Final Geotechnical Investigation Report for Proposed Development – 950 and 960 St. David Street North, Fergus, Ontario

May 18, 2022

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Project No. 161414172

FINAL GEOTECHNICAL INVESTIGATION REPORT FOR PROPOSED DEVELOPMENT – 950 AND 960 ST. DAVID STREET NORTH, FERGUS, ONTARIO

Revision	Description	Author		Quality Check		Independent Review	
0A	Draft	K. Thrams	2022-05-10	R. Saadeldin	2022-05-10	G. Roh	2022-05-10
00	Final	K. Thrams	2022-05-18	R. Saadeldin	2022-05-18	G. Roh	2022-05-18

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1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) has been retained by Reid's Heritage Homes to complete a geotechnical investigation in support of a zoning by-law amendment application (ZBA) related to the lands municipally known as 950 and 960 St. David Street North in Fergus, Ontario (the "subject lands"). The 1.97 ha area is currently occupied by a commercial development complete with asphalt surface and parking lot on the south portion (950 St. David Street N) and vacant grassed area and agricultural area on the north portion (960 St. David Street N). The lands are bound by St. David Street North (Highway 6) to the south, agricultural land to the west, open space protected environmental area to the north, and an existing mid-rise residential development to the east.

The proposed ZBA application is required to permit the development of the subject lands. The north portion of the lands are proposed to be developed into a 1.30 ha residential townhouse development (the "site") complete with 112 stacked townhouses and a common amenity area. Access to the site will be provided by a private access road along the east side of the property connecting the proposed residential development with St David Street North in the south.

The 0.67 ha commercial development (the "commercial property") fronting St. David Street North is not part of this geotechnical investigation. Additional geotechnical investigation including boreholes will be required in support of the planned commercial development.

The information provided in this report is specific to the scope of the investigation and the scope of the proposed development as discussed herein and should not be used for any application or purpose other than that stated herein. The scope of this report focuses on the geotechnical aspects of the project and does not include hydrogeological or environmental components. However, hydrogeological and environmental investigations for the project were completed by Stantec in conjunction with this geotechnical investigation. The results of the hydrogeological and environmental investigations are currently being prepared and will be issued under separate cover during detailed design.

Use of this report is subject to the Statement of General Conditions provided in **Appendix A.**

2.0 SITE DESCRIPTION

2.1 LOCATION AND CURRENT LAND USE

The proposed residential development is located within the north portion of the property located at 950 and 960 St. David Street North in Fergus, Ontario. The south portion of the subject lands is currently occupied by a commercial development, including a secondhand not for profit retail store surrounded by asphalt surface parking and a seasonal fast-food restaurant. The north portion of the subject lands,

which includes the area of the proposed residential development, is vacant with a grassed area abutting the asphalt pavement and an agricultural use field. The overall property is bounded by St. David Street North in the south, agricultural land to the west, open space protected environmental area to the north, and an existing mid-rise residential development to the east. Overall grades within the commercial development and grassed portion of the Site are relatively level. Site grades slope down from the grassed area toward the agricultural field in the north. Ground surface elevations at the borehole locations range from 420.1 m above mean sea level (AMSL) to 421.8 m AMSL.

2.2 PROPOSED DEVELPOMENT

It is understood that the northern portion of the property (960 St. David Street North) is being considered for redevelopment into a rresidential townhouse development complete with 112 stacked townhouses and a common amenity area (subject Site) and will advance to construction first. It is noted that the southern commercial use portion of the subject lands are planned to be redeveloped for future commercial use at a later date, following the residential construction. . Based on the conceptual servicing plan (Stantec, Project No. 161414172, Drawing No. C100, dated November 29, 2021), the residential Site will be developed into five residential townhouse blocks along the perimeter of the Site and a below grade stormwater management (SWM) area in the center of the Site. Basements may be considered for the residential buildings. Infiltration galleries are proposed within the SWM area as well as in the northern portion of the subject Site. Paved parking areas will front each housing block. Access to the proposed development is planned by a private access road through the southern commercial use portion along the eastern property line. The future commercial redevelopment will include a new commercial/retail store for the current operator, loading space and parking. Additional geotechnical investigation including boreholes will be required

It is understood that the development will be serviced by sanitary sewers, storm sewers, and municipal water supply.

According to the conceptual grading plan (Stantec, Project No. 161414172, Drawing No. C400, dated May 9, 2022), proposed site grades are up to 2.5 m above current grades within the proposed residential development area. Proposed grades along the access driveway within the existing commercial use portion of the property will be raised by up to 1.5 m. A retaining wall is proposed along the northern, and portions of the eastern and western limis of the residential development. The conceptual grading plan is included in **Appendix B** for reference.

3.0 DESKTOP REVIEW

3.1 REGIONAL GEOLOGY

The Surficial Geology of Southern Ontario data set (Ontario Geological Survey, Miscellaneous Release - Data 128 Revised, 2003) indicates that the project Site includes glaciofluvial deposits comprising river deposits and delta topset facies (sandy deposits).

According to Ontario Geological Survey, Miscellaneous Release - Data 207 Drift Thickness, the depth to bedrock in the general area of the Site varies from 25 m below ground surface (BGS) to 76 m BGS.

The Paleozoic Geology of Southern Ontario (Ontario Geological Survey, Miscellaneous Release - Data 219, 2007) indicates that the bedrock underlying the project Site is comprised of dolostone of the Guelph Formation.

4.0 METHOD OF INVESTIGATION

4.1 FIELD INVESTIGATION

Prior to commencing the field investigation, the various public utility companies were consulted to identify where public utilities crossed the property boundaries. In addition, a private locator was contracted to clear the boreholes of any private on-site services.

The fieldwork for the investigation was carried out from November 16 to 22, 2021 and included the advancement of six (6) sampled boreholes (BH/MW01-21 to BH/MW06-21A) to depths of 4.4 m BGS to 9.4 m BGS. Borehole BH/MW01-21 was terminated at 4.4 m BGS following a previous refusal at similar depth during a first drilling attempt and hard soil conditions resulting in minimal borehole progress. The approximate borehole locations are shown on the Borehole Location Plan, Drawing 1 included in **Appendix B**.

The boreholes were advanced using a CME 850 track mounted drill rig equipped with hollow-stem augers operated by Aardvark Drilling Inc., a specialist drilling subcontractor. Stantec personnel recorded the subsoil and groundwater conditions encountered in the boreholes. The soil samples were recovered at regular 0.76 m and 1.52 m intervals using a 51 mm (outside diameter) split-tube sampler by conducting Standard Penetration Tests (SPTs) in accordance with the procedures outlined in ASTM specification D1586. Handheld pocket penetrometer tests were completed in the field on selected cohesive soil samples.

Soil sample descriptions were recorded for the soil recovered during split spoon sampling. The soil descriptions, SPT N-values, and results of pocket penetrometer testing are provided on the attached borehole logs within **Appendix C**.

All soil samples recovered from the boreholes were placed in moisture-proof bags and returned to our laboratory for detailed geotechnical classification.

A total of seven (7) groundwater monitoring wells were installed during the current investigation, including six wells in the sampled boreholes BH/MW01-01 to BH/MW06-21A. A monitoring well was also installed in an unsampled, straight-augered borehole at BH/MW06-21B. Water levels were measured by Stantec personnel on November 29, 2021, and March 30, 2022. The monitoring wells consisted of 50 mm inside diameter, Schedule 40 PVC pipe, with a No. 10 slot screen (0.01-inch slot) and screen length of 1.5 m or 3.1 m. The annular space between the monitoring well screen and surrounding geological formation was backfilled with well sand to 0.3 m above the top of screen, with the remainder of the annular space being filled with a granular bentonite to prevent a hydraulic connection from occurring between the soil layers along the length of the casing. Pedestal covers were used for all monitoring wells except for BH/MW06-21A and BH/MW06-21B, which were finished with flush mount covers.

Well records were prepared and submitted to the Ministry of the Environment, Conservation and Parks by the drilling subcontractor. The wells must be properly decommissioned by a licensed well driller prior to or during construction.

4.2 BOREHOLE LOCATION AND ELEVATION SURVEY

The boreholes were surveyed by Stantec's geomatic group. UTM coordinates were recorded for the boreholes to coordinate system NAD 1983 UTM Zone 17. The borehole location and elevation data is provided in Table 4.1. The borehole locations are shown on the Borehole Location Plan Drawing No. 1 in **Appendix B**.

Table 4.1: Borehole Elevations and Coordinates

Borehole Number	Approximate UTM Coordinates (NAD83 - Zone 17)		Elevation (m AMSL)
	Northing (UTM)	Easting (UTM)	
BH/MW01-21	4840628	549013	420.8
BH/MW02-21	4840571	549068	420.1
BH/MW03-21	4840558	548944	421.8
BH/MW04-21	4840526	548969	421.6
BH/MW05-21	4840507	548996	421.8
BH/MW06-21A	4840469	548976	421.6
BH/MW06-21B	4840468	548975	421.6

4.3 GEOTECHNICAL LABORATORY TESTING PROGRAM

All samples recovered from the geotechnical investigation were returned to Stantec's geotechnical and materials testing laboratory and were visually examined by a geotechnical specialist. Geotechnical Laboratory testing was completed by Englobe Corp.

The scope of the geotechnical laboratory testing program is outlined below in Table 4.2.

Table 4.2: Geotechnical Laboratory Testing Program

Laboratory Test	Number of Samples Tested
ASTM D2216-10 – Natural Moisture Content	25
ASTM D422-63 (2007) – Grain Size Distribution with Hydrometer	2
ASTM D4318-10 – Atterberg Limits	1

The results of the laboratory tests are discussed in the text of this report. The results of the moisture content tests are shown on the Borehole Records in **Appendix C**. The results of the grain size distribution tests and Atterberg Limits tests are reported on the borehole records and are included in **Appendix D**.

5.0 RESULTS OF INVESTIGATION

5.1 SUBSURFACE CONDITIONS

5.1.1 Overview

In general, the soil conditions contacted at the Site consisted of pavement structure, fill / possible fill, and/or topsoil underlain by native deposits of silt and sand, which in turn were underlain by glacial till. Groundwater levels were measured at depth of 0.3 m BGS to 1.0 m BGS on March 30, 2022.

Bedrock was not encountered at the boreholes advanced for this investigation.

The subsurface conditions observed in the boreholes are presented in detail on the logs provided in **Appendix C**. An explanation of the symbols and terms used to describe the Borehole Records is also provided.

The stratigraphic boundaries shown on the logs are inferred from non-continuous sampling and should be considered approximate only. Variations to the conditions reported and discussed herein must be anticipated.

5.2 SOIL STRATIGRAPHY

The following sections summarize the soil strata encountered in all boreholes completed for the current investigation.

5.2.1 Pavement Structure

Borehole BH/MW06-21A was advanced through the existing asphalt pavement in the existing parking lot at 950 St David Street North. The contacted pavement structure consisted of approximately 100 mm asphaltic concrete underlain by 660 mm of granular fill.

5.2.2 Fill and Possible Fill

Fill was contacted at boreholes BH/MW03-21, BH/MW04-21, and BH/MW05-21 (grassed area south of the agricultural use field) at ground surface and extended to depths of 0.9 m BGS to 2.0 m BGS. The upper fill at boreholes BH/MW03-21 to BH/MW05-21 consisted of 50 mm to 900 mm topsoil fill. Traces of asphalt and brick were noted within the topsoil fill at borehole BH/MW04-21. The underlying fill consisted of silt with variable sand (some sand to sandy) and gravel (some gravel and gravelly) content. Occasional cobbles and boulders within the fill were inferred from auger grinding and visual confirmation. At the time of fieldwork, the fill was moist to saturated. SPT N-values of 3 to 22 blows per 300 mm were recorded in the fill.

Possible fill was contacted at boreholes BH/MW05-21 and BH/MW06-21A underlying the fill or pavement structure and extended to 2.1 m BGS and 1.5 m BGS, respectively. The possible fill consisted of organic silt with trace sand at borehole BH/MW05-21 and sandy silt with frequent cobbles (inferred from auger grinding and observation) at borehole BH/MW06-21A. The possible fill was described at moist to saturated at the time of sampling. A laboratory determined moisture content of 13% was reported. SPT N-values of 3 blows per 300 mm were recorded indicative of very loose conditions.

5.2.3 Topsoil and Organic Silt (ML)

Silt topsoil with some clay and trace to some sand was contacted at borehole BH/MW02-21 at ground surface and was 300 mm thick. The topsoil was saturated at the time of fieldwork. Black silt with some organics and trace sand was contacted at borehole BH/MW01-21 at ground surface and was 500 mm thick. The silt with some organics was wet to saturated at the time of drilling. SPT N-values of 3 blows per 300 mm indicated a very loose relative density.

A layer of organic silt (ML) was contacted at borehole BH/MW06-21A underlying the possible fill at 1.5 m BGS and extended to 2.3 m BGS. The organic silt contained some sand and occasional cobbles and was described as saturated to moist. A laboratory moisture content of 20% was reported.

5.2.4 Silt (ML), Sandy Silt (ML), Sandy Silt (ML) to Silty Sand (SM)

Layers of silt (ML) with some sand, sandy silt (ML), and sandy silt (ML) to silty sand (SM) were contacted at boreholes BH/MW01-21 to BH/MW03-21 and BH/MW05-21 underlying the topsoil, fill and possible fill and extending to depths of 0.5 m BGS to 3.4 m BGS. Trace to some organics were noted within the silt at borehole BH/MW01-21 from 1.5 m BGS to 2.3 m BGS and at borehole BH/MW05-21 from 2.1 m BGS to 2.3 m BGS. Trace gravel and occasional cobbles were noted visually during sampling and by auger

grinding within the sandy silt at BH/MW01-21 and within the silty sand to sandy silt at BH/MW03-21. The silt, sandy silt, and sandy silt to silty sand were described as wet to saturated. Laboratory determined moisture contents of 14% to 26% were reported. SPT N-values of 3 to 23 blows per 300 mm indicate a very loose to compact relative density.

5.2.5 Sand (SP-SM)

A layer of sand (SP-SM) with trace gravel was contacted at borehole BH/MW04-21 underlying the fill and extending to 2.4 m BGS. The sand was saturated at the time of fieldwork. SPT N-values of 6 and 14 blows indicated a loose to compact relative density.

5.2.6 Silty Clay (CL-ML)

A 300 mm layer of silty clay was contacted interlayered with the silty sand to sandy silt at borehole BH/MW03-21. At the time of drilling, the silty clay was described as about the plastic limit based on visual and tactile examination. An SPT N-value of 5 blows per 300 mm indicates a firm consistency.

5.2.7 Silty Sand (SM) Till, Silt (ML) Till, Clayey Silt (CL-ML) Till, Clay Till (CL)

Glacial tills were generally contacted underlying the silt and sand layers at depths from 0.5 m BGS to 3.4 m BGS. The glacial till ranged from non-cohesive silty sand (SM) till to sandy silt (ML) till to cohesive clayey silt (CL-ML) till to silty clay (CL) till. The glacial till generally contained variable amounts of sand and gravel (trace sand to sandy, trace to some gravel). Occasional cobbles and/or boulders were noted visually during sampling and by auger grinding. Silt seams were noted within the cohesive glacial till. The cohesive glacial till was described as drier than the plastic limit to about the plastic limit with laboratory determined moisture contents of 8% to 16%. Localized, the cohesive glacial till was described as wetter than the plastic limit based on visual and tactile examination. The non-cohesive glacial till was described as wet to saturated. A moisture content of 10% was reported for a sample of the non-cohesive glacial till. The cohesive glacial till was assessed to have a stiff to hard consistency based on approximate shear strengths of 75 kPa to greater than 200 kPa and SPT N-values of 10 to greater than 50 blows per 300 mm. SPT N-values of 14 to 50 blows per 300 mm in the non-cohesive glacial till indicate compact to dense relative densities.

Two grain size distribution analyses and one Atterberg Limits test were completed on representative samples collected from the boreholes. The results are summarized in Tables 5.1 and 5.2 and included in **Appendix D**.

Table 5.1: Results of Grain Size Analyses – Sandy Clay (CL) Till

Borehole No.	Sample No.	Sample Median Depth (m)	Soil Classification	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH/MW02-21	SS5	3.4	Sandy Clay (CL)	9	26	43	22
BH/MW04-21	SS5	3.4	Sandy Clay (CL) with Gravel	16	26	38	20

Table 5.2: Results of Atterberg Limits Test – Sandy Clay (CL) Till

Borehole No.	Sample No.	Sample Median Depth (m)	Soil Classification	Liquid Limit	Plastic Limit	Plasticity Index	Moisture Content (%)
BH/MW02-21	SS5	3.4	Sandy Clay (CL)	20	12	8	8

5.3 GROUNDWATER CONDITIONS

Seven (7) groundwater monitoring wells were installed (sampled boreholes BH/MW01-21 to BH/MW06-21 and unsampled borehole BH/MW06-21B) to record the groundwater conditions. The groundwater levels were measured by Stantec personnel on November 29, 2021 and on March 30, 2022, and the results are summarized in Table 5.3.

Table 5.3: Groundwater Levels – November 29, 2021 and March 30, 2022

Borehole	Date	Depth to Groundwater (m BGS)	Groundwater Elevation (m AMSL)
BH/MW01-21	November 29, 2021	0.5	420.3
	March 30, 2022	0.5	420.3
BH/MW02-21	November 29, 2021	0.4	419.7
	March 30, 2022	0.5	419.6
BH/MW03-21	November 29, 2021	0.9	420.9
	March 30, 2022	0.8	421.0
BH/MW04-21	November 29, 2021	0.6	421.0
	March 30, 2022	0.3	421.2
BH/MW05-21	November 29, 2021	1.1	420.7
	March 30, 2022	0.9	420.9
BH/MW06-21A [1]	November 29, 2021	4.1	417.5
	March 30, 2022	1.0	420.7
BH/MW06-21B [2]	November 29, 2021	0.9	420.7
	March 30, 2022	0.8	420.9

Notes: [1] Deep well with screen from 9.1 m BGS to 6.1 m BGS
[2] Shallow well with screen from 4.6 m BGS to 3.1 m BGS

Seasonal perched conditions should be expected within fill/possible fill materials, as well as within soils overlying less permeable deposits following heavy rain or snow melt in the Spring.

Fluctuations in the groundwater levels should be anticipated throughout the various seasons. The hydrogeological report should be referred to for additional details pertaining to groundwater conditions below the Site.

6.0 DESIGN DISCUSSION & RECOMMENDATIONS

The subject lands are located at 950 and 960 St. David Street North in Fergus, Ontario. The south portion of the subject Site is currently occupied by a commercial development, including a secondhand retail store surrounded by asphalt surface parking. The north portion of the Site is vacant with a grassed area abutting the asphalt pavement and an agricultural use field. The northern portion of the subject property is proposed to be redeveloped into five residential townhouse blocks with internal driveway and surface parking. Access to the proposed residential development is planned by a private access road through the southern commercial use portion along the eastern property line. It is understood that the development will be serviced by sanitary sewers, storm sewers, and municipal water supply. It is further understood that infiltration galleries are being considered within the residential development. The south commercial portion will be redeveloped at a later date and will include a new commercial/retail space for the existing operation, loading and parking spaces. Additional geotechnical investigation including boreholes will be required for the proposed commercial redevelopment.

Based on the conceptual grading plan grades within the proposed residential development will generally be raised by about 1.0 m to 2.5 m above current grades, including construction of a retaining wall along the northern and portions of the eastern and western limits of the residential development. Proposed grades along the access driveway and parking area within the existing commercial use portion of the property will be close to existing site grades.

Based on the conceptual servicing plan sanitary sewers will generally be installed with a cover depth of 3.0 m to 4.3 m equivalent to about 0.5 m to 2.0 m below existing grades within the proposed residential development and about 2.5 m below existing grades along the proposed access road through the southern portion of the property.

Finished floor elevations, basement floor elevations, or underside of footing elevations were not available at the time of this report.

The soil stratigraphy encountered in the boreholes consisted of pavement structure, fill / possible fill and / or topsoil overlying native deposits of silt and sand, which in turn were underlain by glacial till. Occasional cobbles and boulders were noted visually during drilling and inferred by auger grinding. Groundwater levels were measured at depth of 0.3 m BGS to 1.0 m BGS on March 30, 2022.

6.1 GEOTECHNICAL CONSIDERATIONS AND CONSTRAINTS

The following general development considerations and constraints are provided with respect to observations made during the current investigation, the subsurface conditions encountered, and the intended scope of development:

- Surficial topsoil and silt with some organics were contacted at boreholes BH/MW01-21 and BH/MW02-21 to 0.5 m BGS and 0.3 m BGS, respectively. Silt with trace to some organics was noted

at borehole BH/MW01-21 from 1.5 m BGS to 2.3 m BGS and at borehole BH/MW05-21 from 2.1 m BGS to 2.3 m BGS. Organic silt was found at borehole BH/MW06-21A and extended to 2.3 m BGS under the pavement structure. Soils with organic content are not considered suitable for support of building foundations, site services, and site pavements and will require sub-excavation / stripping. Alternatively, soils below buildings could be improved in-situ. A geogrid-soil-system could be considered below pavement structures and site services. Further details on these improvement techniques are provided in the following sections of this report.

- Fill was contacted at boreholes BH/MW03-21 to BH/MW05-21 to depths of 0.9 m BGS to 2.0 m BGS. Possible fill was contacted at boreholes BH/MW05-21 and BH/MW06-21A underlying the fill or pavement structure and extended to 2.1 m BGS and 1.5 m BGS. The fill and possible fill materials are not considered suitable to remain below buildings, services, or paved areas; but, may be suitable to remain below landscaped areas, subject to additional inspection at the time of construction. Fill materials free of organic material and debris are likely suitable for re-use as engineered fill or subgrade fill. Portions of the fill that are wet or saturated will require drying prior to re-use. Further, portions of the existing fill and possible fill may not be suitable for reuse onsite and may have to be removed for off-site disposal.
- Very loose to loose or firm native deposits were contacted at boreholes BH/MW01-21 to BH/MW06-21A to depths of 0.5 m BGS to 2.3 BGS. Loose inorganic soils may be suitable for foundation support at a reduced bearing capacity. Otherwise, very loose soils below proposed structures should be subexcavated and replaced with engineered fill below buildings and retaining walls or subgrade fill below services and site pavements.
- Following stripping of the existing pavement structure, fill / possible fill, and topsoil, as well as subexcavation of native soils with organic content or in very loose / loose condition, the exposed native soils on the Site will typically be suitable to support any fill required to prepare the lands for the proposed development.
- Groundwater was measured on March 30, 2022 at depths of 0.3 m BGS to 1.0 m BGS. The finished floor elevation of basement levels should have a minimum of 0.7 m separation from the seasonal high groundwater table.
- The undisturbed native inorganic soils, or engineered fill placed as recommended in this report, will generally be suitable to support conventional foundations.
- Groundwater dewatering is anticipated to be required during the site preparation as well as installation of site services. The volume of dewatering required will depend on excavation depths, groundwater levels, and soils contacted in the excavations. High infiltration rates should be anticipated for excavations extending into saturated sand deposits. Low to moderate infiltration rates should be expected for the silt and predominant glacial till soils.
- Lower infiltration rates should be expected for the on-site native silt and clay soils for at-source infiltration of precipitation. Infiltration rates would depend on the soils exposed at the bottom of the infiltration facilities (particularly where imported fill material is being placed) as well as depth to groundwater. Reference is made to the hydrogeological investigation report being prepared by Stantec under separate cover for additional commentary on infiltration rates.

Additional geotechnical comments, discussion, and recommendations are provided in the following sections with respect to the design and construction of the planned Site development.

6.2 SITE PREPARATION

6.2.1 Summary of Conditions

Pavement structure, fill / possible fill, and surficial topsoil / organic layer were contacted at the boreholes and extended to depths of 0.3 m BGS to 2.3 m BGS. Native soils containing organics and/or native soils in very loose to loose / firm condition were noted at boreholes BH/MW01-21 to BH/MW06-21A to depths of 0.5 m BGS to 2.3 m BGS. The native deposits of silt and sand were underlain by cohesive and non-cohesive glacial tills at depths of 0.5 m BGS to 3.4 m BGS.

A summary of the depth to competent inorganic soil, depth to glacial till, and the depth of groundwater is presented in Table 6.1 below.

Table 6.1: Summary of Conditions Requiring Attention During Design/Construction

Borehole Number	Ground Surface Elevation (m AMSL)	Depth to Inorganic, Compact / Stiff to Hard, Silt / Sand / Glacial Till (m BGS) *Elevation (m AMSL)*	Depth to Stiff to Hard / Compact Glacial Till (m BGS) *Elevation (m AMSL)*	Depth to Groundwater (m BGS) [2] *Elevation (m AMSL)*
BH/MW01-21	420.8	2.3 *418.5*	2.3 *418.5*	0.5 *420.3*
BH/MW02-21	420.1	0.5 *419.6*	0.5 *419.6*	0.5 *419.6*
BH/MW03-21	421.8	2.3 [1] *419.5*	3.4 *418.4*	0.8 *421.0*
BH/MW04-21	421.6	2.3 [1] *419.2*	2.4 *419.1*	0.3 *421.2*
BH/MW05-21	421.8	2.3 *419.5*	2.3 *419.5*	0.9 *420.9*
BH/MW06-21A	421.6	2.3 *419.4*	2.3 *419.4*	1.0 *420.7*
BH/MW06-21B	421.6	2.3 *419.4*	2.3 *419.4*	0.8 *420.9*

Notes: [1] Loose / firm inorganic native soils were noted at borehole BH/MW03-21 from 0.9 m BGS to 2.3 m BGS (elevation 420.9 m AMSL to 419.5 m AMSL) and borehole BH/MW04-21 from 2.0 m BGS to 2.3 m BGS (elevation 419.6 m AMSL to 419.2 m AMSL). The loose / firm inorganic soil may be suitable for foundation support at a reduced bearing capacity.

[2] As measured on March 30, 2022

The existing pavement structure, topsoil fill / possible fill as well as native soils with organic content or native soils in very loose to loose/ firm condition are generally not considered suitable for structural applications and must be removed from below proposed structures, below paved areas, and other areas sensitive to settlement, and grades raised using engineered fill (below buildings) or subgrade fill (below roadways and services). Loose inorganic soils may be suitable to remain in place below foundations following inspection by geotechnical staff and provided that the proposed structure can be designed for a reduced bearing capacity.

An alternative to subexcavation and engineered fill placement below proposed buildings could be in-situ soil improvement, such as a rammed aggregate piers (RAP) system or controlled modulus columns (CMC) system.

A geogrid-soil-system could be considered below paved areas or site services to minimize excavation of fill materials or soils with organic content or very loose to loose / firm native soils.

6.2.2 General

Based on the conceptual grading plan, proposed site grades within the residential development will generally be raised by 1.0 m to 2.5 m. Site preparation should include stripping of topsoil, removal of fill/possible fill and existing pavement structures, as well as sub-excavation of soils with organic content and very loose to loose/firm native soils.

Existing utilities that are not to remain at their current location should be relocated during the site preparation and prior to construction of the new development.

The program for grading and earthworks should be designed in advance, and carefully executed in consideration of the time of year of execution, prevailing weather conditions, construction stormwater management control, and associated issues and concerns, and the intended end-use of the subject property.

6.2.3 Erosion & Sediment Control and Regulatory Constraints

An erosion and sediment control plan should be developed and implemented prior to commencement of construction, to direct precipitation and ground surface runoff away from the areas of construction. Identification of an outfall/discharge location will be required for this purpose. All erosion sedimentation control should be conducted in accordance with the approved for construction design drawings.

6.2.4 Soil Improvement Options

6.2.4.1 Sub-Excavation and Proof Rolling

Groundwater occurs at a shallow depth below the Site and it is anticipated that temporary construction dewatering would be required as part of the aforementioned subexcavation and engineered fill/subgrade placement, or partial excavations required for general site preparation for site improvement options.

Reference is made to Table 6.1 for depth to compact or stiff to hard inorganic native soils. The soils will need to be dewatered prior to any excavation work. Dewatering must be maintained during construction to a depth sufficient to prevent disturbing (piping/boiling) of the founding subgrade, using sump pumps and/or positive dewatering. It is further recommended that the site preparation is done during the drier months of the year.

The predominant sandy, silty, clayey soils contacted at the Site are considered susceptible to softening in the presence of water and construction activity. Therefore, excavations should be monitored and maintained in stable conditions. Disturbed or softened subgrades during construction should be over-excavated, replaced, and recompacted with approved engineered fill or subgrade fill. Prepared surfaces should be protected to minimize the amount of degradation during wet weather conditions. In addition, native soils that have been successfully compacted and approved, may require removal if they become wet and softened from water infiltration, precipitation or thawing. Therefore, it will be prudent to plan and control water seepage at the Site and into excavations.

Following stripping and subexcavation of soils, the exposed subgrade surface should be inspected by geotechnical personnel to confirm the removal of any deleterious materials, organics, or loose/soft materials or wet zones. Where such materials are identified, they should be removed, and the areas backfilled with engineered or subgrade fill.

Excavation in the native soils should be straight forward using large tracked excavating equipment, or motor scrapers. Further comments with respect to reuse of the on-site soils are provided in Section 6.7. The exposed subgrade surface should be proof rolled and compacted across the entire area of the planned development. The proof rolling program should be undertaken using large, non-vibratory compaction equipment having a minimum static weight of 10 tonnes. This will provide a uniform, compact surface that will minimize the potential for infiltration of precipitation and ground surface runoff and promote overland drainage at the ground surface. The proof rolling program should consist of a minimum of five passes per unit area to provide a uniform surface for construction.

The program for site preparation should be designed in advance, and carefully executed in consideration of the time of year of execution, prevailing weather conditions, construction storm-water management control, and associated issues and concerns, and the intended end-use of the subject property as described herein.

6.2.4.2 Engineered Fill Placement

Prior to engineered fill placement under proposed buildings areas or retaining walls, the subgrade soils must be prepared as described in the preceding Section 6.2.4.1. The engineered fill must extend horizontally 1 m beyond the edge of proposed footings, and then downwards and outwards at a slope of 1 horizontal to 1 vertical to competent soil. Geotechnical comments with respect to excavations are provided in Section 6.3.2.

Engineered fill will need to be benched into any native slopes steeper than 3 horizontal to 1 vertical. The benching should be excavated with heights matching the engineered fill lift thickness.

Based on the conceptual grading plan, it is anticipated that site grades will generally be raised by about 1.0 m to 2.5 m, requiring the importation of fill materials. It is recommended that granular materials or materials with characteristics similar to the native soils on site (as described in this report) be imported for this purpose. Additional details with respect to materials recommended for use during periods of poor weather conditions are discussed below. Imported materials such as OPSS.MUNI 1010 Granular B or OPSS SSM are recommended for use as engineered fill below buildings. Other soil types may also be suitable but must be tested and confirmed as acceptable by a geotechnical engineer prior to being imported to site. Silt should generally be excluded for use as engineered fill as it is easily disturbed even after successful placement.

It is recommended that coarser granular material such as imported sand and gravel similar to OPSS.MUNI 1010 Granular B be placed where wet soils (such as silt / sand layers) or soils with low internal strength are exposed at the subgrade level. Further, the initial lift thickness may be increased on wet subgrade soils to achieve the required compaction. It is noted that where encountered, wet silty subgrade will be easily disturbed and as such construction traffic should be minimized on the initial lift and vibratory compaction equipment should not be used.

Where wet soils and/or soils with low internal strength are exposed at the subgrade level, placement of a woven geotextile followed by placement of imported granular soils such as OPSS.MUNI 1010 Granular B could be considered to create a stable working base for additional fill placement using on-site soils.

Granular import materials should be placed using a loose lift thickness of 300 mm. Each lift should be uniformly compacted to achieve a minimum of 98% of the material's Standard Proctor Maximum Dry Density (SPMDD). Greater lift thicknesses of granular soils may be permitted in areas of wet soils and/or low internal strength following approval by a geotechnical engineer.

6.2.4.3 Subgrade Fill Placement

Subgrade fill placement will also be required to raise grades under proposed roads and paved areas. The preparations of the subgrade prior to subgrade fill placement should be the same as for the engineered fill. Special focus should be given to silt soils considered for use as subgrade fill. Silt soils are easily disturbed in the presence of water and construction traffic / vibration. Silt soils should not be used during unfavorable weather conditions. Any disturbed soils will need to be excavated and replaced.

Any fill placed in paved areas should be placed in 300 mm (imported granular soils) thick loose lifts compacted to 98% SPMDD within the upper 1 m of the subgrade immediately below the pavement structure. Subgrade fill placed below 1 m of the pavement structure should be compacted to at least 95% SPMDD.

6.2.4.4 Soil Improvement Method using a Controlled Modulus Column System or Rammed Aggregate Piers

A Controlled Modulus Column (CMC) system or the installation of Rammed Aggregate Piers (RAP) may be a suitable solution to prepare the Site by improving the fill, possible fill and native soils with organic content or in very loose to loose/firm condition in place and thereby increasing available bearing capacities.

For the CMC system, the elements are installed using a rotary drill rig and specially adapted displacement auger to construct grout columns below the foundation and floor slab. No excess soils or vibrations are generated during the displacement installation process of the elements. A grout-based installation could be considered for greater settlement control of organic layers. Various sized installation equipment is available for the CMC system. A granular load transfer platform is constructed on top of the CMC elements to support footings and floor slabs.

The RAP systems would involve installation of ungrouted or grouted vertically rammed aggregate shafts within unfavorable native soils as well as fill/possible fill materials. The installation methodology of the aggregate shafts increases the lateral stresses within the adjacent soil matrix and creates a soil/pier matrix with an increased overall geotechnical bearing resistance thereby providing an improved subgrade.

The CMC and RAP systems are a proprietary geo-engineering systems. In this respect, design and construction should be carried out by a specialty contractor. Upon request Stantec can provide contact details for local specialty contractors.

6.2.4.5 Soil Improvement Method using Geogrid-Soil-System below Site Services and Pavement Structures

An alternative to excavating and replacing existing fill, soils containing organic content, as well as very loose to loose native soils, especially in areas with anticipated higher traffic loading (i.e., fire/garbage truck route) could be the use of a geogrid-soil-system. The geogrid-soil-system could further be considered for services underlain by very loose to loose soils or soils with organic content. The combination of geotextile, geogrid, and granular fill would create a stiff mechanically stabilized layer able to control differential settlements. The geotextile would provide material separation. The geogrid would provide structural reinforcement and bridging of softer areas as well as limit differential settlements from degradation of underlying organics.

Partial excavation may be required to prepare the installation of the geogrid-soil system. Geogrids and geotextiles are proprietary products. In this respect, design and construction should be carried out by a specialty contractor or the geogrid supplier.

6.2.5 Adverse Weather Construction

Additional precautions, effort, and measures may be required, when and where construction is undertaken during late fall, winter, and early spring when the temperature and climatic conditions have an adverse influence on the standard construction practices or during periods of inclement weather.

With respect to all earthworks activities undertaken during the late fall through to late spring, when less-than-ideal construction conditions may prevail, the following comments are provided:

1. Engineered fill under the buildings should comprise granular materials, such as imported sand or sand and gravel, Granular 'B' or OPSS SSM;
2. The intended area of fill should be clearly identified in the field prior to commencing the work;
3. Temporary ramps or roads for construction access must be constructed outside of the limits of intended fill;
4. Fill placement should be inspected by qualified field personnel on a full-time basis under the supervision of a geotechnical engineer, with the authority to stop the placement of fill at any time when conditions are considered to be unfavourable;
5. Imported materials that contain ice, snow, or any frozen material should not be accepted for use.
6. Overnight frost penetration may occur, even in granular fill materials, where precipitation and ground surface runoff pools and accumulates, and freezing temperatures exist. Any frozen materials must be removed prior to placing subsequent lifts of engineered fill. Breaking the frost in-situ is not considered acceptable; and,
7. It may be necessary to stop the placement of engineered fill during periods of cold, where ambient temperatures of -5°C or less, occur.

It should be noted that the placement of engineered fill materials during cold weather conditions requires extra effort beyond that which is typical when better climatic conditions prevail. At any time where conditions are deemed unfavorable, the engineered fill operation must be suspended. Any frost accumulating in placed fill must be removed prior to re-starting fill operations.

Appropriate scheduling of the work may also require specific consideration and revision from the typical adopted. The scope of work intended may have to be reduced or adjusted, and/or only select construction activities are undertaken during specific climatic conditions. The areas of planned engineered fill may have to be reduced on a daily basis, the extent of excavations may have to be limited, with all excavating and associated backfilling completed without delay.

6.3 SERVICING

6.3.1 General Servicing Overview

The subdivision will be serviced with water and sewer services. Based on the conceptual servicing plan sanitary sewers will generally be installed at conventional depths of about 3 m to 4 m below finished grade, equivalent to about 0.5 m to 2.0 m below existing grades within the proposed residential development and about 2.5 m below existing grades along the proposed access road through the southern portion of the property.

Native soils expected to be encountered during servicing are silt and glacial tills soils (silt and/or clay). Stabilized groundwater was measured on March 30, 2022 at 0.5 m BGS to 1.0 m BGS, equivalent to Elevations 419.6 m AMSL and 421.2 m AMSL.

Based on the conceptual servicing plans, excavations for site services are anticipated to extend below the groundwater table in the southern portion of the Site (near boreholes BH/MW03-21 to BH/MW06-21). Servicing installations may extend close to or into the stabilized groundwater table in the northern portion of the Site (near boreholes BH/MW01-21 and BH/MW02-21). High infiltration rates should be anticipated for excavations extending into saturated sand deposits. Low to moderate infiltration rates should be expected for the silt and predominant glacial till soils. Reference is made to the hydrogeological investigation regarding the hydraulic conductivity of the soils at the project Site. It is recommended that servicing installations are completed during the normally drier summer months.

6.3.2 Excavations

Temporary excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA).

The fill / possible fill and the predominant native deposits (silt, non-cohesive glacial till, cohesive glacial till excavated from below the groundwater table) encountered in the boreholes can be classified as a Type 3 soil. The excavation side slopes for a Type 3 soil must be sloped at a maximum inclination of 1:1 (Horizontal: Vertical) from the base of excavation in accordance with the OHSA regulation.

Any excavations that extend into very loose soils, organic soils, or below the groundwater level and exhibit seepage should be classified as Type 4 soil. The maximum excavation side slope for a Type 4 soil is 3:1 (Horizontal: Vertical) in accordance with the OH&S Act.

Where an excavation contains more than one soil type, the soil shall be classified as the type with the highest number exposed in the excavation.

The side slopes of the excavations should be protected from exposure to precipitation and associated ground surface runoff. Some sloughing and caving must be anticipated for excavations, particularly where excess moisture (precipitation, ground surface runoff and the groundwater table) is present. Unsupported excavation slopes that extend below the groundwater table may slough to angles as flat as 3H:1V.

If space is restricted such that the side slopes cannot be safely cut back in accordance with the OHSA Regulation, or sloughing and cave-in are encountered in the excavation, temporary shoring must be provided.

Stockpiling of any materials adjacent to excavations should be avoided. Similarly, traffic should not be permitted in proximity to open excavations. For this purpose, it is recommended that all storage of materials and traffic be restricted from a 1 m wide strip around the excavations, measured from the crest of the excavation designed and constructed in accordance with the OH&S Act.

Localized seepage encountered during the proposed construction may be handled by pumping from sumps using conventional submersible pumps provided the excavations remain open for a short period of time. Moderate to high groundwater inflow will require a positive dewatering system. The hydrogeological report should be referred to for additional detail.

6.3.3 Bedding

Bedding for services should consist of OPSS.MUNI 1010 Granular 'A' material. In general, a minimum of 150 mm of bedding and 300 mm of cover material is recommended. The portion of bedding below the pipe may comprise clear stone in place of Granular 'A' if needed for groundwater control provided the clear stone is fully wrapped in filter fabric.

The bedding and cover material should be compacted to achieve a minimum of 100% of the material's SPMDD.

These recommendations should be confirmed with the pipe manufacturer and care must be taken to avoid incurring damage to the services. Pipe manufacturers may have additional/alternative requirements that should be reviewed by the Designer and Contractor prior to installation of the services.

6.3.4 Trench Backfill

Backfill for service trenches above the cover material may consist of the on-site native soils, subject to the constraints and limitations stated with respect to reuse of these soils. Cobbles and boulders greater than 150 mm in diameter should be sorted out and removed from of the excavated soils prior to reuse as trench backfill.

All trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 98% SPMDD for the full thickness of the backfill. Thinner lifts and heavy padfoot rollers may be needed where glacial tills are exposed in the trenches and considered for reuse to properly break-down blocky clay lumps to ensure no inter-lump voids are left in the backfill. Silty and clayey material should be inspected prior to reuse as trench backfill and should be excluded from reuse during unfavorable weather conditions.

6.3.5 Municipal Infrastructure Backfilling

Where manholes and catch basins are required, these components should be constructed and backfilled in accordance with specifications outlined in OPSS 407: Construction Specification for Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation.

Settlements around manholes are common, and the settlements can be reduced by backfilling immediately around the manhole structure using OPSS Granular 'B' Type I material.

6.3.6 Dewatering

Based on the conceptual servicing plans, excavations for site services are anticipated to extend below the groundwater table. Depending on the depth of excavation below groundwater table and the soil type exposed in the excavation groundwater inflow may range from low to high.

A hydrogeological investigation was completed by Stantec in conjunction with the geotechnical investigation. Results of the hydrogeological investigation report are provided under separate cover and should be referred to for details related to groundwater at the Site.

6.4 ROAD DESIGN AND CONSTRUCTION

Following area grading as well as installation of site services in accordance with the recommendations provided in the previous sections of this report, the Site will be suitable for construction of the proposed private access road and associated surface parking. The pavement structures in Table 6.2 are recommended based on the anticipated subgrade conditions for local roadways without bus traffic. Considering, that grades within the proposed residential development will generally be raised between 1.0 m and 2.5 m using predominantly imported materials, while grades in the southern portion will remain near existing grade, two pavement structures have been provided, including a pavement structure for granular import subgrade soils and a pavement structure for silty subgrade soils. The provided pavement structures should be reviewed once the source and composition of the fill materials are known.

Table 6.2: Recommended Pavement Structures for Local Roadways

Material	Design Pavement Structure Thicknesses (mm)			
	Local Roads (Light Duty)		Car Parking	
	Granular Subgrade	Silty Subgrade	Granular Subgrade	Silty Subgrade
HL3 Top course	40	40	40	40
HL4 or HL8 Base course	60	60	50	50
OPSS 1010 Granular ‘A’ Base	150	150	150	150
OPSS 1010 Granular ‘B’ Type I Subbase	350	400	300	350

These structures should provide a typical pavement service life, provided regular maintenance is carried out during the life cycle of the pavements. The above pavement structure recommendations are based on typical expected use along with anticipated subgrade conditions. It should be noted that no design traffic data was provided to Stantec at the time of this design, and thus a detailed pavement design analysis was not carried out. The pavement design recommendations should be reviewed once the development

concept has been finalized to ensure that the provided pavement designs are sufficient for the proposed traffic and encountered subgrade conditions.

The pavement subgrade must be proof rolled under the supervision of geotechnical personnel prior to Granular 'B' placement to identify any soft areas where thickened subbase is warranted.

The base and subbase materials should be compacted to a minimum of 100% SPMDD. The asphaltic concrete should be compacted to a minimum of 92% of Maximum Relative Density (MRD). Asphalt compaction must be carried out as specified in OPSS 310.

The finished subgrade surface and the pavement surface should be crowned and graded (typical 2% cross fall) to direct runoff water away from the roadway.

Depending on the composition of the subgrade soils, installation of continuous pavement subdrains or subdrain stubs may be required. Silty/clayey subgrade soils will require installation of continuous pavement subdrains placed under the curb lines and connected to the catch basins. Where grade is raised with imported granular material, 3 m long subdrain stubs should be provided on the uphill side of each catch basin. The subdrains should comprise 150 mm diameter perforated corrugated pipe with filter sock bedded in concrete sand. The top of pipe should be below the lower limit of the granular sub-base, and the subgrade below the sub-base should slope toward the subdrains.

6.5 BUILDING CONSTRUCTION

It is understood that five townhouse blocks are being considered for the Site. Following site preparation including grading, servicing, and road construction, it is anticipated that the residential buildings will be constructed. It is recommended that any engineered fill be allowed to sit for at least 3 months after placement to ensure all settlements under the fill's own weight is completed prior to building construction.

Engineered fill placed as outlined in Section 6.2.4.2 will be suitable to support conventional footings proportioned as per Part 9 of the Ontario Building Code (refer to Table 6.3 for geotechnical bearing resistances on approved engineered fill). The geotechnical bearing resistances for factored Ultimate Limit States (ULS) and Serviceability Limit States (SLS) in Table 6.3 can be utilized for sizing conventional shallow footings for residential houses constructed on undisturbed compact / stiff to hard native soils or on approved engineered fill constructed on compact / stiff to hard native inorganic subgrade with a maximum footing width of up to 3.0 m.

Table 6.3: Geotechnical Bearing Resistances on Approved Engineered Fill and Compact/Stiff to Hard Native Soil

Factored ULS Bearing Resistance (kPa)	SLS Bearing Resistance (kPa)
225	150

The Ultimate Limits States (ULS) values provided above include a resistance factor of 0.5. The Serviceability Limits States (SLS) reaction values have been evaluated to provide a total settlement of 25 mm (or less) and differential settlement of 19 mm.

A reduced bearing resistance would apply where loose inorganic native soils remain in place and reference is made to Table 6.4 below for strip footings of up to 0.9 m width. It is noted that the bearing resistance in Table 6.4 should be confirmed once underside of footings elevations become available.

Table 6.4: Preliminary Geotechnical Bearing Resistances for Footings on Loose/Firm Inorganic Native Soil

Factored ULS Bearing Resistance (kPa)	SLS Bearing Resistance (kPa)
100	75

The Ultimate Limits States (ULS) values provided above include a resistance factor of 0.5. The Serviceability Limits States (SLS) reaction values have been evaluated to provide a total settlement of 25 mm (or less) and differential settlement of 19 mm.

In-situ soil improvement methods such as CMC and RAP systems could be used as an alternative to subexcavation of unsuitable soils or designing footings to lower bearing resistances. Design and construction for these systems would be carried out by a specialty contractor.

The footings must be provided with a minimum of 1.2 m of soil cover for frost protection. Where construction is undertaken during winter conditions, the footing subgrade must be protected from freezing.

Foundation walls should be backfilled with free-draining granular material such as OPSS Granular ‘B’ Type I, or a manufactured drainage layer should be provided. The exterior (perimeter) wall backfill should be placed in loose lifts having a maximum thickness of 300 mm. Each lift should be uniformly compacted using suitable compaction equipment for the purpose intended, to achieve a minimum of 98% of the material’s SPMDD.

The Ontario Building Code specifies that structures should be designed to withstand forces due to earthquake. For the purpose of earthquake design the relevant geotechnical information required based on the conditions at this Site is the “Site Class”. The selection of the seismic site classification is based on the subsurface soil and bedrock conditions encountered in the upper 30 m of the stratigraphy. The recommended site classification for seismic site response for the Site is Site Class D in accordance with Table 4.1.8.4.A of the Ontario Building Code (2012, as amended).

6.5.1 Resistance to Sliding

Resistance to sliding can be developed from the friction between the mass of the concrete footings and the founding soils. A coefficient of friction for mass concrete on soil of tanδ = 0.35 may be used for

retaining wall footings founded on native silts. A coefficient of tanδ = 0.45 should be used for footings on imported granular fill. In accordance with Table 8.1 of the Canadian Foundation Engineering Manual 4th Edition (CFEM), a resistance factor (φ) against sliding (for frictional materials) of 0.8 should be applied to

6.6 RETAINING WALL DESIGN PARAMETERS

Retaining walls are proposed along the northern and portions of the eastern and western limits limits of the proposed residential development. Boreholes BH/MW01-21 to BH/MW03-21 and BH/MW05-21 were advanced in vicinity to the proposed retaining walls. The soils contacted at these boreholes consisted of topsoil / organic silt or fill / possible fill to depths of 0.5 m BGS to 2.1 m BGS underlain by very loose or loose/firm native soils to depths of 0.5 m BGS to 2.3 m BGS, which in turn were underlain by compact / stiff to hard native inorganic soils.

Foundation design for support of the retaining wall should be in accordance with the preceding sections of this report.

The retaining walls must be designed with consideration for influence of lateral earth pressures. Lateral earth pressure parameters for use in design are provided below in Table 6.5. The recommendations presented in this section may also be used for design of temporary shoring, if required.

Table 6.5: Preliminary Un-factored Lateral Earth Pressure Parameters

Parameters	OPSS.MUNI 1010 Granular 'B' or SSM	Fill/Possible Fill	Very Loose/Loose Silt, Silty Sand to Sandy Silt	Compact Silty Sand to Sandy Silt	Stiff to hard Silty Sandy Clay Till
Bulk Unit Weight (kN/m^3)	21	18	18	20	21
Angle of Internal Friction (degrees)	32	26	26	30	32
Coefficient of Active Earth Pressure, k_a	0.31	0.39	0.39	0.33	0.31
Coefficient of Passive Earth Pressure, k_p	3.25	2.56	2.56	3.00	3.25
Coefficient of Earth Pressure at Rest, k_o	0.47	0.56	0.56	0.50	0.47

For rigidly tied structures (i.e., permanent foundation walls) the at-rest pressure should be used for design. If the walls are allowed to rotate (i.e., temporary shoring) the values of the active earth pressure can be used in design. This would assume that deflections in the order of 0.05% of the wall height occur, consistent with mobilizing the active earth pressure.

The values provided in the table presume that the materials as stated are present within a wedge extending from the base of the wall at 45° (or smaller) to the horizontal. It is recommended that free-draining granular materials (OPSS.MUNI 1010 Granular 'B') be used as backfill adjacent the foundations for this purpose. If the zone of Granular 'B' is less than that stated, the coefficients of earth pressures of the materials outside the backfill wedge must be considered in the lateral earth pressure calculations. If free-draining granular materials are used as backfill, a geosynthetic separator fabric is recommended between the face of the adjacent native soils and the granular backfill adjacent to the perimeter foundation walls to prevent the migration of fines into the backfill.

The values provided in the Table 6.5 also presume a horizontal back-slope at the back of the retaining wall. The effects of surcharge loads would need to be added to these lateral earth pressures.

An appropriate safety factor must be used in the design.

obtain the factored resistance at ULS.

6.7 SITE MATERIALS REUSE

6.7.1 Topsoil

Where present, the existing topsoil will need to be stripped from below proposed fill areas, proposed building, pavement, and site servicing areas. The topsoil can either be removed from site or re-used in landscaped areas. The excavated topsoil is not suitable for reuse as engineered fill, trench backfill, granular base and sub-base materials.

6.7.2 Fill / Possible Fill

The existing fill consisted of surficial topsoil with trace organic content underlain by silt fill. Trace asphalt and brick were noted within the topsoil fill and should be removed from the fill should the topsoil fill be considered for reuse in landscaped areas. The inorganic fill / possible fill may be suitable for re-use as bulk fill below paved areas (subgrade fill). Silt fill should not be used as engineered fill below structures as it is easily disturbed in the presence of water (groundwater and surface runoff) and construction traffic even after successful placement. Organics and particles greater than 150 mm must be separated from the possible fill considered for reuse onsite. Portions of the fill and/or possible fill containing organics can either be removed from site or re-used in landscaped areas. Fill / possible fill considered suitable for re-use may require moisture conditioning, such as drying/hydrating or blending. Silt fill excavated from below the groundwater table may not be suitable for reuse on-site.

Further assessment of the geotechnical suitability of the existing inorganic possible fill must be completed at the time of construction, prior to its use. Environmental limitations regarding reuse of on-site soils may apply.

6.7.3 Silts and Sands

Based on the current investigation's findings, there is very limited sand soils within the Site. However, the inorganic sand soils are generally considered suitable for reuse as subgrade fill, engineered fill, and as backfill in trenches to the finished sub-grade level. Sands excavated from below the groundwater table will require drying prior to reuse.

Silt may be suitable for reuse as subgrade fill or backfill in trenches following inspection by geotechnical personnel; however, this will depend on the moisture content of the silt at the time of construction. Silt soils should not be used as subgrade fill or trench backfill below the groundwater table or on wet subgrade soils. Silt soils should not be used during unfavorable weather conditions. Silt excavated from below the groundwater should be excluded from reuse as subgrade fill or trench backfill. Any cobbles greater than 150 mm or soils with organic content should be excluded from materials considered for reuse onsite.

Material considered for reuse should be within ±2.0 % of the optimum moisture content level prior to reuse. It is recommended that the material be approved at the time of placement by qualified geotechnical personnel.

The sandy silt, silty sand, and silt are generally assessed as having a moderate to high frost susceptibility. Sands with low fines content are assessed as having a low frost susceptibility.

The sand and silty sand soils should not be considered as free draining unless additional laboratory testing is carried out at the time of construction to confirm low levels of fines are present. Therefore, these soils should not be used as backfill in any application requiring the use of free draining material, such as for drainage layers, service pipe bedding, or sub-base and base layers in pavements.

6.7.4 Glacial Tills

These soils may be considered for reuse as subgrade fill and engineered fill; however, the silt and clayey materials could be difficult to work with, depending on their moisture levels, and the climatic conditions at the time of use. The results of the gradation analyses on these materials indicate that the soils consist of mainly silt and clay size particles, high sand content and trace to some gravel. The high percentage of clay and silt will make these soils difficult to handle, place, and compact, in any "less-than-ideal" weather conditions. Disturbance and loss of strength in the presence of excess moisture and/or construction traffic is a concern. It is recommended that reuse of this soil be limited to prevailing "dry" conditions and during favorable seasons. Particles in size larger than 150 mm should be separated from these soils prior to reuse on-site.

The glacial till soils should be placed in 150 mm thick loose lifts and compacted using a large pad foot roller to ensure proper break-down of any blocky clay lumps.

This material should be placed with moisture contents that are within +/- 2.0% of the optimum moisture content level. It is recommended that the material be approved at the time of placement by qualified geotechnical personnel. Depending on the in-situ moisture content of the clay materials, scarifying and drying may be required prior to placement.

This material is generally assessed as having moderate to high frost susceptibility.

This material should not be considered as free draining. Therefore, this soil should not be used as backfill in any application requiring the use of free draining material, such as for drainage layers, foundation wall backfill, service pipe bedding, or sub-base and base layers in pavements.

6.8 SURFACE WATER MANAGEMENT

6.8.1 Preliminary Infiltration Potential

It is understood that stormwater management methods/infiltration features will be implemented at the Site; however, design details were not known at the time of report preparation. It is noted that the infiltration potential will depend on the soils exposed below the selected stormwater management control/infiltration feature. The provided recommendations in this section are considered preliminary and should be reviewed once the details of infiltration systems are known.

At source infiltration of the on-site native soils (glacial tills, silts and sands) may be considered; however, lower infiltration rates should be expected and will depend on the gradation of the soils and the distance to groundwater. Infiltration through the existing fill is not recommended.

Table 6.6 below provides preliminary ranges of coefficients of permeability based on soil types observed in the current borehole program as per guidelines presented in the Supplementary Standard SB-6 of the Ontario Building Code. It is recommended that additional laboratory testing of representative soils is completed once site grades are established to confirm the soil type and composition as well as available infiltration potential of the on-site soils. Alternatively, field testing of the soil permeability at the infiltration feature subgrade with double ring permeameter equipment may be considered. It is noted that the distance to the groundwater table will affect the coefficient of permeability. Due to the high silt and clay content of the native soils, infiltration facilities should be designed and constructed to ensure that they are provided with subsurface overflows connected to suitable frost-free outlets, such as a storm sewer.

Table 6.6: Preliminary Ranges of Coefficients of Permeability

Soil Type	Coefficient of Permeability, K (cm/sec)
SP (Poorly graded sands, gravelly sands, little or no fines)	10^{-1} to 10^{-3}
SM (Silty sands, sand-silt mixtures)	10^{-3} to 10^{-5}
ML (Inorganic silts and very fine sands, silty or clayey fine sands, clayey silts with slight plasticity)	10^{-5} to 10^{-6}
CL (Inorganic clays or low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays)	10^{-6} and less

Additional recommendations can be provided once additional design details become available. The hydrogeological report should be referred to for additional detail.

7.0 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of Reid's Heritage Homes who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report;
- Basis of the report;
- Standard of care;
- Interpretation of site conditions;
- Varying or unexpected site conditions; and,
- Planning, design or construction.

Respectfully Submitted,

STANTEC CONSULTING LTD.

APPENDICES

APPENDIX A

A.1 STATEMENT OF GENERAL CONDITIONS

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

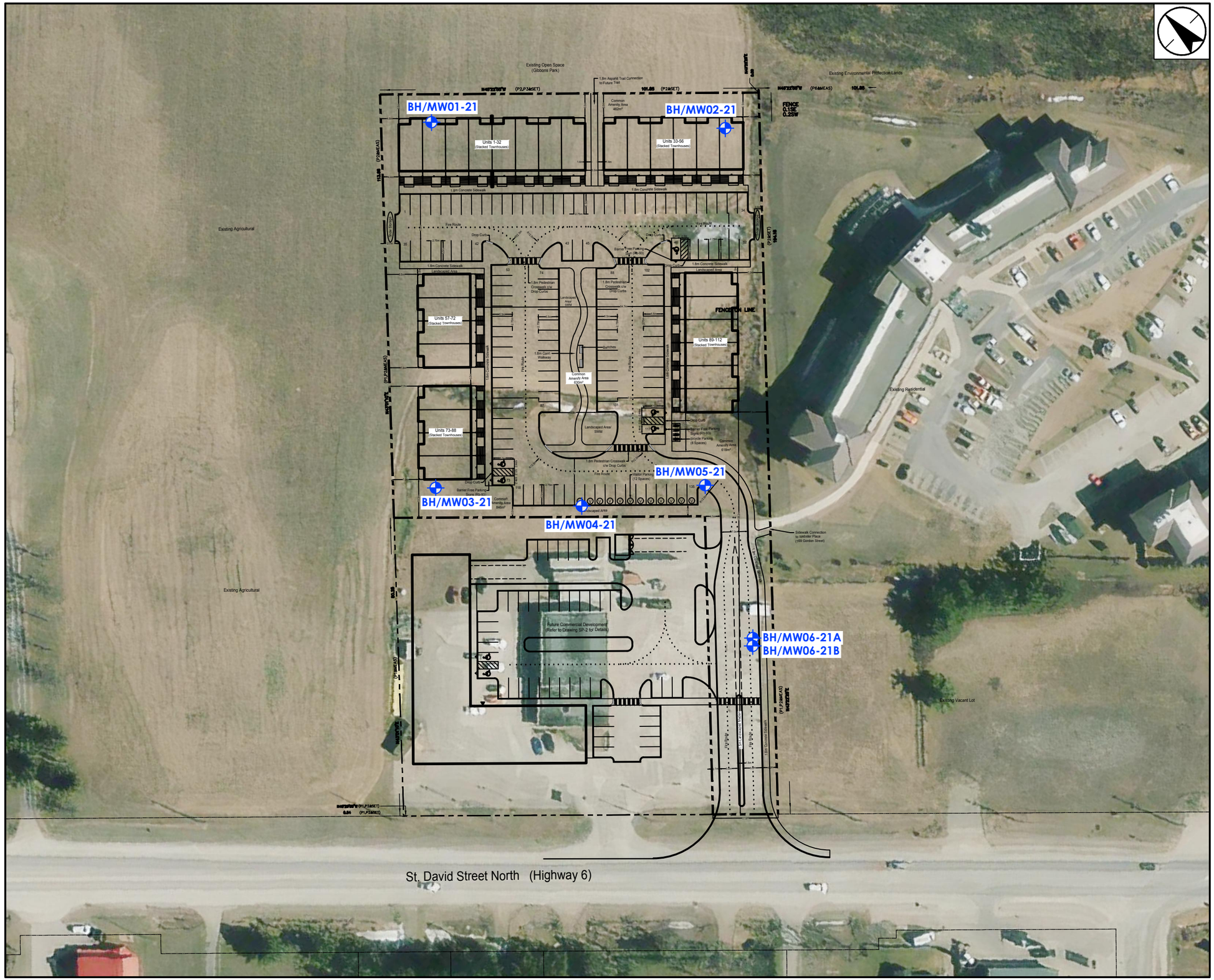
INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

APPENDIX B

B.1 DRAWINGS



C:\CAD Drawings\Acad2019 Drawings\2022\161414172\161414172_Borehole Locations Update.dwg
2022/04/25 1:28 PM By: Briones, Cliceria

Stantec

100-300 Hagey Boulevard
Waterloo ON N2L 0A4
www.stantec.com

LEGEND

- BOREHOLE
- PROPERTY BOUNDARY

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. PROPOSED FEATURES: STANTEC CONSULTING LTD. (FILENAME: 161414172_R-SP.DWG, DATED 2022.04.20)
3. IMAGERY: © 2021 MICROSOFT CORPORATION © 2021 MAXAR © CNES (2021) DISTRIBUTION AIRBUS DS.

10m 0 10 20m

1 : 1000

APRIL 2022
Project No. 161414172

Client/Project

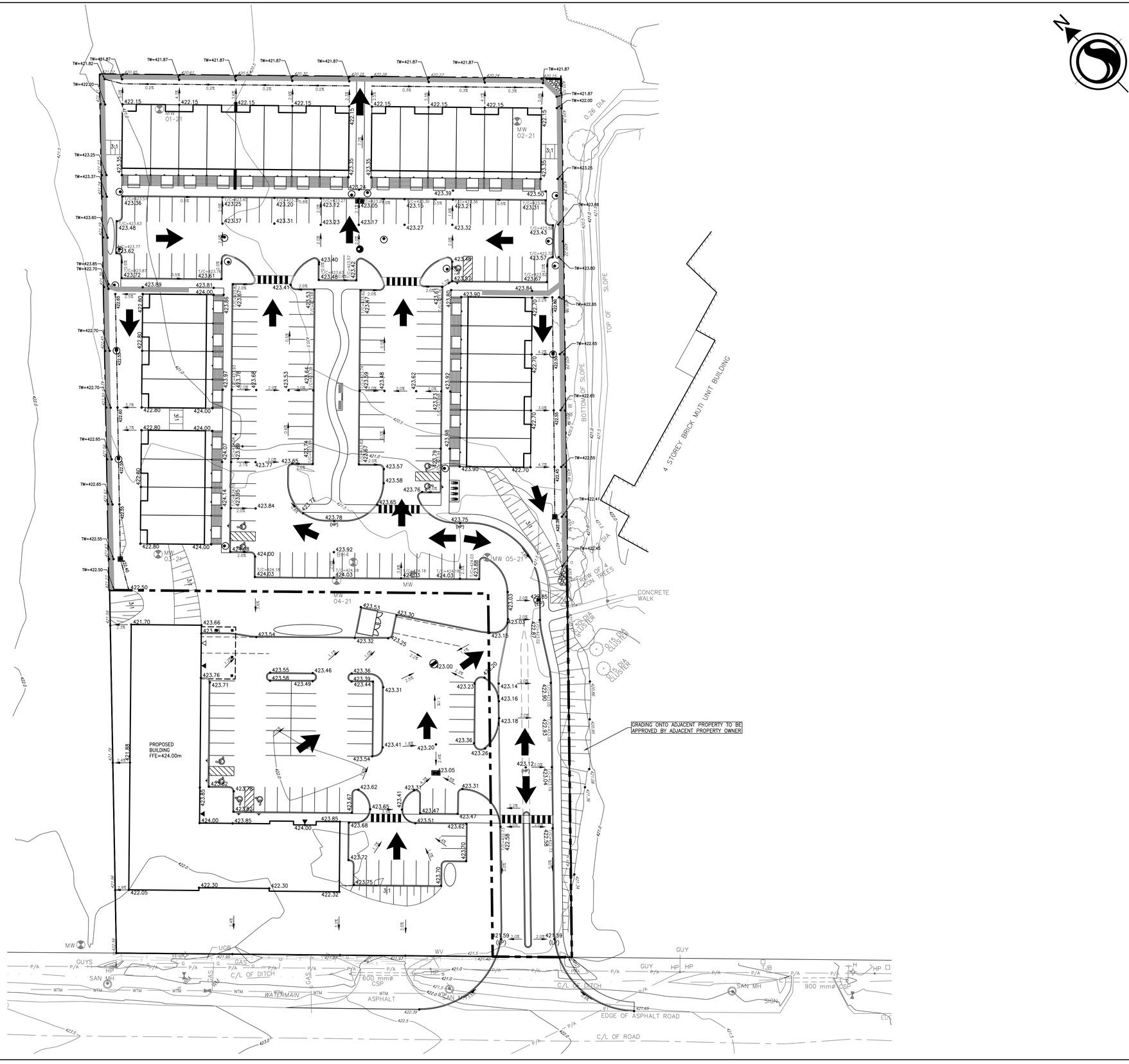
REID'S HERITAGE HOMES
PROPOSED DEVELOPMENT
950-960 ST. DAVID STREET NORTH, FERGUS, ONTARIO

Drawing No.

1

Title

BOREHOLE LOCATION PLAN



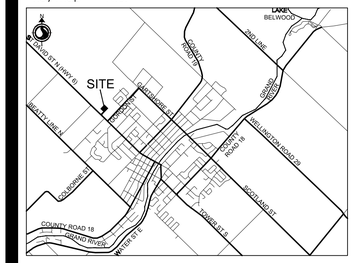
Stantec

Stantec Consulting Ltd.
100-300 Hagey Boulevard
Waterloo ON N2L 0A4
Tel: (519) 579-4410
www.stantec.com

Notes

1. SITE PLAN PREPARED BY STANTEC CONSULTING LTD., DATED APRIL 27, 2022.
2. TOPOGRAPHICAL SURVEY PREPARED BY BSR&D, DATED MARCH 29, 2022.

Key Map NTS.



Legend

352.82	EXISTING ELEVATION
352.92	PROPOSED ELEVATION
2.0% 2.0%	FLOW DIRECTION
	PROPOSED DRAINAGE SWALE
349.00	EXISTING CONTOUR
	RETAINING WALL
	PROPOSED STORM MANHOLE
	PROPOSED STORM CATCHBASIN MANHOLE
	PROPOSED CATCHBASIN
	PROPOSED SANITARY MANHOLE
	PROPOSED VALVE & BOX
	PROPOSED HYDRANT
	PROPOSED SLOPE (3:1 UNLESS NOTED OTHERWISE)
	OVERLAND FLOW DIRECTION

Revision	By	Appd	YYYY.MM.DD
0. ISSUED FOR ZBA	JBM	TAHF	2022.05.09

File Name: 161414172_C-400GP	Dwn.	Chkd.	Dsgn.
	JBM	JBM	TAHF
			2022.05.04 YY.MM.DD

Permit-Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

Client/Project
REID'S HERITAGE HOMES

NORTH FERGUS
950-960 ST. DAVID ST

Fergus, ON

Title
PRELIMINARY GRADING PLAN

Project No. 161414172

Scale 1:400 (0 4 12 20m)

Revision

Sheet 3 of 4

Drawing No. **C400**

ORIGINAL SHEET - ARCH D

APPENDIX C

C.1 SYMBOLS & TERMS USED ON BOREHOLE RECORDS

C.2 BOREHOLE RECORDS

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25 - 0.5	12.5 - 25	2-4
Firm	0.5 - 1.0	25 - 50	4-8
Stiff	1.0 - 2.0	50 – 100	8-15
Very Stiff	2.0 - 4.0	100 - 200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor Quality*
25-50	*Poor Quality*
50-75	*Fair Quality*
75-90	*Good Quality*
90-100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.

Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

measured in standpipe, piezometer, or well

inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

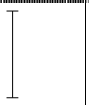
Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

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BOREHOLE RECORD

N: 4 840 628 E: 549 013

BH/MW01-21

CLIENT Reids Heritage Homes — PROJECT No. 161414172

LOCATION 950 - 960 St David Street North, Fegus, Ontario — DATUM geodetic

DATES: BORING November 16, 2021 — WATER LEVEL March 30, 2022 — TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)
0	420.8	**corn field**	0
		Very loose, black, SILT (ML)	
	420.3	- some organics, trace sand	1
		- wet to saturated	2
		Very loose to loose, greybrown,	3
1		Sandy SILT (ML)	4
		- some clay, trace gravel	5
	419.2	- occasional cobbles	
		- wet to saturated	6
		Compact, brown, SILT (ML)	7
2		- some sand, trace to some organics	
	418.5	- wet to saturated	8
		Very stiff to hard, grey, Silty CLAY	9
		(CL) Till	10
3		- some sand to sandy, trace gravel	
		- occasional cobbles and boulder	11
		- APL	12
		- silt seams, wet to saturated	
	417.0	**Refusal on probable boulder at	13
4		3.8 m BGS, moved borehole 2 m	14
		SE**	
	416.4	Hard, grey, Clayey Sandy SILT	15
		(CL-ML) Till	16
5		- some gravel	
		- DTPL	17
		- silt seams, wet to saturated	18
		Borehole terminated at 4.4 m BGS.	19
		A 50 mm diameter well installed	20
6		with a 1.5 m screen across 3.8 to 2.3	21
		m BGS. Sand from 3.8 to 2.0 m	22
		BGS. Bentonite from 2.0 m BGS to	
		surface. MECP Well Tag	23
7		#A324148	24
			25
			26
8			27
			28
			29
9			

STRATA PLOT

WATER LEVEL

SAMPLES

TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
SS	1	510/610	3
SS	2	250/610	10
SS	3	76/610	13
SS	4	200/610	21
SS	5	51/610	43
SS	6	410/610	55

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 840 571 E: 549 068

BH/MW02-21

CLIENT Reids Heritage Homes — PROJECT No. 161414172

LOCATION 950 - 960 St David Street North, Fegus, Ontario — DATUM geodetic

DATES: BORING November 16, 2021 — WATER LEVEL March 30, 2022 — TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	**420.1**	**corn field**	0				
	419.8	Very loose, dark brown, SILT (ML) topsoil	1	SS	1	280/610	3
	419.6	- some clay, trace to some sand - saturated	2				
1		Very loose, mottled greybrown, Sandy SILT (ML) - trace to some clay - wet	3	SS	2	200/610	18
	418.6		4				
		Very stiff, mottled greybrown, Clayey SILT (CL-ML) Till - some sand to sandy, trace gravel - occasional cobbles - WTPL	5				
2			6	SS	3	410/610	26
			7				
			8	SS	4	610/610	21
			9				
3		Very stiff to hard, brown, Silty Sandy CLAY (CL) Till - trace to some gravel - occasional cobbles - APL to DTPL - silt seams, moist to wet	10				
			11	SS	5	610/610	38
			12				
4			13	SS	6	610/610	35
			14				
			15				
			16	SS	7	610/610	40
5			17				
		- center plug wet when pulled from 5.3 m BGS	18	SS	8	610/610	39
			19				
6			20				
			21	SS	9	610/610	28
	413.4		22				
7		Borehole terminated at 6.7 m BGS. A 50 mm diameter well installed with a 3.0 m screen across 6.1 to 3.1 m BGS. Sand from 6.1 to 2.7 m BGS. Bentonite from 2.7 m BGS to surface. MECP Well Tag #A324147	23				
			24				
			25				
8			26				
			27				
			28				
9			29				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

9 26 43 22

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 840 558 E: 548 944

BH/MW03-21

CLIENT Reids Heritage Homes — PROJECT No. 161414172

LOCATION 950 - 960 St David Street North, Fegus, Ontario — DATUM geodetic

DATES: BORING November 16/17, 2021 — WATER LEVEL March 30, 2022 — TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	421.8	**grassed area**	0				
		Dark brown to black silt topsoil FILL - trace sand and rootlets - trace to nil gravel - occasional boulder - moist to wet	1	SS	1	230/610	23*
	420.9		2				
1		Loose, brown, Silty SAND (SM) to Sandy SILT (ML) - nil to trace gravel - wet to saturated	3	SS	2	430/610	8
	419.8		4				
2	419.5	Firm, grey, Silty CLAY (CL) - trace sand and gravel - APL	5	SS	3	460/610	5
			6				
			7				
			8	SS	4	25/610	32*
			9				
3		Compact, grey Silty SAND (SM) to Sandy SILT (ML) - nil to trace gravel - occasional cobbles - saturated	10				
	418.4		11	SS	5	610/610	23
			12				
4		Compact to dense, grey, Sandy SILT (ML) Till - trace gravel, trace to some clay - wet	13				
			14				
			15				
			16	SS	6	51/460	50
5	416.7		17				
		Hard, grey, Clayey SILT (CL-ML) Till to Silty CLAY (CL-ML) Till - trace sand and gravel - DTPL to APL	18				
			19				
6			20				
	415.2		21	SS	7	610/460	48
		Borehole terminated at 6.6 m BGS. A 50 mm diameter well installed with a 3.0 m screen across 4.3 to 1.2 m BGS. Sand from 6.1 to 4.9 m BGS. Bentonite from 4.9 to 4.6 m BGS. Sand from 4.6 to 0.9 m BGS. Bentonite from 0.9 m BGS to surface. MECP Well Tag #A324155 *N-value not representative - Split Spoon bouncing on gravel or cobble	22				
7			23				
			24				
			25				
8			26				
			27				
			28				
9			29				

UNDRAINED SHEAR STRENGTH (kPa): 50 100 150 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%): 10 20 30 40 50 60 70 80 90 100 — GR SA SI CL

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 840 526 E: 548 969

BH/MW04-21

CLIENT Reids Heritage Homes — PROJECT No. 161414172

LOCATION 950 - 960 St David Street North, Fegus, Ontario — DATUM geodetic

DATES: BORING November 19, 2021 — WATER LEVEL March 30, 2022 — TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	421.6	**grassed area**	0				
0		Dark brown, silt topsoil FILL - some sand, trace gravel - trace cobble, brick, asphalt - moist to frozen	1	SS	1	330/610	15
1	421.1	Brown, silt FILL - some sand to sandy - some gravel to gravelly - saturated	3	SS	2	25/610	22
2	419.6	Loose to compact, brown, SAND (SP-SM) - trace gravel - saturated	6	SS	3	25/610	6
3	419.1 418.8	Compact, grey, Sandy SILT (ML) Till - some gravel and clay - wet	9	SS	4	460/610	14
4		Very stiff to hard, grey, Silty CLAY (CL) Till - some sand to sandy - trace to some gravel - DTPL to APL - silt seams, wet	11	SS	5	410/610	26
5			16	SS	6	460/610	35
6	415.0		21	SS	7	610/460	79
7		Borehole terminated at 6.6 m BGS. A 50 mm diameter well installed with a 3.0 m screen across 4.3 to 1.2 m BGS. Sand from 6.1 to 4.9 m BGS. Bentonite from 4.9 to 4.6 m BGS. Sand from 4.6 to 0.9 m BGS. Bentonite from 0.9 m BGS to surface. MECP Well Tag #A324156					
8							
9							

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

16 26 38 20

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 840 507 E: 548 996

BH/MW05-21

CLIENT Reids Heritage Homes — PROJECT No. 161414172

LOCATION 950 - 960 St David Street North, Fegus, Ontario — DATUM geodetic

DATES: BORING November 19, 2021 — WATER LEVEL March 30, 2022 — TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	421.8	**grassed area**	0				
0		Dark brown silt topsoil FILL - wet	1	SS	1	150/610	13
		Brown, sandy silt FILL - some gravel to gravelly - occasional cobbles and boulder - wet	2				
1			3	SS	2	200/610	7
			4				
			5				
		- 20 mm thick black rocky layer	6	SS	3	300/610	3
2	419.8	with slight odor	7				
	419.6	POSSIBLE FILL	8	SS	4	460/610	10
	419.5	Very loose, black organic silt - trace sand - moist to wet	9				
3		Very loose to loose, grey, SILT (ML) - some sand, trace organics - wet to saturated	10				
			11	SS	5	460/610	27
			12				
4		Stiff, grey, Silty Sandy CLAY (CL) Till - trace gravel	13				
	417.2	- APL	14				
			15				
		Stiff, grey, Clayey Sandy SILT (CL-ML) Till - trace to some gravel - APL - silt seams, wet	16	SS	6	510/610	45
5			17				
			18				
			19				
6	415.7		20				
		Hard, grey, Silty CLAY (CL-ML) Till - some sand and gravel	21	SS	7	510/610	34
	415.1	- DTPL	22				
7		Borehole terminated at 6.7 m BGS. A 50 mm diameter well installed with a 3.0 m screen across 4.3 to 1.2 m BGS. Sand from 6.1 to 4.9 m BGS. Bentonite from 4.9 to 4.6 m BGS. Sand from 4.6 to 0.9 m BGS. Bentonite from 0.9 m BGS to surface. MECP Well Tag #A324157	23				
			24				
			25				
8			26				
			27				
			28				
			29				
9							

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 840 469 E: 548 976

BH/MW06-21A

CLIENT Reids Heritage Homes — PROJECT No. 161414172

LOCATION 950 - 960 St David Street North, Fegus, Ontario — DATUM geodetic

DATES: BORING November 22, 2021 — WATER LEVEL March 30, 2022 — TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION
0	421.6	**parking lot**
		100 mm asphaltic concrete
		660 mm Granular Fill - silty sand and gravel - moist
	420.9	
1		POSSIBLE FILL: Very loose, grey, sandy silt - frequent cobbles - wet to saturated
	420.1	
2		Compact to loose, black, Organic SILT - some sand, occasional cobbles - trace rootlets - saturated to moist
	419.4	
3	418.6	Very stiff, grey, Clayey Sandy SILT (ML/CL-ML) Till - trace to some gravel - APL - saturated seams
4		Compact, grey, Silty SAND (SM) Till to Sandy SILT (ML) Till - trace gravel, trace to some clay - saturated
	417.1	
5		Very stiff to hard, grey, Sandy Silty CLAY (CL) Till - trace to some gravel - DTPL
6		
7		
8		
9		

STRATA PLOT — WATER LEVEL

DEPTH (ft)	TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0				
1	SS	1	51/610	6
2				
3	SS	2	200/480	3
4				
5				
6	SS	3	250/610	15*
7				
8	SS	4	330/610	20
9				
10				
11	SS	5	200/610	18
12				
13				
14				
15				
16	SS	6	510/610	30
17				
18				
19				
20				
21	SS	7	480/610	24
22				
23				
24				
25				
26	SS	8	580/610	33
27				
28				
29				

SAMPLES

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m

STANDARD PENETRATION TEST, BLOWS/0.3m

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

Continued Next Page

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 840 469 E: 548 976

BH/MW06-21A

CLIENT Reids Heritage Homes — PROJECT No. 161414172

LOCATION 950 - 960 St David Street North, Fegus, Ontario — DATUM geodetic

DATES: BORING November 22, 2021 — WATER LEVEL March 30, 2022 — TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) TCR(%) / SCR(%)	SAMPLES N-VALUE OR RQD(%)
9	**412.6**								
	412.5	Very dense, grey, Sandy SILT (ML) Till - trace gravel - moist			30	SS	9	250/250	50/100
	412.3	Borehole terminated at 9.4 m BGS. A 50 mm diameter well installed with a 3.0 m screen across 9.1 to 6.1 m BGS. Sand from 9.1 to 5.8 m BGS. Bentonite from 5.8 to 0.3 m BGS. 0.3 m BGS to ground surface concrete and flushmount cover. MECP Well Tag #A324150 *N-value not representative - Split Spoon bouncing on gravel or cobble			31				
10					32				
					33				
					34				
					35				
11					36				
					37				
					38				
					39				
12					40				
					41				
					42				
13					43				
					44				
					45				
14					46				
					47				
					48				
15					49				
					50				
					51				
16					52				
					53				
					54				
17					55				
					56				
					57				
					58				
18					59				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 4 840 468 E: 548 975

BH/MW06-21B

CLIENT Reids Heritage Homes

PROJECT No. 161414172

LOCATION 950 - 960 St David Street North, Fegus, Ontario

DATUM geodetic

DATES: BORING November 22, 2021

WATER LEVEL March 30, 2022

TPC ELEVATION

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES: TYPE	SAMPLES: NUMBER	SAMPLES: RECOVERY (mm) TCR(%) / SCR(%)	SAMPLES: N-VALUE OR RQD(%)	UNDRAINED SHEAR STRENGTH (kPa) / WATER CONTENT & ATTERBERG LIMITS / DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m / STANDARD PENETRATION TEST, BLOWS/0.3m	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0	421.6	**parking lot**			0						
		Refer to BH/MW06A-21 for soil stratigraphy		▼	1						
1					2						
					3						
					4						
2					5						
					6						
					7						
					8						
3					9						
					10						
					11						
					12						
4					13						
					14						
	417.1				15						
		Borehole terminated at 4.6 m BGS. A 50 mm diameter well installed with a 1.5 m screen across 4.6 to 3.1 m BGS. Sand from 4.6 to 2.7 m BGS. Bentonite from 2.7 to 0.3 m BGS. 0.3 m BGS to ground surface concrete and flushmount cover. MECP Well Tag #A324145			16						
5					17						
					18						
					19						
					20						
6					21						
					22						
					23						
					24						
7					25						
					26						
					27						
					28						
8					29						
9											

UNDRAINED SHEAR STRENGTH (kPa): 50 100 150 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

□ Field Vane Test, kPa

■ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

APPENDIX D

D.1 LABORATORY TEST RESULTS

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GRAIN SIZE AND HYDROMETER ANALYSIS REPORT
LS-602, 702 & 703/704

PROJECT NUMBER:	P19533.500	**PROJECT NAME:**	950-960 St David Street, North, Fergus - 161414172.800	**CLIENT:**	Stantec
LAB NUMBER:	S-1730/1731	**SAMPLE ID:**	BH/MW 02-21, SS 5	**SAMPLE DEPTH:**	10-12'
SAMPLED BY:	Client	**DATE RECEIVED:**	November 24, 2021	**DATE COMPLETED:**	November 29, 2021

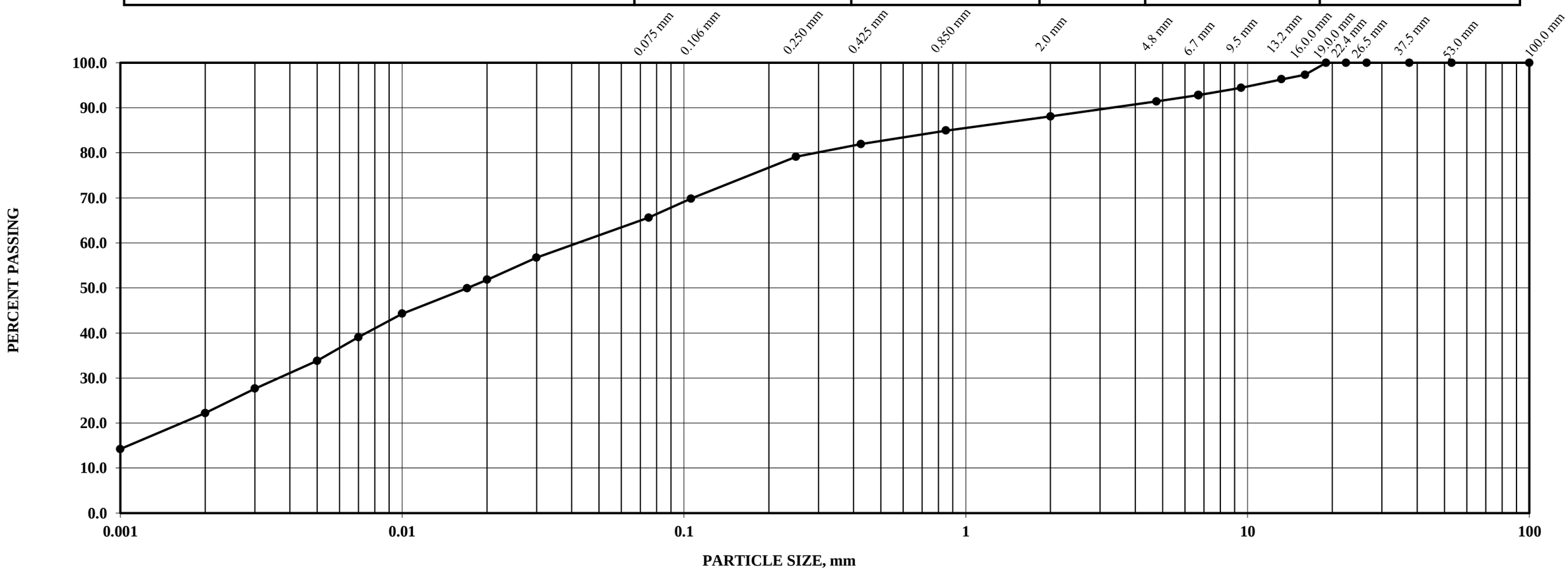
PARTICLE SIZE DISTRIBUTION, MTO LS-702

U.S. BUREAU OF SOILS CLASSIFICATION (AS USED IN MINISTRY OF TRANSPORTATION OF ONTARIO PAVEMENT DESIGNS)

CLAY	SILT	VERY FINE SAND	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	GRAVEL

UNIFIED SOILS CLASSIFICATION ASTM D 2487

FINES (SILT & CLAY)	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	COARSE GRAVEL



COEFFICIENTS

D60	0.047	**D30**	0.004	**D10**		**Cc**		**Cu**	

GRAIN SIZE ANALYSIS		HYDROMETER ANALYSIS	
SIEVE SIZE mm	**% PASSING**	**DIAMETER mm**	**% PASSING**
53	100.0	0.030	56.7
37.5	100.0	0.020	51.8
26.5	100.0	0.017	49.9
22.4	100.0	0.010	44.3
19	100.0	0.007	39.0
16	97.3	0.005	33.8
13.2	96.3	0.002	22.2
9.5	94.5	0.001	14.2
6.7	92.8	**ATTERBERG LIMITS**	
4.75	91.4		
2.00	88.1	Liquid Limit	20
0.850	84.9		
0.425	82.0	Plastic Limit	12
0.250	79.1		
0.106	69.8	Plastic Index	8
0.075	65.6		

GRAIN SIZE PROPORTIONS, %		
% GRAVEL (> 4.75 mm):		8.6
% SAND (75 µm to 4.75 mm):		25.8
% SILT (2 µm to 75 µm):		43.4
% CLAY (<2 µm):		22.2
SOIL DESCRIPTION:	CL	Sandy CLAY
SUSCEPTIBILITY TO FROST HEAVING:		LOW

REMARKS

Figure: 1

TESTED BY: Kevin Frank
Laboratory Technician

REVIEWED BY David McBay, CET.
Laboratory Supervisor

Englobe SWO - Kitchener
London
Brantford

englobecorp.com

GRAIN SIZE AND HYDROMETER ANALYSIS REPORT
LS-602, 702 & 703/704

PROJECT NUMBER:	P19533.500	**PROJECT NAME:**	950-960 St David Street, North, Fergus - 161414172.800	**CLIENT:**	Stantec
LAB NUMBER:	S-1732	**SAMPLE ID:**	BH/MW 04-21, SS 5	**SAMPLE DEPTH:**	10-12'
SAMPLED BY:	Client	**DATE RECEIVED:**	November 24, 2021	**DATE COMPLETED:**	November 29, 2021

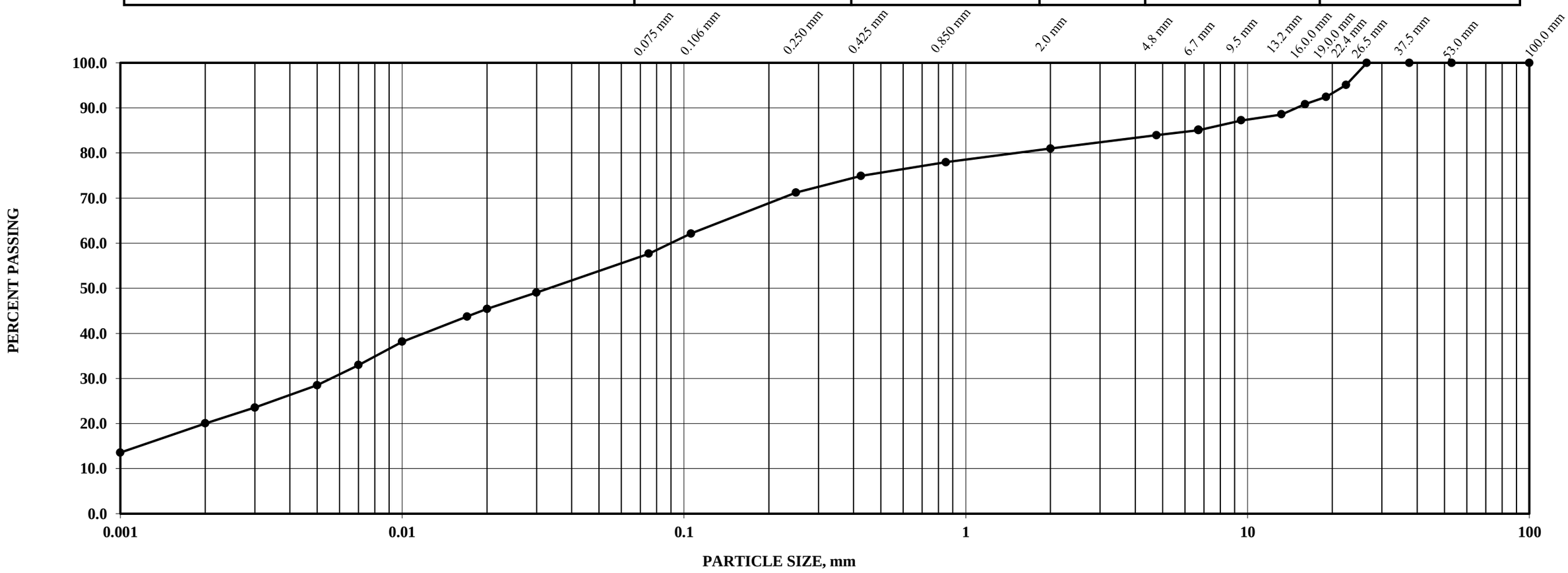
PARTICLE SIZE DISTRIBUTION, MTO LS-702

U.S. BUREAU OF SOILS CLASSIFICATION (AS USED IN MINISTRY OF TRANSPORTATION OF ONTARIO PAVEMENT DESIGNS)

CLAY	SILT	VERY FINE SAND	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	GRAVEL

UNIFIED SOILS CLASSIFICATION ASTM D 2487

FINES (SILT & CLAY)	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	COARSE GRAVEL



COEFFICIENTS

D60	0.091	**D30**	0.006	**D10**		**Cc**		**Cu**	

GRAIN SIZE ANALYSIS		HYDROMETER ANALYSIS	
SIEVE SIZE mm	**% PASSING**	**DIAMETER mm**	**% PASSING**
53	100.0	0.030	49.1
37.5	100.0	0.020	45.4
26.5	100.0	0.017	43.7
22.4	95.1	0.010	38.1
19	92.5	0.007	33.0
16	90.8	0.005	28.5
13.2	88.6	0.002	20.0
9.5	87.2	0.001	13.6
6.7	85.1	**ATTERBERG LIMITS**	
4.75	83.9		
2.00	81.0	Liquid Limit	
0.850	77.9		
0.425	74.9	Plastic Limit	
0.250	71.2		
0.106	62.1	Plastic Index	
0.075	57.7		

GRAIN SIZE PROPORTIONS, %		
% GRAVEL (> 4.75 mm):		16.1
% SAND (75 µm to 4.75 mm):		26.2
% SILT (2 µm to 75 µm):		37.7
% CLAY (<2 µm):		20.0
SOIL DESCRIPTION:	CL	Sandy CLAY with Gravel
SUSCEPTIBILITY TO FROST HEAVING:		LOW

REMARKS

Figure: 2

TESTED BY: Kevin Frank
Laboratory Technician

REVIEWED BY David McBay, CET.
Laboratory Supervisor