Terra GeoTechnical

Where Engineering Meets Earth

# Engineering Geological Report

In support of the proposed upgrade of the

## Gwaing Wastewater Treatment Works

## Phase 2

## George – Western Cape

Final Report TG24/013/2 June 2024

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The information presented in this document is based on the information supplied by the Consultant prior to the commencement of the investigation. All care and diligence have been taken in rendering services and preparing these documents.

## Table of Contents

# 1. Introduction

This report describes the results of a geotechnical site investigation in support of the proposed upgrade to the Gwaing Wastewater Treatment Works (Gwaing WWTW). The developmental area is within the boundaries of the existing Gwaing WWTW, and is located on the south western outskirts of the city of George, Western Cape. The Gwaing WWTW is currently operating under constrained condition and requires a hydraulic upgrade to 21Ml/day as part of this work package (current feasibility design report planning) to ensure sufficient capacity is available for existing and future flows. The ultimate capacity upgrade of the treatment work is 50Ml/day. This upgrade is proposed in four phases (A-D), each with its own objectives. will typically incorporate the construction of a large warehouse with office, storage facilities, parking and ablution facilities.

## 1.1. Terms of Reference

Terra Geotechnical was appointed in March 2024, by Mr Danie Brandt (representing Lukhozi Consulting Engineers (Pty) Ltd), to conduct this geotechnical investigation. The area of the investigation, was defined and approved by the consultant, before the commencement of the investigation. The distribution of testing locations and the associated sampling were indicated by the consultant, and further done where physically possible and to best model the geotechnical character of the site for this specific development. Testing frequency was discussed and approved by the engineer during the quotation phase.

The quantity and nature of samples were governed by the nature of the proposed development and the in-situ characteristics of the material excavated across the site.

## 1.2. Sources of Information

The following sources of information were utilized:

- Remote Sensing Information:
- Google Earth Pro TM
- Elevation Heat Map; Online Resource
- Planet GIS

## 1.3. Objectives

The purpose of the Investigation is to identify the presence and extent of groundwater, rock and most importantly to assess and report on the erodibility and stability of the insitu materials, soils that are exposed by flooding and by excavation during construction.

The investigation had the following aims:

- identify potential **geotechnical hazards**
- to determine and evaluate the **mechanical properties of the soil** material underlying the proposed structures.
- **define the ground conditions** and classify the conditions through detailed soil profile descriptions and groundwater occurrences **within the zone of influence of foundations**
- To assess **the in-situ mechanical properties** and the **re-usability of the natural material** underlying the development in question.
- To evaluate the **excavation characteristics** across the development in question.
- **Ground stability** for deep excavations
- To **recommend** measures to be implemented during the design and development of the area in question.

**It must be noted that this investigation was conducted to assist with the design and construction phase of the development**.

# 2. General Location and Description of Site

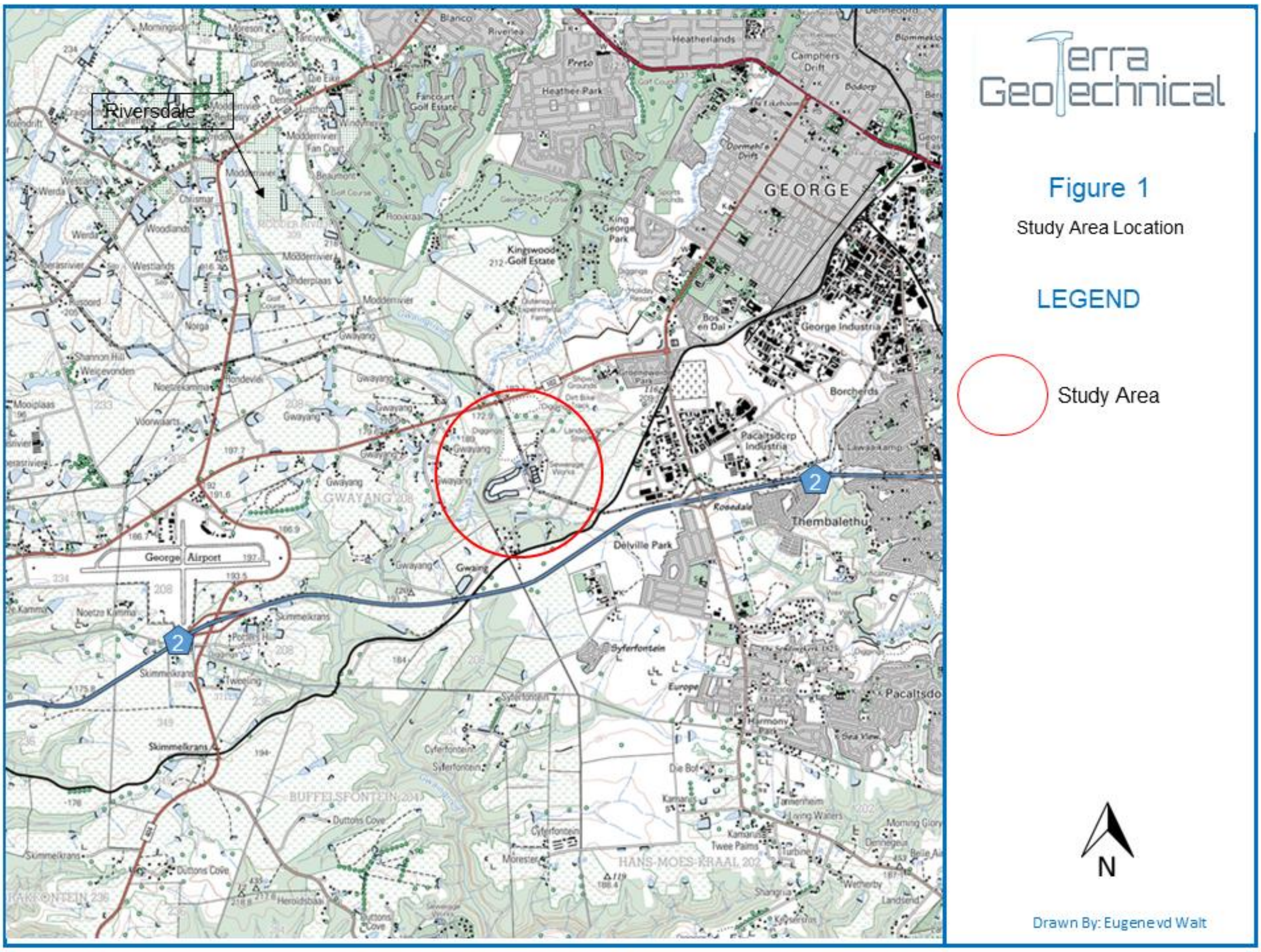
## 2.1. Location

The study area for this investigation is located on the south western outskirts of the city of George, forming part of the George Local Municipality.

Figure 1 graphically depicts the location of the study area.

The site is located roughly at the following coordinates:

Latitude: 33°59'37.92" S Longitude: 22°25'27.88" E




The site is further located within the boundaries of the existing Gwaing WWTW. The site is accessed via the R102 towards the north of the site.

The site currently hosts the existing Gwaing WWTW. The site has been completely altered from the natural due to the construction and operation of the existing Gwaing WWTW and associated infrastructure. Figure 2 below depicts the site location and existing infrastructure.


Figure 2

Site Location & Description

LEGEND

Existing Gwaing WWTW

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Drawn By: Eugene vd Walt

## 2.2. Topography

The study area is characterized by prominent ridge type structures displaying finger-like limbs that gives rise to a highly variable topography with moderate and steeply sloping landscapes. The weaker strata are typically weathered and eroded to form incised valley features.

The site is located on the western side slope of such a such a ridge feature and displays a gentle to moderately sloping morphology, decreasing in elevation towards the west.

Figure 3 below depicts the topographical features of the study area. Various valley type structures are identified by closely spaced contour lines and the presence of a drainage (non-perennial and perennial). The image depicts that no known drainage channels traverse the site.


Figure 3
Site Topographical Features
Aerial View

## 2.3. Drainage

The study area is drained mainly by means of surface run-off (i.e.: sheetwash), with storm water flowing west, towards the Gwaing River to the west of the site. The natural drainage across the site has been altered due to the past construction activities across the site.

## 2.4. Climate

The study area experiences rainfall throughout the year. The mean annual precipitation is approximately 797 mm. Mean monthly maximum and minimum temperatures are 12˚C in July and 20˚C in February.

The climatic N-value (Weinert, 1980) of the area is deemed to be less than 5; therefore, chemical decomposition rather than mechanical disintegration, of the parent rocks is deemed the principal mode of weathering.

## 2.5. Planned Development

**Phase A**

Gwaing WWTW is currently operating just beyond its capacity. The primary purpose of Phase A is to increase the capacity of the plant in the shortest possible time to ensure the works has enough capacity to sufficiently treat wastewater to comply with effluent requirements. It is proposed that for Phase A of the upgrade, the MLE process be used to maximise capacity in the short term. When Phase B is implemented, the UCT process can be implemented to increase phosphorus removal. The proposed solution is to construct 6 additional Secondary Settling Tanks (SSTs) to operate together with the existing Biological Reactor A. The 8 SSTs in total, together with Biological Reactor will give an additional capacity of 3.7 MLD resulting in a total capacity of 14 MLD (ADWF).

Image 4a graphically depicts the planned developmental during Phase A

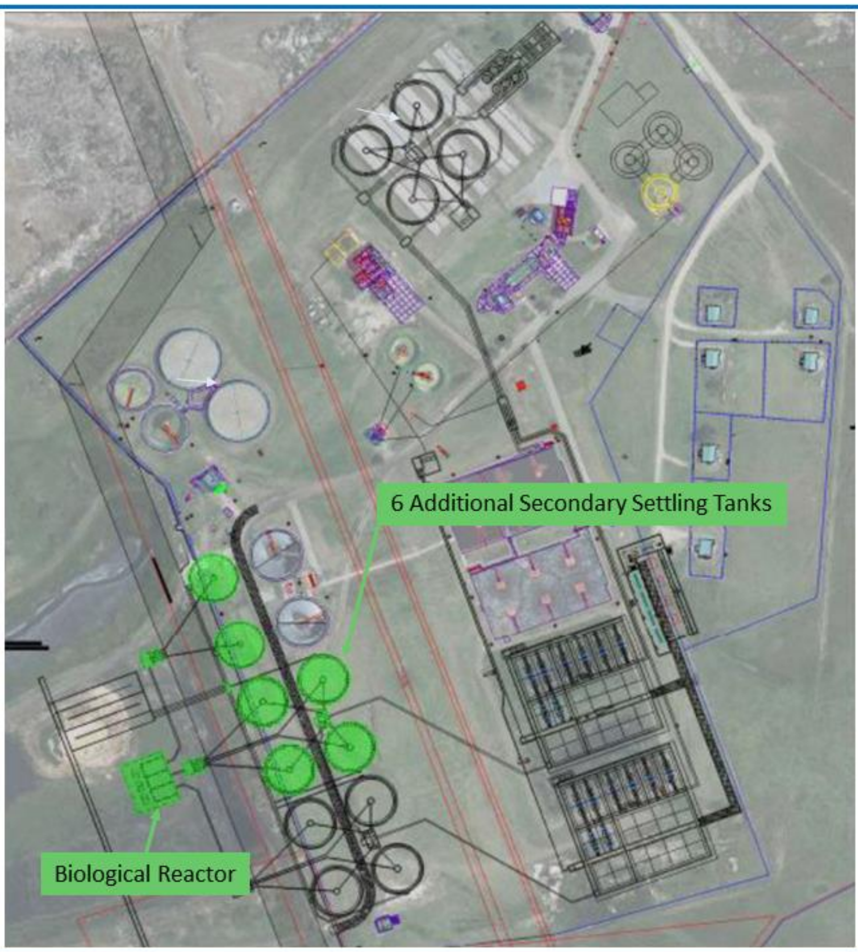



Figure 4a

Proposed Development

Phase A – Site Plan

N

**Phase B**

There were two options investigated for Phase B of the upgrade. The first option is implementing an additional biological reactor and operating a UCT system with unsettled wastewater. The second option is to implement primary settling (including all primary sludge handling) and operating a UCT settled process with the existing Biological Reactor. The two options were compared to each other and workshopped together with George Municipality.

An optioneering exercise was conducted at a Workshop with the Consultants, Municipal Project Managers, Municipal process specialists and Municipal plant operators present. The optioneering was conducted to compare key attributes between Option 1 and Option 2 for Phase B of the upgrades. The optioneering exercise resulted in Option 1 being the preferred option for Phase B.

Image 4a graphically depicts the planned developmental during Phase B

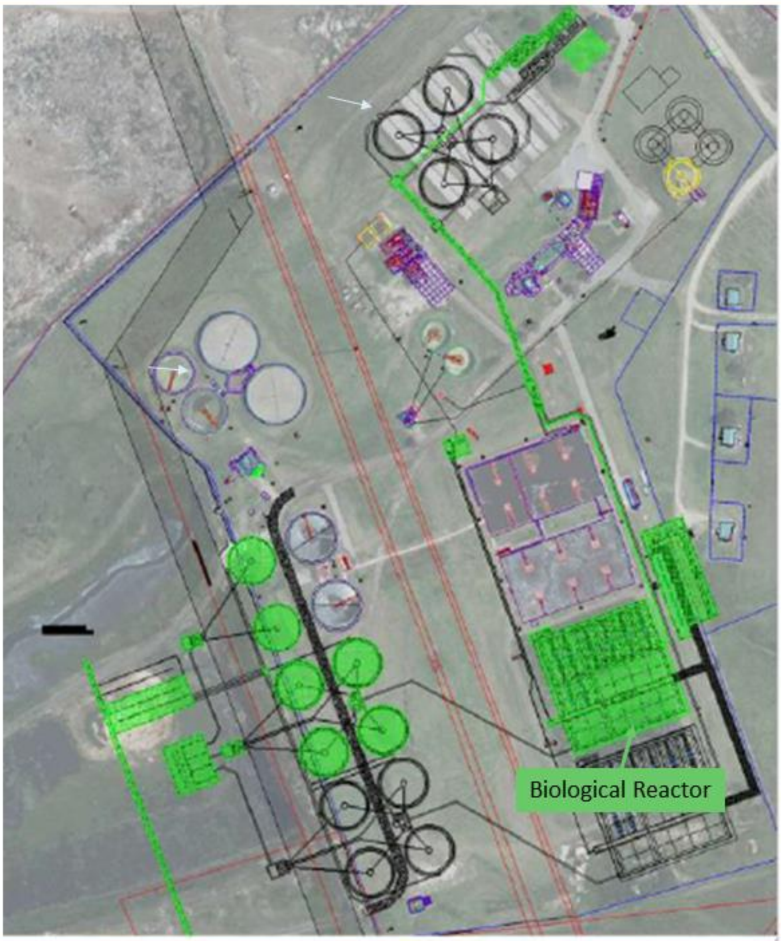



Figure 4b

Proposed Development

Phase B – Site Plan

**Phase C**

Phase C of the upgrade will be to construct Module C's reactor and SSTs. It is proposed to construct the final reactor and SSTs prior to constructing the Primary Settling Tanks (PSTs) and associated primary sludge handling unit processes as all the ancillary infrastructure for the reactors and SSTs would have been constructed as part of Phase B. This includes the Blower House, Return-Activated Sludge (RAS) pump station and Waste-Activated Sludge (WAS) pumpstation. It would also give more redundancy with the additional reactor and SSTs should maintenance on any of the existing infrastructure be required. The total capacity of the plant after the Phase C upgrade will be 33 MLD operating a UCT settled process.

Image 4a graphically depicts the planned developmental during Phase C

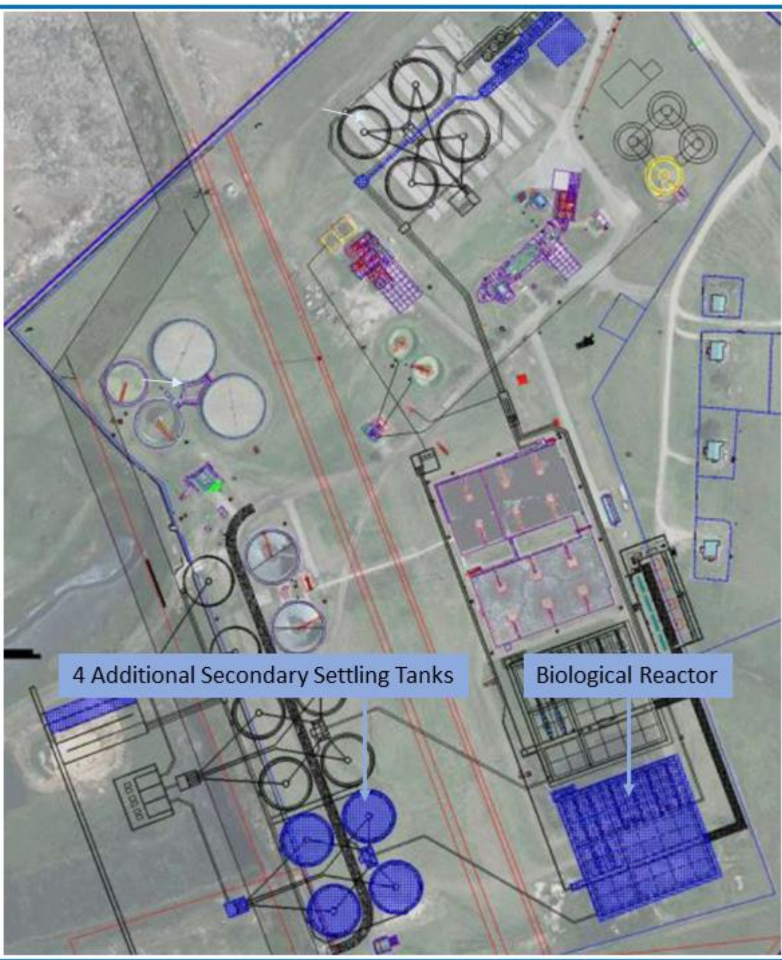



Figure 4c

Proposed Development

Phase C – Site Plan

**Phase D**

Phase D of the upgrades will be the final phase of the Master Plan. The phase will see the construction of the four PSTs, primary sludge pumpstation and three additional anaerobic digestors. The existing PSTs will be refurbished and used as gravity thickeners for the primary sludge. Phase D will increase the plant's capacity from 33 MLD to 50 MLD, operating a UCT settled process. The sequencing of Phase C and D can be switched around if the Municipality chooses to do so when it comes time for the upgrade. Switching the two phases will have the same impact on the capacity.

Image 4a graphically depicts the planned developmental during Phase D

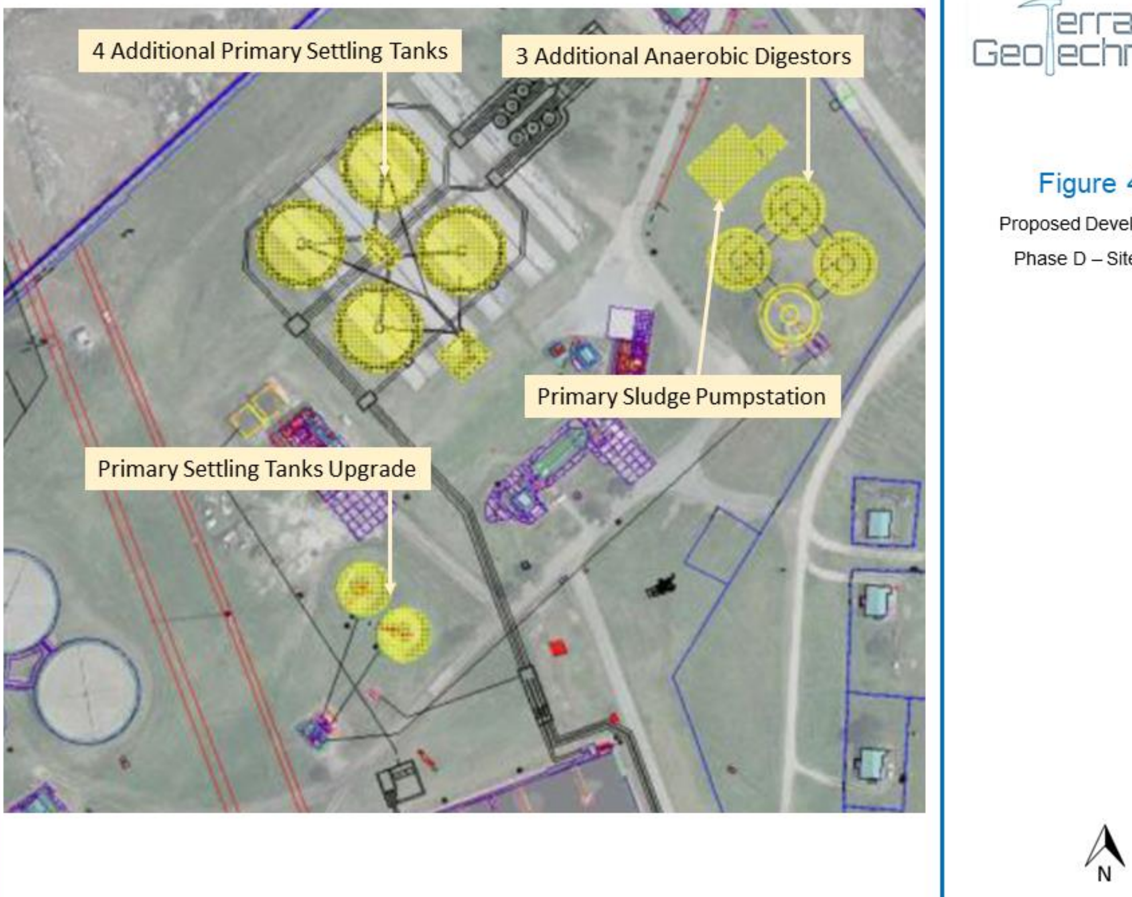



Figure 4d
Proposed Development
Phase D – Site Plan

# 3. Geological Setting

## 3.1. Regional Geological Setting

According to the geology map 3322 CD George, the study area is underlain by Gneissic Granite of the Maalgaten Formation forming part of the George Pluton.

The regional geological setting of the study area (minus the surficial soil cover) is illustrated by Figure 3.

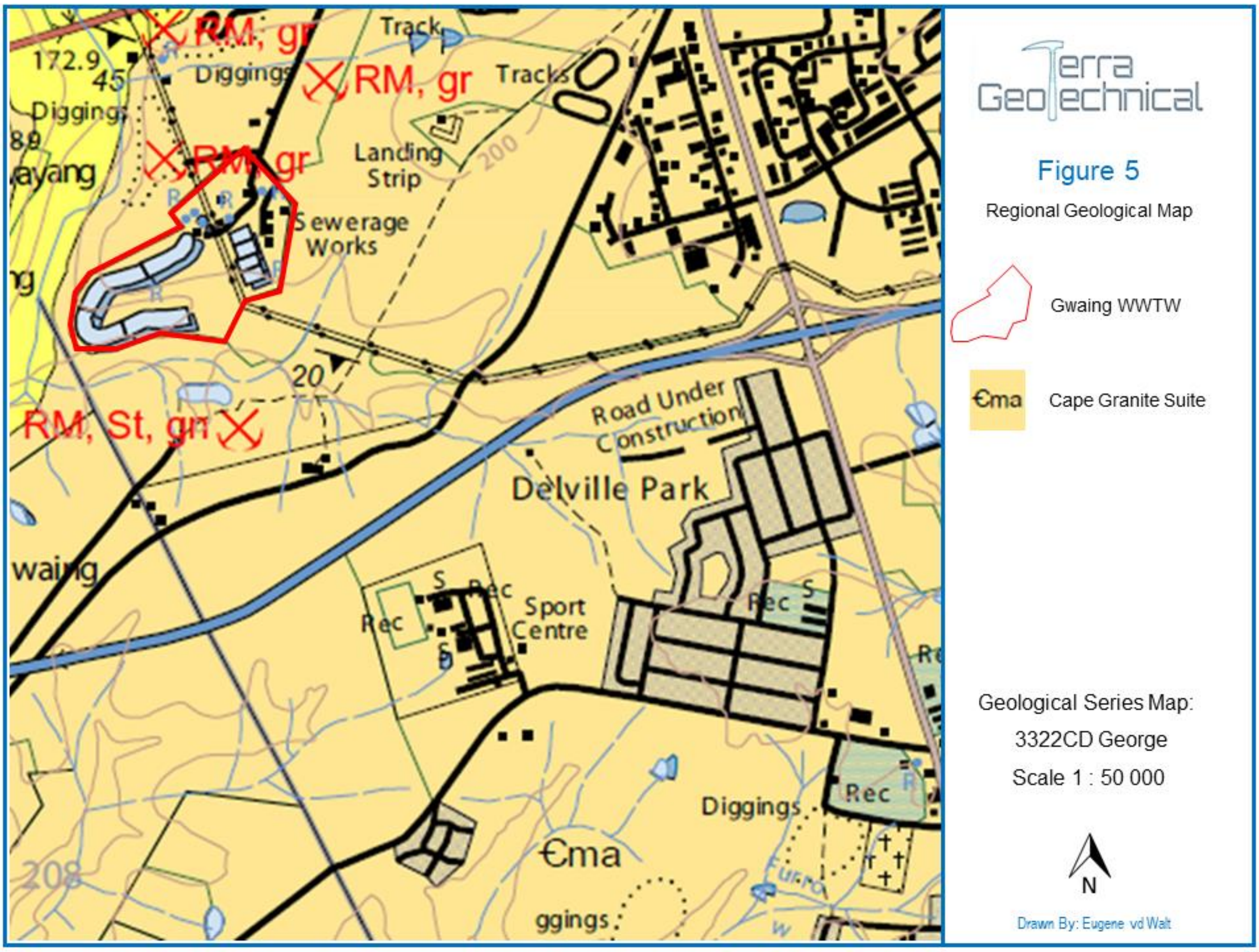



Figure 5
Regional Geological Map

The study area does not reflect any risk for the formation of sinkholes or subsidence caused by the presence of water-soluble rocks (dolomite or limestone), and as such is not deemed “dolomitic land

## 3.2. Prominent Geological Structures

The available geological information does not indicate the presence of any geological structures traversing the site.

# 4. Geotechnical Field Investigation and Laboratory Testing

## 4.1. Reconnaissance Study

The investigation commenced with the conducting of the following actions:

- The collation and evaluation of available geological and geotechnical information, with specific reference to previous geotechnical investigations undertaken within the vicinity.
- The compilation of a base map showing the regional geological setting

## 4.2. Site Investigation

The field work phase was conducted by Terra Geotechnical over multiple days during the months of March and April of 2024. All testing locations were provided by the Consultant.

Test pits were placed at strategic (predefined) positions throughout the study area in such a way as to accurately describe the general soil conditions occurring within the boundaries of the study area. The succession of soil and rock layers exposed within the test pits were logged according to the industry-standard method proposed by Jennings et al (1973), and a series of detailed photographs were taken of the different soil layers, and samples were taken of the soil- and rock material deemed to be important to the proposed development.

Dynamic Probe Super Heavy (DPSH) tests were conducted at predefined locations scattered across the site to assess the consistency (and depth to bedrock) of the material underlying the site.

## 4.3. Laboratory Testing

The following tests were conducted on soil samples taken during the field work phase:

- Standard foundation indicator tests were conducted on disturbed soil samples in order to determine its composition (i.e.: the relative percentages of gravel, sand, silt and clay present within each sample), to evaluate the heave and compressibility potential of these soils, and to calculate the maximum heave and/or differential settlement that can be expected. The following tests were conducted:
  - ❖ Atterberg Limits (Liquid Limit and Plasticity Index) and Linear Shrinkage
  - ❖ Particle-size distribution
- Standard road indicator tests were conducted on bulk soil samples in order to determine its composition, and to evaluate the suitability of the materials for use in the construction of access roads and parking areas. These tests were conducted:
  - ❖ Maximum Dry Density versus Optimum Moisture Content
  - ❖ Californian Bearing Ratio versus Compaction Effort (MOD AASHTO method)
- Specialised Geotechnical testing on undisturbed samples were conducted in order to determine the in-situ properties of the material present across the site. The following tests were conducted:

- Consolidation test (Single Oedometer)
- Swell Potential

# 5. Geotechnical Setting

## 5.1. Trenching

### 5.1.1. Excavation of test pits

A total of 14 test pits, numbered TP1 to TP14 (Figure 6 on the following page), were excavated across the site by means of a TLB-type light mechanical excavator. The test pits were excavated to refusal either refusal or maximum reach.

The test pits were placed at locations proposed by the Consultant. The table below provides the coordinates of each of these test pits.

| Testing Locations | | |
|---|---|---|
| Test Number | Latitude (South) | Longitude (East) |
| Test Pit | | |
| **TP1** | 33.992794 | 22.423955 |
| **TP2** | 33.993049 | 22.424620 |
| **TP3** | 33.993110 | 22.423087 |
| **TP4** | 33.993754 | 22.422824 |
| **TP5** | 33.993780 | 22.423802 |
| **TP6** | 33.994512 | 22.423208 |
| **TP7** | 33.994365 | 22.424319 |
| **TP8** | 33.995883 | 22.421882 |
| **TP9** | 33.995909 | 22.422917 |
| **TP10** | 33.995324 | 22.424623 |
| **TP11** | 33.996280 | 22.423805 |
| **TP12** | 33.996765 | 22.424352 |
| **TP13** | 33.996863 | 22.423009 |
| **TP14** | 33.998017 | 22.422156 |

Figure 6 on the following page graphically depicts the location of each of the test pits.


**Figure 6**

Geotechnical Testing Positions

Test Pit

N

Drawn By: Eugene vd Walt

### 5.1.2. Generalised engineering geological parameters

The following general engineering geological characteristics were noted:

- **Site Excavatability**

The TLB-type light mechanical excavator was generally able to excavate trial pits to depth of between 2.5 and 3.6 m with little or no difficulty**.** For this reason, **no problems** are foreseen during the excavation of **shallow foundations** or **deep service trenches** to a depth of at least 2.5 m below the existing ground level, through the use of a TLB-type light mechanical excavator.

The excavation type to a depth of at least 2.50 m below the existing ground level is deemed to be **Soft Excavation**. (SANS 1200D).

- **Rock- and/or pedocrete outcrops**

Bedrock or pedocrete outcrops were not encountered within the investigated area.

- **Sidewall stability**

The sidewalls of all test pits generally remained stable for at least 1 hour.

- **Groundwater seepage**

Groundwater seepage was observed in three test pits (TP1, TP3 & TP12) across the site. This seepage is categorized as a perched groundwater table, and it was generally identified as slow to moderate flow. It is mainly present within the fill, pedogenic horizon and the upper transported soils. Perched groundwater occurs when an impermeable layer restricts water from infiltrating deeper into the aquifer, causing it to move laterally through the strata.

What is also noted is the generally slightly moist to moist condition of all exposed soil horizons. Pedogenic material (ferricrete nodules) was identified at various locations across the site at shallow depth, indicating the occurrence of a fluctuating water table or soil moisture evaporation.

### 5.1.3. Generalised soil profile

Note: this description is based on field observations, and does not reflect the results of any laboratory tests

The results of the trenching phase indicate that the whole site is covered by a relatively homogeneous succession of soil layers. Typically, the site was covered by a highly organic topsoil with abundant root structures, underlain by a prominent transported horizon. This transported horizon was underlain in some test pits by a thin nodular ferricrete, after which another alluvial horizon was encountered. Below the transported layers, the residuum is encountered in various stages of alteration i.e. reworked residual granite, residual granite and completely weathered granite.

The following Table summarizes the depths at which these various horizons were encountered.

| Soil Profile summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test Pit | Uncontrolled Fill | Transported | Pedogenic Horizon | Residuum | | | Refusal by TLB Y/N | Water Seepage Y/N |
| | | | Ferricrete/Ferruginized Material | Reworked | Residual | Completely Weathered | | |
| TP1 | | 900 | 1100 | 1800 | 2700 | | N | Y @ 900 mm |
| TP2 | | 800 | 1400 | 1800 | 2600 | | N | N |
| TP3 | 2200 | | | | 2600 | | N | Y @ 2200 mm |
| TP4 | | 800 | 1400 | 1800 | 2500 | | N | N |
| TP5 | 400 | 1200 | 1300 | 2000 | 2200 | 2600 | N | N |
| TP6 | | 900 | | 2600 | | | N | N |
| TP7 | | 900 | | 1600 | 2700 | | N | N |
| TP8 | 2600 | | | | | 3600 | N | N |
| TP9 | 400 | | | 1100 | | 2500 | N | N |
| TP10 | 600 | 1000 | | 2500 | | | N | N |
| TP11 | 1000 | | 1300 | 1700 | 2200 | 2500 | N | N |
| TP12 | 1500 | | | 2600 | | | N | Y @ 1100 mm |
| TP13 | 500 | | 600 | 1000 | | 2500 | N | N |
| TP14 | | 600 | | 1100 | 1600 | 2700 | N | N |

These horizons will be discussed in more detail in below:

**Uncontrolled Fill:**

At various locations across the site, uncontrolled fill was encountered and exposed within test pits. The majority of these instances proved the thickness of this uncontrolled fill was up to 600 mm. However, in various test pits, uncontrolled fill was encountered from surface to depths of between 1000 and 2600 mm below existing ground level. These areas are seen to host fill consisting of household refuse, building rubble, etc. At TP8, sewer sludge was encountered to a depth of 2600 mm below ground level.

**Transported:**

The transported horizon was encountered in 8 test pits. It was present generally as slightly moist to moist, brown, silty sand with scattered cobbles and generally exhibited a medium dense consistency with an intact structure. This layer was encountered to depths of between 600 and 1200 mm.

**Pedogenic Horizon:**

A thin pedogenic horizon was encountered at various locations across the site consisting of frequent ferricrete nodules in a matrix of silty/clayey sand. This layer had a thickness of between 200 and 600 mm.

**Residuum**

Below the various imported and transported horizons, the residuum was encountered. The residuum is formed as a result of the weathering and erosion process acting on the underlying bedrock over long periods. Across this site, the granitic bedrock is found to have been altered to various degrees, resulting in variable layers of residuum. These layers typically become less altered with depth. The transition between these layers is not always well defined and is known as gradational contacts.

- **Reworked Residual Granite**

Encountered throughout the majority of the site, this horizon was present as slightly moist to moist, dark red patched brown mottled greyish yellow, very soft to stiff, slickensided and/or relict jointing, clayey/sandy silt.  Water movement in the reworked layers were evident, especially in the upper part of the residual soils. Decomposed rootlets and clay fill is encountered within this relict joints.

These reworked residual soils were typically found to occur to depths of between 1100 and 2600 mm with a typical thickness of between 400 to 1700 mm.

- **Residual Granite**

The residual granite is present as slightly moist to moist, orange patched red mottled grey, clayey/silty sand with scattered gravels. Furthermore, it exhibits a very soft to very stiff consistency. Decomposed rootlets and clay fill is encountered within this relict joints. At times, the residual granites were seen to host a micaceous nature.

- **Completely Weathered Granite**

Completely weathered granite is totally discoloured and decomposed an in a friable condition with only fragments of rock texture and structure preserved. The external appearance is that of a soil. This horizon was present as slightly moist, light yellow mottled orange speckled grey, clayey/silty sand with gravels. Furthermore, it exhibits a very dense/very stiff consistency.

Detailed test pit profiles are included in Appendix A.

The table on the following page summarizes the soil profiles as encountered across the site.

| Soil Profile summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test Pit | Uncontrolled Fill | Transported | Pedogenic Horizon | Residuum | | | Refusal by TLB Y/N | Water Seepage Y/N |
| | | | Ferricrete/Ferruginized Material | Reworked | Residual | Completely Weathered | | |
| TP1 | | 900 | 1100 | 1800 | 2700 | | N | Y @ 900 mm |
| TP2 | | 800 | 1400 | 1800 | 2600 | | N | N |
| TP3 | 2200 | | | | 2600 | | N | Y @ 2200 mm |
| TP4 | | 800 | 1400 | 1800 | 2500 | | N | N |
| TP5 | 400 | 1200 | 1300 | 2000 | 2200 | 2600 | N | N |
| TP6 | | 900 | | 2600 | | | N | N |
| TP7 | | 900 | | 1600 | 2700 | | N | N |
| TP8 | 2600 | | | | | 3600 | N | N |
| TP9 | 400 | | | 1100 | | 2500 | N | N |
| TP10 | 600 | 1000 | | 2500 | | | N | N |
| TP11 | 1000 | | 1300 | 1700 | 2200 | 2500 | N | N |
| TP12 | 1500 | | | 2600 | | | N | Y @ 1100 mm |
| TP13 | 500 | | 600 | 1000 | | 2500 | N | N |
| TP14 | | 600 | | 1100 | 1600 | 2700 | N | N |

**Note: All depths in mm, measured from NGL**

### 5.1.4. DPSH Results

The test pitting phase was supported with the addition of DPSH testing. This utilises a 63.5kg hammer which is repeatedly dropped over a distance of 760mm along a guide rail onto an anvil, driving a string of rods with a cone attached at the end. The cone has a diameter of 50.5mm and an apex angle of 60°. A total of 27 DPSH tests were performed across the site, at locations proposed by the Consultant.

Detailed DPSH results are included in Appendix C. The table below provides the coordinates of each of these tests. Figure 7 on the following page graphically depicts the location of each of the DPSH tests.

| Testing Locations | | |
|---|---|---|
| Test Number | Latitude (South) | Longitude (East) |
| DPSH Test | | |
| **DPSH1** | 33.992794 | 22.423970 |
| **DPSH2.1** | 33.993071 | 22.424650 |
| **DPSH2.2** | 33.993370 | 22.425082 |
| **DPSH3.1** | 33.993088 | 22.423109 |
| **DPSH3.2** | 33.993262 | 22.423232 |
| **DPSH4** | 33.993759 | 22.422846 |
| **DPSH5** | 33.993784 | 22.423826 |
| **DPSH6** | 33.994529 | 22.423189 |
| **DPSH7.1** | 33.994376 | 22.424349 |
| **DPSH7.2** | 33.994530 | 22.424344 |
| **DPSH8.1** | 33.995895 | 22.421909 |
| **DPSH8.2** | 33.996039 | 22.421987 |
| **DPSH9.1** | 33.995914 | 22.422949 |
| **DPSH9.2** | 33.996113 | 22.422723 |
| **DPSH10.1** | 33.995332 | 22.424659 |
| **DPSH10.2** | 33.995446 | 22.424722 |
| **DPSH11.1** | 33.996284 | 22.423847 |
| **DPSH11.2** | 33.996007 | 22.423723 |
| **DPSH11.3** | 33.996145 | 22.424132 |
| **DPSH12.1** | 33.996769 | 22.424383 |
| **DPSH12.2** | 33.996739 | 22.424087 |
| **DPSH12.3** | 33.996584 | 22.424696 |
| **DPSH13.1** | 33.996878 | 22.423046 |
| **DPSH13.2** | 33.996531 | 22.423144 |
| **DPSH14.1** | 33.998048 | 22.422194 |
| **DPSH14.2** | 33.997674 | 22.422504 |
| **Additional DPSH** | 33.994942 | 22.423375 |
| Please note that all GPS co-ordinates are extracted from Garmin eTrex® 30x$^{tm}$. | | |


Figure 7

Geotechnical Testing Positions

Terra GeoTechnical

The test results were used to determine and correlate the in-situ consistencies of the subsoil materials. In order to ascertain a better relationship between the DPSH penetration rates and the in-situ subsoil consistency, the DPSH N counts were converted to Equivalent SPT N values, after the equation by (MacRobert C., Kalumba D. and Beales P., 2011). The table below provides the DPSH n-value strength relationship according to Huntly 1990.

Table 1: DPSH n – Strength Relationship in Clay (Huntley 1990)

| DPSH n (for 100mm) | Classification (as BS5930:1999) | Strength Cu (kN/m2) (as BS5930:1999) | Equivalent SPT N (for 300mm) |
|---|---|---|---|
| <1 | Very soft | <20 | <2 |
| 1-2 | soft | 20-40 | 2-4 |
| 3-4 | Firm | 40-75 | 5-8 |
| 5-8 | Stiff | 75-150 | 9-15 |
| >8 | Very Stiff/Hard | >150 | >16 |

The table correlates the n-values to an empirical soil consistency and an inferred undrained shear strength. This colour coded table is then utilized to summarise all DPSH probing results and its inferred consistencies. The table on the following page provides this summary.

Some tests reveal soils of SOFT to FIRM consistency, which correlate mostly to test pits where uncontrolled fill was encountered.

The DPSH tests revealed that the consistency of the in-situ subsoils underlying the site are generally of at least STIFF consistency, resulting in an undrained shear strength of between 75 and 150 kPa in its natural state.

As discussed in section 5.1.3, residuum is encountered in all test pits below the various imported and transported horizons. Across this site, the granitic bedrock is found to have been altered to various degrees, resulting in variable layers of residuum. These layers typically become less altered with depth. The transition between these layers is not always well defined and is known as gradational contacts.

This variability in the residuum is clearly noted by analysing the DPSH results. The zone where the site soils reach at least VERY STIFF consistency fluctuates throughout the site, proving the varied degree of alteration of the residuum. It can be generally accepted that the DPSH test yielded results of VERY STIFF, within the horizon profiled as either highly weathered or completely weathered. Furthermore, it can be assumed that HARD conditions resemble weathered bedrock. Practical REFUSAL is also deemed to have occurred in the weathered bedrock.

## Summary - Empirical Soil Consistency From DPSH Results

| | DPSH nr | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DeptHard (m) | 1 | 2.1 | 2.2 | 3.1 | 3.2 | 4 | 5 | 6 | 7.1 | 7.2 | 8.1 | 8.2 | 9.1 | 9.2 | 10.1 | 10.2 | 11.1 | 11.2 | 11.3 | 12.1 | 12.2 | 12.3 | 13.1 | 13.2 | 14.1 | 14.2 | Add |
| 0,3 | Firm | Stiff | Firm | Firm | Firm | Stiff | Stiff | Firm | Firm | Firm | Firm | Soft | Stiff | Test abandonded at 1.0 m, due to presence of pipe | Soft | Firm | Firm | Very Stiff | Firm | Stiff | Stiff | Very Stiff | Firm | Firm | Soft | Stiff | Stiff |
| 0,6 | Firm | Very Stiff | Very Stiff | Stiff | Firm | Stiff | Stiff | Stiff | Stiff | Firm | Firm | Soft | Very Stiff | | Firm | Stiff | Hard | Very Stiff | Firm | Stiff | Firm | Stiff | Very Stiff | Stiff | Firm | Stiff | Stiff |
| 0,9 | Stiff | Firm | Stiff | Stiff | Stiff | Stiff | Stiff | Stiff | Very Stiff | Stiff | Very Stiff | Soft | Stiff | | Firm | Stiff | Hard | Very Stiff | Stiff | Stiff | Firm | Stiff | Stiff | Very Stiff | Stiff | Stiff | Stiff |
| 1,2 | Hard | Hard | Hard | Firm | Very Stiff | Stiff | Very Stiff | Stiff | Very Stiff | Stiff | Firm | Soft | Stiff | | Firm | Stiff | Hard | Hard | Firm | Firm | Very Stiff | Stiff | Stiff | Very Stiff | Stiff | Stiff | Stiff |
| 1,5 | Firm | Stiff | Hard | Stiff | Stiff | Stiff | Very Stiff | Very stiff | Stiff | Hard | Firm | Stiff | Very Stiff | | Stiff | Stiff | Stiff | Stiff | Soft | Stiff | Stiff | Stiff | Very Stiff | Stiff | Stiff | Firm | Stiff |
| 1,8 | Firm | Stiff | Hard | Very Stiff | Stiff | Stiff | Stiff | Very stiff | Stiff | Very Stiff | Firm | Stiff | Very Stiff | | Stiff | Firm | Stiff | Stiff | Firm | Stiff | Firm | Very Stiff | Stiff | Stiff | Stiff | Firm | Firm |
| 2,1 | Stiff | Stiff | | Stiff | Very Stiff | Stiff | Stiff | Stiff | Stiff | Very Stiff | Stiff | Firm | Very Stiff | | Stiff | Stiff | Firm | Stiff | Soft | Firm | Stiff | Very Stiff | Stiff | Stiff | Stiff | Stiff | Firm |
| 2,4 | Very Stiff | very Stiff | | Stiff | Very Stiff | Stiff | Very Stiff | Stiff | Stiff | Stiff | Stiff | Firm | Very Stiff | | Stiff | Stiff | Very Stiff | Very Stiff | Soft | Firm | Firm | Firm | Stiff | Stiff | Stiff | Stiff | Stiff |
| 2,7 | Very Stiff | Hard | | Firm | Stiff | Stiff | Very Stiff | Stiff | Stiff | Stiff | Very Stiff | Firm | Very Stiff | | Stiff | Very Stiff | Very Stiff | Very Stiff | Firm | Stiff | Firm | Firm | Stiff | Stiff | Stiff | Stiff | Stiff |
| 3 | Very Stiff | Hard | | Firm | Stiff | Very Stiff | Hard | Stiff | Stiff | Very Stiff | Very Stiff | Stiff | Very Stiff | | Firm | Very Stiff | Hard | Very Stiff | Firm | Stiff | Firm | Stiff | Stiff | Very Stiff | Stiff | Stiff | Stiff |
| 3,3 | Very Stiff | | | Refusal | Stiff | Very Stiff | | Very stiff | | | Very Stiff | Stiff | Very Stiff | | | | | | Firm | | | | | Very Stiff | Stiff | Stiff | Stiff |
| 3,6 | Very Stiff | | | | Stiff | Very Stiff | | | | | Very Stiff | Stiff | Very Stiff | | | | | | Firm | | | | | Hard | Stiff | Stiff | Very Stiff |
| 3,9 | Very Stiff | | | | Very Stiff | Very Stiff | | | | | Hard | Very Stiff | Very Stiff | | | | | | Stiff | | | | | Hard | Stiff | Very Stiff | Very Stiff |
| 4,2 | Very Stiff | | | | Very Stiff | Very Stiff | | | | | Refusal | Very Stiff | Very Stiff | | | | | | Very Stiff | | | | | Refusal | Stiff | Very Stiff | Very Stiff |
| 4,5 | Stiff | | | | Stiff | Hard | | | | | | Hard | Very Stiff | | | | | | Very Stiff | | | | | | Stiff | Very Stiff | Hard |
| 4,8 | Very Stiff | | | | Very Stiff | Hard | | | | | | Refusal | Refusal | | | | | | Very Stiff | | | | | | Stiff | Very Stiff | Hard |
| 5,1 | Very Stiff | | | | Hard | Hard | | | | | | | | | | | | | Very Stiff | | | | | | Stiff | Very Stiff | Hard |
| 5,4 | Very Stiff | | | | Hard | Hard | | | | | | | | | | | | | Very Stiff | | | | | | Very Stiff | Very Stiff | Hard |
| 5,7 | Very Stiff | | | | Hard | Hard | | | | | | | | | | | | | Hard | | | | | | Very Stiff | Very Stiff | Refusal |
| 6 | Hard | | | | Hard | Hard | | | | | | | | | | | | | Refusal | | | | | | Very Stiff | Very Stiff | |
| 6,3 | Refusal | | | | Hard | Refusal | | | | | | | | | | | | | | | | | | | Very Stiff | Very Stiff | |
| 6,6 | | | | | Hard | | | | | | | | | | | | | | | | | | | | Very Stiff | Very Stiff | |
| 6,9 | | | | | Hard | | | | | | | | | | | | | | | | | | | | Very Stiff | Very Stiff | |
| 7,2 | | | | | Hard | | | | | | | | | | | | | | | | | | | | Very Stiff | Very Stiff | |
| 7,5 | | | | | Refusal | | | | | | | | | | | | | | | | | | | | Hard | Very Stiff | |
| 7,8 | | | | | | | | | | | | | | | | | | | | | | | | | Hard | Very Stiff | |
| 8,1 | | | | | | | | | | | | | | | | | | | | | | | | | Refusal | Very Stiff | |
| 8,4 | | | | | | | | | | | | | | | | | | | | | | | | | | Hard | |
| 8,7 | | | | | | | | | | | | | | | | | | | | | | | | | | Refusal | |

| Soft 20-40 kN/m2 | Firm 40-75 kN/m2 | Stiff 75-150 kN/m2 | Very Stiff >150 kN/m2 | Hard | Refusal |
|---|---|---|---|---|---|

# 6. Geotechnical Evaluation

## 6.1. Engineering- and material characteristics

### 6.1.1. Sampling

The following samples were taken:

| | | |
|---|---|---|
| Disturbed samples | : | 1 x Transported |
| | : | 7 x Reworked Residual Granite |
| | : | 2 x Residual Granite |
| | : | 4 x Completely Weathered Granite |
| Bulk samples | : | 1 x Transported |
| | : | 5 x Reworked Residual Granite |
| | : | 4 x Completely Weathered Granite |
| Undisturbed Sample | : | 1 x Consolidation Reworked Residual Granite |
| | : | 1 x Swell Potential Reworked Residual Granite |

Detailed soil test results are included as in Appendix B.

It should be noted that when saturated and loaded, the soils will undergo loss of strength with the soil grains being forced into a denser state of packing and a reduction in void ratio (decrease in volume). Due to the fine-grained nature of the material, the material is also deemed to be sensitive to moisture changes and will undergo heave and shrinkage with changes in moisture. The result of which is varying degrees of consolidation and heave. For this reason, the assessment and quantification of both the degree and nature of consolidation and heave, under planned foundation loads, will form the basis of the mechanical assessment of the sites' subsoils to follow.

### 6.1.2. Soil Test Results: Upper Transported

In the light of the soil test results and visual observations, the **Upper Transported soils** sampled across the site can be summarised as follows:

- The material has a fines fraction (passing the 0.075 mm sieve) of **38%.**
- This **plasticity** of the fines fraction of the material is measured to at **NP**.
- According to the Unified Soil Classification the material classifies as a silty sand **(SM)** with a **Grading Modulus** of **0.68.**
- According the to the ***van der Merwe*** method of determining **Potential expansiveness**, this material classifies as a **low risk** for potential expansiveness.

- This material is deemed to be **Potentially Compressible**

The results of road indicator tests conducted on the bulk samples of this material can be summarized as follows:

This material reacts well to compaction with as CBR value of 17 at a compaction effort of 93% MOD AASHTO. However, this material tested a grading modulus of 0.68, which places this material in the category of a **worse than G9-type** material (COLTO classification system)**.**

### 6.1.3. Soil Test Results: Reworked Residual Granite

In the light of the soil test results and visual observations, the **Reworked Residual Granite** sampled across the site can be summarised as follows:

- The material has a fines fraction (passing the 0.075 mm sieve) of between **65 and 76%**, with the **clay fraction** constituting **32-50%** of the sample.
- This **plasticity** of the fines fraction of the material is deemed to vary **between 6 and 28.**
- According to the Unified Soil Classification the material classifies as a low plasticity clay and/or a high plasticity silt **(CL and MH)** with a **Grading Modulus** of **between 0.36 and 0.75.**
- According the to the ***van der Merwe*** method of determining **Potential expansiveness**, this material generally classifies as a **low risk** for potential expansiveness, however a single instance (TP4) revealed the soils classifies as a **medium to high risk (2-4%)** for potential expansiveness.
- This material is deemed to be **slightly expansive** and **Highly Compressible.**

This material reacts very poorly to compaction with CBR values of between 1 and 4 at a compaction effort of 93% MOD AASHTO. This material classifies as a **worse than G9-type** material (COLTO classification system).

### 6.1.4. Soil Test Results: Residual Granite

In the light of the soil test results and visual observations, the **Residual Granite** sampled across the site can be summarised as follows:

- The material has a fines fraction (passing the 0.075 mm sieve) of between **63 and 85%**.
- This **plasticity** of the fines fraction of the material is measured to between **11** and **16**.
- According to the Unified Soil Classification the material classifies as a low

plasticity clay **(CL).**

- According the to the ***van der Merwe*** method of determining **Potential expansiveness**, this material classifies as a **Low risk** for potential expansiveness.
- This material is deemed to be **Potentially Compressible**

The results of road indicator tests conducted on the bulk samples of this material can be summarized as follows:

This material reacts very poorly to compaction with as CBR value of 4 at a compaction effort of 93% MOD AASHTO. This material classifies as a **worse than G9-type** material (COLTO classification system).

### 6.1.5. Soil Test Results: Weathered Granite

- The material has a fines fraction (passing the 0.075 mm sieve) of between **48 and 66%**, with the **clay fraction** constituting **12-22%** of the sample.
- This **plasticity** of the fines fraction of the material is deemed to vary **between 7 and 10.**
- According to the Unified Soil Classification the material classifies as a low plasticity clay, sand and silt **(CL, SM, ML)** with a **Grading Modulus** of **between 0.66 and 1.03.**
- According the to the ***van der Merwe*** method of determining **Potential expansiveness**, this material classifies as a **low risk** for potential expansiveness.
- This material is deemed to be **potentially slightly Compressible.**

This material reacts very poorly to compaction with CBR values of between 1 of 2 at a compaction effort of 93% MOD AASHTO. This material classifies as a **worse than G9-type** material (COLTO classification system).

Detailed soil test results are included as in Appendix B.

The table on the next page provides a summary of the lab results of the disturbed samples extracted of the on-site material.

| Soil Profile Make-up and Associated Sampling | | Material Characteristics- Laboratory Assessment. Bulk and Disturbed samples tested by Steyn Wilson | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil Composition | | | | | Fines Analysis (measured from material passing the 0.075 mm sieve) | | Unified Soil Classification System | | Activity According to van der Merwe (1964) | | Material Compaction Characteristics | | | | | |
| Test Pit nr & Material Description | Sample Depth (mm below ground level) | Sieve Analysis (cumulative percentage passing) 2,00 mm | 0,425 mm | 0,075 mm | 0,002 mm | Grading Modulus (GM) | Plasticity Index (PI) Minimum / Maximum | Linear Shrinkage (LS) Minimum / Maximum | USCS Symbol | Material Description | Potential Expansiveness (according to van der Merwe) | Swell Percentage | Max Dry Density (kg/m$^3$) | Optimum Moisture Content (%) | COLTO Classification | Measured CBR Values (percentage compaction of MOD AASTHO; CBR of 13.344 kN) 90% | 93% | 95% |
| **Transported** | | | | | | | | | | | | | | | | | | |
| TP7 | 0-900 | 99 | 79 | 38 | 18 | 0,68 | NP | NP | SM | Silty Sand | Low | 0,00% | 2031 | 8,1 | G9 | 10 | 17 | 23 |
| **Reworked Residual Granite** | | | | | | | | | | | | | | | | | | |
| TP1 | 1100-1800 | 99 | 90 | 67 | 44 | 0,42 | 7 | 4 | CL-ML | Low Plasticity Clay & Silt | Low | 0,00% | 1792 | 15.5 | >G9 | 1 | 1 | 2 |
| TP2 | 1400-1800 | 99 | 94 | 72 | 32 | 0,36 | 10 | 5 | CL | Low Plasticity Clay | Low | 0,00% | 1925 | 8,8 | >G9 | 0 | 1 | 1 |
| TP4 | 1400-1800 | 87 | 78 | 69 | 42 | 0,68 | 28 | 14 | MH | High Plasticity Silt | Medium - High | 2-4% | 1690 | 19.1 | >G9 | 1 | 1 | 1 |
| TP5 | 1300-2000 | 93 | 77 | 73 | 50 | - | 19 | 10 | MH | High Plasticity Silt | Low | 0,00% | - | - | Inferred >G9, due to high PI values and low Grading Modulus | | | |
| TP6 | 900-1800 | 86 | 73 | 69 | 50 | 0,75 | 23 | 12 | CL | Low Plasticity Clay | Low | 0,00% | 1598 | 23,1 | >G9 | 3 | 4 | 4 |
| TP10 | 1000-1700 | 100 | 95 | 65 | 40 | - | 13 | 7 | CL | Low Plasticity Clay | Low | 0,00% | - | - | Inferred >G9, due to high PI values and low Grading Modulus | | | |
| TP12 | 1700-2600 | 100 | 99 | 76 | 38 | 0,48 | 6 | 3 | CL-ML | Low Plasticity Clay & Silt | Low | 0,00% | 1939 | 10,3 | >G9 | 1 | 1 | 1 |
| **Residual Granite** | | | | | | | | | | | | | | | | | | |
| TP3 | 2200-2600 | 99 | 99 | 85 | 56 | - | 14 | 7 | CL | Low Plasticity Clay | Low | 0,00% | - | - | Inferred >G9, due to high PI values | | | |
| TP7 | 1600-2700 | 93 | 73 | 63 | 22 | - | 11 | 6 | CL | Low Plasticity Clay | Low | 0,00% | - | - | - | | | |
| **Completely Weathered Granite** | | | | | | | | | | | | | | | | | | |
| TP9 | 1100-2500 | 91 | 72 | 52 | 18 | 0,88 | 10 | 5 | CL | Low Plasticity Clay | Low | 0,00% | 1936 | 8,7 | >G9 | 2 | 2 | 2 |
| TP11 | 2200-2500 | 86 | 66 | 48 | 12 | 1,03 | 9 | 5 | SM | Silty Sand | Low | 0,00% | 1873 | 11,6 | >G9 | 1 | 2 | 2 |
| TP13 | 1000-2500 | 86 | 66 | 54 | 18 | 0,97 | 7 | 4 | ML | Low Plasticity Silt | Low | 0,00% | 1819 | 11.7 | >G9 | 1 | 1 | 1 |
| TP14 | 1600-2700 | 95 | 75 | 66 | 22 | 0,66 | 10 | 5 | CL | Low Plasticity Clay | Low | 0,00% | 1871 | 10,6 | >G9 | 1 | 1 | 1 |

### 6.1.6. Heave Characteristics of In-Situ Soils:

Soil heave is the process of the change in volume correlating to a **change in moisture content**. This phenomenon is prominent in soils containing a high content of active clays.

Two methods viz. **van der Merwe heave equation** (1964) & **free swell**, were utilized to determine the potential for heave of the on-site soils.

The table below summarizes the results of the **free swell tests**.

| Free Swell Test Results | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sample Number** | **Sample Depth m** | **Horizon Thickness m** | **Insitu Moisture Content** | **Free Swell %** | **Swell Presssure kPa** | **Foundation Load kPa** | **% Swell** | **Swell mm** | **Result** |
| **TP10 Reworked Residual** | **1,0-1,7** | **0,7** | **24,3** | 1,2 | 36 | 25 | 0,122 | 1,28 | <5 mm at foundation load of 25 kPa |
| | | | | | | 50 | Negligible | | |

The results of the free swell tests reveal the following;

- Residual granite exhibits a negligible heave under imposed loads of 50 kPa, whilst yielding a swell of up to 5 mm under loads of 25 kPa.

The following comments are relevant to put these results into perspective;

- The initial moisture contents of the samples where notably high (24.3%).
- The sample of reworked residual granite could yield higher free swell and swell pressure results should initial water contents be lower.

The table below summarizes the results of the van der **Merwe heave equation (1964**).

| Van Der Merwe Method (1964) | | | | | | |
|---|---|---|---|---|---|---|
| **Sample Number** | **Sample Depth m** | **Horizon Thickness m** | **Potential Soil Expansiveness** | **Unit heave** | **Depth Factor** | **Potential Heave (m)** |
| **TP4 Reworked Residual** | **1,3-2,0** | **0,7** | Medium - High (3%) | 0,030 | 0,60 | 0,018 |

The following are of importance in the analysis of the van der Merwe heave equation;

- It must be noted that the generalized heave equation is calculated assuming the material transitions from a **completely desiccated state to a completely saturated state**.
- This does not take into account the existing moisture conditions.
- In the majority of the test pits, this active soil horizons was encountered, resulting in a potential heave of approximately 18 mm.

### 6.1.7. Standard Consolidation Characteristics of the In-Situ Soils

There are three components to settlement namely immediate settlement (also referred to as elastic settlement), primary consolidation settlement and secondary consolidation (also referred to as creep).

Immediate settlement takes place as a load is exerted on the soil mainly due to distortion of the soil. As pore water begins to flow out of the soil a time dependant decrease in volume occurs which is termed consolidation settlement. This settlement will continue until a condition of constant effective stress is reached. This primary consolidation settlement takes place generally in fine grained materials (high percentage of clay or silt).

Secondary consolidation settlement is not considered a concern as this type of settlement usually occurs in soft organic clays where plastic flow within the soil mass results in displacement of the soil particles.

Consolidation within these residual granitic soils has been well documented to take place as collapse settlement. Due to the high moisture content however, the probability of collapse is reduced.

The table below summarizes the results of the oedometer tests conducted on the undisturbed samples extracted from the site soils.

| Undisturbed Samples- Summary of the Reworked Residual Granite | | | | | | | |
|---|---|---|---|---|---|---|---|
| Material Origin | Test Pit | Average Depth (m) | Preconsolidation State | | Calculated Maximum Settlement Factor of Saftey = 1.5 (between mm) | | |
| | | | Pressure (kPa) | Normally or Overconsolidated | 50 kPa | 100 kPa | 150 kPa |
| **Reworked Residual Granite** | **TP10** | 1,0-1,7 | 74 | Overconsolidated | 8-11 | 11-16 | 17-23 |

The soils across the site are deemed to be overconsolidated in nature, with collapse settlement of between 17 and 23 mm expected within the residuum at loads of 150 kPa. This assumes foundation widths of 0.8m and incorporates a factor of safety of 1.5.

## 6.2. Material usage

The material encountered across the site displayed a cohesive nature and tested poorly with regards to its re-use during construction. It is recommended that this material not be utilized for layer works during construction and that it rather be stockpiled and removed off-site or be utilized in landscaping purposes. In the light of the soil tests which were completed on the material sampled across the site, these soils can be classified as a **worse than G9** according to the COLTO classification. These poor results are attributed to the high PI values, low grading modulus and poor compaction characteristics.

The soils could be utilized as general fill for bulk earthworks should the necessary standards be adhered to during placement and compaction of cohesive soils. Specific attention should be placed on moisture control, proper equipment selection and layer thickness.

Cohesive soils exhibit a high sensitivity to moisture content. Therefore, it's crucial to ensure that these soils maintain a water content close to the optimum level (preferably) during the paving process. This is most effective during dry weather conditions and when the soil remains firm to prevent subsequent softening.

To achieve proper compaction of cohesive soils, the use of vibration or oscillation at relatively high amplitudes, up to 1.8 mm, is recommended. Heavy padfoot rollers are particularly suitable for this task as they knead the soil, increasing its surface area. This facilitates easier evaporation of water content within the soil. Consequently, the soil gains greater rigidity, enhancing its load-bearing capacity.

Before compaction, cohesive soils can be significantly improved or stabilized through techniques like soil stabilization (e.g., using lime to decrease water content) or soil improvement (e.g., using cement to enhance load-bearing capacity). These measures contribute to better overall performance and durability of the paved surfaces.

It is recommended that material be imported for any engineered layer works in foundations and/or roads.

## 6.3. Bearing Capacity

Observations during the field work phase indicates that the soils encountered across the site exhibits at least a stiff consistency, typically increasing to very stiff/hard with depth.

No structures should be placed on the uncontrolled fill encountered sporadically across the site.

The upper transported soils encountered do depths of approximately 1.0 m across the site is not deemed a suitable founding horizon in its natural state, due to its proclivity for moisture change and its subsequent expected movements.

According to Look (2014), the cohesive **reworked residual soils** (encountered from below the transported soils) exhibiting a stiff consistency, exhibits a bearing capacity of between **100 and 200 kPa**, whilst Huntly (1990) proposes a slightly more conservative bearing capacity of **75 to 150 kPa.**

The **residual & weathered soils** (encountered from below the reworked horizon) exhibiting a very stiff/hard consistency, exhibits a bearing capacity of at least **150 kPa** in its natural state.

The effect that an increase in moisture content has on the strength of the material can clearly be seen with the laboratory tested CBR results. The DCP tests, conducted at in-situ moisture content, indicates that the material exhibits a much higher CBR value than the laboratory tested CBR results. The main reason for this drastic reduction in the lab tested results are that the **lab specimen** is tested under **saturated** conditions. This provides clear insight into the reduction in strength of the on-site soils upon inundation with water.

For this reason, foundation trenches should be well compacted with adequate site drainage installed, to prevent large scale moisture changes below the foundations which will lead to softening of the loadbearing strata.

Foundations should also not be placed in the upper 1.0 m of soil, as this area is typically the most prone to large scale moisture changes.

No information regarding planned foundation levels and imposed loads were provided at the time of compiling this report, as such, no specific information can be provided on the expected bearing capacities at each proposed structure.

Final bearing capacity values will be directly related to the size, shape and depth of the final foundation.

# 7. Proposed Developmental Phase

## 7.1. Phase A

The phase incorporates 6 additional Secondary Settling Tanks (SSTs) to operate together with the existing Biological Reactor A.

6 DPSH tests were conducted within this proposed developmental area (or at least in close proximity) along with 3 Test Pits. The following test numbers where conducted within this area.

| Test Pit | DPSH |
|---|---|
| TP 8 | DPSH 8.1 |
| TP 9 | DPSH 8.2 |
| TP 13 | DPSH 9.1 |
| | DPSH 9.2 |
| | DPSH 13.1 |
| | DPSH 13.2 |

Deep fill (2.6 m) was encountered in the vicinity of TP8, whilst completely weathered granitic bedrock was encountered at shallow depth across the area proposed for the secondary settling tanks.

## 7.2. Phase B

The phase incorporates the construction of a biological reactor.

8 DPSH tests were conducted within this proposed developmental area (or at least in close proximity) along with 3 Test Pits. The following test numbers where conducted within this area.

| Test Pit | DPSH |
|---|---|
| TP 10 | DPSH 10.1 |
| TP 11 | DPSH 10.2 |
| TP 12 | DPSH 11.1 |
| | DPSH 11.2 |
| | DPSH 11.3 |
| | DPSH 12.1 |
| | DPSH 12.2 |
| | DPSH 12.3 |

DPSH 11.3 was conducted on the embankment of the exiting pond. This first 3.6 m of the test proved soft to firm results, deemed to be the material within the embankment. Very stiff consistency was encountered at a depth of 3.6 m. This is deemed to be the depth of weathered granite. The test was advanced to 6.3 m below existing ground level. DPSH 11.1 and 11.2 encountered weathered granitic bedrock was encountered at depths of approximately 2.4 m.

## 7.3. Phase C

Phase C of the upgrade will be to construct Module C's reactor and 4 additional SSTs.

8 DPSH tests were conducted within this proposed developmental area (or at least in close proximity) along with 3 Test Pits. The following test numbers where conducted within this area.

| Test Pit | DPSH |
|---|---|
| TP 11 | DPSH 11.1 |
| TP 12 | DPSH 11.2 |
| TP 13 | DPSH 11.3 |
| | DPSH 12.1 |
| | DPSH 12.2 |
| | DPSH 12.3 |
| | DPSH 13.1 |
| | DPSH 13.2 |

DPSH 11.3 was conducted on the embankment of the exiting pond. This first 3.6 m of the test proved soft to firm results, deemed to be the material within the embankment. Very stiff consistency was encountered at a depth of 3.6 m. This is deemed to be the depth of weathered granite. The test was advanced to 6.3 m below existing ground level. DPSH 11.1 and 11.2 encountered weathered granitic bedrock was encountered at depths of approximately 2.4 m.

Completely weathered granitic bedrock was encountered at shallow depth across the area proposed for the secondary settling tanks

## 7.4. Phase D

The phase will see the construction of the four PSTs, primary sludge pumpstation and three additional anaerobic digestors. The existing PSTs will be refurbished and used as gravity thickeners for the primary sludge.

6 DPSH tests were conducted within this proposed developmental area (or at least in close proximity) along with 4 Test Pits. The following test numbers where conducted within this area.

| Test Pit | DPSH |
|---|---|
| TP 1 | DPSH 1 |
| TP 2 | DPSH 2.1 |
| TP 3 | DPSH 2.2 |
| TP 5 | DPSH 3.1 |
| | DPSH 3.2 |
| | DPSH 5 |

Deep fill (2.2 m) was encountered in the vicinity of TP3, whilst completely weathered granitic bedrock was encountered at depths of at least 2.6 m across the area.

# 8. Geotechnical Site Classification

## 8.1. General

The results of this study reveal that the site exhibits geotechnical characteristics that may require the implementation of specific design and precautionary measures to reduce the risk of structural damage due to adverse geotechnical conditions.

The following constraints needs to be considered;

- The results of this investigation reveal that the soils covering the site may undergo a degree of **heave and/or consolidation** (i.e. loss and gain of volume) under loading or when saturated; requiring that structures be adequately strengthened to prevent structural damage due to **differential settlement** beneath foundations
- In its natural state, the site classifies as C1/C2/H and Localized $P^{\text{uncontrolled fill}}$, according to the NHBRC Site Classification.
- Differential movements will be exaggerated due to heave and shrinkage when moisture conditions under structures change
- Cohesive soils across the site are sensitive to moisture changes. These changes will in turn affect the consolidation and shear strength properties of the soil, resulting in higher settlement and lowering of bearing capacity.
- Presence of ferruginized material at shallow depth, indicating the presence of a seasonal **fluctuating groundwater table** or excessive soil moisture movement.
- Due to its variable and organic nature, it is recommended that the upper **transported material** across the site be **removed to a depth of at least 300 mm**, beyond the perimeter of the proposed developments. Variation in this depth can occur and should be assessed during the planned earthworks.
- Ponding of surface water are encountered across the site. These conditions will hamper moving of heavy machinery.

However, these characteristics do not disqualify the site from being used for the proposed development, but rather require the implementation of site-specific precautionary measures.

## 8.2. Groundwater Occurrence

Groundwater seepage was observed in a few test pits across the site. This seepage is categorized as a perched groundwater table, and it was generally identified as slow to moderate flow. It is mainly present within the pedogenic horizon and the upper alluvial soils. Perched groundwater occurs when an impermeable layer restricts water from infiltrating deeper into the aquifer, causing it to move laterally through the strata.

The natural soils also tested to be moist in its natural state. In general, the on-site soils have a low permeability.

Due to the variability in bedrock depth, this perched water table could also be encountered at various depths.

## 8.3. Soil Excavatability

The TLB-type light mechanical excavator, was generally able to excavate trial pits to depths of at least 2.5 m with little or no difficulty**.** For this reason, **no problems** are foreseen during the excavation of **shallow foundations** or **deep service trenches** to a depth of at least 2.50 m below the existing ground level, through the use of an excavator with similar power.

- The excavation type to a depth of at least 2.50 m below the existing ground level is deemed to be **Soft Excavation**. (SANS 1200D).

Refusal of DPSH penetration testing can be associated with the presence of medium hard rock to hard rock By examining the DPSH tests and correlating their refusal depths to difficulty in excavation, it can be noted that variable excavation depth could be noted. The DPSH tests experienced refusal at depths of between 3.3 and 8.7 m below ground level.

## 8.4. Slope Stability and Stability of Temporary Cuttings

During the time of the investigation, no evidence was noted of any specific site stability problems.

The planned development envisages major earthworks across the site. These earthworks will be in the form of deep cuts.

The major cut slope design parameters are slope geometry, soil shear strength and predicted or measured groundwater levels. For cohesionless soil, stability of a cut slope is independent of height and therefore slope angle becomes the key parameter of concern. For cohesive ($\varphi = 0$) soils, the height of the cut becomes the critical design parameter. For c’-φ’ and saturated soils, slope stability is dependent on both slope angle and height of cut.

Due to the cohesive nature of the on-site soils, shearbox tests were not completed on any samples. Instead, the USCS classification will be utilized to gain insight into typical geotechnical parameters associated with these cohesive soils.

The residual soils classified as low plasticity clays (CL), which typically have cohesion values of 13 kPa and internal angles of friction of 28°.

The high plasticity silty (ML) residual granites typically host cohesion values of 5 kPa and internal angles of friction of 24°.

According to Brink et al, the residual granitic soils typically host cohesion values of 22.6 kPa and friction angles of 33°.

Typically, short term cuts in these overconsolidated cohesive soils will be stable at steep angles, up to vertically unsupported. However, in long term, these values decrease considerably due to a decrease in cohesion and an increase in friction (safe cut slops as low as 25°). This is due to the change in water content and its effect on the pore water pressure and resultant effective stress. Short-term stability in cohesive soils is defined by their undrained shear strength. Experience shows that in the long run only those slopes are stable where the inclination is smaller than the soil's angle of internal friction.

According to Abramson et al (2001), long term cut slopes stability is also dependent on seepage forces and therefore ultimate groundwater level in the slope. The main obstacle to predict the stability is the correct modelling of the recharge in the vicinity of the cut slope.

Also critical to the proper design of cut slopes is the incorporation of adequate surface and subsurface drainage facilities to reduce the potential for future stability or erosional problems.

The reworked residual granite and residual granite will be stable in temporary excavations, i.e. if they remain dry. However, experience has shown that, when subjected to standing water, these clay-silt mixtures soften up, which often leads to slumping that could result in complete failure of the excavations, if appropriate measures are not taken.

It is important, therefore, that dewatering measures be implemented wherever open unsupported excavations will be subjected to flooding. It is imperative that appropriate safety measures be taken to provide safe working conditions in excavations deeper than 1,5m

In general safe battering to 45° is proposed as a safe cut-back for deep excavations.

It is recommended that any deep cuts be assessed and monitored by a competent person periodically.

## 8.5. Site Classification

In the light of the results of this study, the site can be subdivided into a SINGLE geotechnical entity/development potential zone. The site carries a dual class, due to both heave and consolidation/collapse expected under loads.

The site Classifies as C1/C2/H and localized $P^{\text{uncontrolled fill}}$ according to the NHBRC Site Classification System.

Please note that the classification is based on the existing ground conditions at the time of the investigation.

## 8.6. Erodability of material

The following are findings on the relationships between different properties and erodibility parameters of soil:

- An increase in percentage clay leads to an increase in erosion resistance of soil
- An increase in PI in general leads to an increase in erosion resistance (there are few exceptions)
- Increase in Plastic Limit leads to an increase in erosion resistance in fine grained soils.
- Steep slopes increase flow velocities and as such decrease erosion resistance.
- Dispersive soils (typical to those of granitic soils) tend to be less erosion resistant.

Based on the above considerations combined with the knowledge of the granitic soils in this region, it can be noted that the soils encountered across the site are prone to erosion.

The following can be done to minimize erosion of problematic soils during the construction phase.

### 8.6.1. Dispersive soils

Typical of granitic soils encountered across the site

- Minimize longitudinal gradient of excavations
- Consider treating dispersive subsoils with gypsum prior to backfilling to minimise risk of tunnel erosion
- Backfill should be placed to equivalent compaction of surrounding soil. Over-Compaction can cause up-slope groundwater flows to be diverted along the up-slope side of the backfilled trench, possibly leading to tunnel erosion. Under-compaction can lead to tunnel erosion adjacent to the pipe or along the down-slope side of backfilled trench.

### 8.6.2. Expansive soils

Reworked Residual material encountered across the site.

- Minimize mixing of expansive material with other material.
- Wherever practical, ensure the most problematic material is the first to be backfilled.
- Compact the spoil to an equivalent compaction to the surrounding soil to reduce risk of tunnel erosion.

Inadequate temporary erosion and drainage control measures can result in severe damage to backfilled trenches. Recently backfilled trenches are especially vulnerable to both surface and sub-surface (tunnel) erosion because of the low shear strength of the recently disturbed soil, even if some degree of compaction has been applied to the backfill.  The risk of these problems occurring increases if the soils are dispersive.

# 9. Foundation Recommendations and Solutions

The foundation solutions will vary dependant on the final founding horizon and anticipated effective loads of each structure.

Under no circumstances should foundations be placed in/on untreated uncontrolled fill, natural transported or reworked residual subsoils unless it has been specifically engineered to support structural foundations. Should foundations be planned within these horizons, it is recommended that foundations be stiffened with articulation joints. Maximum bearing pressure should not exceed 50 kPa. RC rafts with the same detail as above can also be utilized.

For single- and double-storey structures (or structures with similar loads), the recommended foundation type is reinforced concrete strip/pad foundations. The foundation medium should be compacted to a minimum of 95% Mod AASHTO density, or achieve a penetration of less than 20mm per blow of a Dynamic Cone Penetrometer (DCP). It is advised to have a recommended founding depth of 1 meter below the natural ground level (NGL) (or at least below the transported soils). This will ensure stable and reliable foundation system for the specified building type.

To limit settlement, bearing pressures should not exceed a maximum of 150 kPa. For structures with greater weight, deeper foundations (to weathered granite) are advised or the founding medium can be improved by introducing a layer of imported structural fill (to the engineers' design). Additionally, the use of light reinforced concrete rafts may be considered. It is paramount to inspect all foundation trenches before casting concrete.

It must be noted that differential settlement is assumed to equal 75 % of the total settlement. The relaxation of some of these requirements, e.g. the reduction or omission of steel or articulation joints, may result in a Category 2 level of expected damage.

Where the expansive clay soils will remain as portions of the subgrade, care must be taken to ensure they remain in a moist and fully swelled condition. This is critical to all areas of the site. Covering over dried out expansive clay soils will likely result in swell/heave issues when these re-swell during the wet winter months

The final foundation designs are however the responsibility of the design engineer. It is recommended that the design engineer discuss their designs with the geotechnical specialist to ensure alignment to presented information.

It is understood that the development will follow a phased construction approach. It is recommended that during this time, TerraGeo be involved in the construction process to confirm the conditions encountered during this investigation.

# 10. Limitations

The extent of the investigations undertaken is deemed adequate, within the time and budget constraints, to present an overview of the geotechnical conditions across the investigation site.

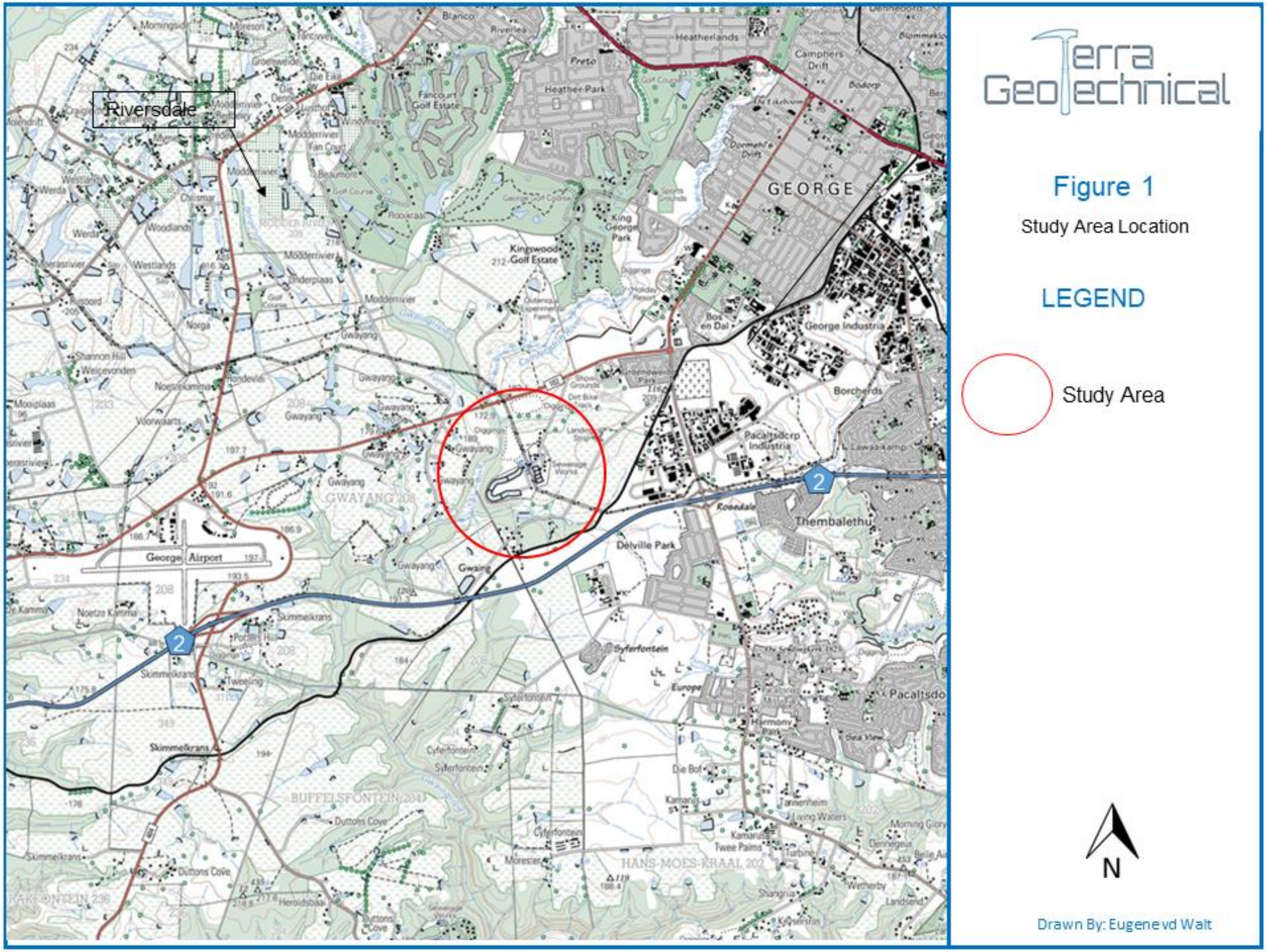
It must be borne in mind that the overall interpretation of geotechnical conditions is based upon point information derived from the respective test positions and that conditions intermediate to these have been inferred by interpolation, extrapolation and professional judgement.

The foundation solutions will vary dependant on the final founding horizon and anticipated effective loads of each structure. These were not known during the reporting phase, as such, this should be discussed with the geotechnical specialist when the data becomes available.

It is recommended the author be appointed to inspect the earthworks and foundation excavations during the development of the site to confirm founding depths and validate the recommendations provided in this report.

Final designs are the responsibility of the design engineer.

# MAPS


Riversdale
GEORGE
George Airport
Delville Park
Thembalethu
Pacaltsdorp Industria
George Industria
Kingswood Golf Estate
Fancourt Golf Estate
Heather Park
Heatherlands
Borcherds
Rosedale
Syferfontein
Gwaing
Gwayang
Modderrivier
Skimmelkrans
BUFFELSFONTEIN 204
HANS-MOES-KRAAL 202
GWAYANG 208
Harmony
Pacaltsdo
Europe
Dutton's Cove
Studv Area: Study Area
Terra GeoTechnical
Figure 1
Study Area Location
LEGEND
Study Area
N
Drawn By: Eugene vd Walt


Terra Geotechnical

**Figure 2**

Site Location & Description

**LEGEND**

Existing Gwaing WWTW

N

Drawn By: Eugene vd Walt


Figure 3

Site Topographical Features

Aerial View

Terra GeoTechnical

Existing fence boundary

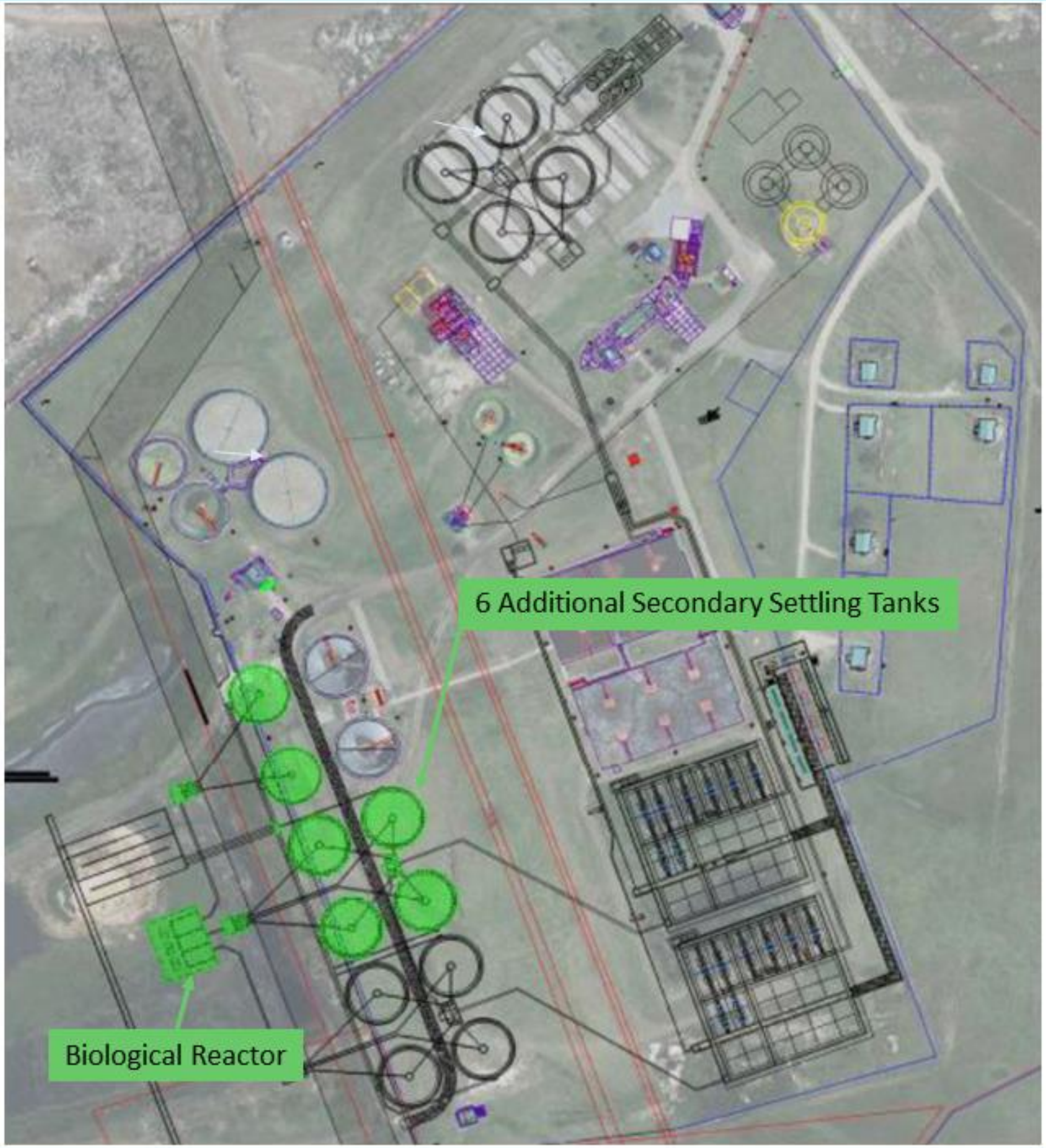
5m contour lines

Non - perennial river

Perennial river

N

Drawn By: Eugene vd Walt

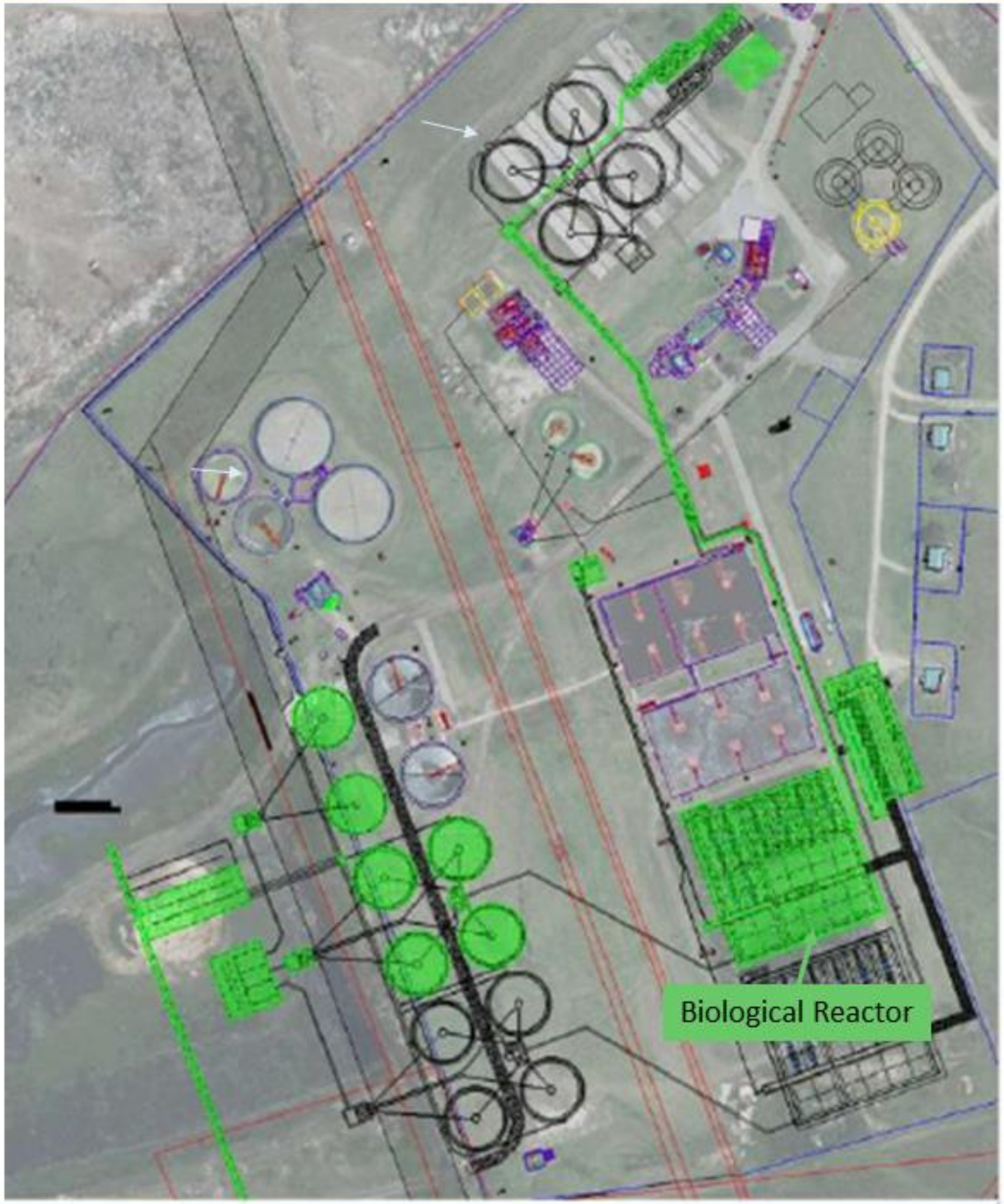



Terra GeoTechnical

## Figure 4a

Proposed Development

Phase A – Site Plan



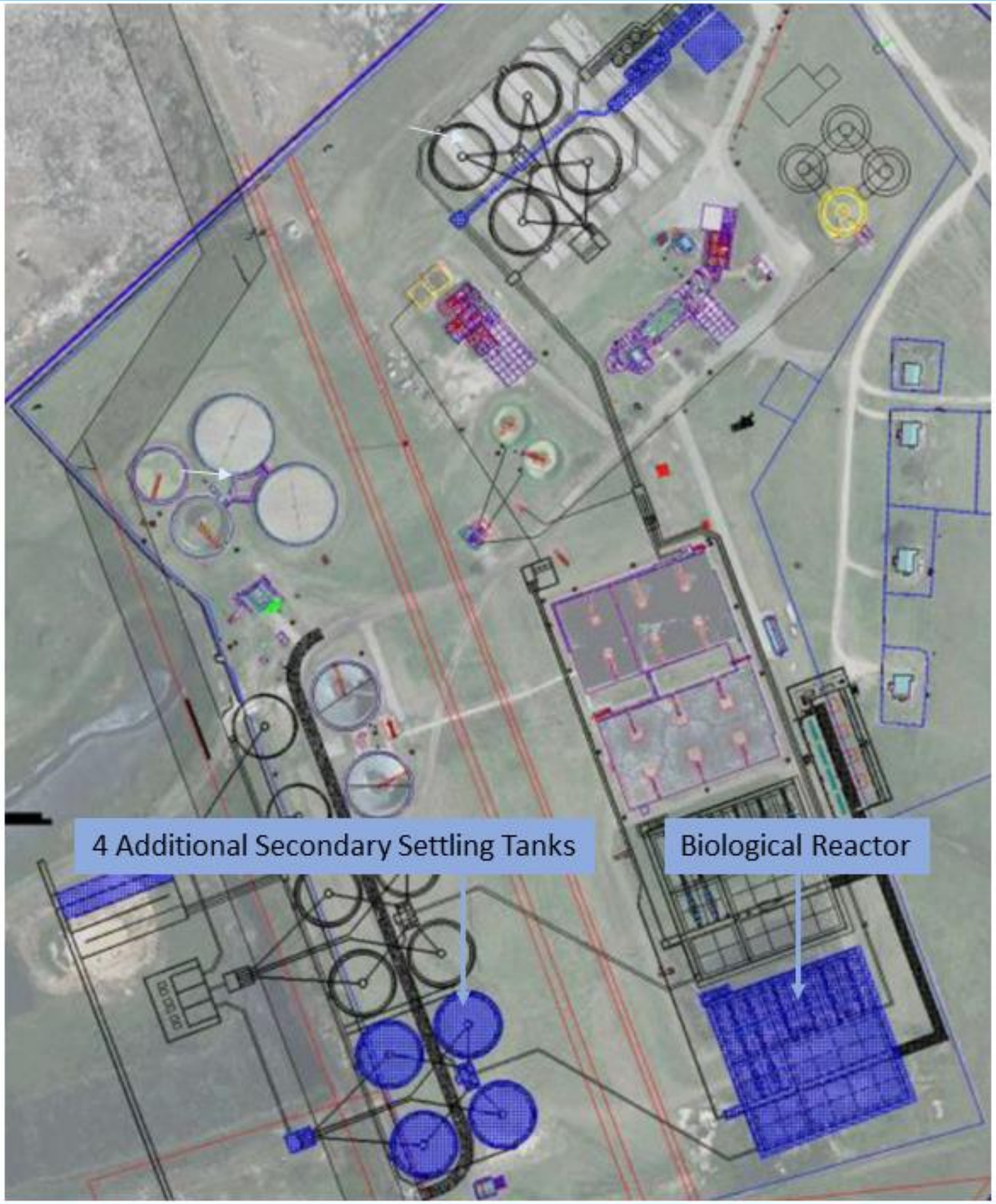

Terra Geotechnical

Figure 4b

Proposed Development

Phase B – Site Plan

N



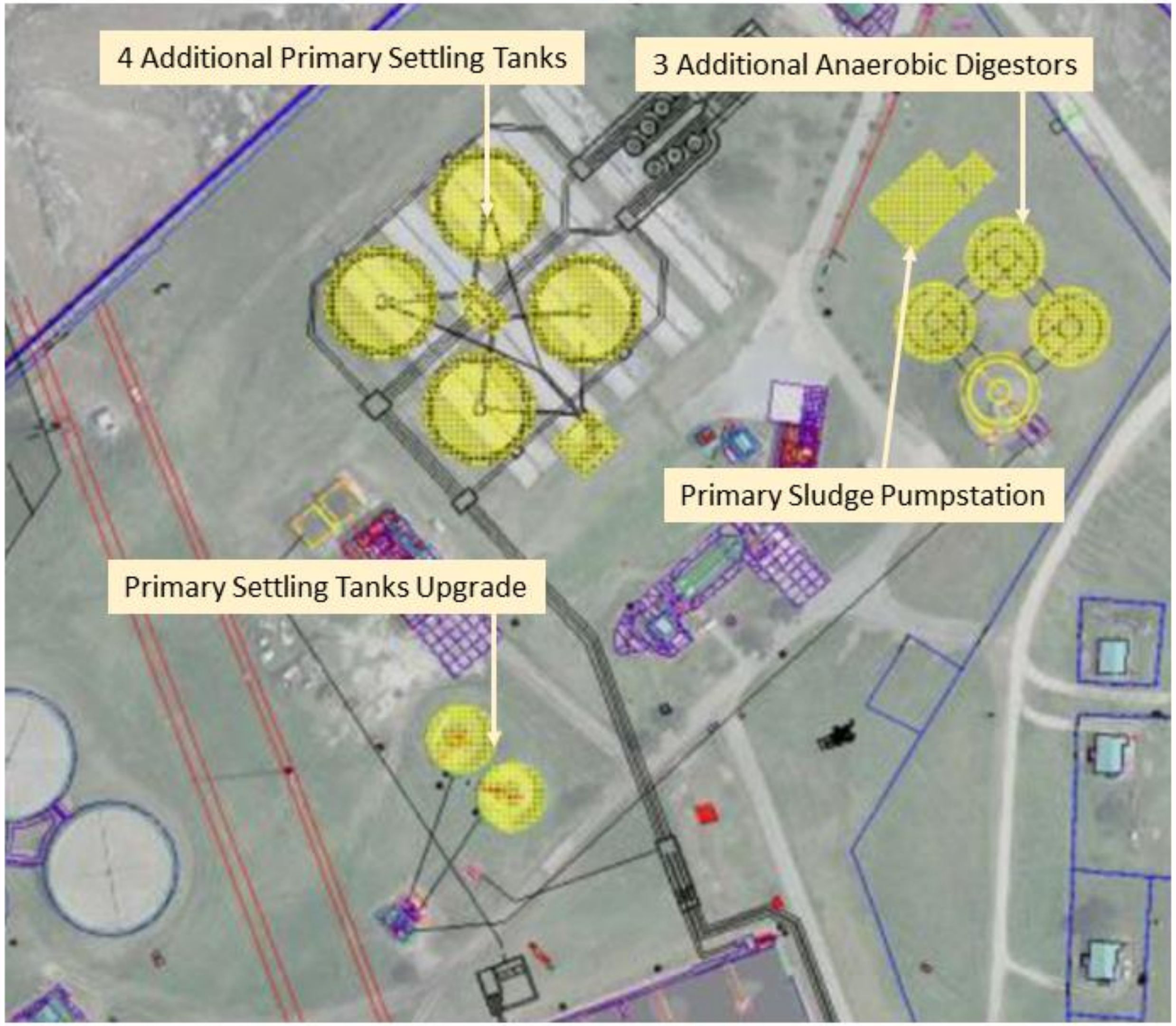

Terra GeoTechnical

**Figure 4c**

Proposed Development

Phase C – Site Plan

N

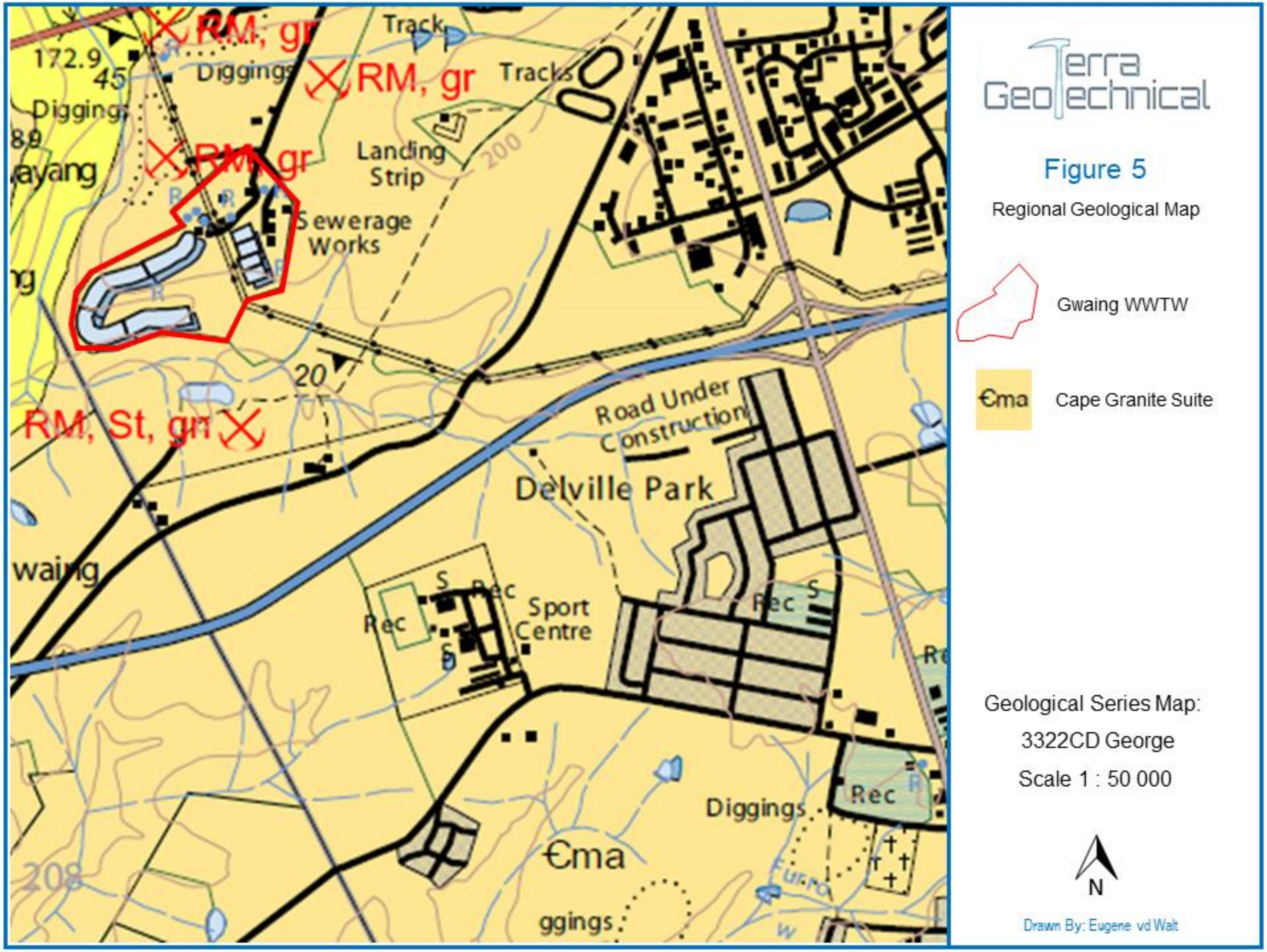



Terra GeoTechnical

**Figure 4d**

Proposed Development

Phase D – Site Plan



Terra GeoTechnical
Figure 5
Regional Geological Map
Gwaing WWTW
Ꞓma
Cape Granite Suite
Geological Series Map:
3322CD George
Scale 1 : 50 000
N
Drawn By: Eugene vd Walt
RM, gr
RM, St, gr
Sewerage Works
Landing Strip
Track
Tracks
Diggings
Road Under Construction
Delville Park
Sport Centre
Rec
Ꞓma


Figure 6

Geotechnical Testing Positions

Test Pit

Terra Geotechnical

N

Drawn By: Eugene vd Walt


Figure 7

Geotechnical Testing Positions

DPSH test

Terra GeoTechnical

N

Drawn By: Eugene vd Walt

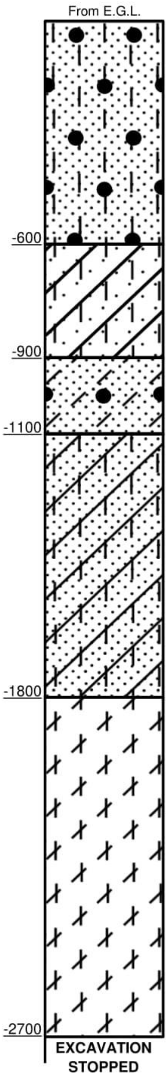
# APPENDIX A

## A.1

## Test Pit Profiles

| | | |
|---|---|---|
| Terra Geotechnical | **Site:** | Gwaing WWTW |
| | **Location:** | George |
| | **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

**Soil Profile for Test Pit TP1**




slightly moist; brown; medium dense; intact; silty sand with scattered cobbles; transported; Not Sampled.

wet; light brown; medium dense; intact; silty sand; transported; Not Sampled.

slightly moist; dark brown; dense; intact; clayey silty sand with frequent ferricrete nodules and concretions; nodular ferricrete; Not Sampled.

slightly moist; dark red patched brown mottled greyish yellow; firm; relict joint; clayey/sandy silt; reworked residual graniite; decomposed rootlets in relict joints; Bulk Sample No. TP1; Disturbed Sample No. TP1.

slightly moist; orange patched red mottled grey; very stiff; intact; clayey/silty sand; residual granite; Not Sampled.

**Test Pit Notes**

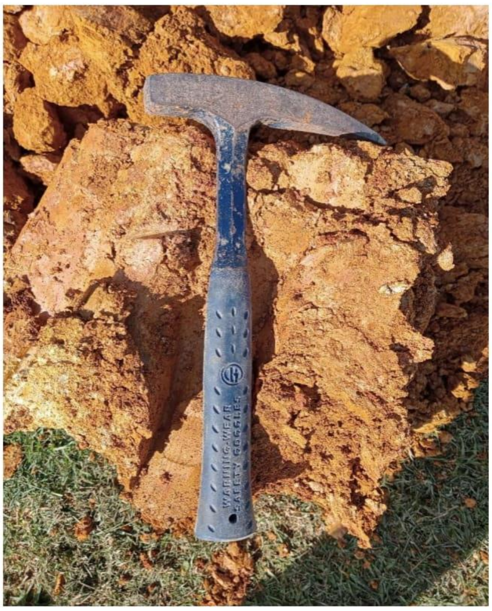
| | |
|---|---|
| **Coordinates:** | 33,992794°S 22,423955°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | slow water seepage from 900 mm below the surface |
| **Samples Extracted:** | 1 Bulk Sample, 1 Disturbed Sample |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

**Terra Geotechnical** Gwaing WWTW

**Soil Profile Photo of Test Pit TP1**

| **Terra Geotechnical** | Gwaing WWTW |
|---|---|

**Material Present in Test Pit TP1**

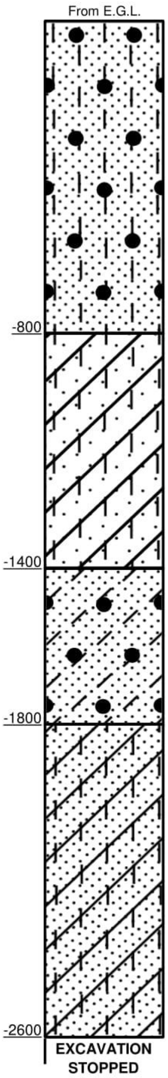


**Terra Geotechnical** Gwaing WWTW

**Surroundings of Test Pit TP1**

| | | |
|---|---|---|
| Terra Geotechnical | **Site:** | Gwaing WWTW |
| | **Location:** | George |
| | **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

**Soil Profile for Test Pit TP2**




| Depth (from E.G.L.) | Description |
|---|---|
| 0 to -800 | slightly moist; brown; loose; intact; silty sand with scattered cobbles; transported; Not Sampled. |
| -800 to -1400 | slightly moist; light orange brown mottled red speckled black; dense; intact; silty sand with frequent ferricrete nodules and concretions; nodular ferricrete; Not Sampled. |
| -1400 to -1800 | slightly moist; dark red patched brown mottled greyish yellow; very soft; relict joint; clayey/sandy silt; reworked residual granite; decomposed rootlets in relict joints; Bulk Sample No. TP2; Disturbed Sample No. TP2. |
| -1800 to -2600 | slightly moist; orange patched red mottled grey; very soft; intact; clayey/silty sand; residual granite; Not Sampled. |

**Test Pit Notes**

| | |
|---|---|
| **Coordinates:** | 33,993049°S 22,42462°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/12 |
| **Date Profiled:** | 2024/04/12 |
| **Groundwater Seepage:** | N/A |
| **Samples Extracted:** | 1 Bulk Sample, 1 Disturbed Sample |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

| **Terra Geotechnical** | Gwaing WWTW |
|---|---|

**Soil Profile Photo of Test Pit TP2**

**Terra Geotechnical** Gwaing WWTW

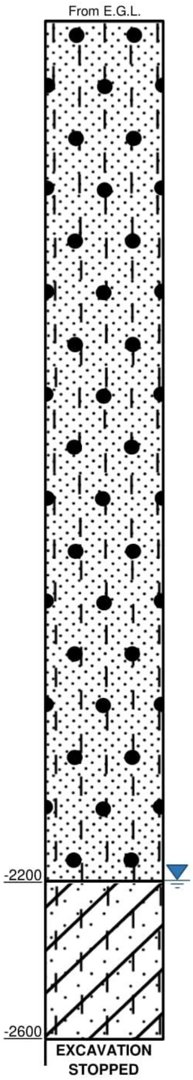
**Material Present in Test Pit TP2**

**Terra Geotechnical** Gwaing WWTW

**Surroundings of Test Pit TP2**

| | | |
|---|---|---|
| Terra Geotechnical | **Site:** | Gwaing WWTW |
| | **Location:** | George |
| | **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

**Soil Profile for Test Pit TP3**




slightly moist; dark brown mottled orange; medium dense; intact; silty sand; Fill; abundant disposable plastics and refusal materials; Not Sampled.

slightly moist; orange patched red mottled grey; firm; intact; clayey/silty sand; Residual granite; Disturbed Sample No. TP3.

**Test Pit Notes**

| | |
|---|---|
| **Coordinates:** | 33,99311°S 22,423087°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | slow water seepage from 2200 mm below the surface |
| **Samples Extracted:** | 1 Disturbed Sample |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

**Terra Geotechnical** Gwaing WWTW

**Soil Profile Photo of Test Pit TP3**

| **Terra Geotechnical** | Gwaing WWTW |
|---|---|

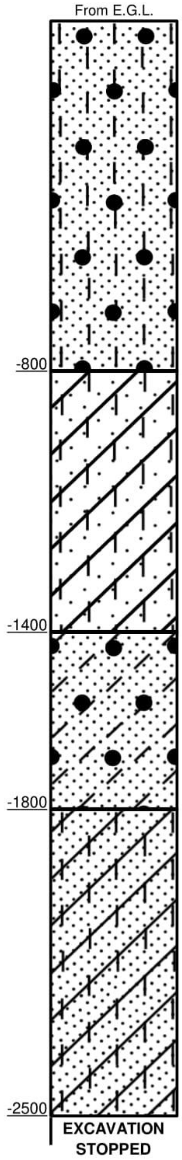
**Material Present in Test Pit TP3**

**Terra Geotechnical** Gwaing WWTW

**Surroundings of Test Pit TP3**


| | |
|---|---|
| **Site:** | Gwaing WWTW |
| **Location:** | George |
| **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

**Soil Profile for Test Pit TP4**




slightly moist; brown; medium dense; intact; silty sand with scattered cobbles; Transported; Not Sampled.

slightly moist; light orange brown mottled red speckled black; medium dense; intact; clayey silty sand with scattered quartz gravel; Nodular ferricrete; Not Sampled.

moist; orange brown patched grey; stiff; slickinsided; sandy/clay silt; Reworked residual granite; Bulk Sample No. TP4; Disturbed Sample No. TP4.

slightly moist; orange streaked red; very stiff; stratified; sandy/clay silt; Micaceous granite residual; soapy texture; Not Sampled.

**Test Pit Notes**

| | |
|---|---|
| **Coordinates:** | 33,993754°S 22,422824°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | N/A |
| **Samples Extracted:** | 1 Bulk Sample, 1 Disturbed Sample |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

**Terra Geotechnical** Gwaing WWTW

**Soil Profile Photo of Test Pit TP4**

**Terra Geotechnical** Gwaing WWTW

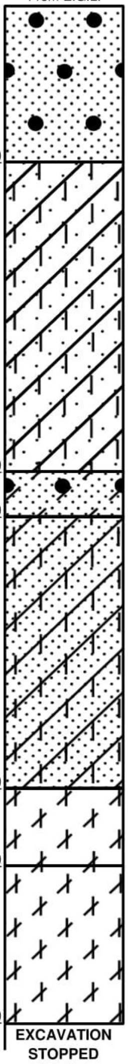
**Material Present in Test Pit TP4**

**Terra Geotechnical** Gwaing WWTW

**Surroundings of Test Pit TP4**

| Terra Geotechnical | Site: | Gwaing WWTW |
|---|---|---|
| | Location: | George |
| | Client: | Lukhozi Consulting Engineers (PTY) LTD |

## Soil Profile for Test Pit TP5




slightly moist; light grey mottled orange; loose; intact; clayey/silty sand with frequent gravel; Imported; Not Sampled.

slightly moist; brown; medium dense; intact; silty sand with scattered cobbles; Transported; Not Sampled.

slightly moist; light orange brown mottled red speckled black; medium dense; intact; clayey silty sand with frequent ferricrete nodules and concretions; Nodular ferricrete; Not Sampled.

slightly moist; dark red patched brown mottled greyish yellow; stiff; relict joint; clayey/sandy silt; Reworked residual graniite; decomposed rootlets in relict joints; Disturbed Sample No. TP5.

slightly moist; orange patched red mottled grey; stiff; intact; clayey/silty sand; Residual granite; Not Sampled.

slightly moist; yellow mottled orange speckled grey; very stiff; intact; silty/clayey sand with frequent gravels; Completely weathered micaceous granite; Not Sampled.

### Test Pit Notes

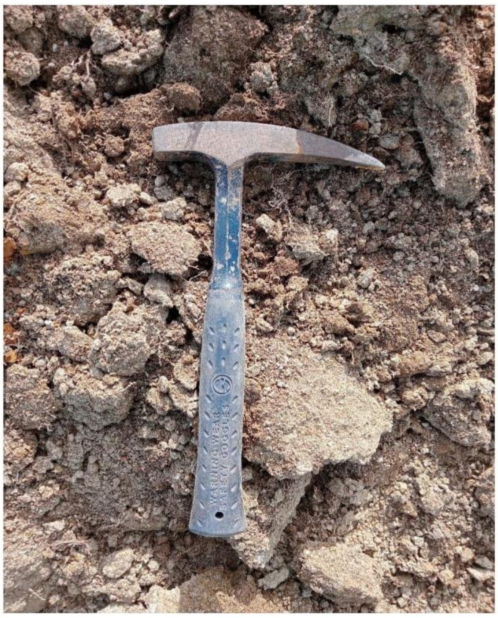
| | |
|---|---|
| **Coordinates:** | 33,99378°S  22,423802°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | N/A |
| **Samples Extracted:** | 1 Disturbed Sample |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

| **Terra Geotechnical** | Gwaing WWTW |
|---|---|

**Soil Profile Photo of Test Pit TP5**

| **Terra Geotechnical** | Gwaing WWTW |
|---|---|

**Material Present in Test Pit TP5**

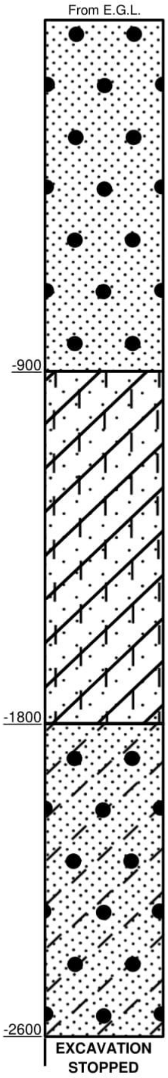


| Terra Geotechnical | Gwaing WWTW |
| --- | --- |

**Surroundings of Test Pit TP5**

| | |
|---|---|
| **Site:** | Gwaing WWTW |
| **Location:** | George |
| **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

**Soil Profile for Test Pit TP6**




slightly moist; brown; loose; intact; silty sand with scattered cobbles; Transported; Not Sampled.

slightly moist; dark red patched brown mottled greyish yellow; very soft; relict joint; clayey/sandy silt; Reworked residual graniite; decomposed rootlets in relict joints; Bulk Sample No. TP6; Disturbed Sample No. TP6.

moist; orange brown patched grey; firm; slickensided; sandy/clay silt; Reworked residual granite; Not Sampled.

**Test Pit Notes**

| | |
|---|---|
| **Coordinates:** | 33,994512°S 22,423208°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | N/A |
| **Samples Extracted:** | 1 Bulk Sample, 1 Disturbed Sample |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

| **Terra Geotechnical** | Gwaing WWTW |
| --- | --- |

**Soil Profile Photo of Test Pit TP6**

| **Terra Geotechnical** | Gwaing WWTW |
|---|---|

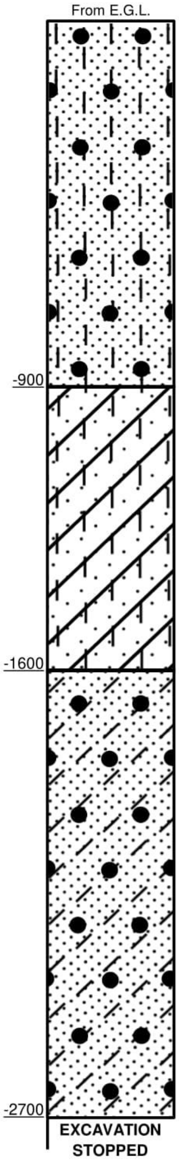
**Material Present in Test Pit TP6**

**Terra Geotechnical** Gwaing WWTW

**Surroundings of Test Pit TP6**


| | |
|---|---|
| **Site:** | Gwaing WWTW |
| **Location:** | George |
| **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

## Soil Profile for Test Pit TP7




| Depth (from E.G.L.) | Description |
|---|---|
| 0 to -900 | slightly moist; brown; medium dense; intact; silty sand with scattered cobbles; Transported; Bulk Sample No. TP7; Disturbed Sample No. TP7. |
| -900 to -1600 | slightly moist; dark red patched brown mottled greyish yellow; stiff; relict joint; clayey/sandy silt; Reworked residual graniite; decomposed rootlets in relict joints; Not Sampled. |
| -1600 to -2700 | slightly moist; orange streaked red; very stiff; stratified; sandy clay silt; Micaceous residual granite; soapy texture; Disturbed Sample No. TP7. |

### Test Pit Notes

| | |
|---|---|
| **Coordinates:** | 33,994365°S 22,424319°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | N/A |
| **Samples Extracted:** | 1 Bulk Sample, 1 Disturbed Sample |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

| Terra Geotechnical | Gwaing WWTW |
|---|---|

**Soil Profile Photo of Test Pit TP7**



Terra Geotechnical

**Terra Geotechnical** Gwaing WWTW

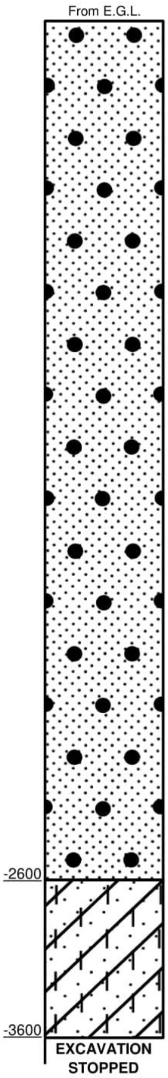
**Material Present in Test Pit TP7**

| **Terra Geotechnical** | Gwaing WWTW |
| --- | --- |

**Surroundings of Test Pit TP7**

| | | |
|---|---|---|
| Terra Geotechnical | **Site:** | Gwaing WWTW |
| | **Location:** | George |
| | **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

**Soil Profile for Test Pit TP8**




wet; dark brown patched black; loose; intact; silty sand; Imported; sewer sludge; Not Sampled.

slightly moist; yellow mottled orange speckled grey; dense; intact; silty/clayey sand with frequent gravels; Completely weathered micaceous granite; Not Sampled.

**Test Pit Notes**

| | |
|---|---|
| **Coordinates:** | 33,995883°S 22,421882°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | N/A |
| **Samples Extracted:** | N/A |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

| Terra Geotechnical | Gwaing WWTW |
|---|---|

**Soil Profile Photo of Test Pit TP8**

**Terra Geotechnical** Gwaing WWTW

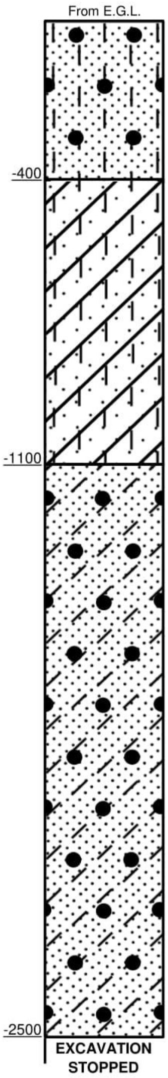
**Material Present in Test Pit TP8**

| Terra Geotechnical | Gwaing WWTW |
|---|---|

**Surroundings of Test Pit TP8**

| | | |
|---|---|---|
| Terra GeoTechnical | **Site:** | Gwaing WWTW |
| | **Location:** | George |
| | **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

## Soil Profile for Test Pit TP9




slightly moist; light grey mottled orange; medium dense; intact; clayey/silty sand with frequent gravels; Imported; Not Sampled.

slightly moist; dark red patched brown mottled greyish yellow; stiff; relict joint; clayey/sandy silt; Reworked residual graniite; decomposed rootlets in relict joints; Not Sampled.

slightly moist; light yellow mottled orange speckled grey; very stiff; intact; silty/clayey sand with frequent gravels; Completely weathered micaceous granite; Bulk Sample No. TP9; Disturbed Sample No. TP9.

### Test Pit Notes

| | |
|---|---|
| **Coordinates:** | 33,995909°S 22,422917°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | N/A |
| **Samples Extracted:** | 1 Bulk Sample, 1 Disturbed Sample |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

| **Terra Geotechnical** | Gwaing WWTW |
|---|---|

**Soil Profile Photo of Test Pit TP9**

**Terra Geotechnical** Gwaing WWTW

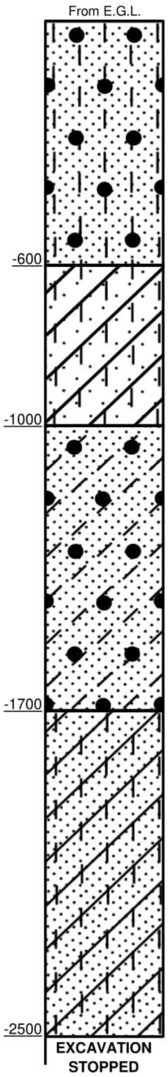
**Material Present in Test Pit TP9**

**Terra Geotechnical** Gwaing WWTW

**Surroundings of Test Pit TP9**

| | |
|---|---|
| **Site:** | Gwaing WWTW |
| **Location:** | George |
| **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

**Soil Profile for Test Pit TP10**




slightly moist; dark brown patched light grey; loose; intact; silty sand; Imported; Not Sampled.

slightly moist; brown; loose; intact; silty sand with scattered cobbles; Transported; Not Sampled.

slightly moist; dark red patched brown mottled greyish yellow; stiff; relict joint; clayey/sandy silt; Reworked residual graniite; decomposed rootlets in relict joints; Disturbed Sample No. TP10; Undisturbed Sample No. TP10.

moist; orange brown patched grey; stiff; slickensided; sandy/clay silt; Reworked residual graniite; Not Sampled.

**Test Pit Notes**

| | |
|---|---|
| **Coordinates:** | 33,995324°S 22,424623°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | N/A |
| **Samples Extracted:** | 1 Disturbed Sample, 1 Undisturbed Sample |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

**Terra Geotechnical** Gwaing WWTW

**Soil Profile Photo of Test Pit TP10**

| **Terra Geotechnical** | Gwaing WWTW |
|---|---|

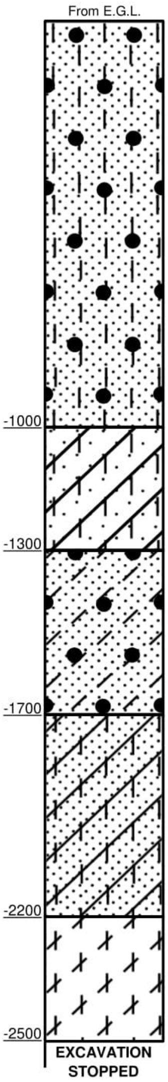
**Material Present in Test Pit TP10**

**Terra Geotechnical** Gwaing WWTW

**Surroundings of Test Pit TP10**

| | |
|---|---|
| **Site:** | Gwaing WWTW |
| **Location:** | George |
| **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

## Soil Profile for Test Pit TP11




slighty moist; brown patched grey; dense; intact; silty sand; Imported; Not Sampled.

slightly moist; light orange brown mottled red speckled black; medium dense; intact; clayey silty sand with frequent ferricrete nodules and concretions; Nodular ferricrete; Not Sampled.

slightly moist; dark red patched brown mottled greyish yellow; stiff; relict joint; clayey/sandy silt; Reworked residual graniite; decomposed rootlets in relict joints; Not Sampled.

slightly moist; orange patched red mottled grey; stiff; intact; clayey/silty sand; Residual granite; Not Sampled.

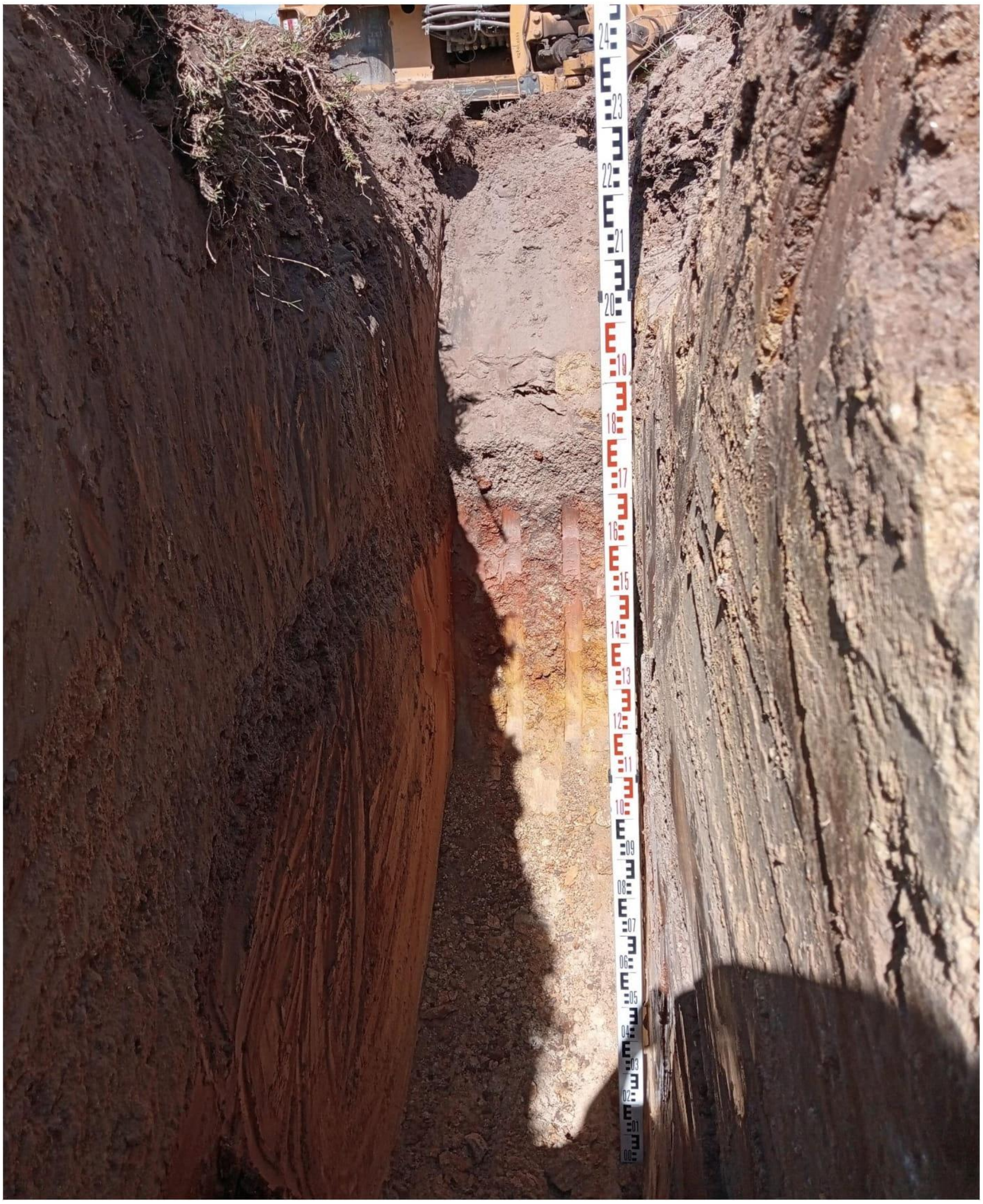
slightly moist; yellow mottled orange speckled grey; very stiff; intact; silty/clayey sand with frequent gravels; Completely weathered micaceous granite; Bulk Sample No. TP11; Disturbed Sample No. TP11.

### Test Pit Notes

| | |
|---|---|
| **Coordinates:** | 33,99628°S 22,423805°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | N/A |
| **Samples Extracted:** | 1 Bulk Sample, 1 Disturbed Sample |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

**Terra Geotechnical** Gwaing WWTW

**Soil Profile Photo of Test Pit TP11**



**Terra Geotechnical** Gwaing WWTW

**Material Present in Test Pit TP11**

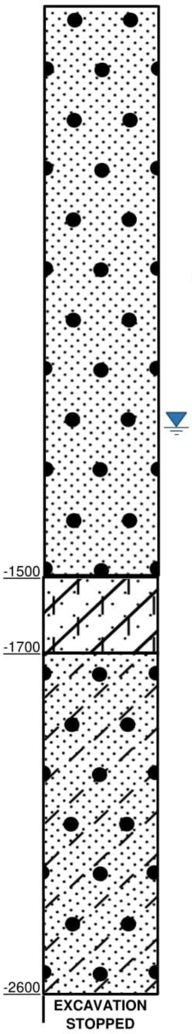
| **Terra Geotechnical** | Gwaing WWTW |
| --- | --- |

**Surroundings of Test Pit TP11**

| | |
|---|---|
| **Site:** | Gwaing WWTW |
| **Location:** | George |
| **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

## Soil Profile for Test Pit TP12

From E.G.L.




| Depth (mm) | Description |
|---|---|
| 0 – 1500 | slightly moist; dark brown; loose; intact; silty sand; Fill; abundant disposable platics and other refusal materials; Not Sampled. |
| 1500 – 1700 | slightly moist; dark red patched brown mottled greyish yellow; firm; relict joint; clayey/sandy silt; Reworked residual graniite; decomposed rootlets in relict joints; Not Sampled. |
| 1700 – 2600 | moist; orange brown patched grey; stiff; slickensided; sandy/clay silt; Reworked residual granite; Not Sampled. |

### Test Pit Notes

| | |
|---|---|
| **Coordinates:** | 33,996765°S 22,424352°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | Moderate water seepage at depth 1100 mm below the surface |
| **Samples Extracted:** | N/A |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

**Terra Geotechnical** Gwaing WWTW

**Soil Profile Photo of Test Pit TP12**

**Terra Geotechnical** Gwaing WWTW

**Material Present in Test Pit TP12**

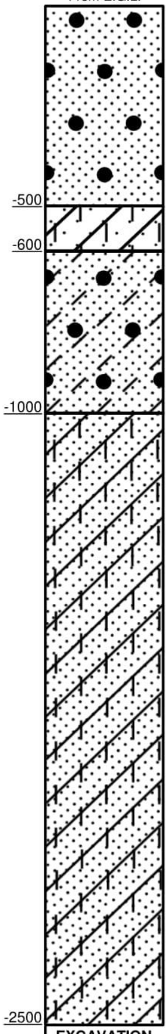
| **Terra Geotechnical** | Gwaing WWTW |
|---|---|

**Surroundings of Test Pit TP12**

| | | |
|---|---|---|
| Terra GeoTechnical | **Site:** | Gwaing WWTW |
| | **Location:** | George |
| | **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

**Soil Profile for Test Pit TP13**

From E.G.L.




EXCAVATION STOPPED

| Depth (mm) | Description |
|---|---|
| 0 – -500 | slightly moist; dark brown patched black; loose; intact; silty sand; Imported; Not Sampled. |
| -500 – -600 | slightly moist; light orange brown; dense; intact; clayey silty sand with frequent ferricrete nodules and concretions; Nodular ferricrete; Not Sampled. |
| -600 – -1000 | slightly moist; dark red patched brown mottled greyish yellow; stiff; relict joint; clayey/sandy silt; Reworked residual graniite; decomposed rootlets in relict joints; Not Sampled. |
| -1000 – -2500 | slightly moist; light yellow mottled orange speckled grey; very stiff; intact; silty/clayey sand with frequent gravels; Completely weathered micaceous granite; Bulk Sample No. TP13; Disturbed Sample No. TP13. |

**Test Pit Notes**

| | |
|---|---|
| **Coordinates:** | 33,996863°S 22,423009°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | N/A |
| **Samples Extracted:** | 1 Bulk Sample, 1 Disturbed Sample |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

**Terra Geotechnical** Gwaing WWTW

**Soil Profile Photo of Test Pit TP13**

**Terra Geotechnical** Gwaing WWTW

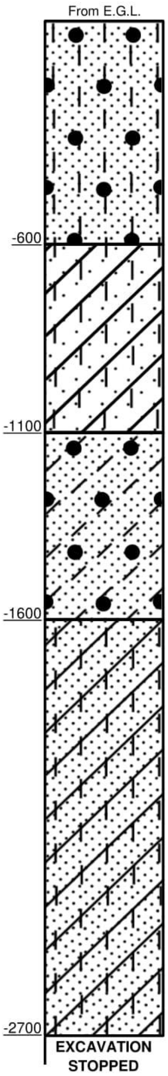
**Material Present in Test Pit TP13**

| Terra Geotechnical | Gwaing WWTW |
|---|---|

**Surroundings of Test Pit TP13**

| | | |
|---|---|---|
| Terra Geotechnical | **Site:** | Gwaing WWTW |
| | **Location:** | George |
| | **Client:** | Lukhozi Consulting Engineers (PTY) LTD |

## Soil Profile for Test Pit TP14




slightly moist; brown; loose; intact; silty sand with scattered cobbles; Transported; Not Sampled.

slightly moist; dark red patched brown mottled greyish yellow; stiff; relict joint; clayey/sandy silt; Reworked residual granite; decomposed rootlets in relict joints; Not Sampled.

slightly moist; orange patched red mottled grey; stiff; intact; clayey/silty sand; Residual granite; Not Sampled.

slightly moist; yellow mottled orange speckled grey; medium dense; intact; silty/clayey sand with frequent gravels; Completely weathered micaceous granite; Bulk Sample No. TP14; Disturbed Sample No. TP14.

### Test Pit Notes

| | |
|---|---|
| **Coordinates:** | 33,998017°S 22,422156°E |
| **Method of Excavation:** | TLB Type Light Mechanical Excavator- CAT |
| **Excavation Character:** | Excavation Stopped |
| **Date Excavated:** | 2024/04/15 |
| **Date Profiled:** | 2024/04/15 |
| **Groundwater Seepage:** | N/A |
| **Samples Extracted:** | 1 Bulk Sample, 1 Disturbed Sample |
| **Notes:** | N/A |
| **Profiled by:** | Eugene van der Walt (Pri.Sci.Nat) |

| **Terra Geotechnical** | Gwaing WWTW |
| --- | --- |

**Soil Profile Photo of Test Pit TP14**

**Terra Geotechnical** Gwaing WWTW

**Material Present in Test Pit TP14**

**Terra Geotechnical** Gwaing WWTW

**Surroundings of Test Pit TP14**

# APPENDIX B

# B.1 Laboratory Test Results

**OUTENIQUA LAB (Pty) Ltd.**
Registration No. 95/07742/07
**Materials Testing Laboratory**
6 Mirrorball Street, George : PO Box 3186, George Industria, 6536
Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

R-CBR-1-9 Jun-23

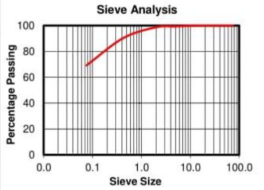
sanas Testing Laboratory
T0347

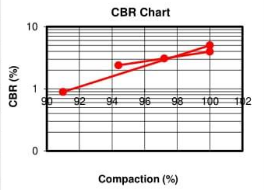
| | | | |
|---|---|---|---|
| Customer : | Terra Geotechnical<br>7 Albatros Street<br>Still Bay<br>6674 | Project : | Gwaing WWTW |
| | | Date Received : | 18/04/2024 |
| | | Date Reported : | 20/05/2024 |
| | | Req. Number : | 1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 1 of 10 |

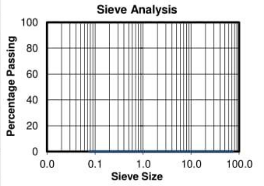
## TEST REPORT
## CALIFORNIA BEARING RATIO

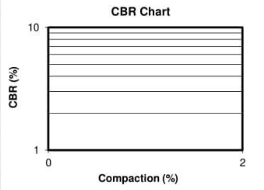
| | | | |
|---|---|---|---|
| Sample Position (SV) | | TP1 | COLTO: Not Classified |
| Depth (mm) | | 1100-1800 | |
| Sample No | | **88280** | |
| Materials Description | Source | In-situ | |
| | Colour | Light Reddish Orange | |
| | Soil Type | Silty Clay | |
| | Classification | Existing | |
| **Material Indicators - (SANS 3001 Method GR1)** | | | Opinion |
| Percentage Passing | 75 mm | 100 | |
| | 63 mm | 100 | |
| | 50 mm | 100 | |
| | 37.5 mm | 100 | |
| | 28 mm | 100 | |
| | 20 mm | 100 | |
| | 14 mm | 100 | |
| | 5 mm | 99 | |
| | 2 mm | 99 | |
| | 0.425 mm | 90 | |
| | 0.075 mm | 69.2 | |
| **Material Indicators - (SANS 3001 Method PR5)** | | | |
| Grading Modulus * | | 0.42 | |
| Coarse Sand Soil-Mortar (%) | | 9 | |
| **Atterberg Limits - (SANS 3001 Method GR10)** | | | |
| Liquid Limit (%) | | 21 | |
| Plasticity Index (%) | | 7 | |
| Linear Shrinkage (%) | | 3.5 | |
| **Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)** | | | |
| MDD | Max Dry Density (kg/m$^3$) | 1792 | |
| | Optimum Moisture Content (%) | 15.5 | |
| | Mould Moisture Content (%) | 15.7 | |
| A | Relative Compaction (%) | 100.0 | |
| | Swell (%) | 1.1 | |
| B | Relative Compaction (%) | 94.4 | |
| | Swell (%) | 1.4 | |
| C | Relative Compaction (%) | 91.0 | |
| | Swell (%) | 1.6 | |
| CBR | @100% Max Dry Density | 5 | |
| | @98% Max Dry Density | 4 | |
| | @95% Max Dry Density | 2 | |
| | @93% Max Dry Density | 1 | |
| | @90% Max Dry Density | 1 | |
| **Material Condition** | | | |
| Insitu Moisture Content (%) | | | |
| **Soil Classification Of The Material Based Only On The Tests Results Above** | | | |
| COLTO Specification: | | Not Classified | |
| AASHTO System | | A-4 | |
| Unified System | | CL-ML | |

88280

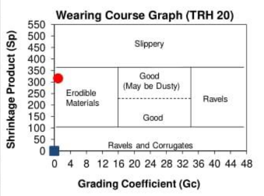



● 88280 ■




- **Tests marked with a ( * ) are NOT SANAS Accredited results.**
- **Specimens delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.



1. The opinion column is an interpretation of the direct comparison between the quoted specification and the single test sample results obtained. The compliant (✓), non compliant (×) and uncertain (*) opinion indicators are based on an approximate 95% level of confidence with reference to SAMM GUIDANCE 1, Issue 2 : 20 June 2007 Section 2.
2. The uncertain (*) indicates that the test result is either equal to or is above / below the specified limit by a margin less than the measurement uncertainty; it is therefore not possible to state compliant (✓) or non compliant (×) based on a 95% level of confidence with reference to SAMM GUIDANCE 1, Issue 2 : 20 June 2007 Section 2.
3. This report (with attachments) is the correct record of all measurements made, and may not be reproduced other than with full written approval from the Director of Outeniqua Lab (Pty) Ltd.
4. Measuring Equipment, traceable to National Standards is used where applicable. Results reported in this Test Report relate only to the items tested and are an indication only of the sample provided and/or taken.
5. While every care is taken to ensure the correctness of all tests and reports, neither Outeniqua Lab (Pty) Ltd nor its employees shall be liable in any way whatever for any error made in the execution or reporting of tests or any erroneous conclusions drawn therefrom or for any consequence thereof.

Director: L Heathcote B-Tech. (Civil Eng.) & BSc Hons (Transport)

**OUTENIQUA LAB (Pty) Ltd.**
Registration No. 95/07742/07
**Materials Testing Laboratory**
6 Mirrorball Street, George : PO Box 3186, George Industria, 6536
Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

R-CBR-1-9 Jun-23

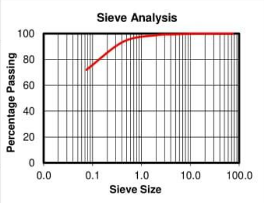
T0347

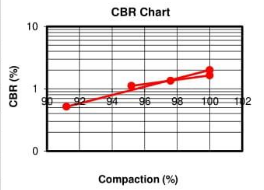
| | | | |
|---|---|---|---|
| Customer : | Terra Geotechnical | Project : | Gwaing WWTW |
| | 7 Albatros Street | Date Received : | 18/04/2024 |
| | Still Bay | Date Reported : | 20/05/2024 |
| | 6674 | Req. Number : | 1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 2 of 10 |

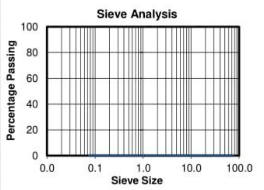
# TEST REPORT
## CALIFORNIA BEARING RATIO

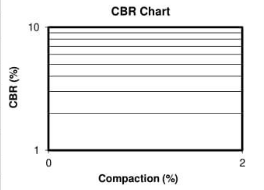
| | | | |
|---|---|---|---|
| Sample Position (SV) | | TP2 | COLTO: Not Classified |
| Depth (mm) | | 1400-1800 | |
| Sample No | | **88281** | |
| Materials Description | Source | In-situ | |
| | Colour | Light Reddish Orange | |
| | Soil Type | Lean Clay with Sand | |
| | Classification | Existing | |
| **Material Indicators - (SANS 3001 Method GR1)** | | | Opinion |
| Percentage Passing | 75 mm | 100 | |
| | 63 mm | 100 | |
| | 50 mm | 100 | |
| | 37.5 mm | 100 | |
| | 28 mm | 100 | |
| | 20 mm | 100 | |
| | 14 mm | 100 | |
| | 5 mm | 99 | |
| | 2 mm | 99 | |
| | 0.425 mm | 94 | |
| | 0.075 mm | 71.9 | |
| **Material Indicators - (SANS 3001 Method PR5)** | | | |
| Grading Modulus * | | 0.36 | |
| Coarse Sand Soil-Mortar (%) | | 5 | |
| **Atterberg Limits - (SANS 3001 Method GR10)** | | | |
| Liquid Limit (%) | | 30 | |
| Plasticity Index (%) | | 10 | |
| Linear Shrinkage (%) | | 5.0 | |
| **Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)** | | | |
| MDD | Max Dry Density (kg/m³) | 1925 | |
| | Optimum Moisture Content (%) | 8.8 | |
| | Mould Moisture Content (%) | 8.9 | |
| A | Relative Compaction (%) | 100.0 | |
| | Swell (%) | 1.0 | |
| B | Relative Compaction (%) | 95.2 | |
| | Swell (%) | 3.8 | |
| C | Relative Compaction (%) | 91.2 | |
| | Swell (%) | 5.3 | |
| CBR | @100% Max Dry Density | 2 | |
| | @98% Max Dry Density | 1 | |
| | @95% Max Dry Density | 1 | |
| | @93% Max Dry Density | 1 | |
| | @90% Max Dry Density | 0 | |
| **Material Condition** | | | |
| Insitu Moisture Content (%) | | | |
| **Soil Classification Of The Material Based Only On The Tests Results Above** | | | |
| COLTO Specification: | | Not Classified | |
| AASHTO System | | A-4 | |
| Unified System | | CL | |

88281

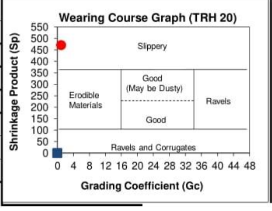



● 88281 ■




- **Tests marked with a ( * ) are NOT SANAS Accredited results.**
- **Specimens delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.



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**Director: L Heathcote B-Tech. (Civil Eng.) & BSc Hons (Transport)**

# OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07

**Materials Testing Laboratory**

6 Mirrorball Street, George : PO Box 3186, George Industria, 6536

Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za


R-CBR-1-9 Jun-23

sanas Testing Laboratory

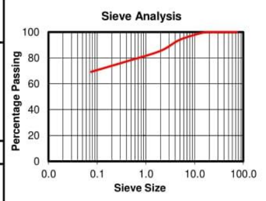
T0347

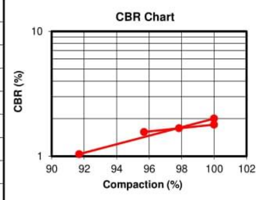
| | | | |
|---|---|---|---|
| Customer : | Terra Geotechnical<br>7 Albatros Street<br>Still Bay<br>6674 | Project : | Gwaing WWTW |
| | | Date Received : | 18/04/2024 |
| | | Date Reported : | 20/05/2024 |
| | | Req. Number : | 1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 3 of 10 |

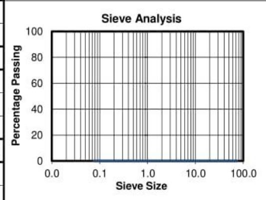
## TEST REPORT
## CALIFORNIA BEARING RATIO

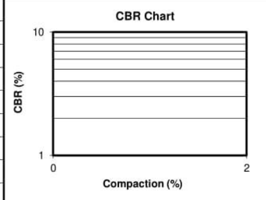
| | | | |
|---|---|---|---|
| | Sample Position (SV) | TP4 | COLTO: Not Classified |
| | Depth (mm) | 1400-1800 | |
| | Sample No | **88283** | |
| Materials Description | Source | In-situ | |
| | Colour | Light Brown Orange | |
| | Soil Type | Sandy Elastic Silt | |
| | Classification | Existing | |
| **Material Indicators - (SANS 3001 Method GR1)** | | | Opinion |
| Percentage Passing | 75 mm | 100 | |
| | 63 mm | 100 | |
| | 50 mm | 100 | |
| | 37.5 mm | 100 | |
| | 28 mm | 100 | |
| | 20 mm | 100 | |
| | 14 mm | 99 | |
| | 5 mm | 94 | |
| | 2 mm | 85 | |
| | 0.425 mm | 78 | |
| | 0.075 mm | 69.2 | |
| **Material Indicators - (SANS 3001 Method PR5)** | | | |
| | Grading Modulus * | 0.68 | |
| | Coarse Sand Soil-Mortar (%) | 9 | |
| **Atterberg Limits - (SANS 3001 Method GR10)** | | | |
| | Liquid Limit (%) | 72 | |
| | Plasticity Index (%) | 28 | |
| | Linear Shrinkage (%) | 14.0 | |
| **Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)** | | | |
| MDD | Max Dry Density (kg/m$^3$) | 1690 | |
| | Optimum Moisture Content (%) | 19.1 | |
| | Mould Moisture Content (%) | 19.2 | |
| A | Relative Compaction (%) | 100.0 | |
| | Swell (%) | 6.9 | |
| B | Relative Compaction (%) | 95.7 | |
| | Swell (%) | 7.1 | |
| C | Relative Compaction (%) | 91.7 | |
| | Swell (%) | 7.4 | |
| CBR | @100% Max Dry Density | 2 | |
| | @98% Max Dry Density | 2 | |
| | @95% Max Dry Density | 1 | |
| | @93% Max Dry Density | 1 | |
| | @90% Max Dry Density | 1 | |
| **Material Condition** | | | |
| | Insitu Moisture Content (%) | | |
| **Soil Classification Of The Material Based Only On The Tests Results Above** | | | |
| | COLTO Specification: | Not Classified | |
| | AASHTO System | A-7-5 | |
| | Unified System | MH | |

88283

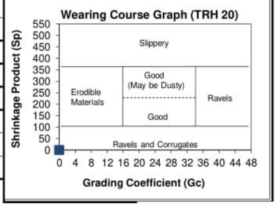



● 88283 ■

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Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.



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**Director: L Heathcote B-Tech. (Civil Eng.) & BSc Hons (Transport)**

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R-CBR-1-9 Jun-23

T0347

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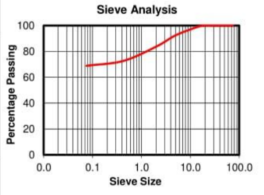
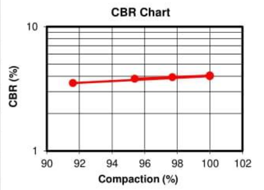
| | | Date Received : | 18/04/2024 |
| | | Date Reported : | 20/05/2024 |
| | | Req. Number : | 1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 4 of 10 |

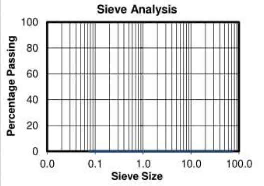
## TEST REPORT
## CALIFORNIA BEARING RATIO

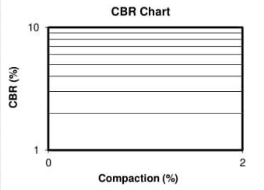
| | | | | |
|---|---|---|---|---|
| Sample Position (SV) | | TP6 | COLTO: Not Classified | |
| Depth (mm) | | 900-1800 | | |
| Sample No | | **88285** | | |
| Materials Description | Source | In-situ | | |
| | Colour | Light Brown Orange | | |
| | Soil Type | Clay | | |
| | Classification | Existing | | |
| **Material Indicators - (SANS 3001 Method GR1)** | | | | Opinion |
| Percentage Passing | 75 mm | 100 | | |
| | 63 mm | 100 | | |
| | 50 mm | 100 | | |
| | 37.5 mm | 100 | | |
| | 28 mm | 100 | | |
| | 20 mm | 100 | | |
| | 14 mm | 99 | | |
| | 5 mm | 92 | | |
| | 2 mm | 84 | | |
| | 0.425 mm | 73 | | |
| | 0.075 mm | 68.9 | | |
| **Material Indicators - (SANS 3001 Method PR5)** | | | | |
| Grading Modulus * | | 0.75 | | |
| Coarse Sand Soil-Mortar (%) | | 13 | | |
| **Atterberg Limits - (SANS 3001 Method GR10)** | | | | |
| Liquid Limit (%) | | 43 | | |
| Plasticity Index (%) | | 23 | | |
| Linear Shrinkage (%) | | 11.5 | | |
| **Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)** | | | | |
| MDD | Max Dry Density (kg/m$^3$) | 1598 | | |
| | Optimum Moisture Content (%) | 23.1 | | |
| | Mould Moisture Content (%) | 23.2 | | |
| A | Relative Compaction (%) | 100.0 | | |
| | Swell (%) | 8.1 | | |
| B | Relative Compaction (%) | 95.4 | | |
| | Swell (%) | 8.4 | | |
| C | Relative Compaction (%) | 91.6 | | |
| | Swell (%) | 8.8 | | |
| CBR | @100% Max Dry Density | 4 | | |
| | @98% Max Dry Density | 4 | | |
| | @95% Max Dry Density | 4 | | |
| | @93% Max Dry Density | 4 | | |
| | @90% Max Dry Density | 3 | | |
| **Material Condition** | | | | |
| Insitu Moisture Content (%) | | | | |
| **Soil Classification Of The Material Based Only On The Tests Results Above** | | | | |
| COLTO Specification: | | Not Classified | | |
| AASHTO System | | A-7-6 | | |
| Unified System | | CL | | |

88285

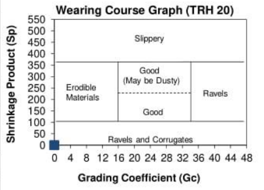



● 88285 ■

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Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.



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R-CBR-1-9 Jun-23

T0347

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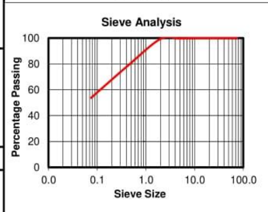
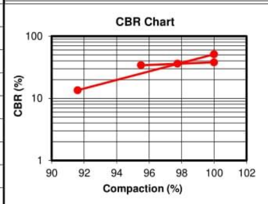
| | | Date Received : | 18/04/2024 |
| | | Date Reported : | 20/05/2024 |
| | | Req. Number : | 1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 5 of 10 |

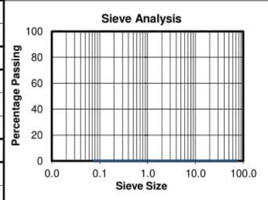
# TEST REPORT
# CALIFORNIA BEARING RATIO

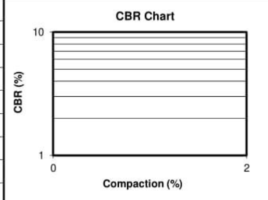
| | | | | |
|---|---|---|---|---|
| Sample Position (SV) | | TP7 | COLTO: Not Classified | |
| Depth (mm) | | 0-900 | | |
| Sample No | | **88286** | | |
| Materials Description | Source | In-situ | | |
| | Colour | Dark Brown | | |
| | Soil Type | Silty Sand | | |
| | Classification | Existing | | |
| **Material Indicators - (SANS 3001 Method GR1)** | | | | Opinion |
| Percentage Passing | 75 mm | 100 | | |
| | 63 mm | 100 | | |
| | 50 mm | 100 | | |
| | 37.5 mm | 100 | | |
| | 28 mm | 100 | | |
| | 20 mm | 100 | | |
| | 14 mm | 100 | | |
| | 5 mm | 100 | | |
| | 2 mm | 99 | | |
| | 0.425 mm | 79 | | |
| | 0.075 mm | 53.7 | | |
| **Material Indicators - (SANS 3001 Method PR5)** | | | | |
| Grading Modulus * | | 0.68 | | |
| Coarse Sand Soil-Mortar (%) | | 21 | | |
| **Atterberg Limits - (SANS 3001 Method GR10)** | | | | |
| Liquid Limit (%) | | Undetermined | | |
| Plasticity Index (%) | | NP | | |
| Linear Shrinkage (%) | | NP | | |
| **Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)** | | | | |
| MDD | Max Dry Density (kg/m$^3$) | 2031 | | |
| | Optimum Moisture Content (%) | 8.1 | | |
| | Mould Moisture Content (%) | 8.3 | | |
| A | Relative Compaction (%) | 100.0 | | |
| | Swell (%) | 0.0 | | |
| B | Relative Compaction (%) | 95.5 | | |
| | Swell (%) | 0.0 | | |
| C | Relative Compaction (%) | 91.6 | | |
| | Swell (%) | 0.0 | | |
| CBR | @100% Max Dry Density | 51 | | |
| | @98% Max Dry Density | 37 | | |
| | @95% Max Dry Density | 23 | | |
| | @93% Max Dry Density | 17 | | |
| | @90% Max Dry Density | 10 | | |
| **Material Condition** | | | | |
| Insitu Moisture Content (%) | | | | |
| **Soil Classification Of The Material Based Only On The Tests Results Above** | | | | |
| COLTO Specification: | | Not Classified | | |
| AASHTO System | | A-4 | | |
| Unified System | | MH | | |

88286

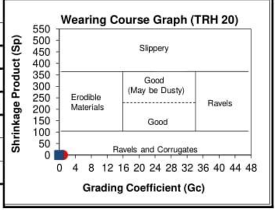



● 88286 ■

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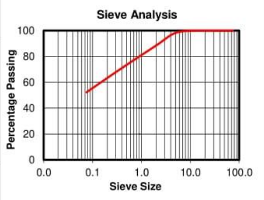
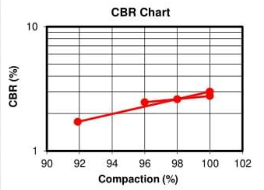
| Attention : | Eugene van der Walt | No. of Pages : | 6 of 10 |

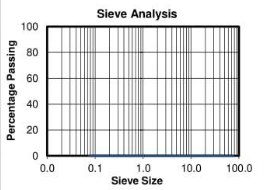
# TEST REPORT
## CALIFORNIA BEARING RATIO

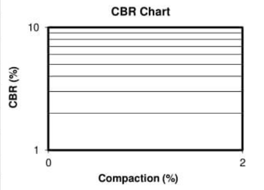
| | | | |
|---|---|---|---|
| Sample Position (SV) | | TP9 | **COLTO: Not Classified** |
| Depth (mm) | | 1100-2500 | |
| Sample No | | **88288** | |
| Materials Description | Source | In-situ | |
| | Colour | Light Brown | |
| | Soil Type | Sand with Lean Clay | |
| | Classification | Existing | |
| **Material Indicators - (SANS 3001 Method GR1)** | | | Opinion |
| Percentage Passing | 75 mm | 100 | |
| | 63 mm | 100 | |
| | 50 mm | 100 | |
| | 37.5 mm | 100 | |
| | 28 mm | 100 | |
| | 20 mm | 100 | |
| | 14 mm | 100 | |
| | 5 mm | 98 | |
| | 2 mm | 88 | |
| | 0.425 mm | 72 | |
| | 0.075 mm | 52.2 | |
| **Material Indicators - (SANS 3001 Method PR5)** | | | |
| Grading Modulus * | | 0.88 | |
| Coarse Sand Soil-Mortar (%) | | 19 | |
| **Atterberg Limits - (SANS 3001 Method GR10)** | | | |
| Liquid Limit (%) | | 33 | |
| Plasticity Index (%) | | 10 | |
| Linear Shrinkage (%) | | 5.0 | |
| **Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)** | | | |
| MDD | Max Dry Density (kg/m$^3$) | 1936 | |
| | Optimum Moisture Content (%) | 8.7 | |
| | Mould Moisture Content (%) | 8.9 | |
| A | Relative Compaction (%) | 100.0 | |
| | Swell (%) | 3.0 | |
| B | Relative Compaction (%) | 96.0 | |
| | Swell (%) | 3.7 | |
| C | Relative Compaction (%) | 91.9 | |
| | Swell (%) | 4.7 | |
| CBR | @100% Max Dry Density | 3 | |
| | @98% Max Dry Density | 3 | |
| | @95% Max Dry Density | 2 | |
| | @93% Max Dry Density | 2 | |
| | @90% Max Dry Density | 2 | |
| **Material Condition** | | | |
| Insitu Moisture Content (%) | | | |
| **Soil Classification Of The Material Based Only On The Tests Results Above** | | | |
| COLTO Specification: | | Not Classified | |
| AASHTO System | | A-4 | |
| Unified System | | CL | |

88288

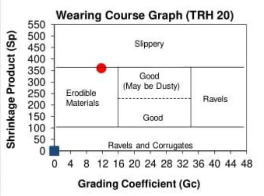



● 88288 ■

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Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.



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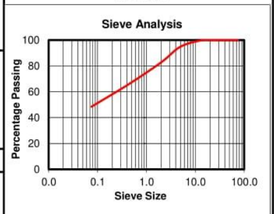
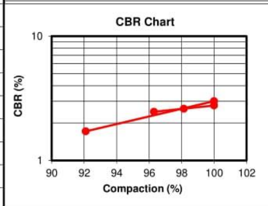
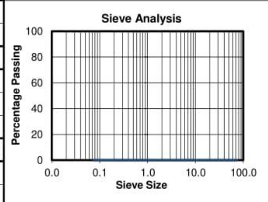
## TEST REPORT
## CALIFORNIA BEARING RATIO

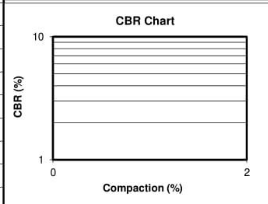
| | | | |
|---|---|---|---|
| Sample Position (SV) | | TP11 | COLTO: Not Classified |
| Depth (mm) | | 2200-2500 | |
| Sample No | | **88290** | |
| Materials Description | Source | In-situ | |
| | Colour | Light Brown | |
| | Soil Type | Silty Sand | |
| | Classification | Existing | |
| **Material Indicators - (SANS 3001 Method GR1)** | | | Opinion |
| Percentage Passing | 75 mm | 100 | |
| | 63 mm | 100 | |
| | 50 mm | 100 | |
| | 37.5 mm | 100 | |
| | 28 mm | 100 | |
| | 20 mm | 100 | |
| | 14 mm | 100 | |
| | 5 mm | 95 | |
| | 2 mm | 83 | |
| | 0.425 mm | 66 | |
| | 0.075 mm | 48.4 | |
| **Material Indicators - (SANS 3001 Method PR5)** | | | |
| Grading Modulus * | | 1.03 | |
| Coarse Sand Soil-Mortar (%) | | 21 | |
| **Atterberg Limits - (SANS 3001 Method GR10)** | | | |
| Liquid Limit (%) | | 35 | |
| Plasticity Index (%) | | 9 | |
| Linear Shrinkage (%) | | 4.5 | |
| **Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)** | | | |
| MDD | Max Dry Density (kg/m$^3$) | 1873 | |
| | Optimum Moisture Content (%) | 11.6 | |
| | Mould Moisture Content (%) | 11.6 | |
| A | Relative Compaction (%) | 100.0 | |
| | Swell (%) | 2.0 | |
| B | Relative Compaction (%) | 96.3 | |
| | Swell (%) | 2.3 | |
| C | Relative Compaction (%) | 92.1 | |
| | Swell (%) | 2.4 | |
| CBR | @100% Max Dry Density | 3 | |
| | @98% Max Dry Density | 3 | |
| | @95% Max Dry Density | 2 | |
| | @93% Max Dry Density | 2 | |
| | @90% Max Dry Density | 1 | |
| **Material Condition** | | | |
| Insitu Moisture Content (%) | | | |
| **Soil Classification Of The Material Based Only On The Tests Results Above** | | | |
| COLTO Specification: | | Not Classified | |
| AASHTO System | | A-4 | |
| Unified System | | SM | |

88290

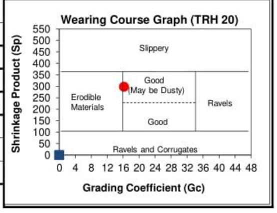



● 88290 ■

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Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.



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R-CBR-1-9 Jun-23

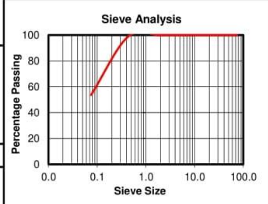
T0347

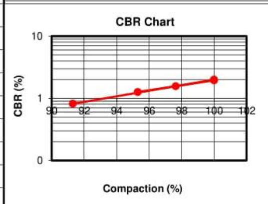
| | | | |
|---|---|---|---|
| Customer : | Terra Geotechnical<br>7 Albatros Street<br>Still Bay<br>6674 | Project : | Gwaing WWTW |
| | | Date Received : | 18/04/2024 |
| | | Date Reported : | 20/05/2024 |
| | | Req. Number : | 1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 8 of 10 |

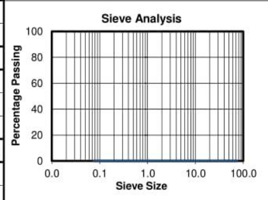
# TEST REPORT
## CALIFORNIA BEARING RATIO

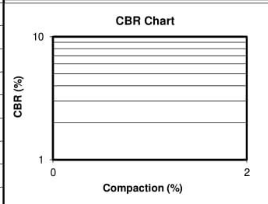
| | | | |
|---|---|---|---|
| Sample Position (SV) | | TP12 | COLTO: Not Classified |
| Depth (mm) | | 1700-2600 | |
| Sample No | | **88291** | |
| Materials Description | Source | In-situ | |
| | Colour | Light Red | |
| | Soil Type | Silty Clay | |
| | Classification | Existing | |
| **Material Indicators - (SANS 3001 Method GR1)** | | | Opinion |
| Percentage Passing | 75 mm | 100 | |
| | 63 mm | 100 | |
| | 50 mm | 100 | |
| | 37.5 mm | 100 | |
| | 28 mm | 100 | |
| | 20 mm | 100 | |
| | 14 mm | 100 | |
| | 5 mm | 100 | |
| | 2 mm | 100 | |
| | 0.425 mm | 99 | |
| | 0.075 mm | 53.6 | |
| **Material Indicators - (SANS 3001 Method PR5)** | | | |
| Grading Modulus * | | 0.48 | |
| Coarse Sand Soil-Mortar (%) | | 1 | |
| **Atterberg Limits - (SANS 3001 Method GR10)** | | | |
| Liquid Limit (%) | | 23 | |
| Plasticity Index (%) | | 6 | |
| Linear Shrinkage (%) | | 3.0 | |
| **Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)** | | | |
| MDD | Max Dry Density (kg/m$^3$) | 1939 | |
| | Optimum Moisture Content (%) | 10.3 | |
| | Mould Moisture Content (%) | 10.1 | |
| A | Relative Compaction (%) | 100.0 | |
| | Swell (%) | 3.4 | |
| B | Relative Compaction (%) | 95.3 | |
| | Swell (%) | 4.4 | |
| C | Relative Compaction (%) | 91.3 | |
| | Swell (%) | 5.8 | |
| CBR | @100% Max Dry Density | 2 | |
| | @98% Max Dry Density | 2 | |
| | @95% Max Dry Density | 1 | |
| | @93% Max Dry Density | 1 | |
| | @90% Max Dry Density | 1 | |
| **Material Condition** | | | |
| Insitu Moisture Content (%) | | | |
| **Soil Classification Of The Material Based Only On The Tests Results Above** | | | |
| COLTO Specification: | | Not Classified | |
| AASHTO System | | A-4 | |
| Unified System | | CL-ML | |

88291

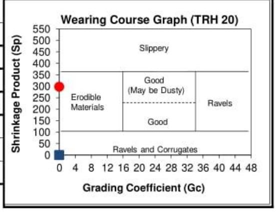



● 88291 ■

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Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.



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**Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za**

R-CBR-1-9 Jun-23

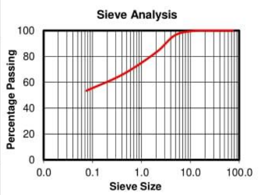
T0347

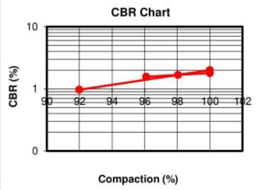
| | | | |
|---|---|---|---|
| Customer : | Terra Geotechnical<br>7 Albatros Street<br>Still Bay<br>6674 | Project : | Gwaing WWTW |
| | | Date Received : | 18/04/2024 |
| | | Date Reported : | 20/05/2024 |
| | | Req. Number : | 1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 9 of 10 |

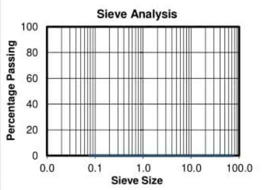
## TEST REPORT
## CALIFORNIA BEARING RATIO

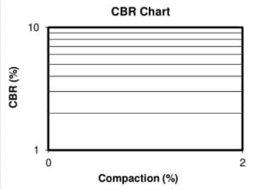
| | | | | |
|---|---|---|---|---|
| | Sample Position (SV) | TP13 | **COLTO: Not Classified** | |
| | Depth (mm) | 1000-2500 | | |
| | Sample No | **88292** | | |
| Materials Description | Source | In-situ | | |
| | Colour | Light Brown | | |
| | Soil Type | Weathered Granite | | |
| | Classification | Existing | | |
| **Material Indicators - (SANS 3001 Method GR1)** | | | | Opinion |
| Percentage Passing | 75 mm | 100 | | |
| | 63 mm | 100 | | |
| | 50 mm | 100 | | |
| | 37.5 mm | 100 | | |
| | 28 mm | 100 | | |
| | 20 mm | 100 | | |
| | 14 mm | 100 | | |
| | 5 mm | 97 | | |
| | 2 mm | 83 | | |
| | 0.425 mm | 66 | | |
| | 0.075 mm | 53.4 | | |
| **Material Indicators - (SANS 3001 Method PR5)** | | | | |
| | Grading Modulus * | 0.97 | | |
| | Coarse Sand Soil-Mortar (%) | 20 | | |
| **Atterberg Limits - (SANS 3001 Method GR10)** | | | | |
| | Liquid Limit (%) | 36 | | |
| | Plasticity Index (%) | 7 | | |
| | Linear Shrinkage (%) | 3.5 | | |
| **Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)** | | | | |
| MDD | Max Dry Density (kg/m$^3$) | 1819 | | |
| | Optimum Moisture Content (%) | 11.7 | | |
| | Mould Moisture Content (%) | 12.0 | | |
| A | Relative Compaction (%) | 100.0 | | |
| | Swell (%) | 5.4 | | |
| B | Relative Compaction (%) | 96.1 | | |
| | Swell (%) | 8.4 | | |
| C | Relative Compaction (%) | 92.0 | | |
| | Swell (%) | 11.9 | | |
| CBR | @100% Max Dry Density | 2 | | |
| | @98% Max Dry Density | 2 | | |
| | @95% Max Dry Density | 1 | | |
| | @93% Max Dry Density | 1 | | |
| | @90% Max Dry Density | 1 | | |
| **Material Condition** | | | | |
| | Insitu Moisture Content (%) | | | |
| **Soil Classification Of The Material Based Only On The Tests Results Above** | | | | |
| | COLTO Specification: | Not Classified | | |
| | AASHTO System | A-4 | | |
| | Unified System | ML | | |

88292

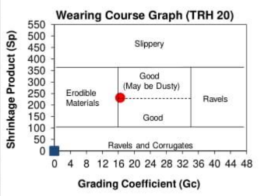



● 88292 ■

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Technical Signatory
For Outeniqua Lab (Pty) Ltd.



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R-CBR-1-9 Jun-23

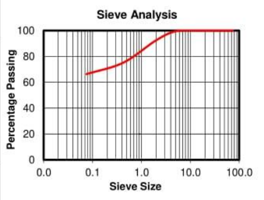
T0347

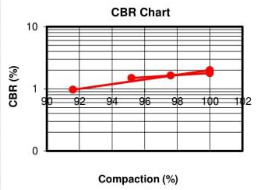
| | | | |
|---|---|---|---|
| Customer : | Terra Geotechnical<br>7 Albatros Street<br>Still Bay<br>6674 | Project : | Gwaing WWTW |
| | | Date Received : | 18/04/2024 |
| | | Date Reported : | 20/05/2024 |
| | | Req. Number : | 1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 10 of 10 |

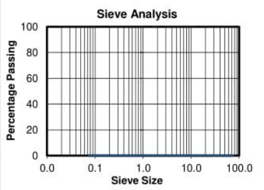
## TEST REPORT
## CALIFORNIA BEARING RATIO

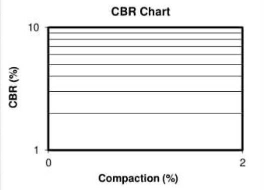
| | | | |
|---|---|---|---|
| Sample Position (SV) | | TP14 | COLTO: Not Classified |
| Depth (mm) | | 1600-2700 | |
| Sample No | | **88293** | |
| Materials Description | Source | In-situ | |
| | Colour | Dark Brown | |
| | Soil Type | Sandy Lean Clay | |
| | Classification | Existing | |
| **Material Indicators - (SANS 3001 Method GR1)** | | | Opinion |
| Percentage Passing | 75 mm | 100 | |
| | 63 mm | 100 | |
| | 50 mm | 100 | |
| | 37.5 mm | 100 | |
| | 28 mm | 100 | |
| | 20 mm | 100 | |
| | 14 mm | 100 | |
| | 5 mm | 99 | |
| | 2 mm | 92 | |
| | 0.425 mm | 75 | |
| | 0.075 mm | 66.3 | |
| **Material Indicators - (SANS 3001 Method PR5)** | | | |
| Grading Modulus * | | 0.66 | |
| Coarse Sand Soil-Mortar (%) | | 19 | |
| **Atterberg Limits - (SANS 3001 Method GR10)** | | | |
| Liquid Limit (%) | | 31 | |
| Plasticity Index (%) | | 10 | |
| Linear Shrinkage (%) | | 5.0 | |
| **Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)** | | | |
| MDD | Max Dry Density (kg/m$^3$) | 1871 | |
| | Optimum Moisture Content (%) | 10.6 | |
| | Mould Moisture Content (%) | 10.7 | |
| A | Relative Compaction (%) | 100.0 | |
| | Swell (%) | 3.1 | |
| B | Relative Compaction (%) | 95.2 | |
| | Swell (%) | 5.3 | |
| C | Relative Compaction (%) | 91.6 | |
| | Swell (%) | 6.8 | |
| CBR | @100% Max Dry Density | 2 | |
| | @98% Max Dry Density | 2 | |
| | @95% Max Dry Density | 1 | |
| | @93% Max Dry Density | 1 | |
| | @90% Max Dry Density | 1 | |
| **Material Condition** | | | |
| Insitu Moisture Content (%) | | | |
| **Soil Classification Of The Material Based Only On The Tests Results Above** | | | |
| COLTO Specification: | | Not Classified | |
| AASHTO System | | A-4 | |
| Unified System | | CL | |

88293

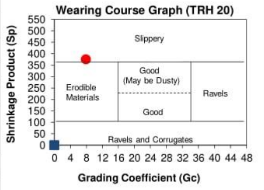



● 88293 ■

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Technical Signatory
For Outeniqua Lab (Pty) Ltd.



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R-FIND-1-6 Jan-22

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sanas Testing Laboratory T0347

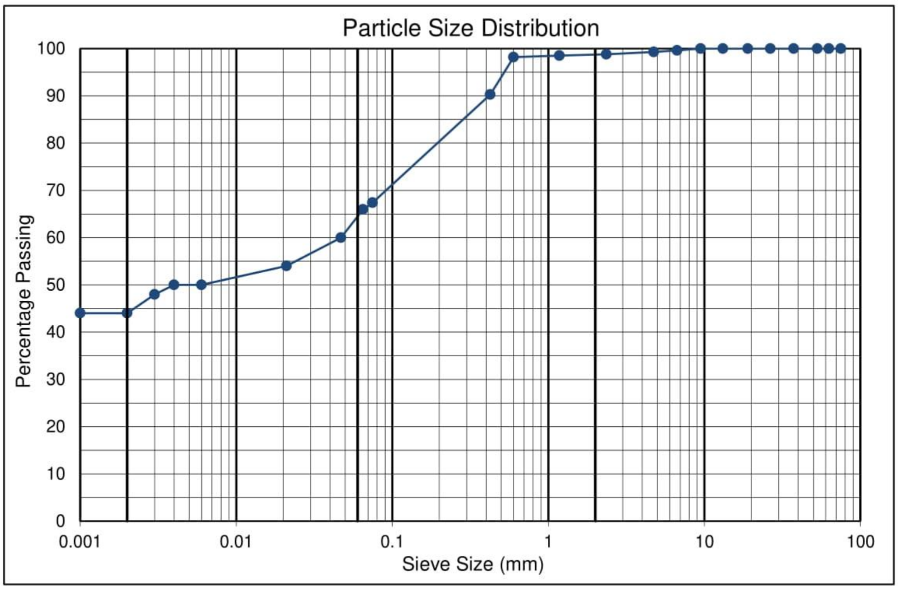
| | | | |
|---|---|---|---|
| Customer : | Terra Geotechnical<br>7 Albatros Street<br>Still Bay<br>6674 | Project :<br>Date Received :<br>Date Reported :<br>Req. Number : | Gwaing WWTW<br>18/04/2024<br>20/05/2024<br>1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 1 of 14 |

## TEST REPORT

## FOUNDATION INDICATOR - (ASTM Method D422)

| | | |
|---|---|---|
| Sample Position (SV) | | TP1 |
| Depth (mm): | | 1100-1800 |
| Sample No.: | | 88280 |
| Materials Description | Source | In-situ |
| | Colour | Light Reddish Orange |
| | Soil Type | Silt/Silty Clay |
| | Classification | Existing |

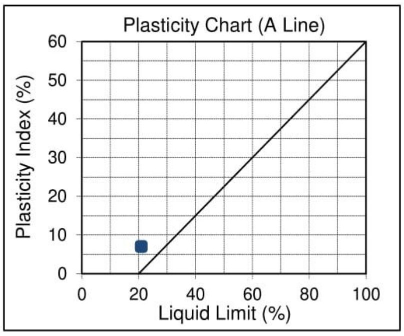
| Sieve | Percentage Passing |
|---|---|
| 75.0mm | 100 |
| 63.0mm | 100 |
| 53.0mm | 100 |
| 37.5mm | 100 |
| 26.5mm | 100 |
| 19mm | 100 |
| 13.2mm | 100 |
| 9.5mm | 100 |
| 6.7mm | 100 |
| 4.75mm | 99 |
| 2.36mm | 99 |
| 1.18mm | 99 |
| 0.6mm | 98 |
| 0.425mm | 90 |
| 0.075mm | 67 |
| 0.065mm | 66 |
| 0.047mm | 60 |
| 0.021mm | 54 |
| 0.006mm | 50 |
| 0.004mm | 50 |
| 0.003mm | 48 |
| 0.002mm | 44 |
| 0.001mm | 44 |

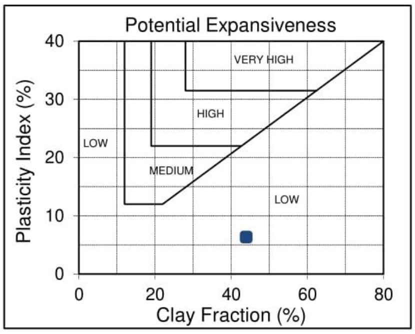



| | |
|---|---|
| Liquid Limit (%) | 21 |
| Plasticity Index (%) | 7 |
| Linear Shrinkage (%) | 4 |
| Moisture Content (%) | 0.0 |

| | |
|---|---|
| % Clay | 44 |
| % Silt | 20 |
| % Sand | 35 |
| % Gravel | 1 |

| | |
|---|---|
| Unified Soil Classification | CL-ML |
| AASHTO Soil Classification | A-4 |

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Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.



**Director: L Heathcote B-Tech. (Civil Eng.) & BSc Hons (Transport)**

OUTENIQUA LAB (Pty) Ltd.
Registration No. 95/07742/07
Materials Testing Laboratory
6 Mirrorball Street, George : PO Box 3186, George Industria, 6536
Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

R-FIND-1-6 Jan-22

T0347

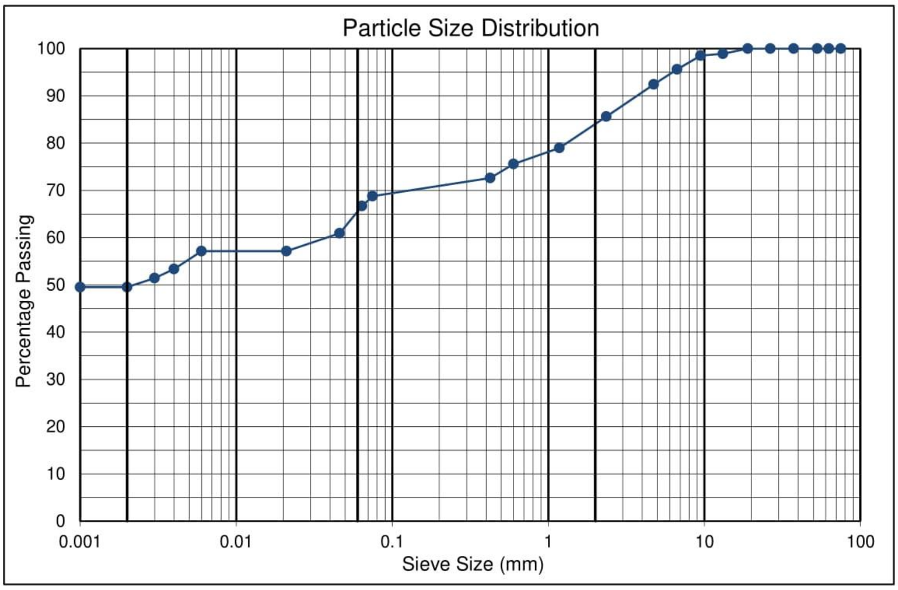
| | | | |
|---|---|---|---|
| Customer : | Terra Geotechnical<br>7 Albatros Street<br>Still Bay<br>6674 | Project :<br>Date Received :<br>Date Reported :<br>Req. Number : | Gwaing WWTW<br>18/04/2024<br>20/05/2024<br>1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 6 of 14 |

## TEST REPORT

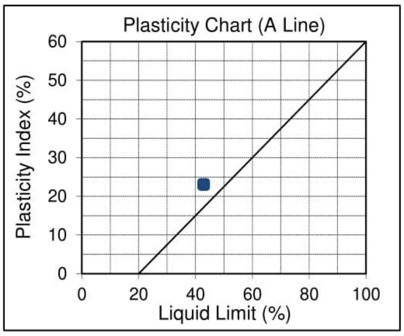
### FOUNDATION INDICATOR - (ASTM Method D422)

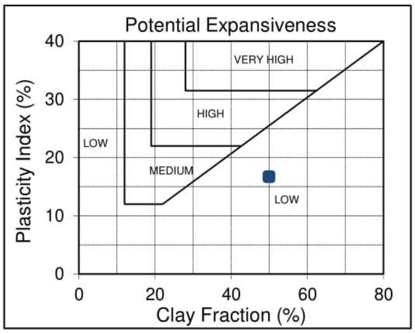
| | | |
|---|---|---|
| Sample Position (SV) | | TP6 |
| Depth (mm): | | 900-1800 |
| Sample No.: | | 88285 |
| Materials Description | Source | In-situ |
| | Colour | Light Brown Orange |
| | Soil Type | Sandy Lean Clay |
| | Classification | Existing |

| Percentage Passing | |
|---|---|
| 75.0mm | 100 |
| 63.0mm | 100 |
| 53.0mm | 100 |
| 37.5mm | 100 |
| 26.5mm | 100 |
| 19mm | 100 |
| 13.2mm | 99 |
| 9.5mm | 99 |
| 6.7mm | 96 |
| 4.75mm | 92 |
| 2.36mm | 86 |
| 1.18mm | 79 |
| 0.6mm | 76 |
| 0.425mm | 73 |
| 0.075mm | 69 |
| 0.064mm | 67 |
| 0.046mm | 61 |
| 0.021mm | 57 |
| 0.006mm | 57 |
| 0.004mm | 53 |
| 0.003mm | 51 |
| 0.002mm | 50 |
| 0.001mm | 50 |




| | |
|---|---|
| Liquid Limit (%) | 43 |
| Plasticity Index (%) | 23 |
| Linear Shrinkage (%) | 12 |
| Moisture Content (%) | 0.0 |
| % Clay | 50 |
| % Silt | 15 |
| % Sand | 19 |
| % Gravel | 16 |
| Unified Soil Classification | CL |
| AASHTO Soil Classification | A-7-6 |

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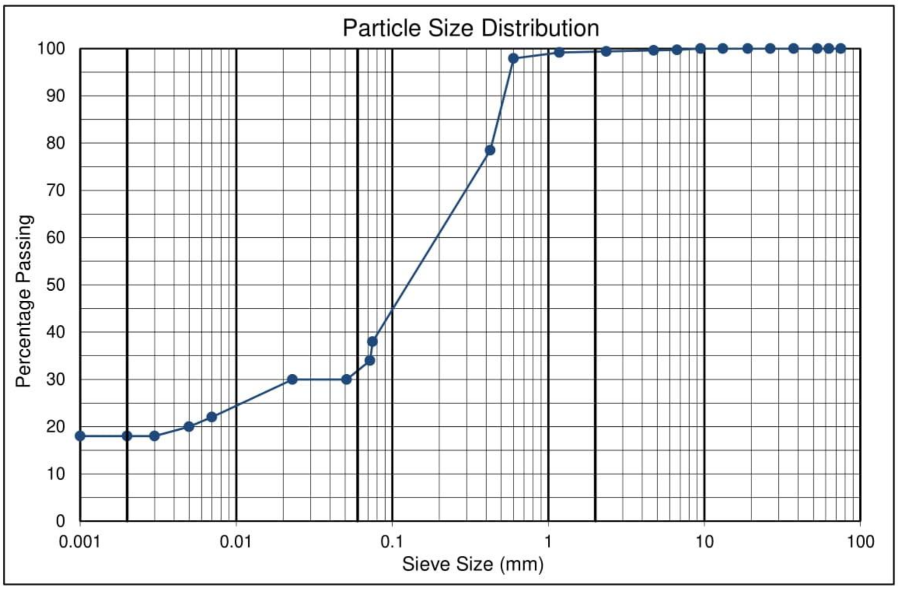
| | | | |
|---|---|---|---|
| Customer : | Terra Geotechnical<br>7 Albatros Street<br>Still Bay<br>6674 | Project : | Gwaing WWTW |
| | | Date Received : | 18/04/2024 |
| | | Date Reported : | 20/05/2024 |
| | | Req. Number : | 1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 7 of 14 |

## TEST REPORT

### FOUNDATION INDICATOR - (ASTM Method D422)

| | | |
|---|---|---|
| Sample Position (SV) | | TP7 |
| Depth (mm): | | 0-900 |
| Sample No.: | | 88286 |
| Materials Description | Source | In-situ |
| | Colour | Dark Brown |
| | Soil Type | Silty Sand |
| | Classification | Existing |

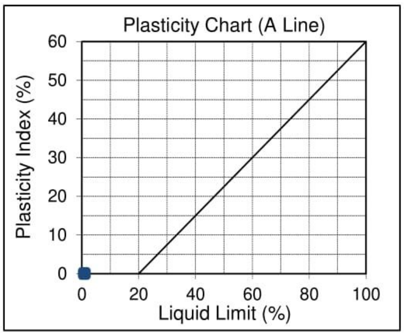
| Sieve | Percentage Passing |
|---|---|
| 75.0mm | 100 |
| 63.0mm | 100 |
| 53.0mm | 100 |
| 37.5mm | 100 |
| 26.5mm | 100 |
| 19mm | 100 |
| 13.2mm | 100 |
| 9.5mm | 100 |
| 6.7mm | 100 |
| 4.75mm | 100 |
| 2.36mm | 99 |
| 1.18mm | 99 |
| 0.6mm | 98 |
| 0.425mm | 79 |
| 0.075mm | 38 |
| 0.072mm | 34 |
| 0.051mm | 30 |
| 0.023mm | 30 |
| 0.007mm | 22 |
| 0.005mm | 20 |
| 0.003mm | 18 |
| 0.002mm | 18 |
| 0.001mm | 18 |

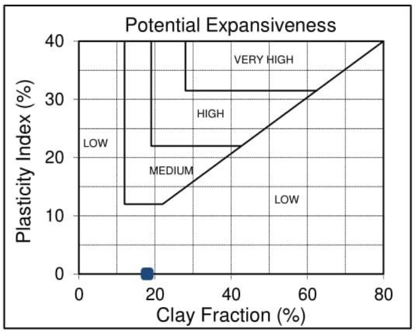



| | |
|---|---|
| Liquid Limit (%) | NP |
| Plasticity Index (%) | NP |
| Linear Shrinkage (%) | NP |
| Moisture Content (%) | 0.0 |

| | |
|---|---|
| % Clay | 18 |
| % Silt | 14 |
| % Sand | 67 |
| % Gravel | 1 |

| | |
|---|---|
| Unified Soil Classification | SM |
| AASHTO Soil Classification | A-4 |

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|---|---|---|---|
| Customer : | Terra Geotechnical<br>7 Albatros Street<br>Still Bay<br>6674 | Project : | Gwaing WWTW |
| | | Date Received : | 18/04/2024 |
| | | Date Reported : | 20/05/2024 |
| | | Req. Number : | 1219/24 |
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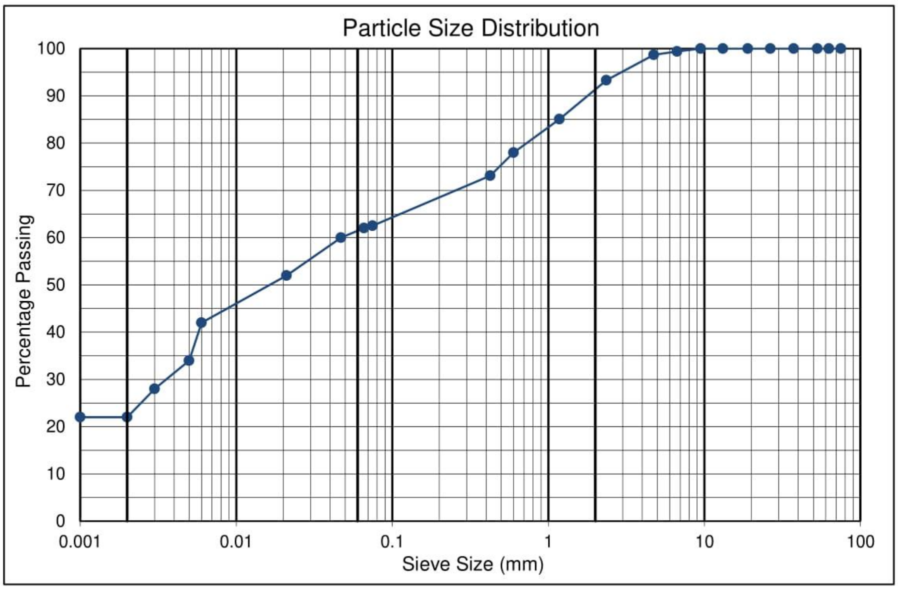
## TEST REPORT

### FOUNDATION INDICATOR - (ASTM Method D422)

| | | |
|---|---|---|
| Sample Position (SV) | | TP7 |
| Depth (mm): | | 1600-2700 |
| Sample No.: | | 88287 |
| Materials Description | Source | In-situ |
| | Colour | Dark Brown |
| | Soil Type | Sandy Lean Clay |
| | Classification | Existing |

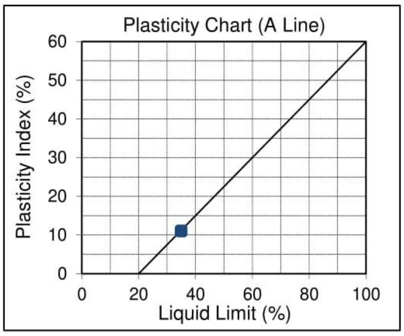
| Percentage Passing | |
|---|---|
| 75.0mm | 100 |
| 63.0mm | 100 |
| 53.0mm | 100 |
| 37.5mm | 100 |
| 26.5mm | 100 |
| 19mm | 100 |
| 13.2mm | 100 |
| 9.5mm | 100 |
| 6.7mm | 99 |
| 4.75mm | 99 |
| 2.36mm | 93 |
| 1.18mm | 85 |
| 0.6mm | 78 |
| 0.425mm | 73 |
| 0.075mm | 63 |
| 0.066mm | 62 |
| 0.047mm | 60 |
| 0.021mm | 52 |
| 0.006mm | 42 |
| 0.005mm | 34 |
| 0.003mm | 28 |
| 0.002mm | 22 |
| 0.001mm | 22 |

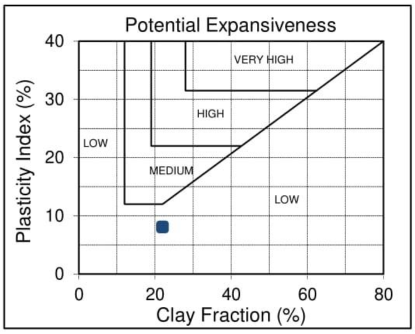



| | |
|---|---|
| Liquid Limit (%) | 35 |
| Plasticity Index (%) | 11 |
| Linear Shrinkage (%) | 6 |
| Moisture Content (%) | 0.0 |

| | |
|---|---|
| % Clay | 22 |
| % Silt | 39 |
| % Sand | 30 |
| % Gravel | 9 |

| | |
|---|---|
| Unified Soil Classification | CL |
| AASHTO Soil Classification | A-6 |

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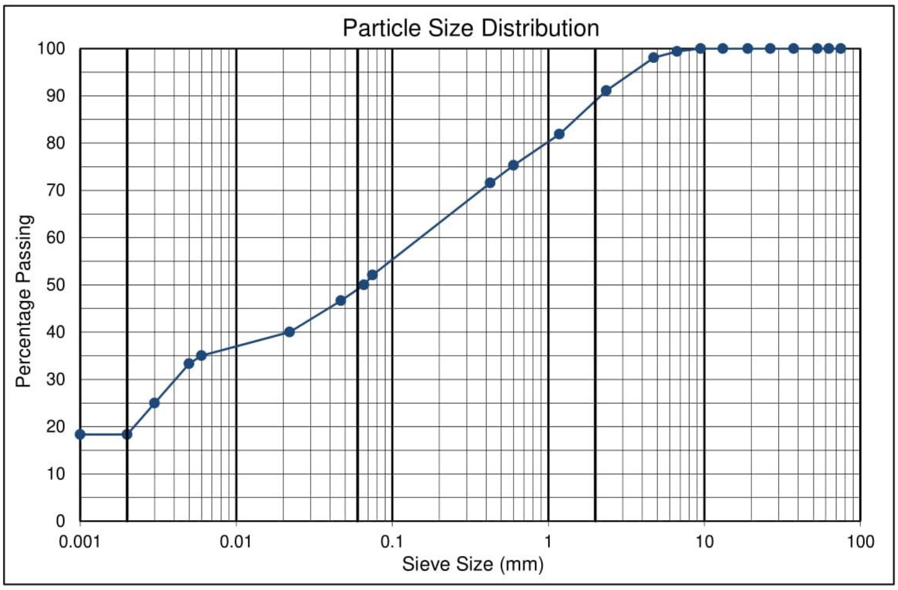
## TEST REPORT

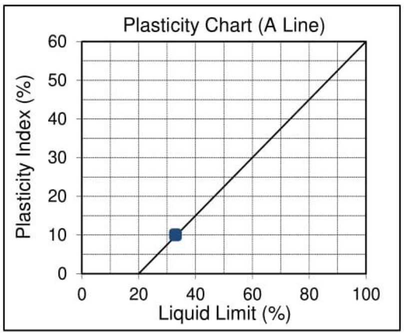
### FOUNDATION INDICATOR - (ASTM Method D422)

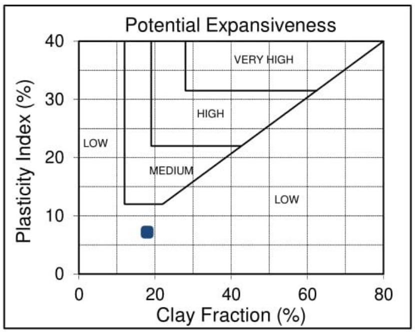
| | | |
|---|---|---|
| Sample Position (SV) | | TP9 |
| Depth (mm): | | 1100-2500 |
| Sample No.: | | 88288 |
| Materials Description | Source | In-situ |
| | Colour | Light Brown |
| | Soil Type | Sandy Lean Clay |
| | Classification | Existing |

| Percentage Passing | |
|---|---|
| 75.0mm | 100 |
| 63.0mm | 100 |
| 53.0mm | 100 |
| 37.5mm | 100 |
| 26.5mm | 100 |
| 19mm | 100 |
| 13.2mm | 100 |
| 9.5mm | 100 |
| 6.7mm | 99 |
| 4.75mm | 98 |
| 2.36mm | 91 |
| 1.18mm | 82 |
| 0.6mm | 75 |
| 0.425mm | 72 |
| 0.075mm | 52 |
| 0.066mm | 50 |
| 0.047mm | 47 |
| 0.022mm | 40 |
| 0.006mm | 35 |
| 0.005mm | 33 |
| 0.003mm | 25 |
| 0.002mm | 18 |
| 0.001mm | 18 |




| | |
|---|---|
| Liquid Limit (%) | 33 |
| Plasticity Index (%) | 10 |
| Linear Shrinkage (%) | 5 |
| Moisture Content (%) | 0.0 |
| % Clay | 18 |
| % Silt | 31 |
| % Sand | 39 |
| % Gravel | 12 |
| Unified Soil Classification | CL |
| AASHTO Soil Classification | A-4 |

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| | | Req. Number : | 1219/24 |
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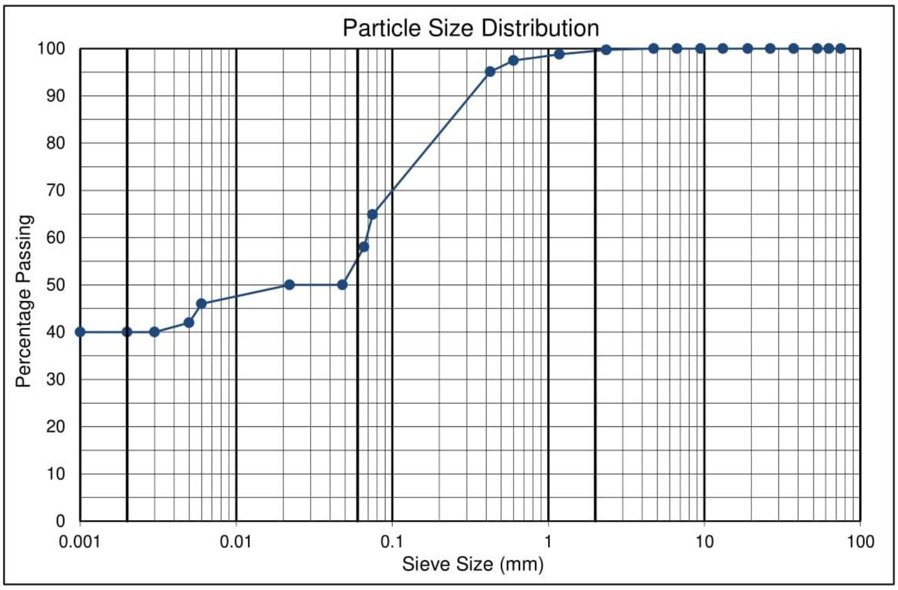
## TEST REPORT

### FOUNDATION INDICATOR - (ASTM Method D422)

| | | |
|---|---|---|
| Sample Position (SV) | | TP10 |
| Depth (mm): | | 1000-1700 |
| Sample No.: | | 88289 |
| Materials Description | Source | In-situ |
| | Colour | Light Brown |
| | Soil Type | Sandy Lean Clay |
| | Classification | Existing |

Percentage Passing

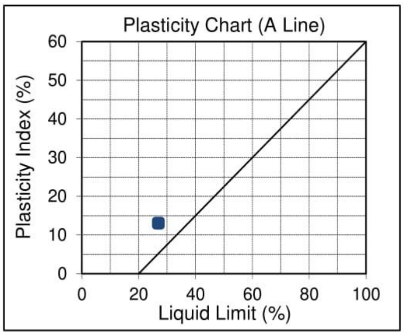
| Sieve | Percentage Passing |
|---|---|
| 75.0mm | 100 |
| 63.0mm | 100 |
| 53.0mm | 100 |
| 37.5mm | 100 |
| 26.5mm | 100 |
| 19mm | 100 |
| 13.2mm | 100 |
| 9.5mm | 100 |
| 6.7mm | 100 |
| 4.75mm | 100 |
| 2.36mm | 100 |
| 1.18mm | 99 |
| 0.6mm | 98 |
| 0.425mm | 95 |
| 0.075mm | 65 |
| 0.066mm | 58 |
| 0.048mm | 50 |
| 0.022mm | 50 |
| 0.006mm | 46 |
| 0.005mm | 42 |
| 0.003mm | 40 |
| 0.002mm | 40 |
| 0.001mm | 40 |

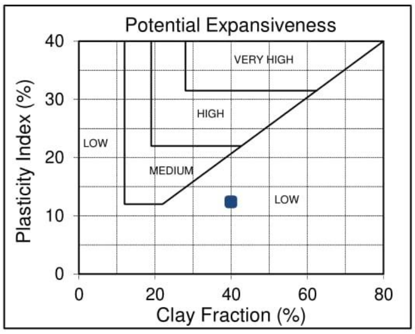



| | |
|---|---|
| Liquid Limit (%) | 27 |
| Plasticity Index (%) | 13 |
| Linear Shrinkage (%) | 7 |
| Moisture Content (%) | 0.0 |

| | |
|---|---|
| % Clay | 40 |
| % Silt | 15 |
| % Sand | 44 |
| % Gravel | 1 |

| | |
|---|---|
| Unified Soil Classification | CL |
| AASHTO Soil Classification | A-6 |

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| | | Req. Number : | 1219/24 |
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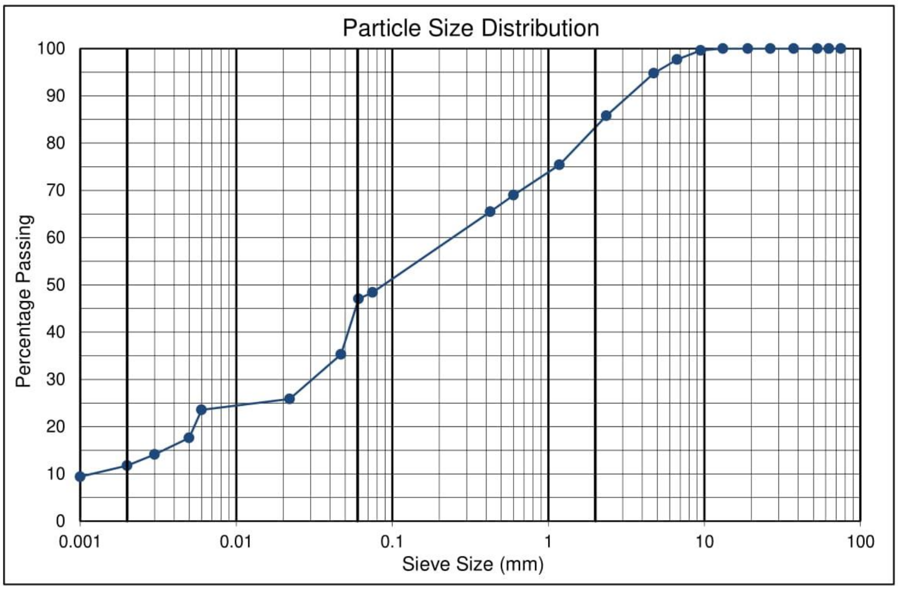
## TEST REPORT

## FOUNDATION INDICATOR - (ASTM Method D422)

| | |
|---|---|
| Sample Position (SV) | TP11 |
| Depth (mm): | 2200-2500 |
| Sample No.: | 88290 |
| Materials Description: Source | In-situ |
| Colour | Light Brown |
| Soil Type | Silty Sand |
| Classification | Existing |

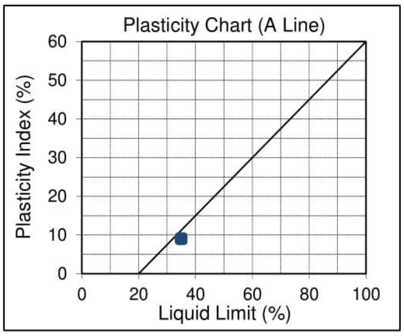
| Percentage Passing | |
|---|---|
| 75.0mm | 100 |
| 63.0mm | 100 |
| 53.0mm | 100 |
| 37.5mm | 100 |
| 26.5mm | 100 |
| 19mm | 100 |
| 13.2mm | 100 |
| 9.5mm | 100 |
| 6.7mm | 98 |
| 4.75mm | 95 |
| 2.36mm | 86 |
| 1.18mm | 75 |
| 0.6mm | 69 |
| 0.425mm | 66 |
| 0.075mm | 48 |
| 0.061mm | 47 |
| 0.047mm | 35 |
| 0.022mm | 26 |
| 0.006mm | 24 |
| 0.005mm | 18 |
| 0.003mm | 14 |
| 0.002mm | 12 |
| 0.001mm | 9 |

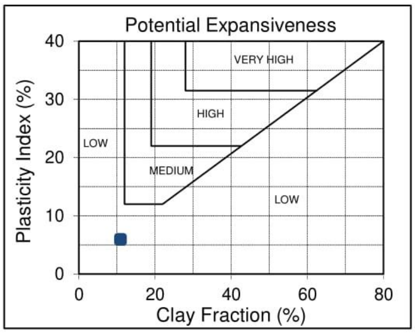



| | |
|---|---|
| Liquid Limit (%) | 35 |
| Plasticity Index (%) | 9 |
| Linear Shrinkage (%) | 5 |
| Moisture Content (%) | 0.0 |

| | |
|---|---|
| % Clay | 11 |
| % Silt | 35 |
| % Sand | 37 |
| % Gravel | 17 |

| | |
|---|---|
| Unified Soil Classification | SM |
| AASHTO Soil Classification | A-4 |

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| Attention : | Eugene van der Walt | No. of Pages : | 12 of 14 |

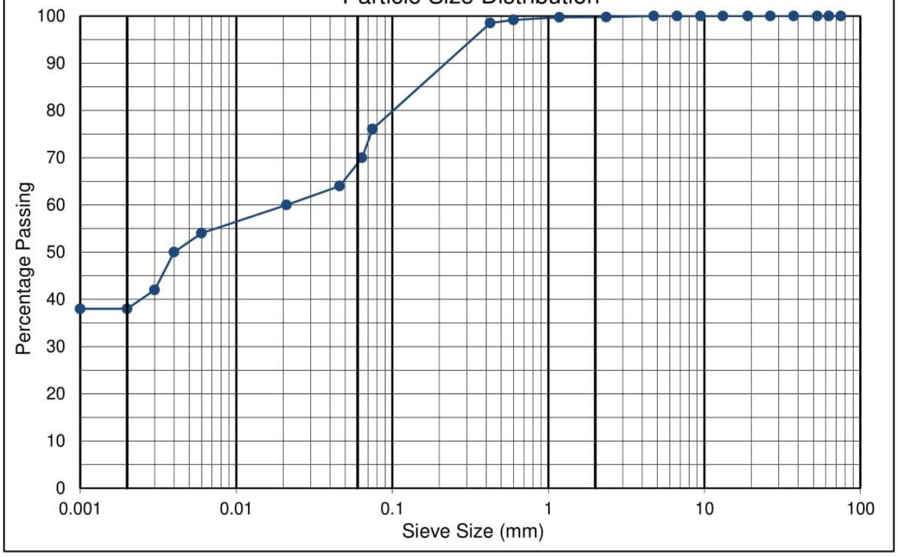
## TEST REPORT

## FOUNDATION INDICATOR - (ASTM Method D422)

| | | |
|---|---|---|
| Sample Position (SV) | | TP12 |
| Depth (mm): | | 1700-2600 |
| Sample No.: | | 88291 |
| Materials Description | Source | In-situ |
| | Colour | Light Red |
| | Soil Type | Silt/Silty Clay |
| | Classification | Existing |

| Sieve | Percentage Passing |
|---|---|
| 75.0mm | 100 |
| 63.0mm | 100 |
| 53.0mm | 100 |
| 37.5mm | 100 |
| 26.5mm | 100 |
| 19mm | 100 |
| 13.2mm | 100 |
| 9.5mm | 100 |
| 6.7mm | 100 |
| 4.75mm | 100 |
| 2.36mm | 100 |
| 1.18mm | 100 |
| 0.6mm | 99 |
| 0.425mm | 99 |
| 0.075mm | 76 |
| 0.064mm | 70 |
| 0.046mm | 64 |
| 0.021mm | 60 |
| 0.006mm | 54 |
| 0.004mm | 50 |
| 0.003mm | 42 |
| 0.002mm | 38 |
| 0.001mm | 38 |

Particle Size Distribution

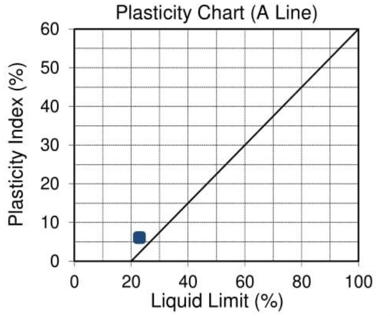



| | |
|---|---|
| Liquid Limit (%) | 23 |
| Plasticity Index (%) | 6 |
| Linear Shrinkage (%) | 3 |
| Moisture Content (%) | 0.0 |

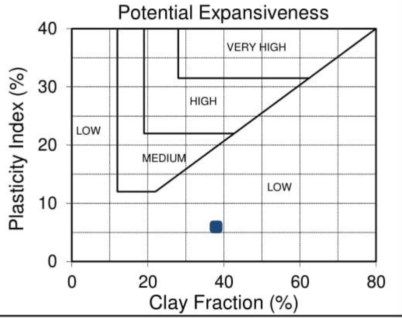
| | |
|---|---|
| % Clay | 38 |
| % Silt | 31 |
| % Sand | 31 |
| % Gravel | 0 |

| | |
|---|---|
| Unified Soil Classification | CL-ML |
| AASHTO Soil Classification | A-4 |

Plasticity Chart (A Line)




Potential Expansiveness

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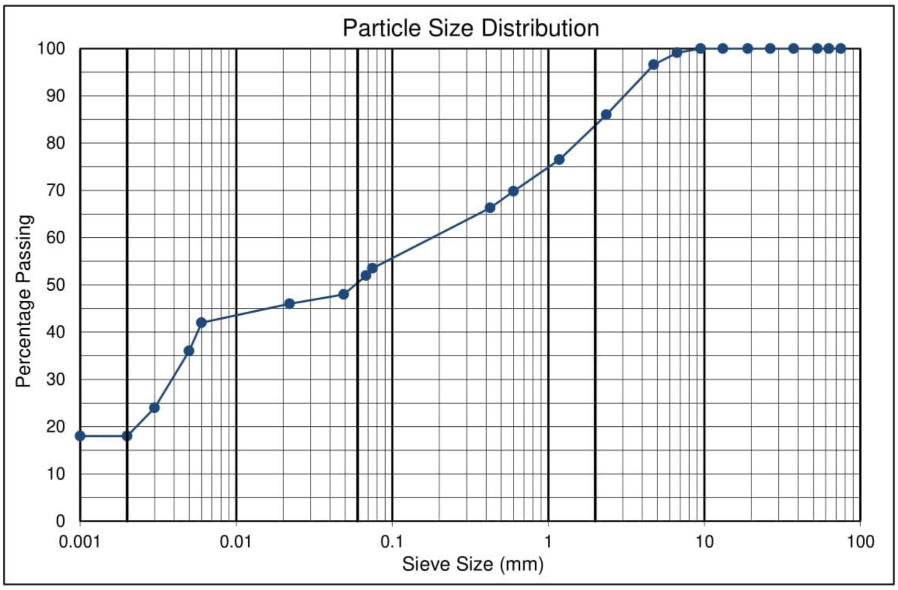
| | | Date Received : | 18/04/2024 |
| | | Date Reported : | 20/05/2024 |
| | | Req. Number : | 1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 13 of 14 |

## TEST REPORT

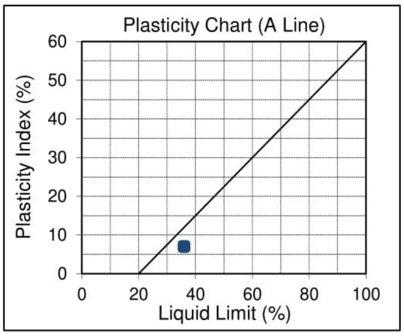
### FOUNDATION INDICATOR - (ASTM Method D422)

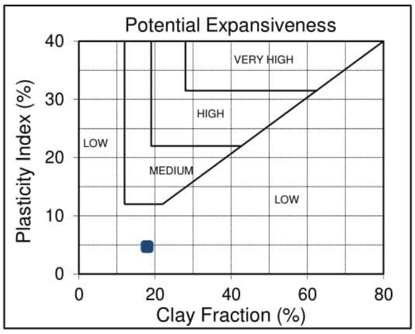
| | |
|---|---|
| Sample Position (SV) | TP13 |
| Depth (mm): | 1000-2500 |
| Sample No.: | 88292 |
| Materials Description: Source | In-situ |
| Colour | Light Brown |
| Soil Type | Sandy Silt |
| Classification | Existing |

| Sieve | Percentage Passing |
|---|---|
| 75.0mm | 100 |
| 63.0mm | 100 |
| 53.0mm | 100 |
| 37.5mm | 100 |
| 26.5mm | 100 |
| 19mm | 100 |
| 13.2mm | 100 |
| 9.5mm | 100 |
| 6.7mm | 99 |
| 4.75mm | 97 |
| 2.36mm | 86 |
| 1.18mm | 77 |
| 0.6mm | 70 |
| 0.425mm | 66 |
| 0.075mm | 54 |
| 0.068mm | 52 |
| 0.049mm | 48 |
| 0.022mm | 46 |
| 0.006mm | 42 |
| 0.005mm | 36 |
| 0.003mm | 24 |
| 0.002mm | 18 |
| 0.001mm | 18 |




| | |
|---|---|
| Liquid Limit (%) | 36 |
| Plasticity Index (%) | 7 |
| Linear Shrinkage (%) | 4 |
| Moisture Content (%) | 0.0 |
| % Clay | 18 |
| % Silt | 32 |
| % Sand | 33 |
| % Gravel | 17 |
| Unified Soil Classification | ML |
| AASHTO Soil Classification | A-4 |




- **Specimen delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.



**Director:** **L Heathcote B-Tech. (Civil Eng.) & BSc Hons (Transport)**

R-FIND-1-6 Jan-22

# OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07
**Materials Testing Laboratory**
6 Mirrorball Street, George : PO Box 3186, George Industria, 6536
Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

T0347

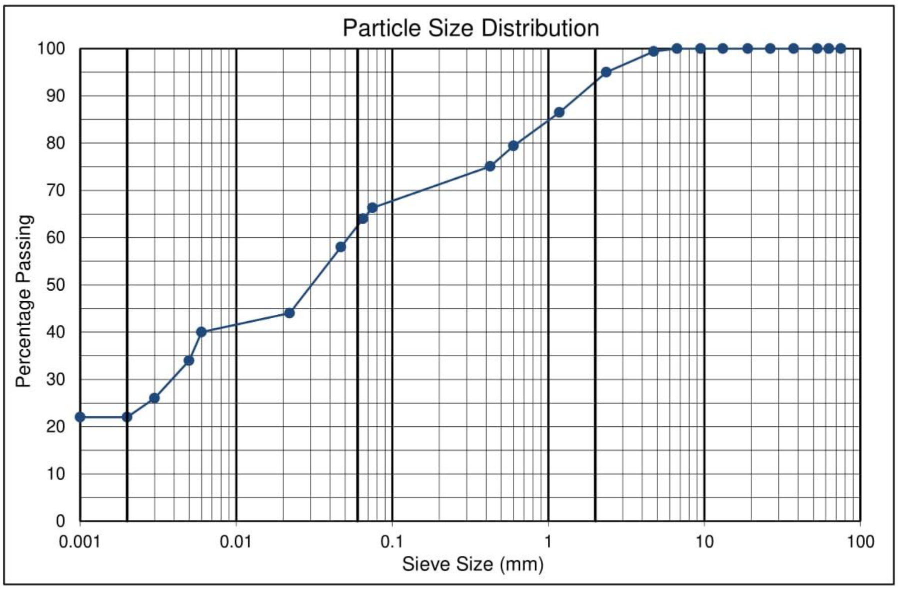
| | | | |
|---|---|---|---|
| Customer : | Terra Geotechnical<br>7 Albatros Street<br>Still Bay<br>6674 | Project : | Gwaing WWTW |
| | | Date Received : | 18/04/2024 |
| | | Date Reported : | 20/05/2024 |
| | | Req. Number : | 1219/24 |
| Attention : | Eugene van der Walt | No. of Pages : | 14 of 14 |

## TEST REPORT

## FOUNDATION INDICATOR - (ASTM Method D422)

| | | |
|---|---|---|
| Sample Position (SV) | | TP14 |
| Depth (mm): | | 1600-2700 |
| Sample No.: | | 88293 |
| Materials Description | Source | In-situ |
| | Colour | Dark Brown |
| | Soil Type | Sandy Lean Clay |
| | Classification | Existing |

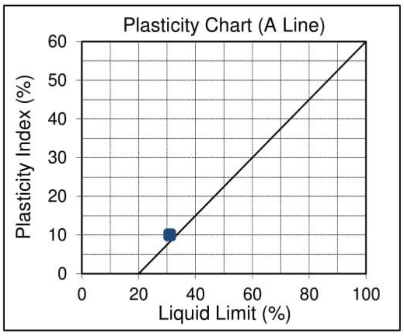
| Percentage Passing | |
|---|---|
| 75.0mm | 100 |
| 63.0mm | 100 |
| 53.0mm | 100 |
| 37.5mm | 100 |
| 26.5mm | 100 |
| 19mm | 100 |
| 13.2mm | 100 |
| 9.5mm | 100 |
| 6.7mm | 100 |
| 4.75mm | 99 |
| 2.36mm | 95 |
| 1.18mm | 87 |
| 0.6mm | 79 |
| 0.425mm | 75 |
| 0.075mm | 66 |
| 0.065mm | 64 |
| 0.047mm | 58 |
| 0.022mm | 44 |
| 0.006mm | 40 |
| 0.005mm | 34 |
| 0.003mm | 26 |
| 0.002mm | 22 |
| 0.001mm | 22 |

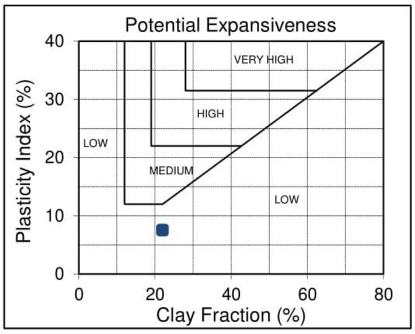



| | |
|---|---|
| Liquid Limit (%) | 31 |
| Plasticity Index (%) | 10 |
| Linear Shrinkage (%) | 5 |
| Moisture Content (%) | 0.0 |

| | |
|---|---|
| % Clay | 22 |
| % Silt | 40 |
| % Sand | 30 |
| % Gravel | 8 |

| | |
|---|---|
| Unified Soil Classification | CL |
| AASHTO Soil Classification | A-4 |




- **Specimen delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.



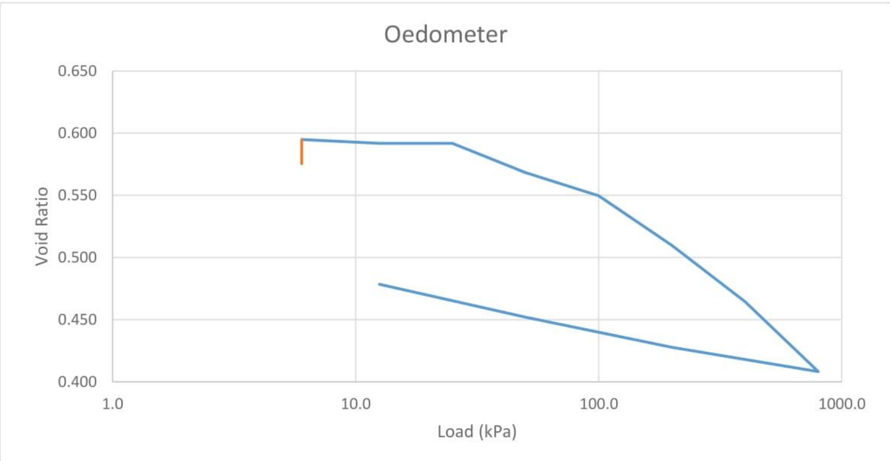
**Director:** **L Heathcote B-Tech. (Civil Eng.) & BSc Hons (Transport)**

## Oedometer Swell Test

| Sample Detail | | Initial | Final |
|---|---|---|---|
| Height | (mm) | 20.2 | 18.9 |
| Diameter | (mm) | 63.2 | 63.2 |
| Weight | (g) | 125.7 | 125.7 |
| Moisture | (%) | 24.3 | 26.8 |
| Dry Density | ($Mg/m^3$) | 1.60 | 1.67 |
| Bulk Density | ($Mg/m^3$) | 1.98 | 2.11 |
| Void Ratio | | 0.575 | 0.479 |
| SG | | 2.52 | |
| Disturbed/Undisturbed | | Undisturbed | |
| Remoulded Density | ($Mg/m^3$) | - | |

| Load (kPa) | Height (mm) | Void Ratio |
|---|---|---|
| 6.0 | 20.170 | 0.575 |
| 6.0 | 20.420 | 0.595 |
| 12.5 | 20.380 | 0.592 |
| 25 | 20.380 | 0.592 |
| 50 | 20.080 | 0.568 |
| 100 | 19.840 | 0.550 |
| 200 | 19.330 | 0.510 |
| 400 | 18.750 | 0.464 |
| 800 | 18.030 | 0.408 |
| 200 | 18.280 | 0.428 |
| 50 | 18.590 | 0.452 |
| 12.5 | 18.930 | 0.479 |

| Swell Results | | |
|---|---|---|
| Swell Percentage | 1.2 | % |
| Swell Pressure | 36 | kPa |




STEYN-WILSON GEOTECHNICAL

sanas

| Project | Gwaing WWTW | | |
|---|---|---|---|
| Sample | G10 | | |
| Client | Terra Geotechnical | Test Method | BS1377 - 5: 1990 |
| Jobfile | SWL35304 | Test Date | 27 04 2024 |

01/02/2021 Rev2 TR/GEO-SW0009 Compiled: M. Steyn Approved: R. Wilson

# APPENDIX C

# C.1

# DPSH Test Results

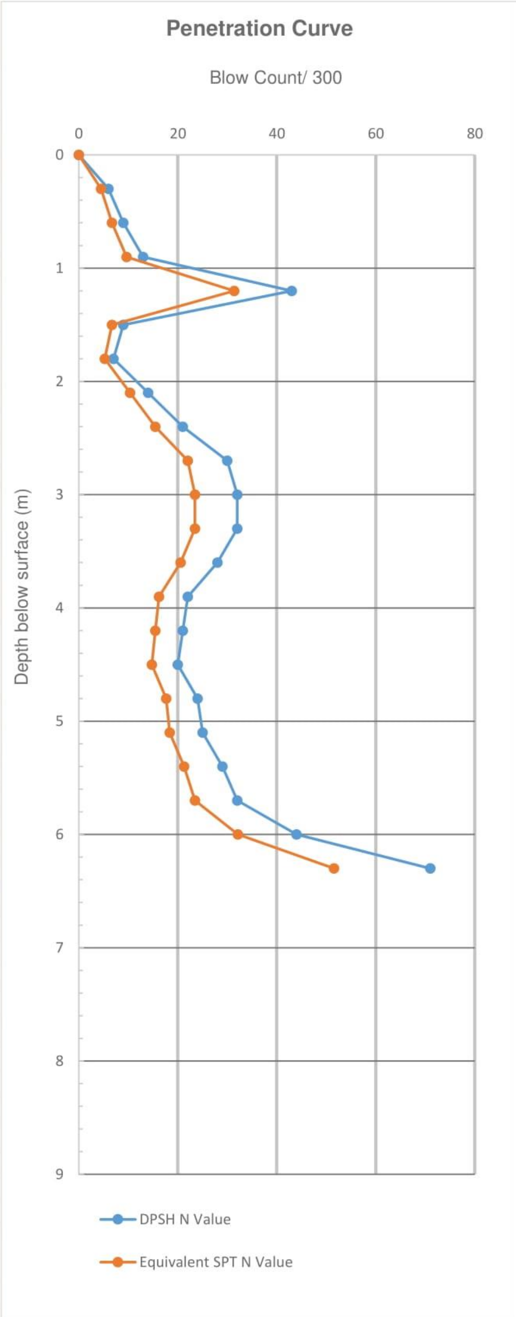
Terra GeoTechnical

Where Engineering Meets Earth

| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.992794 S 22.423970 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 1

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 6 | 4,5 | Firm |
| 0,6 | 9 | 6,7 | Firm |
| 0,9 | 13 | 9,6 | Stiff |
| 1,2 | 43 | 31,4 | Hard |
| 1,5 | 9 | 6,7 | Firm |
| 1,8 | 7 | 5,2 | Firm |
| 2,1 | 14 | 10,4 | Stiff |
| 2,4 | 21 | 15,5 | Very stiff |
| 2,7 | 30 | 22,0 | Very stiff |
| 3 | 32 | 23,5 | Very stiff |
| 3,3 | 32 | 23,5 | Very stiff |
| 3,6 | 28 | 20,6 | Very stiff |
| 3,9 | 22 | 16,2 | Very stiff |
| 4,2 | 21 | 15,5 | Very stiff |
| 4,5 | 20 | 14,7 | Stiff |
| 4,8 | 24 | 17,7 | Very stiff |
| 5,1 | 25 | 18,4 | Very stiff |
| 5,4 | 29 | 21,3 | Very stiff |
| 5,7 | 32 | 23,5 | Very stiff |
| 6 | 44 | 32,1 | Hard |
| 6,3 | 46 | 51,5 | Hard |

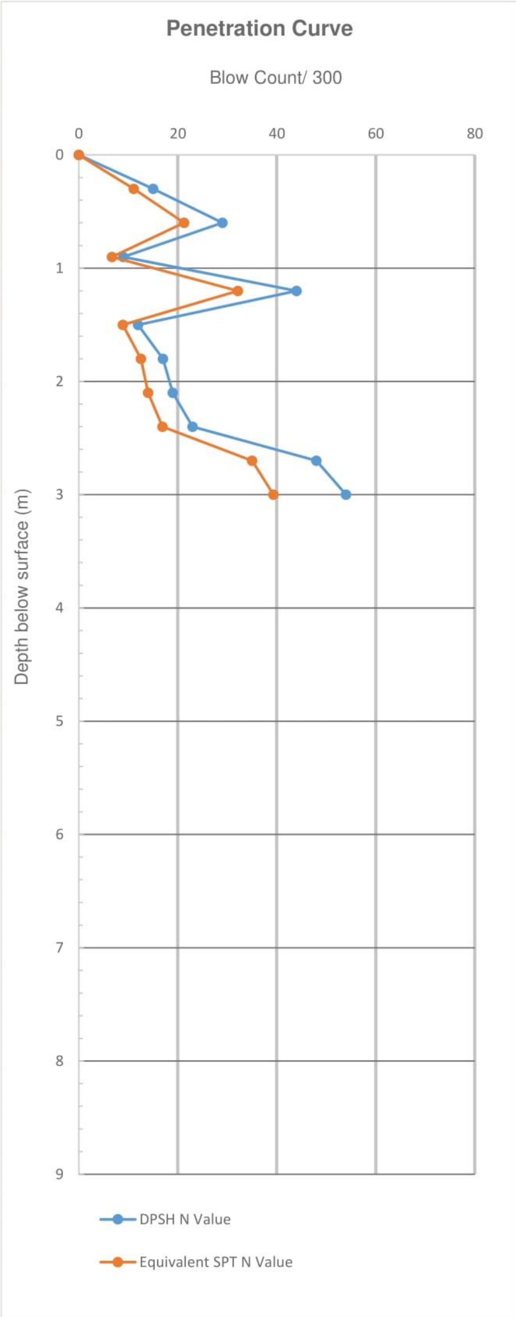


Where Engineering Meets Earth

| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.993071 S 22.424650 E |
| Date | Jun-24 |
| Notes | Test Conducted from the surface |

## DPSH 2.1

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 15 | 11,1 | Stiff |
| 0,6 | 29 | 21,3 | Very stiff |
| 0,9 | 9 | 6,7 | Firm |
| 1,2 | 44 | 32,1 | Hard |
| 1,5 | 12 | 8,9 | Stiff |
| 1,8 | 17 | 12,6 | Stiff |
| 2,1 | 19 | 14,0 | Stiff |
| 2,4 | 23 | 16,9 | Very stiff |
| 2,7 | 48 | 35,0 | Hard |
| 3 | 54 | 39,3 | Hard |

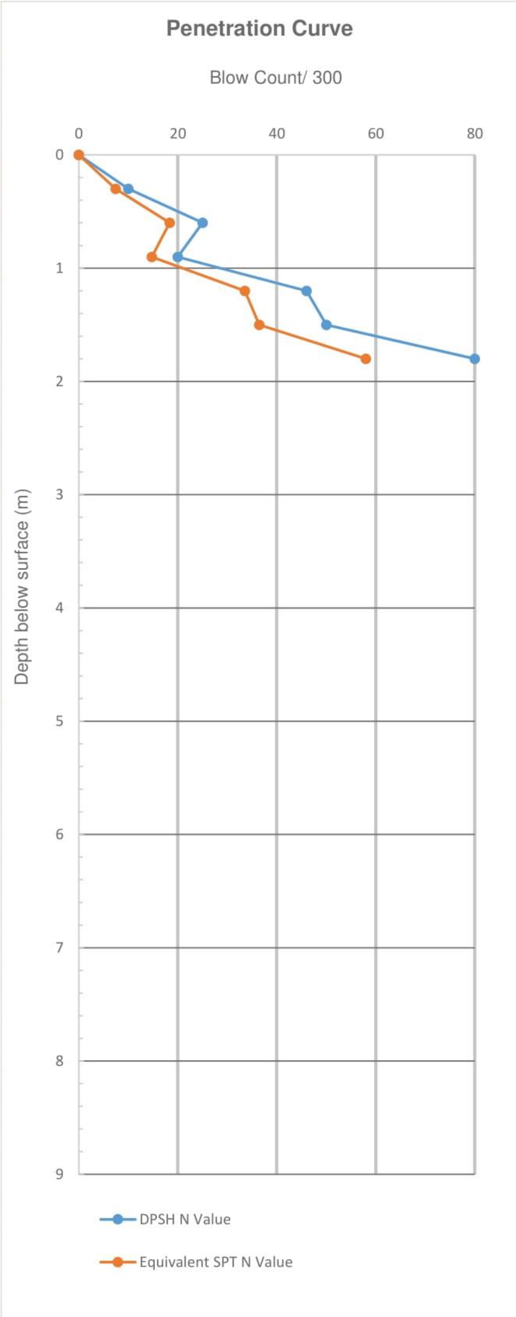


Where Engineering Meets Earth

| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.993370 S 22.425082 E |
| Date | Jun-24 |
| Notes | Test Conducted from the surface |

## DPSH 2.2

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 10 | 7,4 | Firm |
| 0,6 | 25 | 18,4 | Very stiff |
| 0,9 | 20 | 14,7 | Stiff |
| 1,2 | 46 | 33,6 | Hard |
| 1,5 | 50 | 36,5 | Hard |
| 1,8 | 80 | 58,0 | Hard |



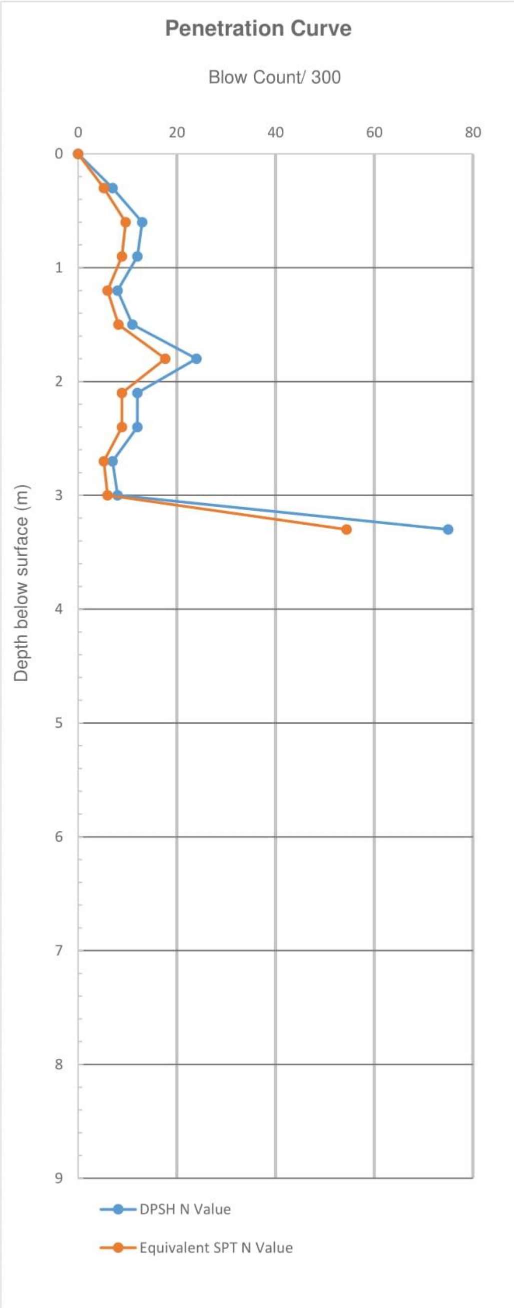
Terra GeoTechnical

Where Engineering Meets Earth

| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.993088 S 22.423109 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 3.1

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 7 | 5,2 | Firm |
| 0,6 | 13 | 9,6 | Stiff |
| 0,9 | 12 | 8,9 | Stiff |
| 1,2 | 8 | 6,0 | Firm |
| 1,5 | 11 | 8,2 | Stiff |
| 1,8 | 24 | 17,7 | Very stiff |
| 2,1 | 12 | 8,9 | Stiff |
| 2,4 | 12 | 8,9 | Stiff |
| 2,7 | 7 | 5,2 | Firm |
| 3 | 8 | 6,0 | Firm |
| 3,3 | 75 | 54,4 | Hard |





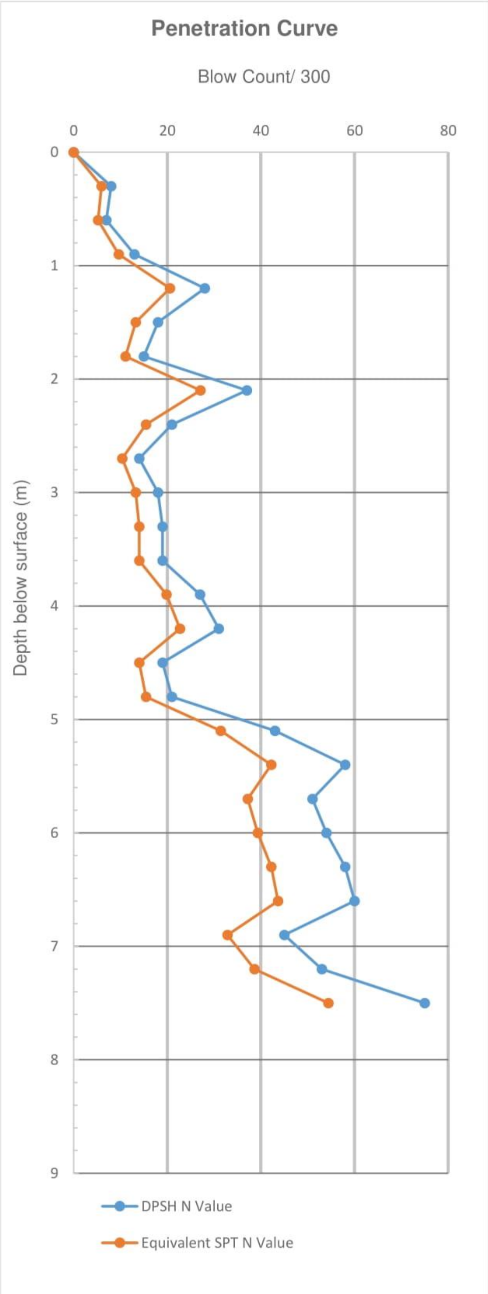

Terra GeoTechnical

Terra GeoTechnical
Where Engineering Meets Earth

| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.993262 S 22.423232 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 3.2

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 8 | 6,0 | Firm |
| 0,6 | 7 | 5,2 | Firm |
| 0,9 | 13 | 9,6 | Stiff |
| 1,2 | 28 | 20,6 | Very stiff |
| 1,5 | 18 | 13,3 | Stiff |
| 1,8 | 15 | 11,1 | Stiff |
| 2,1 | 37 | 27,1 | Very stiff |
| 2,4 | 21 | 15,5 | Very stiff |
| 2,7 | 14 | 10,4 | Stiff |
| 3 | 18 | 13,3 | Stiff |
| 3,3 | 19 | 14,0 | Stiff |
| 3,6 | 19 | 14,0 | Stiff |
| 3,9 | 27 | 19,8 | Very stiff |
| 4,2 | 31 | 22,7 | Very stiff |
| 4,5 | 19 | 14,0 | Stiff |
| 4,8 | 21 | 15,5 | Very stiff |
| 5,1 | 43 | 31,4 | Hard |
| 5,4 | 58 | 42,2 | Hard |
| 5,7 | 51 | 37,2 | Hard |
| 6 | 54 | 39,3 | Hard |
| 6,3 | 58 | 42,2 | Hard |
| 6,6 | 60 | 43,7 | Hard |
| 6,9 | 45 | 32,9 | Hard |
| 7,2 | 53 | 38,6 | Hard |
| 7,5 | 75 | 54,4 | Hard |





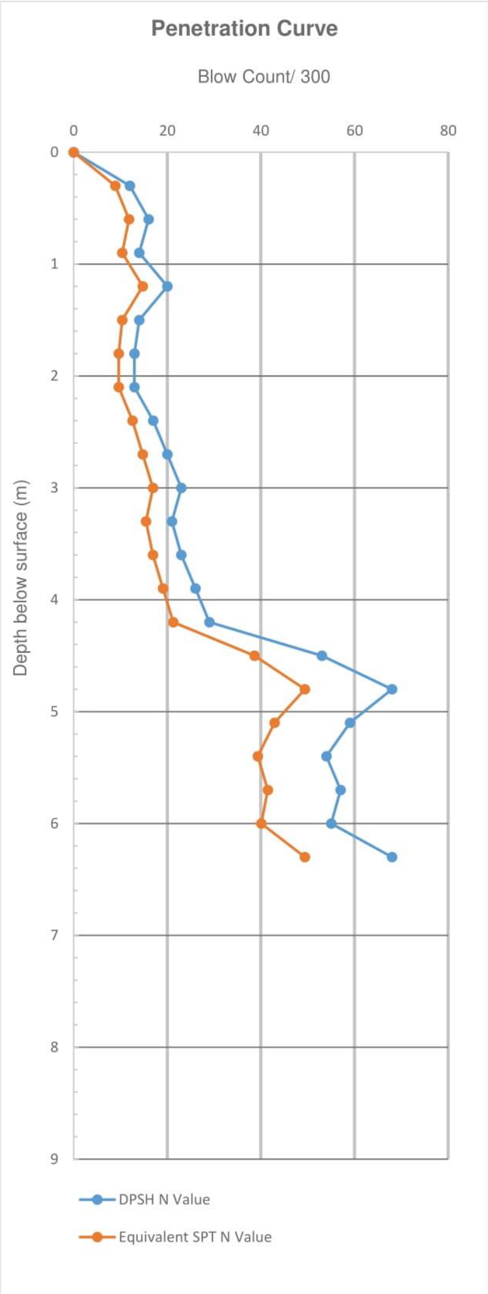

Terra GeoTechnical

Terra GeoTechnical
Where Engineering Meets Earth

| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.993759 S 22.422846 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 4

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 12 | 8,9 | Stiff |
| 0,6 | 16 | 11,8 | Stiff |
| 0,9 | 14 | 10,4 | Stiff |
| 1,2 | 20 | 14,7 | Stiff |
| 1,5 | 14 | 10,4 | Stiff |
| 1,8 | 13 | 9,6 | Stiff |
| 2,1 | 13 | 9,6 | Stiff |
| 2,4 | 17 | 12,6 | Stiff |
| 2,7 | 20 | 14,7 | Stiff |
| 3 | 23 | 16,9 | Very stiff |
| 3,3 | 21 | 15,5 | Very stiff |
| 3,6 | 23 | 16,9 | Very stiff |
| 3,9 | 26 | 19,1 | Very stiff |
| 4,2 | 29 | 21,3 | Very stiff |
| 4,5 | 53 | 38,6 | Hard |
| 4,8 | 68 | 49,4 | Hard |
| 5,1 | 59 | 42,9 | Hard |
| 5,4 | 54 | 39,3 | Hard |
| 5,7 | 57 | 41,5 | Hard |
| 6 | 55 | 40,1 | Hard |
| 6,3 | 68 | 49,4 | Hard |





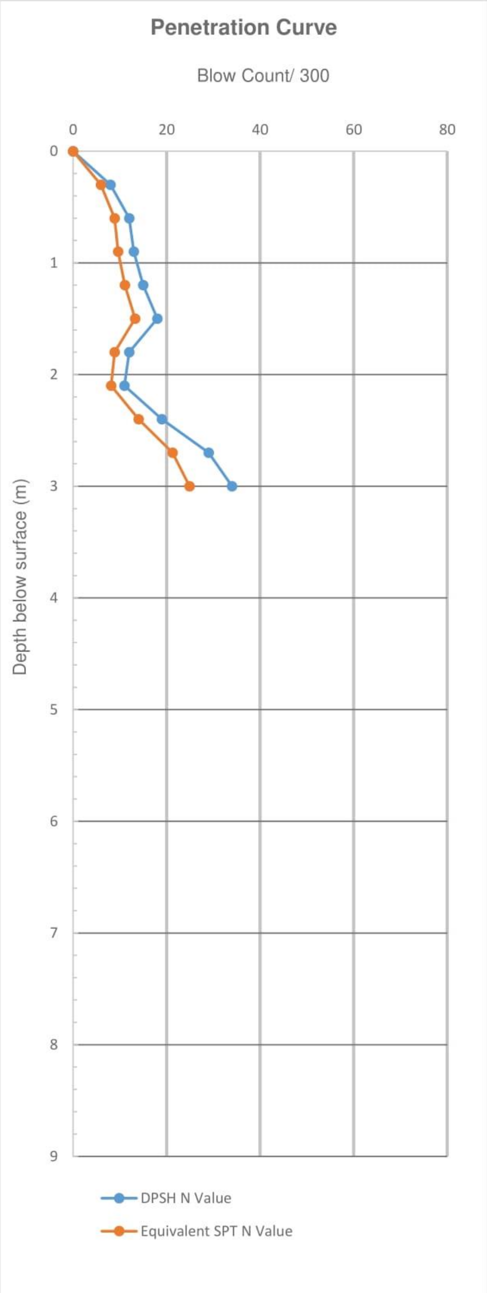

Terra GeoTechnical

Where Engineering Meets Earth

| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.993784 S 22.423826 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 5

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 8 | 6,0 | Stiff |
| 0,6 | 12 | 8,9 | Stiff |
| 0,9 | 13 | 9,6 | Stiff |
| 1,2 | 15 | 11,1 | Very stiff |
| 1,5 | 18 | 13,3 | Very stiff |
| 1,8 | 12 | 8,9 | Stiff |
| 2,1 | 11 | 8,2 | Stiff |
| 2,4 | 19 | 14,0 | Very stiff |
| 2,7 | 29 | 21,3 | Very stiff |
| 3 | 34 | 24,9 | Hard |



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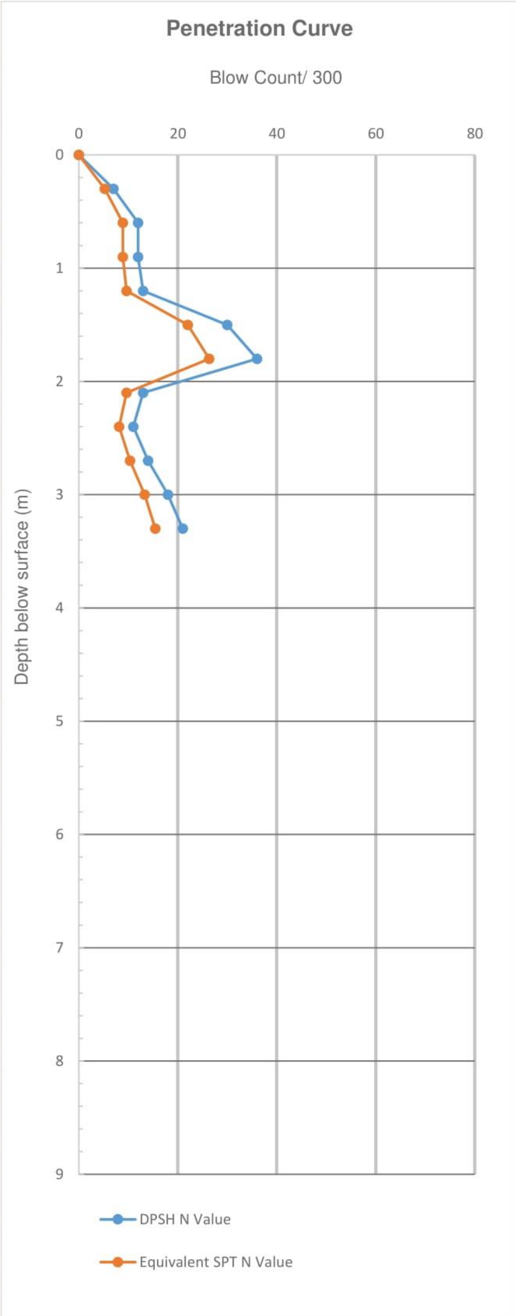
| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.994529 S 22.423189 E |
| Date | Jun-24 |
| Notes | Test Conducted from the surface |

## DPSH 6

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 7 | 5,2 | Firm |
| 0,6 | 12 | 8,9 | Stiff |
| 0,9 | 12 | 8,9 | Stiff |
| 1,2 | 13 | 9,6 | Stiff |
| 1,5 | 30 | 22,0 | Very stiff |
| 1,8 | 36 | 26,4 | Very stiff |
| 2,1 | 13 | 9,6 | Stiff |
| 2,4 | 11 | 8,2 | Stiff |
| 2,7 | 14 | 10,4 | Stiff |
| 3 | 18 | 13,3 | Stiff |
| 3,3 | 21 | 15,5 | Very stiff |



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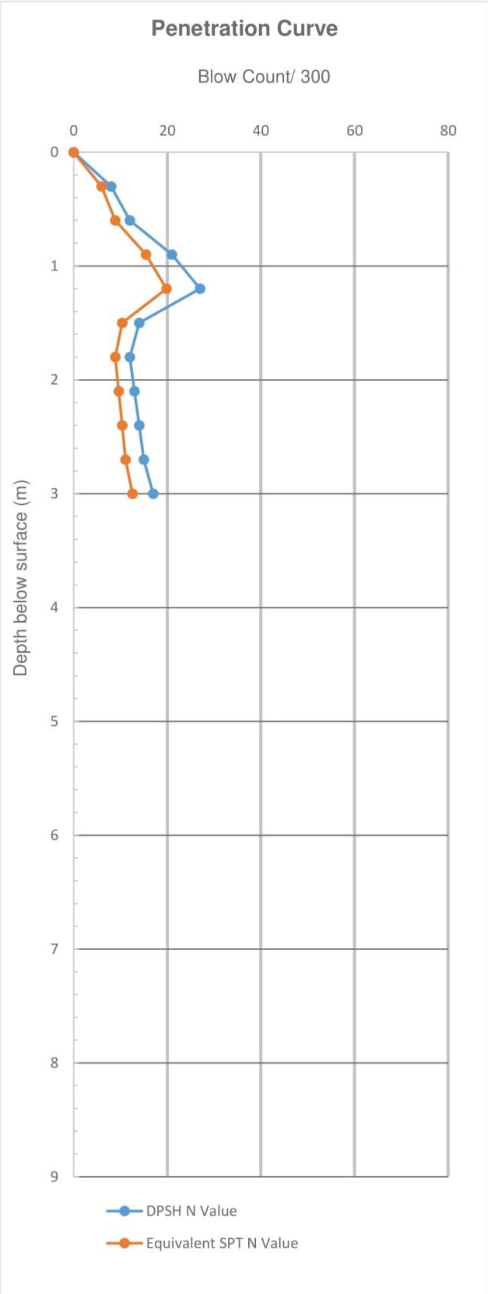
Where Engineering Meets Earth

| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.994376 S 22.424349 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 7.1

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 8 | 6,0 | Firm |
| 0,6 | 12 | 8,9 | Stiff |
| 0,9 | 21 | 15,5 | Very stiff |
| 1,2 | 27 | 19,8 | Very stiff |
| 1,5 | 14 | 10,4 | Stiff |
| 1,8 | 12 | 8,9 | Stiff |
| 2,1 | 13 | 9,6 | Stiff |
| 2,4 | 14 | 10,4 | Stiff |
| 2,7 | 15 | 11,1 | Stiff |
| 3 | 17 | 12,6 | Stiff |






Terra GeoTechnical

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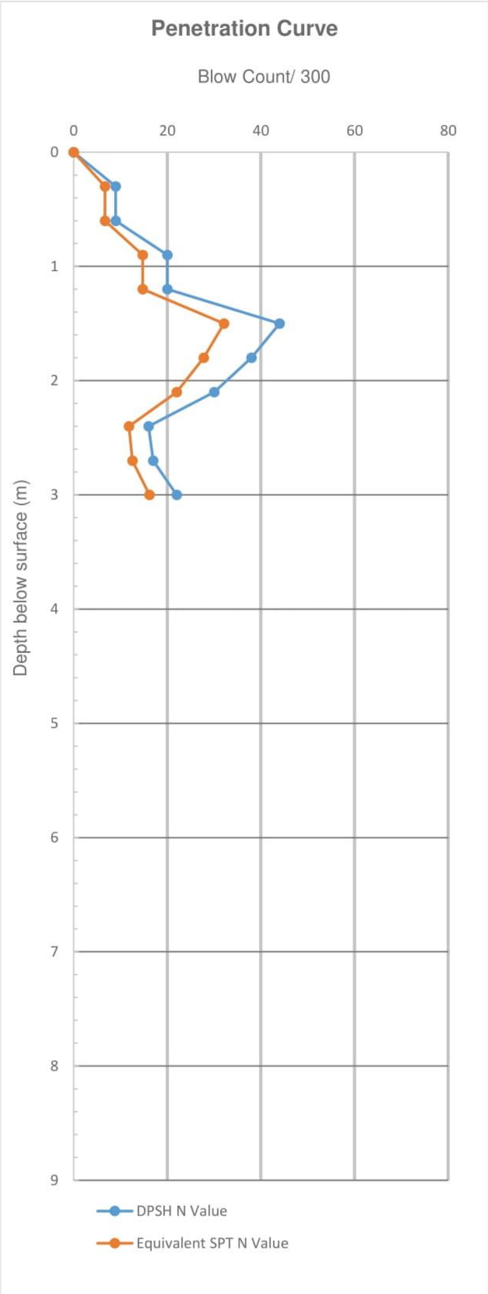
| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.994530 S 22.424344 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 7.2

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 9 | 6,7 | Firm |
| 0,6 | 9 | 6,7 | Firm |
| 0,9 | 20 | 14,7 | Stiff |
| 1,2 | 20 | 14,7 | Stiff |
| 1,5 | 44 | 32,1 | Hard |
| 1,8 | 38 | 27,8 | Very stiff |
| 2,1 | 30 | 22,0 | Very stiff |
| 2,4 | 16 | 11,8 | Stiff |
| 2,7 | 17 | 12,6 | Stiff |
| 3 | 22 | 16,2 | Very stiff |

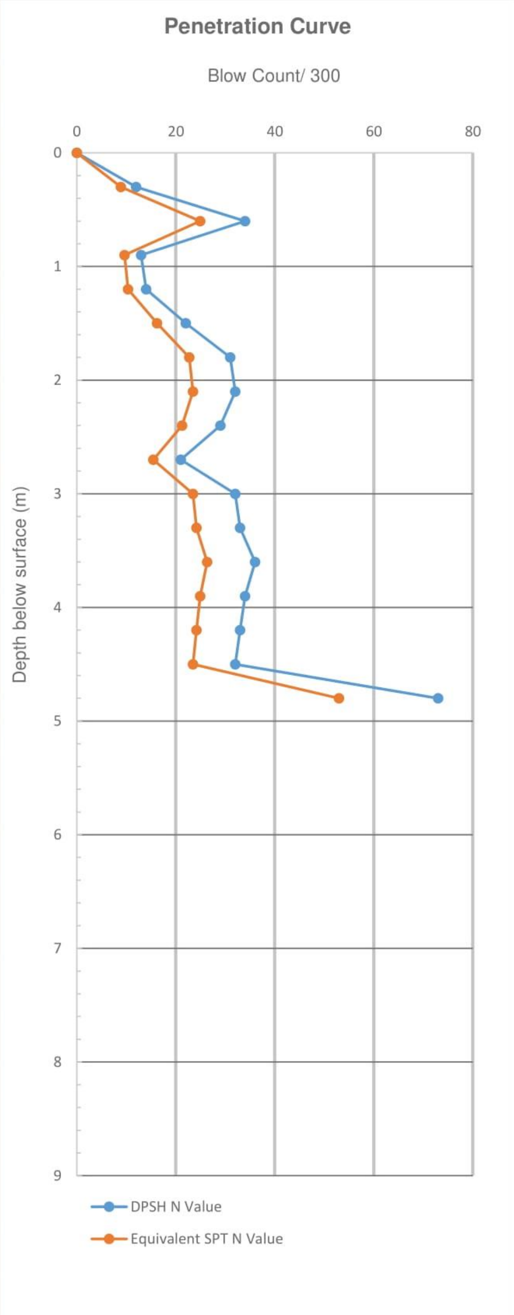


Terra GeoTechnical
Where Engineering Meets Earth

| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.995914 S 22.422949 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 9.1

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 12 | 8,9 | Stiff |
| 0,6 | 34 | 24,9 | Very stiff |
| 0,9 | 13 | 9,6 | Stiff |
| 1,2 | 14 | 10,4 | Stiff |
| 1,5 | 22 | 16,2 | Very stiff |
| 1,8 | 31 | 22,7 | Very stiff |
| 2,1 | 32 | 23,5 | Very stiff |
| 2,4 | 29 | 21,3 | Very stiff |
| 2,7 | 21 | 15,5 | Very stiff |
| 3 | 32 | 23,5 | Very stiff |
| 3,3 | 33 | 24,2 | Very stiff |
| 3,6 | 36 | 26,4 | Very stiff |
| 3,9 | 34 | 24,9 | Very stiff |
| 4,2 | 33 | 24,2 | Very stiff |
| 4,5 | 32 | 23,5 | Very stiff |
| 4,8 | 73 | 53,0 | Hard |





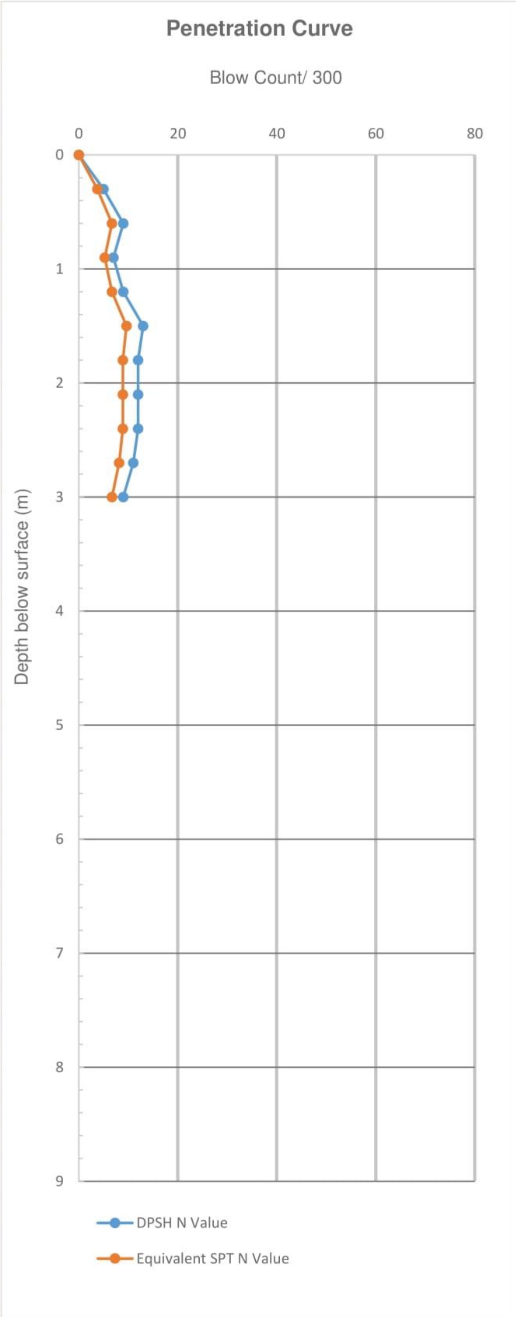

Terra GeoTechnical

Terra GeoTechnical
Where Engineering Meets Earth

| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.995332 S 22.424659 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 10.1

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 5 | 3,7 | Soft |
| 0,6 | 9 | 6,7 | Firm |
| 0,9 | 7 | 5,2 | Firm |
| 1,2 | 9 | 6,7 | Firm |
| 1,5 | 13 | 9,6 | Stiff |
| 1,8 | 12 | 8,9 | Stiff |
| 2,1 | 12 | 8,9 | Stiff |
| 2,4 | 12 | 8,9 | Stiff |
| 2,7 | 11 | 8,2 | Stiff |
| 3 | 9 | 6,7 | Firm |

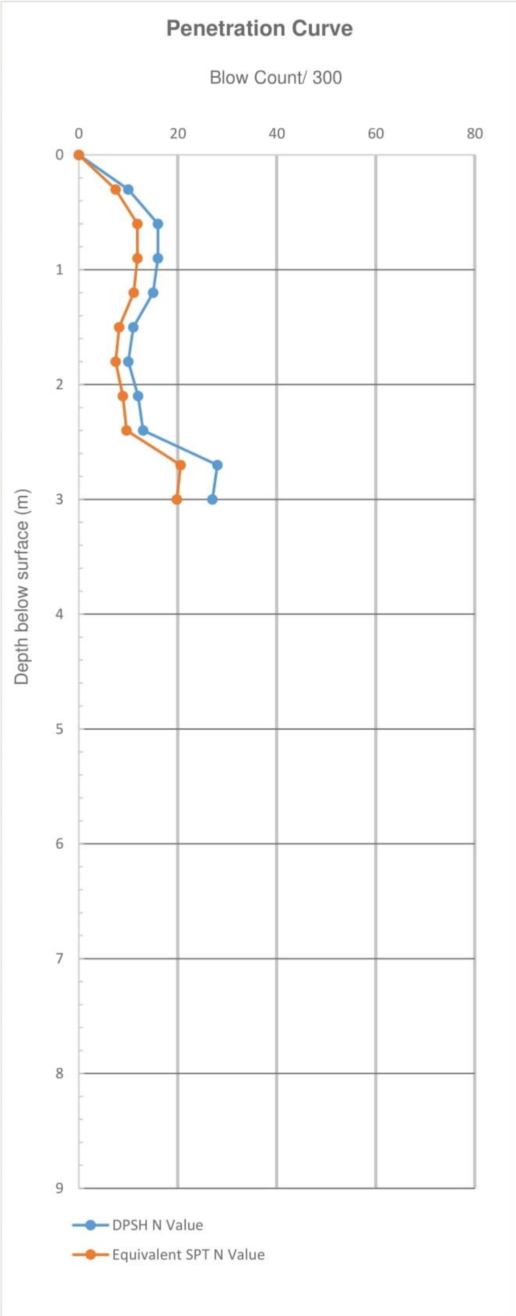


Terra GeoTechnical
Where Engineering Meets Earth

| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.995446 S 22.424722 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 10.2

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 10 | 7,4 | Firm |
| 0,6 | 16 | 11,8 | Stiff |
| 0,9 | 16 | 11,8 | Stiff |
| 1,2 | 15 | 11,1 | Stiff |
| 1,5 | 11 | 8,2 | Stiff |
| 1,8 | 10 | 7,4 | Firm |
| 2,1 | 12 | 8,9 | Stiff |
| 2,4 | 13 | 9,6 | Stiff |
| 2,7 | 28 | 20,6 | Very stiff |
| 3 | 27 | 19,8 | Very stiff |






Terra GeoTechnical

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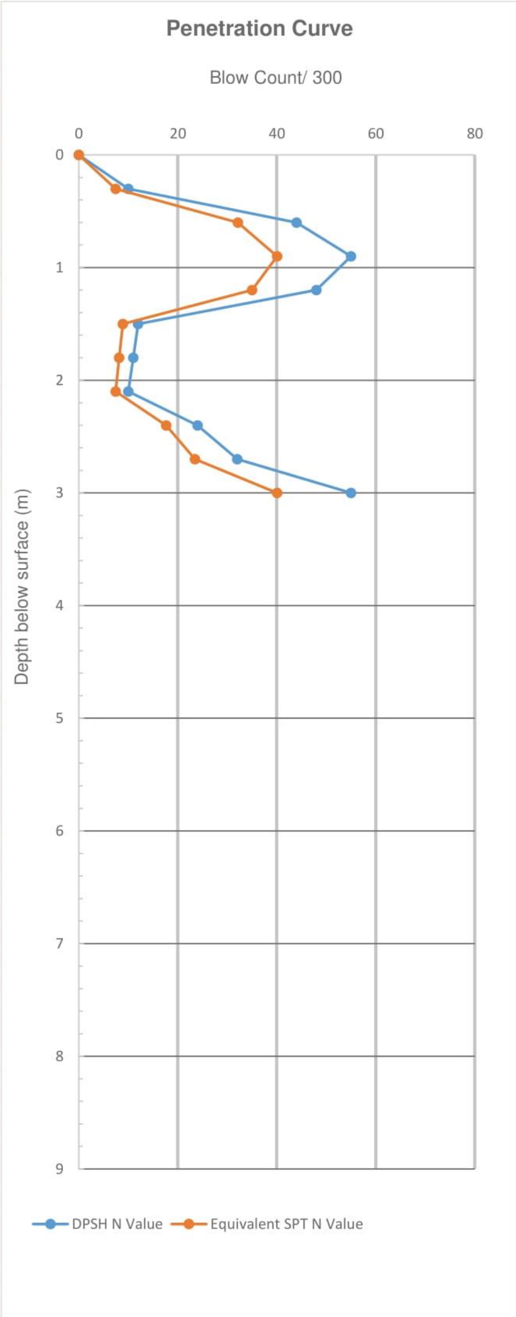
| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.996284 S 22.423847 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 11.1

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 10 | 7,4 | Firm |
| 0,6 | 44 | 32,1 | Hard |
| 0,9 | 55 | 40,1 | Hard |
| 1,2 | 48 | 35,0 | Hard |
| 1,5 | 12 | 8,9 | Stiff |
| 1,8 | 11 | 8,2 | Stiff |
| 2,1 | 10 | 7,4 | Firm |
| 2,4 | 24 | 17,7 | Very stiff |
| 2,7 | 32 | 23,5 | Very stiff |
| 3 | 55 | 40,1 | Hard |



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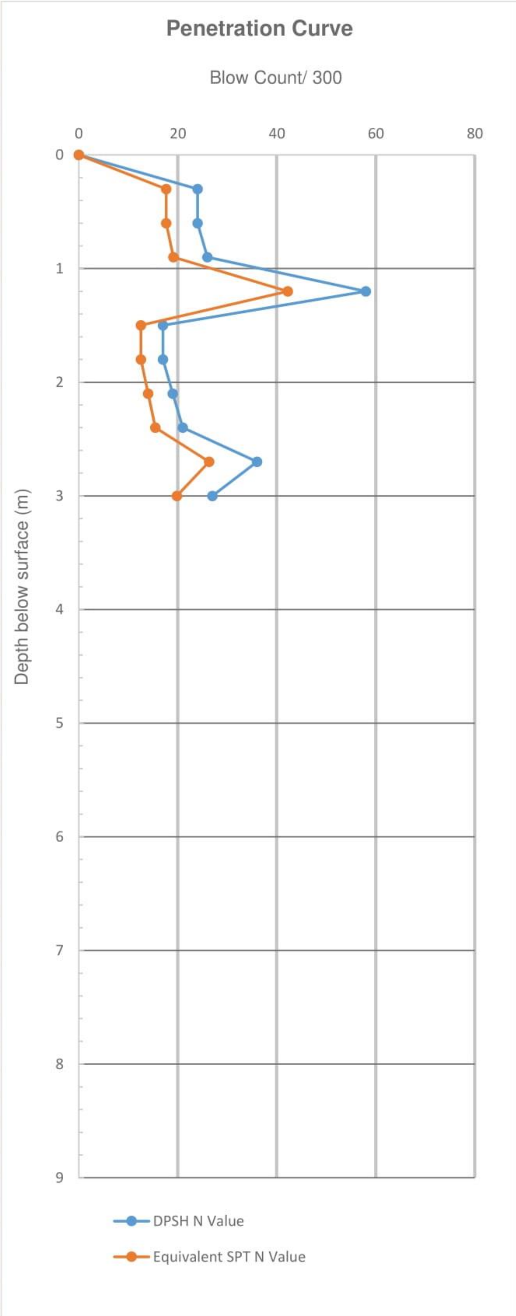
| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.996007 S 22.423723 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 11.2

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 24 | 17,7 | Very stiff |
| 0,6 | 24 | 17,7 | Very stiff |
| 0,9 | 26 | 19,1 | Very stiff |
| 1,2 | 58 | 42,2 | Hard |
| 1,5 | 17 | 12,6 | Stiff |
| 1,8 | 17 | 12,6 | Stiff |
| 2,1 | 19 | 14,0 | Stiff |
| 2,4 | 21 | 15,5 | Very stiff |
| 2,7 | 36 | 26,4 | Very stiff |
| 3 | 27 | 19,8 | Very stiff |



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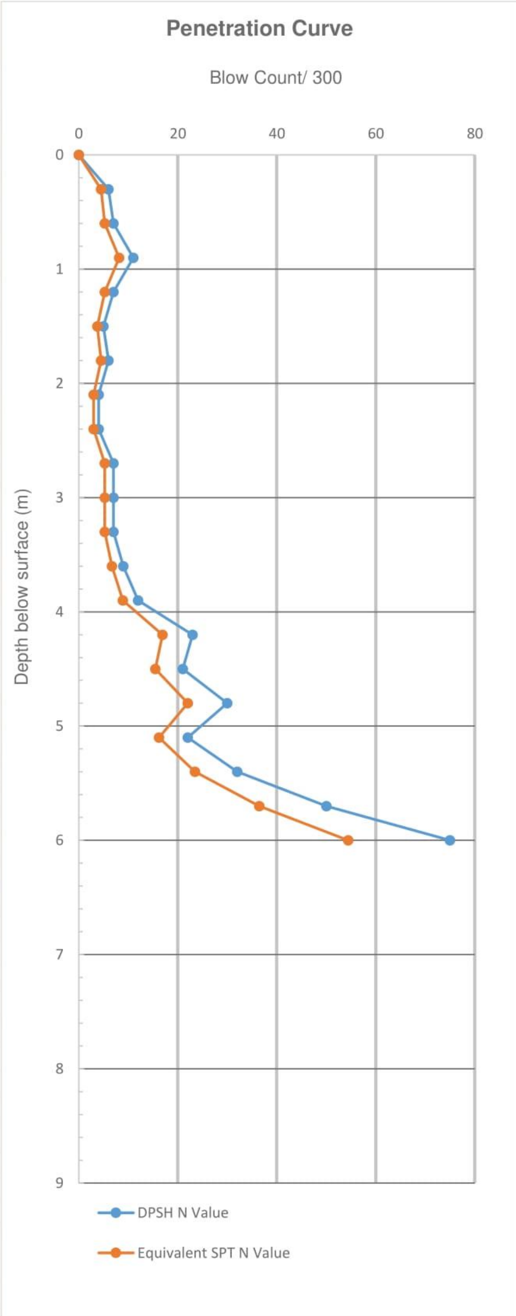
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.996145 S 22.424132 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 11.3

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 6 | 4,5 | Firm |
| 0,6 | 7 | 5,2 | Firm |
| 0,9 | 11 | 8,2 | Stiff |
| 1,2 | 7 | 5,2 | Firm |
| 1,5 | 5 | 3,7 | Soft |
| 1,8 | 6 | 4,5 | Firm |
| 2,1 | 4 | 3,0 | Soft |
| 2,4 | 4 | 3,0 | Soft |
| 2,7 | 7 | 5,2 | Firm |
| 3 | 7 | 5,2 | Firm |
| 3,3 | 7 | 5,2 | Firm |
| 3,6 | 9 | 6,7 | Firm |
| 3,9 | 12 | 8,9 | Stiff |
| 4,2 | 23 | 16,9 | Very stiff |
| 4,5 | 21 | 15,5 | Very stiff |
| 4,8 | 30 | 22,0 | Very stiff |
| 5,1 | 22 | 16,2 | Very stiff |
| 5,4 | 32 | 23,5 | Very stiff |
| 5,7 | 50 | 36,5 | Hard |
| 6 | 75 | 54,4 | Hard |



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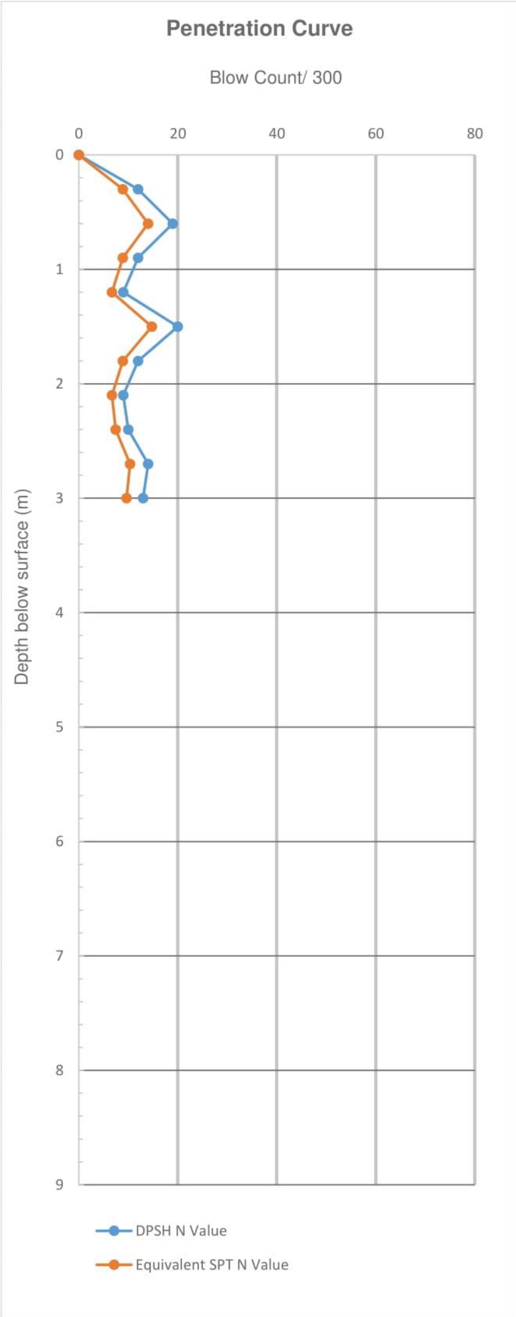
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.996769 S 22.424383 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 12.1

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 12 | 8,9 | Stiff |
| 0,6 | 19 | 14,0 | Stiff |
| 0,9 | 12 | 8,9 | Stiff |
| 1,2 | 9 | 6,7 | Firm |
| 1,5 | 20 | 14,7 | Stiff |
| 1,8 | 12 | 8,9 | Stiff |
| 2,1 | 9 | 6,7 | Firm |
| 2,4 | 10 | 7,4 | Firm |
| 2,7 | 14 | 10,4 | Stiff |
| 3 | 13 | 9,6 | Stiff |



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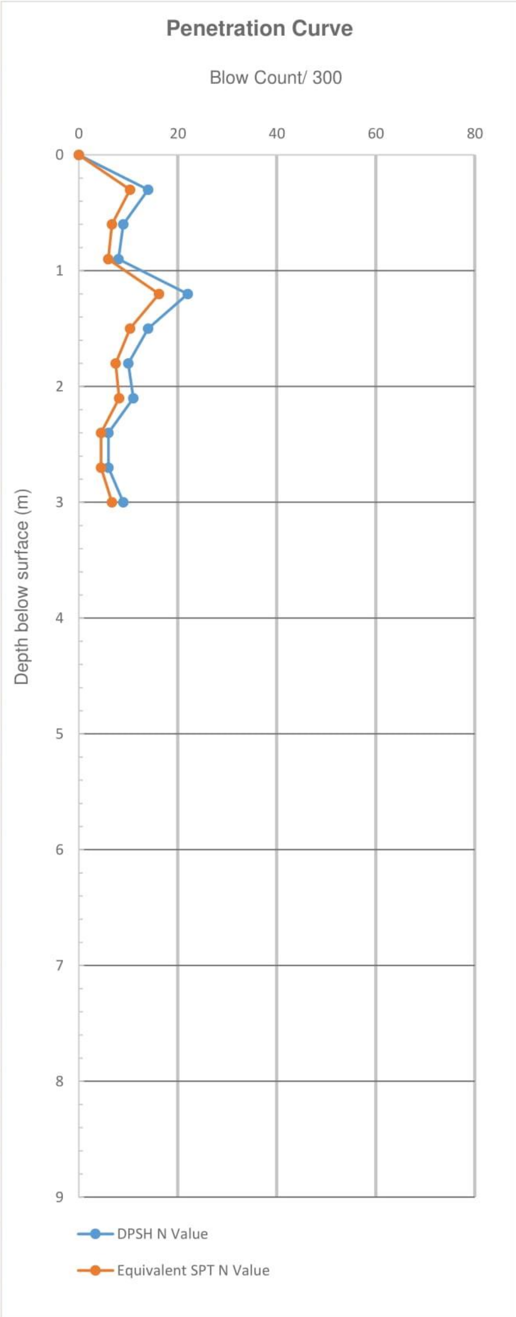
| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.996739 S 22.424087 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 12.2

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 14 | 10,4 | Stiff |
| 0,6 | 9 | 6,7 | Firm |
| 0,9 | 8 | 6,0 | Firm |
| 1,2 | 22 | 16,2 | Very stiff |
| 1,5 | 14 | 10,4 | Stiff |
| 1,8 | 10 | 7,4 | Firm |
| 2,1 | 11 | 8,2 | Stiff |
| 2,4 | 6 | 4,5 | Firm |
| 2,7 | 6 | 4,5 | Firm |
| 3 | 9 | 6,7 | Firm |



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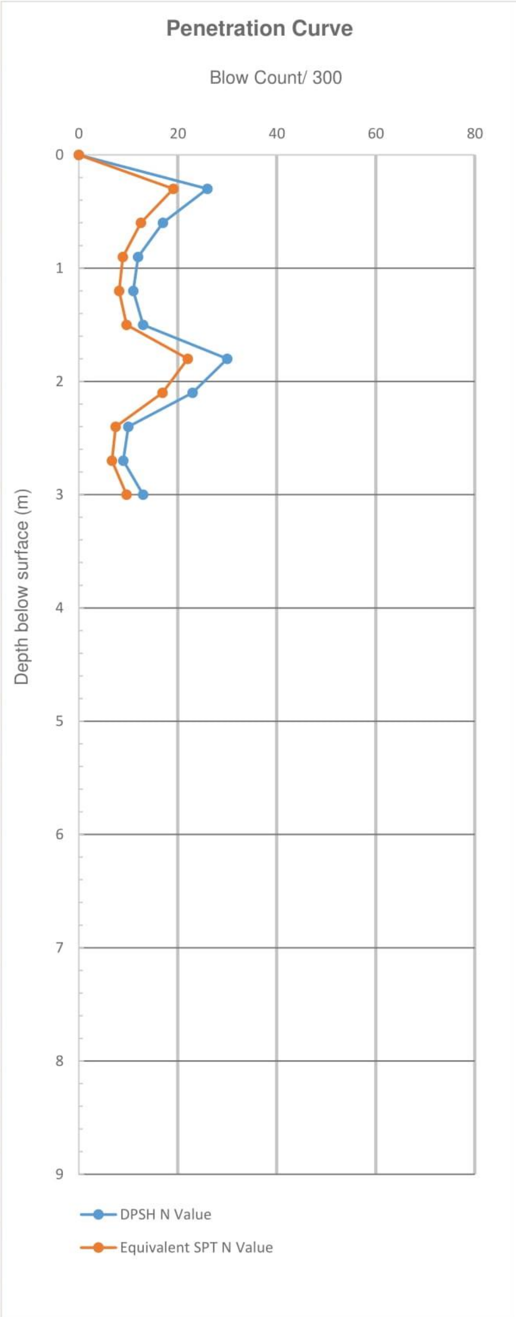
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.996584 S 22.424696 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 12.3

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 26 | 19,1 | Very stiff |
| 0,6 | 17 | 12,6 | Stiff |
| 0,9 | 12 | 8,9 | Stiff |
| 1,2 | 11 | 8,2 | Stiff |
| 1,5 | 13 | 9,6 | Stiff |
| 1,8 | 30 | 22,0 | Very stiff |
| 2,1 | 23 | 16,9 | Very stiff |
| 2,4 | 10 | 7,4 | Firm |
| 2,7 | 9 | 6,7 | Firm |
| 3 | 13 | 9,6 | Stiff |



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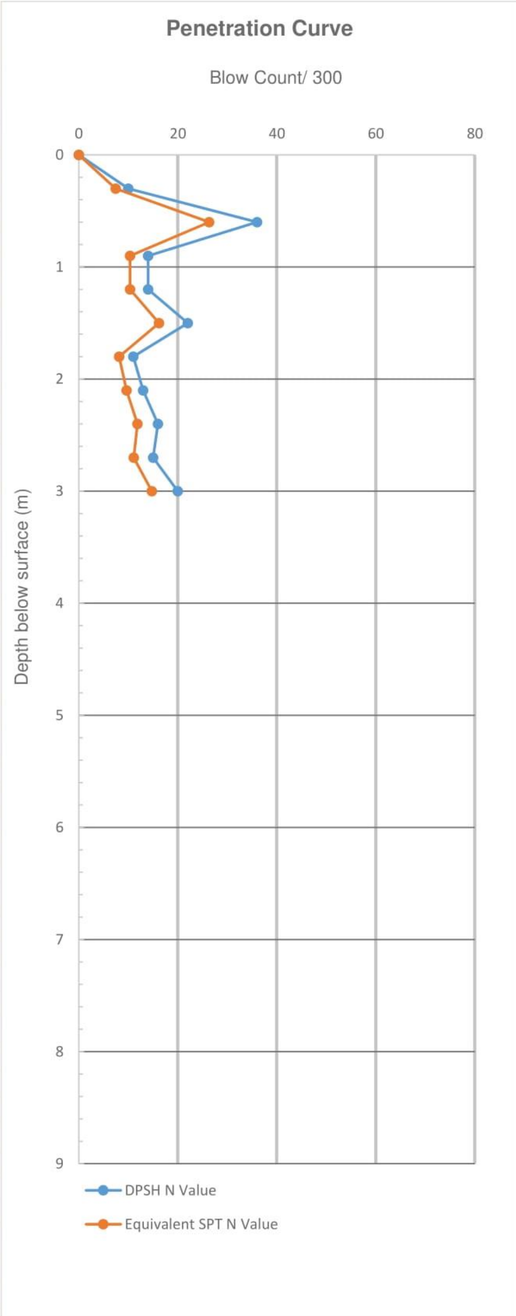
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.996878 S 22.423046 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

# DPSH 13.1

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 10 | 7,4 | Firm |
| 0,6 | 36 | 26,4 | Very stiff |
| 0,9 | 14 | 10,4 | Stiff |
| 1,2 | 14 | 10,4 | Stiff |
| 1,5 | 22 | 16,2 | Very stiff |
| 1,8 | 11 | 8,2 | Stiff |
| 2,1 | 13 | 9,6 | Stiff |
| 2,4 | 16 | 11,8 | Stiff |
| 2,7 | 15 | 11,1 | Stiff |
| 3 | 20 | 14,7 | Stiff |



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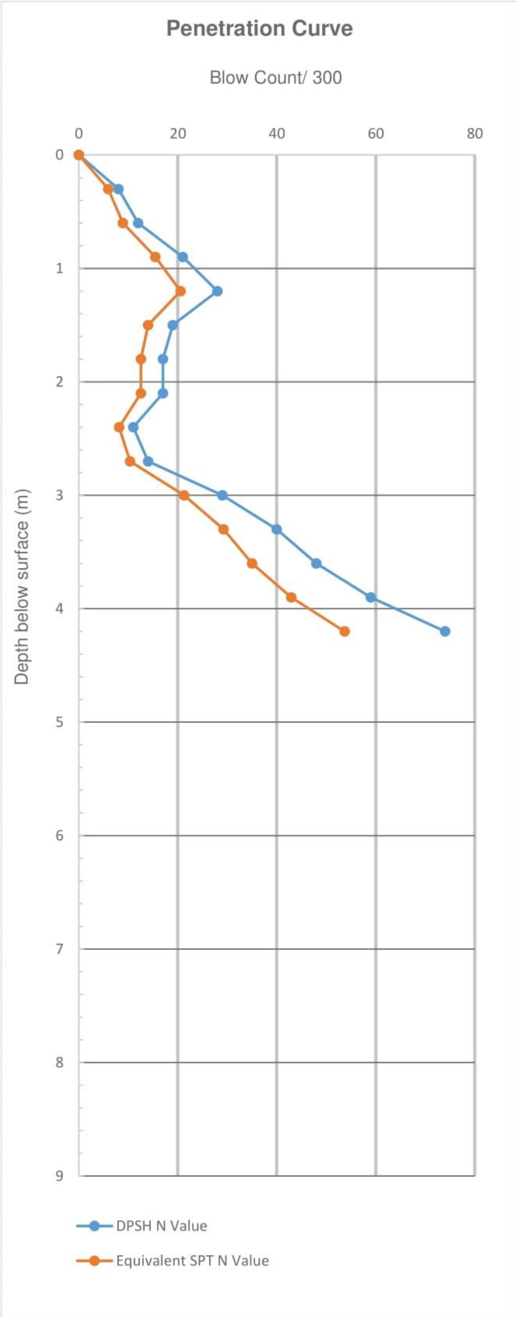
| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.996531 S 22.423144 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

# DPSH 13.2

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 8 | 6,0 | Firm |
| 0,6 | 12 | 8,9 | Stiff |
| 0,9 | 21 | 15,5 | Very stiff |
| 1,2 | 28 | 20,6 | Very stiff |
| 1,5 | 19 | 14,0 | Stiff |
| 1,8 | 17 | 12,6 | Stiff |
| 2,1 | 17 | 12,6 | Stiff |
| 2,4 | 11 | 8,2 | Stiff |
| 2,7 | 14 | 10,4 | Stiff |
| 3 | 29 | 21,3 | Very stiff |
| 3,3 | 40 | 29,2 | Very stiff |
| 3,6 | 48 | 35,0 | Hard |
| 3,9 | 59 | 42,9 | Hard |
| 4,2 | 74 | 53,7 | Hard |



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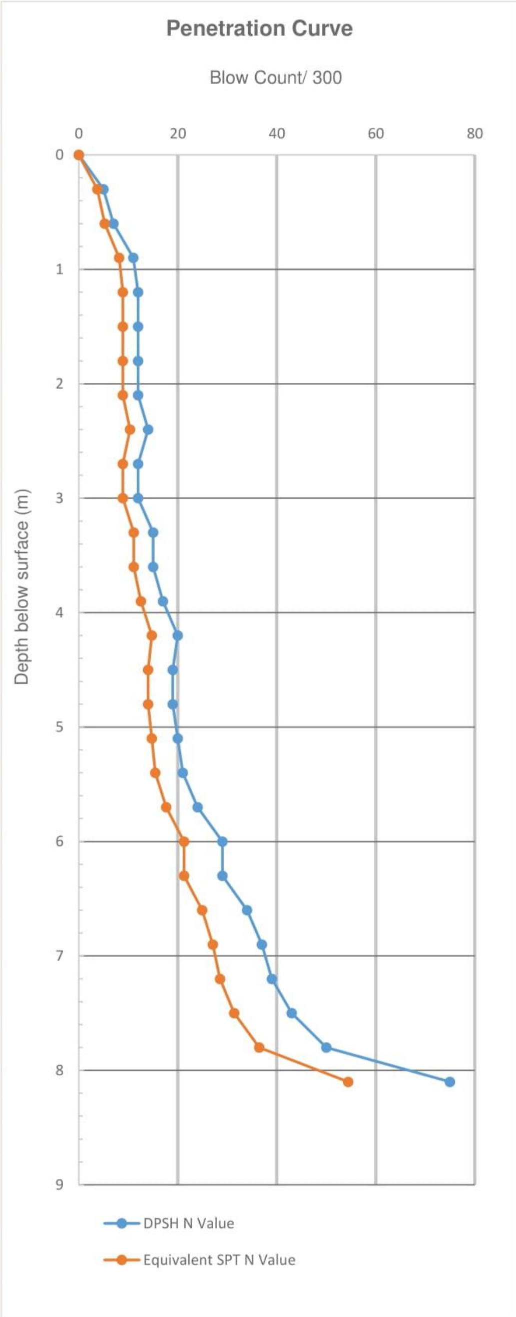
| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.998048 S 22.422194 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 14.1

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 5 | 3,7 | Soft |
| 0,6 | 7 | 5,2 | Firm |
| 0,9 | 11 | 8,2 | Stiff |
| 1,2 | 12 | 8,9 | Stiff |
| 1,5 | 12 | 8,9 | Stiff |
| 1,8 | 12 | 8,9 | Stiff |
| 2,1 | 12 | 8,9 | Stiff |
| 2,4 | 14 | 10,4 | Stiff |
| 2,7 | 12 | 8,9 | Stiff |
| 3 | 12 | 8,9 | Stiff |
| 3,3 | 15 | 11,1 | Stiff |
| 3,6 | 15 | 11,1 | Stiff |
| 3,9 | 17 | 12,6 | Stiff |
| 4,2 | 20 | 14,7 | Stiff |
| 4,5 | 19 | 14,0 | Stiff |
| 4,8 | 19 | 14,0 | Stiff |
| 5,1 | 20 | 14,7 | Stiff |
| 5,4 | 21 | 15,5 | Very stiff |
| 5,7 | 24 | 17,7 | Very stiff |
| 6 | 29 | 21,3 | Very stiff |
| 6,3 | 29 | 21,3 | Very stiff |
| 6,6 | 34 | 24,9 | Very stiff |
| 6,9 | 37 | 27,1 | Very stiff |
| 7,2 | 39 | 28,5 | Very stiff |
| 7,5 | 43 | 31,4 | Hard |
| 7,8 | 50 | 36,5 | Hard |
| 8,1 | 75 | 54,4 | Hard |



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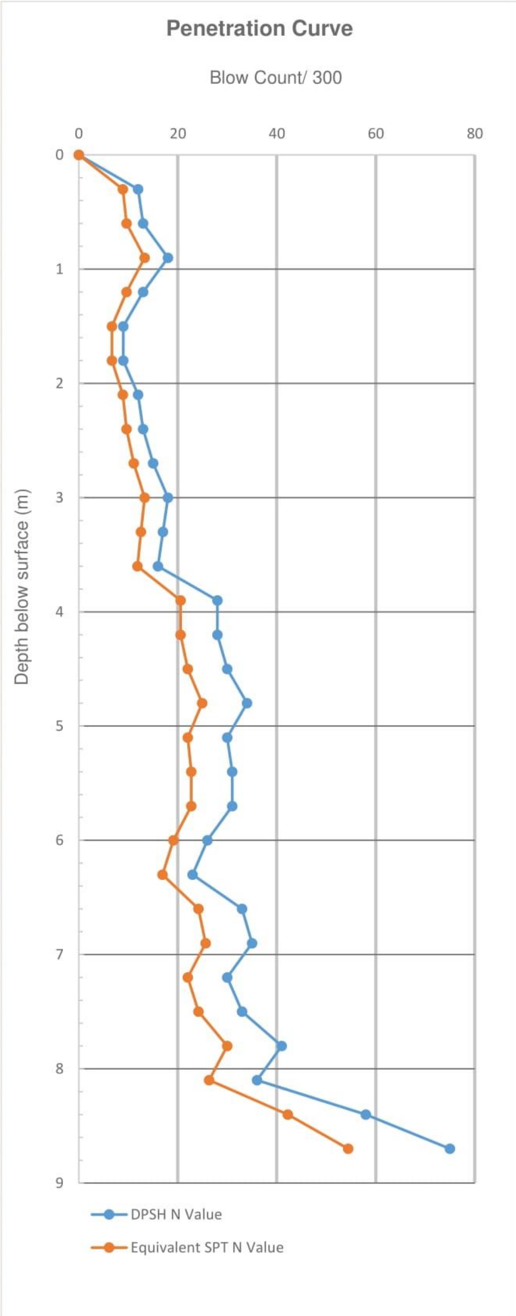
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.997674 S 22.422504 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## DPSH 14.2

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 12 | 8,9 | Stiff |
| 0,6 | 13 | 9,6 | Stiff |
| 0,9 | 18 | 13,3 | Stiff |
| 1,2 | 13 | 9,6 | Stiff |
| 1,5 | 9 | 6,7 | Firm |
| 1,8 | 9 | 6,7 | Firm |
| 2,1 | 12 | 8,9 | Stiff |
| 2,4 | 13 | 9,6 | Stiff |
| 2,7 | 15 | 11,1 | Stiff |
| 3 | 18 | 13,3 | Stiff |
| 3,3 | 17 | 12,6 | Stiff |
| 3,6 | 16 | 11,8 | Stiff |
| 3,9 | 28 | 20,6 | Very stiff |
| 4,2 | 28 | 20,6 | Very stiff |
| 4,5 | 30 | 22,0 | Very stiff |
| 4,8 | 34 | 24,9 | Very stiff |
| 5,1 | 30 | 22,0 | Very stiff |
| 5,4 | 31 | 22,7 | Very stiff |
| 5,7 | 31 | 22,7 | Very stiff |
| 6 | 26 | 19,1 | Very stiff |
| 6,3 | 23 | 16,9 | Very stiff |
| 6,6 | 33 | 24,2 | Very stiff |
| 6,9 | 35 | 25,6 | Very stiff |
| 7,2 | 30 | 22,0 | Very stiff |
| 7,5 | 33 | 24,2 | Very stiff |
| 7,8 | 41 | 30,0 | very stiff |
| 8,1 | 36 | 26,4 | Very stiff |
| 8,4 | 58 | 42,2 | Hard |
| 8,7 | 75 | 54,4 | Hard |



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| | |
|---|---|
| Project | Gwaing WWTW |
| Client | Lukhozi Consulting Engineers (PTY) LTD |
| Test location | 33.994942 S 22.423375 E |
| Date | May-24 |
| Notes | Test Conducted from the surface |

## Additional DPSH

| Depth | DPSH Blows per 300 mm | Equivalent SPT N Value | Inferred Consistency |
|---|---|---|---|
| 0,3 | 19 | 14,0 | Stiff |
| 0,6 | 15 | 11,1 | Stiff |
| 0,9 | 13 | 9,6 | Stiff |
| 1,2 | 16 | 11,8 | Stiff |
| 1,5 | 17 | 12,6 | Stiff |
| 1,8 | 6 | 4,5 | Firm |
| 2,1 | 9 | 6,7 | Firm |
| 2,4 | 15 | 11,1 | Stiff |
| 2,7 | 12 | 8,9 | Stiff |
| 3 | 19 | 14,0 | Stiff |
| 3,3 | 16 | 11,8 | Stiff |
| 3,6 | 31 | 22,7 | Very stiff |
| 3,9 | 25 | 18,4 | Very stiff |
| 4,2 | 30 | 22,0 | Very stiff |
| 4,5 | 42 | 30,7 | Hard |
| 4,8 | 54 | 39,3 | Hard |
| 5,1 | 53 | 38,6 | Hard |
| 5,4 | 61 | 44,4 | Hard |
| 5,7 | 73 | 53,0 | Hard |