Updated Geotechnical Investigation Report

Proposed Residential and Commercial Development – Part Lot 13, Concession 5, Millbrook, Ontario

Vargas Properties Inc.

25 January 2023

→ The Power of Commitment

Executive Summary

This updated report presents the results of a geotechnical investigation that was conducted in support of a proposed residential and commercial development for lands situated within Part Lot 13, Concession 5 in the Township of Cavan Monaghan, County of Peterborough, Millbrook, Ontario (herein referred to as “the Property” and “the Site”). The Property encompasses an area of 29.57 hectares (73.1 acres) and is currently undeveloped or agricultural land. The development will be municipally serviced with piped potable water (water main) and sanitary sewer. GHD Limited (GHD) was retained by Vargas Properties Inc. c/o Charter Properties Inc. (the Client) to complete this geotechnical investigation which includes a hydrogeologic component.

The study included a site inspection, advancement of test holes (boreholes and test pits), soil sampling, water level monitoring, a well survey to compliment a review of available Ministry of the Environment, Conservation and Parks (MECP) well records, hydraulic conductivity testing and an updated water balance evaluation based upon design information.

In summary, the soil profile at the proposed development area is generally comprised of topsoil underlain by silty sand over silty clay or glacial till. A permanent shallow groundwater table was not observed within the upper area (northern portion of the Site). Intermittent groundwater seepage may be encountered in this northern area. On the slope and lower area (southern portion of the Site), water was encountered at elevations between about 211 and 215 masl within each borehole in these areas. Grey soils were also observed in these boreholes suggesting there are conditions with groundwater throughout the year depending on the location. Flowing artesian wells to the west of the Site appear to be at elevations of about 183 to 186 masl and to the southeast at an elevation of about 205 masl. Local area artesian conditions are expected to be sufficiently deep such that flowing conditions are not encountered by the construction or development activities; however, care must be exercised during development to stay well above potential artesian zones and minimize the risk of contacting pressurized groundwater conditions. It is our opinion that there will not be a requirement for significant constraints for the proposed residential and commercial development areas from the seasonal variations of groundwater as the water can be handled with appropriate engineering techniques. In general, it is expected that the groundwater elevation will be below the depth of the future development, although seepage may be encountered in deeper excavations or foundations. If short-term pumping of groundwater at volumes greater than 50,000 L/day and less than 400,000 L/day is required during the construction stage, the EASR must be completed. In summary, the proposed residential development is suitable from both a hydrogeologic and geotechnical perspective.

There are minor impacts expected to groundwater and surface water as a result of the future development provided that appropriate planning (i.e. incorporation of LIDs as supported by the water balance calculations), mitigation measures and proper construction techniques are considered.

From a geotechnical perspective, the Site is suitable for construction of the proposed development including one to two-storey single residential homes with basements, townhomes, commercial buildings and associated servicing and asphalt paved roadways, parking and access areas and a stormwater management pond. Detailed recommendations are provided in subsequent sections of this report.

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1. Introduction

This report presents the results of a geotechnical investigation that was conducted in support of a proposed residential and commercial development for lands within Part Lot 13, Concession 5 in the Township of Cavan Monaghan, County of Peterborough, Millbrook, Ontario (herein referred to as “the Property” and “the Site”). The Property encompasses an area of approximately 29.57 hectares (73.1 acres) and is currently undeveloped or agricultural land. The development will be municipally serviced with piped potable water (water main) and sanitary sewer. GHD Limited (GHD) was retained by Vargas Properties Inc. c/o Charter Properties Inc. (the Client) to complete this geotechnical investigation which includes a hydrogeologic component.

The general location of the Site is illustrated on the Vicinity Plan, Figure 1. The location with respect to surrounding roads and land use is depicted on the Property Plan, Figure 2. Specific details of the Site and surrounding properties based on recent aerial photography is presented on the Plot Plan, Figure 3. The current Conceptual Master Plan prepared by The Biglieri Group Ltd. depicts the proposed development layout and is provided on the Concept Plan, Figure 4. The borehole and test pit locations are illustrated on the Test Hole Location Plan, Figure 5. These plans and other figures can be reviewed in the Figures section.

2. Scope of Investigation

The purpose of the investigation was to define the prevailing hydrogeologic and geotechnical conditions at the Site. The hydrogeologic aspects of the study were completed to investigate the subsurface soil stratigraphy, groundwater movement, to assess groundwater supplies and evaluate potential impacts from the proposed development and related construction. The geotechnical investigation was conducted to provide recommendations relevant to earthwork construction, dewatering, foundation and slab-on-grade design, buried service installation, a stormwater management pond and pavement structure. The following scope of work was performed to accomplish the foregoing purposes.

1. Reviewed available background information relevant to the Site such as geologic, physiographic and water resources reports and maps.
2. Carried out an inventory of available well record data on file with the Ministry of the Environment, Conservation and Parks (MECP) for the immediate area to evaluate the physical characteristics of the aquifer complexes that underlie the region. A field survey of the general area was carried out to supplement the MECP data.
3. A walkover inspection was conducted to review surficial ground characteristics.
4. The subsurface conditions were explored by advancing, sampling and logging a total of thirteen (13) boreholes and six (6) test pits. The subsurface conditions were recorded and are summarized in detail in Appendix A. The boreholes were advanced to depths ranging from 6.3 to 8.2 m. The test pits were excavated to depths that varied from 3.0 to 3.5 m. A monitoring well was installed in three (3) of the boreholes to facilitate water level measurements and further testing.
5. Falling head (slug) tests were completed at all three (3) monitoring well locations to evaluate hydraulic conductivity of the subsoils. The infiltration rate of the upper vadose zone was evaluated based on the soil type observed and in-situ testing.
6. Carried out laboratory analyses of materials encountered including grain size testing, Atterberg Limits testing and moisture content determinations of representative soil samples.
7. Obtained a representative groundwater sample from two (2) of the monitoring wells on Site and subjected the samples to chemical testing to determine background chemistry.
8. Completed and updated the water balance that considers pre- and post-development conditions and evaluates groundwater baseflow conditions based on the current design.
9. Prepared this updated detailed report using engineering analyses of the acquired data outlining our conclusions and recommendations presented herein.

The boreholes were advanced using a track mounted drill rig equipped with continuous flight, solid stem power augers. Representative, disturbed samples of the strata penetrated were obtained using a split-barrel, 50 mm outer-diameter (OD) sampler advanced by a 63.5 kg hammer dropping approximately 760 mm. The results of these standard penetration tests (SPT's) are reported as "N" values on the borehole logs at the corresponding depths. Samples were also obtained directly form augers cuttings. The test pits were conducted using a track excavator.

Soil samples obtained from the test holes were inspected in the field immediately upon retrieval for type, texture, and colour. All test holes were backfilled following completion of the fieldwork. The boreholes that were not constructed into monitoring wells were backfilled with a mixture of auger cuttings and holeplug to the surface. Test pits were backfilled from the excavated material placed back in the approximate sequence that it was removed and tamped in place with the bucket. All samples were sealed in clean plastic containers and transported to the GHD laboratory for further visual-tactile examination, and to select appropriate samples for laboratory analysis.

2.1 Limitations

This report: has been prepared by GHD for Vargas Properties Inc. and may only be used and relied on by Vargas Properties Inc. for the scope of work agreed between GHD and Vargas Properties Inc. as set out in Section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Vargas Properties Inc. arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

Refer to Section 8 for the Statement of Limitations.

3. Project Details

The Conceptual Master Plan is provided as Figure 4 based on the drawing prepared by The Biglieri Group Ltd. (drawing no. CMP-01, dated March 3, 2022). The information provided indicates that the overall area of the Site is 29.57 ha (73.1 acres) and that the proposed development will include two (2) commercial lots, 129 single detached home residential lots with basements, 48 townhouse units, one Stormwater Management (SWM) pond, supporting asphalt paved roadways and sidewalks, natural heritage areas, and parkland and trails. For this report, GHD has assumed that the residential structures will have one-level basements. The development will be municipally serviced for potable water and sanitary sewers.

4. Site Conditions

4.1 General

The field program consisted of a site inspection, soils investigation, hydraulic testing, and measurement of water levels in the monitoring wells. The boreholes were drilled on March 11 to 13, 2020 and April 15 to 16, 2020. The test pits were excavated on March 6, 2020. Borehole and test pit records and physical test results of representative soil samples are presented in Appendix A. A site reconnaissance was conducted by GHD prior to the subsurface investigation to observe the general surficial characteristics of the Site.

The Property is irregular in shape and is bounded by existing and future residential lots to the south, agricultural / residential lands to the north, County Road 10 and agricultural/residential lands to the west and vacant, bush covered lands to the east. Local relief across the Site is on the order of about 35 m. Tributaries of Baxter Creek exists within the environmental areas near the eastern and southern limits of the Site.

4.2 Subsurface

4.2.1 Regional Physiography and Geology

The Property is situated in the physiographic region known as the Peterborough Drumlin Field (Chapman and Putnam, 1984) just north of the Oak Ridges Moraine. As illustrated on the Figure 7, the Site exists within a sand plain with drumlinized till plains to the southeast. The surficial geology (Figure 8) is comprised of modern alluvial deposits within the southern parts of the Site and stone-poor, carbonated-derived silty to sandy till in the northern parts of the Site. The Ontario Geological Survey information (Figure 9) indicates that the Quaternary geology for the area is glaciolacustrine deposits of gravelly sand and nearshore and beach deposits, with till, undifferentiated, predominantly sandy silt to silt matrix, commonly rich in clasts, often high in total matrix carbonated content to the north and glaciofluvial ice-contact deposits , gravel and sand, minor till, includes esker, kame end moraine, ice-marginal delta and subaqueous fan deposits to the west of the Site.

A review of available MECP well records identified eight (8) well records within 250 m of the Site. The well records indicate the presence of topsoil at the surface underlain by till, and layers of sand and gravel. The well records considered are provided and shown in Appendix B. Physical and hydraulic data are presented on some of the MECP well records. The water well information is discussed in Section 5.1.

4.2.2 Local Geology

The subsurface stratigraphy was investigated by drilling thirteen (13) boreholes on March 11 to 13, 2020 and April 15 to 16, 2020. Monitoring wells were installed in three (3) of these boreholes to facilitate water level measurements and testing. The boreholes not constructed into monitoring wells were backfilled with a mixture of auger cuttings and bentonite holeplug to the surface. Six (6) shallow test pits were excavated on March 6, 2020 in areas between the boreholes. The test pits were backfilled from the excavated material, placed back in the approximate sequence that the material was removed and tamped in place with the bucket. The locations of the test holes are illustrated on the Test Hole Location Plan, Figure 5. Details of the subsurface conditions encountered are graphically presented in Appendix A. It should be noted that the boundaries between the strata have been inferred from the test hole observations and non-continuous samples. They generally represent a transition from one soil type to another, and should not be inferred to represent an exact plane of geological change. Further, conditions may vary between and beyond the test holes.

The soils encountered generally consisted of topsoil underlain by silty sand and then glacial till and/or silty clay. Isolated layers of silty sand and/or sand and gravel were encountered sporadically throughout southern parts of the Site. A surficial layer of topsoil was encountered in all test holes and was observed to range from 150 to 300 mm in thickness. This soil was observed to be in a damp, loose state, with a silty, highly organic content. As such, it is expected to be devoid of any structural engineering properties.

Silty sand or sandy silt was encountered below the topsoil in all test holes with the exception of test pit TP-12. The silty sand and sandy silt extended to the full depth of investigation in borehole BH-12 and to depths ranging from 0.3 to 2.7 m in the remaining boreholes. Moisture content tests conducted on samples of the silty sand or sandy silt yielded values ranging from approximately 7 to 36 % moisture by weight indicating that exists in a moist to wet state. SPT N values obtained from within the silty sand layer varied from 2 to 41 blows/300 mm, indicating a loose to dense in-situ state of relative density or soft to hard consistency. Grain size distribution analyses conducted on representative samples of the silty sand/sandy silt suggests the following composition: 0 to 4 % gravel, 33 to 53% sand, and 47 to 63% silt and clay-sized particles (USCS). Hydrometer analyses conducted on these sample suggest that the silty sand/sandy silt contains 41 to 48% particles between 5 and 75 μm in size.

A layer of silty clay was encountered beneath the silty sand or sandy silt layers in borehole BH-9 to BH-11 and BH-13. The silty clay extended to the full depth of investigation in the boreholes BH-10, BH-11 and BH-13 and to 7.6 m in borehole BH-9. The silty clay exists in a generally moist to wet condition with moisture contents ranging from 7 to 42% moisture by weight. The consistency of the clayey silt is generally described as very soft to hard based on SPT N values that ranged from 1 blows/300 mm to 34 blows/300 mm. Grain size distribution analyses conducted on two (2) representative samples of the clayey silt suggests the following compositional ranges: 0 to 2% gravel, 8 to 9% sand, and 90 to 91% silt and clay-sized particles (USCS). Hydrometer analyses conducted on these samples suggest that the clayey silt contains 23 to 33% particles between 5 and 75 μm in size. An Atterberg Limits test conducted on a representative sample of the silty clay indicated the Plasticity Index of 22% and Liquid Limit of 44%.

Glacial till was encountered in all test holes with the exception boreholes BH-10 to BH-13. The till was brown to grey in colour and generally consisted of silty sand or sandy silt containing varying amounts of clay and gravel. Occasional cobbles were encountered in the till at some test hole locations. The till exists in a generally moist to wet condition with moisture contents ranging from 4 to 22% moisture by weight. The relative density of the till is generally described as loose to very dense based on SPT N values that ranged from 5 blows/300 mm to over 100 blows/300 mm. A grain size distribution analysis conducted on a representative sample of the till suggests the following composition: 13% gravel, 29% sand, and 58% silt and clay-sized particles (USCS). A hydrometer analysis conducted on this samples suggest that the till contains 33% particles between 5 and 75 μm in size.

Intermittent layers/seams of silty sand or sand and gravel were observed within the till or silty clay in three (3) of the test holes, i.e. BH-5 and BH-13. The silty sand and sand and gravel layers were observed in a generally wet condition with moisture contents ranging from 18 to 21% moisture by weight. SPT N values obtained from within this layer varied from 10 to 21 blows/300 mm indicating a compact in-situ state of relative density. A grain size distribution analysis conducted on a representative sample of the silty sand suggests the following composition: 0% gravel, 91% sand, and 9% silt and clay-sized particles (USCS).

Table 1 Grain Size Distribution Summary

Location	Depth (m)	Grain Size Distribution				Observed Soil Unit
		% Gravel	% Sand	% Fines		
				% Silt	% Clay	
BH-3, SS-4	2.3 – 2.9	13	29	33	25	Sandy silt till
BH-7, SS-1	0.1 – 0.6	4	33	48	15	Sandy silt
BH-9, SS-5	3.1 – 3.7	2	8	23	67	Silty clay
BH-10, SS-3	1.5 – 2.1	0	9	33	58	Silty clay
BH-11 SS-6A	4.6 – 4.9	0	91	9		Silty sand
BH-12, SS-6	4.6 – 5.2	0	53	41	6	Silty sand

Notes: %Fines indicates silt and clay particles; grain size distribution based on Unified Soil Classification System.

4.2.3 Groundwater

Groundwater seepage was observed in ten (10) of the boreholes and one (1) of the test pits (TP-3) at depths ranging from 1.8 to 4.0 m during the drilling and excavation operations. GHD notes that artesian groundwater conditions were not encountered in any of the test holes although it has been reported at nearby properties. It is expected that artesian conditions may be encountered at depths greater than the depths carried out for this exploration. Flowing artesian wells to the west of the Site appear to be at elevations of about 183 to 186 masl and to the southeast at an elevation of about 205 masl. Local area artesian conditions are expected to be sufficiently deep such that flowing conditions are not encountered by the construction or development activities; however, care must be exercised during development to stay well above potential artesian zones and minimize the risk of contacting pressurized groundwater conditions.

Monitoring wells were installed in four (4) boreholes (BH-4, BH-7 and BH-13 in order to facilitate monitoring of groundwater levels. A summary of the monitoring well details is provided in Table 2.

Table 2 Summary of Monitoring Well Information

Location	Depth of Well (m)	Pipe Stick Up (m)	Effective Well Screen Interval (m)	Water Seepage Depth (m)
BH-4	7.6	0.77	6.1 – 7.6	Not encountered
BH-7	6.1	0.78	4.6 – 6.1	Not encountered
BH-13	6.1	0.77	4.6 – 6.1	2.7

Groundwater potentiometric levels were measured on May 19, 2020 in the installed monitoring wells. The data has been plotted on Figure 6 and summarized in Table 3.

Table 3 Summary of Potentiometric Water Levels

Location	Ground Elevation (m)	Water Level (m)	GW Elevation (m)
		May 19, 2020	
BH-4	247.1	Dry	Dry
BH-7	238.8	Dry	Dry
BH-13	213.8	2.4	211.4

Notes: m = metres; GW = groundwater; (*) Elevations interpreted from contours on Topographic plan prepared by IBW Surveyors File Name "P-0400_Topo_v4.dwg" dated Jan. 14, 2020. The elevations provided are for the purposes of evaluating groundwater elevation and flow direction and should not be relied upon as a legal survey or topographic elevation survey

Based on the water level data collected and the surrounding topography, the overall shallow groundwater flow direction is towards Baxter Creek. The direction of shallow groundwater movement is illustrated on the Groundwater Elevation plan, Figure 6. A permanent shallow groundwater table was not observed within the upper area (northern portion of the Site); however, intermittent groundwater seepage may be encountered in this northern area. On the slope and lower area (southern portion of the Site), water was encountered at elevations between about 211 and 215 masl within each borehole in these areas. Grey soils were also observed in these boreholes suggesting there are conditions with groundwater throughout the year depending on the location. It should be noted that groundwater levels are transient and tend to fluctuate with the seasons, periods of precipitation and temperature.

4.2.4 Water Quality

A groundwater sample was collected from the monitoring wells installed in BH-7 and BH-13 and from an old well located at 963 Fallis Line for the purpose of determining background water quality. The certificate of chemical analysis is presented in Appendix D. The water quality data are summarized and compared with the Ontario Drinking Water Standards (ODWS) in Table 4.

Table 4 Water Quality Summary

Parameter	Monitoring Wells		Water Well	ODWS		
	BH-7	BH-13	W-3 (Water Well N of Site*)	MAC	IMAC	AO/OG
Alkalinity (as $CaCO_3$)	209	216	--	NS	NS	30 to 500
Ammonia – Total	0.03	0.05	<0.03	NS	NS	NS
Calcium	93.2	91.5	113	NS	NS	NS
Chloride	4.2	4.1	11.7	NS	NS	250
Colour (T.C.U.)	<2	5	2	NS	NS	5
Conductivity (mS/cm)	433	435	548	NS	NS	NS
Copper	<0.002	<0.002	<0.002	NS	NS	1.0
Fluoride	<0.1	<0.1	<0.1	1.5	NS	NS
Hardness (as $CaCO_3$)	**265**	**261**	**309**	NS	NS	80 to 100
Iron	0.187	0.082	<0.005	NS	NS	0.3

Parameter	Monitoring Wells		Water Well	ODWS		
	BH-7	BH-13	W-3 (Water Well N of Site*)	MAC	IMAC	AO/OG
Magnesium	7.84	7.73	6.41	NS	NS	NS
Manganese	0.030	0.026	<0.001	NS	NS	0.05
Nitrite (N)	<0.1	<0.1	<0.1	1.0	NS	NS
Nitrate (N)	<0.1	<0.1	3.0	10	NS	NS
pH (unitless)	8.02	7.81	8.00	NS	NS	6.5 to 8.5
Potassium	1.4	1.3	0.9	NS	NS	NS
Sodium	4.1	4.0	6.7	NS	NS	200
Sulphate	7	7	4	NS	NS	500
Turbidity (N.T.U.)	**17.8**	**1180**	0.8	1	NS	5
Zinc	<0.005	<0.005	<0.005	NS	NS	5.0

Notes: All units in mg/L (i.e. parts per million) unless otherwise noted. MAC = maximum acceptable concentration (health related); IMAC = Interim MAC (insufficient data to establish MAC or not feasible to establish MAC to desired level); AO/OG = aesthetic objective or operational guideline (not health related). **Bolded value** exceeds ODWS. NS denotes No Standard. (*) See L-5 water well location on Enclosure B.4 in Appendix B.

The groundwater beneath the Site is relatively hard which is common in Southern Ontario due to overburden materials containing calcium. In general, the water quality is relatively good with no indication of organic pollution as evidenced by the lack of nitrite and nitrate.

4.2.5 Hydraulic Conductivity

Hydraulic conductivity (K) testing was completed at the monitoring wells installed in boreholes BH-4, BH-7 and BH-13. The testing consisted of falling and/or rising head testing and was completed by introducing a one-metre long slug within the well or by filling the monitoring well with potable water, and then measuring the water levels using a data logger programmed to record readings at three (3) second intervals. The data was analyzed using AQTESOLV and the Bouwer-Rice solution for each test (see Appendix C for solution data).

The K values for the hydraulic conductivity testing range from on the order of 10^{-3} to 10^{-5} cm/sec. The K values from the test data indicate that the monitoring wells were screened within medium (sand) to low (till) hydraulic conductivity units. The hydraulic conductivity testing suggests that excavations within these soils are expected to yield low to little water. However, increased amounts of water may be expected when pockets or layer of sand and/or gravel are intersected.

4.2.6 Infiltration Testing

For purposes of Low Impact Development strategies, infiltration data of the shallow site soils is presented in this section. In-situ constant head permeameter tests were conducted at six (6) locations in test pits TP-2 (at 0.6 and 1.2 m depth), TP-5 (at 0.3 m depth), TP-6 (at 1.0 m depth), and near boreholes BH-4 (at 0.6 m depth) and BH-7 (at 0.6 m depth). The importance of infiltration is for the implementation of low impact development strategies to recharge precipitation into the ground at pre-development or near pre-development values. Infiltration testing was completed using an ETC Pask (constant head well) permeameter. The testing was not successful at test pits TP-1, TP-3, TP-4 due to unknown subsurface conditions that may have been related to clayey till, boulders or some other condition.

Based upon the infiltration testing conducted near test pits TP-2, TP-5 and TP-6, the upper vadose zone has a field saturated hydraulic conductivity ranging from 10^{-3} to 10^{-5} cm/sec (Appendix C). The infiltration test results provide preliminary infiltration values for the Site and are indicative of silty sand or sandy silt material. Although LIDs can be applied to any soil type, additional testing should be considered at the detailed design stage when infiltration areas are known.

Based on the Supplementary Guidelines to the Ontario Building Code 2012, this correlates to an infiltration rate in the order of 30 to 75 mm/hr. It is noted, however, that slight variations in the soil stratigraphy may cause variations in the permeability of the soil in both vertical and horizontal orientations.

Based on the Low Impact Development Stormwater Management Planning and Design Guide, the infiltration rate used to design the infiltration facility must incorporate a safety correction factor that compensates for potential reductions in soil permeability due to compaction or smearing during construction, gradual accumulation of fine sediments over the lifespan of the infiltration facility and uncertainty in measured values when less permeable horizons exist within 1.5 m below the bottom of the infiltration facility.

5. Hydrogeology

The hydrogeology of the area is characterized by rolling topography of soils that generally consists of silty clay or glacial till with intermittent layers of silty sand and sand and gravel. Seasonal water is expected to flow within the sandy layers. Limited vertical migration is expected within the silty clay and till. Only a minor portion of the existing infiltration is expected to recharge the deeper aquifers that are confined below the silty clay and till. Information regarding groundwater characteristics of the immediate area was obtained from an inventory of well records. A total of eight (8) well records were found to be available within 250 m of the Site. The well records indicate the clay and stone which is interpreted to be glacial till with occasional sand and gravel or sand layers. Bedrock was reported in two (2) of the local wells at depths ranging from 65 to 69 m. The well records considered are provided and shown in Appendix B. Physical and hydraulic data are presented on the MECP well records. The records include six (6) drilled overburden wells and two (2) drilled bedrock wells.

5.1 Existing Local Water Supplies

Nearby surrounding lands are generally undeveloped treed areas and residential/agricultural properties. The existing residential lands are generally municipally serviced. In addition, the proposed development will be municipally serviced. The compiled MECP data included eight (8) well records within 250 m of the Site. The well records considered are provided and shown in Appendix B. Physical and hydraulic data are presented on some of the MECP well records.

The well records indicate the clay and stone which is interpreted to be glacial till with occasional sand and gravel or sand layers. The information indicates the presence of two (2) principal aquifer systems:

1. Deeper overburden of sand and gravel within the till tapped by a drilled well; and
2. Saturated fractures within the underlying bedrock formation tapped by other drilled wells.

The groundwater was generally described as “fresh” in the well records reviewed (when indicated). The drilled overburden well records indicates that the wells extended to a depth ranging from 16.5 to 63.7m and groundwater was encountered at depth ranging from 16.2 to 63.7 m. The drilled overburden wells reportedly produce test yields 15.1 to 82.3 L/min. The drilled bedrock wells extended to depths ranging from 65.5 to 68.6m and reportedly produce test yields ranging from 7.6 to 11.3 L/min. Bedrock was reported in two (2) of the local wells at depths ranging from 30 to 39 m.

Artesian (flowing) conditions were reported in two (2) of the drilled wells situated to the west of the Site within 250 m with groundwater encountered under artesian pressure at elevations of about 183 to 186 masl and on the order of about 25 m below the lowest elevation of the proposed development. The MECP well data has been summarized in Table 5.

Table 5 Summary of MECP Water Well Data

Total Number of Wells Inventoried:	8					
Dug/Bored Wells:	0 (0%)					
Drilled Wells (Overburden):	6 (75%)					
Drilled Wells (Bedrock):	2 (25%)					
Abandoned or Other:	0 (0%)					
Parameters	**Statistical Summary**					
	Dug / Bored Wells		**Drilled (Overburden)**		**Drilled (Bedrock)**	
Well Yields						
Range	NA		15.1 – 6048 L/min		7.6 – 11.3 L/min	
Average	NA		1044 L/min		9.5 L/min	
Reported Yields						
Not Reported	0	0%	0	0%	0	0%
Dry	0	0%	0	0%	0	0%
0 to 4 L/min	0	0%	0	0%	0	0%
4 to 15 L/min	0	0%	1	17%	2	100%
15 to 35 L/min	0	0%	1	17%	0	0%
> 35 L/min	0	0%	4	66%	0	0%
Static Water Levels						
Range	NA		0 – 53.3 m		20.1 – 21.3 m	
Average	NA		17.5 m		20.7 m	
Water Encountered						
Range	NA		16.2 – 63.7 m		65.8 – 68.6 m	
Average	NA		41.2 m		67.2 m	
Well Depth						
Range	NA		16.5 – 63.7 m		70.1 – 72.2 m	
Average	NA		41.5 m		71.2 m	

Notes: Data based on MECP well record information (see Appendix B). L/m represents litres per minute; m is metres.

To supplement the MECP well records reviewed, GHD staff conducted a well survey of the area to investigate where private wells may still be in use (Appendix B). Information was collected during the survey from a total of three (3) homes close to the Site including the identification of two (2) drilled wells. One dug/bored well was identified to the north of the Site and one dug/ bored well was identified immediately west of Site and has since been decommissioned. Three (3) residents at 963 Fallis Line were interviewed during the well survey and reported that the dug/bored well north of the Property still existed but the house are now connected to the municipal water service. One (1) of the residents indicated that the water produced was cloudy and had methane gas and indicated the water had quality issues. The interviewed residents indicated there were no water quantity issues. Groundwater samples were collected from the home in addition to two (2) samples collected from monitoring wells on the Site. The certificate of chemical analysis is presented in Appendix D.

5.2 Source Water Protection Considerations

Where proposed developments are being planned, it is important to determine the presence of Significant Groundwater Recharge Areas (SGRAs) and Highly Vulnerable Aquifers (HVAs) in the area. These areas are protected under the Clean Water Act (2006). In general, SGRAs are defined as areas where water seeps into an aquifer from rain and melting snow, supplying water to the underlying aquifer. An HVA aquifer occurs where the subsurface material offers limited protection from contamination resulting from surface activities.

GHD considered the potential for SGRAs and HVAs by reviewing the “Source Protection Information Atlas” that is currently available through the MECP website. The published information is updated as of February 18, 2022. In general, there are no HVAs in close proximity to the Site (see Figure 10). Further, the subsurface investigation by GHD has indicated that the existing glacial till and silty clay exhibits low hydraulic conductivity indicating that it has a relative lower contribution to underlying aquifer complexes.

As defined in the Clean Water Act (2006), an area is a significant groundwater recharge area if,

– the area annually recharges water to the underlying aquifer at a rate that is greater than the rate of recharge across the whole of the related groundwater recharge area by a factor of 1.15 or more; or,

– the area annually recharges a volume of water to the underlying aquifer that is 55% or more of the volume determined by subtracting the annual evapotranspiration for the whole of the related groundwater recharge area from the annual precipitation for the whole of the related groundwater recharge area.

The majority of the developable area is located outside of SGRAs as shown on Figure 10. The SGRA is located at the bottom of the slope and the area of the Baxter Creek tributary and has a score of 2. The development will consider maintaining pre-development infiltration. Therefore, no impacts are expected to the SGRA.

6. Conclusions and Recommendations

Supporting data upon which our recommendations are based have been presented in the foregoing sections of this report. The following recommendations are governed by the physical properties of the subsurface materials that were encountered at the Site and assume that they are representative of the overall site conditions. It should be noted that these conclusions and recommendations are intended for use by the designers only. Contractors bidding on or undertaking any work at the Site should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of this factual data as it affects their proposed construction techniques, equipment capabilities, costs, sequencing, and the like.

Comments, techniques, or recommendations pertaining to construction should not be construed as instructions to the contractor. It should be noted that where the Municipality has design standards that apply to specific aspects of this project, such standards shall take precedence over any corresponding dissimilar recommendations contained herein.

Based on the results of the geotechnical investigation, it is our professional opinion that the Site is suitable for the proposed residential and commercial development and there is low potential for groundwater impact as a result of developing the Site. It is recommended that good construction and mitigation techniques must be used to minimize the potential for impact. Detailed conclusions and recommendations are presented in the following sections regarding the water balance and potential impacts to groundwater and surface water resources. Details regarding the Geotechnical Investigation including conclusions and recommendations are provided beginning in Section 6.2.

6.1 Hydrogeology

6.1.1 Updated Water Balance Evaluation

An updated evaluation of the water balance was completed based upon the Conceptual Master Plan to compute the potential impacts that may occur in the recharge/ discharge characteristics related to the proposed development.

The objective of the water balance calculations is to illustrate that post-development infiltration can meet or be close to pre-development values from a conceptual perspective. The computations have used detailed parameters such as precipitation, regional evapotranspiration, infiltration and runoff. Weather data from Peterborough A was selected as it was the closest weather station to the Site (~10.2km to the northeast). The detailed calculations can be reviewed in Appendix E. The total Site area is 29.57 ha based on information provided. The following is a summary of the expected pre-development water balance values for the proposed residential and commercial development based on the updated information.

6.1.1.1 Pre-Development Water Balance

The pre-development water balance incorporated the existing soils, slope and ground cover areas. The infiltration factor for the area was calculated from the table of values presented in the “Land Development Guidelines” (MOEE, 1995). It is based on three sub-factors which are:

– Topography sub-factor;
– Soil sub-factor; and
– Cover sub-factor.

The slope of the Site will be considered as “hilly” (slope of 28 m to 47 m per km) to rolling (slope of 2.8 to 3.8 m per km). The soils are generally comprised of sandy silt till or silty clay material and will be considered a medium combination of clay and loam as per the water balance calculations. Table 6 summarizes the expected updated pre-development water balance values for the Site.

Table 6 Updated Pre-Development Summary

Total Precipitation (Peterborough A)	- 855 mm/year
Regional Evapotranspiration	- 561 mm/year
Recharge Available	- 299 mm/year
Area of Recharge Available	- 295,700 m^2
Total Water Surplus	- 88,465 m^3/year
Total Estimated Infiltration	- 43,579 m^3/year
Total Estimated Runoff	- 44,887 m^3/year

Based upon these values, the Site infiltrates on the order of 43,579 m^3 per year (147 mm/year).

6.1.1.2 Updated Post-Development Water Balance (No Enhancements)

The computation of the water budget was repeated and updated for the proposed development assuming no mitigation techniques, that is, runoff from impervious surfaces is unrecoverable and not infiltrated into the ground. The anticipated impact of the development is related to increased runoff from imperious surfaces, such as asphalt surface for the proposed access roads and the building rooftops. These are assumed to be impervious surfaces with zero infiltration capacity in this model. A summary of the updated computations is provided in Table 7.

Table 7 Post-Development Summary (No Enhancements)

Area of Site	- 295,700 m^2
Impervious Surfaces	- 101,505 m^2
Area Available for Infiltration	- 194,195 m^2
Total Water Surplus	- 127,560 m^3/year
Total Estimated Infiltration	- 31,665 m^3/year
Infiltration % Difference (pre- vs. post-)	- (-27%) Decrease
Total Estimated Runoff	- 95,895 m^3/year
Runoff % Difference (pre- vs. post-)	- 114% Increase

The impermeable surface area of proposed paved areas, concrete sidewalks and building rooftops was estimated based on the design concept plan presented in Figure 4 and information provided by the Client. Under this scenario, the total infiltration volume decreased by 27% and runoff volume increased by 114%. Within the areas evaluated, the infiltration has reduced and the runoff increased versus the pre-development values. Groundwater base flow would be expected to decrease over time in this scenario. However, recharge via infiltration through the underlying till and silty clay to the lower aquifer from these lands is expected to be minor. Based upon this scenario, mitigative strategies are required to minimize infiltration losses and reduce storm water runoff. The following section discusses the water balance after considering the enhanced infiltration option of directing rooftop stormwater runoff to sodded or vegetated / naturalized areas for infiltration.

6.1.1.3 Updated Post-Development Water Balance (Downspout Disconnection)

The post-construction water budget computations were repeated and updated considering enhanced infiltration options which are also known as Low Impact Development (LID) technologies. These technologies include and are not restricted to rainwater harvesting, downspout disconnection, infiltration trenches, vegetated filter strips, bioretention, permeable pavement, enhanced grass swales, dry swales and perforated pipe systems in order to balance the water budget and maintain any wetland features including nearby creeks. The shallow subsurface soils are sandy silt over silty clay and/or glacial till material. It is noted that LIDs can work in any soil type. The

primary enhancement for this Site is to promote infiltration of rooftop runoff and to move water from impervious surfaces to sodded or vegetated areas where infiltration can occur naturally.

The post-development water balance was modelled to include the disconnection of downspouts from storm sewers and directing water from the building roof tops to sodded areas or undeveloped grass areas which can be enhanced with increased topsoil depths or levelled to further encourage infiltration. A summary of the post-construction updated water budget with enhancements for infiltration is presented in Table 8.

Table 8 Updated Post-Development Summary with Downspout Disconnection LID Strategy

Area of Site	-	295,700 m^2
Total Water Surplus	-	127,560 m^3/year
Total Estimated Infiltration	-	43,579 m^3/year
Infiltration % Difference (pre- vs. post-)	-	(0%) No change
Total Estimated Runoff	-	83,981 m^3/year
Runoff % Difference (pre- vs. post-)	-	87% Increase

Under this scenario, the total infiltration volume is maintained and runoff volume increased by 87% compared to pre-development values. Within the areas evaluated, the infiltration and runoff amounts have improved compared to post-development (no mitigation) numbers. Runoff increase compared with the pre-development conditions will need to be managed as per the storm water management plan.

It is expected that recharge via infiltration through the till to the lower aquifers is a small component and impacts to the groundwater aquifer are expected to be insignificant. It is our professional opinion that there would be minimal impact to the local groundwater regime and minimal impact to the downgradient surface water regime from a quantity perspective.

6.1.2 Impact on Groundwater Baseflow

The importance of the groundwater baseflow is that it provides discharge to water bodies, wells and may have some hydraulic functionality with the on-site features. Water balance calculations suggest that conceptually the infiltration to the subsurface can be kept near pre-development values if appropriate LID technologies are used. It is GHD's professional opinion that there is not expected to be a significant impact to the shallow groundwater baseflow that may be supplying baseflow to the downgradient Baxter Creek.

6.1.3 Impact on Surface Water Bodies

The impacts to surface water bodies are related to the reduction of the groundwater baseflow and water quality concerns related to human activities such as salting of paved areas, minor fuel and oil leaks, fertilizer application, etc. It is expected that there will be minor impacts to groundwater and neighbouring surface water bodies. Runoff from the development will be collected by an internal storm sewer system and treated using a stormwater management pond or other LID strategies. Further details are provided within the Functional Servicing Report regarding the stormwater management.

6.1.4 Mitigation Measures

Several mitigative techniques have been recommended in order to address concerns relating to the potential for impact to the base flow. The impact and mitigation measures can be arranged into two (2) distinct categories: construction phase and operational phase. Prior to construction, storm water management techniques should be incorporated to control additional surface water runoff and permit enhanced infiltration into the surrounding ground. Storm water management techniques will minimize the potential for groundwater impact and also minimize the amount of silt or other fine-grained soil particles becoming mobile and entering into down-gradient areas.

The installation of strategically placed silt fences will filter any excess storm water runoff prior to entering the infiltration areas.

During the operational phase of the development, it is expected that storm water excess will be controlled as indicated in the Functional Servicing Report. It is recommended that all roof leader drains of the future residential buildings be allowed to drain onto the ground surface for infiltration. Swales may be required in some areas to

divert the runoff water where required. Other LIDs will be required to reduce storm water runoff and will be evaluated by the detailed design.

6.1.5 Servicing

Private services for water and septic disposal are not considered as the Site will be connected to municipal services. However, any wells at the Site (including monitoring wells) are recommended to be decommissioned in accordance with Ontario Regulation 903 prior to development of the Site.

6.1.6 Dewatering for Construction

Based on groundwater-related observations and the depth of excavations expected for this development (2 to 6 m below existing grades), it is generally anticipated that groundwater seepage will be encountered. It is expected that pumping from collection sumps to an acceptable outlet will control this expected groundwater infiltration. However, should any excavations require more intensive dewatering or groundwater control, the use of filtered sumps, or other suitable method of dewatering and/or sheet piling is recommended. Based on local knowledge and previous experience in the area, it is expected that artesian (pressured) groundwater conditions exist in the confined aquifer located at depths below this area. It is also known that the aquitard (i.e. confining) soil layer within which excavations for this construction will occur, can be “leaky”, in that it can allow upwards leakage of the pressurized groundwater into excavations via hydraulically-conductive seams/senses of sand. As noted in previous sections, flowing artesian wells to the west of the Site appear to be at elevations of about 183 to 186 masl and to the southeast at an elevation of about 205 masl. Local area artesian conditions are expected to be sufficiently deep such that flowing conditions are not encountered by the construction or development activities; however, care must be exercised during development to stay well above potential artesian zones and minimize the risk of contacting pressurized groundwater conditions

For dewatering purposes, hydraulic conductivities on the order of about 10^{-3} to 10^{-5} cm/sec may be expected for the subgrade soils encountered in our boreholes. It should be noted that hydraulic conductivities can vary over a vertical and horizontal extent, and may be outside the stated range if pockets or seams of soils with different grain size (e.g. sand seams) are encountered.

If short-term pumping of groundwater at volumes greater than 50,000 L/day and less than 400,000 L/day is required during the construction stage, the Environmental Activity Sector Registry (EASR) must be completed including a Water Taking Plan and a Discharge Plan that includes water quality testing results. The EASR streamlines the process and water pumping may begin once the EASR registration is completed, the fee paid and supporting document prepared. If water taking in excess of 400,000 litres/day is required, a Permit to Take Water (PTTW) must be obtained in advance. PTTW applications may take up to 90 working days for the MECP to review and approve. The actual rate of groundwater taking performed during construction will be a function of the final design, time of year, and the contractor’s schedule, equipment, and techniques.

6.2 Geotechnical

The soils encountered generally consisted of topsoil underlain by silty sand and then glacial till and/or silty clay. Isolated layers of silty sand and/or sand and gravel were encountered sporadically throughout southern parts of the Site. GHD notes that artesian groundwater conditions were not encountered in any of the test holes. Groundwater seepage was observed in ten (10) of the boreholes and one (1) of the test pits (TP-3) at depths ranging from 1.8 to 4.0 m during the drilling and excavation operations. Groundwater level measurements obtained from the well installed in boreholes BH-13 yielded a water levels of 2.4 m on May 19, 2020. The monitoring wells installed in boreholes BH-4 and BH-7 were measured to be dry on May 19, 2020.

6.2.1 Site Preparation, Excavation, Grading and Backfill

Any and all topsoil, vegetation, fill, disturbed earth, organic and organic-bearing material is to be stripped and removed from the access roads and building envelope areas (including floor slab areas) prior to commencing earthwork construction. Loose, organic, or otherwise deleterious materials will require removal and replacement with an approved backfill material. The subexcavated surface must be proof rolled and/or approved by a member of GHD prior to placement of fill or foundations.

Excavations should be carried out to conform to the manner specified in Ontario Regulation 213/91 and the Occupational Health and Safety Act and Regulations for Construction Projects (OHSA). The soils encountered during this investigation are generally classed by OHSA as Type 3. As such, unsupported / unshored walls of excavations in these soils must be sloped to the bottom of the excavation, with a slope having a gradient of 1 horizontal to 1 vertical (1H:1V) or flatter, or be retained using a suitably designed shoring system. The soils affected by surface water or perched seepage zones should be considered Type 4 soils, requiring unsupported / unshored walls of excavations to be sloped at 3H:1V or flatter to the base of the excavation.

Prior to Site grading activity, the subgrade soils exposed after the removal of topsoil and disturbed native soils within the proposed buildings and unsuitable materials within proposed pavement areas should be visually inspected, compacted if required, and proof rolled using large axially loaded equipment. Any loose/soft, organic, or unacceptable areas should be subexcavated and removed as directed by the Engineer and replaced with suitable fill materials compacted to a minimum of 98 percent Standard Proctor Maximum Dry Density (SPMDD). Clean earth fill used to raise grades in the proposed buildings and pavement areas should be placed in 300 mm thick layers and compacted by a heavy appropriate roller to 100 percent SPMDD.

Based on a review of the site grading plan prepared by Valdor, it is GHD's understanding that a grade raise of over 4m is proposed in the area of boreholes BH-9 and BH-10 where soft clay soils were encountered to depths of about 5 to 6 m below existing ground surface. It is recommended that the soft silty clay material in this area be subexcavated as directed by the Engineer and replaced with suitable fill material compacted to a minimum of 98 percent Standard Proctor Maximum Dry Density prior to grading activity.

It is expected that excavated native till or sandy silt soils may be suitable for reuse as trench and/or pavement subgrade backfill provided they are free of organics and at a moisture content that will permit adequate compaction (may require prior processing such as aeration to lower the moisture content). The native silty clay material excavated from the area of boreholes BH-9 and BH-10 are expected to be suitable to reused as a clay liner for the proposed SWM pond. A final review and approval to reuse any site soils or imported fill material should be made at the time of construction.

Prior to removing any excess soils from the Site, it is recommended that such materials be subjected to chemical testing to characterize the excess soils for handling and disposal purposes.

6.2.2 Service Installation

The materials encountered during this investigation at the anticipated service invert elevations (2 to 6 m below existing ground surface) typically consists of either silty sand or glacial till material. As such, normal compacted bedding material, placed in the Class “B” or Class “C” arrangement, is recommended for all underground services. The recommended bedding material is Granular “A” or 19 mm crusher run (angular) stone, as per Ontario Provincial Standard Specifications (OPSS). The minimum recommended bedding thickness for the underground services is 150 mm. All bedding materials should be compacted to 98% of their Standard Proctor Maximum Dry Density (SPMDD).

It is recommended that cover backfilling of the underground services be accomplished using Granular “A”, sand, or other suitable material as allowed by the Municipality’s standards, to a minimum of 300 mm above the pipe. Compaction of this material should attain 100% SPMDD. It is expected that some of the excavated soils may be suitable for reuse as trench backfill, conditional upon suitable moisture content (within 2% of optimum), final review and approval by an experienced geotechnical engineer at the time of construction, and regular monitoring and inspection of such reuse throughout construction. Compaction of any native soil in service trenches is recommended to be a minimum of 98% of its SPMDD. The soils observed may require processing (such as aeration) to lower the moisture content to appropriate levels prior to being considered as backfill material. Suitability of imported trench backfill material, if required, should be verified and approved by GHD at the time of construction.

It is recommended that trench plugs be installed at appropriate locations along the trench alignment where the bedding and pipe cover is found to conflict with water bearing sand seams to minimize and control any flow of groundwater along the trench bedding and cover materials. Requirement and location of trench plugs to be confirmed during excavation activities. Note that concrete trench plugs for shallower watermain trench are susceptible to differential movement and heaving in relation to surrounding soils, particularly where plugs are located within the frost penetration depth (up to 1.5 to 1.6 m). Clay plugs should be used in such instances, utilizing frost tapers to minimize movement within the frost zones. Trench plugs should be designed and installed in accordance with OPSS 1205 and OPSD 802.095.

6.2.3 Pavement Structures

Based on the results of this investigation, we would recommend the following procedures be implemented to prepare the proposed new roadways and asphalt paved parking areas for construction:

1. Remove any free organic topsoil, fill, disturbed earth, organics and organic-bearing materials, loam, frozen earth, and boulders larger than 150 mm in diameter encountered at subgrade elevation for the full width of construction.
2. Proof roll the subgrade for the purpose of detecting possible zones of wet or soft subgrade. Any deleterious areas thus delineated should be replaced with approved earth fill or granular material compacted to a minimum of 98 % of its SPMDD. Approved excavated soils can be reused as road subgrade backfill provided the soil is workable and at a moisture content that will permit adequate compaction. Saturated silts, organics and wet clay should not be reused. A final review and approval to reuse any soils must be made during construction.
3. Contour the subgrade surface to prevent ponding of water during the construction and to promote rapid drainage of the sub-base and base course materials.
4. To maximize drainage potential, and ensure satisfactory pavement performance, 150 mm diameter perforated pipe subdrains should be installed along any curb lines. The pipe should be encased in filter fabric and surrounded by clear stone aggregate. It is recommended that the subdrains outlet to the storm sewer system.
5. Construct transitions between varying depths of granular subbase materials at a rate of 1:25 minimum.

Depending on the final proposed grades, the subgrade soils at this site are expected to consist of native silty sand/silty clay till or sand. For overall pavement design purposes, the frost susceptibility of the native soils is assessed as being generally moderate to high. The Township’s pavement structures standard (for both asphalt depths and granular depths) are considered sufficient. In this regard, the following minimum flexible pavement structure is recommended for the construction of the new roadways.

Table 9 Pavement Structure for New Roads

Profile	Material	Minimum Thickness (mm)		In Conformance with OPSS Form
		Local Residential	Collectors & Arterial	
Asphalt Surface	H.L. 3	30	30	1150
Asphalt Base	H.L. 4	50	70	
Granular Base	Granular “A”	150		1010
Granular Subbase	Granular “B”	450		

The subgrade materials in the proposed asphalt paved parking and access areas for proposed commercial development will generally consist of sandy silt till. The frost susceptibility of these soils is assessed as being generally moderate. The following minimum flexible pavement structures are recommended for asphalt paved parking and access areas.

Table 10 Pavement Structure

Profile	Material	Thickness (mm)		In Conformance with OPSS Form
		Light Duty	Heavy Duty	
Asphalt Surface	H.L. 3	40	40	1150
Asphalt Base	H.L. 8	50	50	
Granular Base	Granular “A”	150	150	1010
Granular Subbase	Granular “B”	300	450	

The following steps are recommended for optimum construction of paved areas:

1. The Granular “A” and “B” courses should be compacted to a minimum 100 % of their respective SPMDD’s.
2. All asphaltic concrete courses should be placed, spread and compacted conforming to OPSS Form 310 or equivalent. All asphaltic concrete should be compacted to a minimum 92.0 percent of their respective laboratory Maximum Relative Densities (MRD’s).
3. Adequate drainage should be provided to ensure satisfactory pavement performance.

It is recommended that all fill material be placed in uniform lifts not exceeding 200 mm in thickness before compaction. It is suggested that all granular material used as fill should have an in-situ moisture content within 2 % of their optimum moisture content. All granular materials should be compacted to 100 % SPMDD. Granular materials should consist of Granular “A” and “B” conforming to the requirements of OPSS Form 1010 or equivalent.

It is noted that the above recommended pavement structure is for the end use of the project. During construction of the project, the recommended granular depths may not be sufficient to support loadings encountered.

6.2.4 Foundation Design

Relevant information for final design purposes including proposed final grades, finished floor elevations, and proposed underside of foundations were not available to GHD at the time of writing this report. As such, the recommendations contained in this Foundation section must be reviewed by GHD’s geotechnical engineers once such development design parameters become available. Structural loading for the proposed residential dwellings may be supported on strip and spread footings. The footings should be placed on the undisturbed, firm to hard or compact to very dense native soils or on engineered fill place directly on the undisturbed, firm to hard or compact to very dense native soils. Table 11 summarizes the depths to suitably competent native soil encountered within each borehole.

Table 11 Depth to Competent Bearing Native Soil

Borehole ID	Depth to Competent Native Soil (m)	Borehole ID	Depth to Competent Native Soil (m)
BH-1	0.8	BH-8	1.5
BH-2	0.8	BH-9	7.6
BH-3	0.8	BH-10	1.5
BH-4	0.8	BH-11	1.5
BH-5	2.3	BH-12	0.8
BH-6	0.8	BH-13	0.8
BH-7	0.8		

It is noted that a pockets of very soft to soft soils were observed in boreholes, BH-9 and BH-10 and may be present at other locations. If such soils are encountered at the foundation subgrade level, they must be subexcavated and replaced with engineered fill. For preliminary design purposes, it is recommended that footings constructed on firm to hard or compact to very dense native soils or engineered fill be proportioned and designed using the following bearing capacities presented in Table 12.

Table 12 Preliminary Bearing Pressures for Foundation Design of Townhomes and Single

Parameter	Bearing Pressure			
	Firm to Hard or Compact to Very Dense Undisturbed Native Soils	Engineering Fill		
		Rock-Based Fill(2)	Granular Fill(3)	Earth Borrow Fill(3)
Factored Bearing Capacity at ULS(1)	130 kPa	210 kPa	170 kPa	130 kPa
Bearing Capacity at SLS	90 kPa	150 kPa	120 kPa	90 kPa

Notes: (1) Resistance factor Φ =0.5 applied to the ULS bearing pressure for design purposes.
(2) At least 1m of Rock-based fill. Quality of material is to be approved prior to use as engineered fill.
(3) At least 0.3m of Granular or Earth Borrow fill. Quality of material is to be approved prior to use as engineered fill.

Any engineered fill upon which foundations are placed must be a minimum thickness corresponding to the notes that accompany the above table. Rock-based fill must be completely encapsulated with suitable filter fabric to minimize any migration of fine-grained particles from surrounding soils into the voids within the rock fill.

The following is recommended for the construction of any engineered fill for the foundations:

1. Remove any and all existing vegetation, topsoil, fill, organics, and organic-bearing soils to the competent, undisturbed native soil from within the area of the proposed engineered fill.
2. The area of the engineered fill should extend horizontally 1m beyond the outside edge of the building foundations and then extend downward at a 1:1 slope to the competent native soil.
3. The base of the engineered fill area must be approved by a member of GHD prior to placement of any fill, to ensure that all unsuitable materials have been removed, that the materials encountered are similar to those observed, and that the subgrade is suitable for the engineered fill.
4. All engineered fill material is to be approved by GHD at the time of construction. Place approved engineered fill, in maximum 300 mm lifts, compacted to 100% of its SPMDD. Any fill material placed over wet subgrades or under long periods of precipitation should consist of an approved, rock-based fill, with the inclusion of appropriate geotextile fabric around the rock-based fill should the rock fill contain enough voids to warrant.
5. Full time testing and inspection of the engineered fill will be required, to ensure compliance with material and compaction specifications.

All exterior foundations and/or foundations in unheated areas, should be founded at least 1.2 m below the final adjacent grade for frost protection. Foundations and walls exposed to frost action should be backfilled with non-frost susceptible granular material, and positive drainage away from the structure should be ensured.

Under no circumstances should the foundations be placed above organic materials, loose, frozen subgrade, construction debris, or within ponded water. Prior to forming, all foundation excavations must be inspected and approved by a member of GHD's geotechnical group. This will ensure that the foundation bearing material has been prepared properly at the foundation subgrade level and that the soils exposed are similar to those encountered during this investigation.

For design purposes this site is conservatively classed as Site Class D for Seismic Site Response, in accordance with the Ontario Building Code.

For drainage purposes, it is recommended that perimeter drains be installed about the structures. The subdrains would serve to drain seepage water that infiltrates the backfill, intersect the groundwater, and help relieve hydrostatic pressures due to high groundwater levels. The drains should consist of a perforated pipe, at least 150 mm in diameter, surrounded by clear, crushed stone and suitable filter protection. The drain should discharge to a positive sump or other permanent frost-free outlet.

For foundations constructed in accordance with the foregoing manner, total and differential settlements are estimated to be less than 25 mm.

6.2.5 Slab-on-Grade

The ground floor of any proposed building may be constructed as a normal slab-on-grade, on clear stone fill over native, inorganic subsoils, prepared in accordance with Section 6.2.1 of this report. The floor slab of the basement should be formed over a base course consisting of at least 150 mm of 19 mm angular clear stone material, compacted by a plate tamper and visually inspected by the GHD personnel to confirm appropriate compaction. All grade increases or infilling below the clear stone should be constructed in accordance with the engineered fill steps. All clear stone must be surrounded on bottom and sides by appropriate filter fabric to control the migration of fine-grained particles from surrounding soils. All fill placed as engineered fill must be inspected, approved and compaction verified by personnel from GHD.

Below the basement slabs, it is recommended that under floor drains consisting of 100 mm diameter, perforated, filter-wrapped pipe at maximum 3 m centres be installed below the clear stone to safeguard from potential seasonal high groundwater levels. These pipes should be led into a header placed in the middle of the drainage system. The header should consist of a 150 mm diameter, filter-wrapped, perforated pipe. The drainage system should appropriately drain into a positive sump or other permanent frost-free outlet.

6.2.6 Basement Retaining Walls

It is recommended that free draining backfill to walls (basement) be provided. Such walls are to be located above the groundwater table and may be designed for lateral earth pressures using the following equation:

p = k (w h + q), where:

- the lateral earth pressure in kPa acting on the subsurface wall at depth h;
- k_a = the coefficient of active earth pressure;
- (= 0.3 for walls restrained from the bottom only);
- (= 0.5 for walls restrained at the top and bottom*);
- k_p = the coefficient of passive earth pressure, (= 3.0);
- w = the granular or native soil bulk density in kN/m^3;
- (= 21.0 kN/m^3 for well compacted, OPSS-approved Granular "B");
- (= 20.0 kN/m^3 for native soils);
- h = the depth (in metres) below the exterior grade at which the earth pressure is being calculated; and
- q = the equivalent value of any surcharge (in kN/m^3) acting adjacent to the walls.

(*) This value is recommended for rigid walls retaining compacted backfill.

The recommended value for the coefficient for sliding friction between the soil and the concrete is 0.4. Also, any additional surcharge loading that will influence the wall must be taken into account in its design.

6.2.7 Stormwater Management Pond Design

Recommendations provided in this report are for preliminary design purposes and does not include an analysis of the proposed SWM pond berm's stability. GHD can perform such stability analyses once overall grading plans for the Site are finalized.

It is GHD's understanding that a SWM pond is proposed for this development and is to be located in the area of test holes BH-12, as shown on Figure 5. The native soils encountered in borehole BH-12 consisted of topsoil underlain by silty sand to the bottom of the test hole. The hydraulic conductivity of the native soils in the proposed SWM pond area is expected to be on the order of 10^{-3} to 10^{-6} cm/sec based on hydraulic conductivity testing and gradation results of representative samples of these materials. It is noted, however, that slight variations in the soil stratigraphy may cause variations in the permeability of the soil in both vertical and horizontal orientations.

Based on the soils observed, and the anticipated base elevations, it appears that construction of the SWM pond in this area is feasible. In general, excavation of the soils for the SWM pond are expected to be straightforward, provided that appropriate measures are taken during construction to minimize any overland or near-surficial flow of water into the area. Groundwater seepage and surficial water inflow into the open SWM pond excavation is expected at about 213 masl (the bottom of the SWM pond is proposed to be about 211 masl); however, this is generally expected to be controlled by pumping from within the excavation, along with further measures if required including upgradient cutoff trenching with appropriate drainage outletting.

It is recommended that the SWM pond subgrade surfaces be proof rolled, and a representative of GHD approve the subgrade prior to construction of the berms. Construction of the berms may utilize excess site till or silty clay soils having a hydraulic conductivity of 10^{-5} cm/sec or lower. Such operations should place the till soils in lifts no thicker than 150 mm prior to compaction, and compacted to at least 95% SPMDD.

Due to the above noted soil and groundwater conditions, it is recommended that the base of the SWM pond be protected with an appropriate liner. The native, disturbed silty sand till or sand soils in a re-compacted form would not be suitable to form the SWM pond liner since the expected permeability would be too high. Conversely, native, undisturbed silty clay, or till with finer-grained gradation (silts and clays) would have a sufficiently low permeability and could substitute for a liner. An inspection of the excavated and exposed SWM pond surfaces should be performed at the time of construction, to assess where areas of increased hydraulic conductivity are present within the exposed soils, so that such areas may be lined with a more suitable (ie, less hydraulically conductive) material. It is expected that this can be accomplished using the site silty clay till soils (encountered in boreholes BH-9 to BH-11 and BH-13, coordinated with geotechnical inspection and final approval of materials. It is recommended that construction of such approved material be at least 600 mm thick, and must be placed under full time geotechnical inspections.

For the purpose of the proposed SWM pond, the soils observed should be stable from slip circle failure if sloped at 3 horizontal to 1 vertical (3H:1V) or flatter in the long term both above and below the water table. Between the stable water level and the expected high water level, it is recommended that the slopes be lessened to 4H:1V (or flatter) to guard against erosion by wavelet action. The till material will require vegetative root mass (or otherwise suitable erosion protection) to minimize erosional forces on exposed slopes.

Slopes and berms of the SWM pond should be constructed so as to reduce or eliminate the effects of surficial erosion. Features to do so may include slope vegetation, installation of erosion or gabion mats, rip rap, and/or other acceptable stabilizing features.

It is recommended that a regular maintenance program for the SWM pond include monitoring of it for any potential slope erosion, degradation, or otherwise undesirable structural conditions. Should any such conditions become evident, immediate mitigative actions must be performed.

6.2.8 Slope Stability Analysis

Global stability analyses were carried out at three (3) cross-sections locations identified in Figure F.1, based on the proposed grades as per a site grading plan prepared by Valdor. Global stability refers to the potential of a slope to undergo a relatively deep-seated circular failure. The subsurface stratigraphy was based upon the GHD test hole logs and the published geology.

The static slope stability analyses were performed using the Morgenstern & Price Method using the module Slope/W of the computer software Geo-Studio, developed and distributed by Geo Slope International Ltd.

The properties required for the stability analyses of the slopes are bulk density and shear strength parameters of the materials identified at the Site. The subsurface soils encountered in the test holes are generally comprised of shallow sandy silt soils underlain by silty clay or glacial till. Based on the Standard Penetration Test (SPT) blow counts recorded as 'N' values on the GHD borehole logs, the silty clay layer is typically firm to stiff in consistency, and the till is generally compact to very dense in-situ state of relative density.

The material parameters assigned to each soil layer in the slope stability analyses are provided on the respective slope stability analysis on Figures F.2 to F.4. The selected parameters are considered conservative while realistic based on the field and laboratory testing performed on representative samples of the soils, as well as published technical literature and our experience with similar materials. A 120 kPa surcharge load was applied to the model representing proposed building/development loads.

Piezometric surfaces can affect the results of the slope stability analyses if they pass through the soil mass above the critical slip circle / plane. The conditions for a free groundwater table (aquifer) are not present at the Site. Using the groundwater observations obtained from the open boreholes, in conjunction with the data obtained from the groundwater monitoring well installed in BH-4 and BH-7 and BH-13, the groundwater was not observed in the area of cross-section 1-1', 2-2' and 3-3'.

A factor of safety (FS) in slope stability analysis can be defined as the ratio of the available shear strength to that of the applied stresses along a potential failure plane. A factor of safety of 1.0 or greater indicates stable conditions and a value of less than 1.0 represents unstable conditions. Typically, a target factor of safety between 1.3 and 1.5 is considered reasonable for natural slopes, under static conditions. For the purposes of this study a minimum factor of safety of 1.5 was targeted.

The graphical outputs of the slope stability analyses are provided on Figures F.2 to F.4. The following summarizes the minimum factor of safety (FS) obtained for the proposed grades along each modelled cross-section:

– Section 1-1': FS=1.9
– Section 2-2': FS=1.5
– Section 3-3': FS=1.7

All cross-sections obtained a factor of safety above the minimum targeted factor of safety of 1.5 and are considered globally stable. It is noted that the proposed retaining wall in cross-section 2-2' requires a minimum 3 m embedment into the native soil to provide the minimum recommended 1.5 FS for global stability. It is recommended that further global stability analysis be completed once design details for the proposed retaining wall are available.

It is recommended that any future development consider the following regarding the slope:

– Where possible, the existing vegetative cover must not be disturbed by any future development for continuation of the existing conditions.
– Placement of topsoil with seeding or sod or other appropriate means of surficial erosion protection should be carried out as soon as practically possible after construction of new slopes.
– Storm water should not be directed to flow over the crest of the slope.
– The slope must be inspected at regular intervals for signs of erosion / instability and any remedial measures should be performed in consultation with a geotechnical engineer.

6.2.9 Erosion Hazard Limit Assessment

An Erosion Hazard Limit Assessment (EHLA) was completed as requested by the Otonabee Region Conservation Authority. This study is required to assess the potential for slope instability and loss of land due to erosion at a Site, where a development is proposed adjacent to an existing creek. The purpose of this study was to determine the appropriate setback limits for future development on the Site that will protect the development from slope instability and erosion hazard along its boundary in proximity to the slope. An erosion setback is a sum of the results of the following three components:

a. Toe erosion allowance setback
b. Stable top of slope setback
c. Access allowance Setback

The opinions described herein are based on an assessment performed in accordance with the Ontario Ministry of Natural Resources (MNR's) "Technical Guide – River & Stream Systems: Erosion Hazard Limit", 2002 (hereafter referred to as the Guideline).

6.2.9.1 Slope Inspection Evaluation

A GHD geotechnical engineer visited the Site and visually inspected the slope conditions on December 8, 2021. A tributary of Baxter Creek was observed to be less than 15 m distance from the slope toe. The slope crest and face are typically composed of well vegetated surface with heavy shrubs and mature trees present. No signs of mass slope instability were observed during the site visit, such as slope bulging, mass sloughing or tension cracks within or above the slope.

The slope inclinations and height along the selected sections were visually assessed during the slope inspection, and verified using the topographic information provided by the Valdor. The slope inclination was assessed to be approximately 2H:1V or flatter along cross-sections illustrated on Figure G.1.

Based on the results of the site inspection, and subsurface investigation completed, GHD conducted a Slope Stability Rating of the overall slope condition along cross-sections 4-4' to 9-9'. The slope stability rating was conducted in accordance with the requirements of the Ontario Ministry of Natural Resources and Forestry (MNRF) Guideline. The rating chart for the slope condition along each cross-section is attached in Appendix G.2. A rating value ranging from 20 to 24 was obtained for the slope stability rating performed for the cross-sections. According to the MNRF Guidelines, the instability for a slope with a rating smaller than 24 is considered 'Low Potential'.

6.2.9.2 Erosion Hazard Limit Evaluation

6.2.9.2.1 Toe Erosion Allowance

The erosion allowance was determined in accordance with the MNR Guidelines, applicable if the channel is within 15 m of a slope toe, which are reproduced below.

Type of Material Native Soil Structure	Evidence of Active Erosion or Where The Bankfull Velocity is Greater Than Competent Flow Velocity	No Evidence of Active Erosoin Bankfull Width		
		< 5 m	5 -30 m	> 30
Hard Rock (e.g. granite)	0 – 2 m	0 m	0 m	1 m
Soft rock (shale, limestone, cobbles, boulders	2 – 5 m	0 m	1 m	2 m
Clay, clay-silt, gravels	5 – 8 m	1 m	2 m	4 m
Sand, silt, and fill	8 – 15 m	1 – 2 m	5 m	7 m

The slope is comprised of silty clay or silty sand based on borehole observations, and minor evidence of active erosion was observed during the Site visit. Using this data, the toe erosion allowance is set at 8 m (from the above table).

6.2.9.2.2 Slope Stability Evaluation

Based on the results of the slope stability rating completed by GHD along each cross-section (Appendix G.2), the existing slopes along a tributary of Baxter Creek were assessed as having ‘Low potential” for instability and can be considered stable. For the purposes of this evaluation a 3H:1V inclination was used to determine the stable top of slope location along cross-sections 4-4’ to 9-9’. The stable top of slope for each cross-section based on the stable 3H:1V slope inclination is illustrated in Figures G2 to G7.

6.2.9.2.3 Access Allowance

In accordance with the Guide, an erosion access allowance of 6 m could be applied in addition to the toe erosion and the stable top of slope allowances and in accordance with the local conservation authority. It is GHD’s opinion that this allowance could be waived as the slope isn’t steep or high enough to impede access and if required, emergency access to the slope can be achieved through the proposed development.

6.2.9.3 Conclusion

The following summarizes our overall conclusions and recommendations regarding the EHLA along the section of of the tributary of Baxter Creek crossing the property:

1. No slope degradation or stability issues were identified in the visual inspection of the existing slopes along the tributary.
2. A toe erosion allowance of 8m is recommended for this Site.
3. The existing slopes along the tributary of Baxter Creek are assessed as having ‘Low potential” for instability and can be considered stable. For the purposes of this evaluation a 3H:1V inclination was used to determine the stable top of slope.
4. In accordance with the Guide, and as requested by the local conservation authority, an erosion access allowance of 6 m is applied.
5. The line identified in Figure G.1 as the “EHL” illustrates the location of the Erosion Hazard Limit setback based on the 8 m erosion allowance, a 3H:1V stable slope inclination and a 6 m erosion access allowance used for the purpose of this evaluation.

6.2.10 General Recommendations

6.2.10.1 Test Pit During Tendering

It is strongly recommended that test pits be excavated at representative locations of this Site during the tendering phase, with mandatory attendance of interested contractors. This will allow them to make their own assessments of the groundwater and soil conditions at the Site and how these will affect their proposed construction methods, techniques and schedules.

6.2.10.2 Subsoil Sensitivity

The native subsoils are susceptible to strength loss or deformation if saturated or disturbed by construction traffic. Therefore, where the subgrade consists of approved soil, care must be taken to protect the exposed subgrade from excess moisture and from construction traffic.

6.2.10.3 Winter Construction

The subsoils encountered across the site are frost-susceptible and freezing conditions could cause problems for the following reasons.

1. During winter construction, exposed surfaces intended to support foundations must be protected against freezing by means of loose straw and tarpaulins, heating, etc.
2. Care must be exercised so that any sidewalks and/or asphalt pavements do not interfere with the opening of doors during the winter when the soils are subject to frost heave. This problem may be minimized by any one of several means, such as keeping the doors well above outside grade, installing structural slabs at the doors, and by using well-graded backfill and positive drainage, etc.

3. Because of the frost heave potential of the soils during winter, it is recommended that the trenches for exterior underground services be excavated with shallow transition slopes in order to minimize the abrupt change in density between the granular backfill, which is relatively non-frost susceptible, and the more frost-susceptible native soils.

6.2.10.4 Design Review and Inspection

Due to the preliminary nature of the design details at the time of this report, we recommend that our firm be retained to review the foundation design and grading proposals when they are available. Geotechnical inspection and compaction testing must be carried out to ensure compliance with our recommendations.

6.3 Summary Conclusions

In summary, the proposed development area is generally comprised of topsoil underlain by silty sand over silty clay or glacial till. A permanent shallow groundwater table was not observed within the upper area (northern portion of the Site). Intermittent groundwater seepage may be encountered in this northern area. On the slope and lower area (southern portion of the Site), water was encountered at elevations between about 211 and 215 masl within each borehole in these areas. Grey soils were also observed in these boreholes suggesting there are conditions with groundwater throughout the year depending on the location. Flowing artesian wells to the west of the Site appear to be at elevations of about 183 to 186 masl and to the southeast at an elevation of about 205 masl. Local area artesian conditions are expected to be sufficiently deep such that flowing conditions are not encountered by the construction or development activities; however, care must be exercised during development to stay well above potential artesian zones and minimize the risk of contacting pressurized groundwater conditions. It is our opinion that there will not be significant constraints for the proposed residential and commercial development areas from the seasonal variations of groundwater as the water can be handled with appropriate engineering techniques. It is expected that groundwater will generally be below the depth of the future development, although seepage may be encountered in deeper excavations or foundations.

Seepage is expected to be seasonal in nature. If short-term pumping of groundwater at volumes greater than 50,000 L/day and less than 400,000 L/day is required during the construction stage, the EASR must be completed. In summary, the proposed residential development is suitable from both a hydrogeologic and geotechnical perspective.

There are minor impacts expected to groundwater and surface water as a result of the future development provided that appropriate planning (i.e. incorporation of LIDs as supported by the water balance calculations), mitigation measures and proper construction techniques are considered. From a geotechnical perspective, the Site is suitable for construction of the proposed development including one to two-storey single residential homes with basements, townhomes, commercial buildings and associated servicing and asphalt paved roadways, parking and access areas and a stormwater management pond. Detailed recommendations are provided in previous sections of this report.

The following Statement of Limitations should be read carefully and is an integral part of this report. We trust this report meets your immediate needs. Should any questions arise regarding any aspect of our report, please contact our office.

Sincerely,

Leandro Ramos, P.Eng.
Geotechnical Engineer, Project Manager

Robert Neck, P.Geo.(Limited)
Senior Geoscientist, Project Director

7. References

Chapman and Putnam, 1966. The Physiography of Southern Ontario, 2nd Edition. University of Toronto Press.

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City of Toronto, November 2006. Wet Weather Flow Management Guidelines.

Credit Valley Conservation and Toronto and Region Conservation Authority. Low Impact Development Stormwater Management Planning and Design Guide. Version 1.0. 2010.

Freeze, R. Allan and Cherry, John A. 1979. Groundwater.

Ministry of the Environment, Conservation and Parks, January, 2019. Source Protection Information Atlas, available online at www.ontario.ca.

8. Statement of Limitations

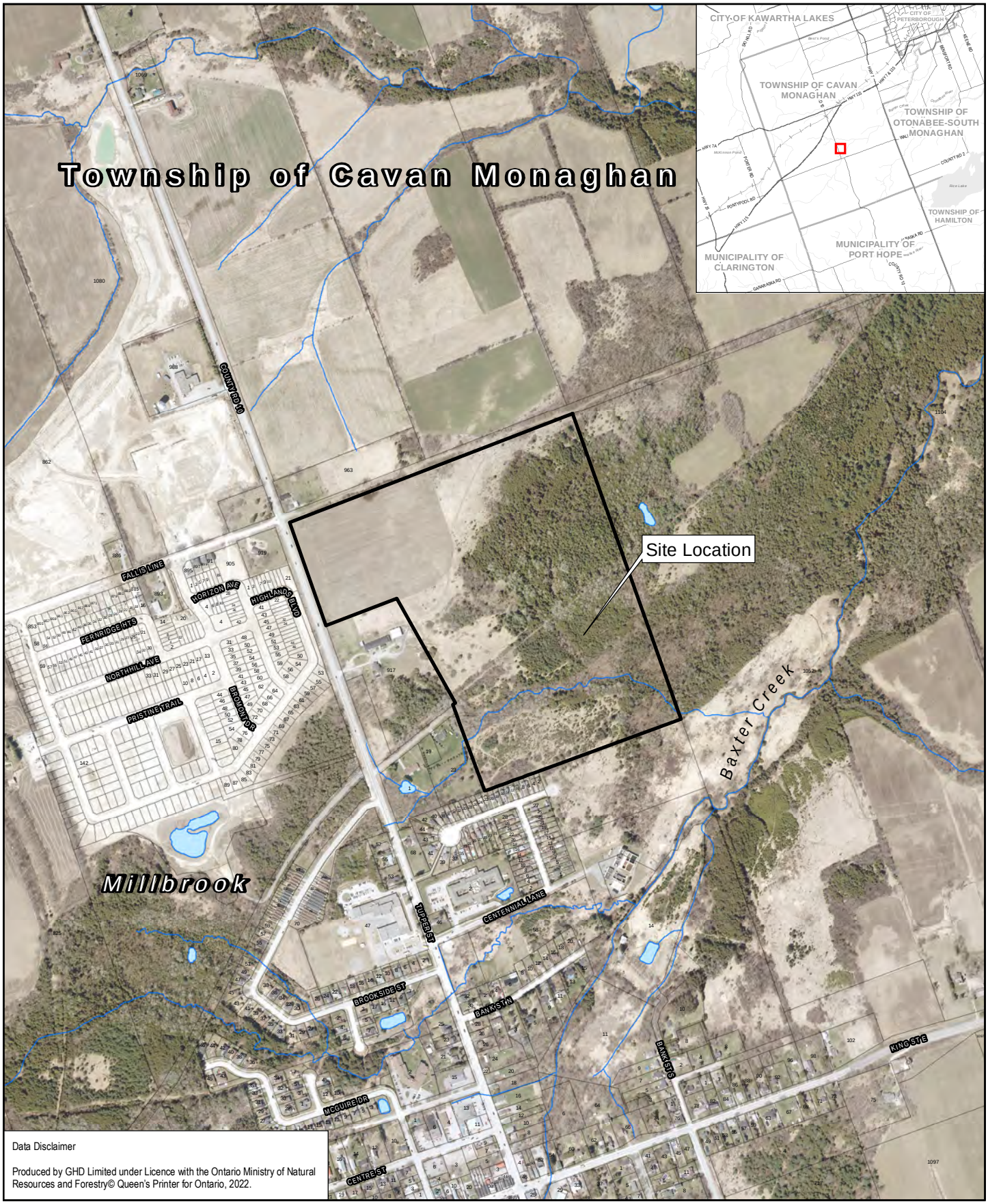
This report is intended solely for Vargas Properties Inc. in assessing the geotechnical and hydrogeologic aspects of the lands situated on Part Lot 13, Concession 5 in Millbrook, Ontario and is prohibited for use by others without GHD's prior written consent. This report is considered GHD's professional work product and shall remain the sole property of GHD. Any unauthorized reuse, redistribution of or reliance on the report shall be at the Client and recipient's sole risk, without liability to GHD. Client shall defend, indemnify and hold GHD harmless from any liability arising from or related to Client's unauthorized distribution of the report. No portion of this report may be used as a separate entity; it is to be read in its entirety and shall include all supporting drawings and appendices.

The recommendations made in this report are in accordance with our present understanding of the project, the current site use, ground surface elevations and conditions, and are based on the work scope approved by the Client and described in the report. The services were performed in a manner consistent with that level of care and skill ordinarily exercised by members of hydrogeological engineering professions currently practicing under similar conditions in the same locality. No other representations, and no warranties or representations of any kind, either expressed or implied, are made. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties.

All details of design and construction are rarely known at the time of completion of a geotechnical or hydrogeological study. The recommendations and comments made in the study report are based on our subsurface investigation and resulting understanding of the project, as defined at the time of the study. We should be retained to review our recommendations when the drawings and specifications are complete. Without this review, GHD will not be liable for any misunderstanding of our recommendations or their application and adaptation into the final design.

It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments included in this report are based on the results obtained at the test hole locations only. The subsurface conditions confirmed at the test hole locations may vary at other locations. The subsurface conditions can also be significantly modified by the construction activities on site (ex. excavation, dewatering and drainage, blasting, pile driving, etc.). These conditions can also be modified by exposure of soils or bedrock to humidity, dry periods or frost. Soil and groundwater conditions between and beyond the test locations may differ both horizontally and vertically from those encountered at the test locations and conditions may become apparent during construction which could not be detected or anticipated at the time of our assessment. Should any conditions at the site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations. If changed conditions are identified during construction, no matter how minor, the recommendations in this report shall be considered invalid until sufficient review and written assessment of said conditions by GHD is completed

Figures



Data Disclaimer

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1 cm = 100 meters

0 70 140 210 280

Metres

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

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Vargas Properties
963 County Road 10, Millbrook, ON
Pt Lot 13, Con 5, Geographic Township of Cavan
Township of Cavan Monghan

Geotechnical Investigation
Vicinity Plan

Project No. 11209539
Revision No.
Date Mar 3, 2022

Figure 1

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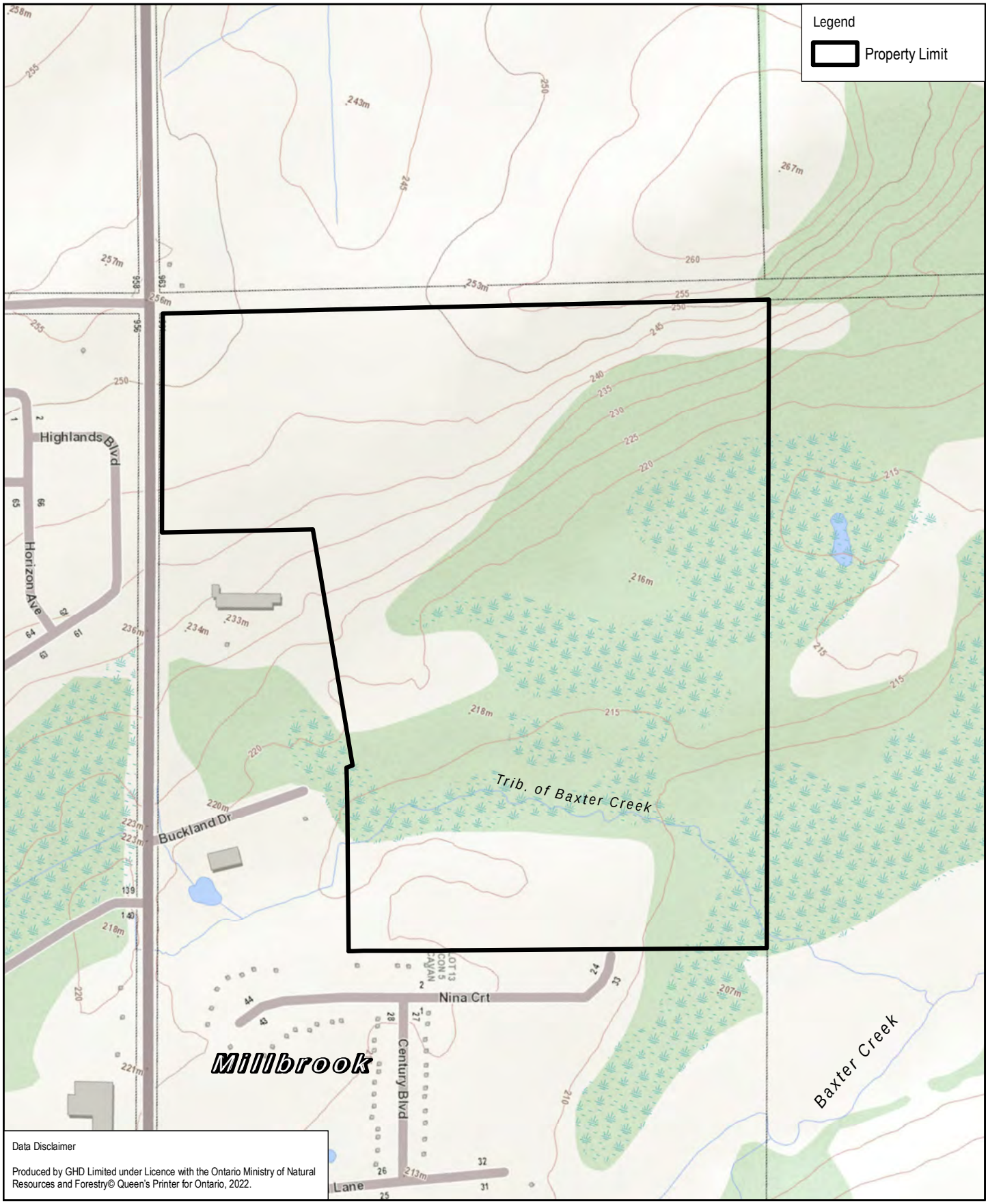

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Grid: NAD 1983 UTM Zone 17N

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Vargas Properties
963 County Road 10, Millbrook, ON
Pt Lot 13, Con 5, Geographic Township of Cavan
Township of Cavan Monghan

Geotechnical Investigation
Property Plan

Project No. 11209539
Revision No.
Date Mar 2, 2022

Figure 2

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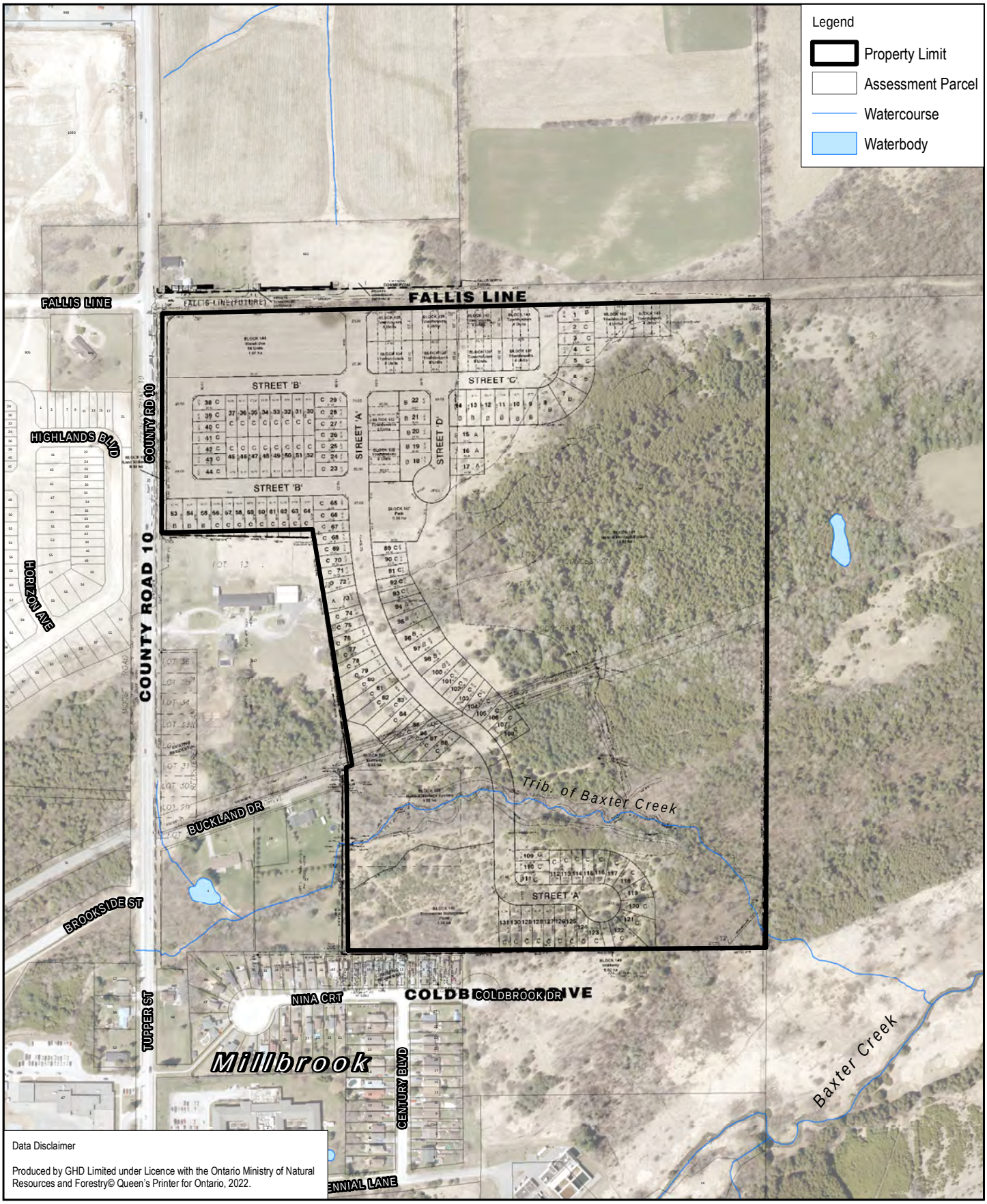

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Metres

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Grid: NAD 1983 UTM Zone 17N

N

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Vargas Properties
963 County Road 10, Millbrook, ON
Pt Lot 13, Con 5, Geographic Township of Cavan
Township of Cavan Monghan

Geotechnical Investigation
Site Plan

Project No. 11209539
Revision No.
Date Jan 25, 2023

Figure 3

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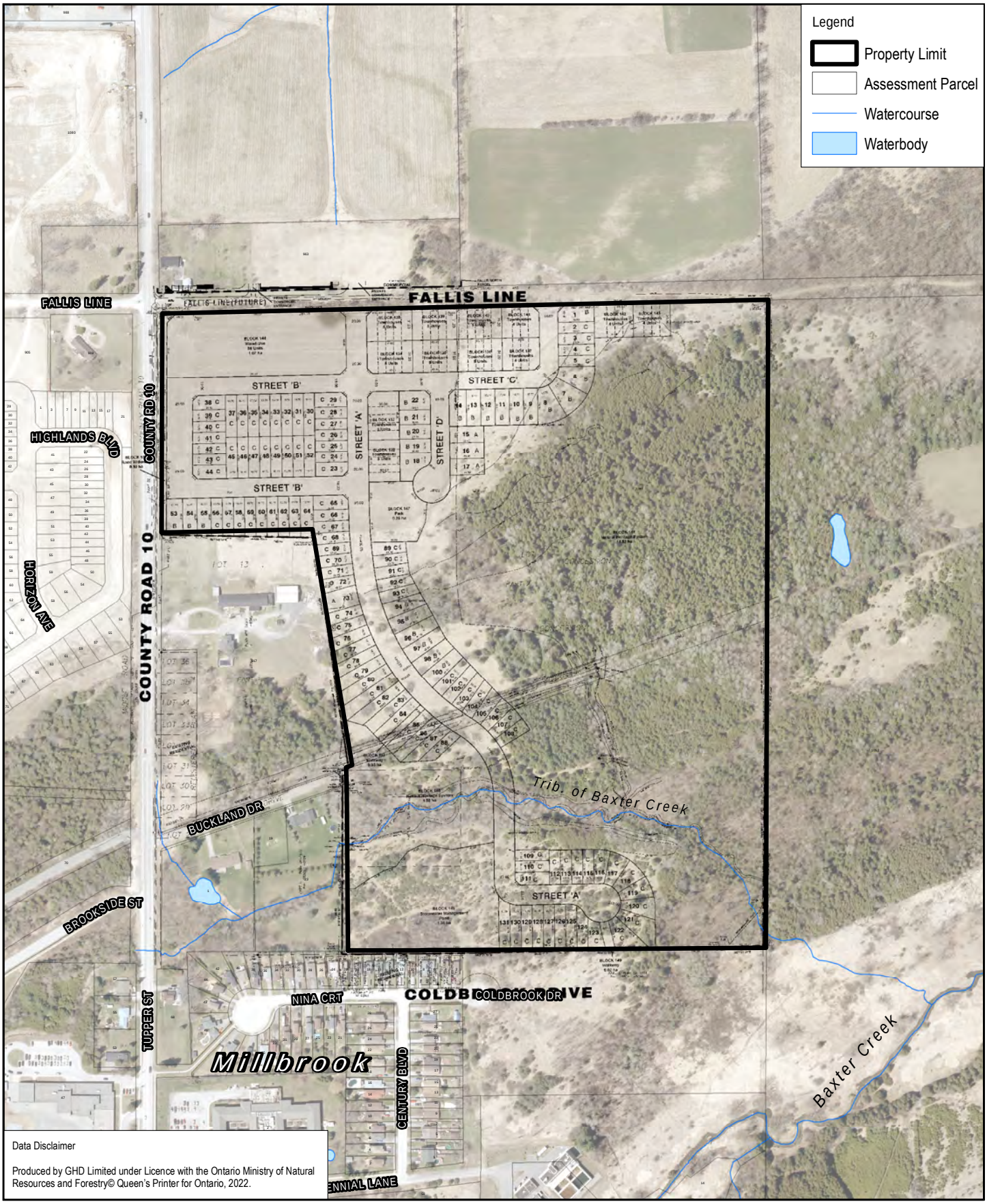

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Vargas Properties
963 County Road 10, Millbrook, ON
Pt Lot 13, Con 5, Geographic Township of Cavan
Township of Cavan Monghan

Geotechnical Investigation
Concept Plan

Project No. 11209539
Revision No.
Date Jan 25, 2023

Figure 4

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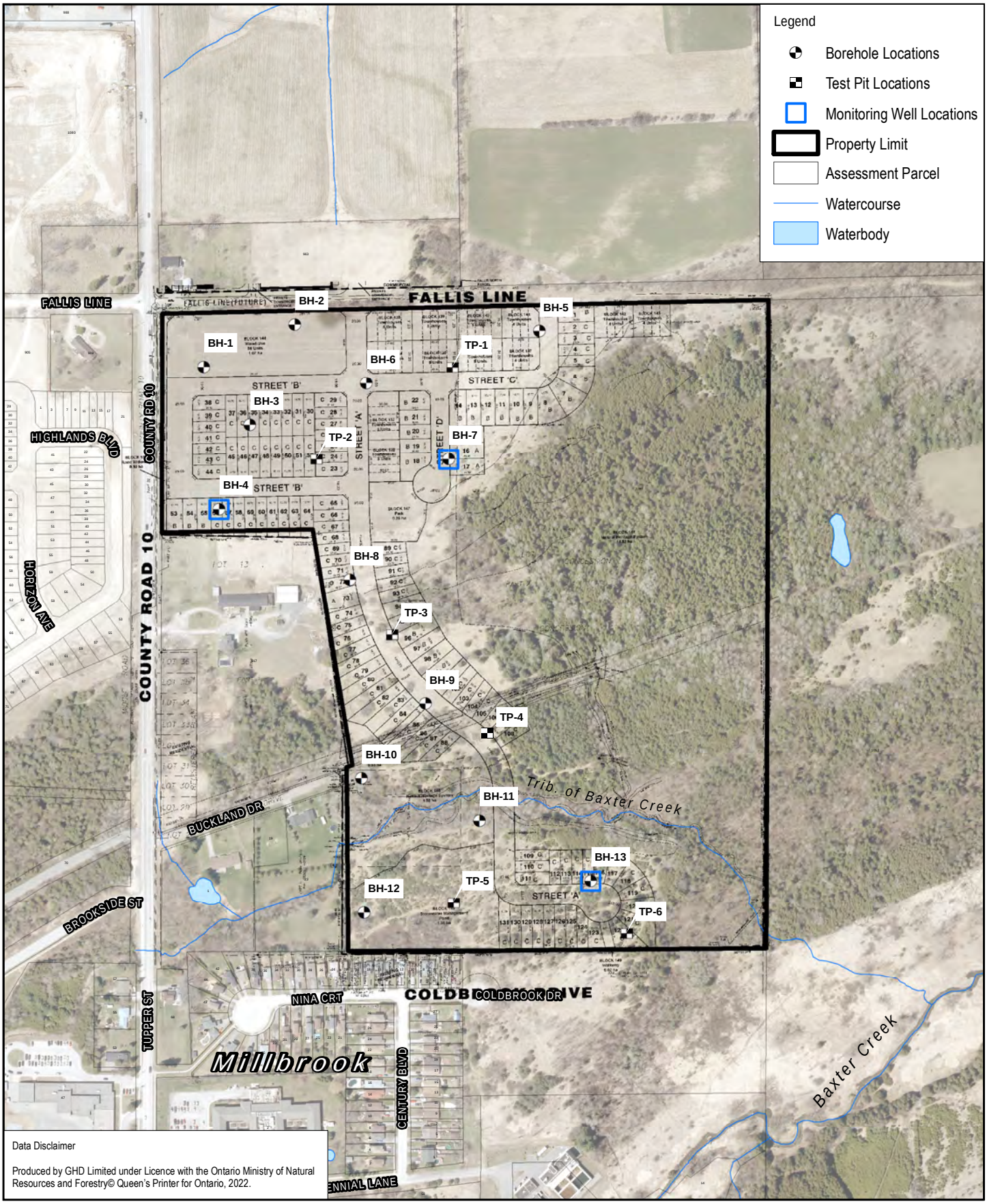

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Vargas Properties
963 County Road 10, Millbrook, ON
Pt Lot 13, Con 5, Geographic Township of Cavan
Township of Cavan Monghan

Geotechnical Investigation
Test Hole Plan

Project No. 11209539
Revision No.
Date Jan 25, 2023

Figure 5

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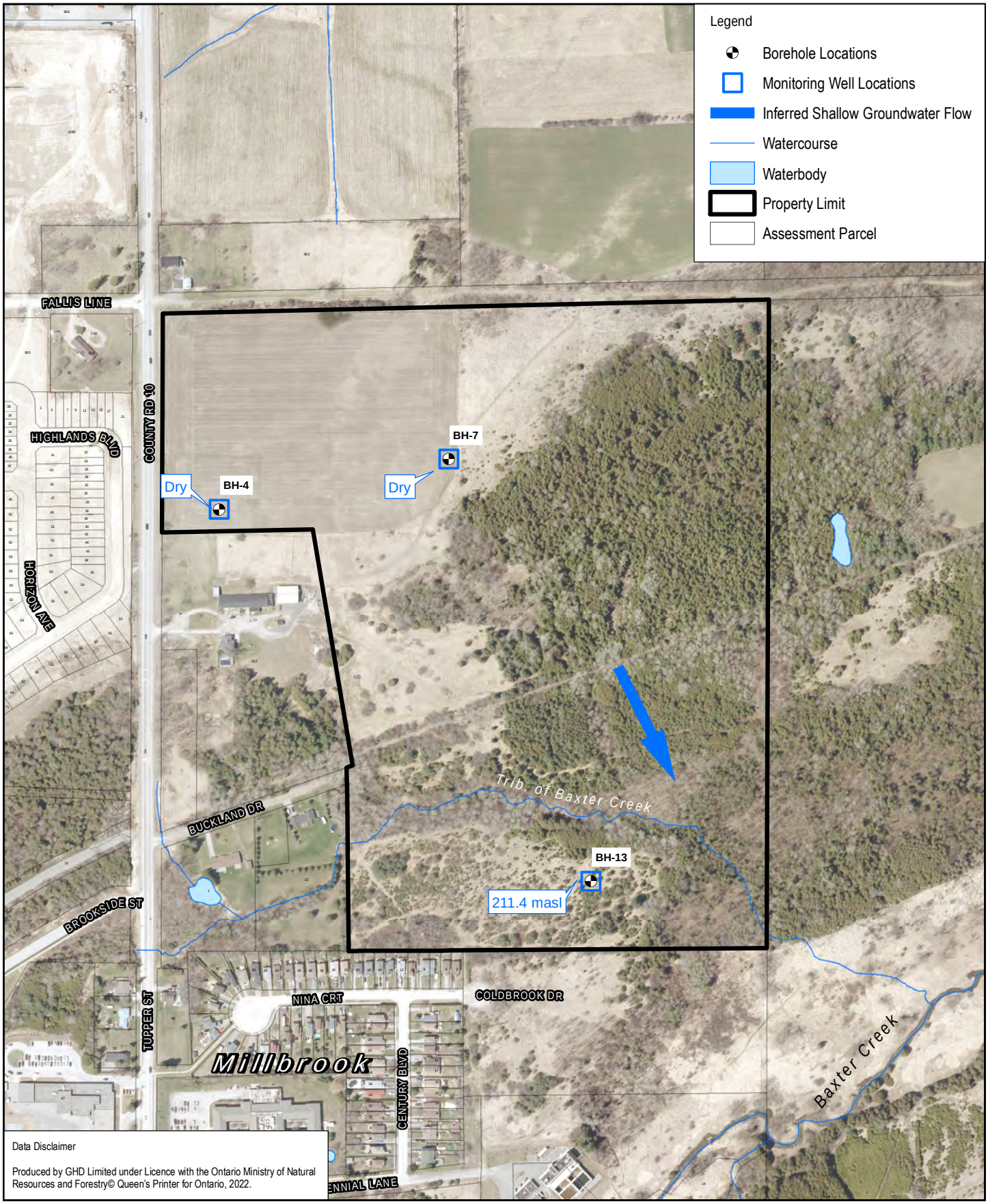

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1 cm = 50 meters

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Metres

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Township of Cavan Monghan

Geotechnical Investigation

Groundwater Elevation Plan

Project No. 11209539
Revision No.
Date Mar 2, 2022

Figure 6

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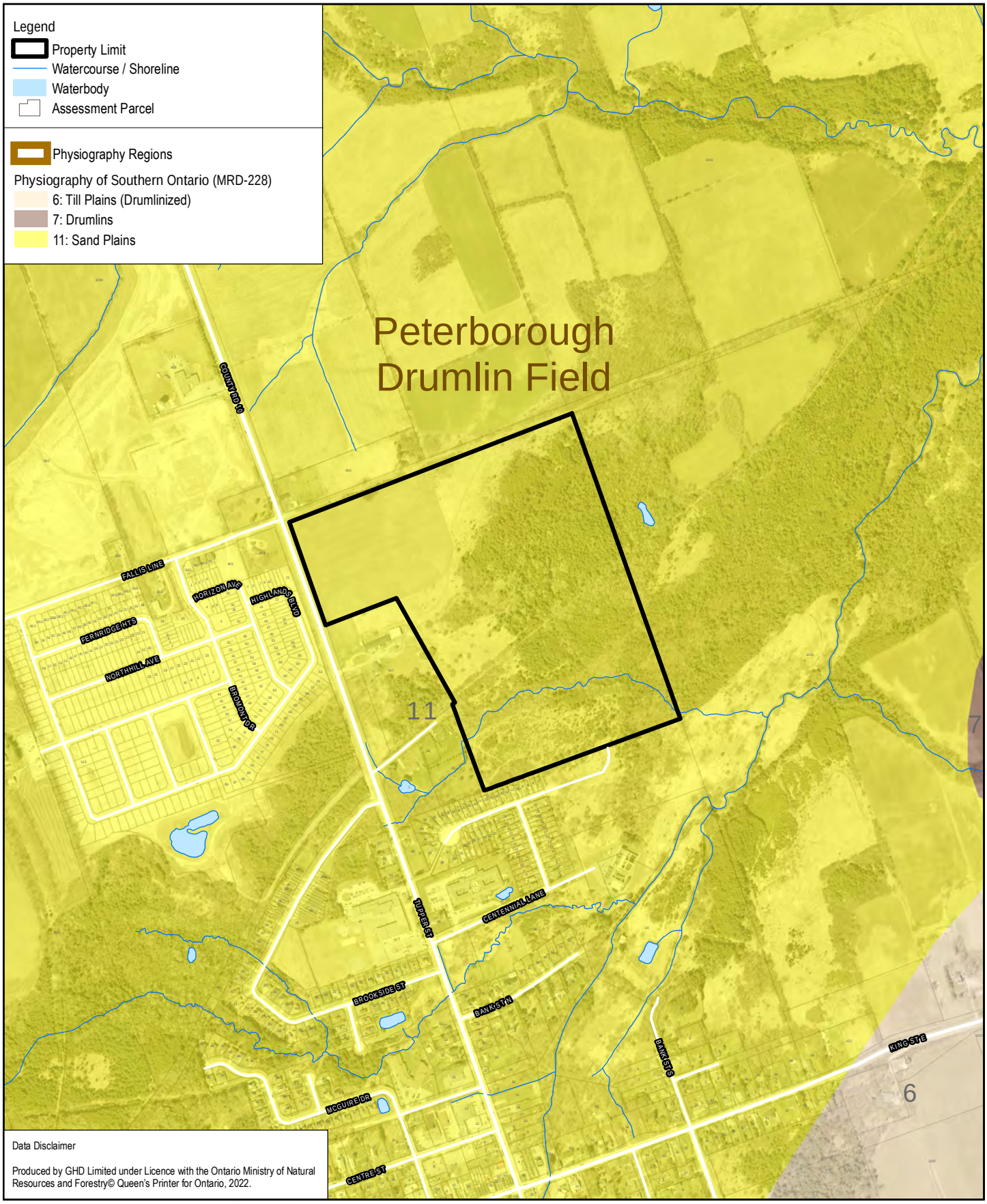

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N

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963 County Road 10, Millbrook, ON
Pt Lot 13, Con 5, Geographic Township of Cavan
Township of Cavan Monaghan

Geotechnical Investigation
Physiography

Project No. 11209539
Revision No.
Date Mar 2, 2022

Figure 6

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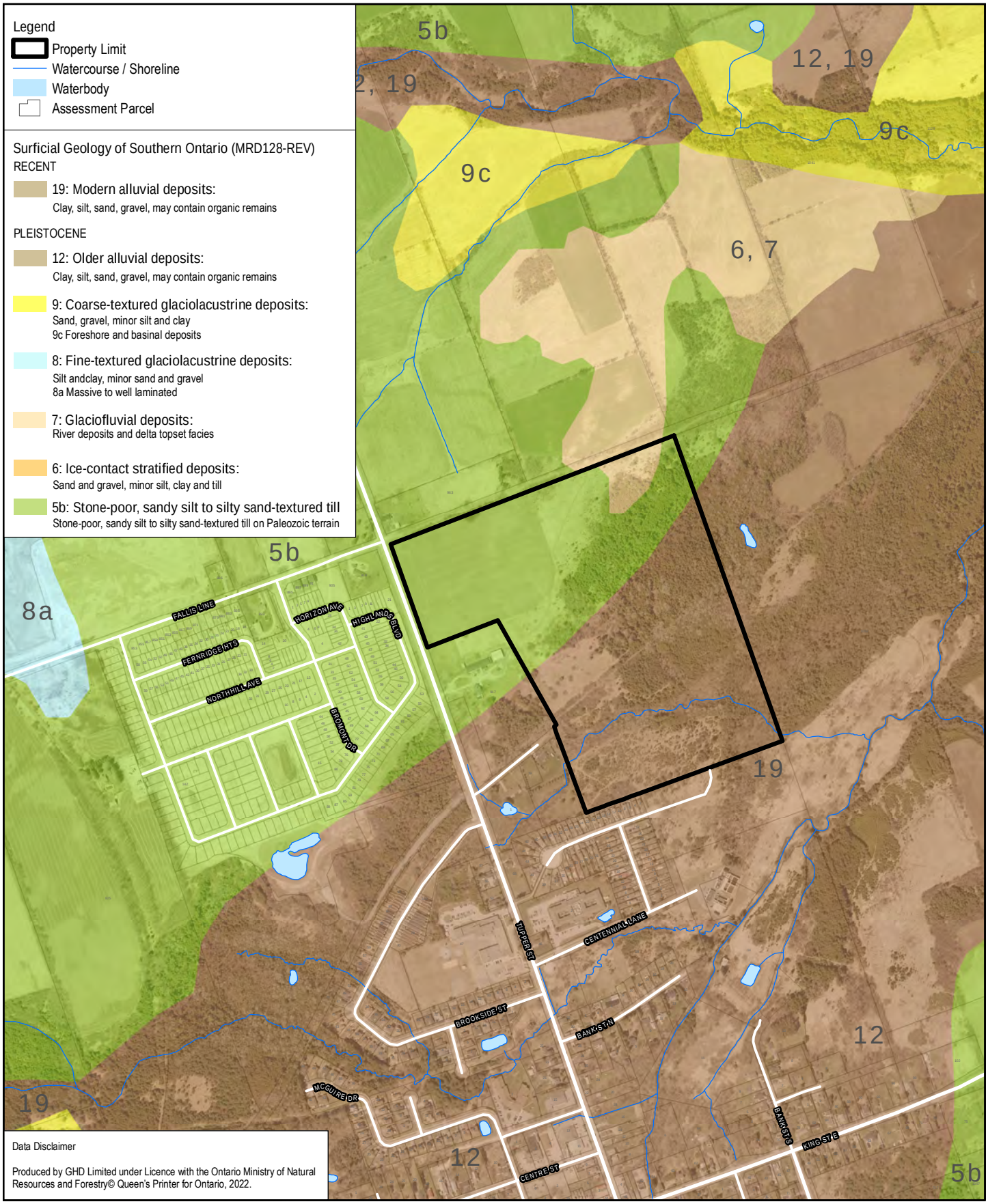

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Metres

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Grid: NAD 1983 UTM Zone 17N

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Vargas Properties
963 County Road 10, Millbrook, ON
Pt Lot 13, Con 5, Geographic Township of Cavan
Township of Cavan Monghan

Geotechnical Investigation

Surficial Geology

Project No. 11209539
Revision No.
Date Mar 2, 2022

Figure 8

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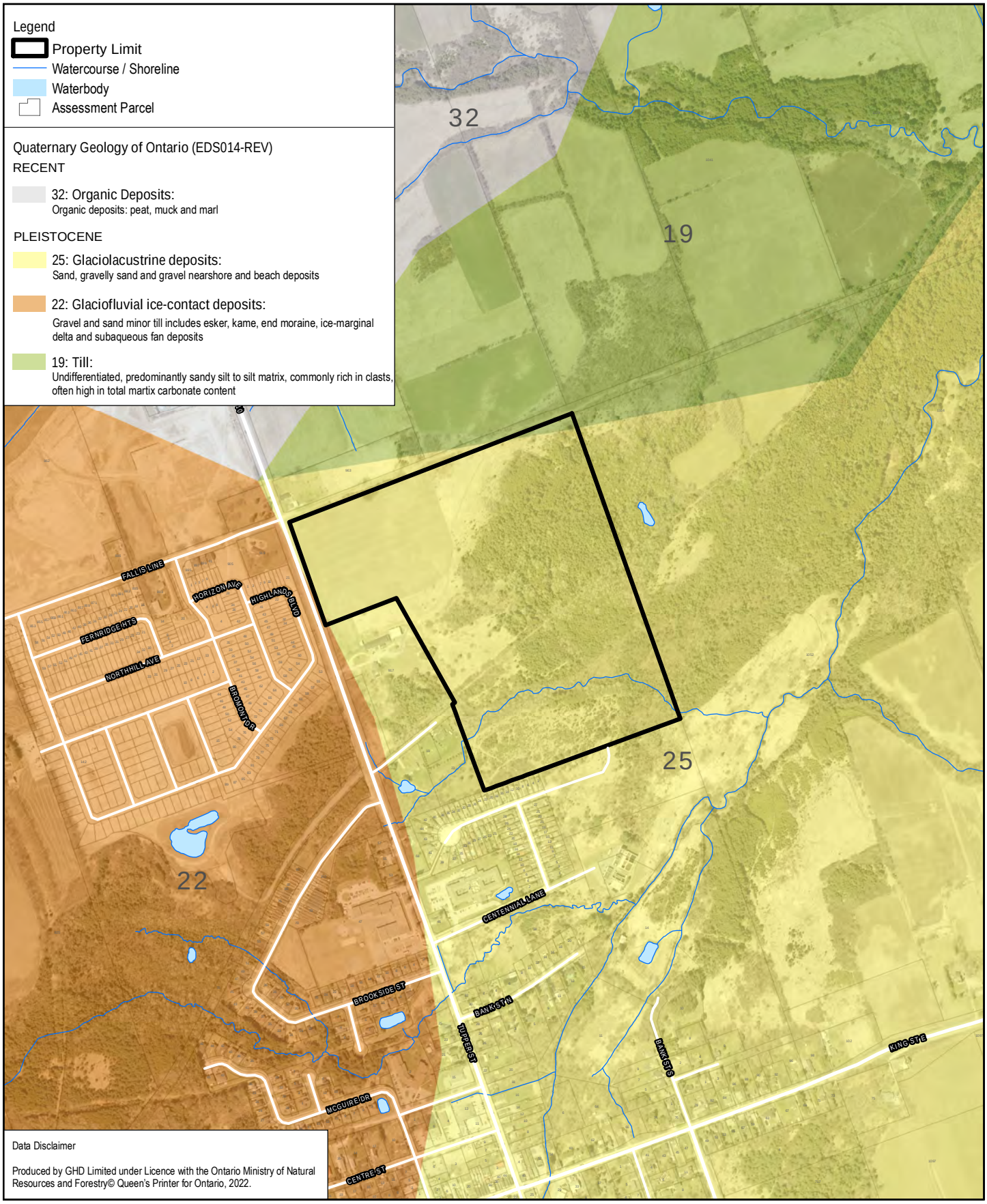

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Metres

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N

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Vargas Properties
963 County Road 10, Millbrook, ON
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Township of Cavan Monghan

Geotechnical Investigation

Quaternary Geology

Project No. 11209539
Revision No.
Date Mar 2, 2022

Figure 9

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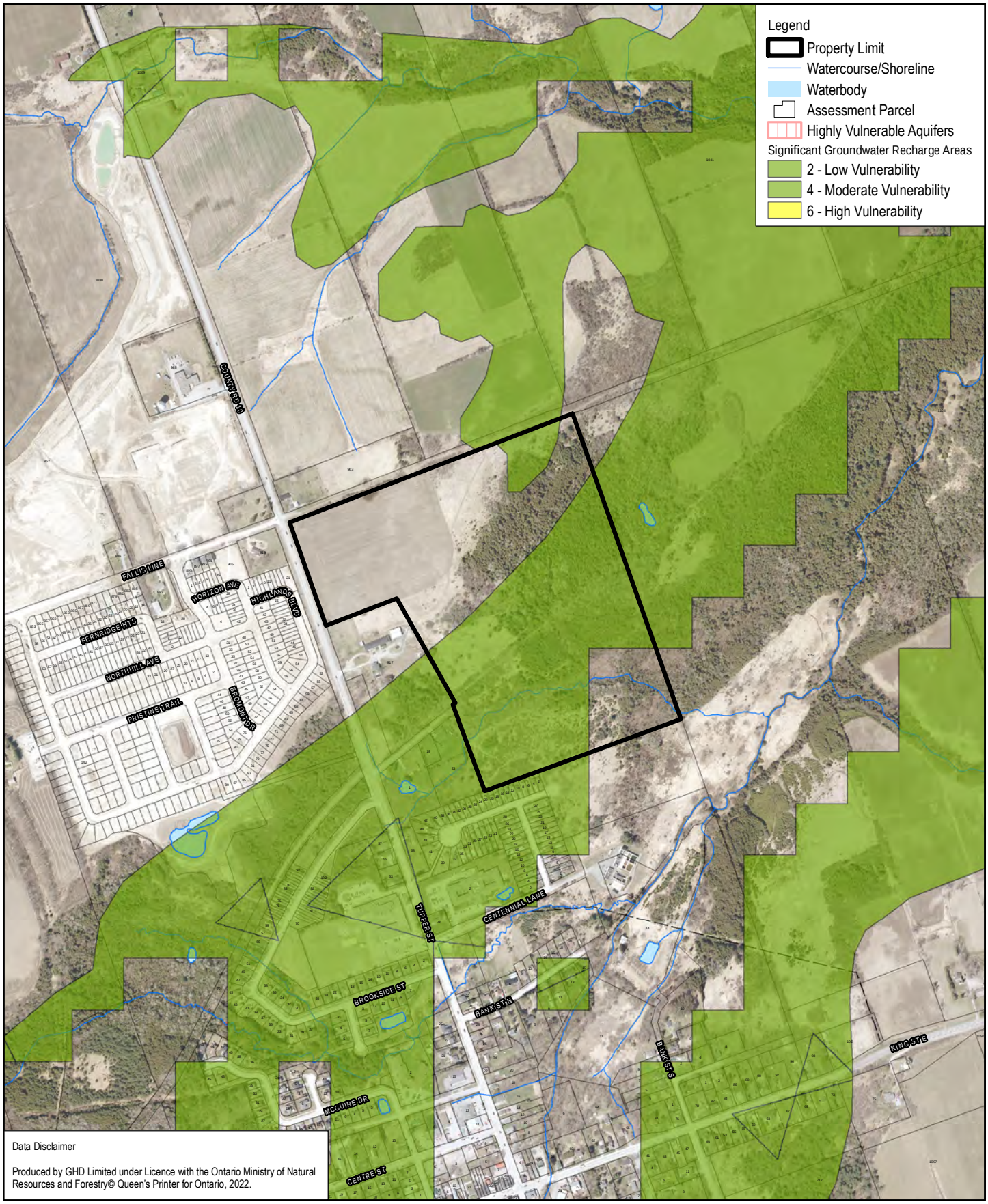

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Metres

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Grid: NAD 1983 UTM Zone 17N

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Vargas Properties
963 County Road 10, Millbrook, ON
Pt Lot 13, Con 5, Geographic Township of Cavan
Township of Cavan Monghan

Geotechnical Investigation

Source Protection

Project No. 11209539
Revision No.
Date Mar 2, 2022

Figure 10

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Print date: 02 Mar 2022 - 10:59

Data source: Source Protection Information Atlas. Ministry of Environment, Conservation and Parks. Web Application., © County of Peterborough, 2018.

Appendices

Appendix A

Soil Exploration Data

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-1

BOREHOLE No.: BH-1
ELEVATION: 250.3 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties
PROJECT: Proposed Residential and Commercial Development
LOGGED BY: Jamie McEachern DATE: 13 March 2020
DRILLING COMPANY: Strong Soil Search METHOD: Solid Stem Augers and Spilt Spoons
NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND
- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	COMMENTS
		0.0		GROUND SURFACE						
		0.3		**TOPSOIL** (300 mm)	SS-1A	63	24	0 2 2	4	Borehole remained open throughout drilling activities
		0.5		**SANDY SILT** - Reddish Brown Sandy Silt, Moist to Wet, Loose	SS-1A		13	2 3 4		
	1.0			**TILL** - Light Brown Sandy Silt, Trace Gravel, Clay, Moist to Wet, Compact	SS-2	72	11	13 13	26	
		1.5		Cobble (Inferred From Augers Grinding), Moist, Very Dense	SS-3	72	7	8 23 28	51	
	2.0				SS-4	100	8	16 37 50=5"	100+	
	3.0				SS-5	100	10	30 50=2"	100+	First encounter of groundwater seepage at 2.6 m
	4.0									WL - 4.1 m immediately after drilling
	5.0				SS-6	100	5	40 50=2"	100+	
	6.0									
		6.3		END OF BOREHOLE	SS-7	100	10	31 50=2"	100+	
	7.0									
	8.0									

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
× "N" Value (blows / 0.3 m)
◆ RQD
◎ CONE

10 20 30 40 50 60 70 80 90

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-2

BOREHOLE No.: BH-2

ELEVATION: 248.6 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties

PROJECT: Proposed Residential and Commercial Development

LOGGED BY: Jamie McEachern DATE: 13 March 2020

DRILLING COMPANY: Strong Soil Search METHOD: Solid Stem Augers and Spilt Spoons

NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	COMMENTS
		0.0		GROUND SURFACE						
		0.3		**TOPSOIL** (300 mm)	SS-1A	71	27	1 2 2	4	
		0.5		**SANDY SILT** - Reddish Brown Sandy Silt, Moist to Wet, Loose	SS-1B		26	4		
	1.0			**TILL** - Light Brown Clayey Silt, Trace Sand, Moist to Wet, Compact	SS-2	78	22	6 10 15	25	
		1.5		With Gravel, Moist	SS-3	100	10	5 7 8	15	
	2.0				SS-4	72	8	5 8 14	22	WL - 2.3 m immediately after drilling First encounter of groundwater seepage at 2.4 m
	3.0	3.0		Light Brown Silty Sand with Gravel, Trace Clay, Moist, Very Dense	SS-5	44	10	20 41 34	75	
	4.0									
					SS-6	94	7	12 28 33	61	
	5.0									Borehole Caving to 5.3 m at completion on drilling
	6.0	6.1		Grey, Dense	SS-7	78		8 17 28	45	
		6.6		END OF BOREHOLE						
	7.0									
	8.0									

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
× "N" Value (blows / 0.3 m)
◆ RQD
◎ CONE

10 20 30 40 50 60 70 80 90

BOREHOLE LOG GEOTECH (MULTIPLE DRILLERS) 11209539-01-DWG-20-06-01, VARGAS BOREHOLE LOGS, JM, EW.GPJ GEOLOGIC.GDT 15/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-3

BOREHOLE No.: BH-3
ELEVATION: 246.5 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties
PROJECT: Proposed Residential and Commercial Development
LOGGED BY: E. Wierdsma DATE: 15 April 2020
DRILLING COMPANY: Landshark Drilling METHOD: Solid Stem Augers and Spilt Spoons
NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND
- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (%) / "N" Value (blows / 0.3 m) / Field / Lab / RQD / CONE	COMMENTS
		0.0		GROUND SURFACE							
				TOPSOIL (300 mm)				1 2 3 4			
1		0.3		**SANDY SILT** - Brown Sandy Silt, Moist, Loose	SS-1	40	7		5		
2											
3	1.0	1.1		**TILL** - Light Brown Sandy Silt with Clay and Gravel, Moist, Compact	SS-2	100	31	4 6 7 7	13		
5											
6	2.0				SS-3	50	12	4 7 11 9	18		
7											
8					SS-4	100	12	6 11 14 12	25		Grain Size Data SS-4: 13% Gravel 29% Sand 58% Silt and Clay-sized Particles 33% Between 5-75 um
9											
10	3.0	3.0		Dense	SS-5	100	10	3 18 30 22	48		
11											
12		3.7		Cobble (Inferred From Augers Grinding)							
13	4.0										
14											
15		4.6		Very Dense	SS-6	100	8	50=4"	100+		
16											
17	5.0										
18											
19											
20	6.0				SS-7	100	11	26 24 26	50		
21		6.4		Wet							
22		6.6		END OF BOREHOLE							End of borehole open and dry upon completion of drilling
23	7.0										
24											
25											
26	8.0										
27											

BOREHOLE LOG GEOTECH (MULTIPLE DRILLERS) 11209539-01-DWG-20-06-01, VARGAS BOREHOLE LOGS, JM, EW.GPJ GEOLOGIC.GDT 15/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-4

BOREHOLE No.: BH-4
ELEVATION: 244.2 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties
PROJECT: Proposed Residential and Commercial Development
LOGGED BY: Jamie McEachern DATE: 13 March 2020
DRILLING COMPANY: Strong Soil Search METHOD: Solid Stem Augers and Spilt Spoons
NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND
- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N
		0.0		GROUND SURFACE					
		0.3		**TOPSOIL** (300 mm)	SS-1	50	11	1 3 2 3	5
		0.9		**SANDY SILT** - Reddish Brown Sandy Silt, Trace Clay, Moist to Wet, Firm	SS-2	39	21	7 8 12	20
	1.0	1.5		**TILL** - Light Brown Silty Sand, Trace Gravel, Clay, Moist to Wet, Compact Dense	SS-3A SS-3B	100	11 5	28 21 16	37
	2.0	2.3		With Gravel, Very Dense	SS-4	83	18	18 28 42	70
	3.0				SS-5	100	10	11 24 47	71
	4.0								
	5.0				SS-6	100	6	14 20 24	44
	6.0				SS-7	100	18	16 31 50=4"	100+
	7.0	7.8		END OF BOREHOLE	SS-8	100		33 50=3"	100+
	8.0								

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
Atterberg limits (%) W_p W_l
× "N" Value (blows / 0.3 m)
◆ RQD
◎ CONE

10 20 30 40 50 60 70 80 90

COMMENTS

— 0.79 m
— 0.77 m

Borehole remained open and dry throughout drilling activities
WL - Dry
05/19/2020 and
03/19/2020

Shallow piezometer installed to 1.5 m. Piezometer measured dry on 05/19/2020

BOREHOLE LOG GEOTECH (MULTIPLE DRILLERS) 11209539-01-DWG-20-06-01, VARGAS BOREHOLE LOGS, JM, EW.GPJ GEOLOGIC.GDT 15/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-5

BOREHOLE No.: BH-5
ELEVATION: 253.6 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties
PROJECT: Proposed Residential and Commercial Development
LOGGED BY: Jamie McEachern DATE: 12 March 2020
DRILLING COMPANY: Strong Soil Search METHOD: Solid Stem Augers and Spilt Spoons
NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND
- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N
		0.0		GROUND SURFACE					
		0.3		**TOPSOIL** (300 mm)					
1				**SANDY SILT** - Reddish Brown Sandy Silt, Trace Clay, Moist to Wet, Loose	SS-1	42	17	1 2 4 7	6
2		0.8							
3	1.0			**TILL** - Light Brown Silty Sand With Gravel, Trace Clay, Moist to Wet, Loose to Compact	SS-2	50	14	2 6 5	11
4									
5					SS-3	100	15	3 2 3	5
6									
7	2.0								
8				- Reddish Brown 75mm Sand Seam at 2.6m	SS-4	78	13	8 8 12	20
9									
10	3.0	3.0		Moist, Very Dense	SS-5	72	9	16 29 36	65
11									
12									
13	4.0								
14									
15					SS-6	100	6	20 30 32	64
16									
17	5.0								
18									
19									
20	6.0				SS-7	100	8	26 30 38	64
21									
22		6.6		END OF BOREHOLE					
23	7.0								
24									
25									
26	8.0								
27									

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
× "N" Value (blows / 0.3 m)
◆ RQD
◎ CONE

10 20 30 40 50 60 70 80 90

COMMENTS

Borehole remained open and dry throughout drilling activities

BOREHOLE LOG GEOTECH (MULTIPLE DRILLERS) 11209539-01-DWG-20-06-01, VARGAS BOREHOLE LOGS, JM, EW.GPJ GEOLOGIC.GDT 15/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-6

BOREHOLE No.: BH-6
ELEVATION: 247.1 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties
PROJECT: Proposed Residential and Commercial Development
LOGGED BY: Jamie McEachern DATE: 13 March 2020
DRILLING COMPANY: Strong Soil Search METHOD: Solid Stem Augers and Spilt Spoons
NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND
- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	COMMENTS
		0.0		GROUND SURFACE						
		0.3		**TOPSOIL** (300 mm)						Borehole remained open and dry throughout drilling activities
1				**SANDY SILT** - Reddish Brown Sandy Silt, Trace Clay, Moist to Wet, Loose	SS-1	67	22	3 2 4 4	8	
2		0.6								
3	1.0	0.9		**TILL** - Light Brown Silty Sand with Gravel, Trace Clay, Moist to Wet, Compact / Moist	SS-2	100	9	3 9 11	20	
5					SS-3	72	10	13 14 12	26	
6	2.0									
8					SS-4	94	7	4 10 15	25	
9										
10	3.0	3.0		Very Dense	SS-5	100	4	11 30 50=4"	100+	
12										
13	4.0									
15					SS-6	100	5	45 50=4"	100+	
16	5.0									
19										
20	6.0				SS-7	100	5	12 19 33	52	
21		6.6		END OF BOREHOLE						
23	7.0									
26	8.0									
27										

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
× "N" Value (blows / 0.3 m)
◆ RQD
◎ CONE

10 20 30 40 50 60 70 80 90

BOREHOLE LOG GEOTECH (MULTIPLE DRILLERS) 11209539-01-DWG-20-06-01, VARGAS BOREHOLE LOGS, JM, EW.GPJ GEOLOGIC.GDT 15/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-7

BOREHOLE No.: BH-7

ELEVATION: 238.8 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties

PROJECT: Proposed Residential and Commercial Development

LOGGED BY: Jamie McEachern DATE: 12 March 2020

DRILLING COMPANY: Strong Soil Search METHOD: Solid Stem Augers and Spilt Spoons

NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N
		0.0		GROUND SURFACE					
1		0.3		**TOPSOIL** (300 mm)					
2		0.6		**SANDY SILT** - Reddish Brown Sandy Silt, Trace Clay, Moist to Wet, Soft	SS-1	58	18	1 2 1 4	3
3	1.0			**TILL** - Light Brown Silty Sand With Gravel, Trace Clay, Moist to Wet, Compact	SS-2	100	12	3 7 11	18
5		1.5		Clayey	SS-3	100	15	2 4 6	10
8	2.0				SS-4A		10	6	
9		2.6		Trace Clay, Moist, Very Dense	SS-4B	100	4	16 34	50
11	3.0				SS-5	83	6	12 24 40	64
16	5.0				SS-6	100	8	18 42 50=4"	100+
20	6.0				SS-7	100	10	28 50=3"	100+
21		6.3		END OF BOREHOLE					
26	8.0								

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
× "N" Value (blows / 0.3 m)
◆ RQD
◎ CONE

10 20 30 40 50 60 70 80 90

— 0.79 m
— 0.78 m

COMMENTS

Grain Size Data
SS-1:
4% Gravel
33% Sand
63% Silt and Clay-sized Particles
48% Between 5-75 um

Shallow piezometer installed to 1.5 m. Piezometer measured dry on 05/19/2020

WL - Dry
05/19/2020 and 03/19/2020

Borehole remained open and dry throughout drilling activities

BOREHOLE LOG GEOTECH (MULTIPLE DRILLERS) 11209539-01-DWG-20-06-01, VARGAS BOREHOLE LOGS, JM, EW.GPJ GEOLOGIC.GDT 15/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-8

BOREHOLE No.: BH-8

ELEVATION: 231.0 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties

PROJECT: Proposed Residential and Commercial Development

LOGGED BY: E. Wierdsma DATE: 15 April 2020

DRILLING COMPANY: Landshark Drilling METHOD: Solid Stem Augers and Spilt Spoons

NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	COMMENTS
		0.0		GROUND SURFACE						
		0.3		**TOPSOIL** (300 mm)						
1				**SANDY SILT** - Brown Sandy Silt, Moist, Very Loose	SS-1	25	33	1 1 1 2	2	
2		0.8								
3	1.0			**TILL** - Light Brown Sandy Silt With Clay and Gravel, Moist, Loose	SS-2	60	10	2 3 5 7	8	
4		1.2		Cobble (Inferred From Augers Grinding)						
5		1.5		Clayey Silt with Sand and Gravel, Mottled, Moist, Compact to Dense	SS-3	50	13	4 20 19 16	39	
6	2.0									
7										
8		2.6		Grey	SS-4	60	9	3 3 25 10	28	
9										
10	3.0	3.0		Wet	SS-5	60	11	7 10 24 14	34	First encounter of groundwater seepage at 3.0 m Water up to 3.4 m upon completion
11										
12										
13	4.0									
14										
15		4.6		Grey Sandy Silt with Clay and Gravel, Moist, Dense	SS-6	50	9	12 19 17 19	31	Borehole cave-in up to 4.3 m upon completion
16	5.0									
17										
18										
19										
20	6.0									
21					SS-7	50	9	14 16 22 10	38	
22		6.7		END OF BOREHOLE						
23	7.0									
24										
25										
26	8.0									
27										

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
× "N" Value (blows / 0.3 m) ◆ RQD ◎ CONE

10 20 30 40 50 60 70 80 90

BOREHOLE LOG GEOTECH (MULTIPLE DRILLERS) 11209539-01-DWG-20-06-01, VARGAS BOREHOLE LOGS, JM, EW.GPJ GEOLOGIC.GDT 15/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-9

BOREHOLE No.: BH-9
ELEVATION: 218.4 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties
PROJECT: Proposed Residential and Commercial Development
LOGGED BY: E. Wierdsma DATE: 15 April 2020
DRILLING COMPANY: Landshark Drilling METHOD: Solid Stem Augers and Spilt Spoons
NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND
- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N
		0.0		GROUND SURFACE					
		0.2		**TOPSOIL** (150 mm)					
1				**SANDY SILT** - Light Brown Sandy Silt With Clay, Mottled, Wet, Loose	SS-1	60	19	1 1 3 3	4
2									
3	1.0				SS-2	60	19	2 3 2 4	5
4									
5		1.7		**SILTY CLAY** - Brown Silty Clay, trace Sand, Mottled, Moist, Soft to Firm	SS-3	60	28	2 2 3 3	5
6	2.0								
7					SS-4	100	39	1 1 2 2	3
8									
9									
10	3.0	3.0		Brown Silty Clay with Sand, Wet, Very Soft	SS-5	100	36	1 1 1 1	2
11									
12									
13	4.0								
14									
15		4.6		Grey	SS-6	100	42	1 0 1 1	1
16	5.0								
17									
18									
19									
20	6.0	6.1		Soft	SS-7	100	21	1 1 3 2	4
21									
22									
23	7.0								
24									
25		7.6		**TILL** - Grey Sandy Silt, With Gravel, Trace Clay, Moist, Dense	SS-8	90	14	5 13 16 31	29
26	8.0								
27		8.2		END OF BOREHOLE					

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
× "N" Value (blows / 0.3 m)
◆ RQD
◎ CONE

10 20 30 40 50 60 70 80 90

COMMENTS

Water up to 2.4 m upon completion
First encounter of groundwater seepage at 3.0 m
Grain Size Data
SS-5:
2% Gravel
8% Sand
90% Silt and Clay-sized Particles
23% Between 5-75 um
Atterberg Limits
LL = 40%
PI = 22%

Borehole cave-in up to 5.8 m upon completion

BOREHOLE LOG GEOTECH (MULTIPLE DRILLERS) 11209539-01-DWG-20-06-01, VARGAS BOREHOLE LOGS, JM, EW.GPJ GEOLOGIC.GDT 15/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-10

BOREHOLE No.: BH-10

ELEVATION: 216.2 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties

PROJECT: Proposed Residential and Commercial Development

LOGGED BY: E. Wierdsma DATE: 15 April 2020

DRILLING COMPANY: Landshark Drilling METHOD: Solid Stem Augers and Spilt Spoons

NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N
		0.0		GROUND SURFACE					
		0.2		**TOPSOIL** (150 mm)					
1				**SANDY SILT** - Brown Sandy Silt, Moist, Very Loose	SS-1	50	29	0 1 1 1	2
2		0.8		Loose					
3	1.0				SS-2	25	36	2 3 4 4	7
4									
5		1.5		**SILTY CLAY** - Brown Silty Clay, trace Sand, Moist, Stiff	SS-3	75	22	2 5 8 9	13
6	2.0								
7		2.3		Very Stiff	SS-4	30	27	5 9 8 9	17
8									
9									
10	3.0	3.0		Stiff	SS-5	100	25	3 4 5 4	9
11									
12									
13	4.0	4.0		Wet					
14									
15		4.6		Grey, Very Soft	SS-6	100	26	1 1 1 1	2
16	5.0								
17									
18									
19									
20	6.0	6.1		Hard	SS-7	25	22	6 10 24 19	34
21									
22		6.7		END OF BOREHOLE					
23	7.0								
24									
25									
26	8.0								
27									

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
× "N" Value (blows / 0.3 m) ◆ RQD ◎ CONE

10 20 30 40 50 60 70 80 90

COMMENTS

Grain Size Data
SS-3:
0% Gravel
9% Sand
91% Silt and Clay-sized Particles
33% Between 5-75 um

Water up to 3.5 m upon completion

First encounter of groundwater seepage at 4.0 m

Borehole cave-in up to 4.6 m upon completion

BOREHOLE LOG GEOTECH (MULTIPLE DRILLERS) 11209539-01-DWG-20-06-01, VARGAS BOREHOLE LOGS, JM, EW.GPJ GEOLOGIC.GDT 15/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-11

BOREHOLE No.: BH-11

ELEVATION: 214.2 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties

PROJECT: Proposed Residential and Commercial Development

LOGGED BY: E. Wierdsma DATE: 16 April 2020

DRILLING COMPANY: Landshark Drilling METHOD: Solid Stem Augers and Spilt Spoons

NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N
		0.0		GROUND SURFACE					
		0.3		**TOPSOIL** (300 mm)					
1		0.5		**SILTY SAND** - Brown Silty Sand, Moist, Very Loose	SS-1	60	25	0 1 2 3	3
2				**SILTY CLAY** - Light Brown Silty Clay, Trace Sand, Moist, Soft					
3	1.0				SS-2	75	25	1 1 3 4	4
4									
5		1.5		Cobble (Inferred From Augers Grinding), Stiff					
6		1.8		Wet	SS-3	90	21	6 6 8 8	14
7	2.0								
8		2.3		Firm					
9					SS-4	100	23	2 4 4 4	8
10	3.0	3.0		Stiff					
11					SS-5	100	27	2 2 11 12	13
12		3.5		**SILTY SAND** - Light Brown Silty Sand, Wet, Compact					
13	4.0								
14									
15					SS-6A		19	3	
16		4.9		**SILTY CLAY** - Light Brown Silty Clay, trace Sand, Moist, Stiff	SS-6B	100	20	2 8 5	10
17	5.0								
18									
19									
20	6.0	6.1		Grey					
21					SS-7	50	19	6 6 10 9	16
22		6.7		END OF BOREHOLE					
23	7.0								
24									
25									
26	8.0								
27									

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
× "N" Value (blows / 0.3 m)
◆ RQD
◎ CONE

10 20 30 40 50 60 70 80 90

COMMENTS

First encounter of groundwater seepage at 1.8 m

Water up to 2.4 m upon completion

Borehole cave-in up to 4.0 m upon completion

Grain Size Data
SS-6A:
0% Gravel
91% Sand
9% Silt and Clay-sized Particles

BOREHOLE LOG GEOTECH (MULTIPLE DRILLERS) 11209539-01-DWG-20-06-01, VARGAS BOREHOLE LOGS, JM, EW.GPJ GEOLOGIC.GDT 15/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-12

BOREHOLE No.: BH-12

ELEVATION: 215.7 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties

PROJECT: Proposed Residential and Commercial Development

LOGGED BY: E. Wierdsma DATE: 16 April 2020

DRILLING COMPANY: Landshark Drilling METHOD: Solid Stem Augers and Spilt Spoons

NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (%) / "N" Value (blows / 0.3 m) / Field / Lab / RQD / CONE	COMMENTS
		0.0		GROUND SURFACE							
		0.2		**TOPSOIL** (300 mm)							
1				**SILTY SAND** - Brown Silty Sand With Clay, Mottled, Moist, Very Loose	SS-1	25	21	0 1 1 2	2		
2		0.8		Wet, Compact							
3	1.0				SS-2	90	18	3 8 6 9	14		
4											
5											
6		1.8		Moist	SS-3	80	16	6 11 9 13	20		
7	2.0	2.1		Grey, Trace Clay, Dense							
8								5 16			
9		2.7		Wet	SS-4	80	15	25 15	41		
10	3.0										First encounter of groundwater seepage at 2.7 m Water up to 3.0 m upon completion Borehole cave-in up to 3.4 m upon completion
11					SS-5	100	17	6 15 20	35		
12											
13	4.0										
14											
15		4.6		Compact				14			
16	5.0				SS-6	100	19	11 7 15	18		Grain Size Data SS-6: 0% Gravel 53% Sand 47% Silt and Clay-sized Particles 41% Between 5-75 um
17											
18											
19											
20	6.0							6			
21					SS-7	100	18	13 16	29		
22		6.6		END OF BOREHOLE							
23	7.0										
24											
25											
26	8.0										
27											

BOREHOLE LOG GEOTECH (MULTIPLE DRILLERS) 11209539-01-DWG-20-06-01, VARGAS BOREHOLE LOGS, JM, EW.GPJ GEOLOGIC.GDT 15/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-13

BOREHOLE No.: BH-13

ELEVATION: 213.8 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Vargas Properties

PROJECT: Proposed Residential and Commercial Development

LOGGED BY: E. Wierdsma DATE: 16 April 2020

DRILLING COMPANY: Landshark Drilling METHOD: Solid Stem Augers and Spilt Spoons

NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N
		0.0		GROUND SURFACE					
		0.3		**TOPSOIL** (300 mm)					
1				**SANDY SILT** - Brown Sandy Silt With Clay, Moist, Loose	SS-1	60	23	1 1 2 2	3
2		0.8		Mottled					
3	1.0				SS-2	90	24	1 3 6 6	9
4									
5		1.5		**SILTY CLAY** - Light Brown Silty Clay, Trace Sand, Moist, Stiff	SS-3	100	26	2 4 7 6	11
6	2.0								
7									
8					SS-4A	100	27	3 3 5 6	8
9		2.7			SS-4B		18		
10	3.0			**SILTY SAND** - Light Brown Silty Sand, Trace Clay, Wet, Compact				8	
11					SS-5	90	21	11 10 10	21
12									
13	4.0								
14									
15		4.6		**SAND & GRAVEL** - Brown Sand and Gravel, Wet, Compact	SS-6	100	18	7 2 8 6	10
16	5.0								
17									
18									
19									
20	6.0	6.1		**SILTY CLAY** - Grey Silty Clay, Moist, Stiff	SS-7	75	21	3 3 6 6	9
21									
22		6.7		END OF BOREHOLE					
23	7.0								
24									
25									
26	8.0								
27									

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
Atterberg limits (%) W_p W_l
× "N" Value (blows / 0.3 m) ◆ RQD ◎ CONE

10 20 30 40 50 60 70 80 90

COMMENTS

— 0.79 m
— 0.77 m

WL - 2.4 m
5/22/2020

First encounter of groundwater seepage at 2.7 m

50mm diameter monitoring well installed to 6.1m

BOREHOLE LOG GEOTECH (MULTIPLE DRILLERS) 11209539-01-DWG-20-06-01, VARGAS BOREHOLE LOGS, JM, EW.GPJ GEOLOGIC.GDT 15/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-14

TEST PIT No.: TP-1
ELEVATION: 247.8 m

TEST PIT REPORT

Page: 1 of 1

CLIENT: Vargas Properties

PROJECT: Proposed Residential and Commercial Development

LOGGED BY: Jamie McEachern DATE: 6 March 2020

EXCAVATION COMPANY: Balterre Contracting Limited METHOD: Track Excavator

NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND

GS - GRAB SAMPLE

▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Moisture Content (%)	COMMENTS
		0.0		GROUND SURFACE			
				TOPSOIL (150 mm)			
		0.2		**SANDY SILT** - Reddish Brown Sandy Silt, Loose, Moist	AS-1	28	
1		0.3		Occasional Cobbles			No seepage observed during the excavation of the test pit
	0.5						
2		0.6		**TILL** - Light Brown Silty Sand and Gravel, Trace Clay, Compact, Moist	AS-2	5	
3	1.0	0.9		Boulders			
4							
5	1.5						
6		1.8		Light Brown Clayey Silt, Trace Gravel, Cobbles and Boulders, Dense, Moist	AS-3	19	
7	2.0						
8							
9	2.5						
10							
11	3.0						
	3.5	3.5		END OF TEST PIT	AS-4	22	
12							
13	4.0						

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
w_p w_l Atterberg limits (%)

10 20 30 40 50 60 70 80 90

TEST PIT LOG GEOTECH 11209539-01-DWG-20-03-31, VARGAS TESTPIT LOGS - .GPJ GEOLOGIC.GDT 12/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-15

TEST PIT No.: TP-2
ELEVATION: 243.0 m

TEST PIT REPORT

Page: 1 of 1

CLIENT: Vargas Properties
PROJECT: Proposed Residential and Commercial Development
LOGGED BY: Jamie McEachern DATE: 6 March 2020
EXCAVATION COMPANY: Balterre Contracting Limited METHOD: Track Excavator
NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND
GS - GRAB SAMPLE
▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Moisture Content (%)	COMMENTS
		0.0		GROUND SURFACE			
				TOPSOIL (200 mm)			
		0.2		**TILL** - Light Brown Silty Sand and Gravel, Cobbles, Compact, Moist	AS-1	2	No seepage observed during the excavation of the test pit
		0.8		With Clay, and Boulders	AS-2	9	
					AS-3	10	
					AS-4	8	
		3.4		Very Dense			
		3.5		END OF TEST PIT			

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
w_p w_l Atterberg limits (%)

10 20 30 40 50 60 70 80 90

TEST PIT LOG GEOTECH 11209539-01-DWG-20-03-31, VARGAS TESTPIT LOGS - .GPJ GEOLOGIC.GDT 12/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-16

TEST PIT No.: TP-3
ELEVATION: 223.2 m

TEST PIT REPORT

Page: 1 of 1

CLIENT: Vargas Properties
PROJECT: Proposed Residential and Commercial Development
LOGGED BY: Jamie McEachern DATE: 6 March 2020
EXCAVATION COMPANY: Balterre Contracting Limited METHOD: Track Excavator
NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND
GS - GRAB SAMPLE
▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Moisture Content (%)	COMMENTS
		0.0		GROUND SURFACE			
				TOPSOIL (150 mm)			
		0.2		**SANDY SILT** - Reddish Brown Sandy Silt, Loose, Moist to Wet	AS-1	23	
1		0.3		**TILL** - Light Brown Silty Sand, With Clay, Compact, Moist			
	0.5						
2							
					AS-2	23	
3	1.0						
4							
	1.5						
5							
6							
	2.0				AS-3	22	
7							Groundwater seepage Observed at 2.1 m
8							
	2.5						
9							
	3.0				AS-4	23	
10							
					AS-5	20	
11		3.4		END OF TEST PIT			
	3.5						
12							
13	4.0						

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
w_p w_l Atterberg limits (%)

10 20 30 40 50 60 70 80 90

TEST PIT LOG GEOTECH 11209539-01-DWG-20-03-31, VARGAS TESTPIT LOGS - .GPJ GEOLOGIC.GDT 12/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-17

TEST PIT No.: TP-4
ELEVATION: 216.0 m

TEST PIT REPORT

Page: 1 of 1

CLIENT: Vargas Properties

PROJECT: Proposed Residential and Commercial Development

LOGGED BY: Jamie McEachern DATE: 6 March 2020

EXCAVATION COMPANY: Balterre Contracting Limited METHOD: Track Excavator

NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND

GS - GRAB SAMPLE

▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Moisture Content (%)	COMMENTS
		0.0		GROUND SURFACE			
				TOPSOIL (150 mm)			
		0.3		**SANDY SILT** - Reddish Brown Sandy Silt, Loose, Moist	AS-1	28	
1		0.4		**TILL** - Light Brown Silty Clay with Sand and Gravel, Compact, Moist			No seepage observed during the excavation of the test pit
	0.5				AS-2	37	
2							
3	1.0						
4							
5	1.5				AS-3	26	
6							
	2.0						
7							
8	2.5						
9							
10	3.0				AS-4	27	
11		3.4		END OF TEST PIT			
	3.5						
12							
13	4.0						

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
w_p w_l Atterberg limits (%)

10 20 30 40 50 60 70 80 90

TEST PIT LOG GEOTECH 11209539-01-DWG-20-03-31, VARGAS TESTPIT LOGS - .GPJ GEOLOGIC.GDT 12/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-18

TEST PIT No.: TP-5
ELEVATION: 215.2 m

TEST PIT REPORT

Page: 1 of 1

CLIENT: Vargas Properties
PROJECT: Proposed Residential and Commercial Development
LOGGED BY: Jamie McEachern DATE: 6 March 2020
EXCAVATION COMPANY: Balterre Contracting Limited METHOD: Track Excavator
NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND
GS - GRAB SAMPLE
▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Moisture Content (%)	COMMENTS
		0.0		GROUND SURFACE			
				TOPSOIL (150 mm)			
		0.3		**SANDY SILT** - Reddish Brown Sandy Silt, Loose, Moist	AS-1	33	No seepage observed during the excavation of the test pit
1	0.5						
2							
3	1.0				AS-2	28	
4							
5	1.5				AS-3	20	
6							
	2.0						
7							
8	2.5						
9		2.7		**TILL** - Light Brown Silty Sand and Gravel, Compact, Moist			
10	3.0	3.0		END OF TEST PIT	AS-4	16	
11							
12	3.5						
13	4.0						

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
w_p w_l Atterberg limits (%)

10 20 30 40 50 60 70 80 90

TEST PIT LOG GEOTECH 11209539-01-DWG-20-03-31, VARGAS TESTPIT LOGS - .GPJ GEOLOGIC.GDT 12/6/20

REFERENCE No.: 11209539-01 ENCLOSURE No.: A-19

TEST PIT No.: TP-6
ELEVATION: 212.7 m

TEST PIT REPORT

Page: 1 of 1

CLIENT: Vargas Properties
PROJECT: Proposed Residential and Commercial Development
LOGGED BY: Jamie McEachern DATE: 6 March 2020
EXCAVATION COMPANY: Balterre Contracting Limited METHOD: Track Excavator
NOTES: Ground surface elevation interpolated from Topographic plan prepared by IBW Surveyors, File Name "P-0400 Topo_v4.dwg" dated Jan. 14, 2020

LEGEND
GS - GRAB SAMPLE
▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Moisture Content (%)	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (%)	COMMENTS
		0.0		GROUND SURFACE				
				TOPSOIL (150 mm)				
		0.2		**SANDY SILT** - Reddish Brown Sandy Silt, Loose, Moist	AS-1	18		
1		0.5		**TILL** - Light Brown Silty Sand and Gravel, Compact, Moist				No seepage observed during the excavation of the test pit
2	0.5							
					AS-2	9		
3	1.0							
4								
5	1.5							
6								
7	2.0							
					AS-3	7		
8	2.5							
9								
					AS-4	8		
10	3.0	3.0		END OF TEST PIT				
11								
12	3.5							
13	4.0							

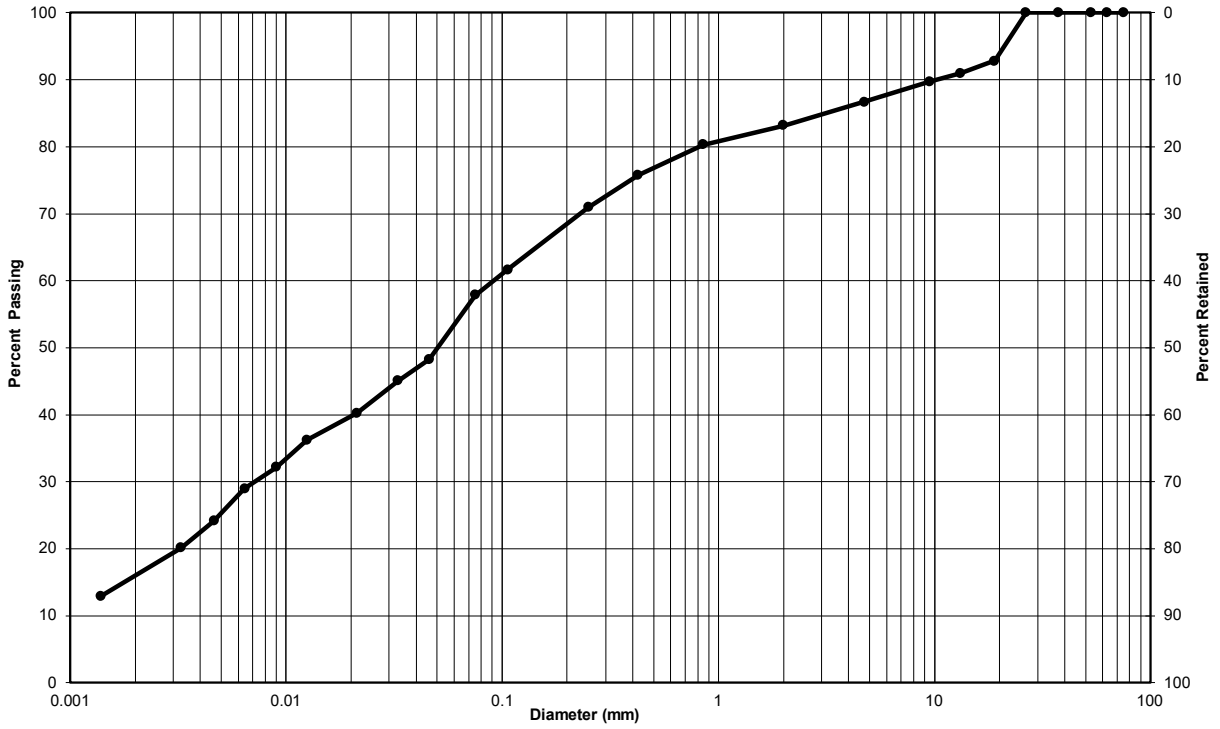
10 20 30 40 50 60 70 80 90

TEST PIT LOG GEOTECH 11209539-01-DWG-20-03-31, VARGAS TESTPIT LOGS - .GPJ GEOLOGIC.GDT 12/6/20

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Vargas Properties	**Lab no.:**	SS-20-25
Project/Site:	Fallis Line and CR10, Millbrook	**Project no.:**	11209539-01

Borehole no.:	BH-3	Sample no.:	SS-4
Depth:	2.3 m - 2.9 m	Enclosure:	A-16



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Soil Description	Gravel	Sand	Clay & Silt
Sandy silt (ML)	13	29	58
Silt-size particles (%):	43		
Clay-size particles (%) (<0.002mm):	15		

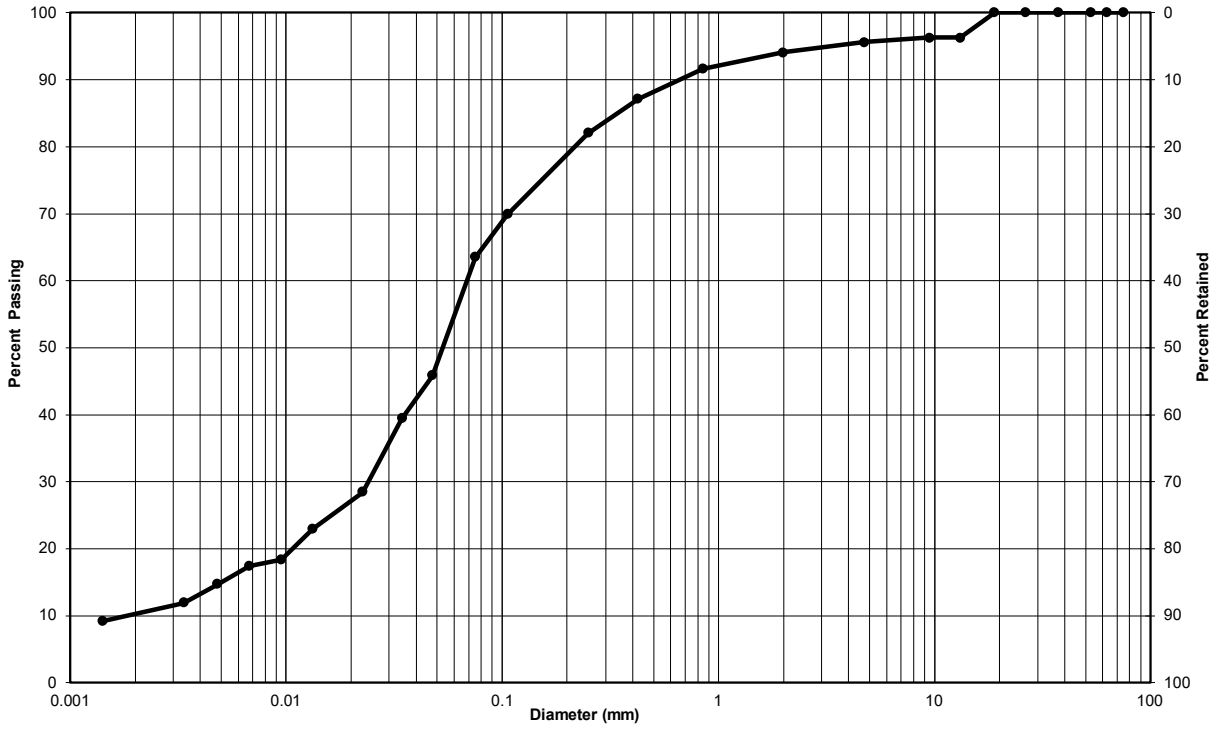
Remarks:

Performed by:	Josh Sullivan	**Date:**	April 29, 2020
Verified by:	Joe Sullivan	**Date:**	May 7, 2020

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Vargas Properties	**Lab no.:**	SS-20-25
Project/Site:	Fallis Line and CR10, Millbrook	**Project no.:**	11209539-01

Borehole no.:	BH-7	Sample no.:	SS-1
Depth:	0.0 m - 0.6 m	Enclosure:	A-17



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Soil Description	Gravel	Sand	Clay & Silt
Sandy silt (ML)	4	33	63
Silt-size particles (%):	53		
Clay-size particles (%) (<0.002mm):	10		

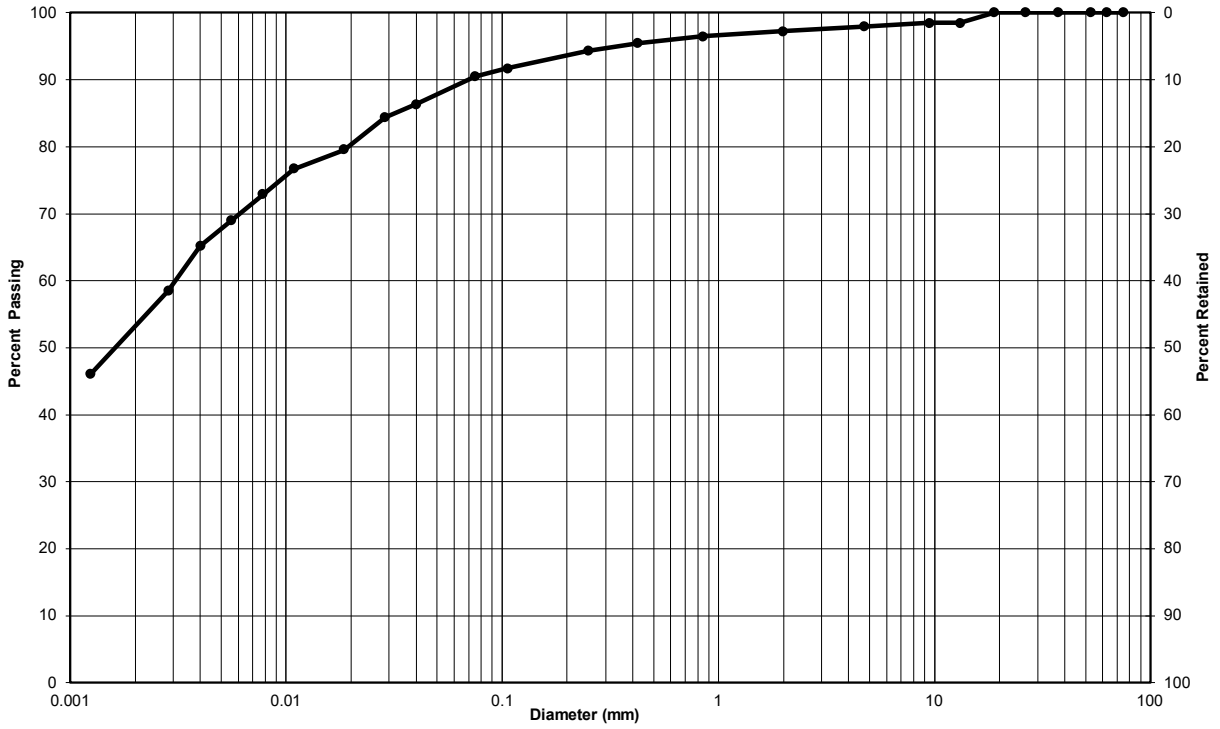
Remarks:

Performed by:	Josh Sullivan	**Date:**	April 29, 2020
Verified by:	Joe Sullivan	**Date:**	May 7, 2020

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Vargas Properties	**Lab no.:**	SS-20-25
Project/Site:	Fallis Line and CR10, Millbrook	**Project no.:**	11209539-01

Borehole no.:	BH-9	Sample no.:	SS-5
Depth:	3.1 m - 3.7 m	Enclosure:	A-18



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Soil Description	Gravel	Sand	Clay & Silt
Lean clay (CL)	2	8	90
Silt-size particles (%):	38		
Clay-size particles (%) (<0.002mm):	52		

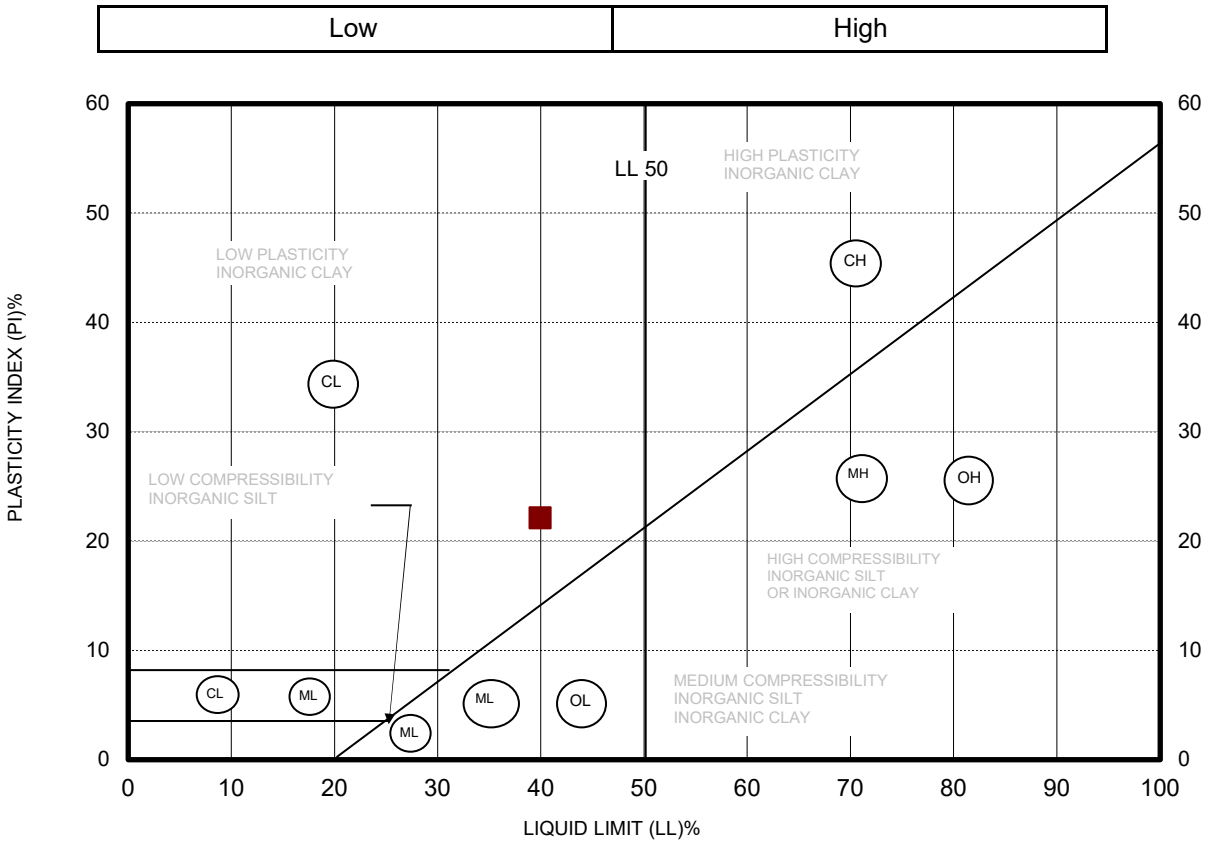
Remarks:

Performed by:	Josh Sullivan	**Date:**	April 29, 2020
Verified by:	Joe Sullivan	**Date:**	May 7, 2020

Plasticity Index and Liquid Limit Testing
LS-703&704

PLASTICITY CHART

Project Name:	Fallis Line and CR10, Millbrook	Project No.:	11209539-01
Client:	Vargas Properties	Depth:	3.0m - 3.7 m
Ref No.:	SS-20-25	Enclosure:	A-19



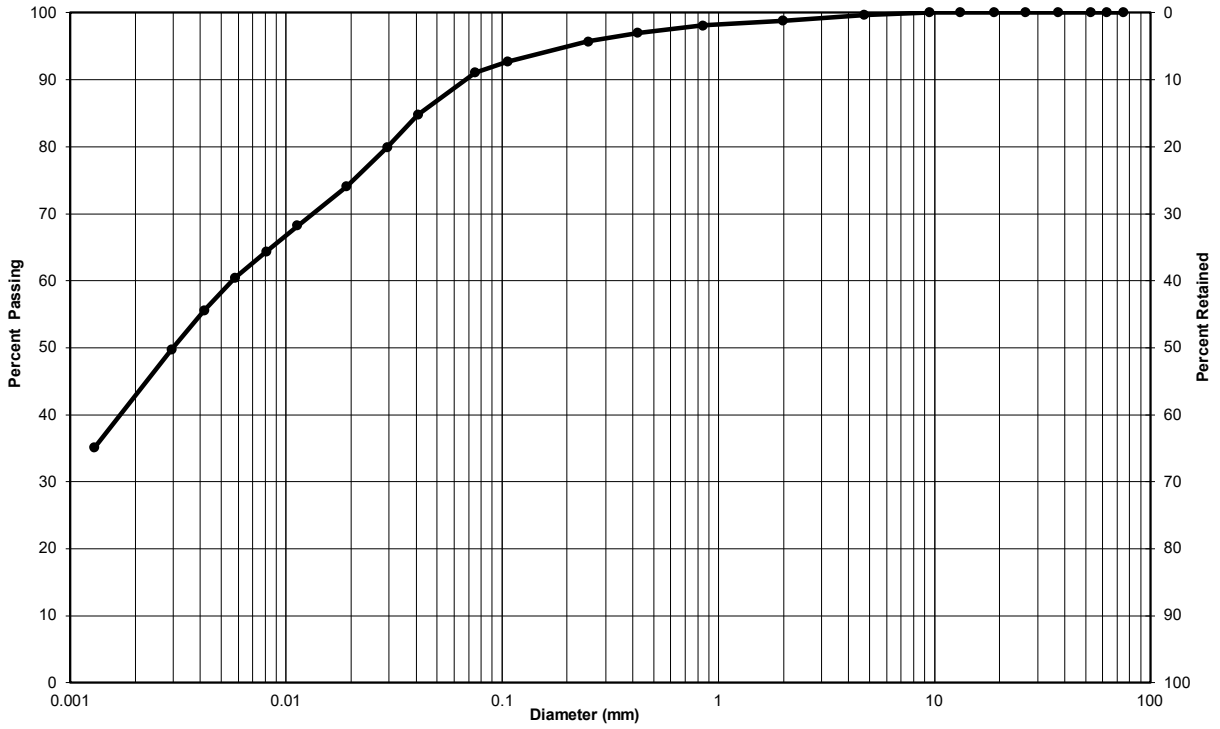
Symbol	Borehole	Sample	Depth	Sample Results	Value
■	BH-9	SS-5	3.0m - 3.7 m	Plasticity Index (%)	22
				Liquid Limit (%)	40

Performed By:	Josh Sullivan	Date:	May 7, 2020
Verified By:	Joe Sullivan	Date:	May 7, 2020

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Vargas Properties	**Lab no.:**	SS-20-25
Project/Site:	Fallis Line and CR10, Millbrook	**Project no.:**	11209539-01

Borehole no.:	BH-10	Sample no.:	SS-3
Depth:	1.5 m - 2.1 m	Enclosure:	A-20



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

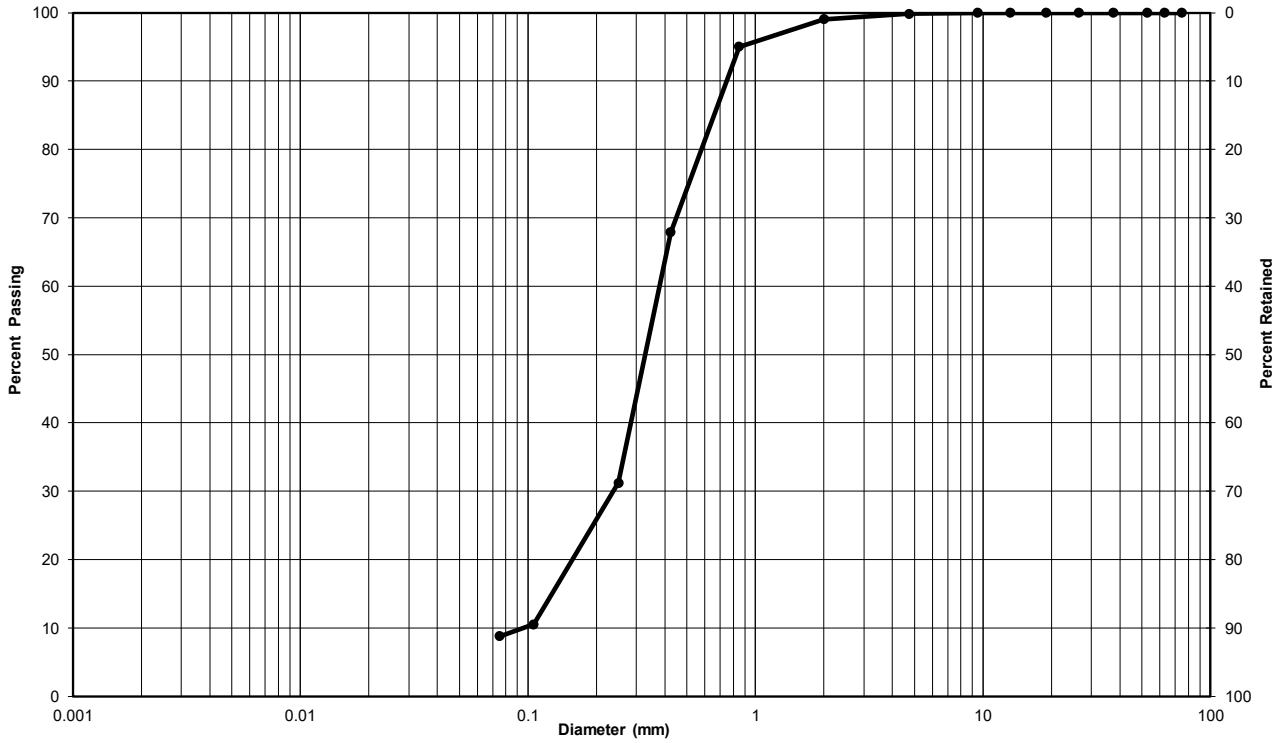
Soil Description	Gravel	Sand	Clay & Silt
Lean Clay (CL)	0	9	91
Silt-size particles (%):	50		
Clay-size particles (%) (<0.002mm):	41		

Remarks:

Performed by:	Josh Sullivan	**Date:**	April 29, 2020
Verified by:	Joe Sullivan	**Date:**	May 7, 2020

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Vargas Properties	**Lab no.:**	SS-20-25
Project/Site:	Fallis Line and CR10, Millbrook	**Project no.:**	11209539-01
Borehole no.:	BH-11	Sample no.:	SS-6a
Depth:	4.6 m - 4.9m	Enclosure:	A-21



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Soil Description	Gravel	Sand	Clay & Silt
Poorly graded sand with silt (SP-SM)	0	91	9

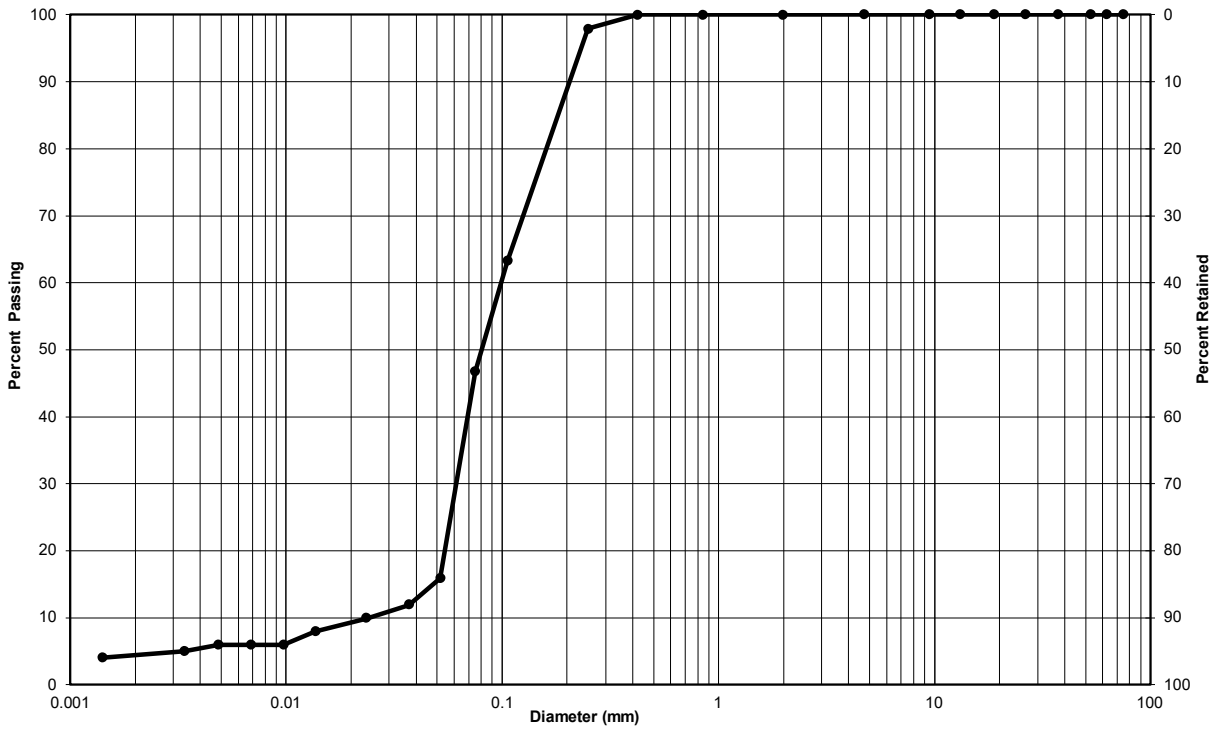
Remarks:

Performed by:	Josh Sullivan	**Date:**	April 27, 2020
Verified by:	Joe Sullivan	**Date:**	May 7, 2020

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Vargas Properties	**Lab no.:**	SS-20-25
Project/Site:	Fallis Line and CR10, Millbrook	**Project no.:**	11209539-01

Borehole no.:	BH-12	Sample no.:	SS-6
Depth:	4.6 m - 5.2 m	Enclosure:	A-22



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

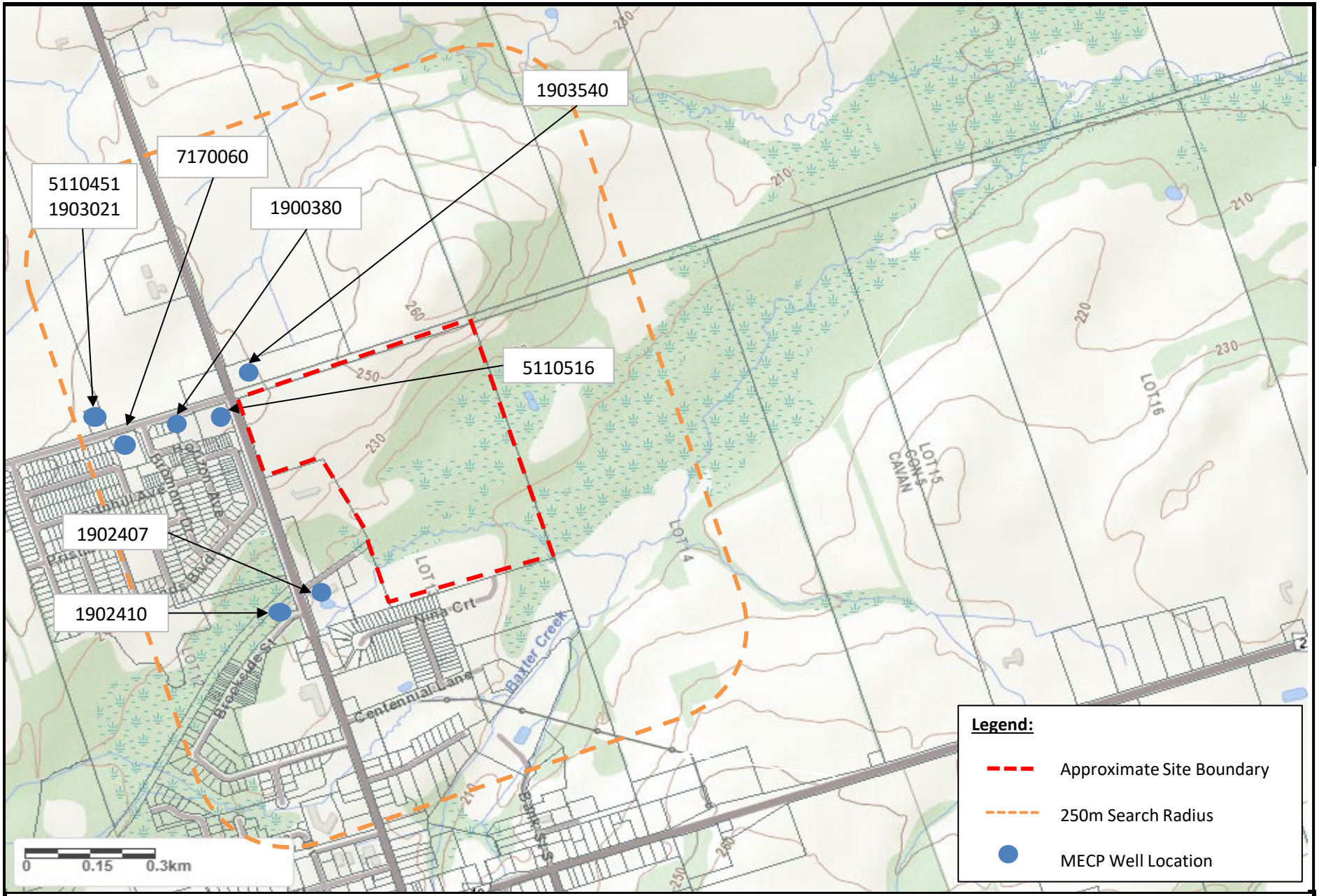
Soil Description	Gravel	Sand	Clay & Silt
Silty sand(SM)	0	53	47
Silt-size particles (%):	43		
Clay-size particles (%) (<0.002mm):	4		

Remarks:

Performed by:	Josh Sullivan	**Date:**	April 29, 2020
Verified by:	Joe Sullivan	**Date:**	May 7, 2020

Appendix B

MECP Well Records and Well Survey



Source: MECP Water Well Record Mapping, accessed online (https://www.ontario.ca/environment-and-energy/map-well-records)

Scale:
Refer to Scale Bar
Coordinate System:
NAD 1983 UTM Zone 17

Vargas Development
Proposed Residential Development
Fallis Line, Millbrook, ON

11209539-01
June, 2020

Well Location Plan

FIGURE B.1

APPENDIX B.2: WELL SUMMARY - OVERBURDEN BEDROCK

Well Record Summary
Vargas Development
Millbrook, ON

	Well	Water Found		Static Level		Pump Rate		Well Depth		Comments
Well No.	Use	Feet	Metres	Feet	Metres	Igpm	L/min	Feet	Metres	
1900380	Domestic	53.0	16.2	39.0	11.9	22.0	100.1	54.0	16.5	Topsoil to 2', till to 20', clay with stones to 53', gravel to 54'
1902407	Domestic	121.0	36.9	0.0	0.0	16.0	72.8	121.0	36.9	Topsoil to 2', clay and stones to 110', clay with gravel and shale rock to 121'
1902410	Domestic	106.0	32.3	0.0	0.0	15.0	68.3	106.0	32.3	Topsoil to 2', clay to 100', gravel to 106'
5110451	Domestic	209	63.7	82	25.0	4.0	18.2	209	63.7	Clay and stones to 16', sand and gravel to 98', sand to 123', clay and gravel to 129', sand to 146', sand with gravel and clay to 208', shale to 209'
5110516	Domestic	115	35.1	49	14.9	6.0	27.3	119	36.3	Topsoil to 1', clay with stones to 37', gravel to 44', clay to 102', gravel and sand to 115', sand and gravel to 119'
717060	Domestic	208.0	63.4	175.0	53.3	10.0	45.5	208.0	63.4	Clay with stones to 15', sand and gravel to 38', clay to 110', clayey silt to 168', clay to 195', silty sand to 203', sand to 208'

Number of wells = 6

	Water Found		Static Level		Pump Rate		Well Depth	
	Feet	Metres	Feet	Metres	Igpm	L/min	Feet	Metres
AVERAGE	135.3	41.2	57.5	17.5	12.2	55.4	136.2	41.5
MAXIMUM	209.0	63.7	175.0	53.3	22.0	100.1	209.0	63.7
MINIMUM	53.0	16.2	0.0	0.0	4.0	18.2	54.0	16.5

APPENDIX B.3: WELL SUMMARY - DRILLED BEDROCK

Well Record Summary
Vargas Development
Millbrook, ON

	Well	Water Found		Static Level		Pump Rate		Well Depth		Depth to Bedrock		Comments
Well No.	Use	Feet	Metres	Feet	Metres	lgpm	L/min	Feet	Metres	Feet	Metres	
1903021	Domestic	216.0	65.8	66.0	20.1	3.0	13.7	237.0	72.2	215.0	65.5	Clay with stones to 130', clay with sand layers to 135', clay with stones to 215', limestone to 237'
1903540	Domestic	225.0	68.6	70.0	21.3	2.0	9.1	230.0	70.1	225.0	68.6	Topsoil to 1', clay and stones to 135', sand and clay to 144', sand and gravel to 155', sand and clay to 225', limestone to 230'

Number of wells = 2

	Water Found		Static Level		Pump Rate		Well Depth		Depth to Bedrock	
	Feet	Metres	Feet	Metres	lgpm	L/min	Feet	Metres	Feet	Metres
AVERAGE	220.5	67.2	68.0	20.7	2.5	11.4	233.5	71.2	220.0	67.1
MAXIMUM	225.0	68.6	70.0	21.3	3.0	13.7	237.0	72.2	225.0	68.6
MINIMUM	216.0	65.8	66.0	20.1	2.0	9.1	230.0	70.1	215.0	65.5

Source: Compiled from Google Earth. Aerial photo dated November 27, 2019

Scale:
Refer to Scale Bar
Coordinate System:
NAD 1983 UTM Zone 17

Geotechnical Investigation
Vargas Development
Proposed Residential Development
Fallis Line, Millbrook, ON

Well Survey Locations

11209539-01
March, 2020

Appendix B.3

APPENDIX B.4: WATER WELL INFORMATION SURVEY
PROJECT: 11209539-01, March 18 and 19, 2020
LOCATION: Fallis Line, Millbrook, ON

Address	Well ID for Map	Easting (m)	Northing (m)	Well Type	Top of Well (m)	Water Level (m)	Depth (m)	Quality	Quantity	Comments
893 Fallis Line	L-1	703391	4892952	Drilled	0.51	18.45	60.5	Methane gas and cloudy	No known issues	Municipally serviced as of 2018. Former well on property.
1 Buckland Drive	L-2	703925	4892576	--	--	--	--	--	--	Municipallly serviced for past 30 years. On a well prior to that.
23 Buckland Drive	L-3	704025	4892662	Drilled	0.01	0.68		No known issues	'No known issues	Municipally serviced since 1986. Former well on property. Water sample collected (W-1).
917 County Road 10	L-4	703867	4892831	Dug	Unknown	Unknown	Unknown	No known issues	No known issues	Current Water Supply- no issues, plenty of water. Water sample collected from tap (W-2).
Onsite (North of Fallis Line)	L-5	7037730	4893143	Dug	0.015	5.15	Unknown	No known issues	No known issues	Current Water Supply- no issues, plenty of water. Water sample collected from tap (W-3).

UTM 17 Z 703510 E
9 R 4892781 N

Elev. 9 R 08215

Basin 24

ONTARIO

RECEIVED
FEB 22 1954
GEOLOGICAL BRANCH
DEPARTMENT of MINES

19 No 380

The Well Drillers Act
Department of Mines, Province of Ontario

Water Well Record

Durham [redacted] Village, Town or City Cavan

[redacted] wn or City) ..... RR#3 Millbrook

Date Completed 9 (day) Dec (month) 53 (year) Cost of Well (excluding pump) .....

Pipe and Casing Record

Casing diameter(s) 6 5/4
Length(s) of casing(s) 54'
Type of screen none
Length of screen .....
Distance from top of screen to ground level .....
Is well a gravel-wall type? .....

Pumping Test

Date Dec 9
Static level 40
Pumping level 44
Pumping rate 220 IGPH
Duration of test 2 hrs
Distance from cylinder or bowls to ground level .....

Water Record

Kind (fresh or mineral) fresh
Quality (hard, soft, contains iron, sulphur, etc.) soft
Appearance (clear, cloudy, coloured) clear
For what purpose(s) is the water to be used? Farm Stock
.....
How far is well from possible source of contamination? none
What is the source of contamination? .....
Enclose a copy of any mineral analysis that has been made of water .....

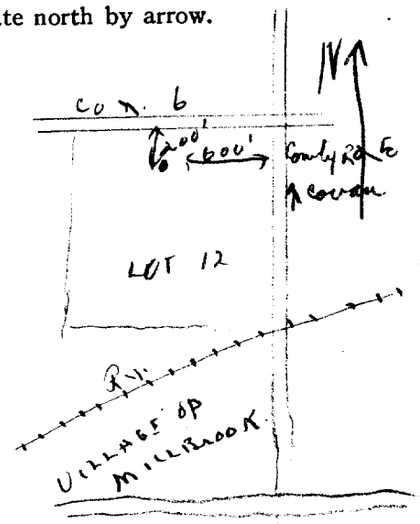
Depth(s) to Water Horizon(s)	Kind of Water	No. of Feet Water Rises
53-54	clear	14'

Well Log

Overburden and Bedrock Record	From	To
Top Soil	0 ft.	2 ft.
Brown Till	2	20
Blue Clay & Stone	20	53
Hard	53	54

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Situation: Is well on upland, in valley, or on hillside? upland
Drilling Firm Jim Sanderson
Address 131 Main St. Peterborough
Name of Driller Jim Sanderson Address .....
Date Feb 15 / 54 Licence Number 209
Jim Sanderson
Signature of Licensee

FORM 5

UTM 17Z 703898E
9R 4892378N
Elev. 9R 0720
Basin 24

ONTARIO

RECEIVED
DEC 29 1954
GEOLOGICAL BRANCH
DEPARTMENT of MINES

19 No. 2407

The Water-well Drillers Act, 1954
Department of Mines

Water-Well Record

MILLBROOK

County or Territorial District Durham Township, Village, ~~Town or City~~ Millbrook
[redacted] Village, ~~Town or City~~) Millbrook
[redacted] ddress Millbrook
Date completed [redacted] (day) (month) (year)

Pipe and Casing Record

Casing diameter(s) 6"
Length(s) 121'
Type of screen
Length of screen

Pumping Test

Static level flowing
Pumping rate 1600 gals per hr.
Pumping level 60'
Duration of test 1 hr.

Well Log

Overburden and Bedrock Record	From ft.	To ft.
Top soil	0	2'
Blue clay + some stones	2'	110'
clay, gravel + shale rock	110'	121'

Water Record

Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, or sulphur)
121'	flows	fresh.

For what purpose(s) is the water to be used?
Domestic
Is water clear or cloudy? clear
Is well on upland, in valley, or on hillside? upland

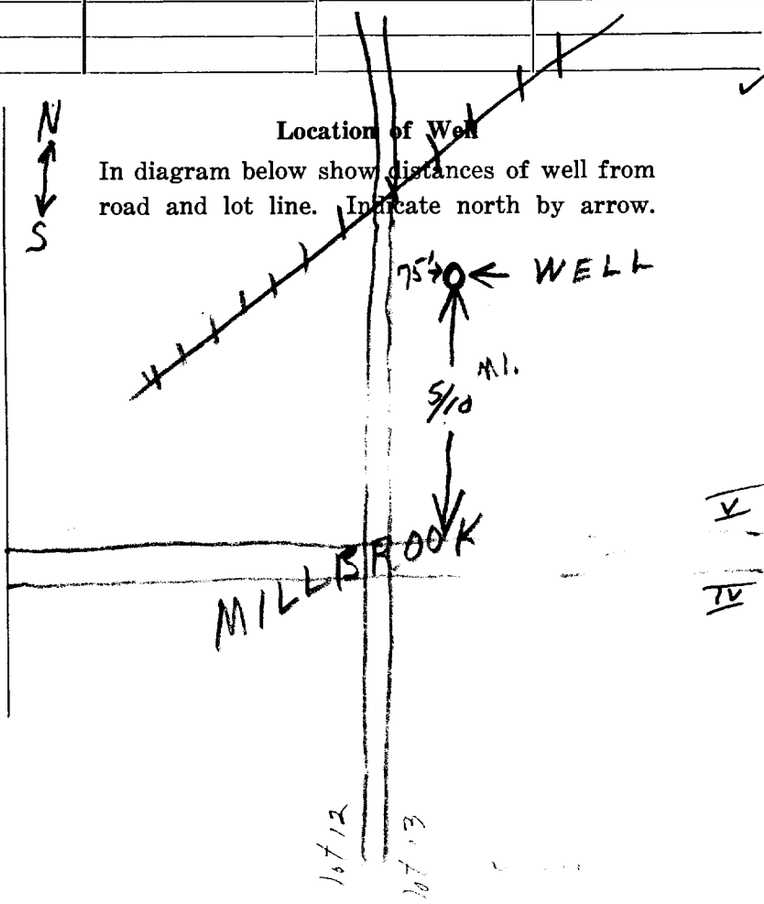
Drilling firm N. N. Faulkner.
Address 687 Water St.
Peterboro
Name of Driller F. G. Sang.
Address Sturgeon Rd
Omemee
Licence Number 456

I certify that the foregoing statements of fact are true.

Date Dec. 19 F. G. Sang
Signature of Licensee

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Form 5

UTM | 17 | Z | 703850 | E
| 9 | R | 4892304 | N
Elev. | 9 | R | 0720
Basin | 29 |

ONTARIO

The Water-well Drillers Act, 1954
Department of Mines

19 No. 2410

Water-Well Record

County or Territorial District Durham Township, Village, Town or City Millbrook

[redacted] Village, Town or City)

Address Millbrook

(day) (month) (year)

Pipe and Casing Record

Casing diameter(s) 6 1/4"
Length(s) 106
Type of screen
Length of screen

Pumping Test

Static level [redacted] flowing gpm
Pumping rate 15 g.p.m.
Pumping level 93
Duration of test 3 hrs

Well Log

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, or sulphur)
top soil	0	2			
brown clay	2	23			
blue clay	23	100			
gravel	100	106	106	106	fresh

Water Record

For what purpose(s) is the water to be used?
Domestic
Is water clear or cloudy? Clear
Is well on upland, in valley, or on hillside? upland

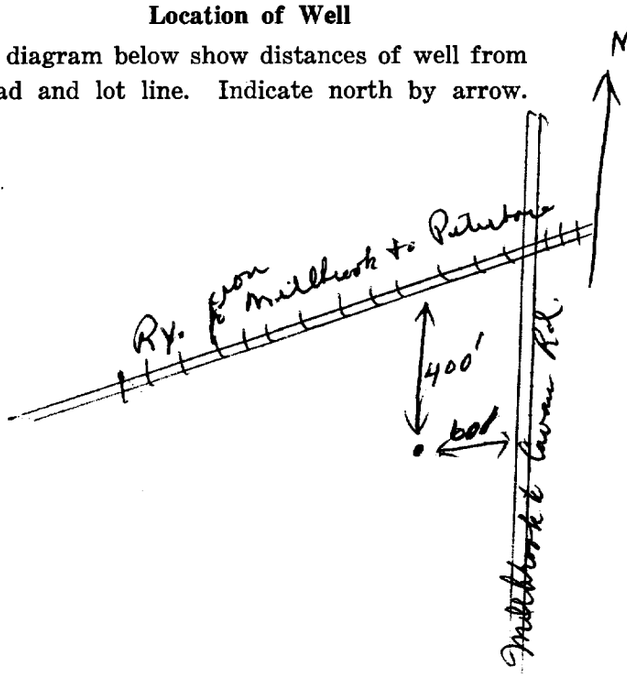
Drilling firm W. Henderson
Address 13 St. Patrick St. Peterborough
Name of Driller H. H. Hammers
Address 153 Nassau St. Peterborough
Licence Number 769

I certify that the foregoing statements of fact are true.

Date May 17/56 H. H. Hammers
Signature of Licensee

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Form 5

The Ontario Water Resources Commission Act

31 D/1 W

WATER WELL RECORD

Water management is Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 1903021 | MUNICIP. 19002 | CON. GCN | OST

COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON. BLOCK, TRACT, SURVEY, ETC. | LOT 012

[redacted] Millbrook, Ontario

DATE COMPLETED DAY 17 MO. Sept YR. 70

[illegible] | RC 4 | ELEVATION 0835 | RC 5 | BASIN CODE 24

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
Brown	clay	Stones	Land	0	22
Blue	clay	Stone	Land	22	130
Blue	clay	Sand layers	Soft	130	135
Blue	clay	Stones	Land	135	215
Grey	limestone		Land	215	237

31 aa27da st12 | a13d3ast12 | a13st3asta9 | a21st3ast12 | a23t2d1st

32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
216-220 0216	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
6 4	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	220 216
06				0216
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE			0237
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET	

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
1 ☐ PUMP 2 ☒ BAILER	0003 GPM.	01 HOURS 00 MINS.

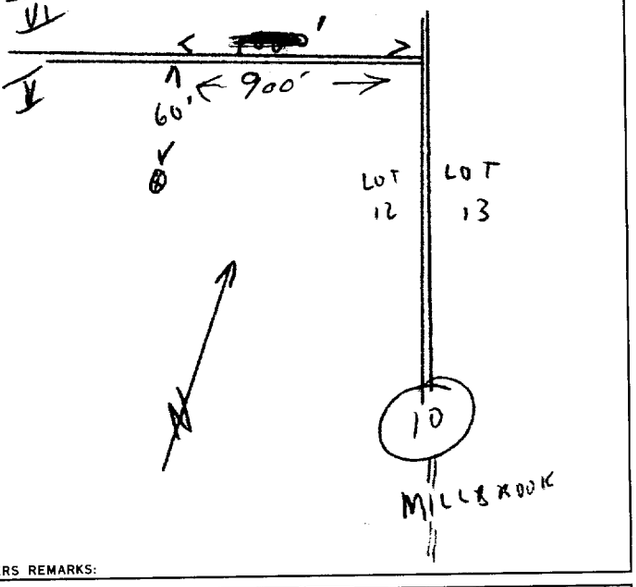
STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
066 FEET	230 FEET	1 ☒ PUMPING 2 ☐ RECOVERY	100 FEET	150 FEET	200 FEET	230 FEET

IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST	RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
GPM.	FEET	1 ☒ CLEAR 2 ☐ CLOUDY	☐ SHALLOW ☒ DEEP	230 FEET	0003 GPM.

50-53 000.0 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS:

FINAL STATUS OF WELL

54

1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

WATER USE 01

55-56

1 ☒ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF DRILLING

57

1 ☒ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: W. Sanderson | LICENCE NUMBER: 4713

ADDRESS: Millbrook

NAME OF DRILLER OR BORER: W. Sanderson | LICENCE NUMBER:

SIGNATURE OF CONTRACTOR: W. Sanderson | SUBMISSION DATE DAY 15 MO. 9 YR. 70

OFFICE USE ONLY

58 DATA SOURCE 1 | 59-62 CONTRACTOR 4713 | 63-68 DATE RECEIVED 040271

DATE OF INSPECTION APR. 14/71 | INSPECTOR SC/J.B.

REMARKS: P/J.B.

OWRC COPY

The Ontario Water Resources Commission Act

WATER WELL RECORD

31D/1E

Water management in Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 1903540 | MUNICIP. 19002 | CON. C&N | 96

COUNTY OR DISTRICT: Durham | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: Cavan | CON., BLOCK, TRACT, SURVEY, ETC.: 6 | LOT: 013

[redacted] R.R.#3 Millbrook

DATE COMPLETED: DAY 13 MO 11 YR. 72

92900 | RC. 4 | ELEVATION 0831S | RC. 5 | BASIN CODE 24

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
	top soil			0'	1'
brown	clay & stones	& boulders		1'	45'
grey	clay	& stones		45'	135'
fine sand &	grey clay			135'	144'
fine sand &	gravel	& grey clay		144'	155'
gravel	fine sand	& grey clay		155'	170'
fine sand,	grey clay	& gravel		170'	225'
grey	limestone rock			225'	230'

31: 0001 02 | 0045 05 12 | 0135 05 12 | 0144 08 05 | 0155 08 11 05 | 0170 11 98 95

32: 0225 08 05 IN | 0230 11 05

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
~~225'~~ ~~230~~ 0225	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
~~6~~ 06	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ~~☐ OPEN HOLE~~	188	0'	~~225~~ 0225
~~6~~ 06	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		225'	~~230'~~ 0230
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET	

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ~~☒~~ BAILER | PUMPING RATE ~~0002~~ 22 GPM. | DURATION OF PUMPING 08 HOURS 00 MINS.

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
070' FEET	~~225~~ FEET	1 ☐ PUMPING 2 ☒ RECOVERY	210 FEET	190 FEET	175 FEET	165 FEET

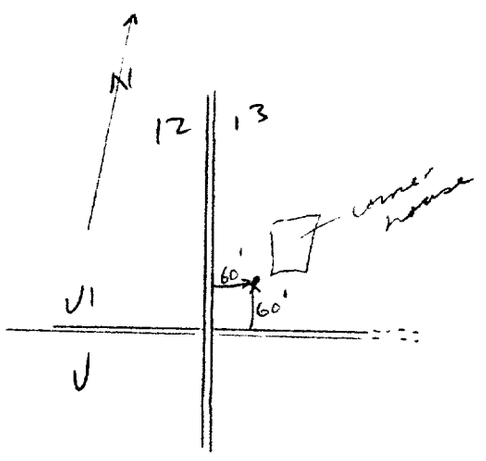
IF FLOWING, GIVE RATE: GPM. | PUMP INTAKE SET AT: FEET | WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ~~☒~~ DEEP | RECOMMENDED PUMP SETTING 225 FEET | RECOMMENDED PUMPING RATE 0002 GPM.

50-53: 0000 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS:

FINAL STATUS OF WELL (54): 1 ☒ WATER SUPPLY; 2 ☐ OBSERVATION WELL; 3 ☐ TEST HOLE; 4 ☐ RECHARGE WELL; 5 ☐ ABANDONED, INSUFFICIENT SUPPLY; 6 ☐ ABANDONED, POOR QUALITY; 7 ☐ UNFINISHED

WATER USE (55-56): 01 — 1 ☒ DOMESTIC; 2 ☐ STOCK; 3 ☐ IRRIGATION; 4 ☐ INDUSTRIAL; ☐ OTHER; 5 ☐ COMMERCIAL; 6 ☐ MUNICIPAL; 7 ☐ PUBLIC SUPPLY; 8 ☐ COOLING OR AIR CONDITIONING; 9 ☐ NOT USED

METHOD OF DRILLING (57): 1 ☒ CABLE TOOL; 2 ☐ ROTARY (CONVENTIONAL); 3 ☐ ROTARY (REVERSE); 4 ☐ ROTARY (AIR); 5 ☐ AIR PERCUSSION; 6 ☐ BORING; 7 ☐ DIAMOND; 8 ☐ JETTING; 9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: Stuart Stockdale Well Drilling | LICENCE NUMBER: 4814

ADDRESS: R.R.#2, Peterborough

NAME OF DRILLER OR BORER: Ernest Seabrooke | LICENCE NUMBER: 4773

SIGNATURE OF CONTRACTOR: Stuart Stockdale | SUBMISSION DATE: DAY ____ MO. ____ YR. ____

OFFICE USE ONLY

DATA SOURCE (58): 1 | CONTRACTOR (59-62): 4814 | DATE RECEIVED (63-68): 090473

DATE OF INSPECTION: 27, 11, 73 | INSPECTOR: K

REMARKS:

P 2

WI

OWRC COPY

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

3 1 D/2

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

(11) 5110451 MUNICIP 5/024 CON. C&N 06

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
Peterborough	Cavan	6	012

[redacted] R. 3, Millbrook, Ont. LOA 1GO

DATE COMPLETED: DAY 16 MO 04 YR 82

UTM ZONE 17 | 0292800 | RC 4 | ELEVATION 0825 | RC 5 | BASIN CODE 24

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
Brown	clay	stones	packed	0	16
Grey	sand	gravel	loose	16	37
Grey	sand	clay, gravel	medium	37	98
Black	sand		soft	98	123
Grey	clay	gravel	packed	123	129
Grey	sand		soft	129	146
Grey	sand	clay, gravel	medium	146	208
Black	shale	gravel	loose	208	209
			9R1334 Pt1		

(31) 0016605121779 | 0037228111777 | 0098209105530 | 0123828855 | 0129205111779 | 0146228855

(32) 0208209130005 | 0209817111777 | 0210 00

(41) WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0209 untested	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL

(51) CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
6 1/4 06	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0210
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET	

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER ETC.)

(71) PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER

PUMPING RATE: 0005 GPM

DURATION OF PUMPING: 02 HOURS 40 MINS

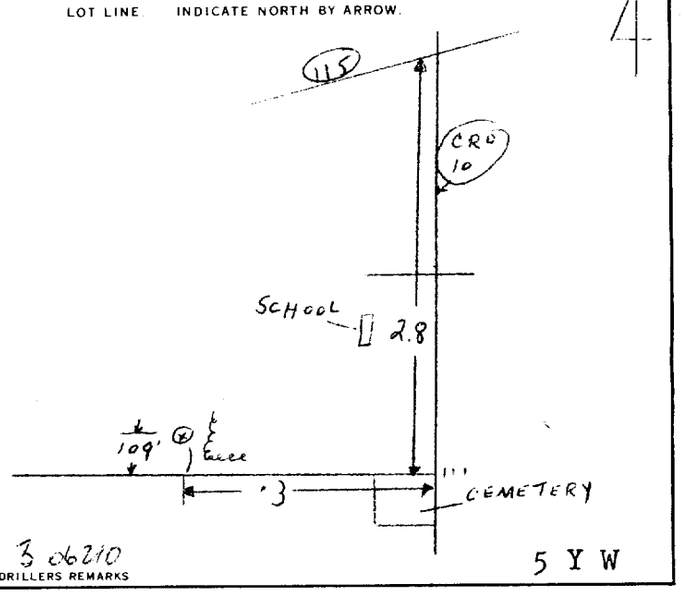
STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING: 1 ☐ PUMPING 2 ☒ RECOVERY			
		15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
082 FEET	199 FEET	119 FEET	082 FEET	082 FEET	082 FEET

IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
-- GPM	204 FEET	1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
☐ SHALLOW ☒ DEEP	204 FEET	0004 4½ GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



3 06210 DRILLERS REMARKS

5 Y W

FINAL STATUS OF WELL 1	1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED
WATER USE 01	1 ☒ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED
METHOD OF DRILLING 1	1 ☒ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: Faulkner Well Drilling Co.Ltd — LICENCE NUMBER: 2104

ADDRESS: 789 Erskine Ave., Peterborough, Ont.

NAME OF DRILLER OR BORER: Edward Taylor — LICENCE NUMBER:

SIGNATURE OF CONTRACTOR: E Faulkner / ET

SUBMISSION DATE: DAY 19 MO. 4 YR. 82

OFFICE USE ONLY

DATA SOURCE 1 | CONTRACTOR 2104 | DATE RECEIVED 11 05 82

DATE OF INSPECTION | INSPECTOR

REMARKS

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506—4—77 FORM 7

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

3101e

1 PRINT ONLY IN SPACES PROVIDED
2 CHECK [X] CORRECT BOX WHERE APPLICABLE

(11) 5110516 MUNICIP 51024 CON CON 05

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON, BLOCK, TRACT, SURVEY, ETC	
[redacted]	[redacted]	CON 5	012

DATE COMPLETED: DAY 03 MO 06 YR 81

[redacted] #3, Millbrook, Ontario

UTM 92800 RC 4 ELEVATION 0825 RC 5 BASIN CODE 24

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
			TOP SOIL	0	1
WHITE	CLAY	STONES		1	37
BROWN	GRAVEL		COARSE	37	44
WHITE	CLAY			44	102
BROWN	GRAVEL	SAND	FINE	102	115
BROWN	SAND	GRAVEL	FINE	115	119

(31) 0001 02 0037105 12 0048631 0102105 01196290 8

32

(41) WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0115-119	1 [X] FRESH 3 [ ] SULPHUR; 2 [ ] SALTY 4 [ ] MINERAL
	1 [ ] FRESH 3 [ ] SULPHUR; 2 [ ] SALTY 4 [ ] MINERAL
	1 [ ] FRESH 3 [ ] SULPHUR; 2 [ ] SALTY 4 [ ] MINERAL
	1 [ ] FRESH 3 [ ] SULPHUR; 2 [ ] SALTY 4 [ ] MINERAL
	1 [ ] FRESH 3 [ ] SULPHUR; 2 [ ] SALTY 4 [ ] MINERAL

(51) CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
06	1 [X] STEEL; 2 [ ] GALVANIZED; 3 [ ] CONCRETE; 4 [ ] OPEN HOLE	188	0	0119
	1 [ ] STEEL; 2 [ ] GALVANIZED; 3 [ ] CONCRETE; 4 [ ] OPEN HOLE			
	1 [ ] STEEL; 2 [ ] GALVANIZED; 3 [ ] CONCRETE; 4 [ ] OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER	LENGTH
014 Slot #14	06000 INCHES	02 2" FEET
MATERIAL AND TYPE: Stainless Steel	DEPTH OF SCREEN: 0111 FEET	110'10"

(61) PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

(71) PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
1 [ ] PUMP 2 [X] BAILER	0006 GPM	04 HOURS 00 MINS

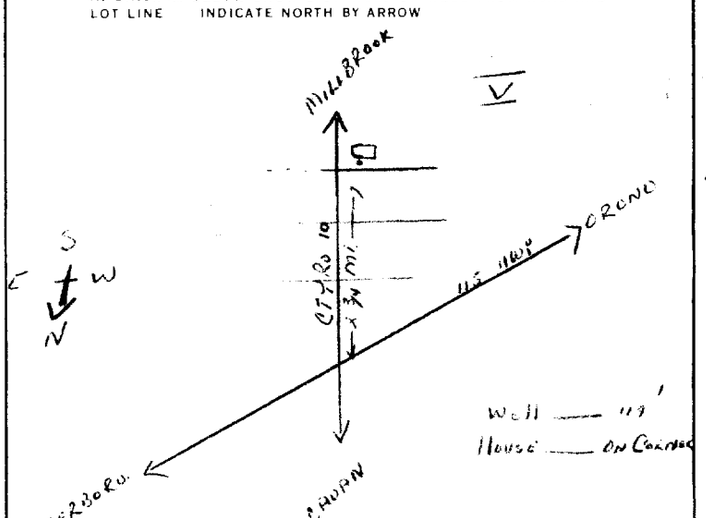
STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING: 1 [ ] PUMPING 2 [ ] RECOVERY			
		15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
049 FEET	113 FEET	FEET	FEET	FEET	FEET

IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
GPM	FEET	1 [X] CLEAR 2 [ ] CLOUDY

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
[ ] SHALLOW [X] DEEP	FEET	GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW



DRILLERS REMARKS: 2.211 0001

FINAL STATUS OF WELL 1
1 [X] WATER SUPPLY; 2 [ ] OBSERVATION WELL; 3 [ ] TEST HOLE; 4 [ ] RECHARGE WELL; 5 [ ] ABANDONED, INSUFFICIENT SUPPLY; 6 [ ] ABANDONED, POOR QUALITY; 7 [ ] UNFINISHED

WATER USE 01
1 [X] DOMESTIC; 2 [X] STOCK; 3 [ ] IRRIGATION; 4 [ ] INDUSTRIAL; [ ] OTHER; 5 [ ] COMMERCIAL; 6 [ ] MUNICIPAL; 7 [ ] PUBLIC SUPPLY; 8 [ ] COOLING OR AIR CONDITIONING; 9 [ ] NOT USED

METHOD OF DRILLING 1
1 [ ] CABLE TOOL; 2 [X] ROTARY (CONVENTIONAL); 3 [ ] ROTARY (REVERSE); 4 [ ] ROTARY (AIR); 5 [ ] AIR PERCUSSION; 6 [ ] BORING; 7 [ ] DIAMOND; 8 [ ] JETTING; 9 [ ] DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: ROBERT RUTH WELLDRILLING LTD. LICENCE NUMBER: 4635
ADDRESS: R. R. #2, CAVAN, Ont. 705-799-5343
NAME OF DRILLER OR BORER: same LICENCE NUMBER:
SIGNATURE OF CONTRACTOR: Robert Ruth SUBMISSION DATE: DAY 30 MO 9 YR 81

OFFICE USE ONLY

DATA SOURCE 1 CONTRACTOR 4635 DATE RECEIVED 09 07 82
DATE OF INSPECTION INSPECTOR
REMARKS

CSS.ES

MINISTRY OF THE ENVIRONMENT COPY

FORM NO 0506—4—77 FORM 7

Ontario — Ministry of the Environment

Measurements recorded in: ☐ Metric ☑ Imperial

Well Tag No. (Place Sticker and/or Print Below) A108386

A108386

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

[redacted]

Address of Well Location (Street Number/Name)	Township	Lot	Concession
893 Fallis Line	Caven	pt. 12	5
County/District/Municipality	**City/Town/Village**	**Province**	**Postal Code**
Peterborough	Millbrook	Ontario	L0A 1G0
UTM Coordinates Zone / Easting / Northing	**Municipal Plan and Sublot Number**	**Other**	
NAD 83 17 703452 4892976			

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brown	Clay	Stones	Hard	0	15
Brown	Sand	Gravel	Loose	15	38
Grey	Clay	Hard	Dense	38	110
Grey	Silt	Clay	Soft	110	168
Grey	Clay		Hard	168	195
Grey	Sand	Silt	Fine	195	203
Grey	Sand		Fine - Sharp	203	208

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	20	Wyoben	

Method of Construction

☐ Cable Tool ☐ Diamond ☑ Rotary (Conventional) ☐ Jetting ☐ Rotary (Reverse) ☐ Driving ☐ Boring ☐ Digging ☐ Air percussion ☐ Other, specify

Well Use

☐ Public ☐ Commercial ☐ Not used ☑ Domestic ☐ Municipal ☐ Dewatering ☐ Livestock ☐ Test Hole ☐ Monitoring ☐ Irrigation ☐ Cooling & Air Conditioning ☐ Industrial ☐ Other, specify

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
6 1/4	Steel	219	0	203

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
5 1/2	S. Steel	8	203	208

Status of Well

☑ Water Supply ☐ Replacement Well ☐ Test Hole ☐ Recharge Well ☐ Dewatering Well ☐ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☐ Abandoned, other, specify ☐ Other, specify

Water Details

Water found at Depth	Kind of Water	
208 (m/ft) ☐ Gas	☑ Fresh ☐ Untested ☐ Other, specify	
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify	
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify	

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	20	10

Results of Well Yield Testing

After test of well yield, water was: ☑ Clear and sand free ☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft): 175

Pumping rate (l/min / GPM): 10

Duration of pumping: 1 hrs + ____ min

Final water level end of pumping (m/ft): 175

If flowing give rate (l/min / GPM):

Recommended pump depth (m/ft): 175

Recommended pump rate (l/min / GPM): 8

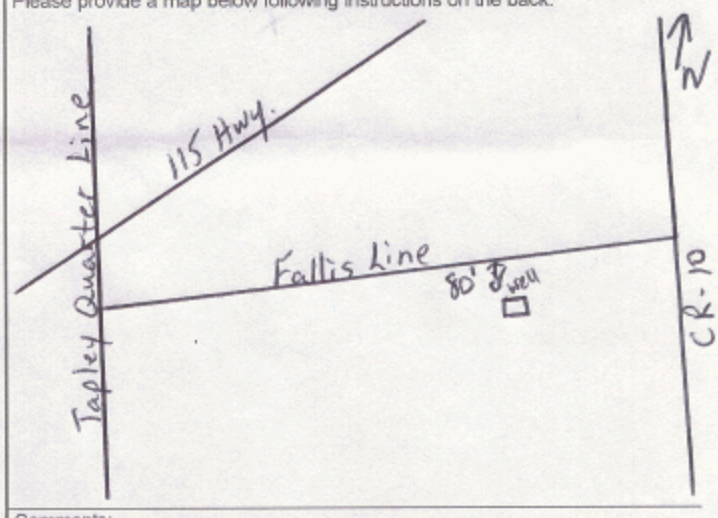
Well production (l/min / GPM): 10

Disinfected? ☑ Yes ☐ No

Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level	75		
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Roger Boadway Ent., Ltd.	1113
Business Address (Street Number/Name)	**Municipality**
P.O. Box 397, Sutton West	York
Province	**Postal Code**	**Business E-mail Address**
ON	L0E 1R0	boadwaywells@bellnet.ca
Bus. Telephone No. (inc. area code)	**Name of Well Technician (Last Name, First Name)**
9057225362	Boadway, Grant
Well Technician's Licence No.	**Signature of Technician and/or Contractor**	**Date Submitted**
0029	Grant Boadway	2011 10 04

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered: Y Y Y Y M M D D

Date Work Completed: 2011 07 12

Ministry Use Only

Audit No. z128143

Received OCT 14 2011

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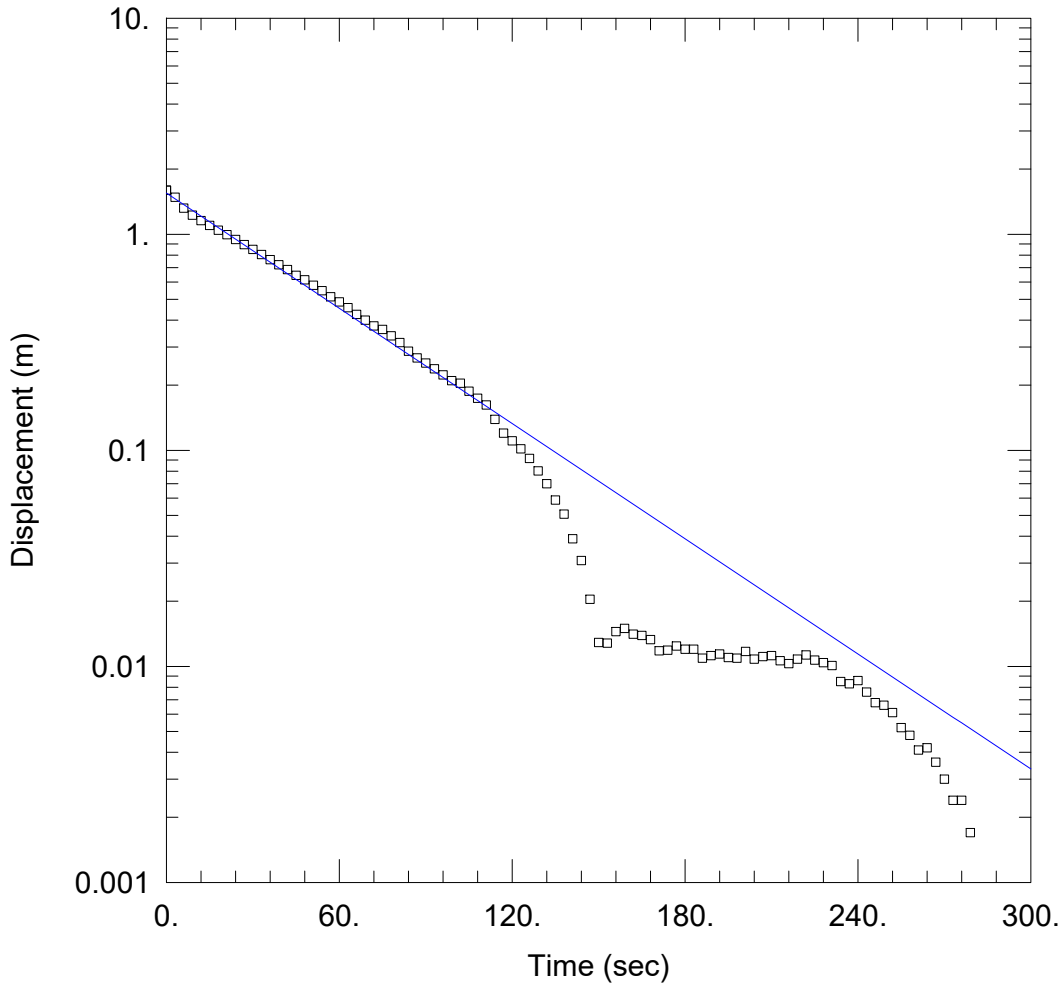
Ministry's Copy

Appendix C

Hydraulic Conductivity Data



BH-4 FALLING HEAD TEST

Data Set: G:\...\BH-4 Falling Head Test 1.aqt
Date: 06/09/20 Time: 10:41:39

PROJECT INFORMATION

Company: GHD
Client: Vargas Developments
Project: 11209539-01
Location: Millbrook, ON
Test Well: BH-4
Test Date: March 18, 2020

AQUIFER DATA

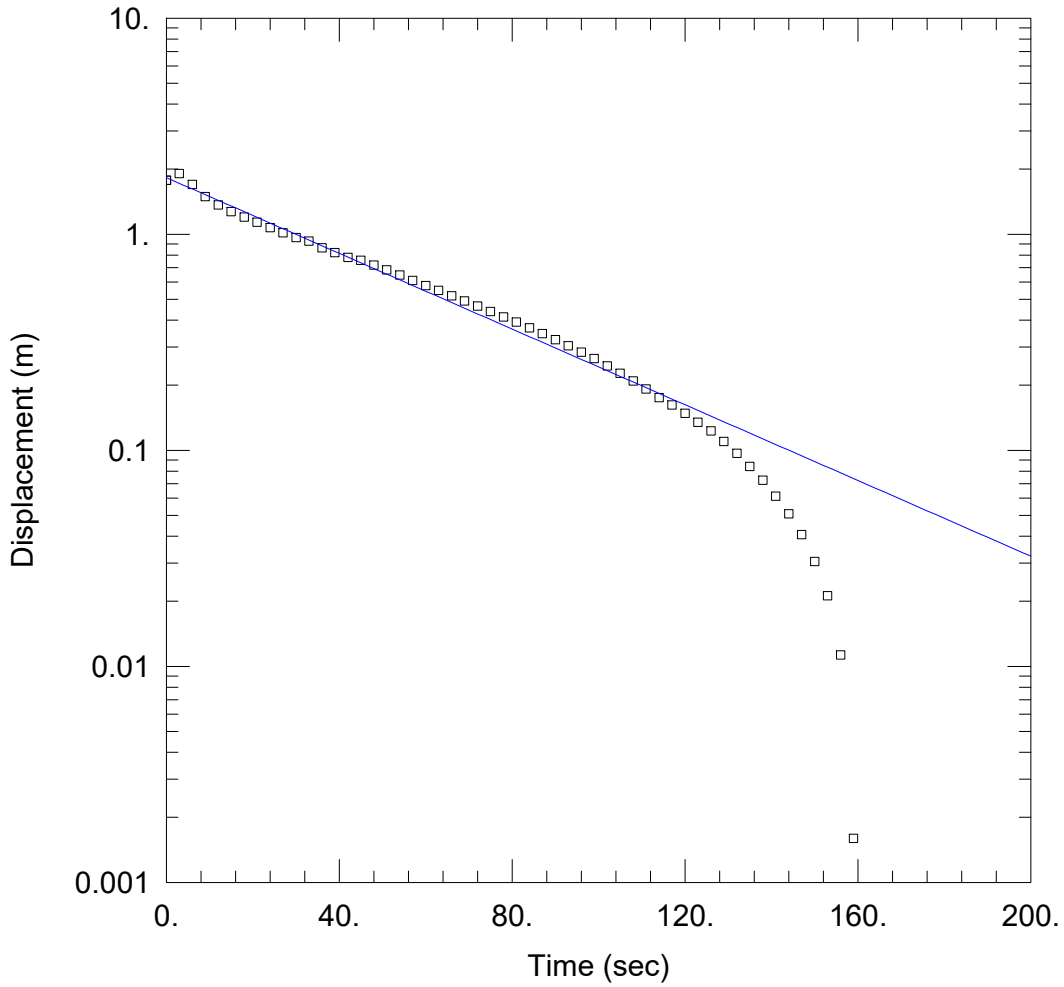
Saturated Thickness: 1.6 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 1.599 m Static Water Column Height: 0. m
Total Well Penetration Depth: 1.6 m Screen Length: 1.52 m
Casing Radius: 0.0254 m Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
K = 0.001377 cm/sec y0 = 1.549 m



BH-4 FALLING HEAD TEST 2

Data Set: G:\...\BH-4 Falling Head Test 2.aqt
Date: 06/09/20 Time: 10:43:23

PROJECT INFORMATION

Company: GHD
Client: Vargas Developments
Project: 11209539-01
Location: Millbrook, ON
Test Well: BH-4
Test Date: March 18, 2020

AQUIFER DATA

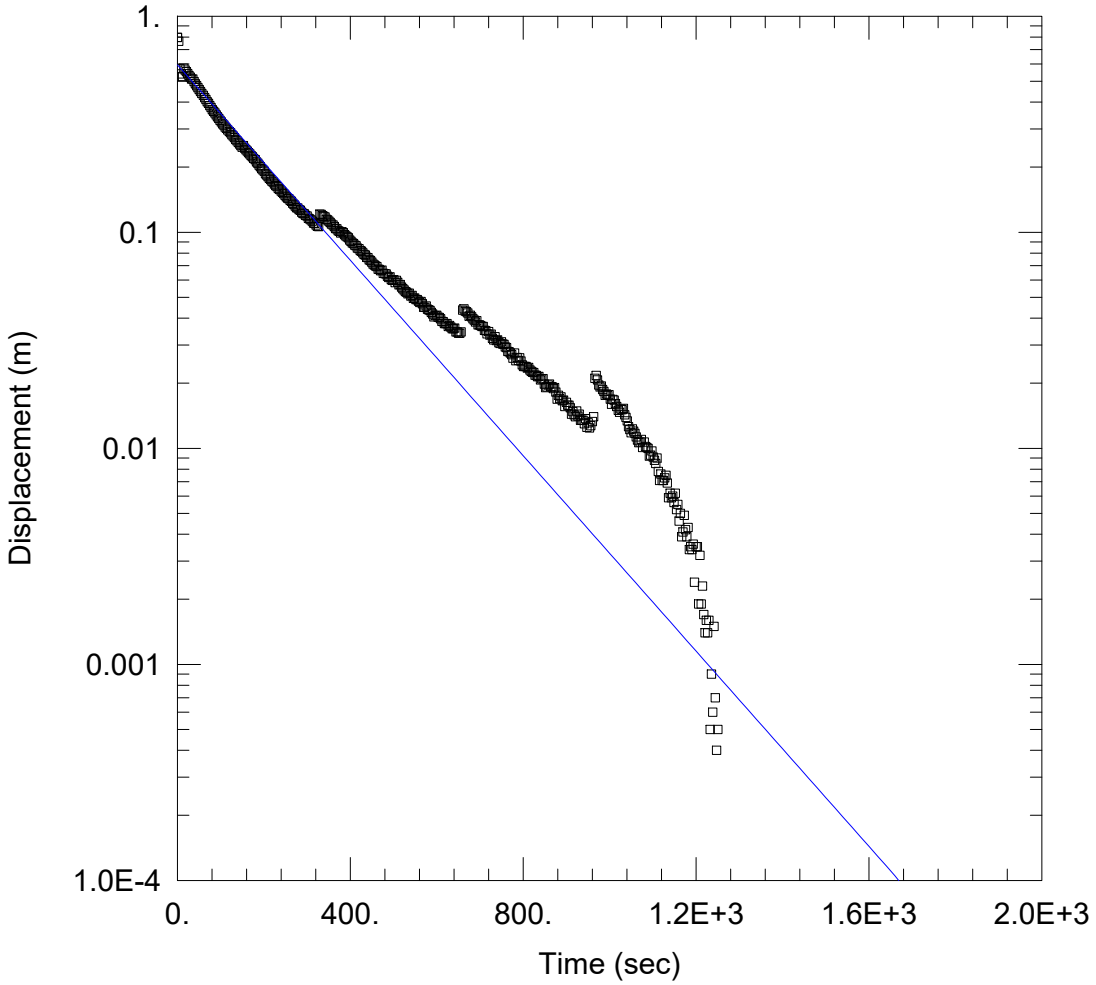
Saturated Thickness: 1.8 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH-4)

Initial Displacement: 1.777 m
Total Well Penetration Depth: 1.8 m
Casing Radius: 0.0254 m
Static Water Column Height: 0. m
Screen Length: 1.52 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00139 cm/sec
y0 = 1.827 m



BH-7 FALLING HEAD TEST 1

Data Set: G:\...\BH-7 Falling Head Test 1.aqt
Date: 06/09/20 Time: 10:47:49

PROJECT INFORMATION

Company: GHD
Client: Vargas Developments
Project: 11209539-01
Location: Millbrook, ON
Test Well: BH-7
Test Date: March 18, 2020

AQUIFER DATA

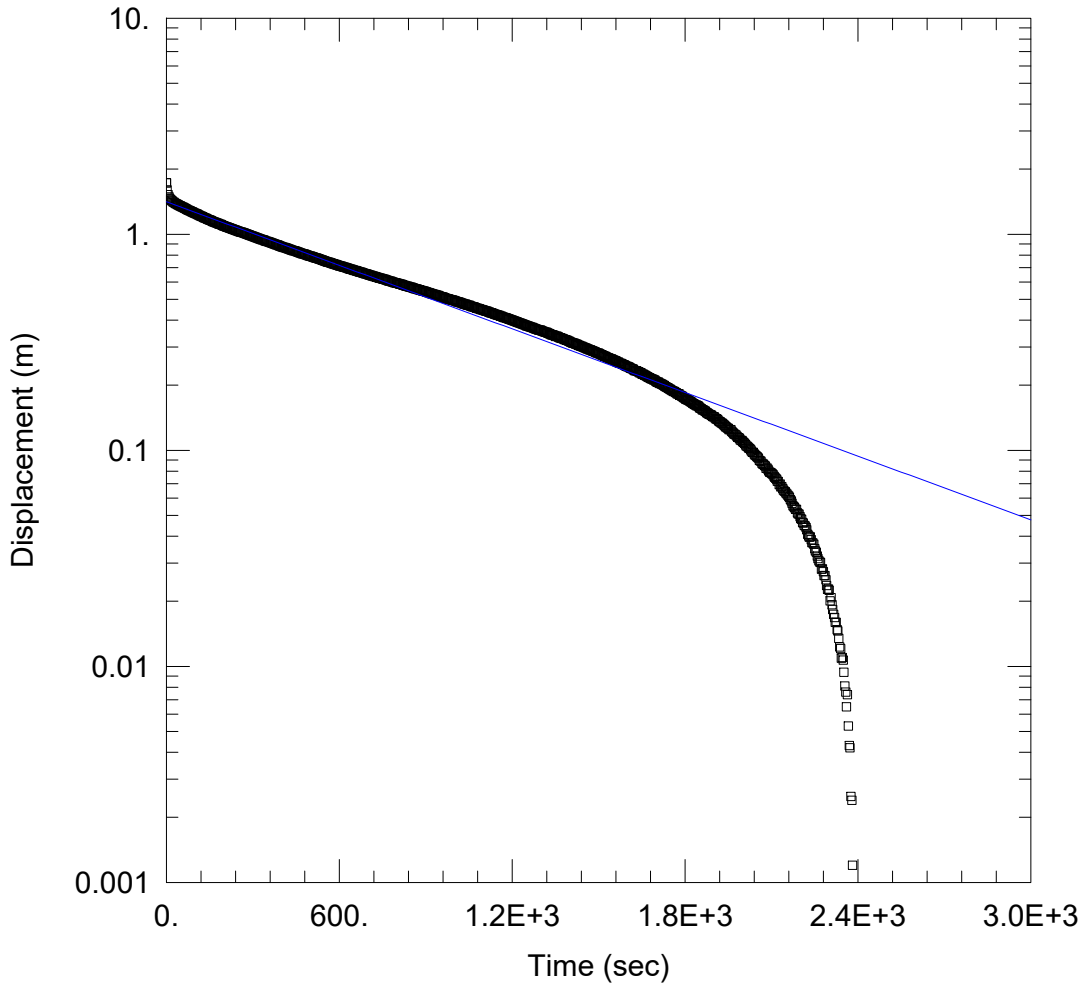
Saturated Thickness: 5.96 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH-7)

Initial Displacement: 0.7969 m
Total Well Penetration Depth: 5.96 m
Casing Radius: 0.0254 m
Static Water Column Height: 5.96 m
Screen Length: 1.52 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0004394 cm/sec
y0 = 0.5946 m



BH-7 FALLING HEAD TEST 2

Data Set: G:\...\BH-7 Falling Head Test 2.aqt
Date: 06/09/20 Time: 10:50:55

PROJECT INFORMATION

Company: GHD
Client: Vargas Developments
Project: 11209539-01
Location: Millbrook, ON
Test Well: BH-7
Test Date: March 18, 2020

AQUIFER DATA

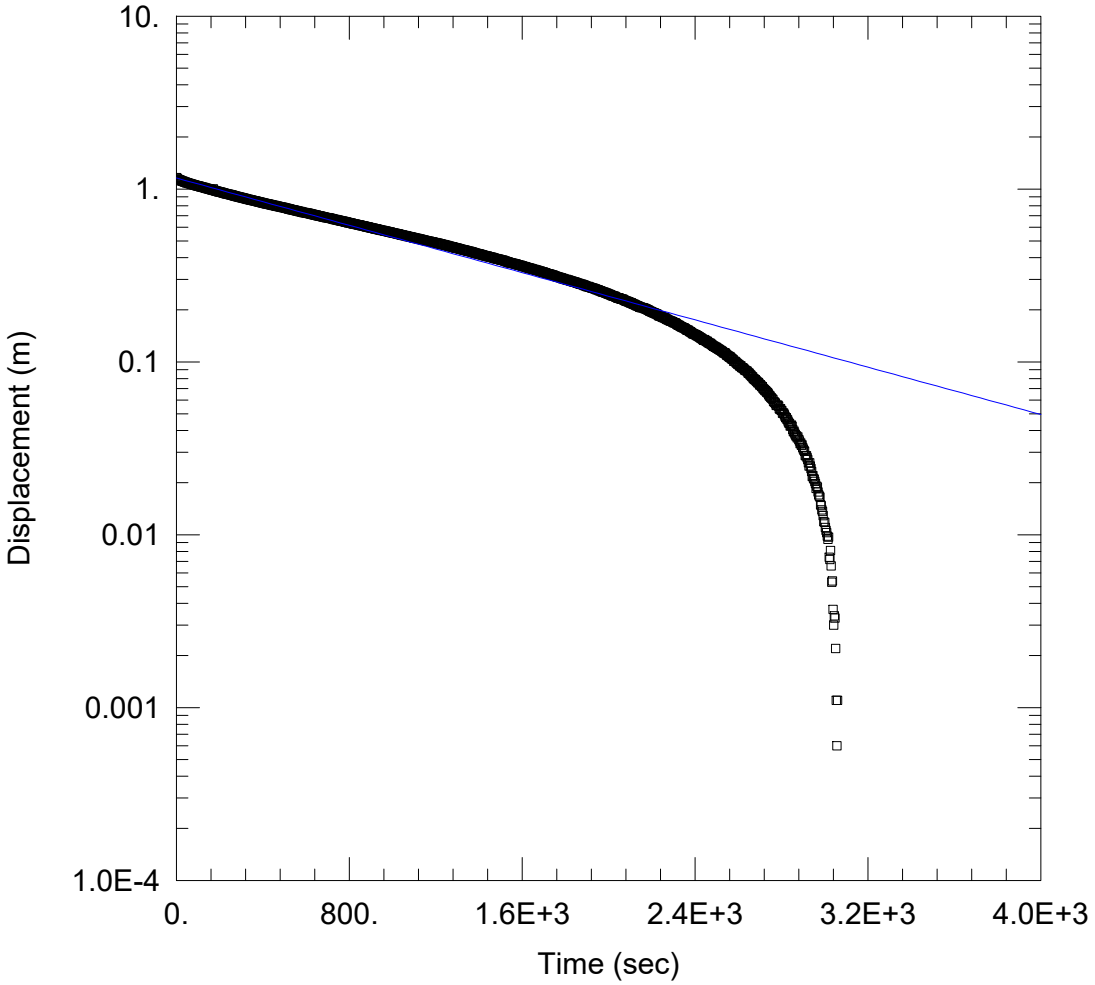
Saturated Thickness: 5.96 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH-7)

Initial Displacement: 1.731 m
Total Well Penetration Depth: 5.96 m
Casing Radius: 0.0254 m
Static Water Column Height: 5.96 m
Screen Length: 1.52 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 9.538E-5 cm/sec
y0 = 1.414 m



BH-7 FALLING HEAD TEST 3

Data Set: G:\...\BH-7 Falling Head Test 3.aqt
Date: 06/09/20 Time: 10:53:08

PROJECT INFORMATION

Company: GHD
Client: Vargas Developments
Project: 11209539-01
Location: Millbrook, ON
Test Well: BH-7
Test Date: March 18, 2020

AQUIFER DATA

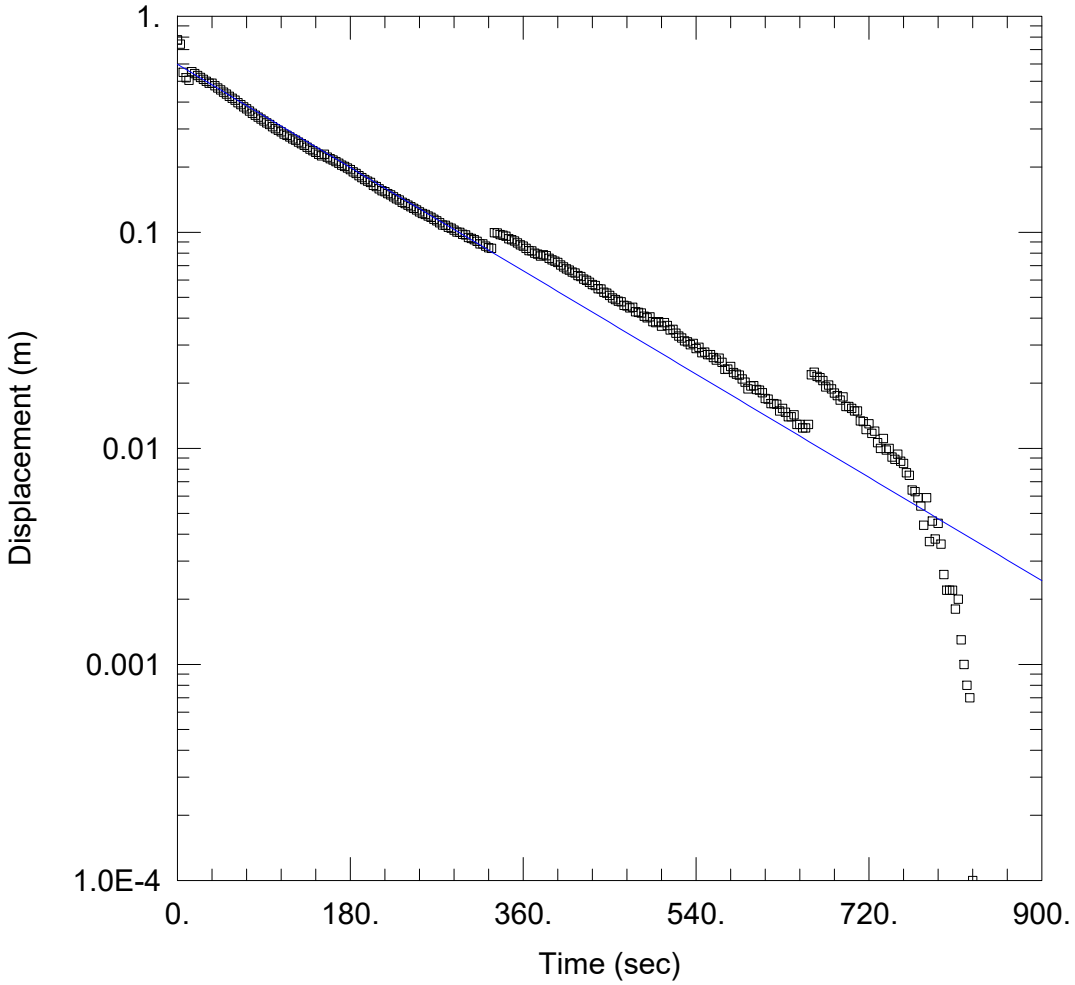
Saturated Thickness: 5.96 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH-7)

Initial Displacement: 1.164 m
Total Well Penetration Depth: 5.96 m
Casing Radius: 0.0254 m
Static Water Column Height: 5.96 m
Screen Length: 1.52 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 6.647E-5 cm/sec
y0 = 1.157 m



BH-13 FALLING HEAD TEST

Data Set: G:\...\BH-13 Falling Head Test.aqt
Date: 06/15/20 Time: 08:21:00

PROJECT INFORMATION

Company: GHD
Client: Vargas Developments
Project: 11209539-01
Location: Millbrook, ON
Test Well: BH-13
Test Date: April 24, 2020

AQUIFER DATA

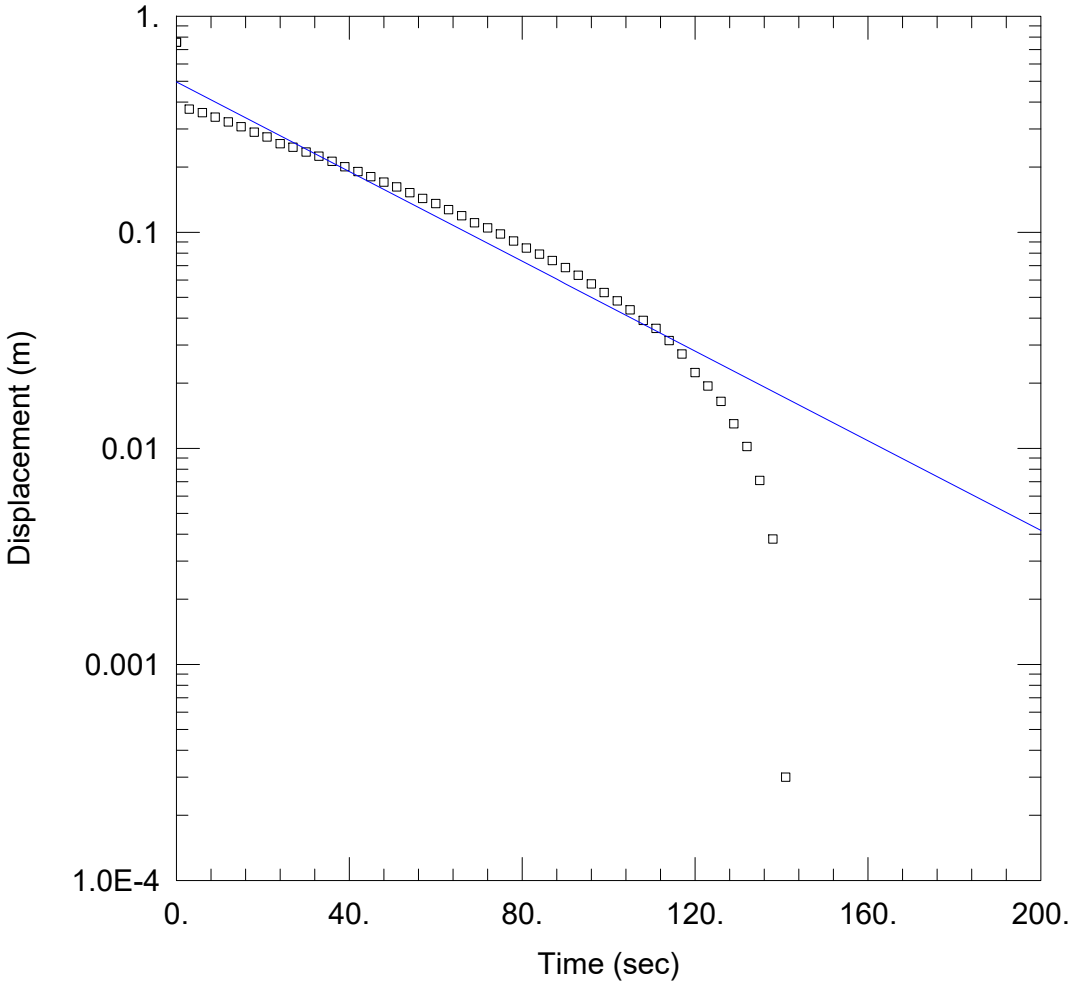
Saturated Thickness: 3.97 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH-13)

Initial Displacement: 0.7752 m
Total Well Penetration Depth: 3.97 m
Casing Radius: 0.0254 m
Static Water Column Height: 3.97 m
Screen Length: 1.52 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.000485 cm/sec
y0 = 0.5991 m



BH-13 RISING HEAD TEST

Data Set: G:\...\BH-13 Rising Head Test.aqt
Date: 06/15/20 Time: 08:22:26

PROJECT INFORMATION

Company: GHD
Client: Vargas Developments
Project: 11209539-01
Location: Millbrook, ON
Test Well: BH-13
Test Date: April 24, 2020

AQUIFER DATA

Saturated Thickness: 3.97 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH-13)

Initial Displacement: 0.7569 m
Total Well Penetration Depth: 3.97 m
Casing Radius: 0.0254 m
Static Water Column Height: 3.97 m
Screen Length: 1.52 m
Well Radius: 0.0254 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.001895 cm/sec
y0 = 0.4959 m

Appendix C.2: Infiltration Testing (in-situ)

Project No. 11209539-01
Date: March 6, 2020
Equipment: ETC Pask Permeameter

Location:	TP-2		TP-2		TP-4		TP-3		TP-5		TP-5	
Depth of hole:	0.6 m		1.2 m		0.15 m		0.6 m		0.3 m		0.6 m	
	Test 1		Test 1		Test 1		Test 1		Test 1		Test 1	
	Elapsed Time (minutes)	Permeameter Level (cm)	Elapsed Time (minutes)	Permeameter Level (cm)	Elapsed Time (minutes)	Permeameter Level (cm)	Elapsed Time (minutes)	Permeameter Level (cm)	Elapsed Time (minutes)	Permeameter Level (cm)	Elapsed Time (minutes)	Permeameter Level (cm)
	0.0	12.8	0.0	29.0	0.0	45.0	0.0	35.0	0.0	32.2	0.0	N/A
	1.0	12.0	0.5	26.5	2.0	45.0	1.0	35.0	15.0	30.0		
	1.5	5.0	1.0	24.7	10.0	45.0	5.0	35.0	19.0	28.9	Water in open hole	
	2.0	1.9	1.5	22.5	20.0	45.0			20.0	28.4		
			2.0	21.5	25.0	45.0			21.0	27.9		
			2.5	20.5					22.0	27.9		
			3.0	19.5					23.0	27.4		
			3.5	17.5					24.0	27.4		
			4.0	15.5					25.0	27.4		
			4.5	13.5					26.0	26.9		
			5.0	11.5					27.0	26.9		
			6.0	21.5					28.0	26.4		
			7.0	20.5					29.0	26.2		
			8.0	19.5					30.0	25.7		
			9.0	17.5					31.0	25.7		
			10.0	15.5					32.0	25.7		
			11.0	13.5					33.0	25.0		
			12.0	11.5					34.0	25.0		
			13.0	22.5					35.0	25.0		
			14.0	21.5					36.0	24.5		
			15.0	20.5								
			16.0	19.5								
			20.0	17.5								
			25.0	15.5								

Quasi Steady Flow Rate ® (cm/min)	7	1.2	N/A	N/A	0.25	N/A
Field-saturated Hydraulic Conductivity (Ksf) (m/sec)	3.70E-05	6.40E-06	N/A	N/A	1.30E-06	N/A

Appendix C.2: Infiltration Testing (in-situ)

Project No. 11209539-01
Date: March 6, 2020 **April 24, 2020** **April 24, 2020**
Equipment: ETC Pask Permeameter

Location:	TP-6		TP-6		BH-7				BH-4	
Depth of hole:	1.0 m		0.4 m		0.6 m				0.6 m	
	Test 1		Test 1		Test 1				Test 1	
	Elapsed Time (minutes)	Permeameter Level (cm)	Elapsed Time (minutes)	Permeameter Level (cm)	Elapsed Time (minutes)	Permeameter Level (cm)			Elapsed Time (minutes)	Permeameter Level (cm)
	1.0	39.4	0.0	22.0	1.0	27.8			1.0	25.6
	2.0	39.4	3.0	22.0	2.0	26.5			2.0	24.3
	3.0	39.4	6.0	22.0	3.0	25.0			3.0	22.8
	6.0	39.4	12.0	22.0	4.0	23.9			4.0	21.7
	8.0	39.0			5.0	22.6			5.0	20.4
	9.0	38.9			6.0	21.5			6.0	19.3
	10.0	38.8			8.0	19.2			8.0	17.0
	11.0	38.7			10.0	17.0			10.0	14.8
	13.0	38.5			12.0	14.6			12.0	12.4
	14.0	38.0			15.0	11.3			15.0	9.1
	15.0	37.8			18.0	9.1			18.0	6.9
	16.0	37.5			20.0	6.6			20.0	4.5
	17.0	37.5								
	18.0	37.2								
	19.0	37.0								
	20.0	36.7								
Quasi Steady Flow Rate ® (cm/min)		0.16		N/A		1.2				1.2
Field-saturated Hydraulic Conductivity (Ksf) (m/sec)		8.00E-07		N/A		6.40E-06				6.40E-06

Appendix D

Analytical Data

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G88320 **REPORT No. B20-07670**

Report To:

GHD Limited
455 Phillip Street,
Waterloo Ontario N2L 3X2 Canada
Attention: Jamie McEachern

Caduceon Environmental Laboratories
110 West Beaver Creek Rd Unit 14
Richmond Hill ON L4B 1J9
Tel: 289-475-5442
Fax: 289-562-1963

DATE RECEIVED: 23-Mar-20
DATE REPORTED: 25-Mar-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Vargas/11209539-01
P.O. NUMBER: 73519407
WATERWORKS NO.

			Client I.D.		W - 1	W - 2	W - 3	
			Sample I.D.		B20-07670-1	B20-07670-2	B20-07670-3	
			Date Collected		19-Mar-20	19-Mar-20	19-Mar-20	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
pH @25°C	pH Units		SM 4500H	24-Mar-20/O	7.81	7.98	8.00	
Conductivity @25°C	µmho/cm	1	SM 2510B	24-Mar-20/O	168	749	548	
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	24-Mar-20/O	73	230	246	
Hardness (as CaCO3)	mg/L	1	SM 3120	24-Mar-20/O	79	335	309	
Chloride	mg/L	0.5	SM4110C	24-Mar-20/O	5.0	71.7	11.7	
Fluoride	mg/L	0.1	SM4110C	24-Mar-20/O	< 0.1	< 0.1	< 0.1	
Nitrite (N)	mg/L	0.1	SM4110C	24-Mar-20/O	< 0.1	< 0.1	< 0.1	
Nitrate (N)	mg/L	0.1	SM4110C	24-Mar-20/O	0.1	5.1	3.0	
Sulphate	mg/L	1	SM4110C	24-Mar-20/O	< 1	24	4	
Colour	TCU	2	SM 2120C	25-Mar-20/O	4	< 2	2	
Turbidity	NTU	0.1	SM 2130	25-Mar-20/O	274	30.1	0.8	
Ammonia + Ammonium (N)	mg/L	0.01	SM4500-NH3-H	25-Mar-20/K	0.31	< 0.01	< 0.01	
o-Phosphate (P)	mg/L	0.002	PE4500-S	25-Mar-20/K	0.008	0.006	0.029	
Potassium	mg/L	0.1	SM 3120	24-Mar-20/O	4.3	1.1	0.9	
Sodium	mg/L	0.2	SM 3120	24-Mar-20/O	2.8	35.9	6.7	
Calcium	mg/L	0.02	SM 3120	24-Mar-20/O	28.8	104	113	
Magnesium	mg/L	0.02	SM 3120	24-Mar-20/O	1.65	18.2	6.41	
Iron	mg/L	0.005	SM 3120	24-Mar-20/O	< 0.005	< 0.005	< 0.005	
Copper	mg/L	0.002	SM 3120	24-Mar-20/O	< 0.002	0.002	< 0.002	
Manganese	mg/L	0.001	SM 3120	24-Mar-20/O	0.245	0.001	< 0.001	
Zinc	mg/L	0.005	SM 3120	24-Mar-20/O	0.028	0.009	< 0.005	
Anion Sum	meq/L		Calc.	25-Mar-20/O	1.61	7.49	5.53	
Cation Sum	meq/L		Calc.	25-Mar-20/O	1.81	8.28	6.48	
% Difference	%		Calc.	25-Mar-20/O	6.07	4.98	7.88	

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G88320 **REPORT No. B20-07670**

Report To:

GHD Limited
455 Phillip Street,
Waterloo Ontario N2L 3X2 Canada
Attention: Jamie McEachern

Caduceon Environmental Laboratories
110 West Beaver Creek Rd Unit 14
Richmond Hill ON L4B 1J9
Tel: 289-475-5442
Fax: 289-562-1963

DATE RECEIVED: 23-Mar-20
DATE REPORTED: 25-Mar-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Vargas/11209539-01
P.O. NUMBER: 73519407
WATERWORKS NO.

			Client I.D.		W - 1	W - 2	W - 3	
			Sample I.D.		B20-07670-1	B20-07670-2	B20-07670-3	
			Date Collected		19-Mar-20	19-Mar-20	19-Mar-20	
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Ion Ratio	AS/CS		Calc.	25-Mar-20/O	0.886	0.905	0.854	
Sodium Adsorption Ratio	-		Calc.	25-Mar-20/O	0.137	0.854	0.165	
TDS(ion sum calc.)	mg/L	1	Calc.	25-Mar-20/O	87	416	303	
Conductivity (calc.)	µmho/cm		Calc.	25-Mar-20/O	172	771	567	
TDS(calc.)/EC(actual)	-		Calc.	25-Mar-20/O	0.518	0.555	0.553	
EC(calc.)/EC(actual)	-		Calc.	25-Mar-20/O	1.02	1.03	1.03	
Langelier Index(25°C)	S.I.		Calc.	25-Mar-20/O	-0.231	0.897	1.00	

Christine Burke
Lab Manager

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G93831 **REPORT No. B20-11183**

Report To:

GHD Limited
455 Phillip Street,
Waterloo Ontario N2L 3X2 Canada
Attention: Wesley Moore

Caduceon Environmental Laboratories
110 West Beaver Creek Rd Unit 14
Richmond Hill ON L4B 1J9
Tel: 289-475-5442
Fax: 289-562-1963

DATE RECEIVED: 29-Apr-20
DATE REPORTED: 05-May-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Vargas Dev Millbrook/11209539-01
P.O. NUMBER: 73519407
WATERWORKS NO.

			Client I.D.		BH-7	BH-13		
			Sample I.D.		B20-11183-1	B20-11183-2		
			Date Collected		24-Apr-20	24-Apr-20		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
pH @25°C	pH Units		SM 4500H	30-Apr-20/O	8.02	7.81		
Conductivity @25°C	µmho/cm	1	SM 2510B	30-Apr-20/O	433	435		
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	30-Apr-20/O	209	216		
Hardness (as CaCO3)	mg/L	1	SM 3120	30-Apr-20/O	265	261		
Chloride	mg/L	0.5	SM4110C	04-May-20/O	4.2	4.1		
Fluoride	mg/L	0.1	SM4110C	04-May-20/O	< 0.1	< 0.1		
Nitrite (N)	mg/L	0.1	SM4110C	04-May-20/O	< 0.1	< 0.1		
Nitrate (N)	mg/L	0.1	SM4110C	04-May-20/O	< 0.1	< 0.1		
Sulphate	mg/L	1	SM4110C	04-May-20/O	7	7		
Colour	TCU	2	SM 2120C	01-May-20/O	< 2	5		
Turbidity	NTU	0.1	SM 2130	30-Apr-20/O	17.8	1180		
Ammonia + Ammonium (N)	mg/L	0.01	SM4500-NH3-H	30-Apr-20/K	0.03	0.05		
o-Phosphate (P)	mg/L	0.002	PE4500-S	30-Apr-20/K	< 0.002	0.040		
Potassium	mg/L	0.1	SM 3120	30-Apr-20/O	1.4	1.3		
Sodium	mg/L	0.2	SM 3120	30-Apr-20/O	4.1	4.0		
Calcium	mg/L	0.02	SM 3120	30-Apr-20/O	93.2	91.5		
Magnesium	mg/L	0.02	SM 3120	30-Apr-20/O	7.84	7.73		
Iron	mg/L	0.005	SM 3120	30-Apr-20/O	0.187	0.082		
Copper	mg/L	0.002	SM 3120	30-Apr-20/O	< 0.002	< 0.002		
Manganese	mg/L	0.001	SM 3120	30-Apr-20/O	0.030	0.026		
Zinc	mg/L	0.005	SM 3120	30-Apr-20/O	< 0.005	< 0.005		
Anion Sum	meq/L		Calc.	05-May-20/O	4.43	4.58		
Cation Sum	meq/L		Calc.	05-May-20/O	5.52	5.42		
% Difference	%		Calc.	05-May-20/O	10.9 [1]	8.36		

Christine Burke
Lab Manager

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: G93831 **REPORT No. B20-11183**

Report To:

GHD Limited
455 Phillip Street,
Waterloo Ontario N2L 3X2 Canada
Attention: Wesley Moore

Caduceon Environmental Laboratories
110 West Beaver Creek Rd Unit 14
Richmond Hill ON L4B 1J9
Tel: 289-475-5442
Fax: 289-562-1963

DATE RECEIVED: 29-Apr-20
DATE REPORTED: 05-May-20
SAMPLE MATRIX: Groundwater

JOB/PROJECT NO.: Vargas Dev Millbrook/11209539-01
P.O. NUMBER: 73519407
WATERWORKS NO.

			Client I.D.		BH-7	BH-13		
			Sample I.D.		B20-11183-1	B20-11183-2		
			Date Collected		24-Apr-20	24-Apr-20		
Parameter	**Units**	**R.L.**	**Reference Method**	**Date/Site Analyzed**				
Ion Ratio	AS/CS		Calc.	05-May-20/O	0.803	0.846		
Sodium Adsorption Ratio	-		Calc.	05-May-20/O	0.109	0.109		
TDS(ion sum calc.)	mg/L	1	Calc.	05-May-20/O	243	246		
Conductivity (calc.)	µmho/cm		Calc.	05-May-20/O	468	469		
TDS(calc.)/EC(actual)	-		Calc.	05-May-20/O	0.562	0.565		
EC(calc.)/EC(actual)	-		Calc.	05-May-20/O	1.08	1.08		
Langelier Index(25°C)	S.I.		Calc.	05-May-20/O	0.877	0.674		

1 Outside of 10% Acceptance Criteria

Christine Burke
Lab Manager

R.L. = Reporting Limit
Test methods may be modified from specified reference method unless indicated by an *
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Appendix E

Water Balance Calculations

Appendix E.1

Revised Water Budget (Thornthwaite Method) - Average Values*

Weather Station: Peterborough A

Climate Station: 6166418 **Elevation:** 191 masl **Distance Away:** ~ 10.2 km

Month	Mean Temperature (^{o}C)	Heat Index	Unadjusted Potential ET (mm)	Daylight Correction Factor	Adjusted ET (mm)	Total Precipitation (mm)
January	-8.5	0	0	0.78	0	57.4
February	-7.5	0	0	0.88	0	51.5
March	-1.8	0	0	0.99	0	56.1
April	5.9	1.28	28.8	1.12	32.2	68.6
May	12.1	3.81	60.1	1.22	73.3	81.5
June	17	6.38	85.1	1.28	109.0	79.9
July	19.6	7.91	98.5	1.25	123.1	70.6
August	18.3	7.13	91.8	1.15	105.6	77
September	13.9	4.70	69.2	1.04	72.0	85.3
October	7.5	1.85	36.8	0.92	33.8	76.9
November	1.9	0.23	9.0	0.8	7.2	86.4
December	-4.4	0	0	0.76	0	64.2
TOTAL	6.2	33.3	479.3		556.2	855.4

TOTAL WATER SURPLUS: 299.2 mm

Notes:

*Average values of precipitation were used. Average values of temperature were also used.

Appendix E.2
Water Budget Pre-Development

Catchment Designation	PRE-DEVELOPMENT SITE			TOTAL
	Agricultural Areas	Naturalized Areas	Natural Heritage Areas	
Area (m^2)	57224	83876	154600	295700
Pervious Area (m^2)	57224	83876	154600	295700
% Pervious	19.4%	28.4%	52.3%	100.0%
Impervious Area (m^2)	0	0	0	0
% Impervious	0%	0%	0%	0.0%
INFILTRATION FACTORS				
Topography Infiltration Factor	0.1	0.1	0.15	
Soil Infiltration Factor	0.2	0.2	0.2	
Land Cover Infiltration Factor	0.1	0.15	0.2	
MECP Infiltration Factor	0.4	0.45	0.55	
Actual Infiltration Factor	0.4	0.45	0.55	
Runoff Coefficient	0.6	0.55	0.45	
Runoff from Impervious Surfaces*	0	0	0	
INPUTS (PER UNIT AREA)				
Precipitation (mm/yr)	855	855	855	855
Run On (mm/yr)	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0
Total Inputs (mm/yr)	855	855	855	855
OUTPUTS (PER UNIT AREA)				
Precipitation Surplus (mm/yr)	299	299	299	299
Net Surplus (mm/yr)	299	299	299	299
Evaportranspiration (mm/yr)	556	556	556	556
Infiltration (mm/yr)	120	135	165	147
Rooftop Infiltration (mm/yr)	0	0	0	0
Total Infiltration (mm/yr)	120	135	165	147
Runoff Pervious Areas	180	165	135	152
Runoff Impervious Areas	0	0	0	0
Total Runoff (mm/yr)	180	165	135	152
Total Outputs (mm/yr)	855	855	855	855
Difference (Inputs - Outputs)	0	0	0	0
INPUTS (VOLUMES)				
Precipitation (m^3/yr)	48949	71748	132245	252942
Run On (m^3/yr)	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0
Total Inputs (m^3/yr)	48949	71748	132245	252942
OUTPUTS (VOLUMES)				
Precipitation Surplus (m^3/yr)	17120	25093	46252	88465
Net Surplus (m^3/yr)	17120	25093	46252	88465
Evaportranspiration (m^3/yr)	31830	46654	85993	164476
Infiltration (m^3/yr)	6848	11292	25439	43579
Rooftop Infiltration (m^3/yr)	0	0	0	0
Total Infiltration (m^3/yr)	6848	11292	25439	43579
Runoff Pervious Areas (m^3/yr)	10272	13801	20813	44887
Runoff Impervious Areas (m^3/yr)	0	0	0	0
Total Runoff (m^3/yr)	10272	13801	20813	44887
Total Outputs (m^3/yr)	48949	71748	132245	252942
Difference (Inputs - Outputs)	0	0	0	0

Notes:
Naturalized areas are open, vacant areas that are not used for agriculture and are not natural heritage areas
Agricultural area based upon Peterborough County GIS.
Natural heritage area based upon Conceptual Master Plan CMP-01 dated Jan. 25, 2022.

Appendix E.3

Water Budget Post-Development - No Mitigation Strategies

Catchment Designation	POST-DEVELOPMENT SITE															TOTAL
	Low Density - Singles A, B, C			Med. Density - Townhouse D			Natural	SWM	Road	Road ROWs		Parkland	Commercial Block			
	Lawns	*Rooftops*	*Driveways*	*Lawns*	*Rooftops*	*Driveways*	Heritage	Pond	Widening	*Asphalt*	*Grass*	& Trails	*Landscaping*	*Rooftops*	*Asphalt*	
Area (m^2)	15725	37740	9435	2560	9600	640	154600	16200	1000	15800	15800	3600	910	1690	10400	295700
Pervious Area (m^2)	15725	0	0	2560	0	0	154600	0	1000	0	15800	3600	910	0	0	194195
% Pervious	5.3%	0%	0%	1%	0%	0%	52.3%	0%	0.3%	0%	5.3%	1.2%	0.3%	0%	0%	65.7%
Impervious Area (m^2)	0	37740	9435	0	9600	640	0	16200	0	15800	0	0	0	1690	10400	101505
% Impervious	0%	12.8%	3.2%	0%	3.2%	0.2%	0%	5.5%	0%	5.3%	0%	0%	0%	0.6%	3.5%	34.3%
	INFILTRATION FACTORS															
Topography Infiltration Factor	0.15	0	0	0.15	0	0.1	0.15	0.1	0.1	0.1	0.1	0.15	0.15	0	0	
Soil Infiltration Factor	0.2	0	0	0.2	0	0	0.2	0	0.2	0	0.2	0.2	0.2	0	0	
Land Cover Infiltration Factor	0.15	0	0	0.15	0	0	0.2	0	0.15	0	0.15	0.15	0.15	0	0	
MECP Infiltration Factor	0.5	0	0	0.5	0	0.1	0.55	0.1	0.45	0.1	0.45	0.5	0.5	0	0	
Actual Infiltration Factor	0.5	0	0	0.5	0	0	0.55	0.05	0.45	0	0.45	0.5	0.5	0	0	
Runoff Coefficient	0.5	1	1	0.5	1	1	0.45	0.95	0.55	1	0.55	0.5	0.5	1	1	
Runoff from Impervious Surfaces*	0	0.8	0.8	0	0.8	0.8	0	0.8	0	0.8	0	0.8	0	0.8	0.8	
	INPUTS (PER UNIT AREA)															
Precipitation (mm/yr)	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855
Run On (mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inputs (mm/yr)	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855
	OUTPUTS (PER UNIT AREA)															
Precipitation Surplus (mm/yr)	299	684	684	299	684	684	299	684	299	684	299	299	299	684	684	431
Net Surplus (mm/yr)	299	684	684	299	684	684	299	684	299	684	299	299	299	684	684	431
Evaportranspiration (mm/yr)	556	171	171	556	171	171	556	171	556	171	556	556	556	171	171	424
Infiltration (mm/yr)	150	0	0	150	0	0	165	34	135	0	135	150	150	0	0	107
Rooftop Infiltration (mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Infiltration (mm/yr)	150	0	0	150	0	0	165	34	135	0	135	150	150	0	0	107
Runoff Pervious Areas	150	0	0	150	0	0	135	0	165	0	165	150	150	0	0	91
Runoff Impervious Areas	0	684	684	0	684	684	0	650	0	684	0	0	0	684	684	233
Total Runoff (mm/yr)	150	684	684	150	684	684	135	650	165	684	165	150	150	684	684	324
Total Outputs (mm/yr)	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	INPUTS (VOLUMES)															
Precipitation (m^3/yr)	13451	32283	8071	2190	8212	547	132245	13857	855	13515	13515	3079	778	1446	8896	252942
Run On (m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inputs (m^3/yr)	13451	32283	8071	2190	8212	547	132245	13857	855	13515	13515	3079	778	1446	8896	252942
	OUTPUTS (VOLUMES)															
Precipitation Surplus (m^3/yr)	4704	25826	6457	766	6569	438	46252	11086	299	10812	4727	1077	272	1157	7117	127560
Net Surplus (m^3/yr)	4704	25826	6457	766	6569	438	46252	11086	299	10812	4727	1077	272	1157	7117	127560
Evaportranspiration (m^3/yr)	8747	6457	1614	1424	1642	109	85993	2771	556	2703	8788	2002	506	289	1779	125382
Infiltration (m^3/yr)	2352	0	0	383	0	0	25439	554	135	0	2127	539	136	0	0	31665
Rooftop Infiltration (m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Infiltration (m^3/yr)	2352	0	0	383	0	0	25439	554	135	0	2127	539	136	0	0	31665
Runoff Pervious Areas (m^3/yr)	2352	0	0	383	0	0	20813	0	165	0	2600	539	136	0	0	26988
Runoff Impervious Areas (m^3/yr)	0	25826	6457	0	6569	438	0	10532	0	10812	0	0	0	1157	7117	68908
Total Runoff (m^3/yr)	2352	25826	6457	383	6569	438	20813	10532	165	10812	2600	539	136	1157	7117	95895
Total Outputs (m^3/yr)	13451	32283	8071	2190	8212	547	132245	13857	855	13515	13515	3079	778	1446	8896	252942
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

Post-Development areas based upon Conceptual Master Plan CMP-01 dated Jan. 25, 2022.

*Evaporation from impervious areas was assumed to be 20% of precipitation.

Asphalt has 0% infiltration capability

Low Density Single Lots: Assume rooftops cover about 60% of the lot. Driveways cover about 15% of the lot; Grass (lawns) cover about 25% of the lot.

Medium Density Townhouse Lots: Assume rooftops cover about 75% of the lot. Driveways cover about 5% of the lot; Grass (lawns) cover about 20% of the lot.

Commercial Lot: Assume rooftops covers about 13% of the lot. Asphalt parking covers about 80% of the lot; Landscaping covers about 7% of the lot.

Road ROWs assumed to be 50% asphalt and 50% grass

Appendix E.4

Water Budget Post-Development - With Downspout Disconnection Mitigation Strategies Only

Catchment Designation	POST-DEVELOPMENT SITE															TOTAL
	Low Density - Singles A, B, C			Med. Density - Townhouse D			Natural	SWM	Road	Road ROWs		Parkland	Commercial			
	Lawns	*Rooftops*	*Driveways*	*Lawns*	*Rooftops*	*Driveways*	Heritage	Pond	Widening	*Asphalt*	*Grass*	& Trails	*Landscaping*	*Rooftops*	*Asphalt*	
Area (m^2)	15725	37740	9435	2560	9600	640	154600	16200	1000	15800	15800	3600	910	1690	10400	295700
Pervious Area (m^2)	15725	0	0	2560	0	0	154600	0	1000	0	15800	3600	910	0	0	194195
% Pervious	5.3%	0%	0%	1%	0%	0%	52.3%	0%	0.3%	0%	5.3%	1.2%	0.3%	0%	0%	65.7%
Impervious Area (m^2)	0	37740	9435	0	9600	640	0	16200	0	15800	0	0	0	1690	10400	101505
% Impervious	0%	12.8%	3.2%	0%	3.2%	0.2%	0%	5.5%	0%	5.3%	0%	0%	0%	0.6%	3.5%	34.3%
	INFILTRATION FACTORS															
Topography Infiltration Factor	0.15	0	0	0.15	0	0.1	0.15	0.1	0.1	0.1	0.1	0.15	0.15	0	0	
Soil Infiltration Factor	0.2	0	0	0.2	0	0	0.2	0	0.2	0	0.2	0.2	0.2	0	0	
Land Cover Infiltration Factor	0.15	0	0	0.15	0	0	0.2	0	0.15	0	0.15	0.15	0.15	0	0	
MECP Infiltration Factor	0.5	0	0	0.5	0	0.1	0.55	0.1	0.45	0.1	0.45	0.5	0.5	0	0	
Actual Infiltration Factor	0.5	0	0	0.5	0	0	0.55	0.05	0.45	0	0.45	0.5	0.5	0	0	
Runoff Coefficient	0.5	1	1	0.5	1	1	0.45	0.95	0.55	1	0.55	0.5	0.5	1	1	
Runoff from Impervious Surfaces*	0	0.8	0.8	0	0.8	0.8	0	0.8	0	0.8	0	0.8	0	0.8	0.8	
	INPUTS (PER UNIT AREA)															
Precipitation (mm/yr)	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855
Run On (mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inputs (mm/yr)	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855
	OUTPUTS (PER UNIT AREA)															
Precipitation Surplus (mm/yr)	299	684	684	299	684	684	299	684	299	684	299	299	299	684	684	431
Net Surplus (mm/yr)	299	684	684	299	684	684	299	684	299	684	299	299	299	684	684	431
Evaportranspiration (mm/yr)	556	171	171	556	171	171	556	171	556	171	556	556	556	171	171	424
Infiltration (mm/yr)	150	0	0	150	0	0	165	34	135	0	135	150	150	0	0	107
%Rooftop Required to Meet Pre-Development	--	35.5%	--	--	35.5%	--	--	--	--	--	--	--	--	35.5%	--	--
Rooftop Infiltration (mm/yr)	0	243	0	0	243	0	0	0	0	0	0	0	0	243	0	40
Total Infiltration (mm/yr)	150	243	0	150	243	0	165	34	135	0	135	150	150	243	0	147
Runoff Pervious Areas	150	0	0	150	0	0	135	0	165	0	165	150	150	0	0	91
Runoff Impervious Areas	0	441	684	0	441	684	0	650	0	684	0	0	0	441	684	193
Total Runoff (mm/yr)	150	441	684	150	441	684	135	650	165	684	165	150	150	441	684	284
Total Outputs (mm/yr)	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	INPUTS (VOLUMES)															
Precipitation (m^3/yr)	13451	32283	8071	2190	8212	547	132245	13857	855	13515	13515	3079	778	1446	8896	252942
Run On (m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inputs (m^3/yr)	13451	32283	8071	2190	8212	547	132245	13857	855	13515	13515	3079	778	1446	8896	252942
	OUTPUTS (VOLUMES)															
Precipitation Surplus (m^3/yr)	4704	25826	6457	766	6569	438	46252	11086	299	10812	4727	1077	272	1157	7117	127560
Net Surplus (m^3/yr)	4704	25826	6457	766	6569	438	46252	11086	299	10812	4727	1077	272	1157	7117	127560
Evaportranspiration (m^3/yr)	8747	6457	1614	1424	1642	109	85993	2771	556	2703	8788	2002	506	289	1779	125382
Infiltration (m^3/yr)	2352	0	0	383	0	0	25439	554	135	0	2127	539	136	0	0	31665
Rooftop Infiltration (m^3/yr)	0	9171	0	0	2333	0	0	0	0	0	0	0	0	411	0	11914
Total Infiltration (m^3/yr)	2352	9171	0	383	2333	0	25439	554	135	0	2127	539	136	411	0	43579
Runoff Pervious Areas (m^3/yr)	2352	0	0	383	0	0	20813	0	165	0	2600	539	136	0	0	26988
Runoff Impervious Areas (m^3/yr)	0	16656	6457	0	4237	438	0	10532	0	10812	0	0	0	746	7117	56993
Total Runoff (m^3/yr)	2352	16656	6457	383	4237	438	20813	10532	165	10812	2600	539	136	746	7117	83981
Total Outputs (m^3/yr)	13451	32283	8071	2190	8212	547	132245	13857	855	13515	13515	3079	778	1446	8896	252942
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

Post-Development areas based upon Conceptual Master Plan CMP-01 dated Jan. 25, 2022.

*Evaporation from impervious areas was assumed to be 20% of precipitation.

Asphalt has 0% infiltration capability

Low Density Single Lots: Assume rooftops cover about 60% of the lot. Driveways cover about 15% of the lot; Grass (lawns) cover about 25% of the lot.

Medium Density Townhouse Lots: Assume rooftops cover about 75% of the lot. Driveways cover about 5% of the lot; Grass (lawns) cover about 20% of the lot.

Commercial Lots: Assume rooftops covers about 13% of the lot. Asphalt parking covers about 80% of the lot; Landscaping covers about 7% of the lot.

Road ROWs assumed to be 50% asphalt and 50% grass

Appendix E.5
Water Budget Summary

PARAMETER	SITE				
	Pre-Development	*Post-Development No Mitigation*	*Difference Pre- vs. Post-*	*Post-Development with Downspout Disconnection Mitigation*	*Difference Pre- vs. Post-*
		INPUTS (VOLUMES)			
Precipitation (m^3/yr)	252942	252942	0%	252942	0%
Run On (m^3/yr)	0	0	0%	0	0%
Other Inputs (m^3/yr)	0	0	0%	0	0%
Total Inputs (m^3/yr)	252942	252942	0%	252942	0%
		OUTPUTS (VOLUMES)			
Precipitation Surplus (m^3/yr)	88465	127560	44%	127560	44%
Net Surplus (m^3/yr)	88465	127560	44%	127560	44%
Evapotranspiration (m^3/yr)	164476	125382	-24%	125382	-24%
Infiltration (m^3/yr)	43579	31665	-27%	31665	-27%
% Rooftop Runoff to balance infiltration	--	--	--	35.5%	--
Rooftop Infiltration (m^3/yr)	0	0	0%	11914	--
Total Infiltration (m^3/yr)	43579	31665	-27%	43579	0%
Runoff Pervious Areas (m^3/yr)	44887	26988	-40%	26988	-40%
Runoff Impervious Areas (m^3/yr)	0	68908	--	56993	--
Total Runoff (m^3/yr)	44887	95895	114%	83981	87%
Total Outputs (m^3/yr)	252942	252942	0%	252942	0%

To maintain pre-development infiltration values; 35.5% of post-development rooftop runoff needs to be infiltrated.

Appendix F

Slope Stability Analysis

Data Disclaimer

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1 cm = 16 meters

0 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

Vargas Properties
963 County Road 10, Millbrook, ON
Pt Lot 13, Con 5, Geographic Township of Cavan
Township of Cavan Monghan

Geotechnical Investigation

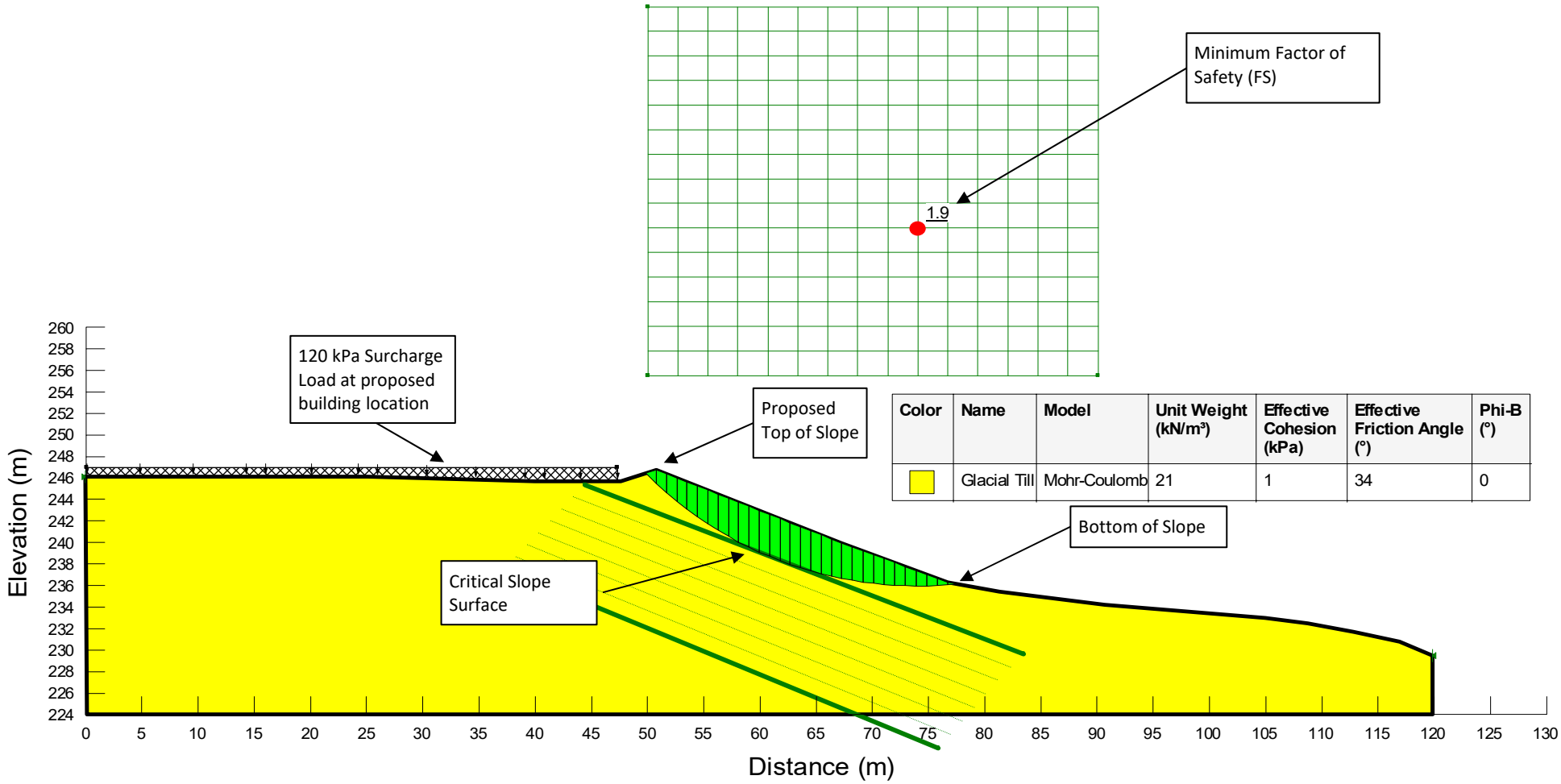
Slope Stability Assessment, Cross-Section Location Plan

Project No. 11209539
Revision No.
Date Jan 25, 2023

Figure F.1.

O:\GIS\PROJECTS\11209000s\11209539\Layouts\202201_RPT003\11209539_202201_RPT003_GIS0F1 - Slope Stability Assessment, Cross-Section Location Plan.mxd
Print date: 25 Jan 2023 - 06:08

Data source: © County of Peterborough, 2018.



Scale:
As Shown Above

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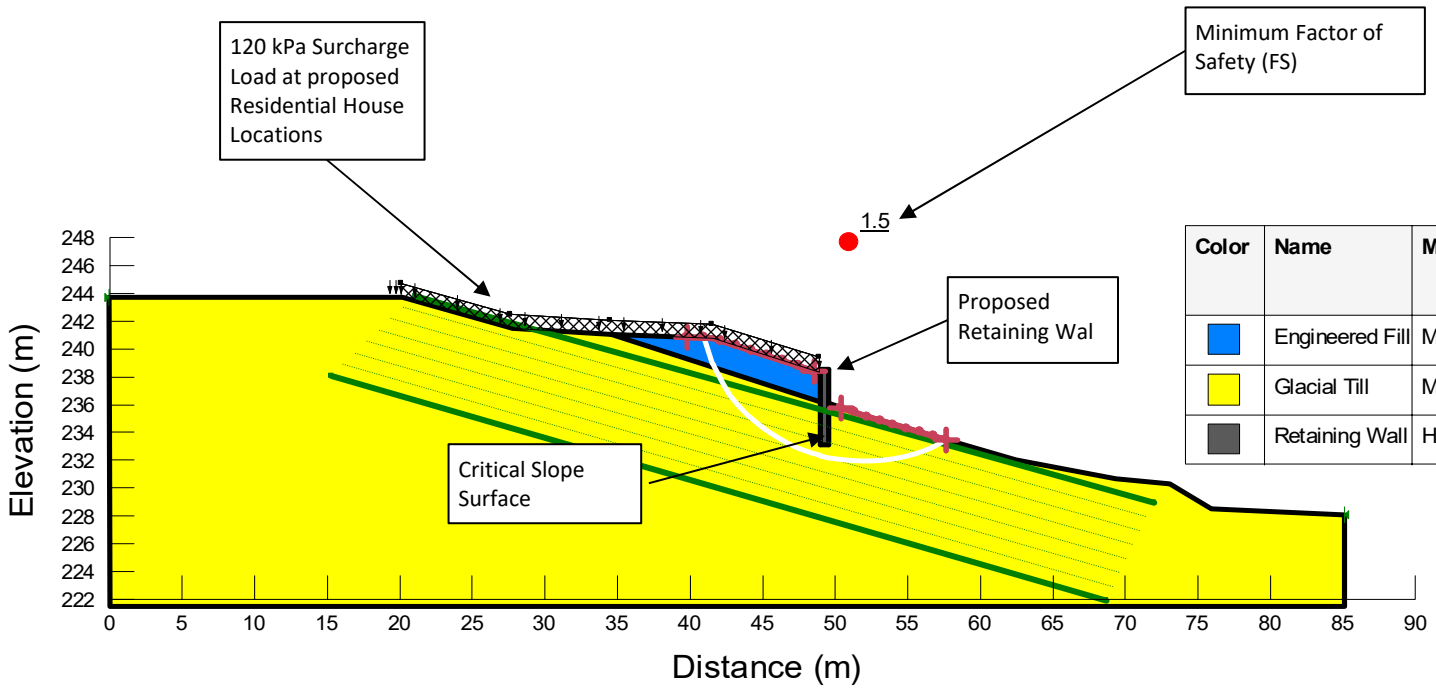
Vargas Properties Inc.
Part Lot 13, Concession 5, Millbrook, Ontario
Updated Geotechnical Investigation Report

11209539
Jan. 2023

SLOPE STABILITY ASSESSMENT - CROSS SECTION 1-1' (PROPOSED CONDITION)

FIGURE F.2



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
	Engineered Fill	Mohr-Coulomb	21	0	30	0
	Glacial Till	Mohr-Coulomb	21	1	34	0
	Retaining Wall	High Strength	24			

Retaining Wall required to be at least 3m embeded into the soil to provide the minimum FS = 1.5 for global stability

Scale:
As Shown Above

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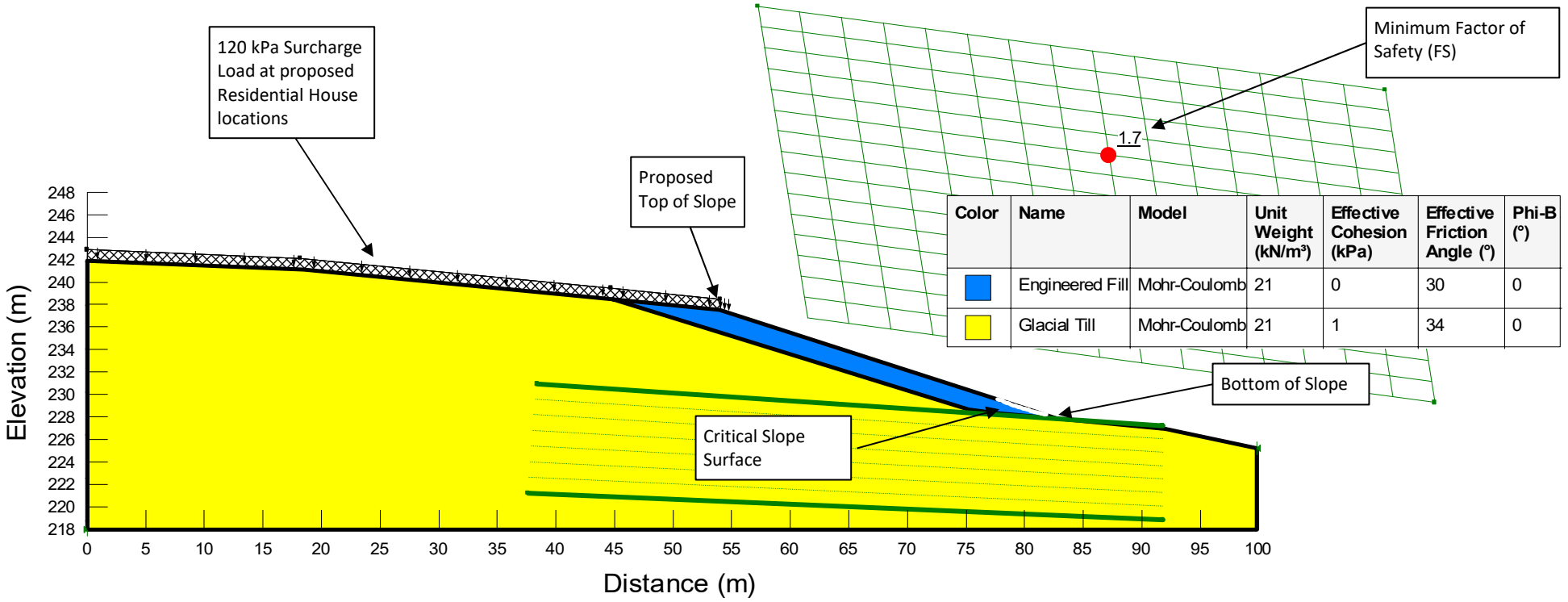
Jan. 2023

SLOPE STABILITY ASSESSMENT - CROSS SECTION 2-2' (PROPOSED CONDITION)

FIGURE F.3



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
	Engineered Fill	Mohr-Coulomb	21	0	30	0
	Glacial Till	Mohr-Coulomb	21	1	34	0

Scale:
As Shown Above

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Part Lot 13, Concession 5, Millbrook, Ontario
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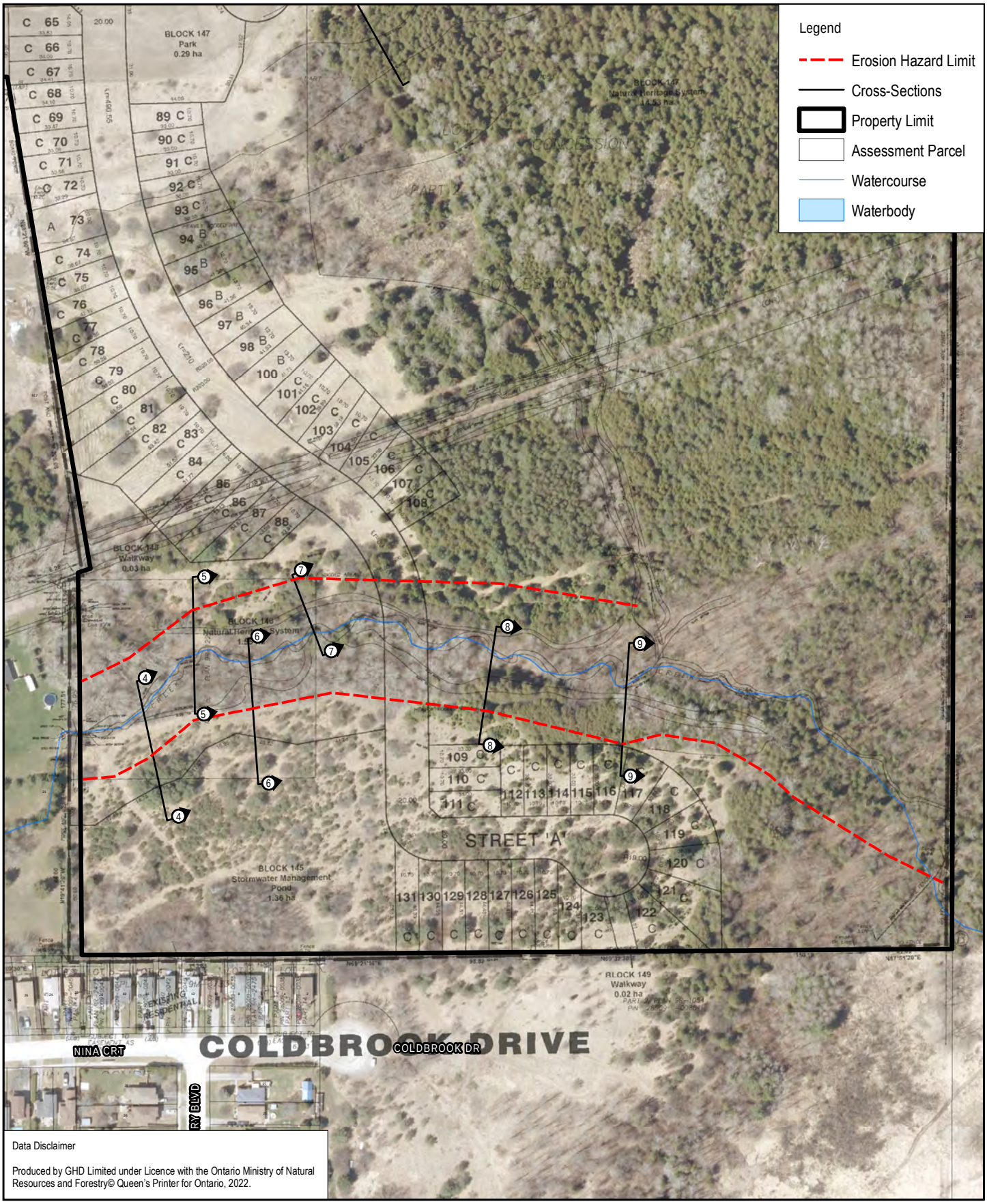
SLOPE STABILITY ASSESSMENT - CROSS SECTION 3-3' (PROPOSED CONDITION)

FIGURE F.4

Appendix G

Erosion Hazard Limit Assessment



1 cm = 24 meters

0 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

Vargas Properties
963 County Road 10, Millbrook, ON
Pt Lot 13, Con 5, Geographic Township of Cavan
Township of Cavan Monghan

Geotechnical Investigation

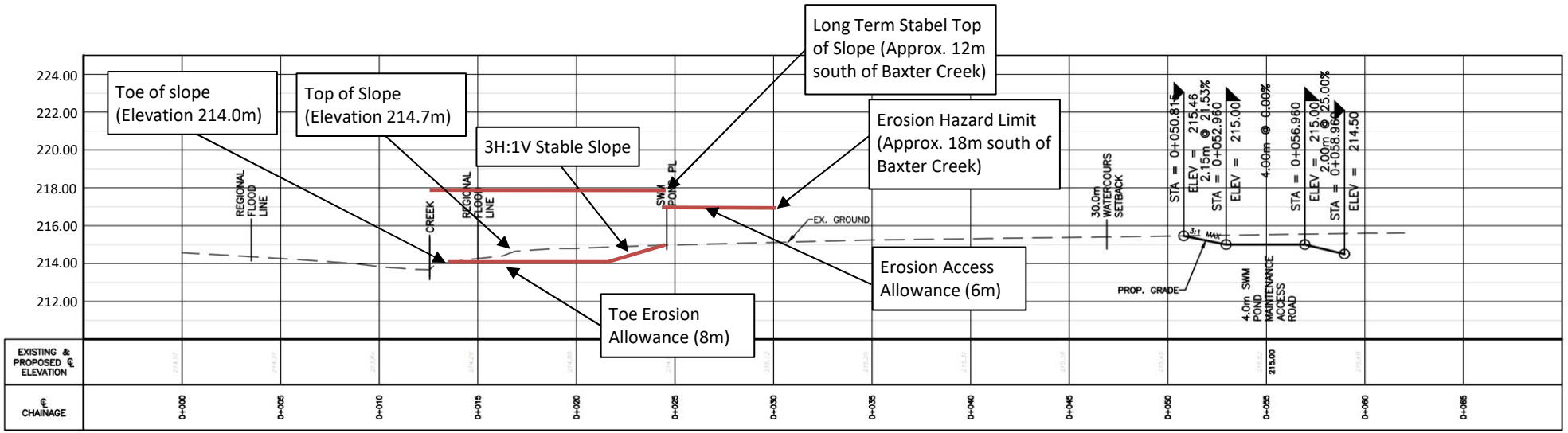
Erosion Hazard Limit Assessment Plan

Project No. 11209539
Revision No.
Date Jan 25, 2023

Figure G.1.

O:\GIS\PROJECTS\11209000s\11209539\Layouts\202201_RPT003\11209539_202201_RPT003_GIS0G1 - Erosion Hazard Limit Assessment Plan.mxd
Print date: 25 Jan 2023 - 12:34

Data source: © County of Peterborough, 2018.



Scale:
As Shown Above

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Part Lot 13, Concession 5, Millbrook, Ontario
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EROSION HAZARD LIMIT ASSESSMENT - CROSS SECTION 4-4'

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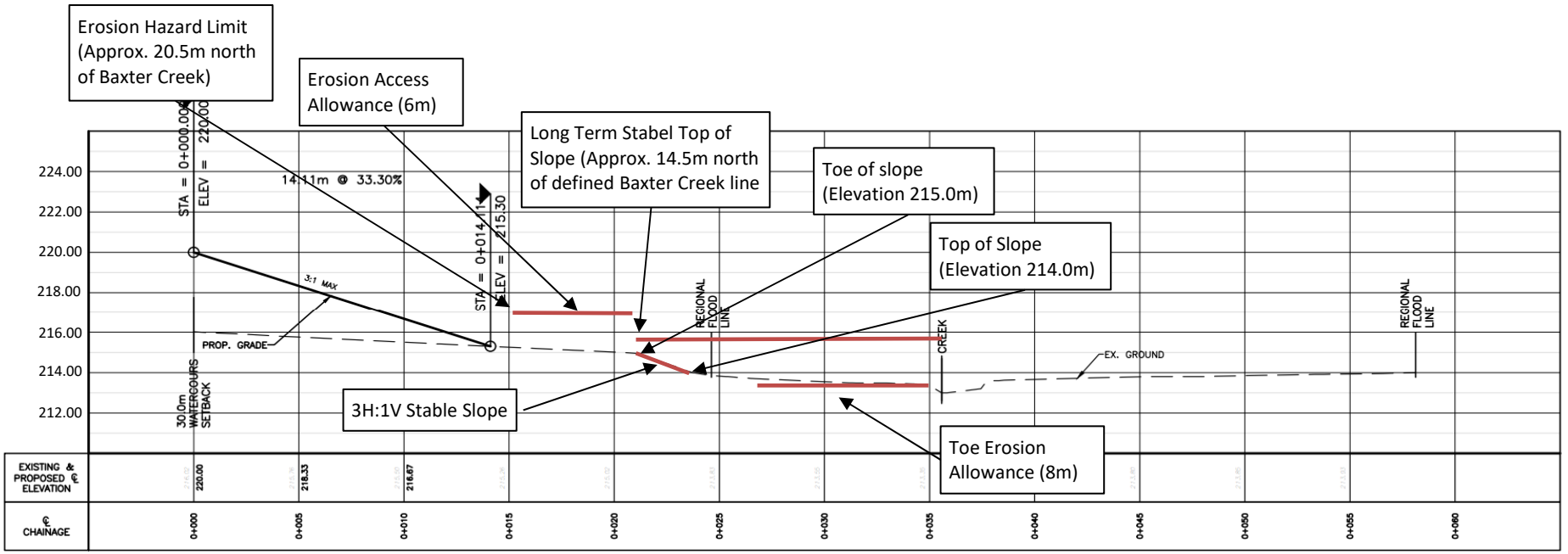
FIGURE G.2



Scale:
As Shown Above

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Part Lot 13, Concession 5, Millbrook, Ontario
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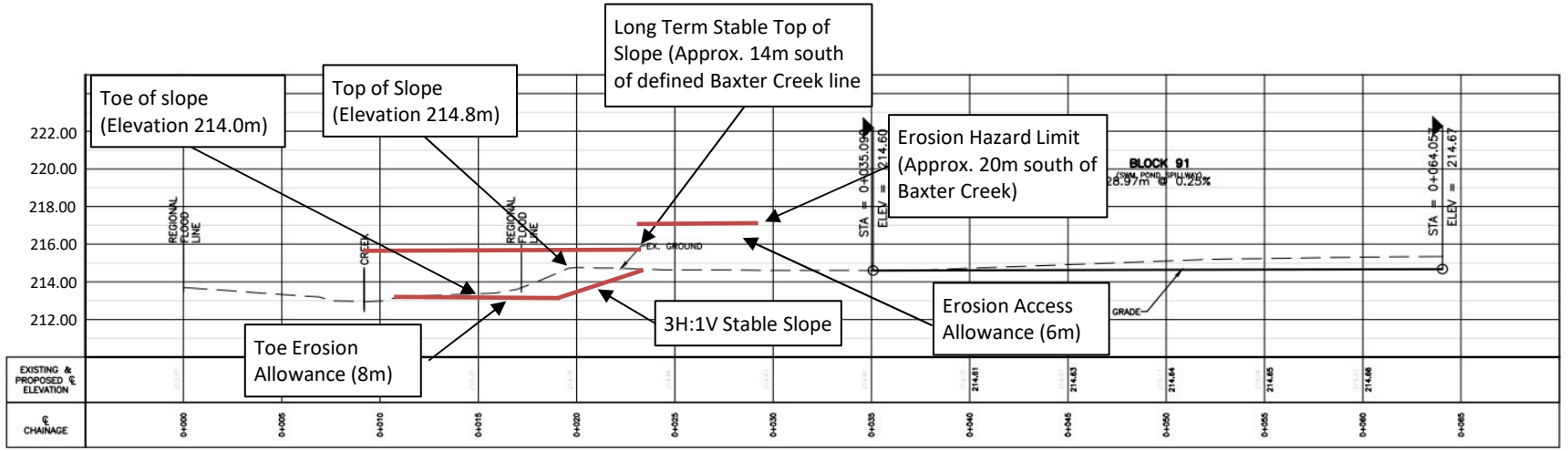
EROSION HAZARD LIMIT ASSESSMENT - CROSS SECTION 5-5'

FIGURE G.3



Scale:
As Shown Above

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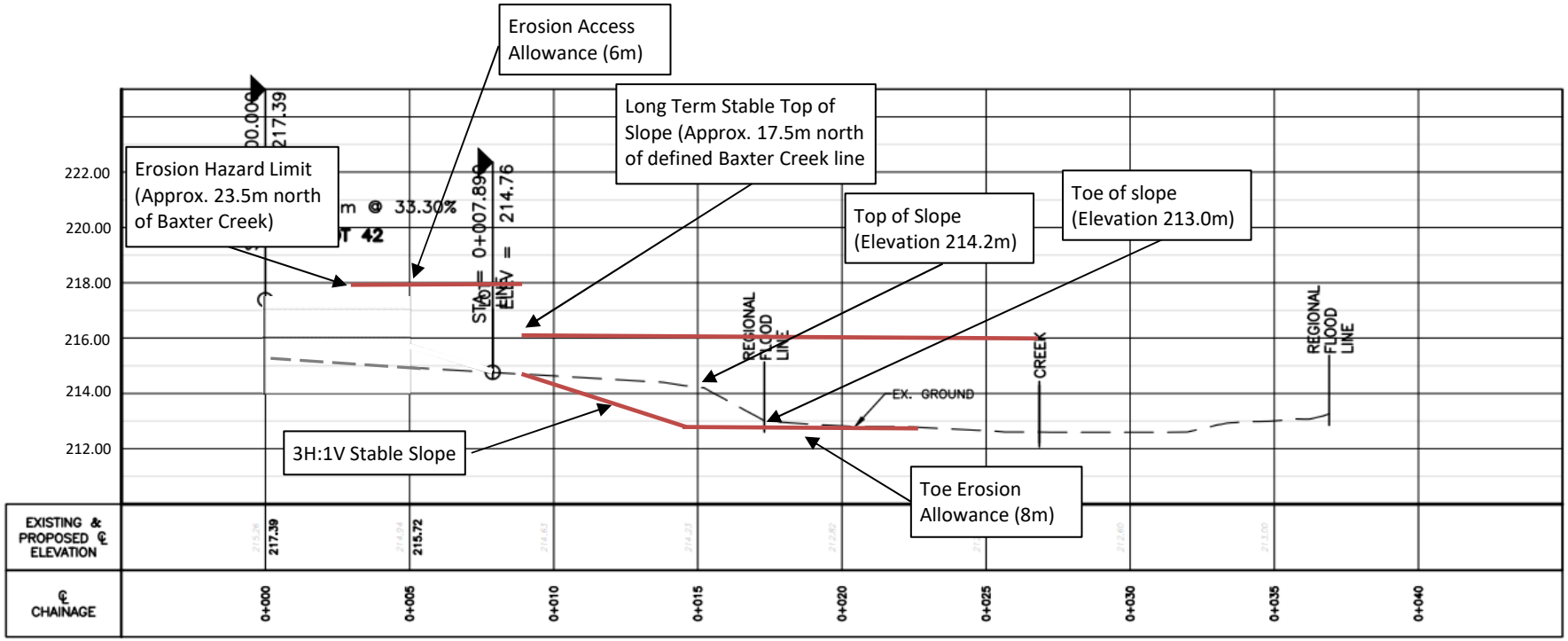
Updated Geotechnical Investigation Report

11209539
Mar. 2020

EROSION HAZARD LIMIT ASSESSMENT - CROSS SECTION 6-6'

FIGURE G.4



Scale:
As Shown Above

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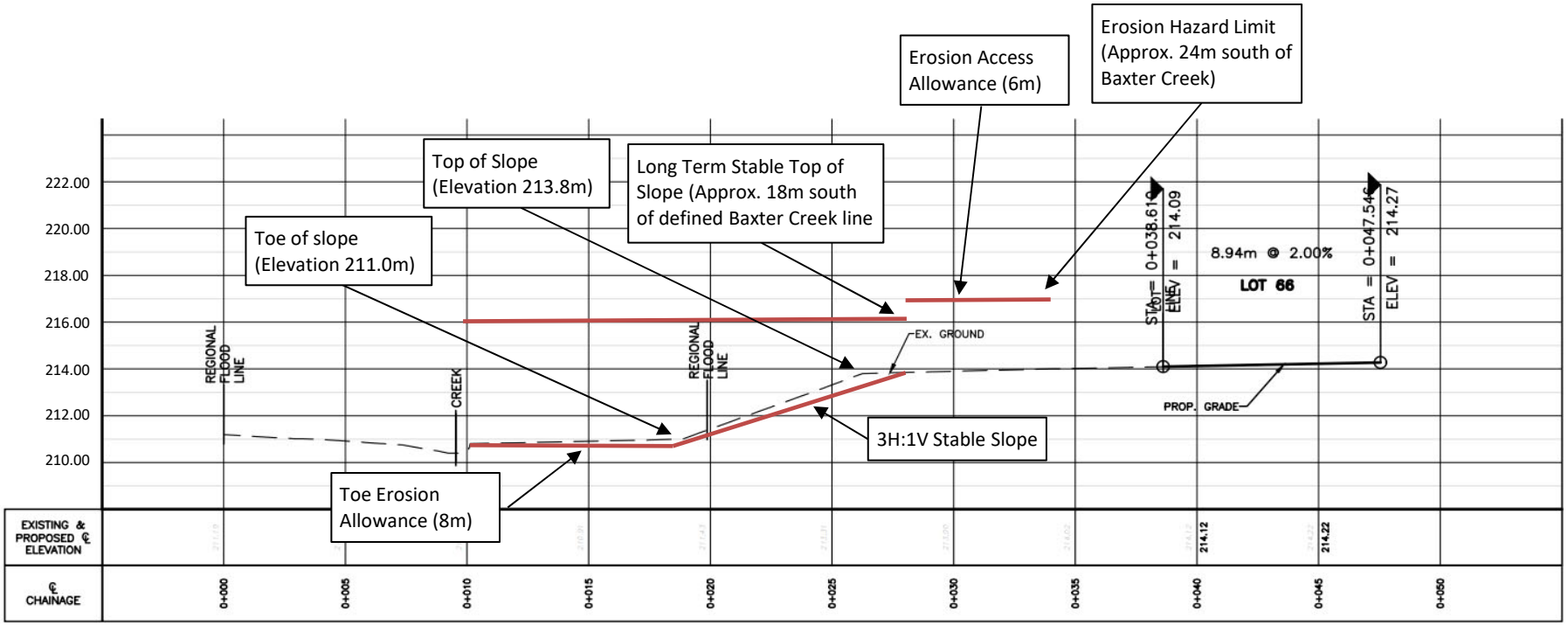
Mar. 2020

EROSION HAZARD LIMIT ASSESSMENT - CROSS SECTION 7-7'

FIGURE G.5



Scale:
As Shown Above

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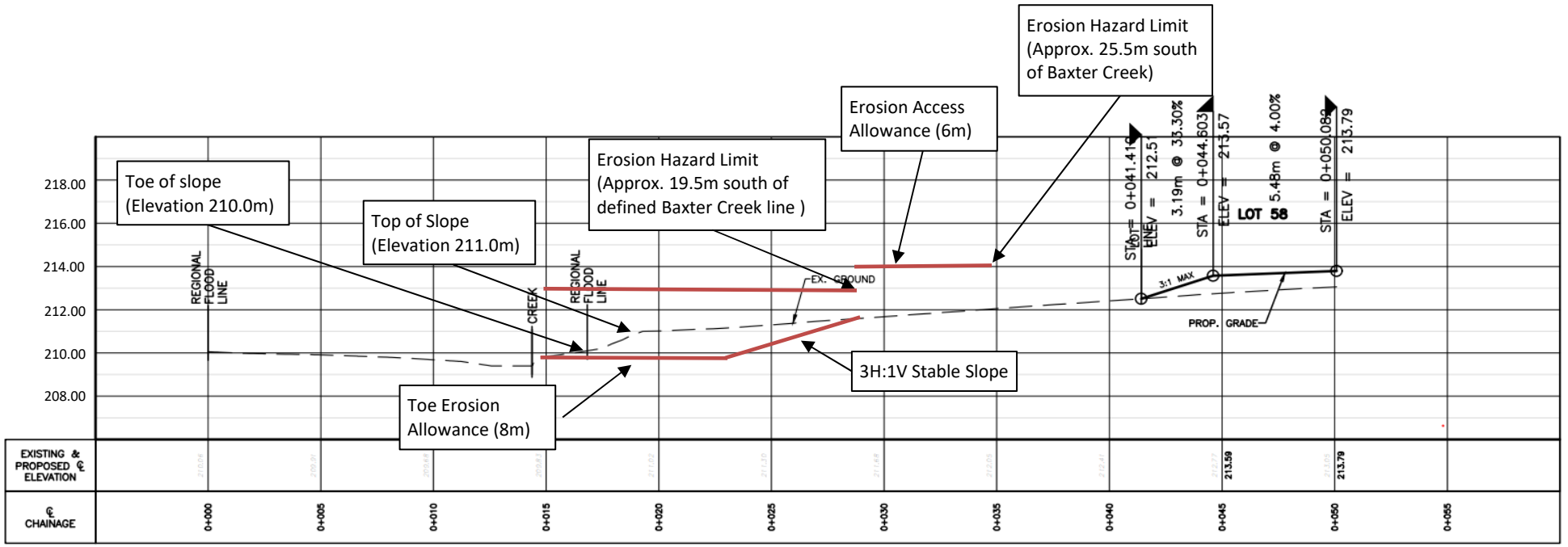
11209539
Mar. 2020

EROSION HAZARD LIMIT ASSESSMENT - CROSS SECTION 8-8'

FIGURE G.6



Scale:
As Shown Above

Vargas Properties Inc.
Part Lot 13, Concession 5, Millbrook, Ontario
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EROSION HAZARD LIMIT ASSESSMENT - CROSS SECTION 9-9'

11209539
Mar. 2020

FIGURE G.7