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April 4, 2024 Reference No. 2402-S095

547 Bayfield Inc.
1501 Creditstone Road
Concord, Ontario
L4K 5V6

Attention: Mr. Alex Sirizzotti

Re: Geotechnical Investigation for
Proposed Car Wash Facility
547 Bayfield Street
City of Barrie

Dear Sir:

In accordance with your written authorization dated February 22, 2024, a geotechnical investigation was carried for the captioned site and we herein present our findings and recommendations.

SITE AND PROJECT DESCRIPTION

The investigated property is located on the east side of Bayfield Street, approximately 100 m south of Hanmer Street East, having a municipal address of 547 Bayfield Street, City of Barrie. At the time of investigation, the site consists of two commercial buildings with access road to Bayfield Street and an on-grade parking lot. The balance of the site is open.

It is understood that the existing commercial buildings will remain on site and will be developed into a car wash facility with construction of underground water storage tank and municipal services.

FIELD WORK

The field work, consisting of 2 boreholes to a depth of 4.8 m, was performed on March 15, 2024, at the locations shown on the enclosed Borehole and Monitoring Well Location Plan, Drawing No. 1.

The boreholes were advanced at intervals to the sampling depths by a truck-mounted machine using solid stem augers and equipped with a split spoon sampler for soil sampling. Standard Penetration Tests, using the procedures described on the enclosed "List of Abbreviations and Terms", were performed at the sampling depths. The test results are recorded as the Standard Penetration Resistance (or 'N' values) of the subsoil. The relative density of the non-cohesive strata and the consistency of the cohesive strata are inferred from the 'N' values. Split-spoon samples were recovered for soil classification and laboratory testing. The field work was supervised and the findings were recorded by a Geotechnical Technician.

Upon completion of drilling and sampling, two (2) monitoring wells were installed in boreholes to facilitate a hydrogeological assessment, which will be presented under separate cover. Details of the monitoring wells are shown on the corresponding Borehole Logs.

The ground elevation of each borehole location was obtained using a handheld Global Navigation Satellite System (GNSS) device.

SUBSURFACE SOIL CONDITIONS

The investigation has disclosed that beneath the pavement structure and a layer of earth fill in places, the site is generally underlain by a stratum of silty sand till.

Detailed descriptions of the encountered subsurface conditions are presented on the enclosed Borehole Logs, comprising Figures 1 and 2, and the revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2. The engineering properties of the disclosed soils are discussed herein.

Pavement Structure

Boreholes 1 and 2 were carried out on the asphalt pavement, which consists of a layer of asphalt, approximately 51 mm in thickness, overlying a layer of granular fill, approximately 100 mm in thickness.

Grain size analyses were performed on two (2) granular fill samples; the results are plotted on Figure 3. The samples indicate the granular fill fails to meet the OPSS gradation requirement for Granular 'A' or Granular 'B', due to excessive fine particles by weight.

Earth Fill

A layer of earth fill, extending to depths of 0.8 m and 1.4 m below the existing grade was encountered in Boreholes 1 and 2, respectively. The fill is dark brown in color and consists of sandy silt with gravel with occasional topsoil inclusions.

The recorded 'N' values range from 5 to 14 blows per 30 cm of penetration. The natural water content values of the fill sample range between 13% and 14% indicating the fill is in moist conditions.

One must be aware that the samples retrieved from the boreholes may not be truly representative of the geotechnical and environmental quality of the fill, and do not indicate the presence of topsoil. This should be further assessed by laboratory testing and/or test pits.

Silty Sand Till

The native silty sand till deposit predominates the soil stratigraphy within the investigated depth of all boreholes. The tills consist of a mixture of clay and gravel, with silt and sand being the dominant fraction. Grain size analysis was performed on 2 representative samples of silty sand till; the results are plotted on Figure 4.

The recorded 'N' values range from 15 to over 50, with a median over 50 blows per 30 cm of penetration, indicating the silty sand till is compact to very dense, being generally very dense in relative density.

The natural water content values range from 6% to 15%, with a median of 7%, indicating that the tills are damp to moist, generally in a moist condition.

The engineering properties of the till deposit are given below:

- High frost susceptibility and low water erodibility.
- The tills will be relatively stable in steep excavation; however, prolonged exposure may lead to localized sloughing.

Compaction Characteristics of the Revealed Soils

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied. As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in Table below.

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Earth Fill	5 to 14 (median 12)	12	6 to 15
Silty Sand Till	6 to 15 (median 7)	11	5 to 16

GROUNDWATER CONDITIONS

The boreholes remained dry upon completion of drilling and the monitoring wells remained dry on March 22, 2024, approximately 1 week after the monitoring well installation.

DISCUSSION AND RECOMMENDATIONS

The investigation has disclosed that beneath the pavement structure and a layer of earth fill in Boreholes 1 and 2, the site is generally underlain by a stratum of silty sand till. All boreholes remained dry upon completion and in the monitoring wells 1 week after the monitoring well installation.

It is understood that the existing commercial buildings will remain on site and the property will be developed into a car wash facility with underground water storage tank and underground services. The geotechnical findings which warrant special consideration are presented below:

1. The existing asphalt can be pulverized and reused on site as the granular sub-base or it can be removed off-site.
2. The granular fill is suitable for use as structural backfill for the pipe bedding or as selected subgrade material.
3. The existing earth fill and weathered soil, in their present state, are not suitable to support any structure sensitive to movement. It can be subexcavated, sorted free of concentrated topsoil inclusions, if any, and recompacted in layers according to engineered fill requirements. In addition, where additional earth filling is required for site grading, an engineered fill can be used.
4. A Class ‘B’ bedding, consisting of compacted 19-mm Crusher-Run Limestone (CRL) or equivalent, is recommended for the construction of underground services. The service pipes must consist of leak-proof joints, or the joints must be wrapped with a waterproof membrane.
5. The final subgrade should be graded towards the catch basins or subdrains to remove any subsurface water percolated through the pavement structure.

The recommendations appropriate for the project are presented herein. One must be aware that the subsurface conditions may vary. Should this become apparent during construction, a geotechnical engineer must be consulted to determine whether the following recommendations require revision.

Underground Tanks for Car Wash Facility

A series of underground tanks are proposed for the car wash facility. At the time of the report preparation, the depth and invert of the tanks are not known.

Based on the borehole finding, the appropriate bearing pressure for the tanks are provided below:

- Maximum Soil Bearing Pressure at Serviceability Limit State (SLS) = 150 kPa
- Factored Ultimate Bearing Pressure at Ultimate Limit State (ULS) = 225 kPa

If the tanks lie below the recorded groundwater level within the property, it must be designed to resist any hydrostatic uplift or buoyancy effect. This can be further reviewed when the design of the tanks is available.

The installation of the tanks must follow the manufacturer's specification to avoid any damages and they must be designed for the surcharge loading. In addition, the fill material above the tank system should consist of inorganic soils, properly compacted to at least 98% of the maximum Standard Proctor Dry Density.

Underground Services

The subgrade for underground services should consist of native soil or compacted inorganic earth fill. Where weathered or soft soils are encountered, these materials must be subexcavated and replaced with properly compacted bedding material.

A Class 'B' bedding, consisting of compacted 19-mm CRL, is recommended for the construction of the underground services. The joints connecting into manholes and catch basins should be leak-proof or wrapped with an appropriate waterproof membrane to prevent subgrade migration.

In order to prevent pipe floatation when the sewer trench is deluged with water, a soil cover with a thickness equal to the diameter of the pipe should be in place at all times after completion of the pipe installation. Openings to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting.

Backfilling in Trenches and Excavated Areas

The on site inorganic soils are suitable for use as trench backfill. The backfill soils should be sorted free of any topsoil inclusions and other deleterious material.

The backfill in service trenches and excavated areas should be compacted to at least 98% SPDD. In the zone within 1.0 m below the pavement subgrade, the backfill should be compacted with the water content at 2% to 3% drier than the optimum. This is to provide the required stiffness for pavement construction.

Narrow trenches should be cut at 2 horizontal:1 vertical, or flatter, so that the backfill can be effectively compacted. Otherwise, soil arching will prevent the achievement of proper compaction. The lift of each backfill layer should either be limited to a thickness of 20 cm, or the thickness should be determined by test strips.

In normal construction practice, the problem areas of settlement largely occur adjacent to manholes, catch basins and services crossings. It is recommended that a granular backfill should be used in the confined spaces, compacted with a light equipment.

Pavement Design

Based on the subsurface soil conditions, the recommended pavement design is presented as follows:

Course	Thickness (mm)	OPS Specifications
Asphalt Surface Course	40	HL3
Asphalt Base Course Light Duty Parking Heavy Duty/Fire Route	 50 70	HL8
Granular Base	150	Granular ‘A’, or equivalent
Granular Sub-base Light Duty Parking Heavy Duty/Fire Route	 300 450	Granular ‘B’, or equivalent

In preparation of pavement subgrade, any compressible material should be removed. The final subgrade must be proof-rolled and inspected. Any soft spot identified must be rectified by subexcavation and replacing with selected inorganic material, compacted to at least 98% SPDD, with the water content at 2% to 3% drier than its optimum. All the granular bases should be compacted to 100% SPDD.

The pavement subgrade will suffer a strength regression if water is allowed to saturate the mantle. Along the perimeter where runoff may drain onto the pavement, swale or an intercept subdrain system should be installed to prevent infiltrating precipitation from seeping into the granular bases (since this may inflict frost damage on the flexible pavement). At the lower spots around catch basins, subdrains consisting of filter-wrapped weepers should also be installed and they should be connected into the catch basins. The subdrains should be backfilled with free-draining granular material.

Soil Parameters

The recommended soil parameters for the project design are given in the following table.

Unit Weight and Bulk Factor	**Bulk Unit Weight (kN/m^3)**	**Estimated Bulk Factor**	
		Loose	**Compacted**
Earth Fill	20.5	1.20	0.98
Silty Sand Till	22.5	1.33	1.05
Lateral Earth Pressure Coefficients	**Active K_a**	**At Rest K_0**	**Passive K_p**
Earth Fill	0.40	0.50	2.50
Silty Sand Till	0.32	0.48	3.12
Coefficients of Friction			
Between Concrete and Granular Base			0.50
Between Concrete and Sound Native Soils/Compacted Earth Fill			0.35

Excavation

The excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils are classified below:

Material	**Type**
Silty Sand Till	2
Earth Fill	3

Any boulders larger than 15 cm in size are not suitable for structural backfill.

Perched water in the granular bedding or earth fill may be encountered during the wet seasons. The groundwater yield will be slow in rate and limited in quantity. It can be collected and removed by conventional pumping from sump pits.

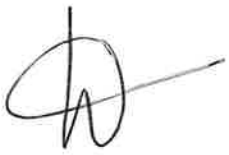
LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of 547 Bayfield Inc. and for review by their designated consultants, financial institutions and government agencies. The material in the report reflects the judgement of Penchala Harish Mannepalli, M.Eng, EIT and Kelvin Hung, P.Eng., in light of the information available to it at the time of the preparation.

Use of the report is subject to the conditions and limitations of the contractual agreement. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Party. Soil Engineers Ltd. 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 trust this letter satisfies your present requirements; however, should any queries arise, please feel free to contact this office.

Yours truly,
SOIL ENGINEERS LTD.



Penchala Harish Mannepalli, M.Eng, EIT
PHM/KH

Kelvin Hung, P.Eng.

ENCLOSURES

Borehole Logs	Figures 1 and 2
Grain Size Distribution Graph	Figures 3 and 4
Borehole Location Plan	Drawing No. 1
Subsurface Profile	Drawing No. 2

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS Auger sample
CS Chunk sample
DO Drive open (split spoon)
DS Denison type sample
FS Foil sample
RC Rock core (with size and percentage recovery)
ST Slotted tube
TO Thin-walled, open
TP Thin-walled, piston
WS Wash sample

PENETRATION RESISTANCE

Standard Penetration Resistance or 'N' Value:

The number of blows of a 63.5 kg hammer falling from a height of 76 cm required to advance a 51 mm outer diameter drive open sampler 30 cm into undisturbed soil, after an initial penetration of 15 cm.

Plotted as '○'

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows per each 30 cm of penetration of a 51 mm diameter, 90° point cone driven by a 63.5 kg hammer falling from a height of 76 cm.

Plotted as '—●—'

WH Sampler advanced by static weight
PH Sampler advanced by hydraulic pressure
PM Sampler advanced by manual pressure
NP No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/30 cm)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
>50	very dense

Cohesive Soils:

Undrained Shear Strength (kPa)	'N' (blows/30 cm)	Consistency
<12	<2	very soft
12 to <25	2 to <4	soft
25 to <50	4 to <8	firm
50 to <100	8 to <15	stiff
100 to 200	15 to 30	very stiff
>200	>30	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0 Field vane test in borehole; the number denotes the sensitivity to remoulding
△ Laboratory vane test

METRIC CONVERSION FACTORS

1 ft = 0.3048 m
1 inch = 25.4 mm
1 lb = 0.454 kg
1 ksf = 47.88 kPa

JOB NO.: 2402-S095

LOG OF BOREHOLE: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Car Wash Facility

METHOD OF BORING: Soild Stem Augers

PROJECT LOCATION: 547 Bayfield Street, City of Barrie

DRILLING DATE: March 15, 2024

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
286.6	Pavement Surface							
0.0	**51 mm ASPHALT**				0			
	100 mm GRANULAR FILL							
	EARTH FILL Dark brown, sandy silt with gravel	1	DO	14			14	
285.8								
0.8		2	DO	15	1		15	
	some clay							
	Brown, compact to very dense **SILTY SAND TILL** traces of clay and gravel occ. cobbles and boulders	3	DO	40			7	
		4	DO	90	2		7	
		5	DO	50/15	3		6	
281.9		6	DO	50/15	4		7	
4.8	**END OF BOREHOLE**				5			
	Installed 50 mm Ø monitoring well to 4.6 m completed with 1.5 m screen Sand backfill from 2.5 m to 4.6 m Bentonite seal from 0.0 m to 2.5 m Provided with a flush mount casing				6			Dry upon Completion
					7			
					8			

JOB NO.: 2402-S095

LOG OF BOREHOLE: 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Car Wash Facility

METHOD OF BORING: Soild Stem Augers

PROJECT LOCATION: 547 Bayfield Street, City of Barrie

DRILLING DATE: March 15, 2024

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
286.3	Pavement Surface							
0.0	**51 mm ASPHALT** **100 mm GRANULAR FILL**				0			
	EARTH FILL Dark brown, sandy silt with gravel	1	DO	12			13	
		2	DO	5	1		13	
284.8								
1.4	Brown, very dense **SILTY SAND TILL** traces of clay and gravel occ. cobbles and boulders	3	DO	64	2		8	
		4	DO	50/15			8	
		5	DO	50/15	3		7	
281.6		6	DO	50/15			7	
4.8	**END OF BOREHOLE**				4			
	Installed 50 mm Ø monitoring well to 4.6 m completed with 1.5 m screen Sand backfill from 2.5 m to 4.6 m Bentonite seal from 0.0 m to 2.5 m Provided with a flush mount casing				5			
					6			
					7			
					8			

Dry upon Completion

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Soil Engineers Ltd. GRAIN SIZE DISTRIBUTION

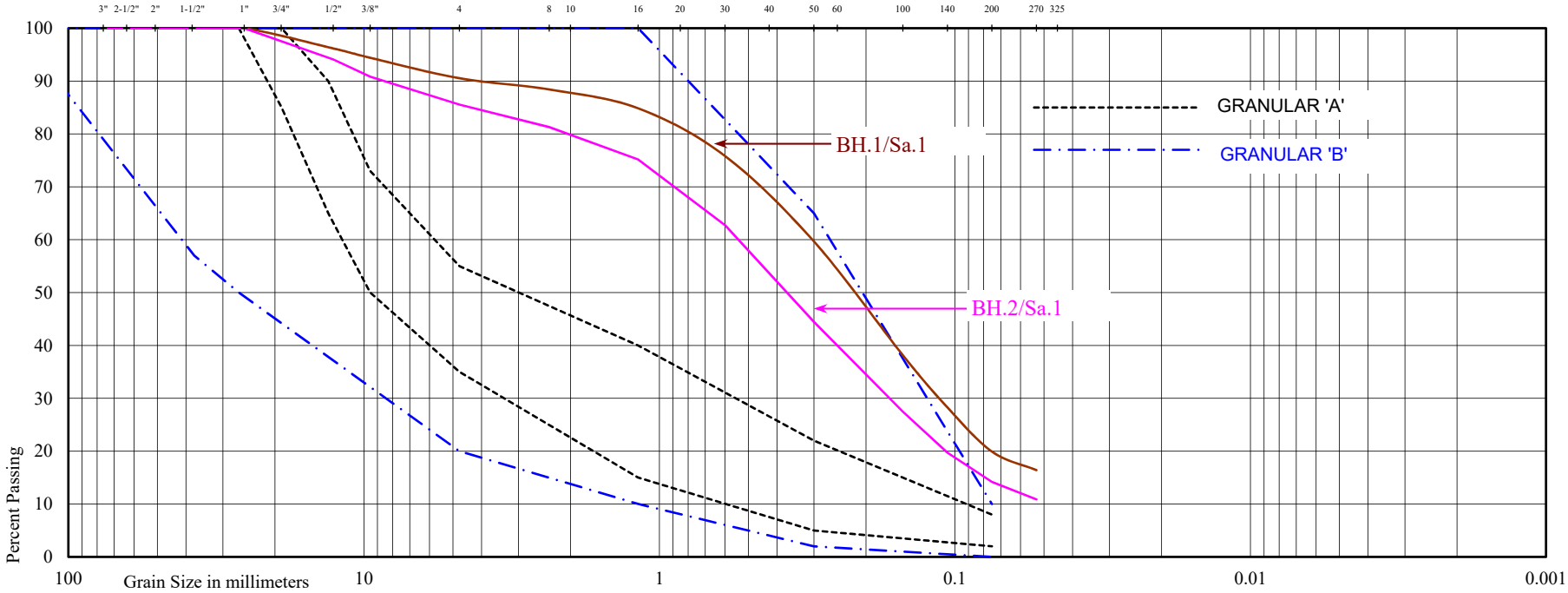
Reference No: 2402-S095

U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project: Proposed Car Wash Facility

Location: 547 Bayfield Street, City of Barrie

Borehole No:	1	2
Sample No:	1	1
Depth (m):	0.2	0.2
Elevation (m):	286.5	286.2

BH./Sa.	1/1	2/1
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	14	13
Estimated Permeability (cm./sec.) =	10^{-3}	10^{-3}

Classification of Sample [& Group Symbol]: GRANULAR FILL

Figure: 3

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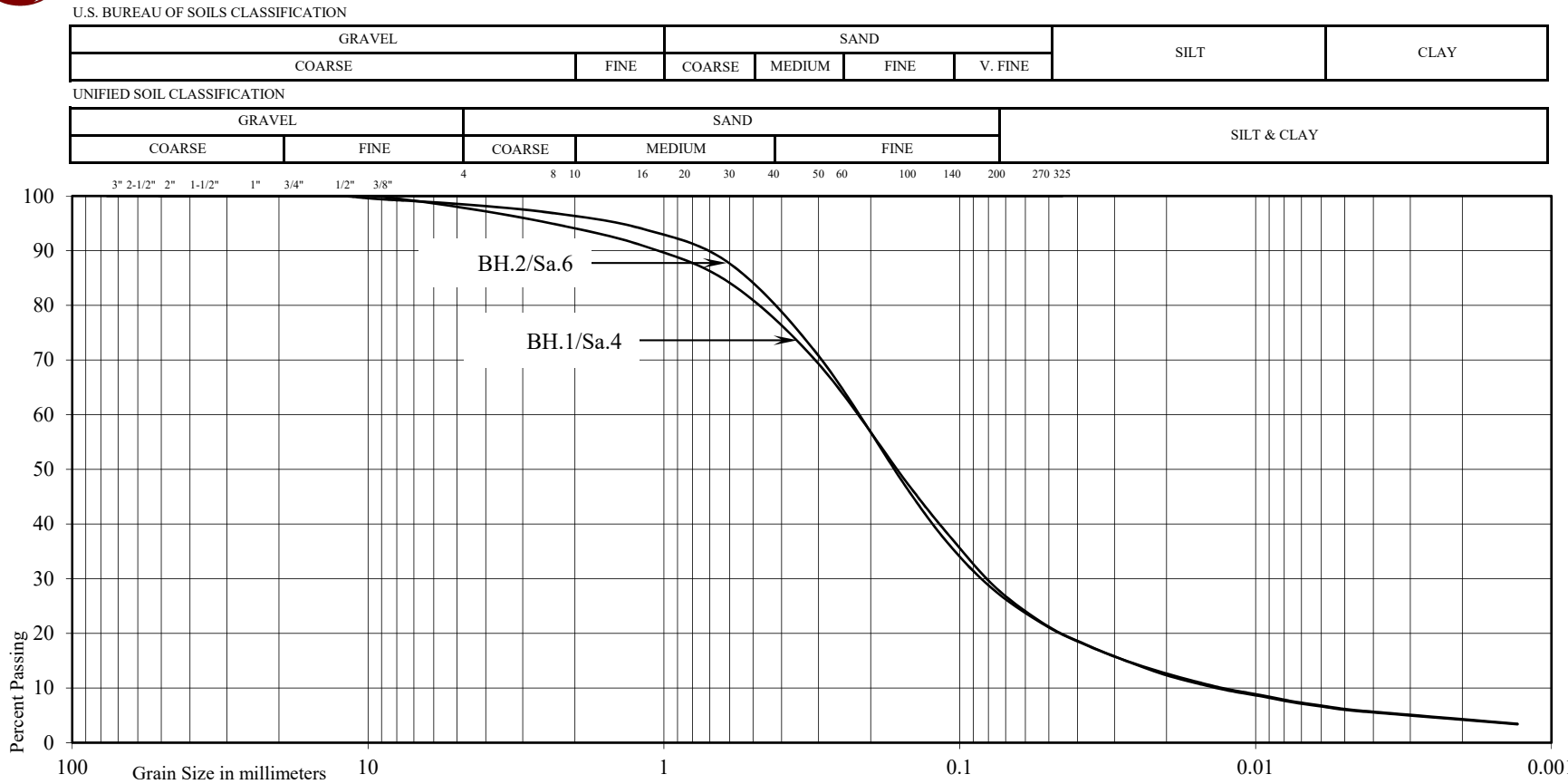
GRAIN SIZE DISTRIBUTION

Reference No: 2402-S095



Project: Proposed Car Wash Facility

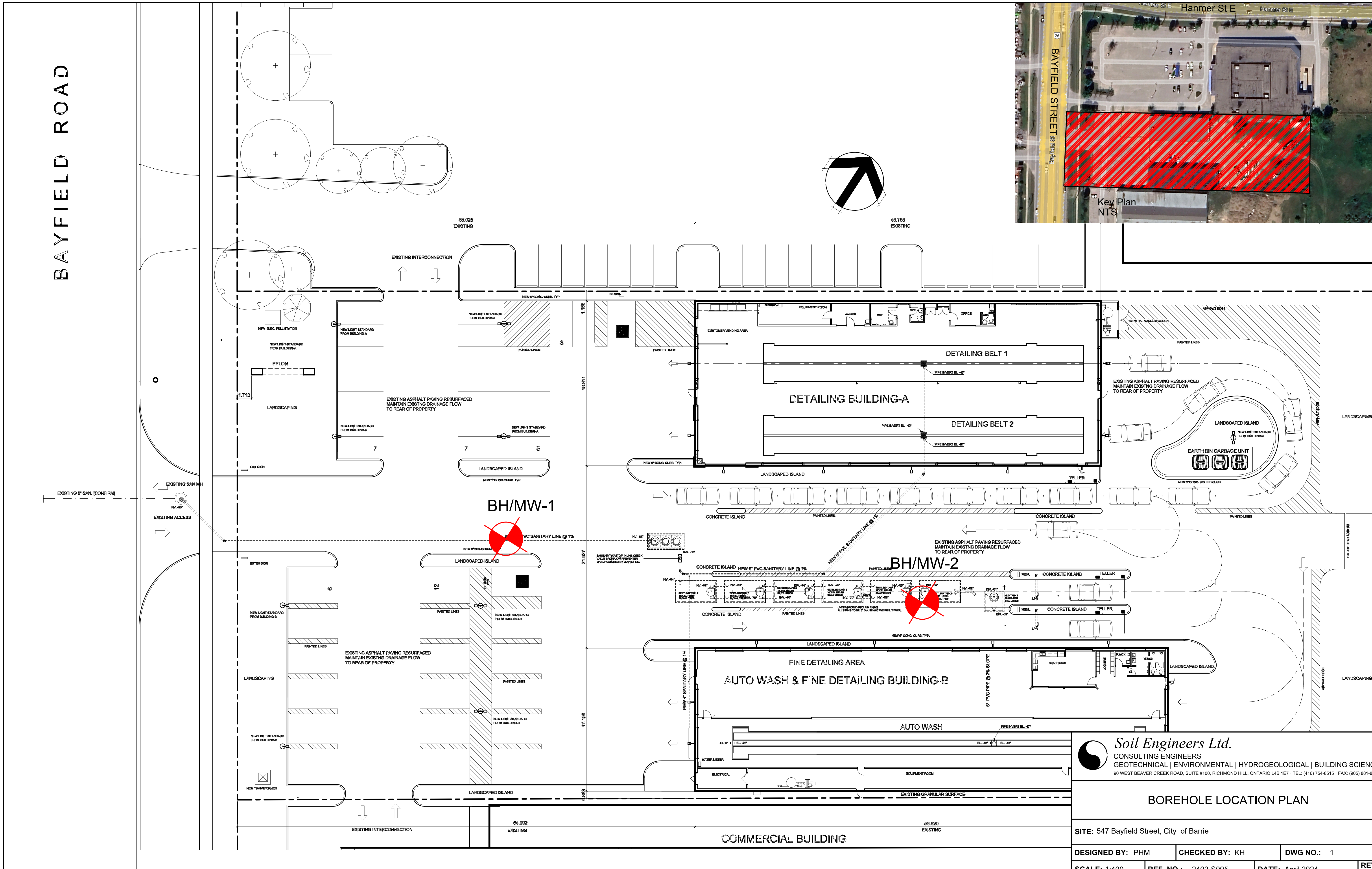
Location: 547 Bayfield Street, City of Barrie

Borehole No:	1	2
Sample No:	4	6
Depth (m):	2.3	4.6
Elevation (m):	284.3	281.7

BH./Sa.	1/4	2/6
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	7	7
Estimated Permeability (cm./sec.) =	10^{-4}	10^{-4}

Classification of Sample [& Group Symbol]: SILTY SAND TILL, traces of clay and gravel

Figure: 4



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BOREHOLE LOCATION PLAN			
SITE: 547 Bayfield Street, City of Barrie			
DESIGNED BY: PHM	**CHECKED BY:** KH	**DWG NO.:** 1	
SCALE: 1:400	**REF. NO.:** 2402-S095	**DATE:** April 2024	**REV**

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SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

JOB NO.: 2402-S095
REPORT DATE: April 2024
PROJECT DESCRIPTION: Proposed Car Wash Facility
PROJECT LOCATION: 547 Bayfield Street, City of Barrie

LEGEND
ASPHALT | FILL | GRANULAR | SILTY SAND TILL