Geotechnical Investigation and Design Report

The Municipality of West Nipissing

Type of Document:
Report

Project Name:
Proposed Retaining Wall Replacement
West Nipissing Municipal Offices
Sturgeon Falls, Ontario

Project Number:
SUD-25011158-A0

Prepared By:

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Date Submitted:
2025-10-16

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Further to our Proposal No. 24/112/GP_rev.2 dated July 9, 2025 and your subsequent authorization to proceed, EXP Services Inc. (EXP) has completed the field investigation and geotechnical engineering evaluation for the retaining wall replacement. Our comments and recommendations, based on the results of the field investigation and our understanding of the project scope, are provided in this report.

1. Introduction

It is understood by EXP that an existing retaining wall located at the Municipality of West Nipissing municipal offices in Sturgeon Falls, Ontario is to be replaced. The replacement wall is envisioned to be a segmental wall. To assist with the design and construction of the proposed replacement wall, EXP has completed a geotechnical investigation at the site, with the results of the investigation and associated recommendations included within this report.

2. Field Investigation

The field investigation for this project consisted of the advancement of two (2) sampled boreholes advanced at accessible locations free of buried and overhead utilities. The first borehole (BH-1) was advanced at the top of the existing retaining wall, with the second borehole (BH-2) advanced at the toe of the existing wall. The borehole locations are shown on Dwg. No. A-1, included in Appendix A. The boreholes were advanced using a power auger drill rig equipped with 200 mm diameter Hollow Stem Augers (HSA) to depths shown on the attached borehole logs, Figures B-2 to B-12, in Appendix B. Soil samples were obtained using a 51 mm (2 inch) outside diameter split spoon sampler in conjunction with Standard Penetration Tests (ASTM D1586), at depths noted on the attached borehole logs in Appendix B. The Standard Penetration Test (SPT) “N” values were recorded and used to provide an assessment of the in-situ compactness condition of the encountered soils. Where cohesive soils were encountered, field vane tests were completed to assess the undrained shear strengths of the soil. Coring of materials beyond the encountered refusal depth did not form part of this scope of work.

Groundwater levels were measured within the open boreholes upon completion. A standpipe piezometer was installed at Borehole BH-1 to observe long term groundwater levels. Borehole BH-2 was backfilled with auger cuttings and sealed with bentonite. EXP returned to the site on October 16, 2025 to measure the groundwater level within the installed piezometer.

The retained soil samples were logged in the field and then carefully packaged and transported to our laboratory for detailed examination and testing.

The locations of the boreholes were determined in the field using a hand-held GPS unit. The elevations of the boreholes were surveyed to a temporary benchmark (TBM) established on the top of concrete of an existing transformer pad at the location shown on Dwg. No. A-1, in Appendix A. The TBM was given a local, non-geodetic elevation of 100.0 m. The locations and elevations should be considered accurate only to the degree implied by the methods used for purposes of this report and should not be utilized for detailed design purposes.

3. Laboratory Testing

A routine geotechnical laboratory testing program was performed on representative soil samples and consisted of moisture content determinations, particle size analyses, and Atterberg Limits tests. The geotechnical laboratory test results are summarized on the attached borehole logs in Appendix B, with detailed results included in Appendix C.

4. Subsurface Conditions

Details of the soils encountered during the field investigation are summarized on the attached logs in Appendix B. The logs include textural descriptions of the subsoil and indicate the soil boundaries inferred from non-continuous sampling and observations during the field investigation. These boundaries reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. When reading this report, the explanatory notes and definitions provided in Figures B-1A and B-1B in Appendix B should be referenced.

In general, the boreholes encountered topsoil and fill materials overlying native silt, native clay and silt, and a thin layer of native silty sand.

Topsoil was encountered at the surface of Borehole BH-1 and was approximately 50 mm thick. Topsoil thicknesses may vary beyond the borehole location.

Underlying the topsoil at BH-1 was silty sand fill that extended to 1.5 m depth. The silty sand fill was brown in colour, moist, and contained some gravel in the upper portion of the layer. Uncorrected SPT “N” values within the silty sand fill ranged from 4 to 12 blows per 300 mm, classifying the silty sand fill as loose to compact in compactness condition. Measured moisture contents within the silty sand fill ranged from 2 to 12%.

At the surface of Borehole BH-2, and extending to 0.8 m depth, was sand and gravel fill. The sand and gravel fill was brown in colour, moist, and contained some silt. One SPT performed within the sand and gravel fill resulted in an uncorrected “N” value of 15 blows per 300 mm, classifying the sand and gravel fill as compact in compactness condition. Measured moisture content within the sand and gravel fill was 5%.

Underlying the fill materials at both boreholes was native silt. The silty extended to 10.7 m depth at Borehole BH-1, and to the borehole termination depth of 5.2 m at BH-2. At BH-1, the upper portion of the silt was generally sandy and contained trace organics. Overall, however, the silt contained trace to some silt and trace clay. The silt was brown to grey in colour and moist to wet. Uncorrected SPT “N” values within the silt ranged from 7 to 44 blows per 300 mm, classifying the silt as loose to dense in compactness condition. The loose soils were encountered at BH-1 below roughly 6 m depth. Measured moisture contents within the silt ranged from 17 to 29%.

Underlying the silt at Borehole BH-1 and extending to 20.5 m depth, was native clay and silt. The clay and silt was grey in colour, wet, and contained trace sand. Field vane tests performed within the clay and silt resulted in undrained shear strengths ranging from 40 to 48 kPa. As such, the clay and silt is classified as firm in consistency. Measured moisture contents within the clay and silt ranged from 33 to 52.5%. Two Atterberg Limits Tests on the clay and silt resulted in Liquid Limits of 35.1 and 35.2%, Plastic Limits of 20.1 and 20.5%, and Plasticity Indices of 14.7 and 15.1%, indicating the clay and silt has medium plasticity and moderate compressibility.

A thin, 100 mm thick layer of silty sand was encountered below the clay and silt at Borehole BH-1 and extended to auger refusal on suspected bedrock or boulders at 19.9 m depth. The silty sand was grey in colour, wet, and contained some gravel. Measured moisture content within the silty sand was 11%.

Upon completion, groundwater was measured at Borehole BH-1 at 11.4 m depth (Local Elev. 91.8 m). Borehole BH-2 was dry during the short term the borehole was left open upon completion. EXP returned to the site on October 16, 2025 to again measure the groundwater level within the installed piezometer at BH-1. Groundwater was encountered at 9.5 m depth (local Elev. 93.69 m) on this date. Seasonal variations in the water table should be anticipated, with higher levels occurring during wet weather conditions (spring thaw and late fall) and lower levels occurring during dry weather conditions.

5. Foundation Recommendations

The type of proposed replacement wall has not been determined; however, it is understood that a segmental block wall is preferred. Factors such as the site condition (i.e. availability of space), constructability, cost, aesthetics, height of wall, etc. should be considered in selecting the type of wall. Overall, gravity walls, like a segmental block wall, would be appropriate for the soil conditions encountered.

EXP should be retained to review the final design and specifications of the retaining wall to confirm that they are in general agreement with the assumptions on which our recommendations are based. Slope stability analysis should be carried out once the detailed design of the retaining wall is completed.

The native subgrade soils will be highly susceptible to disturbances from construction activity and weather. As such, the silt subgrade soils should protected by placing engineered fill over the subgrade immediately following subgrade approval. A non-woven geotextile separator (Terrafix 270R or equivalent) is to be used between the subgrade soils and engineered fill. A minimum 300 mm thick layer of compacted Granular “A” (OPSS 1010) is to be placed below the proposed wall foundation. If upfill is required below the Granular “A”, it is to consist Granular “B” Type I or Type II (OPSS 1010). All engineered fill must be placed in maximum 150 mm thick lifts and be compacted to 100% Standard Proctor Maximum Dry Density (SPMDD) within 1.5% of optimum moisture content. Where engineered fill is to be placed below the wall foundation, it is to extend horizontally a minimum of 1.0 m beyond the edges of the foundation and slope down to the native soils at 1H:1V to ensure the foundation loads are properly transferred to the underlying subgrade. Engineered fill placement and compaction below foundations is to be continuously monitored on a full-time basis by a qualified geotechnical representative from EXP.

Prior to placing any engineered fill all in-situ fill, organics, fill materials, or other deleterious materials must be removed down to the native soils. The exposed subgrade must be proof rolled to identify any soft or unstable areas. The exposed subgrade and proof rolling are to be inspected by a representative from EXP prior to placing fill materials or concrete. Any soft or loose areas encountered below the foundation locations or any areas that are subject to softening/loosening when exposed to water and construction activities should be excavated down to a firm subgrade and replaced with Granular “A” or Granular “B” Type II in accordance with Ontario Provincial Standards and Specifications (OPSS) 1010.

The location of any foundation on an engineered soil 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.

Wall foundations bearing on engineered fill overlying undisturbed, compact, native soils, can be designed with a factored geotechnical resistance at Ultimate Limit States (ULS) of 150 kPa, calculated using a geotechnical resistance factor of 0.5. A bearing pressure at Serviceability Limit States (SLS) of 100 kPa may be used. Foundations designed with the recommendations contained herein are expected to settle less than 25 mm total and 20 mm differential.

The coefficient of friction, tan δ, may be taken as 0.4 between precast concrete (blocks) and the granular pad, and 0.55 for mass (poured) concrete on the granular pad, for construction in-the-dry. These values are unfactored.

Foundations which are to be placed at different elevations in soils or near service trenches should be located such that the footings are set below a line drawn up at 10 horizontal to 7 vertical from the near edge of a lower foundation or bottom of a service trench, as indicated on Figure 5-1 below.

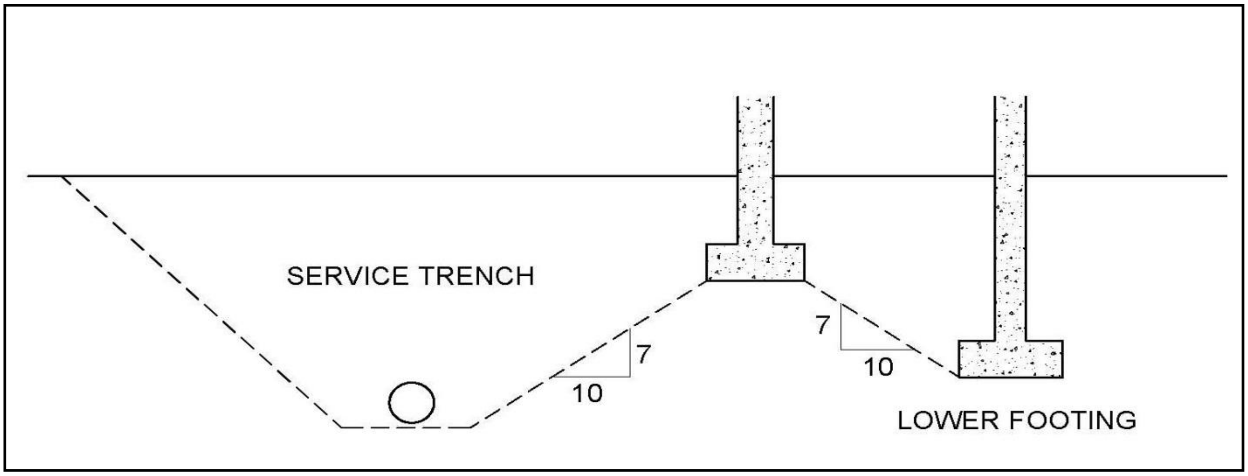

Figure 5-1: Footings near Service Trenches or at Different Elevations

These foundation recommendations do not account for loadings from heavy machinery or vibrations.

5.1 Soil Parameters for Wall Design

The soil parameters outlined on Table 5-1, below, may used for the design of the retaining wall. Values given for horizontal earth pressures are for horizontal backfill behind the wall.

Table 5-1: Soil Parameters

Material	Total Stress Analysis		Effective Stress Analysis		Earth Pressure Coefficients			Unit Weight, γ (kN/m^3)
	C (kPa)	ø (°)	c′ (kPa)	ø′ (°)	Active (k_a)	Passive (k_p)	At Rest (k_o)	
Silt	0	28	0	28	0.36	2.8	0.53	18
Clay and Silt	35	0	0	25	0.41	2.5	0.57	17
Granular "A" *	0	38	0	38	0.24	4.2	0.38	22
Granular "B" Type I *	0	35	0	35	0.27	3.7	0.43	21
Granular "B" Type II *	0	38	0	38	0.24	4.2	0.38	21

* All engineered fill must be compacted to 100% of the SPMDD.

5.2 Frost Considerations

The freezing index in the Sturgeon Falls area is approximately 1,200 C degree-days. There is potential for up to 2.0 m of frost penetration to occur over the winter months in unprotected, unheated areas. Foundations for unheated structures should be provided with a minimum of 2.0 m of earth cover frost protection.

Where sufficient earth cover frost protection is not provided for the foundations, insulation would be required. Insulation should consist of rigid extruded polystyrene, have a minimum compressive strength of 275 kPa, and an R-Value of 5 for every 25.4 mm of thickness, (i.e. Styrofoam HIGHLOAD 40). Any exposed insulation is to be protected against sunlight and physical damage. A rough estimate for cost evaluation purposes can be made by assuming that 25.4 mm of rigid insulation designed for below grade installation is equivalent to 300 mm of soil cover. Note that insulation for unheated structures must extend below the entire foundation. Higher compressive strength insulation (i.e. Styrofoam HIGHLOAD 60 or 100, etc.) may be required if insulation extends below foundations, depending on foundation loading conditions.

Detailed insulation recommendations can be provided by EXP, if necessary, once the final foundation designs have been determined.

5.3 Site Classification for Seismic Response

The Site Classification for Seismic Response has been estimated based on the boreholes advanced at the site. As the Site Classification for Seismic Response is based on soil conditions in the upper 30 m, assumptions were made by EXP for the soil conditions below the borehole termination depths.

Based on EXP's assumptions and previous experience with the soil conditions at depth within the project area, the site is classified as Site Class E as per the OBC clause 4.1.8.4, Site Properties and Table 4.1.8.4 A, Site Classification for Seismic Response.

These earthquake/seismic design parameters should be reviewed in detail by the structural engineer and incorporated into the design as required. As this site class is based on an assumption of the soil conditions, the site class may not be sufficient, and it may result in an overdesign of the structure. If a precise Site Classification is required based on shear wave velocity testing, EXP can provide a quote to perform the necessary testing.

6. Excavations

The in-situ native soils may be classified as Type 3 soils for excavations terminating above the groundwater level and Type 4 soils for excavations terminating below the groundwater level in conformance with the Ontario Occupational Health and Safety Act (OHSA). Excavation side slopes in Type 3 soils should remain stable at a slope of 1H:1V. Excavation side slopes in Type 4 soils should remain stable at a slope of 3H:1V. The need to excavate flatter side slopes if excessively wet or soft/loose materials, or concentrated seepage zone are encountered, should not be overlooked.

Water (i.e. surface water runoff) should not be permitted to enter and/or pond within the construction area.

Excavations must be completed so as not to undermine nearby infrastructure and existing foundations. If the underside of footing elevation for the existing building on site is unknown, it is recommended to expose a footing prior to final wall design to confirm the existing footing elevations and understand how it may impact the wall construction. Temporary shoring may be required to support existing foundations and infrastructure during excavation. The safety of excavations and stability of temporary construction slopes and shoring are the contractor's responsibility. A detailed temporary shoring system design should be provided by the contractor, if necessary, based on the encountered soil and groundwater conditions at the time of the excavations.

All excavations must be completed in accordance with the most recent regulations in the Ontario Occupational Health and Safety Act. The contractor should be aware that slope height, slope inclination, or excavation depths, should in no case, exceed those specified in local, provincial or federal safety regulations. Such regulations are strictly enforced and, if not followed, the owner, the contractor or earthwork or utility subcontractor could be liable for substantial penalties.

It is important to note that soils encountered in the construction excavations may vary significantly across the site. Our preliminary soil classifications are based solely on the materials encountered in widely spaced explorations. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that EXP be contacted immediately to evaluate the conditions encountered.

6.1 Re-Use of Excavated Material

The in-situ fill materials and native soils are too fine-grained to be re-used as free draining engineered fill. The excavated materials may be used for general landscaping purposes, away from areas where free draining fill is specified, provided it is environmentally safe to do so.

7. Dewatering

As noted previously, groundwater was measured within the installed piezometer at Borehole BH-1 at 11.4 m depth (Local Elev. 91.8 m) upon completion. On October 16, 2025, groundwater was measured at 9.5 m depth (Local Elev. 93.69 m) within the installed piezometer. Borehole BH-2 was dry during the short term the borehole was left open upon completion.

Based on the above, groundwater should be anticipated for excavations approaching or extending below Local Elev. 94.0 m. As excavations are not anticipated to approach this depth, significant dewatering is not anticipated for the wall construction. Above this depth, potential perched groundwater should be possible to remove using conventional construction pumps.

Dewatering requirements will be governed by the time of the year the construction is performed. It is the responsibility of the Contractor to propose a suitable dewatering system based on the time of construction and groundwater levels. The method used should not undermine any adjacent structures or buried services. The dewatering method is the responsibility of the Contractor and the Contractor should submit his proposal to the Prime Consultant for review and approval prior to construction.

8. Construction Constraints Under Cold Weather Conditions

For all construction activities at this site, the following applies:

- During excavations, all subgrade soils must be maintained at a minimum temperature of 5° C.
- No granular material may be placed under frozen conditions, with all fill material maintained at a minimum temperature of 5° C prior to and during installation. If granular fill is to be placed in freezing conditions, the granular fill must be restricted to Granular “B” Type II material. Since Granular “B” Type II has a larger aggregate size, care should be taken to prevent point loading on the underside of the concrete.
- Soils and granular fill material that are in direct contact with fresh concrete must be at a minimum temperature of 5° C prior to pouring the concrete and must be free of snow and ice fragments.
- All granular fill, prior to placement of concrete, must be reviewed by this office to ensure that it is free of frost, buried ice and snow.
- All reinforcing steel in the concrete forms must be free of ice and snow, and must be maintained at a minimum temperature of 5° C.
- During the placement of concrete in cold weather conditions, a field cured cylinder should be placed beside the heated form for a period of 6 days. The field cured cylinder should be returned to a designated laboratory on the sixth day for 7-day compressive strength testing.
- All heated and tarped areas should be monitored for temperature using a max/min thermometer.
- All concrete is to have a minimum of 6% to 8% air entrainment to prevent cracking and shall be maintained at a minimum temperature of 10° C for a period of 4 to 7 days.

The 6% to 8% air entrained concrete during cold weather placement is to prevent significant strength loss of concrete as a result of freezing and thawing. The air entrainment will provide the capacity to absorb stresses during freeze/thaw action.

9. Construction Quality Control

Construction quality control of the “earthworks” should be provided throughout the project by a representative of EXP to verify all design assumptions, recommendations, and confirmation of the subsurface soil conditions. This includes inspection of the excavation and subgrade prior to the placement of any structural fill and foundations, to ensure that any and all deleterious materials have been removed and to ensure that the actual conditions are not markedly different than those on which the recommendations made herein are based. Compaction control of structural fill is also recommended as standard practice, as is sampling and testing of aggregates and concrete.

10. Design Review

The recommendations made in this report are considered preliminary and in accordance with our present understanding of the project and are provided solely for the design team responsible for the project. If there are any changes, such as relocation of any structures or other features which may affect our analysis, the information obtained during this investigation may be inadequate and additional field work and reporting may be required.

EXP Services Inc. should be retained to review the final design and specifications to confirm that we are in general agreement with the assumptions on which our recommendations are based. If not accorded the privilege of making this review, EXP will assume no responsibility for interpretation of the recommendations in this report.

11. Limitations

A subsurface investigation is a limited sampling of a site. Should any conditions at the site be encountered that differ from those reported at the test locations, we require that we be notified immediately in order to allow reassessment of our recommendations.

Whereas this investigation has estimated the groundwater level at the time of the fieldwork, and commented on general construction problems, the presence of conditions, which would be difficult to establish from our test holes, may affect the type and nature of dewatering procedures which should be used in practice. These conditions include local and seasonal fluctuations in the groundwater table, erratic changes in the soil profile between the tests, and thin layers of soil with large or small permeabilities compared with the general soil mass, etc.

The comments given in this report are intended only for the guidance of the design team responsible for the project. The number of test holes required to determine the localized underground conditions between test holes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for preliminary design purposes. 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 test hole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

The investigation and comments are necessarily ongoing as new information of underground conditions becomes available. For example, more specific information is available with respect to in-situ subsurface conditions between test locations once construction is underway. Subsurface soil interpretation between test holes, as well as the recommendations of this report, should be verified through field inspections provided by EXP to validate the current information for use during the construction stage.

Virtually no scope of work, no matter how exhaustive, can identify all contaminants or all conditions above or below ground. For example, conditions elsewhere on the property may differ from those encountered, and conditions may change with time. Therefore, no warranty is provided that the entire site condition is represented by those identified at specific borehole locations.

This report in no way reflects any on-site environmental considerations.

12. Closure

We trust that these comments provide you with sufficient information to proceed with design. Should you have any questions, please do not hesitate to contact this office.

Yours truly,

EXP Services Inc.

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Appendix A - Drawing

KEYPLAN - N.T.S.

LEGEND

⊕ EXP BOREHOLE

⊕ TEMPORARY BENCHMARK, TBM (TOP OF CONCRETE PAD)

– NOTES –

1) The boundaries and soil types have been established only at Test Hole locations. Between Test Holes, they are assumed and may be subject to considerable error.
2) Do not use Test Hole elevations for design purposes.
3) Soil samples will be retained in storage for 3 month and then destroyed unless client advises that an extended time period is required.
4) Quantities should not be established from the information provided at the Test Hole locations.
5) This drawing forms part of the report, project number as referenced, and should be used only in conjunction with this report.

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REVISIONS

No.	DESCRIPTION	DATE

CLIENT
THE MUNICIPALITY OF WEST NIPISSING

PROJECT
PROPOSED RETAINING WALL REPLACEMENT
STURGEON FALLS, ON

PROJECT NO.
SUD-25011158-A0

TITLE:
BOREHOLE LOCATION PLAN

DATE
OCTOBER 2025

SCALE:
NTS

DWG NO.
A-1

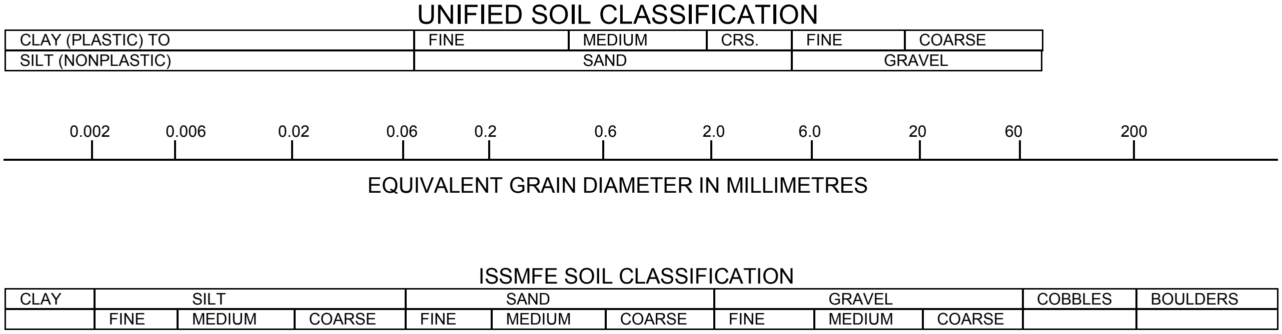
\\exp\data\SUD\SUD-25011158-A0\60 Execution\65 Drawings\SUD-25011158-A0 – BH LOCATION PLAN.dwg

Oct 16, 2025 – 6:50am

Appendix B – Borehole Logs

Notes on Sample Descriptions

1. All sample descriptions included in this report follow the International Society for Soil Mechanics and Foundation Engineering (ISSMFE), as outlined in the Canadian Foundation Engineering Manual. Note, however, that behavioral properties (i.e. plasticity, permeability) take precedence over particle gradation when classifying soil. Please note that, with the exception of those samples where a grain size analysis has 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.



UNIFIED SOIL CLASSIFICATION

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

EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

ISSMFE SOIL CLASSIFICATION

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

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 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 (75 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.

Notes On Soil Descriptions

4. The following table gives a description of the soil based on particle sizes. With the exception of those samples where grain size analyses have been performed, all samples are classified visually. The accuracy of visual examination is not sufficient to differentiate between this classification system or exact grain size.

Soil Classification		Terminology	Proportion
Clay and Silt	<0.060 mm	“trace” (e.g. Trace sand)	1% to 10%
Sand	0.060 to 2.0 mm	“some” (e.g. Some sand)	10% to 20%
Gravel	2.0 to 75 mm	adjective (e.g. sandy, silty)	20% to 35%
Cobbles	75 to 200 mm	“and” (e.g. and sand)	35% to 50%
Boulders	>200 mm		

The compactness of Cohesionless soils and the consistency of the cohesive soils are defined by the following:

Cohesionless Soil		Cohesive Soil		
Compactness	**Standard Penetration Resistance “N” Blows / 0.3 m**	**Consistency**	**Undrained Shear Strength (kPa)**	**Standard Penetration Resistance “N” Blows / 0.3 m**
Very Loose	0 to 4	Very soft	<12	<2
Loose	4 to 10	Soft	12 to 25	2 to 4
Compact	10 to 30	Firm	25 to 50	4 to 8
Dense	30 to 50	Stiff	50 to 100	8 to 15
Very Dense	Over 50	Very Stiff	100 to 200	15 to 30
		Hard	>200	>30

5. **ROCK CORING**

Where rock drilling was carried out, the term RQD (Rock Quality Designation) is used. The RQD is an indirect measure of the number of fractures and soundless of the rock mass. It is obtained from the rock cores by summing the length of the core covered, counting only those pieces of sound core that are 100 mm or more length. The RQD value is expressed as a percentage and is the ratio of the summed core lengths to the total length of core run. The classification based on the RQD value is given below.

RQD Classification	RQD (%)
Very Poor Quality	<25
Poor Quality	25 to 50
Fair Quality	50 to 75
Good Quality	75 to 90
Excellent Quality	90 to 100

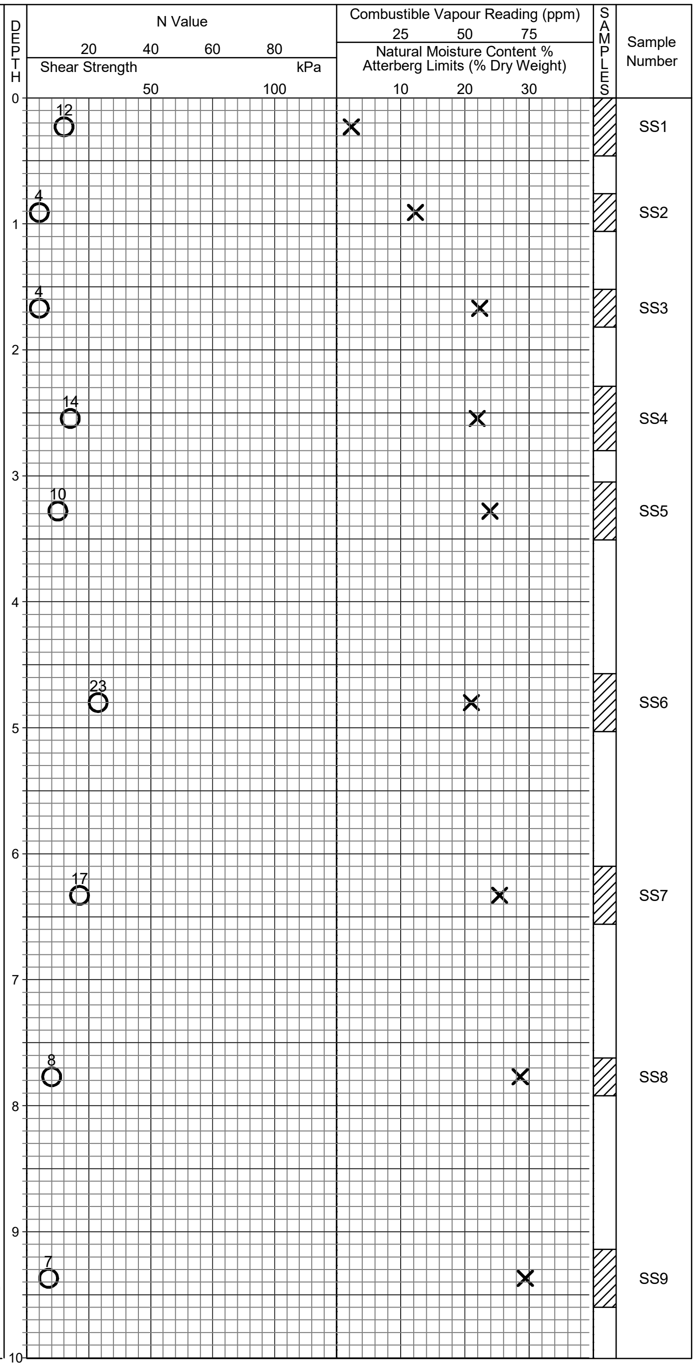
$$\text{Recovery Designation \% Recovery} = \frac{\text{Length of Core Per Run}}{\text{Total Length of Run}} \times 100$$

Log of Borehole BH-1

Project No.	SUD-25011158-A0	Figure No.	B-2
Project:	Proposed Retaining Wall Replacement	Sheet No.	1 of 2
Location:	Sturgeon Falls, ON 582170E; 5135321N		
Date Drilled:	August 18, 2025		
Drill Type:	CME 55 Track Mount		
Datum:	Local (non-geodetic)		

Auger Sample	☒	Combustible Vapour Reading	☐
SPT (N) Value	○ ▨	Natural Moisture	✕
Dynamic Cone Test	—	Plastic and Liquid Limit	├──○
Shelby Tube	■	Undrained Triaxial at % Strain at Failure	⊕
Field Vane Test	✚ S	Penetrometer	▲

Soil Description	ELEV. m
	103.19
TOPSOIL, ~ 50 mm thick	103.1
FILL, silty sand, some gravel, bown, moist, compact no gravel, loose below ~ 0.8 m depth	
	101.7
SANDY SILT, trace organics, brown, moist to wet, compact	
	100.9
SILT, trace to some sand, trace clay, brown, moist to wet, compact trace sand below ~ 3.1 m depth grey, wet below ~ 4.6 m depth loose below ~ 7.6 m depth	
	93.69



Continued Next Page

EXP Services Inc.
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f: +1.705.674.5583

Borehole data requires interpretation assistance from EXP before use by others.

See Figures B-1A and B-1B for Notes on Sample Description

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	11.4	Open
October 16, 2025	9.5	

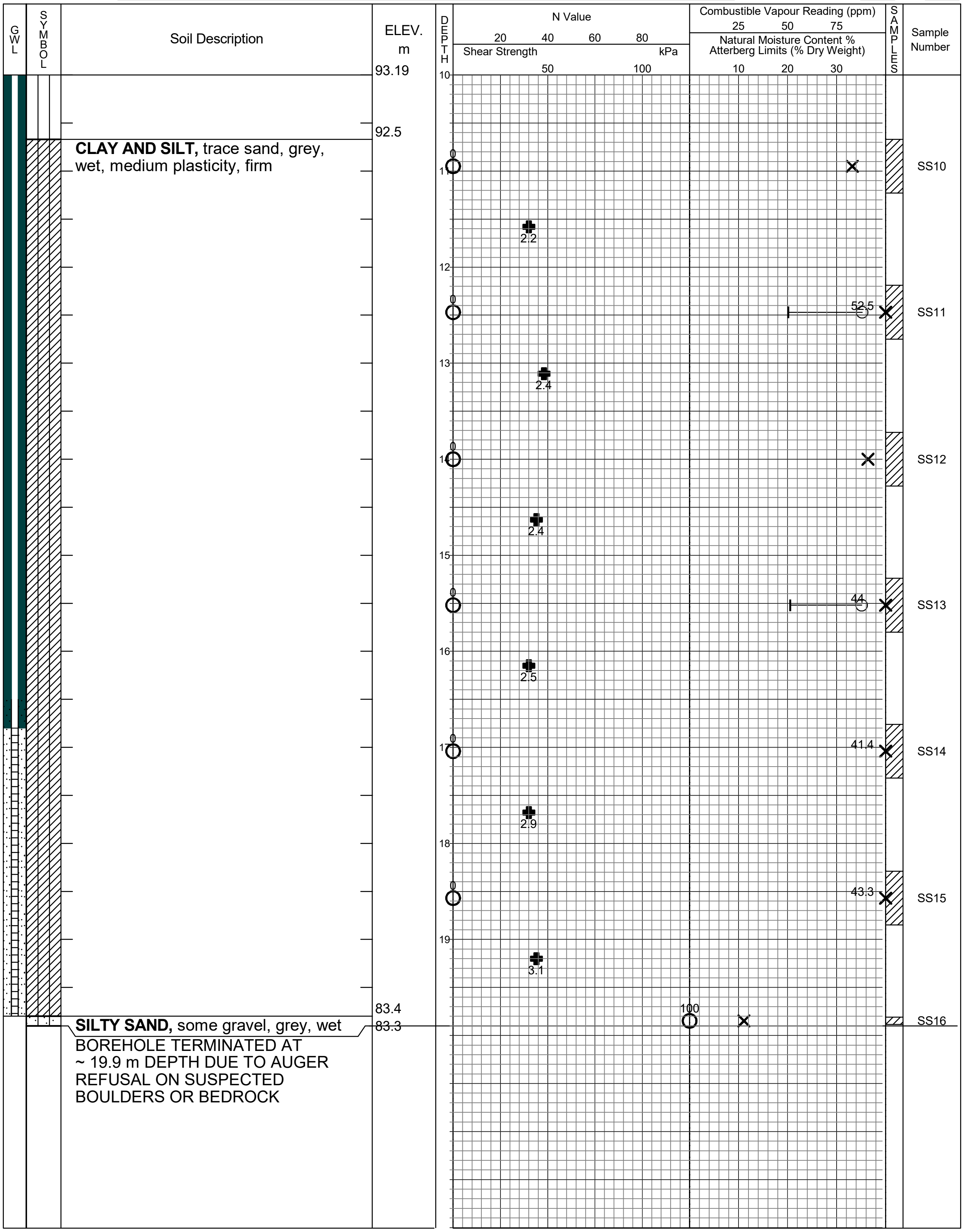
Log of Borehole BH-1

Project No. SUD-25011158-A0

Figure No. B-2

Project: Proposed Retaining Wall Replacement

Sheet No. 2 of 2



CLAY AND SILT, trace sand, grey, wet, medium plasticity, firm

SILTY SAND, some gravel, grey, wet

BOREHOLE TERMINATED AT ~ 19.9 m DEPTH DUE TO AUGER REFUSAL ON SUSPECTED BOULDERS OR BEDROCK

SUDBURY GEO SUD-25011158-A0 - RETAINING WALL - STURGEON FALLS.GPJ NEW.GDT 10/17/25

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Borehole data requires interpretation assistance from EXP before use by others.

See Figures B-1A and B-1B for Notes on Sample Description

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	11.4	Open
October 16, 2025	9.5	

Log of Borehole BH-2

Project No. SUD-25011158-A0

Figure No. B-3

Project: Proposed Retaining Wall Replacement

Sheet No. 1 of 1

Location: Sturgeon Falls, ON

582170E; 5135334N

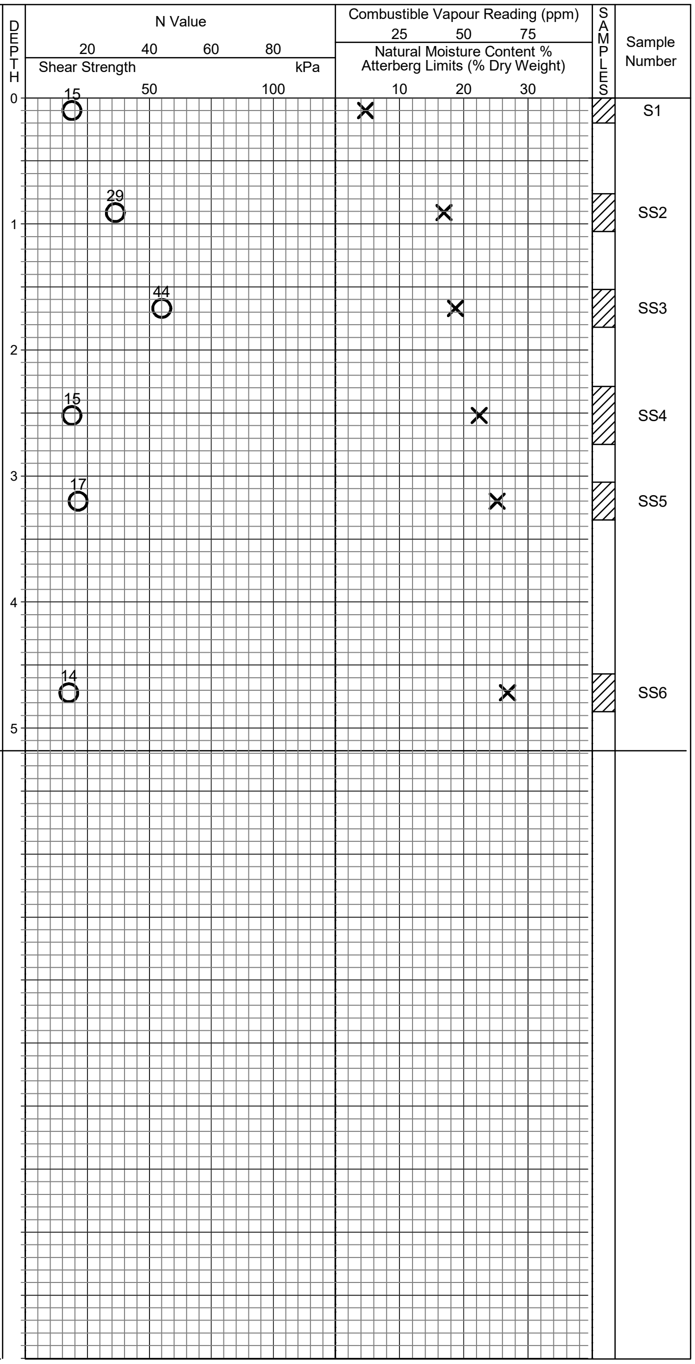
Date Drilled: August 18, 2025

Drill Type: CME 55 Track Mount

Datum: Local (non-geodetic)

Auger Sample	☒	Combustible Vapour Reading	☐
SPT (N) Value	○ ▨	Natural Moisture	✕
Dynamic Cone Test	—	Plastic and Liquid Limit	├──○
Shelby Tube	■	Undrained Triaxial at % Strain at Failure	⊕
Field Vane Test	✚ S	Penetrometer	▲

GWL	SYMBOL	Soil Description	ELEV. m
			98.80
		FILL, sand and gravel, some silt, brown, moist, compact	
			98.0
		SILT, trace sand, trace clay, grey, damp, compact to dense	
		moist to wet below ~ 1.5 m depth	
		compact below ~ 2.3 m depth	
		wet below ~ 3.1 m depth	
			93.6
		BOREHOLE TERMINATED AT ~ 5.2 m DEPTH	



SUDBURY GEO SUD-25011158-A0 - RETAINING WALL - STURGEON FALLS.GPJ NEW.GDT 10/17/25

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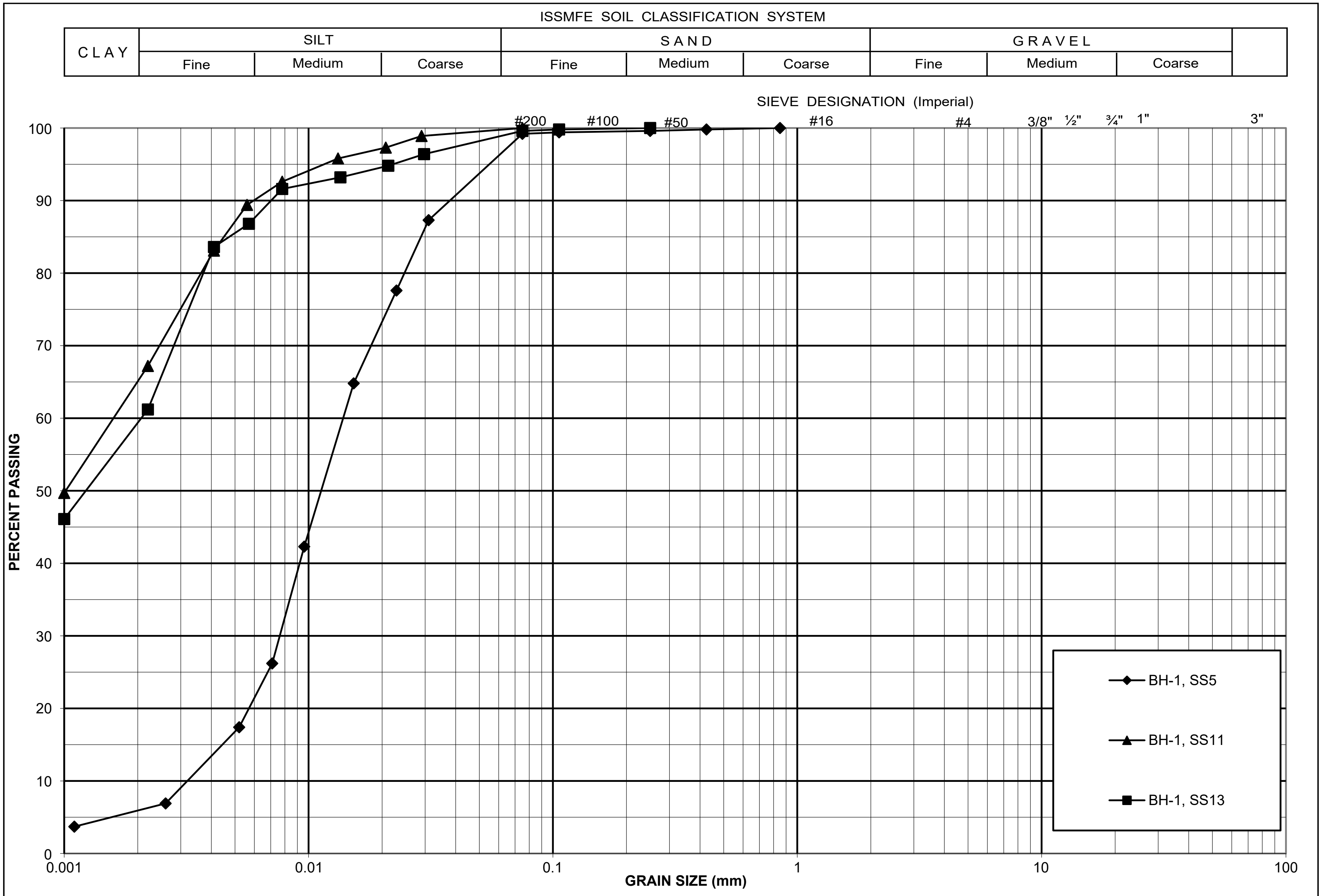
Borehole data requires interpretation assistance from EXP before use by others.

See Figures B-1A and B-1B for Notes on Sample Description

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	Dry	Open

Appendix C – Laboratory Testing



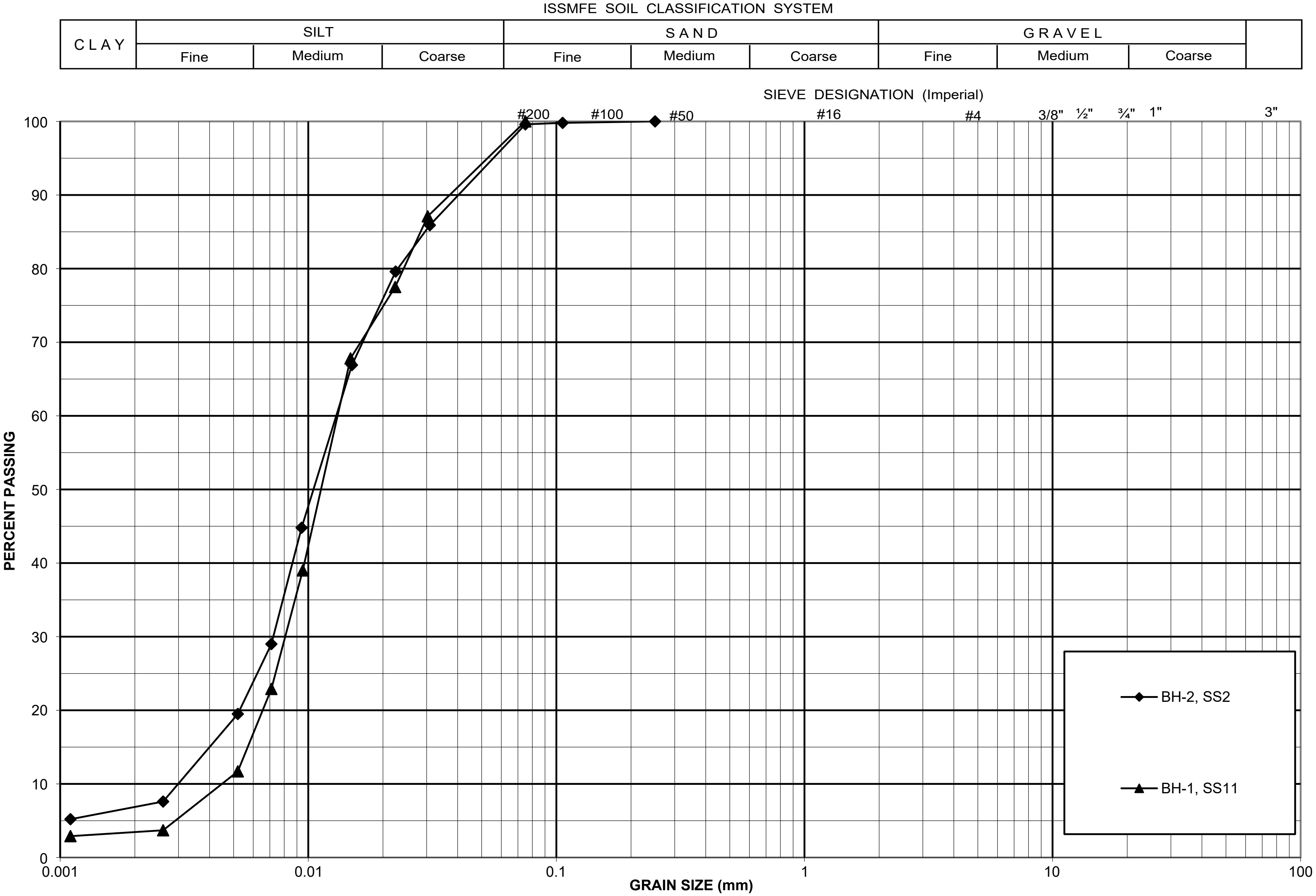
GRAIN SIZE DISTRIBUTION

Proposed Retaining Wall Replacement
Sturgeon Falls, Ontario

FIGURE: C-1

PROJECT No: SUD-25011158-A0

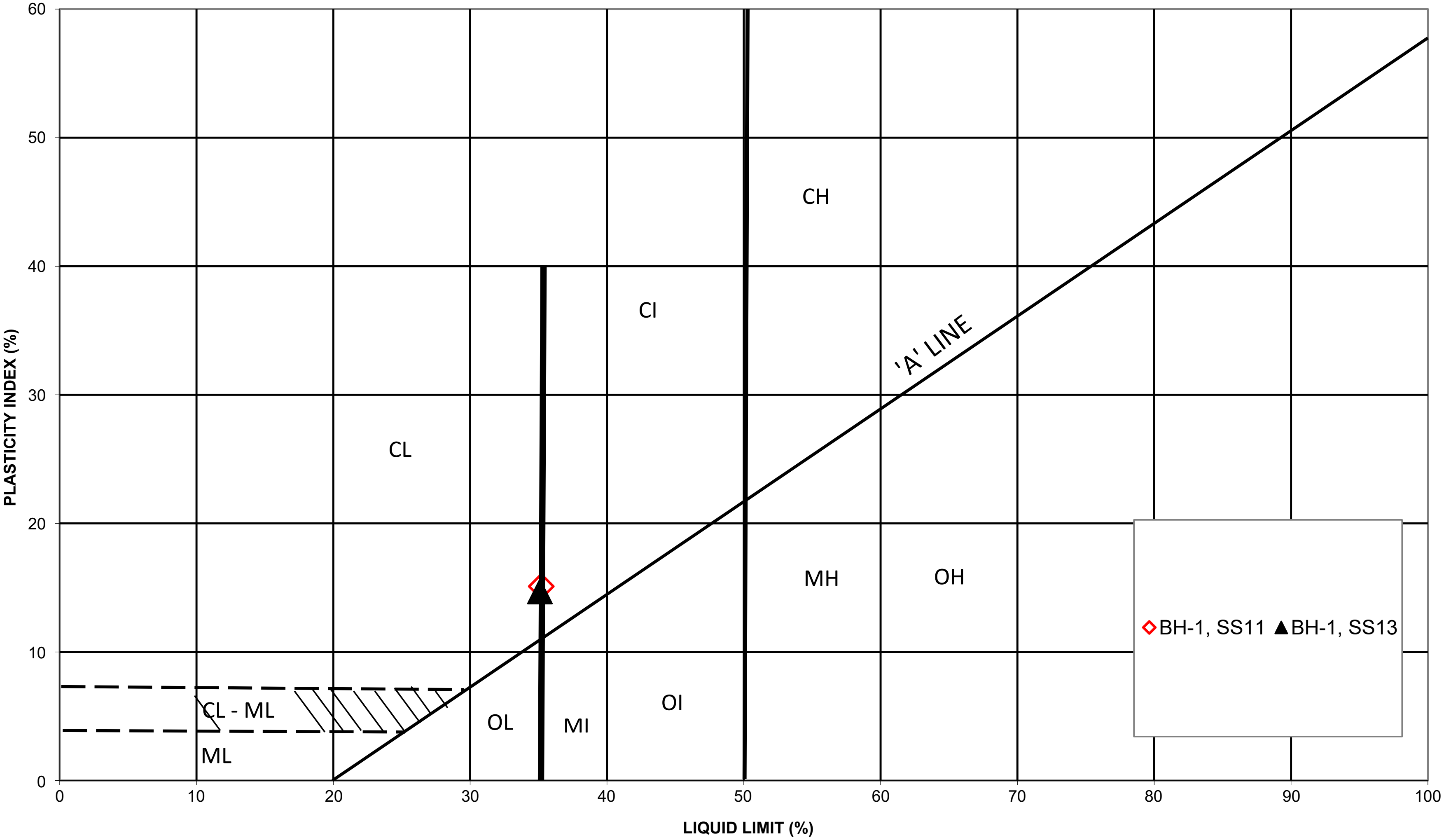
DATE: October 2025



GRAIN SIZE DISTRIBUTION

Proposed Retaining Wall Replacement
Sturgeon Falls, Ontario

FIGURE: C-2
PROJECT No: SUD-25011158-A0
DATE: October 2025



PLASTICITY CHART

Proposed Retaining Wall Replacement
Sturgeon Falls, Ontario

FIGURE: C-3

PROJECT No: SUD-25011158-A0

DATE: October 2025