LOCAL GEOTECHNICS

17 March 2020

Report on

Geotechnical Investigation

469 & 471 Canning Highway, Como, WA

Project:
LG0502020GI REV_0

Client:
Dem

Geotech | Civil | Pavement | Drainage

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LOCAL GEOTECHNICS

17 March 2020

To
Dem
Suite 202, Level 2, Tower B, The Zenith (Railway St entry)
821 Pacific Highway, Chatswood NSW 2067

Dear Sir/Madam,

RE: Geotechnical Investigation for 469 & 471 Canning Highway, Como, WA.

This letter presents our report on a Geotechnical Investigation carried out at 469 & 471 Canning Highway, Como WA. The report must be thoroughly read and implemented in full. No partial implementation of this report is allowed.

If you have any questions in regards to the geotechnical site investigation or we can be of further assistance, please do not hesitate to contact Local Geotechnics.

Sincerely yours

Dr. Harun Meer
Ph.D.(Geotech), M. Eng. (Geotech), B. Eng. (Civil), MIE Aust
Director
Local Geotechnics

PROJECT INFORMATION

Project	**LG0502020GI** **Geotechnical Investigation**
Site Location	**469 & 471 Canning Highway, Como, WA**

Rev	Description	Date	Prepared by	Approved by
0	Issued to client	17 March 2020	R Khan	H Meer

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EXECUTIVE SUMMARY

A geotechnical site investigation was undertaken on 28 February and 5 March 2020 to assess the prevailing subsurface conditions at 469 & 471 Canning Highway, Como WA (site). Subsurface conditions inferred from the site investigation can be described as follows:

- Topsoil, SAND (SP) – fine to medium grained, brown, grey, dark grey-brown, loose, with grass, trace organics, extended from surface to a depth of around 0.2 m, overlying,
- SAND (SP) – fine to medium grained, grey, light grey (white), brown, yellow and light yellow, dry to slightly moist, extended to the maximum investigated depth 25.48 m. In this unit, following generalised densities were assessed.
    - 0.2 – 1 m: loose,
    - 1 – 4.7 m: medium dense,
    - 4.7 – 25.5 m: dense to very dense.

GROUNDWATER & DEWATERING – groundwater was encountered at depths varying between 7.7 m and 7.8 m below ground level (approximately 1.4 m AHD). Historical highest groundwater table was at 2.4 m AHD as per the Perth Groundwater Atlas. That indicates that estimated highest groundwater depth varies between 6.6 m and 7.9 m below the ground surface. Lower basement floor level of the proposed building was unknown during preparation of this report. If the basement Bulk Excavation Level (BEL) leaves a sand cover of less than 1m above the GWT, dewatering will be required to facilitate clean excavation, compaction for foundation bases and subsequent construction.

Site class (AS2870-2011) – the site was classified as 'Class P'. However, if the backfilling, earthworks and compaction are undertaken as per the recommendations presented in Section 7.7.3, the site can be reclassified to 'Class A'.

Earthquake sub-soil class (AS1170.4-2007) – "Class Ce - Shallow Soil".

Geotechnical strength and stiffness parameters, bearing capacity parameters for shallow and pile foundations are presented in Section 7.3, 7.8.1 & 7.8.2, respectively.

Based on the sandy material, a design CBR value of 12% can be considered.

Based on the measured pH, chloride, sulphate and resistivity values, the soil exposure classification for both concrete and steel is 'non-aggressive'.

The ASS field screening tests indicate that the presence of AASS and PASS at the tested locations of the site is less likely.

Temporary excavation up to 1 m depth can be conducted with a maximum dry slope angle of 1V: 2H. Cut and fill batters above groundwater table will be generally stable at 1V: 2H. Intermediate benches have to be created if excavation is deeper than 1m.

The recommended measure for the disposal of stormwater is onsite through soakwells or through to the basement stormwater management network. The volume of expected stormwater is to be estimated by a suitably qualified Civil Engineering professional.

We recommend undertaking an additional site investigation that may comprise a series of borehole drilling which will assist detail design of soldier pile retention wall for basements.

1.0 INTRODUCTION

Dem (the client) engaged Local Geotechnics (LG) to undertake a geotechnical site investigation for a proposed multistorey building development at 469 & 471 Canning Highway, Como, WA.

It is anticipated that the site investigation work will assist developing a concept design of a 2 level basement carparks over which two 10-12 storey residential tower apartments will be constructed. Further geotechnical (detail) investigation for detailed design stage might be taken place prior to the construction.

The site location map is shown in Figure 1.

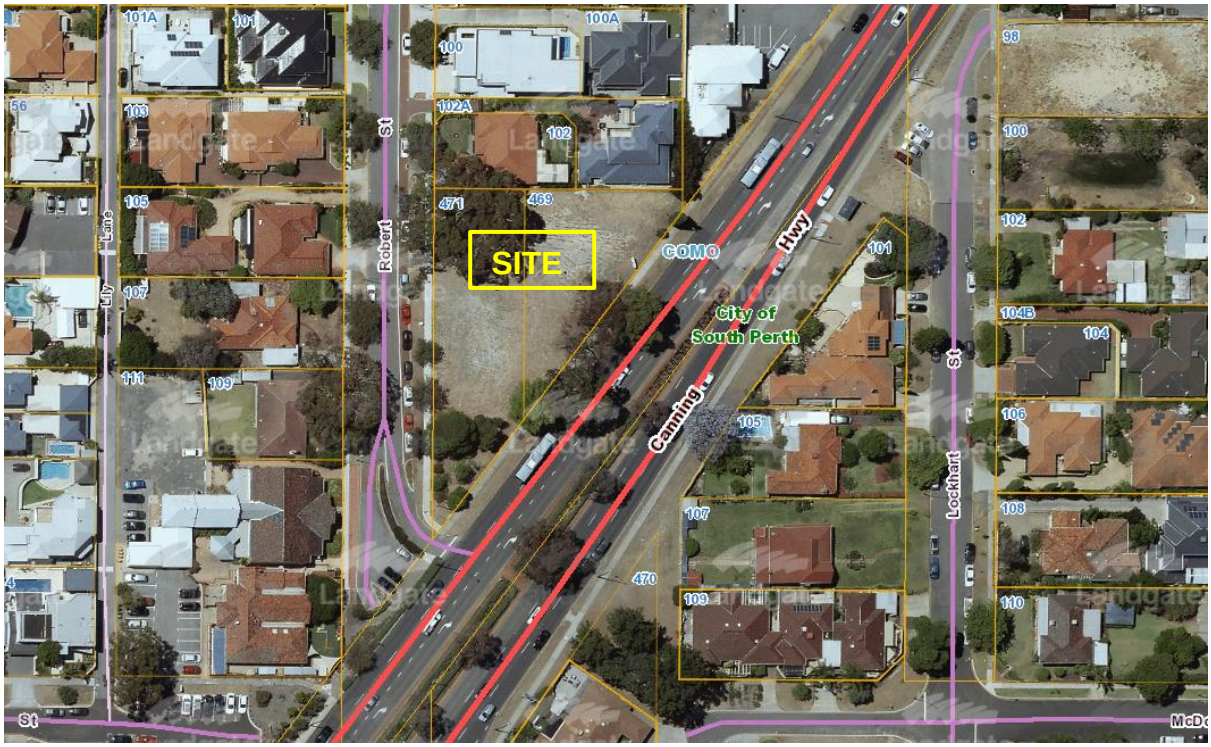


Figure 1. Site location map (source: Landgate Maps)

A geotechnical site investigation, that comprises onsite underground services check, hand auger test holes drilling, Perth Sand Penetrometer tests and electric friction cone penetrometer tests, was undertaken on 28 February 2020 and 5 March 2020 to assess the prevailing subsurface conditions for the proposed development.

This report presents the factual data obtained during the field investigation and recommendations and discussions on site classification, subsurface conditions, bearing pressure, foundation type, backfill and estimated settlements.

2.0 PROPOSED DEVELOPMENT

The proposed development comprises multistorey building. The building may include a 2 level basement below ground and 10 to12 storey residential tower apartments above ground.

The below ground basements may be constructed using soldier pile retention system. The building is understood to be supported on pad and strip footings at lower level basement.

3.0 SCOPE AND OBJECTIVES

Following is the scope of work LG has undertaken to achieve the project objectives:

- Desktop review of geological survey maps, groundwater atlas and other publicly available information for the site.
- Identifying any underground services crossing the proposed field investigation locations by conducting “Dial-Before-You-Dig” search and engaging a service locating contractor.
- Preparation of a Job Safety and Environmental Analysis (JSEA) document for the geotechnical investigation and implementation of the JSEA during the fieldworks.
- Undertaking 3 Electric Friction Cone Penetrometer Tests (CPTs) to a target depth of 25 m. Two tests were undertaken with a piezocone to assess the pore pressure profile and depth to the groundwater table.
- Installation of one 25mm diameter standpipe piezometers at one CPT location. The piezometer was constructed to monitor the groundwater level until the construction.
- Drilling of 4 hand auger Test Holes (THs) across the proposed development site to a target depth of 3 m, refusal or hole collapse, whichever was encountered first.
- Conducting 4 Perth Sand Penetrometer (PSP) tests at the locations of THs, to a depth of 1.95 m from the ground surface.
- Conducting 1 Field Permeability Tests (FPT) across the proposed development site at a depth of 0.5 m below surface level.
- Undertaking laboratory testing of soil.
- Preparation of this geotechnical investigation report to include the following information relevant to the design development.
  - Factual data from the field testing.
  - Site classification (AS2870-2011) and remedial measures to improve this classification if required.
  - Sub-soil class (AS1170.4-2007), earthquake parameter.
  - Subsurface conditions in the significant foundation zone.
  - Recommendations on ground improvement.
  - Description of groundwater conditions.
  - Geotechnical design/strength parameters.
  - Site preparation recommendations (AS 3798-2007).

4.0 SITE CONDITIONS

4.1 Surface Condition

The site is located in a residential suburb of Como, WA and is approximately 6 km south of the Perth CBD.

The topography of the site was observed to be generally flat. Site elevation varies between 9.0 m AHD and 10.3 m AHD (near the intersection of Robert Street and Canning Highway). LG was advised that a heritage tree was located at the south-west corner of the site. A number of grown up trees were observed around the boundary of the site.

The site was vacant, covered with sand, grass and was accessible by 4WD vehicle and CPT rig.

The site photos taken during the field investigation are shown in Appendix D.

4.2 Site Geology

The 1:50,000 Geology Series Map, Fremantle Sheet, No. 2033 I and IV, issued by the Geological Survey of Western Australia, indicates that the site is underlain by Quaternary age Sand Deposit (S7) that is derived from Tamala Limestone.

The sand was described to be pale yellowish brown, medium to coarse grained, subangular, quartz, trace of feldspar, moderately sorted, of residual origin.

The Environmental Geological map also revealed that the site soil has high permeability, low corrosion potential, low to medium slope stability, low to medium bearing capacity.

An extracted site geological map is shown in Figure 2.

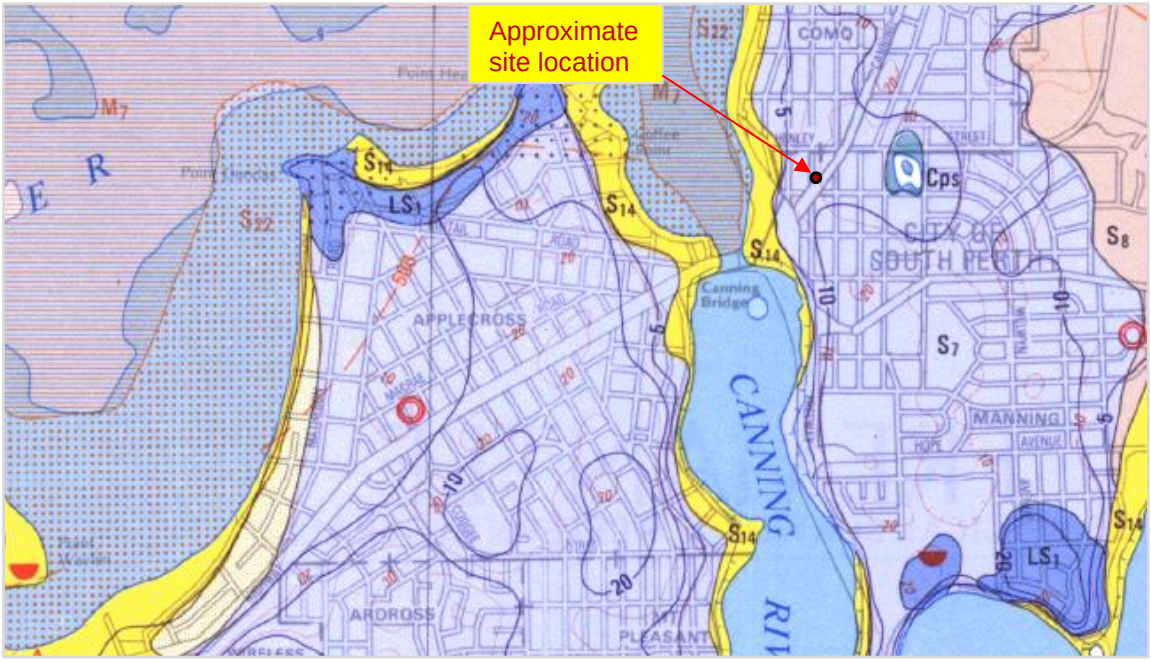


Figure 2. Extracted Geological Map (Ref. 1:50,000 Geology Series Fremantle sheet)

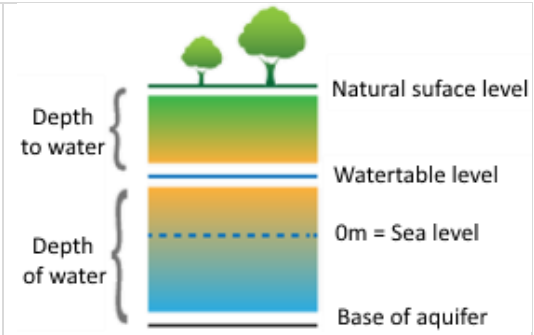
4.3 Groundwater Information

A review of the 'Perth Ground Water Atlas' of the Department of Water was carried out for this site. 'Perth Ground Water Atlas' indicated that the site natural ground surface elevation varied between 9.0 and 10.3 m AHD, annual average water table of 1 m AHD and historical maximum water table of 2.4 m AHD as per May 2003 data.

Natural average surface level: 9.0 to 10.3 m AHD
Annual average water table level: 1.0 m AHD
Historic maximum water level: 2.4 m AHD

Est. average groundwater depth = 8.0 to 9.3 m
Est. historical max. GW depth = 6.6 to 7.9 m

<u>Legend:</u>
Purple line = annual average water table level
Pink line = historic maximum water level



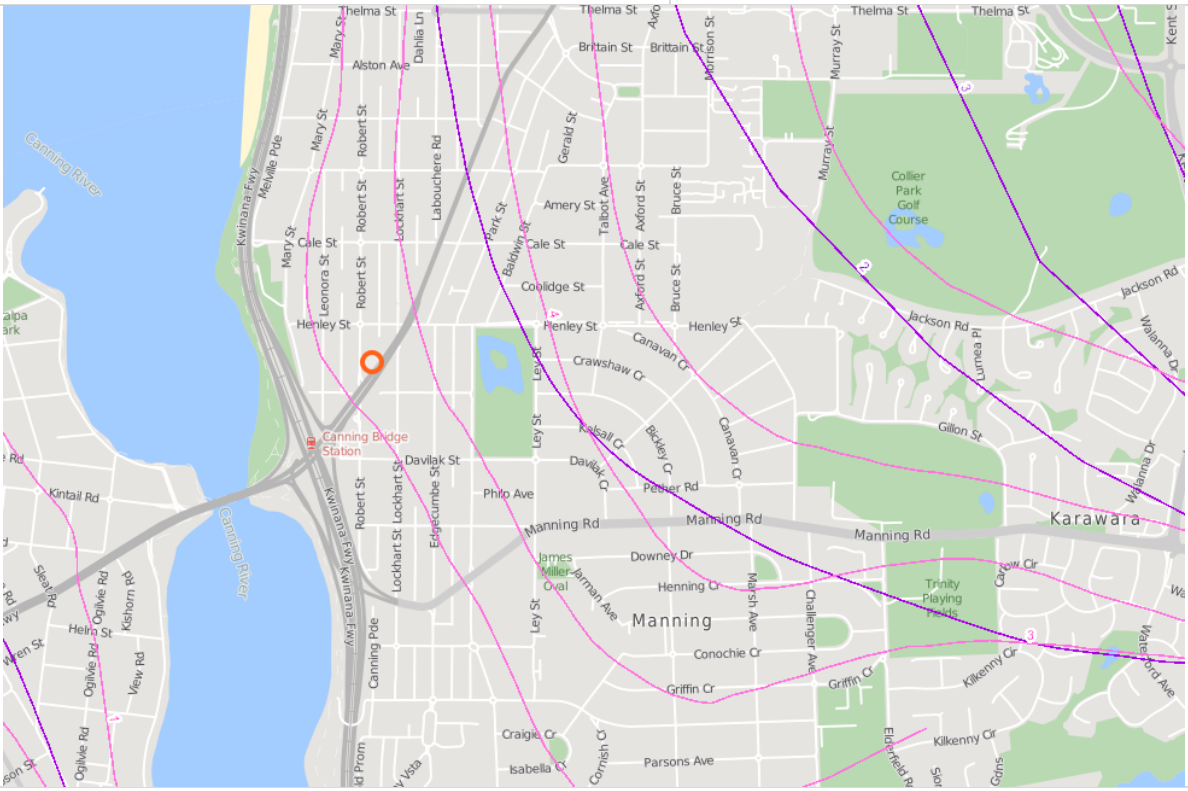


Figure 3. Water table information (Source: Perth Groundwater Atlas)

4.4 Acid Sulfate Soils (ASS) Review

Acid sulfate soils (ASS) maps 1:50 000 "Central Metropolitan Region Scheme acid sulfate soils" of Department of Environment and Conservation, WA revealed that site is in "no known risk of ASS occurring within 3 m of natural surface level (or deeper)".

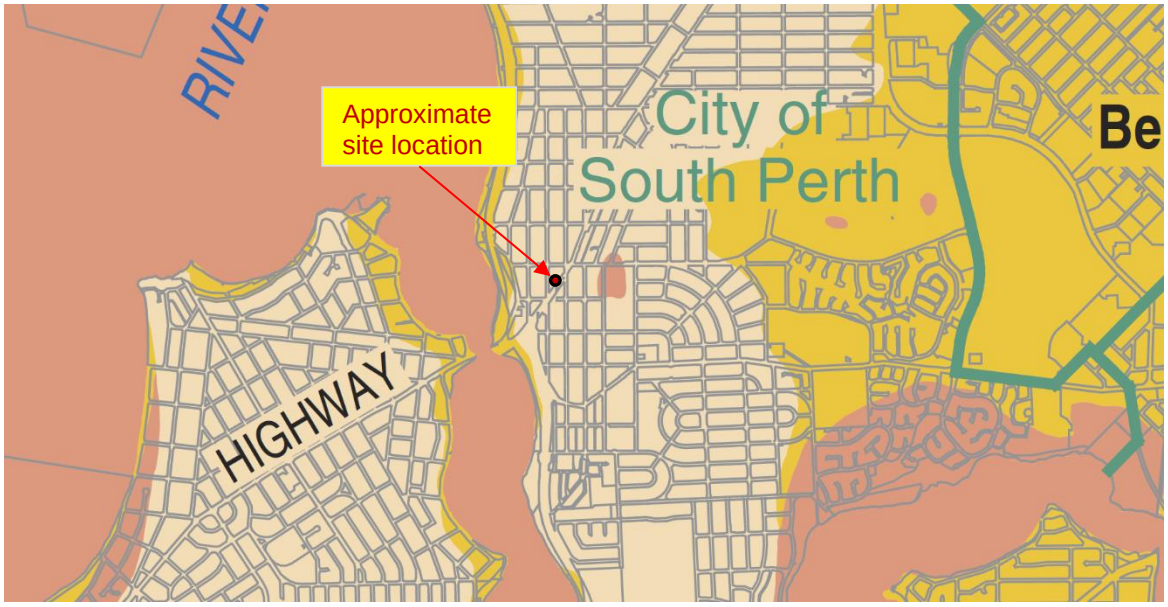


Figure 4. Acid Sulfate Soils (ASS) Maps
(Source: Central Metropolitan Region Scheme acid sulfate soils)

5.0 FIELD INVESTIGATION

5.1 General

The geotechnical site investigation was undertaken on 28 February and 5 March 2020 in the full-time presence of a geotechnical engineer from LG. The geotechnical site investigation comprised 3 CPT tests (CPTu1, CPT2, and CPTu3), 4 Hand Auger Test Holes (TH1 to TH4), 4 Perth Sand Penetrometer tests (PSP1 to PSP4) and 1 Field Permeability Test (FPT1).

Summary of the tests undertaken onsite is shown in Table 1 and test location plan is shown in Appendix A.

Table 1. Summary of Field Tests

Test ID	Test Type	Northing (m, GDA94)	Easting (m, GDA94)	RL * (m, AHD)	Groundwater Depth (m)	Termination Depth (m)
CPTu1	Cone Penetrometer Test	6 458 241	392 176	9.02	7.70	18.28 (refusal)
CPT2		6 458 226	392 151	9.55	-	25.46
CPTu3		6 458 204	392 143	9.19	7.80	25.48
TH1 & PSP1	Hand Auger Hole & PSP Test	6 458 247	392 175	-	NE	3.0
TH2 & PSP2		6 458 236	392 151	-	NE	3.0
TH3 & PSP3		6 458 226	392 154	-	NE	3.0
TH4 & PSP4		6 458 204	392 144	-	NE	3.0
FPT1	Field Permeability Tests	6 458 236	392 151	-	NE	0.3

Note: NE = Not Encountered. * RL of the test locations were not surveyed, however, CPT test location RLs were recorded from the rig's DGPS.

5.2 Test Hole Drilling

Four Test Holes (TH1 – TH4) were drilled across the site by using a hand auger. During test hole drilling, the spoil was stockpiled adjacent to the test location. The subsurface profiles exposed in the test holes were logged in accordance with AS1726 and were photographed to provide a visual record of subsurface conditions encountered. Following these activities, each test location was progressively backfilled in the reverse order of drilling works. During backfilling, test hole was compacted by a tamping rod.

Summary of the THs is shown in Table 1. Logs and photographs of the THs are presented in Appendix B and Appendix D, respectively.

5.3 Perth Sand Penetrometer Test

Four Perth Sand Penetrometer tests (PSP1 – PSP4) were conducted adjacent to each TH in accordance with AS 1289.6.3.3-1997. PSP test data were used to estimate the field density on the basis of correlations presented in Standard Australia HB 160-2006. All PSPs were terminated at 1.95 m below ground level. PSP test data are presented in Appendix B together with the TH logs.

It is observed from the PSP tests data (Table 2) that the site was in loose to very dense condition.

Table 2. Summary of PSP test data

PSP Location	PSP 1	PSP 2	PSP 3	PSP 4
Depth (mm)	**Number of Blows/300mm (Density Classification)**			
0 – 150	Seating	Seating	Seating	Seating
150 – 450	4 (L)	7 (MD)	4 (L)	4 (L)
450 – 750	6 (MD)	11 (D)	10 (D)	4 (L)
750 – 1050	9 (D)	12 (D)	11 (D)	8 (D)

PSP Location	PSP 1	PSP 2	PSP 3	PSP 4
Depth (mm)	**Number of Blows/300mm (Density Classification)**			
1050 – 1350	8 (D)	8 (D)	10 (D)	8 (D)
1350 – 1650	8 (D)	11 (D)	14 (D)	12 (D)
1650 – 1950	12 (D)	16 (VD)	18 (VD)	16 (VD)
Very Loose (VL) ≤ 2; Loose (L) 2 – 6; Medium Dense (MD) 6 – 8; Dense (D) 8 – 15; Very Dense (VD) > 15; R = Refusal				

5.4 Electric Friction Cone Penetrometer Test

The Electric Friction Cone Penetrometer Test (CPT) was undertaken by CPT West using a 22 tonne truck rig. The investigation was carried out in accordance with AS 1289.6.5.1-1999.

The CPT test generally interprets profile of soil, type, subsurface strength and stiffness parameters along the probing depth in accordance with Robertson et. al. (1986).

The results of the test are presented in Appendix C as plots of Cone Tip Resistance (qc), Sleeve Friction (fs), Friction Ratio (Rf = fs/qc x 100%) versus depth.

CPTu1 was met refusal at depth 18.28 m due to high tip resistance (over 90 MPa). The remaining 2 CPTs reached target depth of 25m (CPT2 to 25.46 m and CPTU3 to 25.48 m). After each probing, the probe hole was dipped by a weighted measuring tape with the intention to directly measure the depth to the groundwater table. Groundwater depth was recorded at between 7.7 m and 7.8 m.

5.5 Standpipe Piezometer Installation

One CPT probe, CPTu1, was converted into a standpipe piezometer by installing a 25 mm diameter perforated PVC pipe to a depth of 11.3 m from the existing ground level. Water depth measured post installation was 8.6 m.

5.6 Permeability Test

One field permeability test was conducted as per ASTM D5126 – 90 by using a Guelph Permeameter.

Guelph Permeameter is a constant head device that operates on the Mariotte siphon principle. The method involves measuring the steady-state rate of water recharge into unsaturated soil from a cylindrical well hole, in which a constant head of water is maintained.

Approximate test location (FPT1) is shown in Appendix A.

The results and the interpretation of the testing are presented in Appendix B and summarised in Table 3.

Table 3. Summary of Permeability Test Results

Test ID	Soil Description	Depth bgl* (m)	Estimated Permeability, k (m/day)
FPT 1	Sand (SP)	0.50	5.8

* bgl = Below Ground Level

The summary of permeability tests is:

- Permeability tests were undertaken within the top 500 mm depth.
- The soil profile encountered onsite and in test holes was generally sand.
- According to AS/NZS 1547-2012, sand material is described to have 'Soil Category 1' with an indicative permeability greater than 3 m/day.
- Coefficient of permeability is 5.8 m/day (or 6.7 x 10^{-5} m/s); Ref. Test Certificate at Appendix B.

6.0 LABORATORY TESTING

6.1 General

Laboratory testing was undertaken by a NATA accredited laboratory. The test standard applicable to each test is recorded on the laboratory testing certificates/reports. The scheduled laboratory testing included:

- 1 x Particle Size Distribution test (PSD, from 75 mm to 75 micron, AS1289.3.6.1)
- 20 x pH and PH_{FOX}, Acid Sulfate Soils (ASS) screening test
- 2 x Soil Aggressivity Test (pH, EC, SO_4, Cl).

As clayey soils were not encountered during the site investigation, no Atterberg Limits test was undertaken.

6.2 Geotechnical Laboratory Test Results

The geotechnical laboratory test results are summarised in Table 4. The laboratory test certificates/reports are included in Appendix E.

Table 4. Summary of Geotechnical Laboratory Test Results

Test Parameters	Sample ID: TH1 (1.5 – 3.0 m)
	Particle Size Distribution
Gravel (%)	0
Sand (%)	98
Fines < 75µm (%)	2

Particle Size Distribution testing was undertaken in accordance with Australian Standard, AS 1289.3.6.1. The soil matrix tested comprises approximately 0% gravel, 98% sand and 2% fines. According to AS1726-1993, the samples tested can be classified as Poorly Graded SAND (SP).

6.3 Acid Sulfate Soils (ASS) Test Results

The laboratory ASS test results are summarised in Table 5. The laboratory test certificates/reports are included in Appendix E.

Table 5. Summary of Preliminary ASS Laboratory Test Results

Sample ID	pH_F	pH_{FOX}	ΔpH	Reaction rate	SPOCAS %S	NAAS/AASS/ PASS
TH1_0.25 m	6.1	4.5	1.6	L	-	NASS
TH1_0.75 m	6.3	4.7	1.6	L	-	NASS
TH1_1.25 m	6.6	5.0	1.6	L	-	NASS
TH1_2.0 m	6.8	5.2	1.6	L	-	NASS
TH1_3.0 m	7.0	5.0	2.0	L	-	NASS
TH2_0.0 m	7.9	5.6	2.3	M	-	NASS
TH2_0.5 m	7.5	5.6	1.9	M	-	NASS
TH2_1.0 m	8.3	5.7	2.6	M	-	NASS
TH2_1.75 m	7.6	5.5	2.1	M	-	NASS
TH2_2.5 m	6.8	5.3	1.5	L	-	NASS
TH3_0.25 m	7.1	4.5	2.6	M	-	NASS
TH3_0.75 m	7.2	5.1	2.1	M	-	NASS
TH3_1.5 m	7.1	4.8	2.3	M	-	NASS
TH3_2.0 m	7.0	5.0	2.0	L	-	NASS
TH3_3.0 m	6.9	5.0	1.9	L	-	NASS
TH4_0.0 m	7.0	4.8	2.2	L	-	NASS
TH4_0.50 m	7.1	5.1	2.0	L	-	NASS
TH4_1.25 m	7.2	5.2	2.0	L	-	NASS
TH4_1.75 m	7.2	5.1	2.1	L	-	NASS
TH4_2.50 m	7.2	5.2	2.0	L	-	NASS

Note: M = Moderate, L= Slight, NASS = Non-Acid Sulfate soils, AASS = Actual Acid Sulfate soils, PASS = Potential Acid Sulfate soils. S = Net Acidity excluding ANC (Sulfur units).

A total of 20 samples collected from the 4 THs were submitted to the laboratory for field pH_F and pH_{FOX} screening test. Interpretation of results are presented below:

- pH_F results ranged between 6.1 and 8.3.
- pH_{FOX} results ranged between 4.5 and 5.7.
- None of the samples were assessed to have both pH_F and pH_{FOX} < 4.0, which suggest the samples tested are non-AASS.
- All samples were assessed to have both pH_F and pH_{FOX} > 4.0, which suggest non-ASS (=NASS).
- None of the samples have pH_F > 4.0 and pH_{FOX} < 4.0, which suggest the sample tested is non-PASS.
- The difference between the two measurements, ΔpH (= pH_F - pH_{FOX}), varies between 1.5 and 2.6. pH_{FOX} value at least one unit below pH_F may indicate PASS but depends on the initial and resultant pH. However, one unit change from higher end pH, e.g., 6.1 to 8.3 will not indicate PASS.
- pH_{FOX} value >5 indicates little net acidifying ability and neutral to alkaline pH.
- Slight (L) to Moderate (M) reaction of soil with peroxide is a less likely indication. Moderate (M) reaction may be caused due to the presence of organic matter and other clayey soil constituents.

6.3.1 Concluding Remarks on ASS Status

The foregoing discussions on the ASS field screening tests indicate that the presence of AASS and PASS at the tested locations of the site is less likely.

6.4 Soil Aggressivity Test Results

The aggressivity (chemical) test results are summarised in Table 6. The laboratory test certificates are included in Appendix E.

Chemical tests were undertaken to establish the corrosivity and aggressiveness of the soil at the site.

Exposure classification stated in Tables 6.4.2 (C) and 6.5.2 (C) of AS 2159-2009 'Piling - design and installation' for soils above and below groundwater table were used to assess the soils' aggressivity. These exposure classifications are applicable to all buried concrete and steel structures.

Table 6. Soil Aggressivity Assessment for the Soil Materials

Sample ID	pH	Sulphate in Soil (ppm)	Chloride in Soil (ppm)	Resistivity, ohm.cm	Exposure Classification for [considering Soil Conditions B*]	
					Concrete	Steel
TH1 (0.75m)	6.4	<100	<10	166,600	Non-aggressive	Non-aggressive
TH4 (2.5m)	7.0	<100	<10	333,300	Non-aggressive	Non-aggressive

**Soil conditions B = low permeability soils or all soils above groundwater

Based on the measured pH, chloride, sulphate and resistivity values, the soil exposure classification for both concrete and steel is '**non-aggressive**'.

7.0 ENGINEERING CONSIDERATIONS AND RECOMMENDATIONS

7.1 Inferred Subsurface Conditions

Subsurface conditions inferred from the site investigation can be described as follows:

- **Topsoil, SAND (SP)** – fine to medium grained, brown, grey, dark grey-brown, dry to slightly moist, loose, with grass, trace organics, extended from surface to a depth of around 0.2 m, overlying,
- **SAND (SP)** – fine to medium grained, grey, light grey (white), brown, yellow and light yellow, dry to slightly moist, extended to the maximum investigated depth 25.48 m. In this unit, following generalised densities were assessed:
    - 0.2 – 1 m: loose,
    - 1 – 4.7 m: medium dense,
    - 4.7 – 25.5 m: dense to very dense.

7.2 Groundwater and Dewatering

Groundwater depth recorded on 5 March 2020 during CPT testing is shown in Table 7.

Table 7. Summary of Groundwater Depth

Test Location	Depth (m bgl)	RL (m AHD)
	Date: 5/03/20	(approx.)
CPTu1	7.70	1.32
CPTu3	7.80	1.39

Based on the recorded data, average groundwater depth can be considered as 1.4 m RL.

Ground surface elevation of the site varies between 9.0 m AHD and 10.3 m AHD and historical highest groundwater table was at 2.4 m AHD as per the Perth Groundwater Atlas. That indicates that estimated highest groundwater depth varies between 6.6 m and 7.9 m below the ground surface.

Lower basement floor level of the proposed building was unknown during preparation of this report. We recommend that a sand cover of 1 m above the Ground Water Table (GWT) should be left in the design process to facilitate a clean construction environment, a stable raft and pad foundation construction.

If the basement Bulk Excavation Level (BEL) leaves a sand cover of less than 1m above the GWT, dewatering will be required to facilitate clean excavation, compaction for foundation bases and subsequent construction.

7.3 Geotechnical Design Parameters

Geotechnical design parameters for the site were inferred on the basis of the site investigation data and are presented in Table 8 below.

Table 8. Inferred Geotechnical Design Parameters for the Current Site Conditions

Depth (m, bgl)	Layer Description	Soil Parameters					k_s (MN/m^3)	k (m/s)
		ϕ' (deg.)	c_u (kN/m^2)	γ (kN/m^3)	E' (MPa)	ν'		
0 – 1	Sand (SP) Loose	28	-	18	-	0.3	-	6.7 x 10^{-5}
1 – 4.7	Sand (SP) Medium dense	34	-	20	25	0.3	5	6.7 x 10^{-5}
4.7 – 25.5	Sand (SP) Dense to very dense	38	-	20	90	0.3	20	6.7 x 10^{-5}

Notes: ϕ' = Effective friction angle, c_u = Undrained shear strength, γ = Bulk density, E' = Drained Elastic Modulus, ν' = Poisson's Ratio, k_s = Modulus of vertical subgrade reaction, k = Coefficient of Permeability.

7.4 Geotechnical Design Parameters for Retaining Structures

Earth pressure parameters for the design of retaining structures are presented in Table 9. These parameters should be considered as preliminary.

Table 9. Geotechnical Design Parameters for Retaining Structures

Material type	γ (kN/m^3)	ϕ' (degrees),	K_0	Wall friction, $\delta = 0^o$	
				K_a	K_p
Loose to medium dense in situ sand	17	30	0.50	0.33	3.00
Dense Sand or Compacted Sand Fill	18	34	0.44	0.28	3.54

Notes: γ = Bulk unit weight, ϕ'= Effective friction angle, K_0 = Coefficient of earth pressure at rest, K_a = Coefficient of drained active earth pressure, K_p = Coefficient of drained passive earth pressure.

7.5 Site Classification

Based on the subsurface and surrounding site conditions observed during the field investigation, the site was classified as "**Class P**" in accordance with AS 2870-2011 "Residential Slabs and Footings".

The site classification 'Class P' was based on the following basis:

- 'Loose sand' of the site within the surficial 1 m depth is considered to be an unstable foundation ground.
- Excessive foundation settlement may occur due to loading on the loose and compressible foundation ground.
- Presence of potential demolition debris from the existing structures and the land uses.

Site Classification Upgrade

Provided the earthworks and compaction are completed as per the recommendations presented in Section 7.7.3, the site can be reclassified to **"Class A"** in accordance with the definitions provided in the Australian Standard AS 2870 -2011 "Residential Slabs and Footings - Construction".

Class "A" sites will experience slight or no ground surface movement due to soil wetting and drying cycles associated with seasonal changes in available moisture.

7.6 Earthquake Design Factor

Australian Standard AS1170.4-2007 Structural design actions Part 4 "Earthquake actions in Australia" is recommended for earthquake consideration. AS1170.4-2007 outlines the design criteria required for a structure in consideration of the risk of being subjected to earthquake loads. Earthquake design factors are summarised in Table 10.

Table 10. Earthquake Design Factors

Factor/Class	Value/Name	Ref. AS1170.4- 2007
Hazard Factor (z) (Peak Ground Acceleration, g for 500 years return period)	0.09	Figure3.2 (D)
Site sub-soil class	**Class C_e** – Shallow Soil	Section 4 Clause 4.1

7.7 Earthworks

7.7.1 Suitability of Excavated Materials for use as Fill

In situ sands are considered to be suitable for reuse as structural fill material.

7.7.2 Structural Fill

Suitable materials for structural fill shall be a clean sand fill. The fill material at compaction should comprise sand that is free from oversized material (i.e. material > 75 mm in any dimension), contains less than 5% fines (material passing 0.075 mm sieve), and free from foreign material, organic material or other deleterious material. It should also be free from industrial waste, solid waste, or construction and demolition debris.

7.7.3 Site Preparation

Earthworks should be carried out in general accordance with the Australian Standard AS 3798-2007 “Guidelines on Earthworks for Commercial and Residential Developments”. The following are general guidelines to be followed during preparation of the site areas within the proposed development footprints:

- Remove and grub all root masses and tree stumps, if any.
- Strip top soil, approximately 200 mm, and any uncontrolled fill, cobbles and boulders, paved materials, demolition debris, green waste, weeds/grass, organic matter or other deleterious material, if any and stockpile them separately.

<u>Considering Basement Construction:</u>

- Specialist D&C piling contractor will construct the piled retention system, surrounding the building area.
- Undertake staged excavation, each stage approximately 1.5 m deep depending on site subsurface and surrounding conditions, and then construct infill shotcrete wall. Advice from a geotechnical engineer should be sought to determine the lift depth.
- Excavate up to the Bulk Excavation Level (BEL) and construct shotcrete wall up to the lower basement floor level.
- Excavate locally up to the required depths, for strip and pad/raft foundations, at BEL, allowing a maximum dry slope angle of 1V: 1H for less than 1m deep cut. Allow 1V:1.5H for up to 2 m deep cut.
- Compact the exposed strip and pad foundations’ bases, with required number of passes of a suitable hand-held compactor to a dense state, i.e., to 95% of MMDD in accordance with AS1289.5.2.1. Add moisture as needed during the compaction. Compaction must not be attempted if the exposed ground is saturated or groundwater is at excavation level.

- Care will need to be taken when compacting in the vicinity of existing structures to avoid damage from excessive vibrations.
- A dilapidation survey monitoring plan is recommended to prepare if neighbourhood properties (building, garage, road, electrical poles etc) are located within 2.5 m from the basement retention wall.

It is recommended that a geotechnical engineer supervises the site activities to ensure that all demolition debris have been adequately removed from the area and that site is safely excavated and adequately backfilled and compacted as per the procedures described above.

7.8 Bearing Capacity

7.8.1 Strip and Pad Foundation

The proposed building structure is proposed to be supported on conventional pad, strip and raft footings founded at the Bulk Excavation Level (BEL) of the basement floor. As discussed in Section 7.7.3, all footing bases must be compacted to dense state, to a minimum depth of 1 m below the footing excavation level.

It should be ensured that footings are founded on compacted sand layer. In such conditions, footings may be designed on the basis of the allowable bearing pressures as given in Table 11.

Table 11. Allowable Bearing Pressures for Basement Level Spread & Strip Footings

Founding Layer Description	Footing Type	Allowable Bearing Pressure (kPa)	Approximate Settlement (mm)
Dense Sand (SP/SM)	Pad and Raft	450	20
	Strip	300	15

Considering the proposed depth of BEL, the stress relief will be partially balanced by the total load applied by the proposed structure. Long term settlements are therefore anticipated to be negligible. Localised settlements will take place directly beneath individual footing as a result of recompression of the founding stratum during the construction of the proposed building structure. It is anticipated that the majority of the settlements will take place relatively quickly upon the application of the structural load.

Total settlements were estimated to be approximately 0.5% of the footing width for pad footings and approximately 1.0% of the footing width for strip footings. Differential settlements between adjacent isolated footings subjected to similar loadings are anticipated to be approximately half of the total settlement value. It should be noted that where isolated footings are subject to significantly different loadings, differential settlement between these footings may exceed acceptable limits. Settlements should be checked in detail where such instances arise.

We recommend a qualified engineer be on site to inspect the footing excavations and base ground preparation prior to the placement of concrete to ensure that the founding conditions are consistent with the design recommendations. If the design recommendations are not met it may be necessary to either increase the founding depth of the footings or alternatively increase the plan area of the footings.

7.8.2 Pile Foundation

The geotechnical strength reduction factor, ϕ_g, can be considered as 0.50 in accordance with AS2159. Geotechnical parameters for pile foundation design are preliminary estimated for the encountered subsoil materials and presented in Table 12 below.

Table 12. Ultimate Bearing Capacities for Piles

Foundation Material	End Bearing Capacity, f_{bu} (kPa)	Skin Friction, f_{su} (kPa)
Sand (SP) loose to medium dense	1,000	25
Sand (SP) Dense to very dense	5,000	90

7.9 California Bearing Ratio (CBR) for Roads & Carpark's Subgrade

The subgrade of the proposed carpark, internal roads, hardstand and driveway areas shall be prepared as per the general guidelines set out in Section 7.7.3 and compacted to a density ratio of 98% MMDD.
Based on the sandy material, a design CBR value of 12% can be considered for this project.

7.10 Excavatability

The loose to dense state of the in-situ sandy soils suggests that the materials should be excavatable with a standard earthmoving equipment (e.g., 20 to 30 tonne excavator).

7.11 Cut and Fill Batters

Temporary excavation up to 1 m depth can be conducted with a maximum dry slope angle of 1V: 2H. Cut and fill batters above groundwater table will generally be stable at 1V: 2H. Intermediate benches have to be created if excavation is deeper than 1m. However, batters constructed at 1V: 3H will enable re-establishment of vegetation and be less prone to damage from wetting, drying and erosion.

7.12 Stormwater Drainage

The site is underlain by the Sand. According to AS/NZS 1547-2012, sandy material is described to have 'Soil Category 1'. Groundwater table was at around 1.4 m AHD. Coefficient of permeability was estimated to be 5.8 m/day. Institute of Municipal Engineering Australia WA Division (1998) recommended that finished site levels be maintained at least 1.2 m above the annual average maximum groundwater level.

The recommended measure for the disposal of stormwater is onsite through soakwells or through to the basement stormwater management network. The volume of expected stormwater (worst case scenario) is to be estimated and designed by a suitably qualified Civil Engineering professional considering the above-mentioned soil category and infiltration rate.

7.13 Additional Site Investigation Recommendation

We recommend undertaking an additional site investigation which may comprise a series of borehole drilling that will assist detail design of soldier pile retention wall for the basements.

8.0 LIMITATION OF USE

The ground is a product of continuing natural and man-made processes and therefore exhibits characteristics and properties which vary from place to place and can change with time. Geotechnical site investigation involves gathering and assimilating limited facts about these characteristics and properties in order to better understand or predict the behaviour of the ground at a particular site under certain conditions.

This site investigation has been carried out by inspection, using a limited amount of CPT, pit excavation, sampling, testing or other means of investigation. Achieving a full coverage of the site to ensure all variations is not practical and is seldom done due to cost constraints as well as the impracticality.

It should be noted that the subsurface conditions encountered by the limited number of field tests as part of this geotechnical site investigation represents the ground conditions at the locations where the samples were taken and where tests have been undertaken and as such are an extremely small proportion of the site to be developed.

The facts reported in this document are directly relevant only to the ground at the place where, and time when, the investigation was carried out and are believed to be reported accurately. Given the limited number of field and laboratory testing carried out with respect to the overall site area, variations between investigation locations are likely and ground conditions different to those presented in this report may be present within the subject site area. The risk associated with this variability and the impact it will have on the proposed development should be carefully considered.

The level of geotechnical investigation that has been completed to date is considered appropriate for the project objectives. If the above mentioned client, its subcontractors, agents or employees use this factual information for any other purpose for which it was not intended, then the client, its subcontractors, agents or employees does so at their own risk and Local Geotechnics will not and cannot accept liability in respect of the advice, whether under law of contract, tort or otherwise.

Any interpretation or recommendation given in this report is based on judgement and experience and not on greater knowledge of the facts reported. Local Geotechnics does not represent that the information or interpretation contained in this report addresses completely the existing features, subsurface conditions or ground behaviour at the subject site.

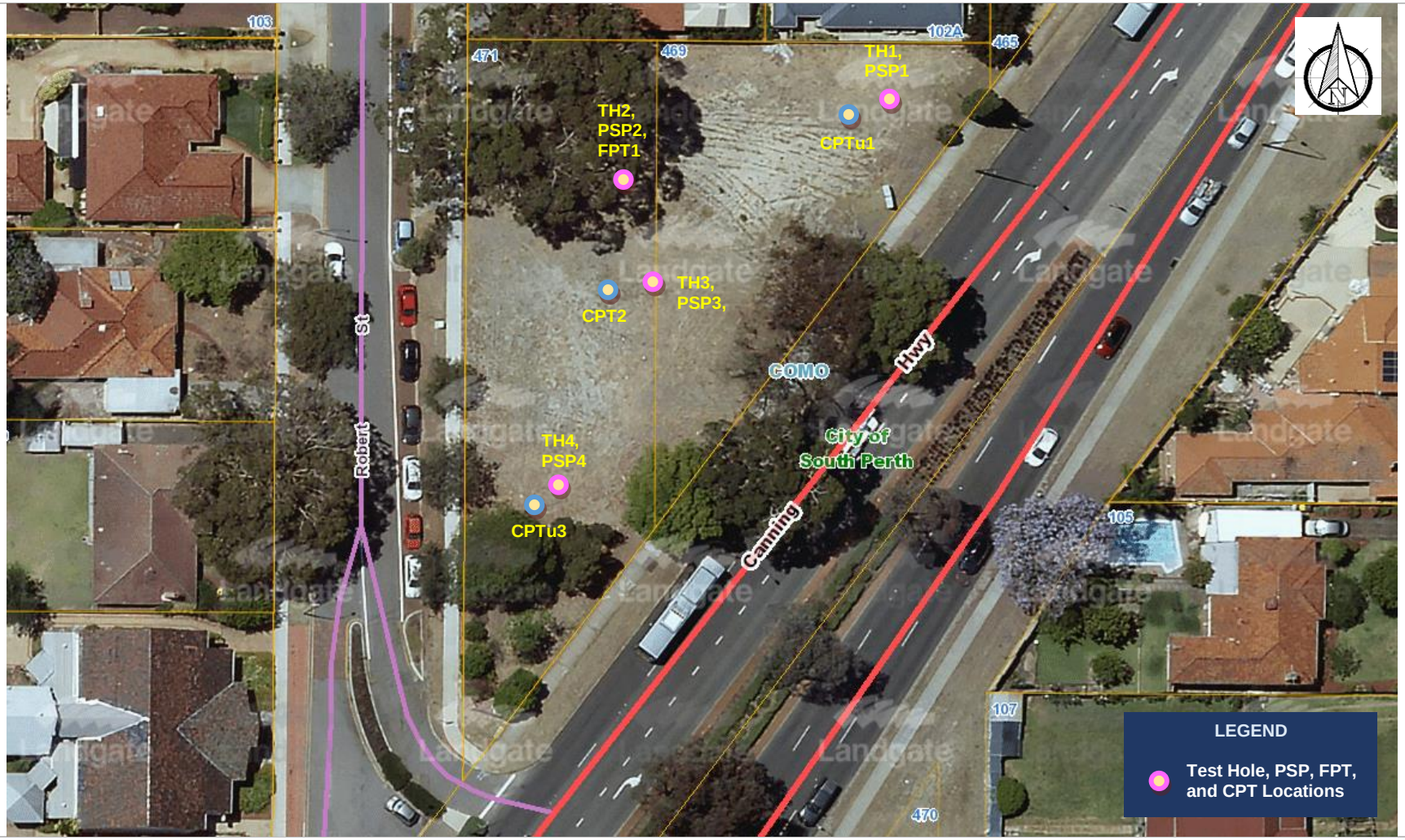
9.0 REFERENCES

- Australian Standard AS1170.4-2007, “Earthquake Actions in Australia”.
- Australian/New Zealand Standard AS/NZS 1547-2012, “On-site Domestic Wastewater Management”.
- Australian Standard AS 1726-1993 *"Geotechnical Site Investigations".*
- Australian Standard AS 2870-2011, *"Residential Slabs and Footings".*
- Australian Standard AS 3798-2007, *"Guidelines on Earthworks for Commercial and Residential Developments".*
- Bowles JE (2013), Foundation Analysis and Design, 5th edition, McGraw Hill London
- CSIRO publication 2003 “Guide to Home Owners on Foundation Maintenance and Footing Performance” in Building Technology File Number 18.
- Geological Survey of Western Australia (1986). 1:50,000 Environmental Geology Series Map, Fremantle Sheet No 2033 I and IV.
- Institute of Municipal Engineering Australia, WA Division Inc (1998), Local Government Guidelines for Subdivisional Development
- Perth Groundwater Atlas online version, https://maps.water.wa.gov.au/#/webmap/gwm, Department of Environment, WA (browsed 5 March 2020).
- Robertson. P.K., Campanella, R.G., Gillespie, D., and Greig, J., (1986), “Use of Piezometer Cone data”, In-Situ’86 Use of In-situ testing in Geotechnical Engineering, GSP 6, ASCE, Reston, VA, Specialty Publication, pp 1263-1280.
- Standards Australia, Hand Book HB 160-2006 "Soil Testing".

APPENDIX A

SITE SKETCH

LOCAL GEOTECHNICS



Site Sketch : Test Hole, PSP, FPT, and CPT Locations

Reference	LG0502020GI
Client	Dem
Project	Geotechnical Investigation Location: 469 & 471 Canning Highway, Como WA

LOCAL GEOTECHNICS

Unit 12, 8 Production Road Canning Vale WA 6155
PO Box 5050, Canning Vale South WA 6155
Phone: 08 9457 3517
E-mail: admin@localgeotechnics.com.au
Web: www.localgeotechnics.com.au

APPENDIX B

TEST HOLE LOGS
PERMEABILITY & PSP TEST CERTIFICATE

LOCAL GEOTECHNICS

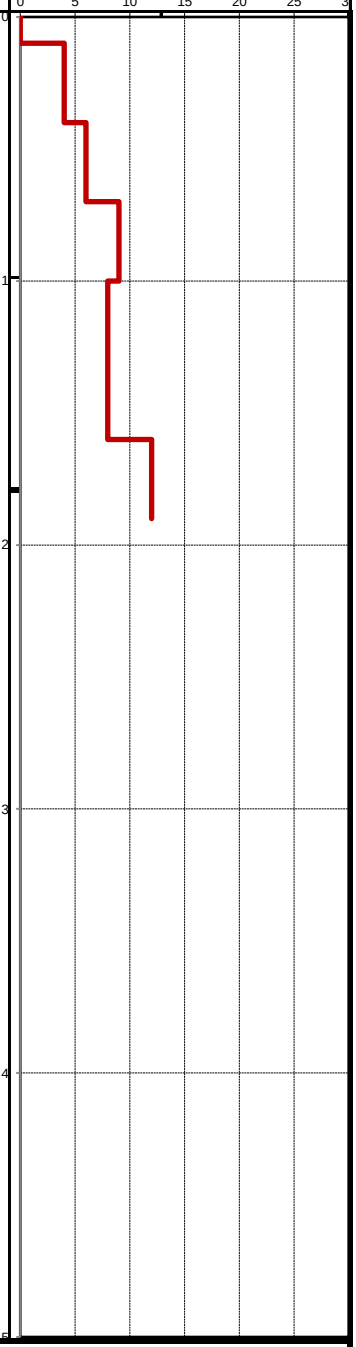
ENGINEERING LOG

RESULT OF TEST HOLES/PITS

LOCAL GEOTECHNICS
ABN:61 737 984 867
12/8 Production Road, Canning Vale WA 6155
PO Box 5050 Canning Vale South WA 6155
admin@localgeotechnics.com.au

Reference	: **LG0502020GI**	Test Pit/BH No.:	**01**
Client	: **Dem**	Date Excavated:	**28-Feb-2020**
Project	: **Geotechnical Investigation**	Date completed:	**28-Feb-2020**
Location	: **469 & 471 Canning Highway, Como WA**	Equipment Type:	**Hand Auger**
GPS Zone 50	: **Northing: 6 458 247** **Easting: 392 175**	Water Table:	**Not Encountered**

Depth (m)	RL (m)	Method	Penetration resistance	Sampling Type	Graphic Log	Classification Symbol	Description of Soil Strata	Additional observations
0.0						SP	**TOPSOIL, SAND-** fine to medium grained, brown, slightly moist, loose, with grass, organics	
0.2						SP	**SAND-** fine to medium grained, light brown, slightly moist, loose	
0.8						SP	**SAND-** fine to medium grained, light yellow, slightly moist, dense	
1.0								
1.5							colour change to yellow at 1.5 m	
2.0								
3.0							**Terminated at the target depth of 3.0 m**	
4.0								
5.0								



Notes:

Sampling Type :
B - Bulk/Disturbed Sample,
UD - Undisturbed Sample

Method:
HA - Hand Auger
E - Excavator
BH - Backhoe Bucket

Moisture:
D - Dry
M - Moist
W - Wet

Logged : AB
Checked: AR

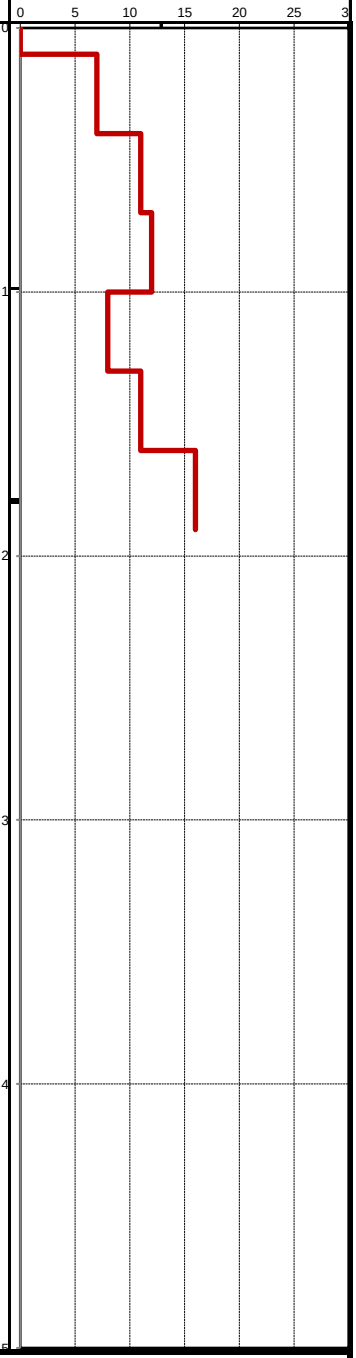
ENGINEERING LOG

RESULT OF TEST HOLES/PITS

LOCAL GEOTECHNICS
ABN:61 737 984 867
12/8 Production Road, Canning Vale WA 6155
PO Box 5050 Canning Vale South WA 6155
admin@localgeotechnics.com.au

Reference	: **LG0502020GI**	Test Pit/BH No.:	**02**
Client	: **Dem**	Date Excavated:	**28-Feb-2020**
Project	: **Geotechnical Investigation**	Date completed:	**28-Feb-2020**
Location	: **469 & 471 Canning Highway, Como WA**	Equipment Type:	**Hand Auger**
GPS Zone 50	: **Northing: 6 458 236** **Easting: 392 151**	Water Table:	**Not Encountered**

Depth (m)	RL (m)	Method	Penetration resistance	Sampling Type	Graphic Log	Classification Symbol	Description of Soil Strata	Additional observations
0.0						SP	**TOPSOIL, SAND-** fine to medium grained, brown-grey, slightly moist, loose, with grass, organics	
0.2						SP	**SAND-** fine to medium grained, light grey-brown, slightly moist, medium dense to dense	
0.8						SP	**SAND-** fine to medium grained, light yellow, slightly moist, dense	
1.0								
1.5							colour change to yellow at 1.5 m	
2.0								
3.0							**Terminated at the target depth of 3.0 m**	
4.0								
5.0								



Notes:

Sampling Type :
B - Bulk/Disturbed Sample,
UD - Undisturbed Sample

Method:
HA - Hand Auger
E - Excavator
BH - Backhoe Bucket

Moisture:
D - Dry
M - Moist
W - Wet

Logged : AB
Checked: AR

LOCAL GEOTECHNICS
ABN:61 737 984 867
12/8 Production Road, Canning Vale WA 6155
PO Box 5050 Canning Vale South WA 6155
admin@localgeotechnics.com.au

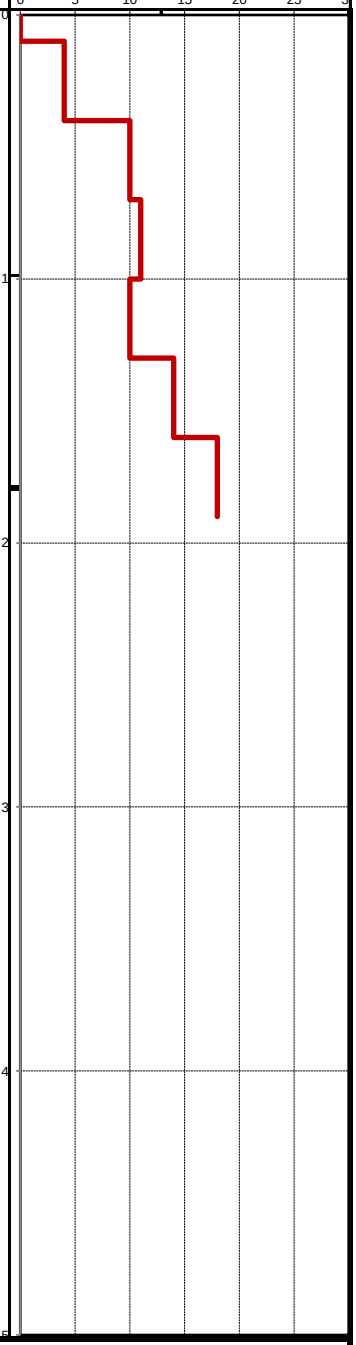
ENGINEERING LOG

RESULT OF TEST HOLES/PITS

Reference	: **LG0502020GI**	Test Pit/BH No.:	**03**
Client	: **Dem**	Date Excavated:	**28-Feb-2020**
Project	: **Geotechnical Investigation**	Date completed:	**28-Feb-2020**
Location	: **469 & 471 Canning Highway, Como WA**	Equipment Type:	**Hand Auger**
GPS Zone 50	: **Northing: 6 458 226** **Easting: 392 154**	Water Table:	**Not Encountered**

Depth (m)	RL (m)	Method	Penetration resistance	Sampling Type	Graphic Log	Classification Symbol	Description of Soil Strata	Additional observations
0.0						SP	**TOPSOIL, SAND-** fine to medium grained, dark grey-brown, dry, loose, with grass, organics	
0.2						SP	**SAND-** fine to medium grained, grey, slightly moist, loose, with organics	
0.4						SP	**SAND-** fine to medium grained, light grey, slightly moist, dense	
0.8							colour change to light yellow at 0.8 m	
1.0								
2.0								
3.0							**Terminated at the target depth of 3.0 m**	
4.0								
5.0								

Perth Sand Penetrometer Test (Blows/300mm)



Notes:

Sampling Type :
B - Bulk/Disturbed Sample,
UD - Undisturbed Sample

Method:
HA - Hand Auger
E - Excavator
BH - Backhoe Bucket

Moisture:
D - Dry
M - Moist
W - Wet

Logged : AB
Checked: AR

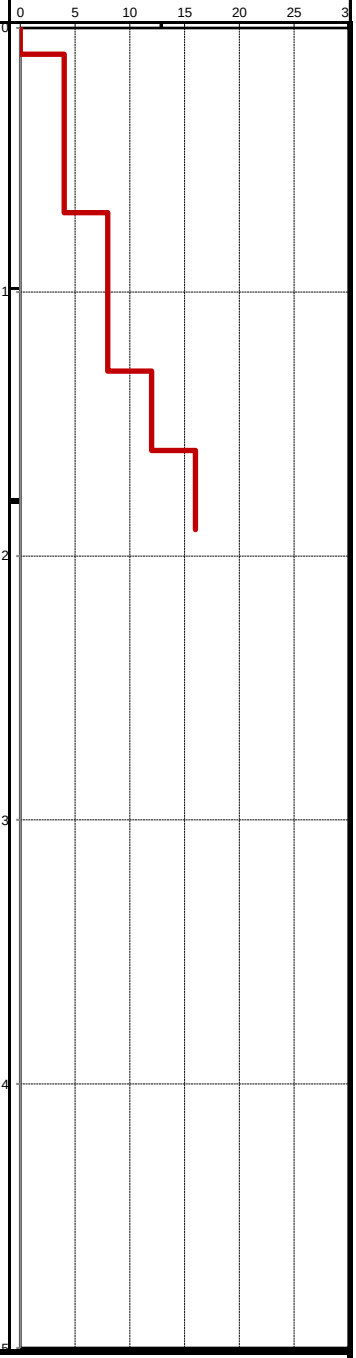
ENGINEERING LOG

RESULT OF TEST HOLES/PITS

LOCAL GEOTECHNICS
ABN:61 737 984 867
12/8 Production Road, Canning Vale WA 6155
PO Box 5050 Canning Vale South WA 6155
admin@localgeotechnics.com.au

Reference	: **LG0502020GI**	Test Pit/BH No.:	**04**
Client	: **Dem**	Date Excavated:	**28-Feb-2020**
Project	: **Geotechnical Investigation**	Date completed:	**28-Feb-2020**
Location	: **469 & 471 Canning Highway, Como WA**	Equipment Type:	**Hand Auger**
GPS Zone 50	: **Northing: 6 458 204** **Easting: 392 144**	Water Table:	**Not Encountered**

Depth (m)	RL (m)	Method	Penetration resistance	Sampling Type	Graphic Log	Classification Symbol	Description of Soil Strata	Additional observations
0.0						SP	**TOPSOIL, SAND-** fine to medium grained, brown, slightly moist, loose, with grass, with organics	
0.2						SP	**SAND-** fine to medium grained, grey, slightly moist, loose colour change to light grey at 0.4 m	
0.4								
1.0								
2.0								
3.0							**Terminated at the target depth of 3.0 m**	
4.0								
5.0								



Notes:

Sampling Type :
B - Bulk/Disturbed Sample,
UD - Undisturbed Sample

Method:
HA - Hand Auger
E - Excavator
BH - Backhoe Bucket

Moisture:
D - Dry
M - Moist
W - Wet

Logged : AB
Checked: AR

LOCAL GEOTECHNICS

ABN: 61 737 984 867
PO Box 5050
Canning Vale South, WA 6155

PERTH SAND PENETROMETER (PSP) TEST CERTIFICATES

(AS 1289.6.3.2)

Density Correlation - Table 6.4.6.2 HB 160-2006

Reference	**LG0502020GI**	Test ID	**01 to 04**
Client	**Dem**	Date Tested	**28/02/2020**
Project	**Geotechnical Investigation**	Tested by	**M Seet**
Site	**469 & 471 Canning Highway, Como WA**	Checked by	**A Rahman**

PSP No.	PSP 1		PSP 2		PSP 3		PSP 4	
Depth below ground level (mm)	Penetration Resistance - Blows/300mm | Density Classification							
0 – 150	Seating		Seating		Seating		Seating	
150 – 450	4	L	7	MD	4	L	4	L
450 – 750	6	MD	11	D	10	D	4	L
750 – 1050	9	D	12	D	11	D	8	D
1050 – 1350	8	D	8	D	10	D	8	D
1350 – 1650	8	D	11	D	14	D	12	D
1650 – 1950	12	D	16	VD	18	VD	16	VD

Remarks:

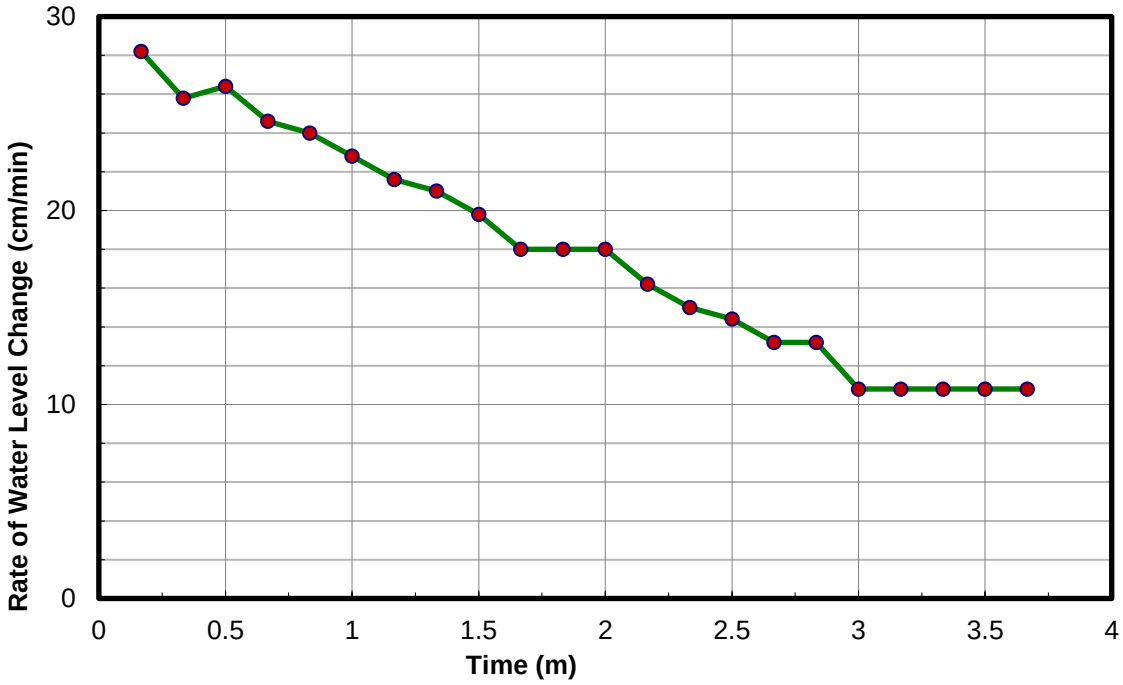
Density Correlation - Table 6.4.6.2 HB 160-2006

Very Loose (VL)	Loose (L)	Medium Dense (MD)	Dense (D)	Very Dense (VD)
≤ 2	2 – 6	6 – 8	8 – 15	> 15

INFILTRATION TEST CERTIFICATES (ASTM D 5126-90)

ABN: 61 737 984 867
PO Box 5050 Canning Vale South
WA 6155
admin@localgeotechnics.com.au

Reference	LG0502020GI			Test ID	FPT1
Client	Dem			Date Tested	28-Feb-20
Project	Geotechnial Investigation			Date Completed	28-Feb-20
Location	469 & 471 Canning Highway, Como WA			Instrument Type	Guelph Permeameter
Position	Northing:	6 458 236	Easting: 50 392 151	Tested by	A Bara



Notes: Test was conducted at a depth of 0.5 m from the existing surface level

Water Hydraulic conductivity K_{fs}: **6.7E-05** **m/sec**

5.8E+00 **m/day**

Signatory: _____ Date: 28/02/2020

Dr. Harun Meer

APPENDIX C

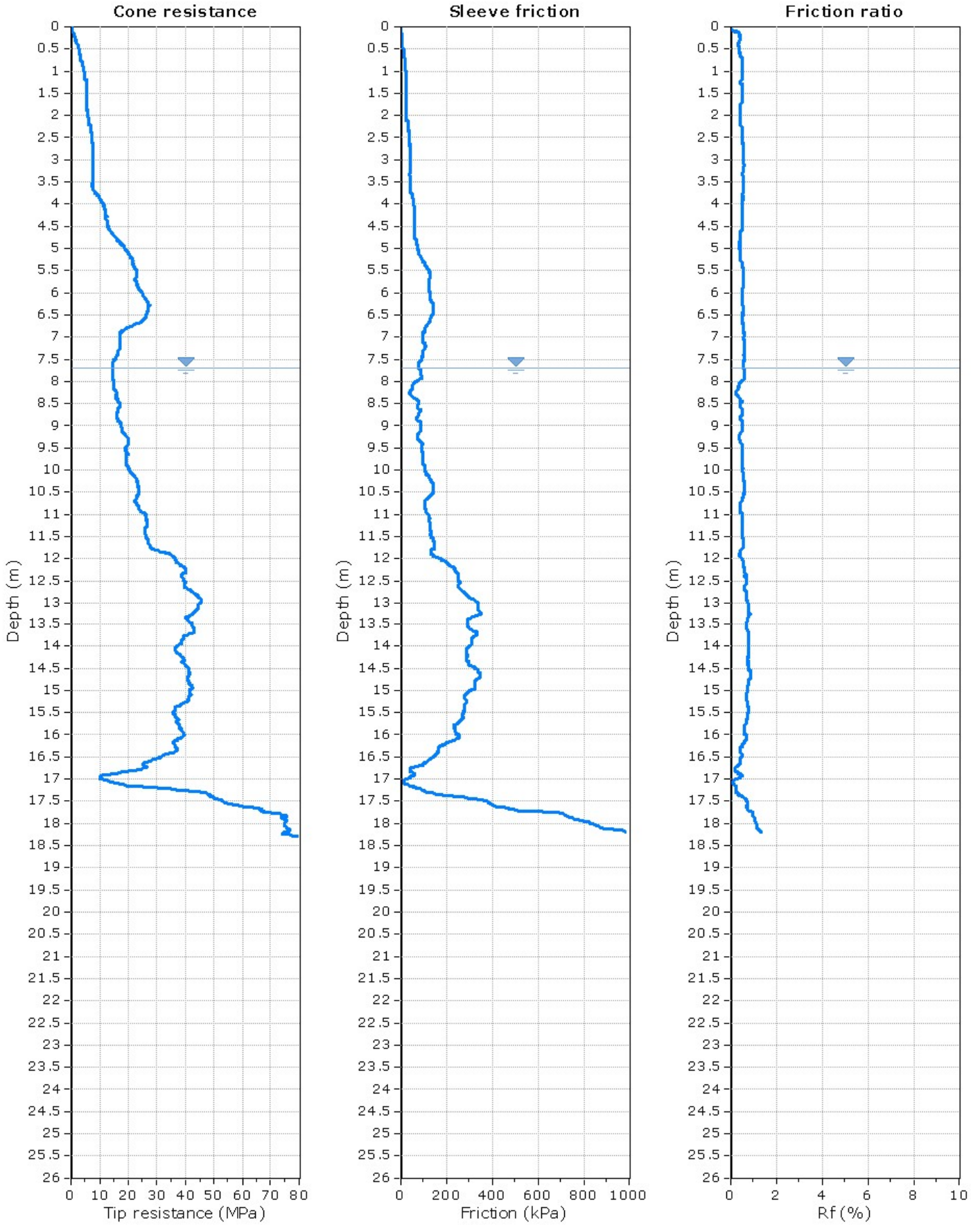
CPT TRACES & INTERPRETATION

LOCAL GEOTECHNICS

info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045

CPTu 1
Total depth: 18.28 m, Date: 5/03/2020
Surface Elevation: 9.02 m
Coords: X:392176.39, Y:6458241.66
Cone Operator: Andrew

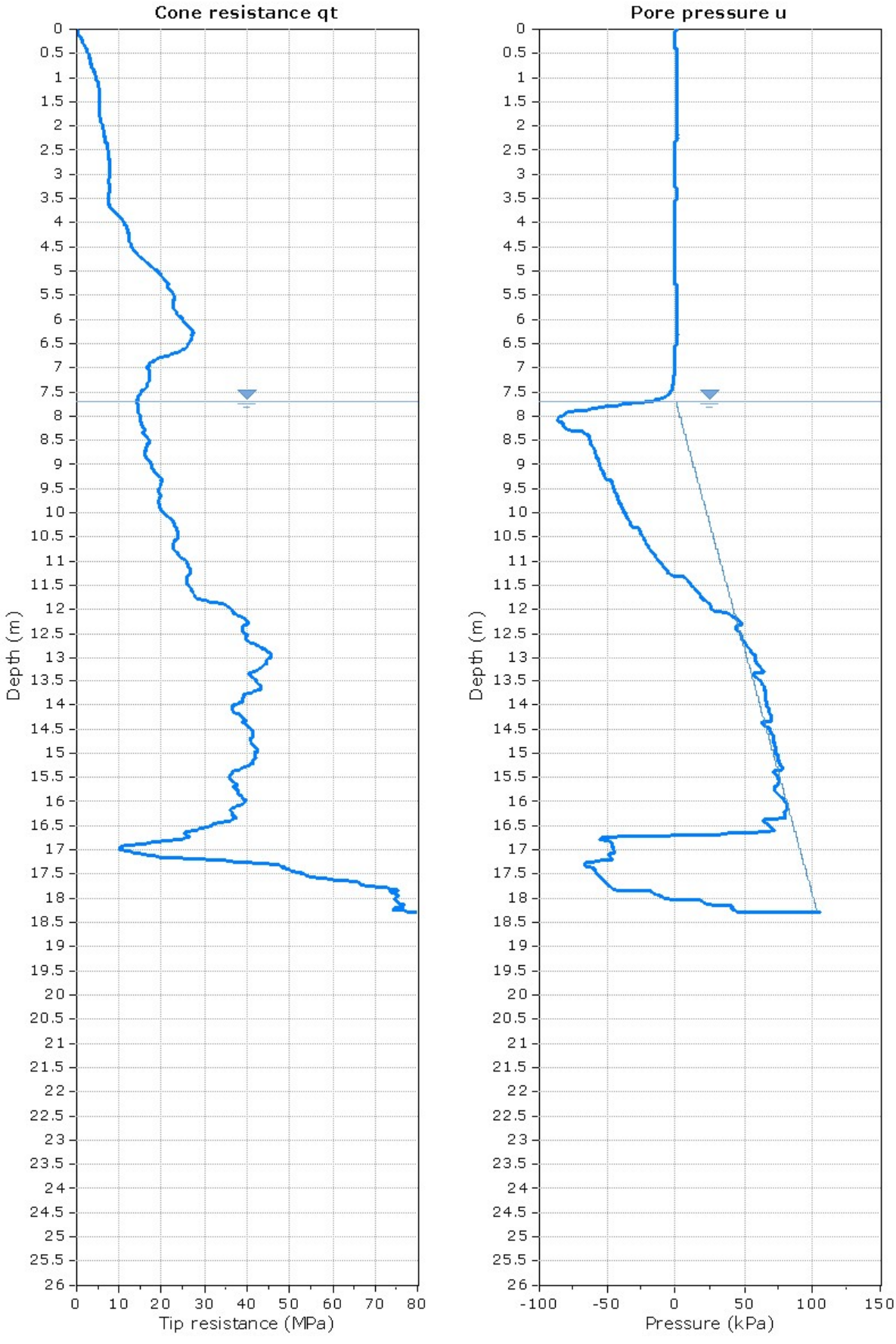
Project: **469 & 471 Canning Highway (Project No.: LG0502020GI)**
Location: **Como**



info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045

CPTu 1
Total depth: 18.28 m, Date: 5/03/2020
Surface Elevation: 9.02 m
Coords: X:392176.39, Y:6458241.66
Cone Operator: Andrew

Project: **469 & 471 Canning Highway (Project No.: LG0502020GI)**
Location: **Como**

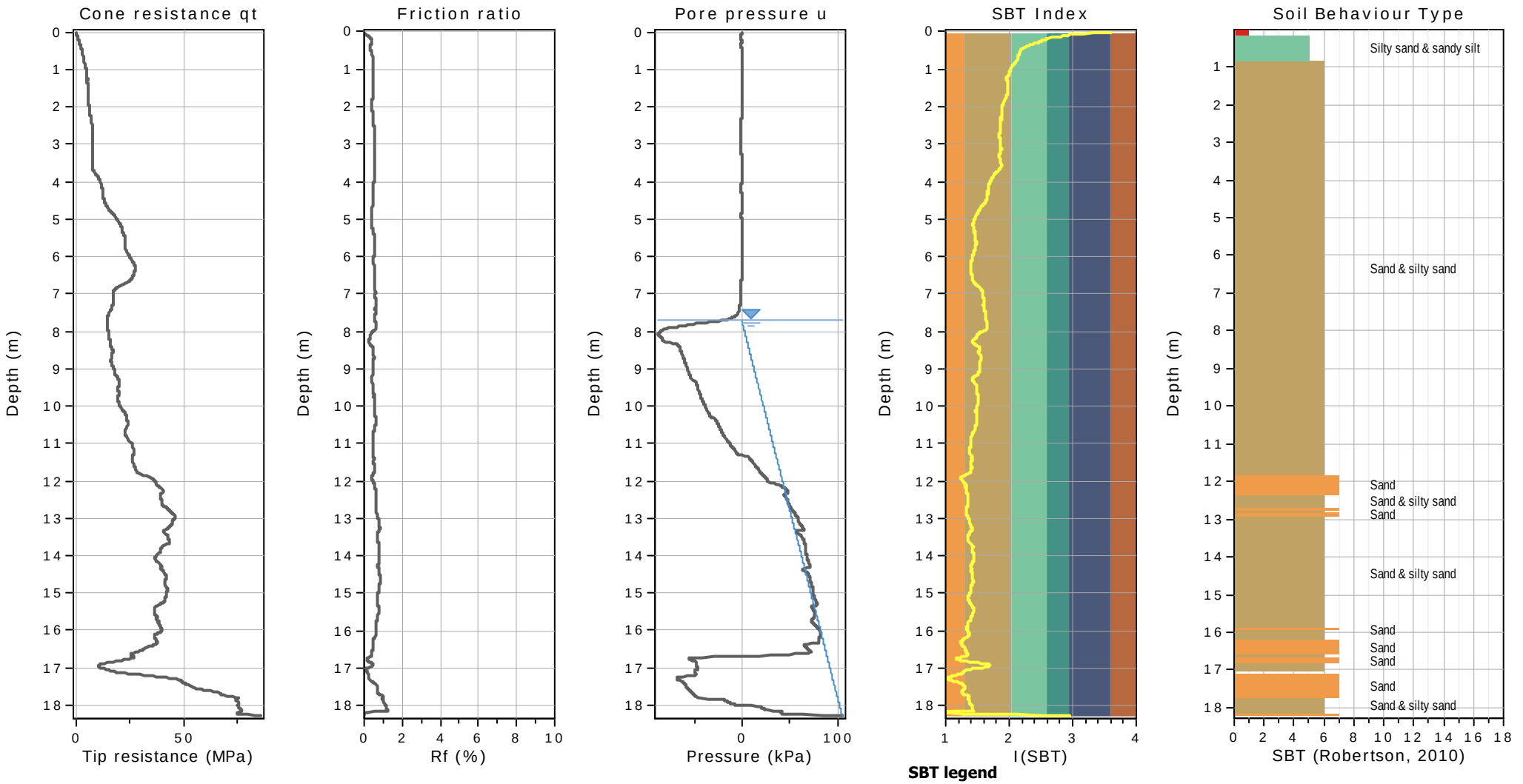


Project: **Project No.: LG0502020G, Geotechnical Site Investigation**

Location: **469 & 471 Canning Highway, Como, WA**

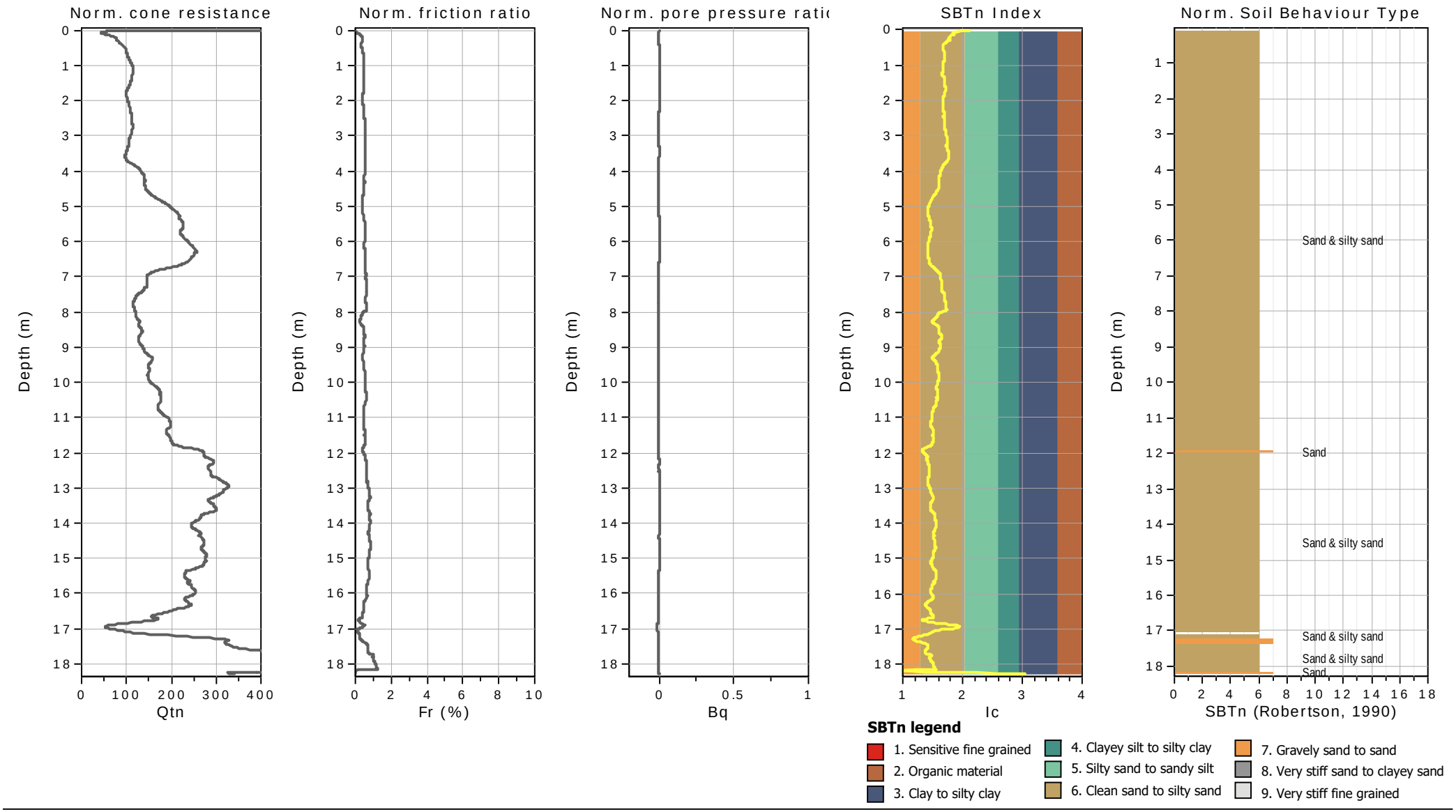
CPTu 1

Total depth: 18.28 m, Date: 05-Mar-20



Project: **Project No.: LG0502020G, Geotechnical Site Investigation**
Location: **469 & 471 Canning Highway, Como, WA**

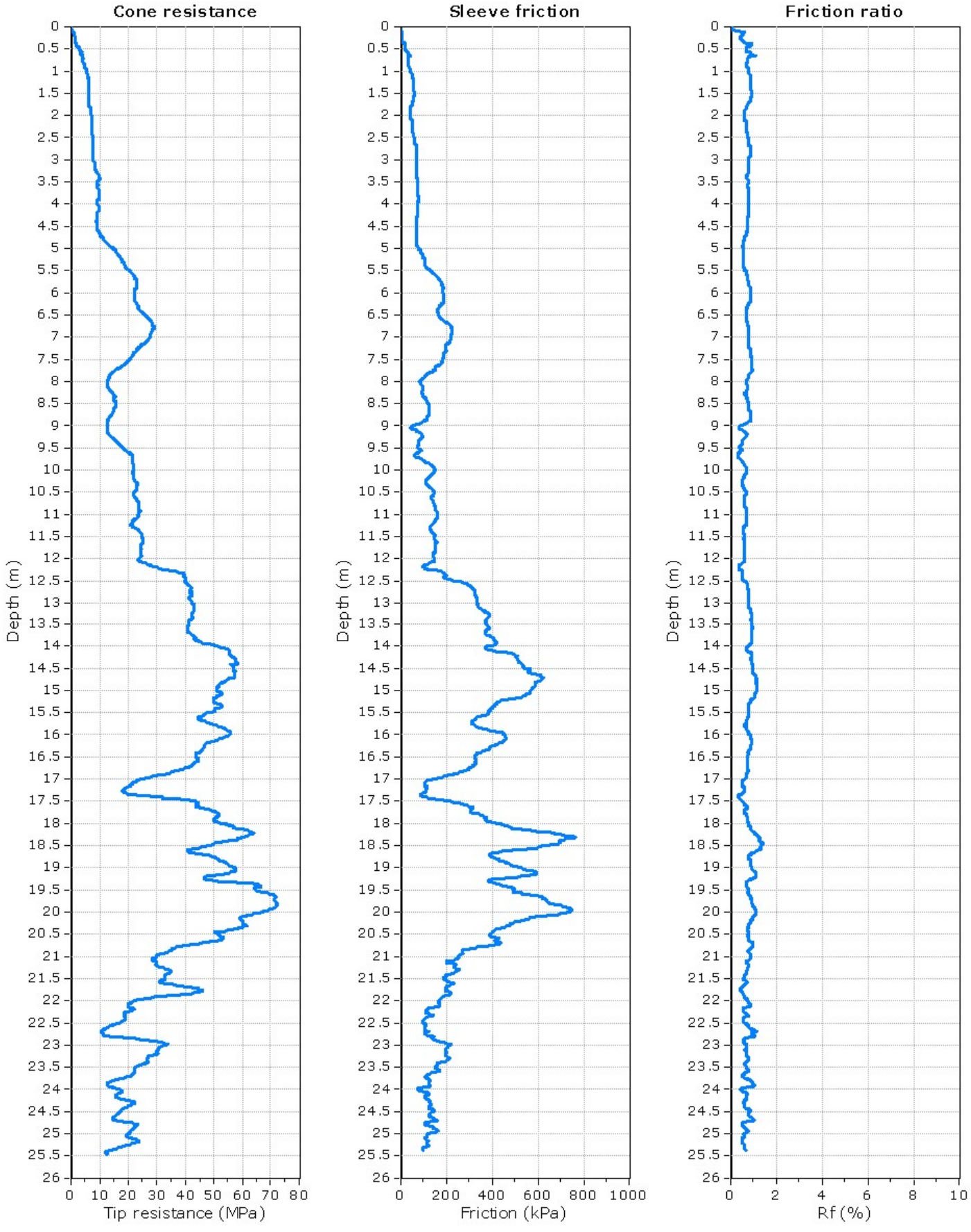
CPT: CPTu 1
Total depth: 18.28 m, Date: 05-Mar-20



info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045

CPT 2
Total depth: 25.46 m, Date: 5/03/2020
Surface Elevation: 9.55 m
Coords: X:392151.08, Y:6458226.94
Cone Operator: Andrew

Project: **469 & 471 Canning Highway (Project No.: LG0502020GI)**
Location: **Como**

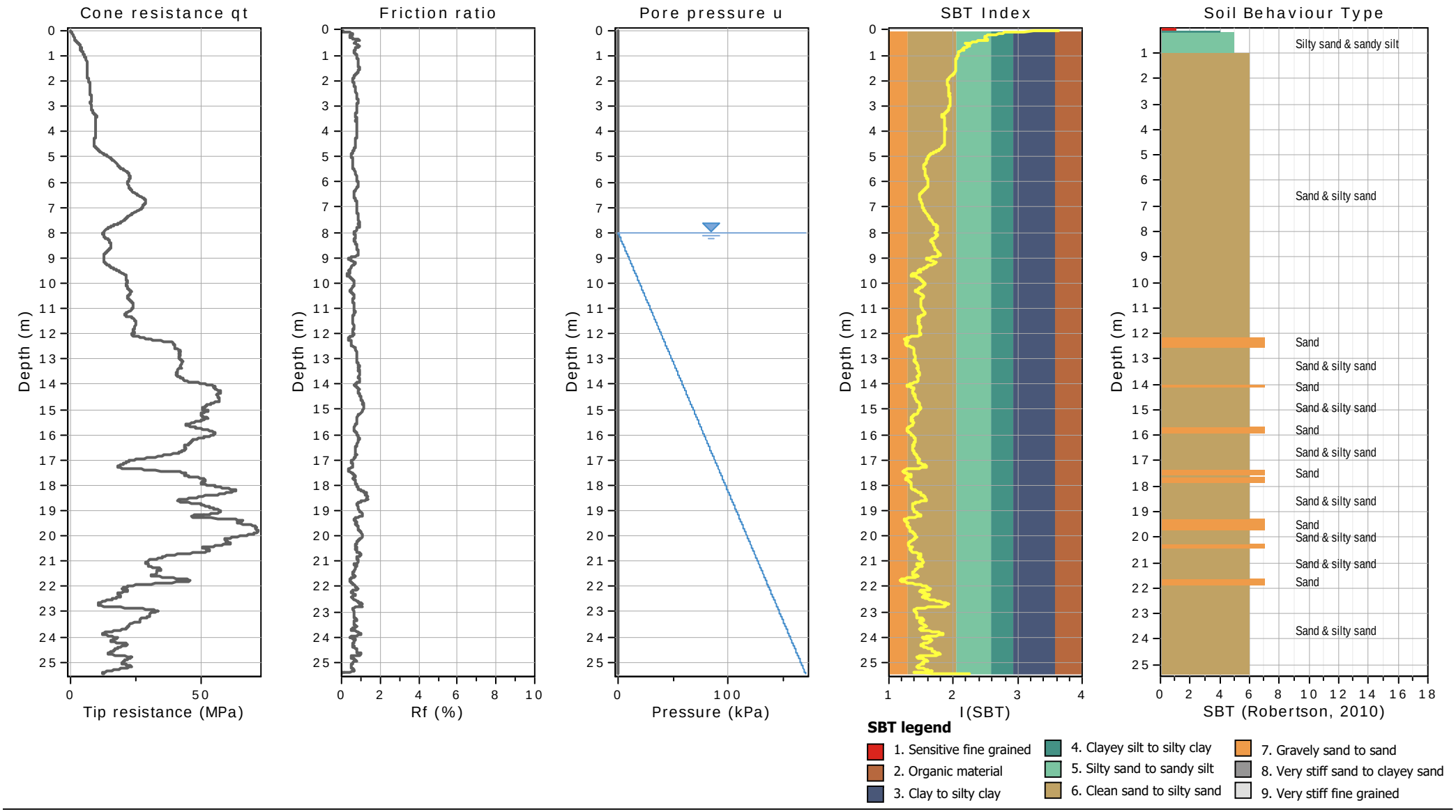


Project: **Project No.: LG0502020G, Geotechnical Site Investigation**

Location: **469 & 471 Canning Highway, Como, WA**

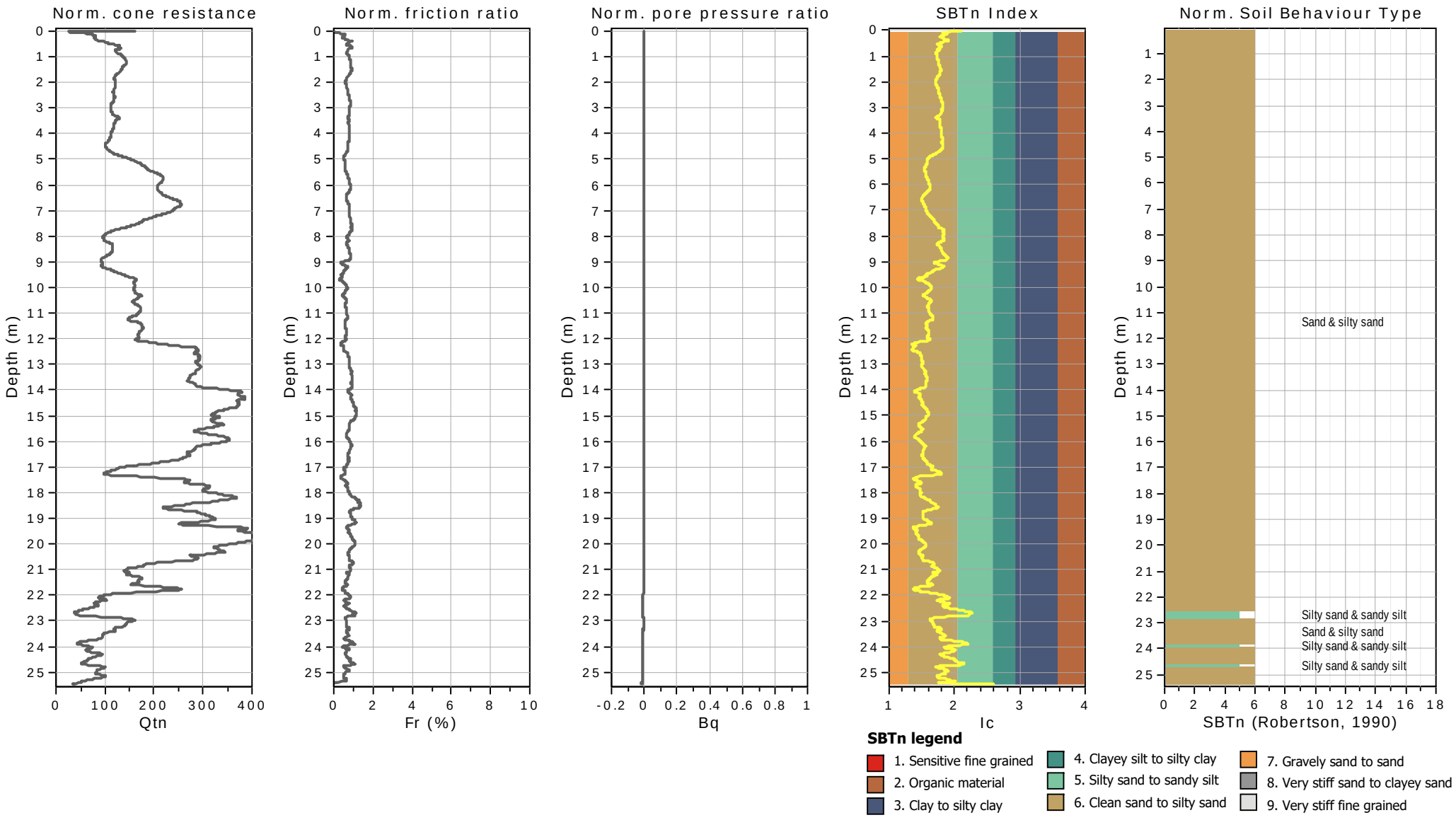
CPT 2

Total depth: 25.46 m, Date: 05-Mar-20



Project: **Project No.: LG0502020G, Geotechnical Site Investigation**
Location: **469 & 471 Canning Highway, Como, WA**

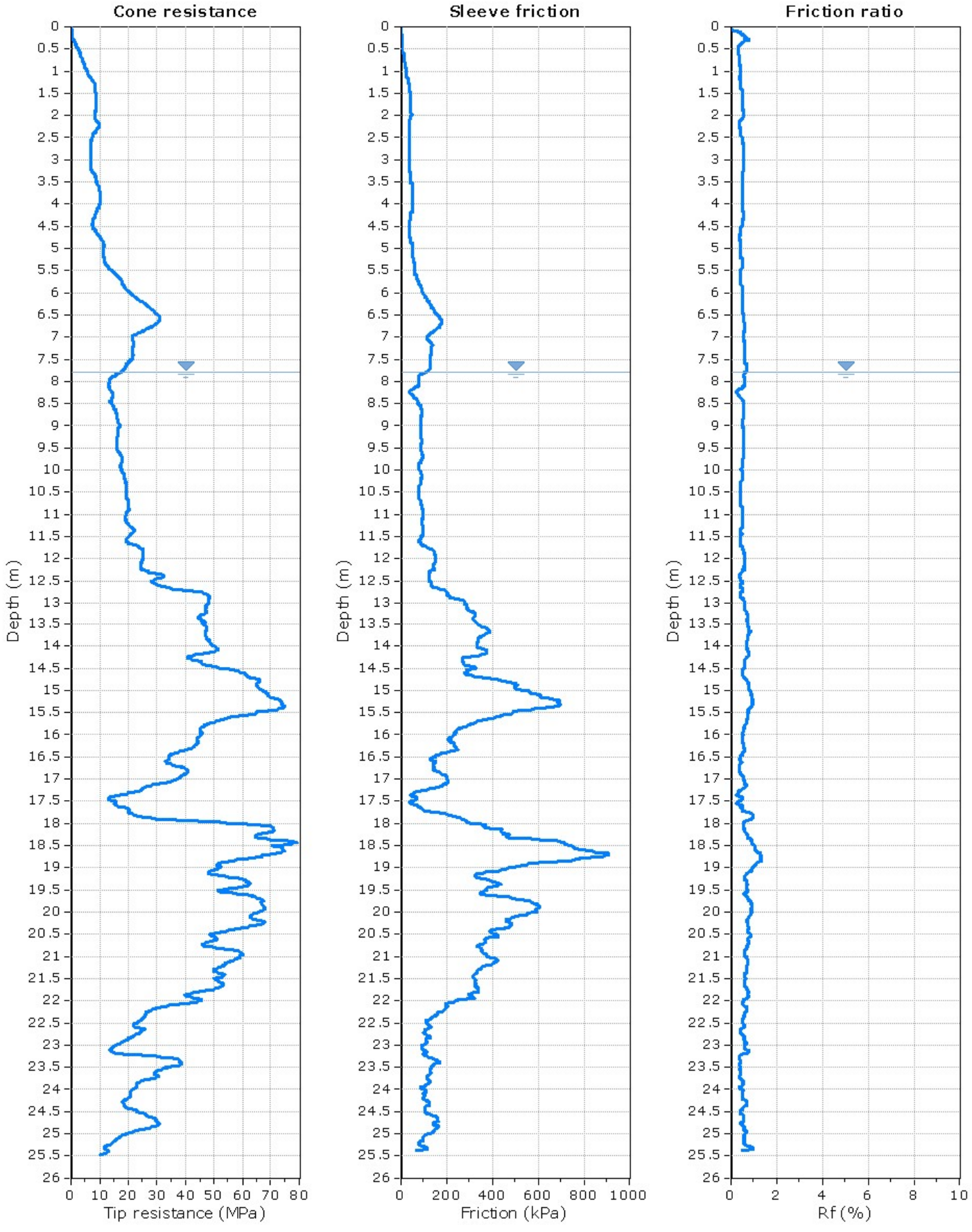
CPT: CPT 2
Total depth: 25.46 m, Date: 05-Mar-20



info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045

CPTu 3
Total depth: 25.48 m, Date: 5/03/2020
Surface Elevation: 9.19 m
Coords: X:392143.31, Y:6458204.43
Cone Operator: Andrew

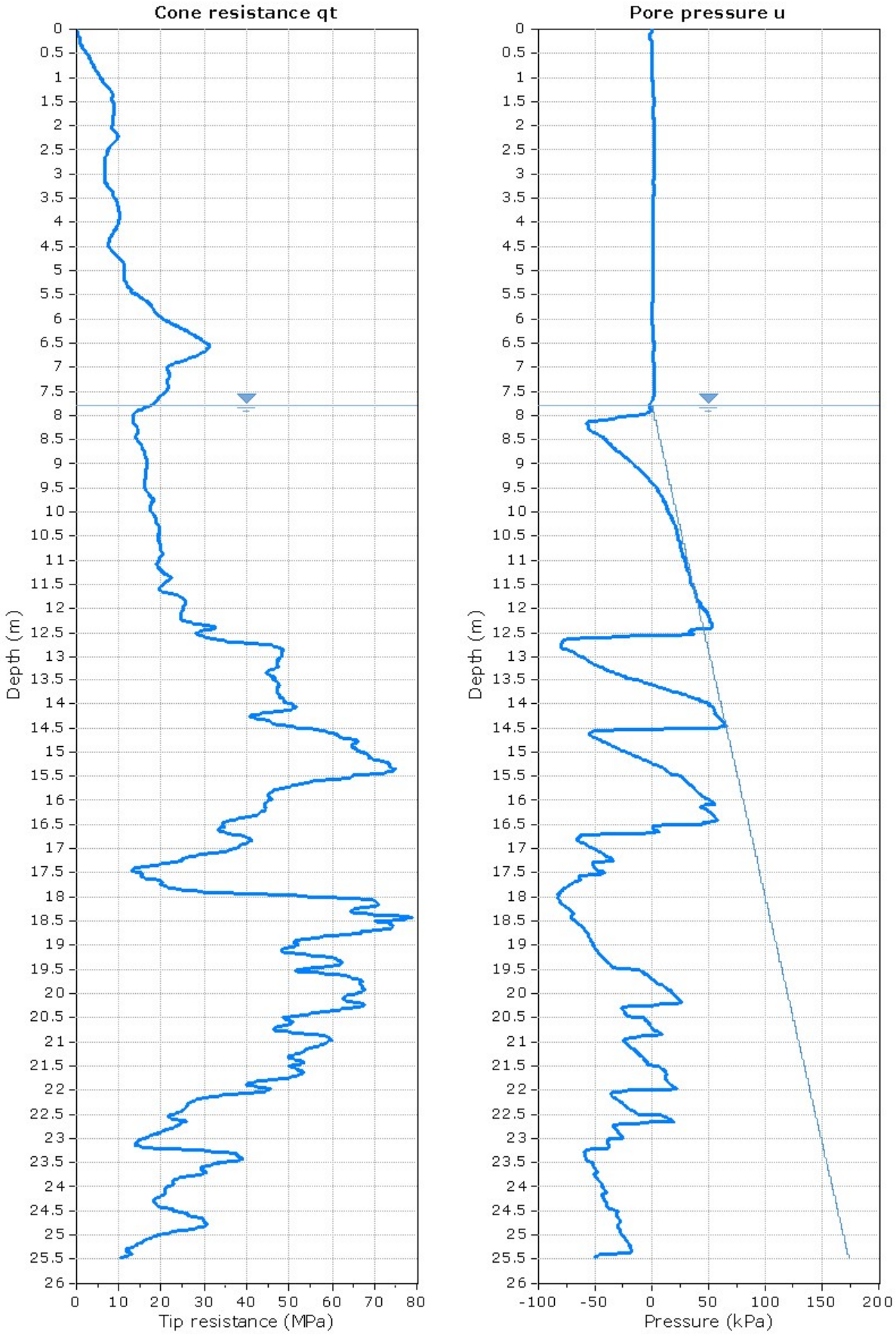
Project: **469 & 471 Canning Highway (Project No.: LG0502020GI)**
Location: **Como**

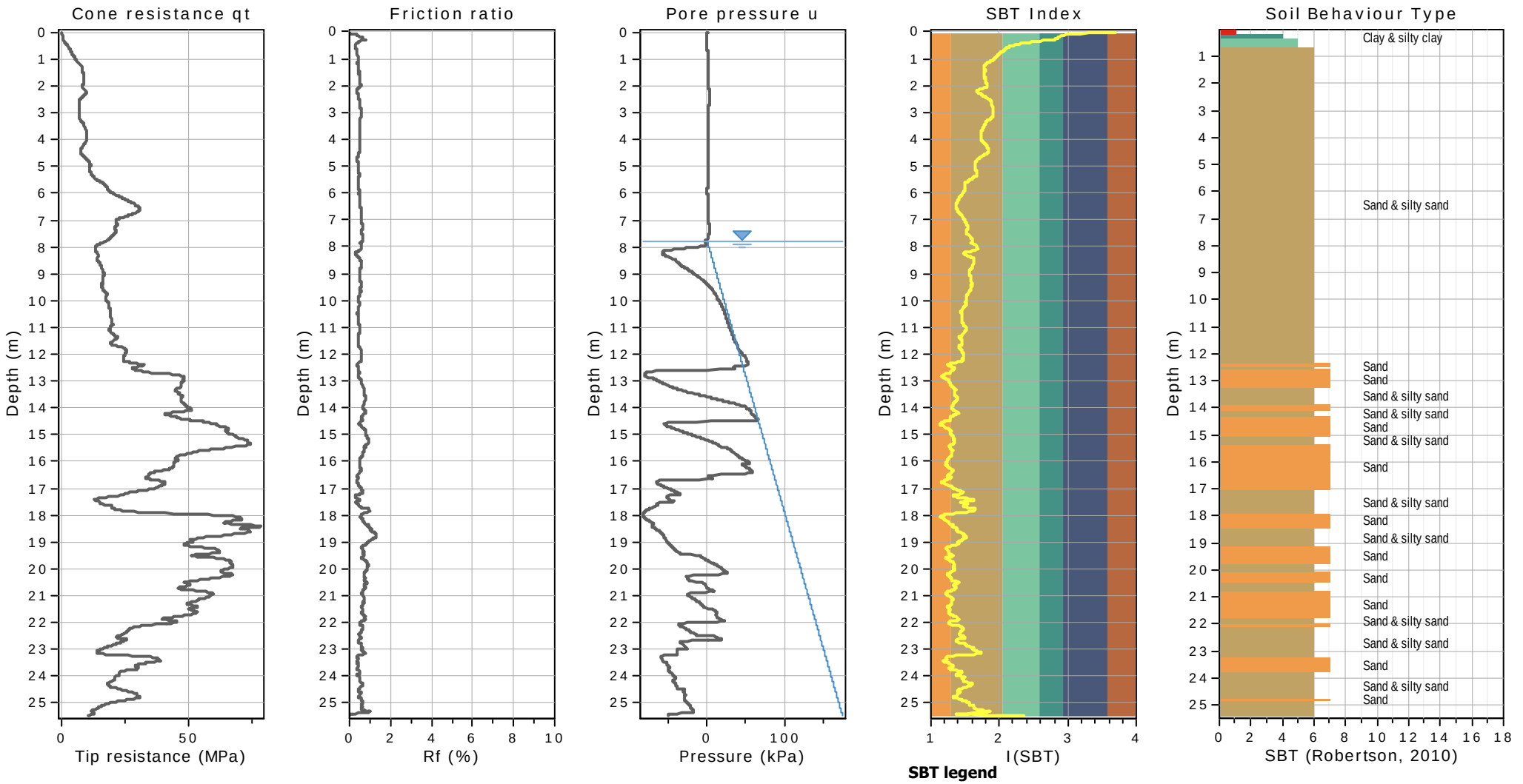


info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045

CPTu 3
Total depth: 25.48 m, Date: 5/03/2020
Surface Elevation: 9.19 m
Coords: X:392143.31, Y:6458204.43
Cone Operator: Andrew

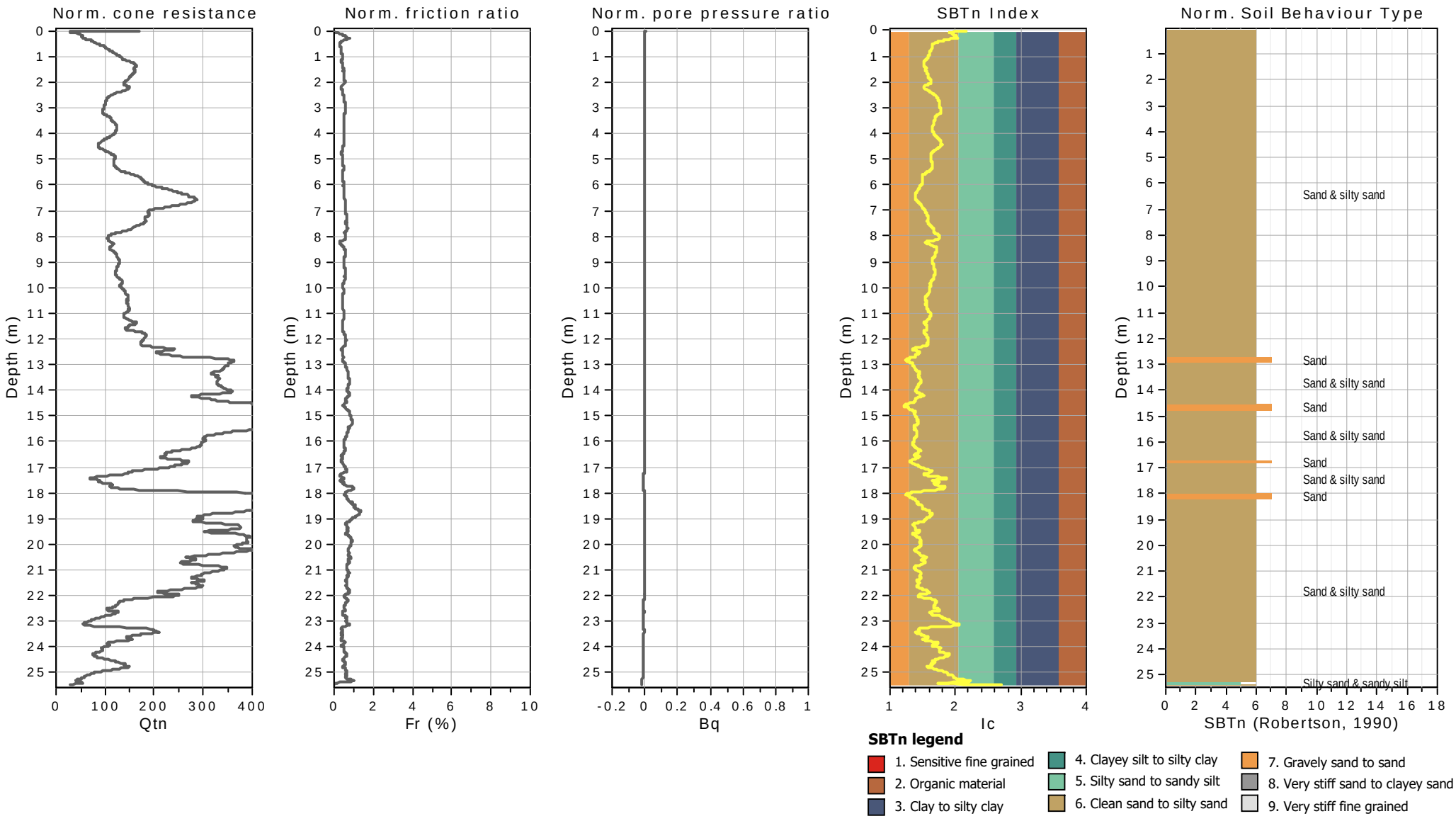
Project: **469 & 471 Canning Highway (Project No.: LG0502020GI)**
Location: **Como**




Cone resistance qt
Depth (m)
Tip resistance (MPa)
Friction ratio
Rf (%)
Pore pressure u
Pressure (kPa)
SBT Index
I(SBT)
Soil Behaviour Type
SBT (Robertson, 2010)
Clay & silty clay
Sand & silty sand
Sand
Sand & silty sand
Sand & silty sand
Sand
Sand & silty sand
Sand
Sand & silty sand
Sand
Sand
Sand
Sand & silty sand
Sand & silty sand
Sand
Sand & silty sand
Sand
SBT legend
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Project: **Project No.: LG0502020G, Geotechnical Site Investigation**
Location: **469 & 471 Canning Highway, Como, WA**

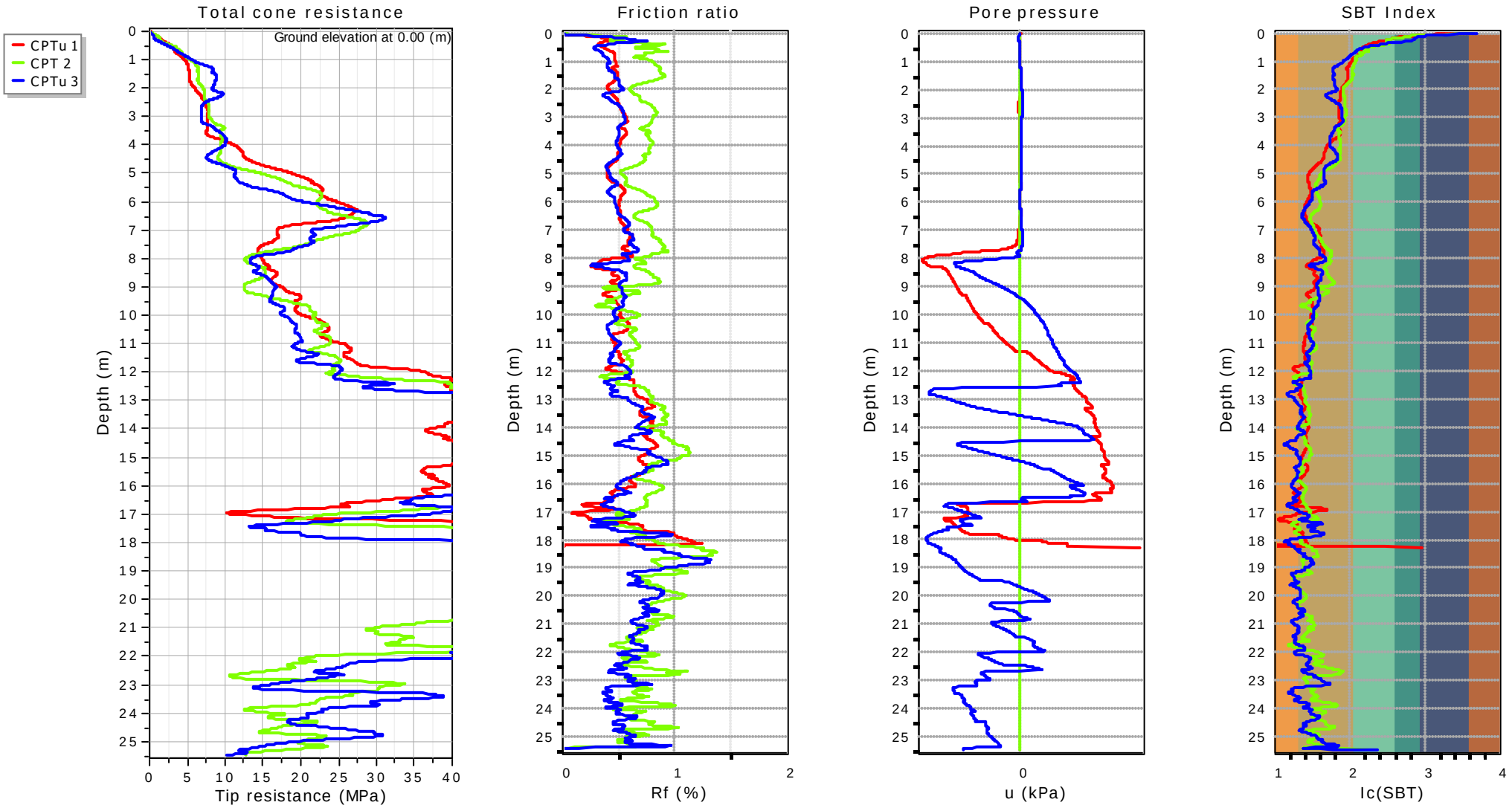
CPT: CPTu 3
Total depth: 25.48 m, Date: 05-Mar-20



Project: **Project No.: LG0502020G, Geotechnical Site Investigation**

Location: **469 & 471 Canning Highway, Como, WA**

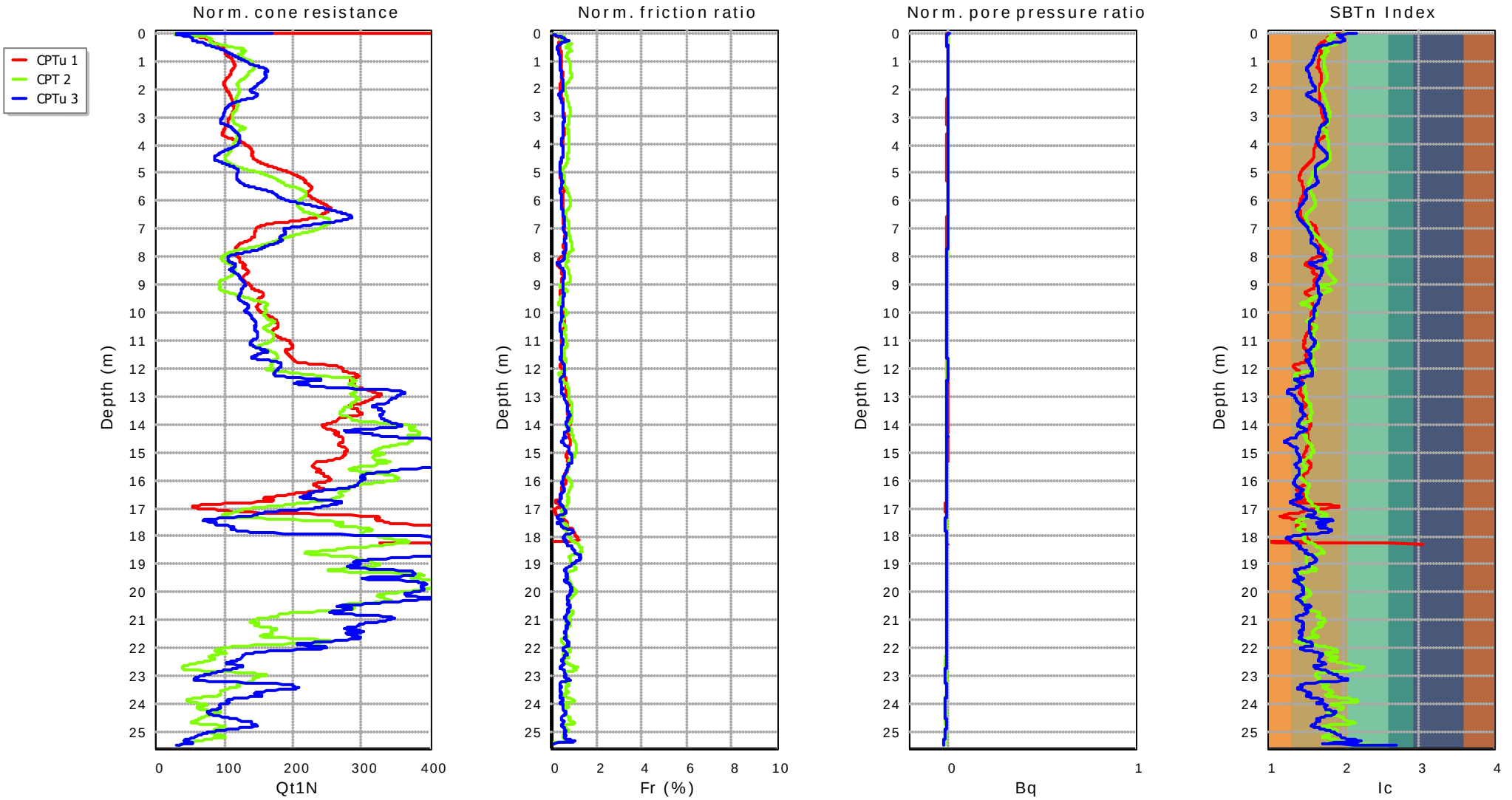
Overlay basic interpretation plots



Project: **Project No.: LG0502020G, Geotechnical Site Investigation**

Location: **469 & 471 Canning Highway, Como, WA**

Normalized basic plots



APPENDIX D

SITE PHOTOS

LOCAL GEOTECHNICS

Photo 1. Site, view from the south west corner, facing north east

Photo 2. Site, view from the north east corner, facing south west

Photo 3. Test Location 01 (TH1), Sub-surface probing by using a hand auger

Photo 4. Soil from Test Location 01 (TH1)

Photo 5. Test Location 02 (TH2), Sub-surface probing by using a hand auger

Photo 6. Test Location 03 (PSP3), Testing by a Perth Sand Penetrometer

Photo 7. Soil from Test Location 03 (TH3)

Photo 8. Test Location 04 (PSP4), Testing by a Perth Sand Penetrometer

Photo 9. Soil from Test Location 04 (TH4)

Photo 10. Soil permeability testing with a Guelph Permeameter (FPT1)

Photo 12. Testing Cone Penetration Test at Test Location, CPT2

Photo 12. Installed Stand Pipe at Test Location, CPTu1

APPENDIX D

LABORATORY TEST RESULTS

LOCAL GEOTECHNICS

TEST CERTIFICATE

CLIENT	**: Local Geotechnics**	**K&A JOB NO :**	**178 / 185 / 20**
PROJECT	**: Geotechnical Investigation**	**SAMPLE No :**	**NB48163**
LOCATION	**: No : 469 - 471 - Canning Highway - Como - WA**	**TEST DATE :**	**05/03/2020**
SAMPLE ID	**: TH : 1**	**LG Ref No :**	**LG0502020GI**
DEPTH(m)	**: (1.5 - 3.0)**		

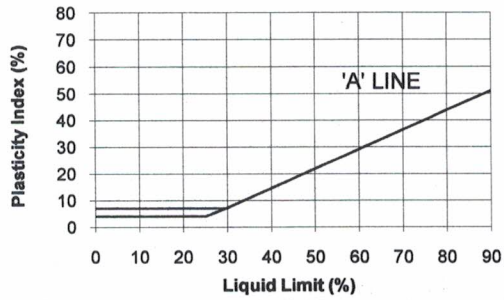
TEST DATA

ATTERBERG LIMITS		TEST METHODS
LIQUID LIMIT(%)	N/A	AS 1289 3.1.2
PLASTIC LIMIT(%)	N/A	AS 1289 3.2.1
PLASTICITY INDEX	N/A	AS 1289 3.3.1
LINEAR SHRINKAGE(%)	N/A	AS 1289 3.4.1

TESTING INFORMATION

ATTERBERG LIMITS:	
SAMPLE HISTORY:	N/A
METHOD OF PREPARATION	N/A
LINEAR SHRINKAGE :	
SIZE OF MOULD (mm)	N/A
CRUMBLING OR CURLING	N/A

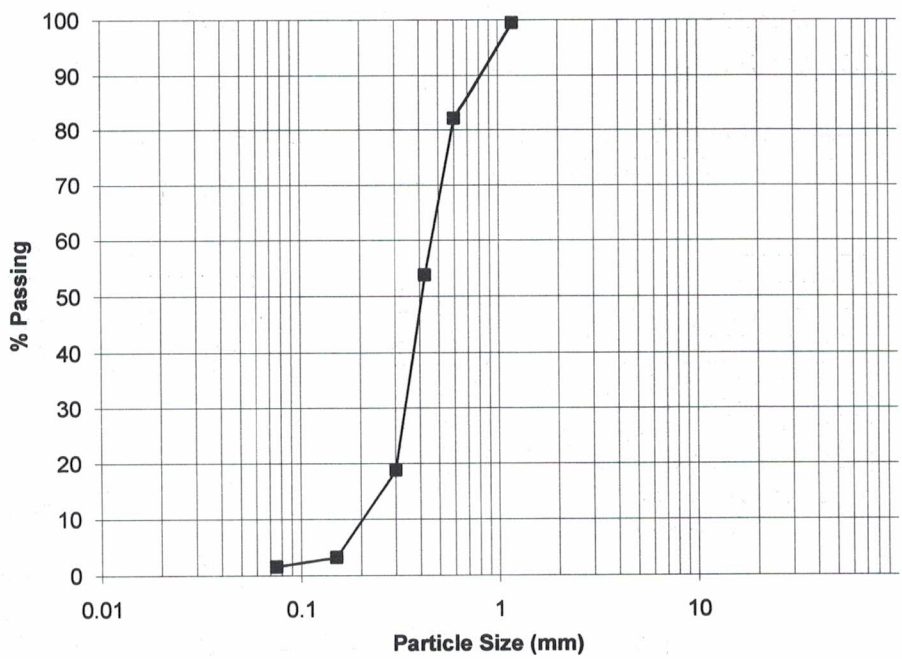
PLASTICITY CHART



AS 1289 3.6.1
PARTICLE SIZE DISTRIBN.

SIEVE SIZE	%PASSING
100.0mm	
75.0mm	
53.0mm	
37.5mm	
26.5mm	
19.0mm	
9.50mm	
4.75mm	
2.36mm	
1.18mm	100
0.600mm	82
0.425mm	54
0.300mm	19
0.150mm	3
0.075mm	2

AS 1289 3.6.1 - PARTICLE SIZE DISTRIBUTION



Note: Sample spplied by client. Results apply to the sample as received.

DATE: 06/03/2020

APPROVED SIGNATORY: J.Waldron

J.Waldron

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

'Accredited for compliance with ISO/IEC 17025'

PARTICLE SIZE DISTRIBUTION - TEST CERTIFICATE

CERTIFICATE No: N43893

Kanga & Associates

42Lionel Street, Naval Base-WA 6165

ACCREDITATION No. 2337

CHAIN OF CUSTODY DOCUMENTATION

ALS Laboratory Group

CLIENT: Local Geotechnics
ADDRESS / OFFICE: 12/8 Production Road, Canning Vale 6155
PROJECT MANAGER (PM) Harun Meer
PROJECT ID: LG0502020GI
SITE: 469 & 471 Canning Highway, Como WA
P.O. NO.:
RESULTS REQUIRED (Date):
QUOTE NO.:

SAMPLER: Aurelian Bara
MOBILE: 0470 082 233
PHONE: 0426 08 4387 (Ashrafur)
EMAIL REPORT TO: ashrafur.rahman@localgeotechnics.com.au; admin@localgeotechnics.com.au, bushra.shamsad
EMAIL INVOICE TO: (if different to report) account@localgeotechnics.com.au

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: Yes No N/A
SAMPLE TEMPERATURE
CHILLED: Yes No

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:

ANALYSIS REQUIRED including SUITES (note - suite codes must be listed to attract suite prices)

Notes: e.g. Highly contaminated samples
e.g. "High PAHs expected".
Extra volume for QC or trace LORs etc.

SAMPLE INFORMATION (note: S = Soil, W=Water)					CONTAINER INFORMATION		pH and pHFOX (ASS field screening test)	pH plus EC (1:5) - IN-48; Chloride (requires 1:5 soil water leach) - ED045; Sulfate - Total as SO4 - ED040T; Salinity - Total Soluble Salts - EA014								
ALS ID	SAMPLE ID	MATRIX	DATE	Time	Type / Code	Total cont										
1-5	TH1 (0.25m, 0.75m,1.25m, 2.0m, 3.0m)	soil					X									
6-10	TH2 (0.0m, 0.5m, 1.0m, 1.75m, 2.5m)	soil					X									
11-15	TH3 (0.25m, 0.75m, 1.5m, 2.0m, 3.0m)	soil					X									
16-20	TH4 (0.0m, 0.5m, 1.25m, 1.75m, 2.5m)	soil					X									
2	TH1 (0.75m)						X									
20	TH4 (2.5m)							X								
								X								

RELINQUISHED BY:		RECEIVED BY		METHOD OF SHIPMENT
Name: Ashrafur Rahman	Date: 28/2/2020	Name: ND	Date: 28/2/2020	Con' Note No:
Of: Local Geotechnics	Time:	Of: ALS	Time: 1655	
Name:	Date:	Name:	Date:	Transport Co:
Of:	Time:	Of:	Time:	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; V = VOA Vial HCl Preserved; VS = VOA Vial Sulphuric Preserved; SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS LABORATORY GROUP

COC Page _1_ of _1_

ENFM (204/5)

Environmental Division
Perth
Work Order Reference
EP2002172

Telephone : +61-8-9406 1301

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP2002172**	Page	: 1 of 6
Client	: **LOCAL GEOTECHNICS**	Laboratory	: Environmental Division Perth
Contact	: Harun Meer	Contact	: Customer Services EP
Address	: PO Box 5050 Canning Vale South Western Australia 6155	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: 08 9457 3517	Telephone	: +61-8-9406 1301
Project	: LG0502020GI	Date Samples Received	: 28-Feb-2020 16:45
Order number	: ----	Date Analysis Commenced	: 03-Mar-2020
C-O-C number	: ----	Issue Date	: 09-Mar-2020 21:47
Sampler	: Aurelian Bara		
Site	: 469 & 471 Canning Highway, Como WA		
Quote number	: EN/222		
No. of samples received	: 20		
No. of samples analysed	: 20		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Chris Lemaitre	Laboratory Manager (Perth)	Perth Inorganics, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth ASS, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth Inorganics, Wangara, WA

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA037 (Rapid Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme
- EA037 ASS Field Screening: NATA accreditation does not cover performance of this service.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	TH1 (0.25m)	TH1 (0.75m)	TH1 (1.25m)	TH1 (2.0m)	TH1 (3.0m)
			Client sampling date / time	28-Feb-2020 00:00	28-Feb-2020 00:00	28-Feb-2020 00:00	28-Feb-2020 00:00	28-Feb-2020 00:00
Compound	CAS Number	LOR	Unit	EP2002172-001	EP2002172-002	EP2002172-003	EP2002172-004	EP2002172-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	----	6.4	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	----	6	----	----	----
EA014 Total Soluble Salts								
Total Soluble Salts	----	5	mg/kg	----	20	----	----	----
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	6.1	6.3	6.6	6.8	7.0
pH (Fox)	----	0.1	pH Unit	4.5	4.7	5.0	5.2	5.0
Reaction Rate	----	1	-	Slight	Slight	Slight	Slight	Slight
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	----	0.6	----	----	----
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	----	<100	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	----	<10	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	TH2 (0.0m)	TH2 (0.5m)	TH2 (1.0m)	TH2 (1.75m)	TH2 (2.5m)
				Client sampling date / time	28-Feb-2020 00:00	28-Feb-2020 00:00	28-Feb-2020 00:00	28-Feb-2020 00:00	28-Feb-2020 00:00
Compound	CAS Number	LOR	Unit		EP2002172-006	EP2002172-007	EP2002172-008	EP2002172-009	EP2002172-010
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**7.9**	**7.5**	**8.3**	**7.6**	**6.8**
pH (Fox)	----	0.1	pH Unit		**5.6**	**5.6**	**5.7**	**5.5**	**5.3**
Reaction Rate	----	1	-		**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	TH3 (0.25m)	TH3 (0.75m)	TH3 (1.5m)	TH3 (2.0m)	TH3 (3.0m)
				Client sampling date / time	28-Feb-2020 00:00	28-Feb-2020 00:00	28-Feb-2020 00:00	28-Feb-2020 00:00	28-Feb-2020 00:00
Compound	CAS Number	LOR	Unit		EP2002172-011	EP2002172-012	EP2002172-013	EP2002172-014	EP2002172-015
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**7.1**	**7.2**	**7.1**	**7.0**	**6.9**
pH (Fox)	----	0.1	pH Unit		**4.5**	**5.1**	**4.8**	**5.0**	**5.0**
Reaction Rate	----	1	-		**Moderate**	**Moderate**	**Moderate**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	TH4 (0.0m)	TH4 (0.5m)	TH4 (1.25m)	TH4 (1.75m)	TH4 (2.5m)
			Client sampling date / time	28-Feb-2020 00:00	28-Feb-2020 00:00	28-Feb-2020 00:00	28-Feb-2020 00:00	28-Feb-2020 00:00
Compound	CAS Number	LOR	Unit	EP2002172-016	EP2002172-017	EP2002172-018	EP2002172-019	EP2002172-020
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**----**	**----**	**----**	**----**	**7.0**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**----**	**----**	**----**	**----**	**3**
EA014 Total Soluble Salts								
Total Soluble Salts	----	5	mg/kg	**----**	**----**	**----**	**----**	**11**
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**7.0**	**7.1**	**7.2**	**7.2**	**7.2**
pH (Fox)	----	0.1	pH Unit	**4.8**	**5.1**	**5.2**	**5.1**	**5.2**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**----**	**----**	**----**	**----**	**0.6**
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	**----**	**----**	**----**	**----**	<100
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**----**	**----**	**----**	**----**	<10

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EP2002172**	Page	: 1 of 3
Client	: **LOCAL GEOTECHNICS**	Laboratory	: Environmental Division Perth
Contact	: Harun Meer	Contact	: Customer Services EP
Address	: PO Box 5050 Canning Vale South Western Australia 6155	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: 08 9457 3517	Telephone	: +61-8-9406 1301
Project	: LG0502020GI	Date Samples Received	: 28-Feb-2020
Order number	: ----	Date Analysis Commenced	: 03-Mar-2020
C-O-C number	: ----	Issue Date	: 09-Mar-2020
Sampler	: Aurelian Bara		
Site	: 469 & 471 Canning Highway, Como WA		
Quote number	: EN/222		
No. of samples received	: 20		
No. of samples analysed	: 20		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Chris Lemaitre	Laboratory Manager (Perth)	Perth Inorganics, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth ASS, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth Inorganics, Wangara, WA

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA002: pH 1:5 (Soils) (QC Lot: 2889731)									
EP2002172-002	TH1 (0.75m)	EA002: pH Value	----	0.1	pH Unit	6.4	6.4	0.00	0% - 20%
EA010: Conductivity (1:5) (QC Lot: 2889732)									
EP2002172-002	TH1 (0.75m)	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	6	6	0.00	No Limit
EA037: Ass Field Screening Analysis (QC Lot: 2893423)									
EP2002172-001	TH1 (0.25m)	EA037: pH (F)	----	0.1	pH Unit	6.1	6.1	0.00	0% - 20%
		EA037: pH (Fox)	----	0.1	pH Unit	4.5	4.5	0.00	0% - 20%
EP2002172-010	TH2 (2.5m)	EA037: pH (F)	----	0.1	pH Unit	6.8	6.8	0.00	0% - 20%
		EA037: pH (Fox)	----	0.1	pH Unit	5.3	5.3	0.00	0% - 20%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 2891372)									
EP2002137-006	Anonymous	EA055: Moisture Content	----	0.1	%	9.4	9.9	5.45	0% - 20%
EP2002196-007	Anonymous	EA055: Moisture Content	----	0.1	%	14.8	14.1	4.78	0% - 50%
ED040T : Total Sulfate by ICPAES (QC Lot: 2889735)									
EP2002172-002	TH1 (0.75m)	ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	<100	0.00	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 2889733)									
EP2002172-002	TH1 (0.75m)	ED045G: Chloride	16887-00-6	10	mg/kg	<10	<10	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA002: pH 1:5 (Soils) (QCLot: 2889731)								
EA002: pH Value	----	----	pH Unit	----	4 pH Unit	100	70.0	130
				----	7 pH Unit	100	70.0	130
EA010: Conductivity (1:5) (QCLot: 2889732)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	24800 µS/cm	102	93.6	106
ED040T : Total Sulfate by ICPAES (QCLot: 2889735)								
ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	2500 mg/kg	112	80.0	120
ED045G: Chloride by Discrete Analyser (QCLot: 2889733)								
ED045G: Chloride	16887-00-6	10	mg/kg	<10	50 mg/kg	98.2	88.0	115
				<10	5000 mg/kg	100	88.0	115

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 2889733)							
EP2002172-020	TH4 (2.5m)	ED045G: Chloride	16887-00-6	5000 mg/kg	98.0	70.0	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP2002172**	Page	: 1 of 4
Client	: **LOCAL GEOTECHNICS**	Laboratory	: Environmental Division Perth
Contact	: Harun Meer	Telephone	: +61-8-9406 1301
Project	: LG0502020GI	Date Samples Received	: 28-Feb-2020
Site	: 469 & 471 Canning Highway, Como WA	Issue Date	: 09-Mar-2020
Sampler	: Aurelian Bara	No. of samples received	: 20
Order number	: ----	No. of samples analysed	: 20

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA002: pH 1:5 (Soils)							
Snap Lock Bag (EA002)							
TH1 (0.75m), TH4 (2.5m)	**28-Feb-2020**	**04-Mar-2020**	06-Mar-2020	✓	**04-Mar-2020**	04-Mar-2020	✓
EA010: Conductivity (1:5)							
Snap Lock Bag (EA010)							
TH1 (0.75m), TH4 (2.5m)	**28-Feb-2020**	**04-Mar-2020**	06-Mar-2020	✓	**04-Mar-2020**	01-Apr-2020	✓
EA037: Ass Field Screening Analysis							
Snap Lock Bag - frozen on receipt at ALS (EA037)							
TH1 (0.25m), TH1 (0.75m), TH1 (1.25m), TH1 (2.0m), TH1 (3.0m), TH2 (0.0m), TH2 (0.5m), TH2 (1.0m), TH2 (1.75m), TH2 (2.5m), TH3 (0.25m), TH3 (0.75m), TH3 (1.5m), TH3 (2.0m), TH3 (3.0m), TH4 (0.0m), TH4 (0.5m), TH4 (1.25m), TH4 (1.75m), TH4 (2.5m)	**28-Feb-2020**	**03-Mar-2020**	26-Aug-2020	✓	**03-Mar-2020**	26-Aug-2020	✓
EA055: Moisture Content (Dried @ 105-110°C)							
Snap Lock Bag (EA055)							
TH1 (0.75m), TH4 (2.5m)	**28-Feb-2020**	**----**	----	----	**03-Mar-2020**	13-Mar-2020	✓
ED040: Sulfur as SO4 2-							
Snap Lock Bag (ED040T)							
TH1 (0.75m), TH4 (2.5m)	**28-Feb-2020**	**03-Mar-2020**	06-Mar-2020	✓	**04-Mar-2020**	31-Mar-2020	✓
ED045G: Chloride by Discrete Analyser							
Snap Lock Bag (ED045G)							
TH1 (0.75m), TH4 (2.5m)	**28-Feb-2020**	**04-Mar-2020**	27-Mar-2020	✓	**04-Mar-2020**	01-Apr-2020	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
ASS Field Screening Analysis	EA037	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride Soluble By Discrete Analyser	ED045G	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Moisture Content	EA055	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chloride Soluble By Discrete Analyser	ED045G	2	2	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	2	2	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride Soluble By Discrete Analyser	ED045G	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride Soluble By Discrete Analyser	ED045G	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH (1:5)	EA002	SOIL	In house: Referenced to Rayment and Lyons 4A1 and APHA 4500H+. pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3)
Electrical Conductivity (1:5)	EA010	SOIL	In house: Referenced to Rayment and Lyons 3A1 and APHA 2510. Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3)
Total Soluble Salts	EA014	SOIL	In house: The concentration of Total Soluble Salts in a soil is calculated from the Electrical conductivity of a water extract. This method is compliant with NEPM (2013) Schedule B(3) (Method 104)
ASS Field Screening Analysis	EA037	SOIL	In house: Referenced to Acid Sulfate Soils Laboratory Methods Guidelines, version 2.1 June 2004. As received samples are tested for pH field and pH fox and assessed for a reaction rating.
Moisture Content	EA055	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 105-110 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 6.1 and Table 1 (14 day holding time).
Sulfate as SO4 2- Total	ED040T	SOIL	In house: Total Sulfate is determined off a HCl digestion by ICPAES as S , and reported as SO4
Chloride Soluble By Discrete Analyser	ED045G	SOIL	In house: Referenced to APHA 4500-Cl- E. The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm. Analysis is performed on a 1:5 soil / water leachate.

Preparation Methods	Method	Matrix	Method Descriptions
Drying only	EN020D	SOIL	In house
HCl Digest	EN24	SOIL	1g of soil is digested in 30 ml of 30% HCl and the resultant digest bulked and filtered for analysis by ICP.
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of reagent grade water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.

LOCAL GEOTECHNICS

11 December 2019

Report on

Geotechnical Investigation

109, 111 & 113 Robert Street, Como WA

Project:
LGK9542019GI REV_0

Client:
dem

Geotech | Civil | Pavement | Drainage

Unit 12, 8 Production Road, Canning Vale WA 6155
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08 9457 3517 (0), 0425 545 508 (M)
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admin@localgeotechnics.com.au
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LOCAL GEOTECHNICS

11 December 2019

To

dem

suite 202, Level 2, tower b, the zenith (railway st entry)
821 pacific hwy chatswood nsw 2067 australia

Dear Sir/Madam,

RE: Geotechnical Investigation for 109, 111 & 113 Robert Street, Como WA.

This letter presents our report on a Geotechnical Investigation carried out at 109, 111 & 113 Robert Street, Como, WA. The report must be thoroughly read and implemented in full. No partial implementation of this report is allowed.

If you have any questions in regards to the geotechnical site investigation or we can be of further assistance, please do not hesitate to contact Local Geotechnics.

Sincerely yours

Dr. Harun Meer
Ph.D.(Geotech), M. Eng. (Geotech), B. Eng. (Civil), MIE Aust
Director
Local Geotechnics

PROJECT INFORMATION

Project	**LGK9542019GI** **Geotechnical Investigation**
Site Location	**109, 111 & 113 Robert Street, Como WA**

Rev	Description	Date	Prepared by	Approved by
0	Issued to client	11 December 2019	R Khan	H Meer

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Appendix A: Site Sketch /Test location Plan
Appendix B: Test Hole Logs, PSP and Infiltration Test Certificates
Appendix C: CPT Traces & Interpretation
Appendix D: Site Photos
Appendix E: Laboratory Test Certificates

EXECUTIVE SUMMARY

A geotechnical site investigation, that comprised onsite underground services check, hand auger test hole drilling, PSP test, CPT tests and standpipe piezometer installation were undertaken on 27 November 2019 to assess the prevailing subsurface conditions at 109, 111 & 113 Robert Street, Como, WA (site). The topography of the site was observed to be gently sloped downward from west to east (Lily Lane to Robert St). Site elevation varies between 9.5 m AHD (near Robert St) and 11.5 m AHD (near Lily Lane).

Subsurface conditions inferred from the site investigation can be described as follows:

- TOPSOIL, SAND (SP) – fine to medium grained, brown, dark brown, grey, dry, loose to dense; with grass, organics; extended from surface to a depth of around 0.2 m, overlying,
- SAND (SP) – fine to medium grained, yellow, light yellow, brown, grey, and light grey at depths, moist, quartz, extended to the maximum investigated depth 25.5 m. In this unit, following generalised densities were assessed:
    - 0.2 – 5.7 m: medium dense,
    - 5.7 – 25.5 m: dense to very dense.

GROUNDWATER & DEWATERING – groundwater was encountered at depths varying between 8.3 m and 10.3 m below ground level (approximately 1.2 m AHD). Ground surface elevation of the site varies between 9.5 m AHD and 11.5 m AHD and historical highest groundwater table (GWT) was at 2 m AHD as per the Perth Groundwater Atlas. That indicates that estimated highest groundwater depth varies between 7.5 m and 9.5 m below the ground surface. Lower basement floor level of the proposed building was unknown during preparation of this report. If the basement Bulk Excavation Level (BEL) leaves a sand cover of less than 1m above the GWT, dewatering will be required to facilitate clean excavation, compaction for foundation bases and subsequent construction.

Site class (AS2870-2011) – the site was classified as 'Class P'. However, if the backfilling, earthworks and compaction are undertaken as per the recommendations presented in Section 7.7.3, the site can be reclassified to 'Class A'.

Earthquake sub-soil class (AS1170.4-2007) – "Class Ce - Shallow Soil".

Geotechnical strength and stiffness parameters for the existing ground is presented in Section 7.3. Bearing capacity parameters for shallow and pile foundations are presented in the report in Sections 7.8.1 & 7.8.2. Based on the sandy material, a design CBR value of 12% can be considered.

Based on the measured pH, chloride, sulphate and resistivity values, the soil exposure classification for both concrete and steel is 'non-aggressive'. The ASS field screening tests indicate that the presence of AASS and PASS at the tested locations of the site is less likely.

Temporary excavation up to 1 m depth can be conducted with a maximum dry slope angle of 1V: 2H. Cut and fill batters above groundwater table will be generally stable at 1V: 2H. Intermediate benches have to be created if excavation is deeper than 1m.

The recommended measure for the disposal of stormwater is onsite through soakwells or through to the basement stormwater management network. The volume of expected stormwater (worst case scenario) is to be estimated and designed by a suitably qualified Civil Engineering professional considering the soil category and infiltration rate.

We recommend undertaking of an additional site investigation soon after the demolition of the existing buildings. The additional investigation may comprise a series of borehole drilling which will assist detail design of soldier pile retention wall for basements

1.0 INTRODUCTION

dem (the client) engaged Local Geotechnics (LG) to undertake a geotechnical site investigation for a proposed church and associated building development at 109, 111 & 113 Robert Street, Como WA.

It is anticipated that the site investigation work will assist developing a concept design of a 2-3 level basement carparks over which two 10-12 storey residential tower apartments will be constructed. Further geotechnical (detail) investigation for detailed design stage might be taken place after the site is cleared or prior to the construction.

The site location map is shown in Figure 1.

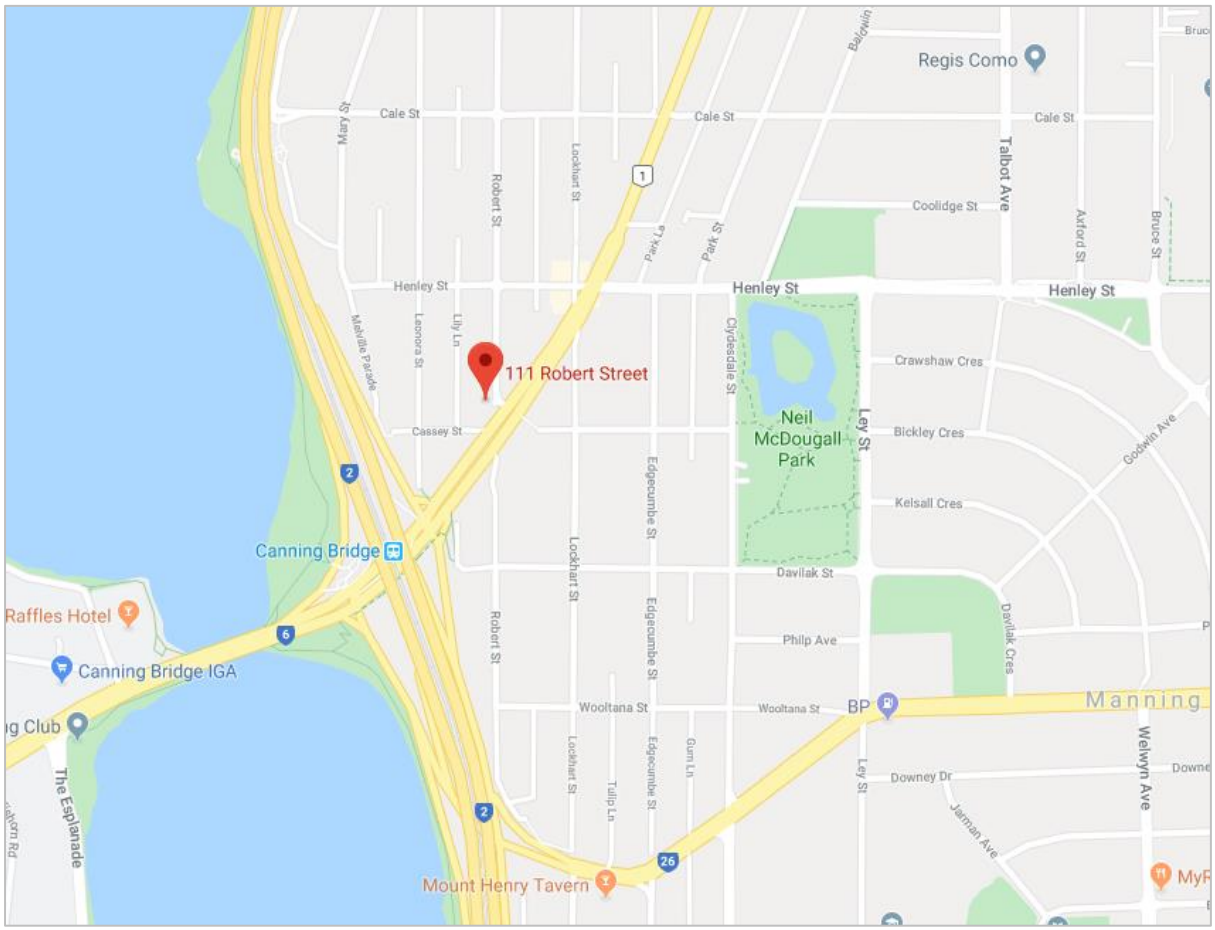


Figure 1. Site location map (source: Google Maps)

A geotechnical site investigation, that comprises onsite underground services check, hand auger test holes drilling, Perth Sand Penetrometer tests and electric friction cone penetrometer tests, was undertaken on 27 November 2019 to assess the prevailing subsurface conditions for the proposed development.

This report presents the factual data obtained during the field investigation and recommendations and discussions on site classification, subsurface conditions, bearing pressure, foundation type, backfill and estimated settlements.

2.0 PROPOSED DEVELOPMENT

A church and associated buildings which may include a 2-3 level basement below ground and 10-12 storey residential tower apartments above ground.

The below ground basements may be constructed using soldier pile retention system. The building can be supported on pad and strip footings at lower level basement.

3.0 SCOPE AND OBJECTIVES

Following is the scope of work LG has undertaken to achieve the project objectives:

- Desktop review of geological survey maps, groundwater atlas and other publicly available information for the site.
- Identifying any underground services crossing the proposed field investigation locations by conducting “Dial-Before-You-Dig” search and engaging a service locating contractor.
- Preparation of a Job Safety and Environmental Analysis (JSEA) document for the geotechnical investigation and implementation of the JSEA during the fieldworks.
- Undertaking 4 Electric Friction Cone Penetrometer Tests (CPTs) to a target depth between 15 m and 25 m. Two tests were undertaken with a piezocone to assess the pore pressure profile and depth to the groundwater table.
- Installation of two 25mm diameter standpipe piezometers at two CPT locations. These piezometers were constructed to monitor the groundwater level until the construction.
- Drilling of 5 hand auger Test Holes (THs) across the proposed development site to a target depth of 3 m, refusal or hole collapse, whichever was encountered first.
- Conducting 5 Perth Sand Penetrometer (PSP) tests at the locations of THs, to a depth of 1.05 m from the ground surface.
- Conducting 2 Field Permeability Tests (FPT) across the proposed development site at a depth of 0.3 m below surface level.
- Undertaking laboratory testing of soil.
- Preparation of this geotechnical investigation report to include the following information relevant to the design development.
  - Factual data from the field testing.
  - Site classification (AS2870-2011) and remedial measures to improve this classification if required.
  - Sub-soil class (AS1170.4-2007), earthquake parameter.
  - Subsurface conditions in the significant foundation zone.
  - Recommendations on ground improvement.
  - Description of groundwater conditions.
  - Geotechnical design/strength parameters.
  - Site preparation recommendations (AS 3798-2007).

4.0 SITE CONDITIONS

4.1 Surface condition

The site is located in a residential suburb of Como, WA and is approximately 6 km south of the Perth CBD.

The topography of the site was observed to be gently sloped downward from west to east (Lily Lane to Robert St). Site elevation varies between 9.5 m AHD (near Robert St) and 11.5 m AHD (near Lily Lane). The site was occupied with church building, residential houses, paved paths, carparks, covered with sand, trees, grass in the front and back yards, and was accessible by 4WD vehicle and CPT rig.

The site photos taken during the field investigation are shown in Appendix D.

4.2 Site Geology

The 1: 50,000 Geology Series Map, Fremantle Sheet, No. 2033 I and IV, issued by the Geological Survey of Western Australia, indicates that the site is underlain by Quaternary age Sand Deposit (S7) that is derived from Tamala Limestone.

The sand was described to be pale yellowish brown, medium to coarse grained, subangular, quartz, trace of feldspar, moderately sorted, of residual origin.

The Environmental Geological map also revealed that the site soil has high permeability, low corrosion potential, low to medium slope stability, low to medium bearing capacity.

An extracted site geological map is shown in Figure 2.

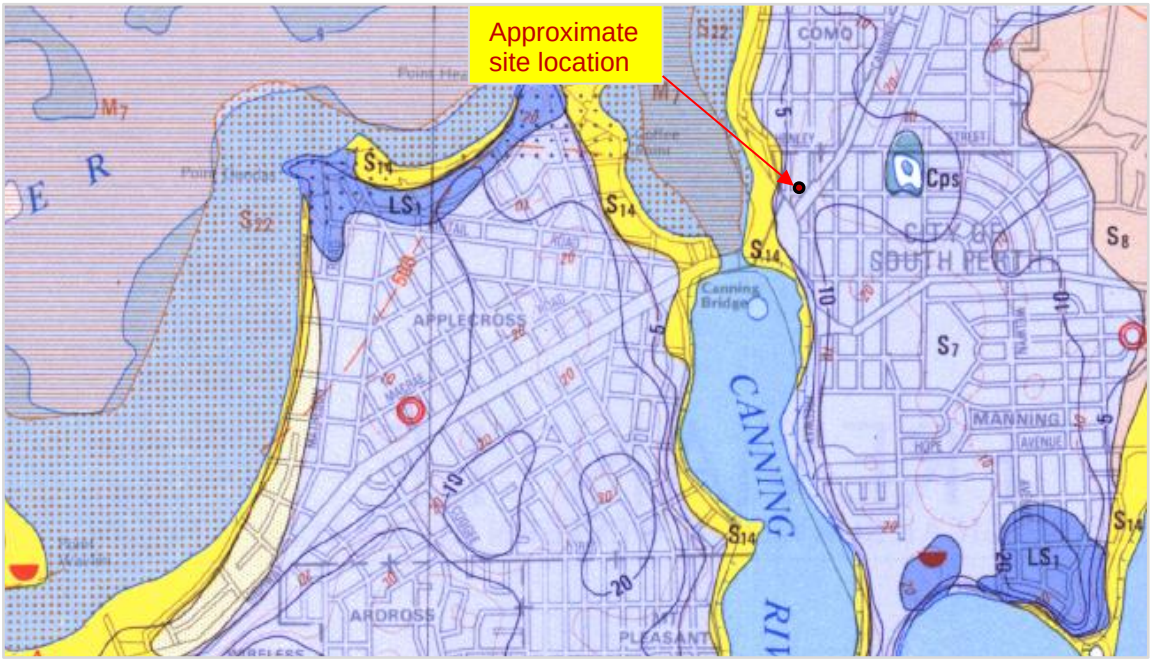


Figure 2. Extracted Geological Map (Ref. 1:50,000 Geology Series Fremantle sheet)

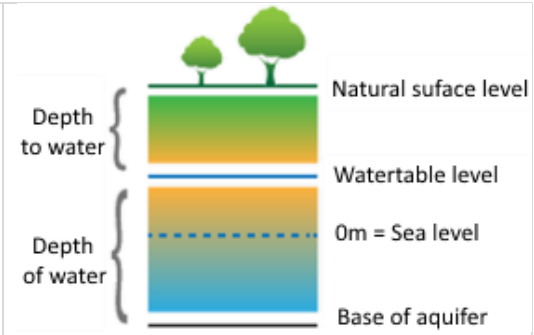
4.3 Groundwater Information

A review of the 'Perth Ground Water Atlas' of the Department of Water was carried out for this site. 'Perth Ground Water Atlas' indicated that the site natural ground surface elevation varied between 9.5 and 11.5 mAHD, annual average water table of 1 m AHD and historical maximum water table of 2 m AHD as per May 2003 data.

Natural average surface level: 9.5 to 11.5 mAHD
Annual average water table level: 1 m AHD
Historic maximum water level: 2 m AHD

Est. average groundwater depth= 8.5 to 10.5 m
Est. historical max. GW depth = 7.5 to 9.5 m

Legend:
Purple line = annual average water table level
Pink line = historic maximum water level



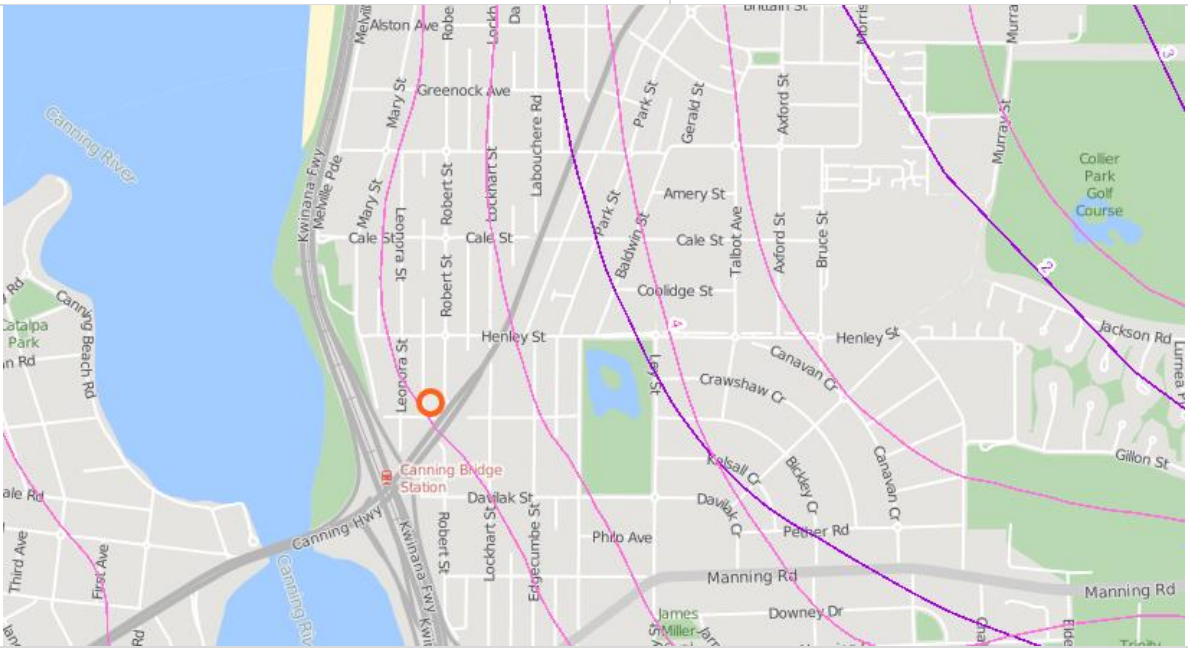


Figure 3. Water table information (Source: Perth Groundwater Atlas)

4.4 Acid Sulfate Soils (ASS) Review

Acid sulfate soils (ASS) maps 1:50 000 "Central Metropolitan Region Scheme acid sulfate soils" of Department of Environment and Conservation, WA revealed that site is in "no known risk of ASS occurring within 3 m of natural surface level (or deeper)".

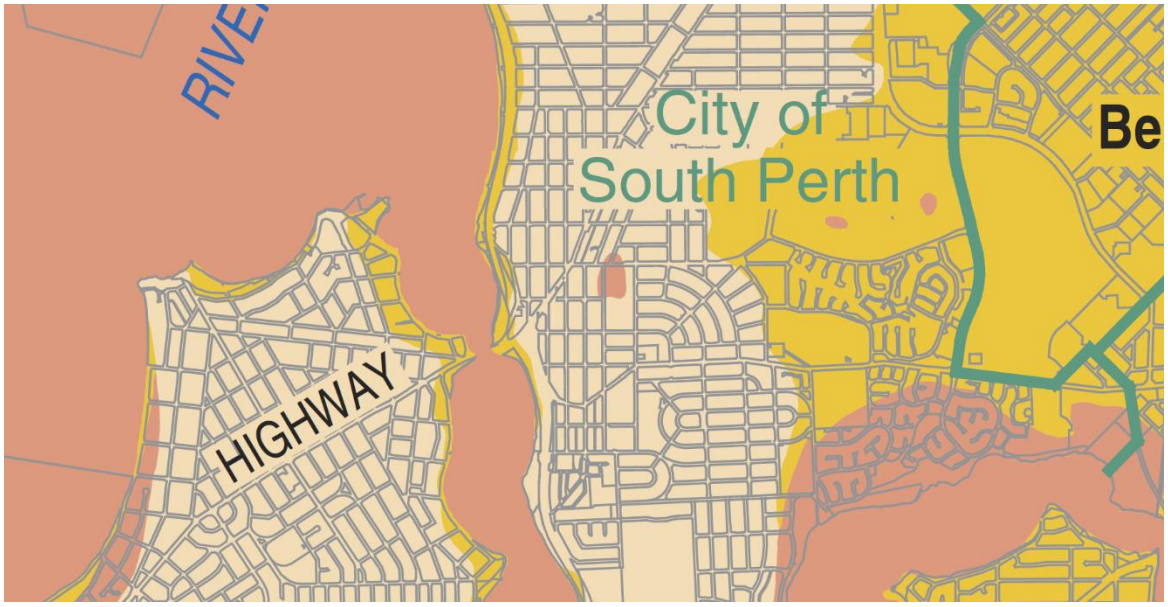


Figure 4. Acid Sulfate Soils (ASS) Maps
(Courtesy from Central Metropolitan Region Scheme acid sulfate soils)

5.0 FIELD INVESTIGATION

5.1 General

The geotechnical site investigation was undertaken on 27 November 2019 in the full-time presence of a geotechnical engineer from LG. The geotechnical site investigation comprised 4 CPT tests (CPTu1, CPTu2, CPT3 and CPT4), 5 Hand Auger test holes (TH1 to TH5), 5 Perth Sand Penetrometer tests (PSP1 to PSP5) and 2 Field Permeability Tests (FPT1 and FPT2).

Summary of the tests undertaken onsite is shown in Table 1 and test location plan is shown in Appendix A.

Table 1. Summary of Field Tests

Test ID	Test Type	Easting (m, GDA94)	Northing (m, GDA94)	RL * (m, AHD)	Groundwater Depth (m)	Termination Depth (m)
CPTu1	Cone Penetrometer Test	392112	6458197	9.69	8.3	19.66 (refusal)
CPTu2		392065	6458147	11.51	10.3	25.47

Test ID	Test Type	Easting (m, GDA94)	Northing (m, GDA94)	RL * (m, AHD)	Groundwater Depth (m)	Termination Depth (m)
CPT3		392080	6458185	10.64	-	15.31
CPT4		392070	6458204	10.72	9.5	15.26
TH1 & PSP1	Hand Auger Hole & PSP Test	392097	6458210	-	NE	3.0
TH2 & PSP2		392088	6458197	-	NE	3.0
TH3 & PSP3		392113	6458199	-	NE	3.0
TH4 & PSP4		392117	6458168	-	NE	3.0
TH5 & PSP5		392063	6458157	-	NE	3.0
FPT1	Field Permeability Tests	392063	6458157	-	NE	0.3
FPT2		392 196	6458196	-	NE	0.3

Note: Approx. = Approximate, NE = Not Encountered. * RL of the test locations were not surveyed, however, CPT test location RLs were recorded from the DGPS.

5.2 Test Hole Drilling

Five Test Holes (TH1 – TH5) were drilled across the site by using a hand auger. During test hole drilling, the spoil was stockpiled adjacent to the test location. The subsurface profiles exposed in the test holes were logged in accordance with AS1726 and were photographed to provide a visual record of subsurface conditions encountered. Following these activities, each test location was progressively backfilled in the reverse order of drilling works. During backfilling, test hole was compacted by a tamping rod.

Summary of the THs is shown in Table . Logs and photographs of the THs are presented in Appendix B and Appendix D, respectively.

5.3 Perth Sand Penetrometer Test

Five Perth Sand Penetrometer tests (PSP1 – PSP5) were conducted adjacent to each TH in accordance with AS 1289.6.3.3-1997. PSP test data were used to estimate the field density on the basis of correlations presented in Standard Australia HB 160-2006. All PSPs were terminated at 1.05 m bgl. PSP test data are presented in Appendix B together with the TH logs.

It is observed from the PSP tests that the site was in loose to dense condition.

5.4 Electric Friction Cone Penetrometer Test

The Electric Friction Cone Penetrometer Test (CPT) was undertaken by CPT West using a 22 tonne truck rig. The investigation was carried out in accordance with AS 1289.6.5.1-1999.

The CPT test generally interprets profile of soil, type, subsurface strength and stiffness parameters along the probing depth in accordance with Robertson et. al. (1986).

The results of the test are presented in Appendix C as plots of Cone Tip Resistance (qc), Sleeve Friction (fs), Friction Ratio (Rf = fs/qc x 100%) versus depth.

CPTu1 was met refusal at depth 19.66 m due to high tip resistance (over 80 MPa). The remaining 3 CPTs reached target depths, between approximately 15 m and 25m. After each probing, the probe hole was dipped by a weighted measuring tape with the intention to directly measure the depth to the groundwater table. Groundwater depth was recorded at between 8.3 m and 10.3 m.

5.5 Standpipe Piezometer Installation

Two CPT probes, CPTu1 and CPTu2, were converted into standpipe piezometers by installing a 25mm diameter perforated PVC pipe to a depth of 11.5m and 14.5 m, respectively. Water depths were measured post installation which were 8.3 m for CPTu1 and 10.3 m for CPTu2.

5.6 Permeability Test

Guelph Permeability Tests to assess infiltration rate/permeability of the surficial ground (within 0.5 m depth) was undertaken by LG. It is a falling head permeability test to assist in designing disposal of stormwater runoff. Approximate test location (FPT1 and FPT2) is shown in Appendix A.

The results and the interpretation of the testing are presented in Appendix B and summarised in Table 2Table .

Table 2. Summary of Permeability Test Results

Test ID	Soil Description	Depth bgl (m)	Estimated Permeability, k (m/day)
FPT 1	Sand (SP)	0.30	5.6
FPT 2	Sand (SP)	0.30	5.4

The summary of permeability tests is:

- Permeability tests were undertaken within the top 300 mm depth.
- The soil profile encountered onsite and in test pits was generally sand.
- According to AS/NZS 1547-2012, sand material is described to have ‘Soil Category 1’ with an indicative permeability greater than 3 m/day.
- Average coefficient of permeability varied between 5.4 m/day (or 6.3 x 10^{-5} m/s) and 5.6 m/day (or 6.5 x 10^{-5} m/s); Ref. Calculation sheets at Appendix B.

6.0 LABORATORY TESTING

6.1 General

Laboratory testing was undertaken by a NATA accredited laboratory. The test standard applicable to each test is recorded on the laboratory testing certificates/reports. The scheduled laboratory testing included:

- 2 x Particle Size Distribution test (PSD, from 75 mm to 75 micron, AS1289.3.6.1)
- 20 x pH and PH_{FOX}, Acid Sulfate Soils (ASS) screening test
- 2 x Soil Aggressivity Test (pH, EC, SO_4, Cl).

As clayey soils were not encountered during the site investigation, no Atterberg Limits test was undertaken.

6.2 Geotechnical Laboratory Test Results

The geotechnical laboratory test results are summarised in Table 3. The laboratory test certificates/reports are included in Appendix E.

Table 3. Summary of Geotechnical Laboratory Test Results

Test Parameters	Sample ID: TH3 (1 – 2 m)	TH5 (1.5 – 3 m)
	Particle Size Distribution	
Gravel (%)	0	0
Sand (%)	99	99
Fines < 75µm (%)	1	1

Particle Size Distribution testing was undertaken in accordance with Australian Standard, AS 1289.3.6.1. The soil matrix tested comprises approximately 0% gravel, 99% sand and 1% fines. According to AS1726-1993, the samples tested can be classified as Poorly Graded SAND (SP).

6.3 Acid Sulfate Soils (ASS) Test Results

The laboratory ASS test results are summarised in Table 4. The laboratory test certificates/reports are included in Appendix E.

Table 4. Summary of Preliminary ASS Laboratory Test Results

Sample ID	pH_F	pH_{FOX}	ΔpH	Reaction rate	SPOCAS %S	NAAS/AASS/ PASS
TH1_0.25 m	6.6	4.6	2.0	M	-	NASS
TH1_1.0 m	7	5	2.0	S	-	NASS
TH1_2.0 m	7	5.1	1.9	S	-	NASS
TH1_3.0 m	7.1	5.2	1.9	S	-	NASS
TH2_0 m	6.9	4.6	2.3	M	-	NASS
TH2_0.5 m	7	5.1	1.9	M	-	NASS
TH2_1.5 m	7.1	5.3	1.8	S	-	NASS
TH2_2.5m	7.1	5.4	1.7	S	-	NASS
TH3_0 m	6.8	4.3	2.5	M	-	NASS
TH3_0.75 m	6.3	4.4	1.9	M	-	NASS
TH3_2.0 m	6.2	4.6	1.6	S	-	NASS
TH3_3.0 m	6.1	4.4	1.7	S	-	NASS
TH4_0.25 m	6.7	4.9	1.8	M	-	NASS
TH4_1.0 m	6.9	5.0	1.9	M	-	NASS
TH4_1.5 m	6.1	5.0	1.1	M	-	NASS
TH4_2.5 m	6.9	5.5	1.4	S	-	NASS
TH5_0.5 m	7.4	5.5	1.9	M	-	NASS
TH5_1.5 m	7.8	5.6	2.2	M	-	NASS
TH5_2.0m	7.9	5.8	2.1	M	-	NASS
TH5_3.0 m	8.2	5.8	2.4	M	-	NASS

Note: M = Moderate, S= Slight, NASS = Non-Acid Sulfate soils, AASS = Actual Acid Sulfate soils, PASS = Potential Acid Sulfate soils. S = Net Acidity excluding ANC (Sulfur units).

A total of 20 samples collected from the 5 THs were submitted to the laboratory for field pH_F and pH_{FOX} screening test. Interpretation of results are presented below:

- pH_F results ranged between 6.1 and 8.2.
- pH_{FOX} results ranged between 4.3 and 5.8.
- None of the samples were assessed to have both pH_F and pH_{FOX} < 4.0, which suggest the samples tested are non-AASS.
- All samples were assessed to have both pH_F and pH_{FOX} > 4.0, which suggest non-ASS (=NASS).
- None of the samples have pH_F > 4.0 and pH_{FOX} < 4.0, which suggest the sample tested is non-PASS.
- The difference between the two measurements, ΔpH (= pH_F - pH_{FOX}), varies between 1.1 and 2.5. pH_{FOX} value at least one unit below pH_F may indicate PASS but depends on the initial and resultant pH. However, one unit change from higher end pH, e.g., 6.1 to 8.2 will not indicate PASS.
- pH_{FOX} value >5 indicates little net acidifying ability and neutral to alkaline pH.
- Slight (L) to Moderate (M) reaction of soil with peroxide is a less likely indication. Moderate (M) reaction may be caused due to the presence of organic matter and other clayey soil constituents.

6.3.1 Concluding Remarks on ASS Status

The foregoing discussions on the ASS field screening tests indicate that the presence of AASS and PASS at the tested locations of the site is less likely.

6.4 Soil Aggressivity Test Results

The aggressivity (chemical) test results are summarised in Table 5. The laboratory test certificates are included in Appendix E.

Chemical tests were undertaken to establish the corrosivity and aggressiveness of the soil at the site.

Exposure classification stated in Tables 6.4.2 (C) and 6.5.2 (C) of AS 2159-2009 'Piling - design and installation' for soils above and below groundwater table were used to assess the soils' aggressivity. These exposure classifications are applicable to all buried concrete and steel structures.

Table 5. Soil Aggressivity Assessment for the Soil Materials

Sample ID	pH	Sulphate in Soil (ppm)	Chloride in Soil (ppm)	Resistivity, ohm.cm	Exposure Classification for [considering Soil Conditions B*]	
					Concrete	Steel
TH3(1-2m)	7.8	<100	<10	200,000	Non-aggressive	Non-aggressive
TH5(1.5-3m)	8.4	<100	<10	43,478	Non-aggressive	Non-aggressive

**Soil conditions B = low permeability soils or all soils above groundwater

Based on the measured pH, chloride, sulphate and resistivity values, the soil exposure classification for both concrete and steel is '**non-aggressive**'.

7.0 ENGINEERING CONSIDERATIONS AND RECOMMENDATIONS

7.1 Inferred Subsurface Conditions

Subsurface conditions inferred from the site investigation can be described as follows:

- TOPSOIL, SAND (SP) – fine to medium grained, brown, dark brown, grey, dry, loose to dense; with weeds, grass, organics; extended from surface to a depth of around 0.2 m, overlying,
- SAND (SP) – fine to medium grained, yellow, light yellow, brown, grey, and light grey at depths, moist, quartz, extended to the maximum investigated depth 25.5 m. In this unit, following generalised densities were assessed:
    - 0.2 – 5.7 m: medium dense,
    - 5.7 – 25.5 m: dense to very dense.

7.2 Groundwater and Dewatering

Groundwater depth was recorded on 27 November and 10 December 2019 as follows:

Table 6. Summary of Groundwater Depth

Test Location	Depth (m bgl)		RL (m AHD)
	Date: 27/11/19	Date: 10/12/19	(approx.)
CPTu1	8.30	8.39	1.30
CPTu2	10.30	10.09	1.14
CPT4	9.50	-	1.22

Ground surface elevation of the site varies between 9.5 m AHD and 11.5 m AHD and historical highest groundwater table was at 2 m AHD as per the Perth Groundwater Atlas. That indicates that estimated highest groundwater depth varies between 7.5 m and 9.5 m below the ground surface.

Lower basement floor level of the proposed building was unknown during preparation of this report. We recommend that a sand cover of 1 m above the Ground Water Table (GWT) should be left in the design process to facilitate a clean construction environment, a stable raft and pad foundation construction.

If the basement Bulk Excavation Level (BEL) leaves a sand cover of less than 1m above the GWT, dewatering will be required to facilitate clean excavation, compaction for foundation bases and subsequent construction.

7.3 Geotechnical Design Parameters

Geotechnical design parameters for the site were inferred on the basis of the site investigation data and are presented in Table 7 below.

Table 7. Inferred Geotechnical Design Parameters for the current site conditions

Depth (m, bgl)	Layer Description	Soil Parameters					k_s (MN/m³)	k (m/s)
		ϕ' (deg.)	c_u (kN/m²)	γ (kN/m³)	E' (MPa)	ν'		
0 – 5.7	Sand (SP) loose to medium dense	34	-	20	25	0.3	5	6.5×10^{-5}
5.7 – 25.5	Sand (SP) Dense to very dense	38	-	20	90	0.3	20	6.5×10^{-5}

Notes: ϕ' = Effective friction angle, c_u = Undrained shear strength, γ = Bulk density, E' = Drained Elastic Modulus, ν' = Poisson's Ratio, k_s = Modulus of vertical subgrade reaction, k = Coefficient of Permeability.

7.4 Geotechnical Design Parameters for Retaining Structures

Earth pressure parameters for the design of retaining structures are presented in Table 8. These parameters should be considered as preliminary.

Table 8. Geotechnical Design Parameters for Retaining Structures

Material type	γ (kN/m³)	ϕ' (degrees),	K_0	Wall friction, δ = 0°	
				K_a	K_p
Loose to medium dense in situ sand	17	30	0.50	0.33	3.00
Dense Sand or Compacted Sand Fill	18	34	0.44	0.28	3.54

Notes: γ = Bulk unit weight, ϕ'= Effective friction angle, K_0 = Coefficient of earth pressure at rest, K_a = Coefficient of drained active earth pressure, K_p = Coefficient of drained passive earth pressure.

7.5 Site Classification

Based on the subsurface and surrounding site conditions observed during the field investigation, the site was classified as "**Class P**" in accordance with AS 2870-2011 "Residential Slabs and Footings".

The site classification 'Class P' was based on the following basis:

- 'Loose sand' of the site within the surficial 3 m depth is considered to be an unstable foundation ground.
- Excessive foundation settlement may occur due to loading on the loose and compressible foundation ground.
- Presence of potential demolition debris from the existing structures and the land uses.

Site Classification Upgrade

Provided the earthworks and compaction are completed as per the recommendations presented in Section 7.7.3, the site can be reclassified to **"Class A"** in accordance with the definitions provided in the Australian Standard AS 2870 -2011 "Residential Slabs and Footings - Construction".

Class "A" sites will experience slight or no ground surface movement due to soil wetting and drying cycles associated with seasonal changes in available moisture.

7.6 Earthquake Design Factor

Australian Standard AS1170.4-2007 Structural design actions Part 4 "Earthquake actions in Australia" is recommended for earthquake consideration. AS1170.4-2007 outlines the design criteria required for a structure in consideration of the risk of being subjected to earthquake loads. Earthquake design factors are summarised in Table 9.

Table 9. Earthquake Design Factors

Factor/Class	Value/Name	Ref. AS1170.4- 2007
Hazard Factor (z) (Peak Ground Acceleration, g for 500 years return period)	0.09	Figure3.2 (D)
Site sub-soil class	**Class C_e** – Shallow Soil	Section 4 Clause 4.1

7.7 Earthworks

7.7.1 Suitability of Excavated Materials for use as Fill

In situ sands are considered to be suitable for reuse as structural fill material.

7.7.2 Structural Fill

Suitable materials for structural fill shall be a clean sand fill. The fill material at compaction should comprise sand that is free from oversized material (i.e. material > 75 mm in any dimension), contains less than 5% fines (material passing 0.075 mm sieve), and free from foreign material, organic material or other deleterious material. It should also be free from industrial waste, solid waste, or construction and demolition debris.

7.7.3 Site Preparation

Earthworks should be carried out in general accordance with the Australian Standard AS 3798-2007 "Guidelines on Earthworks for Commercial and Residential Developments". The following are general guidelines to be followed during preparation of the site areas within the proposed development footprints:

- Remove and grub all root masses and tree stumps, if any.
- Strip top soil, approximately 200 mm, and any uncontrolled fill, cobbles and boulders, paved materials, demolition debris, green waste, weeds/grass, organic matter or other deleterious material, if any and stockpile them separately.

Considering Basement Construction:

- Specialist D&C piling contractor will construct the piled retention system, surrounding the building area.
- Undertake staged excavation, each stage approximately 1.5m deep depending on site subsurface and surrounding conditions, and then construct infill shotcrete wall. Advice from a geotechnical engineer should be sought to determine the lift depth.
- Excavate up to the Bulk Excavation Level (BEL) and construct shotcrete wall up to the lower basement floor level.
- Excavate locally up to the required depths, for strip and pad/raft foundations, at BEL, allowing a maximum dry slope angle of 1V: 1H for less than 1m deep cut. Allow 1V:1.5H for up to 2 m deep cut.
- Compact the exposed strip and pad foundations' bases, with required number of passes of a suitable hand-held compactor to a dense state, i.e., to 95% of MMDD in accordance with AS1289.5.2.1. Add moisture as needed during the compaction. Compaction must not be attempted if the exposed ground is saturated or groundwater is at excavation level.
- Care will need to be taken when compacting in the vicinity of existing structures to avoid damage from excessive vibrations.
- A dilapidation survey monitoring plan is recommended to prepare if neighbourhood properties (building, garage, road, electrical poles etc) are located within 0.5m to 2.5 m from the basement retention wall.

It is recommended that a geotechnical engineer supervises the site activities to ensure that all demolition debris have been adequately removed from the area and that site is safely excavated and adequately backfilled and compacted as per the procedures described above.

7.8 Bearing Capacity

7.8.1 Strip and Pad Foundation

The proposed building structure is proposed to be supported on conventional pad, strip and raft footings founded at the Bulk Excavation Level (BEL) of the basement floor. As discussed in Section 7.7.3, all footing bases must be compacted to dense state, to a minimum depth of 1 m below the footing excavation level.

It should be ensured that footings are founded on compacted sand layer. In such conditions, footings may be designed on the basis of the allowable bearing pressures as given in Table 10.

Table 10. Allowable Bearing Pressures for Basement Level Spread & Strip Footings

Founding Layer Description	Footing Type	Allowable Bearing Pressure (kPa)	Approximate Settlement (mm)
Dense Sand (SP/SM)	Pad and Raft	450	20
	Strip	300	15

Considering the proposed depth of BEL, the stress relief will be partially balanced by the total load applied by the proposed structure. Long term settlements are therefore anticipated to be

negligible. Localised settlements will take place directly beneath individual footing as a result of recompression of the founding stratum during the construction of the proposed building structure. It is anticipated that the majority of the settlements will take place relatively quickly upon the application of the structural load.

Total settlements were estimated to be approximately 0.5% of the footing width for pad footings and approximately 1.0% of the footing width for strip footings. Differential settlements between adjacent isolated footings subjected to similar loadings are anticipated to be approximately half of the total settlement value. It should be noted that where isolated footings are subject to significantly different loadings, differential settlement between these footings may exceed acceptable limits. Settlements should be checked in detail where such instances arise.

We recommend a qualified engineer be on site to inspect the footing excavations and base ground preparation prior to the placement of concrete to ensure that the founding conditions are consistent with the design recommendations. If the design recommendations are not met it may be necessary to either increase the founding depth of the footings or alternatively increase the plan area of the footings.

7.8.2 Pile Foundation

The geotechnical strength reduction factor, ϕ_g, can be considered as 0.50 in accordance with AS2159. Geotechnical parameters for pile foundation design are preliminary estimated for the encountered subsoil materials and presented in Table 11 below.

Table 11. Ultimate Bearing Capacities for Piles

Foundation Material	End Bearing Capacity, f_{bu} (kPa)	Skin Friction, f_{su} (kPa)
Sand (SP) loose to medium dense	1,000	25
Sand (SP) Dense to very dense	5,000	90

7.9 California Bearing Ratio (CBR) for Roads & Carpark's Subgrade

The subgrade of the proposed carpark, internal roads, hardstand and driveway areas shall be prepared as per the general guidelines set out in Section 7.7.3 and compacted to a density ratio of 98% MMDD.

Based on the sandy material, a design CBR value of 12% can be considered for this project.

7.10 Excavatability

The loose to dense state of the in-situ sandy soils suggests that the materials should be excavatable with a standard earthmoving equipment (e.g., 20 to 30 tonne excavator).

7.11 Cut and Fill Batters

Temporary excavation up to 1 m depth can be conducted with a maximum dry slope angle of 1V: 2H. Cut and fill batters above groundwater table will generally be stable at 1V: 2H. Intermediate benches have to be created if excavation is deeper than 1m. However, batters constructed at 1V: 3H will enable re-establishment of vegetation and be less prone to damage from wetting, drying and erosion.

7.12 Stormwater Drainage

The site is underlain by the Sand. According to AS/NZS 1547-2012, sandy material is described to have 'Soil Category 1'. Groundwater table was at around 1.2 mAHD. Coefficient of permeability was estimated to be 5.5 m/day. Institute of Municipal Engineering Australia WA Division (1998) recommended that finished site levels be maintained at least 1.2 m above the annual average maximum groundwater level.

The recommended measure for the disposal of stormwater is onsite through soakwells or through to the basement stormwater management network. The volume of expected stormwater (worst case scenario) is to be estimated and designed by a suitably qualified Civil Engineering professional considering the above-mentioned soil category and infiltration rate.

7.13 Additional Site Investigation Recommendation

We recommend undertaking of an additional site investigation soon after the demolition of the existing buildings. The additional investigation may comprise a series of borehole drilling which will assist detail design of soldier pile retention wall for basements.

8.0 LIMITATION OF USE

The ground is a product of continuing natural and man-made processes and therefore exhibits characteristics and properties which vary from place to place and can change with time. Geotechnical site investigation involves gathering and assimilating limited facts about these characteristics and properties in order to better understand or predict the behaviour of the ground at a particular site under certain conditions.

This site investigation has been carried out by inspection, using a limited amount of CPT, pit excavation, sampling, testing or other means of investigation. Achieving a full coverage of the site to ensure all variations is not practical and is seldom done due to cost constraints as well as the impracticality.

It should be noted that the subsurface conditions encountered by the limited number of field tests as part of this geotechnical site investigation represents the ground conditions at the locations where the samples were taken and where tests have been undertaken and as such are an extremely small proportion of the site to be developed.

The facts reported in this document are directly relevant only to the ground at the place where, and time when, the investigation was carried out and are believed to be reported accurately. Given the limited number of field and laboratory testing carried out with respect to the overall site area, variations between investigation locations are likely and ground conditions different to those presented in this report may be present within the subject site area. The risk associated with this variability and the impact it will have on the proposed development should be carefully considered.

The level of geotechnical investigation that has been completed to date is considered appropriate for the project objectives. If the above mentioned client, its subcontractors, agents or employees use this factual information for any other purpose for which it was not intended, then the client, its subcontractors, agents or employees does so at their own risk and Local Geotechnics will not and cannot accept liability in respect of the advice, whether under law of contract, tort or otherwise.

Any interpretation or recommendation given in this report is based on judgement and experience and not on greater knowledge of the facts reported. Local Geotechnics does not represent that the information or interpretation contained in this report addresses completely the existing features, subsurface conditions or ground behaviour at the subject site.

9.0 REFERENCES

- Australian Standard AS1170.4-2007, “Earthquake Actions in Australia”.
- Australian/New Zealand Standard AS/NZS 1547-2012, “On-site Domestic Wastewater Management”.
- Australian Standard AS 1726-1993 *"Geotechnical Site Investigations".*
- Australian Standard AS 2870-2011, *"Residential Slabs and Footings".*
- Australian Standard AS 3798-2007, *"Guidelines on Earthworks for Commercial and Residential Developments".*
- Bowles JE (2013), Foundation Analysis and Design, 5th edition, McGraw Hill London
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- Geological Survey of Western Australia (1986). 1:50,000 Environmental Geology Series Map, Fremantle Sheet No 2033 I and IV.
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- Perth Groundwater Atlas online version, https://maps.water.wa.gov.au/#/webmap/gwm, Department of Environment, WA (browsed 8 Dec. 2019).
- Robertson. P.K., Campanella, R.G., Gillespie, D., and Greig, J., (1986), “Use of Piezometer Cone data”, In-Situ’86 Use of In-situ testing in Geotechnical Engineering, GSP 6, ASCE, Reston, VA, Specialty Publication, pp 1263-1280.
- Standards Australia, Hand Book HB 160-2006 "Soil Testing".

APPENDIX A

SITE SKETCH

LOCAL GEOTECHNICS

Site Sketch : Test Hole, Perth Sand Penetrometer, Field Permeability Testing and Cone Penetrometer Test Locations

Reference	LGK9542019GI
Client	dem
Project	Geotechnical Investigation Location: 109, 111 & 113 Robert Street, Como WA

LOCAL GEOTECHNICS

Unit 12, 8 Production Road Canning Vale WA 6155
PO Box 5050, Canning Vale South WA 6155
Phone: 08 9457 3517
E-mail: admin@localgeotechnics.com.au
Web: www.localgeotechnics.com.au

APPENDIX B

TEST HOLE LOGS
PERMEABILITY & PSP TEST CERTIFICATE

LOCAL GEOTECHNICS

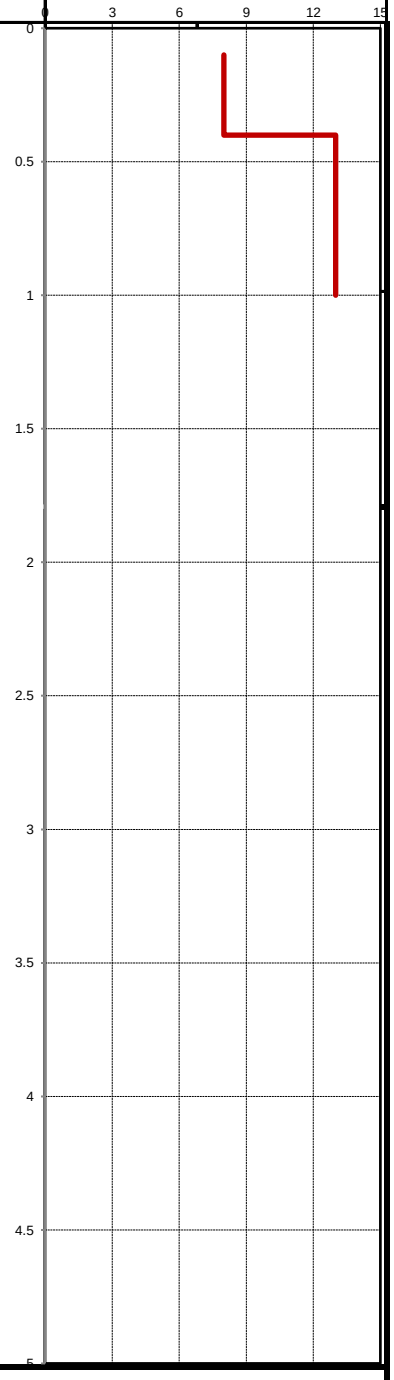
LOCAL GEOTECHNICS
ABN:61 737 984 867
12/8 Production Road, Canning Vale WA 6155
PO Box 5050 Canning Vale South WA 6155
admin@localgeotechnics.com.au

ENGINEERING LOG

RESULT OF TEST HOLES/PITS

Reference	: **LGK9542019GI**	Test Pit/BH No.:	**01**
Client	: **dem**	Date Excavated:	**27-Nov-2019**
Project	: **Geotechnical Investigation**	Date completed:	**27-Nov-2019**
Location	: **109, 111 & 113 Robert Street, Como WA**	Equipment Type:	**Hand Auger**
GPS Zone 50	: **Northing: 6 458 210** **Easting: 392 097**	Water Table:	**Not Encountered**

Depth (m)	RL (m)	Method	Penetration resistance	Sampling Type	Graphic Log	Classification Symbol	Description of Soil Strata	Additional observations
0.0						SP	**TOPSOIL, SAND-** fine to medium grained, light grey, slightly moist, dense with grass	
0.2						SP	**SAND-** fine to medium grained, light grey, slightly moist, dense, trace gravel	
0.5						SP	**SAND-** fine to medium grained, yellow, slightly moist, dense	
1.0								
2.0								
3.0							**Terminated at target depth of 3.0 m**	
4.0								
5.0								



Notes:

Sampling Type :
B - Bulk/Disturbed Sample,
UD - Undisturbed Sample

Method:
HA - Hand Auger
E - Excavator
BH - Backhoe Bucket

Moisture:
D - Dry
M - Moist
W - Wet

Logged : MS
Checked: AR

ENGINEERING LOG

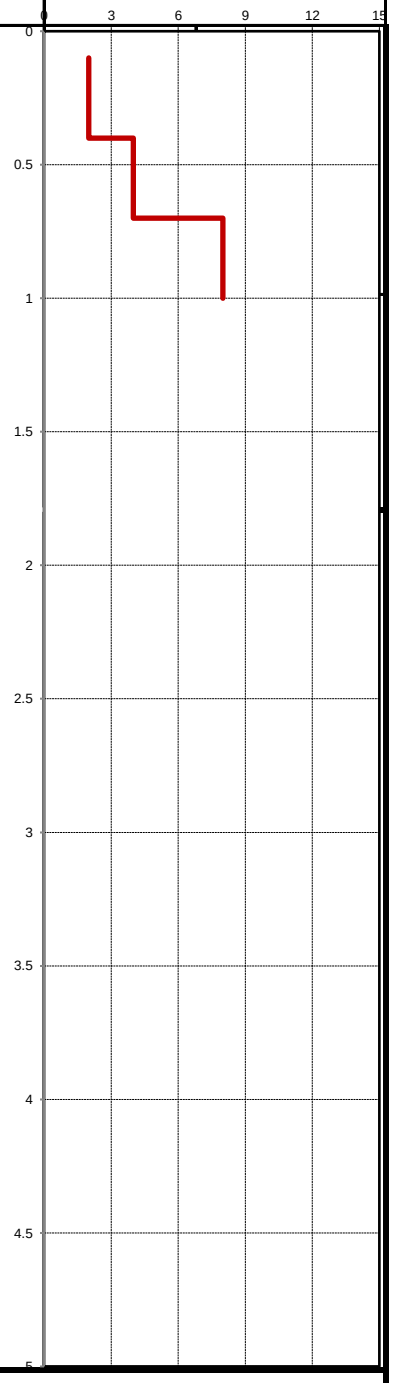
RESULT OF TEST HOLES/PITS

LOCAL GEOTECHNICS
ABN:61 737 984 867
12/8 Production Road, Canning Vale WA 6155
PO Box 5050 Canning Vale South WA 6155
admin@localgeotechnics.com.au

Reference	: **LGK9542019GI**	Test Pit/BH No.:	**02**
Client	: **dem**	Date Excavated:	**27-Nov-2019**
Project	: **Geotechnical Investigation**	Date completed:	**27-Nov-2019**
Location	: **109, 111 & 113 Robert Street, Como WA**	Equipment Type:	**Hand Auger**
GPS Zone 50	: **Northing: 6 458 197** **Easting: 392 088**	Water Table:	**Not Encountered**

Depth (m)	RL (m)	Method	Penetration resistance	Sampling Type	Graphic Log	Classification Symbol	Description of Soil Strata	Additional observations
0.0						SP	**TOPSOIL, SAND-** fine to medium grained, grey, slightly moist, loose with grass	
0.2						SP	**SAND-** fine to medium grained, light grey, dry, loose	
1.0						SP	**SAND-** fine to medium grained, light grey, moist, dense	
2.0								
3.0							**Terminated at target depth of 3.0 m**	
4.0								
5.0								

Perth Sand Penetrometer Test (Blows/300mm)



Notes:

Sampling Type :
B - Bulk/Disturbed Sample,
UD - Undisturbed Sample

Method:
HA - Hand Auger
E - Excavator
BH - Backhoe Bucket

Moisture:
D - Dry
M - Moist
W - Wet

Logged : MS
Checked: AR

ENGINEERING LOG

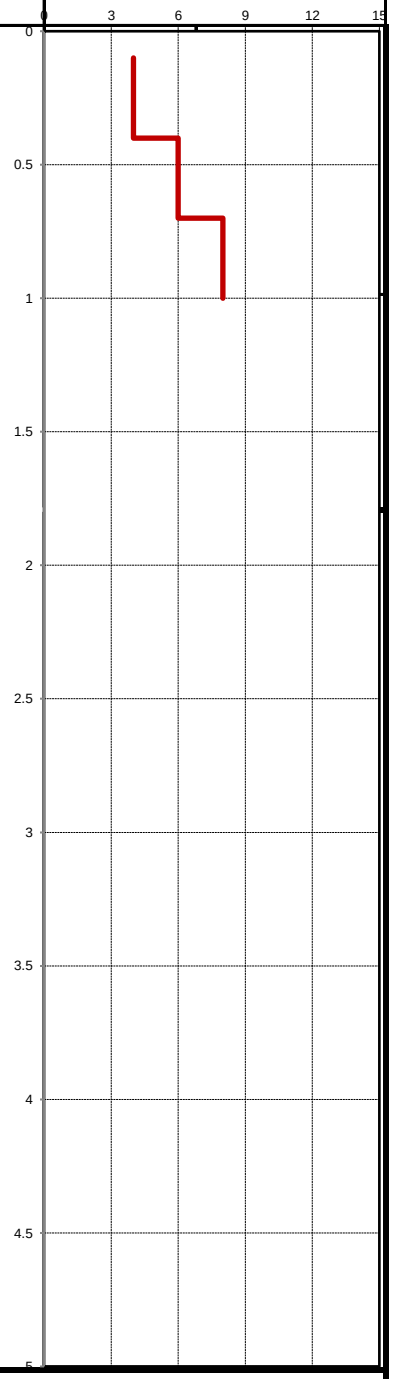
RESULT OF TEST HOLES/PITS

LOCAL GEOTECHNICS
ABN:61 737 984 867
12/8 Production Road, Canning Vale WA 6155
PO Box 5050 Canning Vale South WA 6155
admin@localgeotechnics.com.au

Reference	: **LGK9542019GI**	Test Pit/BH No.:	**03**
Client	: **dem**	Date Excavated:	**27-Nov-2019**
Project	: **Geotechnical Investigation**	Date completed:	**27-Nov-2019**
Location	: **109, 111 & 113 Robert Street, Como WA**	Equipment Type:	**Hand Auger**
GPS Zone 50	: **Northing: 6 458 199** **Easting: 392 113**	Water Table:	**Not Encountered**

Depth (m)	RL (m)	Method	Penetration resistance	Sampling Type	Graphic Log	Classification Symbol	Description of Soil Strata	Additional observations
0.0						SP	**TOPSOIL, SAND-** fine to medium grained, dark brown, slightly moist, loose	
0.2						SP	**SAND-** fine to medium grained, grey, slightly moist, loose	
0.6							colour changes to light grey at 0.6 m	
1.0								
2.0								
2.5							colour change to light yellow at 2.5 m	
3.0							**Terminated at target depth of 3.0 m**	
4.0								
5.0								

Perth Sand Penetrometer Test (Blows/300mm)



Notes:

Sampling Type:
B - Bulk/Disturbed Sample,
UD - Undisturbed Sample

Method:
HA - Hand Auger
E - Excavator
BH - Backhoe Bucket

Moisture:
D - Dry
M - Moist
W - Wet

Logged : MS
Checked: AR

ENGINEERING LOG

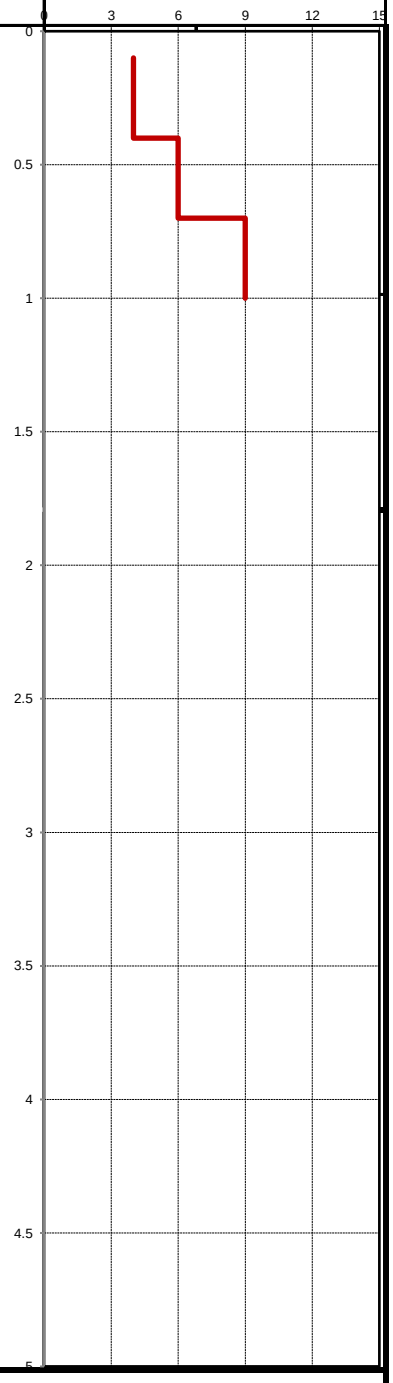
RESULT OF TEST HOLES/PITS

LOCAL GEOTECHNICS
ABN:61 737 984 867
12/8 Production Road, Canning Vale WA 6155
PO Box 5050 Canning Vale South WA 6155
admin@localgeotechnics.com.au

Reference	: **LGK9542019GI**	Test Pit/BH No.:	**04**
Client	: **dem**	Date Excavated:	**27-Nov-2019**
Project	: **Geotechnical Investigation**	Date completed:	**27-Nov-2019**
Location	: **109, 111 & 113 Robert Street, Como WA**	Equipment Type:	**Hand Auger**
GPS Zone 50	: **Northing: 6 458 168** **Easting: 392 117**	Water Table:	**Not Encountered**

Depth (m)	RL (m)	Method	Penetration resistance	Sampling Type	Graphic Log	Classification Symbol	Description of Soil Strata	Additional observations
0.0						SP	**TOPSOIL, SAND-** fine to medium grained, brown dry, loose, with organics	
0.2						SP	**SAND-** fine to medium grained, grey, slightly moist, loose colour changes to light grey at 0.4 m	
0.4								
1.0								
2.0								
3.0							**Terminated at target depth of 3.0 m**	
4.0								
5.0								

Perth Sand Penetrometer Test (Blows/300mm)



Notes:

Sampling Type:
B - Bulk/Disturbed Sample,
UD - Undisturbed Sample

Method:
HA - Hand Auger
E - Excavator
BH - Backhoe Bucket

Moisture:
D - Dry
M - Moist
W - Wet

Logged : MS
Checked: AR

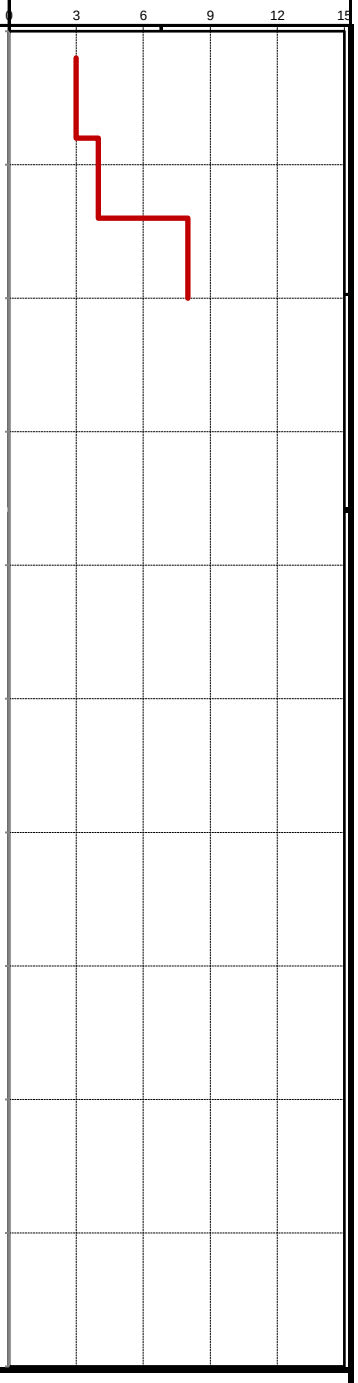
ENGINEERING LOG

RESULT OF TEST HOLES/PITS

LOCAL GEOTECHNICS
ABN:61 737 984 867
12/8 Production Road, Canning Vale WA 6155
PO Box 5050 Canning Vale South WA 6155
admin@localgeotechnics.com.au

Reference	: **LGK9542019GI**	Test Pit/BH No.:	**05**
Client	: **dem**	Date Excavated:	**27-Nov-2019**
Project	: **Geotechnical Investigation**	Date completed:	**27-Nov-2019**
Location	: **109, 111 & 113 Robert Street, Como WA**	Equipment Type:	**Hand Auger**
GPS Zone 50	: **Northing: 6 458 157** **Easting: 392 063**	Water Table:	**Not Encountered**

Depth (m)	RL (m)	Method	Penetration resistance	Sampling Type	Graphic Log	Classification Symbol	Description of Soil Strata	Additional observations
0.1						SP	**TOPSOIL, SAND-** fine to medium grained, dark brown, dry, loose, with organic, tree bark, branches, leaves	
0.4						SP	**SAND-** fine to medium grained, dark brown, dry, loose colour changes to brown at 0.4 m colour changse to light yellow at 0.6 m	
0.6								
1.0								
2.0								
3.0							**Terminated at target depth of 3.0 m**	
4.0								
5.0								



Notes:

Sampling Type:
B - Bulk/Disturbed Sample,
UD - Undisturbed Sample

Method:
HA - Hand Auger
E - Excavator
BH - Backhoe Bucket

Moisture:
D - Dry
M - Moist
W - Wet

Logged : MS
Checked: AR

LOCAL GEOTECHNICS

ABN: 61 737 984 867
PO Box 5050
Canning Vale South, WA 6155

PERTH SAND PENETROMETER (PSP) TEST CERTIFICATES

(AS 1289.6.3.2)

Density Correlation - Table 6.4.6.2 HB 160-2006

Reference	**LGK9542019GI**	Test ID	**01 to 05**
Client	**dem**	Date Tested	**27/11/2019**
Project	**Geotechnical Investigation**	Tested by	**A Bara**
Site	**109, 111 & 113 Robert Street, Como WA**	Checked by	**A Rahman**

PSP No.	PSP1	PSP2	PSP3	PSP4	PSP5
Depth below ground level (mm)	**Penetration Resistance - Blows/300mm**				
150 - 450	8	2	4	4	3
450 - 750	13	4	6	6	4
750 - 1050	13	8	8	9	8
Depth below ground level (mm)	**Density Classification**				
150 - 450	D	L	L	L	L
450 - 750	D	L	MD	MD	L
750 - 1050	D	D	D	D	D

Remarks:

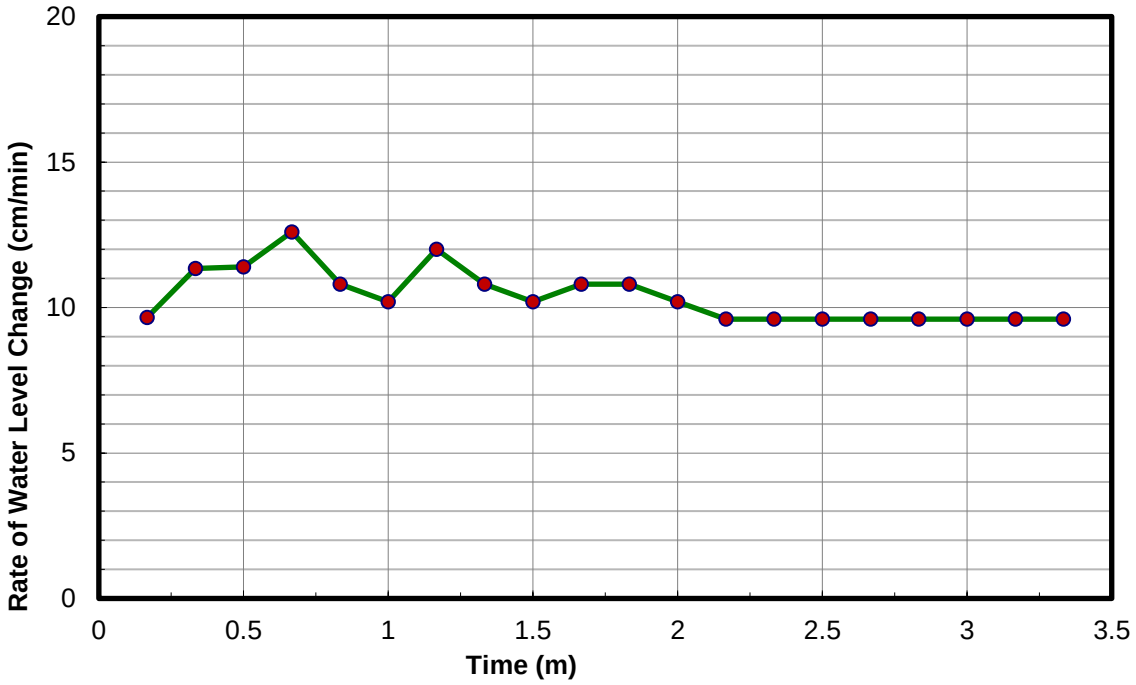
Density Correlation - Table 6.4.6.2 HB 160-2006

Very Loose (VL)	Loose (L)	Medium Dense (MD)	Dense (D)	Very Dense (VD)
< 2	2 – 6	6 – 8	8 – 15	≥ 15

INFILTRATION TEST CERTIFICATES (ASTM D 5126-90)

ABN: 61 737 984 867
PO Box 5050 Canning Vale South
WA 6155
admin@localgeotechnics.com.au

Reference	LGK9542019SA			Test ID	FPT1
Client	dem			Date Tested	27-Nov-19
Project	Geotechnical Investigation			Date Completed	27-Nov-19
Location	109, 111 & 113 Robert Street, Como WA			Instrument Type	Guelph Permeameter
Position	Northing:	6 458 157	Easting: 392 063	Tested by	A Bara



Notes: Test was conducted at a depth of 0.3 m from the existing surface level

Water Hydraulic conductivity K_{fs}: **6.5E-05** **m/sec**
5.6E+00 **m/day**

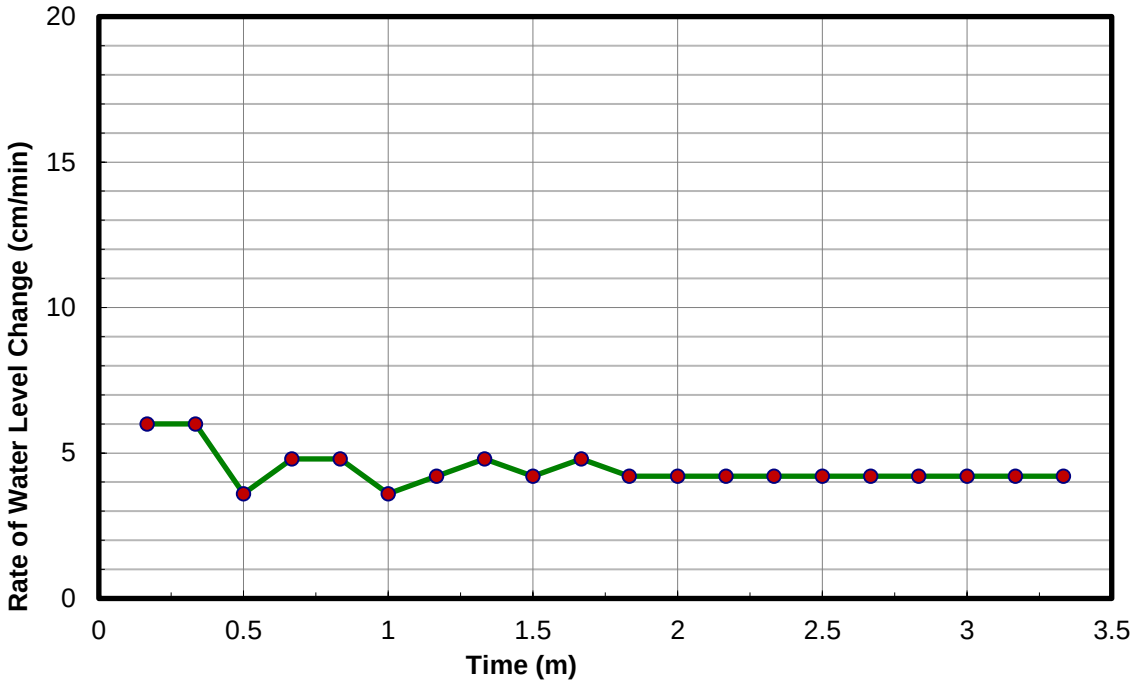
Signatory: *Dr. Harun Meer*

Date: 27/11/2019

ABN: 61 737 984 867
PO Box 5050 Canning Vale South
WA 6155
admin@localgeotechnics.com.au

INFILTRATION TEST CERTIFICATES (ASTM D 5126-90)

Reference	LGK9542019SA			Test ID	FPT2
Client	dem			Date Tested	27-Nov-19
Project	Geotechnical Investigation			Date Completed	27-Nov-19
Location	109, 111 & 113 Robert Street, Como WA			Instrument Type	Guelph Permeameter
Position	Northing:	6 458 196	Easting: 392 085	Tested by	A Bara



Notes: Test was conducted at a depth of 0.3 m from the existing surface level

Water Hydraulic conductivity K_{fs}: **6.3E-05** **m/sec**

5.4E+00 **m/day**

Signatory: *Dr. Harun Meer*

Date: 27/11/2019

APPENDIX C

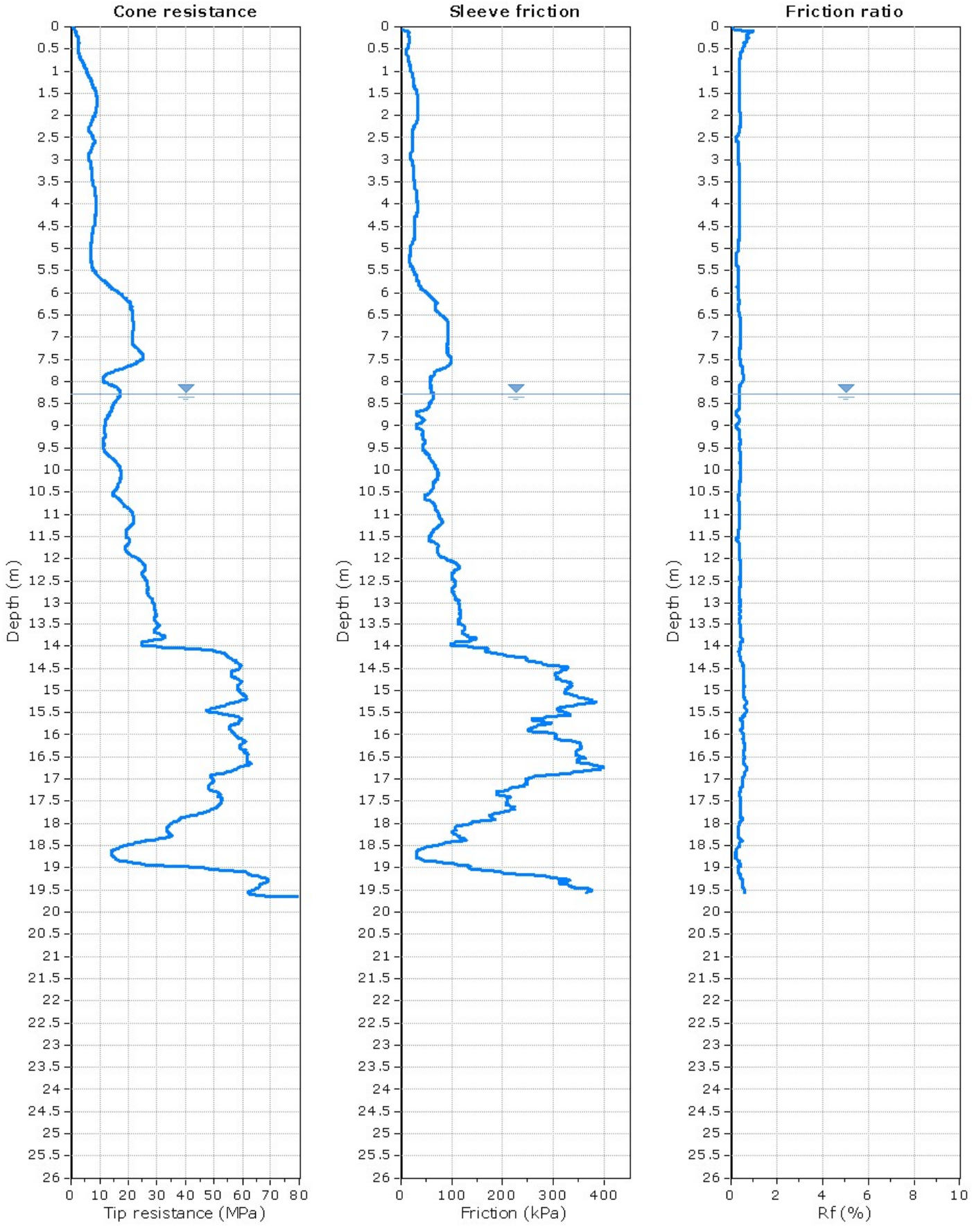
CPT TRACES & INTERPRETATION

LOCAL GEOTECHNICS

info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045

CPTu 1
Total depth: 19.66 m, Date: 27/11/2019
Surface Elevation: 9.69 m
Coords: X:392112.10, Y:6458197.44
Cone Operator: Andrew

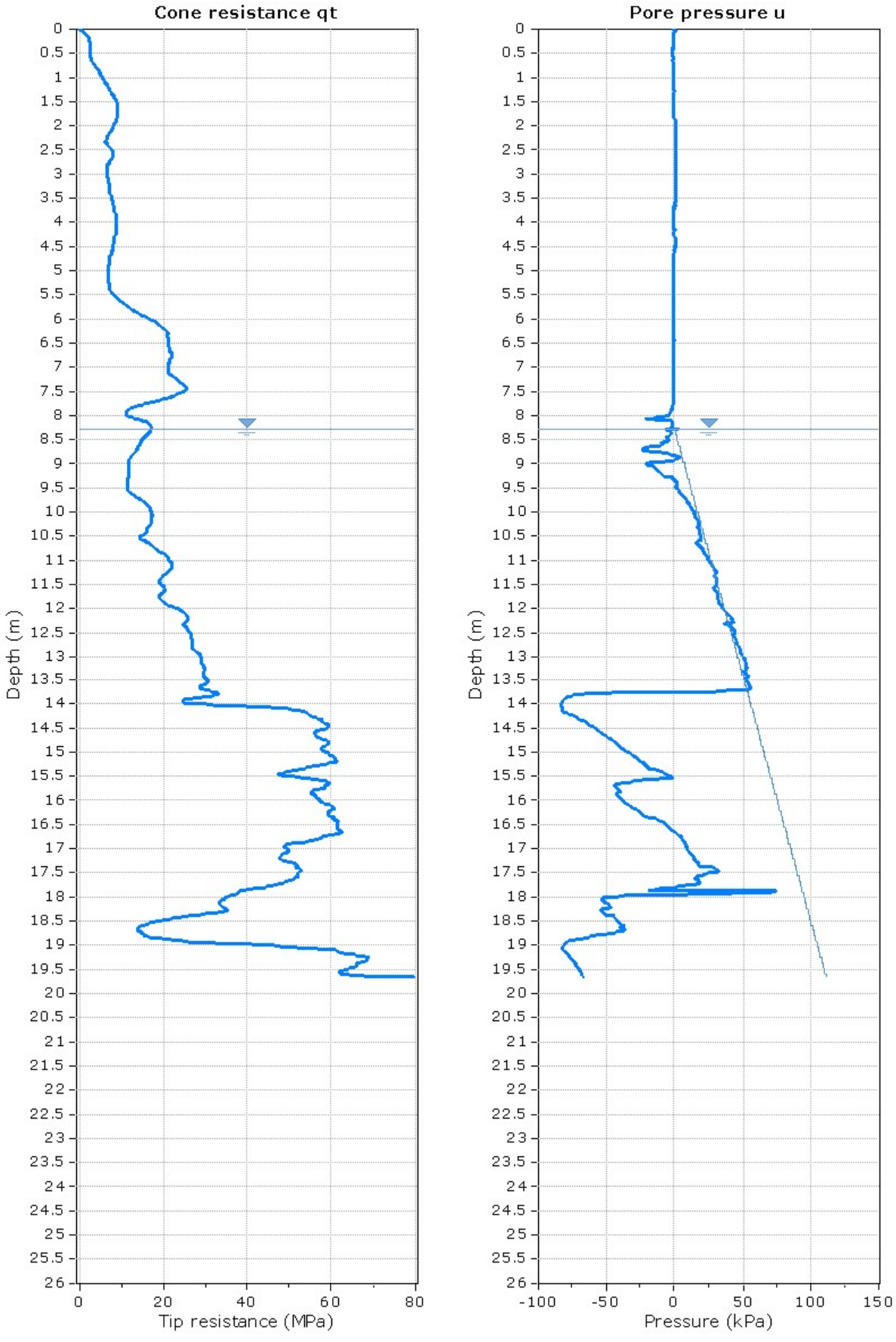
Project: **109 & 111-113 Robert Street (Project No.: LGK9542019GI)**
Location: **Como**



info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045

CPTu 1
Total depth: 19.66 m, Date: 27/11/2019
Surface Elevation: 9.69 m
Coords: X:392112.10, Y:6458197.44
Cone Operator: Andrew

Project: **109 & 111-113 Robert Street (Project No.: LGK9542019GI)**
Location: **Como**

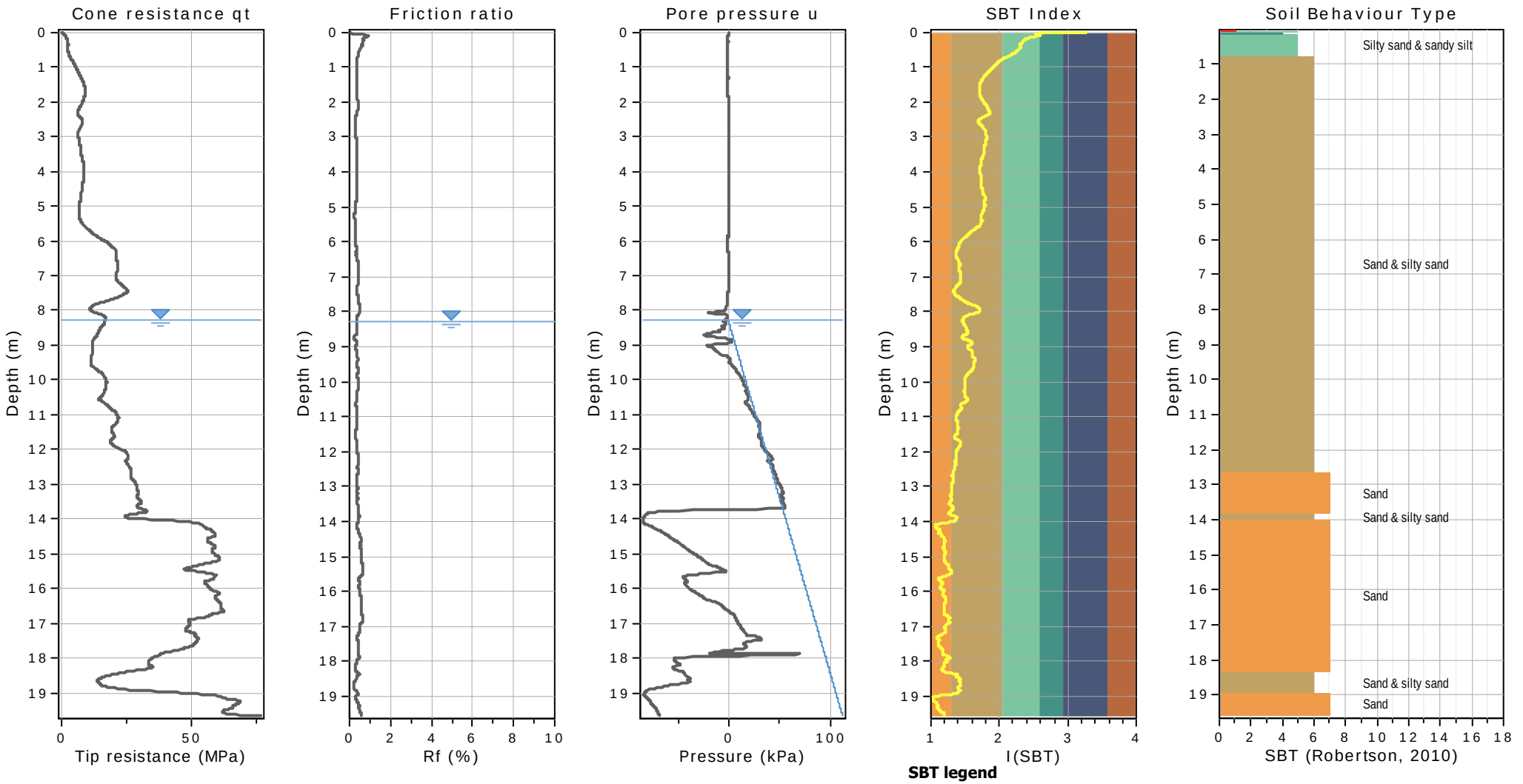


Project: **Project No.: LGK9542019GI - Geotechnical Site Investigation**

Location: **109 & 111-113 Robert Street, Como, WA**

CPTu 1

Total depth: 19.66 m, Date: 27-Nov-19

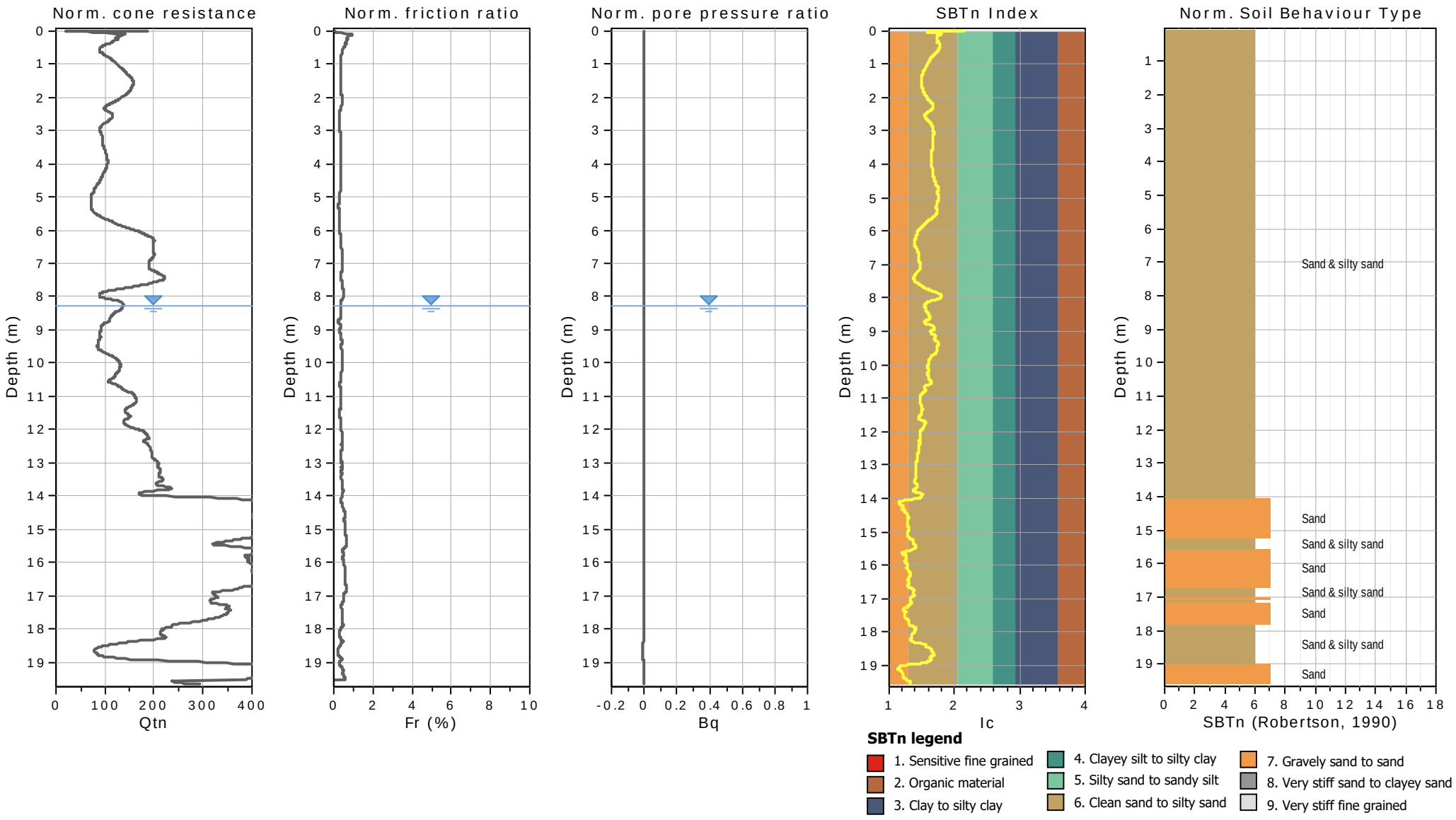


Project: **Project No.: LGK9542019GI - Geotechnical Site Investigation**

Location: **109 & 111-113 Robert Street, Como, WA**

CPT: CPTu 1

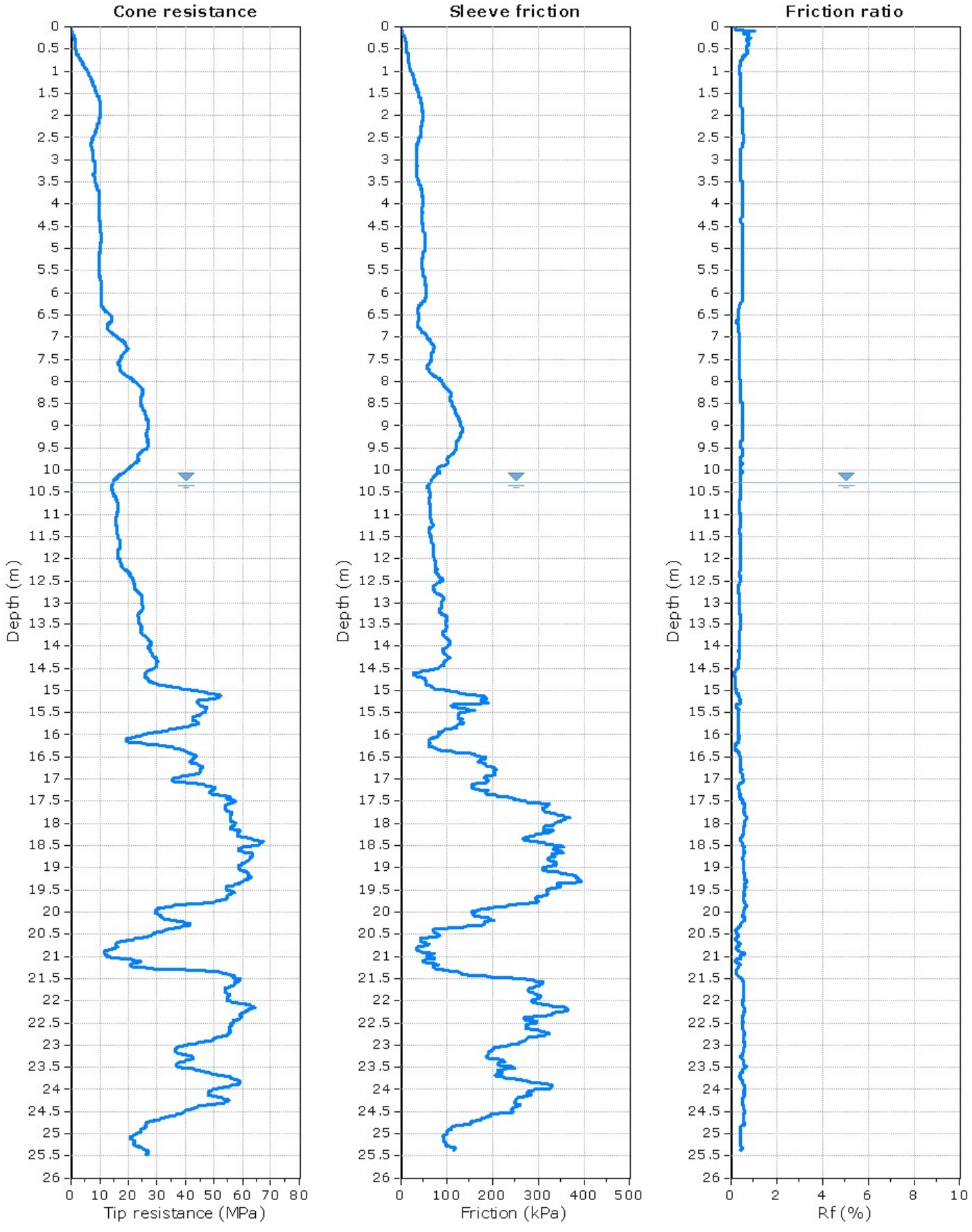
Total depth: 19.66 m, Date: 27-Nov-19



info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045

CPTu 2
Total depth: 25.47 m, Date: 27/11/2019
Surface Elevation: 11.51 m
Coords: X:392065.39, Y:6458147.12
Cone Operator: Andrew

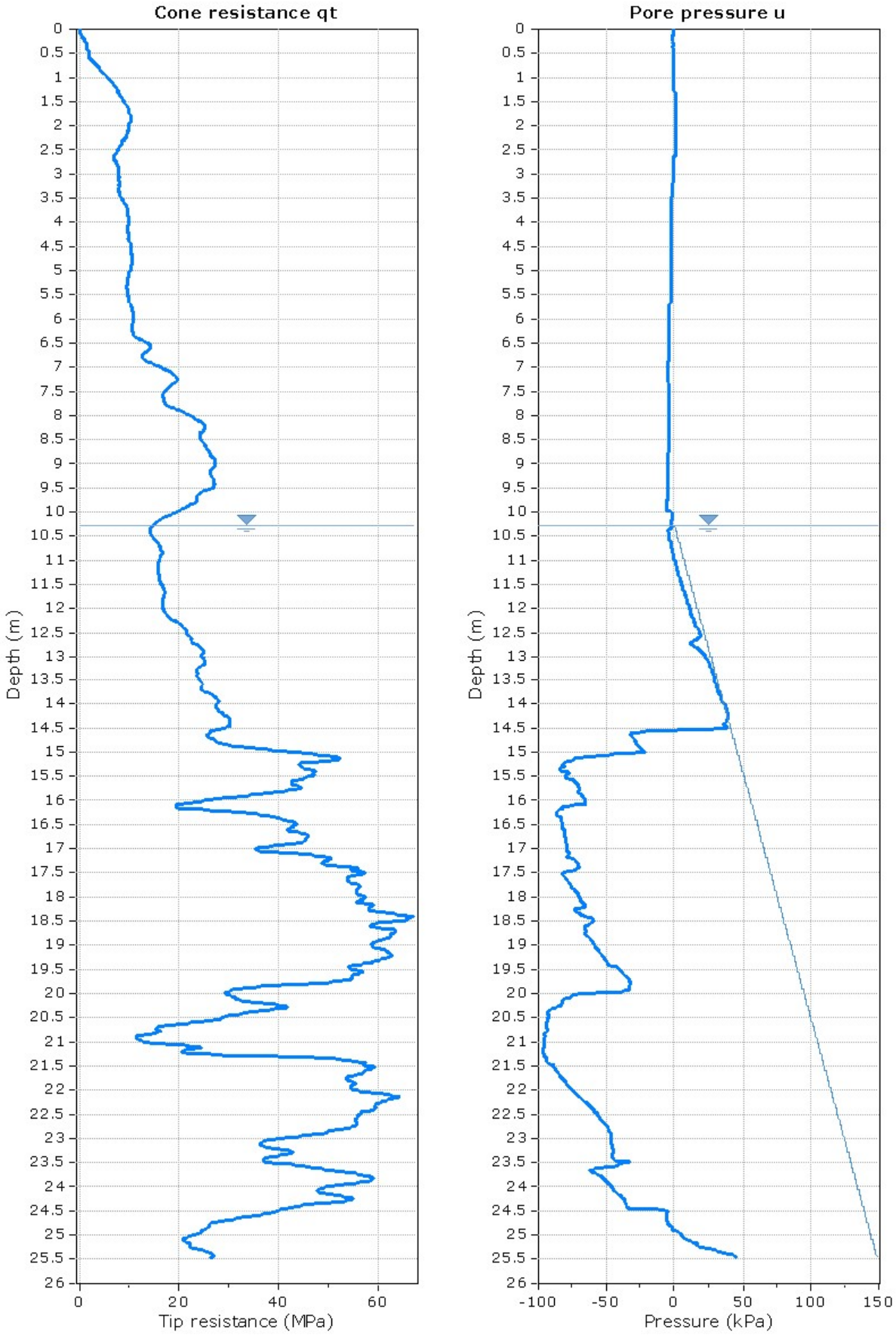
Project: **109 & 111-113 Robert Street (Project No.: LGK9542019GI)**
Location: **Como**

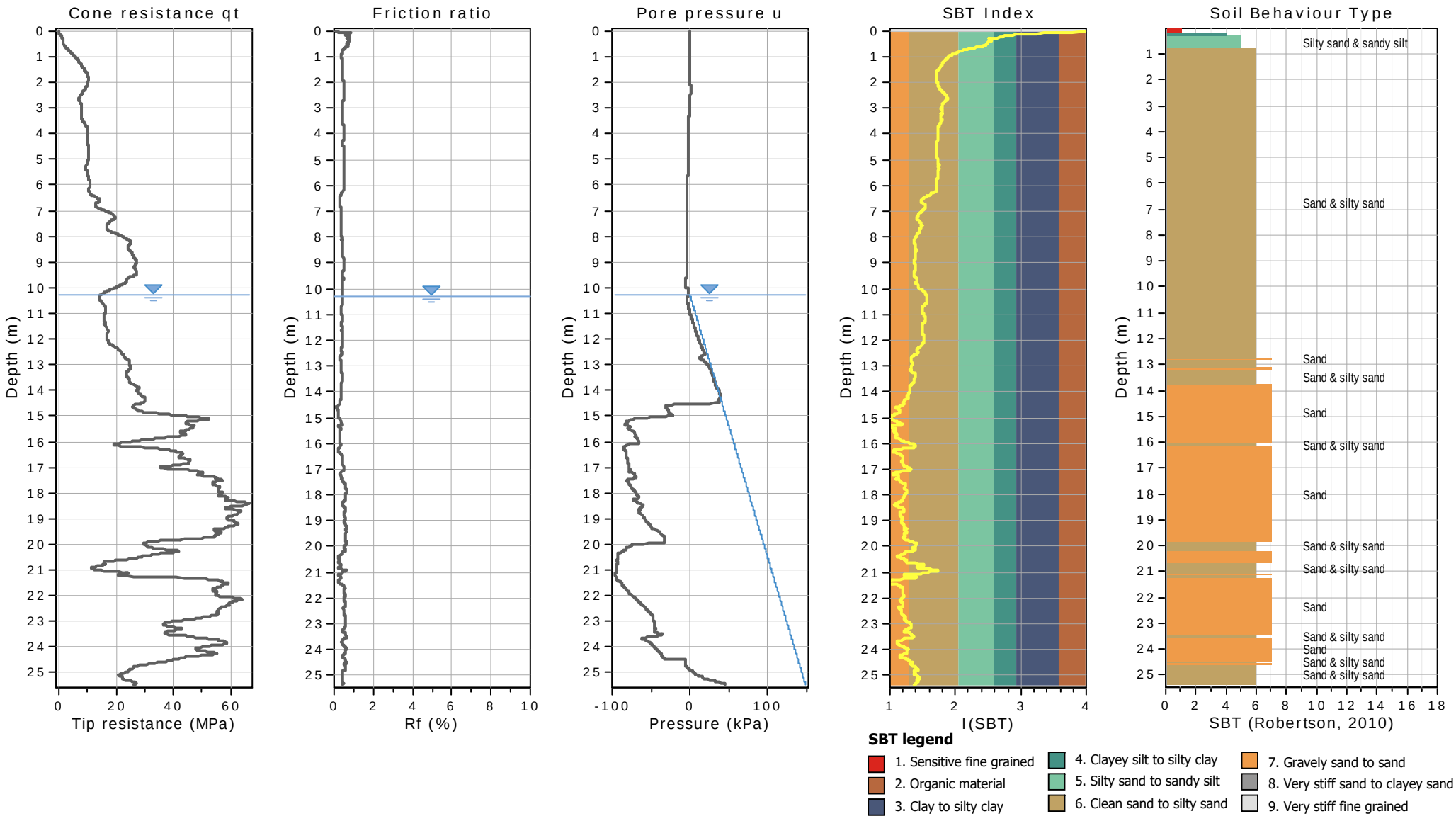


info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045

CPTu 2
Total depth: 25.47 m, Date: 27/11/2019
Surface Elevation: 11.51 m
Coords: X:392065.39, Y:6458147.12
Cone Operator: Andrew

Project: **109 & 111-113 Robert Street (Project No.: LGK9542019GI)**
Location: **Como**



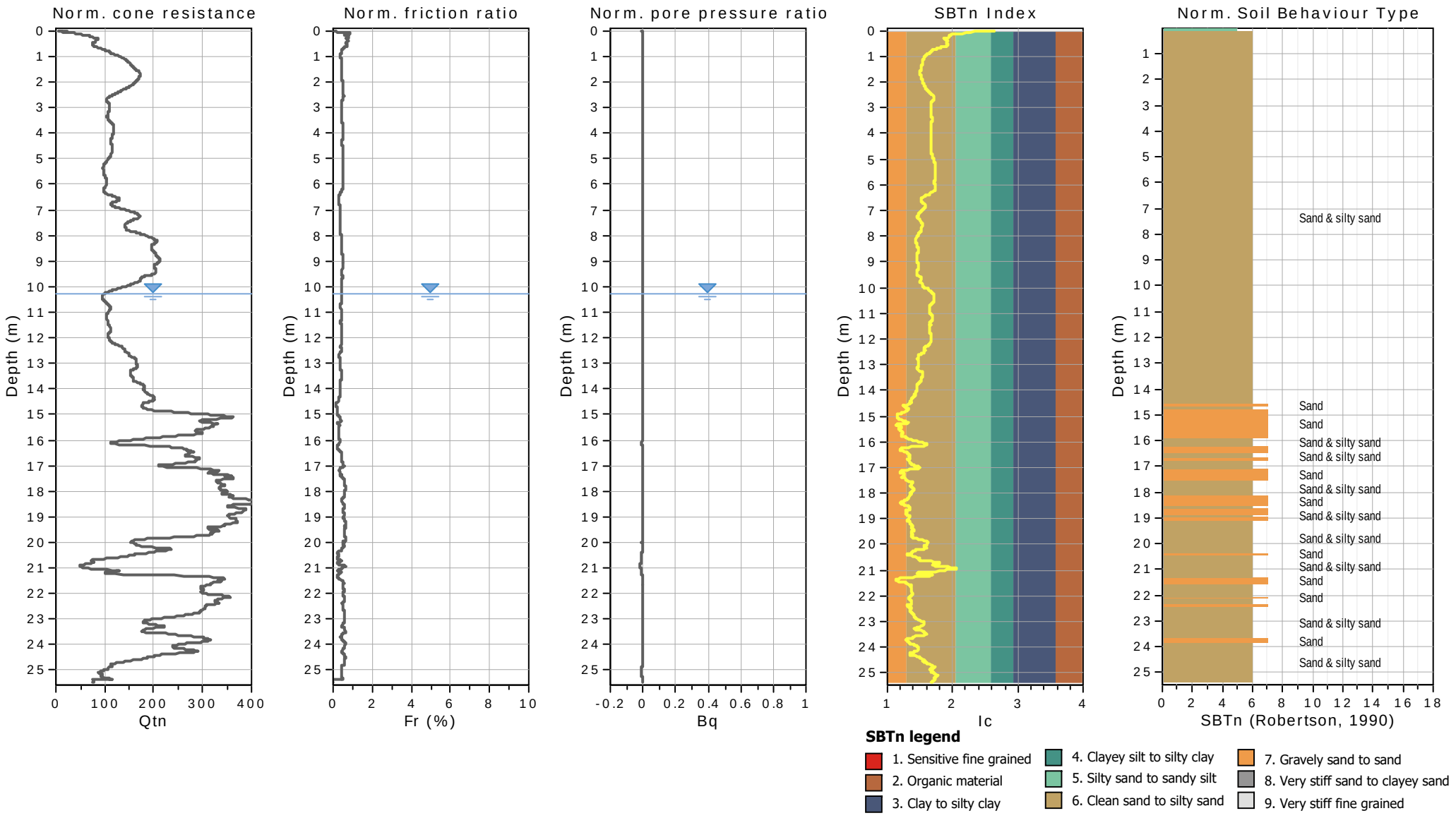

Cone resistance qt
Depth (m)
Tip resistance (MPa)
Friction ratio
Rf (%)
Pore pressure u
Pressure (kPa)
SBT Index
I(SBT)
Soil Behaviour Type
SBT (Robertson, 2010)
Silty sand & sandy silt
Sand & silty sand
Sand
Sand & silty sand
Sand
Sand & silty sand
Sand
Sand & silty sand
Sand & silty sand
Sand
Sand & silty sand
Sand
Sand & silty sand
Sand & silty sand
SBT legend
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Project: **Project No.: LGK9542019GI - Geotechnical Site Investigation**

Location: **109 & 111-113 Robert Street, Como, WA**

CPT: CPTu 2

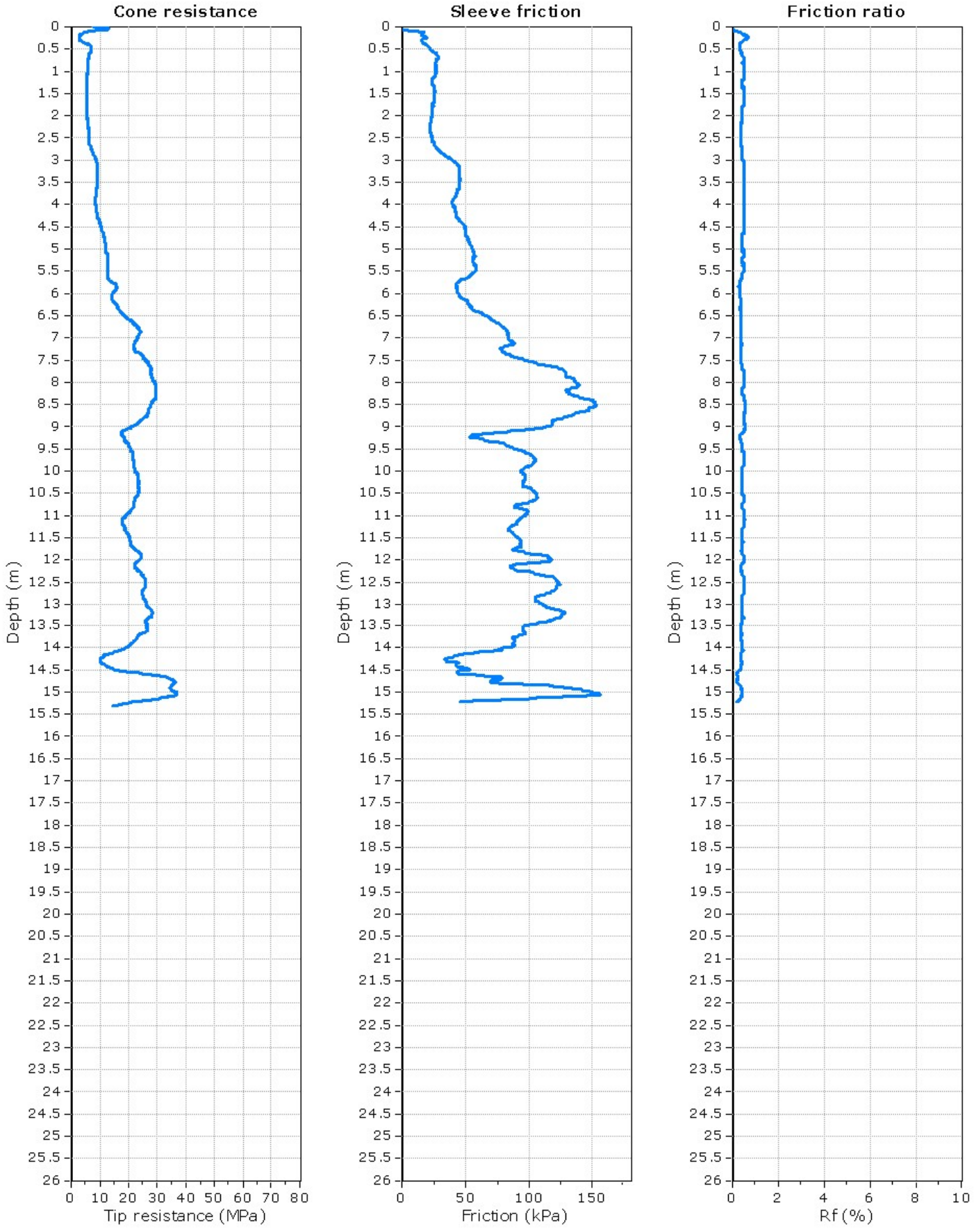
Total depth: 25.47 m, Date: 27-Nov-19



info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045

CPT 3
Total depth: 15.31 m, Date: 27/11/2019
Surface Elevation: 10.64 m
Coords: X:392080.49, Y:6458185.18
Cone Operator: Andrew

Project: **109 & 111-113 Robert Street (Project No.: LGK9542019GI)**
Location: **Como**

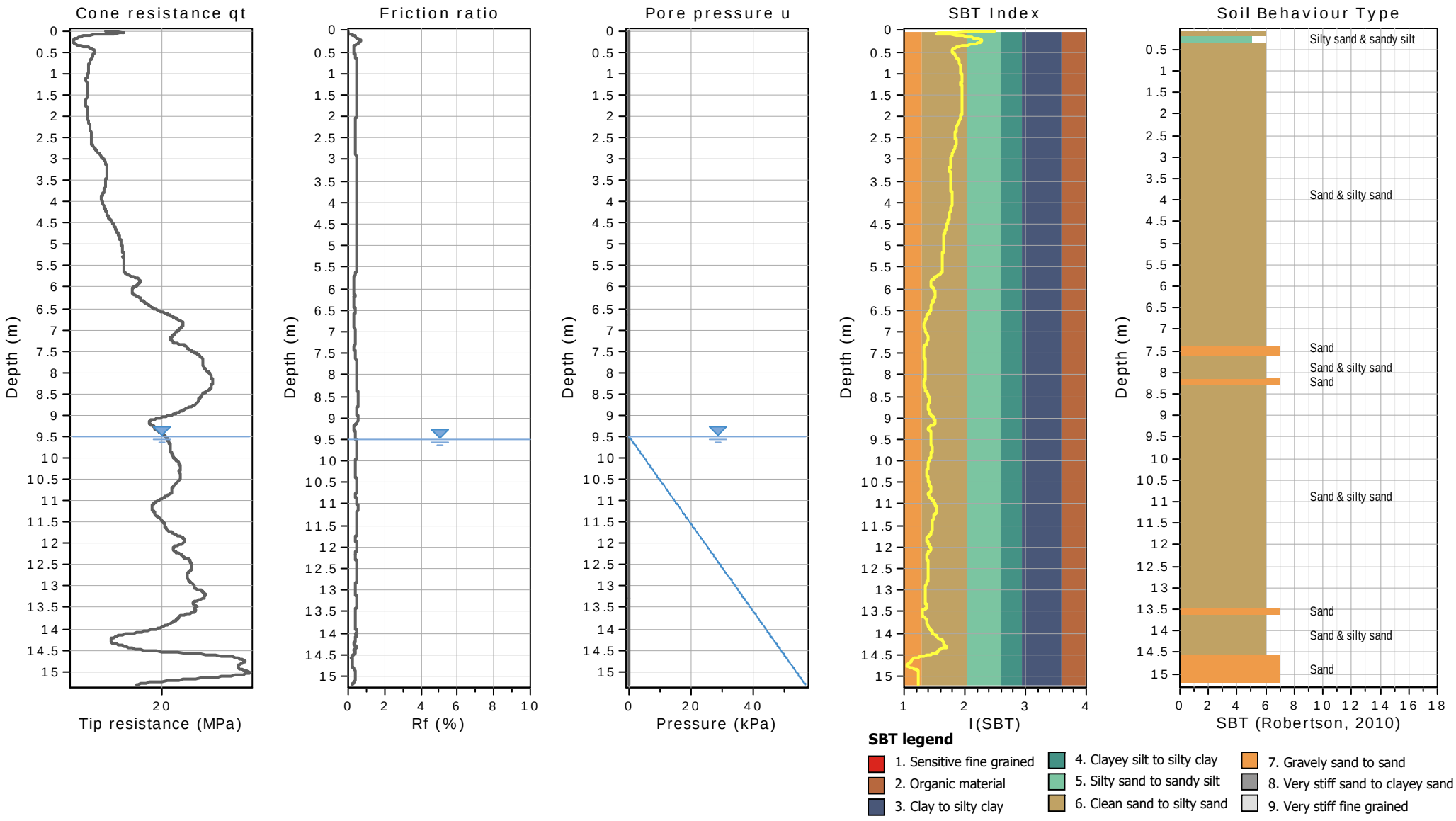


Project: **Project No.: LGK9542019GI - Geotechnical Site Investigation**

Location: **109 & 111-113 Robert Street, Como, WA**

CPT 3

Total depth: 15.31 m, Date: 27-Nov-19

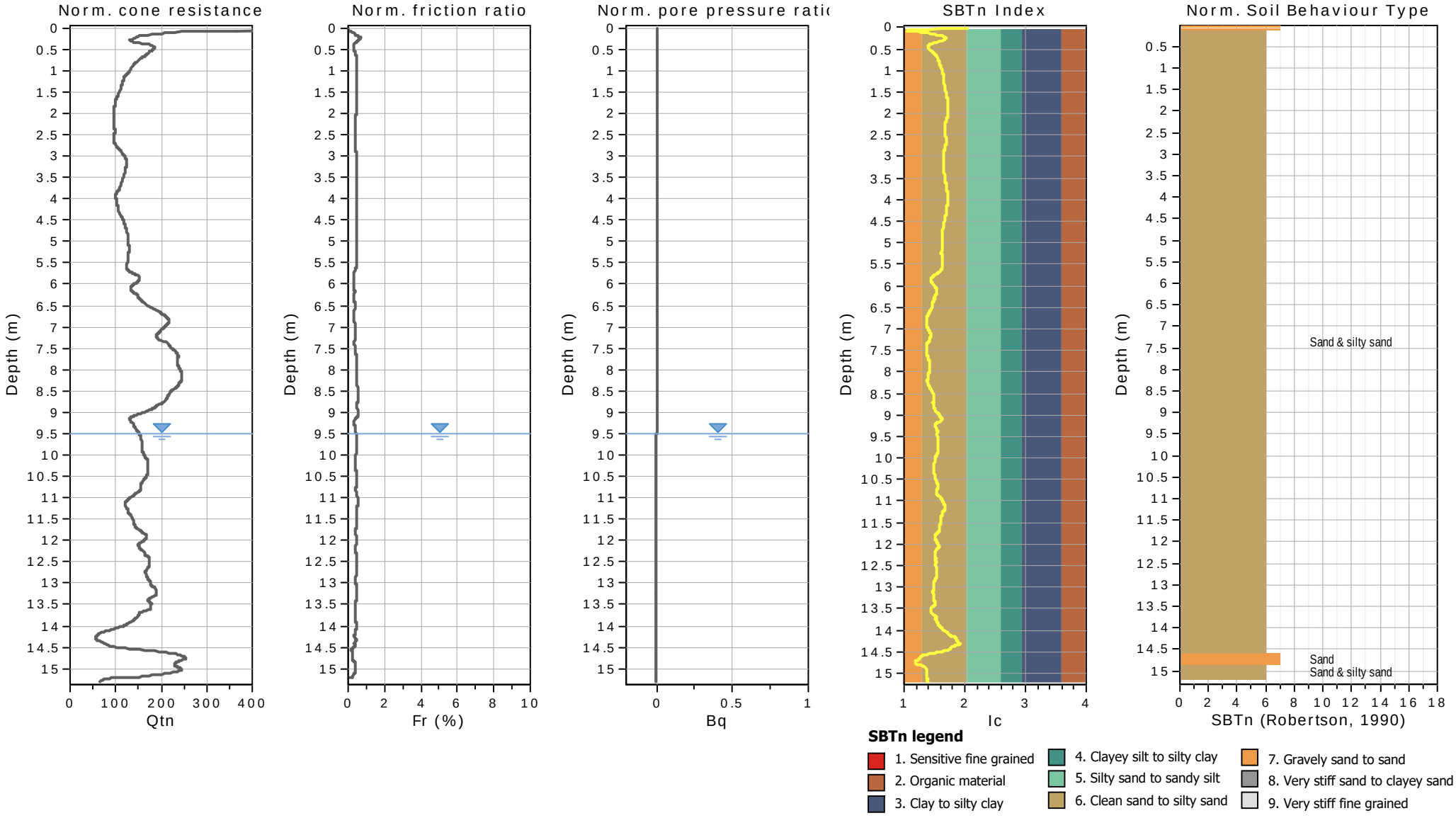


Project: **Project No.: LGK9542019GI - Geotechnical Site Investigation**

Location: **109 & 111-113 Robert Street, Como, WA**

CPT: CPT 3

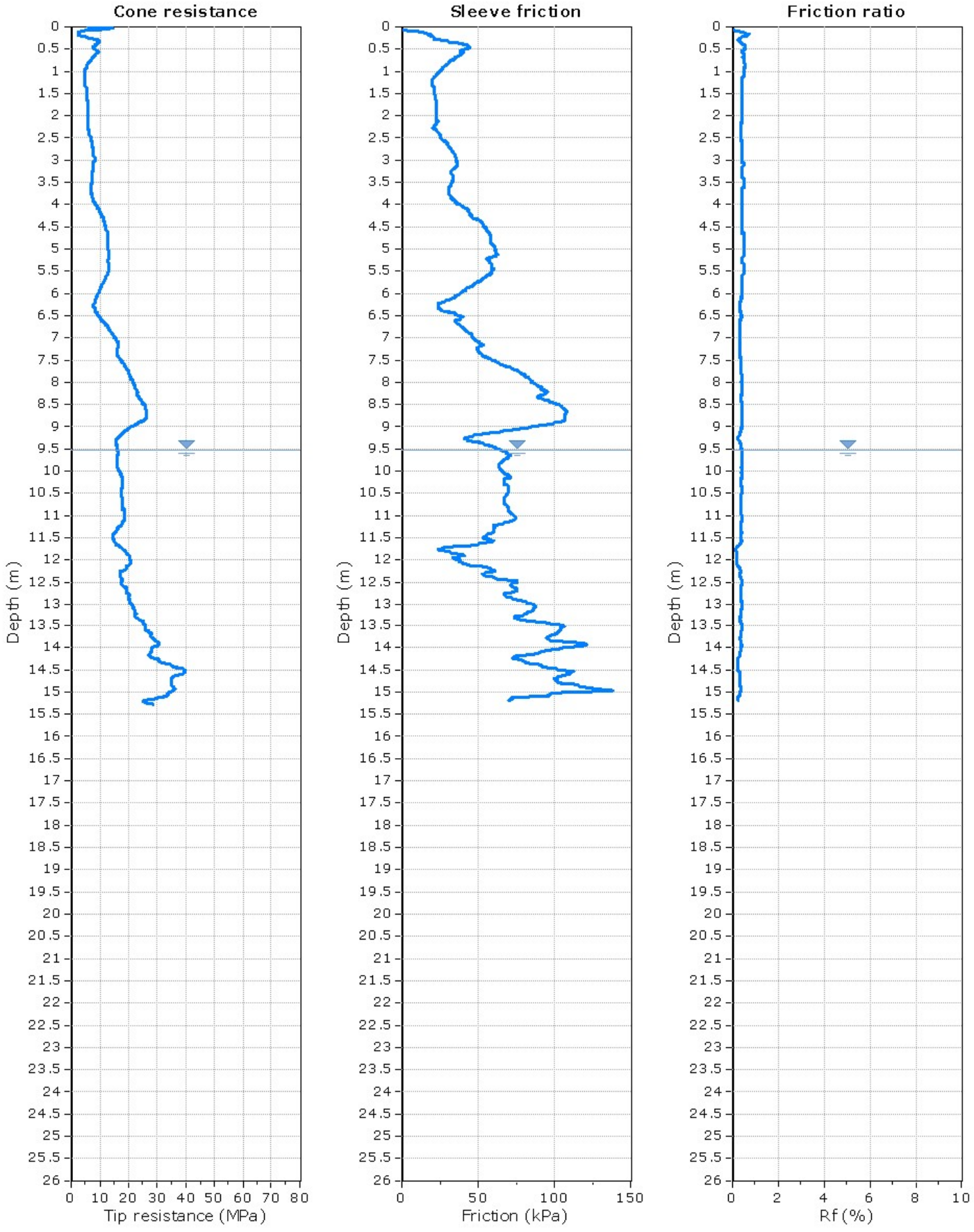
Total depth: 15.31 m, Date: 27-Nov-19



info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045

CPT 4
Total depth: 15.26 m, Date: 27/11/2019
Surface Elevation: 10.72 m
Coords: X:392070.10, Y:6458203.60
Cone Operator: Andrew

Project: **109 & 111-113 Robert Street (Project No.: LGK9542019GI)**
Location: **Como**

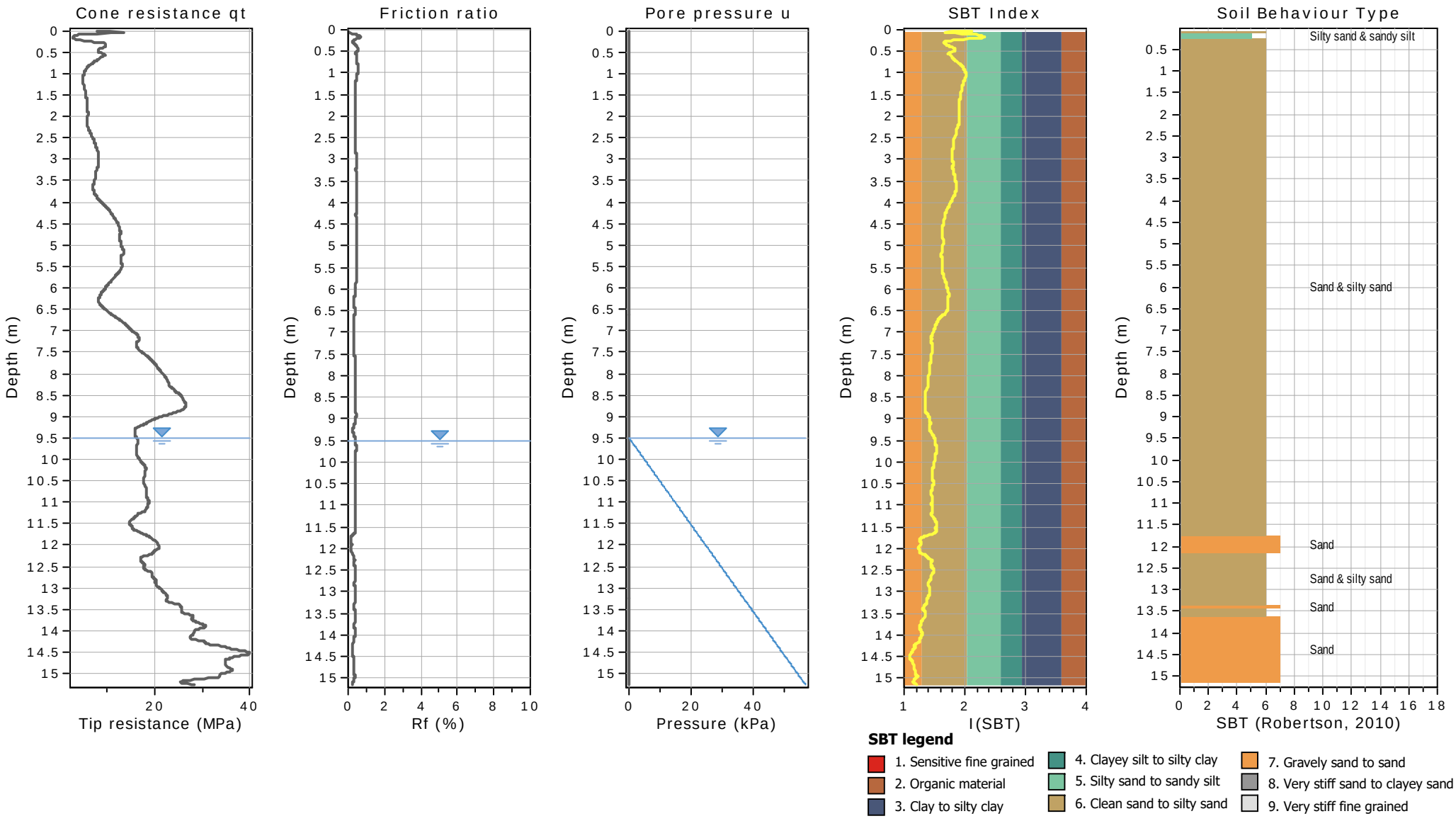


Project: **Project No.: LGK9542019GI - Geotechnical Site Investigation**

Location: **109 & 111-113 Robert Street, Como, WA**

CPT 4

Total depth: 15.26 m, Date: 27-Nov-19

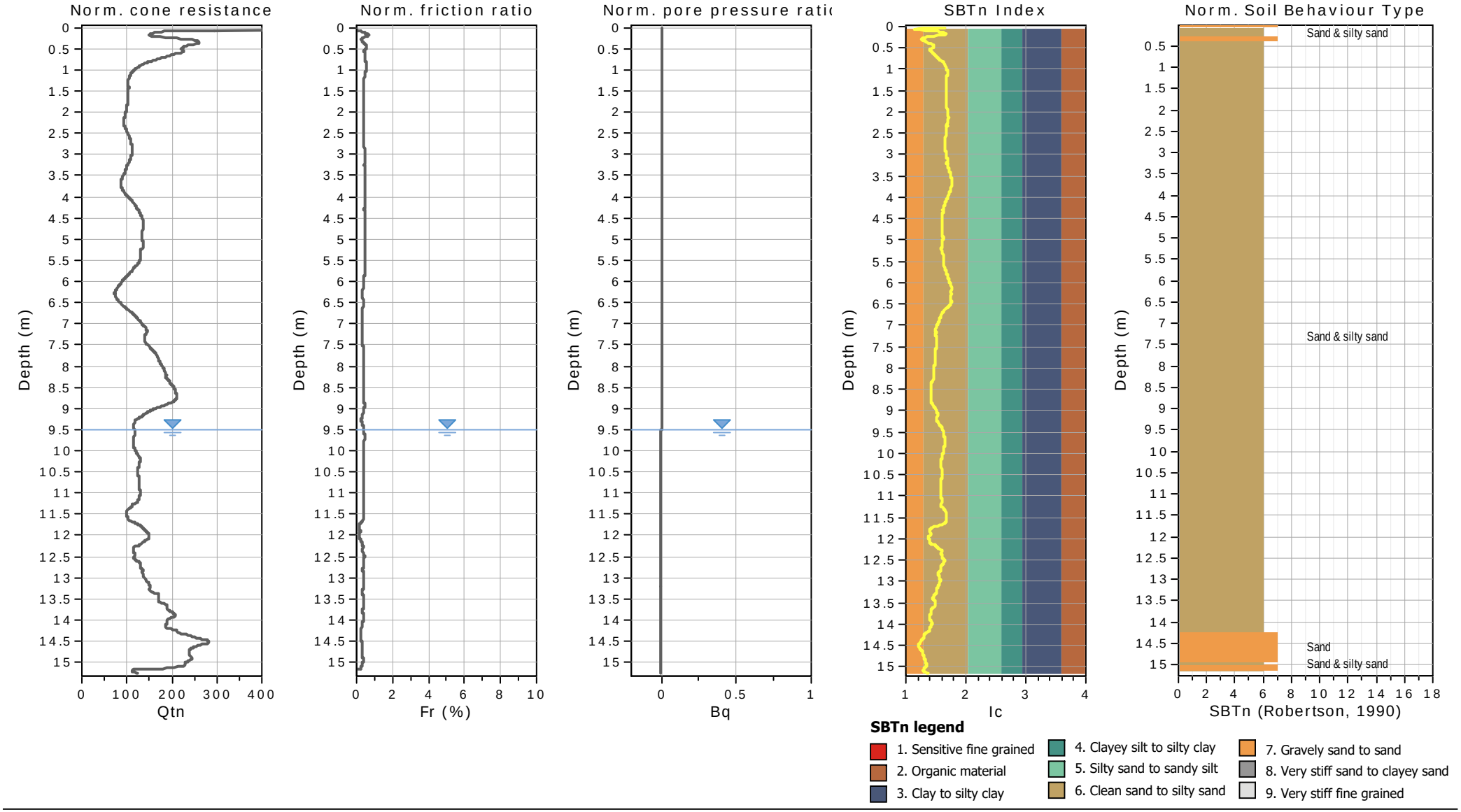


Project: **Project No.: LGK9542019GI - Geotechnical Site Investigation**

Location: **109 & 111-113 Robert Street, Como, WA**

CPT: CPT 4

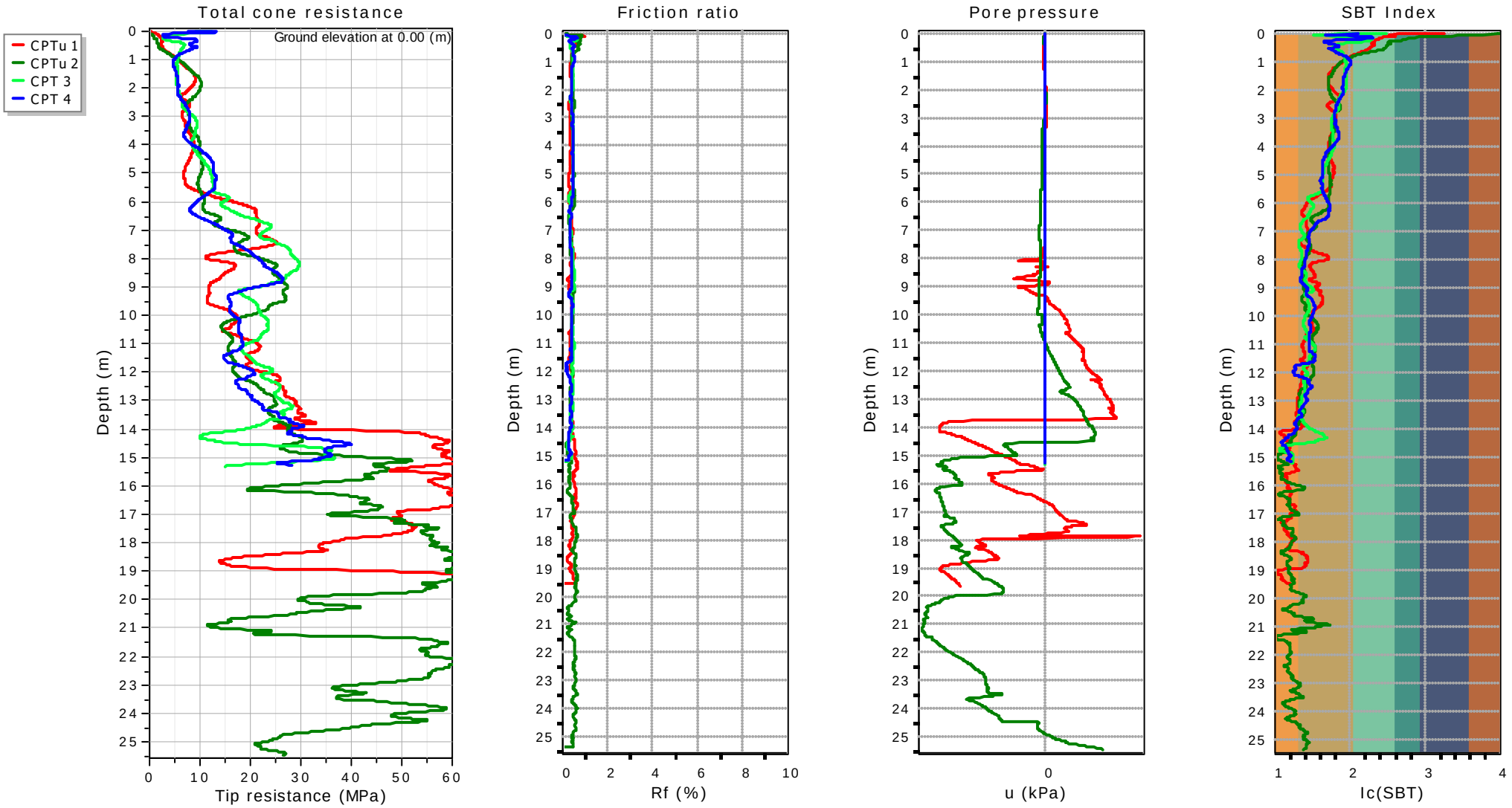
Total depth: 15.26 m, Date: 27-Nov-19



Project: **Project No.: LGK9542019GI - Geotechnical Site Investigation**

Location: **109 & 111-113 Robert Street, Como, WA**

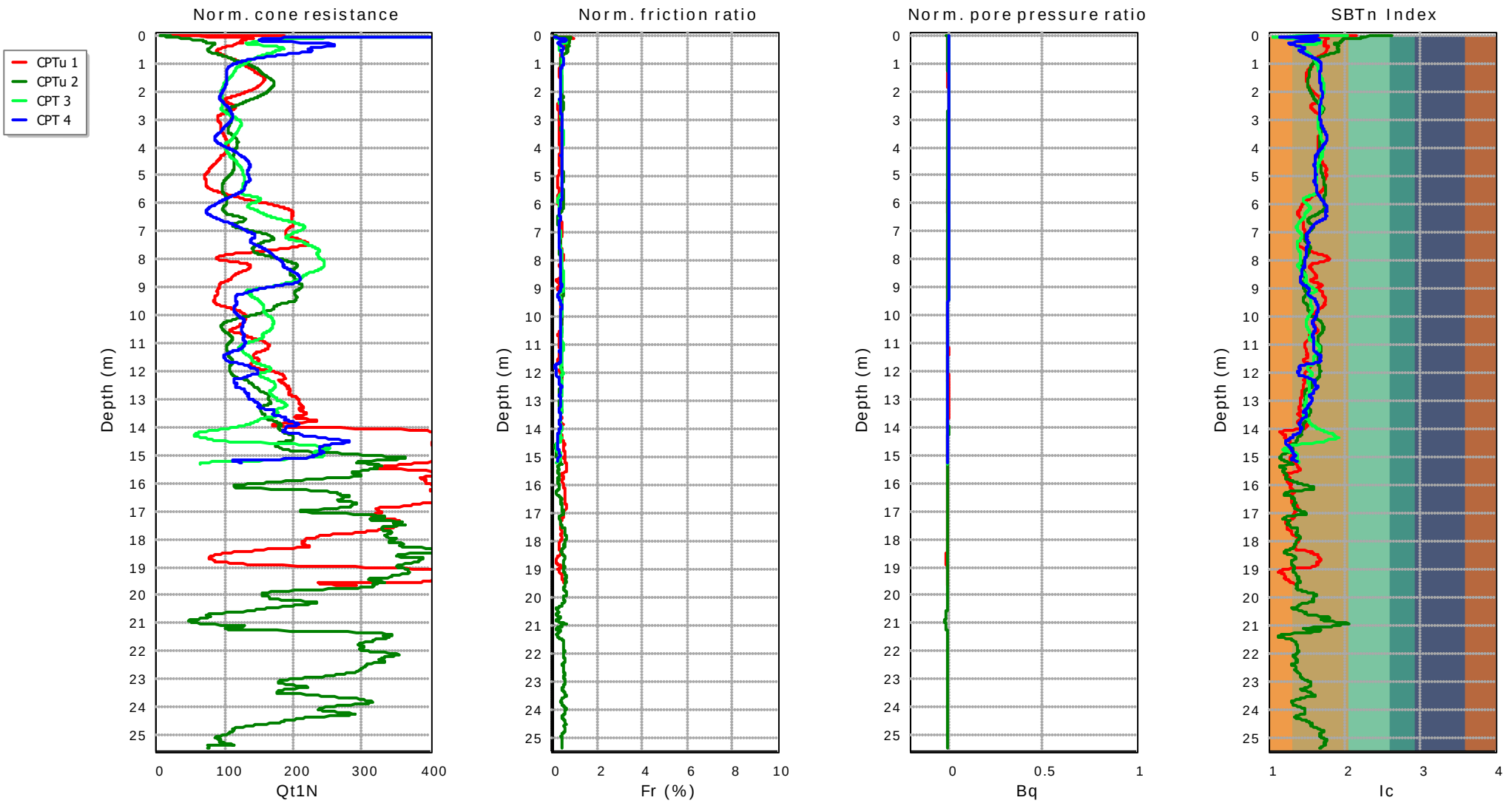
Overlay basic interpretation plots



Project: **Project No.: LGK9542019GI - Geotechnical Site Investigation**

Location: **109 & 111-113 Robert Street, Como, WA**

Normalized basic plots



APPENDIX D

SITE PHOTOS

LOCAL GEOTECHNICS

Photo 1. Site, view from the Robert Street, Como WA

Photo 2. Site, view of daycare car park from Cassey Street, Como WA

Photo 3. Site, view of church car park from Lily Lane, Como WA

Photo 4. Locating of underground services by Ground Penetrating Radar (GPR)

Photo 5. Test Location 02 (TH2), Sub-surface probing by using a hand auger and PSP testing

Photo 6. Soil from Test Location 01 (TH1)

Photo 7. Test Location 03 (TH3), Sub-surface probing by using a hand auger and PSP testing

Photo 8. Test Location 05 (DCP5), testing by a Dynamic Cone Penetrometer

Photo 9. Test Location 02 (TH2), Testing by Guelph Permeameter

Photo 10. CPT Test Location 04 (CPT4), Performing Cone Penetrometer Testing

APPENDIX D

LABORATORY TEST RESULTS

LOCAL GEOTECHNICS

TEST CERTIFICATE

CLIENT	: Local Geotechnics	K&A JOB NO :	164 / 185 / 19
PROJECT	: Geotechnical Investigation	SAMPLE No :	NB47570
LOCATION	: No : 109 & 111 - 113 - Robert Street - Como WA	TEST DATE :	29/11/2019
SAMPLE ID	: TH : 3	LG Ref No :	LGK9542019GI
DEPTH(m)	: (1.0 - 2.0)		

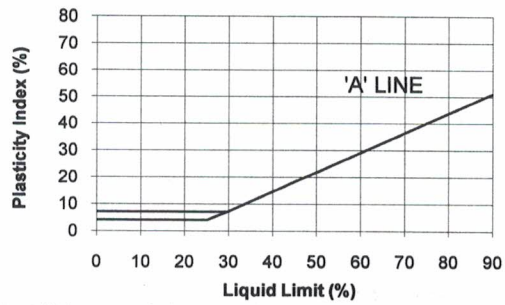
TEST DATA

ATTERBERG LIMITS		TEST METHODS
LIQUID LIMIT(%)	N/A	AS 1289 3.1.2
PLASTIC LIMIT(%)	N/A	AS 1289 3.2.1
PLASTICITY INDEX	N/A	AS 1289 3.3.1
LINEAR SHRINKAGE(%)	N/A	AS 1289 3.4.1

TESTING INFORMATION

ATTERBERG LIMITS:	
SAMPLE HISTORY:	N/A
METHOD OF PREPARATION	N/A
LINEAR SHRINKAGE :	
SIZE OF MOULD (mm)	N/A
CRUMBLING OR CURLING	N/A

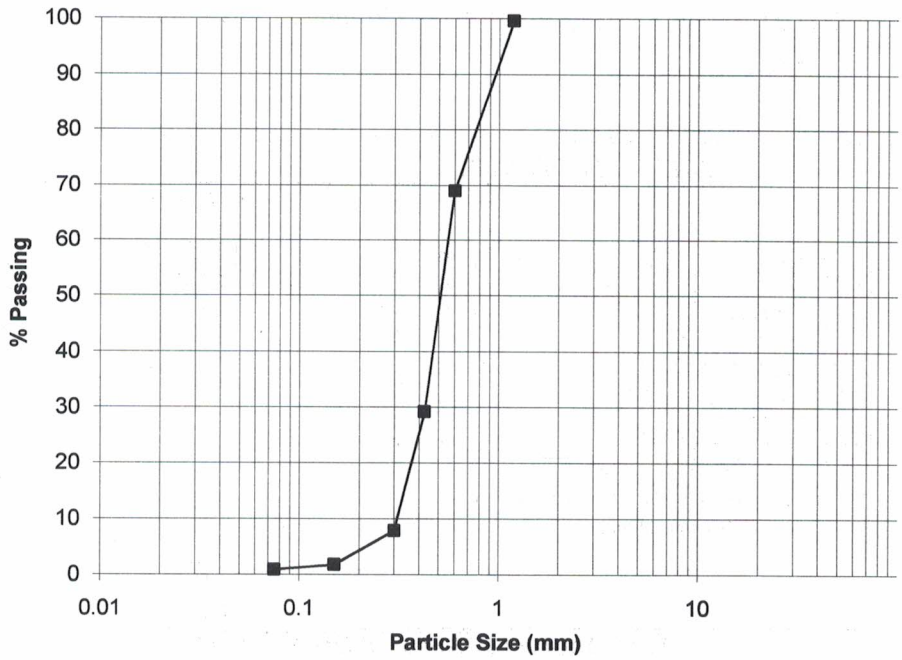
PLASTICITY CHART



AS 1289 3.6.1
PARTICLE SIZE DISTRIBN.

SIEVE SIZE	%PASSING
100.0mm	
75.0mm	
53.0mm	
37.5mm	
26.5mm	
19.0mm	
9.50mm	
4.75mm	
2.36mm	
1.18mm	100
0.600mm	69
0.425mm	29
0.300mm	8
0.150mm	2
0.075mm	1

AS 1289 3.6.1 - PARTICLE SIZE DISTRIBUTION



Note: Sample spplied by client. Results apply to the sample as received.

DATE: 02/12/2019

APPROVED SIGNATORY: J.Waldron

J.Waldron

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

'Accredited for compliance with ISO/IEC 17025'

PARTICLE SIZE DISTRIBUTION - TEST CERTIFICATE

CERTIFICATE No: N43300

Kanga & Associates

42Lionel Street, Naval Base-WA 6165

ACCREDITATION No. 2337

TEST CERTIFICATE

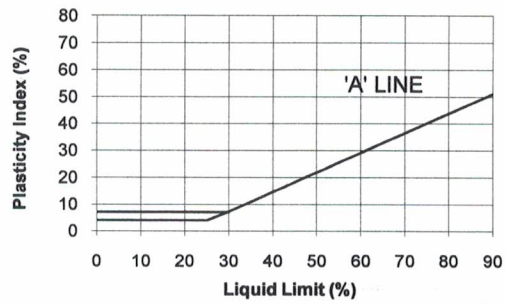
CLIENT	: Local Geotechnics	K&A JOB NO :	164 / 185 / 19
PROJECT	: Geotechnical Investigation	SAMPLE No :	NB47571
LOCATION	: No : 109 & 111 - 113 Robert Street - Como WA	TEST DATE :	29/11/2019
SAMPLE ID	: TH : 5	LG Ref No :	LGK9542019GI
DEPTH(m)	: (1.5 - 3.0)		

TEST DATA

ATTERBERG LIMITS		TEST METHODS
LIQUID LIMIT(%)	N/A	AS 1289 3.1.2
PLASTIC LIMIT(%)	N/A	AS 1289 3.2.1
PLASTICITY INDEX	N/A	AS 1289 3.3.1
LINEAR SHRINKAGE(%)	N/A	AS 1289 3.4.1

TESTING INFORMATION		
ATTERBERG LIMITS:		
	SAMPLE HISTORY:	N/A
	METHOD OF PREPARATION	N/A
LINEAR SHRINKAGE :		
	SIZE OF MOULD (mm)	N/A
	CRUMBLING OR CURLING	N/A

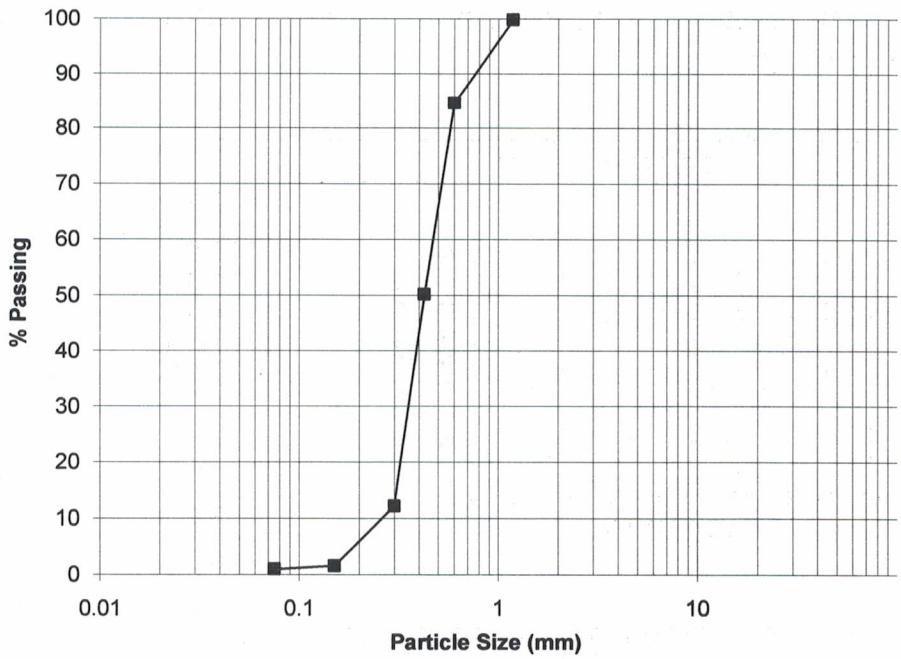
PLASTICITY CHART



AS 1289 3.6.1
PARTICLE SIZE DISTRIBN.

SIEVE SIZE	%PASSING
100.0mm	
75.0mm	
53.0mm	
37.5mm	
26.5mm	
19.0mm	
9.50mm	
4.75mm	
2.36mm	
1.18mm	100
0.600mm	85
0.425mm	50
0.300mm	12
0.150mm	2
0.075mm	1

AS 1289 3.6.1 - PARTICLE SIZE DISTRIBUTION



Note: Sample spplied by client. Results apply to the sample as received.

DATE: 02/12/2019

APPROVED SIGNATORY: J.W.aldron

J.Waldron

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

'Accredited for compliance with ISO/IEC 17025'

PARTICLE SIZE DISTRIBUTION - TEST CERTIFICATE

CERTIFICATE No: N43301

Kanga & Associates

42Lionel Street, Naval Base-WA 6165

ACCREDITATION No. 2337

CHAIN OF CUSTODY DOCUMENTATION

ALS Laboratory Group

CLIENT: Local Geotechnics	SAMPLER: Aurelian Bara
ADDRESS / OFFICE: 12/8 Production Road, Canning Vale 6155	MOBILE: 0470 082 233
PROJECT MANAGER (PM) Harun Meer	PHONE: 0426 08 4387 (Ashrafur)
PROJECT ID: LGK9542019GI	EMAIL REPORT TO: ashrafur.rahman@localgeotechnics.com.au; admin@localgeotechnics.com.au
SITE: 109,111 & 113 Robert St. Como WA P.O. NO.:	EMAIL INVOICE TO: (if different to report)
RESULTS REQUIRED (Date): QUOTE NO.:	ANALYSIS REQUIRED including SUITES (note - suite codes must be listed to attract suite prices)

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: Yes No (N/A)
SAMPLE TEMPERATURE
CHILLED: Yes No

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:

SAMPLE INFORMATION (note: S = Soil, W=Water)					CONTAINER INFORMATION		pH and pHFOX (ASS field screening test)	pH plus EC (1:5) - IN-4S; Chloride (requires 1:5 soil water leach) - ED045; Sulfate - Total as SO4 - ED040T; Salinity - Total Soluble Salts - EA014								Notes: e.g. Highly contaminated samples e.g. "High PAHs expected". Extra volume for QC or trace LORs etc.
ALS ID	SAMPLE ID	MATRIX	DATE	Time	Type / Code	Total cont										
1-4	TH1 (0.25m, 1.0m, 2.0m, 3.0m)	soil					X									
5-8	TH2 (0.0m, 0.5m, 1.5m, 2.5m)	soil					X									
9-12	TH3 (0.0m, 0.75m, 2.0m, 3.0m)	soil					X									
13-16	TH4 (0.25m, 1.0m, 1.5m, 2.5m)	soil					X									
17-20	TH5 (0.5m, 1.5m, 2.0m, 3.0m)	soil					X									
21	TH3 (1.0m-2.0m)							X								
22	TH5 (1.5m-3.0m)							X								

RELINQUISHED BY:		RECEIVED BY		METHOD OF SHIPMENT
Name: Ashrafur Rahman	Date: 2/12/2019	Name: NR AU	Date: 2/12/19	Con' Note No:
Of: Local Geotechnics	Time:	Of:	Time: 1130	
Name:	Date:	Name:	Date:	Transport Co:
Of:	Time:	Of:	Time:	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; V = VOA Vial HCl Preserved; VS = VOA Vial Sulphuric Preserved; SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Environmental Division
Perth
Work Order Reference
EP1912722

Telephone : +61-8-9406 1301

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1912722**	Page	: 1 of 7
Client	: **LOCAL GEOTECHNICS**	Laboratory	: Environmental Division Perth
Contact	: Harun Meer	Contact	: Customer Services EP
Address	: PO Box 5050 Canning Vale South Western Australia 6155	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: 08 9457 3517	Telephone	: +61-8-9406 1301
Project	: LGK9542019GI	Date Samples Received	: 27-Nov-2019 17:30
Order number	: ----	Date Analysis Commenced	: 04-Dec-2019
C-O-C number	: ----	Issue Date	: 10-Dec-2019 08:14
Sampler	: Aurelian Bara		
Site	: 109,111 & 113 Robert St, Como WA		
Quote number	: EN/222		
No. of samples received	: 22		
No. of samples analysed	: 22		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Canhuang Ke	Inorganics Supervisor	Perth Inorganics, Wangara, WA
Chris Lemaitre	Laboratory Manager (Perth)	Perth Inorganics, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth ASS, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth Inorganics, Wangara, WA

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA037 (Rapid Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme
- EA037 ASS Field Screening: NATA accreditation does not cover performance of this service.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	TH1 (0.25m)	TH1 (1.0m)	TH1 (2.0m)	TH1 (3.0m)	TH2 (0.0m)
			Client sampling date / time	27-Nov-2019 00:00	27-Nov-2019 00:00	27-Nov-2019 00:00	27-Nov-2019 00:00	27-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1912722-001	EP1912722-002	EP1912722-003	EP1912722-004	EP1912722-005
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**6.6**	**7.0**	**7.0**	**7.1**	**6.9**
pH (Fox)	----	0.1	pH Unit	**4.6**	**5.0**	**5.1**	**5.2**	**4.6**
Reaction Rate	----	1	-	**Moderate**	**Slight**	**Slight**	**Slight**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	TH2 (0.5m)	TH2 (1.5m)	TH2 (2.5m)	TH3 (0.0m)	TH3 (0.75m)
			Client sampling date / time	27-Nov-2019 00:00	27-Nov-2019 00:00	27-Nov-2019 00:00	27-Nov-2019 00:00	27-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1912722-006	EP1912722-007	EP1912722-008	EP1912722-009	EP1912722-010
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**7.0**	**7.1**	**7.1**	**6.8**	**6.3**
pH (Fox)	----	0.1	pH Unit	**5.1**	**5.3**	**5.4**	**4.3**	**4.4**
Reaction Rate	----	1	-	**Moderate**	**Slight**	**Slight**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	TH3 (2.0m)	TH3 (3.0m)	TH4 (0.25m)	TH4 (1.0m)	TH4 (1.5m)
			Client sampling date / time	27-Nov-2019 00:00	27-Nov-2019 00:00	27-Nov-2019 00:00	27-Nov-2019 00:00	27-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1912722-011	EP1912722-012	EP1912722-013	EP1912722-014	EP1912722-015
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**6.2**	**6.1**	**6.7**	**6.9**	**6.1**
pH (Fox)	----	0.1	pH Unit	**4.6**	**4.4**	**4.9**	**5.0**	**5.0**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	TH4 (2.5m)	TH5 (0.5m)	TH5 (1.5m)	TH5 (2.0m)	TH5 (3.0m)
			Client sampling date / time	27-Nov-2019 00:00	27-Nov-2019 00:00	27-Nov-2019 00:00	27-Nov-2019 00:00	27-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1912722-016	EP1912722-017	EP1912722-018	EP1912722-019	EP1912722-020
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**6.9**	**7.4**	**7.8**	**7.9**	**8.2**
pH (Fox)	----	0.1	pH Unit	**5.5**	**5.5**	**5.6**	**5.8**	**5.8**
Reaction Rate	----	1	-	**Slight**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	TH3 (1.0m-2.0m)	TH5 (1.5m-3.0m)	----	----	----
			Client sampling date / time	27-Nov-2019 00:00	27-Nov-2019 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EP1912722-021	EP1912722-022	--------	--------	--------
				Result	Result	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**7.8**	**8.4**	**----**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**5**	**23**	**----**	**----**	**----**
EA014 Total Soluble Salts								
Total Soluble Salts	----	5	mg/kg	**16**	**75**	**----**	**----**	**----**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**3.4**	**3.0**	**----**	**----**	**----**
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	<100	**----**	**----**	**----**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	**----**	**----**	**----**

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EP1912722**	Page	: 1 of 3
Client	: **LOCAL GEOTECHNICS**	Laboratory	: Environmental Division Perth
Contact	: Harun Meer	Contact	: Customer Services EP
Address	: PO Box 5050 Canning Vale South Western Australia 6155	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: 08 9457 3517	Telephone	: +61-8-9406 1301
Project	: LGK9542019GI	Date Samples Received	: 27-Nov-2019
Order number	: ----	Date Analysis Commenced	: 04-Dec-2019
C-O-C number	: ----	Issue Date	: 10-Dec-2019
Sampler	: Aurelian Bara		
Site	: 109,111 & 113 Robert St, Como WA		
Quote number	: EN/222		
No. of samples received	: 22		
No. of samples analysed	: 22		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Canhuang Ke	Inorganics Supervisor	Perth Inorganics, Wangara, WA
Chris Lemaitre	Laboratory Manager (Perth)	Perth Inorganics, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth ASS, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth Inorganics, Wangara, WA

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA002: pH 1:5 (Soils) (QC Lot: 2744945)									
EP1912611-003	Anonymous	EA002: pH Value	----	0.1	pH Unit	8.0	8.3	3.57	0% - 20%
EA010: Conductivity (1:5) (QC Lot: 2744946)									
EP1912722-021	TH3 (1.0m-2.0m)	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	5	5	0.00	No Limit
EA037: Ass Field Screening Analysis (QC Lot: 2752782)									
EP1912722-001	TH1 (0.25m)	EA037: pH (F)	----	0.1	pH Unit	6.6	6.6	0.00	0% - 20%
		EA037: pH (Fox)	----	0.1	pH Unit	4.6	4.6	0.00	0% - 20%
EP1912722-010	TH3 (0.75m)	EA037: pH (F)	----	0.1	pH Unit	6.3	6.3	0.00	0% - 20%
		EA037: pH (Fox)	----	0.1	pH Unit	4.4	4.3	0.00	0% - 20%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 2747760)									
EP1912722-021	TH3 (1.0m-2.0m)	EA055: Moisture Content	----	0.1	%	3.4	3.5	0.00	0% - 20%
EP1912760-003	Anonymous	EA055: Moisture Content	----	0.1	%	10.4	9.9	5.33	0% - 20%
ED040T : Total Sulfate by ICPAES (QC Lot: 2743446)									
EP1912657-001	Anonymous	ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	350	340	0.00	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 2744947)									
EP1912722-021	TH3 (1.0m-2.0m)	ED045G: Chloride	16887-00-6	10	mg/kg	<10	<10	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA002: pH 1:5 (Soils) (QCLot: 2744945)								
EA002: pH Value	----	----	pH Unit	----	4 pH Unit	100	70.0	130
				----	7 pH Unit	99.8	70.0	130
EA010: Conductivity (1:5) (QCLot: 2744946)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	24800 µS/cm	101	93.6	106
ED040T : Total Sulfate by ICPAES (QCLot: 2743446)								
ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	----	----	----	----
ED045G: Chloride by Discrete Analyser (QCLot: 2744947)								
ED045G: Chloride	16887-00-6	10	mg/kg	<10	50 mg/kg	100	88.0	115
				<10	5000 mg/kg	100	88.0	115

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 2744947)							
EP1912722-022	TH5 (1.5m-3.0m)	ED045G: Chloride	16887-00-6	5000 mg/kg	99.8	70.0	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1912722**	Page	: 1 of 5
Client	: **LOCAL GEOTECHNICS**	Laboratory	: Environmental Division Perth
Contact	: Harun Meer	Telephone	: +61-8-9406 1301
Project	: LGK9542019GI	Date Samples Received	: 27-Nov-2019
Site	: 109,111 & 113 Robert St, Como WA	Issue Date	: 10-Dec-2019
Sampler	: Aurelian Bara	No. of samples received	: 22
Order number	: ----	No. of samples analysed	: 22

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA002: pH 1:5 (Soils)							
Snap Lock Bag							
TH3 (1.0m-2.0m),	TH5 (1.5m-3.0m)	09-Dec-2019	04-Dec-2019	**5**	----	----	----
EA010: Conductivity (1:5)							
Snap Lock Bag							
TH3 (1.0m-2.0m),	TH5 (1.5m-3.0m)	09-Dec-2019	04-Dec-2019	**5**	----	----	----

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA002: pH 1:5 (Soils)								
Snap Lock Bag (EA002)								
TH3 (1.0m-2.0m),	TH5 (1.5m-3.0m)	**27-Nov-2019**	**09-Dec-2019**	04-Dec-2019	×	**09-Dec-2019**	09-Dec-2019	✓
EA010: Conductivity (1:5)								
Snap Lock Bag (EA010)								
TH3 (1.0m-2.0m),	TH5 (1.5m-3.0m)	**27-Nov-2019**	**09-Dec-2019**	04-Dec-2019	×	**09-Dec-2019**	06-Jan-2020	✓
EA037: Ass Field Screening Analysis								
Snap Lock Bag - frozen on receipt at ALS (EA037)								
TH1 (0.25m),	TH1 (1.0m),	**27-Nov-2019**	**05-Dec-2019**	25-May-2020	✓	**05-Dec-2019**	25-May-2020	✓
TH1 (2.0m),	TH1 (3.0m),							
TH2 (0.0m),	TH2 (0.5m),							
TH2 (1.5m),	TH2 (2.5m),							
TH3 (0.0m),	TH3 (0.75m),							
TH3 (2.0m),	TH3 (3.0m),							
TH4 (0.25m),	TH4 (1.0m),							
TH4 (1.5m),	TH4 (2.5m),							
TH5 (0.5m),	TH5 (1.5m),							
TH5 (2.0m),	TH5 (3.0m)							
EA055: Moisture Content (Dried @ 105-110°C)								
Snap Lock Bag (EA055)								
TH3 (1.0m-2.0m),	TH5 (1.5m-3.0m)	**27-Nov-2019**	**----**	----	----	**06-Dec-2019**	11-Dec-2019	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED040: Sulfur as SO4 2-							
Snap Lock Bag (ED040T)							
TH3 (1.0m-2.0m), TH5 (1.5m-3.0m)	**27-Nov-2019**	**04-Dec-2019**	04-Dec-2019	✓	**04-Dec-2019**	01-Jan-2020	✓
ED045G: Chloride by Discrete Analyser							
Snap Lock Bag (ED045G)							
TH3 (1.0m-2.0m), TH5 (1.5m-3.0m)	**27-Nov-2019**	**09-Dec-2019**	25-Dec-2019	✓	**09-Dec-2019**	06-Jan-2020	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
ASS Field Screening Analysis	EA037	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride Soluble By Discrete Analyser	ED045G	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Moisture Content	EA055	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	1	6	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chloride Soluble By Discrete Analyser	ED045G	2	7	**28.57**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	2	8	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride Soluble By Discrete Analyser	ED045G	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Electrical Conductivity (1:5)	EA010	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride Soluble By Discrete Analyser	ED045G	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH (1:5)	EA002	SOIL	In house: Referenced to Rayment and Lyons 4A1 and APHA 4500H+. pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3)
Electrical Conductivity (1:5)	EA010	SOIL	In house: Referenced to Rayment and Lyons 3A1 and APHA 2510. Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3)
Total Soluble Salts	EA014	SOIL	In house: The concentration of Total Soluble Salts in a soil is calculated from the Electrical conductivity of a water extract. This method is compliant with NEPM (2013) Schedule B(3) (Method 104)
ASS Field Screening Analysis	EA037	SOIL	In house: Referenced to Acid Sulfate Soils Laboratory Methods Guidelines, version 2.1 June 2004. As received samples are tested for pH field and pH fox and assessed for a reaction rating.
Moisture Content	EA055	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 105-110 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 6.1 and Table 1 (14 day holding time).
Sulfate as SO4 2- Total	ED040T	SOIL	In house: Total Sulfate is determined off a HCl digestion by ICPAES as S , and reported as SO4
Chloride Soluble By Discrete Analyser	ED045G	SOIL	In house: Referenced to APHA 4500-Cl- E. The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm. Analysis is performed on a 1:5 soil / water leachate.

Preparation Methods	Method	Matrix	Method Descriptions
Drying only	EN020D	SOIL	In house
HCl Digest	EN24	SOIL	1g of soil is digested in 30 ml of 30% HCl and the resultant digest bulked and filtered for analysis by ICP.
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of reagent grade water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.