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Detailed Geotechnical Report
Fergus Golf Course Redevelopment
Fergus, Ontario

GEMTEC Project: 101987.017

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Submitted to:

Fergus Development Inc.
3190 Steeles Avenue East, Suite 300
Markham, Ontario
L3R 1G9

Detailed Geotechnical Report
Fergus Golf Course Redevelopment
Fergus, Ontario

June 5, 2026
GEMTEC Project: 101987.017

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June 5, 2026 File: 101987.017 – Rev4

Fergus Development Inc.
3190 Steeles Avenue East, Suite 300
Markham, Ontario
L3R 1G9

Attention: Bobby Wang, HBSc, MEng, LEED AP BD +C

Re: Detailed Geotechnical Report – Fergus Golf Course Redevelopment
8243 and 8282 Wellington Road 19, Fergus, Ontario

Enclosed is our Geotechnical Site Investigation Report to support the detailed design of the proposed residential development project at 8243 and 8282 Wellington Road 19 in the Town of Fergus, Ontario. The report presented herein is based on the drilling scope of work summarized in our updated proposal dated September 12, 2023. This report was prepared by Matthew Kelly, P.Eng., and reviewed by Graeme Skinner, PhD., P.Eng. and Chris Kellestine, A.Sc.T., PMP.

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TABLE OF CONTENTS

LIST OF APPENDICES

1.0 INTRODUCTION

GEMTEC Consulting Engineers and Scientists Limited (GEMTEC) has been requested by Fergus Development Inc. (Geranium / the Client) to carry out a supplementary geotechnical Site investigation to support the proposed residential development at 8243 and 8282 Wellington Road 19 in the Town of Fergus, Ontario, herein referred to as the "Site".

The purpose of the geotechnical field work outlined herein was to confirm and further investigate the general subsurface conditions at the Site encountered in previous Site investigations by means of a limited number of boreholes and, based on the factual data obtained, to provide engineering comments and recommendations on the geotechnical design aspects of developing the Site, including construction considerations that could influence design or construction decisions.

This report is subject to the Conditions and Limitations of This Report, which follow the text of the report, and are considered an integral part of the report (see Appendix A).

2.0 SITE DESCRIPTION

The subject property is comprised of two parcels, the Fergus Golf Course (north parcel) and south parcel, as shown on Figure 1 in Appendix B. The overall Site is located along Wellington Road 19 Road starting approximately 0.2 km northeast of 2nd Line extending to 3rd Line. The Site presently consists of an operating golf course in the north parcel and south parcel; pockets of forested land are present within the south parcel of the site. The parcels are separated by Wellington Road 19, bounded by 3rd line to the northeast and bounded on all other sides by a mixture of agricultural, and forested lands. The total Site area is approximately 100 acres for the north parcel and approximately 95 acres for the south parcel.

The SE Site is surrounded by Wellington Road 19 to the north Third Line and a combination of existing residential development and farmland to the east, towards Lake Belwood, existing farmland to the south, and existing residential to the west. The SE Site is currently occupied by grass fields, a residential house, and nine holes of a golf course. The SE site (portion of the site south of County Road 19) generally slopes down from County Road 19 to the south and east. There is a large wooded area surrounding two golf holes near the south end of the property that is largely flat covering approximately one third of the total area south of County Road 19, with three small ponds adjacent to the north edge of the wooded area.

The latest development concept plan prepared by GSP Group (dated May 11, 2026) indicates that the proposed development area on the SE Site will include about 446 lots, (mixture of 32', 38', 45', and 52' wide lots), 1.7 ha. of park space, 5.35 ha. of open space, a stormwater management facility and associated roads and utilities.

3.0 FIELD INVESTIGATION PROCEDURES

3.1 Previous Investigations

Golder Associates Ltd./WSP (Golder) was previously retained to perform geotechnical investigations at the Site in 2022 at which time twelve boreholes were advanced across the SE Site to depths ranging from about 5.0 m to 9.6 m. Golder's previous geotechnical Site investigation is presented in the following report:

- Report No. 21456909 (1000) titled *"Preliminary Geotechnical Investigation Proposed Residential Redevelopment, Fergus Golf Club, 8243 and 8282 Wellington Road 19, Fergus, Ontario",* prepared by Golder and dated February 4, 2022.

The results of the previous geotechnical Site investigations have been reviewed and the factual information from Golder's earlier Site investigation has been considered in support of the current geotechnical recommendations and conclusions presented herein. GEMTEC understands that minimal re-working (i.e., importation, exportation or regrading of the on-Site materials) has occurred at the Site since the time of the previous geotechnical investigations.

The Record of Borehole sheets from the previous investigation for the Site are included in Appendix C.

3.2 Current Investigation

The field work for the current geotechnical investigation on the SE Site was carried out between October 31 and November 9, 2023, during which time twenty-five boreholes (designated as Boreholes BH23-1 to BH23-25) were advanced at the Site. Boreholes were advanced to depths between about 3.2 m and 9.6 m below existing ground surface at the approximate locations shown on the Borehole Location Plan, Figure 1 in Appendix B.

The boreholes were advanced using a track-mounted drill rig supplied and operated by a specialist drilling contractor, subcontracted by GEMTEC. Standard Penetration Testing (SPT) and sampling was carried out at regular intervals of depth in the boreholes using conventional 35 mm internal diameter split spoon sampling equipment advanced using an automatic hammer, in accordance with ASTM D1586 (99): "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils". The split-spoon samplers used in the investigations limit the maximum particle size that can be sampled and tested to about 35 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension were not sampled or represented in the grain size distributions. The results of the in-situ field tests (i.e., SPT "N"-values), as presented on the Record of Borehole sheets and in subsequent sections of this report, are the values measured directly in the field and are unfactored / uncorrected.

The groundwater conditions were recorded in the open boreholes immediately following drilling procedures for all boreholes. Six (6) boreholes advanced on site were equipped with 50 mm

diameter monitoring wells to permit further monitoring of the groundwater levels, including a bi-level well installed in Borehole BH23-24.

As part of the geotechnical investigation, monitoring wells were installed at four borehole locations (Boreholes BH23-02, BH23-09, BH23-20 and BH23-24). Bi-level monitoring well installations (i.e., shallow (S) and deep (D) monitoring well pairs installed in separate and adjacent boreholes) were installed at Boreholes BH23-20 and BH23-24 for a total of six monitoring wells.

The monitoring wells were constructed using nominal 50 mm diameter polyvinyl chloride (PVC) standpipe and machine-slotted screen. The annular space between the monitoring well screen and surrounding soils was backfilled with silica filter sand to a maximum of 0.6 m above the top of the screen, and the remainder of the annular space was sealed with bentonite. Monitoring wells were completed with either aboveground protective steel casings or flush mount casings depending on their location throughout the golf course.

The field work for this investigation was directed by a member of our technical staff who located the boreholes in the field, directed the sampling and in-situ testing operation, logged the boreholes and cared for the samples obtained. The samples were identified in the field, placed in appropriate containers, labelled and transported to GEMTEC's Mississauga office for further examination and laboratory testing. Index and classification tests, consisting of water content determinations, Atterberg limits and grain size distribution, were carried out on selected soil samples.

The borehole locations were selected by GEMTEC in consultation with the project team and staked out on Site by GEMTEC technical staff. The ground surface elevations and as-drilled locations of the monitoring wells were surveyed by the project surveyor and the coordinates were provided to GEMTEC. The ground surface elevations for each borehole location where monitoring wells were not installed were taken from the existing site grading drawings.

Descriptions of the subsurface conditions observed in the boreholes are provided on the Record of Borehole sheets in Appendix D. The results of the laboratory tests on soil samples are also summarized on the Record of Borehole sheets (Appendix D), and detailed laboratory testing results are presented in Appendix E.

4.0 SUBSURFACE CONDITIONS

The site is located within a drumlinized till plain of the Guelph Drumlin Field physiographic region as delineated in The Physiography of Southern Ontario (Chapman and Putnam, 1984). This area has been subjected to extensive glaciations during the last 200,000 years. At least two periods of continental glaciation are known to have occurred within this period of time which were interrupted by warmer climate interglacial periods. The glaciers from the most recent glacial periods (Wisconsin Glaciation) withdrew from the area between approximately 8,000 years and 10,000 years ago.

The Guelph Drumlin Field physiographic region lies northwest of the Paris Moraine and consists of approximately 300 drumlins, or glacial hills, of various sizes. The lowland surrounding the drumlins consists of fluvially deposited soil. The till soil in the drumlins is mostly derived from the underlying dolostone. It is loamy, calcareous, pale brown in colour and contains red shale fragments. The till is relatively sandier and covered by a layer of fine sand and silt in the northeast of the physiographic region where the project site is located. Boulders can be found throughout the till deposit.

The overburden is generally greater than 15 m in thickness and is underlain at the site by dolostone of the Guelph Formation.

As previously indicated, the soil and groundwater conditions identified in the boreholes are presented on the Record of Borehole sheets in Appendix C. The Record of Borehole sheets indicate the subsurface conditions at the specific borehole locations only. Boundaries between zones on the Record of Borehole sheets are often not distinct, but rather are transitional and have been interpreted from discontinuous drilling observations. The precision with which subsurface conditions are indicated depends on the method of drilling, the frequency and recovery of samples, the method of sampling, and the uniformity of the subsurface conditions. Subsurface conditions at locations other than the boreholes may vary from the conditions encountered in the boreholes, both laterally and with depth. In addition to soil variability, fill of variable physical and chemical composition is present in portions of the Site associated with previous construction activities (i.e., parking areas, buildings, etc.).

The groundwater conditions described in this report refer only to those observed at the place and time of observation, as noted in the report. These conditions may vary seasonally or as a result of construction activities in the area. A separate Site-specific hydrogeological assessment has been undertaken by GEMTEC and is presented under separate cover.

The soil descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves judgement and GEMTEC does not guarantee descriptions as exact but infers accuracy to the extent that is common in current geotechnical practice.

The subsurface soil conditions at the Site are generally comprised of surficial topsoil materials overlying shallow sand and silt deposits, overlying silty clay to clayey silt deposits. The following presents an overview of the subsurface conditions encountered in the boreholes advanced during the current geotechnical Site investigation.

Topsoil and Organics

Topsoil ranging in classification from clayey silt to sandy silt to silty sand containing varying amount of organics and rootlets was encountered in all boreholes advanced as part of the current investigation, and ranges in thickness from about 0.15 m to 0.36 m, with an average thickness of

0.22 m. The topsoil thickness measured at each Borehole location from the current investigation is noted below in Table 4.1.

Table 4.1: Summary of Topsoil Thickness

Borehole	Approximate Topsoil Thickness (m)
23-1	0.18
23-2	0.25
23-3	0.25
23-4	0.18
23-5	0.25
23-6	0.20
23-7	0.18
23-8	0.15
23-9	0.20
23-10	0.15
23-11	0.36
23-12	0.20
23-13	0.20
23-14	0.25
23-15	0.15
23-16	0.30
23-17	0.28
23-18	0.23
23-19	0.15
23-20	0.15
23-21	0.25
23-22	0.25

Borehole	Approximate Topsoil Thickness (m)
23-23	0.36
23-24	0.15
23-25	0.28

Topsoil thicknesses reported in the previous geotechnical investigation by Golder ranged in thickness between about 50 mm and 300 mm. An underlying organic layer was also noted in Boreholes 21-1 and 21-3, extending to depths between about 0.7 m and 0.9 m.

Materials identified as topsoil in this report were classified based on visual and textural evidence as no other testing for organic content or other nutrients was carried out. As such, the ability for these materials to support vegetation has not been assessed.

At some borehole locations, the materials encountered directly below the topsoil layer contain trace amounts of organics. These materials are anticipated to be suitable to be left in place and/or re-used as earth fill provided that the organic content remains below about 5 percent. In localized areas, if the organic content is greater than about 5 percent the soil below the topsoil will need to be excavated and replaced with engineered fill.

4.1 Silt to Silty Clay (ML/CL)

Deposits of cohesive silty clay to slightly plastic silt were encountered in Boreholes BH23-1 to BH23-6 below the topsoil, and in Boreholes BH23-7 and BH23-13 underlying the silty sand deposit. The surface of this deposit was encountered at depths between 0.2 m and 1.5 m below existing ground surface, and extended to depths between 0.8 m and 2.3 m below existing ground surface.

Standard penetration tests carried out in the silt to silty clay deposits returned SPT N-values ranging from about 4 blows to 18 blows per 0.3 m of penetration suggesting a firm to very stiff consistency.

The water content values measured on samples of the silty clay deposits ranged from about 14 per cent to 43 per cent.

4.2 Sand to Silty Sand to Sand and Silt to Clayey Sand (SP/SM/ML/SC)

Native non-cohesive deposits of sand to silty sand to sand and silt to clayey sand were encountered in Boreholes BH23-01, BH23-02, BH23-05, underlying the silt deposits and in Boreholes BH23-07, BH23-08, BH23-10 to BH23-13, and BH23-15 to BH23-25 underlying the topsoil. At some locations the non-cohesive deposits were associated with slow auger advance resulting from grinding against presumed cobbles and boulders.

Standard penetration tests carried out in the non-cohesive deposits returned SPT N-values ranging from about 4 blows to 45 blows per 0.3 m of penetration, indicating a loose to dense compactness condition.

The water content values measured on samples of the non-cohesive deposits ranged from about 2 per cent to 47 per cent, but generally ranged between about 10 per cent and 20 per cent.

Four grain size distribution tests were undertaken on the non-cohesive deposits and the detailed results are presented in Appendix E.

4.3 Silt to Silty Clay to Clayey Silt Glacial Till (CL-ML)

A cohesive glacial till deposit ranging in composition from silt to silty clay to clayey silt, some sand to sandy, some gravel to gravelly was encountered in all Boreholes underlying the topsoil and near surface silty clay or sandy deposits. The cohesive glacial till was frequently observed to contain angular broken rock fragments and were associated with slow auger advance resulting from grinding against presumed cobbles and boulders and occasional auger refusal, as indicated on the borehole records. All the boreholes except Boreholes BH23-06 and BH23-21 were terminated within this deposit at depths between 3.2 m and 9.6 m.

Standard penetration tests carried out in the cohesive till deposits measured SPT N-values ranging from about 6 blows per 0.3 m of penetration to 50 blows for 0.03 m of penetration, but were typically greater than 30 blows per 0.3 m of penetration, which suggests a firm to hard, but generally hard consistency.

The water content values measured on samples of the cohesive glacial till ranged from about 7 per cent to 20 per cent but generally ranged from about 8 per cent to 12 per cent.

Six grain size distribution tests were undertaken on the glacial till deposits and the detailed results are presented in Appendix E.

Atterberg limits testing was carried out on selected samples of the cohesive glacial till deposits and returned plastic limits ranging from about 11 per cent to 17 per cent, liquid limits ranging from about 15 per cent to 24 per cent, and plasticity indices ranging from about 2 per cent to 10 per cent; indicating that the deposits have slight to low plasticity.

4.4 Silt to Silty Sand (SM/ML)

A deposit of silt to gravelly sandy silt was encountered in Boreholes BH23-06 and BH23-21 underlying the glacial till deposits at depths of 9.1 m and 3.1 m, respectively. Both boreholes were terminated within this layer after penetrating it for about 0.5 m.

Standard penetration tests carried out in this deposit measured SPT N-values of about 15 blows per 0.3 m of penetration and 50 blows for 0.15 m of penetration, indicating a compact to very dense compactness condition.

The water content values measured on one sample of the non-cohesive deposit is about 9 per cent.

4.5 Groundwater Conditions

Details of the monitoring well installations are shown on the borehole records in Appendix C. Groundwater level readings were taken in the monitoring wells installed by GEMTEC and others on five events (November 30 and December 1, December 18, 2023, January 3-5 and 8, February 5, and March 11-12, 2024).

Groundwater levels were measured in the installed monitoring wells as described below. The highest levels measured and recorded from both the current and previous investigations (as discussed further in GEMTEC's Hydrogeology Report for the project, issued under separate cover) are summarized in Table 4.2.

Table 4.2: Groundwater Depths in Monitoring Wells

Borehole No.	Groundwater Elevation (m)	Date of Reading
BH23-02	428.1	11/30/2023
BH23-09	428.6	3/11/2024
BH23-20S	426.4	3/11/2024
BH23-20D	426.3	3/11/2024
BH23-24S	426.5	3/11/2024
BH23-24D	426.4	3/11/2024
BH21-01	425.9	3/22/2021
BH21-03	434.7	2/5/2024
BH21-05	429.4	3/22/2021
BH21-06	427.5	3/22/2021
BH21-07S	428.8	3/11/2024
BH21-07D	428.5	3/11/2024
BH21-08	428.7	3/22/2021
BH21-11	428.4	3/11/2024
BH21-16	429.4	2/5/2024
BH21-17	429.0	4/5/2021
BH21-18	427.2	3/22/2021

It should be noted that the groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation. Groundwater levels at the Site are anticipated to vary between and beyond the borehole locations and to fluctuate with seasonal variations in precipitation and snowmelt.

As previously noted, a separate Site-specific hydrogeological assessment will be completed by others under separate cover.

5.0 DISCUSSION

The following sections of the report provide guidance on the geotechnical engineering design aspects of the project based on our interpretation of the boreholes advanced as part of the various geotechnical Site investigations. It is stressed that the information in the following sections is provided for the guidance of the designers and is intended for this project only. If the project is modified in concept, location, or elevation, or if the project is not initiated within eighteen months of the date of the report, GEMTEC should be given an opportunity to confirm that the recommendations are still valid. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their construction techniques, schedule, safety, and equipment capabilities. GEMTEC will not assume any responsibility for construction-related decisions made by contractors on the basis of this report.

The professional services addressed in this report include only the geotechnical aspects of the subsurface conditions at this Site. The presence or implications of possible surface and/or subsurface contamination resulting from previous uses or activities of this Site or adjacent properties, and/or resulting from the introduction onto the Site of materials from off Site sources are outside the terms of reference for this report and have not been investigated or addressed herein and will be presented under separate cover.

5.1 Site Preparation

The existing site vegetation, surficial topsoil/organics, and other near surface soils containing significant amounts of organic matter (i.e. greater than 5 percent) are not considered to be suitable for the subgrade support of building foundations and/or engineered fill materials and should be completely stripped from the site prior to placing any engineered fill. In addition, any below-grade features associated with existing or previous site features should also be removed prior to engineered fill placement.

5.2 Topsoil Stripping and Reuse

The following geotechnical comments are provided regarding organic and topsoil stripping and reuse at the site:

- As noted above, surficial vegetation and topsoil should be stripped from the proposed development area. The surficial topsoil deposit encountered at the borehole locations ranged from 150 mm to 360 mm in thickness but was generally about 150 mm to 250 mm thick. The actual amount of stripping of any organic soils underlying the topsoil will need to be determined at the time of construction. The stripping activities should be monitored by qualified geotechnical personnel to confirm that the extent of removal of surficial soils containing organics is suitable for the project requirements. Based on our recent experience at golf course sites, it is noted that the topsoil thickness may vary significantly over short distances due to the use of topsoil for grading purposed to create mounds/undulations, etc. typically found on golf courses.
- Consideration may be given to selective stripping operations, consisting of road allowances, and building envelopes (including driveways) and any other settlement sensitive features.
- Outside of road allowances and building envelopes, topsoil, if encountered, may be buried and/or reused as general lot fill to raise grades. The primary factor controlling methane generation is the organic carbon content of the topsoil. The loss on ignition (LOI) test provides an indication of the organic carbon content of the sample. If topsoil is to be reused as general lot fill to raise grades, then LOI testing should be carried out and further recommendations provided by the geotechnical engineer regarding the reuse of topsoil and the potential for methane generation.
- Where low organic content material (trace organics) is used as general lot fill, its thickness should be limited to about 0.6 m. The trace organics fill should be placed in maximum 300 mm loose lifts and uniformly compacted to 95 percent of standard Proctor maximum dry density. To have any success in placing topsoil as lot grading fill, it must be placed at or very close to its optimum water content to achieve workability and adequate compaction, in order to minimize post-construction settlements and/or lateral movements (e.g., of fences, etc.).

5.3 Engineered Fill

In areas where a grade raise is required or where existing loose / soft / deleterious or fill materials must be replaced, engineered fill may be used to transfer structural loads to the competent underlying native soils. Based on ongoing discussions with the design team it is understood that, fill placement will be required across a majority of the site to achieve design grades. Fill thicknesses will generally be between 1 m and 3 m, with localized areas up to about 5 m thick.

Prior to placing engineered fill at the Site, all topsoil, existing fill and disturbed/reworked or deleterious materials within the limits of the engineered fill should first be removed. The limits of any engineered fill should extend laterally beyond the intended structure's footprint in all directions by at least the depth of the engineered fill plus one metre. The exposed area(s) should then be proofrolled in conjunction with an inspection by GEMTEC to confirm that the exposed soils are native, undisturbed, and competent, and have been adequately cleaned of ponded water and all

disturbed, loosened, softened, organic and otherwise deleterious material. Some localized loose/soft zones of soil may also need to be removed prior to placement of engineered fill as directed by GEMTEC during proof-rolling / inspection activities.

Materials intended for reuse as engineered fill must be approved by GEMTEC prior to placement. In this regard, the existing Site materials which are near their optimum water contents and do not contain topsoil, organics or any other deleterious materials can be reused on Site as engineered fill. It should be noted that due to the presence of fine-grained materials in the native deposits, their workability is sensitive to moisture conditions and some difficulty should be expected in achieving adequate compaction during periods of wet or cold weather.

Imported materials to be used for engineered fill must be approved by GEMTEC at the source(s) prior to hauling to the Site. In this regard, imported granular materials which meet the requirements for OPSS Select Subgrade Material (SSM) would be suitable for use as engineered fill. The approved materials for engineered fill should be placed in maximum 300 mm thick loose lifts and uniformly compacted to at least 98 per cent of SPMDD throughout. The placement of engineered fill must be monitored by GEMTEC on a full-time basis. Engineered fill in areas that are not settlement sensitive (i.e. outside building footprints, roadways, driveways, sidewalks, etc.) can be compacted to a minimum 95 per cent SPMDD.

The final surface of the engineered fill should be protected as necessary from both construction traffic and weather and should be sloped to provide positive drainage for surface water during and following the construction period. During periods of freezing weather, additional soil cover should be placed above the final subgrade level to provide frost protection, and removed once construction activities continue.

Cobbles and boulders exceeding 150 mm in diameter should be removed from the engineered fill prior to compaction. It is recommended that the contractor consider the possible presence of cobbles and boulders or other obstructions when developing their excavation and engineered fill construction plans.

5.3.1 Settlement Associated with Engineered Fill Placement

Settlement of the site will occur due to compression of the newly placed fill (engineered fill) itself, as well as due to settlement of the underlying silt to silty clay to silt and sand to sand deposits and the generally very stiff to hard glacial till as a result of the weight of the engineered fill.

5.3.1.1 Settlement of Engineered Fill

The magnitude of the settlement of the engineered fill is estimated to be approximately 2 percent of the total grade raise height. Therefore, provided that the engineered fill material consists of properly compacted select fill, the estimated settlement and time for approximately 90 percent of the settlement to occur for grade raises of up to 5 m are provided in Table 5.3.1.

Table 5.1: Magnitude and Timing of Settlement – Engineered Fill

Engineered Fill Thickness (m)	Estimated Settlement of Engineered Fill (mm)	Anticipated Time for Approximately 90% Settlement to Occur (months)
1	>25	2
2	40	3
3	60	4
4	80	6
5	100	6 to 8

The above estimates of settlement and anticipated time for the majority of this settlement to occur assumes that the engineered fill will be cohesive in nature and will have the following minimum characteristics:

a) the material is free of organic matter and other deleterious materials;
b) the water content of the soil at the time of placement does not vary by more than 2 percent above or below the optimum water content for compaction; and,
c) the plasticity index is equal to or greater than 7 percent and does not exceed 15 percent.

The use of granular fill will reduce the estimated magnitude of settlement, and the majority of the settlement of granular fill will occur during construction.

5.3.1.2 Settlement of the Native Materials

Settlement analyses were carried out to evaluate the anticipated settlement due to placement of the engineered fill. The settlement models were set up taking into account the proposed grade raise in each area of the site and the corresponding subsurface conditions encountered in the nearest boreholes. The estimated magnitude of settlement and time for this settlement to occur when subjected to the load increase imposed by up to about 5 m of engineered fill are provided in Table 5.3.2.

Table 5.2: Magnitude and Timing of Settlement – Native Materials

Engineered Fill Thickness (m)	Anticipated Settlement of Native Soils (mm)	Estimated Time for Approximately 90% Settlement to Occur (months)
2	<25	4
3	25 – 75	4-5
4	75 – 100	5-6
5	100 – 150	6

The anticipated time for approximately 90 percent of the settlement to occur in the native clayey silt to silty clay till assumes that a drainage layer of granular material will be placed as the first lift of engineered fill overlying the native soil.

5.4 Foundation Design

5.4.1 Building Foundations

GEMTEC understands that the development will consist of about four hundred forty-six lots containing detached residential homes. The homes are expected to have up to one basement level and will be serviced via communal sewers and water service.

Based on the results of this investigation, consideration may be given to supporting the proposed buildings on conventional strip or spread footings founded directly in the inorganic, competent and undisturbed native deposits, or on engineered fill at a minimum depth of 1.4 m below ground surface in all areas of the Site. Depending on final grading, excavation depths may vary from that given above, and may also require removal of any loose / soft / deleterious materials as directed by GEMTEC during construction. Alternatively, engineered fill could be constructed to support the footings where raising of the founding level is required. Recommendations for the placement of engineered fill are presented in Section 5.3.

Conventional strip footings with a minimum width of 0.45 m and maximum width of 1.0 m or square spread footings with a minimum width of 1 m and a maximum width of 1.5 m, bearing on the undisturbed, native soils, or on properly placed and compacted engineered fill, at a minimum depth of 1.4 m, may be designed using a factored geotechnical resistance at Ultimate Limit States (ULS) of 250 kPa and a geotechnical reaction at Serviceability Limit States (SLS) of 150 kPa (for a total maximum settlement of 25 mm and an anticipated maximum differential settlement of about 20 mm).

The native founding materials are considered susceptible to disturbance by construction activity, especially during wet and cold weather, and care should be taken to preserve the integrity of the materials at the foundation level. Due to the variability in native soil consistency / compactness (both with depth and location across the Site), it will be essential that all founding soils be inspected by GEMTEC prior to placing concrete for the footings. The founding soils and fresh concrete must be protected from wet conditions and freezing during cold-weather construction.

Foundations should be placed such that the zone of influence of the footings does not intercept proposed or former excavations, or proposed, former or existing underground utilities or structures. The zone of influence of the proposed footings can be defined as any line drawn from the underside edge of the footing down and away at an inclination of 1 horizontal to 1 vertical (or 45 degrees to the horizontal). Complete removal of any former or existing foundations or underground utilities or lowering of the founding elevation (if appropriate) may be required, subject to an inspection by GEMTEC at the time of construction. Stepped strip footings should be

constructed in accordance with the 2012 Ontario Building Code (2012 OBC), Section 9.15.3.9., as required.

5.4.2 Modulus of Subgrade Reaction

For preliminary assessment of the structural requirements, a modulus of subgrade reaction, k_{vb}, is used to represent the soil stiffness. The modulus of vertical subgrade reaction (k_{vb}) is not a fundamental soil property, and the value changes with footing size. The current state of practise uses a standard reference vertical subgrade reaction k_{v1} associated with a 1 ft x 1 ft plate. The modulus of vertical subgrade reaction can be estimated from the equations given below for foundations and/or slabs on non-cohesive or cohesive soils (CFEM, 2006). However, it should be noted that these methods are approximate only and it is generally considered that carrying out a detailed settlement analysis is the more rational approach (once design details are known) to obtain more realistic values of k_{vb}.

For cohesive soils:

$$k_{vb} = \frac{0.3\ k_{v1}}{b}\left[\frac{m + 0.5}{1.5m}\right]$$

where;

k_{vb} is the modulus of vertical subgrade reaction for actual foundation dimension, b (MPa/m);

k_{v1} is the modulus of vertical subgrade reaction for a 1ft x 1ft plate (MPa/m);

b is the foundation width (m)

m is the ratio of foundation length to width (i.e., m = L / b)

For non-cohesive soils:

$$k_{vb} = k_{v1}\left[\frac{3.3b + 1}{6.6b}\right]^2$$

where;

k_{vb} is the modulus of vertical subgrade reaction for actual foundation dimension, b (MPa/m);

k_{v1} is the modulus of vertical subgrade reaction for a 1ft x1ft plate (MPa/m);

b is the foundation width (m)

For design of the floor slabs for the residential structures using a spring constant, a modulus of vertical subgrade reaction, k_{v1}, of 15 MPa/m for properly prepared granular base and the native site soils, may be considered. The design modulus of vertical subgrade reaction is derived based on the assumption that the subgrade is not disturbed during construction. It is noted that the modulus of vertical subgrade reaction is not an intrinsic property of soils. Where designs are sensitive to the specific modulus value(s), a more rigorous method of analysis (i.e., detailed soil-

structure interaction and settlement analysis) should be undertaken to obtain modulus value(s) that better represent the soil-structure interaction.

5.4.3 Slab-on-Grade Floor

Any floor slabs for the proposed residential structures can be designed as a concrete slab-on-grade. For predictable performance of the floor slab, the exposed subgrade should be proof-rolled in conjunction with an inspection by the geotechnical engineer. Remedial work should be carried out on any softened, disturbed, wet or poorly performing zones as directed by the geotechnical engineer. Any low areas may then be brought up to within at least 150 mm of the underside of the floor slab, as required, using OPSS.MUNI Granular 'B', Type I material or other approved material, placed in maximum 300 mm loose lifts and uniformly compacted to at least 98 percent of the material's Standard Proctor Maximum Dry Density (SPMDD) using suitable compaction equipment. The final lift directly beneath the floor slab should consist of a minimum of 150 mm of OPSS Granular A material, uniformly compacted to at least 100 percent of SPMDD.

Special care should be taken to ensure compaction around columns and adjacent to foundation walls. The floor slab should be structurally separate from the foundation walls and columns. Sawcut control joints should be provided at regular intervals and along column lines to minimize shrinkage cracking and to allow for differential settlement of the floor slab.

The exterior foundation walls should be backfilled with an approved site excavated material, placed in lifts, and compacted. Where the backfill against the exterior walls is to support settlement sensitive structures, such as concrete slabs, pavements, or sidewalks, it should be uniformly compacted to at least 98 percent of SPMDD.

5.4.4 Sanitary Pumping Station Structure

The sanitary pumping station is understood to consist of a valve chamber and a wet well. Finished grade in the vicinity of the pumping station is proposed to be about Elevation 429.6 m and the finished floor elevation of the valve chamber is about 425.5 m and the finished floor of the wet well is proposed to be at about Elevation 420.0 m. Existing grade in the vicinity of the pumping station is at about 428 m.

Assuming a slab-on-grade foundation design is incorporated for the valve chamber and the wet well, and is designed in accordance with the recommendations given in the preceding section and at the elevations given above, a modulus of vertical subgrade reaction, k_{v1}, of 25 MPa/m for the valve chamber (El. 425.5 m) and 60 MPa/m for the wet well (El. 420.0 m) can be used for design.

5.4.4.1 Resistance to Uplift (Buoyancy)

Based on the monitoring wells installed in the boreholes in the vicinity of the pumping station as part of the current and previous investigations, the groundwater level in this area of the site has been measured to range between about Elevations 425.9 m and 427.6 m over the monitoring period.

Considering that the design elevations of the valve chamber and wet well are below the groundwater table at the Site, measures will need to be adopted to address the upward pressure from the groundwater acting on the structures. To prevent the uplift forces from adversely affecting the stability of the base slabs, the design may consider the following options:

Design of the valve chamber and wet well should account for a typical and high groundwater elevation equal to the existing ground surface incorporating an adequate factor of safety into the design. The rate of seepage through the glacial till soils present in the area of the pumping station is anticipated to be relatively slow, however, that doesn't alleviate the water pressures that could act on the base of the structures, as the pressure will build up over time.

The pressure acting on the base of the structures can be calculated by multiplying the difference in elevation of the base of the structure and the groundwater level by the unit weight of water (9.81 kN/m3). If the weight of the structures is not sufficient to overcome the uplift pressure, the following mitigation options should be considered in the design:

- Relieving the pressure by incorporating a drainage layer and removing groundwater entering the layer;
- Thickening the walls and base slab to make the structures heavier;
- Designing the structures with shear keys or an oversized slab protruding laterally from the sides to mobilize a wedge of fill that will hold it down; and/or,
- Installing drilled anchors to tie the structure down.

5.4.5 Backfill and Frost Susceptibility

The majority of the native soils encountered at the Site are considered to be frost susceptible and should not be used as backfill against exterior or heated / unheated foundation elements. To reduce the effects of frost heave on such structures, protection measures should be considered in the design as required. Such measures may include positive subgrade grading, provision of subdrains, removal and replacement of native soils with non-frost susceptible (e.g., clean sand) materials, provision of frost tapers, and / or thermal insulation (i.e., expanded polystyrene).

To avoid problems with frost adhesion and heaving, the foundation elements should be backfilled with non-frost susceptible sand or sand and gravel conforming to the requirements of Ontario Provincial Standard (OPSS).MUNI 1010 Granular 'B' Type I material. Alternatively, protection from frost adhesion can be provided through use of a damp-proofing membrane and drainage board / protection board system which creates a slip plane between the foundation wall and frost-susceptible backfill soils.

The backfill should be placed in maximum 300 mm thick loose lifts and should be uniformly compacted to at least 95 per cent of the material's standard Proctor maximum dry density (SPMDD) using suitable vibratory compaction equipment. The upper 300 mm of wall backfill

should consist of clayey material to provide a relatively impermeable cap and the exterior grade should also be shaped to slope away from the building.

In areas where pavement or other hard surfacing will abut structures and backfill was carried out using granular material, differential frost heaving could occur between the granular fill immediately adjacent to the structure and the more frost susceptible native subgrade materials which exist beyond the backfill envelope. To reduce the severity of this potential differential heaving, the backfill adjacent to the wall should be placed to form a frost taper. The frost taper should be brought up to pavement subgrade level from 1.4 m below finished exterior grade at a slope of 3 horizontal to 1 vertical (3H:1V), or flatter, away from the wall.

5.4.6 Insulation of Shallow Foundations

The frost penetration depth at the Site is anticipated to be about 1.4 m based on Ontario Provincial Standard Drawing (OPSD) 3090.101. If any of the proposed structures will be supported on slabs/footings bearing at a depth of less than 1.4 m, provision should be made for frost protection. To control potential movements due to frost action in the underlying materials, the proposed shallow foundations should be insulated using continuous rigid polystyrene insulation with a thermal equivalence to 1.4 m of soil cover. The insulation should be placed over the subgrade materials and beneath any compacted granular base. The insulation should also extend a minimum of 1.4 m and 2.5 m beyond the outer edges of the footings in all directions for heated and unheated structures, respectively. GEMTEC can provide additional guidance on thermal insulation upon request.

5.4.7 Watercourse Crossing

A box culvert is proposed to be constructed to carry Street B over the existing Black Drain alignment to the southwest of the proposed stormwater pond area. Based on the available design information the culvert will be a 2.1 m by 3.0 m concrete box culvert. Both an open footing and closed concrete box culvert configuration is considered to be feasible from a geotechnical perspective.

5.4.7.1 Shallow Foundations – Box Culvert

Closed bottom box culverts are not required to be founded at or below the standard depth of frost penetration for protection given that box structures are tolerant of small magnitudes of movement related to freeze-thaw cycles, should these occur. There are currently no detailed design drawings for the culvert, but it is assumed that the invert of the culvert will be at about Elevation 425.3 m.

The bedding, levelling pad, and granular backfill requirements for the pre-cast box culverts should be in accordance with OPSS 422 (Precast Reinforced Concrete Box Culverts). Given the potential for surface water flow and potential groundwater seepage through the native overburden soils during excavation to invert and bedding level, it is recommended that at least 300 mm of OPSS.PROV 1010 (Aggregates) Granular ‘B’ Type II material be used for bedding. As the overburden deposit below the bedding is generally fine grained it is recommended that a

non-woven geotextile be placed between the overburden soils and the bottom of the bedding. The geotextile should meet the specification for OPSS 1860 (Geotextiles) Class II and have a Fabric Opening Size (FOS) not greater than 212 μm. The bedding should be placed in lifts not exceeding 200 mm in loose thickness and compacted to at least 95 percent of the Standard Proctor maximum dry density of the material as specified in OPSS.PROV 501 (Compacting). In addition, a minimum 75 mm thick uncompacted levelling pad consisting of OPSS.PROV 1010 Granular 'A' or concrete fine aggregate meeting the gradation requirements specified in OPSS.PROV 1002 (Aggregates – Concrete) should be provided as shown on OPSD 803.010 (Backfill and Cover for Concrete Culverts) for culvert construction in dry conditions.

The box culvert founding subgrade should be inspected by geotechnical personnel to ensure that all existing unsuitable fill / softened soils or other unsuitable materials have been removed. Proofrolling of the subgrade will be required to identify any softened zones. Where any softened zones are present, sub-excavation is required to remove unsuitable materials, and the sub-excavated area should be backfilled in accordance with the recommendations for engineered fill given below.

Backfill behind the culvert walls should consist of granular fill meeting the specifications for OPSS.PROV 1010 Granular 'A' or Granular 'B' Type II, but with less than 5 percent passing the No. 200 (0.075 mm) sieve. The granular backfill should be placed and compacted in accordance with OPSS.PROV 501 (Compacting). The fill should also be placed concurrently on both sides of the culvert walls, ensuring that the backfill depth on one side does not exceed the other side by more than 400 mm for a pre-cast box culvert and 500 mm for an open footing culvert.

5.4.7.2 Geotechnical Resistance

A box culvert constructed on compacted bedding (closed box) placed on the compact sand or very stiff silty clay till anticipated to be present at the founding elevation, or strip footings founded directly on the native soils (open footing), and founded at about Elevation 245.0 m, may be designed based on a factored ultimate geotechnical resistance (ULS) of 350 kPa and unfactored serviceability geotechnical resistance (for 25 mm of settlement) (SLS) of 150 kPa. The geotechnical resistances and settlements are dependent on the culvert span, configuration and applied loads, including the loads imparted by any embankment reconstruction; the above geotechnical resistances, therefore, should be reviewed once the culvert span / footing size and founding elevation are determined. The geotechnical resistances provided above are based on loading applied perpendicular to the surface of the footings. Where the load is not applied perpendicular to the surface of the footing, inclination of the load should be taken into account in accordance with Section 6.10.4 of the Canadian Highway Bridge Design Code (CHBDC) (2019).

5.4.7.3 Erosion Protection

Provision should be made for scour and erosion protection at the culvert location. In order to prevent surface water from flowing either beneath the culvert (potentially causing undermining

and scouring), or around the culvert (creating seepage through the embankment fill, and potentially causing erosion and loss of fine soil particles), a clay seal or concrete cut-off wall should be provided at the upstream end of the pre-cast box culvert. If a clay seal is adopted, the clay material should meet the requirements of OPSS 1205 (Clay Seal), and the seal should be a minimum 1 m thick if constructed of natural clay or soil-bentonite mix and extend from a depth of 1 m below the scour level, and to a minimum vertical height equivalent to the high-water level, including along the embankment slopes.

Alternatively, a 0.6 m thick clay blanket (if constructed of natural clay or a soil-bentonite mix) may be constructed, extending upstream three times the culvert height and along the adjacent slopes to a height of two times the culvert height or the high water level, whichever is greater.

The requirements for and design of erosion protection measures for the inlet and outlet of the culvers should be assessed by the hydraulics design engineer. As a minimum, rip-rap treatment for the outlet of the culvert should be consistent with the standard presented in OPSD 810.010 (Rip-Rap Treatment for Sewer and Culvert Outlets). Erosion protection for the inlet of the culvert should generally follow the standard presented in OPSD 810.010, with the rip-rap placed up to the toe of slope level, in combination with the cut-off measures noted above. Similarly, rip-rap should be provided over the full extent of the clay blanket, including the creek side slopes and fill slope over the culvert if this clay seal option is adopted.

5.4.7.4 Resistance to Lateral Loads / Sliding Resistance

Resistance to lateral forces / sliding between the concrete spread / strip footings and the subgrade should be calculated in accordance with Section 6.10.4 of CHBDC 2019. Assuming that the founding soils are not loosened or disturbed during excavation and footing construction, the unfactored coefficient of friction (tan φ') values between the cast-in-place concrete footings and the inspected and approved subgrade may be taken as follows:

Table 5.1 – Coefficient of Friction (tan φ') Values

Subgrade Material	Coefficient of Friction, tan φ'
Precast box culvert on compacted Granular 'A' levelling pad	0.3
Cast-in-place footing or working slab on compacted Granular 'A'	0.6
Cast-in-place footing or working slab on compacted SSM	0.35
Cast-in-place footing on native soils	0.4

An appropriate resistance factor should be applied to the ultimate values calculated based on the above.

5.5 Lateral Earth Pressures for Design

The lateral earth pressures acting on below grade foundation walls, the culvert walls and retaining walls will depend on the type and method of placement of backfill materials, the nature of the soils / fill behind the backfill, the magnitude of surcharge including construction loadings, the freedom of lateral movement of the structure, and the drainage conditions behind the walls.

The following recommendations are made concerning the design of buried walls. It should be noted that these design recommendations and parameters are for level backfill and ground surface behind the walls. Where there is sloping ground behind the walls, the coefficient of lateral earth pressure must be adjusted to account for the slope.

- Select, free draining granular fill meeting the specifications of OPSS.MUNI 1010 Granular 'A' or Granular 'B' Type II but with less than 5 percent passing the No. 200 (0.075 mm) sieve should be used as backfill behind the walls, and on top of the culvert for a thickness of not less than 300 mm. Backfill should be placed in a maximum of 200 mm loose lift thickness and nominally compacted. Weep holes, where applicable, should be installed to provide positive drainage of the granular backfill. Compaction (including type of equipment, target densities, etc.) should be carried out in accordance with OPSS.MUNI 501 (Compacting).
- For restrained walls, granular fill should be placed in a zone with the width equal to at least 1.4m behind the back of the wall (in accordance with Figure C6.20(a) of the Commentary to the CHBDC 2019). For unrestrained walls, fill should be placed within the wedge-shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical (1.5H:1V) extending up and back from the rear face of the footing (in accordance with Figure C6.20(b) of the Commentary to the CHBDC). The pressures are based on granular embankment backfill material and the following parameters (unfactored) may be used:

Table 5.2 - Lateral Earth Pressures for Retaining Walls

Material	OPSS.MUNI 1010 Granular A	OPSS.MUNI 1010 Granular B
Soil Unit Weight	kN/m^3	21 kN/m^3
Coefficients of Static Lateral Earth Pressure At-Rest, K_o Active, K_a	 0.27 0.43	 0.27 0.43

If the culvert structures allow for lateral yielding, active earth pressures may be used in the foundation design. If the structures do not allow for lateral yielding, at-rest earth pressures should be assumed for design. The movement to allow active pressures to develop within the backfill, and thereby assume a restrained structure, may be taken as per Table C6.6 of the Commentary to the CHBDC.

5.6 Temporary Excavations

5.6.1 Geometry and Trench Conditions

All excavations should be carried out in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects (Ontario Regulation 213/91)). Excavations at the Site will generally be advanced through the near-surface loose to compact sand / gravel /silt or firm to stiff silty clay deposits. Depending on final grading and excavation depths, excavations may be advanced into the underlying compact to very dense non-cohesive and firm to hard cohesive glacial till deposits. At this time, the soils at the Site should generally be classified as Type 3 soils according to OHSA; but should be reviewed once the Site grading and foundation levels have been finalized.

In most cases, unsupported temporary excavations may be sloped no steeper than 1H:1V for excavations in Type 3 soils. All excavations should be inspected by the geotechnical engineer for correct soil classification under OHSA. Depending upon the construction procedures adopted by the Contractor, actual groundwater seepage conditions, the success of the contractor's groundwater control methods, and weather conditions at the time of construction, some flattening and/or blanketing of the slopes may be required to enhance stability. Care should be taken to direct surface runoff away from the open excavations.

Conventional hydraulic excavation equipment would be expected to be suitable for excavation in the overburden soils. Some of the soils at this Site are glacially derived and as such are expected to contain cobbles and boulders, which could affect excavations. The contractor should be made aware of the potential presence of cobbles and/or boulders within the overburden soils.

Stockpiles of excavated materials should be kept at least the same horizontal distance away from the top edge of the excavation as the excavation depth to avoid negative impacts on excavation slope stability, subject to confirmation by a geotechnical engineer in the field during construction. Care should also be taken to avoid overloading any underground services or structures with stockpiles. Cobbles and boulders larger than 150 mm in diameter, if encountered, should be removed from the excavation side slopes for worker safety.

5.6.2 Temporary Groundwater Control

Based on the measured depth to groundwater at the Site and depending on the final grading, it is expected that excavations would be completed both above and below the anticipated groundwater level. Due to the generally fine grained and cohesive to slightly plastic nature of the Site soils, groundwater inflows into excavations are anticipated to be minor, and effectively manageable by pumping from properly filtered sumps within excavations (as required).

However, significant groundwater inflows should be expected where layers of saturated granular soil may be encountered or within deeper excavations in the southern portion of the Site (i.e., southeast pond and stormwater outfall), where a higher groundwater table may be present. Active

dewatering from a dedicated groundwater control system may be required in these areas to ensure a stable excavation.

The rate and volume required for dewatering will be dependent on the Site grading, subsurface soil conditions, depth/geometry of the required excavations, the groundwater levels at the time of construction and the construction methods and staging selected by the Contractor. Further discussion on the anticipated dewatering requirements are provided in GEMTEC's hydrogeology report, issued under separate cover.

5.7 Installation of Underground Services

The new water, storm sewer and sanitary services are proposed to have invert depths between about 1.5 m and 6.0 m below final grade throughout the Site. If the invert depths / elevations are changed prior to finalizing the project design plans, GEMTEC should be provided an opportunity to review and update the following recommendations.

5.7.1 Pipe Bedding and Cover

The bedding for the proposed services should be compatible with the size, type and class of pipe, the surrounding subsoils and anticipated loading conditions and should be designed in accordance with OPSS requirements and any Centre Wellington standards. Where granular bedding (up to the springline or obvert as applicable per pipe material type) is deemed to be acceptable, it should consist of at least 150 mm of OPSS.MUNI 1010 Granular 'A' uniformly compacted to at least 98 per cent of its SPMDD. Depending on groundwater conditions at the time of excavation, a thicker Granular 'A' bedding layer may be required at some localized areas in overly wet or loose zones to facilitate the pipe installations. The requirement for additional bedding thicknesses exceeding 150 mm should be verified during construction by the geotechnical engineer. From the springline or obvert (as applicable) of the pipe to 300 mm above the obvert of the pipe, sand cover (OPSS.MUNI 1002 concrete fine aggregate or approved native sand) may be used. All bedding and cover materials should be placed in maximum 200 mm thick loose lifts and should be uniformly compacted to at least 98 per cent of SPMDD using suitable vibratory compaction equipment in accordance with OPSS.MUNI 401.

Consideration should be given to the use of anti-seepage collars (i.e., clay plugs / seals) near inlets and outlet and periodically spaced along longer pipe runs, especially with higher gradients, to avoid potential seepage and erosion around the outside of the pipe in the surrounding bedding and cover layers. Clay plugs / seals should have a minimum thickness of 1 m and should extended the full width of the trench and from the base to the top of the pipe cover.

The use of clear crushed aggregates (e.g., clear stone, HL-6 stone or high-performance bedding materials) as a bedding layer shall not be permitted anywhere on this project since fine particles from the native deposits could potentially migrate into the voids in the clear crushed material and cause loss of vertical and lateral pipe support, leading to pipe settlement and misalignment.

5.7.2 Trench Backfill

It should generally be acceptable to reuse the excavated overburden soils as general trench backfill, provided they are free of significant amounts of organics or other deleterious material and are at a suitable water content for compaction. The excavated materials from the Site will consist predominantly of silt / sand and cohesive glacial till. Materials intended for reuse should be inspected by GEMTEC in the field prior to placement and compaction.

Based on the measured natural water contents, the materials encountered at the Site are estimated to be generally near or below their estimated optimum water contents for compaction and some wetting of the material may be required prior to reuse as backfill. The optimum water content is determined during construction by standard Proctor analysis conforming to Ministry of Transportation Ontario (MTO) standard LS-706. The actual water contents at the time of placement and compaction may differ from the soil's natural state, and the contractor should have contingency plans for wetting or drying backfill soils as needed to achieve the required compaction. Alternatively, if placement water contents at the time of construction are too high, or if there is a shortage of suitable in situ material, then an approved imported granular material which meets the requirements for OPSS Select Subgrade Material may be used.

Soils that contain significant quantities of organics or deleterious material are not suitable for use as trench backfill within settlement sensitive areas. In addition, any boulders or cobbles greater than 150 mm in size should be removed from the trench backfill materials. Backfilling operations during cold weather should avoid inclusions of frozen lumps of material, snow and ice.

All general trench backfill should be placed in maximum 300 mm thick loose lifts and uniformly compacted to at least 95 per cent of the material's SPMDD. Where a trench is constructed beneath a hard-surfaced area (i.e., sidewalk or pavement structure), the upper 1 m of backfill below the subgrade level must be uniformly compacted to at least 98 per cent of the materials' SPMDD in loose lifts not exceeding 300 mm in thickness.

In areas where the trench will be covered with hard-surfaced materials, the type of material placed within the frost zone (between finished grade and about 1.4 m depth) should match the soil exposed on the trench walls for frost heave compatibility. Consideration should also be given to delaying the placement of surface course asphalt for a period of at least 12 months to allow for any normally anticipated post-construction settlement of the trench backfill materials.

5.8 Stormwater Management Pond

A stormwater management (SWM) pond is proposed to be constructed in the general vicinity of Boreholes BH23-18, BH23-19, BH23-20, BH23-21 and BH23-25, at the location shown on the Development Concept Plan. The subsurface soil conditions encountered in these boreholes consist of surficial deposits of silty sand to sand to depths between 1.5 m and 3.1 m, underlain by silty clay to clayey silt glacial till.

The following summarizes the proposed SWM pond design elements based on the latest correspondence with the design team:

Design Pond Base Elevation (m)	Design Pond Liner Elevation (m)	Design Top of Pond Elevation (m)	Operating Water Level Elevation (m)	Existing Groundwater Elevation (m)	Groundwater Level Relative to Pond Base
424.35	422.85	428.10	425.85	426.5	2.2 m above

A forebay is proposed at the east end of the pond and the forebay base is proposed at Elevation 424.85 m. The pond side slopes are proposed to be inclined at 5H:1V from the crest of the bank down to the pond base. A 4 m wide access road is proposed on the west, north and east sides of the pond which will allow access to the pond base at the southwest and southeast ends of the pond. Inlets are present at the east and west ends of the pond in the form of both storm sewers with concrete headwalls. The pond will have an emergency spillways and an outlet riser.

5.8.1 Pond Base Stability – Construction and Maintenance Conditions

The design operating level indicated above has been considered in developing the design recommendations for the proposed SWM Pond. This operating level is considered reasonable based on the groundwater level measured in the piezometers installed in the vicinity of the proposed pond and the potential for higher groundwater levels in the spring or during/following periods of heavy precipitation. The factor of safety against base instability is greater than 1.5 based on the estimated strength properties of the base soils, and the design groundwater level and the proposed pond base elevation, during both the short-term construction period, and long-term during maintenance conditions. It is however noted that there may be localized softening / loosening of the pond bottom and sloughing of the lower portion of the pond banks during construction.

As the design groundwater level is approximately 2.2 m above the design pond base elevation it is anticipated that groundwater seepage will occur through the glacial till soils into the excavation during construction. Additional seepage should also be anticipated during construction where “perched” groundwater may be encountered in the near-surface sandy deposits overlying the cohesive deposits.

The pond base soils are susceptible to disturbance by heavy construction equipment which could affect trafficability during construction, especially during wet weather or where seepage is encountered.

5.8.2 Pond Liner Considerations

If site grading and stormwater storage requirements permit, it is recommended that the permanent pool level (i.e., operating water level) be designed to be close to the groundwater level, as given

above, to minimize inflow of groundwater or recharge of the groundwater regime. It is understood that the permanent pool design operating level is proposed to be about Elevation 425.9 m (i.e. approximately 0.6 m below the measured groundwater level).

For the currently proposed operating condition (i.e. normal operating level below the measured groundwater level), a pond liner (geosynthetic or compacted clay) is recommended for this site to prevent inflow of groundwater. Incorporation of a liner into the system will also require a ballast layer over the liner which could otherwise be uplifted due to differences in head between the higher groundwater level and the water level in the pond.

Where pipes enter or exit the pond, they should be provided with a concrete / seepage collar and be backfilled with a relatively impermeable material (e.g. clayey silt or silty clay) to minimize preferential flow through the pipe bedding and backfill and possible loss of ground. Pipes entering or exiting the pond should be sized and designed to allow for cleaning. The exposed end of the riser portion should be provided with a protective wire mesh or the like to prevent unauthorized access (e.g. by children).

5.8.3 Compacted Clay Liner

If the operating pond level is to be maintained lower than the groundwater level for a significant period of time, a compacted natural clay liner, or a geosynthetic clay liner (GCL) is recommended on the base and side slopes of the pond. The natural clay soil material for the pond liner should have a minimum clay content of 15 per cent, and a plasticity index greater than 10 per cent. The clay liner should consist of a minimum thickness of at least 450 mm of compacted clay, placed in three equal thickness loose lifts and compacted to at least 95 per cent of the material's Standard Proctor maximum dry density.

The clay liner must be covered with ballast fill of sufficient thickness to resist hydrostatic uplift forces. Based on the pond design described above, liner for the bottom of the pond should be constructed with its base at Elevation 421.6 m (2.8 m below the design pond base level); the 450 mm thick natural clay liner or GCL should then be covered with ballast fill up to the design pond base at Elevation 424.4 m. The critical condition (lowest factor of safety) will occur when the pond is dry (i.e. unwatered for maintenance purposes), at which time, for this proposed liner and ballast fill geometry, the factor of safety against uplift forces on the base of the liner would be approximately 1.1 relative to the groundwater level at the site.

The ballast fill could consist of OPSS.MUNI 1010 Granular "B" Type I or approved equivalent. The ballast fill should be placed and nominally compacted by the construction equipment.

The clay liner should extend up the side slopes of the pond to at least the maximum operating water level during the design storm event, in order to control surface water exfiltration into the soil above the groundwater level. The clay liner thickness should be maintained at 450 mm on the pond side slopes; however, the thickness of the ballast fill can be reduced on the side slopes above the pond base by interpolating linearly between that thickness required to resist the full

hydrostatic pressure at the base of the pond, decreasing to a minimum thickness of 300 mm of ballast fill at the elevation of the maximum design operating water level to provide protection to the clay liner from desiccation and possible damage during pond clean-out operations.

In order to reduce excavation depths for pond construction with adequate ballast on top of the liner, incorporation of an underdrain system below the pond liner may be considered. The underdrain system must be capable of temporarily lowering the local groundwater table to the level of the liner during maintenance dewatering and drawdown periods. Alternatively, if geometry and other site constraints permit, raising the design base of the pond to above the level of the seasonal high groundwater table elevation may also eliminate the need for a liner.

The subdrain should be installed immediately beneath the proposed liner across the entire pond liner elevation and around the perimeter of the pond, likely including the slopes, with the captured water discharging to a sump manhole near the ultimate outfall for the pond.

A perimeter underdrain below the subdrain should be installed around the perimeter of the pond and consist at a minimum of a continuous 300 mm by 300 mm French-drain / trench filled with fine sand conforming to OPSS.MUNI 1002 and wrapped in a geotextile. Consideration should be given to the installation a geotextile-wrapped corrugated perforated PVC subdrain pipe within the trench to increase the maximum flow rate for the captured water. The underdrain should be connected to a designated sump manhole through a PVC subdrain pipe.

The sump manhole should have invert level below the base of the SWM pond to allow the subdrain system to be drained completely to below the base of pond level. A note should be made in the operation manual that no maintenance work should be carried out within the pond until the water level in the sump manhole has been lowered below the base of the pond. The sump manhole should be connected to the outfall manhole for the pond to allow captured water to flow out during regular operation. The outfall manhole should be designed to ensure that positive drainage away from the manhole is always provided for the captured water from the subdrain system.

The pond side slopes should be formed no steeper than 3H:1V in order to allow operation of the construction equipment for placement and compaction of the clay liner and ballast fill. It should be noted that for safety considerations, some municipalities stipulate that the perimeter slopes be benched at 7H:1V over the length of the slope from 1 m below to 1 m above the operating pond level.

5.9 Global Stability of Pond Cut Slopes

Slope stability analyses have been performed using the commercially available program SLIDE, developed by Rocscience Inc., at critical sections in accordance with the design information noted above, to check that the cut slopes have a global factor of safety under static conditions equal to or greater than 1.5 for long term conditions, and greater than 1.3 for short-term (unwatering)

conditions. These minimum factors of safety are considered appropriate for the proposed pond side slopes on this project, considering the design requirements and the available field and laboratory testing data.

For the normal operating conditions case, the piezometric level used in the stability analyses is based on a design groundwater level that has been assumed to be at the design groundwater level as noted above. For the dewatered (dry) pond conditions during maintenance, the piezometric level in the stability analyses has been assumed to be depressed to the base of the pond.

The results of the static global stability analyses indicate that a factor of safety greater than 1.5 is achieved for the global stability of permanent cut slopes inclined at an overall profile of 5H:1V at the irrigation pond, both under normal operating conditions and during drained (unwatered level) conditions.

5.10 Surficial Stability and Erosion Protection

The requirements for design of erosion protection measures for the water inlet and outlet works should be assessed by the hydraulic design engineer. As a minimum, rip-rap treatment for the inlet and outlet of any pipes and/or ditches/channels should be consistent with the standard presented in OPSD 810.010 (General Rip-Rap Layout for Sewer and Culvert Outlets) Rip-Rap Treatment Type A, with the rip-rap placed to above the pipe obvert, in combination with cut-off headwalls if these are adopted. Rip-rap should be provided over the full extent of the side slopes and base grade below and adjacent inlet / outlet locations.

The pond slopes above the operating water level should be vegetated as soon as practical after construction to minimize the potential for erosion due to surface water run-off, either by placement of topsoil and seeding or pegged sod. Consideration could also be given to protecting the active water line zone (i.e., from the low water level to the high-water level) with a minimum 150 mm thick layer of rip-rap; however, this may not be necessary if appropriate vegetation can be established in this zone.

In addition, a granular drainage blanket may be required to control surficial sloughing of cut slopes through saturated cohesionless soil (sand) zones or layers, if these are encountered during construction. Determination of the frequency, extent, and exact locations of such seepage zones from the limited borehole data is not possible. Therefore, an observational approach is recommended involving examination of the cut slopes during and following construction to identify any areas of water-bearing cohesionless soils; where present, a granular drainage blanket minimum 0.3 m thick should be placed on the pond cut slopes where lenses or layers or water-bearing cohesionless soils are observed to minimize surficial sloughing and/or erosion.

All the cut side slopes for the ponds should be inspected by the geotechnical engineer during construction. Where differentially erodible layers (e.g., gravel and sand seams) are encountered,

some form of blanketing, flattening of the slope angles or the like may be required depending on hydraulic considerations. The need for and the design of any blanketing or other remedial measures to address differentially erodible materials should be determined during construction by the geotechnical engineer.

5.11 Pavement Design

5.11.1 traffic information

As Site-specific traffic information was not available at the time of preparing this report, it is anticipated that the roads will only be used by passenger cars and other lightly loaded vehicles, and the following design is based on the assumption that large commercial vehicles will not use the roads on a regular basis. Based on the site roadway configuration it is anticipated that the Annual Average Daily Traffic (AADT) will be less than 1000 and commercial/truck traffic will be limited to waste collection and emergency service vehicles. The design will need to be modified if any areas are to be subjected to routine heavy-axle traffic.

5.11.2 Pavement Design Recommendations

In preparation for pavement construction, all topsoil and deleterious material (i.e., refuse, reworked material or material containing organic matter) should be removed from all pavement areas.

The pavement subgrade is variable consisting of sand to silty sand, silt and silty clay to clayey silt. The surface of the material at subgrade level should be proofrolled with a heavy smooth-drum roller under the supervision of GEMTEC personnel to identify soft or loose areas requiring sub-excavation and replacement with more suitable fill.

Sections requiring grade raising to the proposed subgrade level should be filled using acceptable (compactable and inorganic) earth borrow or SSM meeting the requirements of OPSS.MUNI 212 or 1010, respectively. These materials should be placed in maximum 300 mm thick loose lifts and should be uniformly compacted to at least 98 per cent of the material's SPMDD using suitable vibratory compaction equipment.

Based on the results of this investigation, the related frost-susceptibility characteristics of the anticipated subgrade soils, and the Center Wellington Development Manual the recommended flexible pavement design for the local roads is as follows:

Material		Thickness of Pavement Components (mm) Local Roadways (Limited Commercial Vehicles)
Asphaltic Concrete (OPSS 1150)	HL 3 Surface Course	40
	HL 4 Binder Course	50
Granular Materials (OPSS 1010)	**Base** – Granular A	150
	Subbase – Granular B Type I or Type II	450
Total Pavement Structure Thickness (mm)		690
		Prepared and Approved Subgrade

The above pavement design is based on the assumption that the pavement subgrade has been acceptably prepared (i.e., where trench backfill and any grade raise fills have been adequately compacted to the required density and the prepared subgrade surface not disturbed by construction operations or precipitation). Depending on the actual conditions of the pavement subgrade at the time of construction, it could be necessary to increase the thickness of the subbase and/or to place a robust woven geotextile beneath the granular materials.

The granular subbase materials should be placed in loose lifts not exceeding 300 mm in thickness and uniformly compacted to at least 98 per cent of SPMDD. The granular base materials should be uniformly compacted to at least 100 per cent of their SPMDD. Compaction of the granular materials and subgrade soils should be carried out at a moisture content that is within an acceptable range of the material's optimum moisture content. The asphaltic materials should be compacted to a minimum of 92 per cent of their Marshall Relative Densities (MRD), in accordance with OPSS.MUNI 310. Asphalt laboratory testing should be carried out in a CCIL certified laboratory.

It should be noted that in some cases, even though the compaction requirements have been met, the subgrade strength may not be adequate to support heavy construction loading, especially during wet weather or where backfill materials wet of optimum have been placed. In this regard, the design subbase thickness may not be sufficient for a temporary construction haul road and additional subbase (in the order of 300 mm) may be required. In all cases, the subbase should be proofrolled and inspected by a qualified geotechnical engineer prior to placing the granular base, and any additional material, as required.

It should be noted that functional drainage is critical to maintain the long-term good performance of pavements, and the surface of the subgrade should be shaped or crowned to promote drainage

of the pavement base and subbase. From a pavement design perspective, it is recommended that, except for a properly designed longitudinal profile, a minimum of 3 per cent subgrade and 2 per cent asphalt crossfall be provided. Continuous swales should be provided along the sides of the pavements, where applicable, and connected to the adjacent drainage outlet. The invert of the swales should be at least 0.3 m below the underside of the granular subbase. In areas where swales are not practical, a subdrain should be installed at each edge of the pavement, below the base of the granular subbase, and connected to the adjacent drainage outlet. The subdrain should be 150 mm in diameter, wrapped in a geotextile fabric and placed in a 300 mm by 300 mm trench filled with concrete sand conforming to OPSS.MUNI 1002.

5.12 Seismic Site Classification

The 2012 OBC contains updated seismic analysis and design methodology. Seismic hazard is defined for an earthquake with a 2% probability of exceedance in 50 years (i.e., a return period of 2,475 years). Design earthquakes are commonly defined by an earthquake magnitude, distance, and peak ground acceleration (PGA). There are six Site classes designated as A to F related to decreasing ground stiffness from A for hard rock to E for soft soil and Site class F for problematic soils (e.g., Sites underlain by thick peat deposits and/or liquefiable soils).

The conservative Site classification presented below is based on the physical borehole information obtained at depths of less than 30 m and on general knowledge of the local geology and physiography. In this regard, GEMTEC's drilling program included boreholes drilled to depths up to about 9.6 m below the existing ground surface. Based on the results of our boreholes and local knowledge, the underlying geological conditions at the Site below 9.6 m are anticipated to generally consist of very dense/hard till. Based on our borehole information, our local experience, and assuming foundations will be constructed within the competent native soils as described above, Site Class C may be used for the design of the development.

Should optimization of the Site class be recommended by the structural engineer, in situ geophysical testing should be carried out at the Site, although a higher Site class cannot be guaranteed.

5.13 Design Review and Construction Observation

It is recommended that GEMTEC be engaged during construction to confirm that the subsurface conditions throughout any proposed excavation area or the foundation elements do not materially differ from those presented in this report and that the construction methodology does not adversely affect the intent of the design.

During construction, a sufficient degree of foundation / subgrade inspections and an adequate volume of both in situ density testing and materials testing should be carried out to confirm that the exposed conditions and materials placed are consistent with those encountered in the boreholes and to monitor conformance to the pertinent project specifications. Concrete and

asphalt testing should be carried out on both the material in the field and on collected samples in a CCIL certified laboratory.

6.0 CLOSURE

We trust that this report provides sufficient geotechnical information to proceed with the detailed design of the proposed development. If you have any questions regarding the contents of this report or require additional information, please do not hesitate to contact this office.

Regards,

GEMTEC Consulting Engineers and Scientists Limited

Matthew Kelly, P. Eng.
Senior Geotechnical Engineer

Chris Kellestine, A.Sc.T., PMP
Associate VP Operations - Ontario

APPENDIX A

Conditions and Limitations of This Report

GEMTEC
Consulting Engineers and Scientists

Conditions and Limitations of This Report

1. **Standard of Care:** GEMTEC has prepared this report in a manner consistent with generally accepted engineering or environmental consulting practice in the jurisdiction in which the services are provided at the time of the report. No other warranty, expressed or implied is made.
2. **Copyright:** The contents of this report are subject to copyright owned by GEMTEC, save to the extent that copyright has been legally assigned by us to another party or is used by GEMTEC under license. To the extent that GEMTEC owns the copyright in this report, it may not be copied without our prior written agreement for any purpose other than the purpose indicated in this report. The methodology (if any) contained in this report is provided to the Client in confidence and must not be disclosed or copied to third parties without the prior written agreement of GEMTEC. Disclosure of that information may constitute an actionable breach of confidence or may otherwise prejudice our commercial interests.
3. **Complete Report:** This report is of a summary nature and is not intended to stand alone without reference to the instructions given to GEMTEC by the Client, communications between GEMTEC and the Client and to any other reports prepared by GEMTEC for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. GEMTEC can not be responsible for use of portions of the report without reference to the entire report.
4. **Basis of Report:** This Report has been prepared for the specific site, development, design objectives and purposes that were described to GEMTEC by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document, subject to the limitations provided herein, are only valid to the extent that this report expressly addresses the proposed development, design objectives and purposes. Any change of site conditions, purpose or development plans may alter the validity of the report and GEMTEC cannot be responsible for use of this report, or portions thereof, unless GEMTEC is requested to review any changes and, if necessary, revise the report.
5. **Time Dependence:** If the proposed project is not undertaken by the Client within 18 months following the issuance of this report, or within the timeframe understood by GEMTEC to be contemplated by the Client, the guidance and recommendations within the report should not be considered valid unless reviewed and amended or validated by GEMTEC in writing.
6. **Use of This Report:** The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without GEMTEC's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, GEMTEC may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process.

   Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.
7. **No Legal Representations:** GEMTEC makes no representations whatsoever concerning the legal significance of its findings, or as to other legal matters touched on in this report, including but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect to regulatory compliance issues, regulatory statutes are subject to interpretation and change. Such interpretations and regulatory changes should be reviewed with legal counsel.

8. **Decrease in property value:** GEMTEC shall not be responsible for any decrease, real or perceived, of the property or site's value or failure to complete a transaction, as a consequence of the information contained in this report.
9. **Reliance on Provided Information:** The evaluation and conclusions contained in this report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations. information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in this report as a result of misstatements, omissions, misrepresentations. or fraudulent acts of the Client or other persons providing information relied on by us. We are entitled to rely on such representations, information and instructions and are not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
10. **Investigation Limitations:** Site investigation programs are a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions but even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions.

    The data derived from the site investigation program and subsequent laboratory testing are interpreted by trained personnel and extrapolated across the site to form an inferred geological representation and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Conditions between and beyond the borehole/test hole locations may differ from those encountered at the borehole/test hole locations and the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies. Accordingly, GEMTEC does not warrant or guarantee the exactness of of the subsurface descriptions.

    Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination-or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

    In addition, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.
11. **Sample Disposal:** GEMTEC will dispose of all uncontaminated soil and/or rock samples 60 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.
12. **Follow-Up and Construction Services:** All details of the design were not known at the time of submission of GEMTEC's report. GEMTEC should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of GEMTEC's report.

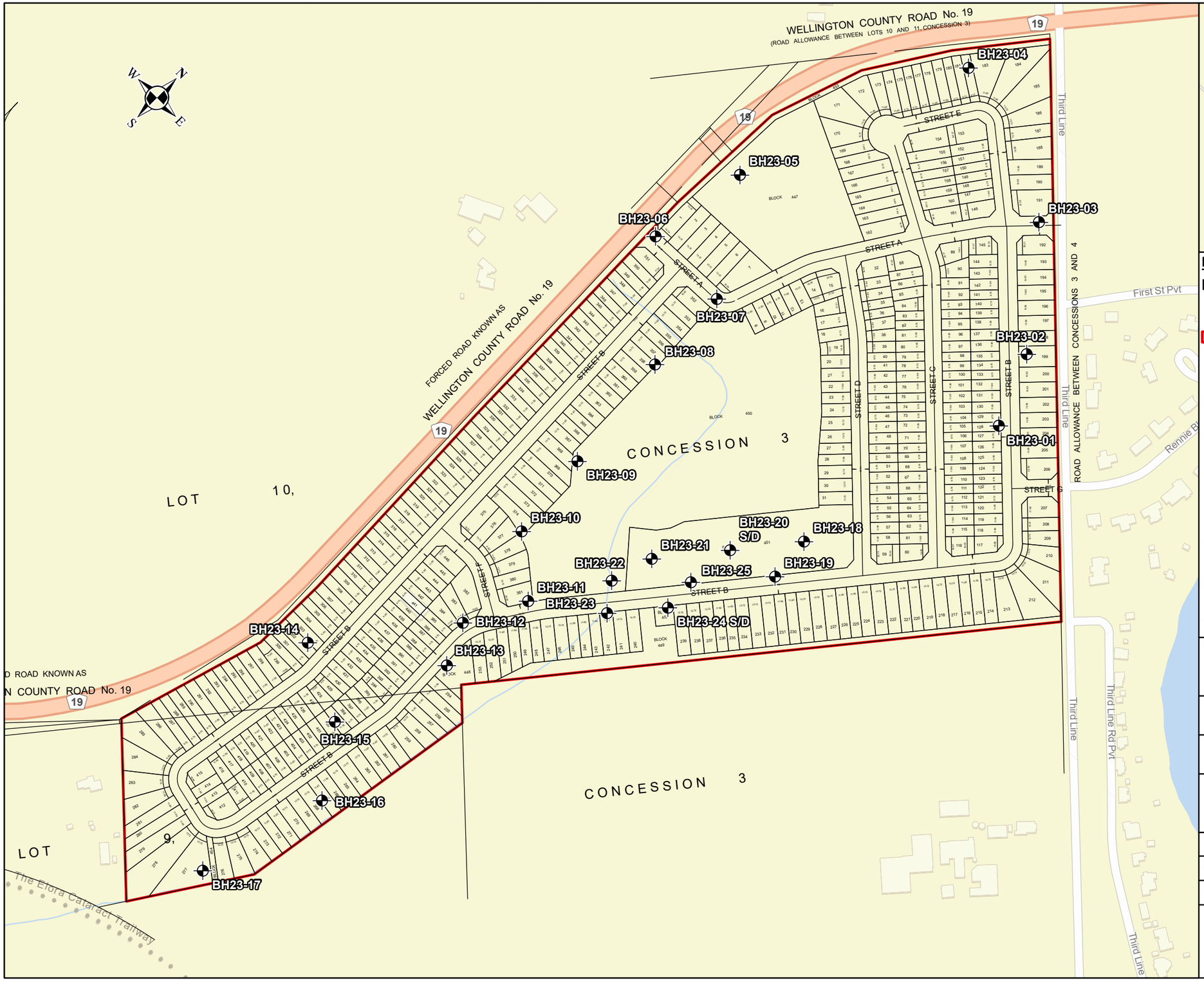
    During construction, GEMTEC should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not

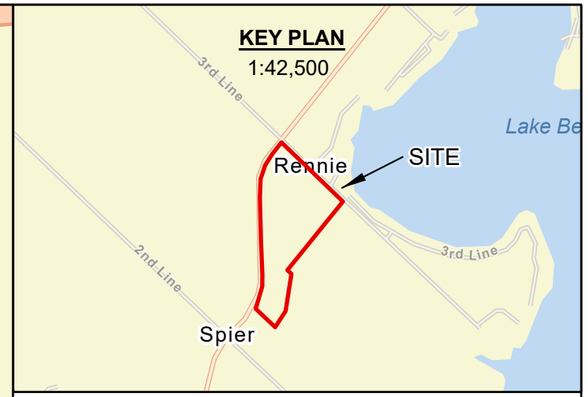
materially differ from those interpreted conditions considered in the preparation of GEMTEC's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in GEMTEC's report. Adequate field review, observation and testing during construction are necessary for GEMTEC to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, GEMTEC's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

13. **Changed Conditions:** Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that GEMTEC be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that GEMTEC be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.
14. **Drainage:** Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. GEMTEC takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

APPENDIX B

Borehole Location Plan





Legend

BH # ← BOREHOLE ID

BOREHOLE LOCATION (GEMTEC 2023)

SOUTHEAST SITE BOUNDARY

NOTES:

1. All locations approximate
2. Coordinate system: NAD 1983 UTM Zone 17N
3. Geographic dataset source: Ontario GeoHub.
4. Contains information licensed under the Open Government Licence – Ontario.
5. Base plans provided in digital format by R-PE SURVEYING LTD., drawing labeled: 21016s01a.dwg, Dated June 04, 2026.
6. Service Layer Credits: World Street Map; Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
World Street Map Background (Community Map of Canada):

Scale:

1:4,000

0 50 100 200 300 Meters

Drawing

BOREHOLE LOCATION PLAN

Client:

FERGUS DEVELOPMENT INC.

Project

FERGUS GOLF COURSE REDEVELOPMENT,
FERGUS, ONTARIO

Drwn By:	S.J.	Chkd By:	M.W.K.
Project No.	101987.017	Revision No.	0
Date	JUNE 2026		**FIGURE 1**

GEMTEC
Consulting Engineers and Scientists
6695 Millcreek DR #7,
Mississauga, ON L5N 5M4
T: (416) 347-7427
www.gemtec.ca

Folder: N:\Projects\101900\101987.017\Drafting\Sheets\GeoTech\

APPENDIX C

Borehole Records
Abbreviations and Terminology Used on Records
of Boreholes and Test Pits
Record of Boreholes BH23-01 to BH23-26

ABBREVIATIONS AND TERMINOLOGY USED ON RECORDS OF BOREHOLES AND TEST PITS

SAMPLE TYPES	
AS	Auger sample
CA	Casing sample
CS	Chunk sample
BS	Borros piston sample
GS	Grab sample
MS	Manual sample
RC	Rock core
SS	Split spoon sampler
ST	Slotted tube
TO	Thin-walled open shelby tube
TP	Thin-walled piston shelby tube
WS	Wash sample

SOIL TESTS	
w	Water content
PL, w_p	Plastic limit
LL, w_L	Liquid limit
C	Consolidation (oedometer) test
D_R	Relative density
DS	Direct shear test
G_S	Specific gravity
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	Organic content test
UC	Unconfined compression test
γ	Unit weight

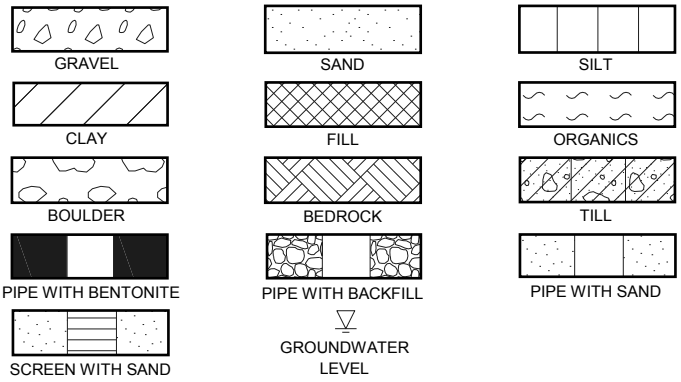
PENETRATION RESISTANCE

Standard Penetration Resistance, N
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 millimetres (30 in.) required to drive a 50 mm split spoon sampler for a distance of 300 mm (12 in.). For split spoon samples where less than 300 mm of penetration was achieved, the number of blows is reported over the sampler penetration in mm.

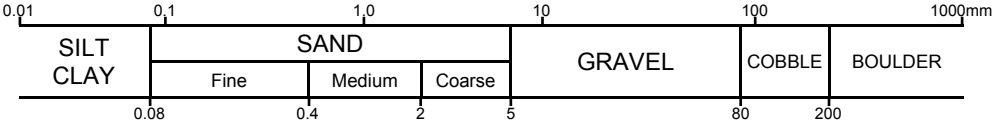
Dynamic Penetration Resistance
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive a 50 mm (2 in.) diameter 60° cone attached to 'A' size drill rods for a distance of 300 mm (12 in.).

WH	Sampler advanced by static weight of hammer and drill rods
WR	Sampler advanced by static weight of drill rods
PH	Sampler advanced by hydraulic pressure from drill rig
PM	Sampler advanced by manual pressure

COHESIONLESS SOIL Compactness		COHESIVE SOIL Consistency	
SPT N-Values	**Description**	**Cu, kPa**	**Description**
0-4	Very Loose	0-12	Very Soft
4-10	Loose	12-25	Soft
10-30	Compact	25-50	Firm
30-50	Dense	50-100	Stiff
>50	Very Dense	100-200	Very Stiff
		>200	Hard

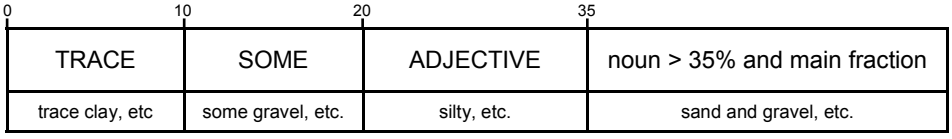


GRAIN SIZE



DESCRIPTIVE TERMINOLOGY

(Based on the CANFEM 4th Edition)



RECORD OF BOREHOLE BH23-01

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 8 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	Power Auger / Solid Stem Auger (152 mm)	Ground Surface						
		TOPSOIL		0.00				
		(ML) SILT, some silt, some sand, trace organics; dark brown; cohesive, w<PL		0.18	1	SS	356	7
1		(SM) SILTY SAND, trace to some gravel; brown; non-cohesive, moist to wet, compact		0.76	2	SS	254	16
					3	SS	254	28
2					4	SS	356	24
3					5	SS	330	12
4								
		(CL) SILTY CLAY, some sand; grey; cohesive, w~PL, stiff		4.57	6	SS	279	15
5		End of Borehole		5.03				
6		Notes: 1. Groundwater measured at approximately 3.1 m depth in open borehole upon completion of drilling.						
7								
8								
9								
10								
11								

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, % — W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/11/08	3.0 ▽	

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LOGGED: CC
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-02

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

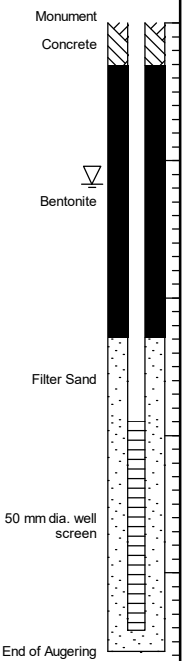
SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 15 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
		Ground Surface		428.00				
0	Power Auger Hollow Stem Auger (203 mm)	TOPSOIL		0.00 / 427.75	1	SS	330	4
		(ML) SILT, some sand, trace organics; dark brown; cohesive, w<PL		0.25 / 427.24				
1		(SM) SILTY SAND, trace gravel; brown; non-cohesive, moist to wet, loose to compact		0.76	2	SS	305	7
2					3	SS	356	13
				425.71				
		(CL) SILTY CLAY, trace gravel; grey (TILL); cohesive, w~PL, stiff to very stiff		2.29	4	SS	305	12
3								
					5	SS	457	13
4								
					6	SS	457	22
5				422.97				
		End of Borehole		5.03				
6		Notes: 1. Borehole dry upon completion of drilling. 2. Monitoring well installed as shown upon completion of drilling.						
7								
8								
9								
10								
11								

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA — NATURAL ⊕ REMOULDED
WATER CONTENT, % — W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
24/03/12	1.2 ▽	426.8

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LOGGED: CC
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-03

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 15 2023

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Solid Stem Auger (152 mm)	Ground Surface								
		TOPSOIL		0.00	1	SS	356	3		
		(ML) SILT, some sand, trace gravel; dark brown; cohesive, w<PL, stiff		0.25						
1					2	SS	356	14		
		(CL) SILTY CLAY, trace sand, trace gravel; grey (TILL); cohesive, w<PL to w~PL, very stiff to hard		1.52	3	SS	305	19		
2					4	SS	457	19	MH	
3					5	SS	254	45		
4										
5					6	SS	457	73		
		End of Borehole		5.03						
6										
7										
8										
9										
10										
11										

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: NATURAL, REMOULDED
WATER CONTENT, %: W_P, W, W_L
10 20 30 40 50 60 70 80 90

Notes:

1. Groundwater measured at approximately 1.5 m depth in open borehole upon completion of drilling.

2. Borehole backfilled with bentonite upon completion of drilling.

GEMTEC
Consulting Engineers and Scientists

LOGGED: CC
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-04

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 15 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	Power Auger / Solid Stem Auger (152 mm)	Ground Surface						
		TOPSOIL		0.00				
		(ML) SILT, some sand, trace gravel, trace organics; dark brown; cohesive, w<PL, firm		0.18	1	SS	203	6
1		(CL-ML) SILTY CLAY to CLAYEY SILT, some sand, some gravel; brown to grey (TILL), cohesive, w<PL, very stiff to hard		0.76	2	SS	457	19
2					3	SS	457	44
					4	SS	330	55
3		- auger grinding between approximately 2.9 m and 4.4 m depths			5	SS	381	50 / 0.15
4								
5					6	SS		56
		End of Borehole		5.03				
6		Notes: 1. Borehole open and dry upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.						
7								
8								
9								
10								
11								

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L

10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

GEMTEC
Consulting Engineers and Scientists

LOGGED: CC
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-05

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 9 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Solid Stem Auger (152 mm)	Ground Surface								
		TOPSOIL		0.00	1	SS	330	2		
		(ML) SILT, some sand, trace gravel, trace organics; brown; cohesive, w<PL		0.25						
1		(SP/ML) SAND and SILT, trace gravel; brown; non-cohesive, moist to wet, loose to dense		0.76	2	SS	381	4		
					3	SS	178	35	MH	
2		(CL-ML) CLAYEY SILT to SILTY CLAY, trace to some sand, trace to some gravel; brown to grey (TILL); cohesive, w<PL to w~PL, hard		2.13	4	SS	432	79		
3					5	SS	432	87		
4					6	SS	102	50 / 0.03		
		End of Borehole:		4.27						
5		Notes: 1. Borehole open and dry upon completion of drilling. 2. Borehole backfilled with soil cuttings upon completion of drilling.								
6										
7										
8										
9										
10										
11										

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

GEMTEC
Consulting Engineers and Scientists

LOGGED: CC
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-06

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 9 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0		Ground Surface						
		TOPSOIL		0.00	1	SS	229	6
		(ML) SILT, some sand, trace organics; dark brown; cohesive, w~PL		0.20				
1	Power Auger / Solid Stem Auger (152 mm)	(CL-ML) CLAYEY SILT to SILTY CLAY, trace to some sand, trace gravel; brown to grey (TILL); w<PL to w>PL, stiff to hard		0.76	2	SS	432	13
					3	SS	457	13
2					4	SS	406	73 / 0.10
3					5	SS	330	50 / 0.10
4					6	SS	457	77
5								
6					7	SS	432	50 / 0.08
7								
8					8	SS	381	50 / 0.13
9		(SM) gravelly SILTY SAND; grey; non-cohesive, moist to wet, very dense		9.14	9	SS	102	50 / 0.15
10		End of Borehole		9.60				
11		Notes: 1. Groundwater measured at approximately 1.0 m depth in open borehole upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.						

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, % W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/11/09	0.9 ▽	

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Consulting Engineers and Scientists

LOGGED: CC
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-07

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 3 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m ● / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m ▲	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Solid Stem Auger (152 mm)	Ground Surface										
		TOPSOIL		0.00								
		(SM) SILTY SAND, trace clay; light brown; non-cohesive; moist, loose		0.18	1	SS	356	4	●			
1		(CL) SILTY CLAY, trace to some sand, trace gravel; light brown to grey (mottled); cohesive, w<PL to w~PL, stiff to very stiff		0.76	2	SS	203	10	●			
					3	SS	203	18	●			
2		- auger grinding between approximately 2.0 m to 3.0 m depths										▽
		(CL) gravelly SILTY CLAY, some gravel, trace sand; grey (TILL); cohesive, w<PL to w~PL, hard		2.29	4	SS	152	90 / 0.25				
3					5	SS	152	80 / 0.25	○			
		End of Borehole		3.51								
4		Notes: 1. Groundwater measured at approximately 2.4 m depth in open borehole upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.										
5												
6												
7												
8												
9												
10												
11												

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/11/03	2.4 ▽	

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-08

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 3 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface								
0	Power Auger Solid Stem Auger (127 mm)	TOPSOIL		0.00						
		(SM) SILTY SAND, trace to some clay; light brown to brown; non-cohesive, moist to wet, compact		0.15	1	SS	356	4		
1					2	SS	254	20		
2					3	SS	406	23		
		(CL-ML) CLAYEY SILT to SILTY CLAY, trace to some gravel, trace to some sand; brown to grey (TILL); cohesive, w<PL to w~PL, hard		2.29	4	SS	152	64	MH	
3					5	SS	203	100 / 0.25		
		End of Borehole		3.51						
4		Notes: 1. Groundwater measured at approximately 1.5 m depth in open borehole upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.								
5										
6										
7										
8										
9										
10										
11										

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: NATURAL, REMOULDED
WATER CONTENT, %: W_P, W, W_L
10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/11/03	1.5 ▽	

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LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-09

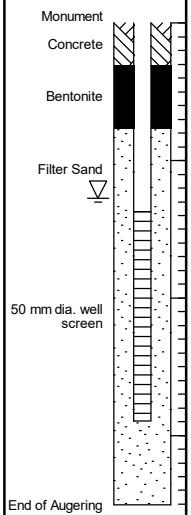
CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 16 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	SHEAR STRENGTH (Cu), kPA (NATURAL / REMOULDED) / WATER CONTENT, %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Solid Stem Auger (152 mm)	Ground Surface		428.80								
		TOPSOIL		0.00 / 428.60								
		(CL-ML) CLAYEY SILT to SILTY CLAY, some sand, trace gravel; brown to grey (TILL); cohesive, w<PL, stiff to hard		0.20	1	SS	406	7				
1					2	SS	457	17				
2					3	SS	457	14				
					4	SS	254	68				
3					5	SS	305	70				
		End of Borehole		425.29 / 3.51								
4		Notes: 1. Borehole dry upon completion of drilling. 2. Monitoring well installed as shown upon completion of drilling.										
5												
6												
7												
8												
9												
10												
11												

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
24/03/12	1.3 ▽	427.5

GEMTEC
Consulting Engineers and Scientists

LOGGED: CC
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-10

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 1 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0		Ground Surface						
		TOPSOIL		0.00				
		(SM) SILTY SAND, trace clay; brown; non-cohesive, moist		0.15	1	SS	152	4
1	Power Auger Solid Stem Auger (127 mm)	(CL-ML) CLAYEY SILT to SILTY CLAY, trace to some sand, trace gravel; brown (TILL); cohesive, w<PL, stiff to hard		0.76	2	SS	305	12
					3	SS	406	14
2					4	SS	356	59
3					5	SS	406	61
		End of Borehole		3.51				
4		Notes:						
		1. Borehole open and dry upon completion of drilling.						
5		2. Borehole backfilled with bentonite upon completion of drilling.						
6								
7								
8								
9								
10								
11								

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, % — W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-11

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 2 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Solid Stem Auger (127 mm)	Ground Surface								
		TOPSOIL		0.00	1	SS	356	5		
		(SM) SILTY SAND, trace gravel; light brown; non-cohesive, moist to wet, compact		0.36	2	SS	152	13		
2		(CL-ML) CLAYEY SILT to SILTY CLAY, trace to some gravel, trace to some sand; light brown to grey (TILL); cohesive, w<PL to w~PL, hard		1.52	3	SS	406	10	MH	
					4	SS	457	6		
3					5	SS	254	47		
		End of Borehole 1. Borehole open and dry upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.		3.51						
4										
5										
6										
7										
8										
9										
10										
11										

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA
NATURAL REMOULDED
WATER CONTENT, %
W_P W W_L
10 20 30 40 50 60 70 80 90

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-12

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 1 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA / WATER CONTENT, %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Solid Stem Auger (127 mm)	Ground Surface									
		TOPSOIL		0.00							
		(SC) CLAYEY SAND, trace gravel; brown: non-cohesive, moist, loose		0.20	1	SS	203	7			
1					2	SS	305	8			
		(CL-ML) CLAYEY SILT to SILTY CLAY, trace to some gravel, trace to some sand, light brown to grey (TILL), cohesive, w<PL to w~PL, very stiff to hard		1.52	3	SS	406	22			
2					4	SS	406	32			
3					5	SS	457	43			
4					6	SS	102	50 / 0	13		
5											
6					7	SS	76	50 / 0	13		
7											
					8	SS	76	50 / 0	13		
8		End of Borehole		7.75							
		Notes: 1. Groundwater measured at approximately 4.9 m depth in open borehole upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.									
9											
10											
11											

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/11/01	4.9 ▽	

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Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-13

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 1 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m ● / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m ▲	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Solid Stem Auger (127 mm)	Ground Surface										
		TOPSOIL		0.00								
		(SM) SILTY SAND, trace gravel; dark brown to brown, non-cohesive, moist, loose		0.20	1	SS	305	10	●			
1					2	SS	305	4	● ○			
		(CL) SILTY CLAY, some sand, trace gravel; brown; cohesive, w~PL, soft		1.52	3	SS	457	4	●			▽
2												
		(CL-ML) CLAYEY SILT to SILTY CLAY, trace to some sand, some gravel; brown to grey (TILL), cohesive, w<PL to w~PL, hard		2.29	4	SS	406	33	○ ●			
3					5	SS	457	58	●			
		- auger grinding between approximately 3.6 m to 4.4 m depths										
4					6	SS	51	50 / 0.08	○			
		End of Borehole		4.65								
5		Notes:										
		1. Groundwater measured at approximately 1.8 m depth in open borehole upon completion of drilling.										
6		2. Borehole backfilled with bentonite upon completion of drilling.										
7												
8												
9												
10												
11												

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/11/01	1.8 ▽	

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-14

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 31 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA / WATER CONTENT, %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface									
		TOPSOIL		0.00	1	SS	356	7			
		(CL-ML) CLAYEY SILT to SILTY CLAY, some sand, some gravel; brown (TILL); cohesive, w~PL, stiff to hard		0.25							
1	Power Auger Solid Stem Auger (127 mm)				2	SS	406	12			
					3	SS	356	11			
2		- auger grinding between approximately 2.5 m to 3.1 m depths			4	SS	457	57			
3					5	SS	457	70			
		End of Borehole		3.51							
4		Notes: 1. Borehole open and dry upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.									
5											
6											
7											
8											
9											
10											
11											

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-15

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 1 2023

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m; DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED); WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, Solid Stem Auger (127 mm)	Ground Surface									
		TOPSOIL		0.00							
		(SM) SILTY SAND, some gravel; brown; non-cohesive, moist, loose		0.15	1	SS	152	8			
1					2	SS	102	6			
		- auger grinding between approximately 1.5 m to 7.6 m depths		1.52							
2		(CL-ML) CLAYEY SILT to SILTY CLAY, some sand, trace to some gravel; brown to grey (TILL); cohesive, w<PL, very stiff to hard			3	SS	457	18			
					4	SS	406	33			
3					5	SS	406	57			
4					6	SS	406	50 / 0.10			
5											
6					7	SS	152	50 / 0.13			
7											
8		End of Borehole		7.90	8	SS	203	50 / 0.13			
9		Notes: 1. Borehole open and dry upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.									
10											
11											

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-16

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 31 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface								
0	Power Auger Solid Stem Auger (127 mm)	TOPSOIL		0.00	1	SS	305	7		
		(SM) SILTY SAND, trace to some silt, trace gravel; brown to grey; moist to wet, compact		0.30						
1					2	SS	305	20		
					3	SS	254	18	MH	
2					4	SS	406	17		
3					5	SS	356	28		
		(CL-ML) CLAYEY SILT to SILTY CLAY, trace gravel, trace sand; grey (TILL); cohesive, w<PL to w~PL, hard - auger grinding between approximately 3.8 m to 4.6 m dpeths		3.51						
4										
5					6	SS	406	110		
		End of Borehole		5.03						
6										
7										
8										
9										
10										
11										

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA
NATURAL REMOULDED
WATER CONTENT, %
W_P W W_L
10 20 30 40 50 60 70 80 90

Notes:

1. Groundwater measured at approximately 1.8 m depth in open borehole upon completion of drilling.

2. Borehole backfilled with bentonite upon completion of drilling.

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/10/31	1.8 ▽	

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-17

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 31 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger / Solid Stem Auger (127 mm)	Ground Surface									
		TOPSOIL		0.00	1	SS	381	5			
		(SM) SILTY SAND, trace clay; brown; non-cohesive, moist to wet		0.28							
1		(SP) SAND, some silt, trace to some gravel, trace clay; brown to light brown; non-coheisve, moist to wet, compact		0.76	2	SS	305	15			
					3	SS	356	18			
2					4	SS	406	10			
3					5	SS	381	18			
4		- auger grinding between approximately 3.8 m to 4.6 m depths			6A	SS	457	89			
5		(CL-ML) CLAYEY SILT to SILTY CLAY, some sand, some gravel; brown to grey (TILL); cohesive, w<PL, hard		4.80	6B						
		End of Borehole		5.03							
6		Notes: 1. Groundwater measured at approximately 1.8 m depth in open borehole upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.									
7											
8											
9											
10											
11											

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/10/31	1.8 ▽	

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-18

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 3 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface								
0	Power Auger Solid Stem Auger (127 mm)	TOPSOIL		0.00	1	SS	229	8		
		(SM) SILTY SAND, some silt; light brown; non-cohesive, wet, compact		0.23						
1					2	SS	254	22		
2					3	SS	406	12	MH	
					4	SS	457	12		
3		(CL) SILTY CLAY, trace gravel, trace sand; grey (TILL); cohesive, w<PL to w~PL, very stiff		3.05	5	SS	254	17		
		End of Borehole		3.51						
4		Notes: 1. Groundwater measured at approximately 0.9 m depth in open borehole upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.								
5										
6										
7										
8										
9										
10										
11										

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, % — W_P W W_L
10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/11/03	0.9 ▽	

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-19

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 3 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Solid Stem Auger (127 mm)	Ground Surface								
		TOPSOIL		0.00						
		(SM) SILTY SAND, trace gravel, trace clay; light brown; non-coheisve, moist to wet, compact		0.15	1	SS	381	9		
1					2	SS	203	13		
		(SP) SAND, trace to some silt; light brown; non-cohesive, wet, compact		1.52	3	SS	457	13		
2		(CL-ML) SILTY CLAY to CLAYEY SILT, trace gravel, trace sand; light brown to grey (TILL); cohesive, w<PL to w~PL, stiff		2.29	4	SS	254	8		
3					5	SS	152	15	MH	
		End of Borehole		3.51						
4		Notes: 1. Groundwater measured at approximately 0.9 m depth in open borehole upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.								
5										
6										
7										
8										
9										
10										
11										

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: NATURAL, REMOULDED
WATER CONTENT, %: W_P, W, W_L
10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/11/03	0.9 ▽	

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-20D

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 2
DATUM: CGVD28
BORING DATE: Nov 7 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, Hollow Stem Auger (203 mm)	Ground Surface		426.60							Monument
		TOPSOIL		426.45 / 0.00							Concrete
		(SM) SILTY SAND; light brown to grey; non-cohesive, moist		0.15	1	SS	305	6			
				425.84							
1		(SP) SAND, some silt; light brown to grey; non-cohesive, wet, loose		0.76	2	SS	152	8			
				425.08							
2		(CL-ML) SILTY CLAY to CLAYEY SILT, trace to some gravel, trace to some sand; light brown to grey (TILL), cohesive, w<PL to w~PL, stiff to hard		1.52	3	SS	203	14			
					4	SS	356	14			
3					5	SS	203	14			Bentonite
4		- auger grinding between approximately 3.7 m to 9.1 m depths									
					6	SS	406	22			
5											
6					7	SS	406	51		MH	
7											Filter Sand
8					8	SS	457	57			50 mm dia. well screen
9					9	SS	457	90			End of Augering
				417.00 / 9.60							
10		End of Borehole Notes: 1. Borehole dry upon completion of drilling. 2. Refusal encountered at approximately 6.7 m depth. Borehole moved approximately 1 m east.									
11											

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-20D

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 2 OF 2
DATUM: CGVD28
BORING DATE: Nov 7 2023

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, mm	SAMPLES: BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m; DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED); WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
11		3. Monitoring well installed as shown upon completion of drilling.									
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											

10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
24/03/12	1.2 ▽	425.4

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-20S

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 7 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger / Hollow Stem Auger (203 mm)	Ground Surface		426.60							Monument, Concrete
		- Refer to BH23-20D for coresponding lithology information.		0.00							
1											Bentonite
2											
3											Filter Sand
4											50 mm dia. well screen
5											
6											
				419.89							
7		End of Borehole 1. Monitoring well installed as shown upon completion of drilling.		6.71							End of Augering
8											
9											
10											
11											

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
24/03/12	1.1 ▽	425.5

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-21

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 3 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	Power Auger Solid Stem Auger (127 mm)	Ground Surface						
		TOPSOIL		0.00	1	SS	254	9
		(SM) SILTY SAND; brown; non-coheisve, moist		0.25				
1		(SP) SAND, some silt, trace gravel; brown; non-cohesive, wet, compact		0.76	2	SS	406	16
2		(CL) SILTY CLAY, trace to some sand, trace gravel; grey (TILL); w~PL to w>PL, stiff to very stiff		1.52	3	SS	254	9
					4	SS	203	15
3		(ML) SILT, some sand; grey; non-cohesive, wet, compact		3.05	5	SS	76	15
		End of Borehole		3.51				
4		Notes:						
		1. Groundwater measured at approximately 0.6 m depth in open borehole upon completion of drilling.						
5		2. Borehole backfilled with bentonite upon completion of drilling.						
6								
7								
8								
9								
10								
11								

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/11/03	0.6 ▽	

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-22

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 2 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger / Hollow Stem Auger (203 mm)	Ground Surface		426.30						
		TOPSOIL		426.05 0.25	1	SS	254	7		
		(SM) SILTY SAND; brown; non-cohesive, moist		425.54 0.76						
1		(SP) gravelly SAND to SAND, some gravel, some silt, trace clay; non-cohesive, moist to wet, compact			2	SS	152	11		
					3	SS	152	20		
2				424.01						
		(ML) gravelly CLAYEY SILT, some sand; cohesive, grey (TILL); w<PL, very stiff to hard		2.29	4	SS	203	28	MH	
3					5	SS	152	90		
				422.49						
4		End of Borehole (auger refusal)		3.81						
5		Notes: 1. Groundwater measured at approximately 0.6 m depth in open borehole upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.								
6										
7										
8										
9										
10										
11										

SOIL PROFILE / SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/11/02	0.6 ▽	425.7

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-23

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 2 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	SHEAR STRENGTH (Cu), kPA (NATURAL / REMOULDED) / WATER CONTENT, %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger / Solid Stem Auger (127 mm) / Hollow Stem Auger (203 mm)	Ground Surface										
		TOPSOIL		0.00	1	SS	356	6				
		(SM) SILTY SAND; light brown to brown; non-coheisve, moist, compact,		0.36								
1					2	SS	254	12				
		(SP) SAND, trace to some silt, trace gravel; light brown; non-cohesive, moist to wet, loose to compact		1.52	3	SS	203	14				
2												
					4	SS	305	18			MH	
3												
					5	SS	152	9				
4												
		(ML) SILT, trace gravel to gravelly; grey (TILL); cohesive, w<PL to w~PL, very stiff to hard		4.57	6	SS	152	26				
5												
6					7	SS	51	50 / 0	13			
7												
					8	SS	102	50 / 0	15			
8		End of Borehole (auger refusal)		7.92								
		Notes: 1. Groundwater measured at approximately 1.8 m depth in open borehole upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.										
9												
10												
11												

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/11/02	1.8 ▽	

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-24D

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 6 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING
		Ground Surface		426.70					
0	Power Auger Hollow Stem Auger (203 mm)	TOPSOIL		426.55 0.00					
		(SP/SM) SAND, some silt to silty; brown; non-cohesive, moist, compact		0.15	1	SS	305	11	
1					2	SS	254	18	
				425.18					
		(ML) SILT, some sand, trace gravel; grey (TILL); non-cohesive, compact to dense, moist		1.52	3	SS	305	14	
2					4	SS	305	41	NP
		- auger grinding between approximately 2.7 m and 8.9 m depths							
3				423.60					
		(CL-ML) SILTY CLAY to CLAYEY SILT, some sand to sandy, some gravel; grey (TILL); cohesive, w<PL, hard		3.10	5	SS	254	40	
4									
					6	SS	356	52	
5									
6					7	SS	254	65	
7									
					8	SS	254	76	
8									
9					9	SS	254	61	
				417.10					
		End of Borehole		9.60					
10		Notes:							
		1. Borehole dry upon completion of drilling.							
		2. Monitoring well installed as shown upon completion of drilling.							
11									

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P W W_L
10 20 30 40 50 60 70 80 90

PIEZOMETER OR STANDPIPE INSTALLATION

Monument
Concrete
Bentonite
Filter Sand
50 mm dia. well screen
End of Augering

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
24/03/12	1.2 ▽	425.5

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-24S

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 7 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m; DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH (Cu), kPA (+ NATURAL, ⊕ REMOULDED); WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Hollow Stem Auger (203 mm)	Ground Surface		426.70					10 20 30 40 50 60 70 80 90		Monument, Concrete
		- Refer to BH23-24D for coresponding lithology information.		0.00							
1											Bentonite
2											Filter Sand
3											50 mm dia. well screen
4				422.13							End of Augering
		End of Borehole 1. Monitoring well installed as shown upon completion of drilling.		4.57							
5											
6											
7											
8											
9											
10											
11											

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
24/03/12	1.0 ▽	425.7

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-25

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 2 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Solid Stem Auger (127 mm)	Ground Surface									
		TOPSOIL		0.00	1	SS	279	7			
		(SP) SAND, some silt, trace gravel; grey; non-cohesive, wet, loose		0.28							
1					2	SS	356	8			
					3A	SS	457	17			
2		(CL-ML) SILTY CLAY to CLAYEY SILT, trace to some gravel, trace sand; grey (TILL); cohesive, w<PL to w~PL, stiff to hard		1.83	3B						
					4	SS	457	26			
3					5	SS	76	50 / 0			
		End of Borehole		3.15							
4		Notes: 1. Groundwater measured at approximately 0.9 m depth in open borehole upon completion of drilling. 2. Borehole backfilled with bentonite upon completion of drilling.									
5											
6											
7											
8											
9											
10											
11											

10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/11/02	0.9 ▽	

GEMTEC
Consulting Engineers and Scientists

LOGGED: RH
CHECKED: MWK

GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

RECORD OF BOREHOLE BH23-26

CLIENT: Fergus Development Inc.
PROJECT: Fergus Golf Course Redevelopment, Fergus, Ontario
JOB#: 101987.017
LOCATION: See Borehole Location Plan

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Nov 9 2023

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
		Ground Surface		432.20				
0	Power Auger / Solid Stem Auger (152 mm)	TOPSOIL		0.00 / 431.97	1	SS	279	6
		(ML) SILT, some sand, trace gravel; dark brown; coheisve, w<PL, firm		0.23 / 431.44				
1		(CL-ML) sandy SILTY CLAY, trace gravel; grey (TILL); cohesive, w<PL, stiff to hard		0.76	2	SS	330	22
					3	SS	356	14
2					4	SS	432	65
		- auger grinding between approximately 2.7 m and 3.1 m depths			5	SS	457	50 / 0.08
3								
4					6	SS	279	50 / 0.14
5		End of Borehole		427.17 / 5.03				
6		Notes: 1. Borehole open and dry upon completion of drilling. 2. Borehole was backfilled with soil cuttings upon completion of drilling. 3. Ground surface interpolation derived from '21016tp07a.dwg' (RP-E Surveying, December 7, 2023). Location not yet surveyed.						
7								
8								
9								
10								
11								

SOIL PROFILE | SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

GEMTEC
Consulting Engineers and Scientists

LOGGED: CC
CHECKED: MWK

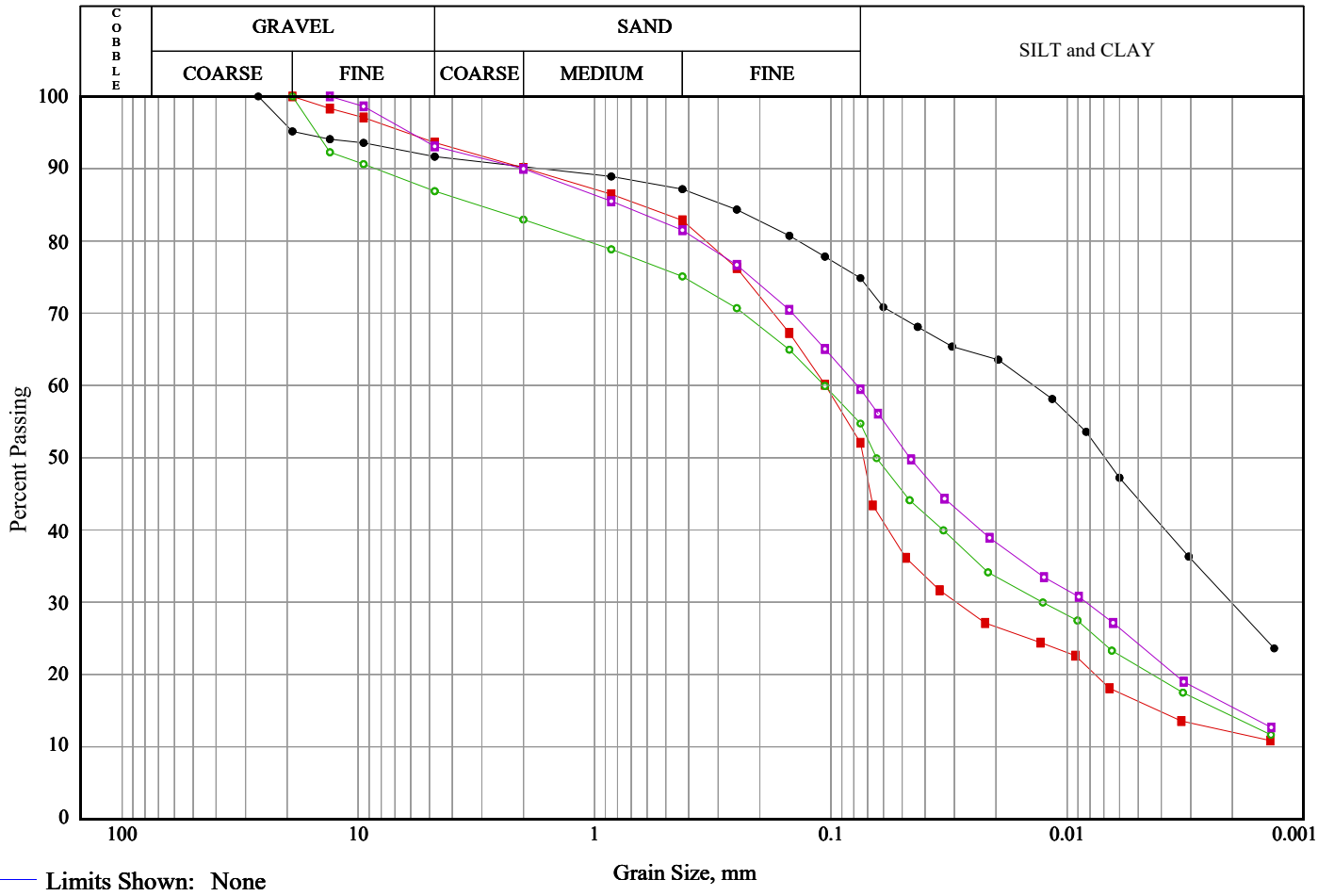
GEO - BOREHOLE LOG 101987.017_FERGUSSOUTH_GEOTECH_R0_2023_11_14.GPJ GEMTEC 2018.GDT 4/18/24

APPENDIX D

Geotechnical Laboratory Testing Results

GEMTEC Consulting Engineers and Scientists	Client: Fergus Development Inc.	Soils Grading LS-702/ASTM D-422
	Project: Fergus Golf Course Redevelopment, Fergus, Ontario	
	Project #: 101987017	

Note: More information available upon request



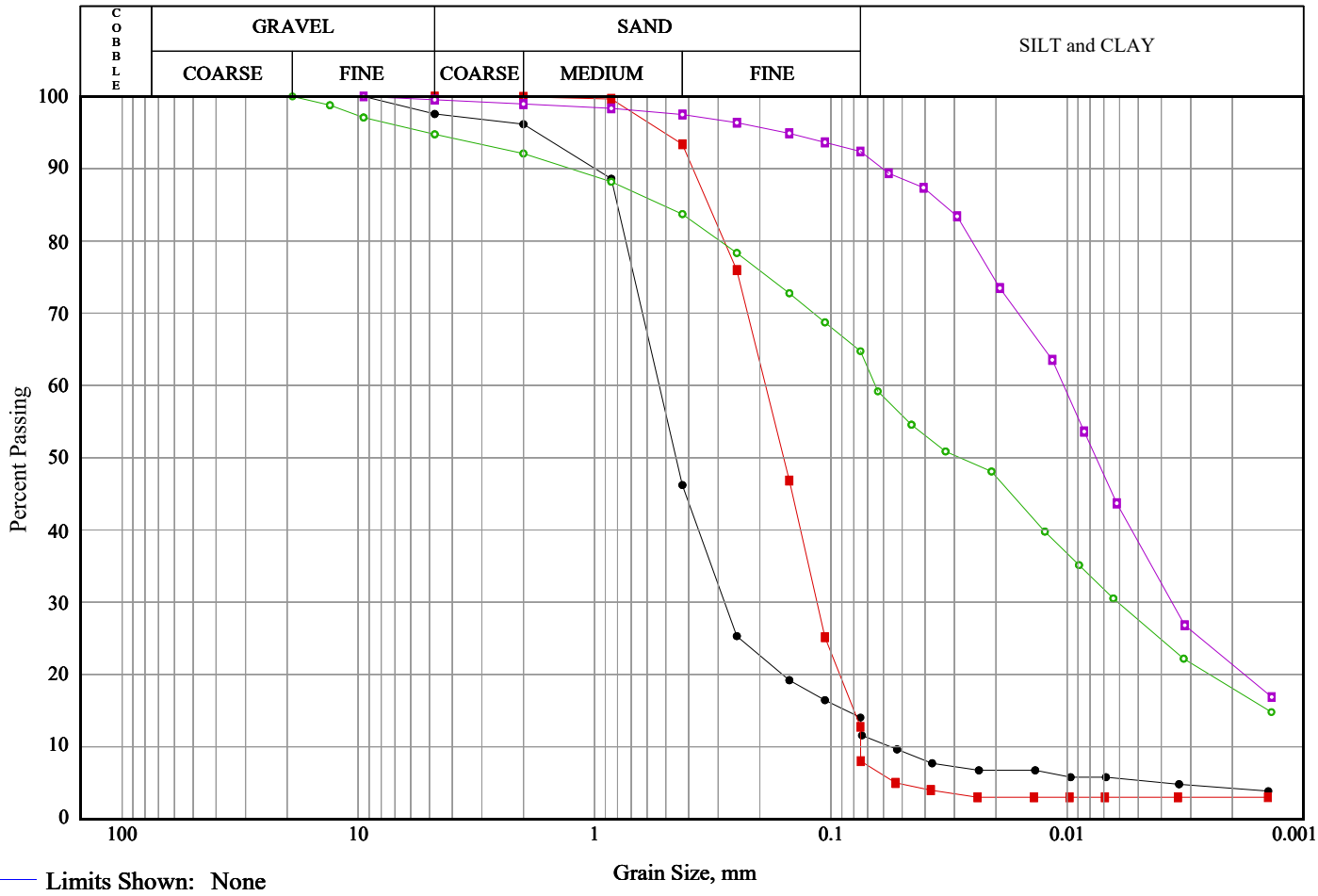
Limits Shown: None

Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt and Clay
●	TILL	BH23-3	SA-4	2.3-2.7	8.3	16.8	74.9
■		BH23-5	SA-3	1.5-2.0	6.4	41.5	52.1
○	TILL	BH23-8	SA-4	2.3-2.7	13.1	32.2	54.7
□	TILL	BH23-11	SA-3	1.5-2.0	6.9	33.6	59.4

Line Symbol	USCS Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
●	Silty clay , some sand , trace gravel	CL	---	---	0.00	0.01	0.01	0.28	30.6
■	Sand and silt , some clay , trace gravel	N/A	---	0.00	0.03	0.07	0.11	0.64	35.8
○	Clayey sand and silt , some gravel	CL-ML	---	0.00	0.01	0.06	0.11	3.14	33.6
□	Sandy clayey silt , trace gravel	N/A	---	0.00	0.01	0.05	0.08	0.78	35.2

GEMTEC Consulting Engineers and Scientists	Client: Fergus Development Inc.	Soils Grading LS-702/ASTM D-422
	Project: Fergus Golf Course Redevelopment, Fergus, Ontario	
	Project #: 101987017	

Note: More information available upon request



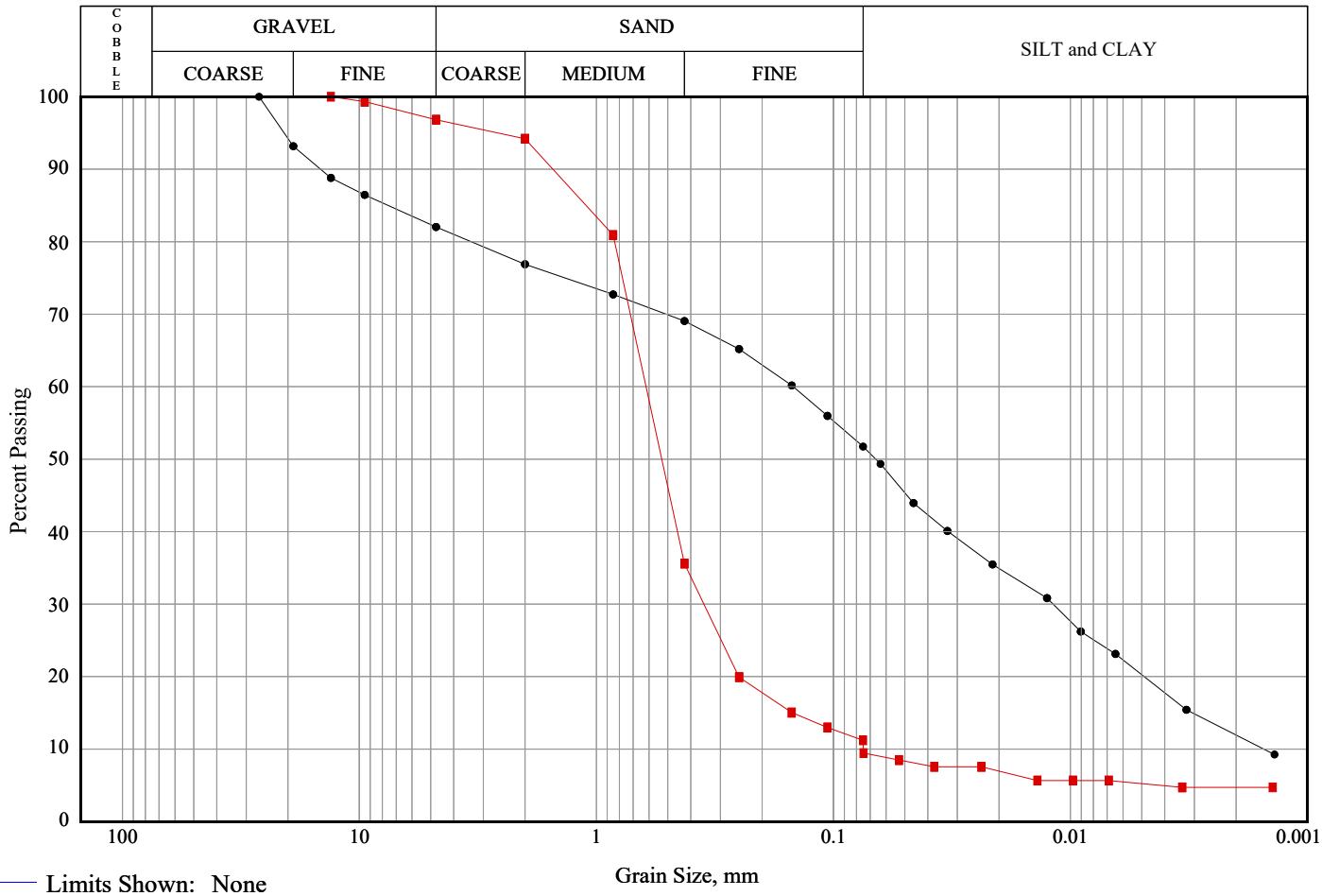
Limits Shown: None

Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt and Clay
		BH23-16	SA-3	1.5-2.0	2.4	83.5	14.1
		BH23-18	SA-3	1.5-2.0	0.0	87.2	12.8
	TILL	BH23-19	SA-5	3.0-3.5	5.2	30.0	64.8
	TILL	BH23-20	SA-7	6.1-6.6	0.5	7.2	92.4

Line Symbol	USCS Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
	Sand , trace gravel, trace silt, trace clay	N/A	0.06	0.09	0.28	0.45	0.53	0.80	8.7
	Sand , trace silt, trace clay	N/A	0.07	0.08	0.11	0.16	0.19	0.33	9.8
	Sandy clayey silt , trace gravel	CL-ML	---	0.00	0.01	0.03	0.06	0.52	37.2
	Silt and clay , trace gravel, trace sand	ML	---	---	0.00	0.01	0.01	0.03	54.1

GEMTEC Consulting Engineers and Scientists	Client: Fergus Development Inc. Project: Fergus Golf Course Redevelopment, Fergus, Ontario Project #: 101987017	Soils Grading LS-702/ASTM D-422

Note: More information available upon request

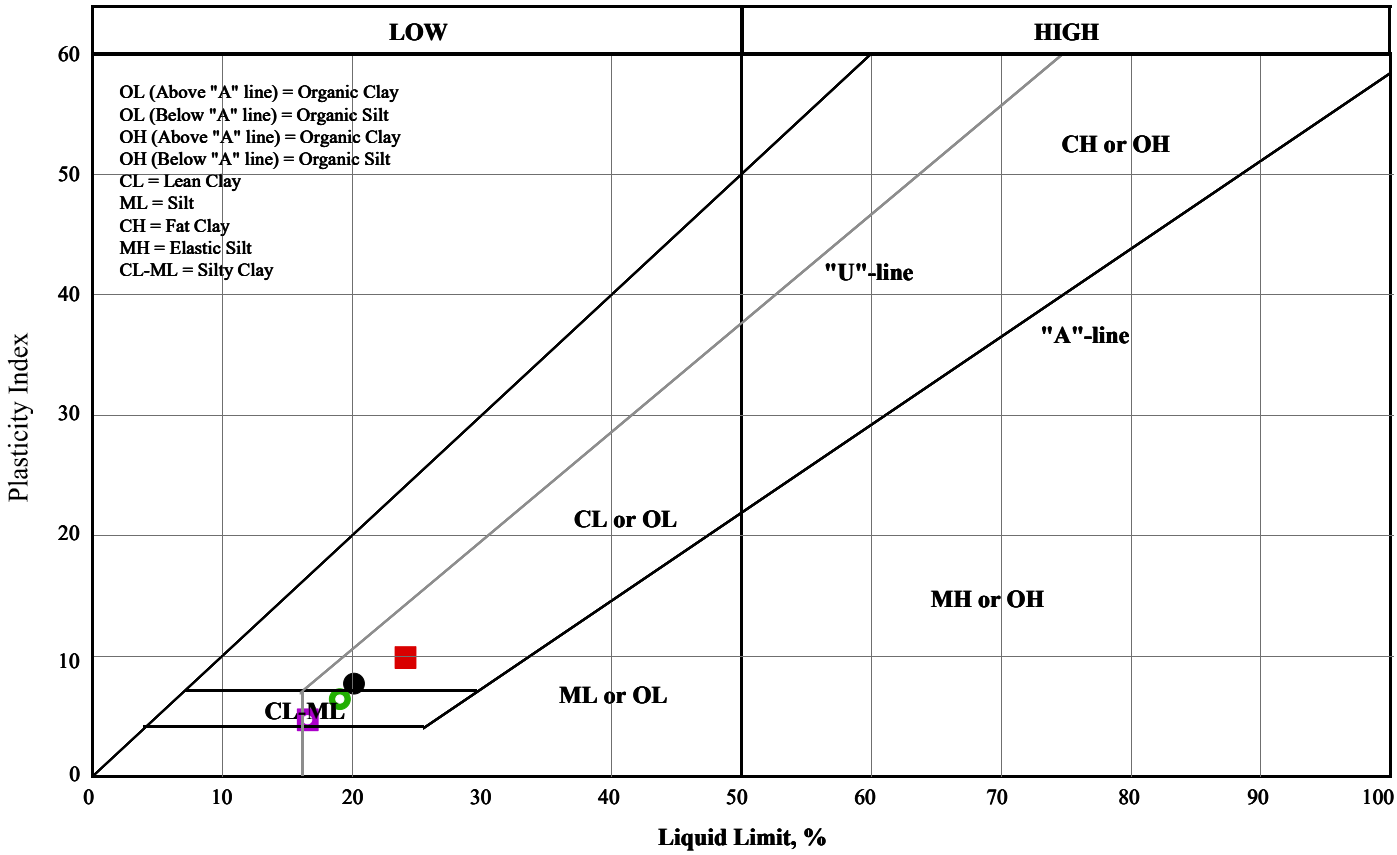


Limits Shown: None

Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt and Clay
●	TILL	BH23-22	SA-4	2.3-2.7	18.0	30.3	51.8
■		BH23-23	SA-4	2.3-2.7	3.2	85.6	11.2

Line Symbol	USCS Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
●	Clayey sand and silt , some gravel	ML	0.00	0.00	0.01	0.07	0.15	7.56	31.5
■	Sand , trace gravel, trace silt, trace clay	N/A	0.07	0.15	0.35	0.53	0.62	1.11	6.0

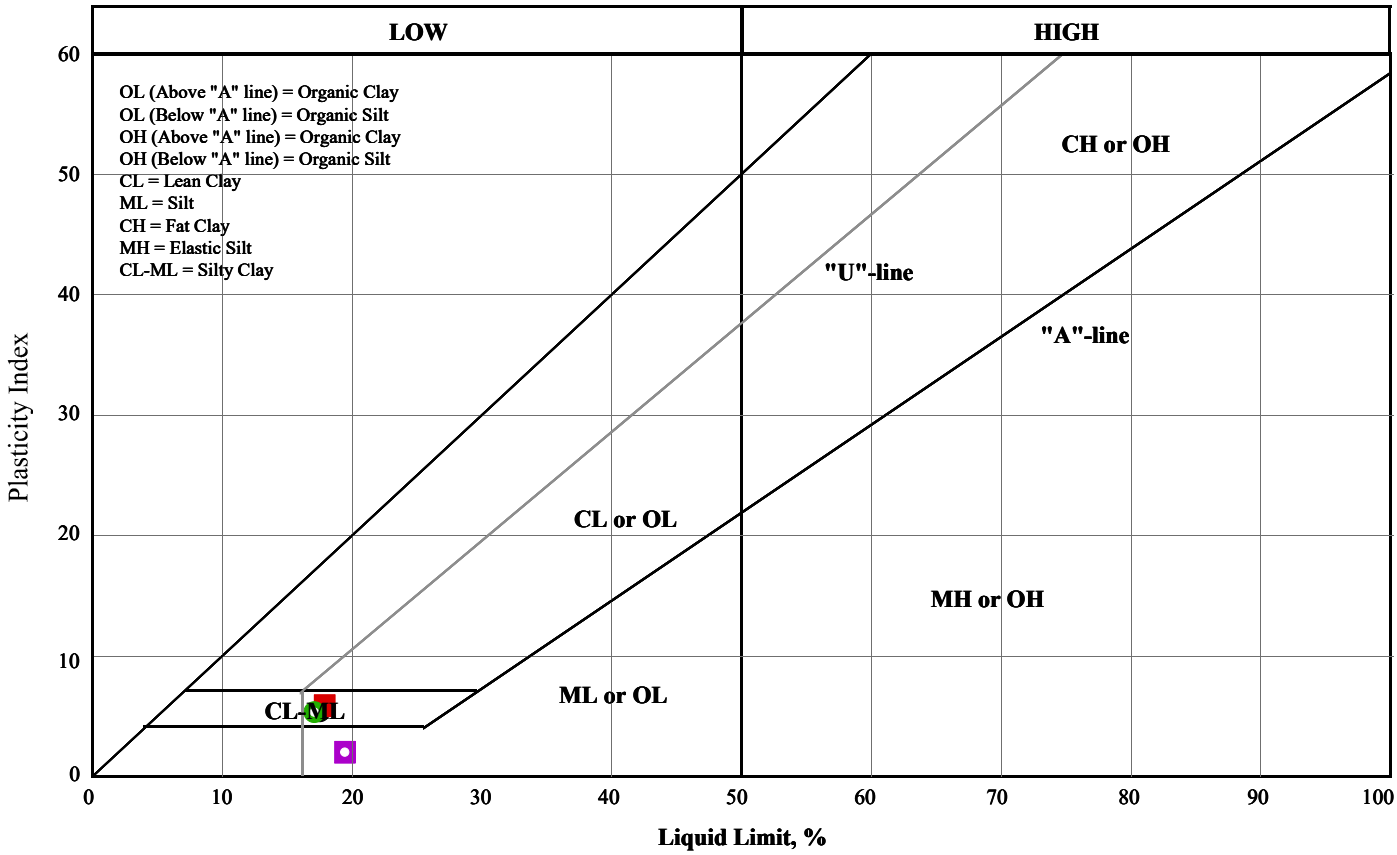
GEMTEC Consulting Engineers and Scientists	Client: Fergus Development Inc.	Plasticity Chart (D4318)
	Project: Fergus Golf Course Redevelopment, Fergus, Ontario	
	Project #: 101987017	



Symbol	Borehole /Test Pit	Sample Number	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	BH23-2	SA-5	3.0-3.5	20.1	12.4	7.7	N/A	13.6
■	BH23-3	SA-4	2.3-2.7	24.1	14.2	9.9	N/A	9.2
○	BH23-6	SA-6	4.6-5.0	19.1	12.6	6.4	N/A	9.7
▣	BH23-8	SA-4	2.3-2.7	16.6	11.9	4.7	N/A	8.2

Note: More information available upon request

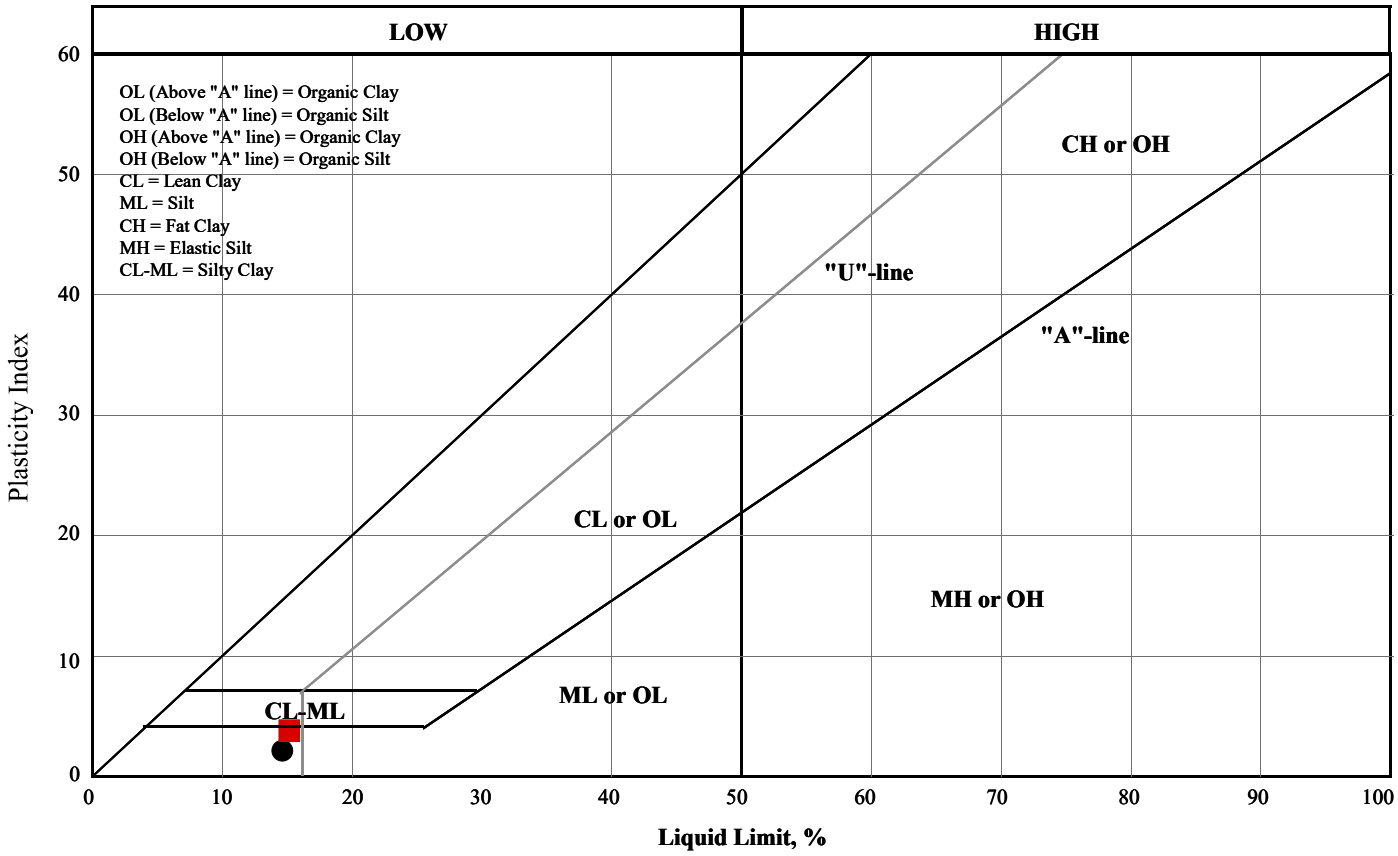
GEMTEC Consulting Engineers and Scientists	Client: Fergus Development Inc.	Plasticity Chart (D4318)
	Project: Fergus Golf Course Redevelopment, Fergus, Ontario	
	Project #: 101987017	



Symbol	Borehole /Test Pit	Sample Number	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	BH23-12	SA-5	3.0-3.5	17.5	12.1	5.4	N/A	9.2
■	BH23-15	SA-5	3.0-3.5	17.9	12.0	5.9	N/A	8.1
◎	BH23-19	SA-5	3.0-3.5	17.1	11.8	5.3	N/A	12.0
◘	BH23-20	SA-7	6.1-6.6	19.4	17.4	2.0	N/A	18.84

Note: More information available upon request

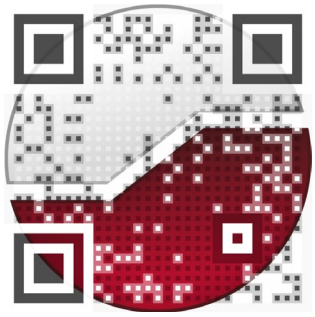
GEMTEC Consulting Engineers and Scientists	Client: Fergus Development Inc.	Plasticity Chart (D4318)
	Project: Fergus Golf Course Redevelopment, Fergus, Ontario	
	Project #: 101987017	



Symbol	Borehole /Test Pit	Sample Number	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	BH23-22	SA-4	2.3-2.7	14.6	12.5	2.1	N/A	8.1
■	BH23-23	SA-6	4.6-5.0	15.2	11.3	3.8	N/A	10.9
⊙	BH23-24	SA-4	2.3-2.7	N/A	N/A	N/A	☑	8.97

Note: More information available upon request

experience • knowledge • integrity



civil	civil
geotechnical	géotechnique
environmental	environnement
structural	structures
field services	surveillance de chantier
materials testing	service de laboratoire des matériaux

expérience • connaissance • intégrité