

REPORT ON
Preliminary Geotechnical Investigation
Proposed Residential Development
Thornbury Gate
Town of the Blue Mountains, ON

PREPARED FOR:
Manorwood Homes

DS Project No: 20-265-400
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APPENDIX A: ENGINEERED FILL GUIDELINES

1. INTRODUCTION

DS Consultants Ltd. (DS) was retained by Manorwood Homes to undertake a preliminary geotechnical investigation for the proposed residential development located at Thornbury Gate in the Town of the Blue Mountains, Ontario.

It is understood that the proposed development will consist of construction of 6 blocks of townhouse units throughout the existing vacant land. All townhouses are assumed to have one level of basement.

The purpose of this geotechnical investigation was to obtain information about the subsurface conditions at borehole locations and from the findings in the boreholes to make preliminary engineering recommendations pertaining to the geotechnical design of underground utilities, roads and to comment on the foundation conditions for the building construction.

This geotechnical investigation is preliminary, based on a limited number of boreholes. More boreholes are recommended for the final design of the proposed development.

This report is provided on the basis of the terms of reference presented above and, on the assumption, that the design will be in accordance with the applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. The format and contents are guided by client specific needs and economics and do not conform to generalized standards for services. Laboratory testing for most part follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for Manorwood Homes and its architect and designers. Third party use of this report without DS consent is prohibited.

2. FIELD AND LABORATORY WORK

Three (3) boreholes (BH20-1 to BH20-3) were drilled on October 1, 2020 at the locations shown on **Drawing 1** to depths ranging from 6.7 to 7.5m. The boreholes were drilled with hollow stem augers by a drilling sub-contractor under the direction and supervision of DS Consultants Ltd. personnel. Samples were retrieved at regular intervals with a 50 mm O.D. split-barrel sampler driven with a hammer weighing 624 N and dropping 760 mm in accordance with the Standard Penetration Test (SPT) method.

The samples were logged in the field and returned to the DS Consultants Ltd. laboratory for detailed examination by the project engineer and for laboratory testing.

In addition, a test pit investigation was completed on October 29th, 2020 for environmental purposes and to investigate location and depth of fill on site and to explore the type of materials observed during the borehole drilling process.

A total of six (6) test pits (TP1, TP2, TP3-1, TP3-2, TP4 and TP5) were completed at the locations shown on **Drawing 1**. The test pits were excavated using a hydraulic backhoe extended to a maximum depth of 2.5m.

Fill material consisting of clayey silt soil with organics and gravel was detected at the location of test pit TP3-2 and extended to an approximate depth of 1.5m. A layer of topsoil, about 200 mm in thickness, was found below the fill followed by Silty sand till which extended to the maximum depth of the test pit, to about 2.5m depth.

Test pit TP5 also contained fill material at the surface and extended to an approximate depth of 1.5m. The fill consisting of clayey silt soil and contained organics, gravel and asphalt pieces. The fill layer was underlain by the possible alluvial deposit of sand and gravel with cobbles and boulders which extended to the maximum explored depth of about 2.0 m.

All other test pits contained surficial topsoil layer varying from 200 to -300mm in thickness followed by a layer of sand and gravel which extended to approximately 1 to 1.5m depth. Underlying sand and gravel deposit a possible an alluvial deposit consisting of sand and gravel with cobbles and boulders was detected and extended to the maximum extent of excavation, to about 2.5 m depth.

As well as visual examination in the laboratory, all soil samples from geotechnical boreholes were tested for moisture contents. Grain size analyses of four (4) soil samples (TP2, BH20-1/SS4, BH20-2/SS5, and BH20-3/SS3) were conducted and the results are presented in **Drawing 6**.

Water level observations were made from water levels in monitoring wells installed at all the borehole locations. Three (3) monitoring wells of 50mm diameter were installed in Boreholes BH20-1, BH20-2 and BH20-3 for the long-term groundwater levels monitoring. The elevation surveying of the boreholes was undertaken by DS Consultants Ltd. personnel, using the differential GPS unit.

3. SUBSURFACE CONDITIONS

The subject site is located from McAuley Street North to Elgin Street North and from Elgin street to the property lines of the adjacent properties (Thornbury Village Cidery and The Blue Mountain Community Health Centre) in The Town of the Blue Mountains, ON. At the time of our drilling work and surveying, the land was vacant land with natural growth.

The borehole and test pit locations are shown on **Drawing 1**. General notes on sample description are provided on **Drawing 1A**. The subsurface conditions in the boreholes by DS are presented in the individual borehole logs presented on **Drawings 2 to 4**. Generalized sub-surface profiles are presented on **Drawing 5**.

3.1 Soil Conditions

Topsoil/Fill Material:

A surficial topsoil layer, varying from 50 to 300 mm was observed below the fill at Test Pits TP3-2 and TP5 and at the surface of all boreholes and the remaining test pits. The test pit investigation confirmed two locations on site that contain fill of approximately 1.5m depth in the vicinity of test pits TP3-2 and TP5. The fill was composed of clayey silt, trace sand, trace gravel and debris such as asphalt pieces.

It should be noted that the thickness of the topsoil explored at the borehole locations may not be representative for the site and should not be relied on to calculate the amount of topsoil at the site. Shallow test pits should be carried out to explore the thickness of topsoil across the site.

The type/quantity and extent of the existing fill layers must be explored by further test pit investigation prior to/during excavation.

Possible Alluvial Deposit:

Across the site, a layer of possible alluvial deposit (nearshore deposit) consisting of sand and gravel with cobbles and boulders underlies the topsoil. The thickness of this layer increases from east to west. The thickness of this layer varies from approximately 1.5m at BH20-3 to 5.2m at BH20-1. SPT “N” values in this layer range from 7 to 30 blows per 300mm penetration indicating a loose to compact state. The moisture content of this moist to wet layer varied from 3 to 16%.

The thickness/depth and extent of this alluvial material must be confirmed by further borehole investigation.

Grain size analyses of two (2) soil samples from the sand and gravel with cobbles (TP2, BH20-1 SS4) were conducted and the results are presented on **Drawing 6-1**, with the following fractions:

Fines:	1 %
Sand:	26 %
Gravel:	46 %
Cobble:	27 %

Clayey Silt:

Underlying the possible alluvial deposit is a soft to very stiff clayey silt layer at all the borehole locations. This layer extended to the maximum explored depth of BH20-1 and to the underlying silty sand/sandy silt at BH 20-2 and BH 20-3, to depths of 4.9 and 2.3, respectively. SPT (N) values ranged from 3 to 35 blows per 300mm penetration. The moisture content of this moist to wet clayey layer varied from 13 to 45%.

The thickness/depth and extent of this less competent clayey layers should be confirmed by further deeper borehole investigation, especially in the area of BH20-1. The future investigation should include field and laboratory tests for settlement analysis of the weak clayey silt deposits under the proposed structural loads and/or due to grade raise.

Grain size analyses of two (2) soil samples from this clayey silt deposit (BH20-2/SS5 and BH20-3/SS3) were conducted and the results are presented on Drawing 6-2, with the following fractions:

Clay: 17 to 20%
Silt: 64 to 75%
Sand: 8%
Gravel: Up to 8%

Sandy Silt/Silty Sand/Sand

Sandy silt/silty sand/sand deposits were encountered beneath the clayey silt layer at BH20-2 and BH20-3 and extended to maximum depth of the boreholes. These deposits contained rock fragments at different depths.

These deposits were present in a dense to very dense state, with SPT 'N' values ranging from 47 to over 100 blows per 300 mm of penetration. The moisture content of this layer varied from 9 to 13%.

3.2 Groundwater Conditions

The groundwater levels in the monitoring wells were measured on October 6, 2020 and are presented in Table 1.

Table 1: Groundwater Levels Observed in Monitoring Wells

Monitoring Well No.	Ground Surface Elevation (m)	Groundwater Table Depth (m)	Elevation of Groundwater Table (m)
BH20-1	186.2	4.33	181.9
BH20-2	185.9	2.57	183.3
BH20-3	186.8	3.30	183.5

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to major weather events.

4. DISCUSSION AND RECOMMENDATIONS

4.1 SITE GRADING, GROUND CONSOLIDATION, AND ENGINEERED FILL

The site will be developed as residential subdivision with residential lots, underground services, roads and driveways. In the areas where earth fill is required for site grading purposes, an engineered fill can be constructed below house foundations, roads, boulevards, etc.

In the areas of BH20-1 and BH20-2, soft clayey silt deposits were encountered. Loose deposits were encountered in the boreholes. It is assumed that the grade will not be raised by more than 1.0 m, so that the settlement due to grade raise is to be controlled.

Where weak (soft to firm) clayey silt such as in the areas of BH20-1 and BH20-2 is present, pre-loading of the ground using surcharge fill should be carried out to consolidate the weak ground. The temporary surcharge fill must be at least 3.0 m higher than the proposed final grade, to be placed at the site for at least 6 to 12 months before its removal to allow the ground to consolidate. Settlement monitoring of ground under the surcharge fill load must be carried out. A detailed geotechnical investigation with additional boreholes is recommended to explore conditions across the site. This office must be contacted for the detailed design of the surcharge fill when the grading plan is available.

Loose alluvial deposits, when encountered, must be compacted to 100% SPMDD.

In test pits TP3-2 and TP5, fill materials were encountered at the surface and extended to an approximate depth of 1.5m. At TP3-2, the fill was piled over topsoil. At TP5, the fill was present within a low area where the nearshore deposit was removed. This existing fill can not support house footings and should be removed and replaced with engineered fill. In the area of BH20-1, BH20-2 and to the west, footings may be supported in the existing compact sand and gravel with cobbles. In the area of BH20-3, the existing material to a depth of 0.8 m below the existing grade can be removed to support a foundation on native soil or replaced with engineered fill to the desired elevation. Dewatering will be required for excavation below groundwater. Additional boreholes will be required to explore the depth/extent of possible alluvial material and the soft clayey layer below.

Prior to placement of engineered fill, all existing surficial organic material/topsoil, fill materials and weathered/disturbed/less competent native soils containing topsoil/organics should be stripped to expose the inorganic native subgrade. The exposed subgrade should then be proof rolled with a heavy smooth roller to identify weak areas.

Any weak or excessively wet zones identified during proof-rolling should be sub-excavated and replaced with compacted competent material to establish stable and uniform conditions. Prior to placement of engineered fill, the subgrade should be inspected and approved by a geotechnical engineer.

General guidelines for the placement and preparation of engineered fill are presented on **Appendix A** of this report. To reduce the risk of improperly placed engineered compacted fill, full-time supervision of the contractor is essential.

The following is a recommended procedure for an engineered fill:

1. Prior to site work involving engineered fill, a site meeting to discuss all aspects must be convened. The surveyor, contractor, design engineer and geotechnical engineer must attend the meeting. At this meeting, the limits of the engineered fill will be defined. The contractor must make known where all fill material will be obtained, and samples must be provided to the geotechnical engineer for review, and approval before filling begins.
2. Detailed drawings indicating the lower boundaries as well as the upper boundaries of the engineered fill must be available at the site meeting and be approved by the geotechnical engineer.
3. The building footprint and base of the pad, including basements, garages, etc. must be defined by offset stakes that remain in place until the footings and service connections are all constructed. Confirmation that the footings are within the pad, service lines are in place, and that the grade conforms to drawings, must be obtained by the owner in writing from the surveyor and DS. Without this confirmation no responsibility for the performance of the structure can be accepted by DS. Survey drawing of the pre and post fill location and elevations will also be required.
4. The area must be stripped of all topsoil, fill materials, weathered/disturbed and less competent native soils, **to be confirmed on site during grading/excavation process.**

Subgrade must be proof-rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by a DS engineer prior to placement of fill.
5. The approved engineered fill must be compacted to 100% Standard Proctor Maximum Dry Density throughout. Granular Fill preferred. Engineered fill should not be placed (where it will support footings) during the winter months. Engineered fill compacted to 100% SPMD D will settle under its own weight approximately 0.5% of the fill height and the structural engineer must be aware of this settlement. In addition to the settlement of the fill, additional settlement due to consolidation of the underlying soils from the structural and fill loads will occur.
6. Full-time geotechnical inspection by DS during placement of engineered fill is required. Work cannot commence or continue without the presence of the DS representative.

7. The fill must be placed such that the specified geometry is achieved. Refer to sketches for minimum requirements. Take careful note that the projection of the compacted pad beyond the footing at footing level is a minimum of 2 m. The base of the compacted pad extends 2 m plus the depth of excavation beyond the edge of the footing.
9. All excavations must be done in accordance with the Occupational Health and Safety Regulations of Ontario.
10. After completion of the pad a second contractor may be selected to install footings. All excavations must be backfilled under full time supervision by DS to the same degree as the engineered fill pad. Surface water cannot be allowed to pond in excavations or to be trapped in clear stone backfill. Clear stone backfill can only be used with the approval of DS.
11. After completion of compaction, the surface of the pad must be protected from disturbance from traffic, rain and frost.
12. If there is a delay in construction, the engineered fill pad must be inspected and accepted by the geotechnical engineer. The location of the structure must be reconfirmed that it remains within the pad.

4.2 ROADS

The investigation has shown that the predominant subgrade soil, after stripping the topsoil and any other organic and otherwise unsuitable and less competent subsoil, will generally consist of sand and gravel with cobbles and boulders.

Based on the above and assuming that traffic usage will be residential local road, the following minimum pavement thickness is recommended for roads to be constructed within the development:

40 mm HL3 Asphaltic Concrete Surface

40 mm HL4 Asphaltic Concrete Base

150 mm Granular 'A'

450 mm Granular 'B'

These values may need to be adjusted according to the Town of Blue Mountain standards. The site subgrade and weather conditions (i.e. if wet) at the time of construction may necessitate the placement of thicker granular sub-base layer in order to facilitate the construction. The need for filter fabric/geo-grid can be evaluated during construction stage. Furthermore, heavy construction equipment may have to be kept off the newly constructed roads before the placement of asphalt and/or immediately thereafter, to avoid damaging the weak subgrade by heavy truck traffic.

4.2.1 Stripping, Sub-Excavation and Grading

The site should be stripped of all topsoil and any organic, weathered or otherwise unsuitable/less competent soils to the full depth of the roads, both in cut and fill areas. Following stripping, the site should be graded to the subgrade level and approved. The subgrade should then be proof-rolled, in the presence of the Geotechnical Engineer, by at least several passes of a heavy compactor having a rated capacity of at least 8 tonnes. Any soft spots thus exposed should be removed and replaced by select fill material, similar to the existing subgrade soil and approved by the Geotechnical Engineer.

The subgrade should then be re-compacted from the surface to at least 98% of its Standard Proctor Maximum Dry Density (SPMDD). The final subgrade should be cambered or otherwise shaped properly to facilitate rapid drainage and to prevent the formation of local depressions in which water could accumulate.

Proper cambering is required to allow the surface water to escape towards the sides, where it can be removed by means of subdrains. Otherwise, any water collected in the granular sub-base materials could be trapped thus causing problems due to softened subgrade, differential frost heave, etc. For the same reason damaging the subgrade during and after placement of the granular materials by heavy construction traffic should be avoided. If the moisture content of the local material cannot be maintained at $\pm 2\%$ of the optimum moisture content, imported granular material may need to be used.

Any fill required for re-grading the site or backfill should be select, clean material, free of topsoil, organic or other foreign and unsuitable matter. The fill should be placed in thin layers and compacted to at least 98% of its SPMDD. The compaction of the new fill should be checked by frequent field density tests.

4.2.2 Road Construction

Once the subgrade has been inspected and approved, the granular base and sub-base course materials should be placed in layers not exceeding 200 mm (uncompacted thickness) and should be compacted to 100% of their respective SPMDD. The grading of the material should conform to current OPS Specifications.

The placing, spreading and rolling of the asphalt should be in accordance with OPS Specifications or, as required by the local authorities.

Frequent field density tests should be carried out on both the asphalt and granular base and sub-base materials to ensure that the required degree of compaction is achieved.

4.2.3 Drainage

The Town of the Blue Mountains requires the installation of full-length subdrains on all roads with curb and gutter.

The subdrains should be properly filtered to prevent the loss of (and clogging by) soil fines.

All paved surfaces should be sloped to provide satisfactory drainage towards catch-basins. As discussed in Section 4.2.1, by means of good planning any water trapped in the granular sub-base materials should be drained rapidly towards subdrains or other interceptors.

4.3 SEWERS

As a part of the site development, a network of new watermain, storm and sanitary sewers will be constructed. It is assumed that the trenches will generally be within 4 to 5 m below the existing grade.

The type of material for the pipes to be used for watermain or sewers will be the choice of civil engineer.

4.3.1 Trenching

The boreholes show that below the existing topsoil/fill, the trenches will be mostly dug through the sand and gravel with cobbles and boulders deposit, as well as clayey silt to sandy silt in the east. Water seepage in excavations above groundwater can be controlled by conventional pumping methods. **Positive dewatering** will be required prior to any excavation in cohesionless soils (sand, silt, sand & gravel, sandy silt to silty sand till) below the groundwater table; otherwise it will result in unstable base and flowing sides. The groundwater table should be lowered to a minimum depth of 1 m below the base of the excavation.

Excavations in fill (if any), alluvial materials and native soils can be carried out with heavy hydraulic backhoe.

Subject to depth of excavations, soft clay will have to be removed and replaced with granular engineered fill (600 mm crusher run material) or lean concrete to support pipes and manholes. Geogrid might also be required.

Further deep borehole investigation is required to investigate the depth and extent of alluvial material and soft clay deposit. Our recommendations should be updated upon the completion of the investigation.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, sandy silt and soft clayey silt deposits can be classified as Type 3 Soil above the groundwater table and Type 4 below the groundwater table. Silty sand till, sand, silt, sandy silt to silty sand and sand & gravel can be classified as Type 3 Soil above the groundwater table and Type 4 Soil below the groundwater table.

It should be noted that the alluvial deposit and very dense sandy silt materials may contain cobbles and boulders.

Possible large obstructions such as buried concrete pieces are also anticipated in the fill material. Provisions must be made in the excavation contract for the removal of possible boulders in the till and obstructions in the fill material.

4.3.2 Bedding

The stiff and compact to dense undisturbed native soils encountered are considered to be competent to provide adequate support for the sewer pipes and will allow the use of normal Class B type bedding. The recommended minimum thickness of Class B bedding below the invert of the pipes is 150 mm. The thickness of the bedding may, however, have to be increased depending on the pipe diameter or in accordance with local standards or if wet or weak subgrade conditions are encountered, especially when the soil at the trench base level consists of wet, dilatant silt.

However, subject to design grades and the depth of service utilities in the middle to west portion of the site, where loose and soft to firm soils are encountered, weak materials must be removed and replaced with granular engineered fill (600 mm crusher run material) or lean concrete prior to placing the bedding material, subject to further borehole investigation.

It is recommended that the bedding material consist of well-graded granular material such as Granular 'A' (OPSS 1010). To avoid the loss of soil fines from the subgrade, uniformly graded clear stone should not be used unless, below the granular bedding material, a suitable, approved filter fabric (geotextile) is placed. The geotextile should extend along the sides of the trench and should be wrapped all around the uniformly graded bedding material.

4.3.3 Backfilling of Trenches

Based on visual and tactile examination, the existing on site material containing cobbles and boulders is not considered suitable for backfilling (unless cobbles and boulders are separated from the sand and gravel material). Imported fill material will need to be used as backfill following approval by this office.

The backfill should be placed in maximum 200 mm thick layers at or near ($\pm 2\%$) their optimum moisture content and each layer should be compacted to at least 95% SPMDD. In the upper 1.0 m of the subgrade, underneath the road base, the compaction should be increased to 98% SPMDD. Unsuitable materials such as organic soils, boulders, cobbles, frozen soils, etc. should not be used for backfilling.

Granular B material should be used as backfill for trenches located under slab on grade or paved areas. Compaction of the granular soils should be carried out with vibratory compactors and loose lifts not exceeding about 200 mm.

Imported granular fill, which can be compacted with hand held equipment, should be used in confined areas.

The excavated soils are considered to be free draining however not suitable due to high presence of cobbles. Where free draining backfill is required, imported granular fill such as OPSS Granular B should be used.

It should be noted that finer soils are subject to moisture content increase during wet weather which would make these materials too wet for adequate compaction. Any stockpiles of imported fill should be compacted at the surface or be covered with tarpaulins to minimize moisture uptake.

4.4 FOUNDATION CONDITIONS

It is understood that the proposed subdivision will consist of single-family homes (detached, townhomes, back-to-back, and/or stacked) with one level of basement.

Subject to design grades and Based on the borehole information, due to the variable depth of sand and gravel layer and the presence of less competent clayey soils, the sand and gravel layer encountered below the topsoil/fill in the boreholes can support the proposed houses on conventional footings. The spread and strip footings founded on the sand and gravel materials can be designed for a bearing capacity of 75 kPa at SLS (Serviceability Limit State), and for a factored geotechnical resistance of 110 kPa at ULS (Ultimate Limit State), subject to confirmation by further borehole investigation.

The encountered sand and gravel with cobbles and boulders at the base of footings can be easily disturbed by construction activities. A concrete skim coat, about 50 mm in thickness, on the founding subgrade immediately after its approval might be required, on a case by case basis, to prevent its disturbance by construction activities.

However, due to the difference in ground elevations and subject to design grades, should the proposed footings be founded above the sand and gravel layer, then the proposed houses can also be supported on spread and strip footings founded on engineered fill and can be designed for a bearing capacity of 75 kPa at the serviceability limit states (SLS) and for a factored geotechnical resistance of 110 kPa at the ultimate limit states (ULS), provided all requirements on **Appendix A** are adhered to .

Foundations designed to the specified bearing capacities at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential.

All footings exposed to seasonal freezing conditions must have at least 1.6 metres of soil cover for frost protection.

All footings bases must be inspected by this office to confirm the bearing capacity values, prior to pouring concrete.

Where it is necessary to place footings at different levels, the upper footing must be founded below an imaginary 10 horizontal to 7 vertical line drawn up from the base of the lower footing. The lower footing must be installed first to help minimize the risk of undermining the upper footing.

It should be noted that the recommended bearing capacities have been calculated by DS from the limited borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of the underground conditions becomes available.

For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between boreholes and the recommendations of this report must therefore be checked through field inspections provided by DS to validate the information for use during the construction stage.

4.5 EARTH PRESSURES

The lateral earth pressures acting on foundation and basement walls may be calculated from the following expression:

$$p = k(\gamma h + q)$$

where, p	=	Lateral earth pressure in kPa acting at depth h
K	=	Earth pressure coefficient, assumed to be 0.40 for vertical walls and horizontal backfill for permanent construction
γ	=	Unit weight of backfill, a value of 21 kN/m ³ may be assumed
h	=	Depth to point of interest in metres
q	=	Equivalent value of surcharge on the ground surface in kPa

The above expression assumes that the perimeter drainage system prevents the build up of any hydrostatic pressure behind the wall.

4.6 FLOOR SLAB AND PERMANENT DRAINAGE

The floor slab can be supported on grade provided all organic materials/topsoil, fill (if encountered), and surficial softened/disturbed native soils are removed and the base thoroughly proof rolled.

The fill required to raise the grade can consist of inorganic soil, approved by this office, placed in shallow lifts and compacted to 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

Where engineered fill is used to support the foundations, the floor slab can also be supported by engineered fill.

Depending on design grade, a perimeter and underfloor drainage system will not be required around the exterior basement walls since the water table is low compared to the existing grade. If the design grade is greater than 2m below existing grade, a drainage system shall be installed as shown on **Drawing 7**.

5. GENERAL COMMENTS AND LIMITATIONS OF REPORT

DS Consultants Ltd. (DS) should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, DS will assume no responsibility for interpretation of the recommendations in the report.

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to DS at the time of preparation.

Unless otherwise agreed in writing by DS, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably.

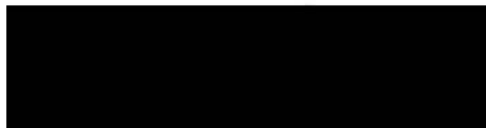
The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. DS accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

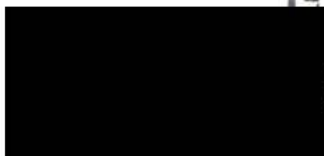
We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

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Drawings



Legend

-  Approx Site Boundary
-  Test Pit
-  Borehole Location



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Manorwood Homes

Project
Environmental and Geotechnical Investigation - Thornbury Gate

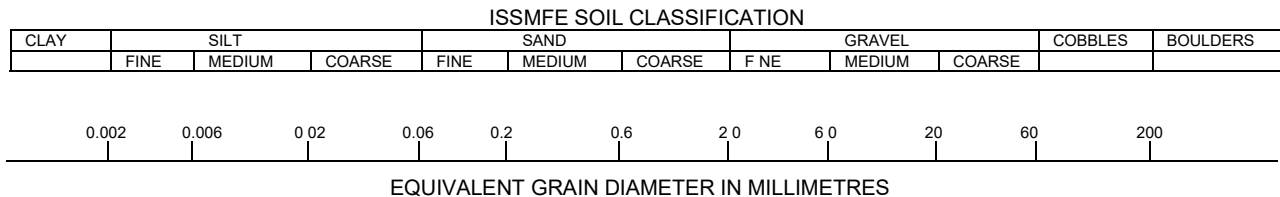
Title
Borehole Location Map



Size 8.5 x 11	Approved By S.W.	Drawn By M.Z.	Date November 2020
Rev 0	Scale As Shown	Project No 20 265 400	Figure No 1
Image/Map Source Google Satellite Image			

Drawing 1A: Notes On Sample Descriptions

1. All sample descriptions included in this report generally follow the Unified Soil Classification. Laboratory grain size analyses provided by DSCL also follow the same system. Different classification systems may be used by others, such as the system by the International Society for Soil Mechanics and Foundation Engineering (ISSMFE). Please note that, with the exception of those samples where a grain size analysis and/or Atterberg Limits testing have been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.



CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary geotechnical site investigation.
3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

DRILLING DATA

Method: Hollow Stem Augers

Diameter: 200mm

REF. NO.: 20-265-400

Date: Oct/01/2020

ENCL NO.: 2

BOREHOLE LOCATION: N 4934285.098 E 543946.978

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	METHANE AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m		SHEAR STRENGTH (kPa)				WATER CONTENT (%)					
							20	40	60	80	100	W _p	W			
186.2																
186.1	TOPSOIL: 50mm		1	SS	10											
	NEARSHORE DEPOSIT: sand and gravel with cobbles, brown, moist, compact (possible alluvial deposit)															
			2	SS	27											
			3	SS	20											
			4	SS	29											
			5	SS	11											
	trace silt, wet		6	SS	14											
	saturated		7	SS	12											
181.0	CLAYEY SILT: grey, wet, soft to firm		8	SS	5											
	sandy at 5.8m		9	SS	3											
			10	VANE												
178.7	END OF BOREHOLE:															
	Notes:															
	1) 50 mm diameter monitoring well installed upon completion															
	2) Water level Readings:															
	Date: Oct 6, 2020															
	Water Depth (mbgs) 4.33															

GROUNDWATER ELEVATIONS

	1st	2nd	3rd	4th
Measurement				

GRAPH
NOTES

$+3, \times 3$: Numbers refer to Sensitivity

○ $\epsilon = 3\%$ Strain at Failure

DRILLING DATA

Method: Hollow Stem Augers

Diameter: 200mm

REF. NO.: 20-265-400

Date: Oct/01/2020

ENCL NO : 3

BOREHOLE LOCATION: N 4934254.246 E 544010.114

[illegible]

DS SOIL LOG 20-265-400.GPJ DS.GDT 20/11/5

GROUNDWATER ELEVATIONS

Measurement    

GRAPH
NOTES

+3, ×3: Numbers refer to Sensitivity

○ $\epsilon = 3\%$ Strain at Failure

DRILLING DATA

Method: Hollow Stem Augers

Diameter: 200mm

REF. NO.: 20-265-400

Date: Oct/02/2020

ENCL NO: 4

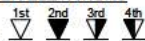
BOREHOLE LOCATION: N 4934223.603 E 544065.324

[illegible]

DS SOIL LOG 20-265-400.GPJ DS.GDT 20/11/5

GROUNDWATER ELEVATIONS

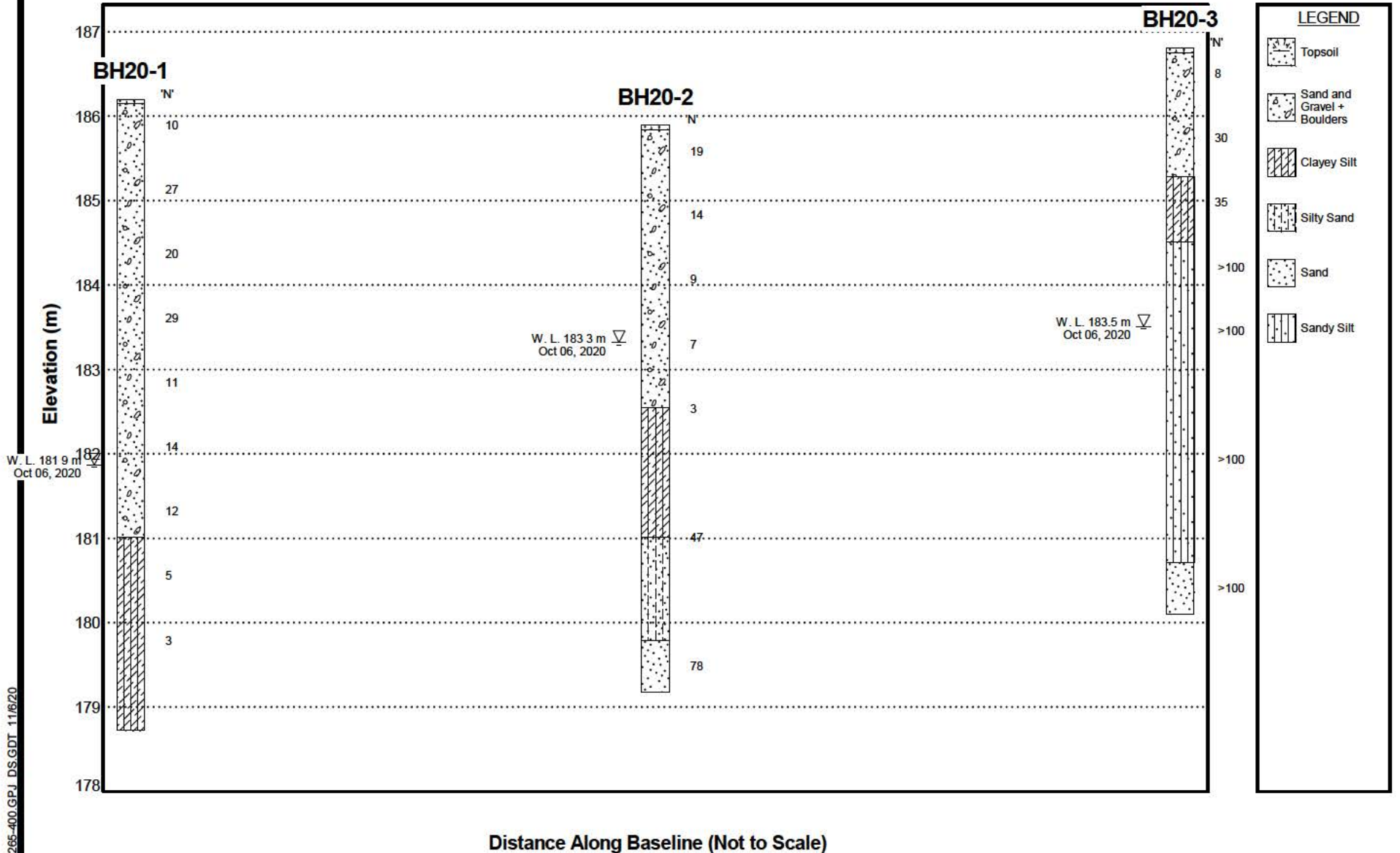
Measurement



GRAPH
NOTES

$+^3, \times^3$: Numbers refer to Sensitivity

○ $\epsilon = 3\%$ Strain at Failure

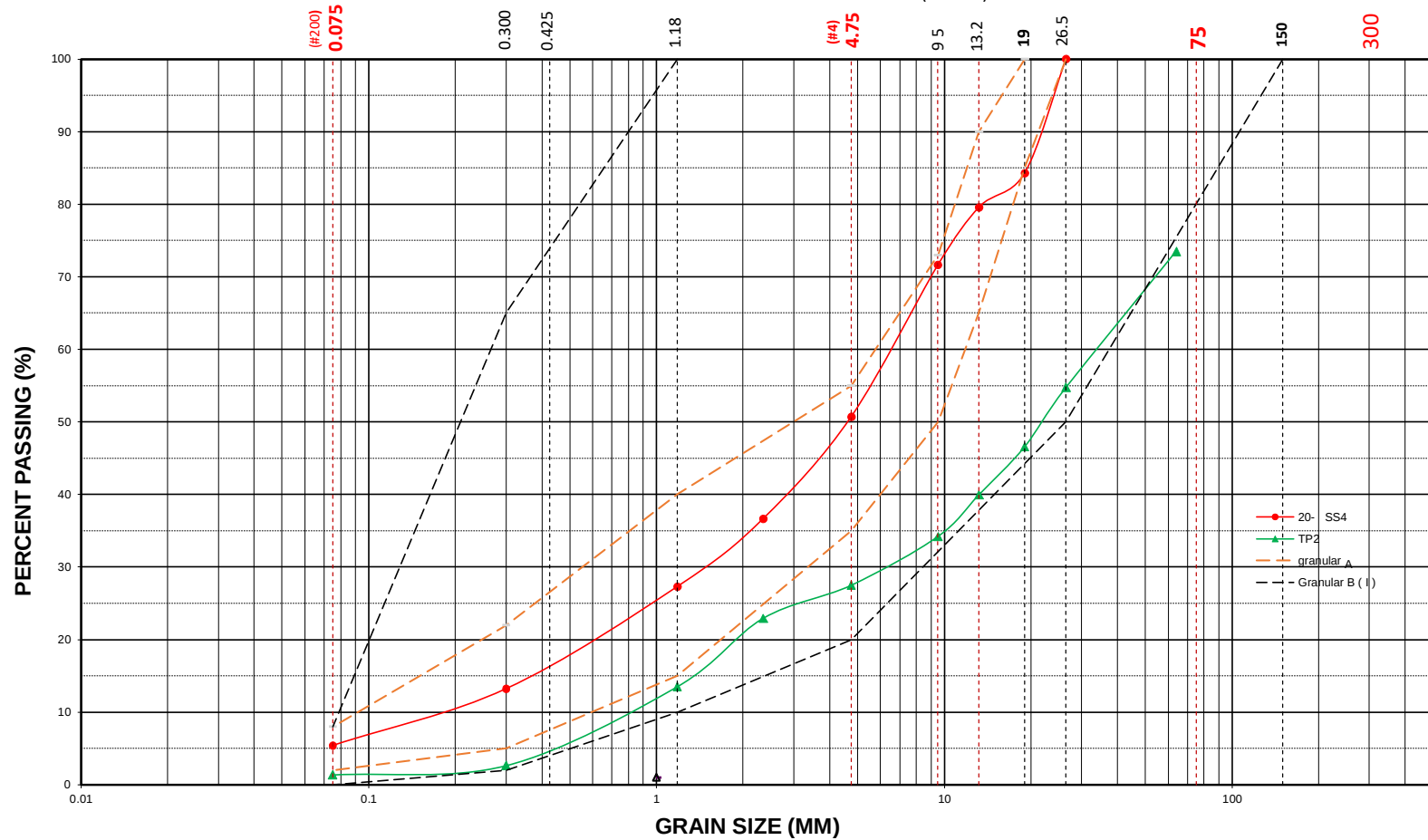


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Geotechnical ♦ Environmental ♦ Materials ♦ Hydrogeology

Generalized Sub-surface Profile

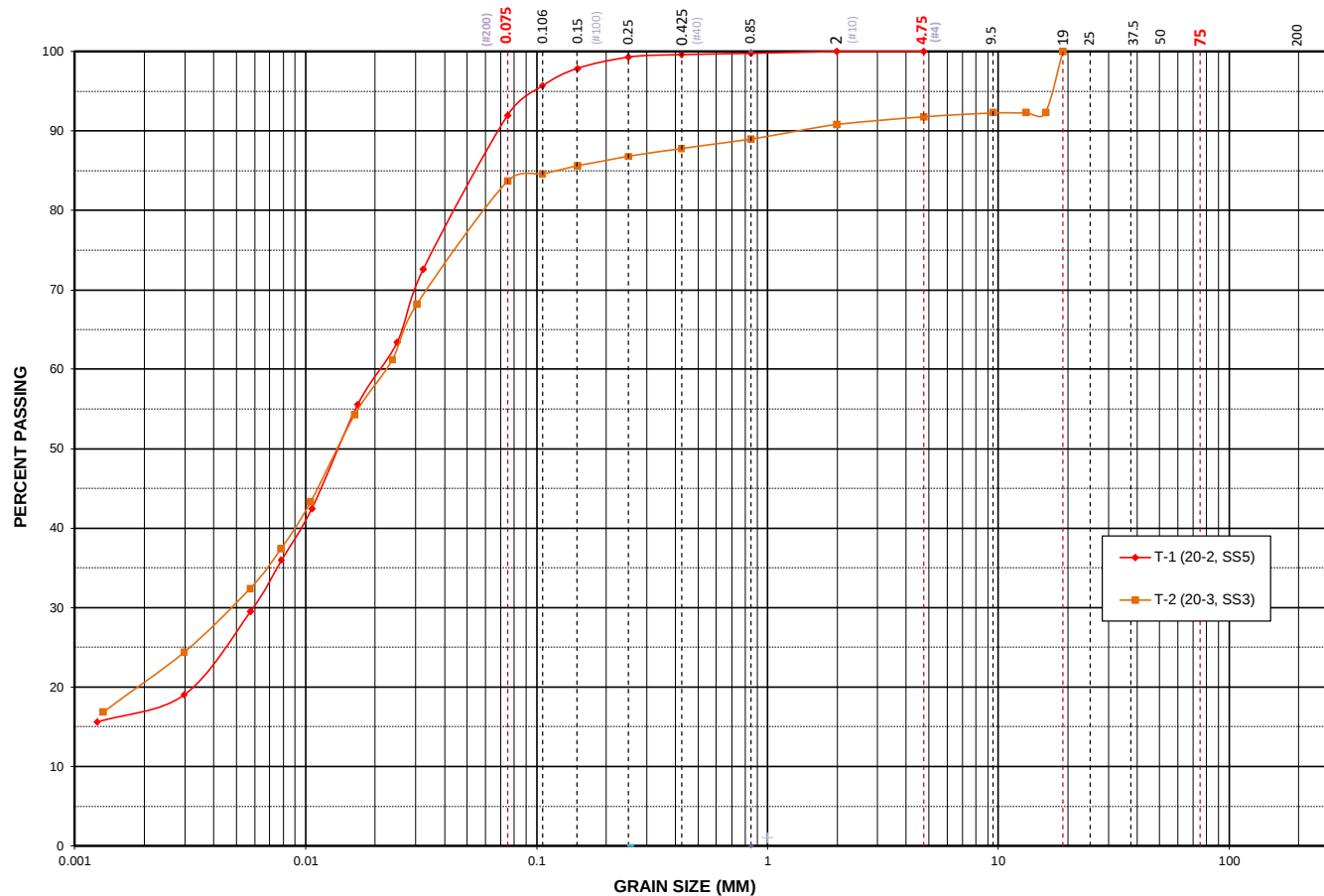
DRAWING NO.	5
JOB NO.	20-265-400
DATE	Nov 06, 2020

Particle Size Distribution (LS-602)

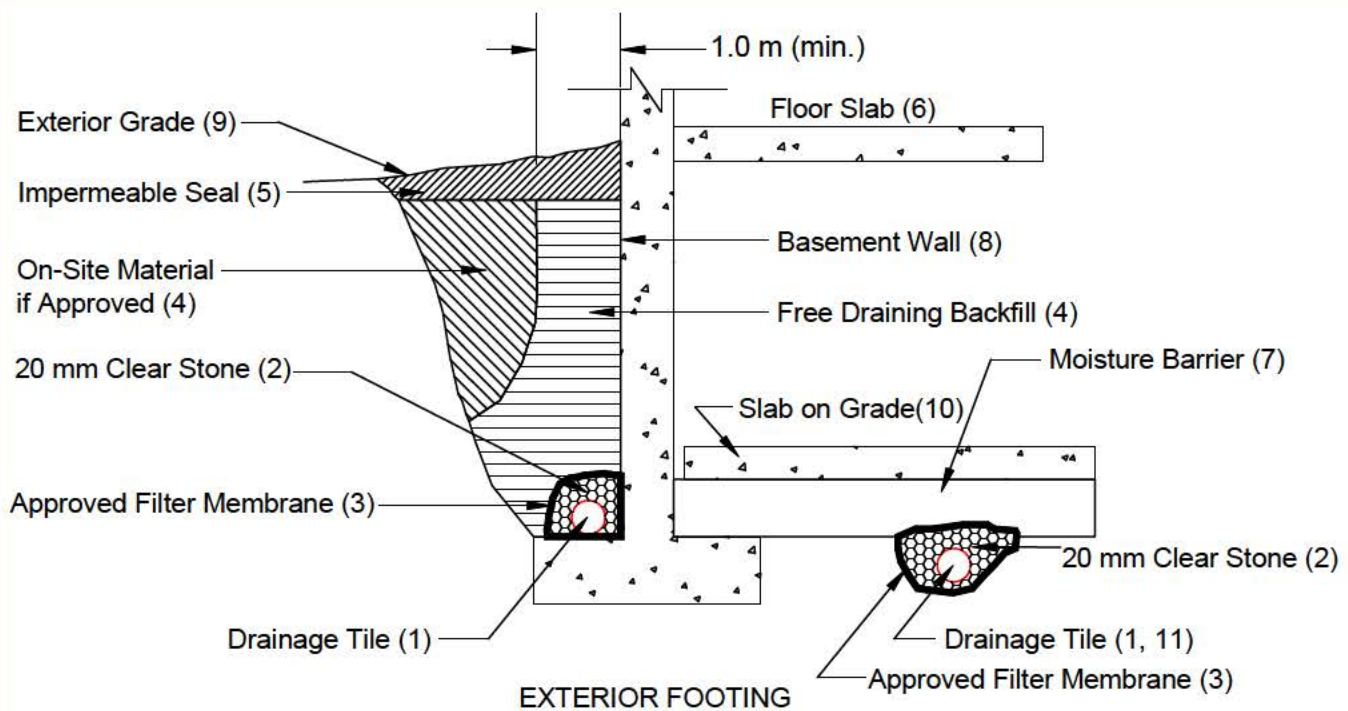


Silt and Clay		Sand			Gravel		Cobble +
Silt -		Fine	Medium	Coarse	Fine	Coarse	
Specification and Comments:		OPSS1010					
 DS CONSULTANTS LTD. 6221 Highway 7, Unit 16 Vaughan, Ontario, L4H 0K8 Telephone: (905) 264-9393 www.dsconsultants.ca	Project:	Thornbury Gate				Project No.:	20-265-400
	Client:	Manorwood Homes				Date:	Nov/06/2020
	Location:	Thornbury, ON				Figure No.:	6-1

Particle Size Distribution (ASTM-D421/D422)



Silt and Clay		Sand			Gravel		Cobble +
Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	
Specification and Comments:							
 DS CONSULTANTS LTD. 6221 Highway 7, Unit 16 Vaughan, Ontario, L4H 0K8 Telephone: (905) 264-9393 www.dsconsultants.ca		Project:	Geotechnical and Enviro Investigation, Thornbury Gate.			Tested by :	Matt
		Project No.:	20-265-400			Date:	Oct-16-2020
		Client:	Manorwood homes			Figure No.:	6-2



Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place 100 mm (4 inches) of stone below drain.
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. Free Draining backfill - OPSS Granular B or equivalent compacted to the specified density. Do not use heavy compaction equipment within 450 mm (18") of the wall. Use hand controlled light compaction equipment within 1.8 m (6') of wall. The minimum width of the Granular 'B' backfill must be 1.0 m.
5. Impermeable backfill seal - compacted clay, clayey silt or equivalent. If original soil is free-draining, seal may be omitted. Maximum thickness of seal to be 0.5 m.
6. Do not backfill until wall is supported by basement and floor slabs or adequate bracing.
7. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
8. Basement wall to be damp proofed /water proofed.
9. Exterior grade to slope away from building.
10. Slab on grade should not be structurally connected to the wall or footing.
11. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab.
12. Drainage tile placed in parallel rows 6 to 8 m (20 to 25') centers one way. Place drain on 100 mm (4") clear stone with 150 mm (6") of clear stone on top and sides. Enclose stone with filter fabric as noted in (3).
13. The entire subgrade to be sealed with approved filter fabric (Terrafix 270R or equivalent) if non-cohesive (sandy) soils below ground water table encountered.
14. Do not connect the underfloor drains to perimeter drains.
15. Review the geotechnical report for specific details.

DRAINAGE AND BACKFILL RECOMMENDATIONS

Basement with Underfloor Drainage

(not to scale)

Appendix A

GENERAL REQUIREMENTS FOR ENGINEERED FILL

Compacted imported soil that meets specific engineering requirements and is free of organics and debris and that has been continually monitored on a full-time basis by a qualified geotechnical representative is classified as engineered fill. Engineered fill that meets these requirements and is bearing on suitable native subsoil can be used for the support of foundations.

Imported soil used as engineered fill can be removed from other portions of a site or can be brought in from other sites. In general, most of Ontario soils are too wet to achieve the 100% Standard Proctor Maximum Dry Density (SPMDD) and will require drying and careful site management if they are to be considered for engineered fill. Imported non-cohesive granular soil is preferred for all engineered fill. For engineered fill, we recommend use of OPSS Granular 'B' sand and gravel fill material.

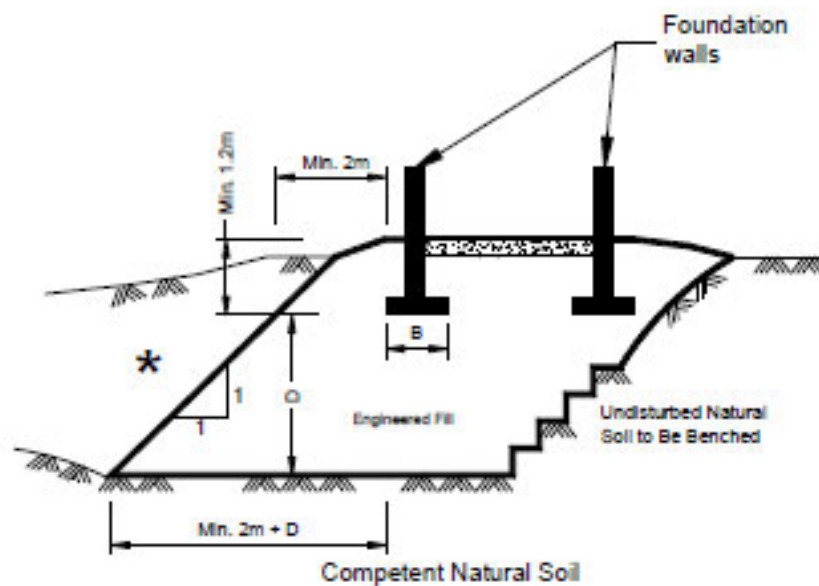
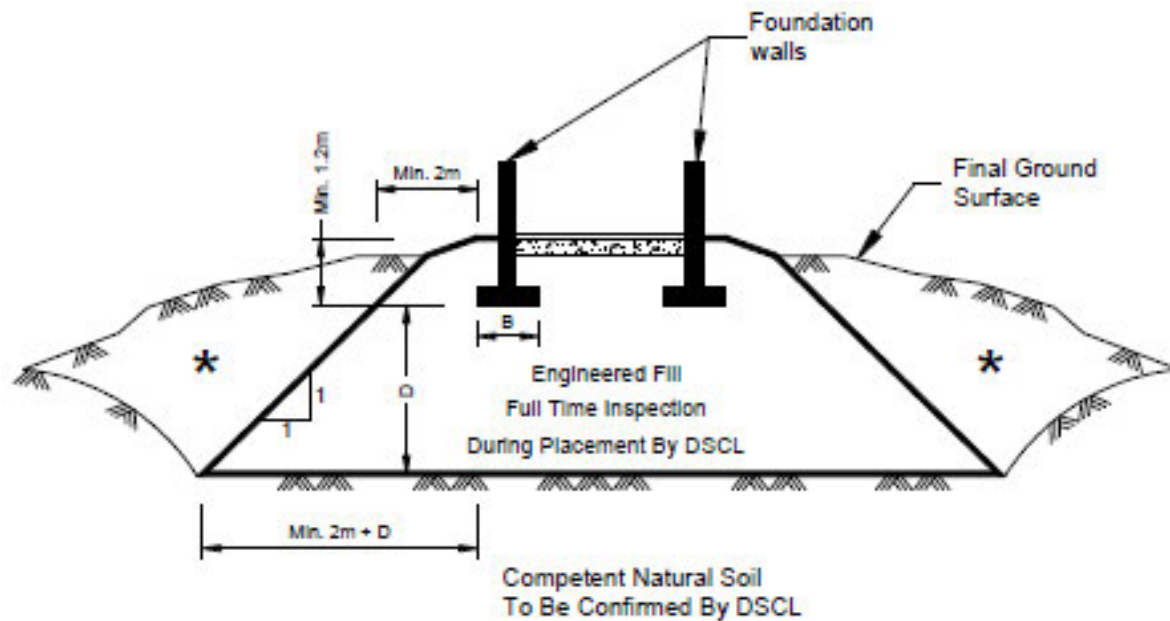
Adverse weather conditions such as rain make the placement of engineered fill to the required degree of density difficult or impossible; engineered fill cannot be placed during freezing conditions, i.e. normally not between December 15 and April 1 of each year.

The location of the foundations on the engineered fill pad is critical and certification by a qualified surveyor that the foundations are within the stipulated boundaries is mandatory. Since layout stakes are often damaged or removed during fill placement, offset stakes must be installed and maintained by the surveyors during the course of fill placement so that the contractor and engineering staff are continually aware of where the engineered fill limits lie. Excavations within the engineered fill pad must be backfilled with the same conditions and quality control as the original pad.

To perform satisfactorily, engineered fill requires the cooperation of the designers, engineers, contractors and all parties must be aware of the requirements. The minimum requirements are as follows; however, the geotechnical report must be reviewed for specific information and requirements.

1. Prior to site work involving engineered fill, a site meeting to discuss all aspects must be convened. The surveyor, contractor, design engineer and geotechnical engineer must attend the meeting. At this meeting, the limits of the engineered fill will be defined. The contractor must make known where all fill material will be obtained from and samples must be provided to the geotechnical engineer for review, and approval before filling begins.
2. Detailed drawings indicating the lower boundaries as well as the upper boundaries of the engineered fill must be available at the site meeting and be approved by the geotechnical engineer.
3. The building footprint and base of the pad, including basements, garages, etc. must be defined by offset stakes that remain in place until the footings and service connections are all constructed. Confirmation that the footings are within the pad, service lines are in place, and that the grade conforms to drawings, must be obtained by the owner in writing from the surveyor and DS Consultants Ltd (DSCL). Without this confirmation no responsibility for the performance of the structure can be accepted by DSCL. Survey drawing of the pre and post fill location and elevations will also be required.
4. The area must be stripped of all topsoil and fill materials. Subgrade must be proof-rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by a DSCL engineer prior to placement of fill.

5. The approved engineered fill material must be compacted to 100% Standard Proctor Maximum Dry Density throughout. Engineered fill should not be placed during the winter months. Engineered fill compacted to 100% SPMDD will settle under its own weight approximately 0.5% of the fill height and the structural engineer must be aware of this settlement. In addition to the settlement of the fill, additional settlement due to consolidation of the underlying soils from the structural and fill loads will occur and should be evaluated prior to placing the fill.
6. Full-time geotechnical inspection by DSCL during placement of engineered fill is required. Work cannot commence or continue without the presence of the DSCL representative.
7. The fill must be placed such that the specified geometry is achieved. Refer to the attached sketches for minimum requirements. Take careful note that the projection of the compacted pad beyond the footing at footing level is a minimum of 2 m. The base of the compacted pad extends 2 m plus the depth of excavation beyond the edge of the footing.
8. A bearing capacity of 150 kPa at SLS (225 kPa at ULS) can be used provided that all conditions outlined above are adhered to. A minimum footing width of 500 mm (20 inches) is suggested and footings must be provided with nominal steel reinforcement.
9. All excavations must be done in accordance with the Occupational Health and Safety Regulations of Ontario.
10. After completion of the engineered fill pad a second contractor may be selected to install footings. The prepared footing bases must be evaluated by engineering staff from DSCL prior to footing concrete placements. All excavations must be backfilled under full time supervision by DSCL to the same degree as the engineered fill pad. Surface water cannot be allowed to pond in excavations or to be trapped in clear stone backfill. Clear stone backfill can only be used with the approval of DSCL.
11. After completion of compaction, the surface of the engineered fill pad must be protected from disturbance from traffic, rain and frost. During the course of fill placement, the engineered fill must be smooth-graded, proof-rolled and sloped/crowned at the end of each day, prior to weekends and any stoppage in work in order to promote rapid runoff of rainwater and to avoid any ponding surface water. Any stockpiles of fill intended for use as engineered fill must also be smooth-bladed to promote runoff and/or protected from excessive moisture take up.
12. If there is a delay in construction, the engineered fill pad must be inspected and accepted by the geotechnical engineer. The location of the structure must be reconfirmed that it remains within the pad.
13. The geometry of the engineered fill as illustrated in these General Requirements is general in nature. Each project will have its own unique requirements. For example, if perimeter sidewalks are to be constructed around the building, then the projection of the engineered fill beyond the foundation wall may need to be greater.
14. These guidelines are to be read in conjunction with DS Consultants Ltd report attached.



★ Backfill in this area to be as per the DSCL report.