Preliminary
Geotechnical Investigation Report
Proposed Residential Development
17-27 Jacobs Terrace
Barrie, Ontario

PREPARED FOR:
Tonlu Holdings Limited

Project No: 21-018-100
Date: August 5, 2021

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1. INTRODUCTION

DS Consultants Ltd. (DS) was retained by Tonlu Holdings Limited to carry out a preliminary geotechnical investigation for the proposed residential development, located at 17-27 Jacobs Terrace in Barrie, Ontario.

DS carried out a preliminary geotechnical investigation field work at the subject site during the period of February 3 to 9, 2021, consisting of four (4) boreholes (BH 21-1 to BH 21-4) which were drilled to depths ranging from 31.1 to 45.9 m below the existing grade, at the locations shown on the Borehole Location Plan, Drawing 1. The Borehole logs are attached in Drawings 2 to 5 of this report.

The purpose of this preliminary geotechnical investigation was to obtain information about the subsurface conditions at boreholes locations and from the findings in the boreholes to provide geotechnical recommendations based on the available geotechnical information, for the proposed residential development, located at 17-27 Jacobs Terrace in Barrie, Ontario.

Monitoring wells were installed in Boreholes BH20-1, BH20-3 and BH20-4 to monitor long-term stabilized groundwater levels.

Based on the provided conceptual site plan and information, it is understood that the proposed residential development will consist of two towers (24 and 26 storey structures) with 5 story podiums.

The proposed development will not include underground parking or basement. The design grades are not known at this stage.

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. Earth pressures
5. Earthquake considerations
6. Pavement

This report deals with geotechnical issues only. The hydrogeological investigation report by DS will be submitted under separate cover.

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 Tonlu Holdings Limited and its architect and designers. Third party use of this report without DS consent is prohibited.

2. FIELD AND LABORATORY WORK

DS carried out the geotechnical investigation field work at the subject site during the period of February 3 to 9, 2021, consisting of four (4) boreholes (BH 21-1 to BH 21-4) which were drilled to depths ranging from 31.1 to 45.9 m below the existing grade, at the locations shown on the Borehole Location Plan, Drawing 1. The Borehole logs are attached in Drawings 2 to 5 of this report.

Boreholes were drilled with hollow stem continuous flight augers and mud rotary methods by a drilling sub-contractor under the direction and supervision of DS 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 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. Selected soil samples were subjected to grain size analyses and Atterberg Limits testing. The gradation curves are provided on **Drawings 7 to 10** of this report.

Water level observations could not be obtained during and upon completion of drilling due to the mud drilling method techniques. Monitoring wells were installed in Boreholes BH21-1, BH21-3 and BH21-4 for long term groundwater monitoring and sampling.

The surface elevations at the borehole locations were surveyed by DS, using differential GPS system, leased from Sokkia Canada Inc.

3. SUBSURFACE CONDITIONS

DS Boreholes logs are presented on **Drawings 2 to 5** of this report, at the locations shown on borehole location plan Drawing 1. The generalized subsurface profile in the boreholes is shown on **Drawing 6.** The subsurface conditions in the boreholes are summarized below.

3.1 Soil Conditions

Pavement: A layer of asphalt, varying in thickness from 75 to 150 mm, was present at the surface of all the boreholes except BH21-1. Granular base, consisting of sand and gravel and varying in

thickness from 305 to 430 mm, underlies the asphalt in the boreholes. Granular fill, about 800 mm in thickness, was also observed at the surface at borehole BH21-1.

Fill Materials:

Fill materials consisting of silty sand material was detected below the granular fill in all the boreholes and extended to depths ranging from about 2.3 to 2.6 m below the existing ground surface. The fill was brown in color and contained trace of rootlets.

SPT 'N' values measured in fill material ranged in general from 4 to 6 blows per 300mm penetration, indicating a loose state. The moisture content of this moist to wet moist fill layer varied from 8 to 31%.

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

Silty Sand/Sand to Sandy Silt

Brown to grey deposit consisting of silty sand to sand and sandy silt to silt extended below the fill materials to the maximum explored depth of all the boreholes except BH21-1 where it extended to the underlying sand and gravel, to an approximate depth of 41.3 m. This deposit included a layer of clayey silt to silt (in BH21-2 and BH21-4) between approximate depths of 18.3 to 24.3 m. This deposit also contained some to trace of clay, sand and gravel. SPT 'N' values measured within the sandy/silty layers varied from 5 to over 100 blows per 300mm of penetration, indicating loose to very dense relative density. SPT 'N' values measured in the clayey layers ranged from 8 to 20 blows per 300mm of penetration, indicating a stiff to very stiff consistency. The moisture content of the moist to wet cohesive clayey material varied from 17 to 22% and the cohesionless sandy/silty materials varied from 6 to 24%.

Sand and Gravel

Grey sand and gravel extended below the silty sand/sandy silt deposit (at an approximate depth of 41.3 m) to the maximum depth of BH21-1 (to a depth of 45.9 m). This deposit contained trace of silt. SPT 'N' values measured within the sand and gravel layer varied from 41 to over 100 blows per 300mm of penetration, indicating dense to very dense relative density. The moisture content of the moist to wet cohesionless sand and gravel materials varied from 11 to 13%.

Grain size analyses of seven (24 soil samples from the sandy, silty, sand and gravel materials (BH21-1/SS5, SS9, SS17, SS19, SS25, SS30, SS32, BH21-2/SS5, SS10, SS13, SS23, BH21-3/SS6, SS8, SS11, SS16, SS17, SS21, SS23 and BH21-4/SS6, SS11, SS13, SS18, SS19, SS22) were conducted, and the results are presented in Drawings 7 to 10, with the following fractions:

Clay: 1 to 12%
Silt: up to 93%
Sand: 1 to 93%
Gravel: up to 57%

Grain size analyses of three (3) clayey/silty soil samples (BH21-2/SS15, SS18 and BH21-4/SS15) were conducted, and the results are presented in **Drawings 7 to 10**, with the following fractions:

Clay: 11 to 15%
Silt: 74 to 88%
Sand: 1 to 12%
Gravel: up to 2%

Atterberg limits tests of one (1) soil sample (BH21-4/SS15) were conducted. The results are shown on the borehole logs and are summarized as follows:

Liquid limit (W_L): 20.1%
Plastic limit (W_P): 14.4%
Plasticity index (PI): 5.7

3.2 Groundwater Conditions

During drilling, short-term (unstabilized) groundwater levels were not obtained due to the mud drilling method techniques.

Groundwater levels in the monitoring wells installed at three (3) DS's borehole locations (BH21-1, BH21-3 and BH21-4) were measured on February 26, 2021 at approximate depths of 3.7, 4.2 m and 3.9, at approximate Elevations of 225.8, 226.2 and 226.0 m, respectively.

The groundwater levels (depths and elevations) are summarized in the following Table 1.

Table 1: Groundwater Levels Observed in DS Monitoring Wells

BH No.	Ground Surface Elevation (m)	Date of Drilling	Date of Observation	Depth of Groundwater (m)	Elevation of Groundwater (m)
BH21-1	229.5	Feb 8, 2021	Feb 26, 2021	3.7	225.8
BH21-3	230.4	Feb 3, 2021	Feb 26, 2021	4.2	226.2
BH21-4	229.9	Feb 9, 2021	Feb 26, 2021	3.9	226.0

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

4. FOUNDATIONS

Based on the provided information, it is understood that the proposed development will consist of two towers (24 and 26 storey structures) with a common 5 storey podium with no basement/underground parking.

Design details/grades of the proposed development are not available to us at the time of writing this report.

Therefore, our recommendations should be considered preliminary and will be revised when the proposed Site/Foundation plan becomes available.

The subsoils consists of mainly sandy deposits below groundwater level. Drilled caissons are not recommended due to anticipated soil caving and base heaving problems associated with groundwater. Driven piles are also not recommended because it will be difficult to drive the piles to design depth through dense to very dense soil layers which are interbedded with weak soil layers.

Based on the borehole information, due to the variable soil conditions and the presence of weak soil conditions and less competent sandy, silty and clayey layers, the proposed development can be supported by auger cast piles (CFA) or raft foundations supported by CFA, subject to design loads.

4.1 Continuous Flight Auger Piles (CFA)

Subject to design loads, the proposed buildings with one level of underground parking can be supported on continuous flight auger piles (CFA) and grade beams system.

The bearing resistance of the piles will highly depend on the quality and procedure of the pile installation, as well as on the diameter and depth of the piles. Due to presence of weak soil layers at the site, the pile skin friction from the soils listed in the following should be ignored:

- Skin friction above ELev. 201.0 m (i.e. depth of 28.5 m) in BH21-1 is to be ignored.
- Skin friction above ELev. 208.0 m (i.e. depth of 22.4 m) in BH21-2 is to be ignored.
- Skin friction above ELev. 205.0 m (i.e. depth of 24.6 m) in BH21-3 is to be ignored.
- Skin friction above ELev. 208.0 m (i.e. depth of 21.9 m) in BH21-4 is to be ignored.

A pile skin friction of 100 kPa at SLS (140 kPa at ULS) can be used for the more competent soils below the elevations listed above for preliminary design purpose.

For CFA piles of 610 mm in diameter and minimum 6 m in length below the elevations listed above (i.e. pile tip/toe to or below Elev. 195.0m, 202.0m, 199.0m and 202.0 m in BH21-1, BH21-2, BH21-

3 and BH21-4, respectively), bearing capacity values of 1500 kN/pile at SLS and 2100 kN/pile at ULS can be used in the design. A pile base/toe bearing capacity of 1250 kPa at SLS (1750 kPa at ULS) is also considered in estimating the pile capacity.

In addition, based on the deep borehole BH21-1, CFA piles of 610 mm in diameter (with pile tip/toe to or below Elev. 185.0m), pile design load of 2500 kN/pile at SLS and 3500 kN/pile at ULS could be considered in the design, **subject to confirmation by pile load test**.

The actual bearing resistance and required length of the piles must be determined by field load tests, prior to the installation of the production piles. The purpose of pile load testing is to determine the skin friction of the strong soils below the elevation indicated above. The skin friction of the weak soil layers above the more dense competent soils as indicated above should not be included in the pile load testing.

It should be noted that the required depth of the CFA piles is quite significant. A specialty contractor must be retained to install the piles.

The bearing resistances of CFA piles will be highly dependent on the contractor's experience, the quality and procedure of the pile installation, and the skills of the installation operator(s). The CFA contractor must review the borehole information and evaluate bearing capacity of the piles based on their experience. The quality and the design bearing resistance of the piles must be ensured by the CFA contractor. A specialty contractor should be retained to design and install the CFA piles based on the performance specification and design bearing resistances.

Prior to the pile construction, the contractor should submit the details of the installation plan, load test program, installation procedure, automated monitoring system and control parameters, grout/concrete mix design, and reinforcement installation etc. for the review by the structural engineer and the geotechnical engineer.

All pile installation must be inspected by this office. In addition to the pre-production pile load tests, post-installation integrity tests and/or verification load tests are also required.

4.2 General Comments on Foundations

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 borehole information for the preliminary 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.

Subject to the proximity of the site to Railway, a pre-construction survey/instrumentation and monitoring and other precautionary measures should be carried out prior to commencement of design/foundation installations.

Should a crash wall be required to mitigate potential impact of a train crash into the proposed development. A conceptual design of the proposed wall should be prepared by the structural engineer and reviewed by this office.

5. FLOOR SLAB AND PERMANENT DRAINAGE

The floor slab can be supported on grade, provided all fill/loose/disturbed native soils (if any) are removed, the base thoroughly proof rolled. Any 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). Alternatively, structural slab could be utilized.

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

6. ELEVATOR PITS

The elevator pits will be installed in cohesionless wet sandy soils below groundwater table. In this case, drainage systems at the base level of the elevator pits are not recommended, due to the concern of loss of fines. The elevator pits should be designed as a water-tight structures and should be fully waterproofed to avoid any water leaks, due to the presence of wet seams/layers of silt/sandy silt/ silty sand soils.

7. EARTH PRESSURES

The lateral earth pressures acting on the 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.

8. FROST PROTECTION

All exterior underside of raft/grade beams/caps exposed to seasonal freezing conditions must have at least 1.5 metres of soil cover for frost protection.

There is no official rule governing the required founding depth for grade beams below unheated basement floors.

Certainly, it will not be greater than the 1.5 m required in Southern Ontario (Barrie) for exterior footings. Un-monitored experience indicates that a shallower depth ranging from 0.82 to 0.9 m for interior column footings. The 0.82 m depth is believed to be close to the minimum structural requirement for interior column footings. Adjacent to air shafts and entrance and exit doors, a footing depth of 1.5 m below floor level is required or, alternatively, insulation protection must be provided.

It is also emphasized that an adequate free draining gravel base is required to minimize the risk of floor dampness. Floor dampness could lead to temporary icing and the risk of accidents.

9. EARTHQUAKE CONSIDERATION

Based on the drilled boreholes on site and our review of the general subsurface information in the area, and according to Table 4.1.8.4.A of OBC 2012, the subject site for the proposed development founded on undisturbed native soils can be classified as 'Class D' for seismic site response.

For the proposed buildings, it may be possible to classify the site as 'Class C', provided field seismic shear wave velocity test (SWVT) is to be carried out at the site to confirm the 'Class C' classification.

10. EXCAVATIONS AND GROUNDWATER CONTROL

Excavations in the fill and native soils can be carried out with heavy hydraulic backhoe. Groundwater in the monitoring wells installed in Boreholes BH21-1, BH21-3 and BH21-4 was recorded at depths ranging from 3.7 to 4.2 m below the existing grade, corresponding to Elevations ranging from 225.8 to 226.2 m. Long-term groundwater table is expected to be 1 to 2 m higher. Positive dewatering will be required prior to any excavation in wet cohesionless soils below the groundwater table (such as elevator pit and services), otherwise it will be result in unstable base and flowing sides. A contractor specializing in dewatering should be retained to design the dewatering systems. The groundwater table must be lowered to at least 1.0m below the deepest excavation base.

The hydrogeological investigation report by DS presents more comments and recommendations on dewatering requirement.

It should be noted that the till is a non-sorted sediment and therefore may contain 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 or obstructions 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 and the native soils can be classified as Type 3 Soil above the groundwater table and as Type 4 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.

11. PAVEMENTS

11.1 At Grade Asphalt Pavement Structure

For public roads (**if any**): subject to the anticipated road traffic volumes/AADT/axle loads, the pavement structural design matrix as per City of Barrie Standards must be followed.

For the remaining pavement areas, **if any**, 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 city/regional standards. Consequently, the recommended pavement structures should be considered for preliminary design purposes only.

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) 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 300 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.

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.

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 MCR and DS 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.

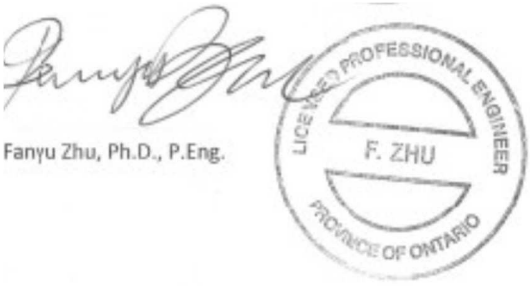
Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. DS accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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.

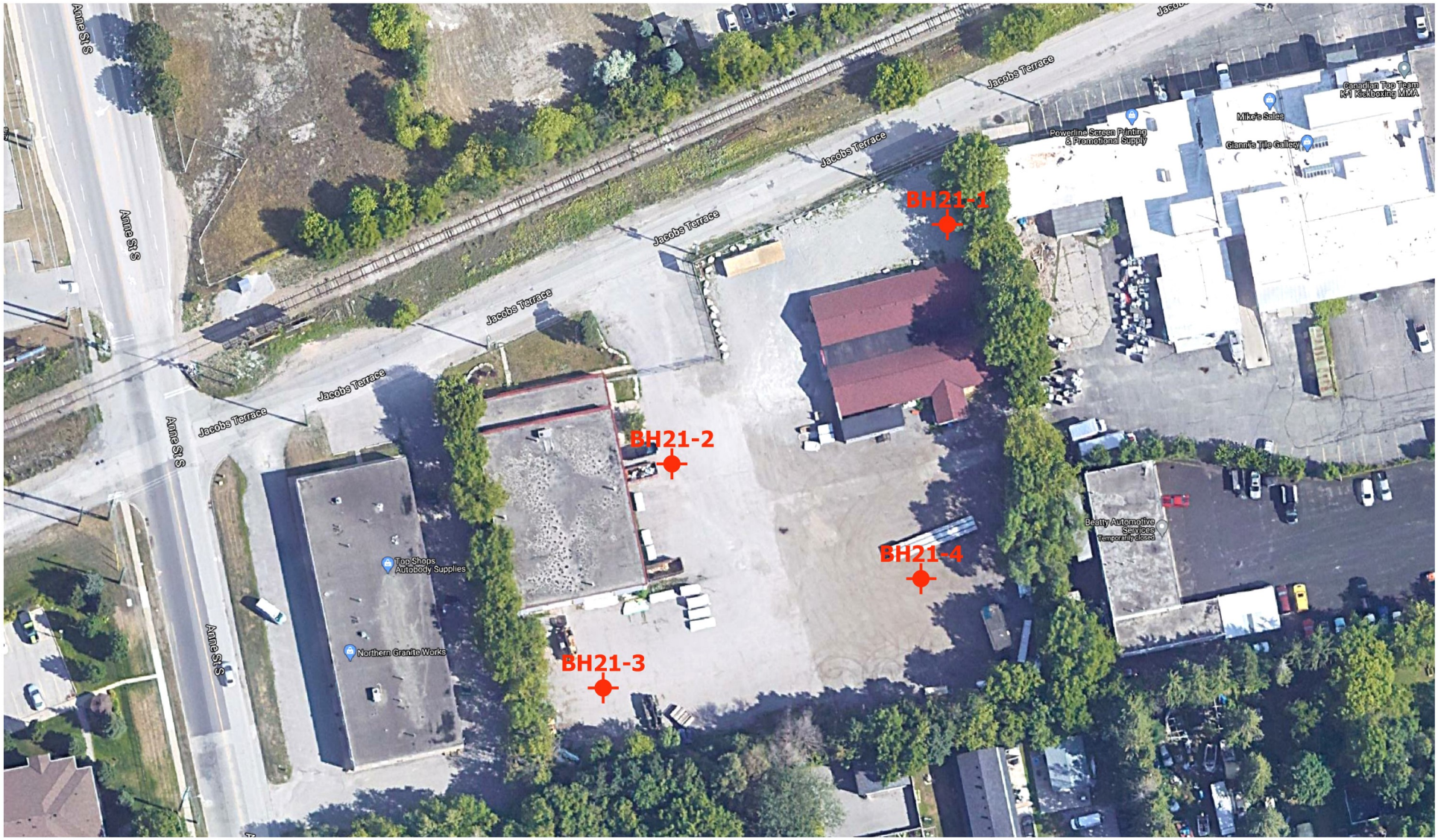
Labib Mousa, P. Eng.



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

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

Drawings



Legend

Borehole Location

0 25 50 m

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Project: Geotechnical Investigation - Proposed Residential Development, Barrie, ON

N

Title: **Borehole Location Plan**

Client: Tonlu Holdings Limited

Size:	Approved By:	Drawn By:	Date:
8.5 x 11	LM	MM	Mar 04, 2021
Rev: 0	Scale: As Shown	Project No.: 21-018-100	Drawing No.: 1

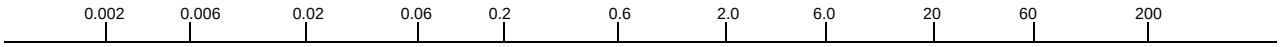
Image/Map Source: *Google Satellite Image*

Figure 1A: Notes on Soil 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 BH21-1

PROJECT: Geotechnical Investigation - Proposed Residential Development
CLIENT: Tonlu Holdings Limited
PROJECT LOCATION: 17-27 Jacobs Terrace, Barrie, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4914070.44 E 603957.52

DRILLING DATA
Method: Hollow Stem Auger/ Mud Rotary
Diameter: 200mm
Date: Feb/08/2020

REF. NO.: 21-018-100
ENCL NO.: 2

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	ELEVATION
229.5 / 0.0	**FILL:** sand and gravel, brown, moist, compact	1	SS	21	
228.7 / 0.8	**FILL:** silty sand, brown, moist, loose	2	SS	5	
		3	SS	4	
227.2 / 2.3	**SILTY SAND TO SANDY SILT:** trace clay, brown, wet, loose to dense	4	SS	5	
		5	SS	15	226
		6	SS	21	224
	grey below 6m	7	SS	45	
	sandy silt, wet below 7.5m	8	SS	47	222
		9	SS	22	220
		10	SS	29	218
217.3 / 12.2	**MEDIUM SAND:** trace silt, grey, wet, very dense	11	SS	31	
216.0 / 13.5	**FINE SILTY SAND TO SANDY SILT:** trace clay, grey, wet, dense to very dense	12	SS	51	216
		13	SS	33	214
		14	SS	34	212
		15	SS	38	
209.7 / 19.8	**SILT:** trace to some clay, trace sand, grey, wet, compact to dense	16	SS	19	210
		17	SS	12	208
	some sand below 22.9m	18	SS	33	206
		19	SS	11	
202.5 / 27.0	**FINE SAND:** some silt, trace clay, grey, wet, compact to very dense	20	SS	42	204
		21	SS	69	202
		22	SS	56	200
		23	SS	16	
198.0 / 31.5	**SILTY TO SANDY SILT:** trace clay, grey, wet, compact	24	SS	20	198
196.0 / 33.5	**MEDIUM TO COARSE SAND:** some silt, grey, wet, compact to very dense	25	SS	26	196
		26	SS	57	194
192.9 / 36.6	**SILTY SAND:** trace clay, grey, wet, compact	27	SS	23	
191.4 / 38.1		28	SS	36	192

GROUND WATER CONDITIONS: W. L. 225.8 m Feb 26, 2021; Filter Pack; Slotted Pipe; Bentonite: Bottom of hole; Grout

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)

METHANE AND GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
	0	86	13	1
	0	47	51	2
	0	9	81	10
	1	17	75	7
	0	93		(7)

DS SOIL LOG 21-018-100 PROPOSED RESIDENTIAL DEVELOPMENT_TONLU HOLDINGS LIMITED.GPJ DS.GDT 3/5/21

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH21-1

PROJECT: Geotechnical Investigation - Proposed Residential Development
CLIENT: Tonlu Holdings Limited
PROJECT LOCATION: 17-27 Jacobs Terrace, Barrie, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4914070.44 E 603957.52

DRILLING DATA
Method: Hollow Stem Auger/ Mud Rotary
Diameter: 200mm
Date: Feb/08/2020

REF. NO.: 21-018-100
ENCL NO.: 2

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	TYPE	"N" BLOWS 0.3 m	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)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
40	**MEDIUM TO COARSE SAND:** some silt, grey, wet, dense to very dense(Continued)		29	SS	76		190					
188.2												
41.3	interbed of silt at 41.1m		30	SS	41		188					0 7 82 11
42	**SAND AND GRAVEL:** trace silt, grey, wet, dense to very dense		31	SS	50/ 100mm		186					
44			32	SS	50/ 125mm							57 31 (12)
183.6							184					
45.9	**END OF BOREHOLE:** Notes: 1) 50mm dia. monitoring well installed upon completion. 2) Water level Reading: Date: Feb 26, 2021 Water Level (mbgl): 3.7		33	SS	60/ 150mm							

DS SOIL LOG 21-018-100 PROPOSED RESIDENTIAL DEVELOPMENT_TONLU HOLDINGS LIMITED.GPJ DS.GDT 3/5/21

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

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LOG OF BOREHOLE BH21-2

PROJECT: Geotechnical Investigation - Proposed Residential Development
CLIENT: Tonlu Holdings Limited
PROJECT LOCATION: 17-27 Jacobs Terrace, Barrie, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4914027.94 E 603908.51

DRILLING DATA
Method: Hollow Stem Auger/ Mud Rotary
Diameter: 200mm
Date: Feb/04/2020

REF. NO.: 21-018-100
ENCL NO.: 3

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	BLOWS "N" 0.3 m	ELEVATION	GR	SA	SI	CL
229.6									
229.5 / 0.1	**ASPHALT:** 150mm	1	SS	50/100mm					
229.4 / 0.2	**GRANULAR BASE:** sand and gravel, 430mm	2	SS	5					
227.3	**FILL:** silty sand, brown, moist, loose	3	SS	6	228				
2.3		4	SS	5					
	SAND: some silt, brown, moist to very moist, loose to compact	5	SS	16	226	0	86	13	1
225.1									
4.5	**SILTY SAND TO SANDY SILT:** trace clay, brown, wet, compact to dense	6	SS	18	224				
	grey below 6m	7	SS	43					
222.1					222				
7.5	**FINE SAND:** some silt, trace clay, grey, wet, compact to dense	8	SS	28					
		9	SS	30	220				
		10	SS	28		0	80	19	1
		11	SS	35	218				
		12	SS	19	216				
214.4									
15.2	**SANDY SILT TO FINE SILTY SAND:** trace clay, grey, wet, compact	13	SS	27	214	0	42	56	2
		14	SS	24	212				
211.3									
18.3	**CLAYEY SILT AND SILT:** interbeded, trace to some sand, occasional gravel, grey, wet, stiff to very stiff	15	SS	18		0	1	88	11
		16	SS	18	210				
		17	SS	10	208				
		18	SS	8		2	12	74	12
205.2					206				
24.4	**SILTY SAND TO SANDY SILT:** trace clay, grey, wet, compact to very dense	19	SS	67					
		20	SS	58	204				
		21	SS	14	202				
200.6									
29.0	**FINE TO MEDIUM SAND:** trace silt, occasional gravel, grey, wet, dense	22	SS	47	200				
		23	SS	37		1	90		(9)
		24	SS	48	198				
195.5		25	SS	47	196				
34.1	**END OF BOREHOLE:** Notes: 1)								

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)
METHANE 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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LOG OF BOREHOLE BH21-3

PROJECT: Geotechnical Investigation - Proposed Residential Development
CLIENT: Tonlu Holdings Limited
PROJECT LOCATION: 17-27 Jacobs Terrace, Barrie, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4913988.19 E 603896.32

DRILLING DATA
Method: Hollow Stem Auger/ Mud Rotary
Diameter: 200mm
Date: Feb/03/2020

REF. NO.: 21-018-100
ENCL NO.: 4

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	BLOWS "N" 0.3 m	ELEVATION
230.4 / 0.0	**ASPHALT:** 75mm	1	SS	21	230
230.3 / 0.1	**GRANULAR BASE:** sand and gravel, 305mm	2	SS	4	
230.0 / 0.4	**FILL:** silty sand, trace rootlets, brown, moist, loose	3	SS	4	
228.1 / 2.3	**SAND:** trace to some silt, trace clay, brown, very moist, loose to dense	4	SS	8	228
	wet below 4.5m	5	SS	16	
		6	SS	15	
		7	SS	30	224
		8	SS	15	
		9	SS	37	222
	grey below 10.5m	10	SS	40	220
218.2 / 12.2	**FINE SILTY SAND:** trace clay, grey, wet, dense	11	SS	33	218
		12	SS	31	
		13	SS	32	214
212.1 / 18.3	**SILT:** trace sand, trace clay, grey, wet, compact	14	SS	39	212
		15	SS	14	
		16	SS	13	210
208.8 / 21.6	**SANDY SILT:** trace clay, trace gravel, grey, wet, compact	17	SS	25	
		18	SS	96/ 280mm	208
206.4 / 24.0	**SILTY SAND:** trace clay, grey, wet, very dense	19	SS	50/ 125mm	206
204.5 / 25.9	**SANDY SILT:** trace clay, grey, wet, very dense	20	SS	68	
		21	SS	79	202
201.4 / 29.0	**SILTY SAND TO SANDY SILT:** trace clay, grey, wet, very dense	22	SS	53	
		23	SS	57	200
		24	SS	65	198
196.3 / 34.1	**END OF BOREHOLE:**	25	SS	76	

Notes:
1) 50mm dia. monitoring well installed upon completion.
2) Water level Reading:

Date:	Water Level (mbgl):
Feb 26, 2021	4.2

GROUND WATER CONDITIONS: W. L. 226.1 m Feb 26, 2021

Bentonite

Filter Pack
Slotted Pipe

Bentonite: Bottom of hole

Grout

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × 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)

METHANE AND GRAIN SIZE DISTRIBUTION (%)				
GR	SA	SI	CL	
0	85	14	1	
0	92		(8)	
0	63	36	1	
0	1	93	6	
2	22	69	7	
0	15	81	4	
0	45	53	2	

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

DS SOIL LOG 21-018-100 PROPOSED RESIDENTIAL DEVELOPMENT_TONLU HOLDINGS LIMITED.GPJ DS.GDT 3/5/21

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LOG OF BOREHOLE BH21-4

PROJECT: Geotechnical Investigation - Proposed Residential Development
CLIENT: Tonlu Holdings Limited
PROJECT LOCATION: 17-27 Jacobs Terrace, Barrie, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4914007.57 E 603952.83

DRILLING DATA
Method: Hollow Stem Auger/ Mud Rotary
Diameter: 200mm
Date: Feb/09/2020

REF. NO.: 21-018-100
ENCL NO.: 5

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS "N" 0.3 m	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)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
229.9												
229.8	**ASPHALT:** 75mm		1	SS	50/125mm							
229.5	**GRANULAR BASE:** sand and gravel, 330mm		2	SS	4							
227.3	**FILL:** silty sand, trace rootlets, brown, moist, loose		3	SS	4		228					
2.6	**SAND:** some silt, trace clay, brown, wet, loose to dense		4	SS	6							
			5	SS	11	▽	226					
								W. L. 226.0 m Feb 26, 2021				
			6	SS	26							0 88 (12)
			7	SS	24		224					
			8	SS	26		222					
	grey below 9m		9	SS	42		220					
			10	SS	28			Filter Pack Slotted Pipe				
217.7							218					
12.2	**FINE SILTY SAND:** trace clay, brown, wet, compact to dense		11	SS	20							0 53 46 1
			12	SS	25			Bentonite: Bottom of hole				
			13	SS	25		214					0 58 41 1
			14	SS	36							
211.6							212					
18.3	**CLAYEY SILT TO SILT:** trace sand, grey, wet, stiff to very stiff		15	SS	10							0 2 83 15
			16	SS	20		210					
208.6												
21.3	**SILTY SAND TO SANDY SILT:** trace clay, grey, wet, dense		17	SS	40		208					
207.0												
22.9	**SILT:** trace sand, trace to some clay, grey, wet, very dense		18	SS	52			Grout				0 4 86 10
							206					
	sandy below 24.4m		19	SS	57							0 20 74 6
204.0												
25.9	**SILTY SAND TO SANDY SILT:** trace clay, grey, wet, dense to very dense		20	SS	50		204					
			21	SS	46		202					
			22	SS	43							0 42 56 2
198.8			23	SS	48		200					
31.1	**END OF BOREHOLE:**											

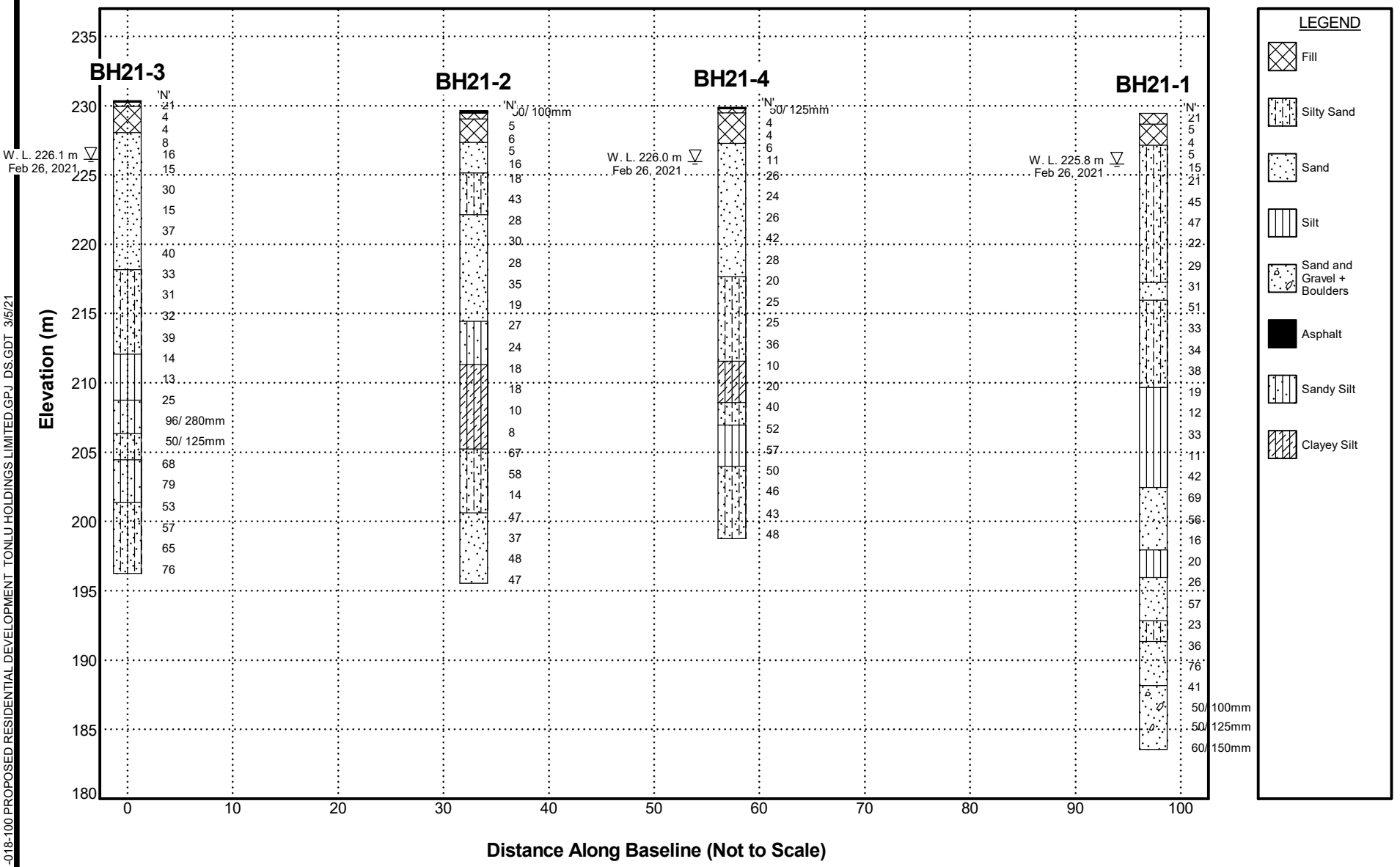
Notes:
1) 50mm dia. monitoring well installed upon completion.
2) Water level Reading:

Date:	Water Level (mbgl):
Feb 26, 2021	3.9

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

DS SOIL LOG 21-018-100 PROPOSED RESIDENTIAL DEVELOPMENT_TONLU HOLDINGS LIMITED.GPJ DS.GDT 3/5/21



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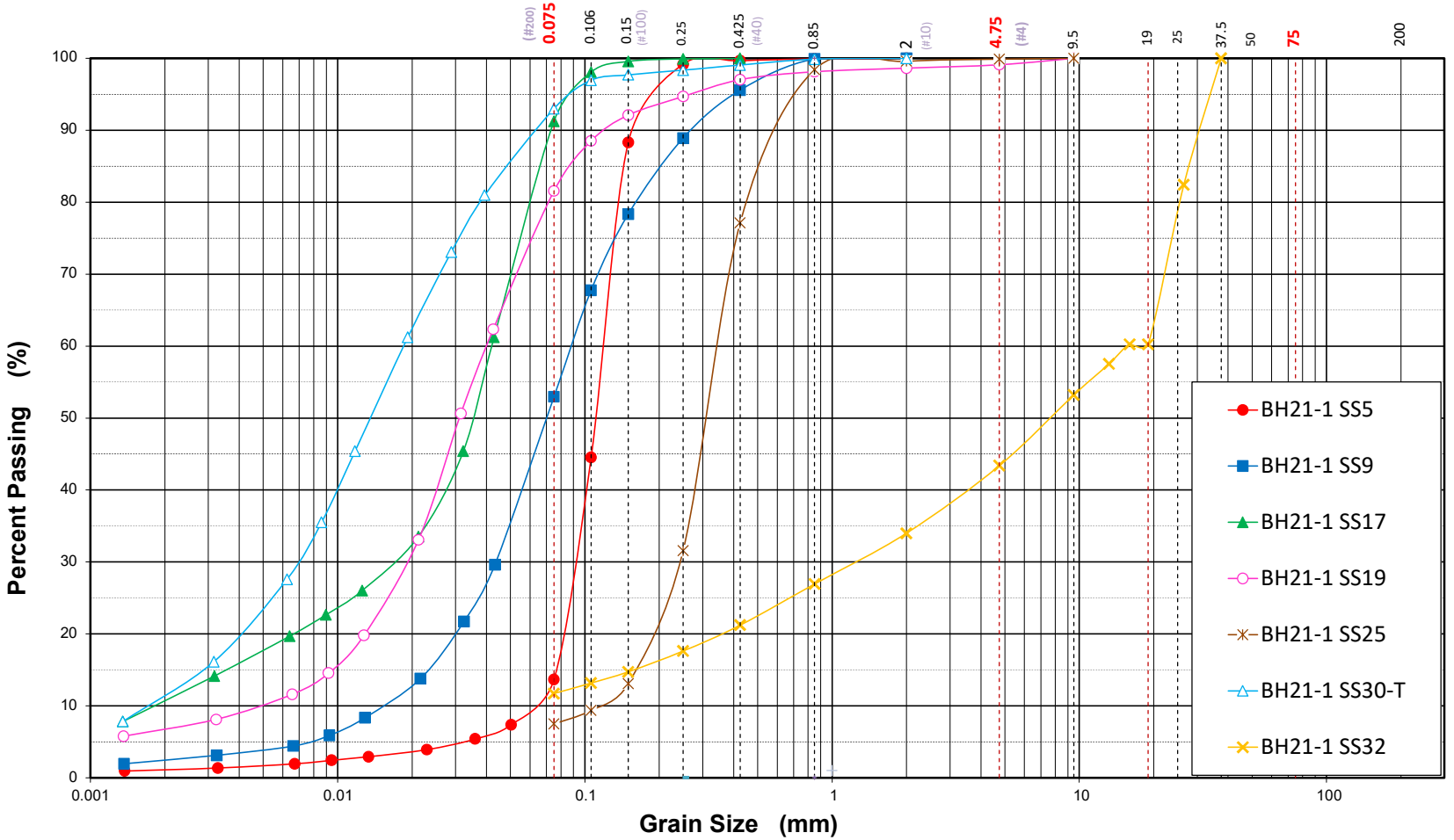
Generalized Sub-surface Profile

DRAWING NO.	6
JOB NO.	21-018-100
DATE	Mar 05, 2021

DS FENCE (M) 21-018-100 PROPOSED RESIDENTIAL DEVELOPMENT TONLU HOLDINGS LIMITED.GPJ DS.GDT 3/5/21

Particle Size Distribution (ASTM-D421/D422)



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

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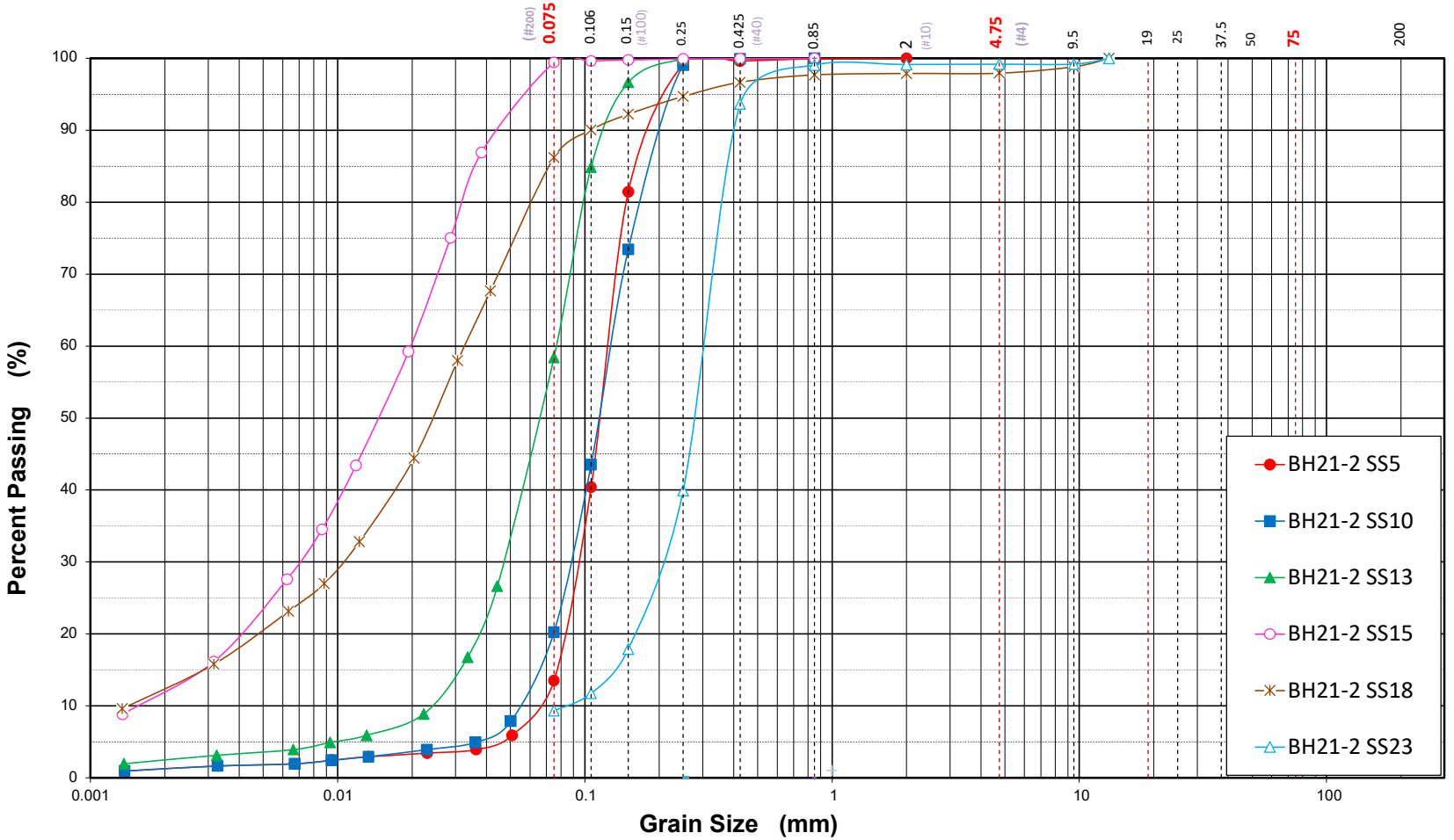
Project	**Proposed Residential Development**	Project No	**21-018-100**
Location	**17-27 Jacobs Terrace, Barrie, ON**	Date	**Feb-17-2021**
Client	**Tonlu Holdings Limited**	Figure No	**7**

Particle Size Distribution (ASTM-D421/D422)



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

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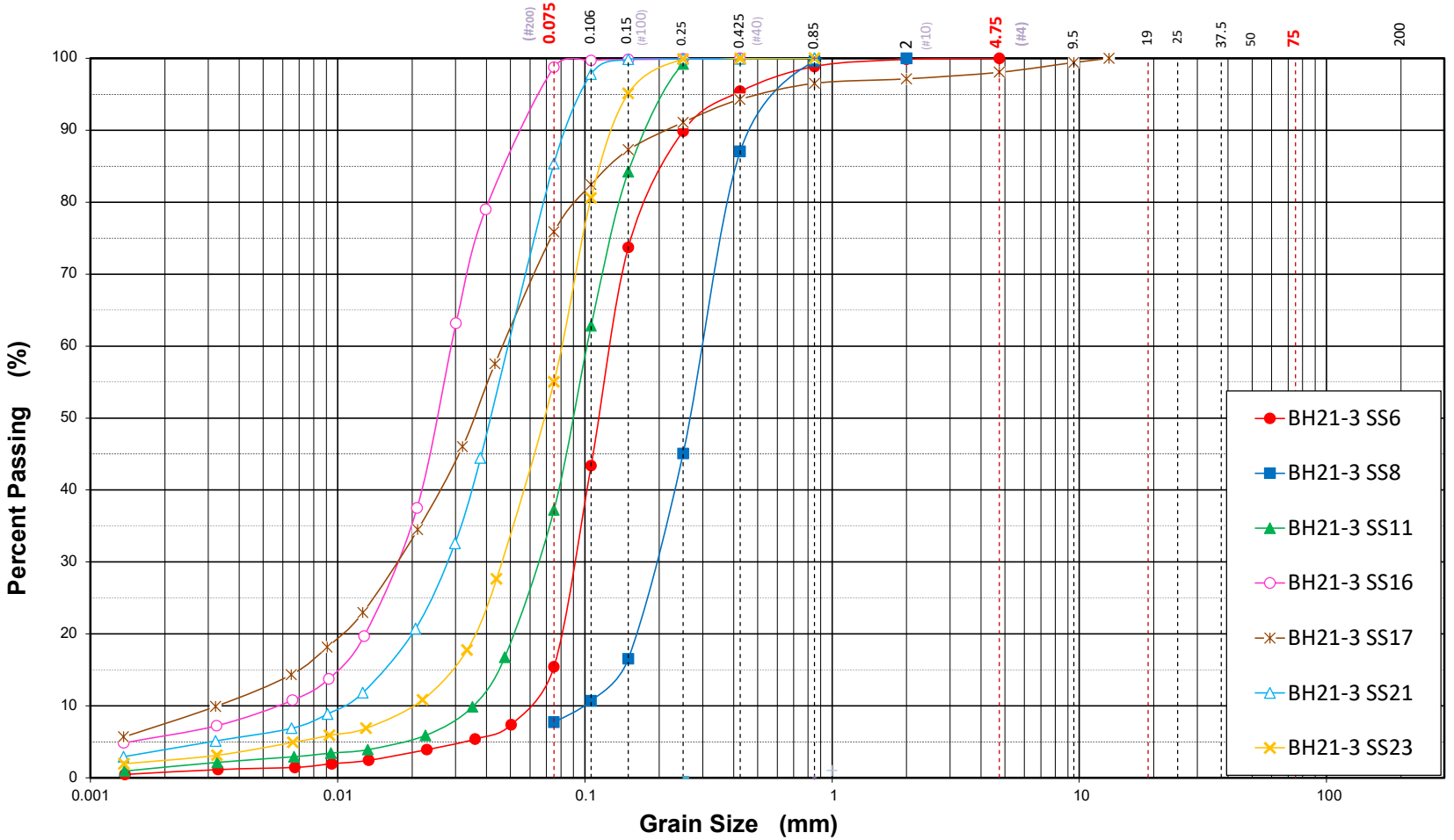
Project	**Proposed Residential Development**	Project No	**21-018-100**
Location	**17-27 Jacobs Terrace, Barrie, ON**	Date	**Feb-17-2021**
Client	**Tonlu Holdings Limited**	Figure No	**8**

Particle Size Distribution (ASTM-D421/D422)



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

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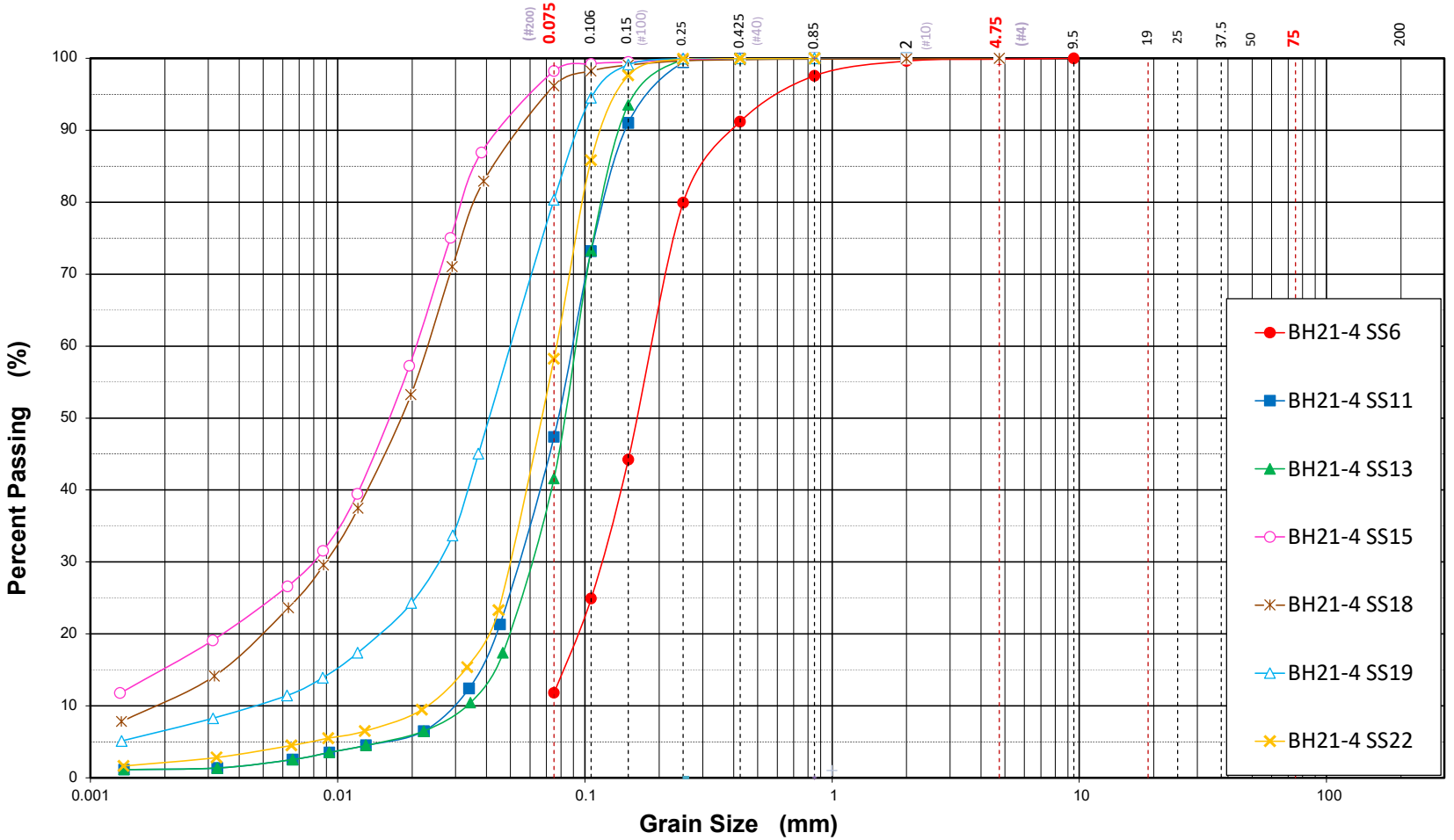
Project	**Proposed Residential Development**	Project No	**21-018-100**
Location	**17-27 Jacobs Terrace, Barrie, ON**	Date	**Feb-17-2021**
Client	**Tonlu Holdings Limited**	Figure No	**9**

Particle Size Distribution (ASTM-D421/D422)



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

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Project	**Proposed Residential Development**	Project No	**21-018-100**
Location	**17-27 Jacobs Terrace, Barrie, ON**	Date	**Feb-17-2021**
Client	**Tonlu Holdings Limited**	Figure No	**10**