Toronto Inspection LTD.
GEO-ENVIRONMENTAL CONSULTANTS

SLOPE STABILITY STUDY
452 RAGLAN STREET
COLLINGWOOD, ONTARIO

REPORT NO.: 4688-17-GD (R)
REPORT DATE: DECEMBER 6, 2021

PREPARED FOR:
EDEN OAK MCNABB INC.
833 HURONTARIO STREET
COLLINGWOOD, ONTARIO
L9Y 0G7

110 KONRAD CRESCENT, UNIT 16, MARKHAM, ONTARIO L3R 9X2
TEL.: 905-940-8509 FAX: 905-940-819

Toronto Inspection Ltd.

Table of Contents

Drawings

Figures

TorontoInspection LTD.
GEO-ENVIRONMENTAL CONSULTANTS

110 KONRAD CRESCENT,
UNIT 16
MARKHAM, ONTARIO
L3R 9X2
TEL.: 905-940-8509
FAX : 905-940-8192

December 6, 2021
Project No.: 4688-17-GD (R)

Eden Oak McNabb Inc.
833 Hurontario Street
Collingwood, Ontario
L9Y 0G7

Attention : Mr. Romas Kartavicius

Re: Slope Stability Report
452 Raglan Street, Collingwood, Ontario

Toronto Inspection Ltd. was authorised by Mr. Romas Kartavicius to carry out a slope stability study at the above referenced site. The purpose of the investigation was to establish the stable top of slope in order to determine the setback of the proposed development at the site.

This report evaluates the stability of the existing slope at two sections within the site, based on the subsoil and groundwater conditions encountered in the boreholes along the northeast and southeast side of the site, close to the staked top of the bank.

1.0 SITE CONDITION

The Site, having an area of approximately 9.02 Ha (22.3 acres), is located 250m west of Raglan Street, 320m north of Poplar Side Road, and just south of Williams Street and Peel Street, in Collingwood, Ontario. It should be noted that Raglan Street was assumed in a north-south orientation in this report. A site inspection was conducted in November 2017, the below observations are of that date:

The site is currently occupied by a one-storey residential building and a small storage shed at the northwest corner, landscaped and natural vegetation cover at the north portion and agricultural land on the remainder, to the south. The site gradient is relatively flat, with a grade difference of approximately 1m to 1.4m between the west end and east end of the property. Pretty River meanders from north to south through the site along the east portion. Train tracks are located along the west property line of the site.

The grade difference between the top of bank and the toe along the river bank is approximately 2.8m to 3.8m, with a slope angle of 30º to 52º to the horizontal. Pretty River meanders throughout the site.

Most of the slope surface is vegetated, except along the toe of the slope, where significant river bank erosion was evident during our site reconnaissance. Due to the dense vegetation growing along the slope, the roots of the vegetation have increased the strength of the bank material, by binding the soil along the slope. Some of the trees near the toe of the slope have bent trunks, are leaning in the easterly direction, due to the river bank erosion. Erosion gullies were not observed on the slope during our site reconnaissance.

2.0 FIELD INVESTIGATION

The field work of the investigation was carried out under the supervision of ***Toronto Inspection Ltd.***, during the period of November 16 to 24, 2017. The investigation, consisting of drilling a total of twenty four sampled boreholes, designated as BH-1 to BH-24, were to obtain subsoil and groundwater conditions, within the site, for:

- A Slope Stability Study along the east boundary of the site,
- Geotechnical data for the for the design and construction of the proposed redevelopment of the site,
- A Hydrogeological Study to determine the groundwater conditions within the site, which might an effect the stability of the slope, design and construction of the proposed buildings / infra-structures, and
- A Phase Two Environmental Site Assessment of the site.

This report deals primarily with the Slope Stability Study along the east portion of the site, along the Pretty River. The findings of the other investigations will be presented under separate covers.

The locations of the boreholes are shown on Borehole Location Plan, Drawing No.1. The subsoil and the groundwater conditions, encountered at BH-23 and BH-24 locations, were taken into consideration for the slope stability assessment.

Boreholes BH-23 and BH-24 were advanced to depths of 7.5m below the existing ground level, using a truck mounted drill rig, equipped with continuous flight solid stem augers, supplied by a specialist drilling contractor. Soil samples were retrieved from the boreholes at regular intervals of 0.8m to a depth of 3.0m from grade and at 1.5m intervals thereafter, using a split spoon sampler in conjunction with Standard Penetration Tests using a driving energy of 475 joules (350 ft-lbs). The samples were identified and logged in the field and were carefully bagged for later visual identification in the laboratory. Groundwater

observations were made in the boreholes during and upon the completion of drilling. Upon completion of the field work, the boreholes were backfilled to the ground surface and the areas reinstated to the original grade level.

The ground elevations at the Borehole locations were interpolated from the drawing, prepared by JoeTOPO Surveys and CADD Inc., dated November 22, 2017, provided to our office by the client.

3.0 SUBSURFACE CONDITIONS

Reference is made to the appended Borehole Location Plan (Drawing No. 1) and the Logs of Boreholes BH-23 and BH-24, for details of field work, including soil classification and inferred stratigraphy.

The overburden at the borehole locations, below the surficial topsoil, consisted of fill, overlying clayey silt / silty clay and sandy silt till deposits. Limestone bedrock was contacted at the boreholes at a depth of 7.5m below the existing ground level. Brief description of the subsoils, at the borehole locations, are as follows:

3.1 Surface Course

At Boreholes BH-23 and BH-24, topsoil 300mm to 310mm in thickness was contacted at the ground surface.

3.2 Fill

Underlying the topsoil, a layer of fill was encountered at Boreholes BH-23 and BH-24, at depths of 0.3m below the ground surface. The fill consisted of brown silty sand to sandy silt. The fill extended to depths of 0.8m below the ground surface.

3.3 Silty Sand / Sandy Silt

Underlying the fill, silty sand / sandy silt deposits were encountered, at Boreholes BH-23 and BH-24, at depths of 0.8m below the ground surface. The silty sand / sandy silt deposits were brown, with occasional gravel. Based on the Standard Penetration N-values of 7 to 14 blows for a penetration of 300mm, the relative density of the deposit was loose to

compact.

The in-situ moisture content of the soil samples, retrieved from the silty sand / sandy silt deposits, ranged from 12% to 27%, indicating moist to very moist conditions, with some wet pockets.

The silty sand / sandy silt deposits extended to depths of 2.3m to 2.9m below the ground surface.

3.4 Clayey Silt / Silty Clay

Underlying the silty sand / sandy silt deposits, clayey silt / silty clay deposits were encountered, at Boreholes BH-23 and BH-24, at depths of 2.3m to 2.9m below the ground surface. The clayey silt / silty clay deposits were brown to grey. Based on the Standard Penetration N-values of 5 to 29 blows for a penetration of 300mm, the consistency of the clayey silt / silty clay deposits was firm to very stiff.

The in-situ moisture content of the soil samples, retrieved from the clayey silt / silty clay deposits, ranged from 7% to 25%, indicating moist to very moist conditions.

Grain size analysis was carried out on two selected soil samples, obtained from Boreholes BH-23 and BH-24, at depths of 3.0m, using mechanical sieves and hydrometer. The grain size distributions are shown on the appended Figure No. 3.

Atterberg limits were carried out on two selected soil samples, obtained from Boreholes BH-23 and BH-24, at depths of 3.0m. The results of the Atterberg limits are shown on the appended Figure No. 4.

The clayey silt / silty clay deposits extended to depths of 4.8m to 4.9m below the ground surface.

3.5 Silt Till

Underlying the clayey silt / silty clay deposits, a silt till deposit was encountered, at Boreholes BH-23 and BH-24, at depths of 4.8m to 4.9m

below the ground surface. The silt till deposit was grey. Based on the Standard Penetration N-values of 19 to more than 100 blows for a penetration of 300mm, the silt till deposit was compact to very dense.

The in-situ moisture content of the soil samples, retrieved from the silt till deposit, ranged from 6% to 12%, indicating moist conditions.

The silt till deposit extended to depths of 7.0m to 7.3m below the ground surface.

3.6 Bedrock

Limestone bedrock was encountered below the silt till deposit at depths of 7.0m to 7.3m below the ground surface. Boreholes BH-23 and BH-24 were terminated in the limestone bedrock, due to refusal to augering, at depths of 7.5m below the ground surface. An examination of the rock cores, obtained at BH-5, BH-9 and BH-20, indicated that below a minor depth of weathering the bedrock at the site was of fair to good quality.

3.7 Ground Water

Free water was recorded at 3.0m at Boreholes BH-23 and BH-24, upon the completion of drilling.

Based on the field observation and the moisture content profile of soil samples, it is our opinion that the free water may be attributed to the perched water in the upper permeable silty sand deposits overlying less permeable clayey silt / silty clay deposits and wet condition of the natural clayey silt / silty clay deposits.

Static water levels of 5.1m (17MW-18) and 5.4m (17MW-20) from nearby monitoring wells completed during field investigation, for the goetechnical, hydrogeological, and environmental investigations, were used in our analysis. For the purposes of our slope stability study, we have assumed a water level of 3.0m below the ground surface to reflect the possible water table following a very wet season.

4.0 SLOPE STABILITY ANALYSES

4.1 Computerized Simplified Bishop Method

Two computerised slope stability analyses were carried out for the site, at locations shown on the Borehole Location Plan, Drawing No. 1. These slope profiles were based on the ground contours shown on the drawing prepared by JoeTOPO Surveys and CADD Inc., dated November 22, 2017, provided to our office by the client. Since the proposed development will be set back beyond the stable top of the slope, additional loads from the proposed development were not considered in the analyses.

For the overburden and the bedrock at the site, the following soil parameters were used in the slope stability analyses:

	Fill	Silty Sand / Sandy Silt	Clayey Silt / Silty Clay	Silt Till	Bedrock
Unit Weight of Soil (kN/m^3)	18	20	20	21	22
Effective Cohesion, c' (kPa)	0	0	5	0	20
Angle of Internal Friction, φ'	20	30	30	36	40

5.0 COMMENTS ON SLOPE STABILITY ANALYSIS

The existing top of bank was staked out (with flags) by the Nottawasaga Valley Conservation Authority (NVCA) on November 8, 2017. GPS points of the stakes were provided to our office for use in our slope stability analysis. The existing top of bank is approximately 1.5m and 3.1m west of the estimated top of slope at Sections A-A and B-B, respectively.

The results of the slope stability analyses are presented on Figure Nos. 1 and 2. At Sections A-A and B-B, the intercepts for the slip surfaces, with factors of safety of 1.5 or higher, are at distances of 5.3m west and 1.1m east of the existing top of the bank.

The erosion hazards limit for the proposed development of the site should be based on the combined influence of the following:

5.1 Toe Erosion Allowance

Significant river bank erosion was noted during our site reconnaissance. The material at the toe of the slope consists of clayey silt / silty clay deposits. These deposits are classified as clays, clay-silt, gravels and the slopes of 3H:1V or flatter in this material are considered to be stable.

With reference to *Natural Hazards Training Manual, Provincial Policy Statement, Public Health and safety, Policies 3.1, Version 1.0, Ontario Ministry of Natural Resources*, the allowance for the toe erosion in clays, clay-silt, gravels, for a river within 15 m of the slope toe, is 5m to 8m.

A Meander Belt Width Assessment of Pretty River was completed by GEO Morphix Ltd., dated May 14, 2021. Within this geomorphological assessment a toe erosion of 5m was recommended for the site using detailed technical analyses. Therefore, a 5m toe erosion for the site can be used based on reliance of this document.

5.2 Stable Slope Allowance

The results of the slope stability analyses are presented on Figure Nos. 1 and 2. At Sections A-A and B-B, the intercepts for the slip surfaces, with factors of safety of 1.5 or higher, are at distances of 5.3m west and 1.1m east of the existing top of the bank.

5.3 Erosion Access Allowance

Based on the current Town of Collingwood Official Plan, a minimum buffer of 6m is required for the set-back of the proposed development, between the stable top of slope and the proposed development.

6.0 CONCLUSION & RECOMMENDATIONS

The setback of the proposed development should be based on the maximum distance of the following conditions:

- As required by the Town of Collingwood Official Plan, all developments adjacent to Pretty River must be setback a minimum of 30.0m from the long term stable top of slope, or
- The following analytical values, whichever is greater:
  - A toe erosion allowance of 5 m.
  - The stable top of slope of 5.3m and 1.1m inland from the existing top of bank.
  - A minimum 6m erosion access allowance, as required by the Town of Collingwood Official Plan.

The above analytical values indicate that the long term stable top of slope will be at distances of 10.3m and 6.1m, from the existing top of bank at Sections A-A and B-B, respectively. The development setback will be at distances of 16.3m and 12.1m, from the existing top of bank at Sections A-A and B-B, respectively.

Based on the above conditions, the total setback of 30.0m from the long term stable top of slope will be required for any development on the site, as required by the Town of Collingwood Official Plan. This would then equate to a total development setback of 40.3m and 36.1m, from the existing top of bank at Sections A-A and B-B, respectively.

We recommend that:

i. No additional surcharge should be placed within 10m from the top of the bank.
ii. No uncontrolled flow of surface water should be allowed onto the slope, as this may result in erosion gullies on the bank.

7.0 GENERAL STATEMENT OF LIMITATION

The comments and recommendations presented in this report are based on the subsoil and ground water conditions encountered at the borehole locations, indicated in the borehole location plan, and are intended for the guidance of the design engineer.

Any use and / or the interpretation of the data presented in this report, and any decisions made on it by the third party are responsibility of the third parties. The responsibility of ***Toronto Inspection Ltd.*** is limited to the accurate interpretation of the soil and ground water conditions prevailing in the locations investigated and accepts no responsibility for the loss of time and damages, if any, suffered by the third party as a result of decisions or actions based on this report.

Any legal actions arising directly or indirectly from this work and/or ***Toronto Inspection Ltd.'s*** performance of the services shall be filed no longer than two years from the date of ***Toronto Inspection Ltd.'s*** substantial completion of the services. ***Toronto Inspection Ltd.*** shall not be responsible to the client for lost revenues, lost of profits, cost of content, claims of customers, or other special indirect, consequential or punitive damages.

To the fullest extent permitted by law, the client's maximum aggregate recovery against ***Toronto Inspection Ltd.***, its directors, employees, sub-contractors and representatives, for any and all claims by clients for all causes including, but not limited to, claims of breach of contract, breach of warranty and /or negligence, shall be the amount of the fee paid to ***Toronto Inspection Ltd.*** for its professional services rendered with respect to the particular site which is the subject of the claim by the client.

Yours very truly,
TORONTO INSPECTION LTD.

Shan Goel, P.Eng.
Project Manager

LICENSED PROFESSIONAL ENGINEER
A.S.GOEL
100222578
Dec 6, 2021
PROVINCE OF ONTARIO

David S. Wang, P. Eng.
Senior Engineer

LICENSED PROFESSIONAL ENGINEER
S. WANG
100131918
Dec 6, 2021
PROVINCE OF ONTARIO

Upkar S. Sappal, P. Eng.
Principal Engineer

Toronto Inspection Ltd.

Drawings

LEGEND

Borehole and Monitoring Well Location

Site Boundary

NOT TO SCALE

TorontoInspection LTD.
GEO-ENVIRONMENTAL CONSULTANTS

110 Konrad Crescent,
Unit 16
Markham, Ontario
L3R 9X2

Tel: 905-940 8509 Fax: 905-940 8192 Email : til@torontoinspection.com

TITLE:	Borehole and Monitoring Well Location Plan
LOCATION:	452 Raglan Street, Collingwood, Ontario
PROJECT NO.	4688-17-GD
DATE :	December 2021
FIGURE NO.	1

LEGEND

Borehole Location — Site Boundary

NOT TO SCALE

TorontoInspection LTD.
GEO-ENVIRONMENTAL CONSULTANTS
110 Konrad Crescent, Unit 16
Markham, Ontario
L3R 9X2
Tel: 905-940 8509 Fax: 905-940 8192 Email : til@torontoinspection.com

TITLE:	Cross Sections
LOCATION:	452 Raglan Street, Collingwood, Ontario
PROJECT NO.	4688-17-GD
DATE :	December 2021
FIGURE NO.	1A

Project No. 4688-17-GD

Log of Borehole 23

Dwg No. 24

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: 452 Raglan Street, Collingwood, Ontario

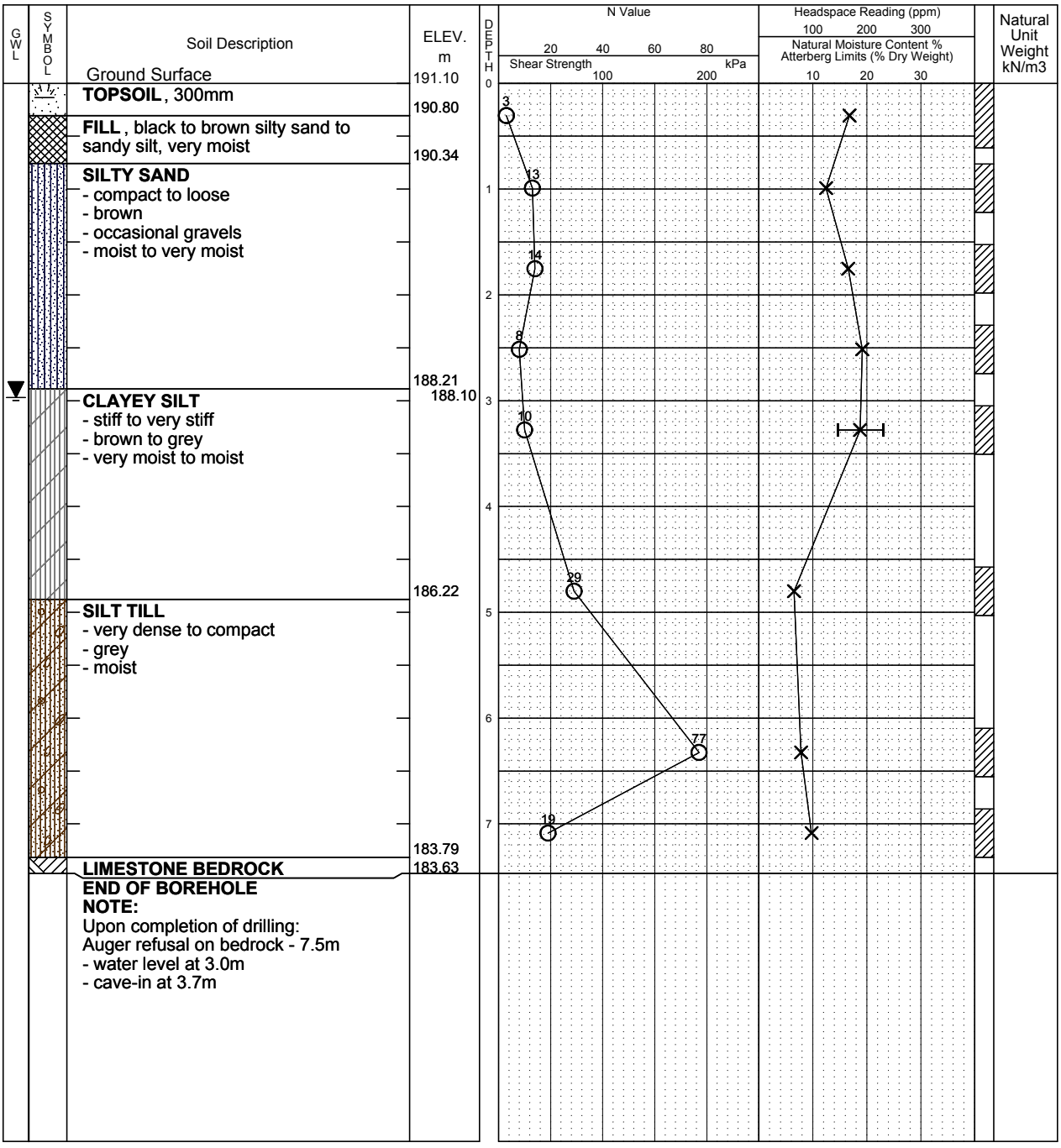
Date Drilled: 11/24/17

Drill Type: Track Mounted Drill Rig

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Headspace Reading (ppm)
Natural Moisture
Plastic and Liquid Limit
Unconfined Compression
% Strain at Failure
Penetrometer



LGBE3 4688-17-GD.GPJ 1/4/18

NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 4688-17-GD

Log of Borehole 24

Dwg No. 25

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: 452 Raglan Street, Collingwood, Ontario

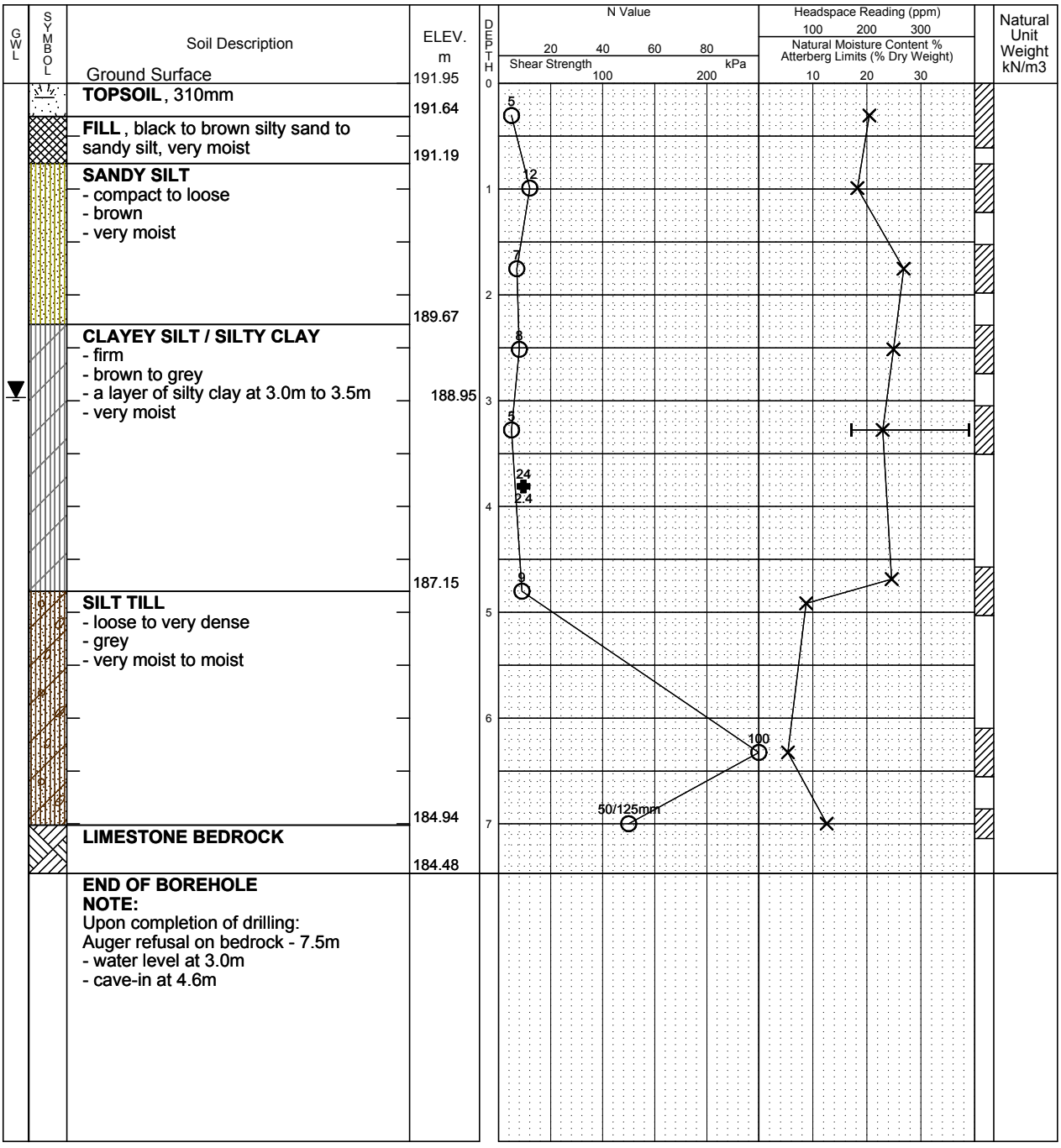
Date Drilled: 11/24/17

Drill Type: Track Mounted Drill Rig

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Headspace Reading (ppm)
Natural Moisture
Plastic and Liquid Limit
Unconfined Compression
% Strain at Failure
Penetrometer



LGBE3 4688-17-GD.GPJ 1/4/18

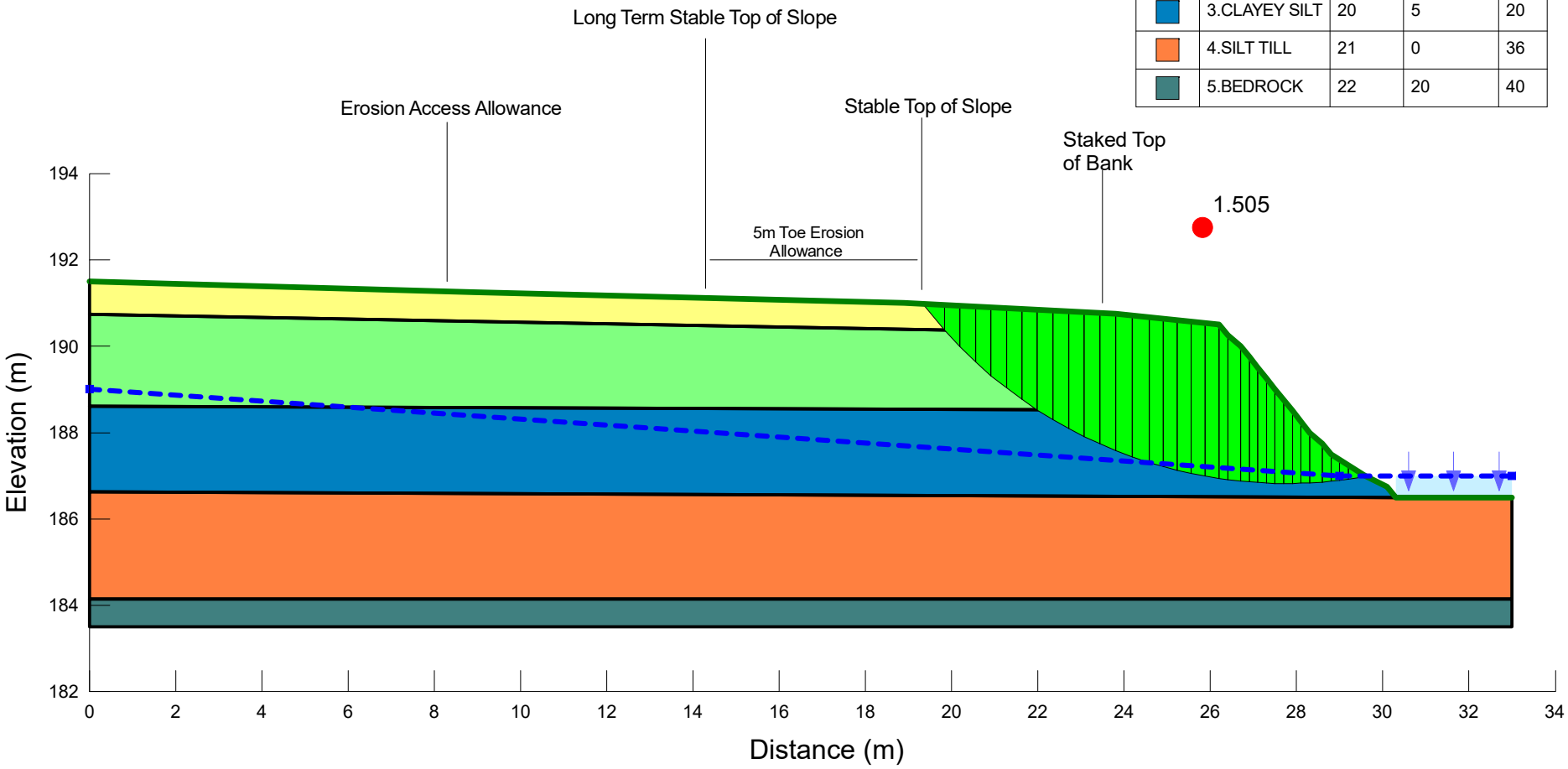
NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

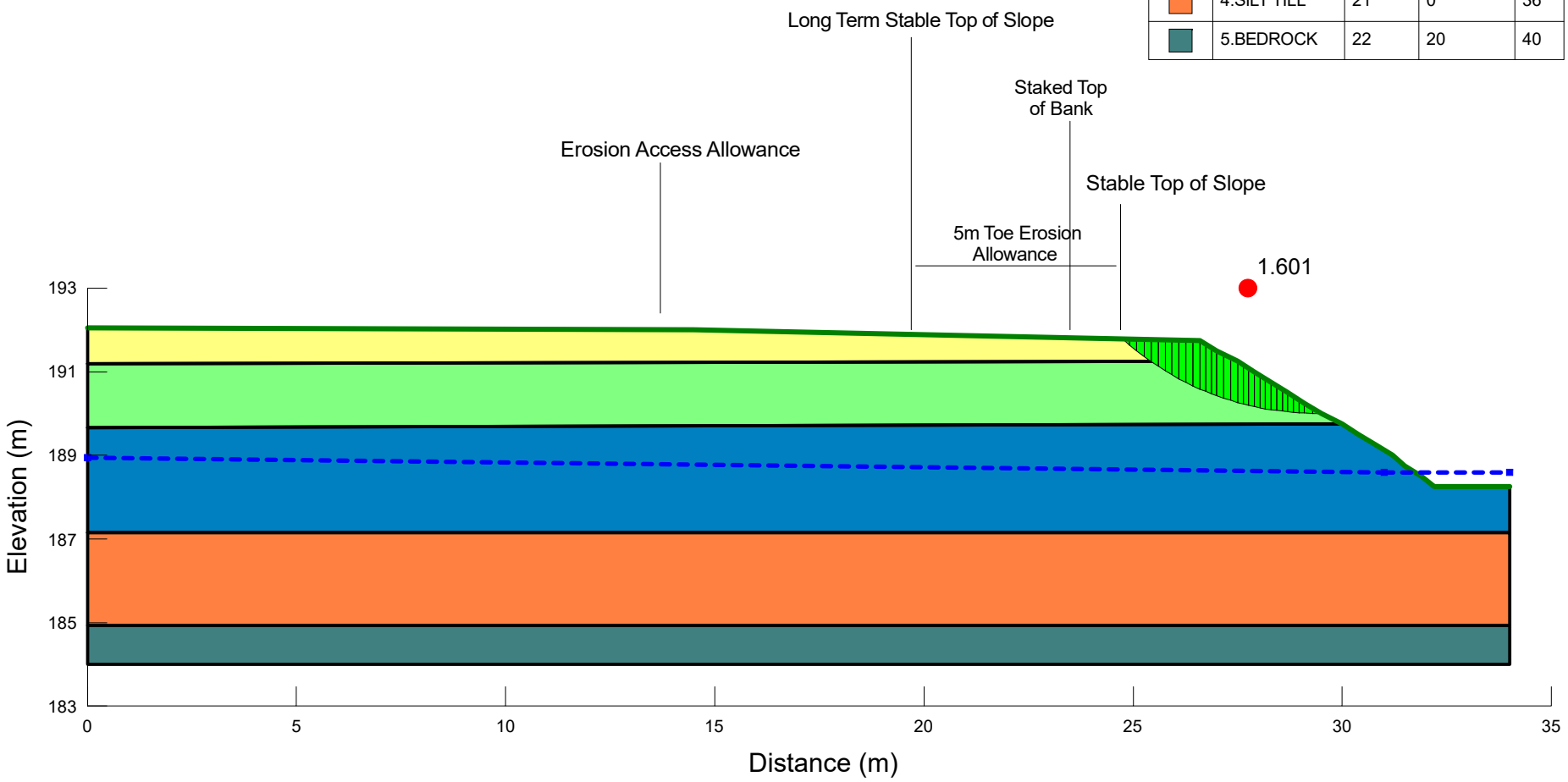
Figures

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	1.FILL	18	0	20
	2.SILTY SAND	20	0	21
	3.CLAYEY SILT	20	5	20
	4.SILT TILL	21	0	36
	5.BEDROCK	22	20	40

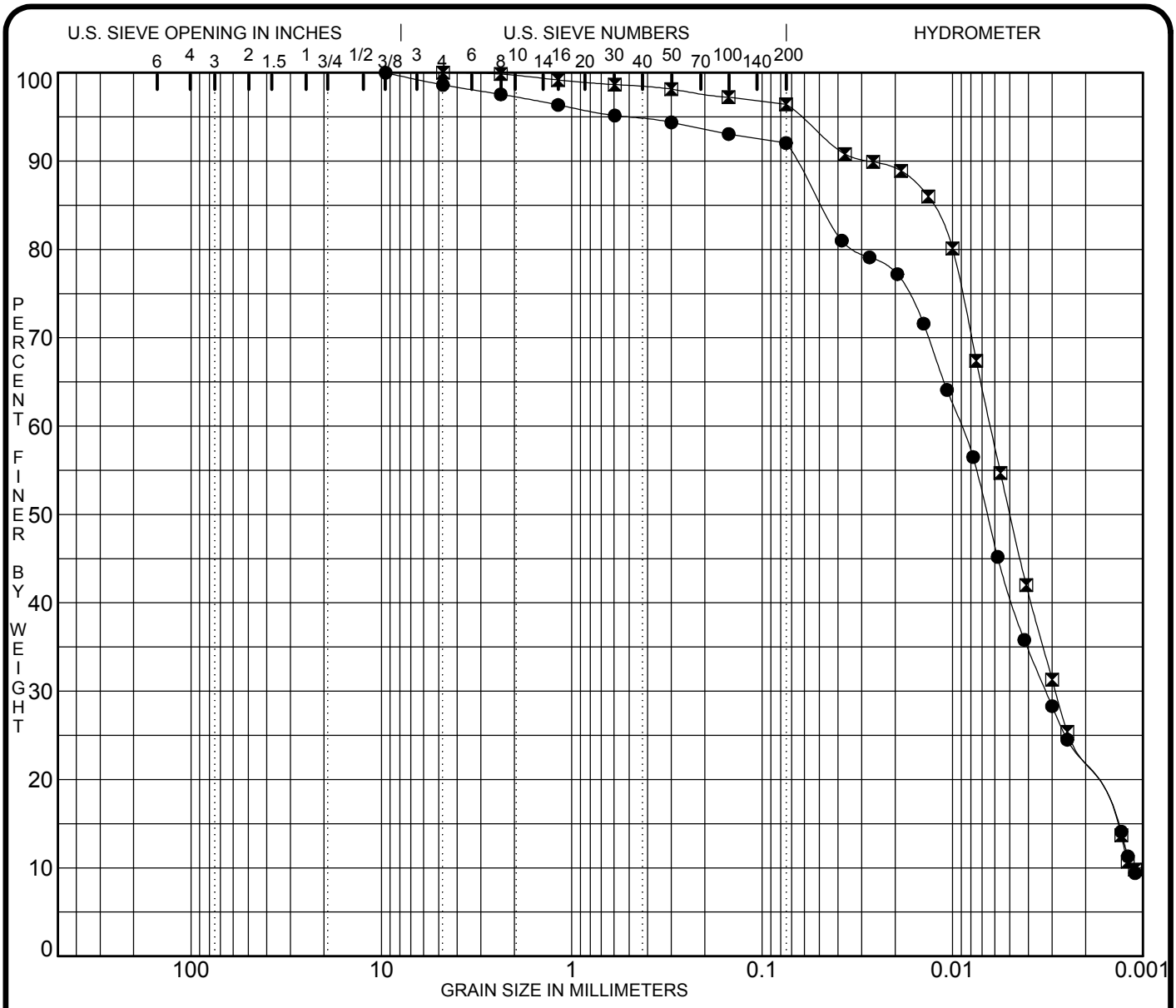


SLOPE/W	4688-17-GD (R)	452 Raglan Street, Collingwood
Section A		Figure No. 1
2021-12-07		1:147

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	1.FILL	18	0	20
	2.SILTY SAND	20	0	30
	3.CLAYEY SILT	20	5	30
	4.SILT TILL	21	0	36
	5.BEDROCK	22	20	40



SLOPE/W	4688-17-GD	452 Raglan Street, Collingwood
Section B		Figure No. 2
2021-12-07		1:153



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**BH-23**	**3.0**	**LEAN CLAY CL**		**23**	**15**	**8**	**1.03**	**8.0**
⊠	**BH-24**	**3.0**	**LEAN CLAY CL**		**39**	**17**	**22**	**1.17**	**5.6**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH-23**	**3.0**	**9.50**	**0.01**	**0.003**	**0.0011**	**1.4**	**6.6**	**51.2**	**40.9**
⊠	**BH-24**	**3.0**	**4.75**	**0.01**	**0.003**	**0.0011**	**0.0**	**3.6**	**46.3**	**50.1**

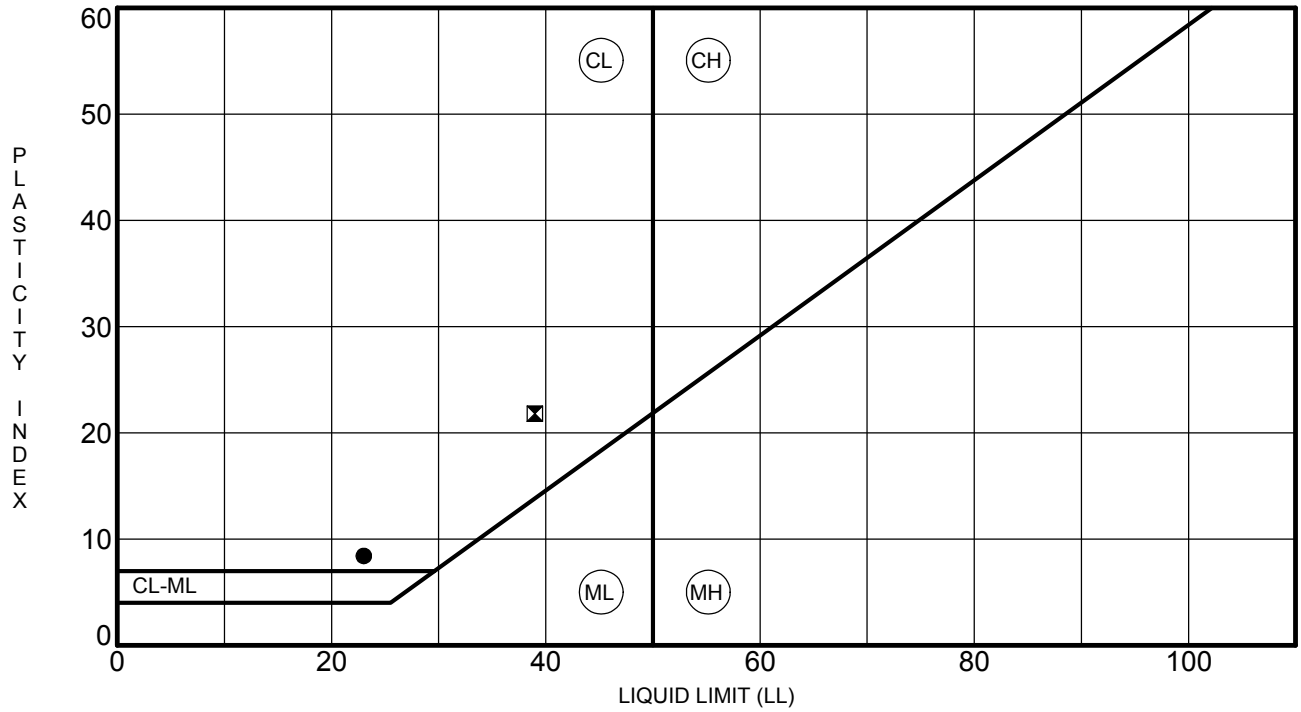
PROJECT **Slope Stability Study - 452 Raglan Street, Collingwood, Ontario**

JOB NO. **4688-17-GD**

DATE **1/15/18**

GRADATION CURVES

Toronto Inspection Ltd.



Specimen Identification			LL	PL	PI	Fines	Classification
●	**BH-23**	**10.0**	**23**	**15**	**8**	**92.0**	**LEAN CLAY CL**
⧓	**BH-24**	**10.0**	**39**	**17**	**22**	**96.4**	**LEAN CLAY CL**

PROJECT **Slope Stability Study - 452 Raglan Street, Collingwood, Ontario**

JOB NO. **4688-17-GD**

DATE **1/15/18**

ATTERBERG LIMITS' RESULTS

Toronto Inspection Ltd.