Hydrogeological Investigation

555 Canal Bank Street, Welland, ON

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Project Number:
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Table of Contents

List of Figures

List of Appendices

Summary

The proposed development lies north of Dain City, a rural residential area. The topography is considered relatively flat, with a gradual westerly slope towards the old (1833) canal (west) while the east side of the site has a slope towards the new (1973) bypass canal (east). The canals drain to Lake Ontario which is approximately 25 km north of the Site. There are few surface-water features onsite such as man-made drainage ditches, one (1) surface drainage on the southwest and few wetlands scattered within the woodlot areas in the northeast and southeast portions of the Site. The nearest surface water features are the old Welland canal on the west, the new Welland bypass on the east and a wetland southeast of the Site. Lake Erie is located approximately 9 km south of the Site and Lake Ontario is approximately 25 km from the Site boundary to the north. The surficial geology can be described as fine-textured glaciolacustrine deposits consisting of silt and clay, minor sand and gravel, massive to well laminated (Ministry of Northern Development and Mines, 2012). The western portion of the Site consists of man-made deposits.

As part of geotechnical investigations, a total of ten (10) monitoring wells were installed across the Site. the groundwater elevations in the shallow wells ranged from dry condition to 176.46 masl. The groundwater elevations recorded in the deep wells ranged from 168.30 masl to 175.44 masl. The highest K-value for the tested water-bearing zones is estimated to be 1.7×10^{-6} m/s and the geometric mean of the K-values is 4.9×10^{-8} m/s. The laboratory's Certificate of Analysis (CofA) for the groundwater sample collected from the Site showed that all parameters conform the Sanitary Sewer Use By-Law limits. The proposed development plan consists of a residential development which includes single family dwellings, townhouses, a mixed-use block, an elementary school, as well as the associated roadways, Site servicing and two (2) stormwater management ponds (SWMPs). One of the SWMPs is planned to be constructed southeast of the Site. Moreover, the northeast portion of the Site will be raised between 2 and 3 meters above the existing grading with native soil. Also, a proposed SWMP will be constructed south of the noted soil pile. Based on the assumptions provided in this report, the dewatering rate during the construction phase (short-term) is estimated to be 305 m^3/day. As the estimated dewatering rate is between 50 m^3/day and 400 m^3/day, an EASR will be required to facilitate the construction dewatering program for the residential structures. Moreover, the dewatering flow rate for a single dwelling during the post-construction phase (long-term) is estimated to be 5 m^3/day. As the estimated flow rate for long-term is less than 50 m^3/day, a permit to take-water will not be required for the post-construction phase.

1 Introduction

1.1 Project Description

EXP Services Inc. (EXP) was retained by **555 Canal Bank Developments GP Inc.** to prepare a Hydrogeological Investigation Report associated with the proposed development located at 555 Canal Bank Street, Welland, Ontario (hereinafter referred to as the 'Site').

Previously, the Site was partly occupied by an industrial facility, which was demolished at the time of preparation of this report. Based on the provided engineering drawing, the construction plan is anticipated to consist of a residential development including single family dwellings and townhouses, a mixed-use block and an elementary school, as well as the associated roadways, stormwater management pond (SWMP) and Site servicing. For this hydrogeological assessment, it is assumed that each proposed building will have one (1) level of basement. Also, the northeastern part of the proposed development will be raised by 2 to 3 meters above existing grade with native fill material. The Site location plan is shown on Figure 1. The engineering drawings are provided in Appendix G.

EXP conducted a Preliminary Geotechnical Investigation and an Environmental Site Assessment in conjunction with this investigation. The pertinent information gathered from the noted Investigations is utilized for this report.

1.2 Project Objectives

The main objectives of the Hydrogeological Investigation are as follows:

- Establish the local hydrogeological settings within the Site;
- Provide preliminary recommendations for the construction dewatering;
- Provide a preliminary assessment on the post-construction dewatering;
- Assess groundwater quality;
- Prepare a Hydrogeological Investigation Report;
- Conduct seasonal groundwater monitoring; and
- Prepare a Preliminary Water Balance Report under a separate cover.

1.3 Scope of Work

To achieve the investigation objectives, EXP has completed the following scope of work:

- Review available geological and hydrogeological information for the Site;
- Develop and conduct Single Well Response Tests (SWRT) on eight (8) monitoring wells installed in conjunction with the geotechnical investigation to evaluate hydraulic properties of the saturated soils at the Site.
- Complete eight (8) rounds of groundwater level measurements at all monitoring wells;
- Collect one (1) groundwater sample for laboratory testing of the Regional Municipality of Niagara Sanitary and Storm (Combined) Sewer By-Law parameters;

- Evaluate the information collected during the field investigation program, including borehole geological information, SWRT results, groundwater level measurements and groundwater water quality;
- Prepare site plans, cross sections, geological mapping and groundwater contour mapping for the Site;
- Provide preliminary assessments on the construction (short-term) and post-construction dewatering rates (long-term);
- Prepare a Hydrogeological Investigation Report;
- Conduct seasonal groundwater monitoring for one (1) year with monitoring events every two (2) months;
- Conduct infiltration tests to assess percolation rates of shallow soils to support the design of infiltration systems in post development reported under separate cover. Provide infiltration rates to support design of infiltration measures for stormwater management and water balance mitigations; and
- Prepare a Preliminary Water Balance Report to assess pre-development and post-development infiltration levels using a combined Thornthwaite and Mather method and GIS. The results of the percolation tests will support the sizing of the infiltration measures in post development.

The results from the infiltration tests and the Preliminary Water Balance Report will be provided under a separate cover.

The scope of work outlined above does not include a review of Environmental Site Assessments (ESA).

1.4 Review of Previous Reports

The following reports were reviewed as part of this Hydrogeological Investigation:

- EXP Services Inc. (August 10, 2020). Geotechnical Investigation, 555 Canal Bank Street, Welland, ON, prepared for 555 Canal Bank Developments GP Inc.
- Upper Canada Consultants (July 2020), Site Alteration Plan, Former John Deere Site, City of Welland, Ontario, prepared for 555 Canal Bank Developments GP Inc.
- Armstrong (May 2020), Dain City West, Draft Plan of Subdivision, Draft Site Drawing.
- EXP Services Inc. (2019), Preliminary Geotechnical Investigation, 555 Canal Bank Street, Welland, ON, prepared for Empire Communities.

2 Hydrogeological Setting

2.1 Regional Setting

2.1.1 Regional Physiography

The Site is located within a physiographic region known as the Haldimand Clay Plain. The physiographic landform is the Clay Plains. (Chapman & Putnam, 2007). These clay plains were deposited during the time of Paleo-Lake Warren (Chapman & Putnam, 2007), around 12,700 years before present. Although the area was all submerged in former Lake Warren the underlying till was not all buried by stratified clay. The till comes to surface on the low ridges of the Fort Erie Moraine.

2.1.2 Regional Geology and Hydrogeology

The surficial geology can be described as fine-textured glaciolacustrine deposits consisting of silt and clay, minor sand and gravel, massive to well laminated (Ministry of Northern Development and Mines, 2012). The western portion of the Site consists of man-made deposits. The surficial geology of the Site and surrounding areas is shown on Figure 2.

Regional groundwater flow across the area is expected to be directed towards the north. Local deviation from the regional groundwater flow pattern may occur in response to changes in topography and/or soils, as well as the presence of surface water features and/or existing subsurface infrastructure.

2.1.3 Existing Water Well Survey

Well Records from the Ministry of the Environment, Conservation and Parks (MECP) Water Well Record (WWR) Database were reviewed to determine the number of water wells present within a 500-m radius of the Site boundaries.

The MECP WWR database indicated a total of sixty-six (66) well records within a 500 m radius from the Site centroid where forty-one (41) well records were identified onsite.

The database indicated that the offsite wells were at an approximate distance of four-hundred and forty-eight (448) m or greater from the Site centroid. All offsite wells were reportedly identified as monitoring and observation wells, test holes, water supply wells, abandoned and/or listed with unknown use. Onsite well records were reportedly identified as monitoring and test holes, water supply well, abandoned and/or listed with unknown use.

The Well Identification Numbers (Well ID No.) of the offsite water supply wells are 6603366, 6603887, 6603968 and 6604005, where they are reportedly located 450 to 751 meters from the Site centroid. The Well ID No. of the only onsite water supply well is 6604290; it is seventy-five (75) m from the Site centroid.

The reported depth to water levels ranged approximately from 4.6 m to 46.0 meters below ground surface (mbgs).

Based on the onsite water supply wells' date of installations and since the area is municipally serviced, it is unknown if the noted water supply wells are still active.

The locations of the MECP WWR within 500 m of the Site are shown on Figure 3. A summary of the WWR is included in Appendix A.

2.2 Site Setting

2.2.1 Site Topography

The proposed development lies north of Dain City, an urban area. The topography is considered relatively flat, with a gradual westerly slope towards the old (1833) canal (west) while the east side of the Site has a slope towards the new (1973) bypass (east). The canal drains to Lake Ontario which is approximately 25 km north of the Site.

As indicated on the borehole logs included in Appendix B, the surface elevation of the Site ranges between approximately 176.61 to 177.90 meters above sea level (masl).

2.2.2 Local Surface Water Features

There are a few surface-water features onsite, such as scattered man-made drainage ditches, few small wetlands and one (1) small pond on the southwest of the Site. The other nearest surface water features are the old Welland canal on the west, new Welland bypass on the east, as well as a wetland southeast of the Site. Lake Erie is located approximately 9 km south of the Site and Lake Ontario is approximately 25 km from the Site boundary to the north.

2.2.3 Local Geology and Hydrogeology

A summary of subsurface soil stratigraphy is provided in the following paragraphs. The soil descriptions are based on the geotechnical investigation report (EXP, 2019) and they are summarized for the hydrogeological interpretations. As such, the information provided in this section shall not be used for the construction design purposes.

The detailed soil profiles encountered in each borehole and the results of moisture content determinations are presented on the attached borehole logs (Appendix B). The interpreted geology is provided in a cross-section on Figure 5. The soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones for the hydrogeological investigation and should not be interpreted as exact planes of geological change.

The "Notes on Sample Description" preceding the borehole logs form an integral part of and should be read in conjunction with this report. The following is a brief description of the soil conditions encountered during the investigation.

Based on the results of the geotechnical investigation, the general subsurface soil stratigraphy consist of the following units from top to maximum depth of investigation onsite as follows:

Topsoil

A surficial layer of topsoil was encountered at Boreholes BH-01 to BH-03, BH-06, BH-08 to BH-12, BH-19, and BH-25 to BH-27. The thickness of the topsoil at the borehole locations ranged from approximately 50 mm to 150 mm.

It should be noted that the topsoil measurements were carried out at the borehole locations only and were found to be variable. A more detailed analysis (involving test pits) is recommended to accurately quantify the amount of topsoil to be removed for construction purposes. Consequently, topsoil quantities should not be established from the information provided at the widely spaced borehole locations only.

Fill/ Reworked Native Soil

Fill (or reworked native soil) was encountered below the surficial topsoil or pavement structure at nineteen of the twenty-seven boreholes locations and extended to depths ranging from approximately 0.3 m to 4.6 m below existing grade. The fill generally consisted of brown or grey, moist silty clay with traces of sand, gravel, rootlets, and wood fragments. Black organic staining was noted at Boreholes BH-04, BH-08, BH-16, BH-19, BH-20, BH-21, BH-23, and BH-27. Moisture contents of the material ranged from 7 to 39 percent.

Silty Clay

Native silty clay was encountered below the surficial topsoil / pavement structure in Boreholes BH-09, BH-11 to BH-14, BH-18, BH-22, and BH-24, and below the fill at all the remaining borehole locations. The silty clay extended to the borehole termination depths of 6.6 m to 12.8 m below grade at all the borehole locations. The silty clay was brown, generally became greyish brown with depth, and was in a moist to wet state with moisture contents ranging from 8 to 48 percent. SPT N values ranged from 0 to 24 blows per 305 mm penetration. Based on undrained shear strengths ranging from 15 to greater than 225 kPa as determined by pocket penetrometer measurements and in-situ shear vane testing, the silty clay is classified as soft to hard in consistency. It should be noted that the stratum generally became weaker with depth.

3 Results

3.1 Monitoring Well Details

The monitoring well network installed as part of the Geotechnical Investigations at the Site consists of the following:

- Six (6) shallow monitoring wells, including BH/MW 2, BH/MW 4, BH/MW 6, BH/MW 8, BH/MW 15 and BH/MW 27 were installed to an approximate depth range from 5.9 to 6.9 mbgs;
- Four (4) deep well monitoring wells, including BH/MW 1, BH/MW 3, BH/MW 9 and BH/MW 10 were installed to an approximate depth of 9 mbgs.

Each well was equipped with a 50-mm (2-inch) PVC casing, a thee (3)-meter long screen and with over-ground protective casing.

Borehole logs and monitoring well installation details are provided in Appendix B. The monitoring well locations are shown on Figure 4.

3.2 Water Level Monitoring

As part of the Hydrogeological Investigation, static water levels were recorded in the monitoring wells installed outside of the existing building during eight (8) monitoring events, including February 19, March 4, April 15, June 3, August 8 and October 11, 2019, as well as January 23 and July 27,2020. A summary of all static water level data as it relates to the elevation survey is summarized in Table 3-1 below.

Accordingly, the groundwater elevation in the shallow wells ranged from dry condition (at BH/MW 2 and BH/MW 3 on February 19, March 4, April 15 and June 3, 2019, as well as August 8, 2019 at BH/MW 3) to 176.45 masl (0.72 mbgs at BH/MW 15 on July 27, 2020). The groundwater elevations recorded in the deep wells ranged from dry condition (at BH/MW 9 on February 19, March 4, April 15 and October 11, 2019, as well as July 27, 2020) to 175.44 masl (1.18 mbgs at BH/MW 10 on October 11, 2019 and January 23, 2020).

Groundwater contours are delineated for the shallow water-bearing zone of the Site on Figure 6. The groundwater flow direction in the shallow zone is interpreted to be southeast.

Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions; this may also affect the direction and rate of flow.

Table 3-1: Summary of Measured Groundwater Elevations

Monitoring Well ID	Ground Surface Elevation (masl)	Stick Up (+) / Stick Down (-) (m)	Approximate Full Well Depth (mbgs)	Depth	19-Feb-19	4-Mar-19	15-Apr-19	3-Jun-19	8-Aug-19	11-Oct-19	23-Jan-20	27-Jul-20
BH/MW 1	**176.88**	**1.02**	**9.1**	mbTOP	5.46	7.75	6.15	5.89	5.77	5.58	5.39	4.68
				mbgs	4.44	6.73	5.13	4.87	4.75	4.56	4.37	3.66
				masl	172.44	170.15	171.75	172.01	172.13	172.32	172.51	173.23
BH/MW 2	**177.39**	**0.08**	**6.9**	mbTOP	DRY	DRY	DRY	DRY	Inaccessible	Inaccessible	Inaccessible	Inaccessible/ Damaged
				mbgs								
				masl								
BH/MW 3	**177.90**	**0.16**	**9.0**	mbTOP	DRY	DRY	DRY	DRY	DRY	Inaccessible	Inaccessible	Inaccessible/ Damaged
				mbgs								
				masl								
BH/MW 4	**177.22**	**1.10**	**6.1**	mbTOP	5.68	3.47	2.32	2.21	2.12	2.47	2.43	2.03
				mbgs	4.59	2.38	1.22	1.12	1.02	1.37	1.34	0.93
				masl	172.63	174.85	176.00	176.11	176.20	175.85	175.89	176.29
BH/MW 6	**177.24**	**0.27**	**5.9**	mbTOP	2.88	2.33	1.70	1.26	1.23	1.67	1.47	Inaccessible/ Damaged
				mbgs	2.61	2.06	1.43	0.99	0.96	1.40	1.20	
				masl	174.63	175.18	175.81	176.26	176.28	175.85	176.04	
BH/MW 8	**176.95**	**1.06**	**6.0**	mbTOP	6.45	5.41	3.53	2.83	2.52	2.50	2.29	2.36
				mbgs	5.40	4.35	2.47	1.78	1.46	1.45	1.24	1.30
				masl	171.56	172.60	174.48	175.18	175.49	175.51	175.71	175.65
BH/MW 9	**177.18**	**0.29**	**9.0**	mbTOP	DRY	DRY	DRY	9.15	9.17	DRY	9.10	DRY
				mbgs				8.86	8.88		8.81	
				masl				168.33	168.30		168.37	
BH/MW 10	**176.61**	**0.97**	**9.2**	mbTOP	2.75	2.68	2.37	2.29	2.37	2.14	2.14	2.18
				mbgs	1.78	1.71	1.40	1.33	1.40	1.18	1.18	1.22
				masl	174.83	174.90	175.21	175.29	175.21	175.44	175.44	175.40
BH/MW 15	**177.17**	**0.91**	**5.9**	mbTOP	-	-	-	-	-	-	-	1.69
				mbgs								0.72
				masl								176.45
BH/MW 27	**176.77**	**0.90**	**6.4**	mbTOP	-	-	-	-	-	-	-	3.05
				mbgs								2.09
				masl								174.69

Notes:
mbTOP meters below top of pipe
mbgs: meters below ground surface
masl: meters above mean sea level
* Based on field measurements

3.3 Hydraulic Conductivity Testing

3.3.1 Single Well Response Test (SWRT)

Seven (7) Single Well Response Tests (SWRT's) were completed on monitoring wells on March 4, 2019 and July 27, 2020. The tests were completed to estimate the saturated hydraulic conductivity (K) of the soils at the well screen depths.

The static water level within each monitoring well was measured prior to the start of testing. In advance of performing SWRTs, each monitoring well underwent development to remove fines introduced into the screens following construction. The development process involved purging of the monitoring wells to induce the flow of fresh formation water through the screen. Each monitoring well was permitted to fully recover prior to performing SWRTs.

Hydraulic conductivity values were calculated from the SWRT and constant rate test data as per Hvorslev's solution included in the Aqtesolv Pro. V.4.5 software package. The semi-log plots for normalized drawdown versus time are included in Appendix C. A summary of the hydraulic conductivity (K) values estimated from the SWRTs are provided in Table 3-2.

Table 3-2: Summary of Hydraulic Conductivity Testing

Monitoring Well	Well Depth (mbgs)*	Screen Interval (mbgs)		Soil Formation Screened**	Estimated Hydraulic Conductivity (m/s)
		from	to		
BH/MW 1	**9.1**	**6.1**	**9.1**	**Silty Clay**	1.0E-8
BH/MW 4	**6.1**	**3.1**	**6.1**	**Silty Clay**	5.6E-9
BH/MW 6	**6.0**	**3.0**	**6.0**	**Silty Clay**	1.7E-6
BH/MW 8	**6.0**	**3.0**	**6.0**	**Silty Clay**	2.1E-8
BH/MW 10	**9.3**	**6.3**	**9.3**	**Silty Clay**	1.3E-8
BH/MW 15	**5.9**	**2.9**	**5.9**	**Silty Clay**	4.5E-7
BH/MW 27	**6.4**	**3.4**	**6.4**	**Silty Clay**	5.7E-8
				Highest Estimated K Value	1.7E-6
				Arithmetic Mean of K Values	3.2E-7
				Geometric Mean of Estimated K Values	4.9E-8

Notes:
*Well depth is based on the field measurements
** Soil descriptions are based on the borehole logs.

SWRTs provide estimates of K for the geological formation in the immediate media zone surrounding the well screens and may not be representative of bulk formation hydraulic conductivity. As shown in Table 3-2, the highest K for the tested water-bearing zones is 1.7×10^{-6} m/s at BH/MW 6 and the geometric mean of the K values is 4.9×10^{-8} m/s. The arithmetic mean of K values for overburden is 3.2×10^{-7} m/s.

3.3.2 In-Situ Infiltration Testing

A total of six (6) infiltration tests were completed at the selected locations, including IT-1 through IT- 6 on July 8 and 27, 2020. The hydraulic conductivities of unsaturated soil horizons were estimated using the Reynold's method (Reynolds et.al, 2015 and Reynolds, 2016) as per the Toronto and Region Conservation Authority's guidelines (TRCA, 2012 and TRCA 2019). A summary of the hydraulic conductivity (K) values estimated from the infiltration tests are provided in Table 3-3. The calculations are provided in Appendix C. The infiltration test locations are shown on Figure 4.

Table 3-3: Summary of Hydraulic Conductivity Testing

Test Locations	Tested Depth (mbgs)*	Tested Lithologic Unit	Estimated Hydraulic Conductivity (m/s)	Design Infiltration Rate (DIR) (mm/hr)	Percolation Time (min/cm)
IT-1	0.62	Clay, trace silt	2.6E-7	13	47
IT-2	0.56	Clay, some silt and trace organics	1.2E-7	11	57
IT-3	0.65	Clay, trace silt	3.3E-8	7	81
IT-4	0.54	Fill (silty clay, trace gravel)	9.9E-6	34	18
IT-5	0.56	Clay, some silt	5.4E-7	16	38
IT-6	0.61	Clay, some silt	1.0E-7	10	60
		Geometric Mean	2.8E-7	14	44

Notes:
*mbgs: meters below ground surface
* Soil descriptions are based on the field observations

Based on the infiltration test results, the geometric mean of estimated design infiltration rates is 14 mm/hr. The estimated design infiltration rate is less than 15 mm/h and therefore if an infiltration system is considered to be installed at the Site, a sub-drain system will be required to be installed below the future infiltration systems as per the TRCA's guidelines. The design infiltration rates (DIR) can be used for designing LID system/s to enhance post-development groundwater infiltration to help maintain the pre-development groundwater infiltration rate at the Site. The results of LID calculations are provided in Attachment C.

3.4 Groundwater Quality

To assess the suitability for discharge of pumped groundwater to sewers owned by the City of Welland during dewatering activities, one (1) groundwater sample was collected from monitoring well BH/MW 10 on March 4, 2019 using a peristaltic pump. Prior to collecting the noted water sample, approximately three (3) standing well volumes of groundwater were purged from the noted well.

The sample was collected unfiltered and placed into pre-cleaned laboratory-supplied vials and/or bottles provided with analytical test group specific preservatives, as required. Dedicated nitrile gloves were used during sample handling. The groundwater samples were submitted for analysis to Maxxam Analytics Inc., a CALA certified independent laboratory in Mississauga, Ontario.

When compared to the Regional Municipality of Niagara's Sanitary and Storm (Combined) Sewer By-Law Limits the laboratory's Certificate of Analysis (CofA) showed that all parameters conform the By-Law limits. Analytical results are provided in Appendix D.

For the short-term dewatering system (construction phase), it is anticipated that TSS levels and some other parameters (for example, Total Metals) in the pumped groundwater may become elevated and exceed both, Sanitary and Storm By-Law limits. To control the concentration of TSS and associated metals, it is recommended that a suitable treatment method be implemented (filtration or decantation facilities and/ or any other applicable treatment system) during construction dewatering activities to discharge into the applicable sewer system. The specifications of the treatment system will need to be adjusted to the reported water quality results by the treatment contractor/process engineer.

The water quality results presented in this report are not representative of the long-term condition of groundwater quality onsite. As such, regular water quality monitoring is recommended for the post-construction phase as required.

An agreement to discharge to the sewers owned by the City of Welland will be required prior to discharging dewatering effluent.

Also, the Environmental Site Assessment Report(s) should be reviewed for more information on the groundwater quality conditions at the Site.

4 Construction Dewatering Assessment

4.1 Construction Dewatering Rate Assumptions

Based on the provided engineering drawings, the construction plan consists of a residential development which includes single family dwellings, townhouses, a mixed-use block, an elementary school, as well as the associated roadways, Site servicing and two (2) stormwater management ponds (SWMPs). For this hydrogeological assessment, it is assumed that each proposed building will have one (1) level of basement. The engineering drawings are provided in Appendix G. EXP should be retained to review the assumptions outlined in this section, should the proposed shoring design change. Table 4-1 presents the assumptions used to calculate the dewatering rate for the Site services.

Table 4-1 Dewatering Estimate Assumptions – Underground Services and SWMP

Input Parameter			Assumption	Notes
Ground surface elevation			177.9 masl	Highest ground surface elevation based on the geotechnical borehole logs
Groundwater elevation			177.28 masl	The highest groundwater elevation of 176.28 masl recorded at BH/MW 6 on August 8, 2019 plus one (1) meter to account for seasonal fluctuations
Lowest Excavation Elevation	Underground Services		173.9 masl	Assumed to be 4 mbgs and 5 mbgs for underground services and the southeast SWMP, respectively
	SWMP	Southwest	172.9 masl	
		Northeast	175.88 masl	One (1) mbgs for the northeast SWMP (Upper Canada Consultants, 2020) and based on the exiting ground surface elevation of 176.88 masl
Dewatering target elevation	Underground Services		172.9 masl	Assumed to be approx. 1 m below the lowest excavation elevation
	SWMP	Southwest	171.9 masl	
		Northeast	174.88 masl	
Base of the Water-Bearing Zone			170.4 masl	Assumed
Excavation Area	Underground Services		500 m^2 (100 m x 5 m)	Assumed
	SWMP	Southwest	11,111 m^2 (189.6 m x 58.6 m)	Based on the proposed development plan (Armstrong, 2020 and Upper Canada Consultants, 2020) and the information provided by client
		Northeast	1,125 m^2 (45 m x 25 m)	
Hydraulic Conductivity (K)			3.2 x 10^{-7} m/s	Arithmetic mean of K values estimated for overburden

Note: based on the provided Site grading plan, only a limited area on the eastern portion of the Site is planned to be raised by approximately 2 to 3 meters above the existing grade (Appendix E). Therefore, the above assumptions are applicable for most of the Site area.

Table 4-2 presents the assumptions used to calculate the dewatering rate for the residential buildings of the Site.

Table 4-2 Dewatering Estimate Assumptions – Residential Buildings

Input Parameter	Assumption	Notes
Ground surface elevation	177.9 masl	Highest ground surface elevation based on the geotechnical borehole logs
Groundwater elevation	177.28 masl	The highest groundwater elevation of 176.28 masl recorded at BH/MW 6 on August 8, 2019 plus one (1) meter to account for seasonal fluctuations
Lowest footing elevation	175.4 masl	Assumed to be 2.5 mbgs. According to the geotechnical report, the footings are recommended to be placed above 3 mbgs due to the soil conditions (EXP, 2019).
Lowest basement top elevation	175.9 masl	Assumed to be 2 mbgs for one (1) level of basement.
Dewatered elevation target	174.4 masl	Assumed to be approx. 1 m below the lowest excavation elevation
Base of the Water-Bearing Zone	170.4 masl	Assumed
Excavation Area	2,500 m^2 (~250 m x 10 m)	It is assumed to be open for 50 single dwellings per excavation phase. Each single dwelling is assumed to cover an approximate area of 50 m^2 (10 m x 5 m).
Hydraulic Conductivity (K)	3.2 x 10^{-7} m/s	Arithmetic mean of K values estimated for overburden

Note: based on the provided Site grading plan, only a limited area on the eastern portion of the Site is planned to be raised by approximately 2 to 3 meters above the existing grade (Appendix E). Therefore, the above assumptions are applicable for most of the Site area.

4.1.1 Dewatering Flow Rate Estimate and Zone of Influence

The Dupuit equation for steady linear flow to both sides of an excavation through an unconfined aquifer resting on a horizontal impervious surface was used to obtain a flow rate estimate. Dewatering flow rate is expressed as follows:

$$Q_w = xK(H^2 - h^2)/Lo$$

Where:
Qw = Rate of pumping (m^3/sec)
X = Length of excavation (m)
K = Hydraulic conductivity (m/sec)
H = Saturated thickness beyond the influence of pumping (static groundwater elevation) (m)
h = Saturated thickness above the base of aquifer in an excavation (m)
Lo = Distance of influence (m)

It is expected that the initial dewatering rate will be higher to remove groundwater from within the overburden formation. The dewatering rates are expected to decrease once the target water level is achieved in the excavation footprint as groundwater will have been removed, primarily from storage resulting in lower seepage rates into the excavation. The calculations for dewatering flow rates during the construction phase are provided in Appendix E.

4.1.2 Sichardt's Radius of Influence

The radius of influence (ROI) for the construction dewatering was calculated based on Sichardt's equation. This equation is used to predict the distance at which the drawdown resulting from pumping is negligible. This empirical formula was developed to provide flow rates using the steady state flow dewatering equations, as discussed below.

The estimated radius of influence (R_o) of pumping based on Sichardt's formula is described as follows:

$$\mathrm{R_o} = C(H - h)\sqrt{(K)}$$

Where:
Ro = Estimated radius of influence (m)
H = Saturated aquifer thickness (m)
h = Lowered saturated aquifer thickness (m)
K = Hydraulic conductivity (m/sec)
C = Constant (3,000)

The calculations for radius of influence are provided in Appendix E.

4.2 Stormwater

Additional pumping capacity may be required to maintain dry conditions within the excavation during and following significant precipitation events. Therefore, the dewatering rates at the Site should also include removing stormwater from the excavation.

A 15-mm precipitation event was utilized for the estimate. The calculation for the stormwater input estimate is included in Appendix E.

A two (2) years storm event over a 24-hour period is approximately 59.1 mm and a hundred (100) years storm event over a 24-hour period is 129.6 mm
http://www.mto.gov.on.ca/IDF_Curves/results_out.shtml?coords=42.957952,-79.24751.
During large precipitation events, the water should be retained onsite to not exceed the allowable water taking and discharge limits, as necessary.

4.3 Results of Construction Dewatering Rate Assessment

Based on the assumptions provided in this report, the results of the dewatering rate estimate given in Table 4-3.

Table 4-3 Summary of Dewatering Flow Rate Estimate

Location		**Peak Dewatering Flow Rate Including Safety Factor and Precipitation-Rounded-Up (m^3/day)**
Underground Services		72
SWMP	Southwest	305
	Northeast	70
Fifty (50) single dwellings per construction phase		188

The calculations for the peak dewatering rates are provided in Appendix E. This peak dewatering flow rates accounts for accumulation of some precipitation, seasonal fluctuations in the groundwater table, flow from beddings of existing sewers and variation in hydrogeological properties beyond those encountered during this study. This peak dewatering flow rate also provides additional capacity for the dewatering contractor. It is the responsibility of the contractor to ensure dry conditions are always maintained within the excavation at all costs.

4.4 Construction MECP Water Taking Permit

In accordance with the Ontario Water Resources Act, if groundwater dewatering rates falls between 50 m^3/day and 400 m^3/day, an EASR will be required from the MECP.

Based on the highest dewatering estimate of approximately 305 m^3/day, an online registration in the EASR will be required to facilitate the construction dewatering program.

5 Sub-Drain Discharge Estimate

5.1 Long-Term Dewatering Rate Assumptions

It is our understanding that the development plan includes a permanent foundation sub-drain system that will ultimately discharge to the municipal sewer system if conventional footings are installed. The details of the assumptions are outlined in Table 4-1 of Section 4.1. However, the dewatering target for post-construction is assumed to be 0.5 m below the lowest top slab elevation.

5.2 Preliminary Sub-Drain Flow Rate Estimate

To estimate the groundwater flow to the future sub-rain, the Dupuit equation for steady linear flow to both sides of a partially penetrating excavation through an unconfined aquifer resting on a horizontal impervious surface was used to obtain a flow rate estimate, which is expressed as follows:

$$Q_w = \left[0.73 + 0.23\left(\frac{P}{H}\right)\right] xK(H^2 - h^2)/Lo$$

Where:

Q_w = Rate of pumping (m^3/sec)
x = Length of excavation (m)
P = Depth of penetration of drainage (m)
K = Hydraulic conductivity (m/sec)
H = Saturated thickness of water-bearing zone beyond the influence of pumping (static groundwater elevation) (m)
h = Saturated thickness above the base of water-bearing zone in an excavation (m)
Lo = Distance of influence (Ro/2) (m)

The calculations for the dewatering flow rates are provided in Appendix F.

5.3 Results of Post-Construction Dewatering Assessments

Based on the assumptions provided in this report (outlined in Section 4.1), the results of the long-term discharge volume estimate can be summarized as follows:

Table 5-1 Summary of Post-Construction Dewatering Flow Estimates

Proposed Structure	Peak Dewatering Flow Rate Including Factor of Safety (m^3/day)
Single Dwelling	5

Intermittent cycling of sump pumps and seasonal fluctuation in groundwater regimes should be considered for pump specifications. A safety factor was applied to the flow rate to accommodate the variability in seasonal water level fluctuations.

This preliminary sub-drain rate estimate is preliminary and based on the assumptions outlined in this report. Any variations in hydrogeological conditions beyond those encountered as part of this investigation may significantly influence the sub-drain discharge volumes. As a result, the exact volume discharged will be confirmed once the system is operational. It is recommended that once the sub-drain systems are in place, that a flow meter be installed at the sump(s) to record daily discharge volumes to provide more representative estimates during the commissioning stage of the system.

5.4 Post-Development MECP Water Taking Permit

In accordance with the Ontario Water Resources Act, if the water taking for the construction dewatering will be more than 50 m^3/day, an application for a Category 3 Permit to Take Water (PTTW) will be required from the MECP.

Based on the dewatering estimate of approximately 5 m^3/day (rounded) per single dwelling, a water-taking permit will not be required for the post construction dewatering program of each unit.

6 Environmental Impact

6.1 Surface Water Features

There are few surface-water features onsite such as man-made drainage ditches and one (1) small pond southwest of the Site. The other nearest surface water features are the old Welland canal on the west, new Welland bypass canal on the east, as well as a wetland southeast of the Site. Lake Erie is located approximately 9 km south of the Site and Lake Ontario is approximately 25 km from the Site boundary to the north.

The main source of dewatering during the construction phase is anticipated to be stormwater, as such, no impacts on surface water features are expected during construction activities. The nature of the assumed drainage ditches needs to be assessed prior to backfilling these.

6.2 Groundwater Sources

Well Records from the MECP Water Well Record (WWR) Database were reviewed to determine the number of water supply wells present within a 500 m radius of the Site boundaries. One (1) onsite and four (4) offsite supply well records were identified. Given that no groundwater lowering is anticipated, no related impact is expected on the offsite water wells in the area. The status of the onsite well should be confirmed, and it should be decommissioned, if it is not being used.

6.3 Geotechnical Considerations

Under certain conditions, dewatering activities can cause settlements due to an increase in the effective stress in the dewatered soil.

A letter related to geotechnical issues (i.e. settlement) as it pertains to the Site is recommended to be completed under a separate cover.

6.4 Groundwater Quality

It is our understanding that the potential discharge from the dewatering system during the construction will be directed to the municipal sewer system. As such, the quality of groundwater discharge is required to conform to the Sewer Use By-Law.

For the short-term dewatering system (construction phase), it is anticipated that TSS levels and some other parameters (for example, Total Metals) in the pumped groundwater may become elevated and exceed the both Sanitary and Storm By-Law limits. To control the concentration of TSS and associated metals, it is recommended that a suitable treatment method be implemented (filtration or decantation facilities and/ or any other applicable treatment system) during construction dewatering activities to discharge into the applicable sewer system. The specifications of the treatment system will need to be adjusted to the reported water quality results by the treatment contractor/process engineer.

An agreement to discharge to the sewers owned by the City of Welland will be required prior to discharging dewatering effluent. If no sewer system is available during the construction phase, the discharge water

shall be initially stored onsite and removed from the Site by a MCEP's licenced hauler to a designated disposal wastewater facility.

Also, the Environmental Site Assessment Report(s) should be reviewed for more information on the groundwater quality conditions at the Site.

6.5 Well Decommissioning

In conformance with Regulation 903 of the Ontario Water Resources Act, the installation and eventual decommissioning of any dewatering system wells or monitoring wells must be completed by a licensed well contractor. This will be required for all wells that are no longer in use.

7 Conclusions and Recommendations

Based on the findings of the Hydrogeological Investigation, the following conclusions and recommendations are provided:

- When compared to the Niagara Sanitary and Storm (Combined) Sewer By-Law Limits the laboratory Certificate of Analysis (CofA) showed that all parameters were detected at concentrations below the Sanitary By-Law limits.
- Based on the highest dewatering estimate of approximately 305 m^3/day, an online registration in the EASR will be required to facilitate the construction dewatering program.
- The preliminary long-term flow rate of the foundation sub-drain is estimated to be approximately 5 m^3/day for a single dwelling. The exact volume discharged can be confirmed once the system is operational. It is recommended that once the sub-drain system is in place, a flow meter be installed at the sump(s) to record daily discharge volumes to provide more representative estimates during the commissioning stage of the system. Regular maintenance/cleaning of the sub-drain system is recommended to ensure its proper operation. A permit to take-water is not required for the post-construction phase.
- The construction dewatering volume is based on the assumptions outlined in this report. Any variations in hydrogeological conditions beyond those encountered as part of this investigation may significantly influence the discharge volumes.
- For the short-term dewatering system (construction phase), it is anticipated that TSS levels and some other parameters (for example, Total Metals) in the pumped groundwater may become elevated and exceed the both Sanitary and Storm Sewer Use By-Law limits. To control the concentration of TSS and associated metals, it is recommended that a suitable treatment method be implemented (filtration or decantation facilities and/ or any other applicable treatment system) during construction dewatering activities to discharge into the applicable sewer system. The specifications of the treatment system will need to be adjusted to the reported water quality results by the treatment contractor/process engineer. The ESA findings should be considered to evaluate treatment options.
- An agreement to discharge to the sewers owned by the City of Welland will be required prior to discharging dewatering effluent.
- In conformance with Regulation 903 of the Ontario Water Resources Act, the installation and eventual decommissioning of any dewatering system wells or monitoring wells must be completed by a licensed well contractor. This will be required for all wells that are no longer in use.

The conclusions and recommendations provided above should be reviewed in conjunction with the entirety of the report. They assume that the present design concept described throughout the report will proceed to construction. Also, this report is solely intended for the construction and post-construction dewatering assessments. Any changes to the design concept may result in a modification to the recommendations provided in this report.

8 Limitations

This report is based on a limited investigation designed to provide information to support an assessment of the current hydrogeological conditions within the study area. The conclusions and recommendations presented within this report reflect Site conditions existing at the time of the assessment. EXP must be contacted immediately if any unforeseen Site conditions are experienced during construction activities. This will allow EXP to review the new findings and provide appropriate recommendations to allow the construction to proceed in a timely and cost-effective manner.

Our undertaking at EXP, therefore, is to perform our work within limits prescribed by our clients, with the usual thoroughness and competence of the geoscience/engineering profession. No other warranty or representation, either expressed or implied, is included or intended in this report.

This report was prepared for the exclusive use of 555 Canal Bank Developments GP Inc. This report may not be reproduced in whole or in part, without the prior written consent of EXP, or used or relied upon in whole or in part by other parties for any purposes whatsoever. Any use which a third party makes of this report, or any part thereof, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. EXP Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We trust that this information is satisfactory for your purposes. Should you have any questions or comments, please do not hesitate to contact this office.

Sincerely,

EXP Services Inc.

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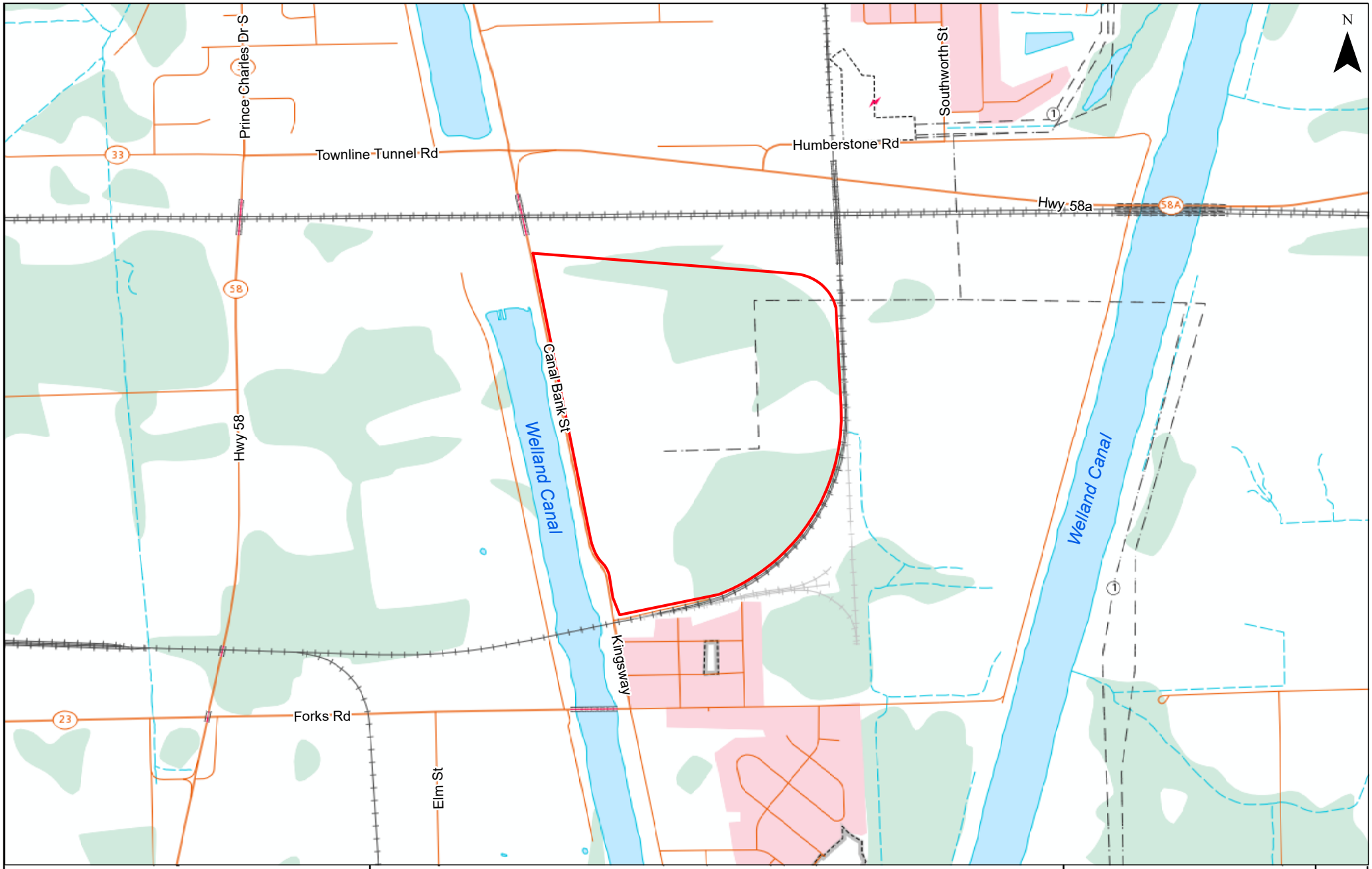
Figures



SCALE:

0 200 400 600 800 1,000 m

LEGEND:

APPROXIMATE SITE BOUNDARY

SITE LOCATION PLAN

FIGURE: 1

exp.

DRAWN BY:	CHECKED BY:
AC	PS

HYDROGEOLOGICAL INVESTIGATION
555 CANAL BANK STREET
WELLAND, ONTARIO

PROJECT NUMBER: HAM-00801631-A0

DATE: JULY 2020

SCALE:

0 200 400 600 800 1,000 m

SOURCE:

BASED ON ONTARIO GEOLOGICAL SURVEY DATA PUBLISHED IN 2010

exp.

DRAWN BY:	CHECKED BY:
AC	PS

LEGEND:

- APPROXIMATE SITE BOUNDARY
- 21: MAN-MADE DEPOSITS
- 8A: FINE-TEXTURED GLACIOLACUSTRINE DEPOSITS

SURFICIAL GEOLOGY

FIGURE: 2

HYDROGEOLOGICAL INVESTIGATION
555 CANAL BANK STREET
WELLAND, ONTARIO

PROJECT NUMBER: HAM-00801631-A0

DATE: JULY 2020

SCALE:

0 100 200 300 400 500 m

SOURCE:

BASED ON GOOGLE EARTH IMAGERY DATED 2018,
AVAILABLE WELL RECORD INFORMATION AS OF SEPTEMBER 2019

exp.

DRAWN BY:	CHECKED BY:
AC	PS

LEGEND:

- MONITORING WELL / TEST HOLE
- WATER SUPPLY WELL
- ABANDONED WELL
- UNCLASSIFIED / UNFINISHED WELL
- APPROXIMATE SITE BOUNDARY
- 500 m ZONE

MECP WATER WELL RECORDS MAP

FIGURE: 3

HYDROGEOLOGICAL INVESTIGATION
555 CANAL BANK STREET
WELLAND ONTARIO

PROJECT NUMBER: HAM-00801631-A0

DATE: JULY 2020

SCALE:

0 80 160 240 320 400 m

exp.

DRAWN BY:	CHECKED BY:
AC	PS

LEGEND:

- INFILTRATION TEST LOCATION
- BOREHOLE (EXP GEOTECHNICAL, 2020)
- BOREHOLE / MONITORING WELL (EXP GEOTECHNICAL, 2020)
- BOREHOLE (EXP GEOTECHNICAL, 2019)
- BOREHOLE / MONITORING WELL (EXP GEOTECHNICAL, 2019)
- CROSS SECTION AXIS
- APPROXIMATE SITE BOUNDARY

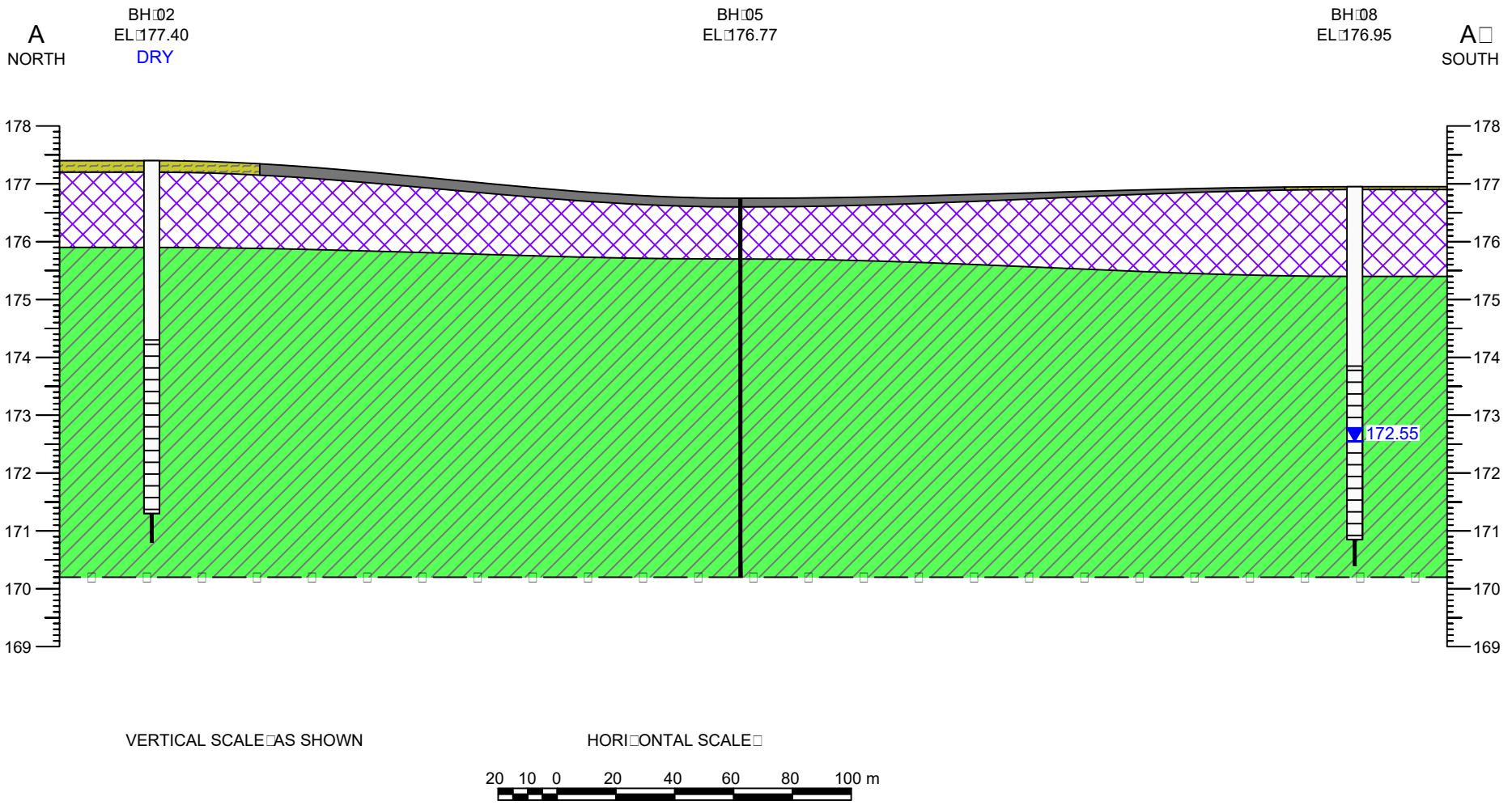
BOREHOLE / MONITORING WELL LOCATION PLAN

FIGURE: 4

HYDROGEOLOGICAL INVESTIGATION
555 CANAL BANK STREET
WELLAND, ONTARIO

PROJECT NUMBER: HAM-00801631-A0

DATE: JULY 2020



VERTICAL SCALE AS SHOWN

HORIZONTAL SCALE

20 10 0 20 40 60 80 100 m

X:\DRAWINGS\801000\801600\801631\801631A\HG FIGURES\MARCH 25 2019\HAM-00801631-A0.dwg

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LEGEND

- TOPSOIL
- ASPHALT
- FILL
- SILTY CLAY

▼ GROUNDWATER ELEVATION AS MEASURED ON MARCH 4 2019

TITLE AND LOCATION

CROSS SECTION A-A'

HYDROGEOLOGICAL INVESTIGATION
555 CANAL BANK STREET
WELLAND ONTARIO

PROJECT NO.	HAM-00801631-A0
DWN.	AS
SCALE	AS NOTED
CK	CS
DATE	MARCH 2019
FIG. NO.	5

SCALE:

0 80 160 240 320 400 m

exp.

DRAWN BY:	CHECKED BY:
AC	PS

LEGEND:

- BOREHOLE / MONITORING WELL (EXP GEOTECHNICAL, 2020)
- BOREHOLE / MONITORING WELL (EXP GEOTECHNICAL, 2019)
- APPROXIMATE SITE BOUNDARY
- xx.xx GROUNDWATER ELEVATION (m asl) AS MEASURED ON JULY 27, 2020
- GROUNDWATER CONTOUR
- GROUNDWATER FLOW DIRECTION

NOTE: GROUNDWATER ELEVATIONS AT BH/MW-01 AND BH/MW-10 WERE NOT USED FOR GROUNDWATER CONTOUR ANALYSIS DUE TO ANOMALOUS MEASUREMENT.

GROUNDWATER CONTOUR PLAN

FIGURE: 6

HYDROGEOLOGICAL INVESTIGATION
555 CANAL BANK STREET
WELLAND, ONTARIO

PROJECT NUMBER: HAM-00801631-A0 DATE: JULY 2020

Appendix A:
MECP WWR Summary Table

On-Site

BORE_HOLE_ID	WELL_ID	DATE	EAST83	NORTH83	ELEVATION (m ASL)	LOCATION ACCURACY	STREET	CITY	DISTANCE FROM SITE CENTROID (m)	CONSTRUCTION METHOD	WELL DEPTH (m bgs)	WATER FOUND (m BGS)	CASING DIAMETER (cm)	1st USE	2nd USE	FINAL STATUS
10463887	6604290	1/15/1998	643037	4757277	175.6	UTM very unreliable			75		19.8	19.2	12.7	Domestic		Water Supply
1002422539	7122825	4/21/2009	642937	4757302	175.1	margin of error : 30 m - 100 m	555 CANAL RD.	Welland	168		5.4		5.2	Monitoring		Other Status
1002422539	7122825	4/21/2009	643012	4757160	175.1	margin of error : 10 - 30 m	555 CANAL RD.	Welland	175		5.4		5.2	Monitoring		Other Status
1002037786	7121371	2/17/2009	643416	4757405	179.0	margin of error : 30 m - 100 m	555 CANAL ROAD	Welland	325		10.0		5.2	Monitoring and Test Hole		Test Hole
1002037786	7121371	2/17/2009	642802	4757167	179.0	margin of error : 10 - 30 m	555 CANAL ROAD	Welland	335		10.0		5.2	Monitoring and Test Hole		Test Hole
1002037786	7121371	2/17/2009	642864	4756890	179.0	margin of error : 10 - 30 m	555 CANAL ROAD	Welland	483		10.0		5.2	Monitoring and Test Hole		Test Hole
1002037786	7121371	2/17/2009	642827	4756991	179.0	margin of error : 10 - 30 m	555 CANAL ROAD	Welland	422		10.0		5.2	Monitoring and Test Hole		Test Hole
1002037786	7121371	2/17/2009	642785	4757154	179.0	margin of error : 10 - 30 m	555 CANAL ROAD	Welland	356		10.0		5.2	Monitoring and Test Hole		Test Hole
1002037786	7121371	2/17/2009	642728	4757374	179.0	margin of error : 10 - 30 m	555 CANAL ROAD	Welland	383		10.0		5.2	Monitoring and Test Hole		Test Hole
1002037786	7121371	2/17/2009	643103	4757145	179.0	margin of error : 10 - 30 m	555 CANAL ROAD	Welland	164		10.0		5.2	Monitoring and Test Hole		Test Hole
1002037786	7121371	2/17/2009	643416	4757405	179.0	margin of error : 10 - 30 m	555 CANAL ROAD	Welland	325		10.0		5.2	Monitoring and Test Hole		Test Hole
1002037786	7121371	2/17/2009	642877	4757008	179.0	margin of error : 10 - 30 m	555 CANAL ROAD	Welland	377		10.0		5.2	Monitoring and Test Hole		Test Hole
1002037786	7121371	2/17/2009	643056	4756911	179.0	margin of error : 10 - 30 m	555 CANAL ROAD	Welland	401		10.0		5.2	Monitoring and Test Hole		Test Hole
1003570552	7169092	7/28/2011	642848	4757061	175.4	margin of error : 10 - 30 m	555 CANAL BANK RD.	Welland	357		4.6		5.0	Not Used		Test Hole
1003782163	7181007	4/4/2012	642866	4757224	175.3	margin of error : 30 m - 100 m	555 CANAL BANK RD	Welland	254							Other Status
1003782178	7181008	2/8/2012	642868	4757302	174.9	margin of error : 30 m - 100 m	555 CANAL BANK RD	Welland	237							Abandoned-Other
1003227812	7121371	2/17/2009	643056	4756911	175.3	margin of error : 10 - 30 m	555 CANAL ROAD	Welland	401		10.0		5.2	Monitoring and Test Hole		Test Hole
1002422629	7122855	4/26/2009	642886	4756797	178.4	margin of error : 10 - 30 m	555 CANAL RD	Welland	557		5.5		5.2	Monitoring		
1002422629	7122855	4/26/2009	642889	4756801	178.4	margin of error : 10 - 30 m	555 CANAL RD	Welland	552		5.5		5.2	Monitoring		
1002422629	7122855	4/26/2009	642892	4756775	178.4	margin of error : 10 - 30 m	555 CANAL RD	Welland	575		5.5		5.2	Monitoring		
1002422629	7122855	4/26/2009	642885	4756763	178.4	margin of error : 10 - 30 m	555 CANAL RD	Welland	588		5.5		5.2	Monitoring		
1002422629	7122855	4/26/2009	642878	4756751	178.4	margin of error : 10 - 30 m	555 CANAL RD	Welland	602		5.5		5.2	Monitoring		
1002422629	7122855	4/26/2009	643047	4757281	178.4	margin of error : 10 - 30 m	555 CANAL RD	Welland	64		5.5		5.2	Monitoring		
1002422629	7122855	4/26/2009	643046	4757256	178.4	margin of error : 10 - 30 m	555 CANAL RD	Welland	79		5.5		5.2	Monitoring		
1002422629	7122855	4/26/2009	642879	4757422	178.4	margin of error : 10 - 30 m	555 CANAL RD	Welland	253		5.5		5.2	Monitoring		
1002422629	7122855	4/26/2009	642876	4757544	178.4	margin of error : 10 - 30 m	555 CANAL RD	Welland	329		5.5		5.2	Monitoring		
1002422629	7122855	4/26/2009	643089	4757480	178.4	margin of error : 10 - 30 m	555 CANAL RD	Welland	172		5.5		5.2	Monitoring		
1007465738	7333713	2/14/2019	643121	4757593		margin of error : 30 m - 100 m	555 CANAL BANK ST	Welland	285		6.1			Monitoring		Observation Wells
1007465747	7333716	2/14/2019	643495	4757159		margin of error : 30 m - 100 m	555 CANAL BANK ST	Welland	418		9.1			Monitoring		Observation Wells
1007607815	7340258	7/2/2019	643025	4756860		margin of error : 30 m - 100 m	555 Canal Bank Street	Welland	456		6.1	4.6		Monitoring and Test Hole		Monitoring and Test Hole
1007607818	7340259	7/2/2019	642849	4757247		margin of error : 30 m - 100 m	555 Canal Bank Street	Welland	264		6.1	4.9		Monitoring and Test Hole		Monitoring and Test Hole
1007465732	7333711	2/14/2019	642773	4757388		margin of error : 30 m - 100 m	555 Canal Bark Street	Welland	342		6.1			Monitoring		Monitoring and Test Hole
1007465735	7333712	2/14/2019	643475	4757698		margin of error : 30 m - 100 m	555 Canal Bank Street	Welland	537		9.1			Monitoring		Monitoring and Test Hole
1007465741	7333714	2/14/2019	643446	4757430		margin of error : 30 m - 100 m	555 Canal Bank Street	Welland	362		6.1			Monitoring		Monitoring and Test Hole
1007465744	7333715	2/14/2019	642714	4757690		margin of error : 100 m - 300 m	555 Canal Bank Street	Welland	546		9.1			Monitoring		Monitoring and Test Hole
1007498223	7333717	2/14/2018	643143	4757183		margin of error : 30 m - 100 m	555 Canal Bank Street	Welland	131		6.1			Monitoring		Monitoring and Test Hole
1007498226	7333718	2/14/2019	642941	4756767		margin of error : 30 m - 100 m	555 Canal Bank Street	Welland	566		9.1			Monitoring		Monitoring and Test Hole
1004199222	7190960	4/4/2012	642879	4757246	175.2	margin of error : 30 m - 100 m			235							
1004199266	7190961	2/8/2012	642868	4757302	174.9	margin of error : 30 m - 100 m			237							
1007499497	7336456	6/26/2019	642912	4756961		margin of error : 30 m - 100 m			398							

Off-Site

BORE_HOLE_ID	WELL_ID	DATE	EAST83	NORTH83	ELEVATION (m ASL)	LOCATION ACCURACY	STREET	CITY	DISTANCE FROM SITE CENTROID (m)	CONSTRUCTION METHOD	WELL DEPTH (m bgs)	WATER FOUND (m BGS)	CASING DIAMETER (cm)	1st USE	2nd USE	FINAL STATUS
10460954	6601220	12/22/1967	643579	4757772	175.2	margin of error : 100 m - 300 m			663		46.0	36.0	30.5	Not Used		Test Hole
10462981	6603366	10/11/1978	642635	4756723	174.7	margin of error : 30 m - 100 m			751		25.9	25.3	17.8	Industrial		Water Supply
10463484	6603887	10/14/1989	643555	4757287	177.8	UTM very unreliable			450		14.0	13.7	12.7	Domestic		Water Supply
10463565	6603968	11/29/1990	643555	4757287	177.8	UTM very unreliable			450		12.2	8.8	12.7	Domestic		Water Supply
10463602	6604005	6/15/1991	643555	4757287	177.8	UTM very unreliable			450		25.9	14.0	15.2	Domestic		Water Supply
10542189	6604706	1/17/2003	643553	4757287	177.8	Approximate location: margin of error : 1 km - 3 km			448					Livestock		Abandoned-Quality
10542190	6604707	1/17/2003	643553	4757287	177.8	Approximate location: margin of error : 1 km - 3 km			448					Livestock		Abandoned-Quality
1002422539	7122825	4/21/2009	######	########	175.1	margin of error : 10 - 30 m	555 CANAL RD.	Welland	744		5.4		5.2	Monitoring		Other Status
1002422539	7122825	4/21/2009	643875	4757241	175.1	margin of error : 10 - 30 m	555 CANAL RD.	Welland	773		5.4		5.2	Monitoring		Other Status
1002422539	7122825	4/21/2009	643850	4757270	175.1	margin of error : 10 - 30 m	555 CANAL RD.	Welland	746		5.4		5.2	Monitoring		Other Status
1002777272	7132914	8/7/2009	642508	4757643	174.9	margin of error : 10 - 30 m			684							Abandoned-Other
1002777275	7132915	8/7/2009	642882	4756640	174.1	margin of error : 30 m - 100 m	CANAL ST.	WELLAND	705		4.9		5.1	Test Hole		Test Hole
1004155764	7187215	5/30/2012	642349	4758165	174.9	margin of error : 10 - 30 m	HUMBERSTONE RD + COLBOURNE ST W	Welland	1142		7.6		4.6	Monitoring		Observation Wells
1004198598	7189007	7/24/2012	643622	4758143	180.0	margin of error : 30 m - 100 m			981							
1006713624	7293200	6/23/2017	643902	4757616	179.5	margin of error : 30 m - 100 m	285 FORKS ROAD EAST	Welland	854		13.7			Test Hole	Monitoring	Monitoring and Test Hole
1006713627	7293201	6/23/2017	643667	4756774	180.1	margin of error : 30 m - 100 m	285 FORKS ROAD EAST	Welland	776		12.2			Test Hole	Monitoring	Monitoring and Test Hole
1006713630	7293202	6/23/2017	643849	4757182	189.5	margin of error : 30 m - 100 m	285 FORKS RD. EAST	Welland	754		13.7			Test Hole	Monitoring	Monitoring and Test Hole
1006713678	7293218	6/23/2017	643798	4756831	178.0	margin of error : 30 m - 100 m	285 FORKS RAOD EAST	Welland	841		6.1			Test Hole	Monitoring	Monitoring and Test Hole
1007002391	7307449	2/12/2018	643061	4758153		margin of error : 30 m - 100 m	405 HUMBERSTONE RD	Welland	846		7.6			Test Hole	Monitoring	Monitoring and Test Hole
1007002394	7307450	2/12/2018	643046	4758153		margin of error : 30 m - 100 m	405 HUMBERSTONE RD	Welland	846		7.6			Test Hole	Monitoring	Monitoring and Test Hole
1007002397	7307451	2/12/2018	643045	4758138		margin of error : 30 m - 100 m	405 HUMBERSTONE RD	Welland	832		7.6			Test Hole	Monitoring	Monitoring and Test Hole
1007299773	7320765	6/25/2018	642947	4756551		margin of error : 30 m - 100 m	16 ERIE ST	Welland	774		6.1			Monitoring		Observation Wells
1007299776	7320766	6/25/2018	642949	4756565		margin of error : 30 m - 100 m	16 ERIE ST	Welland	760		6.1			Monitoring		Observation Wells
1007299779	7320767	6/25/2018	642963	4756578		margin of error : 30 m - 100 m	16 ERIE ST	Welland	744		6.1			Monitoring		Observation Wells
1007562145	7338177	5/24/2019	642947	4756697		margin of error : 30 m - 100 m			632							

Appendix B: Borehole Logs

Log of Borehole BH-01

Project No. HAM-00801631-A0 Drawing No. 3

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

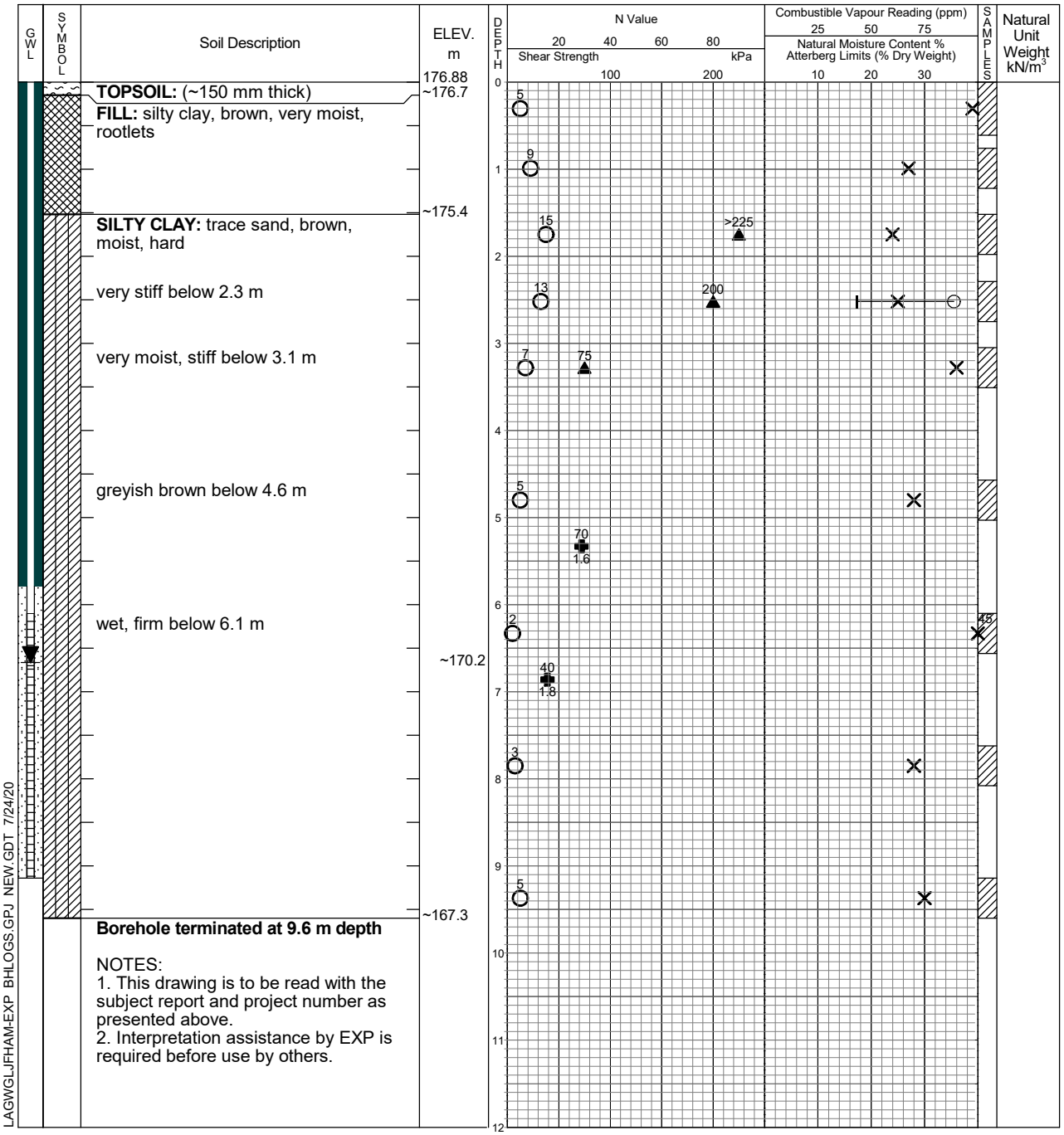
Date Drilled: February 14, 2019

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	9.6
February 19, 2019	4.4	N/A
March 4, 2019	6.7	N/A

Log of Borehole BH-02

Project No. HAM-00801631-A0 Drawing No. 4

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

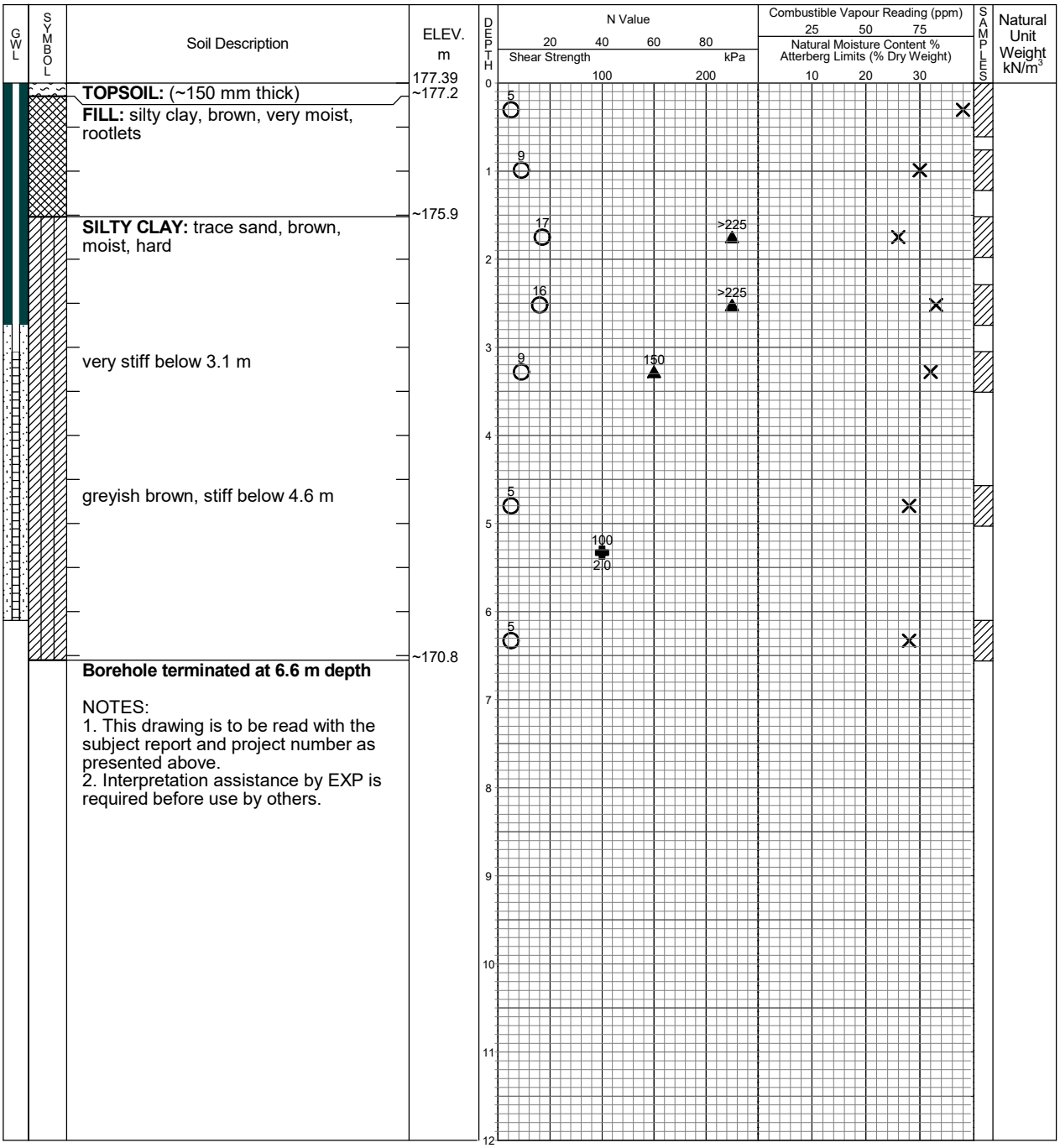
Date Drilled: February 13, 2019

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.

LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.6
February 19, 2019	no free water	N/A
March 4, 2019	no free water	N/A

Log of Borehole BH-03

Project No. HAM-00801631-A0 Drawing No. 5

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

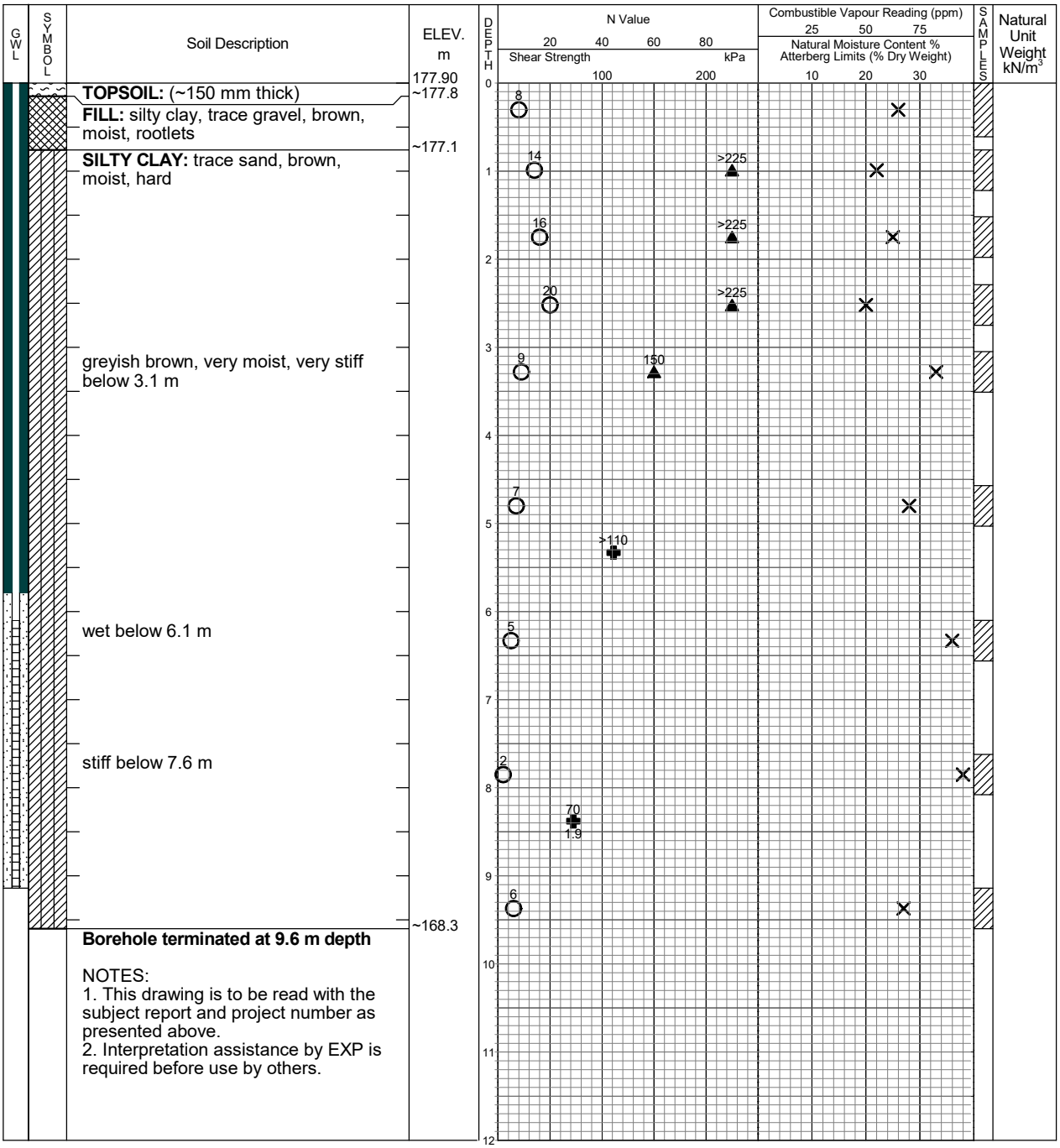
Date Drilled: February 13, 2019

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	9.6
February 19, 2019	no free water	N/A
March 4, 2019	no free water	N/A

Log of Borehole BH-04

Project No. HAM-00801631-A0 Drawing No. 6

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

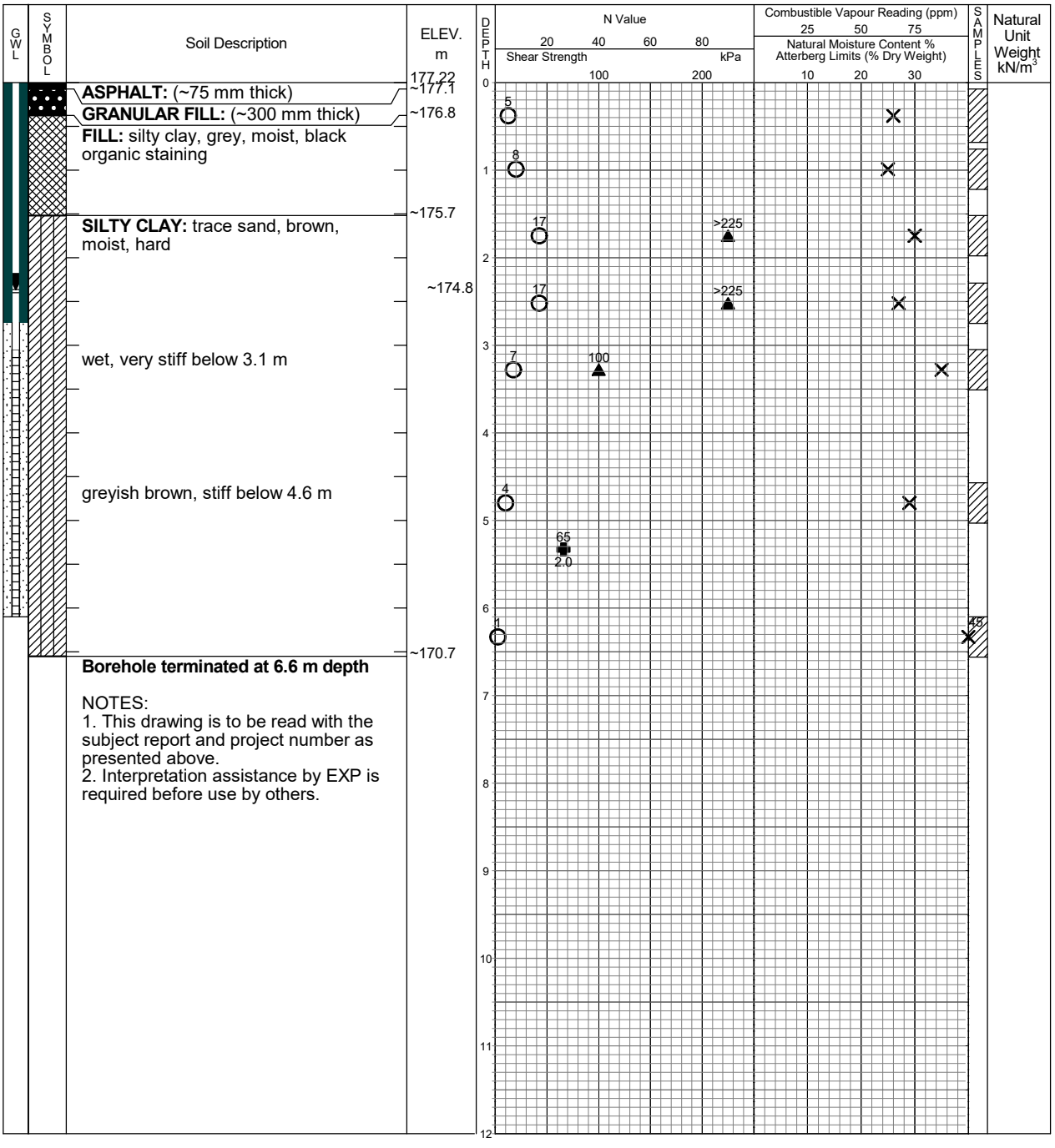
Date Drilled: February 14, 2019

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	5.3	6.6
February 19, 2019	4.6	N/A
March 4, 2019	2.4	N/A

Log of Borehole BH-05

Project No. HAM-00801631-A0 Drawing No. 7

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: February 13, 2019

Drill Type: CME 75 Truck Mount. Solid Stem.

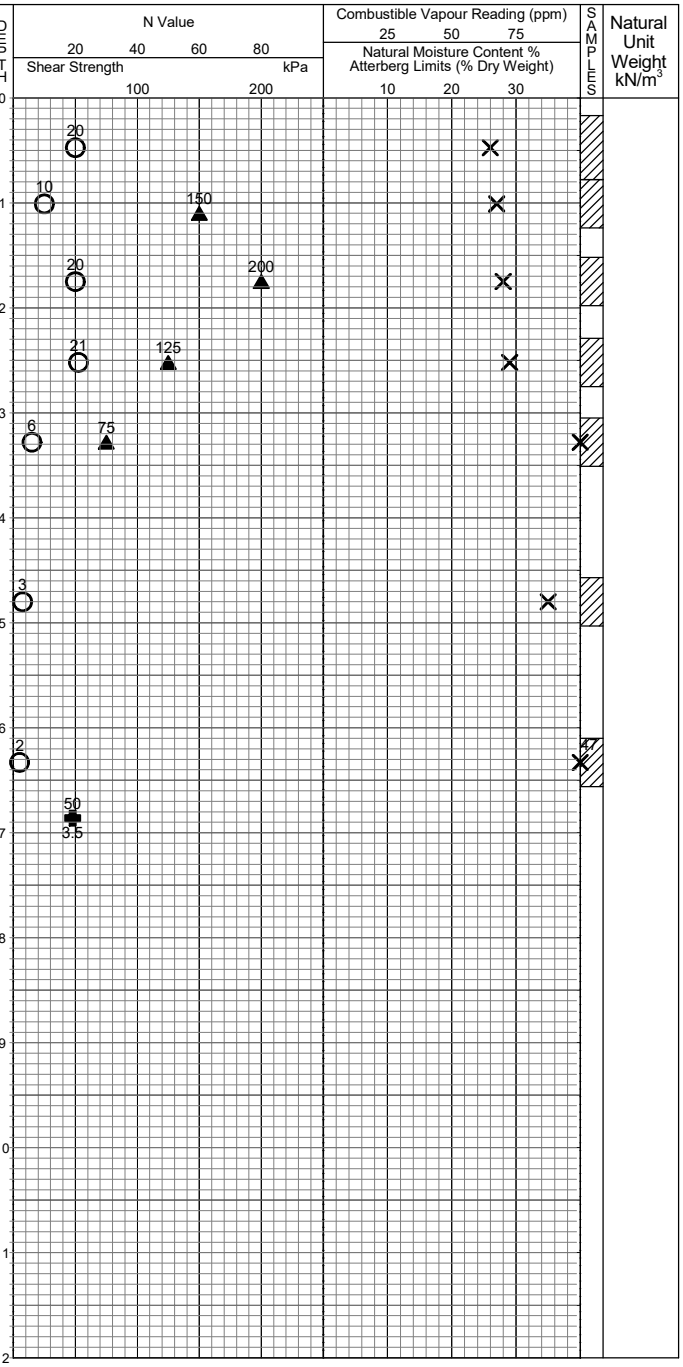
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
		ASPHALT: (~170 mm thick)	176.77
		GRANULAR FILL: (~340 mm thick)	~176.6
		FILL: silty clay, brown, moist	~176.3
		SILTY CLAY:trace sand, brown, moist, very stiff trace gravel below 1.5 m	~175.7
		wet, stiff below 3.1 m	
		greyish brown below 4.6 m	
		Borehole terminated at 6.9 m depth	~169.9

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	4.0	6.6

Log of Borehole BH-06

Project No. HAM-00801631-A0 | Drawing No. 8

Project: Proposed Subdivision | Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

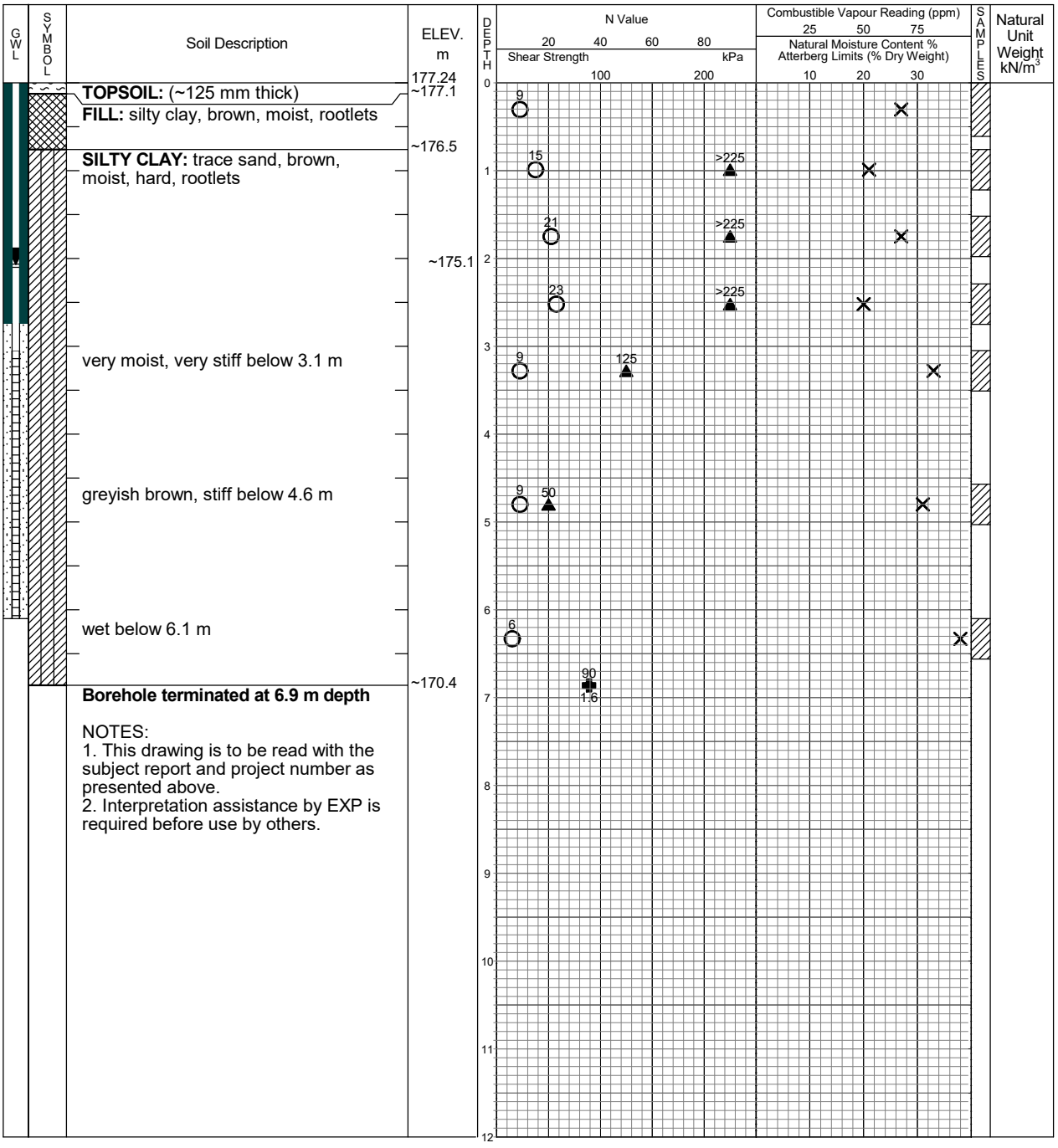
Date Drilled: February 13, 2019

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.6
February 19, 2019	2.6	N/A
March 4, 2019	2.1	N/A

Log of Borehole BH-07

Project No. HAM-00801631-A0 Drawing No. 9

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: February 11, 2019

Drill Type: D-50 Track Mount. Solid Stem.

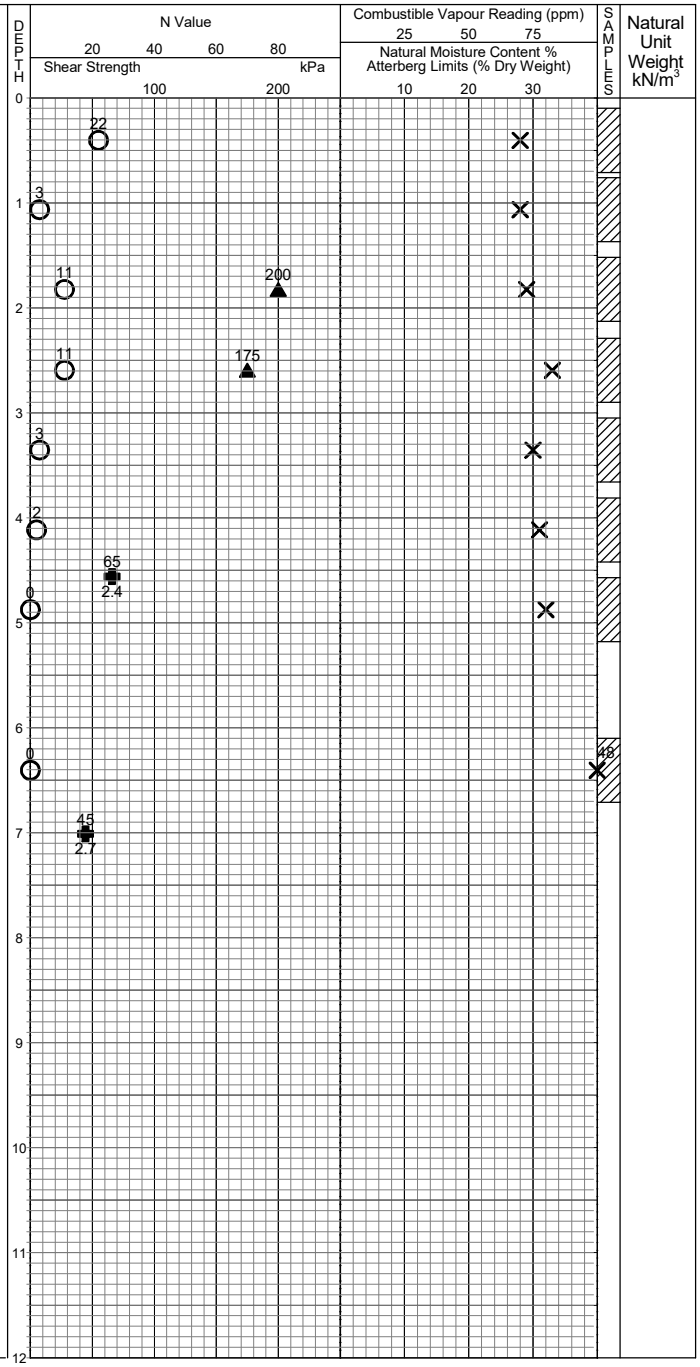
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
			176.77
		ASPHALT: (~100 mm thick)	~176.7
		GRANULAR FILL: (~300 mm thick)	~176.4
		FILL: silty clay, grey, moist, rootlets, wood fragments	
			~175.3
		SILTY CLAY: trace sand, brown, moist, very stiff	
		very moist below 2.3 m	
		grey, stiff below 3.1 m	
		wet, firm below 6.1 m	
			~169.8
		Borehole terminated at 7.0 m depth	

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.



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EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	4.6	6.6

Log of Borehole BH-08

Project No. HAM-00801631-A0 Drawing No. 10

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

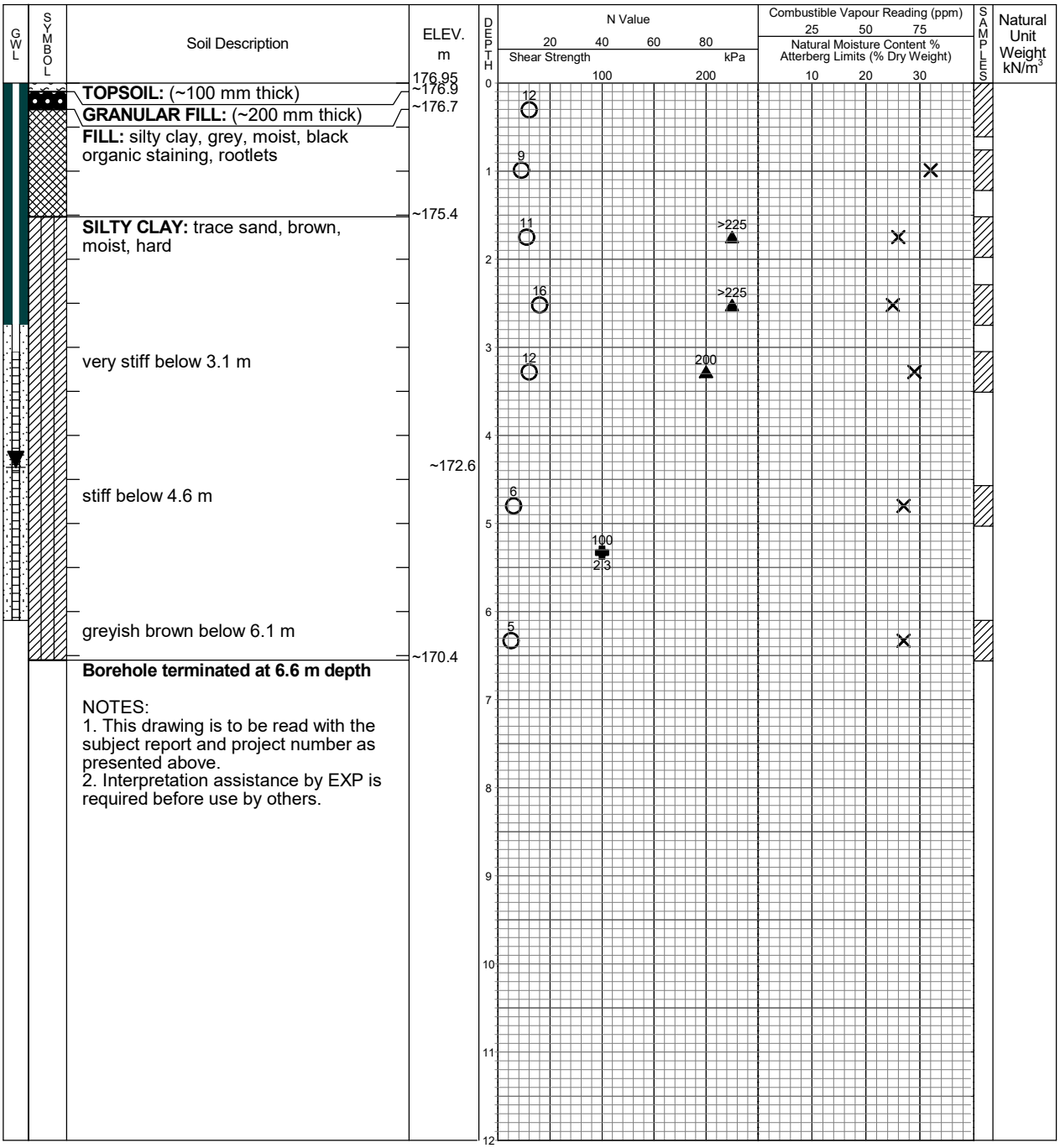
Date Drilled: February 11, 2019

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.

LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.6
February 19, 2019	5.4	N/A
March 4, 2019	4.4	N/A

Log of Borehole BH-09

Project No. HAM-00801631-A0 Drawing No. 11

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

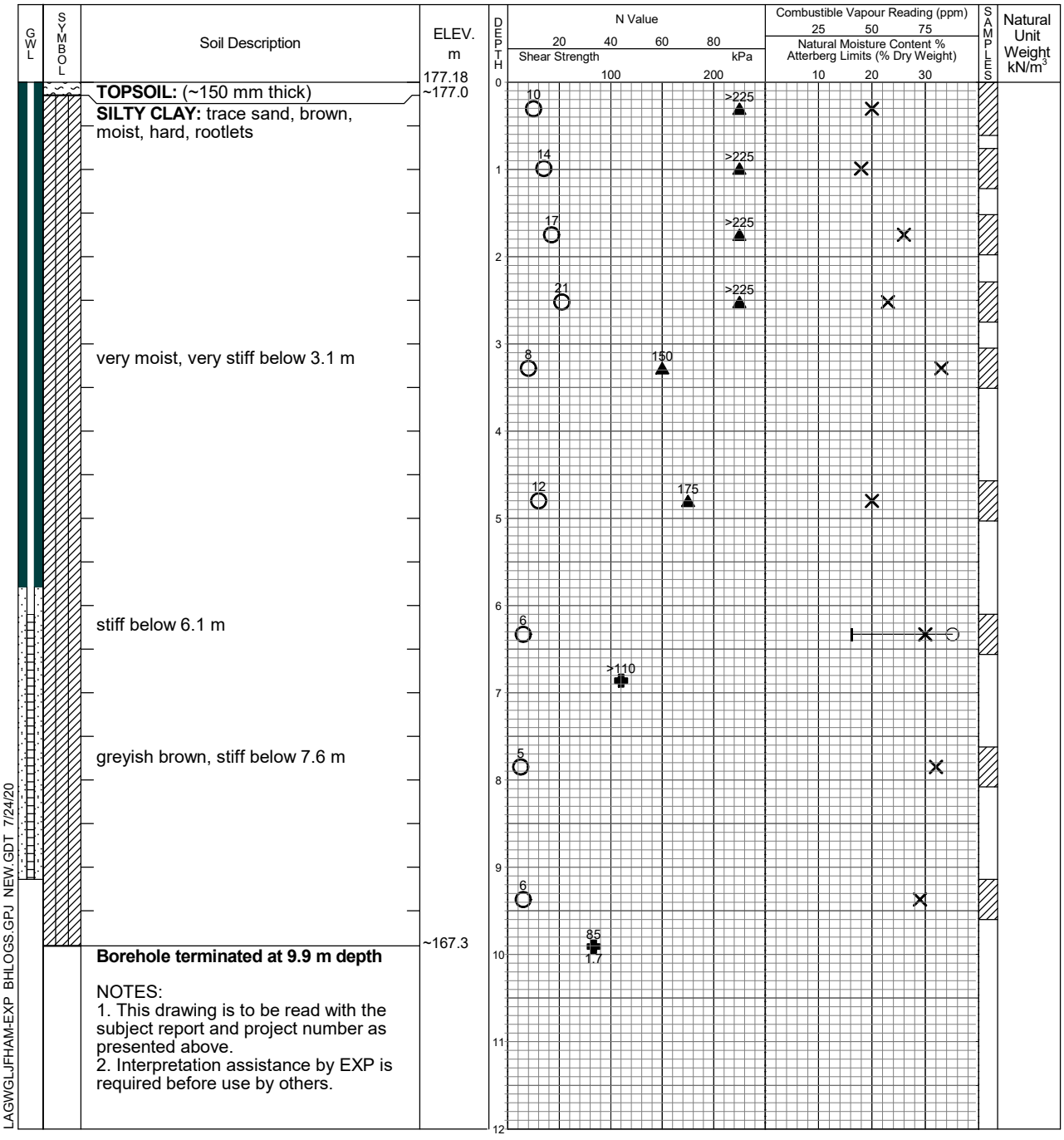
Date Drilled: February 11, 2019

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	9.6
February 19, 2019	no free water	N/A
March 4, 2019	no free water	N/A

Log of Borehole BH-10

Project No. HAM-00801631-A0 Drawing No. 12

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

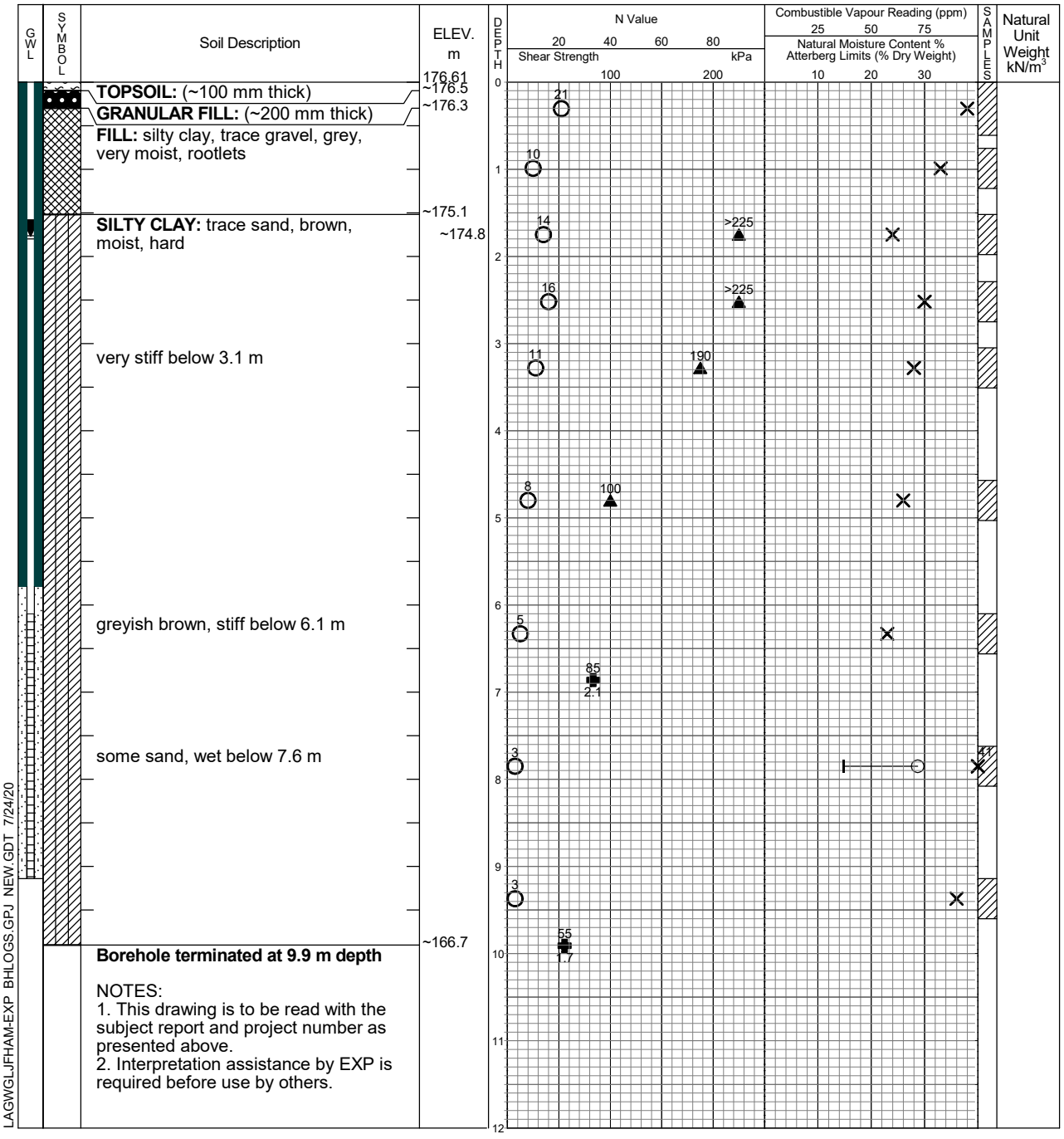
Date Drilled: February 11, 2019

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	8.2	9.6
February 19, 2019	1.9	N/A
March 4, 2019	1.8	N/A

Log of Borehole BH-11

Project No. HAM-00801631-A0 Drawing No. 13

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

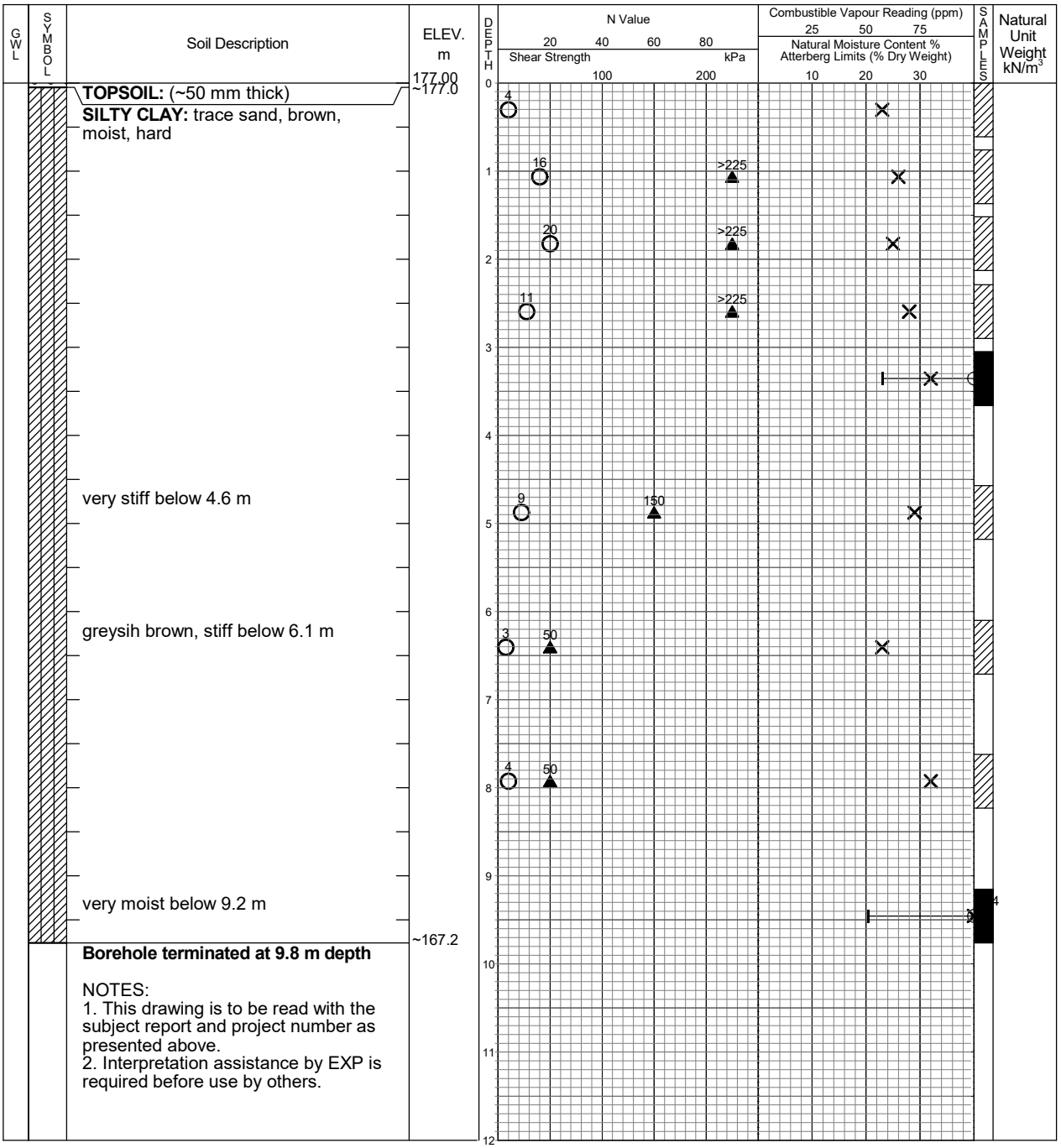
Date Drilled: January 27, 2020

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	9.8

Log of Borehole BH-12

Project No. HAM-00801631-A0 | Drawing No. 14

Project: Proposed Subdivision | Sheet No. 1 of 2

Location: 555 Canal Bank Street, Welland, ON

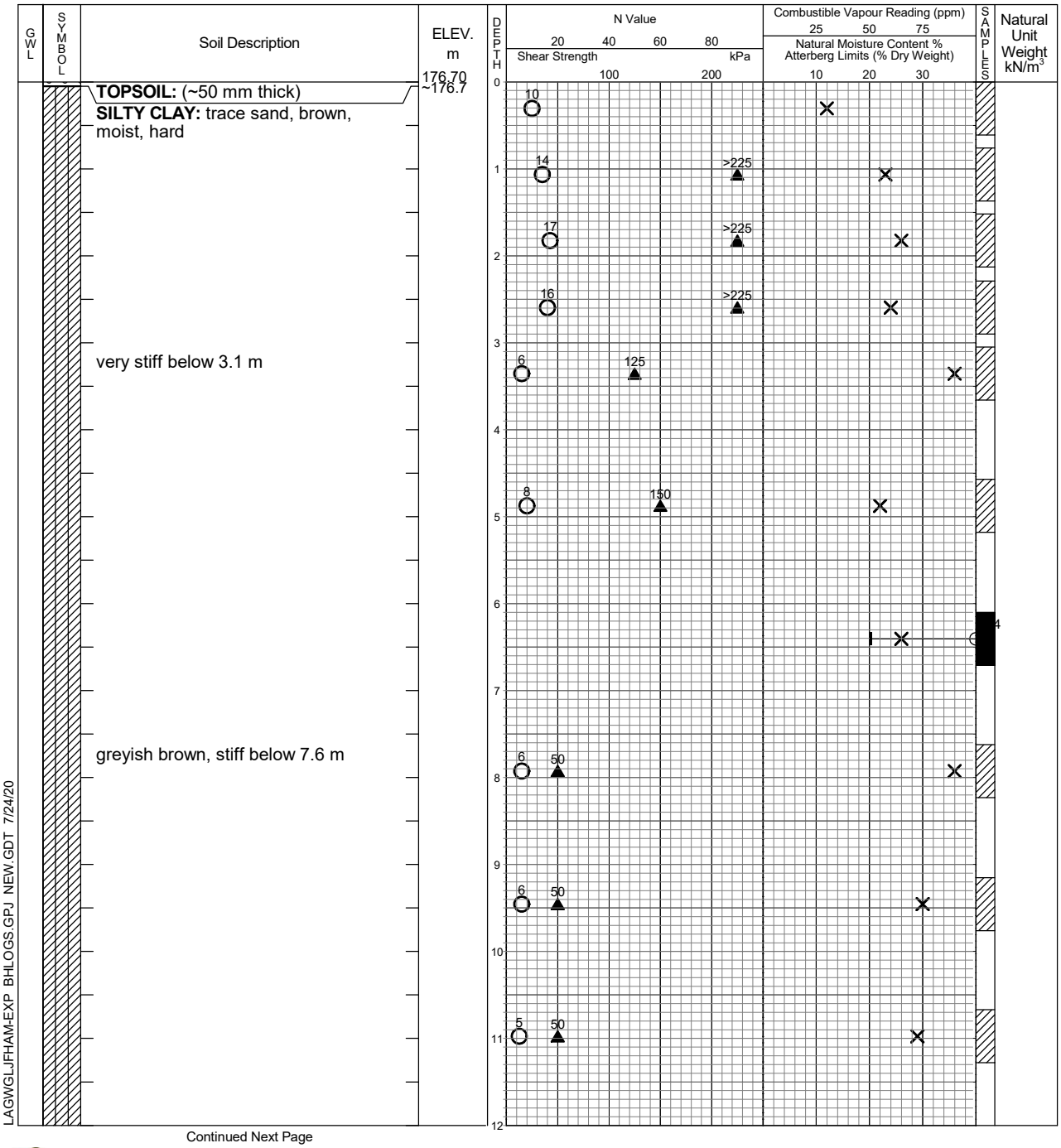
Date Drilled: January 27, 2020

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



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Continued Next Page

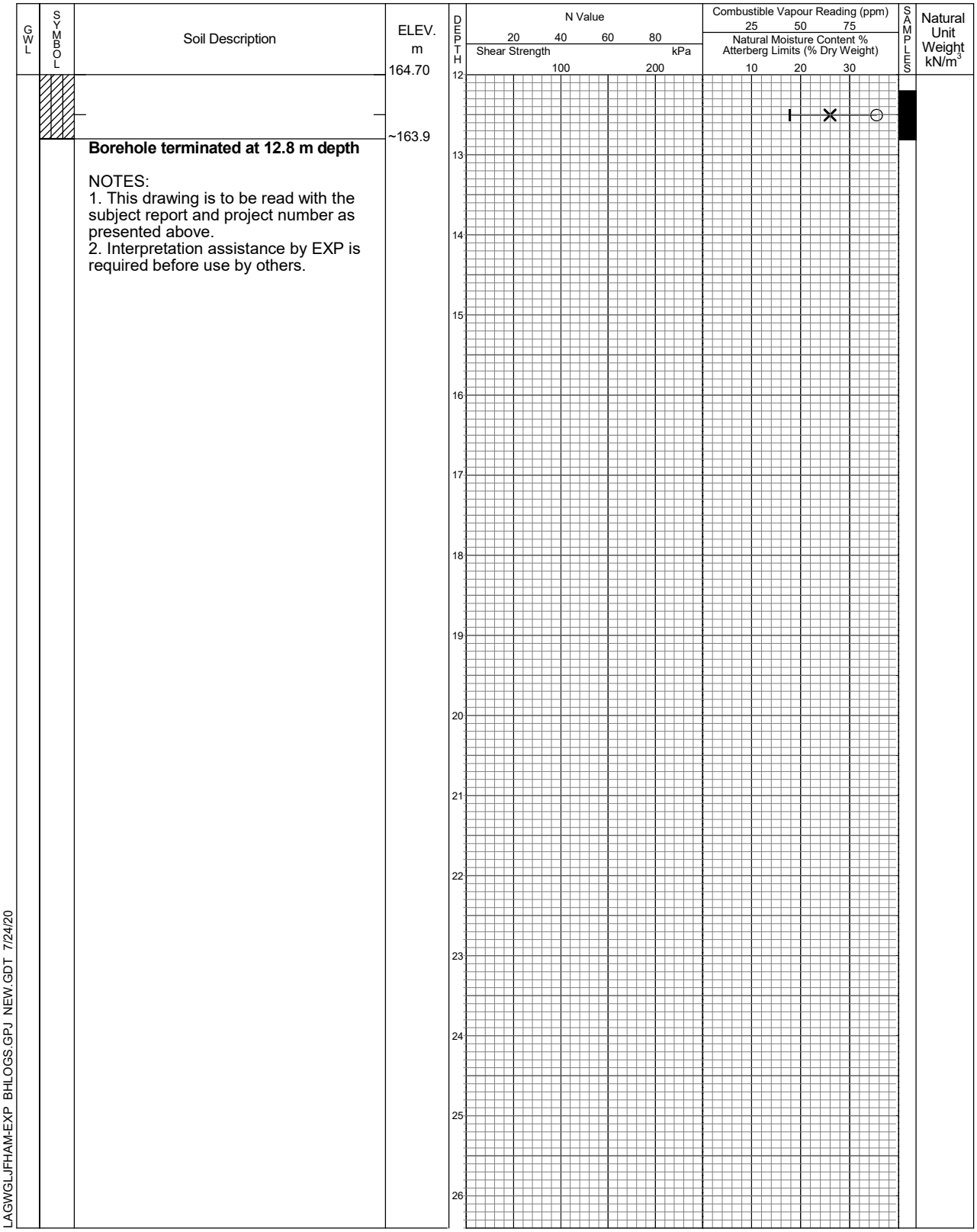
EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	12.8

Log of Borehole BH-12

Project No. HAM-00801631-A0 Drawing No. 14

Project: Proposed Subdivision Sheet No. 2 of 2



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	12.8

Log of Borehole BH-13

Project No. HAM-00801631-A0 Drawing No. 15

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

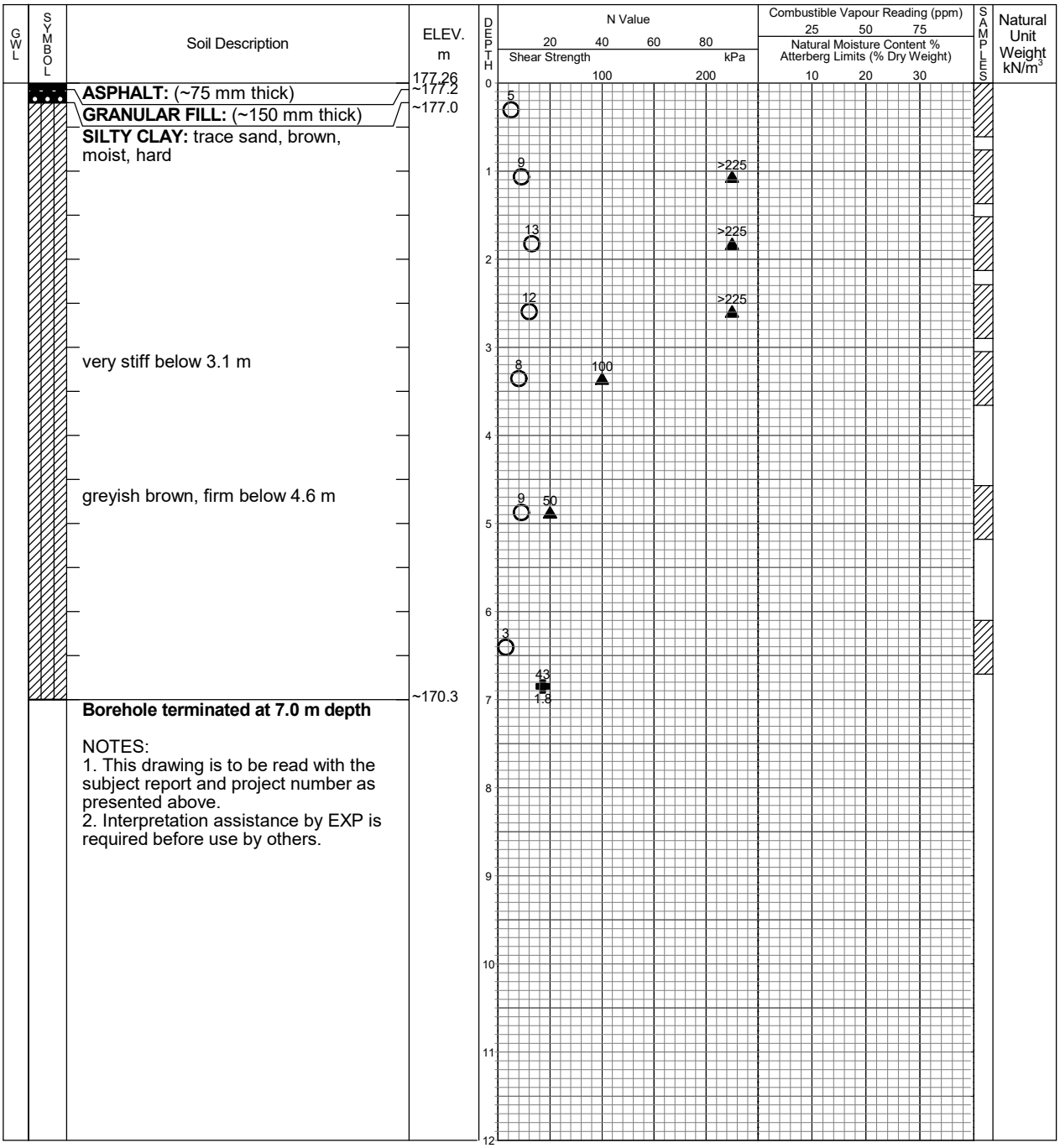
Date Drilled: July 16, 2020

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.7

Log of Borehole BH-14

Project No. HAM-00801631-A0 | Drawing No. 16

Project: Proposed Subdivision | Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 14, 2020

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH
			177.57	0
		ASPHALT: (~75 mm thick)	~177.5	
		GRANULAR FILL: (~200 mm thick)	~177.3	
		SILTY CLAY: trace sand, brown, moist, hard		1
				2
		very stiff below 3.1 m		3
		greyish brown, firm below 3.8 m		4
				5
				6
			~170.9	7
		Borehole terminated at 6.7 m depth		8
				9
				10
				11
				12

N Value (20, 40, 60, 80)
Shear Strength kPa (100, 200)

16
13 >225
16 >225
12 >225
8 100
4 50
2
20 2.7
2
2

Combustible Vapour Reading (ppm) (25, 50, 75)
Natural Moisture Content % / Atterberg Limits (% Dry Weight) (10, 20, 30)

SAMPLES

Natural Unit Weight kN/m³

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.

LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	6.4	6.7

Log of Borehole BH-15

Project No. HAM-00801631-A0 Drawing No. 17

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 13, 2020

Drill Type: D-50 Track Mount. Solid Stem.

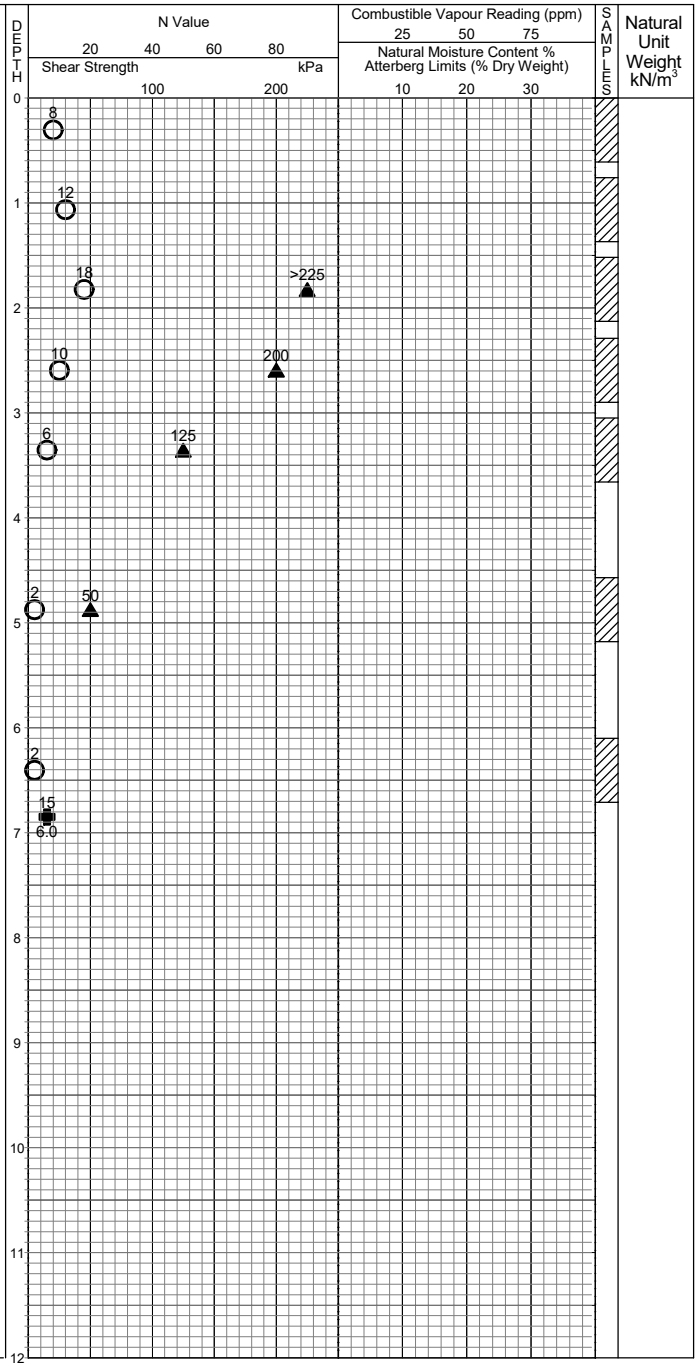
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
			177.17
		ASPHALT: (~75 mm thick)	~177.1
		GRANULAR FILL: (~75 mm thick)	~177.0
		FILL: silty clay, trace to some sand, brown, moist	
			~175.7
		SILTY CLAY: trace sand, brown, moist, hard	
		very stiff below 3.1 m	
		greyish brown, firm below 4.6 m	
			~170.2
		Borehole terminated at 7.0 m depth	

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.7

Log of Borehole BH-16

Project No. HAM-00801631-A0 Drawing No. 18

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 14, 2020

Drill Type: D-50 Track Mount. Solid Stem.

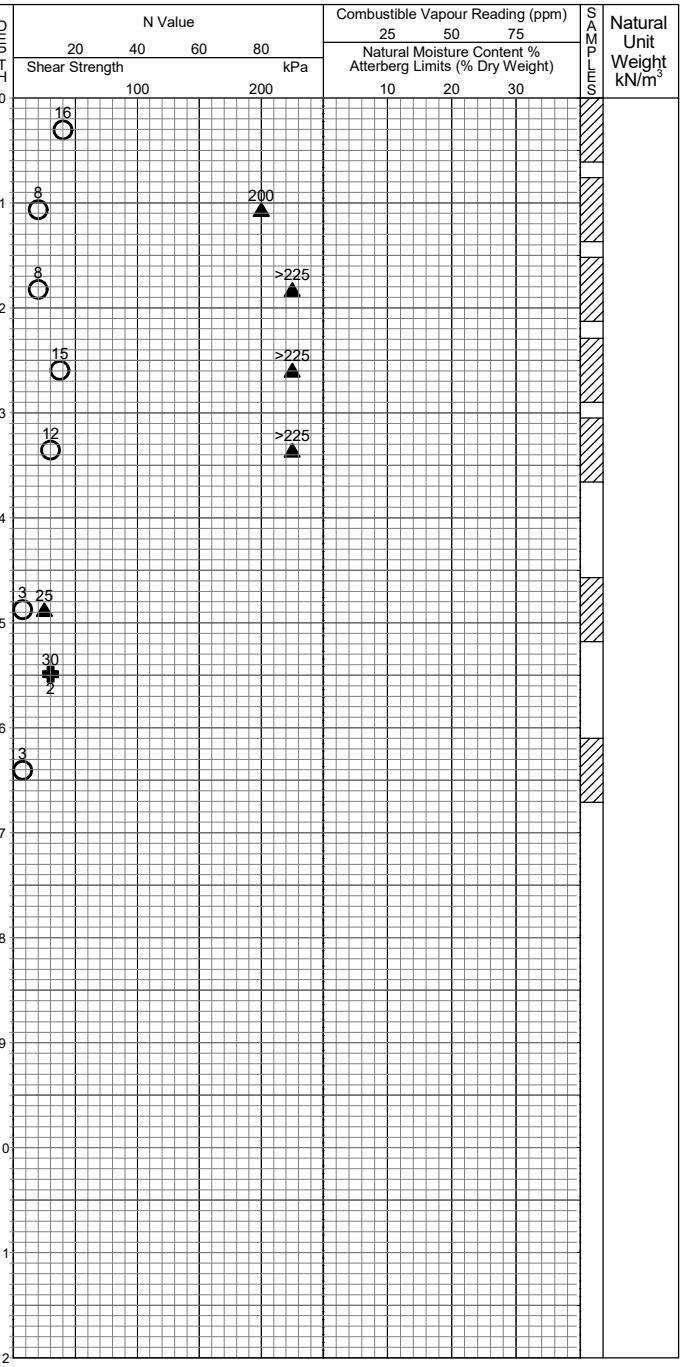
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
		GRANULAR FILL: (~125 mm thick)	177.69
		FILL: silty clay, trace sand, brown, moist, black organic staining	~177.6
		SILTY CLAY: trace sand, brown, moist, hard	~176.8
		greyish brown, firm below 4.6 m	
		Borehole terminated at 6.7 m depth	~171.0

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.7

Log of Borehole BH-17

Project No. HAM-00801631-A0 | Drawing No. 19

Project: Proposed Subdivision | Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 13, 2020

Drill Type: D-50 Track Mount. Solid Stem.

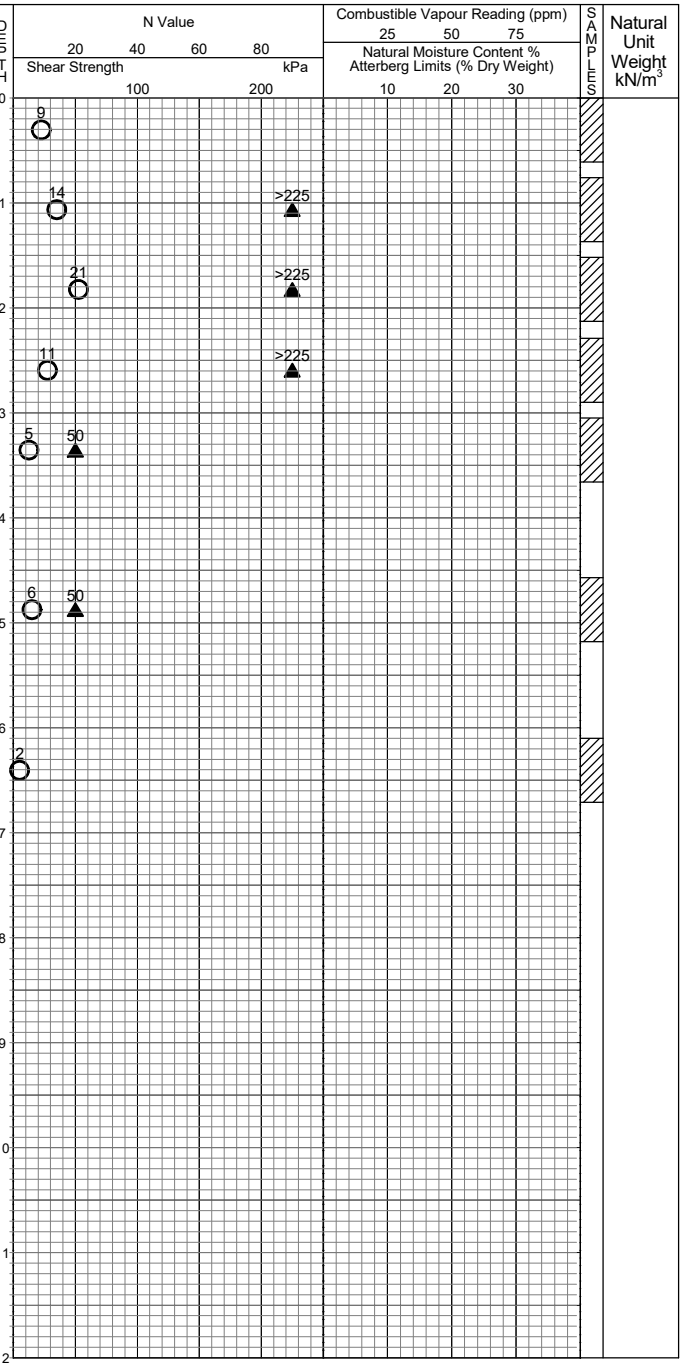
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
		FILL: silty clay, occasional rootlets, brown, moist,	177.16
			~176.9
		SILTY CLAY: trace sand, brown, moist, hard	
		greyish brown, firm below 3.1 m	
			~170.5
		Borehole terminated at 6.7 m depth	

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.7

Log of Borehole BH-18

Project No. HAM-00801631-A0 Drawing No. 20

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 13, 2020

Drill Type: D-50 Track Mount. Solid Stem.

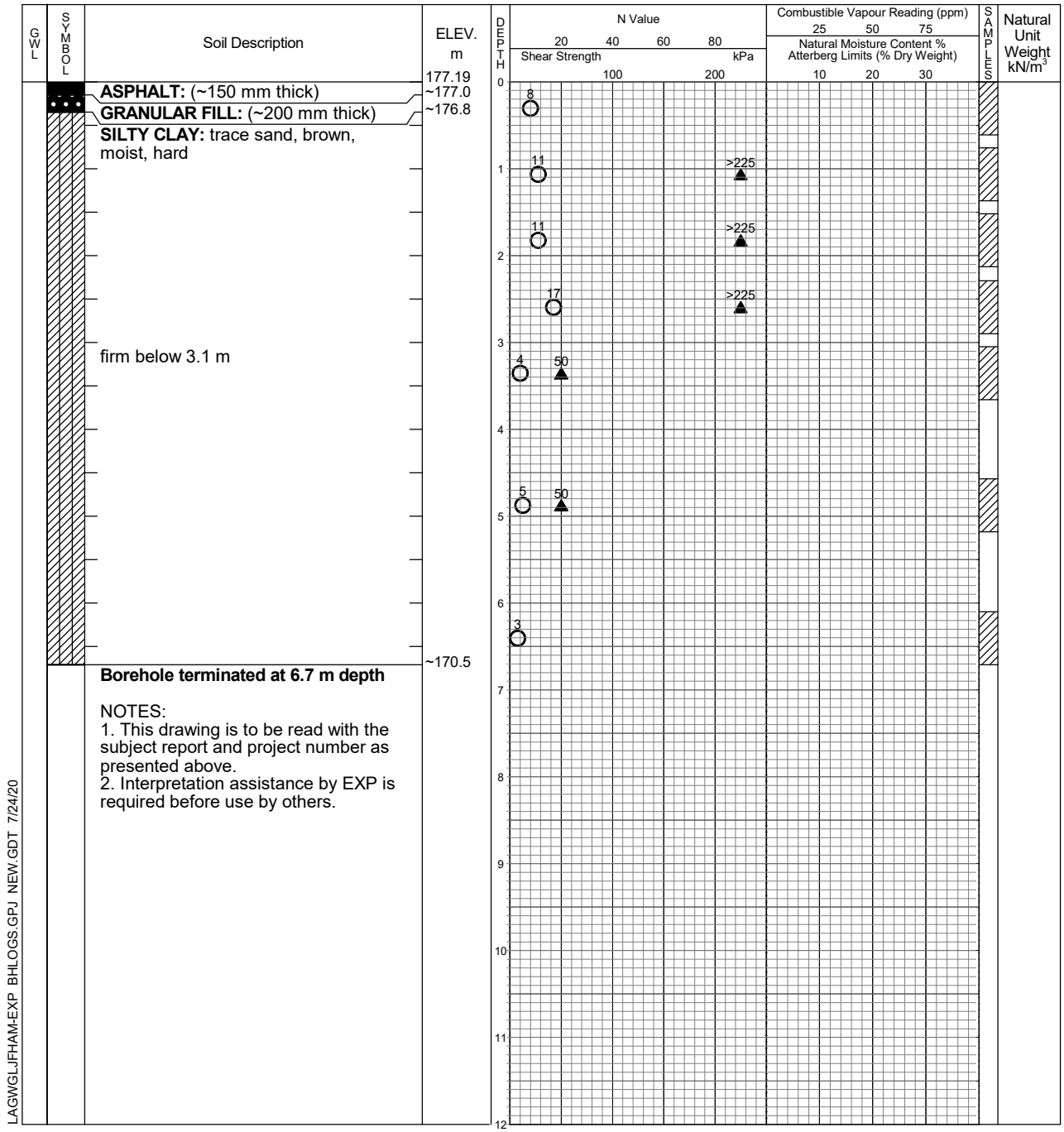
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
		ASPHALT: (~150 mm thick)	177.19
		GRANULAR FILL: (~200 mm thick)	~177.0
		SILTY CLAY: trace sand, brown, moist, hard	~176.8
		firm below 3.1 m	
		Borehole terminated at 6.7 m depth	~170.5

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.7

Log of Borehole BH-19

Project No. HAM-00801631-A0 Drawing No. 21

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

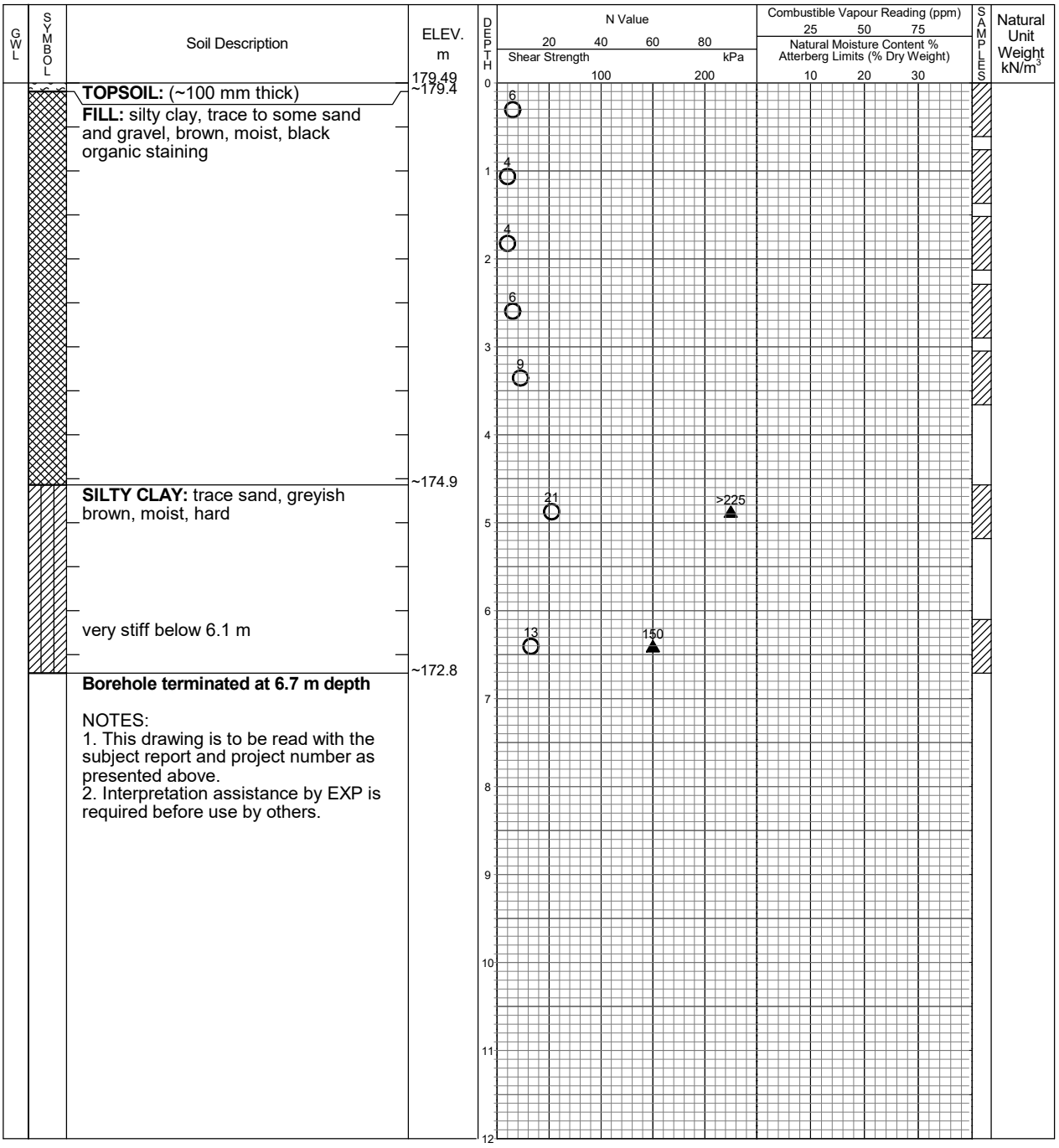
Date Drilled: July 13, 2020

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.7

Log of Borehole BH-20

Project No. HAM-00801631-A0 Drawing No. 22

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 13, 2020

Drill Type: D-50 Track Mount. Solid Stem.

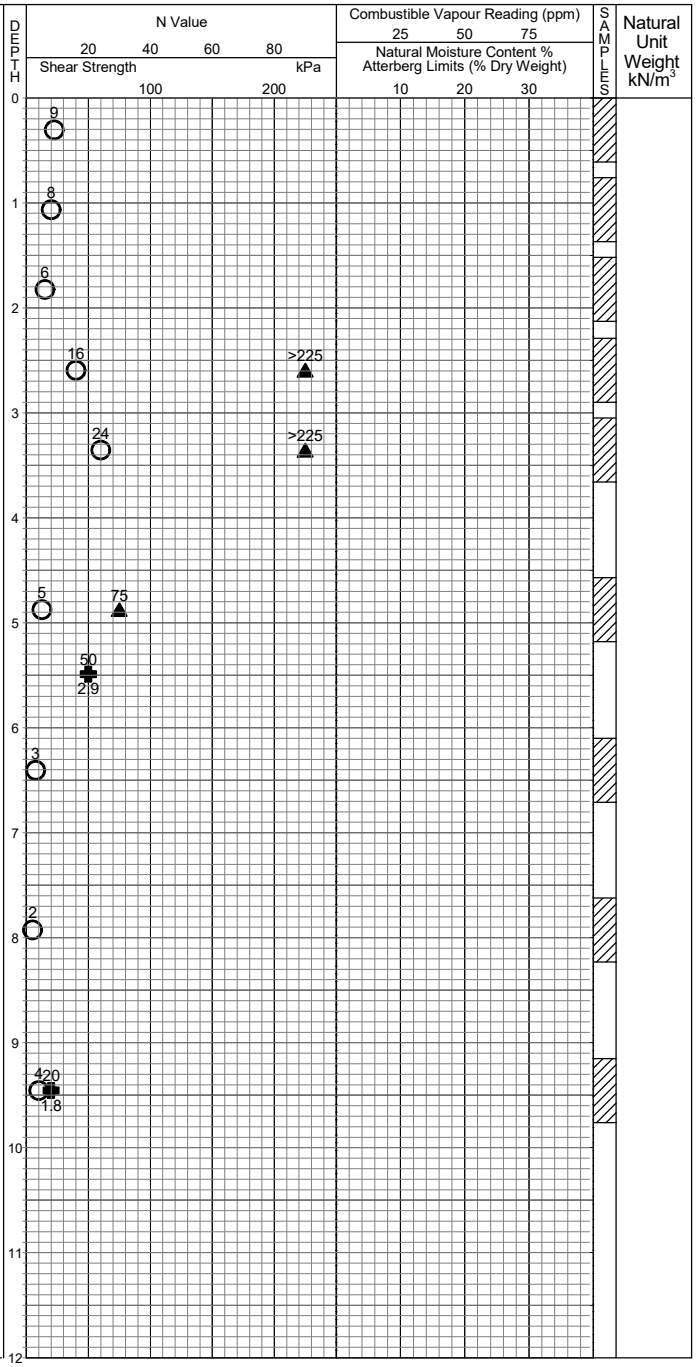
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
			178.29
		ASPHALT: (~75 mm thick)	~178.2
		GRANULAR FILL: (~100 mm thick)	~178.1
		FILL:silty clay, trace sand, moist, black organic staining	
			~176.0
		SILTY CLAY: trace sand, brown, moist, hard	
		greyish brown, stiff below 4.6 m	
		firm below 5.5 m	
			~171.6
		Borehole terminated at 6.7 m depth	

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	9.8

Log of Borehole BH-21

Project No. HAM-00801631-A0 Drawing No. 23

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 13, 2020

Drill Type: D-50 Track Mount. Solid Stem.

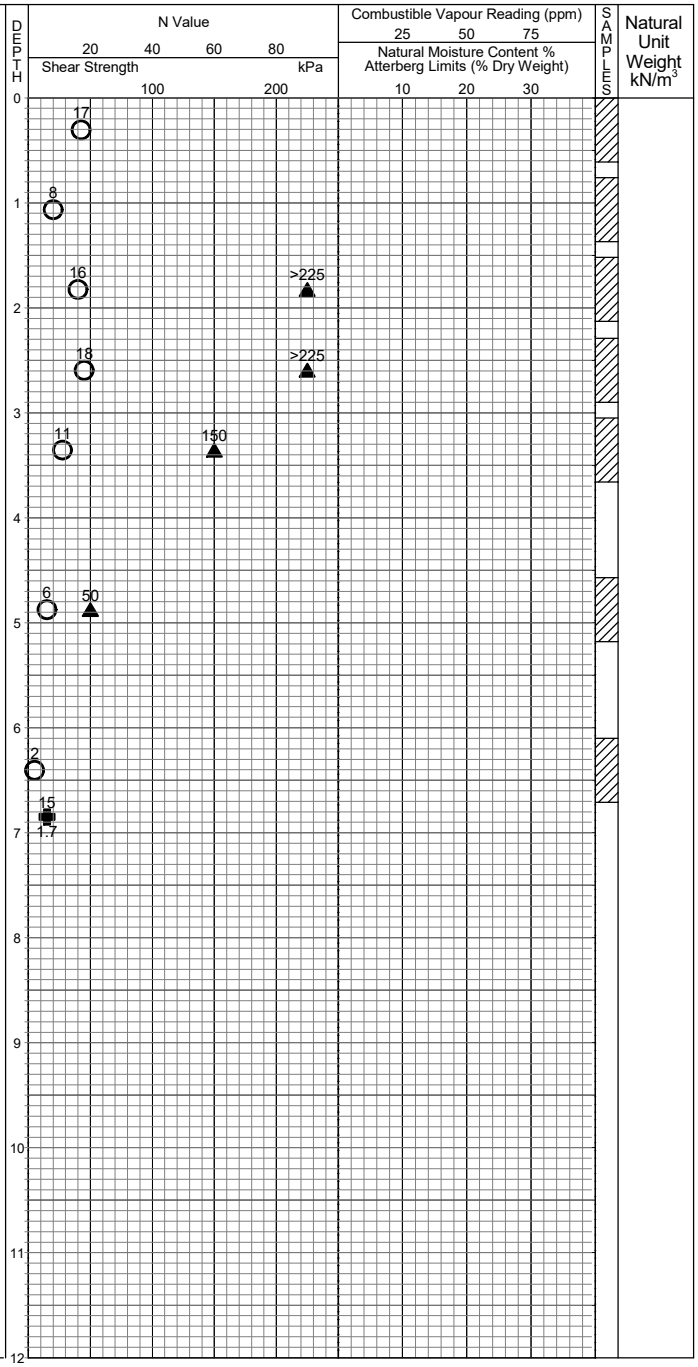
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
			177.65
		ASPHALT: (~75 mm thick)	~177.6
		GRANULAR FILL: (~100 mm thick)	~177.5
		FILL:silty clay with granular seams and topsoil inclusions, moist, black organic staining	~176.8
		SILTY CLAY: trace sand, brown, moist, hard	
		very stiff below 3.1 m	
		greyish brown, firm below 4.6 m	
			~170.7
		Borehole terminated at 7.0 m depth	

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	6.4	6.7

Log of Borehole BH-22

Project No. HAM-00801631-A0 Drawing No. 24

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 14, 2020

Drill Type: D-50 Track Mount. Solid Stem.

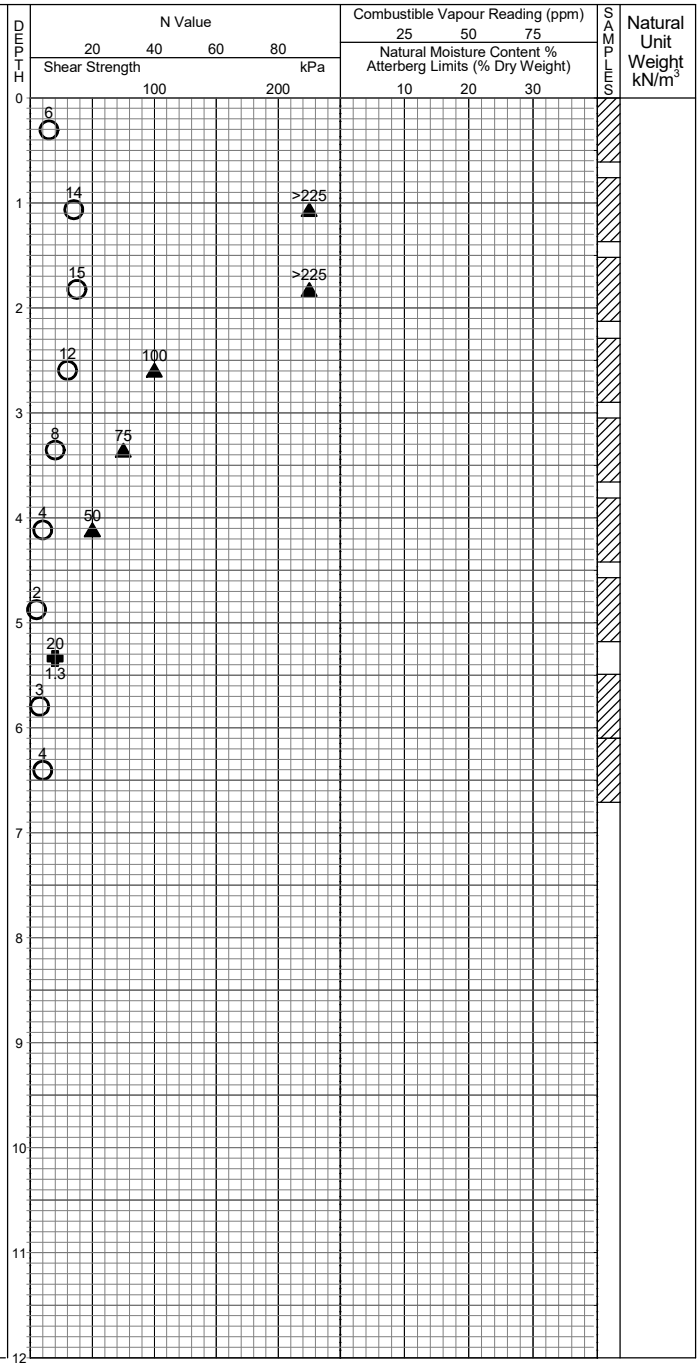
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
			176.88
		ASPHALT: (~75 mm thick)	~176.8
		GRANULAR FILL: (~100 mm thick)	~176.7
		SILTY CLAY: trace sand, brown, moist, hard	
		stiff below 2.3 m	
		greyish brown, firm below 3.8 m	
			~170.2
		Borehole terminated at 6.7 m depth	

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.7

Log of Borehole BH-23

Project No. HAM-00801631-A0 Drawing No. 25

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 14, 2020

Drill Type: D-50 Track Mount. Solid Stem.

Datum: Geodetic

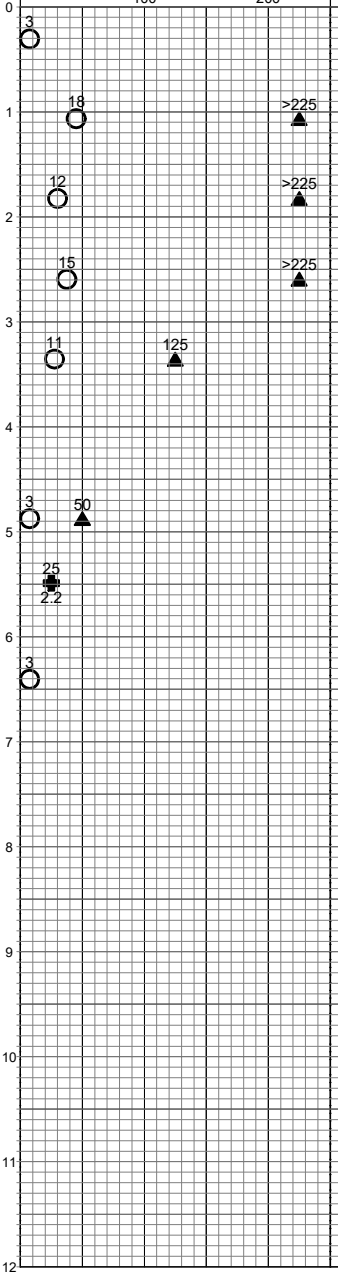
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH
		FILL: silty clay, brown, moist, black organic staining	176.99	0
		SILTY CLAY: trace sand, brown, moist, hard	~176.2	1
		very stiff below 3.1 m		3
		greyish brown, firm below 4.6 m		4
		Borehole terminated at 6.7 m depth	~170.3	7

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.

N Value (20, 40, 60, 80)
Shear Strength kPa (100, 200)
Combustible Vapour Reading (ppm) (25, 50, 75)
Natural Moisture Content % Atterberg Limits (% Dry Weight) (10, 20, 30)
SAMPLES
Natural Unit Weight kN/m³



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.7

Log of Borehole BH-24

Project No. HAM-00801631-A0 | Drawing No. 26

Project: Proposed Subdivision | Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 14, 2020

Drill Type: D-50 Track Mount. Solid Stem.

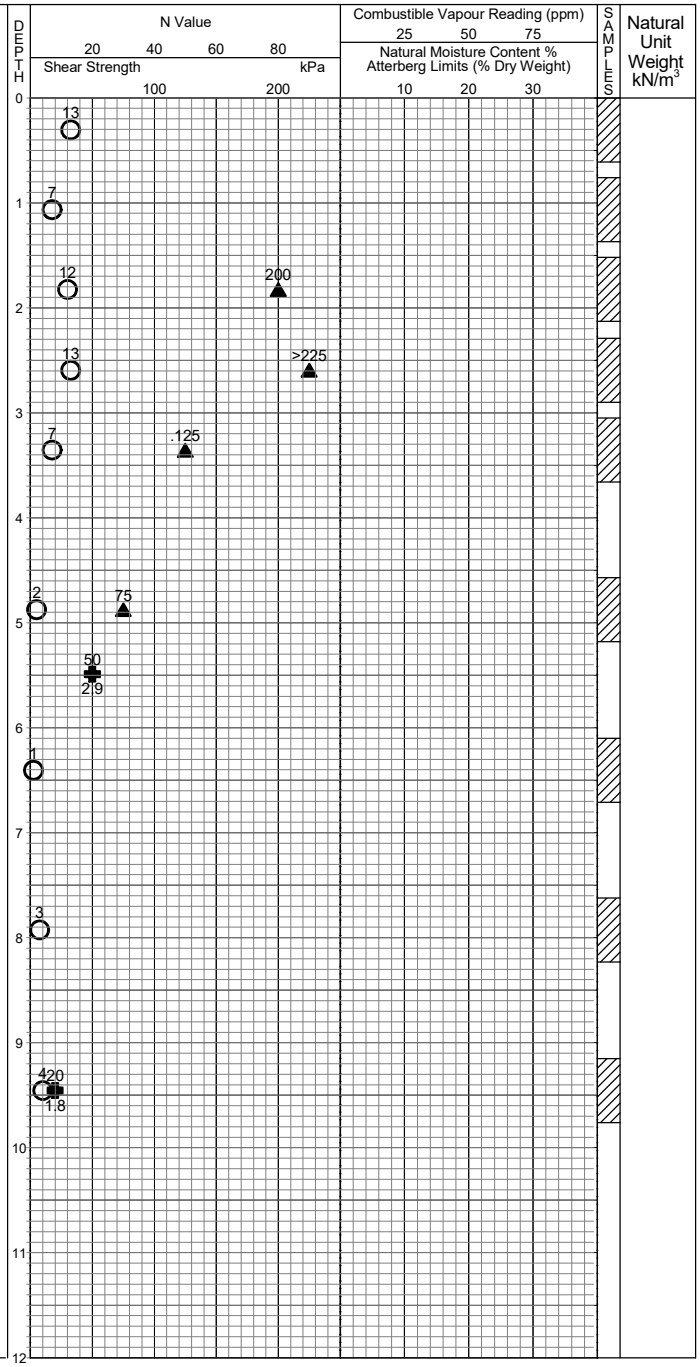
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

Soil Description	ELEV. m
177.06	
ASPHALT: (~75 mm thick)	~177.0
GRANULAR FILL: (~825 mm thick)	
SILTY CLAY: trace sand, brown, moist, hard	~176.2
very stiff below 3.1 m	
greyish brown below 3.8 m	
stiff below 4.6 m	
firm below 5.5 m	
Borehole terminated at 9.8 m depth	~167.3

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	7.9	9.8

Log of Borehole BH-25

Project No. HAM-00801631-A0 Drawing No. 27

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 16, 2020

Drill Type: D-50 Track Mount. Solid Stem.

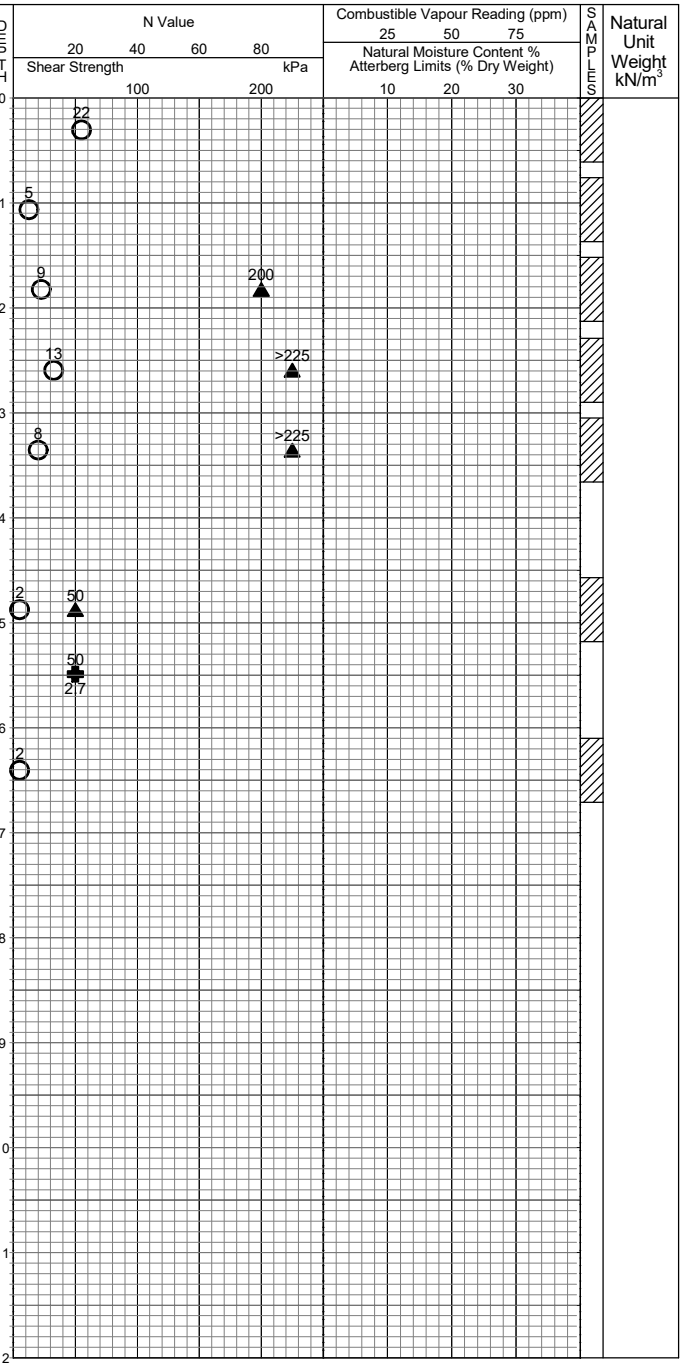
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
			177.23
		TOPSOIL: (~150 mm thick)	~177.1
		FILL: silty clay, trace sand and gravel, brown, moist	
			~176.2
		SILTY CLAY: trace sand, brown, moist, hard	
		greyish brown below 3.1 m	
		stiff below 4.6 m	
			~170.5
		Borehole terminated at 6.7 m depth	

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.7

Log of Borehole BH-26

Project No. HAM-00801631-A0 Drawing No. 28

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 16, 2020

Drill Type: D-50 Track Mount. Solid Stem.

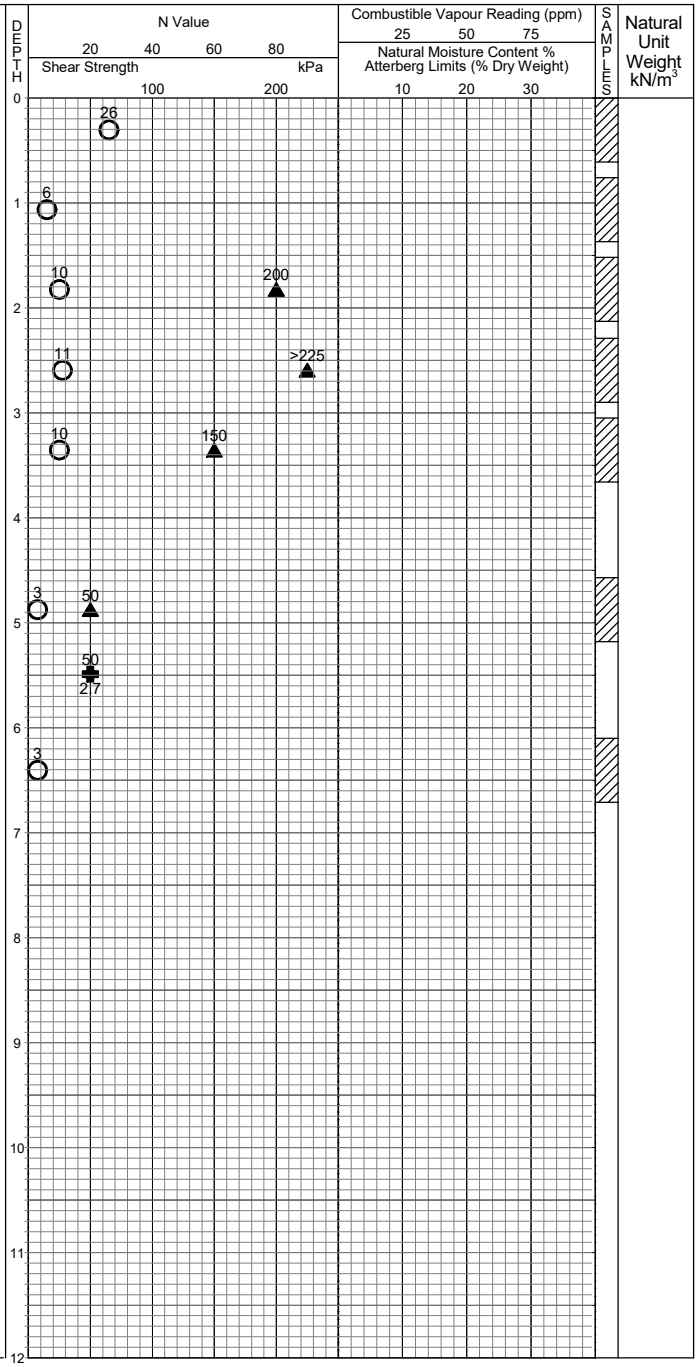
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
			176.66
		TOPSOIL: (~75 mm thick)	~176.6
		FILL: silty clay, trace sand and gravel, brown, moist	
			~175.6
		SILTY CLAY: trace sand, brown, moist, hard	
		greyish brown, very stiff below 3.1 m	
		stiff below 4.6 m	
			~170.0
		Borehole terminated at 6.7 m depth	

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.7

Log of Borehole BH-27

Project No. HAM-00801631-A0 Drawing No. 29

Project: Proposed Subdivision Sheet No. 1 of 1

Location: 555 Canal Bank Street, Welland, ON

Date Drilled: July 14, 2020

Drill Type: D-50 Track Mount. Solid Stem.

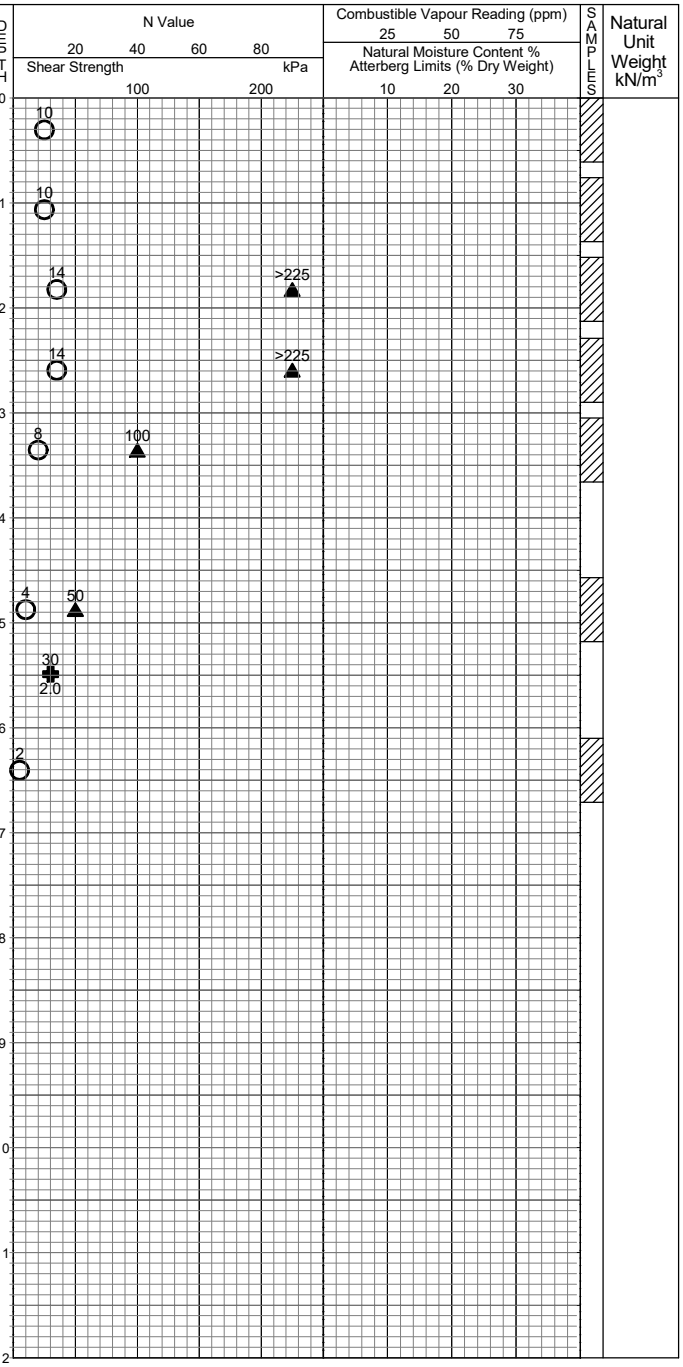
Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m
			176.77
		TOPSOIL: (~125 mm thick)	~176.6
		FILL: silty clay, trace sand and gravel, brown, moist, black organic staining	
			~175.7
		SILTY CLAY: trace sand, brown, moist, hard	
		very stiff below 3.1 m	
		greyish brown, firm below 4.6 m	
			~170.1
		Borehole terminated at 6.7 m depth	

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.

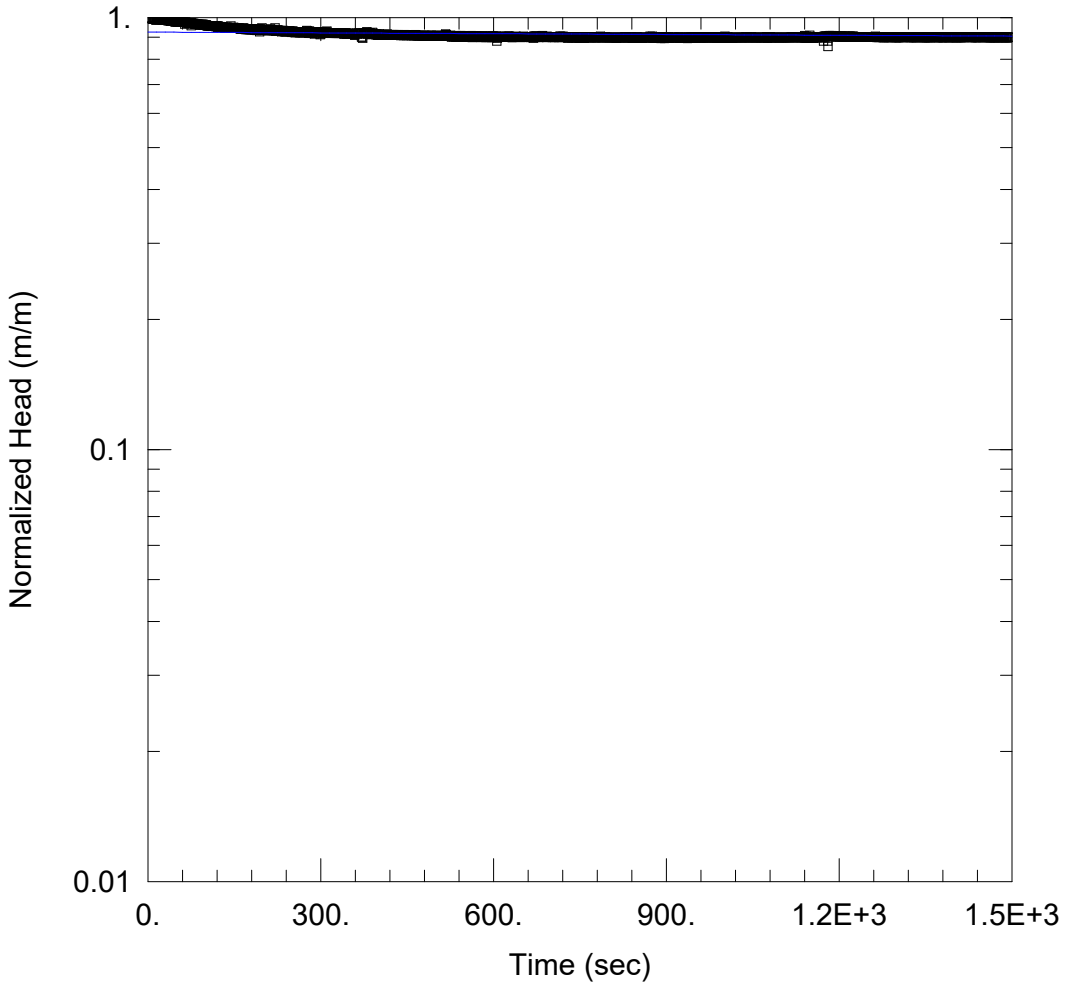


LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 7/24/20

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	6.7

Appendix C:
SWRT and Infiltration Testing Results



RISING HEAD - SWRT - BH/MW 1

Data Set: \...\BHMW1.aqt
Date: 03/12/19 Time: 10:37:18

PROJECT INFORMATION

Company: EXP Service Inc.
Client: Empire Communities
Project: HAM-00801631
Location: 555 Canal Bank St, Welland, ON
Test Well: BH/MW 1
Test Date: March 4, 2019

AQUIFER DATA

Saturated Thickness: 2.386 m Anisotropy Ratio (Kz/Kr): 1.

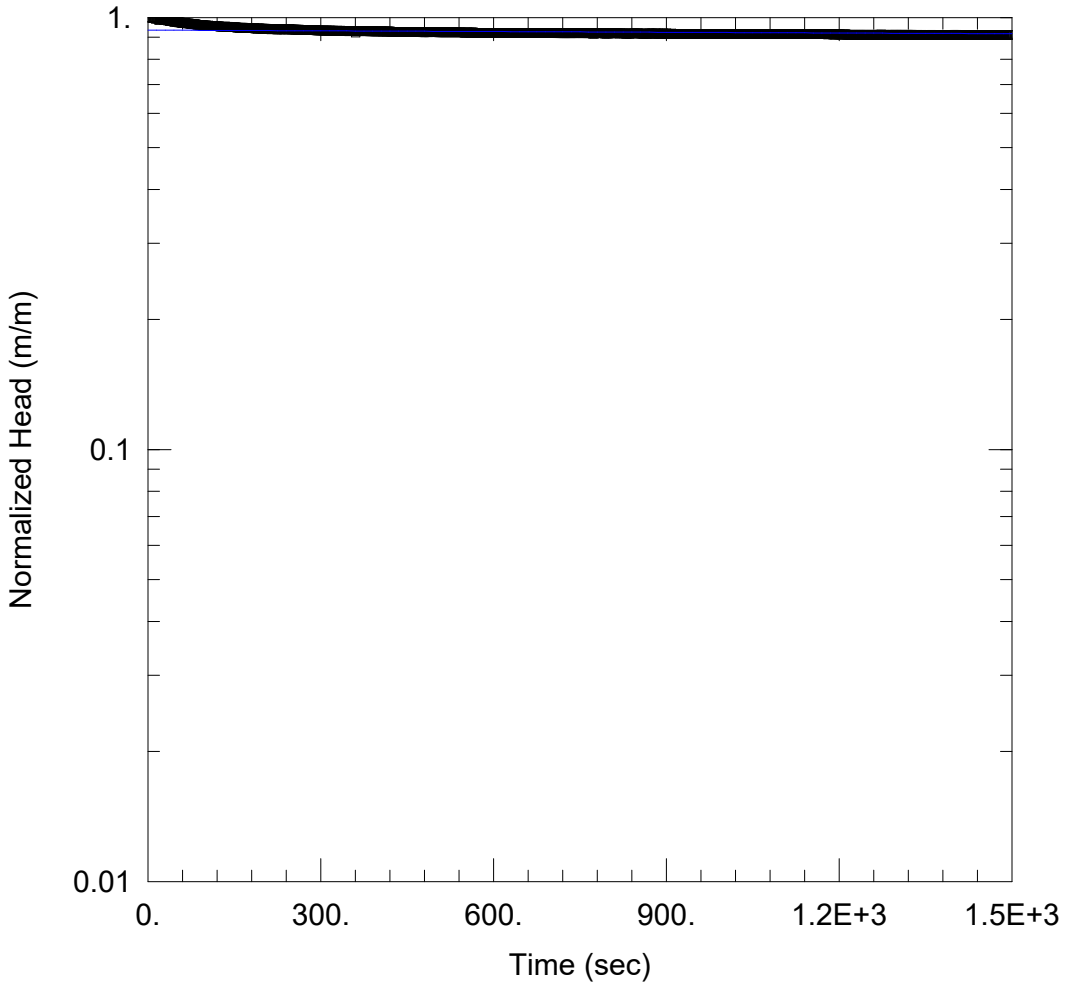
WELL DATA (BH/MW 1)

Initial Displacement: 1.071 m
Total Well Penetration Depth: 3. m
Casing Radius: 0.0254 m
Static Water Column Height: 2.386 m
Screen Length: 3. m
Well Radius: 0.1016 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 1.02E-8 m/sec y0 = 0.991 m



RISING HEAD - SWRT - BH/MW 4

Data Set: \...\BHMW4.aqt
Date: 03/12/19 Time: 10:40:38

PROJECT INFORMATION

Company: EXP Service Inc.
Client: Empire Communities
Project: HAM-00801631
Location: 555 Canal Bank St, Welland, ON
Test Well: BH/MW 4
Test Date: March 4, 2019

AQUIFER DATA

Saturated Thickness: 3.76 m Anisotropy Ratio (Kz/Kr): 1.

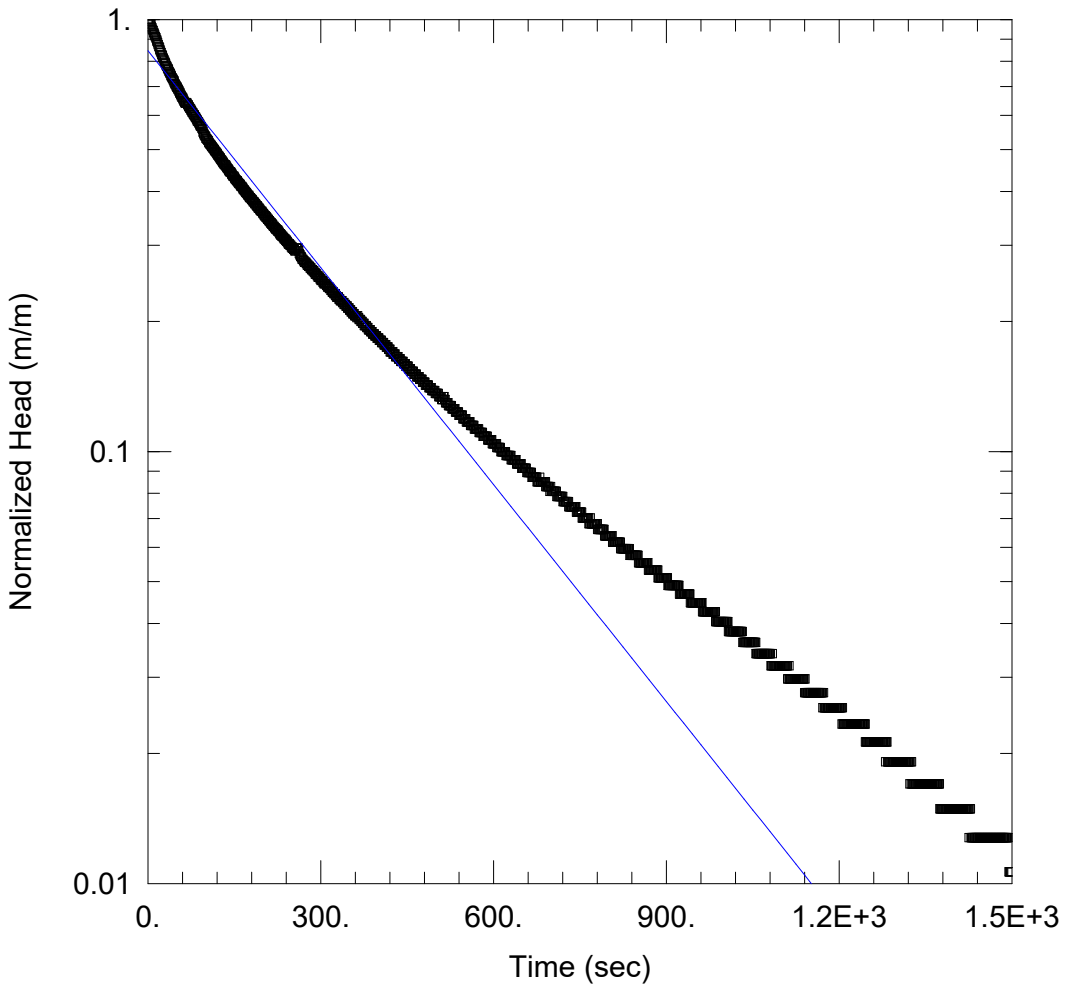
WELL DATA (BH/MW 4)

Initial Displacement: 1.681 m
Total Well Penetration Depth: 3.76 m
Casing Radius: 0.0254 m
Static Water Column Height: 3.76 m
Screen Length: 3. m
Well Radius: 0.1016 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 5.59E-9 m/sec y0 = 1.572 m



FALLING HEAD - SWRT - BH/MW 6

Data Set: \...\BHMW6.aqt
Date: 03/12/19 Time: 10:44:33

PROJECT INFORMATION

Company: EXP Service Inc.
Client: Empire Communities
Project: HAM-00801631
Location: 555 Canal Bank St, Welland, ON
Test Well: BH/MW 6
Test Date: March 4, 2019

AQUIFER DATA

Saturated Thickness: 3.895 m Anisotropy Ratio (Kz/Kr): 1.

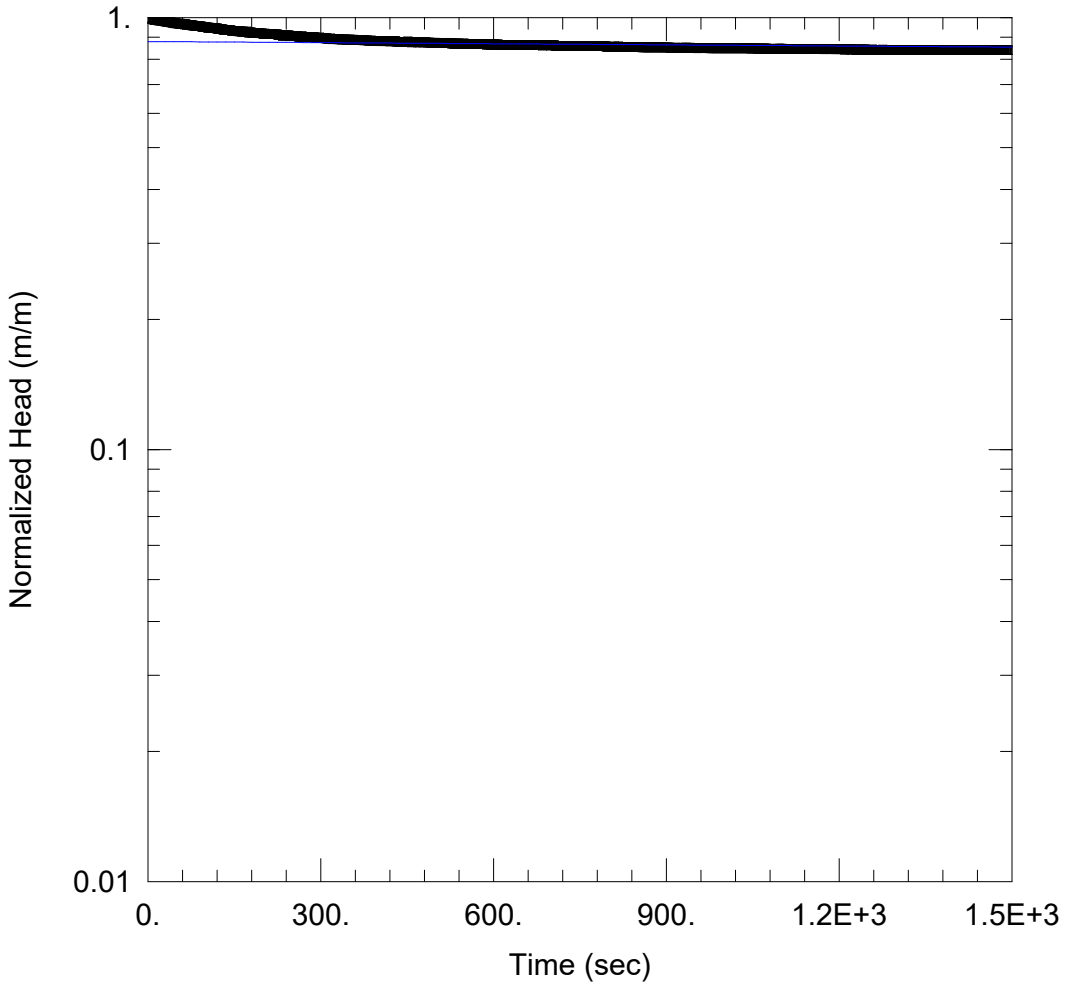
WELL DATA (BH/MW 6)

Initial Displacement: 1.41 m
Total Well Penetration Depth: 3.895 m
Casing Radius: 0.0254 m
Static Water Column Height: 3.895 m
Screen Length: 3. m
Well Radius: 0.1016 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 1.69E-6 m/sec y0 = 1.193 m



RISING HEAD - SWRT - BH/MW 8

Data Set: \...\BHMW8_risinghead.aqt
Date: 03/12/19 Time: 11:10:58

PROJECT INFORMATION

Company: EXP Service Inc.
Client: Empire Communities
Project: HAM-00801631
Location: 555 Canal Bank St, Welland, ON
Test Well: BH/MW 8
Test Date: March 4, 2019

AQUIFER DATA

Saturated Thickness: 1.595 m Anisotropy Ratio (Kz/Kr): 1.

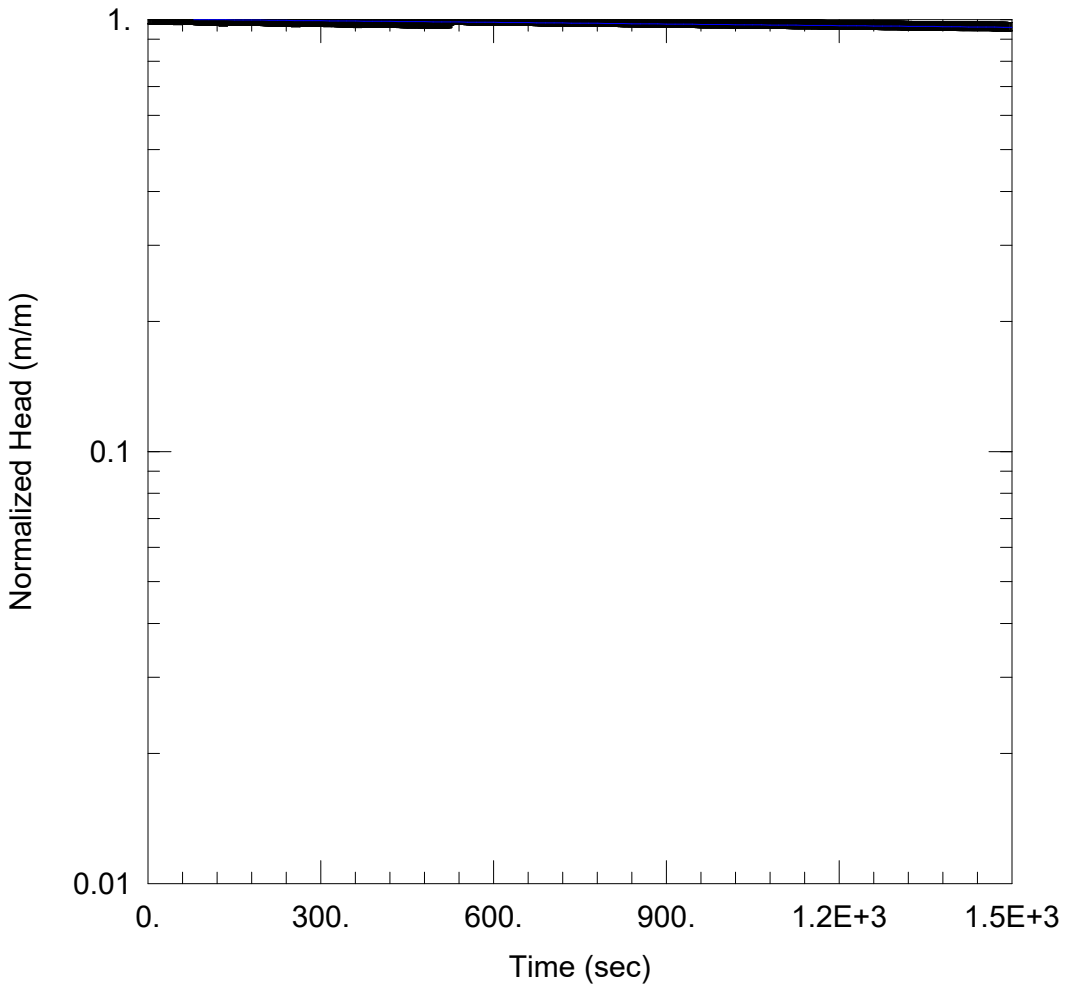
WELL DATA (New Well)

Initial Displacement: 1.287 m Static Water Column Height: 1.595 m
Total Well Penetration Depth: 3. m Screen Length: 3. m
Casing Radius: 0.0254 m Well Radius: 0.1016 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 2.13E-8 m/sec y0 = 1.132 m



RISING HEAD - SWRT - BH/MW 10

Data Set: \...\BHMW10.aqt
Date: 03/12/19 Time: 11:13:31

PROJECT INFORMATION

Company: EXP Service Inc.
Client: Empire Communities
Project: HAM-00801631
Location: 555 Canal Bank St, Welland, ON
Test Well: BH/MW 10
Test Date: March 4, 2019

AQUIFER DATA

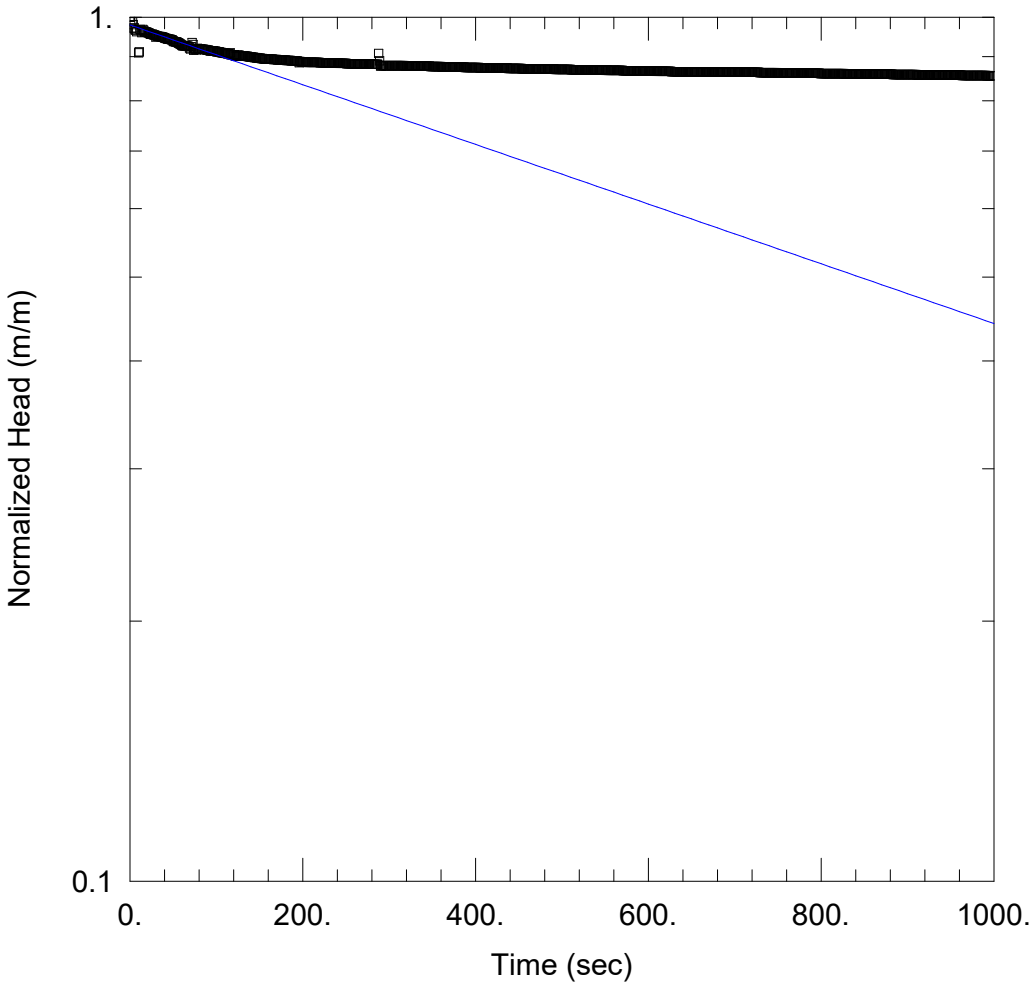
Saturated Thickness: 7.482 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH/MW 10)

Initial Displacement: 1.528 m
Total Well Penetration Depth: 7.482 m
Casing Radius: 0.0254 m
Static Water Column Height: 7.482 m
Screen Length: 3. m
Well Radius: 0.1016 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 1.28E-8 m/sec
y0 = 1.532 m



BH/MW 15_RISING HEAD SWRT

Data Set: C:\Working Projects\555 Canal Bank St\Slug tests\BHMW15.aqt
Date: 07/28/20 Time: 13:44:19

PROJECT INFORMATION

Company: Exp Services Inc.
Client: Elite Construction Inc
Project: HAM-00801631-A0
Location: 555 Canal Bank, Welland, ON
Test Well: BH/MW 15
Test Date: July 27, 2020

AQUIFER DATA

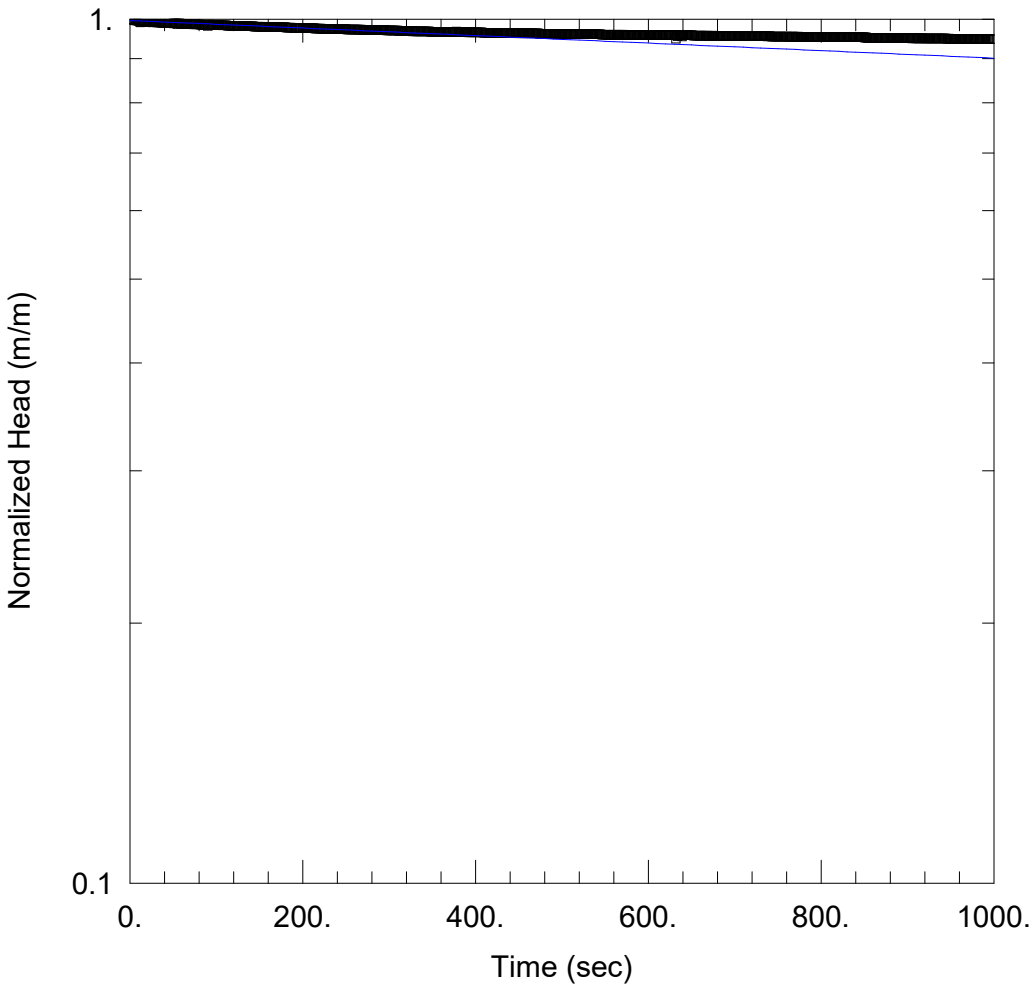
Saturated Thickness: 5.135 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH/MW 15)

Initial Displacement: 4.2 m
Total Well Penetration Depth: 5.135 m
Casing Radius: 0.025 m
Static Water Column Height: 5.135 m
Screen Length: 3. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 4.542E-7 m/sec
y0 = 4.113 m



BH/MW 27_RISING HEAD SWRT

Data Set: C:\Working Projects\555 Canal Bank St\Slug tests\BHMW27.aqt
Date: 07/28/20 Time: 13:50:12

PROJECT INFORMATION

Company: Exp Services Inc.
Client: Elite Construction Inc
Project: HAM-00801631-A0
Location: 555 Canal Bank, Welland, ON
Test Well: BH/MW 27
Test Date: July 27, 2020

AQUIFER DATA

Saturated Thickness: 4.21 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH/MW 27)

Initial Displacement: 3.48 m
Total Well Penetration Depth: 4.21 m
Casing Radius: 0.025 m
Static Water Column Height: 4.21 m
Screen Length: 3. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 5.731E-8 m/sec y0 = 3.467 m

Location:	John Deere
Date:	Jul 8 and 27, 2020
Weather:	Sunny, 35*C
Analyst:	JL

Borehole radius (cm):	3.8
Soil class:	Strong capillarity

Test Location	Start depth of water (cm)	End depth of water (cm)	Start time (*decimal min)	End time (*decimal min)	K_{fs} (mm/hr)	Kfs (cm/sec)	Kfs (m/sec)
IT1	34.32	31.22	0.0	16.5	0.9	2.6E-05	2.6E-07
IT2	27.91	14.52	0.0	228.2	0.4	1.2E-05	1.2E-07
IT3	36.54	33.03	0.0	137.7	0.1	3.3E-06	3.3E-08
IT4	38.7	1.5	0.0	8.3	35.5	9.9E-04	9.9E-06
IT5	23.7	22.5	0.0	4.3	2.0	5.4E-05	5.4E-07
IT6	47.11	33.8	0.0	137.7	0.4	1.0E-05	1.0E-07

John Deere Lands
HAM-00801631-A0
Low Impact Design (LID) Calculations for Infiltration Gallery

Test Location	Hydraulic Conductivity (K_{fs}) (cm/s)	Infiltration Rate (IR) (mm/hr)	Discrete Design Infiltration Rate(DIR) (mm/hr)	Perculation Time (min/cm)
IT1	2.6E-05	32	13	47
IT2	1.2E-05	26	11	57
IT3	3.3E-06	19	7	81
IT4	9.9E-04	85	34	18
IT5	5.40E-05	39	16	38
IT6	1.00E-05	25	10	60

Geology Units	Geometric Mean of K_{fs} (cm/s)	Infiltration Rate (I) (mm/hr)*	Ratio of Mean Measured Infiltration Rates	Safety Correction Factor (SCF)
Overlying Geology Unit	2.86E-05	33	1.0	2.5
Underlying Geology Unit (1.5 m below the bottom of trench)	2.86E-05	33		

Design Infiltration Rate(DIR) (mm/hr)	Minimum	7	**Perculation Time (min/cm)**	18
	Maximum	34		81
	Geometric Mean	**14**		**44**

Note:
Analytical Solutions (CVC and TRCA 2010)

$$Infiltration\ Rate\ (IR) = \left(\frac{K_{fs}}{6x10^{-11}}\right)^{\frac{1}{3.7363}}$$

$$Design\ Infiltration\ Rate\ (DIR) = \frac{IR}{SCF}$$

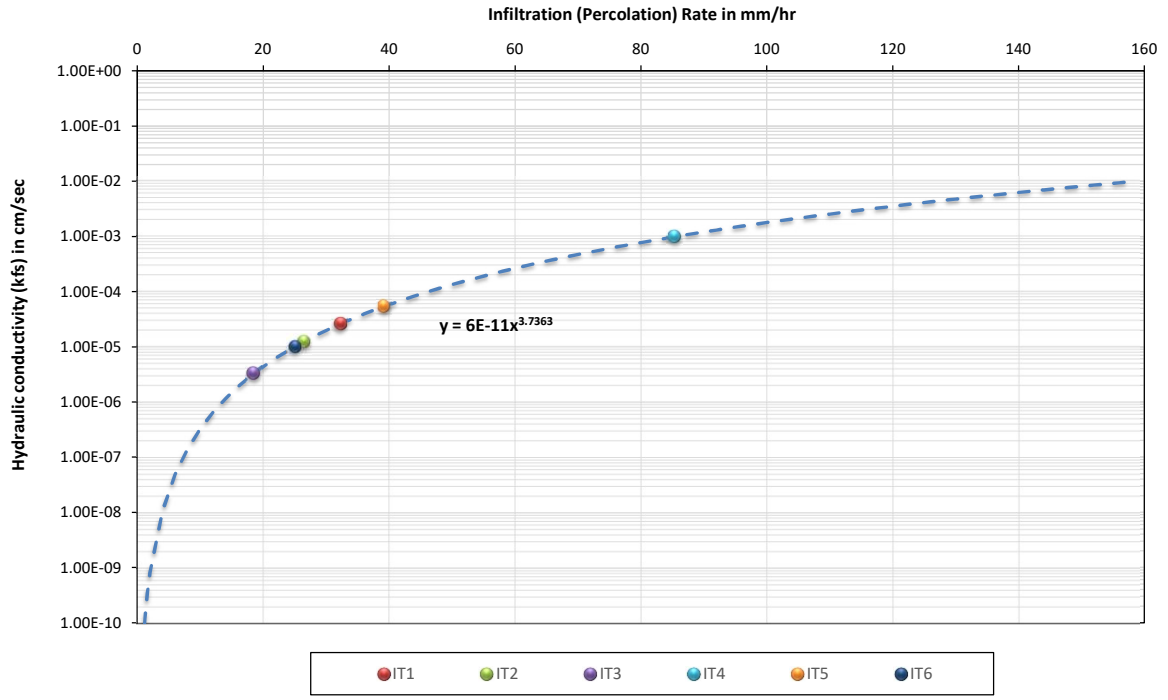
Kfs: hydraulic conductivity (cm/sec)

IR: infiltration rate (mm/hr)

DIR: design infiltration rate (mm/hr)

SCF: Safety Correction Factor (based on the chart recommended by CVC and TRCA, 2010)

Figure : Approximate relationship between infiltration rate and hydraulic conductivity (LID SWM planning and Design Guide, Appendix C1)

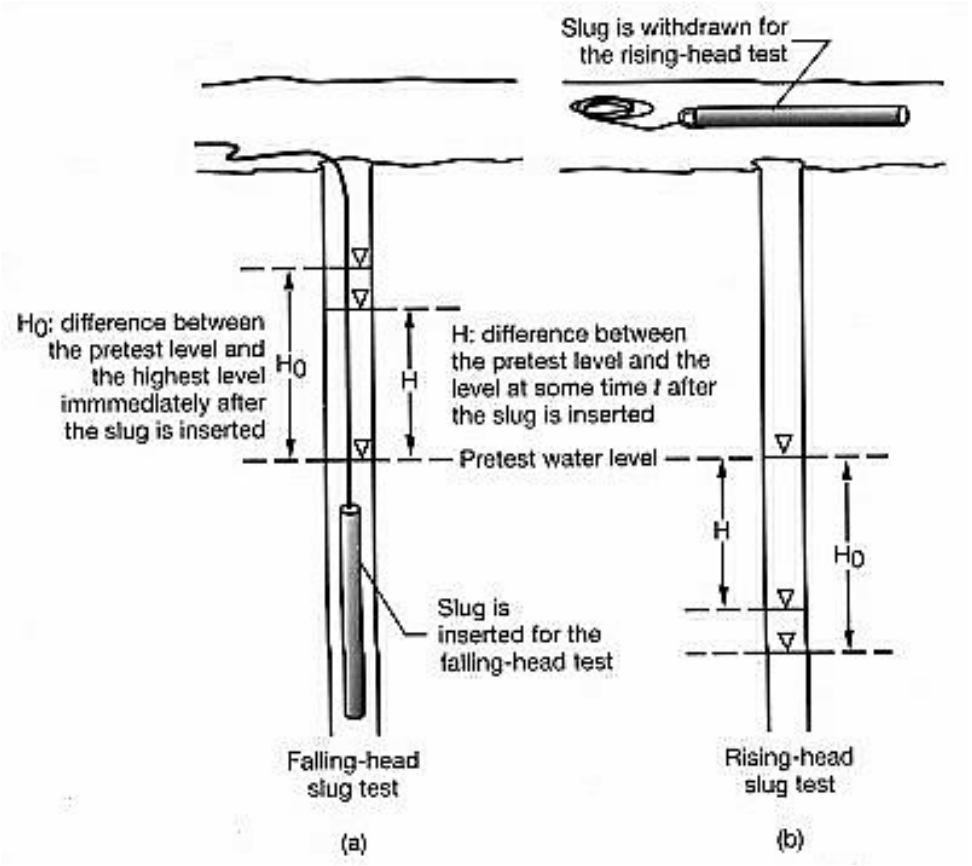


Single Well Response Test Procedure

A Single Well Response Test (SWRT), also known as a bail test or a slug test, is conducted in order to determine the saturated hydraulic conductivity (K) of an aquifer. The method of the SWRT is to characterize the change of groundwater level in a well or borehole over time.

In order to ensure consistency and repeatability, all **exp** employees are to follow the procedure outlined in this document when conducting SWRTs.

The figure below depicts a schematic of a slug and bail test and the respective water level changes.



Initials ___

Slug Test Procedure

Equipment Required

- Copy of a signed health and safety plan
- Copy of the work program
- PPE as required by Site-Specific HASP
- Copy of the monitoring well location plan/site plan
- Waterproof pen and bound field note book
- SWRT field data Entry form
- Disposable gloves
- Duct tape
- Deionized water
- Alconox (phosphate free detergent)
- Spray bottles
- Electronic water level meter and spare batteries
- Solid PVC or stainless steel slug of known volume or clean water
- String (nylon)
- Water pressure transducer (data logger) and baro-logger
- Watch or stop watch with second hand
- Plastic sheeting

Testing Procedure

1. Remove cap from well and collect static water level
2. Remove waterra tubing/bailer and place in garbage bag. Record static water level measurement again.
3. Lower the slug into the well and record the dynamic water level.
4. Record the drawdown (for the slug test) at set five (5) second intervals for the first five (5) minutes, then reduce to every one (1) minute.
5. Continue recording the drawdown until 95% recovery is reached. To calculate this value: Find the difference between the dynamic water level and the static water level, then multiply by 95% (.95). Add the resulting value to the dynamic water level.

   (Static Water Level – Dynamic Water Level).95 + Static Water Level = 95% Recovery Value
6. Once complete, replace the waterra tubing/bailer and re-secure the well cap.

Note: If the well is deep, more than one slug may be inserted by attaching the slugs to a series.

Slugs must be washed with methanol, then lab grade soap, and then rinsed with de-ionized water after each use.

Based on the recorded observations, the hydraulic conductivity (in m/s) of the aquifer will be determined. In order to determine the hydraulic conductivity; the well diameter, radius of the borehole and length of the screen will also be required.

Bail Test Procedure

Equipment Required

- 20 L (5 gal) Graduated pail
- Stop watch or watch with seconds
- Garbage bags
- Water level meter
- Field sheets/log book
- Latex Gloves
- Bailer and Rope

Procedure

1. Remove cap from well and collect static water level.
2. If using a **bailer**:
    a. Affix the rope to the bailer.
    b. Remove the waterra tubing and place in garbage bag
    c. Record static water level measurement again.
    d. Record how much water was removed by either counting the number of full bailers or emptying removed water into a container.
    e. Quickly lower the bailer into the well and remove.
    f. Continue this process until the water level will reduce no further.
    g. Record the dynamic water level.
3. If using **waterra** to bail the water:
    a. Pump the water into graduated bucket until the water level will reduce no further.
    b. Record how much water has been removed.
    c. Record the dynamic water level.
4. Record the recovery at set five (5) second intervals for the first (5) minutes, then reduce to every one (1) minute.
5. Continue recording the drawdown/recovery until 95% recovery is reached.
6. Once complete, replace any waterra tubing that may have been removed from the well and re-secure the well cap.

Appendix D:
Laboratory's Certificates of Analysis

Maxxam
A Bureau Veritas Group Company

Your P.O. #: ENV-BRM
Your Project #: HAM-00801631-A0
Site Location: John Deere Lands
Your C.O.C. #: 706566-01-01

Attention: Francois Chartier

exp Services Inc
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2019/03/11
Report #: R5624491
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B956353
Received: 2019/03/04, 17:37

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Biochemical Oxygen Demand (BOD)	1	2019/03/06	2019/03/11	CAM SOP-00427	SM 23 5210B m
Total Cyanide	1	2019/03/06	2019/03/06	CAM SOP-00457	OMOE E3015 5 m
Fluoride	1	2019/03/06	2019/03/06	CAM SOP-00449	SM 23 4500-F C m
Mercury in Water by CVAA	1	2019/03/06	2019/03/07	CAM SOP-00453	EPA 7470A m
Total Metals Analysis by ICPMS	1	N/A	2019/03/06	CAM SOP-00447	EPA 6020B m
Animal and Vegetable Oil and Grease	1	N/A	2019/03/08	CAM SOP-00326	EPA1664B m,SM5520B m
Total Oil and Grease	1	2019/03/08	2019/03/08	CAM SOP-00326	EPA1664B m,SM5520A m
pH	1	N/A	2019/03/06	CAM SOP-00413	SM 4500H+ B m
Phenols (4AAP)	1	N/A	2019/03/06	CAM SOP-00444	OMOE E3179 m
Sulphate by Automated Colourimetry	1	N/A	2019/03/06	CAM SOP-00464	EPA 375.4 m
Sulphide	1	N/A	2019/03/06	CAM SOP-00455	SM 23 4500-S G m
Total Kjeldahl Nitrogen in Water	1	2019/03/06	2019/03/06	CAM SOP-00938	OMOE E3516 m
Mineral/Synthetic O & G (TPH Heavy Oil) (1)	1	2019/03/08	2019/03/08	CAM SOP-00326	EPA1664B m,SM5520F m
Total Suspended Solids	1	2019/03/05	2019/03/07	CAM SOP-00428	SM 23 2540D m
Volatile Organic Compounds in Water	1	N/A	2019/03/07	CAM SOP-00226	EPA 8260C m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Maxxam
A Bureau Veritas Group Company

Your P.O. #: ENV-BRM
Your Project #: HAM-00801631-A0
Site Location: John Deere Lands
Your C.O.C. #: 706566-01-01

Attention: Francois Chartier

exp Services Inc
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2019/03/11
Report #: R5624491
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B956353
Received: 2019/03/04, 17:37

Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) Note: TPH (Heavy Oil) is equivalent to Mineral / Synthetic Oil & Grease

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Tanya Fidlin, Project Manager
Email: tfidlin@maxxam.ca
Phone# (905)817-5700
==========
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B956353
Report Date: 2019/03/11

exp Services Inc
Client Project #: HAM-00801631-A0
Site Location: John Deere Lands
Your P.O. #: ENV-BRM
Sampler Initials: CS

NIAGARA SANITARY SEWER BYLAW (27-2014)

Maxxam ID			JCR222			JCR222		
Sampling Date			2019/03/04 12:00			2019/03/04 12:00		
COC Number			706566-01-01			706566-01-01		
	UNITS	Criteria	BH/MW10	RDL	QC Batch	BH/MW10 Lab-Dup	RDL	QC Batch
Calculated Parameters								
Total Animal/Vegetable Oil and Grease	mg/L	150	2.0	0.50	6000560			
Inorganics								
Total BOD	mg/L	300	ND	2	6004412			
Fluoride (F-)	mg/L	10	0.21	0.10	6004184			
Total Kjeldahl Nitrogen (TKN)	mg/L	100	0.22	0.10	6004518	0.24	0.10	6004518
pH	pH	6.0:11	7.53		6004180			
Phenols-4AAP	mg/L	1	ND	0.0010	6004239			
Total Suspended Solids	mg/L	350	10	10	6002328			
Dissolved Sulphate (SO4)	mg/L	1500	1300	5.0	6002487			
Sulphide	mg/L	1	ND	0.020	6004407	ND	0.020	6004407
Total Cyanide (CN)	mg/L	1	ND	0.0050	6005125			
Petroleum Hydrocarbons								
Total Oil & Grease	mg/L	-	2.0	0.50	6008228			
Total Oil & Grease Mineral/Synthetic	mg/L	15	ND	0.50	6008231			
Metals								
Mercury (Hg)	mg/L	0.01	ND	0.0001	6004589			
Total Antimony (Sb)	ug/L	5000	0.80	0.50	6004480	0.76	0.50	6004480
Total Arsenic (As)	ug/L	1000	1.2	1.0	6004480	1.2	1.0	6004480
Total Cadmium (Cd)	ug/L	700	ND	0.10	6004480	ND	0.10	6004480
Total Chromium (Cr)	ug/L	3000	ND	5.0	6004480	ND	5.0	6004480
Total Cobalt (Co)	ug/L	5000	1.3	0.50	6004480	1.3	0.50	6004480
Total Copper (Cu)	ug/L	3000	1.5	1.0	6004480	1.5	1.0	6004480
Total Lead (Pb)	ug/L	1000	ND	0.50	6004480	ND	0.50	6004480
Total Molybdenum (Mo)	ug/L	5000	5.4	0.50	6004480	5.6	0.50	6004480
Total Nickel (Ni)	ug/L	2000	2.2	1.0	6004480	2.4	1.0	6004480

No Fill	No Exceedance
Grey	Exceeds 1 criteria policy/level
Black	Exceeds both criteria/levels

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
Criteria: By-Law To Regulate Discharges To The Sanitary And Storm Sewer Systems Of The Regional Municipality Of Niagara BY-LAW No. 27-2014
ND = Not detected

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B956353
Report Date: 2019/03/11

exp Services Inc
Client Project #: HAM-00801631-A0
Site Location: John Deere Lands
Your P.O. #: ENV-BRM
Sampler Initials: CS

NIAGARA SANITARY SEWER BYLAW (27-2014)

Maxxam ID			JCR222			JCR222		
Sampling Date			2019/03/04 12:00			2019/03/04 12:00		
COC Number			706566-01-01			706566-01-01		
	UNITS	Criteria	BH/MW10	RDL	QC Batch	BH/MW10 Lab-Dup	RDL	QC Batch
Total Phosphorus (P)	ug/L	-	ND	100	6004480	ND	100	6004480
Total Selenium (Se)	ug/L	1000	ND	2.0	6004480	ND	2.0	6004480
Total Silver (Ag)	ug/L	5000	ND	0.10	6004480	ND	0.10	6004480
Total Tin (Sn)	ug/L	5000	3.6	1.0	6004480	3.6	1.0	6004480
Total Zinc (Zn)	ug/L	3000	ND	5.0	6004480	ND	5.0	6004480
Volatile Organics								
Benzene	ug/L	10	ND	1.0	6004666			
Chloroform	ug/L	40	ND	1.0	6004666			
1,2-Dichlorobenzene	ug/L	50	ND	2.0	6004666			
1,4-Dichlorobenzene	ug/L	80	ND	2.0	6004666			
Ethylbenzene	ug/L	160	ND	1.0	6004666			
Methylene Chloride(Dichloromethane)	ug/L	210	ND	5.0	6004666			
1,1,2,2-Tetrachloroethane	ug/L	40	ND	2.0	6004666			
Tetrachloroethylene	ug/L	50	ND	1.0	6004666			
Toluene	ug/L	200	ND	2.0	6004666			
Trichloroethylene	ug/L	50	ND	1.0	6004666			
p+m-Xylene	ug/L	-	ND	1.0	6004666			
o-Xylene	ug/L	520	ND	1.0	6004666			
Total Xylenes	ug/L	-	ND	1.0	6004666			
Surrogate Recovery (%)								
4-Bromofluorobenzene	%	-	97		6004666			
D4-1,2-Dichloroethane	%	-	100		6004666			
D8-Toluene	%	-	101		6004666			

No Fill	No Exceedance
Grey	Exceeds 1 criteria policy/level
Black	Exceeds both criteria/levels

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
Criteria: By-Law To Regulate Discharges To The Sanitary And Storm Sewer Systems Of The Regional Municipality Of Niagara BY-LAW No. 27-2014
ND = Not detected

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B956353
Report Date: 2019/03/11

exp Services Inc
Client Project #: HAM-00801631-A0
Site Location: John Deere Lands
Your P.O. #: ENV-BRM
Sampler Initials: CS

TEST SUMMARY

Maxxam ID: JCR222
Sample ID: BH/MW10
Matrix: Water

Collected: 2019/03/04
Shipped:
Received: 2019/03/04

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Biochemical Oxygen Demand (BOD)	DO	6004412	2019/03/06	2019/03/11	Althea Gonzalez
Total Cyanide	SKAL/CN	6005125	2019/03/06	2019/03/06	Xuanhong Qiu
Fluoride	ISE	6004184	2019/03/06	2019/03/06	Surinder Rai
Mercury in Water by CVAA	CV/AA	6004589	2019/03/06	2019/03/07	Medhat Nasr
Total Metals Analysis by ICPMS	ICP/MS	6004480	N/A	2019/03/06	Matthew Ritenburg
Animal and Vegetable Oil and Grease	BAL	6000560	N/A	2019/03/08	Automated Statchk
Total Oil and Grease	BAL	6008228	2019/03/08	2019/03/08	Francis Afonso
pH	AT	6004180	N/A	2019/03/06	Surinder Rai
Phenols (4AAP)	TECH/PHEN	6004239	N/A	2019/03/06	Bramdeo Motiram
Sulphate by Automated Colourimetry	KONE	6002487	N/A	2019/03/06	Alina Dobreanu
Sulphide	ISE/S	6004407	N/A	2019/03/06	Gnana Thomas
Total Kjeldahl Nitrogen in Water	SKAL	6004518	2019/03/06	2019/03/06	Rajni Tyagi
Mineral/Synthetic O & G (TPH Heavy Oil)	BAL	6008231	2019/03/08	2019/03/08	Francis Afonso
Total Suspended Solids	BAL	6002328	2019/03/05	2019/03/07	Mandeep Kaur
Volatile Organic Compounds in Water	P&T/MS	6004666	N/A	2019/03/07	Dina Wang

Maxxam ID: JCR222 Dup
Sample ID: BH/MW10
Matrix: Water

Collected: 2019/03/04
Shipped:
Received: 2019/03/04

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Metals Analysis by ICPMS	ICP/MS	6004480	N/A	2019/03/06	Matthew Ritenburg
Sulphide	ISE/S	6004407	N/A	2019/03/06	Gnana Thomas
Total Kjeldahl Nitrogen in Water	SKAL	6004518	2019/03/06	2019/03/06	Rajni Tyagi

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Maxxam Job #: B956353
Report Date: 2019/03/11

exp Services Inc
Client Project #: HAM-00801631-A0
Site Location: John Deere Lands
Your P.O. #: ENV-BRM
Sampler Initials: CS

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	2.0°C

Sample JCR222 [BH/MW10] : VOC Water Analysis: Due to foaming, sample required dilution. The detection limits were adjusted accordingly.

Results relate only to the items tested.

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Maxxam Job #: B956353
Report Date: 2019/03/11

QUALITY ASSURANCE REPORT

exp Services Inc
Client Project #: HAM-00801631-A0
Site Location: John Deere Lands
Your P.O. #: ENV-BRM
Sampler Initials: CS

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
6004666	4-Bromofluorobenzene	2019/03/07	98	70 - 130	98	70 - 130	96	%				
6004666	D4-1,2-Dichloroethane	2019/03/07	97	70 - 130	100	70 - 130	94	%				
6004666	D8-Toluene	2019/03/07	101	70 - 130	102	70 - 130	103	%				
6002328	Total Suspended Solids	2019/03/07					ND, RDL=10	mg/L	0	25	100	85 - 115
6002487	Dissolved Sulphate (SO4)	2019/03/06	NC	75 - 125	106	80 - 120	ND, RDL=1.0	mg/L	0.62	20		
6004180	pH	2019/03/06			102	98 - 103			0.48	N/A		
6004184	Fluoride (F-)	2019/03/06	85	80 - 120	101	80 - 120	ND, RDL=0.10	mg/L	1.0	20		
6004239	Phenols-4AAP	2019/03/06	97	80 - 120	98	80 - 120	ND, RDL=0.0010	mg/L	NC	20		
6004407	Sulphide	2019/03/06	91	80 - 120	88	80 - 120	ND, RDL=0.020	mg/L	NC	20		
6004412	Total BOD	2019/03/11					ND,RDL=2	mg/L	NC	30	97	80 - 120
6004480	Total Antimony (Sb)	2019/03/06	100	80 - 120	98	80 - 120	ND, RDL=0.50	ug/L	5.3	20		
6004480	Total Arsenic (As)	2019/03/06	97	80 - 120	97	80 - 120	ND, RDL=1.0	ug/L	0.90	20		
6004480	Total Cadmium (Cd)	2019/03/06	97	80 - 120	98	80 - 120	ND, RDL=0.10	ug/L	NC	20		
6004480	Total Chromium (Cr)	2019/03/06	94	80 - 120	93	80 - 120	ND, RDL=5.0	ug/L	NC	20		
6004480	Total Cobalt (Co)	2019/03/06	98	80 - 120	97	80 - 120	ND, RDL=0.50	ug/L	0.99	20		
6004480	Total Copper (Cu)	2019/03/06	94	80 - 120	93	80 - 120	ND, RDL=1.0	ug/L	2.6	20		
6004480	Total Lead (Pb)	2019/03/06	94	80 - 120	95	80 - 120	ND, RDL=0.50	ug/L	NC	20		
6004480	Total Molybdenum (Mo)	2019/03/06	102	80 - 120	96	80 - 120	ND, RDL=0.50	ug/L	4.5	20		
6004480	Total Nickel (Ni)	2019/03/06	94	80 - 120	95	80 - 120	ND, RDL=1.0	ug/L	11	20		
6004480	Total Phosphorus (P)	2019/03/06	100	80 - 120	102	80 - 120	ND, RDL=100	ug/L	NC	20		
6004480	Total Selenium (Se)	2019/03/06	102	80 - 120	101	80 - 120	ND, RDL=2.0	ug/L	NC	20		
6004480	Total Silver (Ag)	2019/03/06	96	80 - 120	97	80 - 120	ND, RDL=0.10	ug/L	NC	20		
6004480	Total Tin (Sn)	2019/03/06	99	80 - 120	95	80 - 120	ND, RDL=1.0	ug/L	1.4	20		
6004480	Total Zinc (Zn)	2019/03/06	95	80 - 120	99	80 - 120	ND, RDL=5.0	ug/L	NC	20		
6004518	Total Kjeldahl Nitrogen (TKN)	2019/03/06	106	80 - 120	98	80 - 120	ND, RDL=0.10	mg/L	8.7	20	97	80 - 120
6004589	Mercury (Hg)	2019/03/07	96	75 - 125	98	80 - 120	ND, RDL=0.0001	mg/L	NC	20		
6004666	1,1,2,2-Tetrachloroethane	2019/03/07	99	70 - 130	94	70 - 130	ND, RDL=0.20	ug/L	NC	30		
6004666	1,2-Dichlorobenzene	2019/03/07	98	70 - 130	90	70 - 130	ND, RDL=0.20	ug/L	NC	30		
6004666	1,4-Dichlorobenzene	2019/03/07	100	70 - 130	90	70 - 130	ND, RDL=0.20	ug/L	NC	30		

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QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
6004666	Benzene	2019/03/07	98	70 - 130	88	70 - 130	ND, RDL=0.10	ug/L	NC	30		
6004666	Chloroform	2019/03/07	98	70 - 130	88	70 - 130	ND, RDL=0.10	ug/L	13	30		
6004666	Ethylbenzene	2019/03/07	100	70 - 130	89	70 - 130	ND, RDL=0.10	ug/L	NC	30		
6004666	Methylene Chloride(Dichloromethane)	2019/03/07	94	70 - 130	87	70 - 130	ND, RDL=0.50	ug/L	NC	30		
6004666	o-Xylene	2019/03/07	103	70 - 130	92	70 - 130	ND, RDL=0.10	ug/L	NC	30		
6004666	p+m-Xylene	2019/03/07	104	70 - 130	92	70 - 130	ND, RDL=0.10	ug/L	NC	30		
6004666	Tetrachloroethylene	2019/03/07	96	70 - 130	85	70 - 130	ND, RDL=0.10	ug/L	NC	30		
6004666	Toluene	2019/03/07	100	70 - 130	89	70 - 130	ND, RDL=0.20	ug/L	15	30		
6004666	Total Xylenes	2019/03/07					ND, RDL=0.10	ug/L	NC	30		
6004666	Trichloroethylene	2019/03/07	96	70 - 130	87	70 - 130	ND, RDL=0.10	ug/L	NC	30		
6005125	Total Cyanide (CN)	2019/03/06	100	80 - 120	106	80 - 120	ND, RDL=0.0050	mg/L	NC	20		
6008228	Total Oil & Grease	2019/03/08			101	85 - 115	ND, RDL=0.50	mg/L	2.8	25		
6008231	Total Oil & Grease Mineral/Synthetic	2019/03/08			96	85 - 115	ND, RDL=0.50	mg/L	4.3	25		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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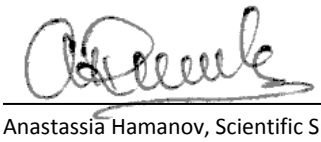
Maxxam Job #: B956353
Report Date: 2019/03/11

exp Services Inc
Client Project #: HAM-00801631-A0
Site Location: John Deere Lands
Your P.O. #: ENV-BRM
Sampler Initials: CS

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Anastassia Hamanov, Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#30554 exp Services Inc	Company Name:	EXP SERVICES INC	Quotation #:	B45997	Maxxam Job #:	Bottle Order #:
Attention:	Central Services	Attention:	Francois Chartier	P.O. #:	Stream 2 ENV-BRM		706566
Address:	1595 Clark Blvd Brampton ON L6T 4V1	Address:	JEFFREY.LEON@EXP.COM CHANTEL.SIMON@EXP.COM	Project:	HAM-00801631-A0	COC #:	Project Manager:
Tel:	(905) 793-9800 Fax: (905) 793-0641	Tel:	(905) 793-9800 Ext: 2523 Fax:	Project Name:	John Deere Lands	C#706566-01-01	Tanya Fidlin
Email:	Karen.Burke@exp.com; Luizza.Jose@exp.com; AP@e	Email:	Francois.Chartier@exp.com; TOMSON.HECKY@EXP.COM	Site #: / Sampled By:	CS / JL		

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
- ☐ Table 1 ☐ Res/Park ☐ Medium/Fine
- ☐ Table 2 ☐ Ind/Comm ☐ Coarse
- ☐ Table 3 ☐ Agri/Other ☐ For RSC
- ☐ Table ___

Other Regulations
- ☐ CCME ☒ Sanitary Sewer Bylaw
- ☐ Reg 558. ☒ Storm Sewer Bylaw
- ☐ MISA Municipality NIAGARA.
- ☐ PWQO
- ☐ Other

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? Y

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests..
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: _____ Time Required: _____ ☐
Rush Confirmation Number: _____ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Niagara Sanitary Sewer Bylaw (27-2014)	# of Bottles	Comments
1		BH/MW 10	04/03/19	12:00 PM	GW	X	X	13	5 DAY FIRM TURN AROUND TIME
2									
3									
4									
5									
6									
7									
8									
9									
10									

04-Mar-19 17:37
Tanya Fidlin
B956353
GK1 ENV-1091

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
ChantelSimon	19/03/04	17:36		2019/03/04	17:37	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei			Custody Seal	Yes	No
	2	2	2 ICE	Present	☐	
				Intact	☐	

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: Maxxa Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

Maxxam Job #: B956353
Report Date: 2019/03/11

exp Services Inc
Client Project #: HAM-00801631-A0
Site Location: John Deere Lands
Your P.O. #: ENV-BRM
Sampler Initials: CS

Exceedence Summary Table – Niagara Combined Sewer

Result Exceedences

Sample ID	Maxxam ID	Parameter	Criteria	Result	DL	Units
No Exceedences						

The exceedence summary table is for information purposes only and should not be considered a comprehensive listing or statement of conformance to applicable regulatory guidelines.

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Appendix E:
Construction Dewatering Estimates (Short-Term)

APPENDIX E: Construction Dewatering Calculations

Site Name John Deere
Project Number HAM-00801631-A0

Table E-1: Flow all Sides of the Excavation

Parameters	Symbols	Unit	Underground Services	SWMP (Southwest)	SWMP (Northeast)	Fifty Single Dwellings
Geological Formation	-	-	Glacial Deposit	Glacial Deposit	Glacial Deposit	Glacial Deposit
Ground Elevation	-	mASL	177.9	177.9	176.9	177.9
Highest Groundwater Elevation	-	mASL	177.3	177.3	177.3	177.3
Top of the Water-Bearing Zone	-	mASL	177.3	177.3	177.3	177.3
Base of the Water-Bearing Zone	-	mASL	170.4	170.4	170.4	170.4
Height of Static Water Table Above the Base of the Water-Bearing Zone	**H**	m	6.88	6.88	6.90	6.88
Dewatered Elevation Target	-	mASL	172.90	171.90	174.88	172.40
Height of Target Water Level Above the Base of Water-Bearing Zone	**h_w**	m	2.50	1.50	4.48	2.00
Hydraulic Conductivity	**K**	m/s	3.20E-07	3.20E-07	3.20E-07	3.20E-07
Length of Excavation	-	m	100.0	189.6	45.0	250.0
Width of Excavation	-	m	5.0	58.6	25.0	10.0
Method to Calculate Radius of Influence	-	-	**Sichardt**	**Sichardt**	**Sichardt**	**Sichardt**
Radius of Influence from Sides of Excavation	**Ro**	m	7.4	9.1	4.1	8.3
Distance to Linear Source from Sides of excavation	**Lo=Ro/2**	m	3.7	4.6	2.1	4.1
Dewatering Flow Rate (unconfined linear flow component)	**Q**	m^3/day	32	68	26	75
Factor of Safety	**FS**	-	2.0	2.0	2.0	2.0
Dewatering Flow Rate (multiplied by factor of safety)	**Q.FS**	m^3/day	64	136	52	150

Table E-2: Precipitation Estimate

Location	Assumed Precipitation Event (mm)	Length of Excavation (m)	Width of Excavation (m)	Rainwater Collection (m^3)
Services	15	100.0	5.0	8
SWMP-Southwest	15	190	59	167
SWMP-Northeast	15	45	25	17
Fifty (50) Single Dwellings	15	250	10	38

Table E-3: Total Flow Estimate

Locations	Symbols	Unit	Value
Underground Services (with safety factor and stormwater)	**Q (Total)**	m^3/day	72
SWMP-Northeast (with safety factor and stormwater)			302
SWMP-Southwest (with safety factor and stormwater)			69
Fifty (50) Single Dwellings (with safety factor and stormwater)			188

Notes:

mASL - meters above sea level

Analytical Solution for Estimating Plane Flow from an Unconfined Aquifer to a Fully-Penetrating Excavation

$$Q_w = Kx\frac{H^2 - {h_w}^2}{L_o}$$

(Based on the Dupuit Equation)

Where:

Q_w = Flow rate per unit length of excavation (m^3/s)

K = Hydraulic conductivity (m/s)

H = Height of static water table above base of water-bearing zone (m)

h_w = Height of target water level above the base of water-bearing zone (m)

L_o=Distance of Influence (m)

x=Length of excavation (m)

Appendix F:
Post-Construction Dewatering Estimates (Long-Term)

APPENDIX F: Long-Term Flow Rate

Site Name John Deere
Project Number HAM-00801631-A0

Table F-1: Flow from Under-Slab Drain System

Parameters	Symbols	Unit	A Single Dwelling
Geological Formation	-	-	Glacial Deposit
Ground Elevation	-	mASL	177.90
Highest Groundwater Elevation	-	mASL	177.28
Top of the Water-Bearing Zone	-	mASL	177.28
Base of the Water-Bearing Zone	-	mASL	172.40
Height of Static Water Table Above the Base of the Water-Bearing Zone	**H**	m	4.88
Dewatered Elevation Target	-	mASL	175.40
Height of Target Water Level Above the Base of Water-Bearing Zone	**h_w**	m	3.00
Hydraulic Conductivity	**K**	m/s	3.20E-07
Length of Excavation	-	m	10.00
Width of Excavation	-	m	5.00
Method to Calculate Radius of Influence	-	-	**Sichardt**
Radius of Influence from Sides of Excavation	**Ro**	m	3.19
Distance to Linear Source from Sides of excavation	**Lo=Ro/2**	m	1.60
Dewatering Flow Rate (unconfined linear flow component)	**Q**	m^3/day	3.15
Factor of Safety	**fs**	-	1.50
Dewatering Flow Rate (multiplied by factor of safety)	**Q.fs**	m^3/day	4.73

Notes:
mASL - meters above sea level

Analytical Solution for Estimating Plane Flow from an Unconfined Aquifer to a Partially-Penetrating Excavation

$$Q_w = \left[0.73 + 0.23\left(\frac{P}{H}\right)\right] Kx \frac{H^2 - {h_w}^2}{L_o}$$

(Based on the Dupuit Equation)

Where:

Q_w = Flow rate per unit length of excavation (m^3/s)

P = Depth of penetration of the excavation below the original water table (m)

K = Hydraulic conductivity (m/s)

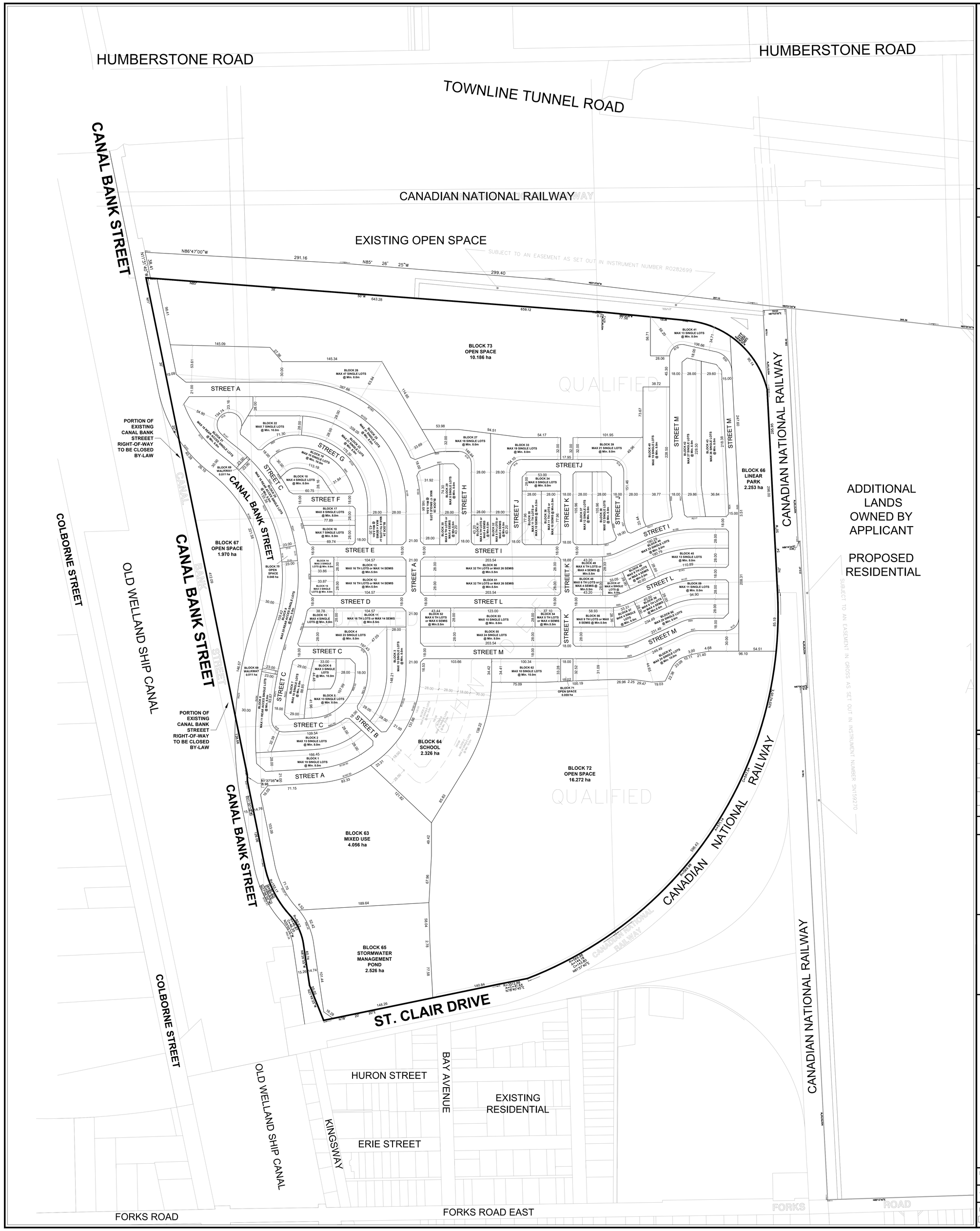
H = Height of static water table above base of water-bearing zone (m)

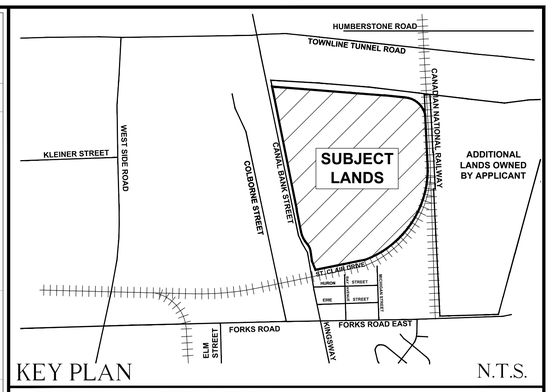
h_w = Height of target water level above the base of water-bearing zone (m)

L_o=Distance of Influence (m)

x=Length of excavation (m)

Appendix G:
Engineering Drawings





KEY PLAN N.T.S.

ADDITIONAL INFORMATION

Required Under Section 51(17)
Of The Planning Act R.S.O. 1990 c.P.13

a. SHOWN ON DRAFT PLAN
b. SHOWN ON DRAFT AND KEY PLANS
c. SHOWN ON KEY PLAN
d. LAND TO BE USED IN ACCORDANCE WITH LAND USE SCHEDULE
e. SHOWN ON DRAFT PLAN
f. SHOWN ON DRAFT PLAN
g. SHOWN ON DRAFT PLAN AND KEY PLAN
h. MUNICIPAL PIPED WATER TO BE PROVIDED
i. SOIL IS SILTY CLAY
j. SHOWN ON DRAFT PLAN
k. ALL MUNICIPAL SERVICES TO BE PROVIDED
l. SHOWN ON DRAFT PLAN

SCHEDULE OF LAND USE

TOTAL SITE AREA - 74.729 ha

Proposed Land Use	Units	Reference	Area (Ha.)
Residential Singles 10.0m	54	Blocks 6,19,22,61-62	2.052
Residential Singles 8.0m	553	Blocks 1-5,7,10,14-18,23,25-29,33,34,37-45,47,53,55,57,59,60	15.353
Residential Rear Access Singles 8.0m	63	Blocks 8,9,20,21	1.477
Residential Townhomes 5.5m	202	Blocks 11-13,24,30,31, 32,35-36,46,48,49,50,51, 52, 54,56,58	3.791
Mixed Use		Block 63	4.056
School		Block 64	2.326
Stormwater Management Pond		Block 65	2.526
Park / Linear Park		Blocks 66-67	4.223
Walkway		Blocks 68-69	0.023
Open Space		Blocks 70-73	26.566
ROADS			
30m R.O.W. (Canal Bank Street)			2.475
21m R.O.W. (Street A)			2.108
18m R.O.W. (Streets B-M)			7.753
TOTAL	872		74.729

Proposed Summary Yield		
Proposed Unit Mix	Unit Count with Alternate 5.50m Townhouse Units	Unit Count with Alternate 5.50m Semi-Detached Units
Residential Singles 10.0m	54	54
Residential Singles 8.0m	553	553
Residential Rear Lane Access Singles 8.0m	63	63
Residential Townhomes 5.5m	202	
Residential Semi-Detached 5.5m		164
TOTAL	872	834

No.	REVISION	DATE
5		
4		
3		
2		
1		

REVISIONS

OWNER'S CERTIFICATE

WE, BEING THE REGISTERED OWNER OF THE SUBJECT LANDS HEREBY AUTHORIZE ARMSTRONG PLANNING AND PROJECT MANAGEMENT TO PREPARE AND SUBMIT A DRAFT PLAN OF SUBDIVISION FOR APPROVAL.

SIGNED _____ DATE _____

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE SUBJECT LANDS AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN ON THIS PLAN.

SIGNED _____ DATE _____

DAIN CITY WEST
DRAFT PLAN OF SUBDIVISION

PART LOTS 21, 22 AND 23, CONCESSION 5,
PART OF THE ROAD ALLOWANCE BETWEEN
LOTS 22 AND 23, CONCESSION 5,
(CLOSED BY BY-LAW 855, INST NO. HU8243)
GEOGRAPHIC TOWNSHIP OF HUMBERSTONE)
THE CITY OF WELLAND
REGIONAL MUNICIPALITY OF NIAGARA

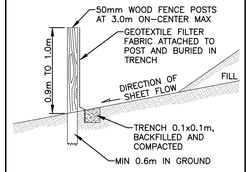
armstrong
planning | project management

DESIGN:	DRAWN:	SCALE 1: 2000
APPROVED	DATE: May 29, 2020	PROJECT No. 20.2699.00

DRAWING No. Dain City West Subdivison.dwg PHASES 1-2

NOTES:

1. THIS TYPE OF FILTER BARRIER CONSISTS OF GEOTEXTILE FILTER FABRIC SECURELY ATTACHED ON THE UPSTREAM SIDE.
2. SILT FENCES SHOULD BE USED ONLY FOR INTERCEPTING SHEET FLOWS OF DRAINAGE AREA NO LONGER THAN 30m AND NO STEEPER THAN 2:1.
3. THE FENCE HEIGHT SHOULD BE 0.9m TO 1.0m AND THE LENGTH APPROX. 30m PER 1000m² OF DRAINAGE AREA.
4. THE FABRIC IS TO BE RECESSED INTO A TRENCH 0.1m x 0.1m, BACKFILLED, AND COMPACTED.
5. FENCE POST SHOULD BE SPACED NO MORE THAN 3.0m APART AND SET INTO THE GROUND AT LEAST 0.6m.



SILT FENCE DETAIL
N.T.S.

LEGEND

- NPCA REGULATED AREA
- EXISTING WETLAND AREAS FROM TERRASTORY ENVIRONMENTAL OCT 8, 2019
- PROPOSED SILT FENCE
- PROPOSED DOUBLE ROW SILT FENCE AND STRAW BALES
- PROPOSED LIMIT OF FILL
- 180.00 PROPOSED PREGRADE ELEVATION (0.8m BELOW FINISHED GRADE)

NOTE: FILL MATERIAL IS SILTY CLAY PER EXP GEOTECH INVESTIGATION #HAM-00801631-B1

KEY PLAN
N.T.S.

I, JASON P. SCHOOLEY P.ENG., HAVE REVIEWED THE PLANS FOR THE CONSTRUCTION OF PLACING FILL LOCATED AT #475 AND #635 CANAL BANK STREET AND HAVE PREPARED THIS PLAN TO INDICATE THE COMPATIBILITY OF THE PROPOSED TO EXISTING ADJACENT PROPERTIES AND MUNICIPAL SERVICES. IT IS MY BELIEF THAT ADHERENCE TO THE PROPOSED GRADES AS SHOWN WILL PRODUCE ADEQUATE SURFACE DRAINAGE AND PROPER FACILITY OF THE MUNICIPALITY SERVICES WITHOUT ANY DETRIMENTAL EFFECT TO THE EXISTING DRAINAGE PATTERNS OR ADJACENT PROPERTIES.

#	REVISION	DATE	INIT
2	REVISED PER NPCA COMMENTS	2020-07-14	JC
1	ADDED NATURAL FEATURE SETBACK	2020-05-21	JC
0	ISSUED FOR SITE ALTERATION PERMIT	2020-05-13	JC

NOTES:
1. THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWER, AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.
2. PROPERTY LINES WERE PLOTTED USING REGISTERED PLANS AND BARS LOCATED IN THE FIELD. TO VERIFY THE ACCURACY OF THESE PROPERTY LINES, A LEGAL SURVEY SHOULD BE PERFORMED PRIOR TO CONSTRUCTION.
3. ALL CONSTRUCTION MUST COMPLY WITH THE NIAGARA PENINSULA STANDARD CONTRACT DOCUMENT.

DRAFTING: JC
DESIGN: -
CHECKED BY: -
APPROVED BY: -

BENCHMARKS
TOP NUT OF HYD 140m SOUTH OF C.N. RAIL BRIDGE ON CANAL BANK ST. =178.18
TOP NUT OF HYD @ CRESCENT DRIVE/FORKS RD = 175.79
SIB NORTH SIDE OF ST. CLAIR DRIVE, 280m EAST OF CL CANAL BANK ST. = 177.18

LICENSED PROFESSIONAL ENGINEER — J. P. SCHOOLEY — PROVINCE OF ONTARIO — Jul 14/20

Welland Ontario Canada

UPPER CANADA CONSULTANTS ENGINEERS / PLANNERS

OWNER
555 CANAL BANK DEVELOPMENTS GP Inc.
125 VILLARBOIT CRES.
VAUGHAN, ON
L4K 4K2

SITE ALTERATION PLAN
FORMER JOHN DEERE SITE
CITY OF WELLAND

CONSULTANT FILE No. 0585
DATE 2020-07-14
PRINTED 2020-07-14
SCALE 1:1000 m
REF No.
DWG No. 0585-SITE ALT
REV 2

DRAWING FILE: C:\Users\josh\appdata\local\temp\AcPublish_11700\0585-Site Alteration.dwg PLOTTED: Jul 14, 2020 - 3:47pm PLOTTED BY: Josh