



- Geotechnical Engineering Services
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- Project Management

***Report to Naidu Consulting (Pty) Ltd on the Results of a Geotechnical Investigation for the Proposed Upgrades to the Water Treatment Works at Tongaat, eThekweni Municipality, KwaZulu-Natal***

***Reference: 035-22.R01 Revision 0***

***Date: 08 February 2024***

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## Abbreviations and Expansions

Abbreviation	Expansion		
<b>AASHTO</b>	American Association of State Highway and Transportation		
<b>CBR</b>	California Bearing Ratio		
<b>COLTO</b>	Committee of Land and Transport Officials		
<b>COTO</b>	Committee of Transport Officials		
<b>DCP</b>	Dynamic Cone Penetrometer		
<b>E</b>	east		
<b>EGL</b>	existing ground level		
<b>Geosure</b>	Geosure (Pty) Ltd		
<b>GM</b>	grading modulus		
<b>h</b>	horizontal		
<b>IMC</b>	insitu moisture content		
<b>km</b>	kilometre(s)		
<b>LL</b>	liquid limit		
<b>LS</b>	linear shrinkage		
<b>m</b>	metre (s)		
<b>MDD</b>	maximum dry density		
<b>mm</b>	Millimetre(s)		
<b>No.</b>	number		
<b>NP</b>	non plastic		
<b>OHS</b>	Occupational Health and Safety		
<b>OMC</b>	Optimum Moisture Content		
<b>PI</b>	plasticity index		
<b>SANS</b>	South African National Standards		
<b>S</b>	south		
<b>SP</b>	slightly plastic		
<b>TMH</b>	Technical Manual for Highways		
<b>IP</b>	Inspection Pit/s		
<b>TRH</b>	Technical Recommendations for Highways (1985)		
<b>USCS</b>	Unified Soil Classification System		
<b>v</b>	vertical		
<b>USCS Symbols</b>			
<b>SC</b>	Clayey-sands, sand clay mixtures	<b>GW</b>	Clean gravel – well graded
<b>SM</b>	Silty sands, sand-silt mixtures	<b>GP</b>	Clean gravel – poorly Graded
<b>SW</b>	Clean sand – well graded	<b>GC</b>	Clayey gravel, sand-clay-gravel
<b>SP</b>	Clean sand – poorly graded	<b>GM</b>	Silty gravel, Gravel-sand-silt
<b>ML</b>	Inorganic silts of low plasticity	<b>CL</b>	Low plasticity clay
<b>MH</b>	Highly plastic inorganic silts	<b>CH</b>	High plasticity clay
<b>OH</b>	Highly plastic organic silts / clays	<b>OL</b>	Organic silts / clays of low plasticity

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**Reference: 035-22.R01 Revision 0**

**Date: 08 February 2024**

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## **1. TERMS OF REFERENCE**

The Water Treatment Works at Tongaat (TWTW) is currently operating at an average of 20Mℓ/day and requires refurbishment to the existing buildings, structures, chambers, mechanical and electrical infrastructure, as well as improvements to the unit treatment processes, to ensure that the works can operate optimally at the ultimate design capacity of 21Mℓ/day, when required.

The main project objective of the proposed refurbishment is to restore the TWTW to full operational capacity through multiple improvements, refurbishments and upgrades, where required.

In a document titled “*Request For Quotation (RFQ) Geotechnical Investigations For The Improvements To The Tongaat Water Treatment Works*” attached to an electronic mail dated 14 March 2022, Geosure was invited by Naidu Consulting (Pty) Ltd to provide a proposal and cost estimate for a geotechnical investigation for the Proposed Upgrades to the TWTW in Tongaat, eThekweni Municipality, hereafter referred to as the site.

Accordingly, a proposal and cost estimate was issued to Naidu Consulting (Pty) Ltd under the cover of a letter referenced p022-22 (Tonga Water Treatment Works)/mb and dated 17 March 2022.

Subsequently, Geosure was authorised by Naidu Consulting (Pty) Ltd, hereafter referred to as the Client, in a letter of authorisation dated 24 March 2022 and reference D791/32/11396, to carry out the investigation, as proposed, of the site.

## **2. PURPOSE AND SCOPE OF REPORT**

This report details the findings arising from a geotechnical investigation of the site to facilitate design of proposed improvements to the TWTW.

Accordingly, this report provides the following:

- i. Description of the site and subsurface conditions encountered;
- ii. Discussion of the field exploration and laboratory testing programs;
- iii. Summary of laboratory test data;
- iv. Evaluation of anticipated subsurface conditions during construction;
- v. Recommendations for earthworks and material excavation;
- vi. Evaluation and recommendations for materials usage, subgrade treatment for roads, foundation solutions, drainage and quality assurance for the proposed development; and
- vii. Summary of major findings and conclusions.

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### 3. PROPOSED DEVELOPMENT

It is understood from a document prepared by the Client titled “*Concept & Viability Report*” dated 25 March 2022 and reference D791/01/11, that the scope of works for the proposed refurbishments is as follows:

- Raw water off-take, inlet control chamber and screen;
- Head of works, including inlet chamber, flocculation mixing tank and new chemical dosing infrastructure;
- New and refurbishment works to the existing clarifiers and existing filters;
- New and refurbishment works to the existing process equipment;
- New and refurbishment works to the chemical dosing systems;
- New and refurbishment works to the sludge disposal works;
- New and refurbishment works to the clear water reservoir;
- New and refurbishment works to the Backwash recovery tank;
- New and refurbishment works to the Onsite chambers;
- Refurbishment and extension of the administration and chemical storage buildings;
- New and refurbishment works to the Pump station;
- New entrance to the gate and gatehouse;
- Upgrade to the existing access road to the works;
- New perimeter fence line;
- New and refurbishment works to the Other infrastructure components;
- Mechanical works for existing and new infrastructure;
- New electrical, control and instrumentation supply and all associated electrical reticulation;
- New and refurbishment works to the Control & Instrumentation.

### 4. GUIDELINES FOR METHODOLOGY OF INVESTIGATION

The fieldwork and report for the investigation was carried out according to guidelines relevant to geotechnical investigations of this nature, in particular the “*Site Investigation Code of Practice, 1st Edition*”, prepared by the South African Institution of Civil Engineering - Geotechnical Division, dated January 2010 refers.

The formation and weathering of geological materials are discontinuous processes and unexpected variations in soil, rock and groundwater regimes may occur even on sites where the conditions seem to be uniform or consistent. Variations in what is reported here may become evident during construction. It is thus imperative that an appropriately qualified and experienced Competent Person inspects all critical stages of development including, but not limited to, excavations to assess the conditions encountered and to assist in the interpretation of observations at variance with the information supplied in this report.

This report was prepared for use by the Client and their professional team for the purpose stated and should not be relied upon for any other purpose.

## 5. INFORMATION SUPPLIED

The following information was utilised to assist with the investigation and reporting:

- i. Digital copies (.pdf & .dwg) of a plan and titled “*Tongaat WTW Emergency Remediation Works Overall Site Plan*”, dated September 2022, Drawing Number 60425/01 Sheet 1 of 1 (Revision Z), and prepared by Naidu Consulting (Pty) Ltd.
- ii. Digital copies (.pdf & .dwg) of a plan and titled “*Tongaat WTW Emergency Remediation Works Stormwater Plan*”, dated September 2022, Drawing Number 60425/02 Sheet 1 of 1 (Revision Z), and prepared by Naidu Consulting (Pty) Ltd.
- iii. Digital copies (.pdf & .dwg) of a plan titled “*Tongaat WTW Emergency Remediation Works Sewer Site Plan*”, dated September 2022, Drawing Number 60425/03 Sheet 1 of 1 (Revision Z), and prepared by Naidu Consulting (Pty) Ltd.
- iv. Digital copies (.pdf & .dwg) of a plan titled “*Tongaat WTW Emergency Remediation Works Raw Water & Rising Mains Site Plan*”, dated September 2022, referenced 1936, Drawing Numbers 60425/04 Sheet 1 of 1 (Revision Z), and prepared by Naidu Consulting (Pty) Ltd.
- v. Digital copy (.pdf) of a report by the Client titled “*Concept & Viability Report*” dated 25 March 2022 and reference D791/01/11 (Document Version 04), attached to an electronic mail dated 01 February 2024.
- vi. Digital copy of regional geological map sheet titled “*2930 Durban*” by Council for Geoscience, (1988) to scale 1:250 000.
- vii. Low-resolution satellite imagery from Google Earth, 2023.

## 6. SITE DESCRIPTION

The site is located along the eastern edge of a tributary to the Tongati River downstream of the Dudley Pringle Dam and upstream of the confluence with the Tongati River. Co-ordinates at the centre of the site comprise 29.5449° South and 31.12859° East.

Terracing has given rise to two platform levels in the northern portion of the existing development footprint, separated by an embankment approximately 3m in height. Ground levels in the southern portion of the development generally slope from the eastern to lower western site area.

Access to the site is via a gravel road off the R614.

Photographs of the site are included in Appendix B of this report.

## 7. FIELDWORK

Fieldwork for the investigation was carried out over the period 15 November to 21 November 2023 and comprised the following:

- i. Rotary Core Boreholes;
- ii. Inspection Pits; and
- iii. Dynamic Cone Penetrometer Tests.

Positions of the field tests were provided to Geosure by the Client. Co-ordinates of the rotary core boreholes and inspection pits are given in Table 1 below.

**Table 1: List of Co-ordinates of Rotary Core Boreholes and Inspection Pits**

Borehole (BH) & Inspection Pit (IP)	Latitude (South) (°)	Longitude (East) (°)
BH1	-29.544569	31.128303
BH2	-29.544639	31.128364
BH3	-29.544947	31.128089
IP1	-29.54358	31.12819
IP2	-29.54395	31.12830
IP3	-29.54431	31.12841
IP4	-29.54458	31.12856
IP5	-29.54453	31.12829
IP6	-29.54461	31.12840
IP7	-29.54473	31.12836
IP8	-29.54490	31.12859
IP9	-29.54505	31.12828
IP10	-29.54498	31.12806

### 7.1 Rotary Core Borehole Drilling

Continuous coring of three rotary core boreholes, designated BH1 to BH3, was carried out by TFI (Pty) Ltd at the above-mentioned co-ordinates within the footprint of the existing Water Works at the approximate positions shown in Figure 2 included in Appendix A.

The agreed scope of work provided for drilling at each borehole to NXC and NWD4 size to either 15m or proving 3m of rock, wherever was the shallower. Drilling also allowed for Standard Penetration Tests (SPTs) of soil strengths at intervals of 1.5m. BH1 BH2 and BH3 were terminated in rock at depths of 12.20m, 13.80m, and 12.44m below EGL, respectively.

The borehole cores and SPT samples were profiled using the AEG/SAICE/SAIEG Guidelines for Soil and Rock Logging in South Africa, Brink, A.B.A. and Bruin, R.M.H. (eds.), Proceedings of the Geoterminology Workshop, 1990, 2<sup>nd</sup> Impression 2002.

Samples of rock samples from BH1 and BH2 were submitted for point load strength testing at a SANAS approved laboratory. Suitable samples for unconfined compressive strength tests were not available.

Photographs of the borehole core are given in Appendix C of this report.

The detailed logs of boreholes are included as Appendix D of this report.

## 7.2 Inspection Pits

Ten inspection pits, designated IP1 to IP10, were excavated by hand implements at the approximate positions shown in Figure 2, attached.

The inspection pits were advanced to final / refusal depths at 1.30m (IP2 & IP6 refer) and 1.50m (IP1, IP3 to IP5 and IP7 to IP10 refer) below EGL.

The inspection pits were profiled in accordance with the South African Geoterminology Guidelines (Brink & Bruin, 2002), sampled for materials testing at a SANAS approved laboratory, and backfilled.

The detailed inspection pit profiles are given in Appendix E of this report.

## 7.3 Dynamic Cone Penetrometer Tests

Twenty Dynamic Cone Penetrometer (DCP) tests, designated DC1 to DC20, were carried out at the approximate positions shown in Figure 2, attached.

The DCP tests were advanced to final depths in the range 0.3m (DC3 & DC11 refer) to 4.0m (DC5, DC10 & DC16 refer) below EGL.

The DCP test results comprising plots of blow count versus depth of penetration are given in Appendix F of this report.

# 8. GEOLOGY AND ANTICIPATED SUBSURFACE CONDITIONS

According to the regional geological map series by Council for Geoscience - Sheet "2930 Durban" to scale 1:250 000, the site and surrounds are underlain by alluvium (waterborne) deposits of Quaternary age and shale of the Pietermaritzburg Formation, Ecca Group. Exposures of Jurassic age dolerite are mapped some 1km to 3km to the east and west of the site. An inferred geological fault is mapped some 1.5km to the west of the site

An extract of the above geological map is given in Figure 3, included in Appendix A of this report.

The site at the positions investigated was observed to be underlain by:

- i. *Extensive thicknesses of variable fill* (man-made earth), comprising clay and granular materials. The fill is assumed to be related to levelling earthworks carried out for the existing water works development;
- ii. *Variable thickness of clayey and granular alluvium*;
- iii. *Limited weathered dolerite rock*;
- iv. *Limited residual shale* (fully decomposed former shale rock); and
- v. *Weathered shale rock of the Pietermaritzburg Formation*.

The occurrences of these units and general soil descriptions from profiling / logging are summarised in Table 2 below.

Table 2: Summary of General Geology and Subsurface Conditions in Rotary Core Boreholes and Inspection Pits

Unit (Geological Symbol)	General Description	BH / IP	Observed Depth Range (m below EGL)
<b>Fill</b>	Slightly moist, brown and olive brown, dense to very dense, medium SANDY medium to coarse GRAVEL / slightly moist, medium olive brown / greyish brown, medium dense, fine gravelly medium SAND with cobbles and boulders / slightly moist, dark grey, slightly gravelly, clayey fine SAND with fine roots and occasional shale fragments / moist, light brown, medium dense, silty fine to medium SAND with plastic waste / slightly moist, soft, clayey sandy SILT	IP1 – IP10	0.00 to 1.30 - 1.50
	Brown and light grey olive grey / grey mottled dark orange, very soft to firm, gravelly, sandy CLAY with organic odour and containing gravel cobbles boulders and occasional builder's rubble / reddish brown, clayey sandy GRAVEL with boulders / reddish brown blotched grey, stiff, gravelly, sandy CLAY to clayey, silty fine to medium SAND with shale fragments and boulders / cobbles and hard boulders / orange brown blotched grey, dense, clayey silty SAND containing gravel and sandstone boulders NB: Potentially collapsible sidewalls.	BH1 – BH3	0.0 to 5.5 – 7.5
<b>Alluvium</b>	Brown and bluish grey, clayey sandy GRAVEL / brown and olive grey, firm, slightly gravelly to gravelly, sandy CLAY with organic odour / greyish brown, clayey, silty, fine to medium SAND with shale fragments and unconfirmed odour. NB: Potentially collapsible sidewalls.	BH1 – BH3	7.50 (BH1; BH2) - 10.50 (BH1)
<b>Weathered Dolerite Rock</b>	Bluish grey speckled white stained dark brown, slightly weathered, fine to medium grained hard rock.	BH3	8.25 – 8.52
<b>Residual Shale</b>	Brown to dark grey, gravelly, clayey SILT.	BH3	8.52 – 8.64
<b>Weathered Shale Rock</b>	Dark grey and bluish grey stained dark brown / dark orange brown, slightly weathered, fine grained, highly to very highly fractured, carbonaceous, soft to hard indurated rock.	BH1 – BH3	8.64 (BH3) to 13.80 (BH2)

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## 9. GROUNDWATER

Groundwater seepage activity of slight intensity was only encountered in IP10 at a depth of 1.40m below EGL.

Blotched soil and stained rock synonymous with intermittent concentrations of groundwater, however, were profiled.

Moreover, being positioned on low-lying terrain adjacent to the Tongati River, the site is expected to show a weak slope drainage character generally.

Groundwater, thus, may be encountered at varying intensities and depths across the site. It is also considered that a perched intermittent groundwater condition is likely to be pronounced during the typical rainfall months of spring and summer and after heavy rains during other times of the year; conversely, depressed during the late autumn and winter periods.

The incidence of intermittent groundwater concentrations and the need for suitable mitigation measures to engineer's detail should be addressed during design and implementation of this project in consultation with a geotechnical professional such as Geosure.

## 10. LABORATORY TESTING

The following laboratory tests were carried out on disturbed soil samples and rock core retrieved from site:

- i. Sieve Grading;
- ii. Atterberg Limits;
- iii. Hydrometer Analysis;
- iv. Point Load Strength; and
- v. Direct Shear Box.

Testing by direct shear box was underway at the time of reporting, and results of these tests shall be submitted under separate cover.

Results of the completed laboratory tests are given in Appendix G and summarised in Tables 3 to 5 below.

**Table 3: Summary of Particle Size Distribution, Grading Moduli, Moisture Content and Material Classifications**

IP No.	Depth (m)	Description	Particle Size %				Atterberg Limits %			OMC (%)	IMC (%)	GM	MDD kg/m <sup>3</sup>	CBR Values			Swell %	Material Code & Classification
			Clay	Silt	Sand	Gravel	LL	PI	LS					Compaction MDD %				
														90	93	95		
<b>FILL</b>																		
IP1	0.01 – 1.00	Yellowish brown to olive brown, medium SANDY medium GRAVEL	16	26	58	26	8	4.0	6.4	-	2.16	2321	28	34	39	0.1	A-2-4 (0) GC G6 (#)	
IP2	0.40 – 1.00	Medium brown, gravelly, silty, fine to medium SAND to SANDY GRAVEL	18	46	36	16	4	2.0	7.1	-	1.67	2169	9.6	17	24	0.1	A-2-4 (0) SM - SC G7 (#)	
IP3	0.01 – 1.00	Yellowish brown, medium SANDY GRAVEL	14	31	55	25	8	4.0	5.6	-	2.14	2343	20	30	40	0.0	A-2-4 (0) GC G6 (#)	
IP3	1.00 - 1.40	Medium brown, gravelly medium SAND to SANDY GRAVEL	5	12	53	30	15	4	2.0	-	6.8	1.56	-	-	-	-	A-2-4 (0) SM - SC *Low	
IP4	0.30-0.90	Medium brown, slightly gravelly, silty medium SAND	15	65	20	NP	NP	0.0	5.8	-	1.40	2086	11	16	21	0.0	A-2-4 (0) SM G7(#)	
IP5	0.10 – 0.65	Medium brown, medium SANDY medium to coarse GRAVEL	17	28	55	30	10	5.0	7.6	-	2.07	2202	19	24	28	0.1	A-2-4 (0) GC G7 (#)	
IP6	0.07 – 1.30	Medium brown, medium SANDY fine to coarse GRAVEL	15	25	60	25	8	4.0	5.9	-	2.18	2389	25	32	38	0.2	A-2-4 (0) GC G6 (#)	
IP7	0.12 – 0.60	Medium olive brown, medium SANDY fine to coarse GRAVEL	14	22	64	28	9	5.0	6.2	-	2.25	2238	16	24	32	0.2	A-2-4 (0) GC G6 (#)	
IP7	1.00 – 1.50	Light brown, silty fine to medium SAND	3	5	79	13	NP	NP	0	-	13.2	1.31	-	-	-	-	A-2-4 (0) SP - SM *Low	
IP8	0.30-0.80	Medium greyish brown, gravelly, silty fine to medium SAND	16	63	21	NP	NP	0.0	6.3	-	1.41	1983	14	21	28	0.0	A-2-4 (0) SM G6(#)	
IP9	0.50 – 0.98	Medium brown, gravelly, silty, fine to medium SAND	20	34	46	21	7	4.0	7.9	-	1.82	2049	12	16	21	0.1	A-1-b (0) SM - SC G6 (#)	

IP No.	Depth (m)	Description	Particle Size %				Atterberg Limits %			OMC (%)	IMC (%)	GM	MDD kg/m <sup>3</sup>	CBR Values			Swell %	Material Code & Classification
			Clay	Silt	Sand	Gravel	LL	PI	LS					Compaction MDD %				
														90	93	95		
<b>FILL</b>																		
IP10	0.07 – 0.60	Medium brown, gravelly, silty, fine to coarse SAND	5	41	19		NP	NP	0.0	6.4	-	1.68	1833	17	22	26	0.0	A-2-4 (0) SP - SM G7 (#)
IP10	1.00 – 1.50	Medium greyish brown, clayey medium SAND	15	20	63	2	21	7	3.5	-	46.4	0.84	-	-	-	-	-	A-4 (0) SM - SC *Low

**KEY:**

LL	-	Liquid Limit	OMC	-	Optimum Moisture Content	MDD	-	Maximum Dry Density
LS	-	Linear Shrinkage	G7(#)	-	Classification in Terms of COLTO	A-2-4 (0)	-	AASHTO Classification
PI	-	Plasticity Index	SM; GC	-	Unified Soil Classification	GM	-	Grading Modulus
IMC	-	In situ Moisture Content	*Low	-	Potential Expansiveness (van der Merwe (1964))	'-'	-	Not Tested

**Table 4: Summary of Estimated Point Load Strengths of Weathered Shale Rock from Boreholes**

BH No.	Depth (m)	Description	Estimated Uniaxial Compressive Strength (MPa)
BH1	11.28 – 11.41	Slightly weathered, very highly fractured, soft rock. SHALE	8.95
BH2	11.74 – 11.83	Slightly to moderately weathered, very highly fractured, hard rock. SHALE	42.03
BH3	8.74 – 8.84	Slightly weathered, very highly fractured, medium hard rock. SHALE	13.82

**Table 5: Summary of Direct Shear Box Test Results**

Field No.	Depth	Material Description	Sample Type	Angle of Friction ( $\phi$ )	Apparent Cohesion, C (kPa)
IP2	0.40 – 1.00	Silty, gravelly silty fine to medium SAND to SANDY GRAVEL	Disturbed	<i>Test Results Pending</i>	<i>Test Results Pending</i>
IP4	0.30 – 0.90	Silty, slightly gravelly medium SAND	Disturbed		
IP8	0.30 – 0.80	Fine to coarse gravelly medium SAND	Disturbed		
IP9	0.50 – 0.98	Fine to coarse gravelly, fine to medium SAND	Disturbed		
IP10	0.07 – 0.60	Silty, slightly gravelly, medium to coarse SAND	Disturbed		

## **11. DISCUSSION**

### **11.1 General Global Stability and Suitability of the Site for Proposed Development**

A high erosion potential and a deep and potentially wet founding character have been confirmed during the investigation.

Design is to be based upon the results of a 1:100 flood-line risk determination.

Suitable measures / revetment to engineer's detail to ensure protection against potential scour action by the river are considered essential.

Notwithstanding the above, based on the results of the fieldwork undertaken during this investigation, it is considered that the site is generally stable and suitable for the proposed development upgrades provided the recommendations given in this report are adhered to.

These measures amount to no more than sound development controls appropriate to the site conditions expected and the nature of the development proposals confirmed with Geosure at the time of preparation of this report.

### **11.2 Material Classification and Recommendations for Usage**

The materials encountered on site have been classified in terms of COLTO, USCS and visual assessments made on site, to provide a general assessment of these materials for consideration to use during construction.

The characteristics of the materials and their suitability is summarised in Table 6 below.

**Table 6: Summary of Material Classifications**

<b>Material Description</b>	<b>USC; AASHTO (COLTO)</b>	<b>Remarks on Usage</b>
<b>FILL</b>		
SANDY fine to coarse GRAVEL	A-2-4 (0) GC (G6(#))	Considered suitable for use as upper subgrade material, select fill, and general fills, subject to screening to remove organic content, boulders, and sporadic waste inclusions, and laboratory verification testing.
Gravelly SAND to SANDY GRAVEL	A-2-4 (0) SM-SC (G7(#))	
Silty GRAVELLY SAND	A-2-4 (0) SM (G7(#))	
Clayey SAND	A-4 (0) SM-SC (Not Tested)	
Clay with cobbles boulders and concrete rubble / clayey SILT	Not Tested	
<b>WEATHERED DOLERITE ROCK</b>		
Slightly weathered, hard rock	Not Tested	Limited volume encountered (BH3 only) and excessive depths of occurrence.  Considered provisionally suitable for use as select fill after crushing and subject to laboratory verification testing.
<b>RESIDUAL SHALE</b>		
Gravelly, clayey SILT	Not Tested	Limited volume and encountered at excessive depth (BH3 only).  Considered suitable for use only as general fill.
<b>WEATHERED SHALE ROCK</b>		
Slightly to moderately weathered, soft to hard rock	Not Tested	Provisionally considered suitable for use after crushing as lower subgrade material subject to laboratory verification testing, and general fills.  Excessive depths to rock encountered from 8.64m below EGL

The classification of materials encountered on the site should be confirmed by laboratory verification testing during construction, as part of process and acceptance control monitoring, prior to the material being considered for use in construction.

### 11.3 Excavation Classification

It is considered that *Soft* and *Boulder* excavations in terms of SANS 1200 can be anticipated to at least the final depths of the SPT tests carried out and theoretically to rock level. Nonetheless, existing structural remnants of concrete slabs and / or foundations may be encountered if structures are to be demolished or abandoned. Accordingly, it is recommended that allowance for *Intermediate* excavation also be allowed for in the contract document.

Collapsing sidewalls of excavations and groundwater may result in slower excavation rates.

### 11.4 General Earthworks

All earthworks should be carried out in a manner to promote stable development of the site. It is recommended that earthworks be carried out along the guidelines given in SANS 1200 (current version).

In the above regard, guidelines are provided below:

- i. Allowance is to be made for a suitable subsoil drainage solution to engineer's detail to effectively manage the relatively high risk of a perched groundwater condition.
- ii. Prior to commencement of earthworks, any shallow structural remnants, organic-rich soils, and vegetation should be cleared and the topsoil grubbed.
- iii. If ground slopes are steeper than 1 vertical to 6 horizontal (6 degrees), the fill must be benched into the slope. Benches should be 0.5m deep and 2.0m wide.
- iv. Placement of fill layers should be undertaken in layers not exceeding 200mm thick when placed loose and compacted using suitable compaction plant to achieve 93% of Modified AASHTO maximum dry density within 1 – 2 percent (wet / dry) of OMC.
- v. Any terraces should be graded to direct water away from all structures and fill edges.
- vi. Small earth bunds should be constructed along the crests of fills, to prevent overtopping and erosion of fill embankment slopes. These bunds should be a minimum 450mm wide and 300mm high.
- vii. Density control testing of placed fill material should be undertaken at regular intervals during fill construction.
- viii. Cut and fill embankments formed in soil may be formed to batters not steeper than 1 vertical to 2 horizontal ( $\leq 26^\circ$ ) and to a height not greater than approximately 2m.
- ix. Should excavations intersect groundwater seepage, then the excavated sidewalls may need to be permanently shored to engineer's detail or battered to a flatter slope than recommended above to promote stability.
- x. Workers should not enter any excavations deeper than 1.5 metres that is not shored or battered back as described above.

All excavations are to be inspected on a daily basis by a competent person to confirm stability and these inspections should be recorded. However, it remains the responsibility of the contractor to ensure compliance with the current Occupational Health and Safety (OHS) Act.

### 11.5 Subgrade Treatment for Gate Entrance

Recommendations are set down below regarding procedures for treatment of the insitu materials for use as general fill during construction of the gate entrance.

Where material of G9 quality or better (in terms of COLTO criteria) is encountered, the materials should be ripped to a minimum of 300mm in the centre of the road-bed and a minimum of 500mm at the edges of the road-bed and re-compacted to 93% of Modified AASHTO maximum dry density within 1 – 2 percent (wet / dry) of OMC. A design CBR of 7 can be used for the subgrade treated in this manner.

If unsuitable material of quality worse than G9 is exposed, undercutting into the unsuitable materials to the specified depth is recommended to accommodate a select layer comprising material of at least G8 quality and compacted to at least 93% of Modified AASHTO maximum dry density within 1 – 2 percent (wet / dry) of OMC. Provided the above recommendations are followed, a design CBR of 10 can be adopted.

The pavement formation layer for the vehicular access and parking areas should be designed taking into account anticipated traffic loads, volumes and design life of the parking area and the driveway.

### 11.6 Anticipated Founding Conditions

The following founding conditions are anticipated to characterise the site at the positions investigated:

- i. Shale rock was encountered only in boreholes BH1, BH2, and BH3 from depths of 10.50m, 10.24m, and 8.64m, respectively, below EGL.
- ii. Extensive thicknesses of variable fill materials have been encountered down to a depth of 7.5m below EGL comprising highly compressible very soft to firm clays / clayey sands with hard cobble / boulder inclusions, capped by a mantle of mostly select and compacted fill approximately 1.3m to 1.6m in thickness with cobble inclusions.
- iii. The fill materials rest on alluvium encountered to depths in the range 7.5m (BH1 refers) 8.25m (BH3 refers) and 10.24m (BH2 refers) below EGL, comprising firm clays with lenses of sands and limited gravels.
- iv. Perched groundwater was encountered in IP10 at a depth of 1.40m below EGL, however, it is likely to be encountered at varying depths and positions across the low-lying and weakly drained site.
- v. Low bearing capacities are associated with the very soft to firm clay fill and alluvial deposits. Foundations placed on such soils are likely to settle excessively and may even undergo bearing capacity failure, even due to lightly loaded structures.
- vi. There is also the potential for collapse settlement movements on wetting up of the weakly cohesive granular horizons without an increase in applied load.

- vii. Trench / excavation sidewalls are likely to be unstable and require shoring / battering back to engineer's detail. In severe instances, liquefaction may characterise the subsurface materials.

## 11.7 Founding Recommendations

In the report by the Client titled "*Concept & Viability Report*" as referenced above in Section 3 and Section 5 of this report, details of structural design loads / pressures have not been confirmed. For the purpose of this report, lightly to relatively heavily loaded structures have been assumed. In the event that design loads differ from this assumption, Geosure should be afforded an opportunity to review the following foundation recommendations and propose amendments, where necessary.

Owing to the generally unsuitable nature of the fill encountered as described in Section 11.6 above, the placement of shallow foundations such as footings and / or a raft on these materials does not appear feasible.

Accordingly, the following founding solutions are proposed to cater for the anticipated founding conditions and proposed development upgrades:

- i. Reinforced concrete footing and stiffened raft foundations on structural fill; and*
- ii. Piled foundations.*

### 11.7.1 Reinforced Concrete Footing and Stiffened Raft Foundations on Structural Fill

For relatively lightly loaded structures, this founding option comprises the development of either RC strip footings or stiffened reinforced concrete raft foundation on structural fill, purpose-designed to address the anticipated soil conditions described in this report. In this regard, design should accommodate expected deflections due to compression / consolidation movements approximately of at least 20mm per metre of soil.

A proprietary raft such as a "Waffle" Raft design in conjunction with structural fill is considered suitable under these circumstances.

General guidelines in with regards to structural fill are presented below, as follows:

- i. Undercut and spoil all poorly consolidated soils from beneath foundation level to a level to be confirmed in the geotechnical engineer's design layout. As a guide for budgetary purposes only subject to confirmation by geotechnical design, a provisional undercut of 1.5m and 1.0m below foundation invert design level, respectively, to cater for footing and raft is proposed, and 2m beyond the foundation footprint.
- ii. Allowance is to be made for any remnant foundations arising from demolition of existing structures.
- iii. Should the excavation intersect groundwater seepage, the excavation should then be backfilled with clean free draining sand to engineer's detail. Alternatively, if severe inundation is experienced, the placement of rock fill to engineer's specification may be necessary.
- iv. The excavation will need to be backfilled and compacted with granular material of at least G7 quality (COLTO refers) to well above average compaction specification.

- v. Installation of the footing / raft foundation may then proceed.

A net allowable bearing pressure of  $125\text{kN/m}^2$  is applicable for foundations placed on structural fill / soil raft to geotechnical engineer's design. Total settlement of between approximately 5mm and 15mm can be expected, with differential settlement taken as 50%. However, final settlement estimates will depend on the detailed design of the ground improvement and structural design loads.

The design of the ground improvement is to be carried out by an experienced geotechnical specialist such as Geosure.

Any groundwater and all loose or soft material must be removed from the foundation excavations before concrete is cast.

A geotechnical professional, such as Geosure, should be appointed to carry out regular inspections of foundation excavations in order to confirm suitable founding media at foundation design / construction level(s).

Blinding should be cast as soon as excavations for footing foundations have been inspected and approved.

The surrounding ground should be graded away from structures to limit infiltration of water into the soils adjacent to and beneath foundations.

All footings and brickwork / blockwork will need to be reinforced as determined by a structural engineer in order to address the founding conditions of both sites as highlighted above.

### 11.7.2 Piled Foundations

For heavily loaded / settlement sensitive structures, a pile type foundation is recommended.

In this regard, it is considered that Pressure Grouted Continuous Flight Auger (CFA) pile would be best suited for the foundation loads assumed.

In view of inadequate thicknesses of overburden above rock level (8.64m to 10.50m below EGL) to cater for support of structural service loads in skin friction, the design of piles to carry structural loads in end bearing socketed into rock, devoid of residual / completely weathered zones, is recommended.

Pile diameters ( $\phi$ ) less than 350mm  $\phi$  are not recommended due to the presence of boulders up to 0.3m e.g. IP5.

As a guide only, pile working loads for various pile diameters are given in Table 7 below.

**Table 7: Typical Pile Working Loads for CFA Piles**

Pile Type	Pile Diameter (mm)	Pile Working Load (kN)
CFA	350	450
	400	600
	450	800

\* - Pile working loads are calculated using a shaft stress of approximately 5 MPa

Inferring from the profiles of BH1 to BH3, suitable shale rock was encountered from approximate depths in the range 8.64m (BH3 refers) and 10.5m (BH1 refers) below EGL. As a guide only, pile lengths are to allow for a suitable rock socket equivalent to at least thrice the pile  $\phi$ .

Pile lengths will be dependent on the final platform level(s) and the detailed pile design must be provided by the piling contractor. Negative skin friction due to existing and any proposed fills will need to be taken into account in the design of the piles.

Axial settlement of single isolated piles, excluding settlement that occurs during construction of the superstructure, should not exceed elastic shortening of the pile shaft plus 10mm. Additional settlement due to grouping of piles would depend on spacing, depth and number of piles in each group.

It is recommended that pile integrity testing be carried out on the piles formed and should be specified in the tender document. This is a quality assurance test that checks the structural integrity of the pile for defects such as voids, cracks and even depths and should be carried out by an independent consultant and not by the piling contractor.

### **11.8 Precautions for Collapse Potential Mechanism of Existing Fill and Insitu Soils**

The weakly cohesive and loosely consolidated subsurface materials have the potential to collapse and settle under constant load in response to increases in ground moisture content.

To assist with countering this mechanism, the construction of a 1m wide concrete apron around the proposed structure(s) is recommended in order to minimize seasonal subsurface moisture fluctuations beneath the structure(s) that could lead to collapse settlement.

The surrounding ground should also be graded away from the structure to limit infiltration of water into the soils immediately beneath the building.

A provision for possible movements between floors and walls should be allowed for in the design e.g. provision of construction joints and use of appropriate soft-board between walls and floors as per structural engineer's detail.

All brickwork and foundations will need to be reinforced.

The use of movement joints should also be considered.

The following precautions should also be taken to prevent the sandy soils from wetting up and causing collapse:

- i. Any gardens which are located against the external perimeter of the proposed structures should not be excessively watered;
- ii. Leaks in plumbing associated damage must be attended to as soon as possible without any delay;
- iii. No plumbing and drainage to be placed under floor slabs;
- iv. 1m<sup>2</sup> concrete aprons to be provided at all downpipes; and
- v. No large shrubs and trees being planted within 1.5m of structures.

## 11.9 Drainage and Erosion Controls

One of the critical factors in the stable development of the site is the effective control and removal of both surface and groundwater from the site.

Allowance should be made for subsoil drainage measures to cater for perched groundwater activity which may be encountered across the site.

Stormwater from roofed and surface areas is to be reticulated allowing for attenuation and erosion controls to engineer's detail.

The employment of one (or more) soakaways for the disposal of either stormwater and / or wastewater effluent is to be avoided.

The granular soils observed on site are considered susceptible to rapid erosion due to uncontrolled / channelled runoff. As such, it is imperative that earthworks and drainage measures be designed in such a way as to prevent ponding of, or high concentrations of, stormwater or groundwater anywhere on the site, both during and after the development. To this end, any open stormwater collectors and disposal drains should be concrete-lined.

Any terraces should be shaped to a gradient to prevent water ponding on the surface and should be graded to direct water away from the structures.

It is recommended that contingencies be made in the Bill of Quantities to allow for the above measures.

## 12. SUMMARY OF FINDINGS AND RECOMMENDATIONS

- i. This report details the results of a Geotechnical Investigation for the Proposed Upgrades to the Water Treatment Works at Tongaat, eThekweni Municipality, KwaZulu-Natal.
- ii. The scope of investigation comprised Rotary Core Borehole (BH) Drilling, Inspection Pits (IP), Dynamic Cone Penetrometer (DCP) probes, and Laboratory Tests. Further details in this regard are set down in Section 7 and Section 10 of this report.
- iii. The site at the positions investigated is underlain by extensive thicknesses of fill comprising a mantle of mostly select and compacted granular materials formed on highly compressible soft clays and clayey sands, with cobble and boulder inclusions.
- iv. The fill materials in turn rest on alluvium encountered to depths in the range 7.5m (BH1 refers) 8.25m (BH3 refers) and 10.24m (BH2 refers) below EGL.
- v. Rock of the Pietermaritzburg Formation was encountered to underlie the fill materials and alluvial deposits, and was drilled in the three boreholes from depths in the range 8.64m and 10.5m below EGL. Further details in this regard are set down in Section 8 of this report.
- vi. Perched groundwater seepage was identified in IP10 at a depth of 1.4m below EGL. Groundwater activity may also be present at positions elsewhere on site and at further levels, and is anticipated to vary in intensity seasonally.

- 
- vii. The fill materials and alluvial soils encountered at the site are considered susceptible to rapid erosion by uncontrolled stormwater runoff.
  - viii. The mantle of granular fill materials tested are considered suitable for use as subgrade and select material subject to screening to remove any organic content, boulders, particle contaminants, and laboratory verification testing, and as general fills. The balance of the fill materials encountered, and alluvial soils, may be considered for use as general fill only subject to removal of boulders and any organic content.
  - ix. It is considered that soft and boulder excavation in terms of SANS 1200 can be anticipated to at least the final depths of the fill materials and alluvium carried out and theoretically to rock level. Nonetheless, a contingency amount should be allowed for intermediate excavation to address potentially remnants of buried concrete.
  - x. All earthworks should be carried out in a manner to promote stable development of the site. It is recommended that earthworks be carried out along the guidelines given in SANS 1200 (current version). Further details in this regard are set down in Section 11.4 of this report.
  - xi. Extensive thicknesses of variable fill materials have been encountered down to a depth of 7.5m below EGL comprising highly compressible very soft to firm clays / clayey sands with hard cobble / boulder inclusions, capped by a mantle of mostly select and compacted fill approximately with cobble inclusions.
  - xii. The fill materials rest on alluvium encountered to depths in the range 7.5m to 10.24m below EGL, comprising firm clays with lenses of sands and limited gravels.
  - xiii. Shale rock was encountered from depths in the range 8.64m and 10.5m below EGL.
  - xiv. Low bearing capacities are associated with the greater majority of the fill, and alluvium. Foundations placed on such soils are likely to settle excessively and may even undergo bearing capacity failure, even as lightly loaded structures. There is also the potential for collapse settlement movements on wetting up of the weakly cohesive granular horizons without an increase in applied load.
  - xv. Two foundations solutions are discussed in Section 11.7 of this report to act for the assumed range of structural design loads, namely, reinforced concrete footings and / or raft foundation on structural fill, and piled foundations to carry structural service loads in end bearing.
  - xvi. In the event that design loads differ from the assumptions made in this report, Geosure should be afforded an opportunity to review the recommended foundation solutions and propose amendments, where necessary.
  - xvii. Design of the proposed upgrades is to be based upon the results of a 1:100 flood-line risk determination.
  - xviii. Suitable measures / revetment to engineer's detail to ensure protection against potential scour action by the river are considered essential.

### 13. LIMITATIONS

The conclusions, recommendations and discussions presented in this report are (1) based upon an evaluation and interpretation of the findings of the field and laboratory programs, (2) based upon an interpolation of subsurface conditions between and beyond the explorations, (3) subject to confirmation of the actual conditions encountered during construction, and (4) based upon the assumption that sufficient observation and testing will be provided by Geosure during construction.

The conclusions in this report are based on interpolation and extrapolation of subsurface conditions encountered at the field test locations. The actual subsurface conditions at unexplored locations may be different.

Consequently, the findings and recommendations in this report may require re-evaluation if subsurface conditions different than stated herein are encountered. Inherent in most projects performed in the heterogeneous subsurface environment, continuing subsurface investigations and analyses may reveal conditions that are different than those presented herein. This facet of the geotechnical profession should be considered when formulating professional opinions on the limited data collected on this project.

The findings and recommendations contained in this report were developed in accordance with generally accepted current professional principles and practice ordinarily exercised, under similar circumstances, by geotechnical engineers and geologists practicing in this locality. No other warranty, express or implied, is made.

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**APPENDIX A**



**FIGURE 1 – REGIONAL AND LOCAL  
CONTEXTS OF SITE**

**FIGURE 2 – SITE PLAN**

**FIGURE 3 – GEOLOGICAL PLAN**



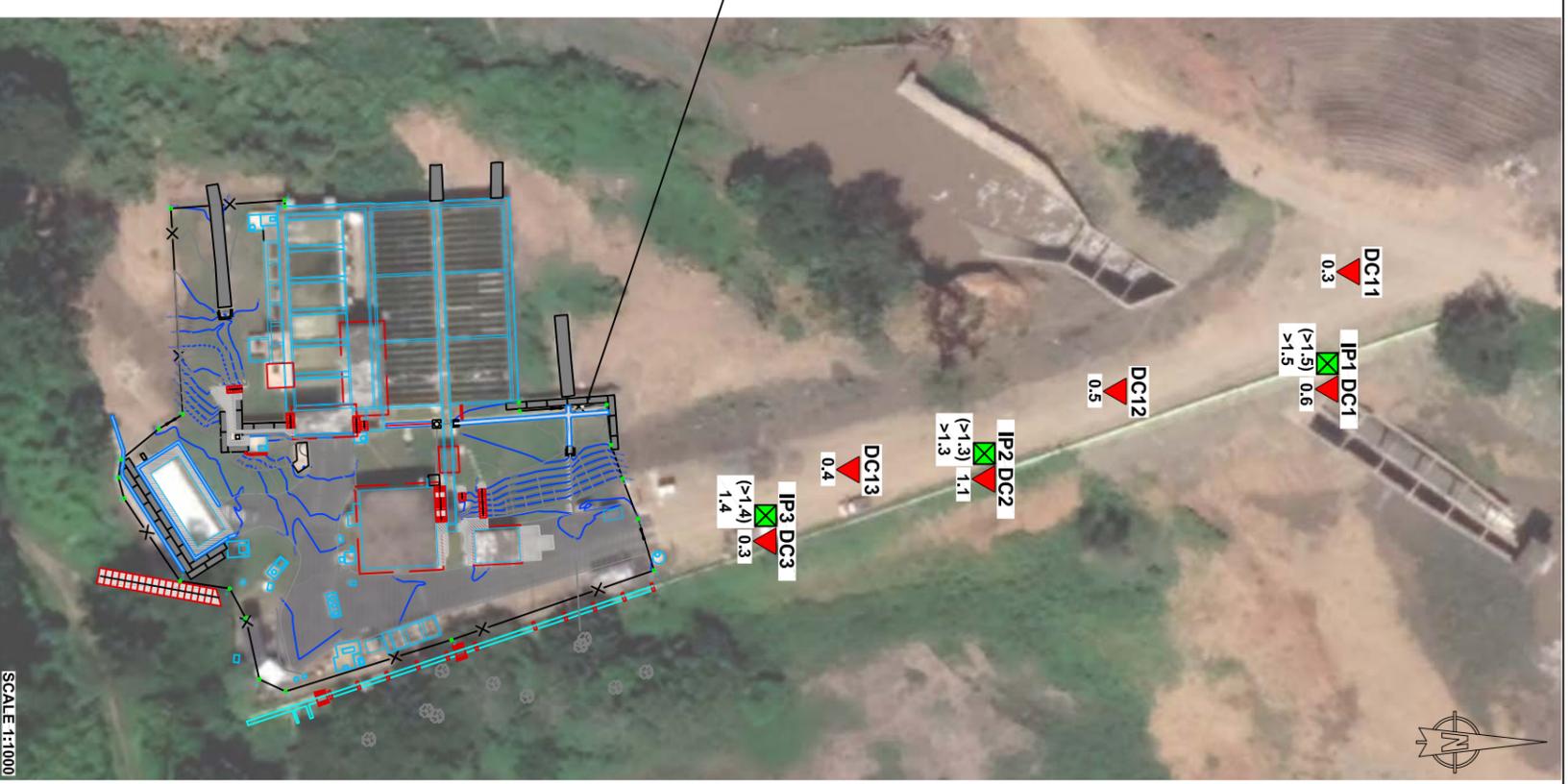
Plan 1: Aerial View of Site – Regional Plan



Plan 2: Aerial View of Site – Locality Plan



<p><b>Naidu Consulting (Pty) Ltd</b>                  Geotechnical Investigation for the Improvements to                  Tongaat Water Treatment Works, Tongaat,                  eThekweni Municipality</p> <hr/> <p><b>GEOSURE (PTY) LTD</b></p> <p><small>Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians                  and Geotechnical Quality Assurance Specialists</small></p> <p><small>P.O. BOX 1461 Westville, 3630, 122 Intersite Avenue, Umgeni Business Park                  Tel: +27 031 266 0458, Fax: +27 086 689 5506, Cell: 082 784 0544</small></p>	DATE	11-01-2023
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		<p><b>Figure 1</b></p>



SCALE 1:1500

SCALE 1:1000

**KEY:**

- BH1 Approximate position of Rotary Core Borehole.
- IP1 Approximate position of Inspection Pit showing depth to rock ( ) and depth to refusal in metres below existing ground level.
- DC1 Approximate position of Dynamic Cone Penetrometer Test showing depth to refusal in metres below existing ground level.
- WT-1.4 Denotes depth to ground water seepage in metres below existing ground level.

Site plan showing approximate positions of:

- Rotary Core Boreholes;
- Inspection Pits; and
- Dynamic Cone Penetrometer Tests.

SCALE 1:1000

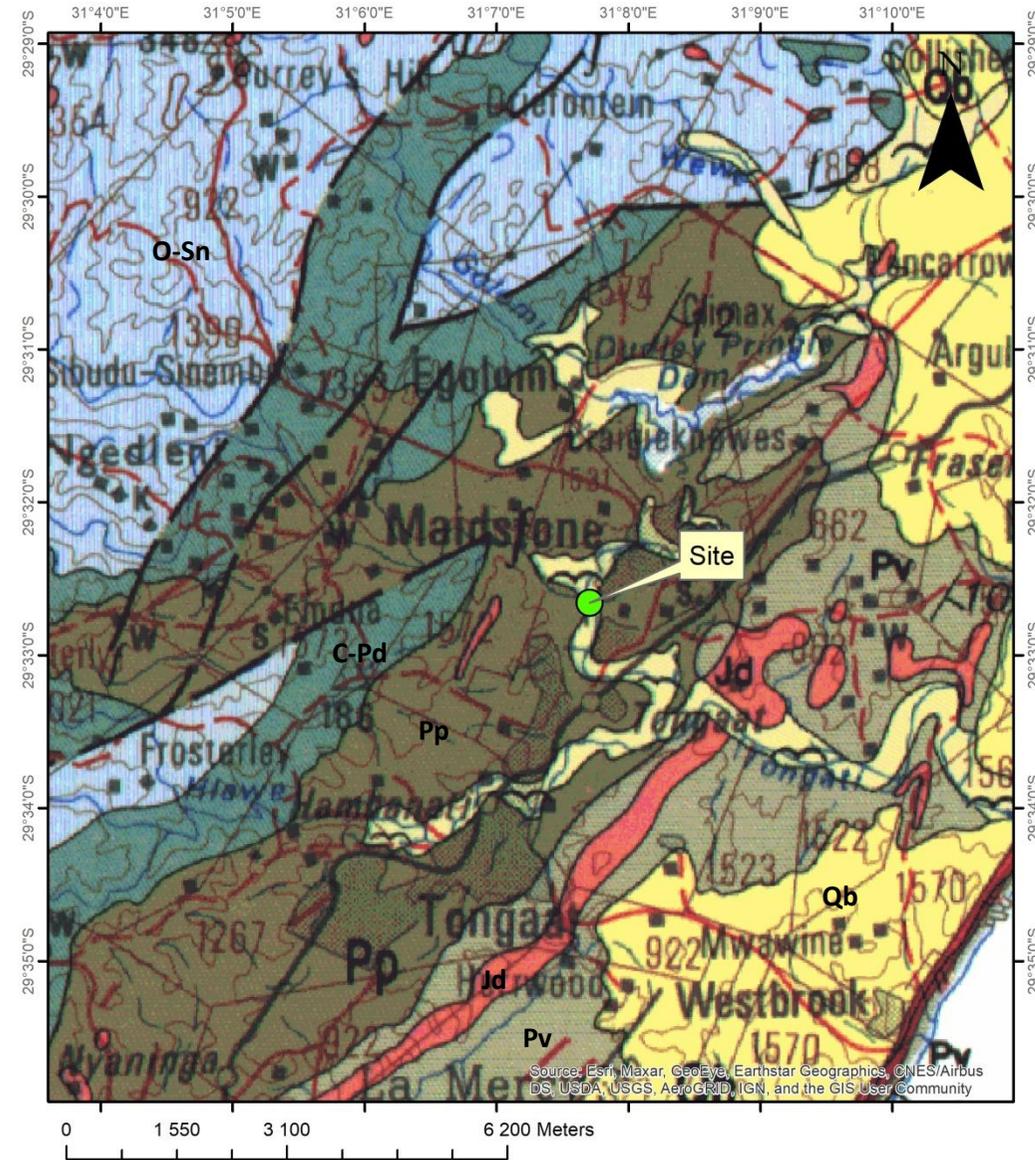


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Extract from Geological Map 2930 Durban



**KEY:**

-  Alluvium. Quaternary Age.
-  Red sand subordinate white, yellow, brown and purple sand; basal conglomerate. Berea Formation.
-  Dolerite. Jurassic Age.
-  Medium to coarse grained sandstone with thin grit beds; subordinate grey shale and siltstone; sporadic coal. Vryheid Formation.
-  Dark grey shale; siltstone; subordinate sandstone. Pietermaritzburg Formation.
-  Tillite; subordinate varved shale and boulder shale. Dwyka Group.
-  Red brown coarse grained arkosic to subarkosic sandstone; quartz arenite, micaceous sandstone; small pebble conglomerate; subordinate siltstone and mudstone. Natal Group.
-  - f - Inferred geological fault.
-  — Inferred geological contact.

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Figure 3



**APPENDIX B**



**SITE PHOTOGRAPHS**



## Site Photographs

Photograph 1: General view of site



Photograph 2: General view of site



Photograph 3: General view of site



Photograph 4: General view of site



Photograph 5: IP1



Photograph 6: IP9



<p><b>Naidu Consulting (Pty) Ltd</b>                  Geotechnical Investigation for the Improvements to                  Tongaat Water Treatment Works, Tongaat,                  eThekweni Municipality</p>	<p>DATE 11-01-2023</p>
<p><b>GEOSURE (PTY) LTD</b></p> <p><small>Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians                  and Geotechnical Quality Assurance Specialists</small></p> <p><small>P.O. BOX 1461 Westville, 3630, 122 Intersite Avenue, Umgeni Business Park                  Tel: +27 031 266 0458, Fax: +27 086 689 5506, Cell: 082 784 0544</small></p>	<p>DRAWN V.G</p> <p>CHECK F.S</p> <p>REFERENCE No. 035-22</p>
<p><b>Appendix B</b></p>	



**APPENDIX C**



**BOREHOLE CORE PHOTOGRAPHY**



<b>CLIENT:</b>	Naidu Consulting (Pty) Ltd
<b>PROJECT:</b>	Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works, Tongaat, eThekweni Municipality
<b>REFERENCE NO.:</b>	035-22
<b>BOREHOLE NO.:</b>	<b>BH 01</b>
<b>DEPTH:</b>	0.0m to 12.20m
<b>BOX NO.:</b>	Box 1 to Box 1



**CLIENT:** Naidu Consulting (Pty) Ltd

**PROJECT:** Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works, Tongaat, eThekweni Municipality

**REFERENCE NO.:** 035-22

**BOREHOLE NO.:** BH 02

**DEPTH:** 0.0m to 13.80m

**BOX NO.:** Box 1 to Box 1



Box 1 of 1



**CLIENT:** Naidu Consulting (Pty) Ltd

**PROJECT:** Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works, Tongaat, eThekweni Municipality

**REFERENCE NO.:** 035-22

**BOREHOLE NO.:** BH 03

**DEPTH:** 0.0m to 12.44m

**BOX NO.:** Box 1 to Box 1



Box 1 of 4





**APPENDIX D**



**LOGS OF ROTARY CORE  
BOREHOLES**





P O Box 1461, Westville, 3630, South Africa  
 Tel: (031) 266-0458  
 email: geosure@iafrica.com

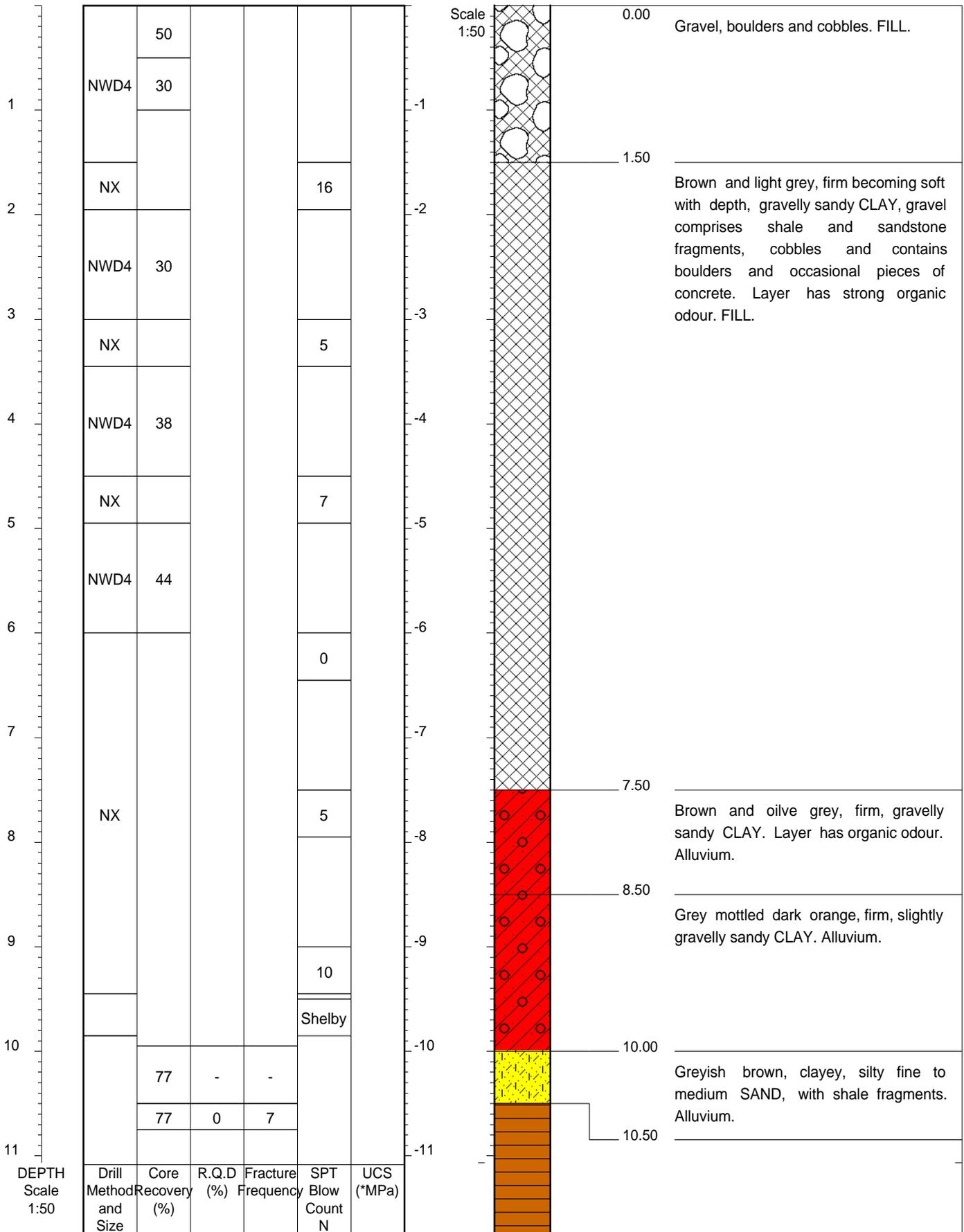
Geotechnical, Environmental &  
 Groundwater Engineering  
 Pile Integrity Testing & Civil  
 Engineering Laboratory

Fax: 086 689-5506  
 www.geosure.co.za

Naidu Consulting (Pty) Ltd  
 Geotechnical Investigation for Proposed  
 Improvement to the Tongaat Water Treatment  
 Works  
 Tongaat, eThekweni Municipality

HOLE No: BH01  
 Sheet 1 of 2

JOB NUMBER: 035-22







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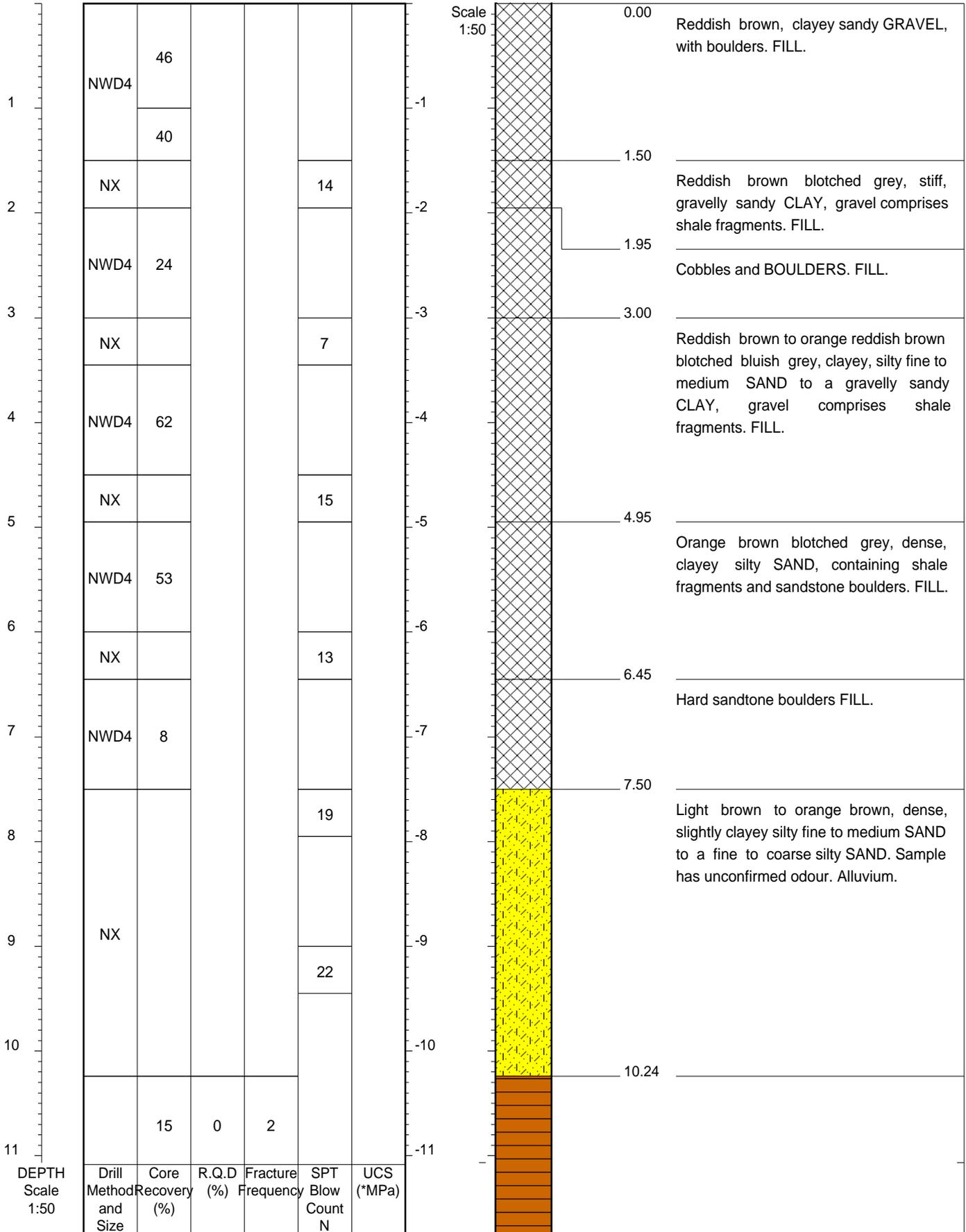
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 Tongaat, eThekweni Municipality

HOLE No: BH02  
 Sheet 1 of 2

JOB NUMBER: 035-22





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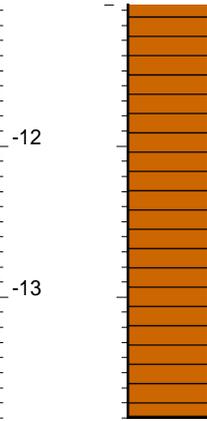
Fax: 086 689-5506  
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Naidu Consulting (Pty) Ltd  
 Geotechnical Investigation for Proposed  
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 Works  
 Tongaat, eThekweni Municipality

HOLE No: BH02  
 Sheet 2 of 2

JOB NUMBER: 035-22

DEPTH Scale 1:50	Drill Method and Size	Core Recovery (%)	R.Q.D (%)	Fracture Frequency	SPT Blow Count N	UCS (*MPa)
12	NWD4	100	0	23		
13		87	0	35		



Dark bluish grey and dark grey stained orange brown, slightly to moderately weathered, fine grained, very highly fractured, thinly laminated, carbonaceous hard to soft indurated rock. SHALE (Pietermaritzburg Formation).

NOTES

- 1) No water level recorded.
- 2) Borehole terminated at 13.80m below EGL.

CONTRACTOR : TFI (Pty) Ltd  
 MACHINE :  
 DRILLED BY :  
 PROFILED BY : S.Chattergoon  
 TYPE SET BY : K.Kistasamy  
 SETUP FILE : STANDARG.SET

INCLINATION :  
 DIAM : NWD4  
 DATE : 20.11.2023  
 DATE : 29 November 2023  
 DATE : 26/01/24 11:14  
 TEXT : ..C:\LOGS\BH02.TXT

ELEVATION : m  
 X-COORD : 31.128364E  
 Y-COORD : 29.544639S

HOLE No: BH02



P O Box 1461, Westville, 3630, South Africa  
 Tel: (031) 266-0458  
 email: geosure@iafrica.com

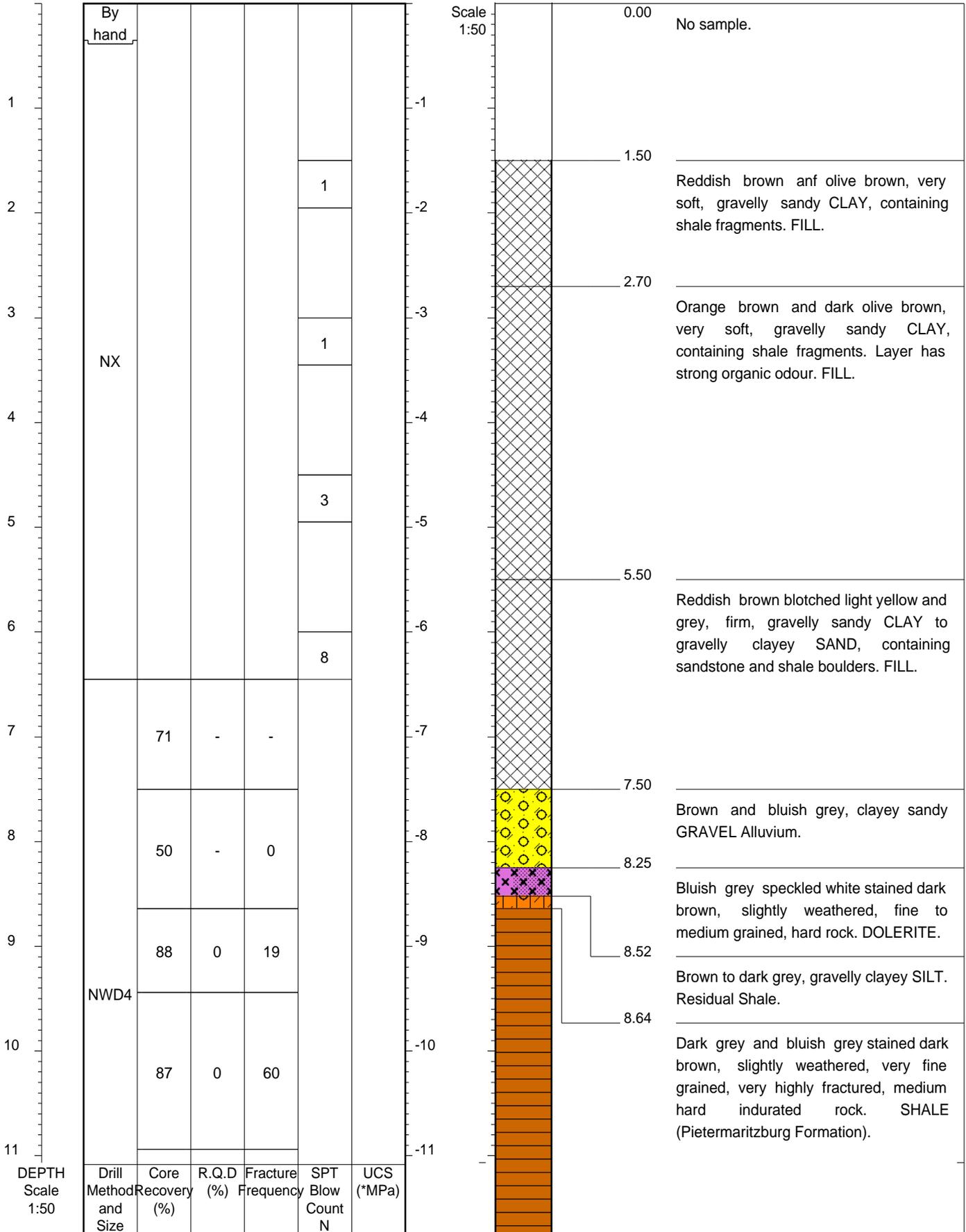
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Naidu Consulting (Pty) Ltd  
 Geotechnical Investigation for Proposed  
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 Works  
 Tongaat, eThekweni Municipality

HOLE No: BH03  
 Sheet 1 of 2

JOB NUMBER: 035-22





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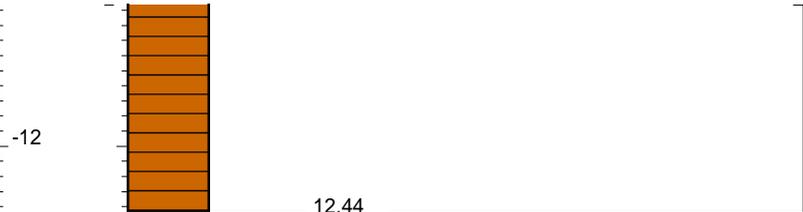
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 Works  
 Tongaat, eThekweni Municipality

HOLE No: BH03  
 Sheet 2 of 2

JOB NUMBER: 035-22

12	87	0	42			
-12						
DEPTH Scale 1:50	Drill Method and Size	Core Recovery (%)	R.Q.D (%)	Fracture Frequency	SPT Blow Count N	UCS (*MPa)



NOTES

- 1) No water level recorded.
- 2) Borehole terminated at 12.44m below EGL.

CONTRACTOR : TFI (Pty) Ltd  
 MACHINE : Tone 170  
 DRILLED BY :  
 PROFILED BY : S.Chattergoon  
 TYPE SET BY : K.Kistasamy  
 SETUP FILE : STANDARG.SET

INCLINATION :  
 DIAM : NWD4  
 DATE : 15.11.2023  
 DATE : 27 November 2023  
 DATE : 24/01/24 14:54  
 TEXT : ..C:\LOGS\BH03.TXT

ELEVATION : m  
 X-COORD : 31.128089E  
 Y-COORD : -29.544947S

HOLE No: BH03  
 -



**APPENDIX E**



**INFERRED PROFILES OF  
INSPECTION PITS**





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 Tel: (031) 266-0458  
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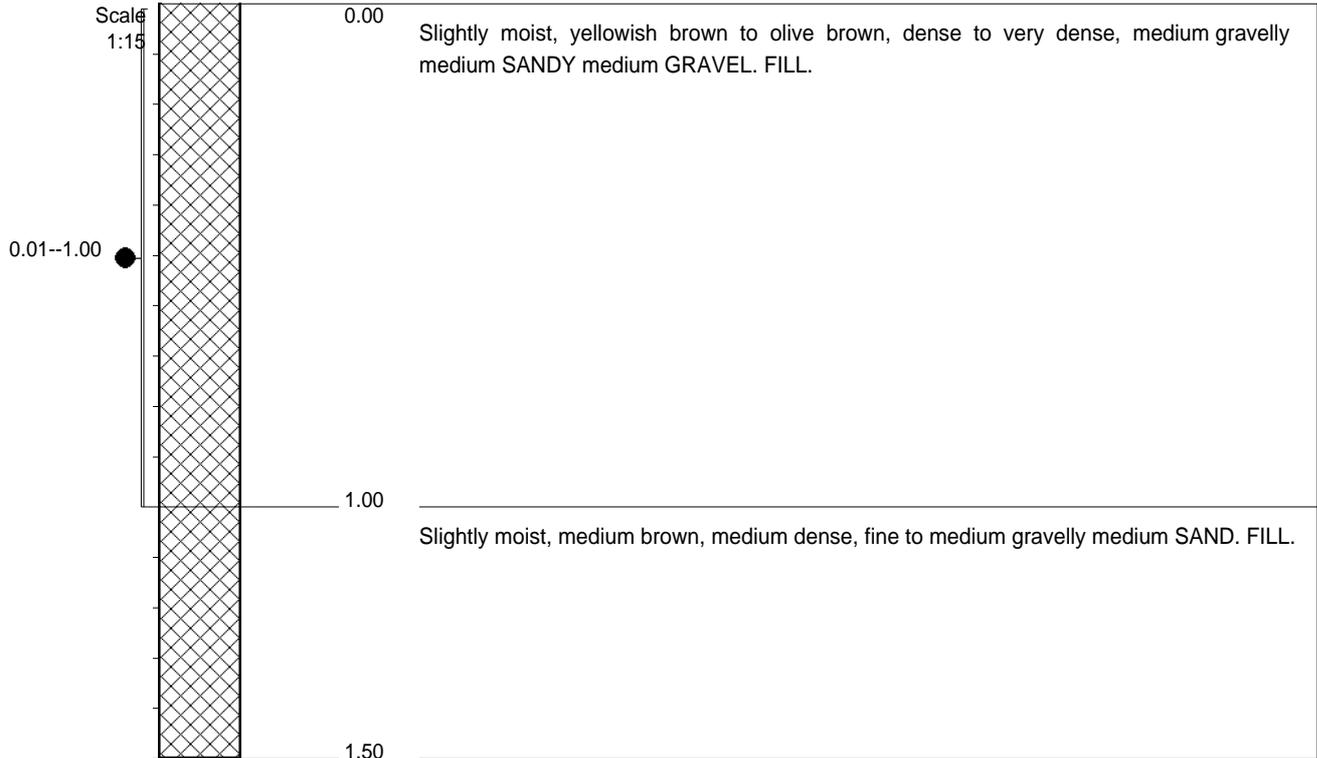
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 Tongaat, eThekweni Municipality

HOLE No: IP1  
 Sheet 1 of 1

JOB NUMBER: 035-22



NOTES

- 1) No groundwater seepage observed.
- 2) Sample taken at:  
 S1 0,01--1,00 (2 x Bulk)
- 3) Final depth at 1.50m.

CONTRACTOR :

MACHINE : By hand  
 DRILLED BY :  
 PROFILED BY : S.Maharaj

TYPE SET BY : K.Kistasamy  
 SETUP FILE : STANDARD.SET

INCLINATION :

DIAM :  
 DATE : 15 November 2023  
 DATE : 17 November 2023

DATE : 26/01/24 11:13  
 TEXT : ..C:\LOGS\PITS.TXT

ELEVATION : -

X-COORD : 31.12819 E  
 Y-COORD : 29.54358 S

HOLE No: IP1



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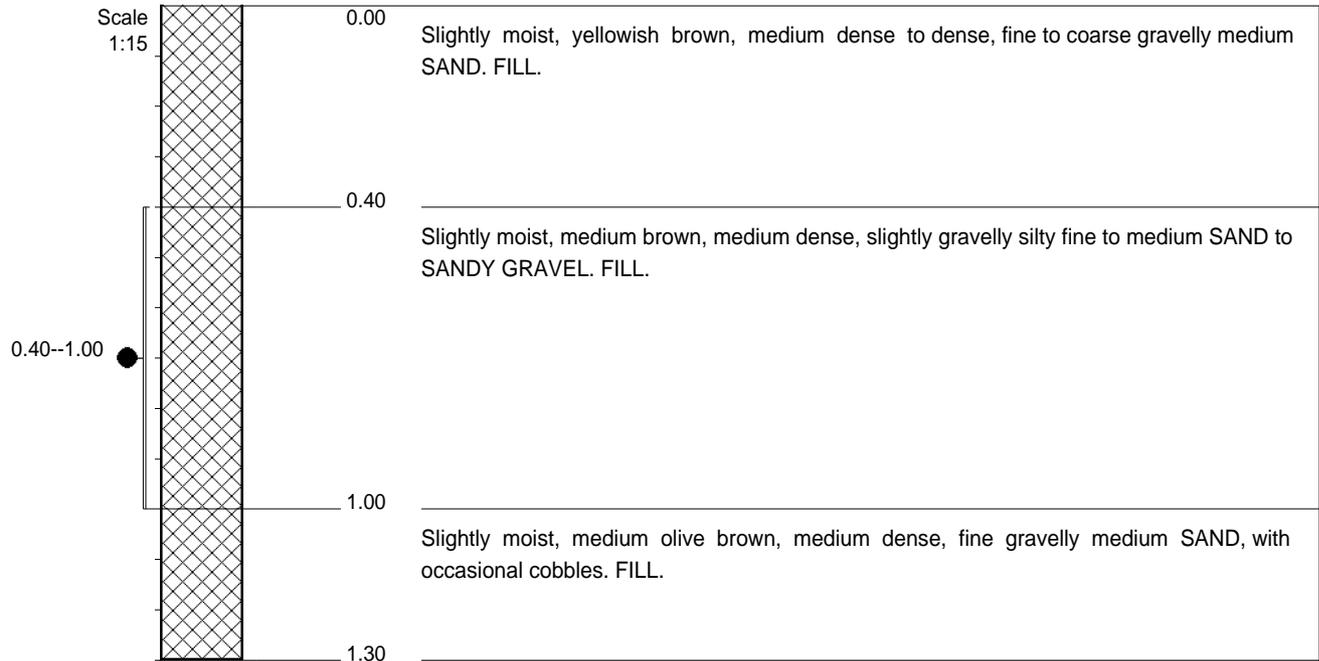
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 Tongaat, eThekweni Municipality

HOLE No: IP2  
 Sheet 1 of 1

JOB NUMBER: 035-22



NOTES

- 1) No groundwater seepage observed.
- 2) Pipe observed at 1.30m.
- 3) Inspection pit terminated due to presence of burial services.
- 4) Sample taken at:  
S1 0,40--1,00 (3 x Bulk)
- 5) Final depth at 1.30m.

CONTRACTOR :

MACHINE : By hand  
 DRILLED BY :  
 PROFILED BY : S.Maharaj

TYPE SET BY : K.Kistasamy  
 SETUP FILE : STANDARD.SET

INCLINATION :

DIAM :  
 DATE : 15 November 2023  
 DATE : 17 November 2023

DATE : 26/01/24 11:14  
 TEXT : ..C:\LOGS\PITS.TXT

ELEVATION : -

X-COORD : 31.12830 E  
 Y-COORD : 29.54396 S

HOLE No: IP2



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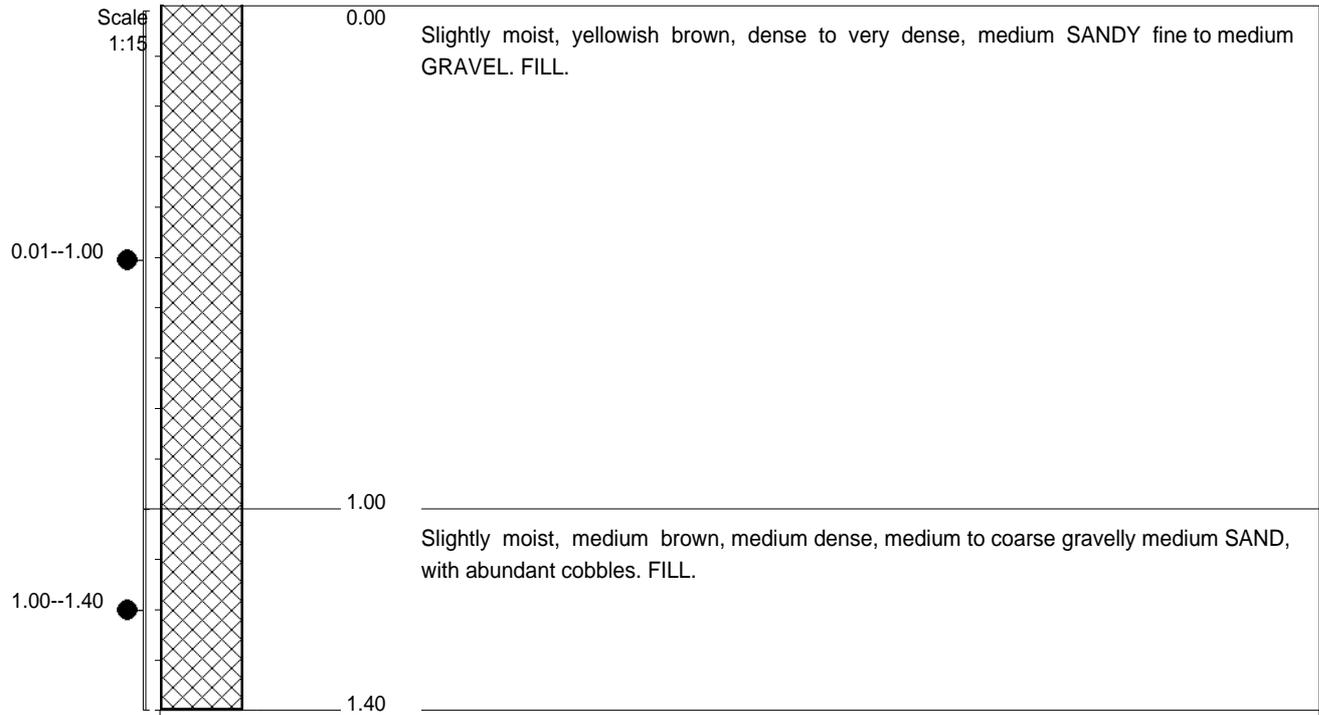
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 Geotechnical Investigation for Proposed  
 Improvement to the Tongaat Water Treatment  
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 Tongaat, eThekweni Municipality

HOLE No: IP3  
 Sheet 1 of 1

JOB NUMBER: 035-22



NOTES

- 1) No groundwater seepage observed.
- 2) Samples taken at:  
 S1 0,01--1,00 (2 x Bulk)  
 S2 1,00--1,40 (1 x Ind)
- 3) Refusal depth at 1.40m on cobbles.

CONTRACTOR :

MACHINE : By hand  
 DRILLED BY :  
 PROFILED BY : S.Maharaj

TYPE SET BY : K.Kistasamy  
 SETUP FILE : STANDARD.SET

INCLINATION :

DIAM :  
 DATE : 15 November 2023  
 DATE : 17 November 2023

DATE : 26/01/24 11:14  
 TEXT : ..C:\LOGS\PITS.TXT

ELEVATION : -

X-COORD : 31.12841 E  
 Y-COORD : 29.54431 S

HOLE No: IP3



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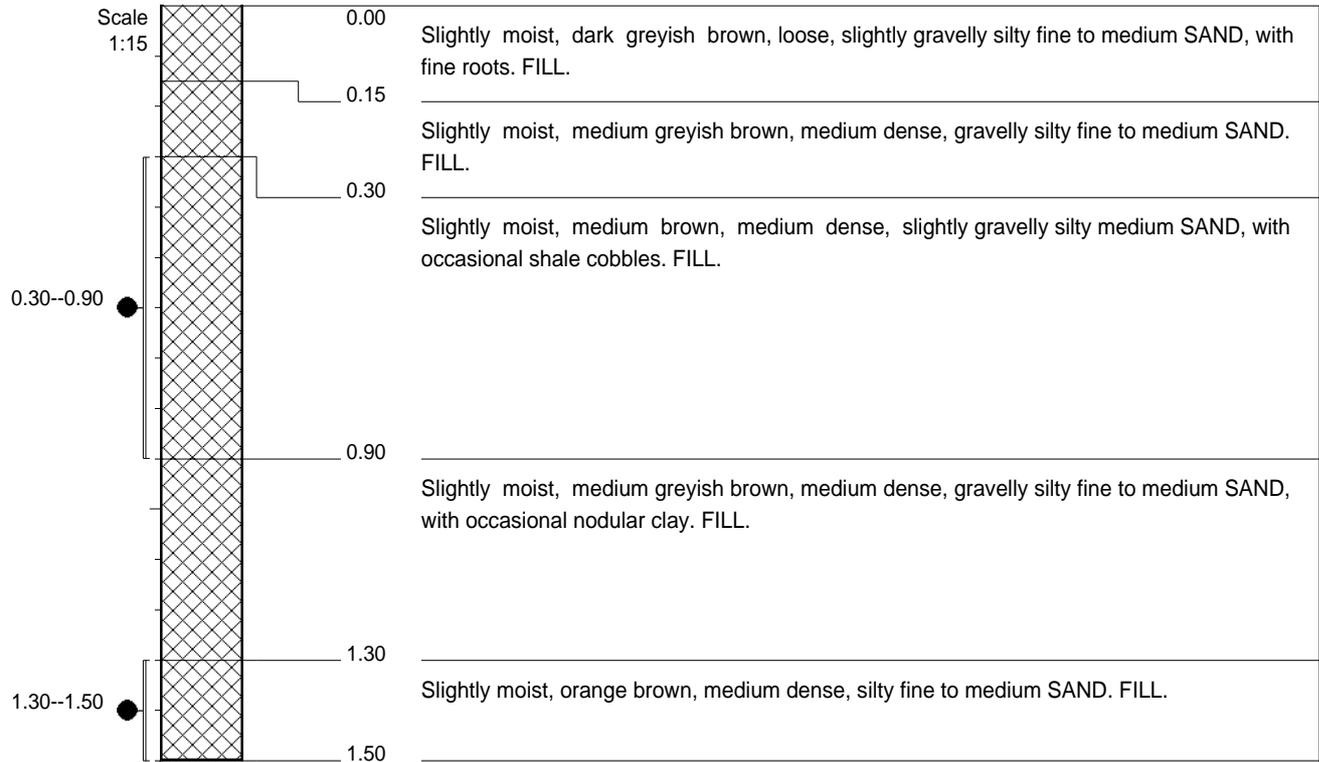
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 Improvement to the Tongaat Water Treatment  
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 Tongaat, eThekweni Municipality

HOLE No: IP4  
 Sheet 1 of 1

JOB NUMBER: 035-22



NOTES

- 1) No groundwater seepage observed.
- 2) Samples taken at:  
 S1 0,30--0,90 (3 x Bulk)  
 S2 1,30--1,50 (1 x Ind)
- 3) Final depth at 1.50m.

CONTRACTOR :

MACHINE : By hand

DRILLED BY :

PROFILED BY : S.Maharaj

TYPE SET BY : K.Kistasamy

SETUP FILE : STANDARD.SET

INCLINATION :

DIAM :

DATE : 15 November 2023

DATE : 17 November 2023

DATE : 26/01/24 11:14

TEXT : ..C:\LOGS\PITS.TXT

ELEVATION : -

X-COORD : 31.12856 E

Y-COORD : 29.54458 S

HOLE No: IP4



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 Tel: (031) 266-0458  
 email: geosure@iafrica.com

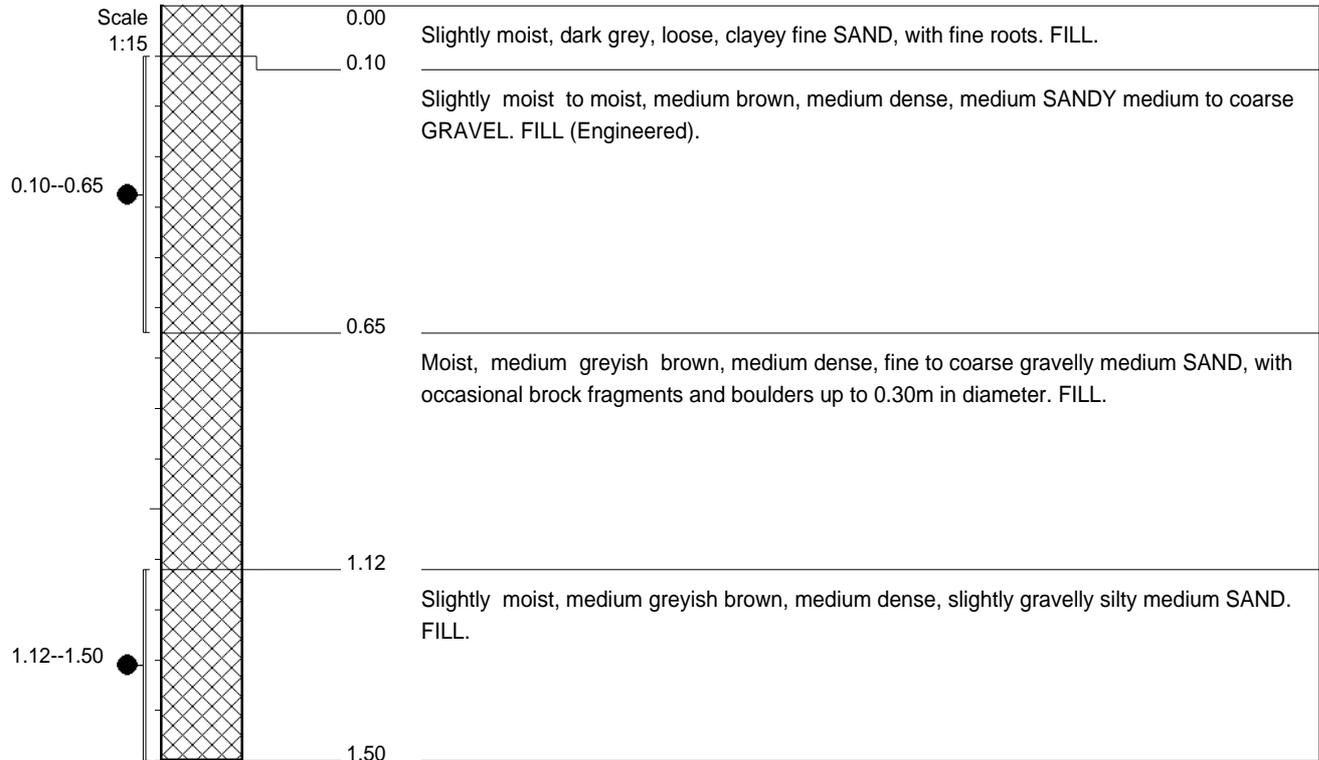
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 Geotechnical Investigation for Proposed  
 Improvement to the Tongaat Water Treatment  
 Works  
 Tongaat, eThekweni Municipality

HOLE No: IP5  
 Sheet 1 of 1

JOB NUMBER: 035-22



NOTES

- 1) No groundwater seepage observed.
- 2) Samples taken at:  
 S1 0,10--0,65 (2 x Bulk)  
 S2 1,12--1,50 (1 x Ind)
- 3) Final depth at 1.50m.

CONTRACTOR :

MACHINE : By hand  
 DRILLED BY :  
 PROFILED BY : S.Maharaj  
 TYPE SET BY : K.Kistasamy  
 SETUP FILE : STANDARD.SET

INCLINATION :

DIAM :  
 DATE : 15 November 2023  
 DATE : 17 November 2023  
 DATE : 26/01/24 11:14  
 TEXT : ..C:\LOGS\PIITS.TXT

ELEVATION : -

X-COORD : 31.12829 E  
 Y-COORD : 29.54453 S

HOLE No: IP5



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 Tel: (031) 266-0458  
 email: geosure@iafrica.com

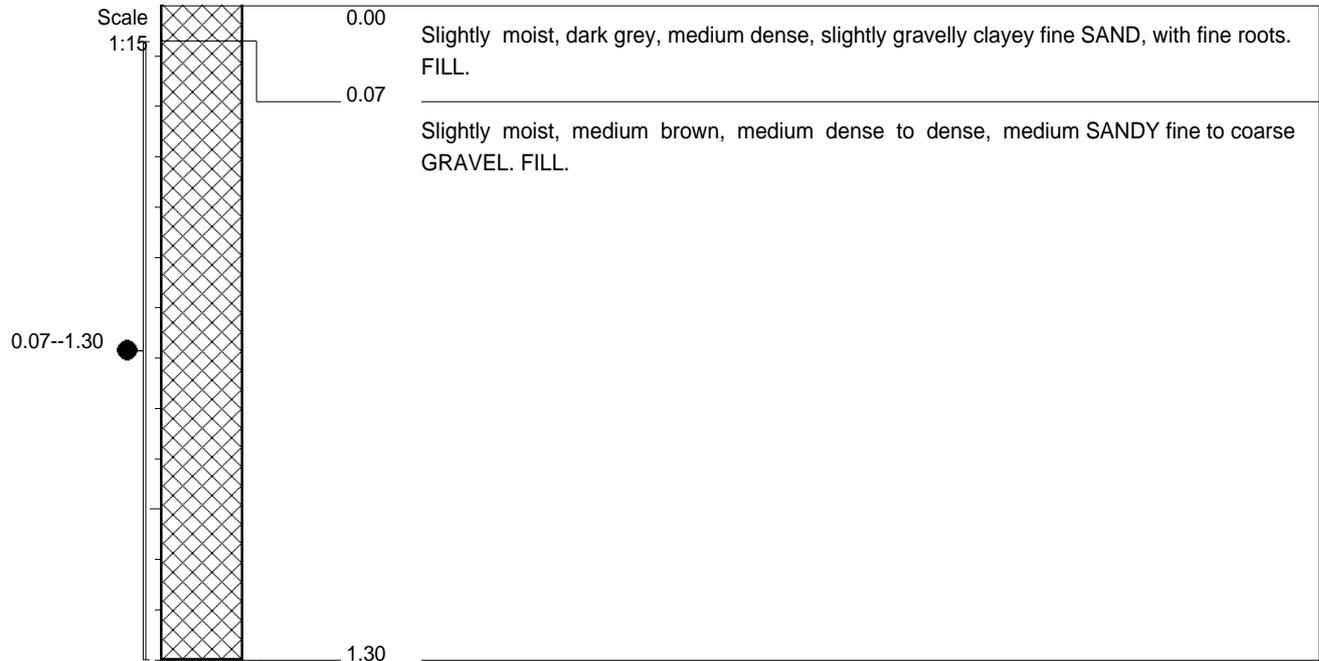
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 Engineering Laboratory

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 Geotechnical Investigation for Proposed  
 Improvement to the Tongaat Water Treatment  
 Works  
 Tongaat, eThekweni Municipality

HOLE No: IP6  
 Sheet 1 of 1

JOB NUMBER: 035-22



NOTES

- 1) No groundwater seepage observed.
- 2) Inspection pit done at toe of embankment.
- 3) Sample taken at:  
S1 0,07--1,30 (3 x Bulk)
- 4) Refusal depth at 1.30m on dense gravel.

CONTRACTOR :

MACHINE : By hand  
 DRILLED BY :  
 PROFILED BY : S.Maharaj

TYPE SET BY : K.Kistasamy  
 SETUP FILE : STANDARD.SET

INCLINATION :

DIAM :  
 DATE : 15 November 2023  
 DATE : 17 November 2023

DATE : 26/01/24 11:14  
 TEXT : ..C:\LOGS\PITS.TXT

ELEVATION : -

X-COORD : 31.12840 E  
 Y-COORD : 29.54461 S

HOLE No: IP6



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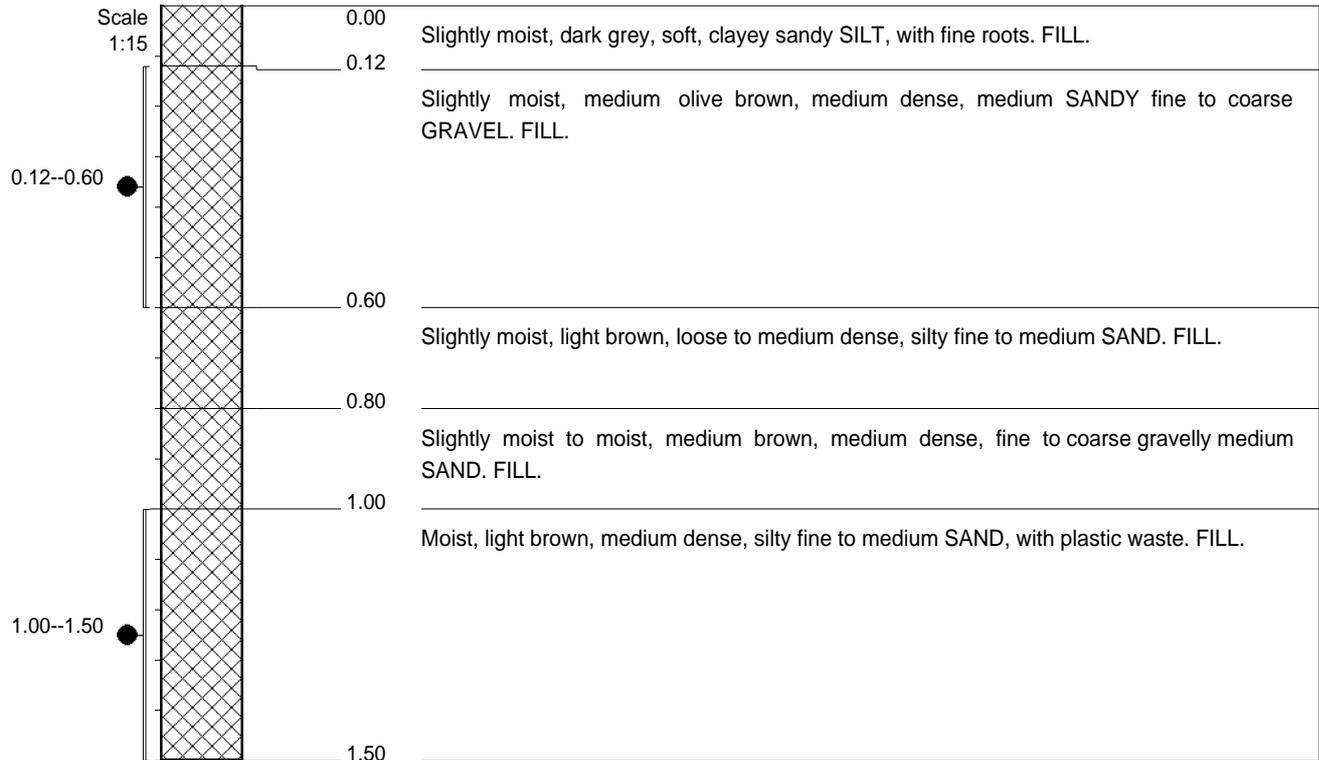
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 Geotechnical Investigation for Proposed  
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 Works  
 Tongaat, eThekweni Municipality

HOLE No: IP7  
 Sheet 1 of 1

JOB NUMBER: 035-22



NOTES

- 1) No groundwater seepage observed.
- 2) PVC pipe observed at 0.60m.
- 3) Samples taken at:  
 S1 0,12--0,60 (3 x Bulk)  
 S2 1,00--1,50 (1 x Ind)
- 4) Final depth at 1.50m.

CONTRACTOR :

MACHINE : By hand

DRILLED BY :

PROFILED BY : S.Maharaj

TYPE SET BY : K.Kistasamy

SETUP FILE : STANDARD.SET

INCLINATION :

DIAM :

DATE : 15 November 2023

DATE : 17 November 2023

DATE : 26/01/24 11:14

TEXT : ..C:\LOGS\PITS.TXT

ELEVATION : -

X-COORD : 31.12836 E

Y-COORD : 29.54473 S

HOLE No: IP7



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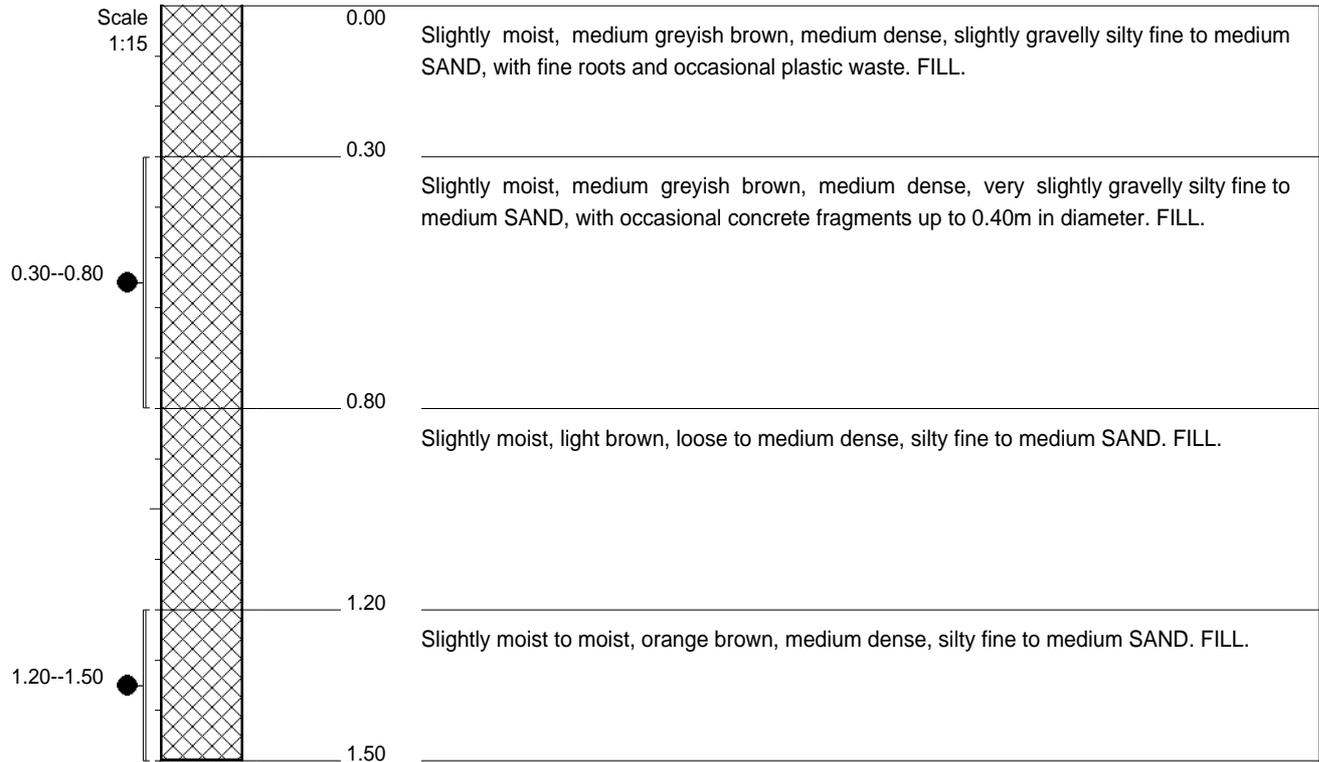
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 Geotechnical Investigation for Proposed  
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 Tongaat, eThekweni Municipality

HOLE No: IP8  
 Sheet 1 of 1

JOB NUMBER: 035-22



NOTES

- 1) No groundwater seepage observed.
- 2) Pipe observed at 0.30m.
- 3) Samples taken at:  
 S1 0,30--0,80 (2 x Bulk)  
 S2 1,20--1,50 (1 x Ind)
- 4) Final depth at 1.50m.

CONTRACTOR :

MACHINE : By hand

DRILLED BY :

PROFILED BY : S.Maharaj

TYPE SET BY : K.Kistasamy

SETUP FILE : STANDARD.SET

INCLINATION :

DIAM :

DATE : 15 November 2023

DATE : 17 November 2023

DATE : 26/01/24 11:14

TEXT : ..C:\LOGS\PITS.TXT

ELEVATION : -

X-COORD : 31.12859 E

Y-COORD : 29.54490 S

HOLE No: IP8



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 email: geosure@iafrica.com

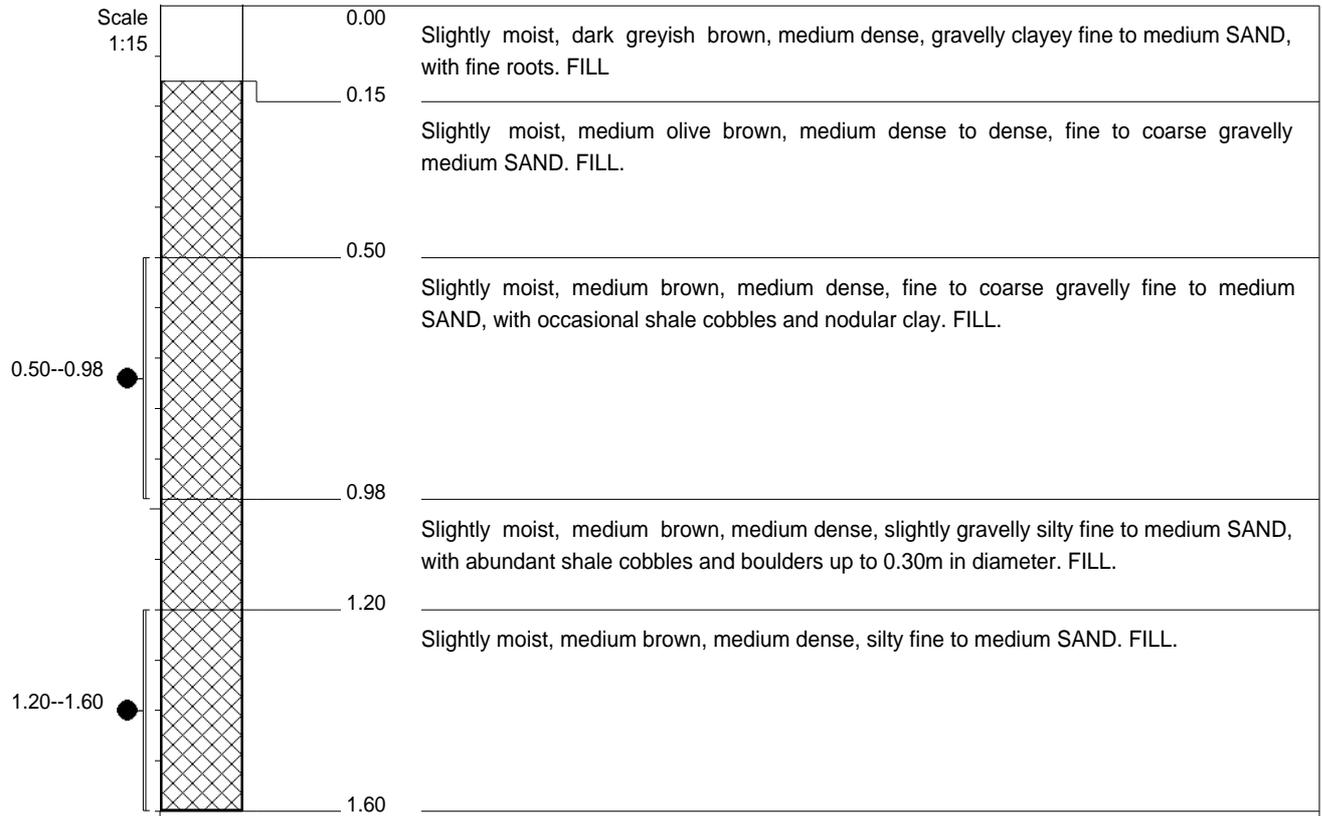
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 Groundwater Engineering  
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 Engineering Laboratory

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Naidu Consulting (Pty) Ltd  
 Geotechnical Investigation for Proposed  
 Improvement to the Tongaat Water Treatment  
 Works  
 Tongaat, eThekweni Municipality

HOLE No: IP9  
 Sheet 1 of 1

JOB NUMBER: 035-22



NOTES

- 1) No groundwater seepage observed.
- 2) Samples taken at:  
 S1 0,50--0,98 (3 x Bulk)  
 S2 1,20--1,60 (1 x Ind)
- 3) Final depth at 1.60m.

CONTRACTOR :

MACHINE : By hand

DRILLED BY :

PROFILED BY : S.Maharaj

TYPE SET BY : K.Kistasamy

SETUP FILE : STANDARD.SET

INCLINATION :

DIAM :

DATE : 15 November 2023

DATE : 17 November 2023

DATE : 26/01/24 11:14

TEXT : ..C:\LOGS\PITS.TXT

ELEVATION : -

X-COORD : 31.12828 E

Y-COORD : 29.54505 S

HOLE No: IP9



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 Tel: (031) 266-0458  
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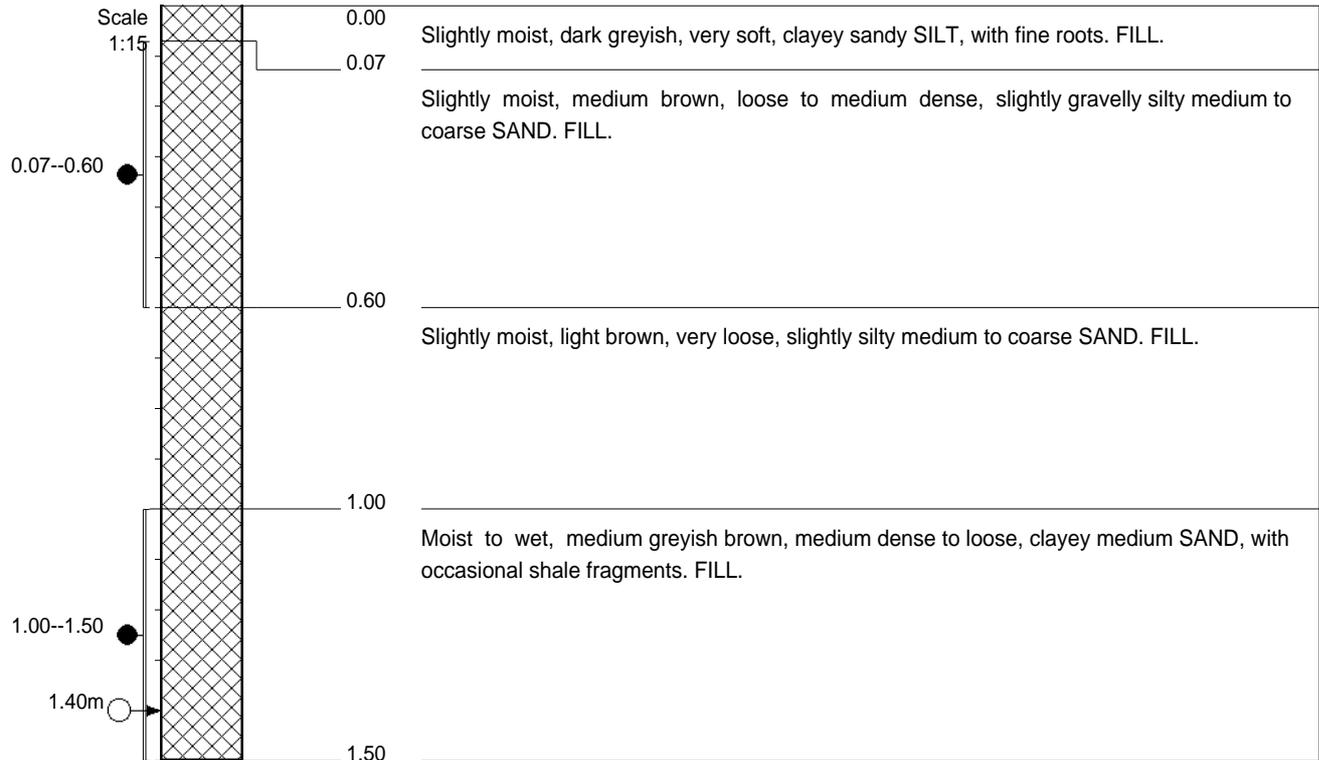
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Naidu Consulting (Pty) Ltd  
 Geotechnical Investigation for Proposed  
 Improvement to the Tongaat Water Treatment  
 Works  
 Tongaat, eThekweni Municipality

HOLE No: IP10  
 Sheet 1 of 1

JOB NUMBER: 035-22



NOTES

- 1) Slight groundwater seepage observed at 1.40m.
- 2) Potentially unstable sidewalls.
- 3) Samples taken at:  
 S1 0,07--0,60 (3 x Bulk)  
 S2 1,00--1,50 (1 x Ind)
- 4) Final depth at 1.50m.

CONTRACTOR :

MACHINE : By hand

DRILLED BY :

PROFILED BY : S.Maharaj

TYPE SET BY : K.Kistasamy

SETUP FILE : STANDARD.SET

INCLINATION :

DIAM :

DATE : 15 November 2023

DATE : 17 November 2023

DATE : 26/01/24 11:14

TEXT : ..C:\LOGS\PITS.TXT

ELEVATION : -

X-COORD : 31.12806 E

Y-COORD : 29.54498 S

HOLE No: IP10



**APPENDIX F**



**RESULTS OF DYNAMIC CONE  
PENETROMETER TESTS**



# GEOSURE (PTY) LTD.

Geotechnical Engineering Consultants

Tel: (031) 266 0458

Fax: 086 689 5506

Email: info@geosure.co.za

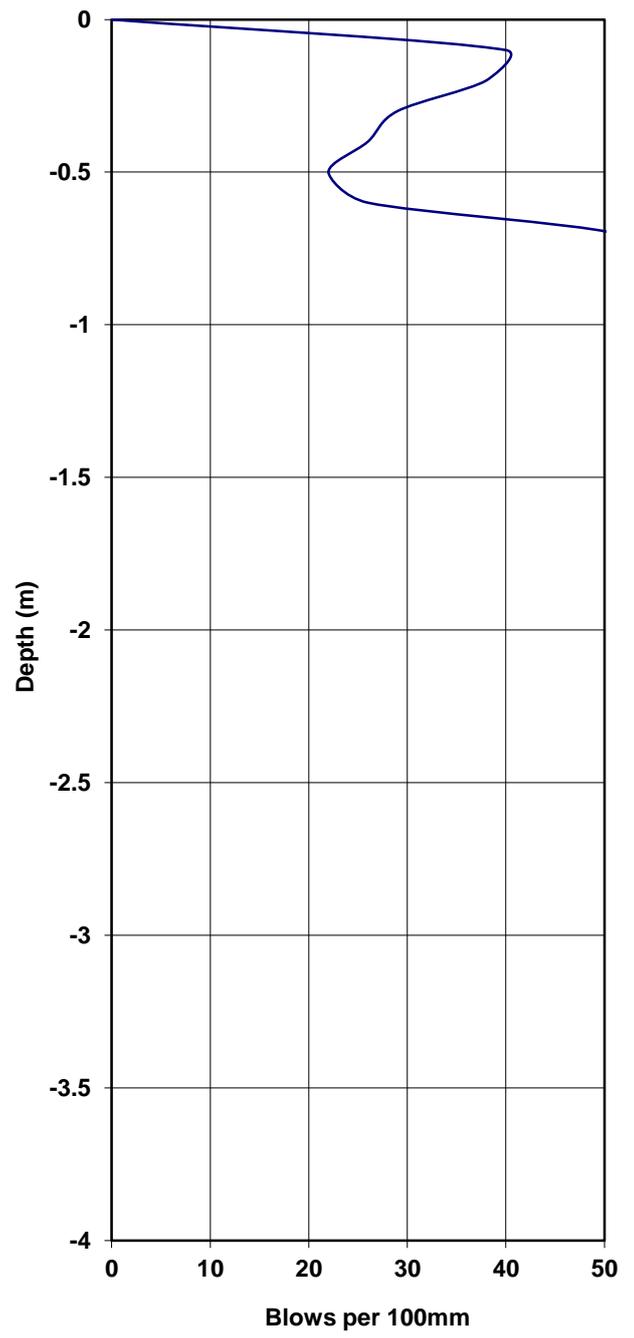


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 1

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	40	Very Dense	>38 deg	>55
0.2	38	Very Dense	>38 deg	>55
0.3	29	Very Dense	>38 deg	>55
0.4	26	Very Dense	>38 deg	51
0.5	22	Dense	38 deg	42
0.6	26	Very Dense	>38 deg	51
	Refusal			



# GEOSURE (PTY) LTD.

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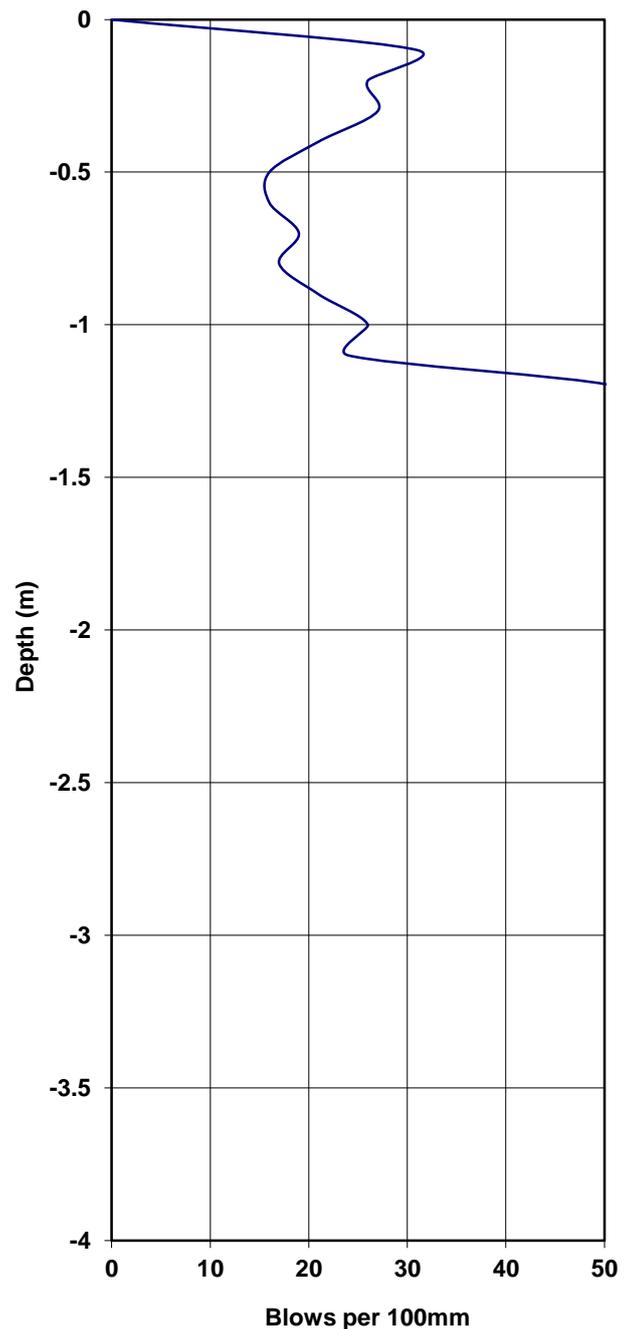


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 2

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	31	Very Dense	>38 deg	>55
0.2	26	Very Dense	>38 deg	51
0.3	27	Very Dense	>38 deg	54
0.4	21	Dense	38 deg	40
0.5	16	Dense	37 deg	29
0.6	16	Dense	37 deg	29
0.7	19	Dense	37 deg	35
0.8	17	Dense	37 deg	31
0.9	21	Dense	38 deg	40
1	26	Very Dense	>38 deg	51
1.1	24	Dense	38 deg	47
	Refusal			



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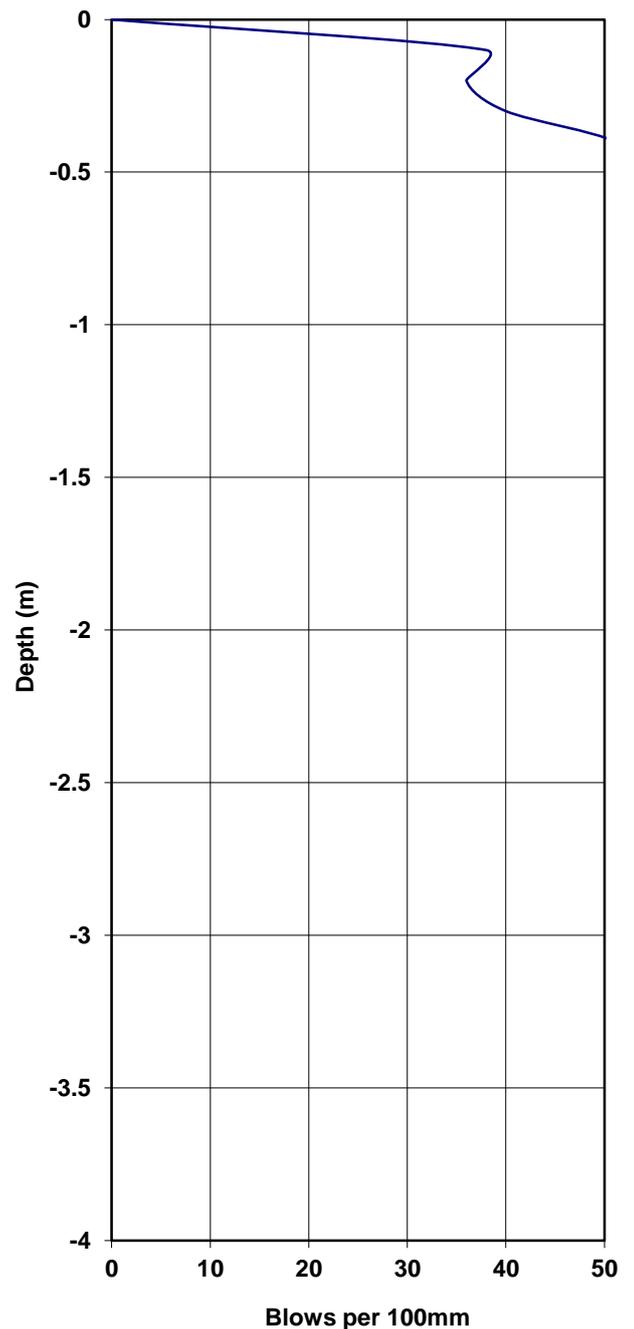


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 3

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	38	Very Dense	>38 deg	>55
0.2	36	Very Dense	>38 deg	>55
0.3	40	Very Dense	>38 deg	>55
	Refusal			



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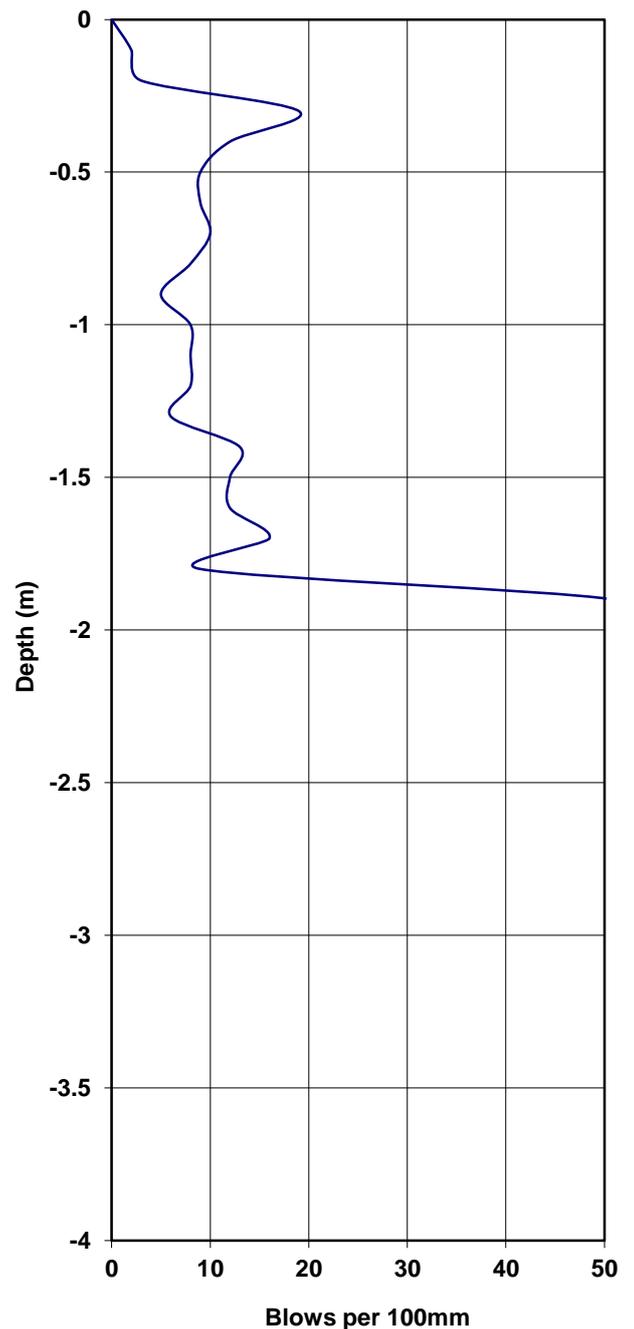


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 4

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	2	Loose	<30 deg	3
0.2	3	Loose	<30 deg	5
0.3	19	Dense	37 deg	35
0.4	12	Dense	36 deg	21
0.5	9	Med.Dense	35 deg	15
0.6	9	Med.Dense	35 deg	15
0.7	10	Med.Dense	36 deg	17
0.8	8	Med.Dense	35 deg	14
0.9	5	Med.Dense	32 deg	8
1	8	Med.Dense	35 deg	14
1.1	8	Med.Dense	35 deg	14
1.2	8	Med.Dense	35 deg	14
1.3	6	Med.Dense	33 deg	10
1.4	13	Dense	37 deg	23
1.5	12	Dense	36 deg	21
1.6	12	Dense	36 deg	21
1.7	16	Dense	37 deg	29
1.8	9	Med.Dense	35 deg	15
	Refusal			



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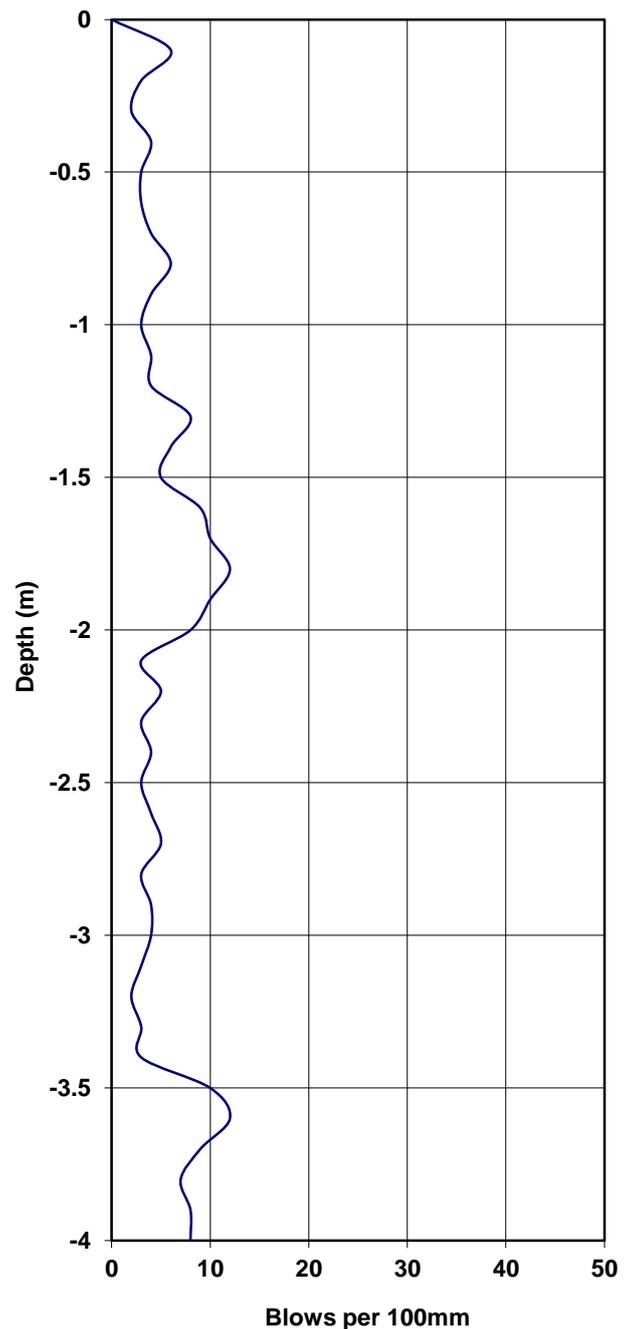


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 5

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	6	Med.Dense	33 deg	10
0.2	3	Loose	<30 deg	5
0.3	2	Loose	<30 deg	3
0.4	4	Med.Dense	30 deg	7
0.5	3	Loose	<30 deg	5
0.6	3	Loose	<30 deg	5
0.7	4	Med.Dense	30 deg	7
0.8	6	Med.Dense	33 deg	10
0.9	4	Med.Dense	30 deg	7
1	3	Loose	<30 deg	5
1.1	4	Med.Dense	30 deg	7
1.2	4	Med.Dense	30 deg	7
1.3	8	Med.Dense	35 deg	14
1.4	6	Med.Dense	33 deg	10
1.5	5	Med.Dense	32 deg	8
1.6	9	Med.Dense	35 deg	15
1.7	10	Med.Dense	36 deg	17
1.8	12	Dense	36 deg	21
1.9	10	Med.Dense	36 deg	17
2	8	Med.Dense	35 deg	14
2.1	3	Loose	<30 deg	5
2.2	5	Med.Dense	32 deg	8
2.3	3	Loose	<30 deg	5
2.4	4	Med.Dense	30 deg	7
2.5	3	Loose	<30 deg	5
2.6	4	Med.Dense	30 deg	7
2.7	5	Med.Dense	32 deg	8
2.8	3	Loose	<30 deg	5
2.9	4	Med.Dense	30 deg	7
3	4	Med.Dense	30 deg	7
3.1	3	Loose	<30 deg	5
3.2	2	Loose	<30 deg	3
3.3	3	Loose	<30 deg	5
3.4	3	Loose	<30 deg	5
3.5	10	Med.Dense	36 deg	17
3.6	12	Dense	36 deg	21
3.7	9	Med.Dense	35 deg	15
3.8	7	Med.Dense	34 deg	12
3.9	8	Med.Dense	35 deg	14
4	8	Med.Dense	35 deg	14



End

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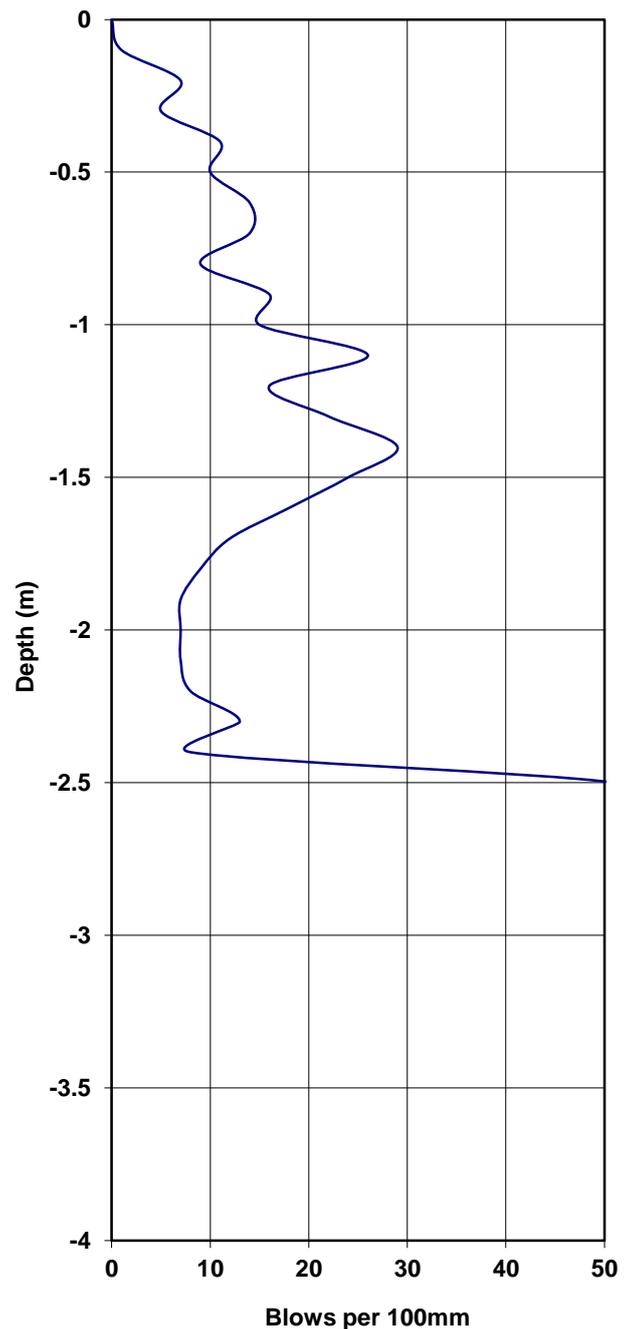


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 6

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	1	Very Loose	<29 deg	2
0.2	7	Med.Dense	34 deg	12
0.3	5	Med.Dense	32 deg	8
0.4	11	Dense	36 deg	19
0.5	10	Med.Dense	36 deg	17
0.6	14	Dense	37 deg	25
0.7	14	Dense	37 deg	25
0.8	9	Med.Dense	35 deg	15
0.9	16	Dense	37 deg	29
1	15	Dense	37 deg	27
1.1	26	Very Dense	>38 deg	51
1.2	16	Dense	37 deg	29
1.3	22	Dense	38 deg	42
1.4	29	Very Dense	>38 deg	>55
1.5	24	Dense	38 deg	47
1.6	18	Dense	37 deg	33
1.7	12	Dense	36 deg	21
1.8	9	Med.Dense	35 deg	15
1.9	7	Med.Dense	34 deg	12
2	7	Med.Dense	34 deg	12
2.1	7	Med.Dense	34 deg	12
2.2	8	Med.Dense	35 deg	14
2.3	13	Dense	37 deg	23
2.4	8	Med.Dense	35 deg	14
	Refusal			



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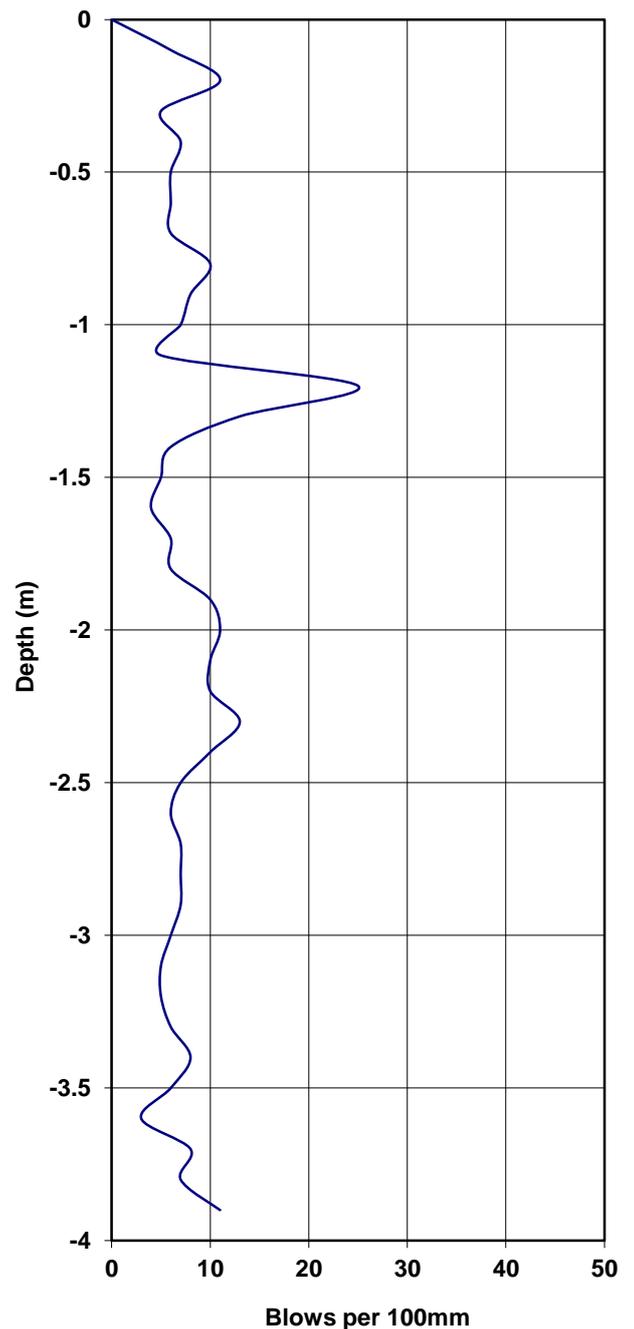


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 7

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	6	Firm	50 kPa	10
0.2	11	Dense	36 deg	19
0.3	5	Med.Dense	32 deg	8
0.4	7	Med.Dense	34 deg	12
0.5	6	Med.Dense	33 deg	10
0.6	6	Med.Dense	33 deg	10
0.7	6	Med.Dense	33 deg	10
0.8	10	Med.Dense	36 deg	17
0.9	8	Med.Dense	35 deg	14
1	7	Med.Dense	34 deg	12
1.1	5	Med.Dense	32 deg	8
1.2	25	Very Dense	>38 deg	49
1.3	13	Dense	37 deg	23
1.4	6	Med.Dense	33 deg	10
1.5	5	Med.Dense	32 deg	8
1.6	4	Med.Dense	30 deg	7
1.7	6	Med.Dense	33 deg	10
1.8	6	Med.Dense	33 deg	10
1.9	10	Med.Dense	36 deg	17
2	11	Dense	36 deg	19
2.1	10	Med.Dense	36 deg	17
2.2	10	Med.Dense	36 deg	17
2.3	13	Dense	37 deg	23
2.4	10	Med.Dense	36 deg	17
2.5	7	Med.Dense	34 deg	12
2.6	6	Med.Dense	33 deg	10
2.7	7	Med.Dense	34 deg	12
2.8	7	Med.Dense	34 deg	12
2.9	7	Med.Dense	34 deg	12
3	6	Med.Dense	33 deg	10
3.1	5	Med.Dense	32 deg	8
3.2	5	Med.Dense	32 deg	8
3.3	6	Med.Dense	33 deg	10
3.4	8	Med.Dense	35 deg	14
3.5	6	Med.Dense	33 deg	10
3.6	3	Loose	<30 deg	5
3.7	8	Med.Dense	35 deg	14
3.8	7	Med.Dense	34 deg	12
3.9	11	Dense	36 deg	19
End				

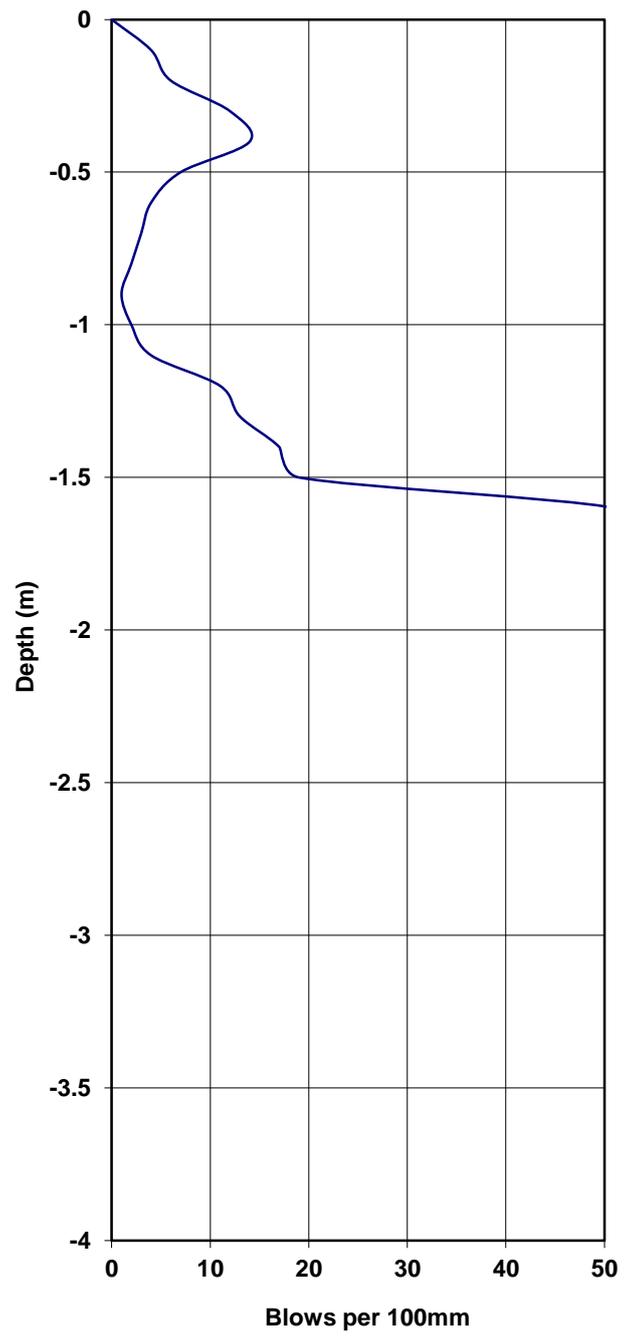


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 8

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	4	Med.Dense	30 deg	7
0.2	6	Med.Dense	33 deg	10
0.3	12	Dense	36 deg	21
0.4	14	Dense	37 deg	25
0.5	7	Med.Dense	34 deg	12
0.6	4	Med.Dense	30 deg	7
0.7	3	Loose	<30 deg	5
0.8	2	Loose	<30 deg	3
0.9	1	Very Loose	<29 deg	2
1	2	Loose	<30 deg	3
1.1	4	Med.Dense	30 deg	7
1.2	11	Dense	36 deg	19
1.3	13	Dense	37 deg	23
1.4	17	Dense	37 deg	31
1.5	19	Dense	37 deg	35
	Refusal			



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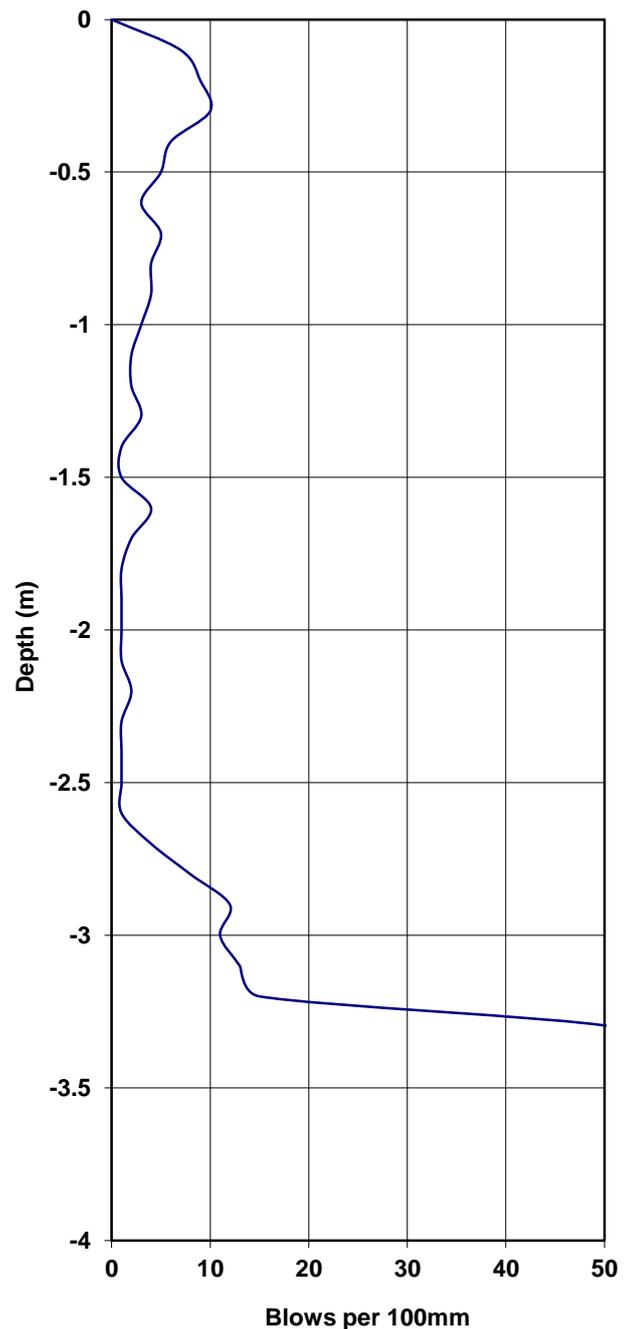


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 9

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	7	Med.Dense	34 deg	12
0.2	9	Med.Dense	35 deg	15
0.3	10	Med.Dense	36 deg	17
0.4	6	Med.Dense	33 deg	10
0.5	5	Med.Dense	32 deg	8
0.6	3	Loose	<30 deg	5
0.7	5	Med.Dense	32 deg	8
0.8	4	Med.Dense	30 deg	7
0.9	4	Med.Dense	30 deg	7
1	3	Loose	<30 deg	5
1.1	2	Loose	<30 deg	3
1.2	2	Loose	<30 deg	3
1.3	3	Loose	<30 deg	5
1.4	1	Very Loose	<29 deg	2
1.5	1	Very Loose	<29 deg	2
1.6	4	Med.Dense	30 deg	7
1.7	2	Loose	<30 deg	3
1.8	1	Very Loose	<29 deg	2
1.9	1	Very Loose	<29 deg	2
2	1	Very Loose	<29 deg	2
2.1	1	Very Loose	<29 deg	2
2.2	2	Loose	<30 deg	3
2.3	1	Very Loose	<29 deg	2
2.4	1	Very Loose	<29 deg	2
2.5	1	Very Loose	<29 deg	2
2.6	1	Very Loose	<29 deg	2
2.7	4	Med.Dense	30 deg	7
2.8	8	Med.Dense	35 deg	14
2.9	12	Dense	36 deg	21
3	11	Dense	36 deg	19
3.1	13	Dense	37 deg	23
3.2	15	Dense	37 deg	27
	Refusal			



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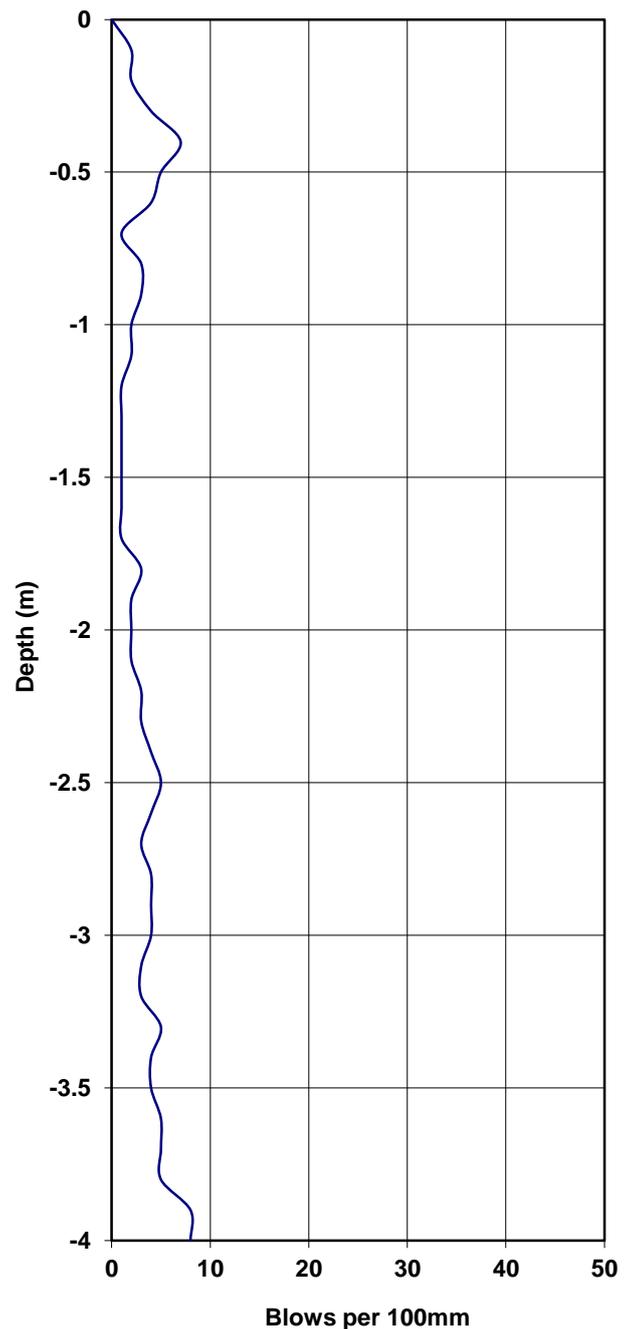


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
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<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 10

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	2	Soft	20 kPa	3
0.2	2	Loose	<30 deg	3
0.3	4	Med.Dense	30 deg	7
0.4	7	Med.Dense	34 deg	12
0.5	5	Med.Dense	32 deg	8
0.6	4	Med.Dense	30 deg	7
0.7	1	Very Loose	<29 deg	2
0.8	3	Loose	<30 deg	5
0.9	3	Loose	<30 deg	5
1	2	Loose	<30 deg	3
1.1	2	Loose	<30 deg	3
1.2	1	Very Loose	<29 deg	2
1.3	1	Very Loose	<29 deg	2
1.4	1	Very Loose	<29 deg	2
1.5	1	Very Loose	<29 deg	2
1.6	1	Very Loose	<29 deg	2
1.7	1	Very Loose	<29 deg	2
1.8	3	Loose	<30 deg	5
1.9	2	Loose	<30 deg	3
2	2	Loose	<30 deg	3
2.1	2	Loose	<30 deg	3
2.2	3	Loose	<30 deg	5
2.3	3	Loose	<30 deg	5
2.4	4	Med.Dense	30 deg	7
2.5	5	Med.Dense	32 deg	8
2.6	4	Med.Dense	30 deg	7
2.7	3	Loose	<30 deg	5
2.8	4	Med.Dense	30 deg	7
2.9	4	Med.Dense	30 deg	7
3	4	Med.Dense	30 deg	7
3.1	3	Loose	<30 deg	5
3.2	3	Loose	<30 deg	5
3.3	5	Med.Dense	32 deg	8
3.4	4	Med.Dense	30 deg	7
3.5	4	Med.Dense	30 deg	7
3.6	5	Med.Dense	32 deg	8
3.7	5	Med.Dense	32 deg	8
3.8	5	Med.Dense	32 deg	8
3.9	8	Med.Dense	35 deg	14
4	8	Med.Dense	35 deg	14



End

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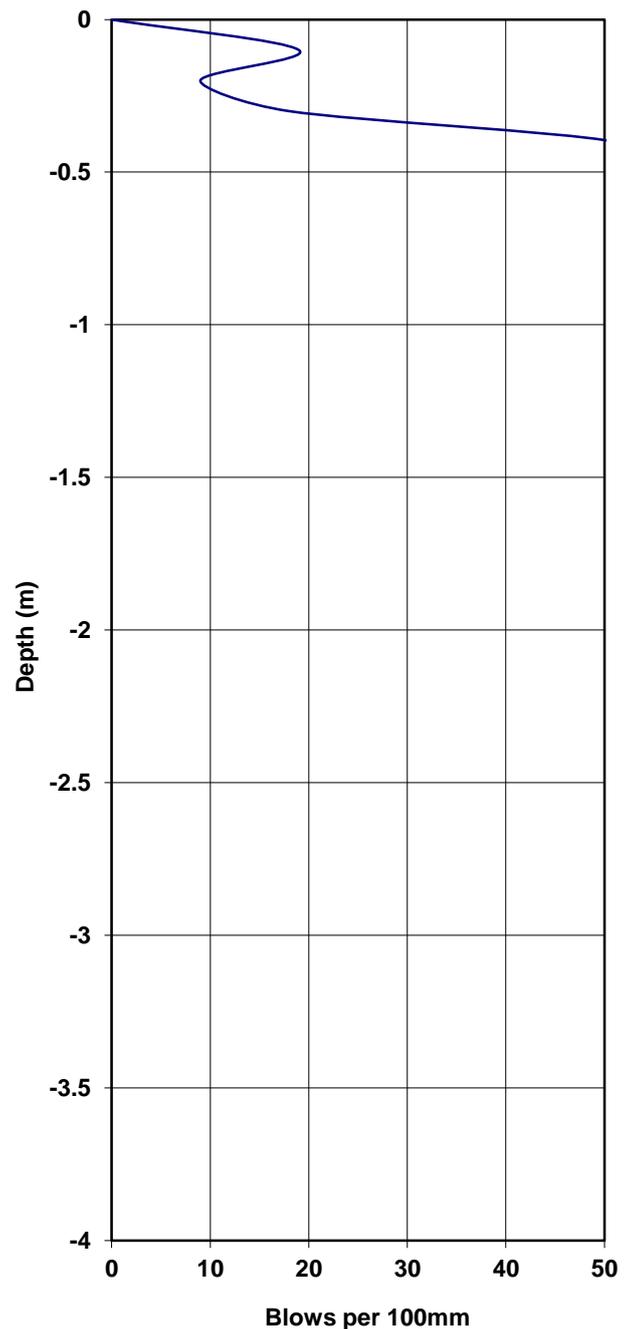


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<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 11

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	19	Dense	37 deg	35
0.2	9	Med.Dense	35 deg	15
0.3	18	Dense	37 deg	33
	Refusal			



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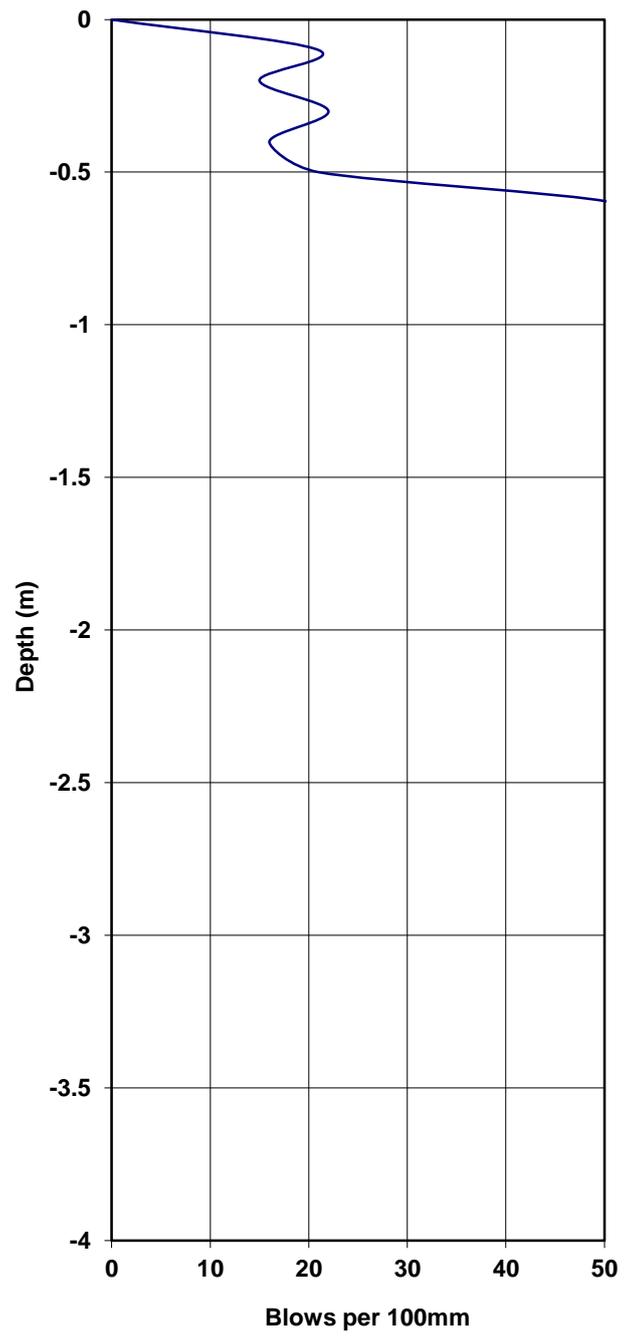


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<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 12

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	21	Dense	38 deg	40
0.2	15	Dense	37 deg	27
0.3	22	Dense	38 deg	42
0.4	16	Dense	37 deg	29
0.5	21	Dense	38 deg	40
	Refusal			



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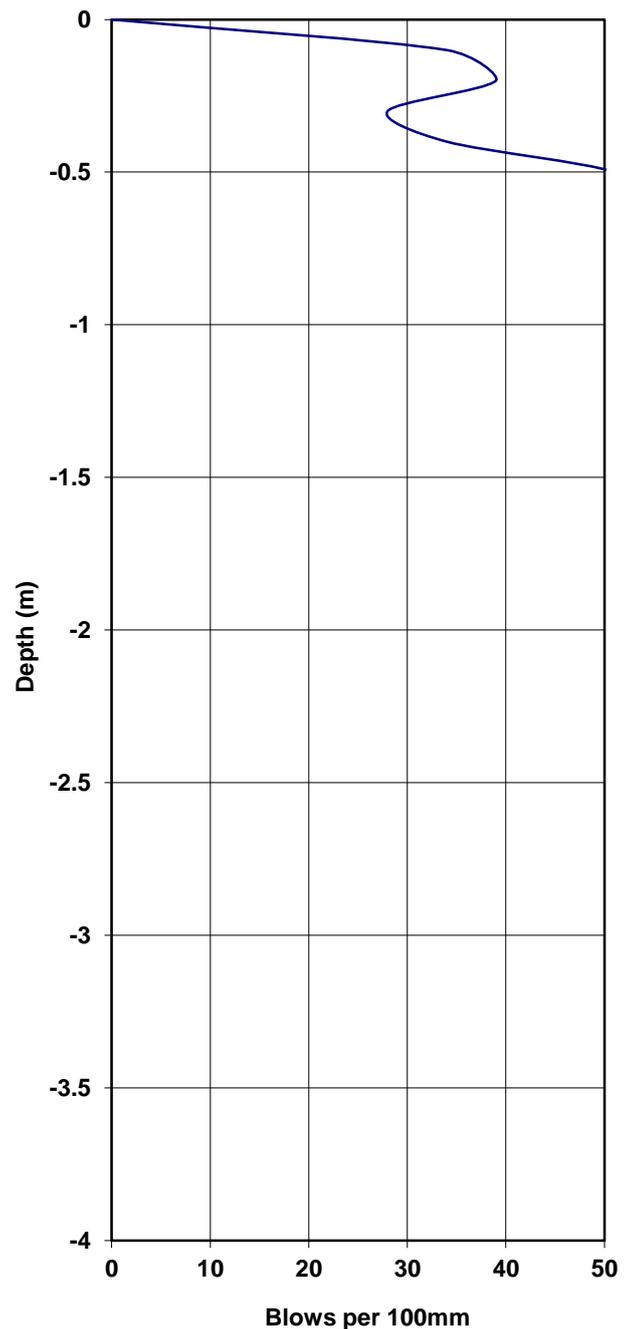


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<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 13

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	34	Very Dense	>38 deg	>55
0.2	39	Very Dense	>38 deg	>55
0.3	28	Very Dense	>38 deg	>55
0.4	34	Very Dense	>38 deg	>55
	Refusal			



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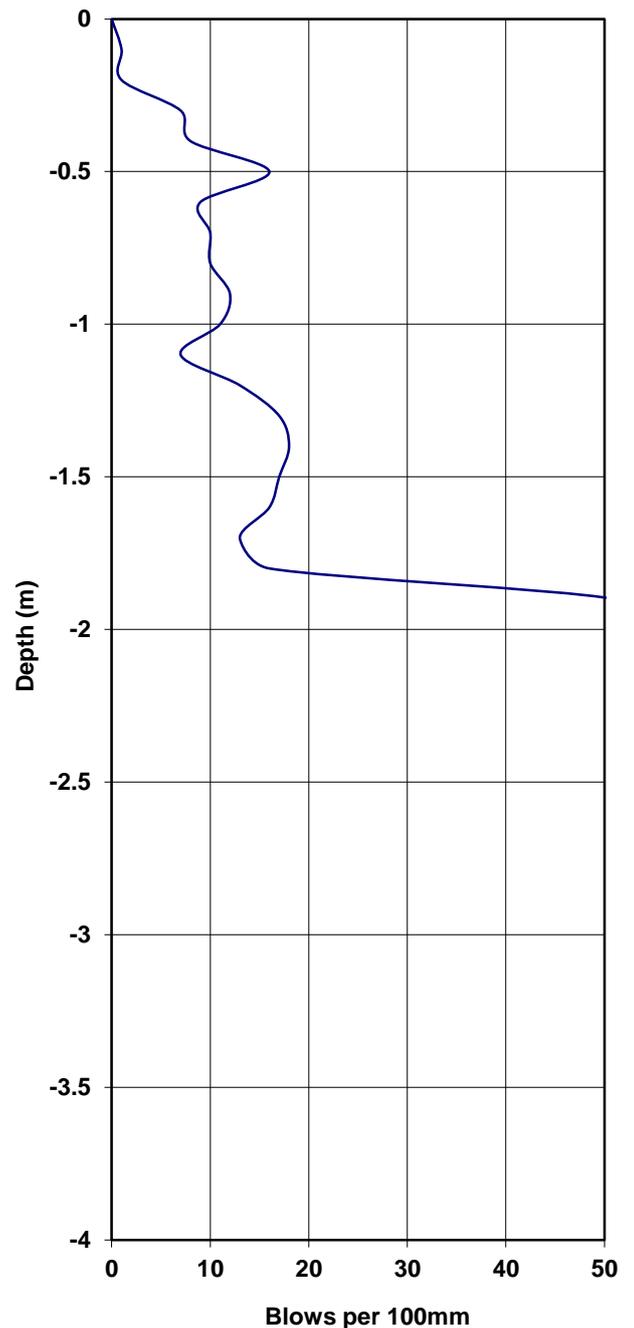
<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Works	<b>Operator:</b> S.Maharaj

Tongaat, eThekweni Municipality

## CBR Penetrometer Probe ----- Test No. DC 14

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	1	Very Loose	<29 deg	2
0.2	1	Very Loose	<29 deg	2
0.3	7	Med.Dense	34 deg	12
0.4	8	Med.Dense	35 deg	14
0.5	16	Dense	37 deg	29
0.6	9	Med.Dense	35 deg	15
0.7	10	Med.Dense	36 deg	17
0.8	10	Med.Dense	36 deg	17
0.9	12	Dense	36 deg	21
1	11	Dense	36 deg	19
1.1	7	Med.Dense	34 deg	12
1.2	13	Dense	37 deg	23
1.3	17	Dense	37 deg	31
1.4	18	Dense	37 deg	33
1.5	17	Dense	37 deg	31
1.6	16	Dense	37 deg	29
1.7	13	Dense	37 deg	23
1.8	16	Dense	37 deg	29
	Refusal			



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Geotechnical Engineering Consultants

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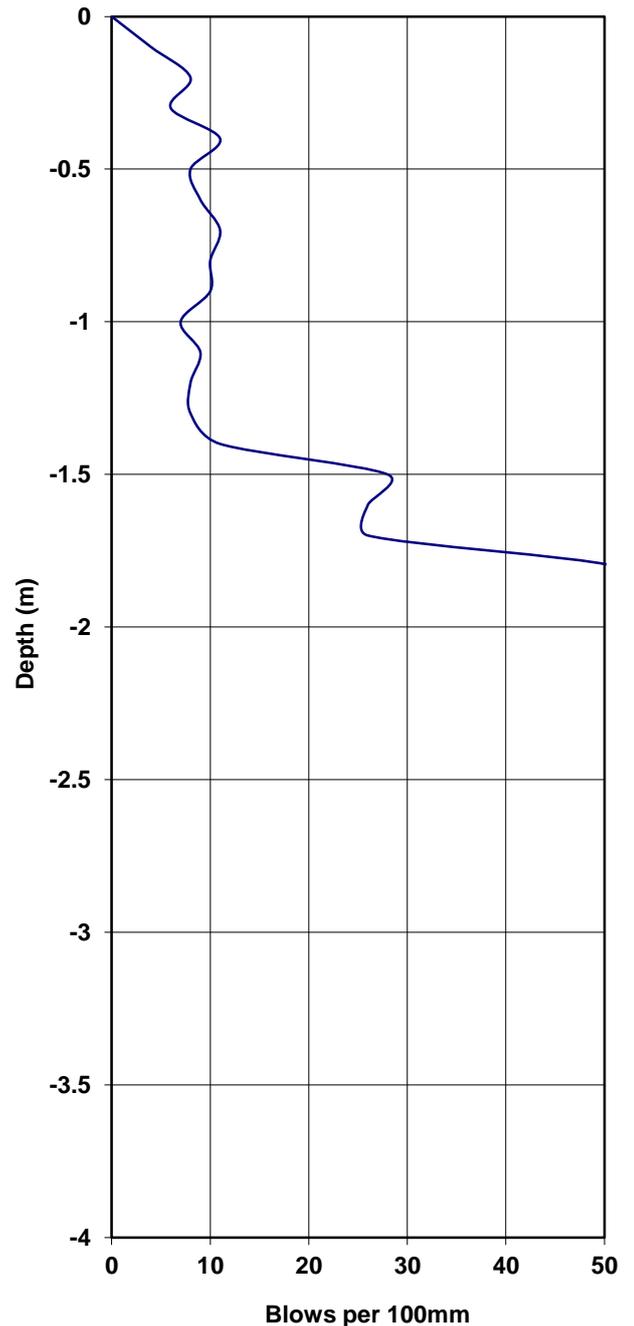


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 15

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	4	Med.Dense	30 deg	7
0.2	8	Med.Dense	35 deg	14
0.3	6	Med.Dense	33 deg	10
0.4	11	Dense	36 deg	19
0.5	8	Med.Dense	35 deg	14
0.6	9	Med.Dense	35 deg	15
0.7	11	Dense	36 deg	19
0.8	10	Med.Dense	36 deg	17
0.9	10	Med.Dense	36 deg	17
1	7	Med.Dense	34 deg	12
1.1	9	Med.Dense	35 deg	15
1.2	8	Med.Dense	35 deg	14
1.3	8	Med.Dense	35 deg	14
1.4	11	Dense	36 deg	19
1.5	28	Very Dense	>38 deg	>55
1.6	26	Very Dense	>38 deg	51
1.7	26	Very Dense	>38 deg	51
	Refusal			



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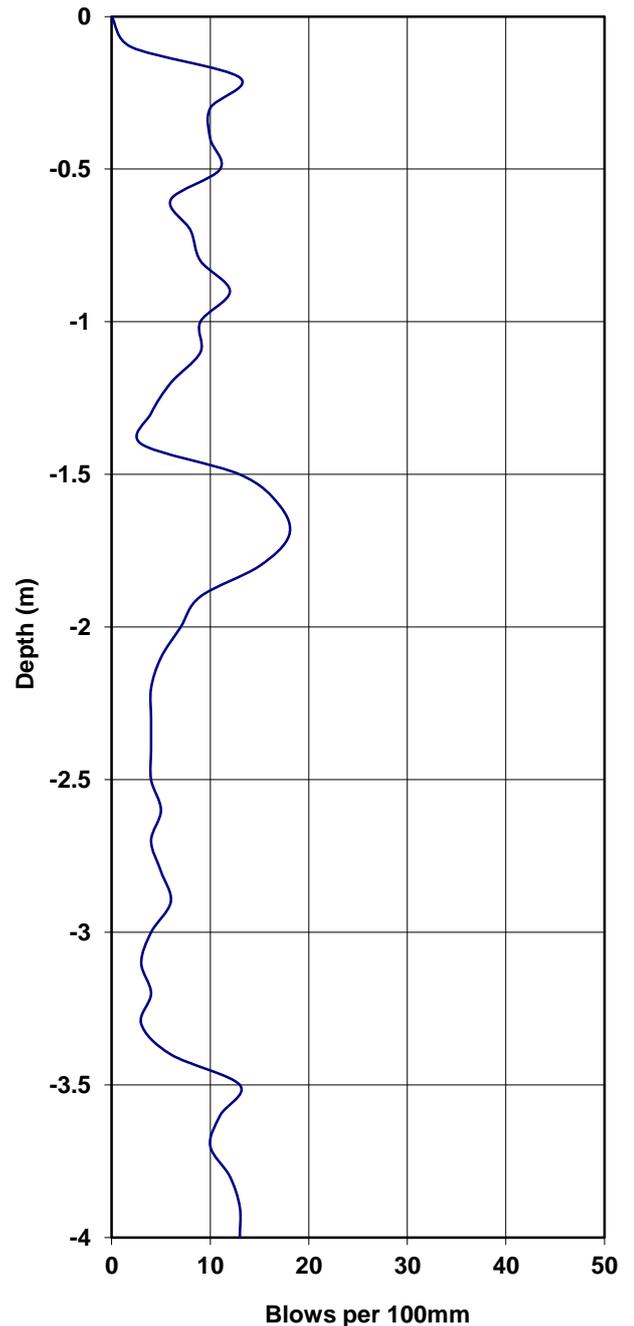


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 16

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	2	Loose	<30 deg	3
0.2	13	Dense	37 deg	23
0.3	10	Med.Dense	36 deg	17
0.4	10	Med.Dense	36 deg	17
0.5	11	Dense	36 deg	19
0.6	6	Med.Dense	33 deg	10
0.7	8	Med.Dense	35 deg	14
0.8	9	Med.Dense	35 deg	15
0.9	12	Dense	36 deg	21
1	9	Med.Dense	35 deg	15
1.1	9	Med.Dense	35 deg	15
1.2	6	Med.Dense	33 deg	10
1.3	4	Med.Dense	30 deg	7
1.4	3	Loose	<30 deg	5
1.5	13	Dense	37 deg	23
1.6	17	Dense	37 deg	31
1.7	18	Dense	37 deg	33
1.8	15	Dense	37 deg	27
1.9	9	Med.Dense	35 deg	15
2	7	Med.Dense	34 deg	12
2.1	5	Med.Dense	32 deg	8
2.2	4	Med.Dense	30 deg	7
2.3	4	Med.Dense	30 deg	7
2.4	4	Med.Dense	30 deg	7
2.5	4	Med.Dense	30 deg	7
2.6	5	Med.Dense	32 deg	8
2.7	4	Med.Dense	30 deg	7
2.8	5	Med.Dense	32 deg	8
2.9	6	Med.Dense	33 deg	10
3	4	Med.Dense	30 deg	7
3.1	3	Loose	<30 deg	5
3.2	4	Med.Dense	30 deg	7
3.3	3	Loose	<30 deg	5
3.4	6	Med.Dense	33 deg	10
3.5	13	Dense	37 deg	23
3.6	11	Dense	36 deg	19
3.7	10	Med.Dense	36 deg	17
3.8	12	Dense	36 deg	21
3.9	13	Dense	37 deg	23
4	13	Dense	37 deg	23



End

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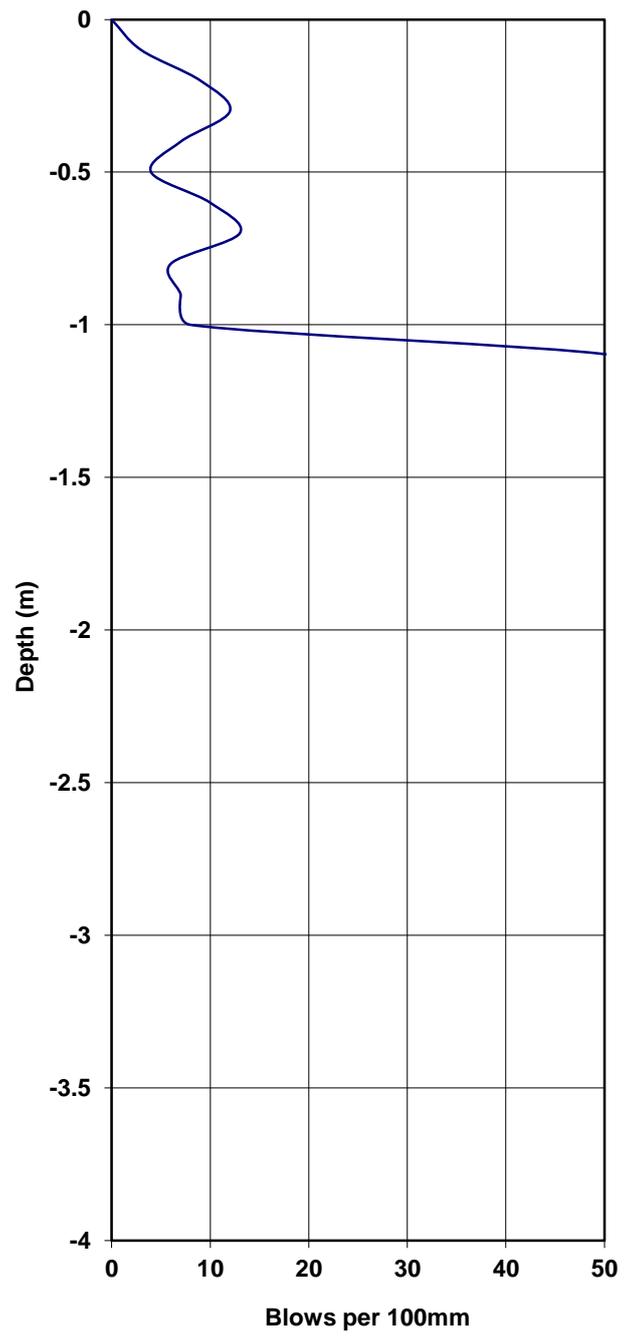


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 17

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	3	Loose	<30 deg	5
0.2	9	Med.Dense	35 deg	15
0.3	12	Dense	36 deg	21
0.4	7	Med.Dense	34 deg	12
0.5	4	Med.Dense	30 deg	7
0.6	10	Med.Dense	36 deg	17
0.7	13	Dense	37 deg	23
0.8	6	Med.Dense	33 deg	10
0.9	7	Med.Dense	34 deg	12
1	8	Med.Dense	35 deg	14
	Refusal			



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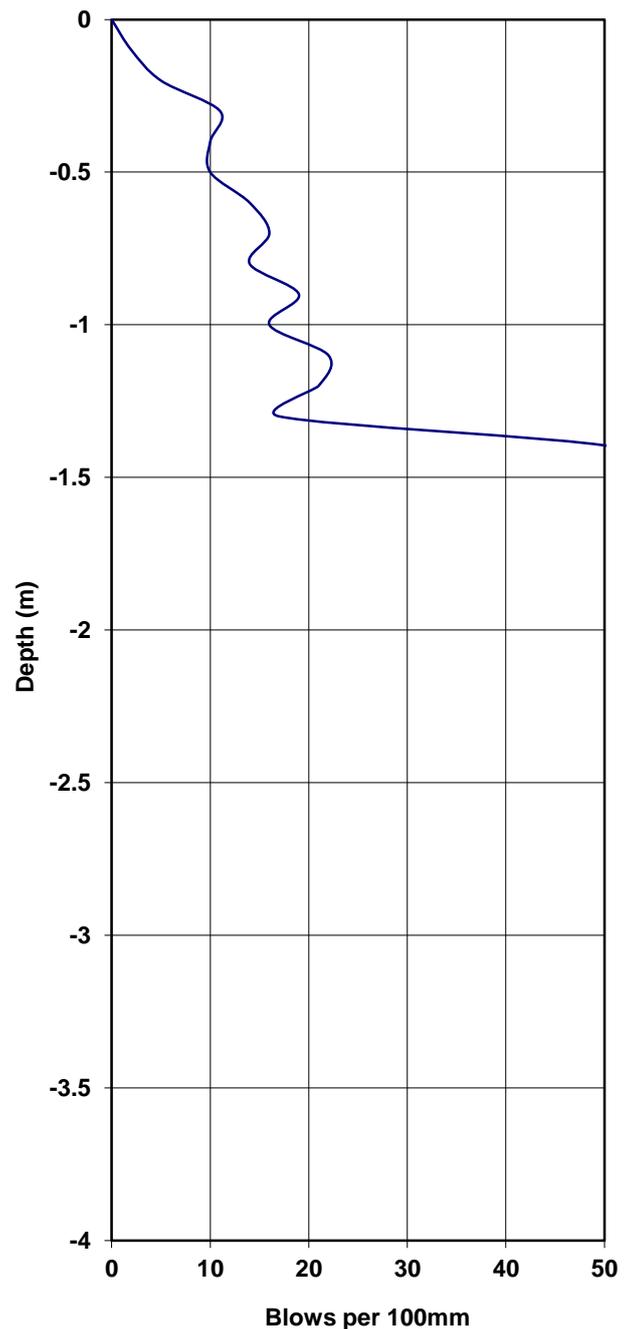


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 18

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	2	Loose	<30 deg	3
0.2	5	Med.Dense	32 deg	8
0.3	11	Dense	36 deg	19
0.4	10	Med.Dense	36 deg	17
0.5	10	Med.Dense	36 deg	17
0.6	14	Dense	37 deg	25
0.7	16	Dense	37 deg	29
0.8	14	Dense	37 deg	25
0.9	19	Dense	37 deg	35
1	16	Dense	37 deg	29
1.1	22	Dense	38 deg	42
1.2	21	Dense	38 deg	40
1.3	17	Dense	37 deg	31
	Refusal			



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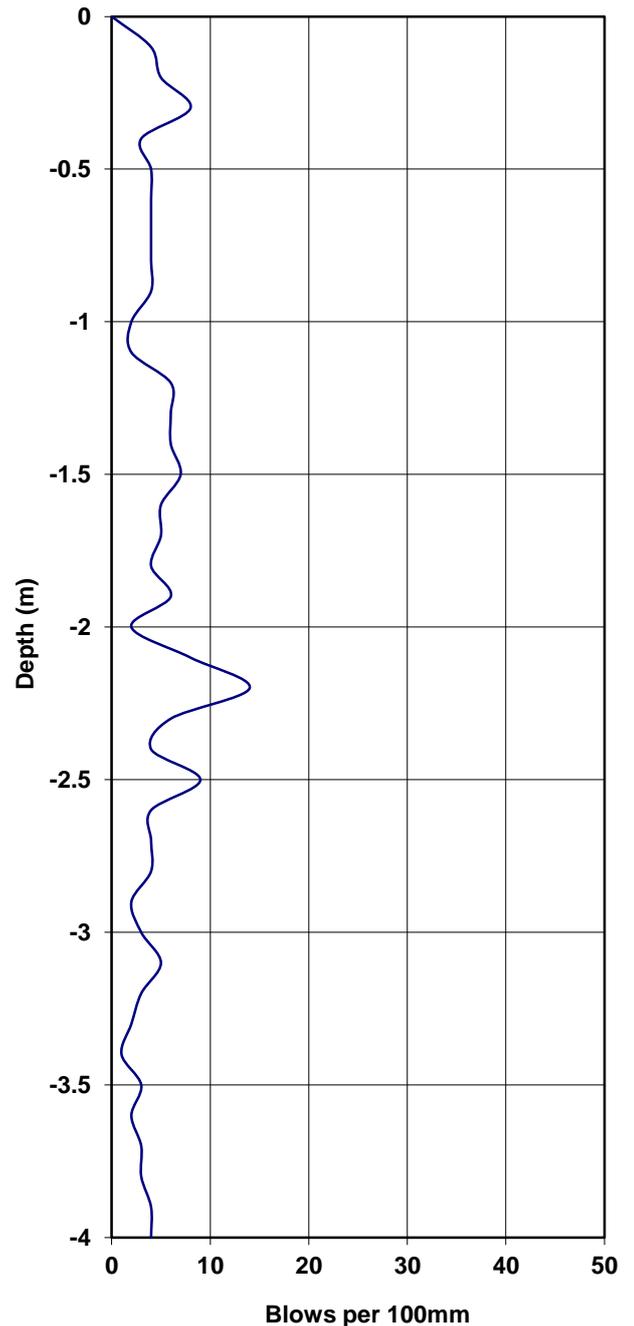


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 19

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	4	Med.Dense	30 deg	7
0.2	5	Med.Dense	32 deg	8
0.3	8	Med.Dense	35 deg	14
0.4	3	Loose	<30 deg	5
0.5	4	Med.Dense	30 deg	7
0.6	4	Med.Dense	30 deg	7
0.7	4	Med.Dense	30 deg	7
0.8	4	Med.Dense	30 deg	7
0.9	4	Med.Dense	30 deg	7
1	2	Loose	<30 deg	3
1.1	2	Loose	<30 deg	3
1.2	6	Med.Dense	33 deg	10
1.3	6	Med.Dense	33 deg	10
1.4	6	Med.Dense	33 deg	10
1.5	7	Med.Dense	34 deg	12
1.6	5	Med.Dense	32 deg	8
1.7	5	Med.Dense	32 deg	8
1.8	4	Med.Dense	30 deg	7
1.9	6	Med.Dense	33 deg	10
2	2	Loose	<30 deg	3
2.1	8	Med.Dense	35 deg	14
2.2	14	Dense	37 deg	25
2.3	6	Med.Dense	33 deg	10
2.4	4	Med.Dense	30 deg	7
2.5	9	Med.Dense	35 deg	15
2.6	4	Med.Dense	30 deg	7
2.7	4	Med.Dense	30 deg	7
2.8	4	Med.Dense	30 deg	7
2.9	2	Loose	<30 deg	3
3	3	Loose	<30 deg	5
3.1	5	Med.Dense	32 deg	8
3.2	3	Loose	<30 deg	5
3.3	2	Loose	<30 deg	3
3.4	1	Very Loose	<29 deg	2
3.5	3	Loose	<30 deg	5
3.6	2	Loose	<30 deg	3
3.7	3	Loose	<30 deg	5
3.8	3	Loose	<30 deg	5
3.9	4	Med.Dense	30 deg	7
4	4	Med.Dense	30 deg	7



End

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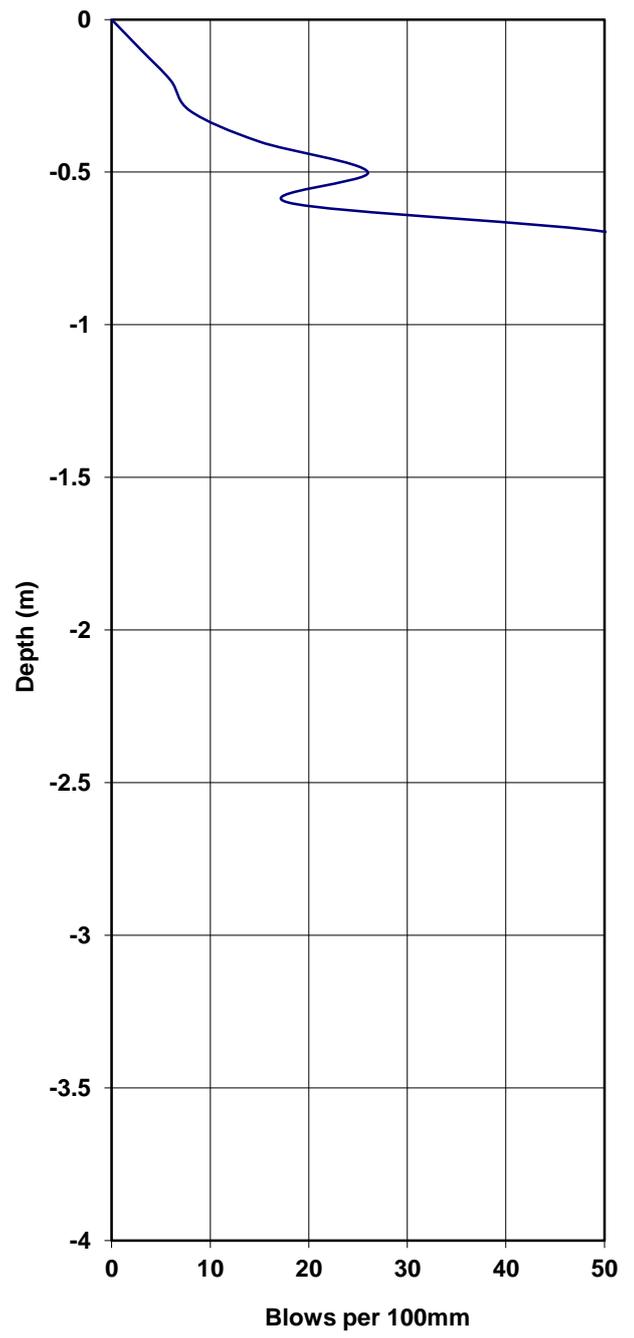


<b>Client:</b> Naidu Consulting (Pty) Ltd	<b>Ref.No.</b> 035-22
<b>Project:</b> Geotechnical Investigation for Proposed Improvement to the Tongaat Water Treatment Works	<b>Date:</b> 15-17.11.2023
<b>Section:</b> Tongaat, eThekweni Municipality	<b>Operator:</b> S.Maharaj

## CBR Penetrometer Probe ----- Test No. DC 20

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth (m)	Blows/100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	3	Loose	<30 deg	5
0.2	6	Med.Dense	33 deg	10
0.3	8	Med.Dense	35 deg	14
0.4	15	Dense	37 deg	27
0.5	26	Very Dense	>38 deg	51
0.6	18	Dense	37 deg	33
	Refusal			





**APPENDIX G**



**RESULTS OF LABORATORY TESTS**



CLIENT : Geosure (Pty) Ltd  
 PHYSICAL ADDRESS : 122 Intersite Avenue, Springfield Park,  
 Umgeni  
 Durban, 4001  
 ATTENTION : Mr D. Naidoo  
 PROJECT : Tongaat Water Treatment Works, KZN

**TEST REPORT REFERENCE NUMBER: 73516**

**Dear Sir/Madam,**

Enclosed herewith, please find the original reports pertaining to the above-mentioned project.

Date Received	27.11.2023		
Date Tested	05.12.2023 to 12.12.2023		
Sample Location	Refer to Report		
Sampling Method	N/A		
Sample Condition	Good		
Sampling Environmental Condition	N/A		
Sampler(s) Name	Client		
Total Number of Pages	27		
<b>Test Carried Out</b>			
SANS3001 GR1	✓	SANS3001 AG1	
SANS3001 GR10, GR12	✓	TMH1 Method C4a	
SANS3001 GR30	✓	TMH1 Method B6	
SANS3001 GR40	✓	Hydrometer Analysis - ASTM D422	✓
SANS3001 GR20		SANS3001 GR20	
SANS3001 GR50, GR53		BS1377: Part 1 & 5:1990	
SANS3001 GR50, GR54		SANS 5860, 5861-1, 5861-2, 5861-3	
SANS3001 GR58		TMH1 Method B9	
✓ - Tick denotes tests that were carried out. # - Denotes non accredited tests			

**We would like to take this opportunity of thanking you for your continued support.**

**Should you have any queries please do not hesitate to contact me.**

**Refer to Appendix A for Uncertainty of Measurement and notes on the Decision Rule**

**Yours faithfully**



**Technical Signatory,  
 Dheeran Ramcharan for Geosure (Pty) Ltd.**

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<b>Head Office</b> 122 Intersite Avenue, Umgeni Business Park, Durban 4091, South Africa PO Box 1461, Westville, 3630, South Africa Tel.: +27 (0)861 GEOSURE / 0861 436 7873 Fax: +27 (0)86 689 5506 Mobile: +27 (0)82 784 0544 E-mail: geosure@iafrica.com	<b>Civil Engineering Laboratory</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091, South Africa PO Box 1461, Westville, 3630, South Africa Tel: 031 701 9732 Fax: +27 (0) 86 684 9785 Mobile: 072 870 2621 E-mail: lab@geosure.co.za	<b>Gauteng Branch</b> P. O. Box 32381, Kyalami 1684 Tel.: 0861 GEOSURE / 0861 436 7873 Fax: 086 689 8327 Mobile: 083 377 6559 Email: gauteng@geosure.co.za
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<b>LABORATORY AND HEAD OFFICE ADDRESS:</b>	Reg.No.: 92/03145/07		
	122 Intersite Avenue, Umgeni Business Park, Durban, 4091		
<b>LABORATORY CONTACT INFO.:</b>	Tel.: +27(0) 31 701 9732	Fax: 086 684 9785	
	Mobile: +27(0) 72 870 2621	e-mail: <a href="mailto:lab@geosure.co.za">lab@geosure.co.za</a>	
<b>HEAD OFFICE CONTACT INFO.:</b>	Tel.: +27(0) 31 266 0458	Fax: 086 689 5506	
	Mobile: +27(0) 82 784 0544	e-mail: <a href="mailto:geosure@iafrica.com">geosure@iafrica.com</a>	
<b>WEBSITE:</b>	<a href="http://www.geosure.co.za">www.geosure.co.za</a>		

Client	: Geosure (Pty) Ltd	Our Ref. : 73516
Project	: Tongaat Water Treatment Works, KZN	Your Ref. : 035-22
		Date Tested : 04.12.2023 to 12.12.2023
Attention	: Mr D. Naidoo	Date Reported : 14.12.2023

Sample No.	T50227	T50233	T50236
Field No.	IP3	IP10	IP7
Position in Field	Layer 2	Layer 4	Layer 5
Depth (m)	1.00-1.40	1.00-1.50	1.00-1.50
Material Description	Medium brown medium to coarse gravelly medium SAND. Fill	Medium greyish brown clayey medium SAND. Fill	Light brown silty fine to medium SAND. Fill

**Sieve Analysis ( Wet Preparation ) - SANS3001 GR 1 - Percent Passing Sieve Size**

	Sieve Size (mm)	T50227	T50233	T50236
<b>% Passing</b>	100.0	100	100	100
	75.0	100	100	100
	63.0	100	100	100
	50.0	100	100	100
	37.5	100	100	100
	28.0	99	100	100
	20.0	90	100	97
	14.0	86	100	97
	5.00	75	99	93
	2.00	70	98	87
	0.425	54	81	71
	0.250	38	58	48
	0.150	27	45	23
0.075	20	37	10	

**Hydrometer Analysis - ASTM - D422 - Percent Passing Particle Diameter (<0.425mm)**

	Particle Diameter (mm)	T50227	T50233	T50236
<b>% Passing</b>	0.060	17	35	8
	0.050	14	34	7
	0.040	12	33	6
	0.026	9	31	4
	0.015	8	28	4
	0.010	8	26	4
	0.0074	7	23	3
	0.0036	6	18	3
	0.0020	5	15	3
	0.0015	4	15	2

**Mechanical analysis - SANS3001 GR1 - Percent of Soil Mortar (<2 mm) for Grain Size range**

Grain Size	%	T50227	T50233	T50236
Coarse Sand	%	22	18	18
Coarse Fine Sand	%	24	23	27
Medium Fine Sand	%	15	13	28
Fine Fine Sand	%	10	8	15
Silt & Clay	%	29	38	12
Grading Modulus		1.56	0.84	1.31

**Atterberg Limits - SANS3001 GR10, GR12 (<0.425mm)**

Parameter	%	T50227	T50233	T50236
Liquid Limit	%	15	21	NP
Plasticity Index	%	4	7	NP
Linear Shrinkage	%	2.0	3.5	0.0
AASHTO Classification (Group Index)*		A-2-4 (0)	A-4 (0)	A-2-4 (0)
Unified Classification*		SM-SC	SM-SC	SP-SM
Moisture Content	%	6.8	46.4	13.2

<b>Remarks:</b>	Date Received: 27.11.2023
	Sampled by Client.
	*Opinions expressed herein fall outside the scope of SANAS accreditation.

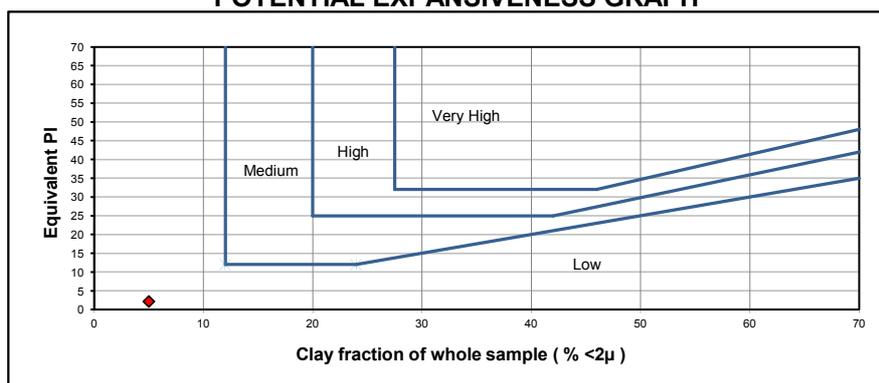
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<b>HEAD OFFICE CONTACT INFO.:</b>	Tel.: +27(0) 31 266 0458 Mobile: +27(0) 82 784 0544	Fax: 086 689 5506 e-mail: <a href="mailto:geosure@iafrica.com">geosure@iafrica.com</a>
<b>WEBSITE:</b>	<a href="http://www.geosure.co.za">www.geosure.co.za</a>	

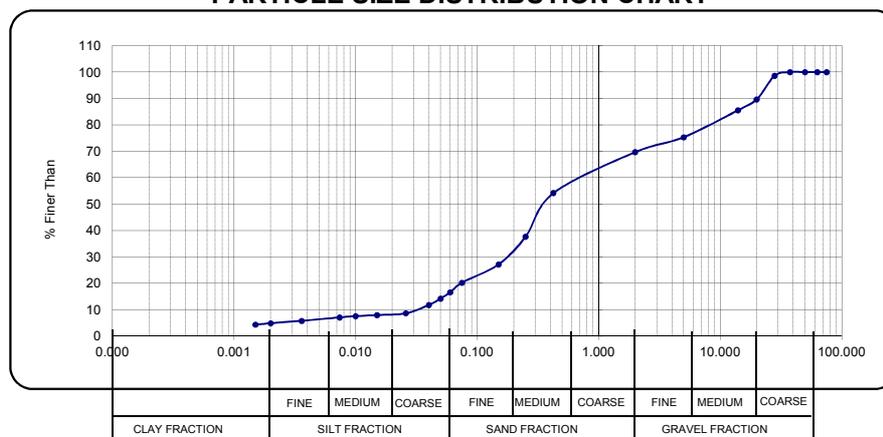
<b>Client</b> : Geosure (Pty) Ltd	<b>Job No.</b> : 73516
<b>Project</b> : Tongaat Water Treatment Works, KZN	<b>Your Ref.No.</b> : 035-22
	<b>Date Tested</b> : 04.12.2023 to 12.12.2023
<b>Attention</b> : Mr D. Naidoo	<b>Date Reported</b> : 14.12.2023

**Sample Number** : T50227  
**Field No.** : IP3  
**Sample Description** : Medium brown medium to coarse gravelly medium SAND. Fill  
**Equivalent PI** : 2 **Clay fraction of whole sample (% <2μ)** : 5

**POTENTIAL EXPANSIVENESS GRAPH**



**PARTICLE SIZE DISTRIBUTION CHART**



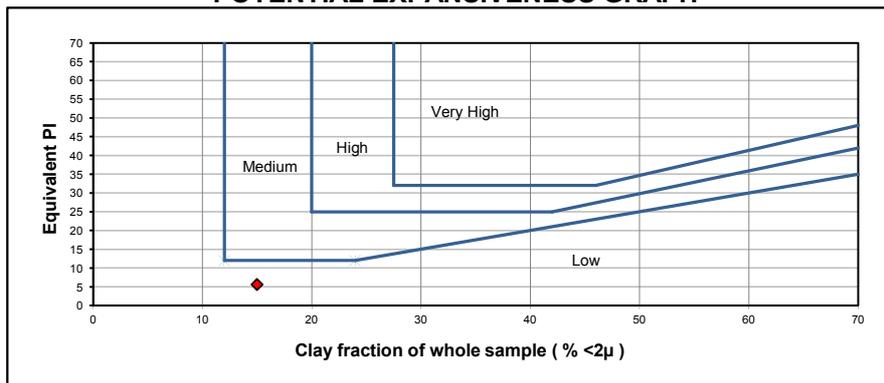
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<b>HEAD OFFICE CONTACT INFO.:</b>	Tel.: +27(0) 31 266 0458 Mobile: +27(0) 82 784 0544	Fax: 086 689 5506 e-mail: <a href="mailto:geosure@iafrica.com">geosure@iafrica.com</a>
<b>WEBSITE:</b>	<a href="http://www.geosure.co.za">www.geosure.co.za</a>	

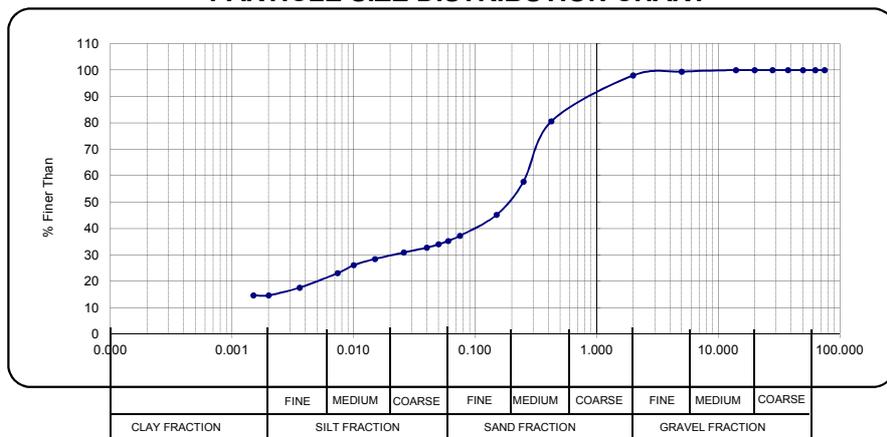
<b>Client</b> : Geosure (Pty) Ltd	<b>Job No.</b> : 73516
<b>Project</b> : Tongaat Water Treatment Works, KZN	<b>Your Ref.No.</b> : 035-22
	<b>Date Tested</b> : 04.12.2023 to 12.12.2023
<b>Attention</b> : Mr D. Naidoo	<b>Date Reported</b> : 14.12.2023

<b>Sample Number</b> : T50233
<b>Field No.</b> : IP10
<b>Sample Description</b> : Medium greyish brown clayey medium SAND. Fill
<b>Equivalent PI</b> : <span style="border: 1px solid black; padding: 2px;">6</span> <b>Clay fraction of whole sample (% &lt;2μ)</b> : <span style="border: 1px solid black; padding: 2px;">15</span>

**POTENTIAL EXPANSIVENESS GRAPH**



**PARTICLE SIZE DISTRIBUTION CHART**



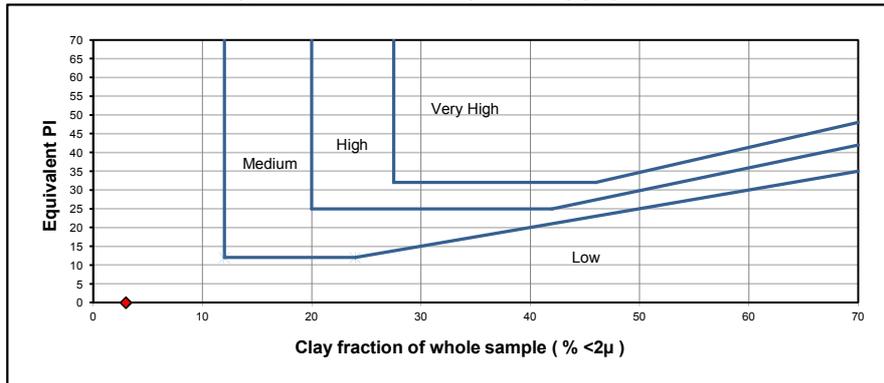
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<b>Reg.No.: 92/03145/07</b>		
<b>LABORATORY AND HEAD OFFICE ADDRESS:</b>	122 Intersite Avenue, Umgeni Business Park, Durban, 4091	
<b>LABORATORY CONTACT INFO.:</b>	Tel.: +27(0) 31 701 9732 Mobile: +27(0) 72 870 2621	Fax: 086 684 9785 e-mail: <a href="mailto:lab@geosure.co.za">lab@geosure.co.za</a>
<b>HEAD OFFICE CONTACT INFO.:</b>	Tel.: +27(0) 31 266 0458 Mobile: +27(0) 82 784 0544	Fax: 086 689 5506 e-mail: <a href="mailto:geosure@iafrica.com">geosure@iafrica.com</a>
<b>WEBSITE:</b>	<a href="http://www.geosure.co.za">www.geosure.co.za</a>	

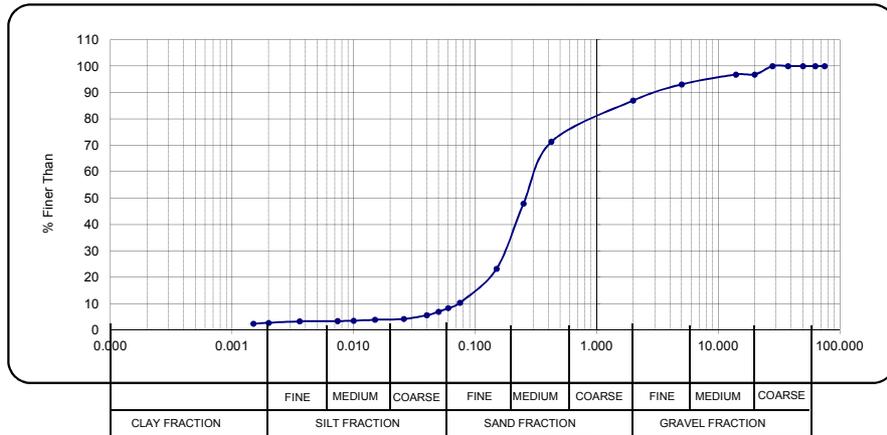
<b>Client</b> : Geosure (Pty) Ltd	<b>Job No.</b> : 73516
<b>Project</b> : Tongaat Water Treatment Works, KZN	<b>Your Ref.No.</b> : 035-22
	<b>Date Tested</b> : 04.12.2023 to 12.12.2023
<b>Attention</b> : Mr D. Naidoo	<b>Date Reported</b> : 14.12.2023

<b>Sample Number</b> : T50236
<b>Field No.</b> : IP7
<b>Sample Description</b> : Light brown silty fine to medium SAND. Fill
<b>Equivalent PI</b> : <span style="border: 1px solid black; padding: 2px;">NP</span> Clay fraction of whole sample (% <2 $\mu$ ) : <span style="border: 1px solid black; padding: 2px;">3</span>

**POTENTIAL EXPANSIVENESS GRAPH**



**PARTICLE SIZE DISTRIBUTION CHART**



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<b>LABORATORY:</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091 P.O. Box 1461, Westville 3630 Mobile: +27(0)72 870 2621 Tel.: +27 (0)31 701 9732	<b>Reg. No. :</b> 92/03145/07  <b>Fax:</b> 086 684 9785 email: lab@geosure.co.za	<b>HEAD OFFICE:</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091, KwaZulu Natal, South Africa. Tel: +27 (0)31 266 0458 Fax: 086 689 5506 email: geosure@iafrica.com www.geosure.co.za
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**Client :** Geosure (Pty) Ltd **Your Ref No. : 035-22**  
**Project :** Tongaat Water Treatment Works, KZN **Our Ref No. : 73516**  
**Attention :** Mr D. Naidoo **Date Reported : 14/12/2023**

### Test Report - SANS 3001

Sample No.	T50224	T50225	T50226	T50228	T50229
<b>Field No.</b>	IP1	IP6	IP3	IP2	IP9
<b>Position</b>	Layer 1	Layer 2	Layer 1	Layer 2	Layer 3
<b>Depth ( m )</b>	0.01-1.00	0.07-1.30	0.01-1.00	0.40-1.00	0.50-0.98
<b>Method of Preparation</b>	Scalped	Scalped	Scalped	Scalped	Scalped
<b>Material Description</b>	Yellowish brown to olive brown medium gravelly medium SAND. Fill	Medium brown fine to coarse gravelly medium SAND. Fill	Yellowish brown fine to medium to coarse gravelly medium SAND. Fill	Medium brown slightly gravelly silty fine to medium SAND. Fill	Medium brown fine to coarse gravelly fine to medium SAND. Fill

Sieve Analysis - Percent Passing Sieve Size						
Sieve Aperture (mm)	100.00	-	-	-	-	-
	75.00	-	-	-	-	-
	63.00	-	-	-	-	-
	53.00	100	-	100	100	-
	50.00	98	100	99	97	100
	37.50	90	90	91	91	88
	28.00	85	82	84	87	87
	26.50	85	82	84	87	87
	20.00	76	74	76	83	85
	19.00	76	74	76	83	85
	14.00	68	66	69	77	75
	13.20	68	66	69	77	75
	5.00	51	50	56	70	62
	4.750	51	50	56	70	62
	2.000	42	40	45	64	54
0.425	26	27	27	51	44	
0.075	16	15	14	18	20	
<b>Grading Modulus</b>	2.16	2.18	2.14	1.67	1.82	
Mechanical analysis - Percent of Soil Mortar (<2 mm) for Grain Size range						
Coarse Sand	2.000 - 0.425	38	32	40	20	19
Coarse-Fine Sand	0.425 - 0.250	8	11	12	28	21
Medium-Fine Sand	0.250 - 0.150	7	9	7	15	15
Fine-Fine Sand	0.150 - 0.075	10	11	9	10	9
Silt and Clay	< 0.075	37	37	31	28	36
Atterberg Limits SANS 3001 on <0.425 mm fraction						
Liquid Limit	% or symbol	26	25	25	16	21
Plasticity Index	% or symbol	8	8	8	4	7
Linear Shrinkage	%	4.0	4.0	4.0	2.0	4.0
Maximum Dry Density and Optimum Moisture Content						
<b>Maximum Dry Density (kg/m<sup>3</sup>)</b>		2321	2389	2343	2169	2049
<b>Optimum moisture content (%)</b>		6.4	5.9	5.6	7.1	7.9
California Bearing Ratio						
CBR @100% Compaction	%	56	57	81	61	36
CBR @ 98% Compaction	%	48	48	61	42	29
CBR @ 97% Compaction	%	45	45	53	35	26
CBR @ 95% Compaction	%	39	38	40	24	21
CBR @ 93% Compaction	%	34	32	30	17	16
CBR @ 90% Compaction	%	28	25	20	9.6	12
Swell @100% Compaction	%	0.1	0.2	0.0	0.1	0.1
<b>COLTO Classification (1998)**</b>		G6 (#)	G6 (#)	G6 (#)	G7 (#)	G7 (#)
<b>TRH 14 Classification (1985)**</b>		G6	G6	G6	G7	G7
<b>AASHTO Classification (Group Index)**</b>		A-2-4 (0)				
<b>Unified Classification **</b>		GC	GC	GC	SM-SC	SM-SC

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**Remarks:** \*Subject to further testing as required by TRH14.

† Subject to further testing as required by COLTO. COLTO above uses only: Atterberg Limits (<0.425 mm fraction; not arithmetic mean), Nominal Max Size, Grading Curve, Coarse Sand Ratio, Grading Modulus, Strength (CBR), and Swell.

# Check that Max Size <= 2/3 of compacted layer thickness.

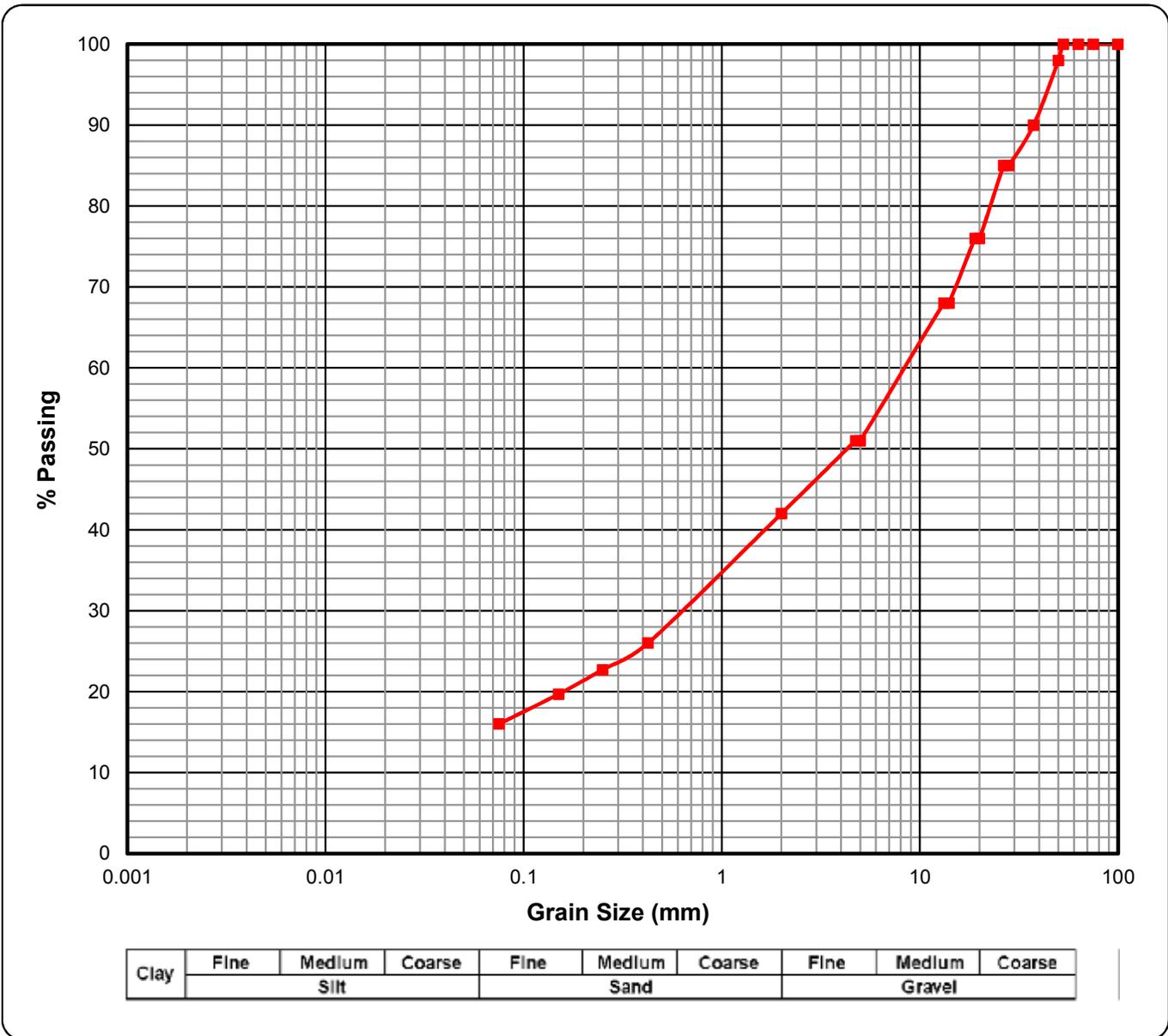
\*\* Opinions and interpretations expressed herein are outside the scope of SANAS accreditation

Version 5.05 - 14 February 2018

<b>LABORATORY:</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091 P.O. Box 1461, Westville 3630 Mobile: +27(0)72 870 2621    Fax: 086 684 9785 Tel.: +27 (0)31 701 9732    email: <a href="mailto:lab@geosure.co.za">lab@geosure.co.za</a>	Reg. No. : 92/03145/07	<b>HEAD OFFICE:</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091, KwaZulu Natal, South Africa. Tel: +27 (0)31 266 0458    Fax: 086 689 5506 email: <a href="mailto:geosure@iafrica.com">geosure@iafrica.com</a> <a href="http://www.geosure.co.za">www.geosure.co.za</a>
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<b>Client : Geosure (Pty) Ltd</b> <b>Project : Tongaat Water Treatment Works, KZN</b> <b>Attention : Mr D. Naidoo</b>	<b>Your Ref No.: 035-22</b> <b>Our Ref No. : 73516</b> <b>Date Reported : 14/12/2023</b>
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### Grading Curve for Sample T50224 – SANS 3001



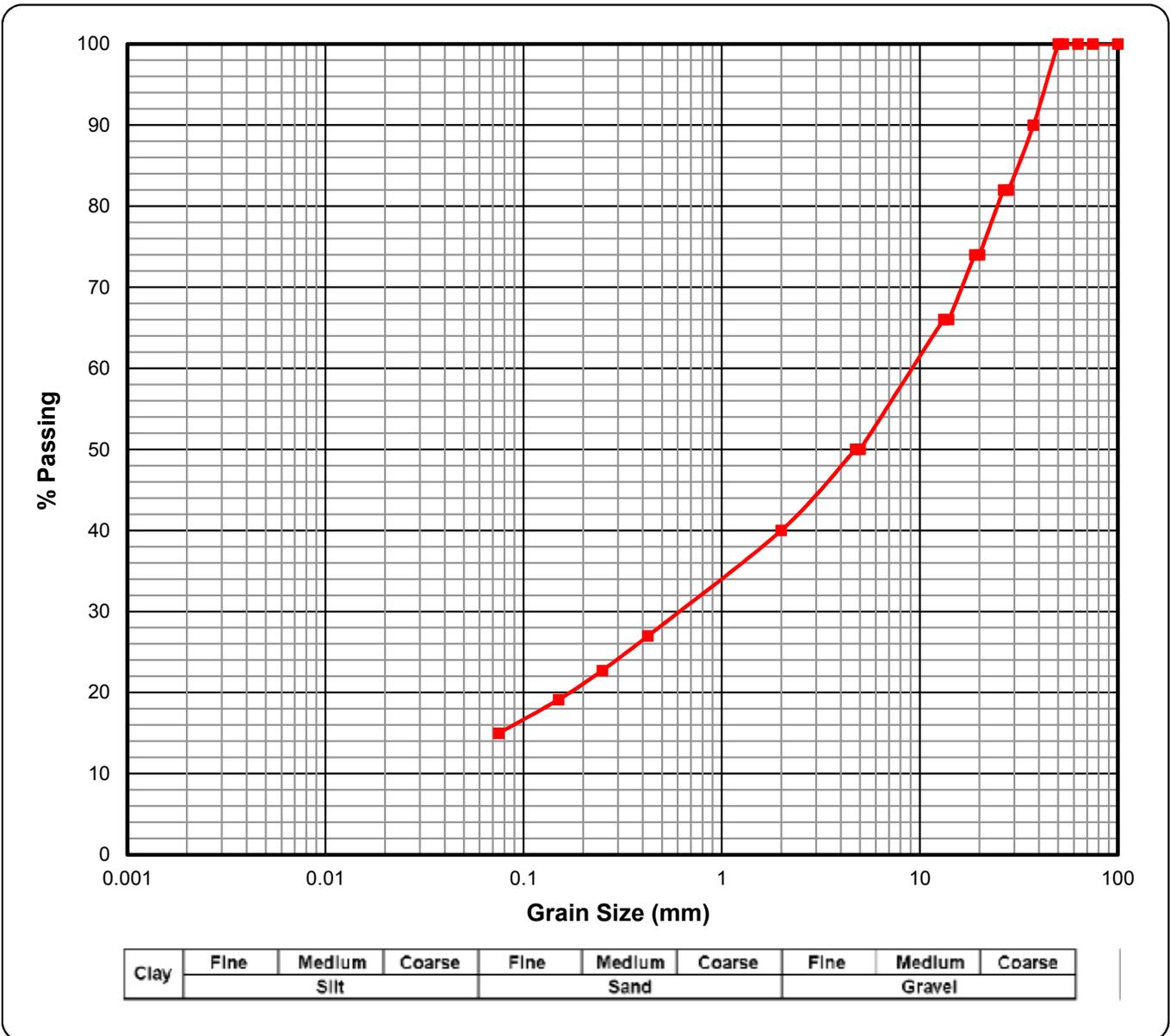
**Thick Red Line is the Grading Curve (COLTO Classification = G6 (#)) (TRH 14 Classification = G6)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	16%	20%	23%	26%	42%	51%	51%	68%	68%	76%	76%	85%	85%	90%	98%	100%	100%	100%	100%

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<b>Client</b> : Geosure (Pty) Ltd <b>Project</b> : Tongaat Water Treatment Works, KZN <b>Attention</b> : Mr D. Naidoo	<b>Your Ref No.:</b> 035-22 <b>Our Ref No. :</b> 73516 <b>Date Reported :</b> 14/12/2023
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### Grading Curve for Sample T50225 – SANS 3001



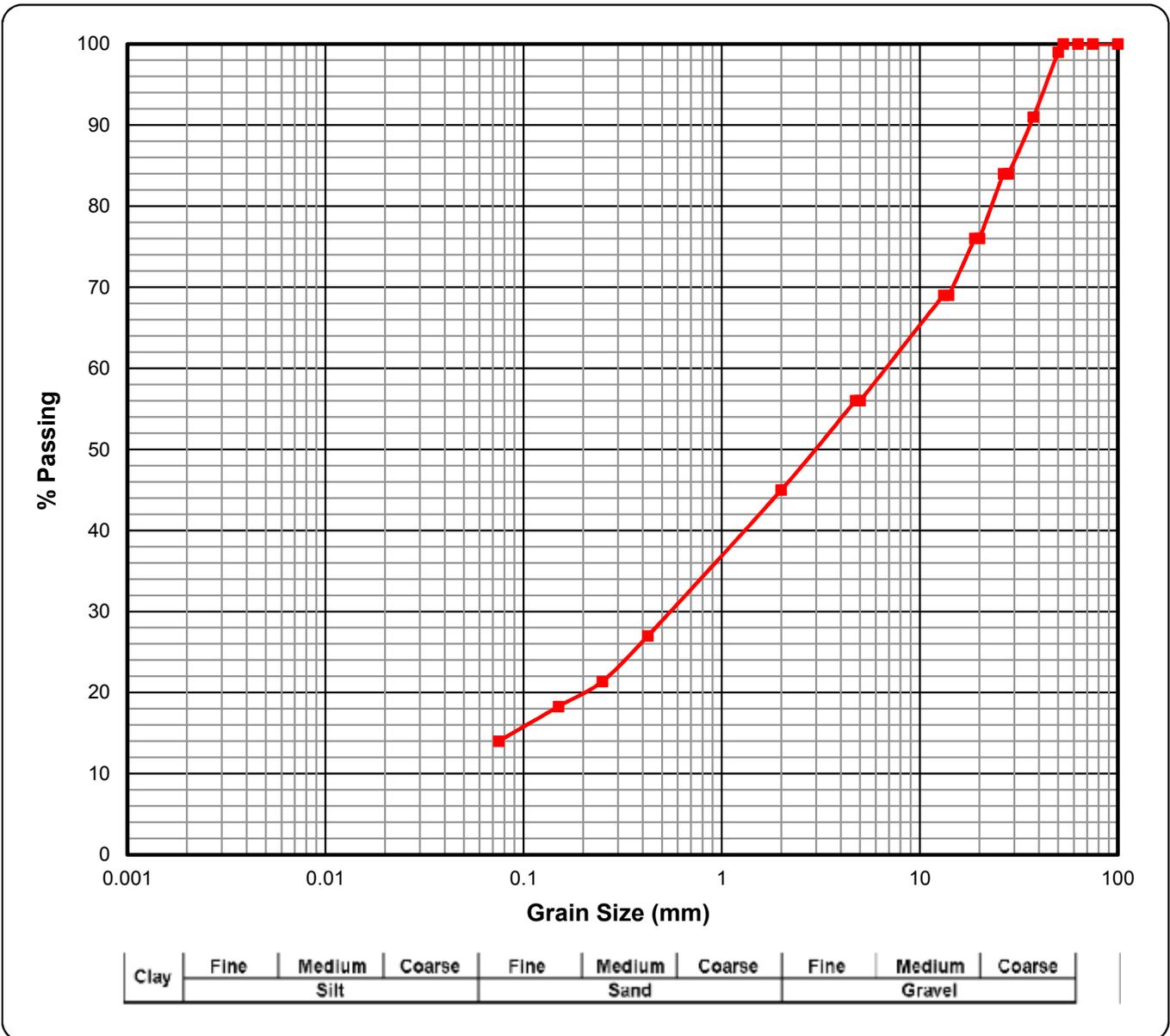
**Thick Red Line is the Grading Curve (COLTO Classification = G6 (#)) (TRH 14 Classification = G6)**

Sieve Aperture Size	0.075	0.150	0.015	0.026	0.05	0.06	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	15%	19%	23%	27%	40%	50%	50%	66%	66%	74%	74%	82%	82%	90%	100%	100%	100%	100%	100%

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<b>Client : Geosure (Pty) Ltd</b> <b>Project : Tongaat Water Treatment Works, KZN</b> <b>Attention : Mr D. Naidoo</b>	<b>Your Ref No.: 035-22</b> <b>Our Ref No. : 73516</b> <b>Date Reported : 14/12/2023</b>
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### Grading Curve for Sample T50226 – SANS 3001



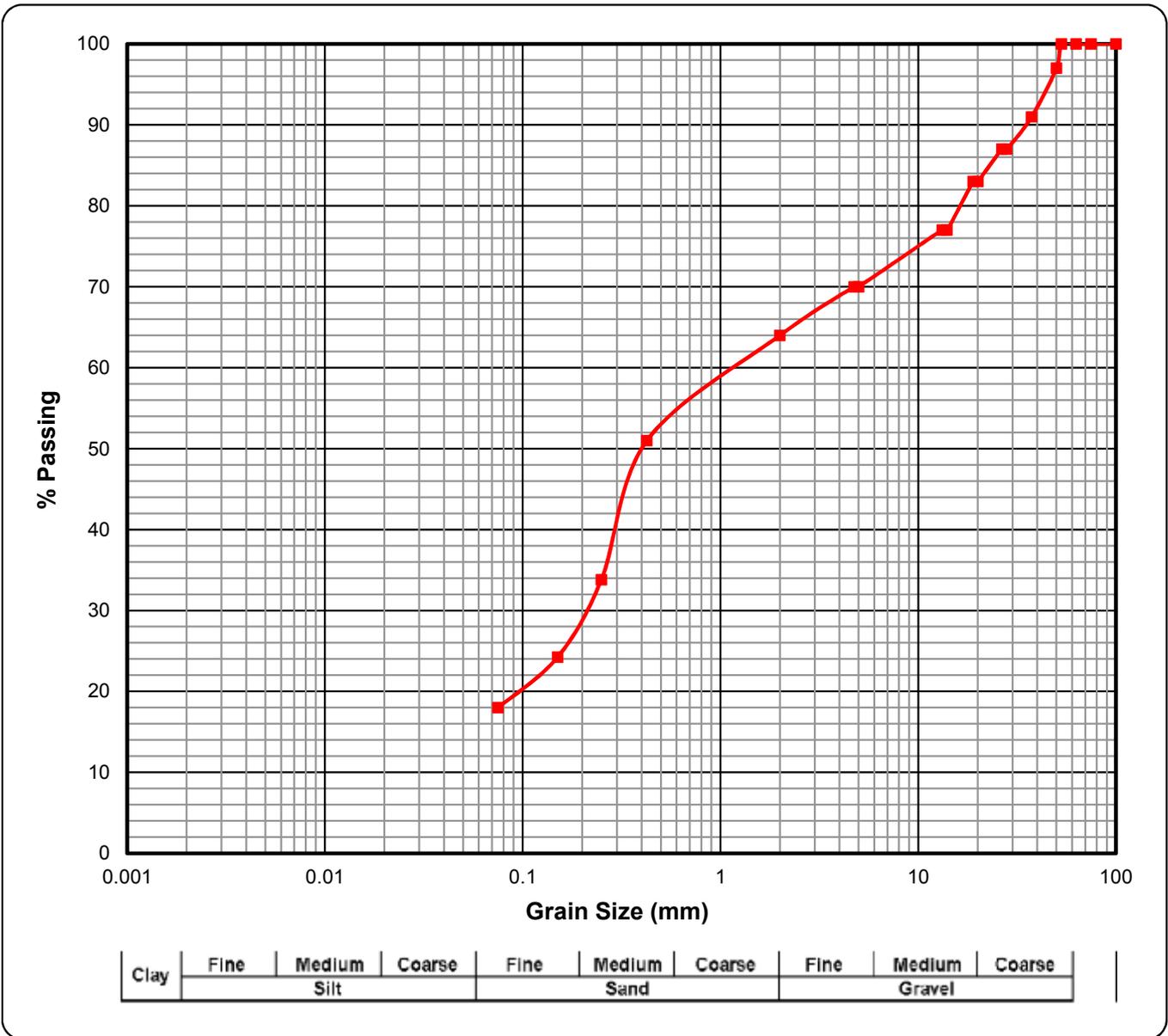
**Thick Red Line is the Grading Curve (COLTO Classification = G6 (#)) (TRH 14 Classification = G6)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	14%	18%	21%	27%	45%	56%	56%	69%	69%	76%	76%	84%	84%	91%	99%	100%	100%	100%	100%

<b>LABORATORY:</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091 P.O. Box 1461, Westville 3630 Mobile: +27(0)72 870 2621    Fax: 086 684 9785 Tel.: +27 (0)31 701 9732    email: <a href="mailto:lab@geosure.co.za">lab@geosure.co.za</a>	Reg. No. : 92/03145/07	<b>HEAD OFFICE:</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091, KwaZulu Natal, South Africa. Tel: +27 (0)31 266 0458    Fax: 086 689 5506 email: <a href="mailto:geosure@iafrica.com">geosure@iafrica.com</a> <a href="http://www.geosure.co.za">www.geosure.co.za</a>
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<b>Client : Geosure (Pty) Ltd</b> <b>Project : Tongaat Water Treatment Works, KZN</b> <b>Attention : Mr D. Naidoo</b>	<b>Your Ref No.: 035-22</b> <b>Our Ref No. : 73516</b> <b>Date Reported : 14/12/2023</b>
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### Grading Curve for Sample T50228 – SANS 3001



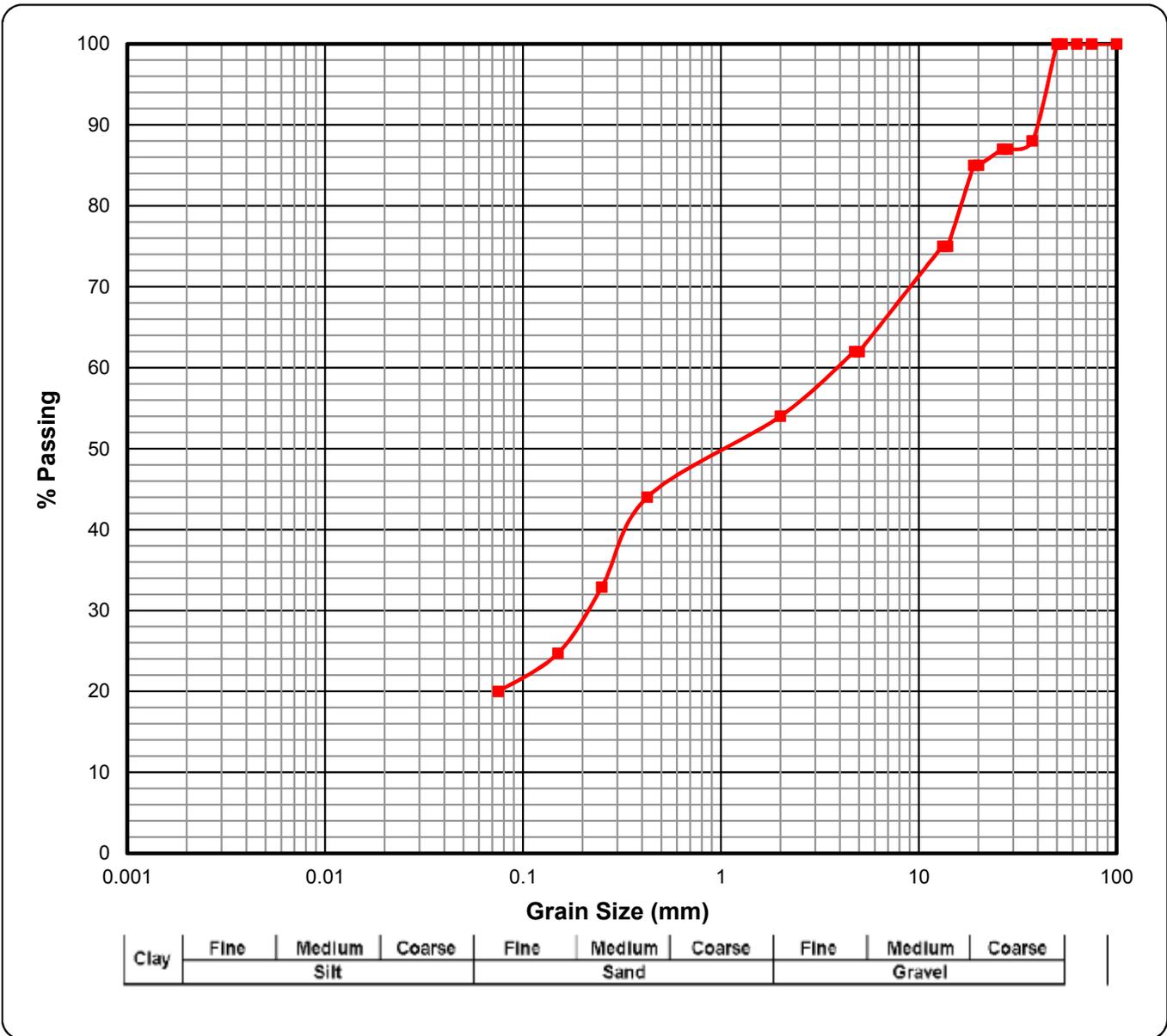
**Thick Red Line is the Grading Curve (COLTO Classification = G7 (#)) (TRH 14 Classification = G7)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	18%	24%	34%	51%	64%	70%	70%	77%	77%	83%	83%	87%	87%	91%	97%	100%	100%	100%	100%

<b>LABORATORY:</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091 P.O. Box 1461, Westville 3630 Mobile: +27(0)72 870 2621    Fax: 086 684 9785 Tel.: +27 (0)31 701 9732    email: <a href="mailto:lab@geosure.co.za">lab@geosure.co.za</a>	Reg. No. : 92/03145/07	<b>HEAD OFFICE:</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091, KwaZulu Natal, South Africa. Tel: +27 (0)31 266 0458    Fax: 086 689 5506 email: <a href="mailto:geosure@iafrica.com">geosure@iafrica.com</a> <a href="http://www.geosure.co.za">www.geosure.co.za</a>
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<b>Client : Geosure (Pty) Ltd</b> <b>Project : Tongaat Water Treatment Works, KZN</b> <b>Attention : Mr D. Naidoo</b>	<b>Your Ref No.: 035-22</b> <b>Our Ref No. : 73516</b> <b>Date Reported : 14/12/2023</b>
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### Grading Curve for Sample T50229 – SANS 3001



**Thick Red Line is the Grading Curve (COLTO Classification = G9 (#)) (TRH 14 Classification = G10)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	20%	25%	33%	44%	54%	62%	62%	75%	75%	85%	85%	87%	87%	88%	100%	100%	100%	100%	100%

<b>LABORATORY:</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091 P.O. Box 1461, Westville 3630 Mobile: +27(0)72 870 2621 Tel.: +27 (0)31 701 9732	<b>Reg. No. :</b> 92/03145/07  <b>Fax:</b> 086 684 9785 email: lab@geosure.co.za	<b>HEAD OFFICE:</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091, KwaZulu Natal, South Africa. Tel: +27 (0)31 266 0458 Fax: 086 689 5506 email: geosure@iafrica.com www.geosure.co.za
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**Client :** Geosure (Pty) Ltd  
**Project :** Tongaat Water Treatment Works, KZN  
**Attention :** Mr D. Naidoo

**Your Ref No. :** 035-22  
**Our Ref No. :** 73516  
**Date Reported :** 14/12/2023

### Test Report - SANS 3001

Sample No.	T50230	T50231	T50232	T50234	T50235
<b>Field No.</b>	IP8	IP4	IP10	IP5	IP7
<b>Position</b>	Layer 2	Layer 3	Layer 2	Layer 2	Layer 2
<b>Depth ( m )</b>	0.30-0.80	0.30-0.90	0.07-0.60	0.10-0.65	0.12-0.60
<b>Method of Preparation</b>	N/A	Scalped	Scalped	Scalped	Scalped
<b>Material Description</b>	Medium greyish brown very slightly gravelly silty fine to medium SAND. Fill	Medium brown slightly gravelly silty medium SAND. Fill	Medium brown slightly gravelly silty medium to coarse SAND. Fill	Medium brown medium to coarse gravelly medium SAND. Fill (Engineered)	Medium olive brown fine to coarse gravelly medium SAND. Fill

Sieve Analysis - Percent Passing Sieve Size						
Sieve Aperture (mm)	100.00	-	-	-	-	-
	75.00	-	-	100	-	-
	63.00	-	-	97	-	-
	53.00	-	100	97	100	100
	50.00	-	99	97	99	99
	37.50	100	94	96	93	93
	28.00	99	93	95	88	85
	26.50	99	93	95	88	85
	20.00	95	92	93	79	74
	19.00	95	92	93	79	74
	14.00	90	88	92	71	64
	13.20	90	88	92	71	64
	5.00	82	82	88	55	46
	4.750	82	82	88	55	46
	2.000	79	80	81	45	36
0.425	64	65	46	31	26	
0.075	16	15	5	17	14	
<b>Grading Modulus</b>	1.41	1.40	1.68	2.07	2.25	
Mechanical analysis - Percent of Soil Mortar (<2 mm) for Grain Size range						
Coarse Sand	2.000 - 0.425	19	19	43	32	28
Coarse-Fine Sand	0.425 - 0.250	31	32	30	14	14
Medium-Fine Sand	0.250 - 0.150	19	20	15	8	9
Fine-Fine Sand	0.150 - 0.075	10	10	5	8	11
Silt and Clay	< 0.075	20	19	6	38	38
Atterberg Limits SANS 3001 on <0.425 mm fraction						
Liquid Limit	% or symbol	NP	NP	NP	30	28
Plasticity Index	% or symbol	NP	NP	NP	10	9
Linear Shrinkage	%	0.0	0.0	0.0	5.0	5.0
Maximum Dry Density and Optimum Moisture Content						
<b>Maximum Dry Density (kg/m<sup>3</sup>)</b>		1983	2086	1833	2202	2238
<b>Optimum moisture content (%)</b>		6.3	5.8	6.4	7.6	6.2
California Bearing Ratio						
CBR @100% Compaction	%	54	39	41	41	62
CBR @ 98% Compaction	%	41	30	34	35	48
CBR @ 97% Compaction	%	36	27	31	33	42
CBR @ 95% Compaction	%	28	21	26	28	32
CBR @ 93% Compaction	%	21	16	22	24	24
CBR @ 90% Compaction	%	14	11	17	19	16
Swell @100% Compaction	%	0.0	0.0	0.0	0.1	0.2
<b>COLTO Classification (1998)**</b>		G6 (#)	G7 (#)	G6 (#)	G6 (#)	G6 (#)
<b>TRH 14 Classification (1985)**</b>		G7	G7	G7	G7	G7
<b>AASHTO Classification (Group Index)**</b>		A-2-4 (0)	A-2-4 (0)	A-1-b (0)	A-2-4 (0)	A-2-4 (0)
<b>Unified Classification **</b>		SM	SM	SP-SM	GC	GC

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**Remarks:** \*Subject to further testing as required by TRH14.

† Subject to further testing as required by COLTO. COLTO above uses only: Atterberg Limits (<0.425 mm fraction; not arithmetic mean), Nominal Max Size, Grading Curve, Coarse Sand Ratio, Grading Modulus, Strength (CBR), and Swell.

# Check that Max Size <= 2/3 of compacted layer thickness.

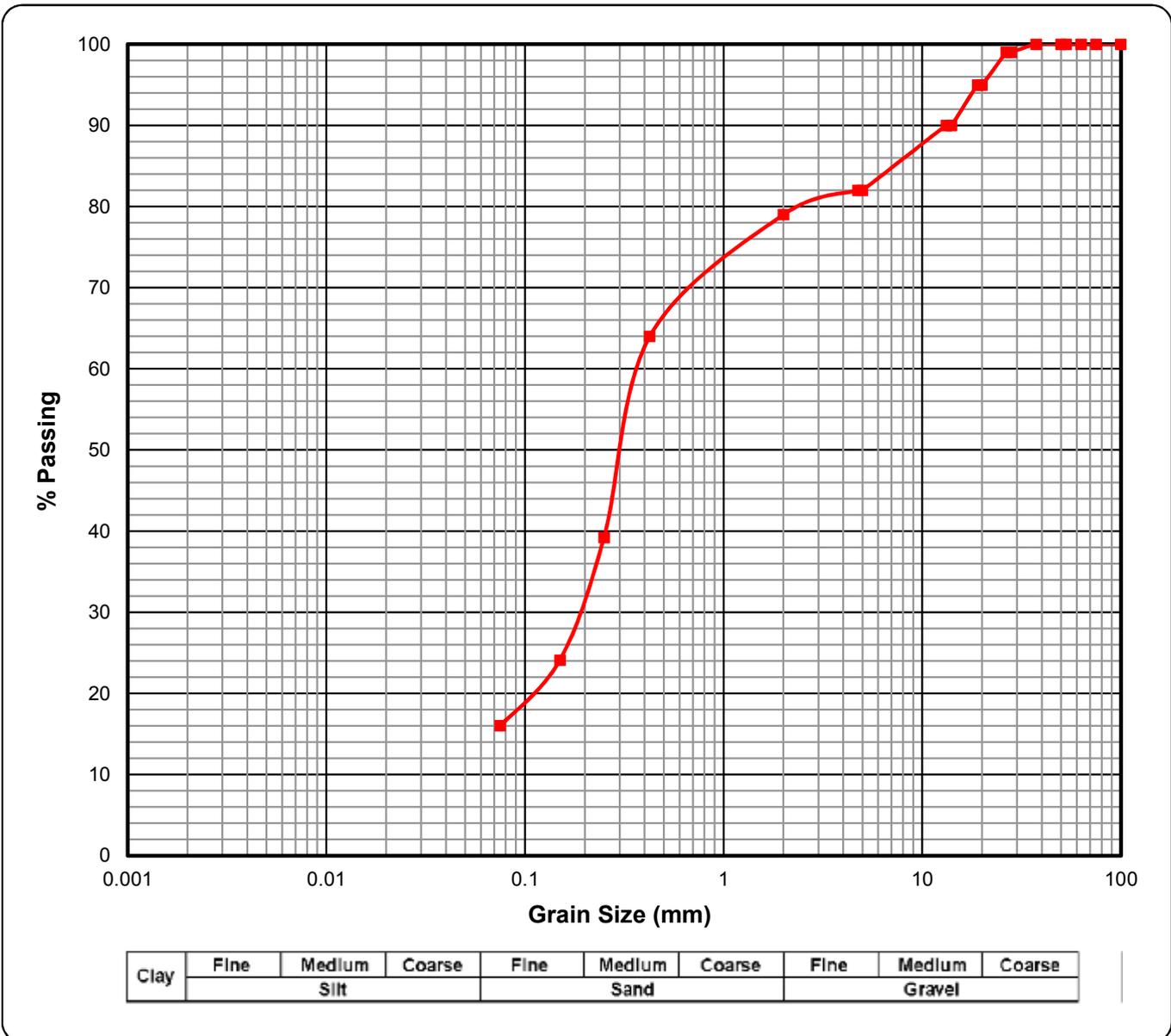
\*\* Opinions and interpretations expressed herein are outside the scope of SANAS accreditation

Version 5.05 - 14 February 2018

<b>LABORATORY:</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091 P.O. Box 1461, Westville 3630 Mobile: +27(0)72 870 2621    Fax: 086 684 9785 Tel.: +27 (0)31 701 9732    email: <a href="mailto:lab@geosure.co.za">lab@geosure.co.za</a>	Reg. No. : 92/03145/07	<b>HEAD OFFICE:</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091, KwaZulu Natal, South Africa. Tel: +27 (0)31 266 0458    Fax: 086 689 5506 email: <a href="mailto:geosure@iafrica.com">geosure@iafrica.com</a> <a href="http://www.geosure.co.za">www.geosure.co.za</a>
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<b>Client : Geosure (Pty) Ltd</b> <b>Project : Tongaat Water Treatment Works, KZN</b> <b>Attention : Mr D. Naidoo</b>	<b>Your Ref No.: 035-22</b> <b>Our Ref No. : 73516</b> <b>Date Reported : 14/12/2023</b>
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### Grading Curve for Sample T50230 – SANS 3001



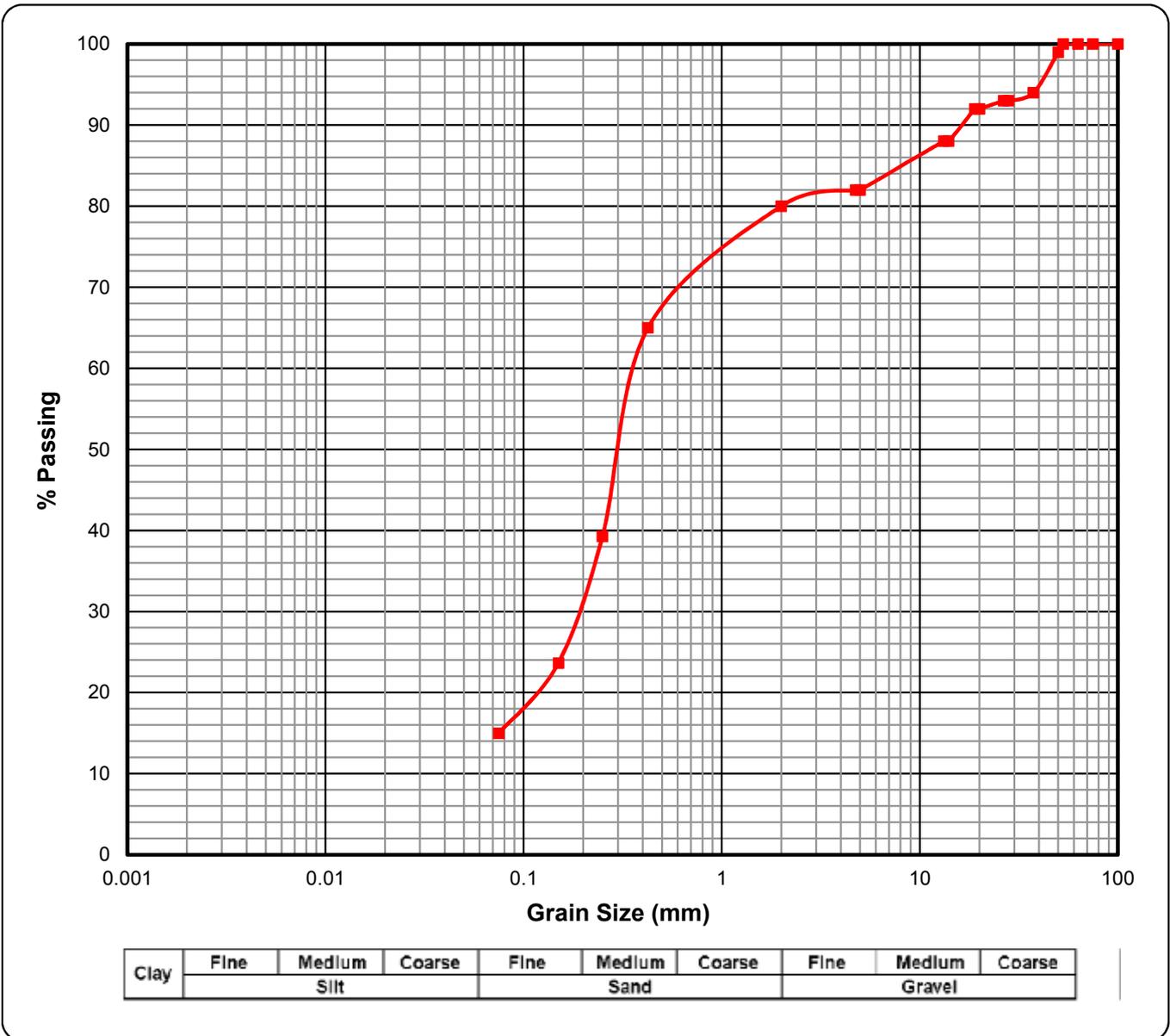
**Thick Red Line is the Grading Curve (COLTO Classification = G6 (#)) (TRH 14 Classification = G7)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	16%	24%	39%	64%	79%	82%	82%	90%	90%	95%	95%	99%	99%	100%	100%	100%	100%	100%	100%

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<b>Client : Geosure (Pty) Ltd</b> <b>Project : Tongaat Water Treatment Works, KZN</b> <b>Attention : Mr D. Naidoo</b>	<b>Your Ref No.: 035-22</b> <b>Our Ref No. : 73516</b> <b>Date Reported : 14/12/2023</b>
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### Grading Curve for Sample T50231 – SANS 3001



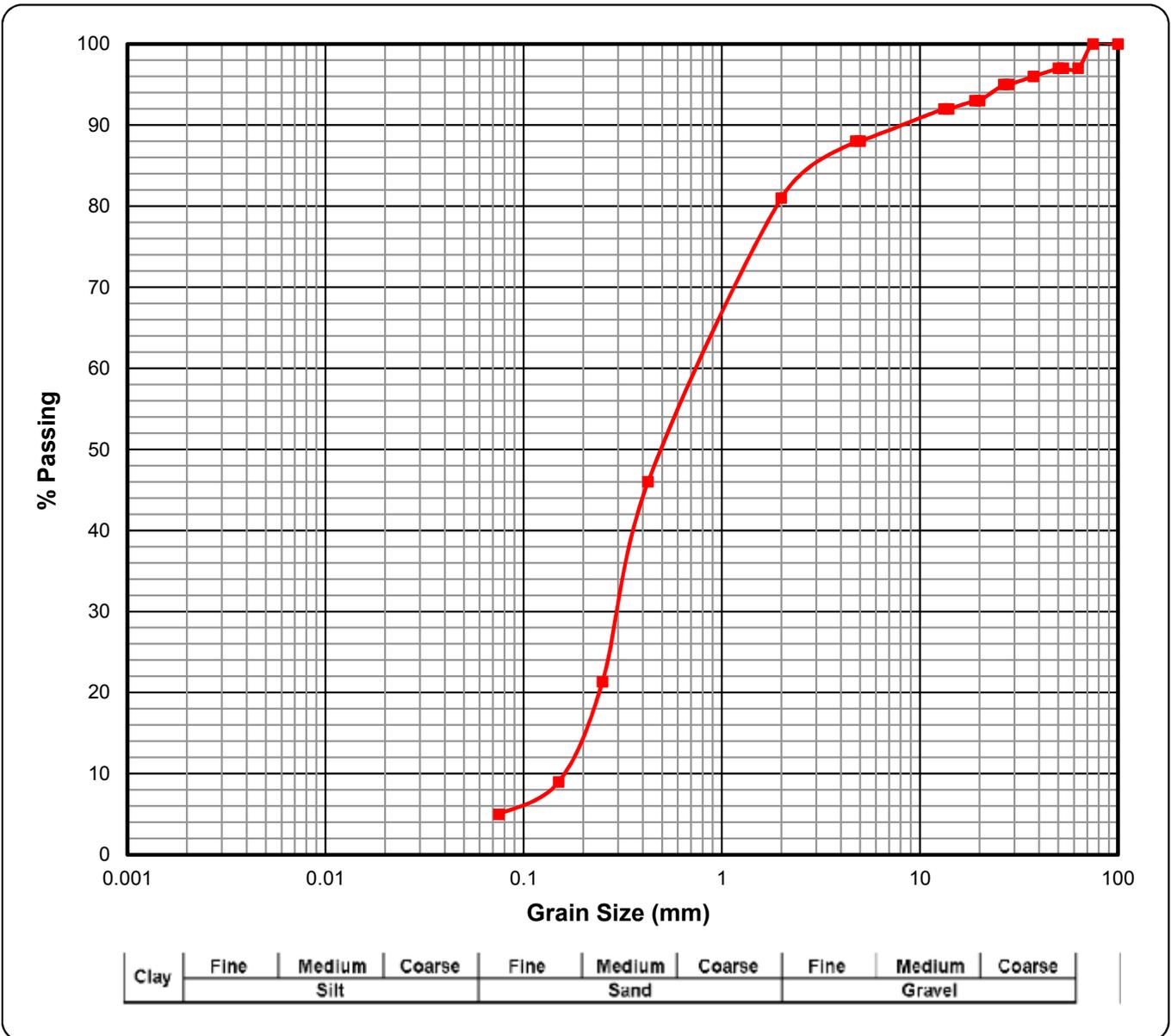
**Thick Red Line is the Grading Curve (COLTO Classification = G7 (#)) (TRH 14 Classification = G7)**

Sieve Aperture Size	0.075	0.150	0.015	0.026	0.05	0.06	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	15%	24%	39%	65%	80%	82%	82%	88%	88%	92%	92%	93%	93%	94%	99%	100%	100%	100%	100%

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### Grading Curve for Sample T50232 – SANS 3001



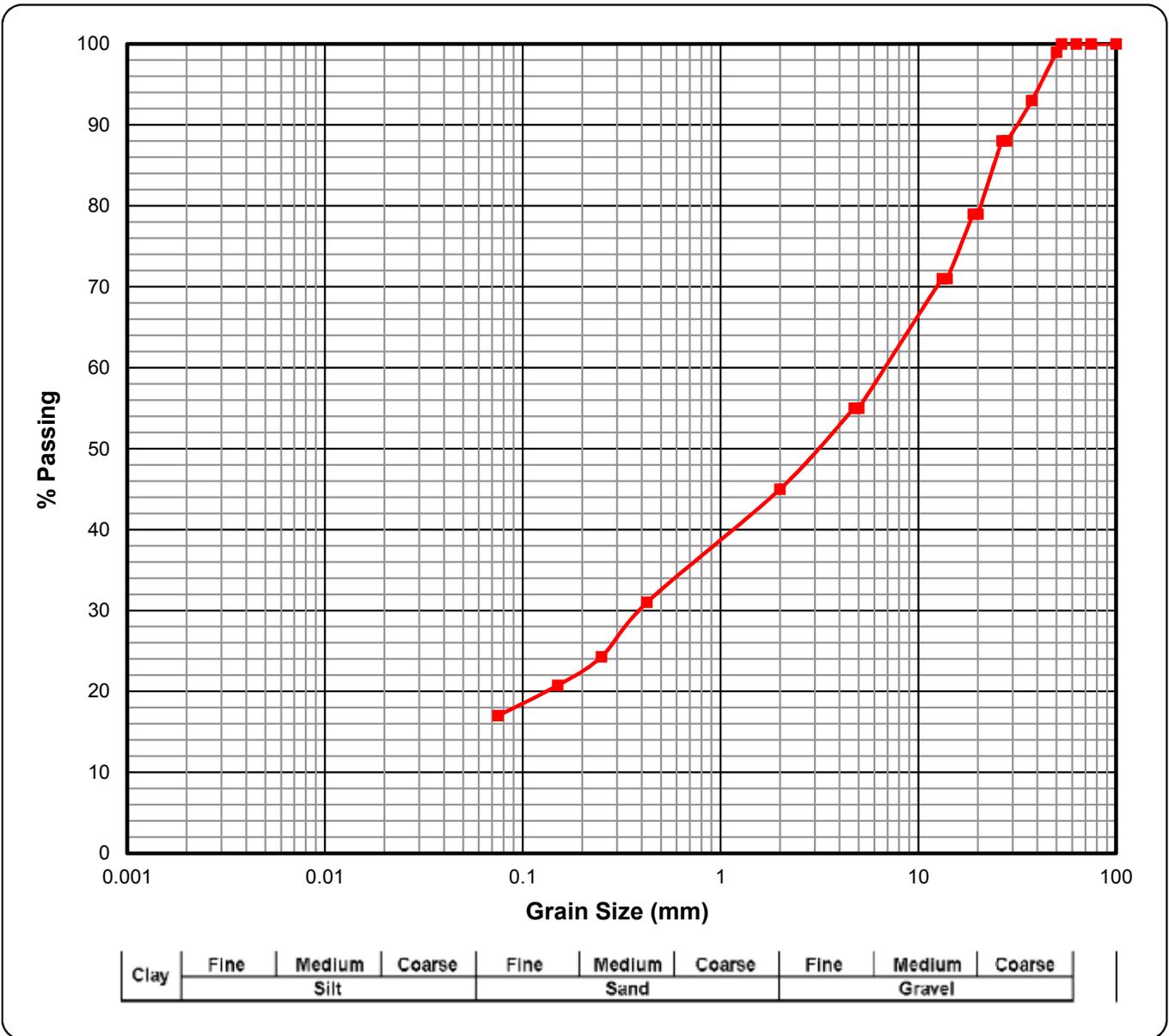
**Thick Red Line is the Grading Curve (COLTO Classification = G6 (#)) (TRH 14 Classification = G7)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100	
Percentage Passing	5%	9%	21%	46%	81%	88%	88%	92%	92%	93%	93%	95%	95%	96%	97%	97%	97%	97%	100%	100%

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### Grading Curve for Sample T50234 – SANS 3001



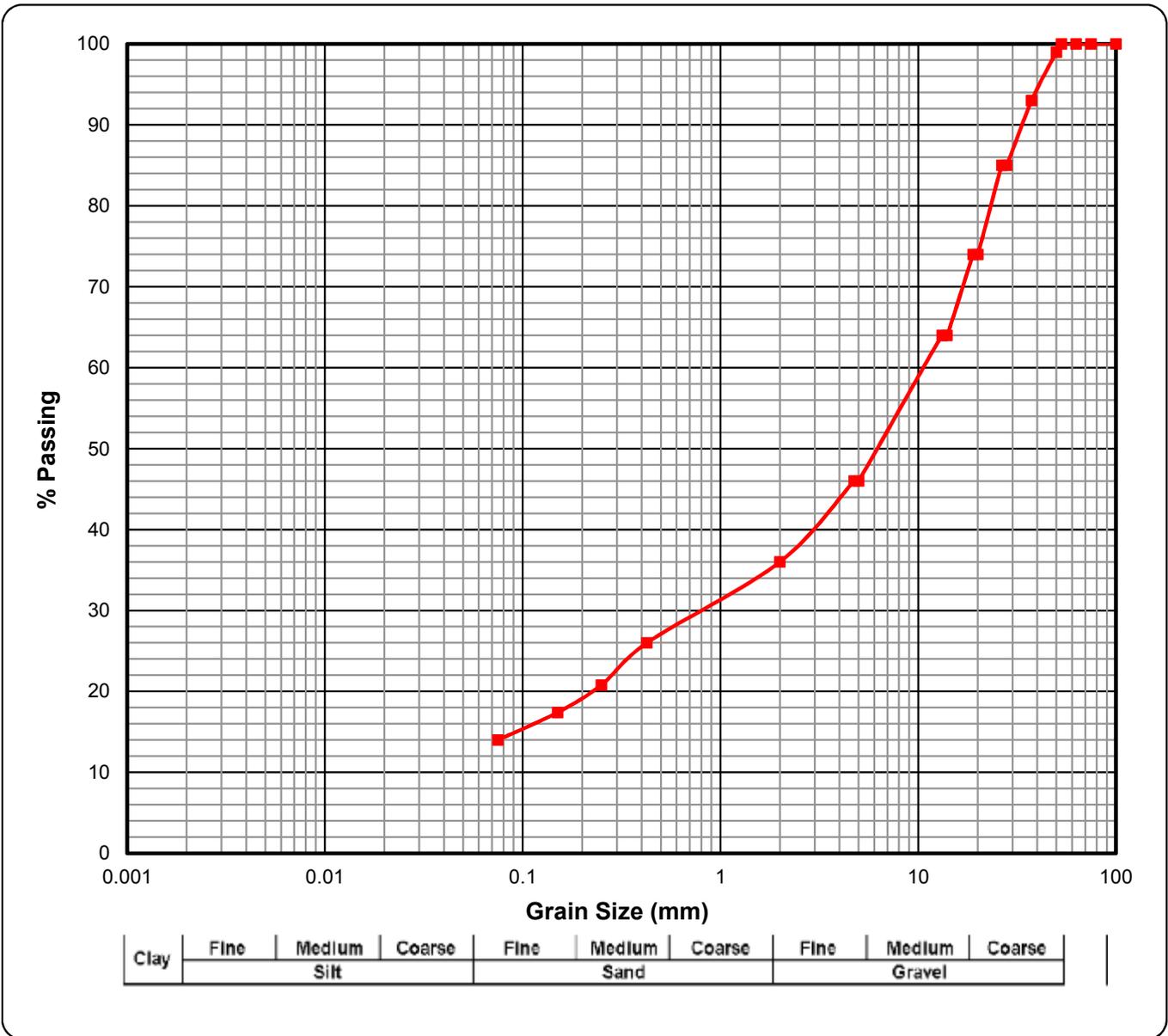
**Thick Red Line is the Grading Curve (COLTO Classification = G6 (#)) (TRH 14 Classification = G7)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	17%	21%	24%	31%	45%	55%	55%	71%	71%	79%	79%	88%	88%	93%	99%	100%	100%	100%	100%

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### Grading Curve for Sample T50235 – SANS 3001



**Thick Red Line is the Grading Curve (COLTO Classification = G6 (#)) (TRH 14 Classification = G7)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	14%	17%	21%	26%	36%	46%	46%	64%	64%	74%	74%	85%	85%	93%	99%	100%	100%	100%	100%



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**Client** : Geosure (Pty) Ltd  
**Project** : Tongaat Water Treatment Works, KZN  
**Attention** : Mr D. Naidoo

**Your Ref No.** : 035-22  
**Our Ref No.** : 73516  
**Date Reported** : 14.12.2023

**SANS 3001 Moisture/Density Relationship**

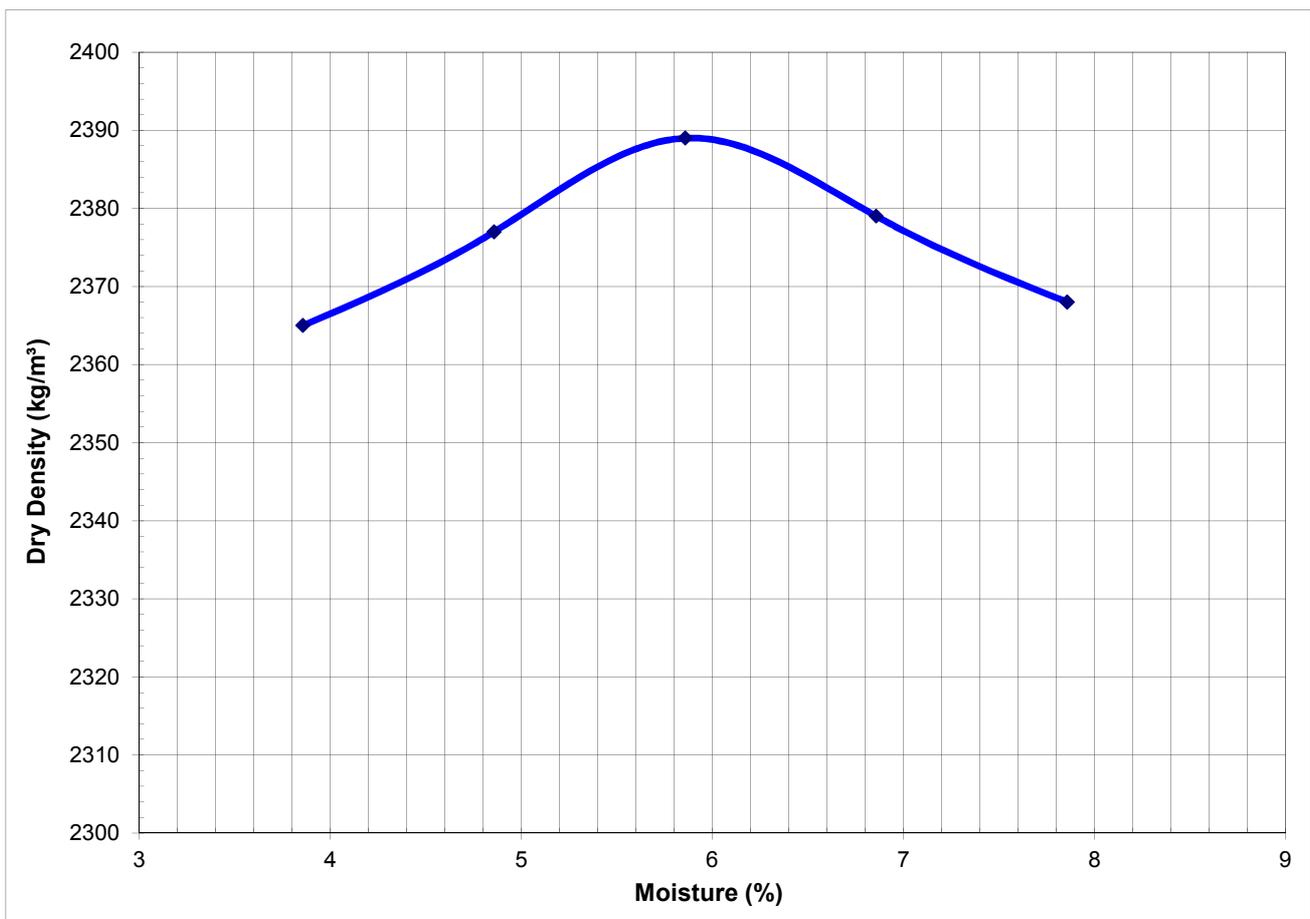
**Sample No.** : T50225 **Field No.** : IP6  
**Method of preparation** : Scalped **Depth (m)** : 0.07-1.30  
**Natural/Stabilised** : Natural **Origin** : Layer 2  
**Material Description** : Medium Br.Fine to Coarse gravelly medium SAND. **Compaction Effort** : Mod AASHTO

**Maximum Dry Density (kg/m<sup>3</sup>)**      **2389**

**Optimum Moisture Content (%)**      **5.9**

Plotted Values:

Moisture (%)	3.9	4.9	5.9	6.9	7.9
Dry Density (kg/m <sup>3</sup> )	2365	2377	2389	2379	2368



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**SANS 3001 Moisture/Density Relationship**

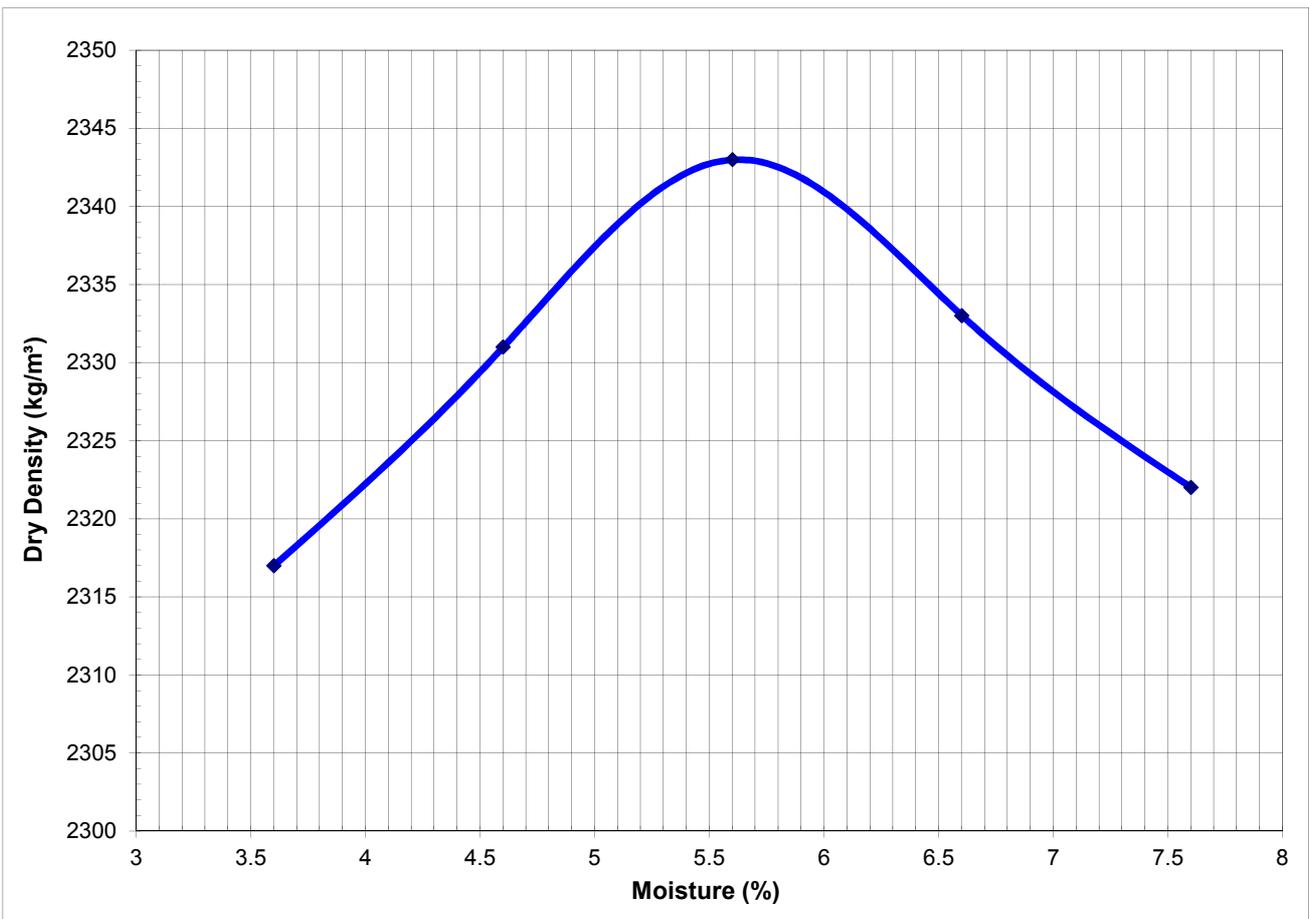
Sample No. : T50226 Field No. : IP3  
Method of preparation : Scalped Depth (m) : 0.01-1.00  
Natural/Stabilised : Natural Origin : Layer 1  
Material Description : Yell.Br.Fine to medium gravelly medium SAND. Fill Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m<sup>3</sup>) 2343**

**Optimum Moisture Content (%) 5.6**

Plotted Values:

Moisture (%)	3.6	4.6	5.6	6.6	7.6
Dry Density (kg/m <sup>3</sup> )	2317	2331	2343	2333	2322



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**SANS 3001 Moisture/Density Relationship**

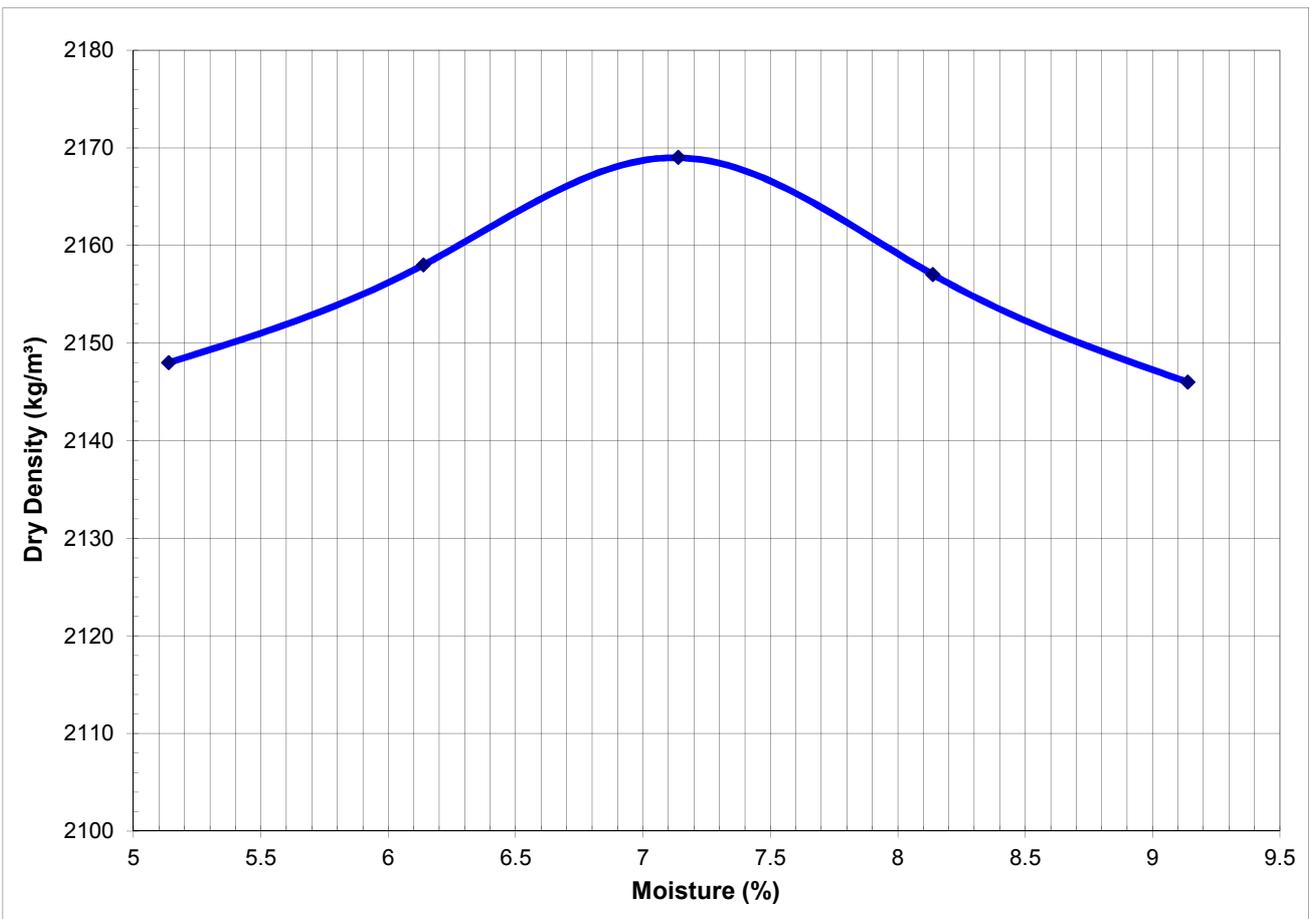
Sample No. : T50228 Field No. : IP2  
 Method of preparation : Scalped Depth (m) : 0.40-1.00  
 Natural/Stabilised : Natural Origin : Layer 2  
 Material Description : Medium Br.Sl.Gravelly Silty Fine to medium SAND. Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m<sup>3</sup>) 2169**

**Optimum Moisture Content (%) 7.1**

Plotted Values:

Moisture (%)	5.1	6.1	7.1	8.1	9.1
Dry Density (kg/m <sup>3</sup> )	2148	2158	2169	2157	2146



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**SANS 3001 Moisture/Density Relationship**

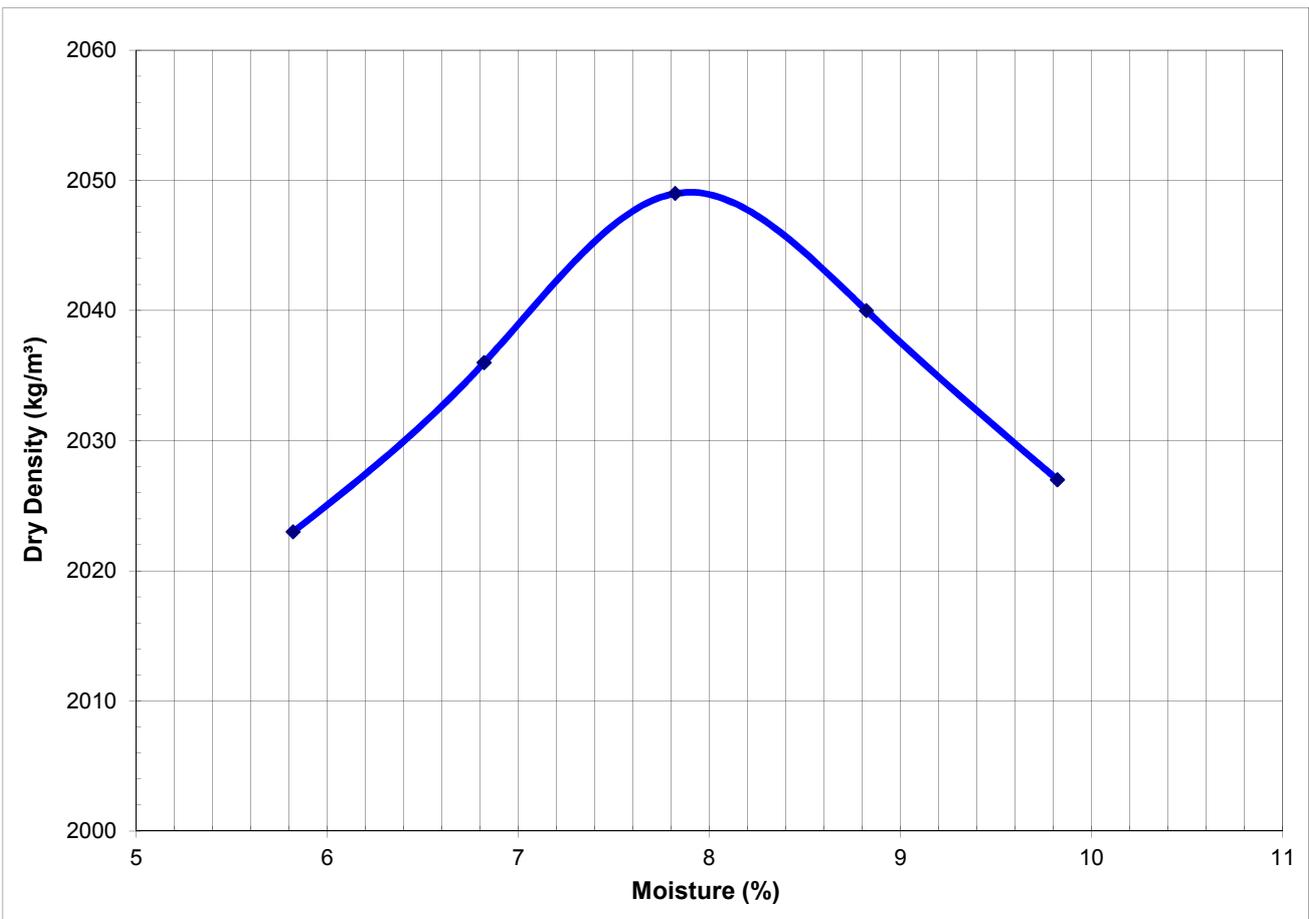
Sample No. : T50229 Field No. : IP9  
Method of preparation : Scalped Depth (m) : 0.50-0.98  
Natural/Stabilised : Natural Origin : Layer 3  
Material Description : Medium Br.Fine to coarse gravelly fine to medium  $\zeta$  Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m<sup>3</sup>) 2049**

**Optimum Moisture Content (%) 7.9**

Plotted Values:

Moisture (%)	5.8	6.8	7.8	8.8	9.8
Dry Density (kg/m <sup>3</sup> )	2023	2036	2049	2040	2027



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**SANS 3001 Moisture/Density Relationship**

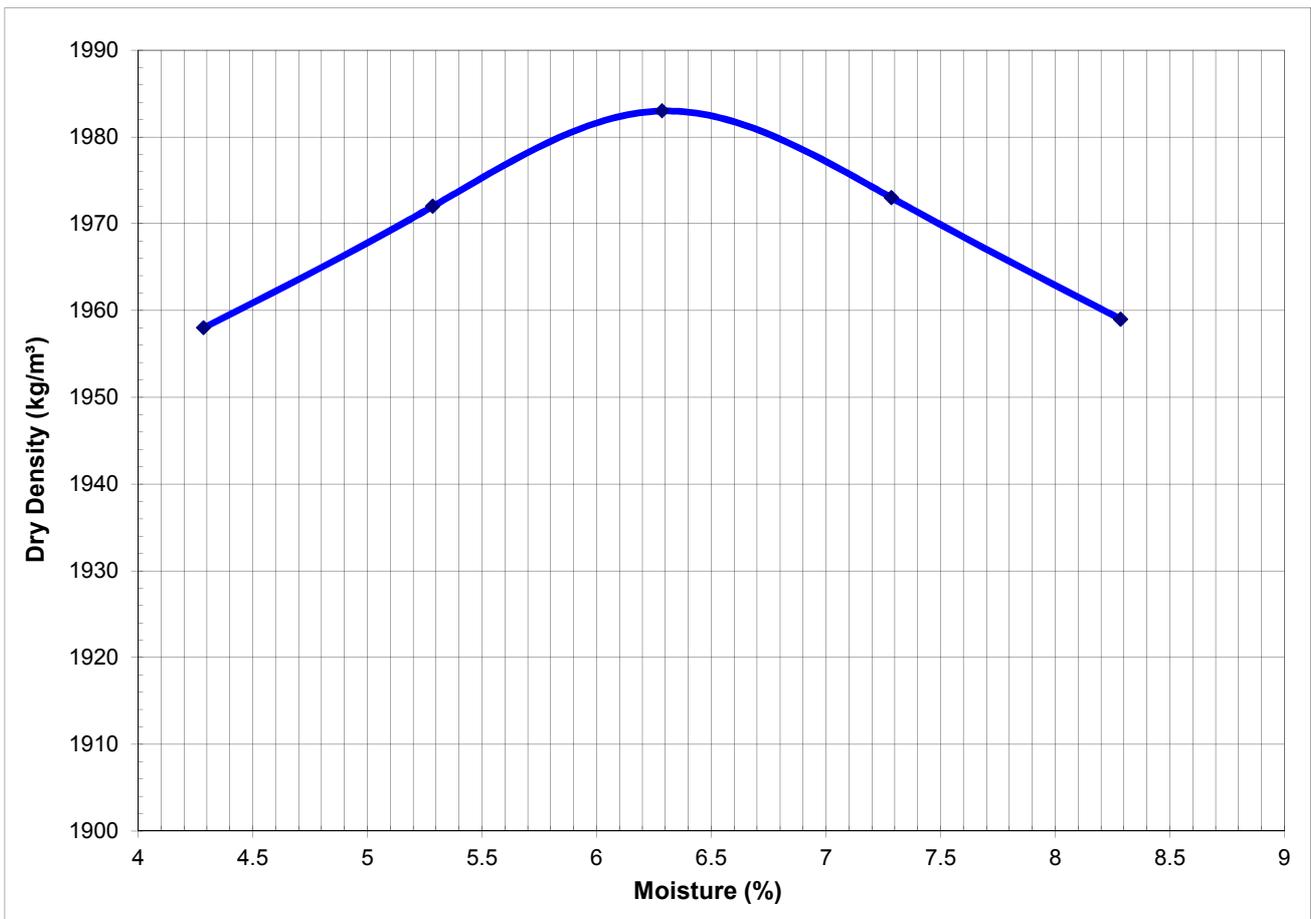
Sample No. : T50230 Field No. : IP8  
Method of preparation : N/A Depth (m) : 0.30-0.80  
Natural/Stabilised : Natural Origin : Layer 2  
Material Description : Medium Gr.Br.Very Sl.Gravelly Silty fine to Medium Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m<sup>3</sup>) 1983**

**Optimum Moisture Content (%) 6.3**

Plotted Values:

Moisture (%)	4.3	5.3	6.3	7.3	8.3
Dry Density (kg/m <sup>3</sup> )	1958	1972	1983	1973	1959



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**SANS 3001 Moisture/Density Relationship**

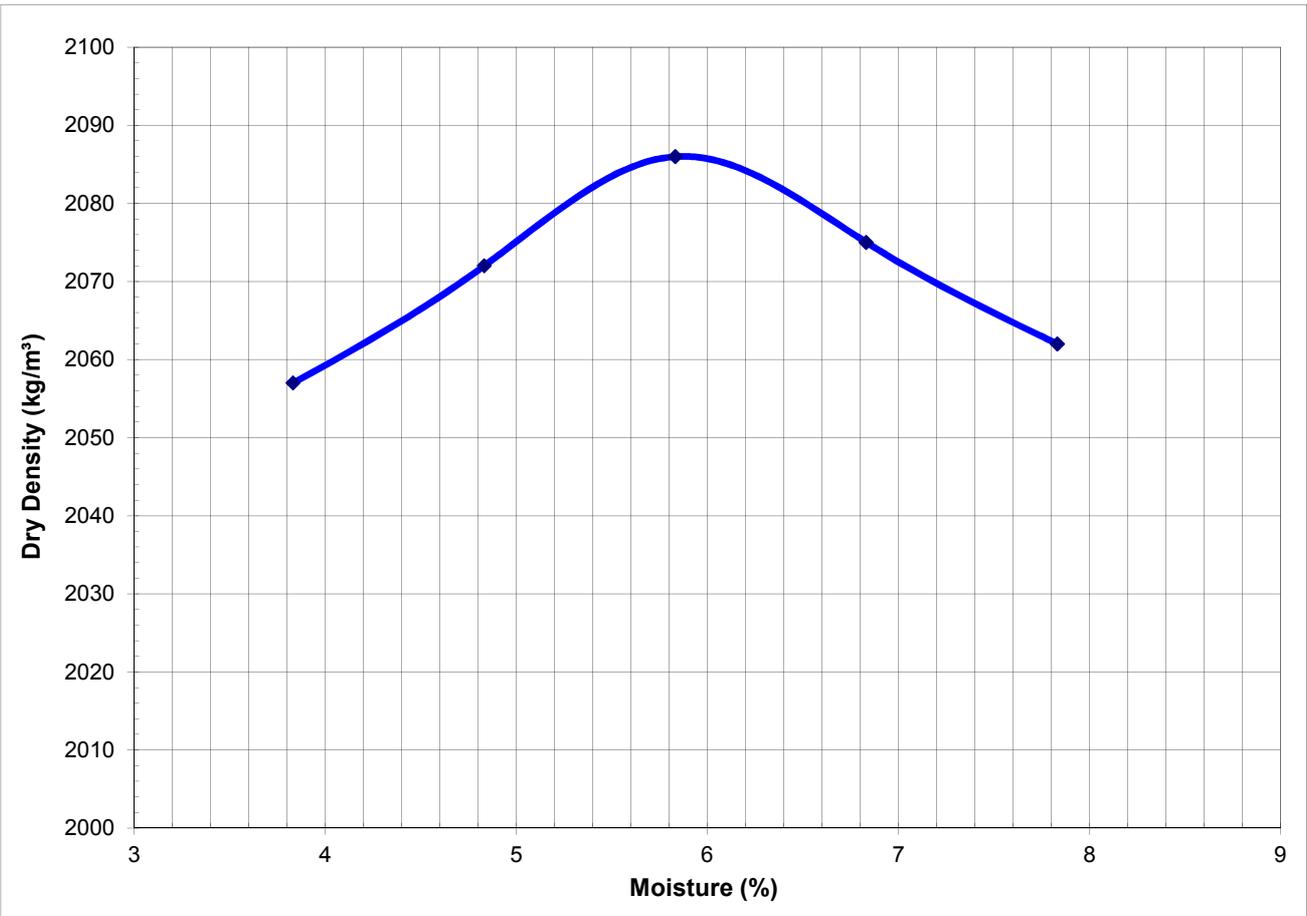
Sample No. : T50231	Field No. : IP4
Method of preparation : Scalped	Depth (m) : 0.30-0.90
Natural/Stabilised : Natural	Origin : Layer 3
Material Description : Medium Br.Sl.Gravelly Silty Medium SAND. Fill	Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m<sup>3</sup>) : 2086**

**Optimum Moisture Content (%) : 5.8**

Plotted Values:

Moisture (%)	3.8	4.8	5.8	6.8	7.8
Dry Density (kg/m <sup>3</sup> )	2057	2072	2086	2075	2062



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**SANS 3001 Moisture/Density Relationship**

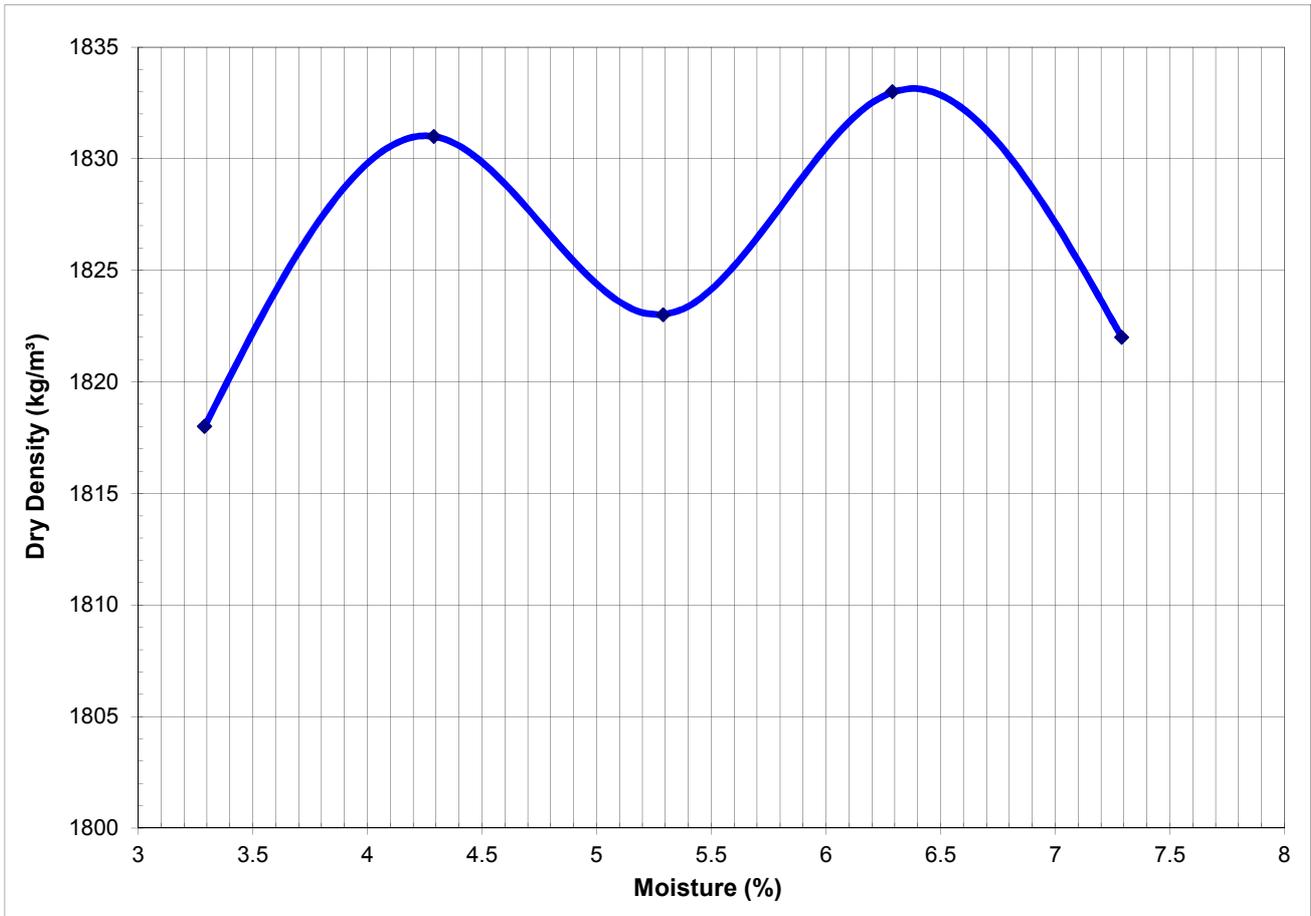
Sample No. : T50232 Field No. : IP10  
Method of preparation : Scalped Depth (m) : 0.07-0.60  
Natural/Stabilised : Natural Origin : Layer 2  
Material Description : Medium Br.Sl.Gravelly Silty Medium to coarse SAN Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m<sup>3</sup>) 1833**

**Optimum Moisture Content (%) 6.4**

Plotted Values:

Moisture (%)	3.3	4.3	5.3	6.3	7.3
Dry Density (kg/m <sup>3</sup> )	1818	1831	1823	1833	1822



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### SANS 3001 Moisture/Density Relationship

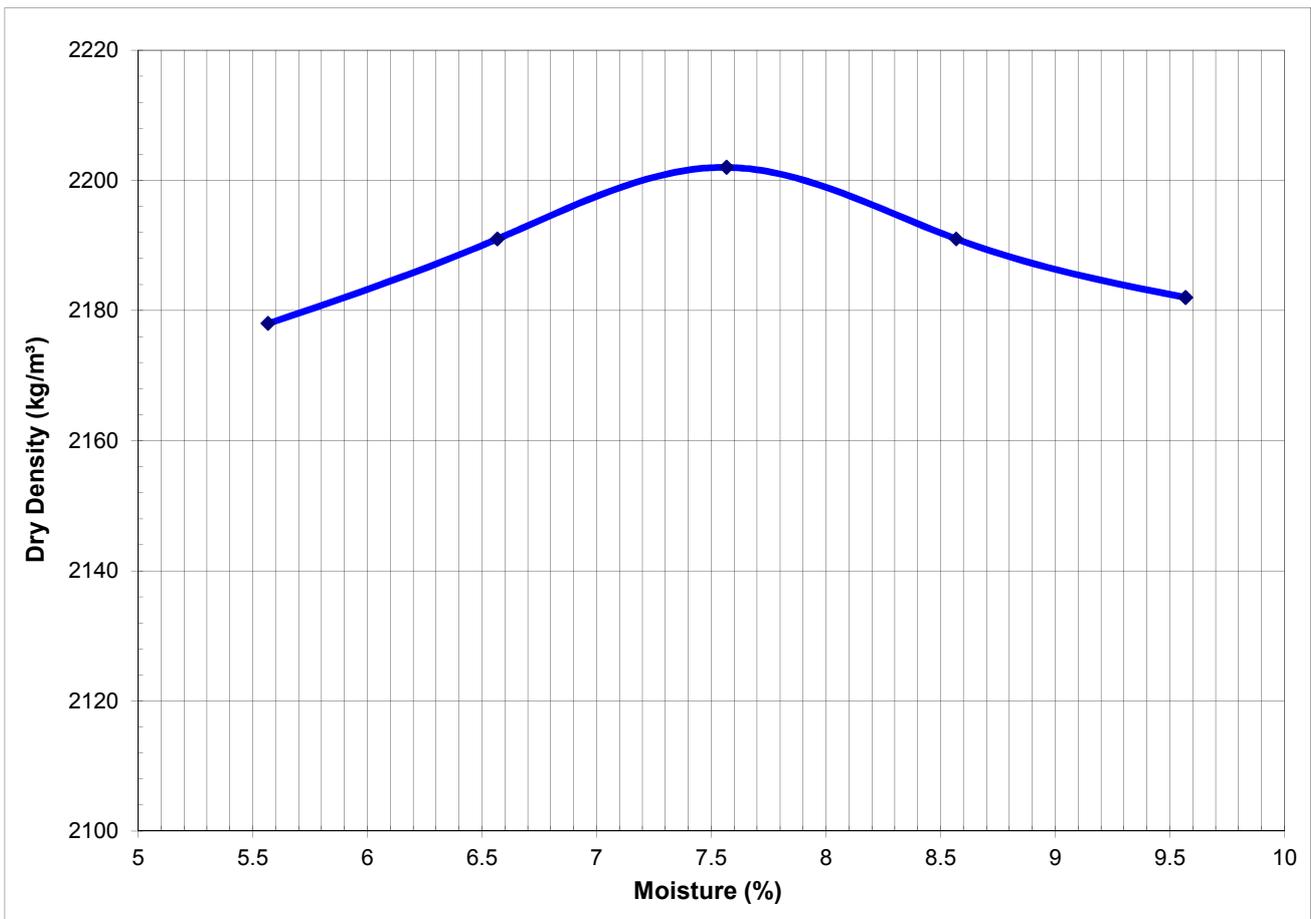
Sample No. : T50234	Field No. : IP5
Method of preparation : Scalped	Depth (m) : 0.10-0.65
Natural/Stabilised : Natural	Origin : Layer 2
Material Description : Medium Br. Medium to coarse gravelly medium SAI	Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m<sup>3</sup>) : 2202**

**Optimum Moisture Content (%) : 7.6**

Plotted Values:

Moisture (%)	5.6	6.6	7.6	8.6	9.6
Dry Density (kg/m <sup>3</sup> )	2178	2191	2202	2191	2182



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**SANS 3001 Moisture/Density Relationship**

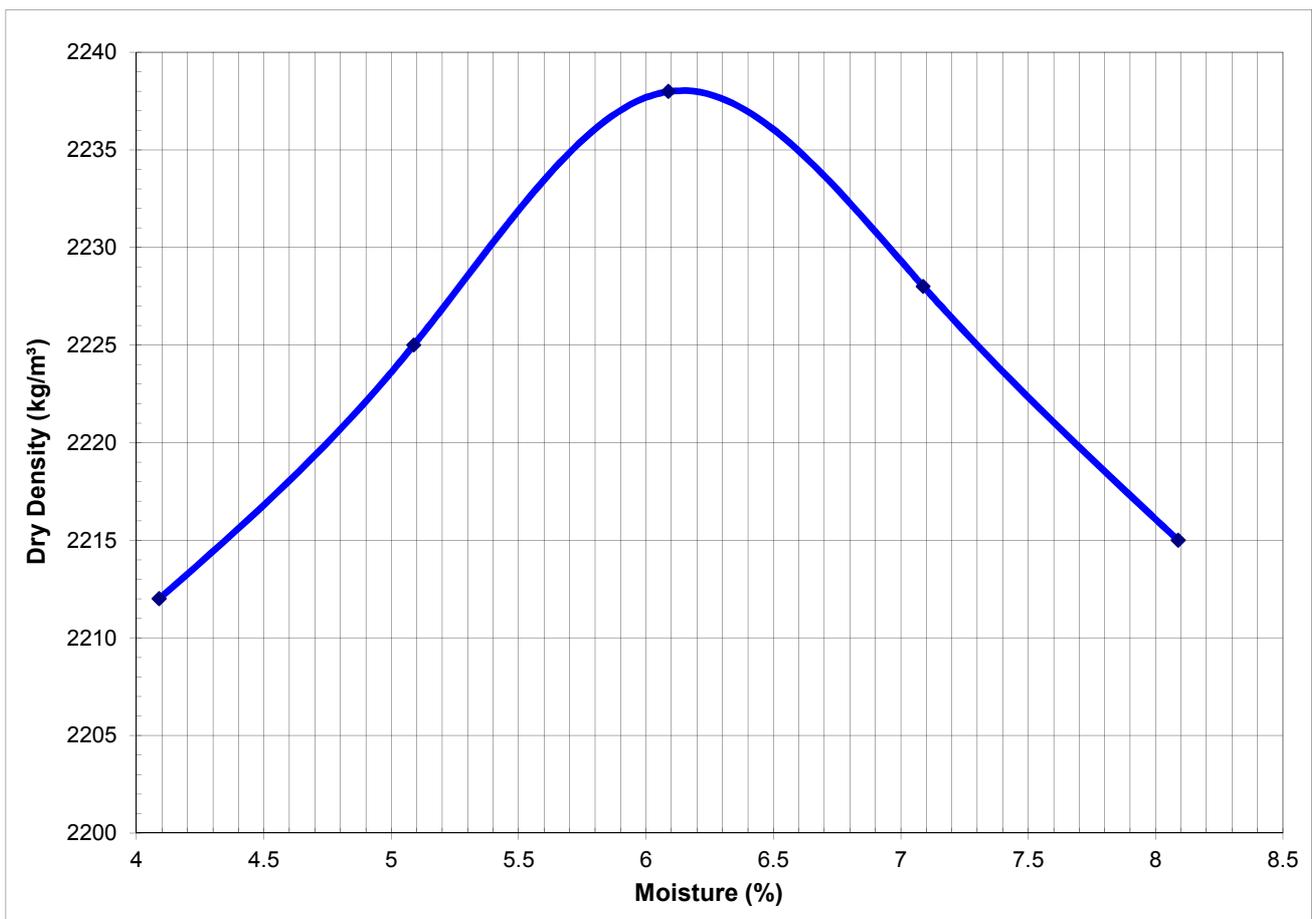
Sample No. : T50235 Field No. : IP7  
Method of preparation : Scalped Depth (m) : 0.12-0.60  
Natural/Stabilised : Natural Origin : Layer 2  
Material Description : Medium Olive Br.Fine to coarse gravelly medium S. Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m<sup>3</sup>) 2238**

**Optimum Moisture Content (%) 6.2**

Plotted Values:

Moisture (%)	4.1	5.1	6.1	7.1	8.1
Dry Density (kg/m <sup>3</sup> )	2212	2225	2238	2228	2215



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# APPENDIX A

## UNCERTAINTY OF MEASUREMENT AND DECISION RULE

**Notes on Uncertainty:**

1. ABBREVIATIONS: UoM = Uncertainty of Measurement; E.UoM = Expanded Uncertainty of Measurement
2. UoM for gravels, sands, cohesive materials and asphalt was determined from a reproducibility study
2. UoM for aggregates and concrete was determined from a repeatability study

**Notes on Decision Rule:**

1. The decision rule employed by this laboratory is based on ILAC-G9:03/2009
2. Decision rules are only applicable to classification of gravels, sands and cohesive materials
3. Contact GEOSURE for further information related to the decision rule

MATERIAL TYPE		GRAVELS AND CRUSHED STONE (G1 - G5)	SANDS (G8-G9)	COHESIVE MATERIALS (G5 - G9)
PROPERTY		E.UoM (K=2)	E.UoM (K=2)	E.UoM (K=2)
% Passing Sieve Aperture	100.0 mm	0.00	0.00	0.00
	75.0 mm	0.00	0.00	2.56
	63.0 mm	0.00	0.00	1.48
	50.0 mm	0.00	0.00	1.56
	37.5 mm	0.36	0.00	1.32
	28.0 mm	2.08	0.00	0.98
	20.0 mm	0.78	0.00	0.98
	14.0 mm	0.38	0.00	1.82
	5.00 mm	1.94	0.44	1.10
	2.00 mm	2.44	0.56	0.90
	0.425 mm	1.42	1.40	1.42
0.075 mm	0.38	0.72	0.98	
Mechanical Analysis (%)	CS	1.32	1.08	0.98
	CFS	1.32	0.66	0.00
	MFS	0.00	1.56	0.00
	FFS	0.74	0.92	1.02
	S+C	1.36	0.36	0.00
Grading Modulus		0.04	0.02	0.06
Atterberg Limits (%)	LL	0.00	0.00	1.60
	PI	0.00	0.00	0.64
	LS	0.00	0.00	0.22
CBR (%)	100% Comp.	18.36	8.24	2.70
	98% Comp.	9.24	7.50	1.10
	97% Comp	5.84	6.82	0.62
	95% Comp	1.32	3.04	0.40
	93% Comp.	1.94	2.44	0.66
	90% Comp.	3.54	1.50	0.66
Swell @ 100%		0.04	0.00	0.92
MOD	MDD (kg/m <sup>3</sup> )	5.74	3.42	7.76
	O.M.C (%)	0.08	0.12	0.50

AGGREGATE (SINGLE SIZED CRUSHED STONE)			
PROPERTY	E.UoM (K=2)		
% Passing Sieve Aperture	100.0 mm	0.00	
	75.0 mm	0.00	
	63.0 mm	0.00	
	50.0 mm	0.00	
	37.5 mm	0.00	
	28.0 mm	0.00	
	20.0 mm	0.16	
	14.0 mm	0.14	
	10.0 mm	0.32	
	7.1 mm	0.18	
	5.0 mm	0.20	
	2.0 mm	0.08	
	1.0 mm	0.18	
	0.600 mm	0.20	
	0.425 mm	0.20	
	0.300 mm	0.16	
	0.150 mm	0.04	
0.075 mm	0.12		
Fineness Mod.	0.00		
Flak. Index	%	0.22	
ALD	mm	0.12	
ALD Comp.	mm	0.10	
Sand Equiv		0.54	
ACV (AG10)	%	0.10	
10% FACT(AG10)	kN	1.08	
ACV (AG15)	%	0.00	
10% FACT(AG15)	kN	1.00	
BD (AG20)	kg/m <sup>3</sup>	0.38	
AD (AG20)	kg/m <sup>3</sup>	0.44	
WA (AG20)	%	0.00	
BD (AG21)	kg/m <sup>3</sup>	22.76	
AG (AG21)	kg/m <sup>3</sup>	27.04	
WA (AG21)	%	0.00	
ARD (AG22)	kg/m <sup>3</sup>	1.92	
RD (AG23)	kg/m <sup>3</sup>	2.04	
PD (AG23)	kg/m <sup>3</sup>	0.00	

ASPHALT			
PROPERTY	E.UoM (K=2)		
% Passing Sieve Aperture	37.5 mm	0.00	
	28.0 mm	0.00	
	20.0 mm	0.00	
	14.0 mm	0.13	
	10.0 mm	0.46	
	7.1 mm	1.53	
	5.00 mm	1.31	
	2.00 mm	1.08	
	1.00 mm	0.76	
	0.600 mm	0.53	
	0.425 mm	0.51	
0.300 mm	0.48		
0.150 mm	0.36		
0.075 mm	0.41		
Binder Cont.	%	0.15	
Fineness Mod		0.04	
BD	kg/m <sup>3</sup>	4.22	
Stability	kN	0.74	
Flow	mm	0.09	
MVD	kg/m <sup>3</sup>	4.84	

CONCRETE		
AGE	E.UoM (K=2)	
7 Day Results		
Strength( MPa)	2.30	
28 Day Results		
Strength( MPa)	1.26	

Nuclear Density	
Property	E.UoM (K=2)
Wet Density (kg/m <sup>3</sup> )	8.88
Dry Density (kg/m <sup>3</sup> )	11.36
Moisture Content (%)	0.38

