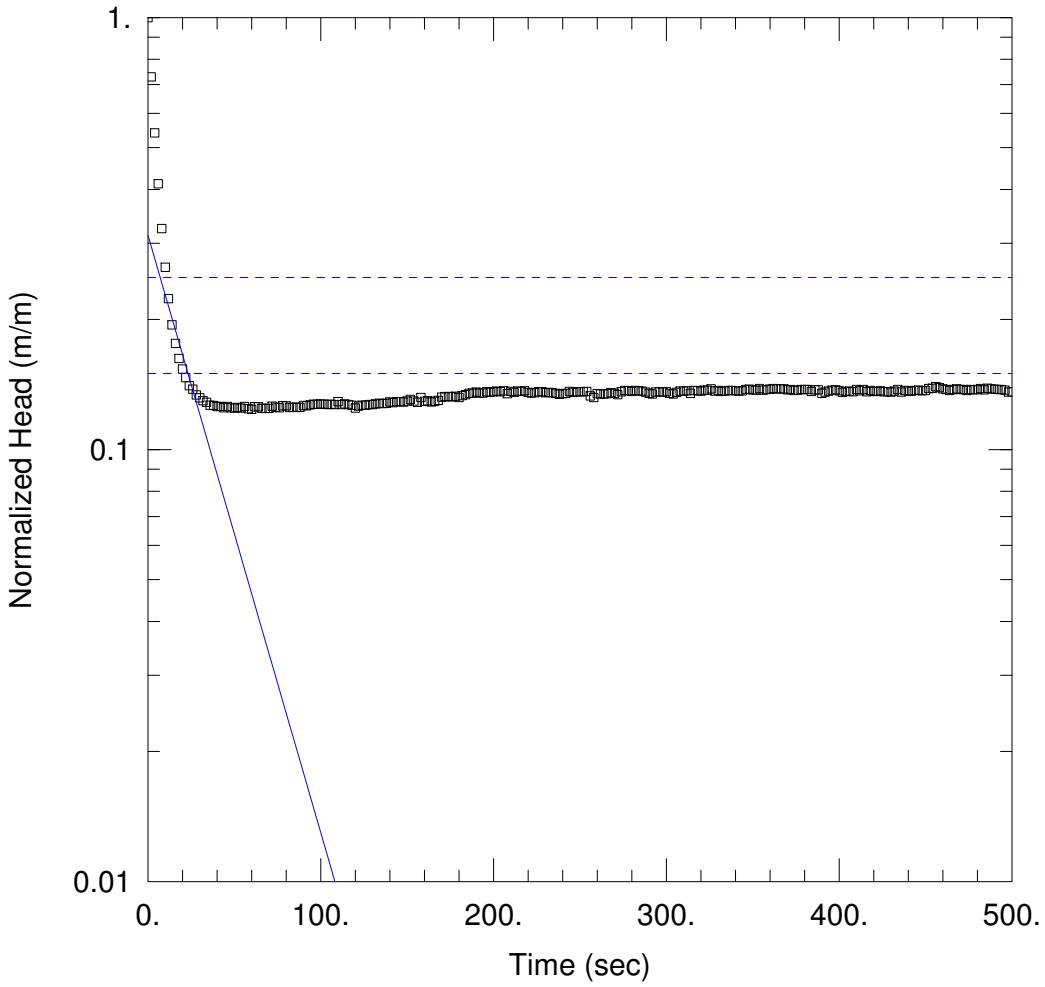
WELL DATA (MW4)

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.

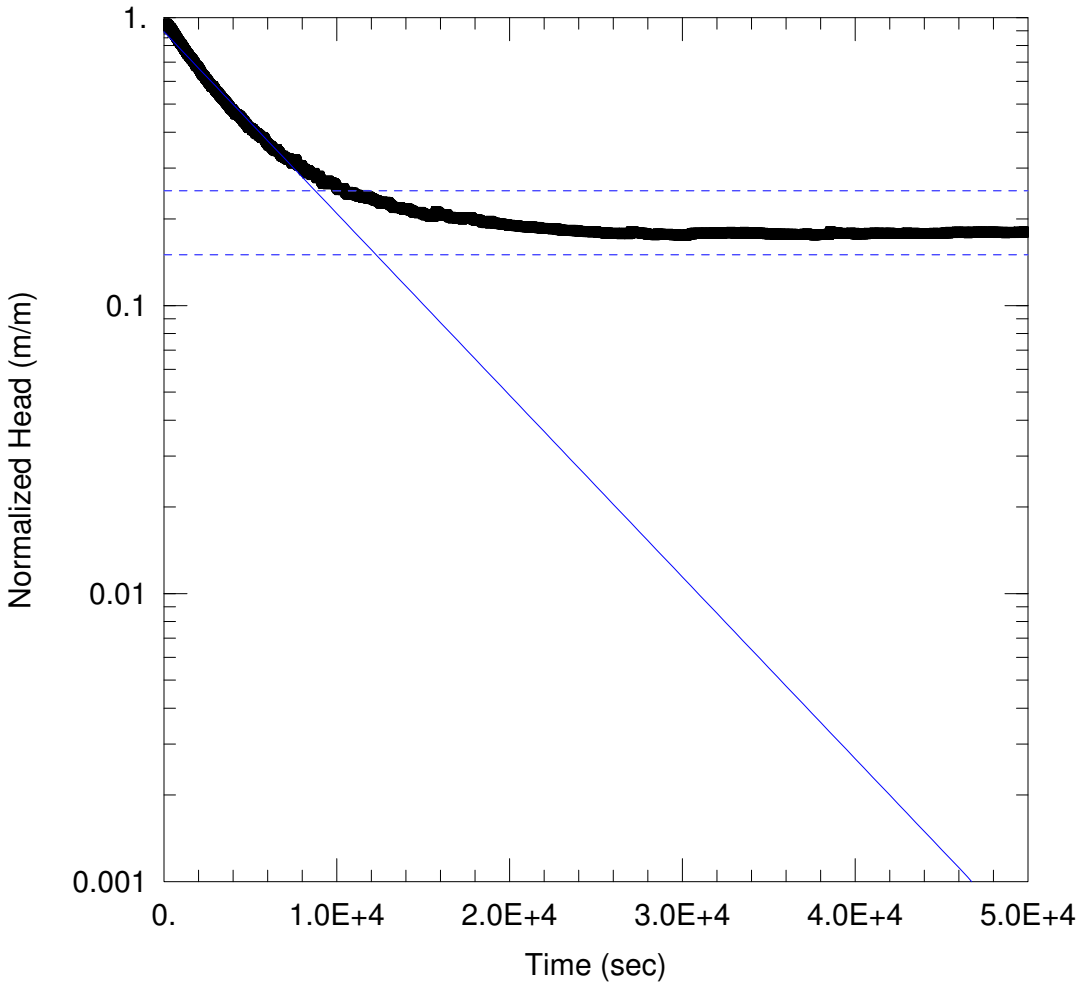
WELL DATA (MW5)

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.

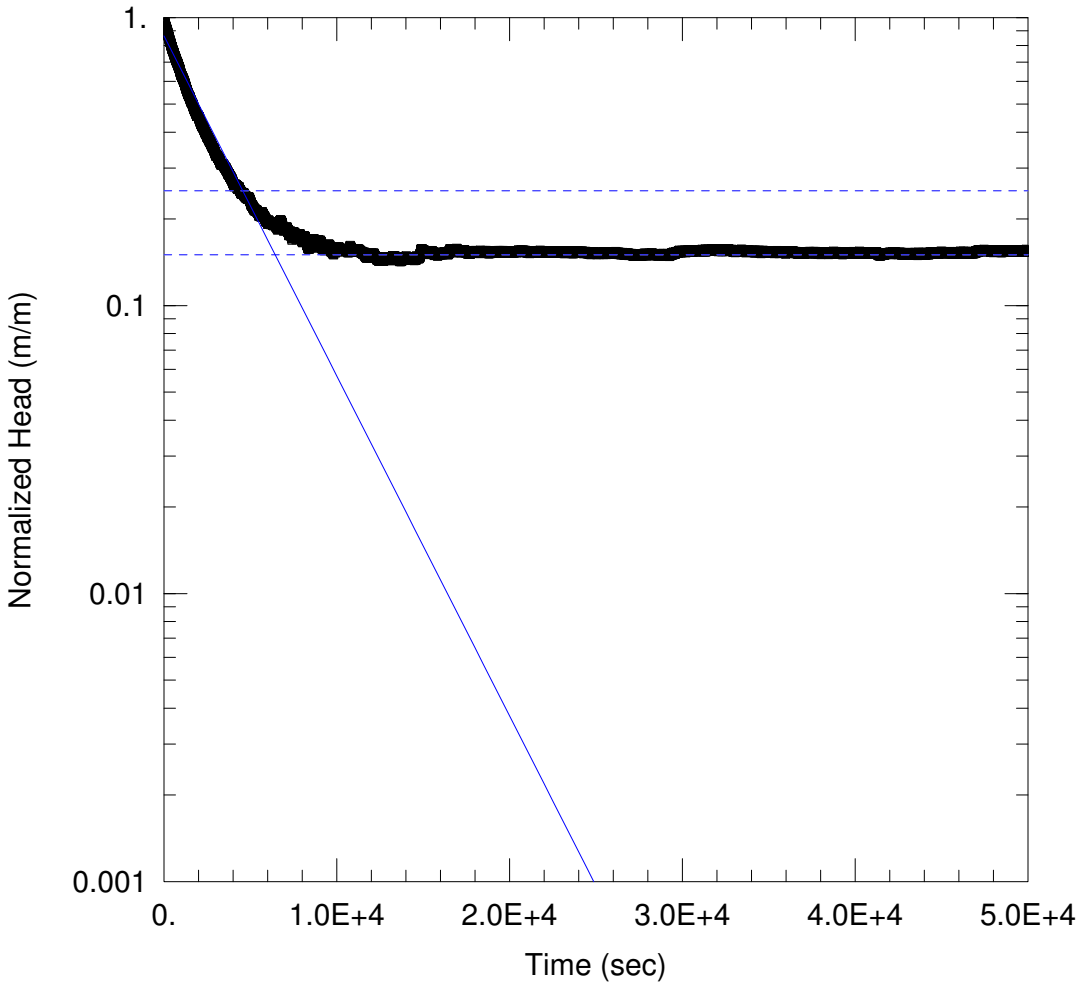
WELL DATA (MW8)

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 Erober
PROJECT: 20255A
AGAT WORK ORDER: 20T653951
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 20T653951, Version 1, issued October 1, 2020. Complete.

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
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Environmental Services Association of Alberta (ESAA)

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AGAT Laboratories

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

Certificate of Analysis

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erober

SAMPLING SITE:

SAMPLED BY:

E. Coli (Using MI Agar)

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

		SAMPLE DESCRIPTION:		**MW1**	**MW4**
		SAMPLE TYPE:		**Water**	**Water**
		DATE SAMPLED:		**2020-09-21 13:30**	**2020-09-21 13:30**
Parameter	**Unit**	**G / S**	**RDL**	**1468787**	**1468793**
Escherichia coli	CFU/100mL	200	1	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.

1468793 ND - Not Detected.

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

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

Certificate of Analysis

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erober

SAMPLING SITE:

SAMPLED BY:

Burlington Storm Sewer - Organics

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

		SAMPLE DESCRIPTION:		MW1	MW4
		SAMPLE TYPE:		Water	Water
		DATE SAMPLED:		2020-09-21 13:30	2020-09-21 13:30
Parameter	Unit	G / S	RDL	1468787	1468793
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	0.0004	0.0004
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: Jinkal Patel

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
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erober

SAMPLING SITE:

SAMPLED BY:

Nonylphenol and Nonylphenol Ethoxylates (Ontario, mg/L)

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

				SAMPLE DESCRIPTION:	MW1	MW4
				SAMPLE TYPE:	Water	Water
				DATE SAMPLED:	2020-09-21 13:30	2020-09-21 13:30
Parameter	**Unit**	**G / S**	**RDL**		**1468787**	**1468793**
Total Nonylphenol	mg/L	0.001	0.001		<0.001	<0.001
NP1EO	mg/L		0.001		0.002	0.001
NP2EO	mg/L		0.0003		<0.0003	<0.0003
Total Nonylphenol Ethoxylates	mg/L	0.01	0.001		0.002	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:

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

Certificate of Analysis

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erober

SAMPLING SITE:

SAMPLED BY:

BOD-Toronto

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

				SAMPLE DESCRIPTION:	MW1	MW4
				SAMPLE TYPE:	Water	Water
				DATE SAMPLED:	2020-09-21 13:30	2020-09-21 13:30
Parameter	Unit	G / S	RDL		1468787	1468793
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

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

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erober

SAMPLING SITE:

SAMPLED BY:

Burlington Storm Sewer Use By-law - Inorganics

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

		SAMPLE DESCRIPTION:		MW1	MW4
		SAMPLE TYPE:		Water	Water
		DATE SAMPLED:		2020-09-21 13:30	2020-09-21 13:30
Parameter	Unit	G / S	RDL	1468787	1468793
pH	pH Units	6.5 - 8.5	NA	6.73	6.92
Total Suspended Solids	mg/L	15	10	**19**	**25**
Total Cyanide	mg/L	0.02	0.002	<0.002	<0.002
Phenols	mg/L	0.008	0.002	<0.002	<0.002
Total Phosphorus	mg/L	0.4	0.02	0.02	0.04
Total Arsenic	mg/L	0.02	0.015	<0.015	<0.015
Total Cadmium	mg/L	0.008	0.005	<0.005	<0.005
Total Chromium	mg/L	0.08	0.020	<0.020	<0.020
Chromium VI	mg/L	0.04	0.005	<0.005	<0.005
Total Copper	mg/L	0.04	0.020	<0.020	<0.020
Total Lead	mg/L	0.12	0.020	<0.020	<0.020
Total Manganese	mg/L	0.05	0.020	**0.757**	**0.447**
Total Mercury	mg/L	0.0004	0.0002	<0.0002	<0.0002
Total Nickel	mg/L	0.08	0.030	<0.030	<0.030
Total Selenium	mg/L	0.02	0.020	**0.066**	**0.041**
Total Silver	mg/L	0.12	0.020	<0.020	<0.020
Total Zinc	mg/L	0.04	0.020	<0.020	<0.020

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: Iris Verástegui

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MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
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Exceedance Summary

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erober

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
1468787	MW1	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Manganese	mg/L	0.05	0.757
1468787	MW1	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Selenium	mg/L	0.02	0.066
1468787	MW1	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Suspended Solids	mg/L	15	19
1468793	MW4	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Manganese	mg/L	0.05	0.447
1468793	MW4	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Selenium	mg/L	0.02	0.041
1468793	MW4	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Suspended Solids	mg/L	15	25

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

Quality Assurance

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

ATTENTION TO: Henry Erober

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

Quality Assurance

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

ATTENTION TO: Henry Erober

SAMPLING SITE:

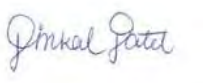
SAMPLED BY:

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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AGAT Laboratories

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

Quality Assurance

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

ATTENTION TO: Henry Erober

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%

Certified By:

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Quality Assurance

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

ATTENTION TO: Henry Erober

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	1468130		<10	<10	NA	< 10	104%	80%	120%						
Total Cyanide	1438860		<0.002	<0.002	NA	< 0.002	90%	70%	130%	101%	80%	120%	103%	70%	130%
Phenols	1468787	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	1471475		<0.015	<0.015	NA	< 0.015	104%	70%	130%	104%	80%	120%	106%	70%	130%
Total Cadmium	1471475		<0.005	<0.005	NA	< 0.005	99%	70%	130%	100%	80%	120%	105%	70%	130%
Total Chromium	1471475		<0.020	<0.020	NA	< 0.020	96%	70%	130%	101%	80%	120%	98%	70%	130%
Chromium VI	1468718		<0.005	<0.005	NA	< 0.005	100%	70%	130%	100%	80%	120%	97%	70%	130%
Total Copper	1471475		<0.020	<0.020	NA	< 0.020	98%	70%	130%	103%	80%	120%	92%	70%	130%
Total Lead	1471475		<0.020	<0.020	NA	< 0.020	95%	70%	130%	106%	80%	120%	98%	70%	130%
Total Manganese	1471475		0.021	<0.020	NA	< 0.020	99%	70%	130%	109%	80%	120%	101%	70%	130%
Total Mercury	1472485		<0.0002	<0.0002	NA	< 0.0002	103%	70%	130%	96%	80%	120%	97%	70%	130%
Total Nickel	1471475		<0.030	<0.030	NA	< 0.030	88%	70%	130%	99%	80%	120%	97%	70%	130%
Total Selenium	1471475		<0.020	<0.020	NA	< 0.020	106%	70%	130%	105%	80%	120%	102%	70%	130%
Total Silver	1471475		<0.020	<0.020	NA	< 0.020	90%	70%	130%	101%	80%	120%	93%	70%	130%
Total Zinc	1471475		<0.020	<0.020	NA	< 0.020	105%	70%	130%	111%	80%	120%	104%	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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5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

QA Violation

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

ATTENTION TO: Henry Erober

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	MW4	49%	60%	140%	NA	60%	140%	NA	60%	140%

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CANADA L4Z 1Y2
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Method Summary

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

ATTENTION TO: Henry Erober

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

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
http://www.agatlabs.com

Method Summary

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653951

PROJECT: 20255A

ATTENTION TO: Henry Erober

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

Mtbl

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
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)

Laboratory Use Only

Work Order #: 20T653951

Cooler Quantity:

Arrival Temperatures: 6.2 | 6 | 6 | 6.2 | 6 | 6 | 6.4

Custody Seal Intact: ☐Yes ☐No ☐N/A

Notes: ICP

Report Information:

Company: Landtek Limited
Contact: Henry Ereker
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:

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

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

Project Information:

Project: 20255A
Site Location: 774 to 782 Brant st. 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:

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	O. Reg 153: Metals - ☐CrVI, ☐Hg, ☐HWSB	O. Reg 153: BTEX, F1-F4 PHCs Analyze F4G if required ☐Yes ☐No	O. Reg 153: PAHs	O. Reg 153: PCBs	O. Reg 153: 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	O. Reg 406: 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)
MW1	21-Sep-20	1:30 PM		GW		N												✓	✓					
MW4	" "	"		"		✓												✓	✓					
		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): K. Crisfield	Date: Sept. 22/20	Time: 2:00pm	Samples Received By (Print Name and Sign): John Chupyha	Date: Sept 22	Time: 1:45
Samples Relinquished By (Print Name and Sign):	Date:	Time:	Samples Received By (Print Name and Sign): John Chupyha	Date: Sept 22	Time: 4:30
Samples Relinquished By (Print Name and Sign):	Date:	Time:			

Page ____ of ____

№: 109222

AGAT Laboratories

Sample Temperature Log

Client: Landtek

# of Coolers: 8

COC# or Work Order #: 20T653951

# 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)

APPENDIX G

DEWATERING ASSUMPTIONS AND 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 = 14.9 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 Parking	H (m)	h_w (m)	R (m)	r_e (m)	Q L/day	Q L/day (1.5 Factor of Safety
	17.57	7.9	~26.4	~46.2.0	~142,733 (1.652 x 10-3 m3/s)	~ 214,100

Assumptions for hydrogeological setting:

1. A confined aquifer is presumed to exist locally with a water table determined to be 2.43 mbgs at MW4 on January14, 2021 and extending to an estimated depth of approximately 20.0 mbgl.
2. The maximum dewatering depth of construction activities is assumed to be 12.1 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 = 14.9 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	H (m)	h_w (m)	R (m)	r_e (m)	Q L/day	Q L/day (1.5 Factor of Safety
	17.57	7.90	~2.90	~46.2	~12,609 (1.50 x 10-4 m3/s)	~ 18,914

Assumptions for hydrogeological setting:

1. A confined aquifer is presumed to exist locally with a water table determined to be 2.43 mbgs at MW4 on January14, 2021 and extending to an estimated depth of approximately 20.0 mbgl.
2. The maximum dewatering depth of construction activities is assumed to be 12.1 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 - 774-782 Brant Street (Phase 1), 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 mainly underlain by clayey 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	0.000	ha	0 m^2
Parking Areas, Roadways, Other impervious Areas	0.000	ha	0 m^2
Green space, open space, natural areas	0.670	ha	6,704 m^2
TOTAL	0.670	ha	6,704 m^2

Post-Development:

Building Roof	0.312	ha	3,122 m^2
Parking Areas, Roadways, Other impervious Areas	0.191	ha	1,906 m^2
Green space, SWMP, natural areas	0.168	ha	1,676 m^2
TOTAL	0.670	ha	6,704 m^2

Industrial Buildings

Landscape coverage (25.0%)	0.168	ha	1,676 m^2
Parking Areas, Roadways, Other impervious Areas (28.4%)	0.191	ha	1,906 m^2
Building Roof (46.6%)	0.312	ha	3,122 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	0	0	-	-	0
Green Space	6,704	6,235	4,083	670	1,482
Roads, Other impervious	0	0	-	-	0
TOTAL	6,704	6,235	4,083	670	1,482

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	3,122	2,903	-	-	2,903
Roads, Other impervious	1,906	1,773	-	-	1,773
Green space, open space, natural areas	1,676	1,558	1,020	168	370
TOTAL	6,704	6,235	1,020	168	5,047

6. Comparison of Pre-Development and Post-Development

		Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Pre-Development		6,235	4,083	670	1,482
Post-Development		6,235	1,020	168	5,047

7. Post development infiltration measures

Post-development infiltration volume	168	m^3
Pre-development infiltration volume	670	m^3
Deficit from pre to post-development infiltration	503	m^3
Percentage of water collected from roof area required to match pre-development infiltration	17	%

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		

