Geotechnical Investigation Report
Proposed Residential Development
Elm Road and 9th Line
Whitchurch-Stouffville, Ontario

PREPARED FOR:
Madori Limited

Project No: 23-072-100
Date: March 23, 2023

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1. INTRODUCTION

DS Consultants Ltd. (DS) was retained by Madori Limited to undertake a geotechnical investigation for the proposed residential development located at Elm Road and 9th Line in Whitchurch-Stouffville, Ontario.

It is understood that the proposed development will consist of construction of 3 storey stacked houses with one level of basement.

The purpose of this geotechnical investigation was to obtain information about the subsurface conditions at boreholes locations and from the findings in the boreholes to make 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 the available drilled boreholes and the preliminary project design information available at the time of preparing this report.

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.

The purpose of this geotechnical report was to provide geotechnical recommendations for the following:

1. Foundations
2. Floor slabs and permanent drainage
3. Excavations and groundwater control
4. Underground Utilities
5. Earth pressures
6. Earthquake considerations
7. Pavement

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.

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

2. FIELD AND LABORATORY WORK

Two boreholes (BH23-1 and BH23-2, see **Drawing 1** for borehole location plan) were drilled by DS to a depth of 6.7 m on March 17, 2023. The boreholes were drilled with solid 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.

As well as visual examination in the laboratory, all soil samples from geotechnical boreholes were tested for moisture contents. Grain size analyses of selected soil samples were conducted, and the results are presented in **Drawing 4**.

Water level observations were made during drilling and in the open boreholes at the completion of the drilling operations. One (1) monitoring well of 50mm diameter was installed in Borehole BH23-1 for the long-term groundwater levels monitoring.

The elevation surveying of the borehole locations was undertaken by DS personnel, using the differential GPS unit. It should be noted that the elevations at the as-drilled borehole/well locations were not provided by a professional surveyor and should be considered approximate. Contractors performing any work referenced to the borehole elevations should confirm the borehole elevations for their work.

It should be noted that two previous boreholes (BH1 and BH2) were drilled on site by Soil-Eng Limited, on December 17, 1999, to a depth of 4.3m. The borehole records and Grain size analyses of selected soil samples are presented in Appendix A. However, the borehole records did not provide the geodetic elevations. In addition, no monitoring wells were installed in the boreholes at the time of the previous investigation.

3. SUBSURFACE CONDITIONS

DS Borehole logs are presented on **Drawings 2 and 3** of this report, at the locations shown on borehole location plan Drawing 1. General notes on sample description are provided on **Drawing 1A**. The subsurface conditions in the previous (by Soil-Eng Limited) and current boreholes (by DS) are summarized below.

3.1 Soil Conditions

Topsoil/Organic Material:

A layer of topsoil/organic material, varying from approximately 130 to 330 mm in thickness, was present at the surface of all the previous and current boreholes.

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.

Fill Materials:

Fill materials consisting of silty sand materials were detected below the topsoil/organic soil in the DS boreholes (BH23-1 and BH23-2) and extended to an approximate depth of 0.8 m below the existing ground surface. The loose fill was brown in color and contained trace of organics and gravel. The moisture content of this moist to wet fill layer varied from 13 to 15%.

The type/quantity and extent of the existing fill/topsoil/organic layers must be explored by further test pit investigation.

Silty Sand to Sand and Sandy Silt to Sandy Silt Till/Silt Deposits

Brown to grey deposits consisting of silty sand to sand and sandy silt to sandy silt till and silt extended below the fill/topsoil layers in all the previous and current boreholes and extended to the maximum depth of all the boreholes. This deposit contained very stiff clayey silt till (in BH23-1) and some to trace of clay, gravel, cobbles and boulders. SPT 'N' values measured within the sandy/silty layers varied from 9 to over 100 blows per 300mm of penetration, indicating loose to very dense relative density. The moisture content of the moist to wet cohesionless sandy/silty deposits varied from 9 to 25%.

Grain size analyses of five (5) soil samples from DS boreholes, from the sandy and silty materials (BH23-1/SS3, SS5, SS6, BH23-2/SS3 and SS6) were conducted, and the results are presented in **Drawing 4**, with the following fractions:

Clay: 2 to 15%
Silt: 25 to 61%
Sand: 25 to 90%
Gravel: up to 10%

Layers of clayey silt till to (clayey) silt were detected in BH23-1 within the sandy/silty deposits at and between approximate depths of 1.0 and 3.1 m. These layers contained trace sand and gravel. SPT 'N' values measured in this clayey silt layers ranged from 17 to 20 blows per 300mm of penetration, indicating a very stiff consistency. The moisture content of this clayey deposit varied from 13 to 17%.

Grain size analyses of two (2) of the clayey silt soil sample (BH23-1/SS2 and SS4) were conducted, and the results are presented in **Drawing 4**, with the following fractions:

Clay: 19%
Silt: 43 to 78%
Sand: 3 to 32%
Gravel: Up to 6%

Atterberg limits tests of the one (1) clayey soil sample (BH23-1/SS2) were conducted. The results are shown on the borehole log and are summarized as follows:

Liquid limit (WL): 19.6%
Plastic limit (WP): 12.2%
Plasticity index (PI): 7.4

3.2 Groundwater Conditions

During drilling of the boreholes, short-term (unstabilized) groundwater level was observed at a depth of 2.3 in DS's Borehole BH23-2.

Groundwater levels in the monitoring well installed at the DS's borehole location (BH23-1) was measured (in the installed monitoring well) on March 22, 2023 at approximate depth of 1.95 m, i.e. at approximate Elevation of 269.0m.

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to major weather events. Furter groundwater monitoring process is required to determine the long-term groundwater levels.

In addition, a hydrogeology study is recommended for further details on the extent and the conditions of the groundwater, as well as the recommended groundwater control.

4. FOUNDATIONS

It is understood that the proposed development will consist of construction of 3 storey stacked houses with one level of basement.

The design grades are not known at this stage. However, based on the provided information, the lowest basement floor slab is expected to be at an Elevation of 269.7 m.

In addition, the previous boreholes did not provide geodetic elevations.

Therefore, our recommendations are preliminary and soil bearing capacity and depth to competent subgrade must be confirmed on site during excavations/construction.

4.1 Bearing Capacity of Native Soils for Footings Foundations

Based on the variable soil conditions in the boreholes, the available bearing capacity values and the corresponding founding elevations at the borehole locations are summarized on **Table 1**.

Table 1: Bearing Values and Founding Levels of Footings on Undisturbed Native Soils

Borehole No.	Borehole Ground Elevation (m)	Bearing Capacity at SLS (kPa)	Bearing Capacity at ULS (kPa)	Minimum Depth below Existing Ground (m)	Founding Level at or Below Elevation (m)
BH23-1 (By DS)	270.9	150	225	1.0	269.9
BH23-2* (By DS)	271.1	150	225	1.5	269.6
BH1 (By Soil-Eng)	N/A	150	225	1.0	N/A)
BH2 (By Soil-Eng)	N/A	150	225	1.0	N/A)

Soil bearing capacity and depth to competent native soils must be confirmed on site during excavations/construction.

Positive dewatering will be required for foundation installations below groundwater, subject to groundwater monitoring results.

A hydrogeology study is recommended for further details on the extent and the conditions of the groundwater, as well as the recommended groundwater control.

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

4.2 General Notes on Foundations

Low strength concrete (to be determined by the structural engineer) to bring the subgrade up to the specified underside of foundation elevations, subject to design grades.

Prior to placing concrete, all footing bases must be inspected by this office to confirm the founding soil conditions and design bearing capacity.

The excavated footing bases must be covered with 50 mm thick mud slab immediately after inspection and cleaning, in order to avoid disturbance of the founding soil due to weathering and construction activity.

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 available 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.

5. FLOOR SLAB

The basement floor slab can be supported on grade, provided any organic soils/fill/loose/disturbed native soils are removed, the base thoroughly proof rolled. The backfill required to raise the grade can consist of inorganic soil, placed in shallow lifts and compacted to 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

A moisture barrier consisting of at least 200 mm of 19 mm clear crushed stone should be installed under the floor slab.

Feasibility study of installing permanent perimeter and underfloor drainage must be carried out in the hydrogeological investigation.

A permanent perimeter and subfloor drainage system will be required around the exterior basement walls as shown on **Drawing 5**.

Subject to design grades and groundwater conditions, reference is made to the recommended hydrogeology study report for further details on the extent and the conditions of the groundwater, as well as the recommended groundwater control.

6. EARTH PRESSURES

The lateral earth pressures acting on the basement and retaining walls can 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, K = 0.4.

γ = Unit weight of backfill, a value of 21 kN/m^3 may be assumed

h = Depth to point of interest in meters

q = Equivalent value of surcharge on the ground surface in kPa

The above expression assumes that a drainage system will be installed to prevent the build-up of any hydrostatic pressure behind the wall.

7. FROST PROTECTION

All exterior underside of footings/grade beams/caps exposed to seasonal freezing conditions must have at least 1.4 metres of soil cover for frost protection.

8. EARTHQUAKE CONSIDERATION

For seismic site classification, based on the drilled boreholes on site for proposed buildings with basements, the site can be classified as Class D.

9. EXCAVATIONS AND GROUNDWATER CONTROL

Excavations in the fill and native soils can be carried out with heavy hydraulic backhoe.

Positive dewatering will be required prior to any excavation below the groundwater table, otherwise it will be result in unstable base and flowing sides. The groundwater must be lowered to at least 1.0 m below the excavation base.

Therefore, reference is made to the recommended hydrogeology study report for further details on the extent and the conditions of the groundwater, as well as the recommended groundwater control.

Above the groundwater table, the water seepage from the perched water in the fill materials or wet sand in the native soils above the groundwater table will be slow and can be handled by conventional pumping from sumps. However, the contractor should be prepared to employ more elaborate dewatering methods, should the seepage become severe.

It should be noted that the till is a non-sorted sediment and therefore may contain cobbles and boulders. Provisions must be made in the excavation contract for the removal of possible boulders in the till or other obstructions (or unexpected large obstructions) that may be encountered in the fill material.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, the fill materials, firm to stiff clayey soil, and cohesionless deposits (sand, silt, sandy silt to silty sand) can be classified as Type 3 Soil above the groundwater table and as Type 4 Soil below the groundwater table. Very stiff to hard clayey deposits can be classified as Type 2 Soil above the groundwater table and as Type 3 Soil below the groundwater table.

Select inorganic fill and native soils free from topsoil and organics can be used as general construction backfill. Loose lifts of soil, which are to be compacted, should not exceed 200 mm.

Depending on the time of construction and weather, some excavated material may be too wet to compact and will require aeration prior to its use.

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

Underfloor fill should be compacted to at least 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

The excavated soils are not considered to be free draining. Where free draining backfill is required, imported granular fill such as OPSS Granular B should be used.

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

10. UNDERGROUND UTILITIES

The boreholes show that below the existing topsoil and fill, the trenches will be predominantly dug through the clayey silt, sandy silt and silty sand soil deposits.

Comments on excavation and groundwater control are provided in Section 9 of this report. Positive dewatering will be required for any excavations below groundwater table.

Again, reference is made to the recommended hydrogeology study report for further details on the extent and the conditions of the groundwater, as well as the recommended groundwater control.

The boreholes show that the pipes will predominantly be laid within the native soils which will provide adequate support for the sewer pipes and allow the use of normal Class B type bedding. The bedding should conform to the current Ontario Provincial Standard specifications (OPSS 401/OPSD 802) and/or standards set by the local municipality.

However, where loose fill and less competent loose/soft native soil, where encountered, then this material must be removed and replaced with granular engineered fill prior to placing the bedding material, geogrid might also be required.

The recommended minimum thickness of granular 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 or fill materials are encountered at the trench base level. The bedding material should consist of well graded granular material such as Granular 'A' or equivalent. After installing the pipe on the bedding, a granular surround of approved bedding material, which extends at least 300 mm above the obvert of the pipe, or as set out by the local Authority, should be placed.

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 poorly graded bedding material.

Based on visual and tactile examination, the on-site excavated soils free from topsoil and organics are considered to be suitable for re-use as backfill in the service trenches provided their moisture contents at the time of construction are within 2 percent of their optimum moisture content. Significant aeration of the wet excavated soils (sand, silt, sandy silt to silty sand) will be required prior to their use as backfill material.

The dense to very dense native and very stiff to hard clayey soils are likely to be excavated in cohesive chunks or blocks and will be difficult to compact in confined areas. For use as backfill, the

soils will have to pulverized and placed in thin layers. The soils will have to be compacted using heavy equipment suitable for these soils which may be difficult to operate in the narrow confines of the trenches. Unless the soils are properly pulverized and compacted in sufficiently thin lifts post-construction settlements could occur. Their use in narrow trenches such as laterals (where heavy compaction equipment cannot be operated) may not be feasible.

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

The excavated soils are not considered to be free draining. Where free draining backfill is required, imported granular fill such as OPSS Granular B should be used.

The backfill should be placed in maximum 200 mm thick layers at or near (±2%) their optimum moisture content and each layer should be compacted to at least 95% SPMDD. In the upper 1.5 m of 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.

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

11. PAVEMENTS

11.1 At Grade Asphalt Pavement Structure

For public roads: subject to the anticipated road traffic volumes/AADT/axle loads, the pavement structural design matrix as per Town of Whitchurch-Stouffville Standards must be followed.

For the remaining pavement areas, the recommended pavement structures provided in Table 2 are based upon an estimate of the subgrade soil properties determined from visual examination and textural classification of the soil samples.

The values may need to be adjusted based on the Town/regional standards. Consequently, the recommended pavement structures should be considered in conjunction with the Town standards and reviewed during detailed design.

A functional design life of eight to ten years has been used to establish the pavement recommendations. This represents the number of years to the first rehabilitation, assuming regular maintenance is carried out. If required, a more refined pavement structure design can be performed based on specific traffic data and design life requirements and will involve specific

laboratory tests to determine frost susceptibility and strength characteristics of the subgrade soils, as well as specific data input from the client.

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions.

Stringent construction control procedures should be maintained to ensure uniform subgrade moisture and density conditions are achieved. In addition, the need for adequate drainage cannot be over-emphasized. The finished pavement surface and underlying subgrade should be free of depressions and should be sloped (preferably at a minimum grade of two percent or to be determined by the designer) to provide effective surface drainage toward catch basins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. Subdrains should be installed to intercept excess subsurface moisture and prevent subgrade softening. This is particularly important in heavy-duty pavement areas.

Table 2: Recommended Pavement Structure Thickness for Parking Lots

Pavement Layer	Compaction Requirements	Light Duty Parking (Cars)	Heavy Duty Parking (Delivery Trucks)
Asphaltic Concrete	92.0 to 96.5% Maximum Relative Density (MRD)	40 mm HL 3 or SP 12.5 50 mm HL 8 or SP 19.0	40 mm HL 3 or SP 12.5 80 mm HL 8 or SP 19.0
OPSS Granular A Base (or 20mm Crusher Run Limestone)	100% SPMDD*	150 mm	150 mm
OPSS Granular B (or 50mm Crusher Run Limestone)	100% SPMDD	250 mm	350 mm

* Denotes Standard Proctor Maximum Dry Density, ASTM-D698
The subgrade must be compacted to 98% SPMDD for at least the upper 500 mm unless accepted by DS Consultants Ltd.

Additional comments on the construction of parking areas and access roadways are as follows:

1. As part of the subgrade preparation, proposed parking areas and access roadways should be stripped of topsoil and other obvious objectionable material. Fill required to raise the grades to design elevations should conform to backfill requirements outlined in previous sections of this report. The subgrade should be properly shaped, crowned then proof-rolled in the full time presence of a representative of this office.

Soft or spongy subgrade areas should be sub-excavated and properly replaced with suitable approved backfill compacted to 98% SPMDD. **Due to presence of loose/soft soils, geogrid might be required, subject to confirmation during subgrade inspections.**

2. The locations and extent of sub-drainage required within the paved areas should be reviewed by this office in conjunction with the proposed lot grading.

Assuming that satisfactory crossfalls in the order of two percent have been provided, subdrains extending from and between catch basins may be satisfactory.

In the event that shallower crossfalls are considered, a more extensive system of sub-drainage may be necessary and should be reviewed by DS Consultants Ltd.

3. The most severe loading conditions on light-duty pavement areas and the subgrade may occur during construction. Consequently, special provisions such as restricted access lanes, half-loads during paving, etc., may be required, especially if construction is carried out during unfavourable weather.

4. It is recommended that DS Consultants Ltd. be retained to review the final pavement structure designs and drainage plans prior to construction to ensure that they are consistent with the recommendations of this report.

11.2 Concrete Sidewalk

It is understood that the sidewalks may be constructed in the area. Recommendations for the pavement structure of the sidewalk are as follows:

150 mm Concrete, over 150 mm Granular 'A' Base

The Granular 'A' base must be compacted to at least 100 percent of Standard Proctor Maximum Dry Density (SPMDD). The subgrade must be stripped of topsoil or other unsuitable material. The top 300 mm of the subgrade must be compacted to at least 98 percent of SPMDD. Prior to placing the Granular 'A' base material, the subgrade must be inspected by the geotechnical engineer.

12. 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.

The comments given in this report are intended only for the guidance of designer. The number of boreholes required to determine the localized underground conditions between test holes (i.e. boreholes and/or test pits) affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for design purposes. 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. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole and test pit results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

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 borehole locations.

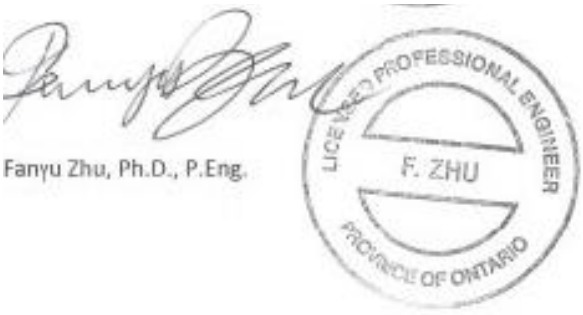
The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer.

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.

DS CONSULTANTS LTD.

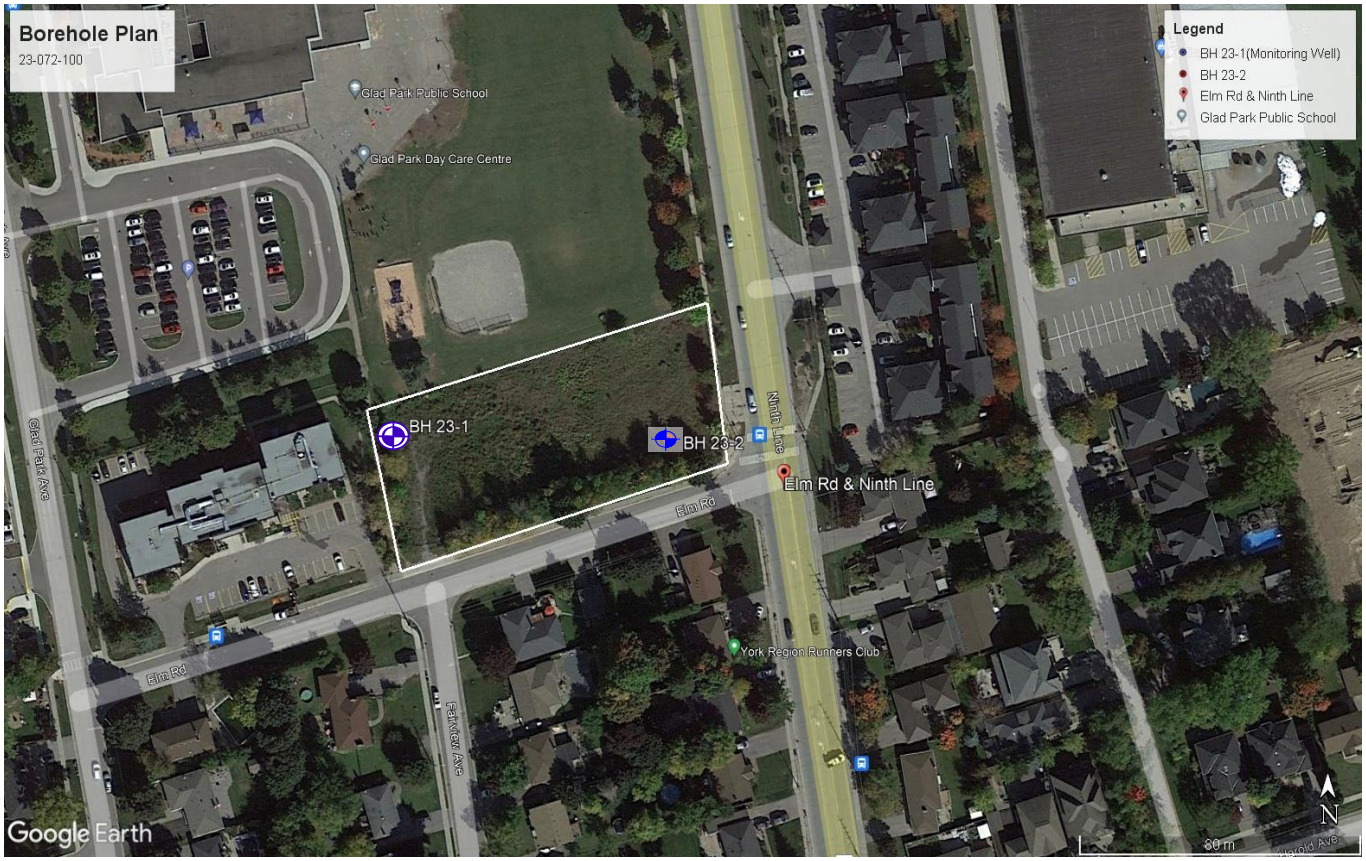
Labib Mousa, P. Eng.



Fanyu Zhu, Ph.D., P.Eng.

Shabbir Dandukwala, M.Eng., P.Eng.

Drawings



NOTES:

1. The boundaries and soil types have been established only at borehole locations between and beyond boreholes they are assumed and may be subject to considerable error.
2. Soil samples will be retained in storage for 3 months and then destroyed unless the client advises an extended time period is required.
3. Topsoil quantities should not be established from the information provided at the borehole locations.
4. Borehole elevations should not be used to design building(s) or floor slab(s) or parking lot(s) grades.
5. This drawing forms part of the report (project number as referenced) and should only be used in conjunction with this report.

Borehole

Borehole with Monitoring Well

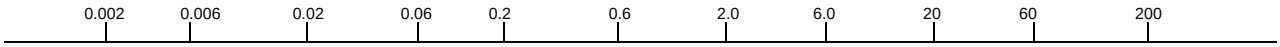
Client:	**Fieldgate Developments**			Project No. **23-072-100**	Drawing No: **1**
Drawn:	**J.M / K.T**	Approved:	**LB**	Title:	**Borehole Location Plan**
Date:	**24/3/2023**	Scale:	**N.T.S**	Project:	**Elm road and Ninth Line,Whitchurch-Stouffville,ON**
Original Size:	**Letter**	Rev:	**N/A**	DS CONSULTANTS LTD. Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology	

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 DS 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.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

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.

DS CONSULTANTS LTD.
Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE BH23-1

PROJECT: Geotechnical Investigation
CLIENT: Fieldgate Developments
PROJECT LOCATION: Elm Road & 9th Line, Whitchurch-Stouffville, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4870382.55 E 639726.12

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Mar-17-2023

REF. NO.: 23-072-100
ENCL NO.: 2

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	ELEVATION	GR	SA	SI	CL
270.9									
270.8	**TOPSOIL:** 150mm								
0.2	**FILL:** silty sand, trace organics, trace gravel, brown, moist, loose	1	SS	5					
270.1									
269.9	**SILTY SAND:** trace clay, trace gravel, brown, very moist, compact	2	SS	17	270	6	32	43	19
1.0									
269.4	**CLAYEY SILT TILL:** sandy, trace gravel, brown, moist, very stiff								
1.5		3	SS	18		10	38	39	13
2	**SILTY SAND TILL:** some clay, some gravel, occasional cobble, brown, moist, compact				269				
268.6					W. L. 269.0 m Mar 22, 2023				
2.3	**CLAYEY SILT:** trace sand, brown, moist, very stiff	4	SS	20			3	78	19
3					268				
267.8									
3.1	**SANDY SILT:** some clay, trace gravel, brown, wet, dense	5	SS	42		1	25	61	13
4					267				
266.3									
4.6	**SAND:** trace silt, trace clay, trace gravel, brown, saturated, compact	6	SS	13	266	1	90		(9)
5									
6					265				
		7	SS	12					
264.2									
6.7	**END OF BOREHOLE:**								

Notes:
1) 50mm dia. monitoring well installed upon completion.
2) Water Level Readings:

Date:	Water Level(mbgl):
Mar. 22, 2023	1.95

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH (kPa) (20 40 60 80 100)
○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)
REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

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Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE BH23-2

PROJECT: Geotechnical Investigation
CLIENT: Fieldgate Developments
PROJECT LOCATION: Elm Road & 9th Line, Whitchurch-Stouffville, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4870382.64 E 639803.75

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Mar-17-2023

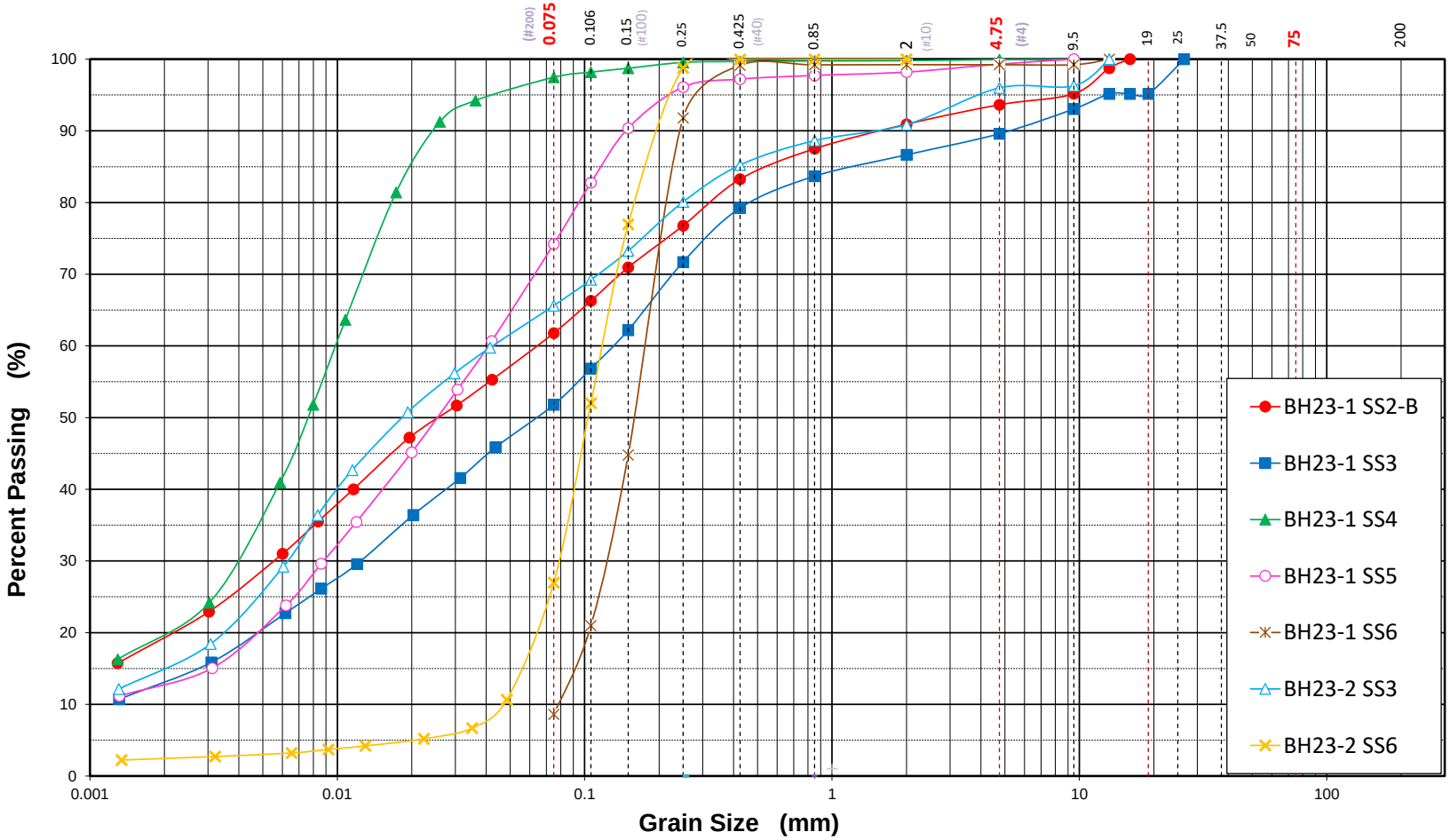
REF. NO.: 23-072-100
ENCL NO.: 3

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS / 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
271.1												
271.0 / 0.0	**TOPSOIL:** 150mm						271					
270.8 / 0.2	**FILL:** silty sand, trace gravel, brown, moist, loose		1	SS	4							
270.3												
1 0.8	**SILTY SAND TILL:** some clay, trace gravel, brown, moist to wet, loose to compact		2	SS	9		270					
			3	SS	13							4 30 51 15
2 268.8							269					
2.3	**SAND:** trace to some silt, brown, saturated, dense		4	SS	30							
3			5	SS	30		268					
4 266.5							267					
4.6	**SILTY SAND:** trace clay, brown, saturated, compact		6	SS	10							0 73 25 2
5							266					
6			7	SS	18		265					
264.4												
6.7	**END OF BOREHOLE:** Notes: 1) Water observed at 2.3m during drilling.											

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

Particle Size Distribution (ASTM-D421/D422)



Silt and Clay		Sand			Gravel		Cobble +
Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	

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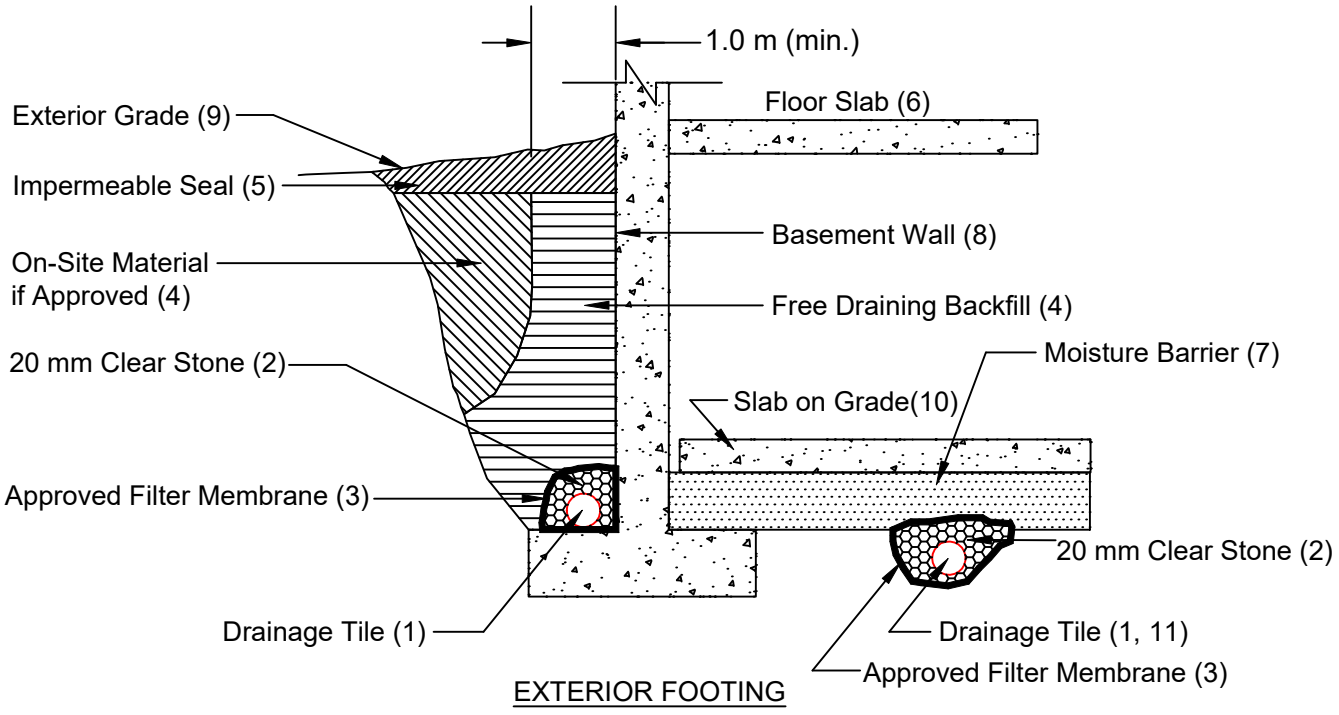
Project	**Geotechnical Investigation**	Project No	**23-072-100**
Location	**Elm Road & 9th Line, Whitchurch-Stouffville, ON**	Date	**Mar/20/2023**
Client	**Fieldgate Developments**	Figure No	4



EXTERIOR FOOTING

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, place100 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

LOG OF BOREHOLE No. 1 and 2

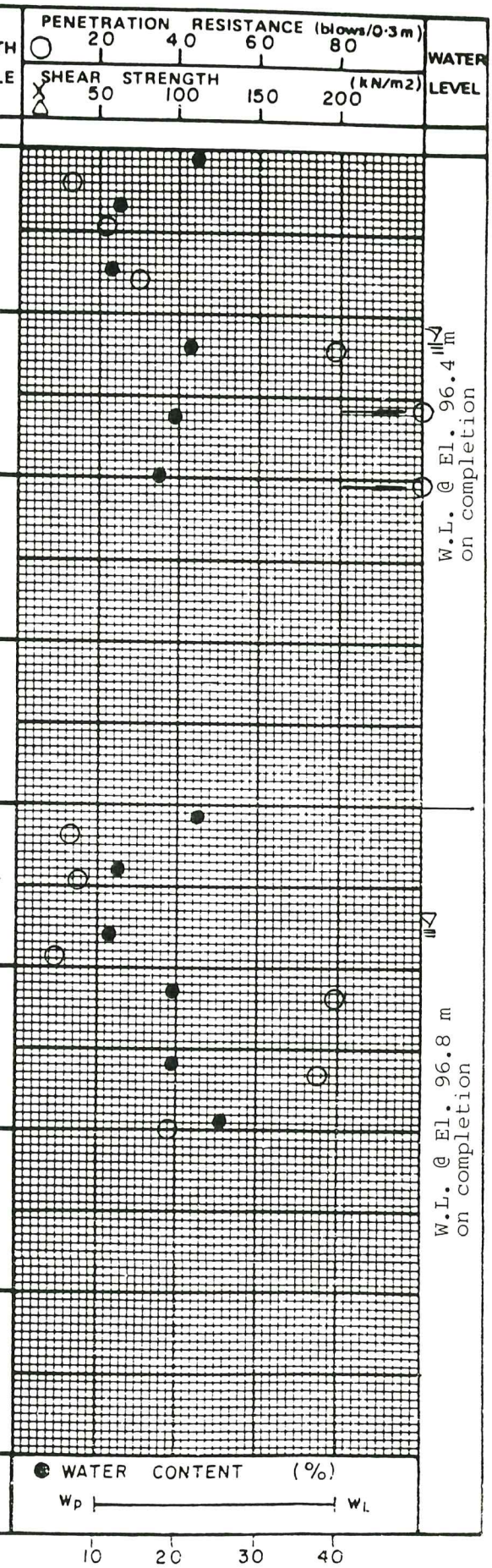
NW Corner of Ninth Line & Elm Road

JOB No.: 9912-S.10 **LOCATION:** Town of Whitchurch-Stouffville **FIG. No.:** 1 & 2

JOB DESCRIPTION: Proposed Townhouse Development

METHOD OF BORING: Flight-Auger **DATE:** December 17, 1999

ELEV. / DEPTH m	SOIL DESCRIPTION	SAMPLES No.	TYPE	"N"
98.7	Ground Surface		BH	1
0.0	33cm TOPSOIL	1	DO	14
	Brown, compact weathered SANDY SILT, Till traces of gravel and clay	2	DO	23
96.6	occ. cobbles, boulders, and wet sand and silt seams	3	DO	31
2.1	and layers Brown, very dense to compact SILTY FINE SAND occ. sandy silt layers a tr. of clay	4	DO	80
		5	DO	100+
94.4		6	DO	30
4.3	END OF BOREHOLE			
98.3	Ground Surface		BH	2
0.0	33cm TOPSOIL	1	DO	14
	Brown, compact weathered SANDY SILT, Till traces of gravel and clay	2	DO	16
96.2	occ. cobbles, boulders, and wet sand and silt seams	3	DO	10
2.1	and layers Brown, very dense to dense SILTY FINE SAND occ. sandy silt layers a tr. of clay	4	DO	80
		5	DO	76
94.0		6	DO	39
4.3	END OF BOREHOLE			



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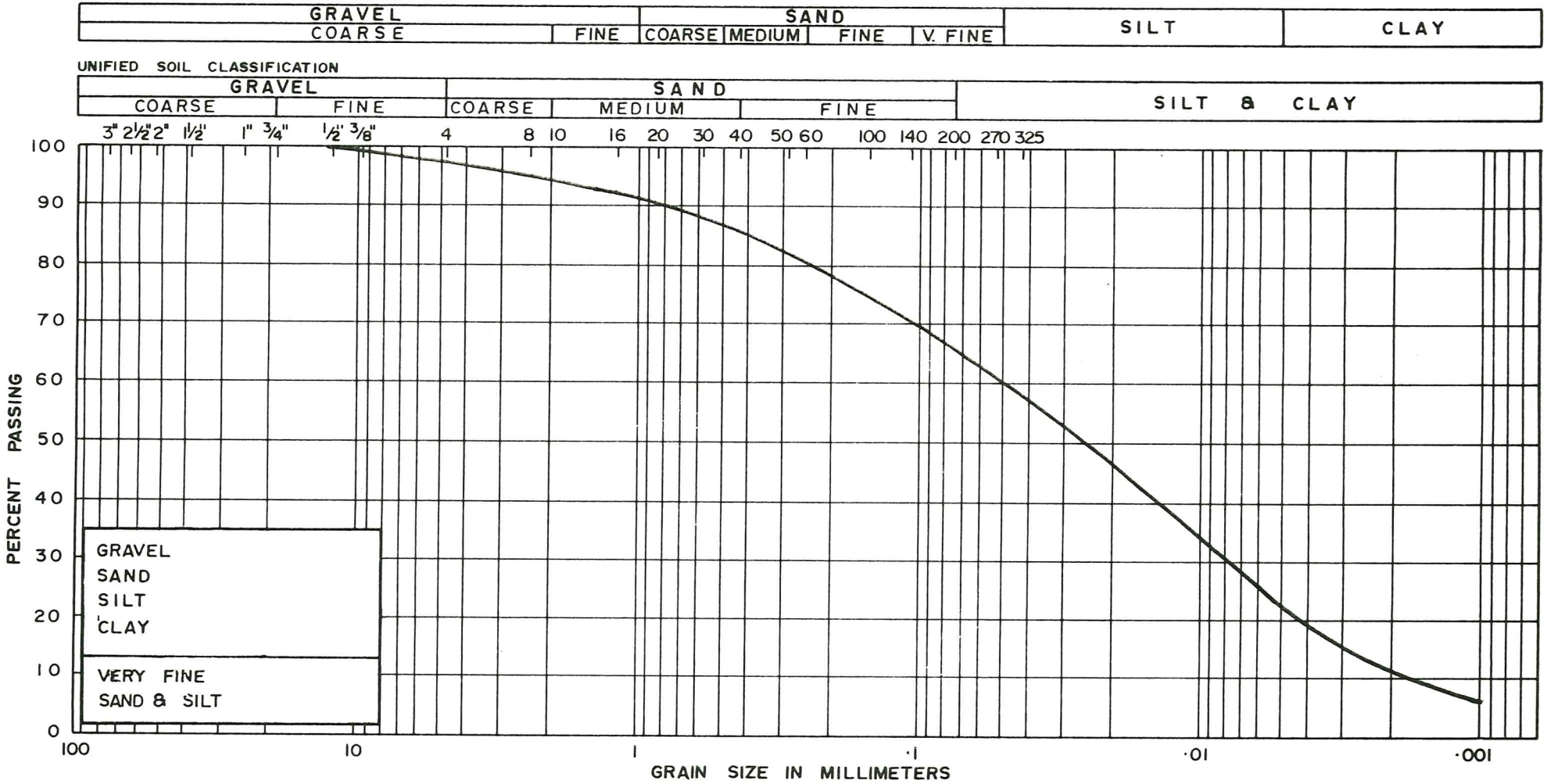
REFERENCE Nº 9912-S10

GRAIN SIZE DISTRIBUTION



PROJECT: Proposed Townhouse Development

LOCATION: NW Corner of Ninth Line & Elm Rd., Town of Whitchurch-Stouffville

BOREHOLE Nº: 1

SAMPLE Nº: 3

DEPTH: (m) 1.8

ELEVATION: (m) 96.9

Classification of Sample and Group Symbol:

SANDY SILT, Till

traces of gravel and clay

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % =

PERMEABILITY (cm./sec.) = 10^{-6}

(Estimated)

FIGURE 3

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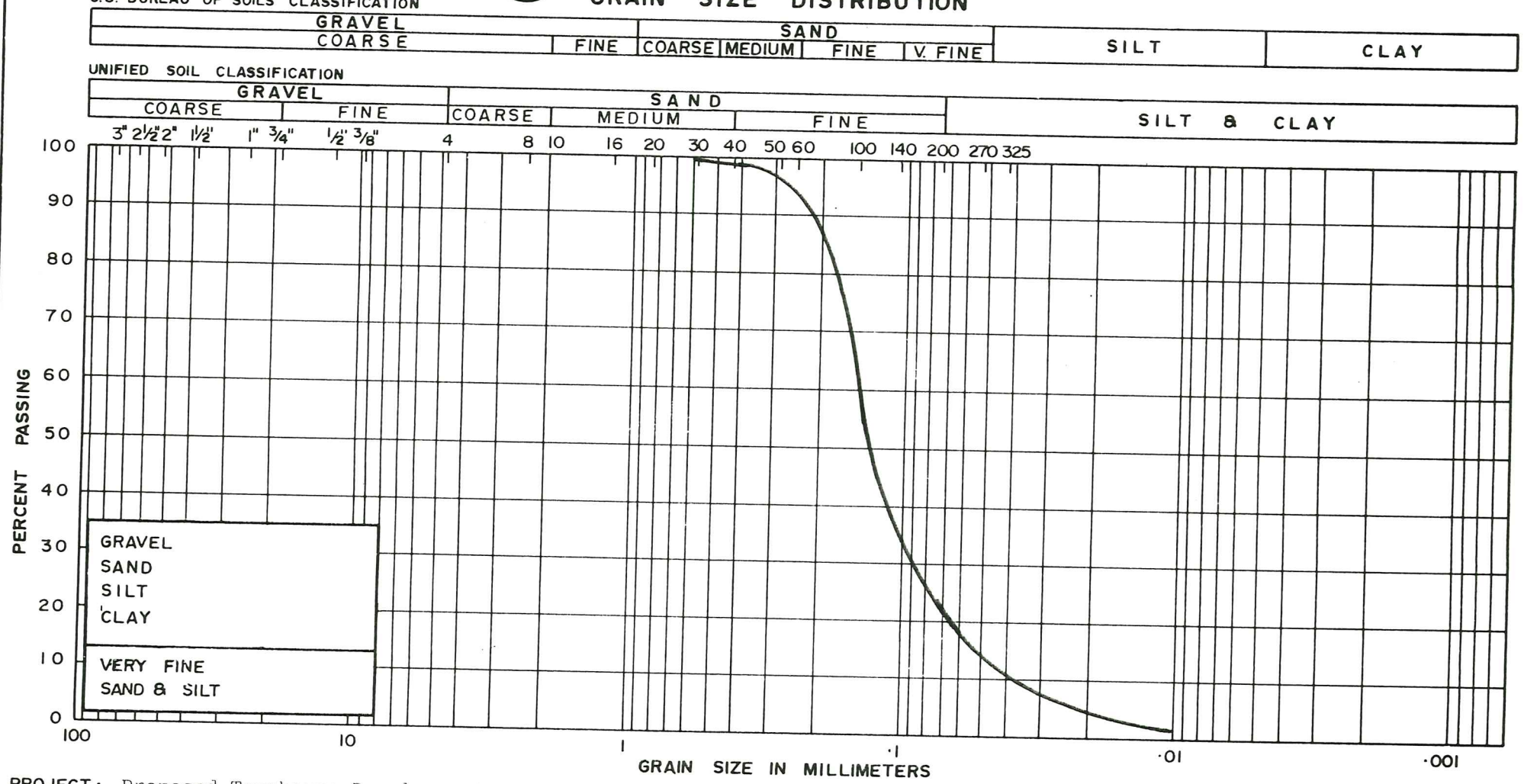
REFERENCE Nº 9912-S10

GRAIN SIZE DISTRIBUTION



PROJECT: Proposed Townhouse Development

LOCATION: NW Corner of Ninth Line & Elm Rd., Town of Whitchurch-Stouffville

BOREHOLE Nº: 2

SAMPLE Nº: 4

DEPTH: (m) 2.5

ELEVATION: (m) 95.8

Classification of Sample and Group Symbol:

SILTY FINE SAND

LIQUID LIMIT % =

PLASTIC LIMIT % =

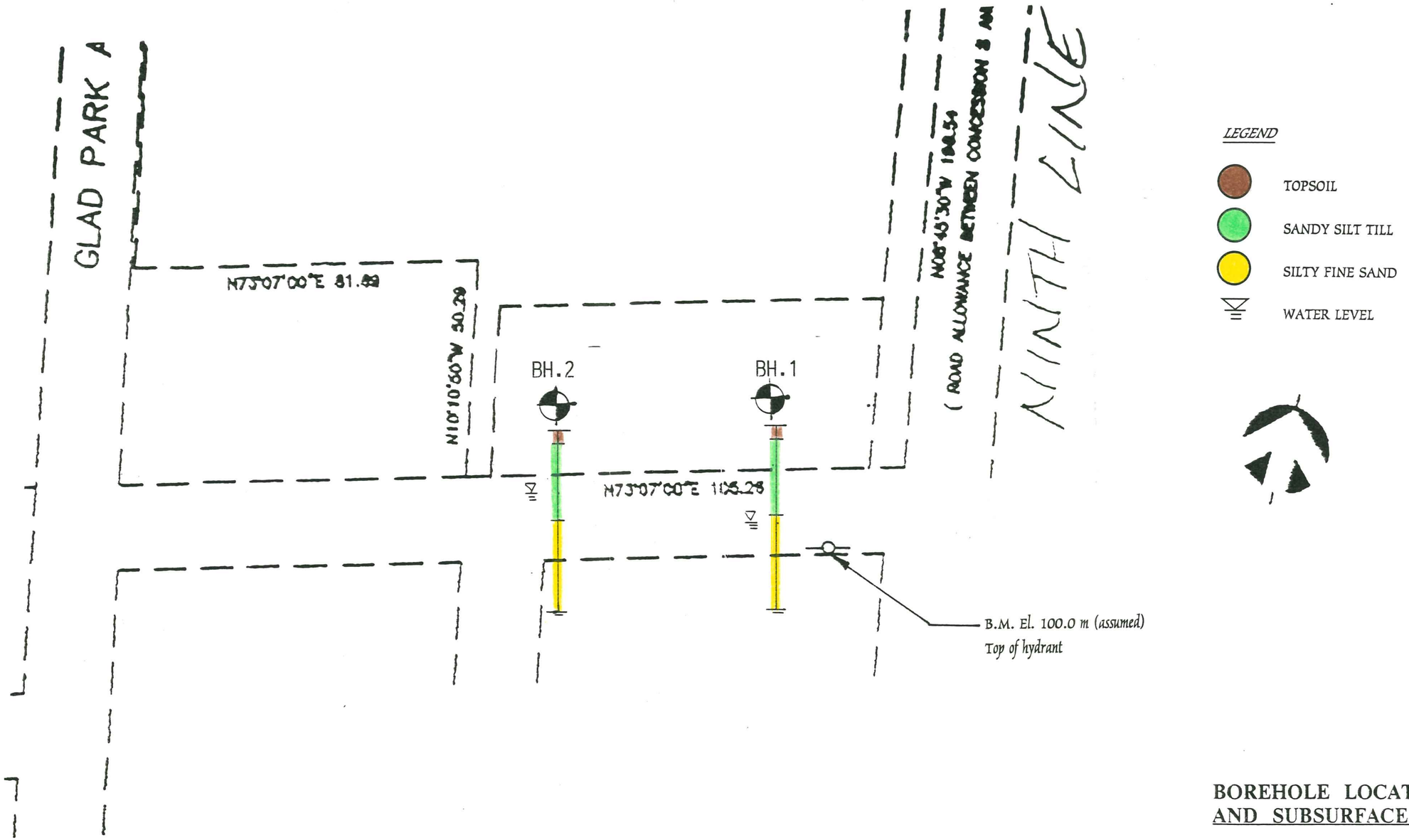
PLASTICITY INDEX % =

MOISTURE CONTENT % =

PERMEABILITY (cm./sec.) = 10^{-3}

(Estimated)

FIGURE: 4



LEGEND

- TOPSOIL
- SANDY SILT TILL
- SILTY FINE SAND
- WATER LEVEL

BOREHOLE LOCATION PLAN AND SUBSURFACE PROFILE

Ref. No. 9912-S10

Date: February 2000

Drawing No. 1

Scale: Horiz. - 1:1000 Vert. - 1:100

SOIL-ENG LIMITED