PRE-FEASIBILITY STUDY RAPID RAIL LOS UPGRADE FOR WESSELS & MAMATWAN MINES

GEOTECHNICAL INVESTIGATIONS REPORT

DOC. NO.: 504733-0000-

PREPARED BY:
AURECON SOUTH AFRICA
4 Daventry Street
PRETORIA
0081
South Africa

PREPARED FOR:
SOUTH 32
39 Melrose Blvd
Johannesburg
2196
South Africa

CONTACT PERSONS:
Daniel Chelopo (Study Manager)
Tel No: +27 12 427 2000

CONTACT PERSON:
Tshego Milanzi (Directional Studies Manager)
Tel No: +27 11 376 2780

South32

Pre-Feasibility Study – Rapid Rail LOS Upgrade

Wessels & Mamatwan Mines

Geotechnical Investigations

Doc. No.: 504733-0000-

For Aurecon:

Prepared By:

Siya Nyathi
Engineering Geologist

22 July 2019
Date

Reviewed By:

Willem du Preez
Geotechnical Engineer

22 July 2019
Date

Approved By:

Salona Naidoo
Technical Director

22 July 2019
Date

For South32:

Approved by:

David Mitchell
Manager (Directional Studies)

Date

Approved by:

Tshego Milanzi
Directional Studies

Date

Approved by:

Herman Swanepoel
Major Projects Manager

Date

Contents

Appendices

Figures

Tables

1 Introduction

1.1 Terms of reference

Aurecon was appointed by South 32 Ltd to conduct a pre-feasibility study for the proposed new rail loops at Wessels and Mamatwan mines. Aurecon's Ground Engineering team conducted the geotechnical investigations of these studies.

At the Wessel mine two options (Option 1 and Option 2) were identified for the new rail loop. At the Mamatwan mine, only one option was identified for the pre-feasibility study.

The associated structures of the new rail loops comprise:

- Transfer structures,
- New load out structures,
- Conveyors, and
- Stackers and sampler plants.

This report, which focuses on the proposed rail loops at Wessels and Mamatwan mines, presents the results of the geotechnical investigations and an interpretation of the ground conditions along the routes and associated structures.

1.2 Objectives of the geotechnical study

The objectives of the geotechnical investigation were to comment on:

- Ground and groundwater conditions at the sites,
- Stability of excavations and general excavation conditions as per SANS 1200D guidelines,
- The suitability of excavated/ in situ materials for backfill and rail layer works,
- Geotechnical considerations that may have an influence on the proposed development,
- Recommendations for the rail loops, and
- Geotechnical inputs for the founding of the proposed structures.

2 Site locality and description

The Mamatwan mine is situated about 40km north of Kathu (see Figure 1). The Wessels mine is located approximately 50km north-west of the Mamatwan mine near Santoy (Blackrock) town. Various alignment scenarios have been considered in the project pre-feasibility study, of which one route of 4.3km of new railway alignment was selected as the preferred option for Wessels mine and a route of 5.5 km was selected for Mamatwan Mine (see drawing 504733-0000-DRG-GG-0001 to 504733-0000-DRG-GG-003).

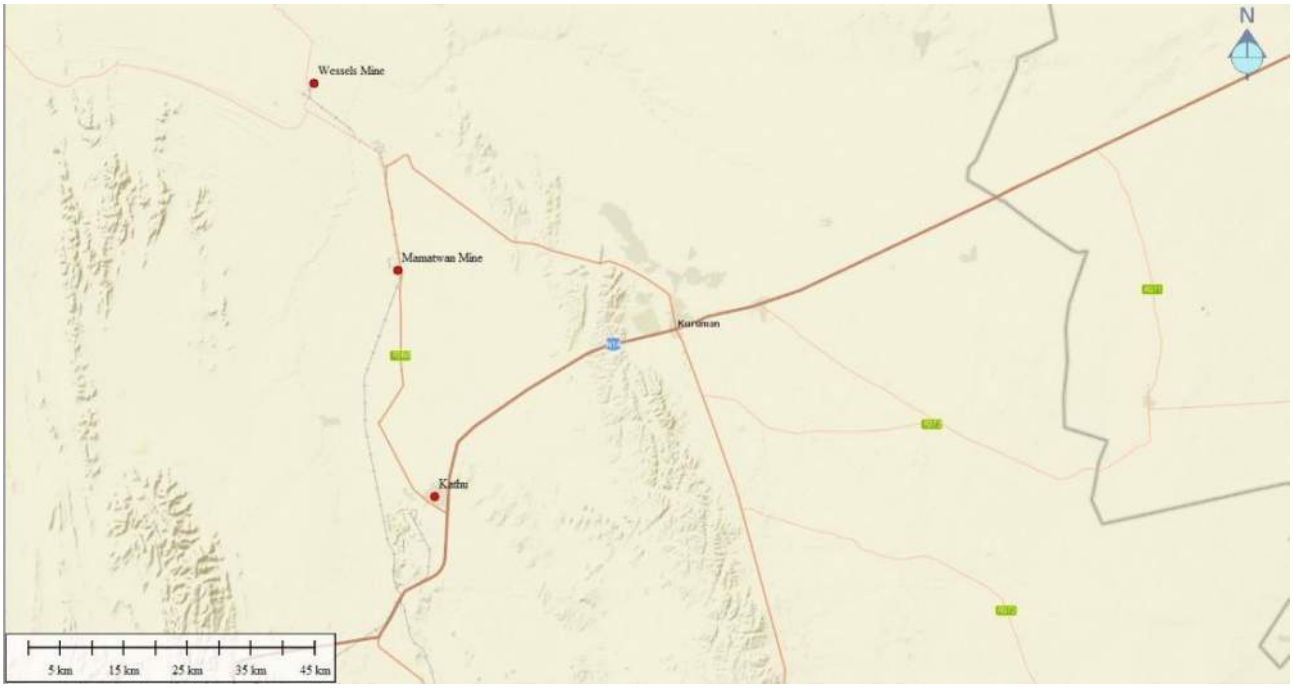


Figure 1: Site locality plan, indicating locations of Wessels and Mamatwan mines (from: worldstreetmap.org)

3 Available information

Geotechnical information from published sources and data from nearby geotechnical investigations was considered for the desktop study, which included the following:

- Council for Geoscience (1979). 1:250 000 Geological Map, Sheet 2722 Kuruman,
- Kimatlab (2007). Geotechnical investigations for the new wet screening plant at Wessels mine. Report SL 3111/07272
- S410 (2006). Specifications for railway earthworks, technical specifications. Technology management and track technology. Spoortnet, a division of Transnet Limited

4 Geology and Seismicity

4.1 Regional geology

According to the geological map (sheet 2722 Kuruman), the sites are underlain by red to flesh-coloured windblown (unconsolidated) sand, which is underlain by gravel, calcrete with some gravel layers (Figure 2).

No bedrock was encountered in the current investigation with the unconsolidated sands and calcrete gravel or nodules mainly encountered at both sites.

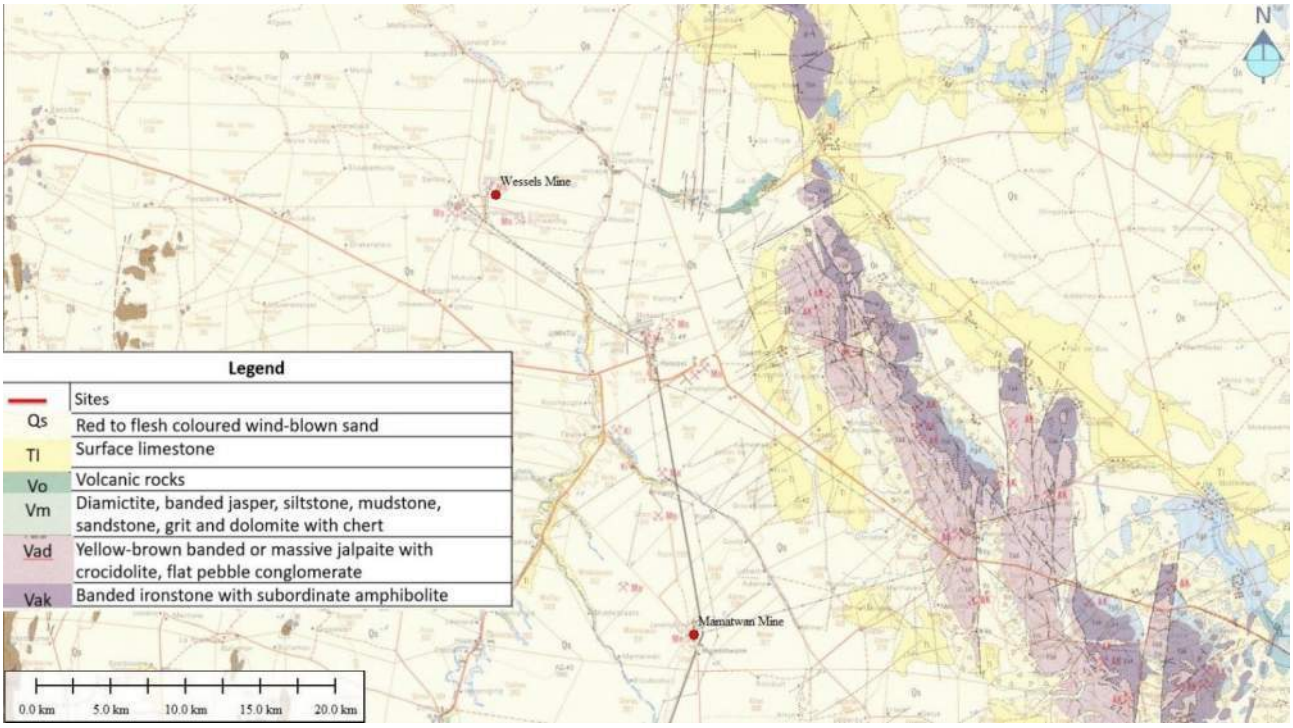


Figure 2: The regional geological map indicating Wessels and Mamatwan mines (Council for Geoscience, 1979)

4.2 Seismicity

On the published seismic hazard map of South Africa (SANS 10160-4:2011), the seismic hazard is defined in terms of peak ground acceleration. According to this map (presented in Figure 3), the sites occurs in an area with a Peak Ground Acceleration (PGA) value of less than 0.05g, with a 10% probability exists that this value will be exceeded in a 50-year period.

According to the SANS 10160-4:2011 guidelines, the site is located outside Zone I and Zone II and therefore are considered non-seismic activity zones and, according to the SANS guidelines, no specific seismic design requirements other than normal structural design requirements are required.

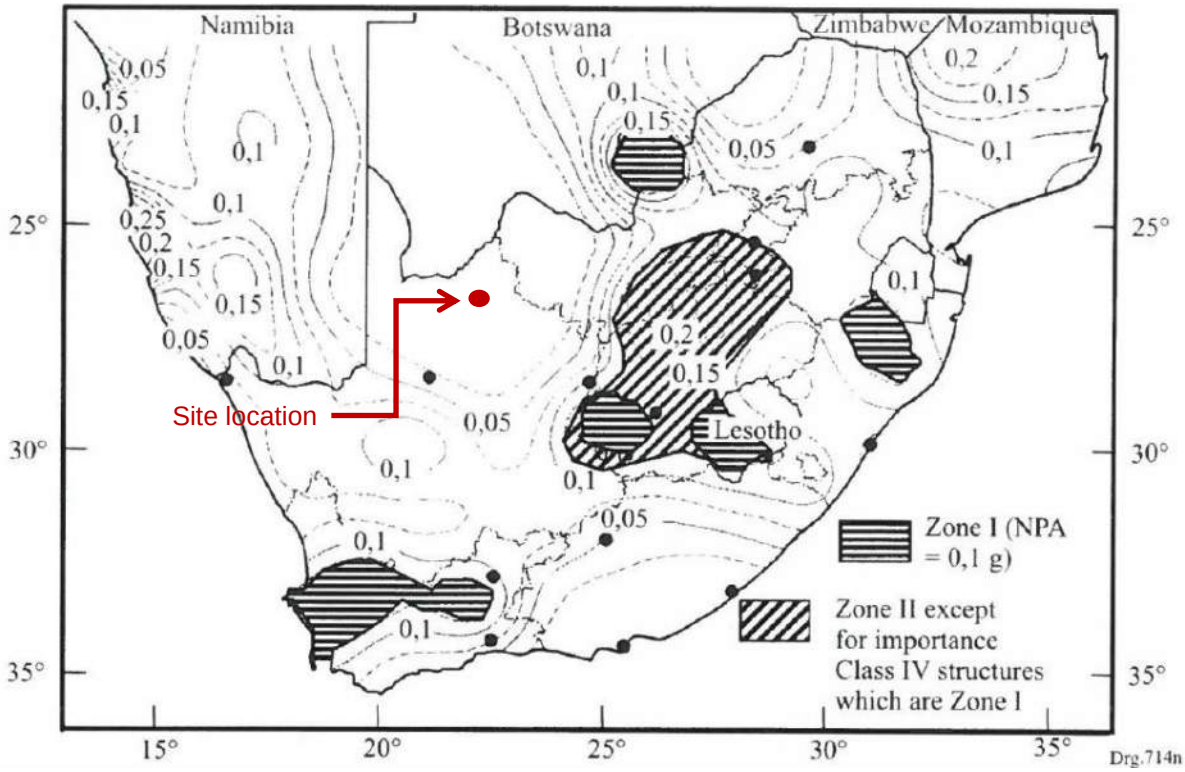


Figure 3: Peak ground acceleration (g) with 10% probability for being exceeded in a 50-year-old period (after SANS 10160-4:2011).

5 Geotechnical investigation methodology

5.1 Site features, topography and climate

A site walk over survey was also carried out by a representative of the Aurecon Ground Engineering team, where the following observations were made:

- The proposed Wessels mine rail loop is partially covered by a mine dump, a tailings dam and a waste dump area (Figure 4),
- The proposed Mamatwan mine rail loop will traverse two mine waste dumps (Figure 5),
- No pans or wetlands were identified along the proposed rail alignments.

Figure 4: Site conditions at the Wessels mine, view the mine waste dump

Figure 5: General site conditions at the Mamatwan mine, view of one of the waste dumps along the route

The Weinert climatic N-number for the area is 9. This indicates that the climate is semi-arid, and that physical mineral grain disintegration is the predominant mode of weathering of the underlying bedrock.

5.2 Summary of geotechnical investigation

The geotechnical investigations consisted of the following:

- 8 No. (WTP03 to WTP18) test pits with a TLB at the Wessels mine,
- 10 No. (MTP01 to MTP16) test pits with a TLB at the Mamatwan mine,
- Laboratory testing on selected soil samples.

At the Wessels mine not all the proposed test pit positions were investigated as the proposed rail loop footprint is in the operational area and partially covered by a waste dump. Other reasons why test pits were cancelled include:

- Two positions were located within the Blackrock property;
- Environmental constraints; and
- Locations not surveyed or scanned for services prior to the investigations.

Subsequently only test pits WTP03, WTP 04, WTP 05, WTP 11, WTP 15, WTP 16 and WTP 18 were approved for geotechnical investigations. The ground conditions encountered were however uniform across site.

At the Mamatwan mine the investigations were conducted at every second test pit position. Ground conditions were also uniform across this site.

The field investigations were conducted from 18 to 21 June 2019 between the two mines. A two-person team carried out the test pitting to comply with accepted safety requirements as reflected in the South African Code of Practice (SAICE: 2007). The positions of the test pits were recorded with a handheld GPS and the coordinates given in WGS84 Lo 23 coordinate systems. All the test pits were excavated with a TLB to refusal, the maximum reach of the equipment or until the sidewalls of the test pits became unstable. These test pit positions are indicated on drawing 504630-0000-DRG-GG-0001-01 to 504630-0000-DRG-GG-0002-01 in Appendix D. The test pits were profiled in accordance with the methodology proposed by Jennings, Brink, and Williams (1973) and were backfilled after profiling.

Representative soil samples were taken and submitted to Roadlab Engineering Materials Laboratory for testing. The following tests were done:

- Foundation Indicators with Atterberg limits (16 No.)
- California Bearing Ratio (CBR) including MOD ASSHTO (9 No)
- Moisture Content (8 No); and
- pH and Conductivity (6 No).

The positions, maximum depths of the test pits as well as a brief description of the material encountered at the termination depths are listed in Table 1, where the prefix WTP and MTP represents Wessels and Mamatwan test pit respectively. The detailed logs are attached in Appendix B and the locations of the test pits are on shown on drawings 504630-0000-DRG-GG-0001-01 to 504630-0000-DRG-GG-0002-01 in Appendix D.

Table 1: Schedule of test pits

Test Pit No	Coordinates (WGS84 Lo 23)		Termination depth (m)	General soil and rock profile at termination depth
	Easting	Northing		
Wessels mine				
WTP03	-14458	-3000782	2.7	Loose sand. Aeolian
WTP04	-14276	-3000323	3.0	Dense sand with calcrete concretions. Pedogenic
WTP05	-14099	-2999881	1.7	Medium dense sand. Aeolian
WTP08	-13702	-3000319	3.0	Medium dense sand. Aeolian
WTP11	-13661	-2999854	3.0	Medium dense sand. Aeolian
WTP15	-13325	-3000350	3.0	Medium dense to dense sand. Aeolian
WTP16	-13769	-3000923	3.0	Dense sand with calcrete concretions. Pedogenic
WTP18	-13945	-3000229	3.2	Medium dense to dense sand. Aeolian
Mamatwan mine				
MTP01	-890	-3032118	2.7	Medium dense to dense sand. Aeolian
MTP03	-549	-3031176	2.4	Medium dense to dense sand. Aeolian
MTP05	-218	-3030230	2.3	Dense sand. Aeolian
MTP06	-221	-3029620	2.5	Medium dense to dense sand. Aeolian
MTP07	-310	-3029123	2.7	Dense sand. Aeolian
MTP09	-971	-3029257	2.1	Dense sand. Aeolian
MTP11	-750	-3029773	2.4	Dense to very dense sand. Aeolian
MTP14	-563	-3030249	2.0	Medium dense to dense sand. Aeolian
MTP15	-345	-3029448	2.6	Medium dense to dense sand. Aeolian
MTP16	-680	-3029511	2.7	Dense sand. Aeolian

6 Fieldwork results

6.1 Test pit results

The detailed descriptions of the soil profiles encountered in the test pits are presented in Appendix B; while the geological profiles are summarised below in Table 2.

Table 2: Test pit profile summary

Test pit No:	Manganese gravel and sand, Fill material (m)	Silty sand, Topsoil (m)	Sand, Aeolian sand (m)	Calcritised sand and calcrete nodules, Pedogenic material (m)
Wessels mine				
WTP03	0-0.3	-	0.3-2.7+	-
WTP04	0-0.5	-	0.5-2.5	2.5-3.0+
WTP05	0-1.5	-	1.5-1.7+	-
WTP08	0-0.3	-	0.3-3.0+	-
WTP11	-	0-0.4	0.4-3.0+	-
WTP15	-	0-0.2	0.2-3.0	-
WTP16	0-0.2	-	0.2-2.3	2.3-3.0+
WTP18	0-0.3	-	0.3-2.6	2.6-3.2+
Mamatwan mine				
MTP01	0-0.4	-	0.4-2.7+	-
MTP03	-	0-0.2	0.2-2.4+	-
MTP05	0-0.3	-	0.3-2.3+	-
MTP06	-	0-0.3	0.3-2.5+	-
MTP07	-	0-0.2	0.2-2.7+	-
MTP09	0-0.2	-	0.2-2.1	2.1+
MTP11	-	0-0.3	0.3-2.4+	-
MTP14	-	0-0.1	0.1-2.0+	-
MTP15	-	0-0.2	0.2-2.6+	-
MTP16	-	0-0.1	0.1-2.7+	-

Two different geological profiles were encountered along both alignments. A distinction between the profiles has been made according to the origin of the soils to zone the rail routes into geological zones. The section covered by aeolian sand with topsoil and no refusal has been zoned as Zone G1. The section where aeolian sands are underlain by calcritised gravel or calcrete nodules is zoned as Zone G2. The descriptions of the zones are summarised in Table 3 and zoning of the alignments on drawings 504733-0000-DRG-GG-0001-01 to 504733-0000-DRG-GG-0002-01 in Appendix D.

Table 3: Geotechnical zonation with soil description

Geotechnical zonation descriptions		
Geotechnical zone	**Summary**	**Description**
G1	Aeolian sand	**At Wessels mine**, this material on average is encountered to 2.8m. **At Mamatwan mine**, the aeolian material is encountered to an average depth of 2.6m. Encountered as dry to moist, loose to dense sand.
G2	Aeolian sand underlain by calcritised gravel or calcrete nodules	**At Wessels mine**, encountered in three test pits as indicated in Table 2. It was encountered between 2.4m and 3.0m depth and comprised moist medium dense to dense calcritised sand with calcrete concretions or nodules. **At Mamatwan mine**, this was only encountered at test pit MTP09 at the refusal depth of 2.1m. Encountered as very dense to very soft rock hardpan calcrete.

6.2 Groundwater conditions/ seepage

No groundwater seepage was encountered during the investigations. The presence of calcrete and calcritised materials are an indication that shallow seasonal perched water tables may be present (as indicated in Table 3) during and after high rainfall periods.

7 Laboratory test results

7.1 Foundation indicators

Representative soil samples were collected for laboratory testing at both the mines. The detailed test results are attached in Appendix C and the summary of foundation indicator results is presented in Table 4.

Table 4: Summary of foundation indicators

Test Pit No	Depth (m)	Origin	Soil Composition				GM	Atterberg Limits			Activity	USC
			Clay (%)	Silt (%)	Sand (%)	Gravel (%)		LL (%)	WPI (%)	LS (%)		
Wessels mine												
WTP04	0.5-2.5	Aeolian sand	1	8	92	0	0.98	18	0	0	Low	SP-SM
WTP04	2.5-3.0	Pedogenic	1	5	71	23	1.46	18	0	0	Low	SP-SM
WTP08	0.3-3.0	Aeolian sand	1	8	90	1	0.97	16	0	0	Low	SP-SM

WTP11	0.4-3.0	Aeolian sand	1	9	90	0	0.98	16	0	0	Low	SP-SM
WTP15	0.2-2.6	Aeolian sand	1	7	92	0	0.96	16	0	0	Low	SP-SM
WTP16	2.3-3.0	Pedogenic	1	7	92	0	0.96	16	0	0	Low	SP-SM
WTP18	2.6-3.2	Pedogenic	1	11	75	13	1.19	17	0	0	Low	SM
Mamatwan mine												
MTP01	1.0-2.7	Aeolian sand	0	4	96	0	1.11	19	0	0	Low	SP-SM
MTP03	1.0-2.4	Aeolian sand	1	10	86	3	1.05	16	0	0	Low	SP-SM
MTP05	0.3-2.3	Aeolian sand	1	13	85	1	0.98	15	0	0	Low	SM
MTP06	0.3-2.5	Aeolian sand	2	12	86	0	0.98	17	0	0	Low	SM
MTP07	0.2-2.7	Aeolian sand	1	12	87	0	0.99	16	0	0	Low	SM
MTP09	0.2-2.1	Aeolian sand	1	13	85	1	1.0	16	0	0	Low	SM
MTP14	0.1-2.0	Aeolian sand	1	9	90	0	0.97	16	0	0	Low	SP-SM
MTP16	0.1-2.7	Aeolian sand	1	13	86	0	1.0	16	0	0	Low	SM

Legend
GM = Grading modulus
LL = Liquid Limit
WPI = Weighted Plasticity Index
LS = Linear Shrinkage
USC = Classification of the soil according to the Unified Soil Classification system
Activity = Potential expansiveness of the soil according to Van der Merwe's method (Van der Merwe, 1973)

From the results in Table 4 it is evident that:

At Wessels mine:

The **aeolian sand material** comprises of silty sands (SM) and poorly graded sands (SP). The material typically consists of zero to 1% gravel, 90% to 92% sand, 7% to 9% silt material, and 1% for clays. The fines fraction material exhibits a low liquid limit between 16% and 18%, zero linear shrinkage and zero weighted plasticity index. These aeolian sand are of low potential expansiveness.

The **pedogenic material** encountered on site comprises of silty sands (SM) and poorly graded sands (SP). The material consists of 0% to 23% gravel, 71% to 92% sand material, 5% to 11% silt and 1% clay. The fines fraction material exhibits a low liquid limit between 16% and 18%, zero linear shrinkage and zero weighted plasticity index. These aeolian sand are of low potential expansiveness.

At Mamatwan mine:

The **aeolian sand material** comprises of silty sands (SM) and poorly graded sands (SP). The material typically consists of zero to 3% gravel, 85% to 96% sand, 4% to 13% silt material, and zero to 2% for clays. The fines fraction material exhibits a low liquid limit between 15% and 19%, zero linear shrinkage and zero weighted plasticity index. These aeolian sand are of low potential expansiveness.

7.2 Compaction test results

Representative sample of potential sources of construction materials were sampled for laboratory testing. The samples were subjected to compaction tests in which the moisture-density relationship was established, with California Bearing Ratio (CBR) tests carried out to determine the suitability of the soils for use in constructing layer works. The test results are summarised below.

Table 5: Summary of compaction test results

Test No.	Depth (m)	Origin	OMC (%)	MDD (kg-/m3)	Swell (%)	CBR at various densities				COLTO
						90(%)	93(%)	95(%)	98(%)	
Wessels mine										
WTP04	0.5-2.5	Aeolian sand	5.9	1860	0	5	8	12	19	G9
WTP11	0.4-3.0	Aeolian sand	5.8	1852	0	6	8	11	17	G9
WTP15	0.2-2.6	Aeolian sand	5.8	1834	0	5	8	10	17	G9
WTP16	2.3-3.0	Pedogenic	6.3	1809	0	6	9	12	19	G9
WTP18	2.6-3.2	Pedogenic	6.5	1815	0	5	8	11	18	G9
Mamatwan mine										
MTP 01	1.0-2.7	Aeolian	6.0	1899	0	5	7	10	15	G9
MTP 05	0.3-2.3	Aeolian	6.9	1966	0	7	10	12	17	G9
MTP 09	0.2-2.1	Aeolian	6.9	1992	0	6	9	12	17	G9
MTP 16	0.1-2.7	Aeolian	6.0	1908	0	3	4	6	8	G10

Legend: OMC = Optimum moisture content
MDD = Maximum dry density (Mod AASHTO)
Swell = Soaked at 100% Mod AASHTO compaction
COLTO = Committee of Land Transport Officials

From the results in **Error! Reference source not found.** it is evident that:

At Wessels mine:

The **aeolian sand material** generally has low dry density between 1834 kg/m^3 and 1860 kg/m^3 and low optimum moisture content between 5.8% and 5.9%. The CBR values indicates zero swell, with low value at both 93% Mod AASHTO and 95% Mod AASHTO. This material is classified as G9 according to COLTO guidelines and is classified as suitable for use in selected subgrade or alternatively used for landscaping or spoiled.

The **pedogenic material** was encountered with low dry density between 1809 kg/m^3 and 1815 kg/m^3 and low optimum moisture content between 6.3% and 6.5%. The CBR values indicates zero swell, with low value at both 93% Mod AASHTO and 95% Mod AASHTO. This material is classified as G9 according to COLTO

guidelines and is classified as suitable for use in selected subgrade or alternatively used for landscaping or spoiled.

At Mamatwan mine:

The **aeolian sand material** was encountered with low dry density between 1899 kg/m^3 and 1992 kg/m^3 and low optimum moisture content between 6.0% and 6.9%. The CBR values indicates zero swell, with low value at both 93% Mod AASHTO and 95% Mod AASHTO. This material is classified as G9 and G10 according to COLTO guidelines and is classified as suitable for use in selected subgrade or alternatively used for landscaping or spoiled.

7.3 Properties and classification of materials for placing purposes

The materials have been classified as per the specifications for railway earthworks, S410. This section results are to be viewed in conjunction with Section 7.1 and 7.2 and full laboratory results in Appendix C.

Table 6: Material properties for earthworks construction (S410 specification)

Formations	MATERIAL PROPERTIES										
	SAR Index	Min. Grading Modulus	% BY MASS PASSING SIEVE (sieve size in mm)					PI	Max. CBR Swell %	Minimum compaction % of modified AASHTO Density	Minimum strength after compaction CBR
			75	13.2	2.0	0.425	0.075				
SSB	<50	2.0	100	60-85	20-50	10-30	5-15	3-10	0.5	98	60 **(o)** (1.5-3 MPa)
SB	<80	1.8	100	70-100	20-60	10-40	5-20	3-10	0.5	95	+ 30 **(o)** (1.5-3 MPa)
A	<110	1.0					<40	<12		95 100*	20
B	<155	0.5					<70	<17		93 98*	10
Bulk earth works								<25	2	90 95*	5

*	These densities apply to non-cohesive soils
(o)	Strengths in brackets apply in place of CBR values where sub-ballast is stabilised
+	Increase to 45 in the absence of Layer SSB unless otherwise specified (Increase not normally required in dry areas.)
Note:-	See Appendix A for comparable road materials (S410). The classifications shown may be used by the Contractor at his discretion when preparing preliminary assessments of availability of materials for use in the listed layers.

Table 7: Summary of laboratory results for material properties for earthwork construction

Sample No	Origin	Depth (m)	SAR Index	Min grading modulus	PI	Structural layer classification
Wessels mine						
WTP04	Aeolian sand	0.5-2.5	8	1.0	NP	Bulk earthworks, A and B
WTP11	Aeolian sand	0.4-3.0	10	1.0	NP	Bulk earthworks, A and B
WTP15	Aeolian sand	0.2-2.6	8	1.0	NP	Bulk earthworks, A and B
WTP16	Pedogenic	2.3-3.0	8	1.0	NP	Bulk earthworks, A and B
WTP18	Pedogenic	2.6-3.2	12	1.2	NP	Bulk earthworks, A and B
Mamatwan mine						
MTP01	Aeolian sand	1.0-2.7	4	1.1	NP	Bulk earthworks, A and B
MTP05	Aeolian sand	0.3-2.3	14	1.0	SP	Bulk earthworks, A and B
MTP09	Aeolian sand	0.2-2.1	16	1.0	NP	Bulk earthworks, A and B
MTP16	Aeolian sand	0.1-2.7	14	1.0	NP	Not suitable *

Notes:

Not suitable* - Minimum strength after compaction CBR for layer A at 100% should be 20 but the sample test results showed 11, and layer B at 98% should be 10, but the results show 8.

SAR index - a sum of the Liquid Limit, the Plastic Limit and the percentage passing the 0.075mm sieve

7.4 Chemical test results

The conductivity of the soil has an influence on the rate of corrosion of buried metallic objects. Based on significance of soil resistivity on corrosivity, Duligal (1996) provides the following table for evaluation of the conductivity of soil (Table 8).

Table 8: Guideline values for the interpretation of soil conductivity (Duligal, 1996)

Soil conductivity (mS/m)	Soil resistivity (Ohm.cm)	Corrosivity classification
More than 50	0 – 2000	Extremely corrosive
25 – 50	2000 – 4000	Very corrosive
20 – 25	4000 – 5000	Corrosive
10 – 20	5000 – 10000	Mildly corrosive
Less than 10	>10000	Not generally corrosive

Representative soil sample of different soil horizons encountered on site were subjected to chemical (pH and conductivity) tests. The test results are summarised as follows. Based on Evans guideline (1977) a soil pH less than 6 indicates serious corrosion potential.

Table 9: Chemical test summary results

Test pit No	Depth (m)	Origin	pH	Conductivity (mS/m)
Wessels mine				
WTP04	0.5-2.5	Aeolian sand	7.88	33
WTP08	0.3-3.0	Aeolian sand	6.56	9
WTP18	2.6-3.2	Pedogenic	7.74	37
Mamatwan mine				
MTP03	1.0-2.4	Aeolian sand	7.65	12
MTP09	0.2-2.1	Aeolian sand	7.58	22
MTP14	0.1-2.0	Aeolian sand	6.55	5

At the Wessels mine, the pH values range between 6.56 and 7.88 which indicates non-corrosive soils (based on Evans guidelines) with the soil conductivity ranging between 9.0 and 37, indicating generally non-corrosive soil to very corrosive. At the Mamatwan mine, the pH values are ranging between 6.55 and 7.65 which indicates non-corrosive soils according to Evans guidelines and the soil conductivity ranging between 5.0 and 22, indicating generally non-corrosive to corrosive soils. Due to the conductivity of the soil, special consideration may be necessary in the design against the deterioration of buried steel, copper and concrete elements in soil.

8 Geotechnical considerations

8.1 Excavatability

The refusal depth of the TLB during the test pitting exercise can be used as an indication of the depth to which soft and hard excavations can be expected to extend.

The material encountered in both mines can be classified as "*Soft excavation"* in terms of SANS 1200D to an average depth of 2.8m (between 1.7m and 3.0) below natural ground in Wessels mine and 2.4m in Mamatwan mine. Previous report by Kimatlab indicates that sand and pedogenic materials are encountered to 18m depth, "*Soft excavations*" may be expected to deeper depths.

8.2 Suitability of material for re-use

Laboratory results indicates that the aeolian sand and the pedogenic material as encountered at both mines can generally be classified as suitable for bulk earthworks, layer B and A material according to the S410 guidelines. One sample taken from Mamatwan mine indicates the aeolian sand not suitable for use for either bulk earthworks, layer B and A material according to the S410 guidelines.

Given that one sample indicates that aeolian sand may sometime not be suitable for construction purposes, the onerous selection of this material may be a challenge. As a result, it may be feasible for all construction material to be imported from elsewhere with the rest of the soils used as general fill or for landscaping purposes, or alternatively spoiled.

The SB and SSB formation materials must be sourced from existing/commercial sources.

For the associated structured, the aeolian sand and pedogenic material encountered in both mines is classified as G9 and G10 according to COLTO guidelines and is classified as suitable for use in selected subgrade or alternatively used for landscaping or spoiled.

8.3 Soil corrosivity

The pH indicates that the soils are generally not corrosive, however the soil conductivity results indicates that the soils are generally non-corrosive to very corrosive based on the laboratory results. Due to the conductivity of the soil, special consideration may be necessary in the design against the deterioration of buried steel, copper and concrete elements in soil.

8.4 Seismic activity

The site is located outside Zone I and Zone II seismic zones according to the SANS 10160-4:2011 guidelines and no specific seismic design requirements other than normal structural design requirements are required.

8.5 Groundwater conditions/ seepage

Groundwater seepage was not encountered during the investigations. The presence of calcrete nodules and calcritised materials are an indication that shallow seasonal perched water table may be present during and after periods of rainfall.

8.6 Compressible / collapsible soils

The loose silty sand material encountered in the topsoil and aeolian sand may be potentially compressible or collapsible to a maximum depth of investigation (i.e. 3m) in both mines. Komatlab (2007) indicates the loose aeolian sands encountered in Wessels mine to be highly compressible and possess a collapse potential.

9 Evaluation of founding conditions

9.1 Mamatwan mine

The following table summarises cut and fill for rail construction in Mamatwan mine from drawing number 504733-0000-DRG-DD-0501:

Table 10: Cut and fill chainages for rail loop in Mamatwan mine

Chainages (km distance)	Cut or fill	Maximum cut/fill (m)
0+000 to 0+650	Fill	1
0+650 to 1+100	Cut	19 (dump)
1+100 to 1+550	Fill	4
1+550 to 1+650	Cut	9 (dump)
1+650 to 2+700	Fill	4
2+700 to 3+200	Fill	1
3+200 to 4+450	Cut	1
4+450 to 5+943	Fill	1

9.1.1 Construction of fills along the track

The fill sections will be constructed on the topsoil which comprises loose sand with roots and the fill material comprising of manganese gravel and sand. These areas vary from natural ground level to about 4m as indicated in drawing 504733-0000-DRG-DD-0501. The following methodology is proposed for the construction of fills:

- Remove fill material and topsoil to an average depth of 0.3m between (0.1m and 0.4m). The excavated topsoil material must be stockpiled for possible later re-use as landscaping material.
- Compact the base of the excavation to the required density as specified in S410 guidelines.
- Construct bulk earthworks and formation layers to required levels, compacted as specified in the S410 guidelines.

9.1.2 Cut areas along the track

The cut depth between 1m and 2m in the natural ground sections and between 9 m and 19 m in the sections covered by the dumps. The cuttings in the mine dumps may create slope stability issues which are further discussed in Section 9.1.3.

The cut material encountered in the natural profile between 1m and 2m will comprise of loose to dense silty sand material of aeolian origin.

The following methodology is proposed prior to construction of formation/structural layers:

- Compact the base of the excavation to the required density prior to construction of bulk earthworks and the formation layers.
- Construct bulk earthworks and formation layers to required levels, compacted as specified in the S410 guidelines.

9.1.3 Slope stability on the mine dumps in Mamatwan mine

The waste dumps comprise of sand, calcrete gravel and some banded ironstone gravels. These are present in two locations along the proposed rail loop (see drawing 504733-0000-DRG-GG-0001-01) and are at the maximum heights of 19m in the southern dump and at 9m in the northern dump.

Shallow ground water table was not encountered in any of the test pits along the rail loop.

The table below presents materials design estimated parameters and Swiss Norm (1999) correlations.

Table 11: Ground parameters for dumps in Mamatwan mine

Profile Description	Unit weight (kN/m^3)	Drained Cohesion (kPa)	Friction angle (°)
Sand	20	0	34
Calcrete sandy gravel	21	0	32

Due to economic risk associated with the proposed rail loop and to ensure stability, the following slope batters are recommended:

- The dump of 19m height must be flattened to a maximum gradient of 23.1° (1:2.3) to achieve a factor of safety (FoS) of 1.5.
- The 9m high dump must be flattened to a maximum gradient of 23.2° (1:2.3) to achieve a FoS of 1.5.

9.1.4 Conveyors

The conveyor alignment for Mamatwan is divided into the following sections as indicated in drawing number 504733-0000-DRG-GG-0001-01:

- MMT-MIL/SIN-CV01,
- MMT-MIL/SIN-CV02,
- MMT-SIN-CV03,
- MMT-SIN-CV04,
- MMT-MIL-CV05,
- MMT-RECLAIM-CV01, and

- MMT-RECLAIM-CV02.

The ground profiles for the conveyors was assessed using the profile descriptions of test pits MTP11, MTP14, MTP15 and MTP16. The soil profile in area generally comprises of loose silty sand to an average depth of 0.2m, which is underlaid by the loose to dense sand to the depth of 2.7m.

At this pre-feasibility stage no detail information is available on the trestles or any conveyor structures and their proposed founding depth, loads and footing dimensions. However, analysis of the ground conditions indicates that the following provisional recommendations can be made on the lighter structures (such as the trestles and at-grade section) and shall be revised after the drilling investigation:

- Remove all the loose material to an average depth of 1m,
- Compact the in-situ material at the base of excavation to the required density,
- Replace the excavated material with better or imported material, constructed in layers not exceeding 150mm up to soffit level,
- Excavations to be inspected by a competent person, i.e. geotechnical engineer or engineering geologist.

9.2 Wessels mine

The following table summarises cut and fill for rail construction in Wessels mine from drawing number 504733-0000-DRG-DD-0603:

Table 12: Cut and fill chainages for rail loop in Wessels mine

Chainages (km distance)	Cut or fill	Maximum cut/fill (m)
0+00 to 0+850	Cut	2
0+850 to 1+450	Fill	1
1+450 to 2+400	Cut	2
2+400 to 2+800	Fill	1
2+800 to 3+350	Cut	7 (tailings dam)
3+350 to 3+900	Fill	1
3+900 to 4+250	Fill	1
4+250 to 4+916	Cut	2

9.2.1 Construction of fills along the track

The fill sections will be constructed on the topsoil which comprises loose sand with roots and the dense to very dense fill material comprising of manganese gravel and sand. These areas vary from natural ground level to about 2m as indicated in drawing 504733-0000-DRG-DD-0603.

The following methodology is proposed for the construction of fills:

- Remove fill material and topsoil to an average depth of 0.3m (0.1m and 0.4m). The excavated topsoil material must be stockpiled for possible later re-use as landscaping material.
- Compact the base of the excavation to the required density.
- Construct bulk earthworks and formation layers to required levels, compacted as specified in the S410 guidelines.

9.2.2 Cut areas along the track

The cut sections vary in depth between 1m and 2m below the natural ground and to a maximum depth of 7m in the tailings dam. The cut in the tailings dam is further discussed in Section 9.2.3 below in regard to slope stability.

The cut material encountered between 1m and 2m will comprise of loose to dense silty sand material of aeolian origin.

The following methodology is proposed prior to construction of formation/structural layers:

- Compact the base of the excavation to the required density prior to construction of bulk earthworks and the formations.
- Construct bulk earthworks and formation layers to required levels, compacted as specified in the S410 guidelines.

9.2.3 Slope stability on the tailings dam in Wessels mine

Tailings dam is typically an earth-fill embankment dam used to store by products of mining operations after separation of the ore from the gangue.

The material on the Wessels tailings dam was not sampled and tested for soil composition or classification. However, it has been stated (via email from the client) that the dam comprises of slime material made of <0.5mm material. The preferred option at the Wessels mine will traverse through the existing tailings dam as indicated in drawing 504733-0000-DRG-GG-0001.

No shallow ground water table was not encountered in any of the excavated test pits near the tailings dam. It is also understood that the tailings dam is currently dry as per email correspondence with the client. The ground parameters are summarised in table below.

Table 13: Ground parameters for the tailings dam

Profile Description	Unit weight (kN/m^3)	Drained Cohesion (kPa)	Friction angle (°)
Sand	20	0	34
Tailings slime (received via email)	19	2	28

It is recommended that the Wessels tailings slope of 7m height be flattened to a maximum gradient of 25.0° (1:2.1) to achieve a FoS of 1.5, due to economic risk associated with the proposed rail loop and to ensure stability.

9.2.4 Conveyors

The conveyor alignment for Wessels mine is divided into the following sections as indicated in drawing number 504733-0000-DRG-GG-0002-01:

- WSL-CV04,
- WSL-CV04B,
- WSL-CV05,
- WSL-CV06,
- WSL-CV07, and
- WSL-CV08.

WSL-CV04 and WSL-CV04B sections traverse over the mine dump which is characterised by a combination of sand, calcrete, clay, gravel and banded ironstone excavated during the decline development. It is understood as this stage that there are no plans to remove the mine dump and the conveyor is expected to traverse over it. The rest of the conveyor sections are appraised using test pit WTP05 and WTP11 which comprises of well compacted, very dense fill material to 1.5m depth and loose to medium dense sand of aeolian origin to 3.0m below ground level.

The provisional recommendations are as follows:

- Where the very dense fill material is encountered to at least 1m below surface, conveyor footings can be constructed within this material,
- Remove the loose to medium dense sand to 1m below natural ground,
- The sides of the excavation must be battered to ensure stability (typically at 60°).
- Replace the excavated material with a G8 or better material,
- Compacted to the required density in layers not exceeding 150mm up to soffit level,
- Excavations to be inspected by a competent person, i.e. geotechnical engineer or engineering geologist.

9.3 Drainage

The drainage requirements detailed in the S410 specification must be implemented.

10 Additional investigations and required information

In order to provide design parameters for the heavier structures, it is recommended that further investigations are undertaken to characterise the soil and rock profiles at depth. These investigations and required information shall entail drilling of rotary core boreholes to 25m each in conjunction with Standard Penetration Testing (SPT) as follows:

- Transfer structures (3 No borehole),

- New load out structure (1 No borehole), and
- Stackers and sampler plants (1 No boreholes)

This equates to four (5 No) boreholes at Wessels mine and five (5 No) borehole at Mamatwan mine.

This drilling investigation shall include all associated laboratory testing (such as Uniaxial Compressive Strength test on core samples).

11 Conclusions

The following conclusions are presented:

- The shallow soils of aeolian sands and pedogenic material are generally considered suitable for use as bulk earthworks, layer A and B. One sample in Mamatwan mine indicates the aeolian sand not suitable for use for either bulk earthworks, layer B and A material. The material for construction of SB and SSB layers is to be sourced elsewhere.
- Given that one sample indicates that aeolian sand may sometime not be suitable for construction purposes. The onerous selection of this material may be a challenge. As a result, it may be feasible for all construction material to be imported from elsewhere with the rest of the soils used as general fill or for landscaping purposes, or alternatively spoiled.
- The material encountered in both mines can be classified as "*Soft excavation"* in terms of SANS 1200D to an average depth of 2.8m below natural ground in Wessels mine and 2.4m in Mamatwan mine.
- The loose sand of topsoil is to be removed prior to construction of cut/fill along the route. This material is to be stockpiled for possible later re-use as landscaping material.
- The loose silty sand material encountered in the topsoil and aeolian sand may be potentially compressible or collapsible.
- Due to the soil conductivity of the soil, special consideration may be necessary in the design against the deterioration of buried steel, copper and concrete elements in soil.
- The drainage requirements detailed in the S410 specification must be implemented.
- The slope stability checks were high-level checks conducted to give an idea on safe and acceptable cut slopes. It is further proposed that samples be taken from the tailings dam in Wessels mine and in the mine dumps at Mamatwan mine for laboratory testing to further analyse and provide more suitable slope designs.
- The conveyor provisional recommendations are to be revised once the drilling investigation and laboratory testing has been concluded and more information with regards to footing dimensions, height, founding levels below ground level and general foundation loads becomes available.
- The founding recommendations for the transfer structures, load out structures, stackers and sampler plants will be addressed once drilling investigation has been conducted in both mines as recommended in Section 10.
- The material on the tailings dam may be toxic and potentially radioactive. It is therefore proposed that this material should be verified of any potential health and environmental risk prior to being disposed. If it has been evaluated to pose a risk, the material will have to be disposed of in a manner and a location deemed appropriate.
- Should the above point also apply to the very dense well compacted stockpile material, it is proposed that all fill material be removed prior to construction and the competent person be present on site to re-evaluate recommendation stated in this report.
- The information contained herein is based on a limited number of test pits. As indicated in Section 10, additional work is recommended for heavier structures.

- There are no fatal flaws in terms of geotechnical inputs to prevent the proposed development from proceeding. However, the indicated geotechnical constrains and recommendations pertaining to slope stability, usability of in-situ material for construction purposes, environmental/health risk associated with the tailings, cut/fill and associated structures are to be adhered to as proposed.

12 Limitations

The following limitations apply to this interpretive report:

1. The Aurecon Tshwane Ground Engineering Group has prepared this report for the use of our Client, South 32. The report has not been prepared for use by parties other than the Client, and the Client's respective consulting advisors.
2. This report has been written with the express intent of providing sufficient information for the pre-feasibility stage purposes. The interpretation of the ground conditions has been conducted in accordance with generally accepted engineering practice, and the opinions and conclusions expressed in the report are made in good faith based on the information available to the Aurecon Tshwane Ground Engineering Group at the time of preparing this report.
3. There may be some variations in subsurface conditions across a site due to geological conditions that cannot be defined fully even by exhaustive investigation. Hence, it is possible that the measurements and values obtained from sampling and testing during the investigation may not represent the extremes of conditions which exist within the site. The precision with which subsurface conditions are identified depends on the method of drilling, the frequency and recovery of samples, the method of sampling, and the uniformity of the subsurface conditions. Subsurface conditions at locations other than the test pit and borehole locations may vary from the conditions encountered at the test pit / borehole locations. In advancing the project to more definitive levels of engineering additional geotechnical investigations will prove necessary.
4. Furthermore, subsurface conditions, including groundwater levels can change over time. The groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These conditions may vary seasonally or because of construction activities in the area. This should be borne in mind, particularly if the report is used after a protracted delay or a period of protracted climatic conditions.
5. Should conditions exposed at the site during subsequent investigation or construction works vary significantly from those provided in this report, we request that the Aurecon Tshwane Ground Engineering Group be informed and have the opportunity to review any of the findings or conclusions of this report. It is highly recommended that during construction the site conditions be inspected by a representative of the Aurecon Tshwane Ground Engineering Group to confirm the geotechnical interpretations and ground model in this report.
6. Unless otherwise stated, this report does not address potential environmental hazards, or groundwater contamination. In addition to soil variability, fil material of variable physical and chemical composition can be present over portions of the site or on adjacent properties.

13 References

- Association of Swiss Road and Traffic Engineers, 1999. Characteristic Coefficients of soils. In: Swiss Standard SN 670 010b. S.I.
- Brink A. B. A. (1979). Engineering Geology of South Africa. Printed in South Africa by the Natal Witness printing and publishing company (Pty) Ltd, 8293LM
- Byrne. G & Berry, AD, Franki A, 2008. Guide to Practical Geotechnical Engineering in Southern Africa, Fourth Edition.
- Duligal, E. (1996). Significance of Soil Resistivity on Corrosivity. Unpublished report compiled for Africon.
- Evans, U.R. (1977). The Corrosion and Oxidation of Metals: Scientific Principles and Practical Applications. Edward Arnold (Publishers) Ltd. 1977.
- Geotechnology Workshop (1990). Guidelines for Soil and Rock Logging. SAIEG-AEG-SAICE (Geotech Division).
- Jennings, J. E. B, Brink, A.B.A and Williams, A. A. B, (1973). Revised Guide to Soil Profiling for Civil Engineering Purposes in Southern Africa. The Civil Engineer in S A, p 3-12. January 1973.
- Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J. (Eds) (2006). The Geology of South Africa. Geological Society of South Africa, Johannesburg/Council for Geoscience, Pretoria, 585-593 pp.
- Kimatlab (2007). Geotechnical investigations for the new wet screening plant at Wessels mine. Report SL 3111/07272
- S410 (2006), Specifications for railway earthworks, technical specifications. Technology management and trach technology. Spoortnet, a division of Transnet Limited
- SANS 10160-4:2011 (2011). South African National Standard: Basis of structural design and actions for buildings and industrial structures. Part 4: Seismic actions and general requirements for buildings. ISBN 978-0-626-26431-4
- SANS 10160-4:2011 (2011). South African National Standard: Basis of structural design and actions for buildings and industrial structures. Part 4: Seismic actions and general requirements for buildings. ISBN 978-0-626-26431-4
- SANS 10160-1:2011 (2011). South African National Standard: Basis of structural design and actions for buildings and industrial structures. Part 1: Basis of structural design. ISBN 978-0-626-26428-4
- SANS 1200DB: 1989 Standardised specification for civil engineering construction. DB Earthworks (Pipe trenches), South African Bureau of Standards, Pretoria.
- SABS 1200D: 1988 Standardised specification for civil engineering construction. D: Earthworks, South African Bureau of Standards, Pretoria.
- South African Institution of Civil Engineering (SAICE) – Geotechnical Division. 2007. The Safety of Persons Working in Small Diameter Shafts and Test Pits for Geotechnical Engineering Purposes – Code of Practice, 1st Edition.
- The government of Hong Kong Special Administrative Region, 2011. Geotechnical Manual for Slope, Civil Engineering and Development Department, Hong Kong.
- Weinert, H.H. The natural road construction materials of southern Africa. Academica, Pretoria 298pp. 1980.

Appendix A

Soil and rock profile description terminology

STANDARD DESCRIPTIONS USED IN SOIL PROFILING

1. MOISTURE CONDITION

Term	Description
Dry	
Slightly moist	Requires addition of water to reach optimum moisture content for compaction
Moist	Near optimum content
Very Moist	Requires drying to attain optimum content
Wet	Fully saturated and generally below water table

2. COLOUR

The Predominant colours or colour combinations are described including secondary coloration described as banded, streaked, blotched, mottled, speckled or stained.

3. CONSISTENCY

3.1 Non-Cohesive Soils

Term	Description
Very Loose	Crumbles very easily when scraped with geological pick
Loose	Small resistance to penetration by sharp end of geological pick
Medium Dense	Considerable resistance to penetration by sharp end of geological pick
Dense	Very high resistance to penetration to sharp end of geological pick. Requires many blows of hand pick for excavation.
Very Dense	High resistance to repeated blows of geological pick. Requires power tools for excavation

3.2 Cohesive Soils

Term	Description
Very soft	Easily penetrated by thumb. Sharp end of pick can be pushed in 30 - 40mm. Easily moulded by fingers.
Soft	Pick head can easily be pushed into the shaft of handle. Moulded by fingers with some pressure.
Firm	Indented by thumb with effort. Sharp end of pick can be pushed in up to 10mm. Can just be penetrated with an ordinary spade.
Stiff	Penetrated by thumbnail. Slight indentation produced by pushing pick point into soil. Cannot be moulded by fingers. Requires hand pick for excavation.
Very Stiff	Indented by thumbnail. Slight indentation produced by blow of pick point. Requires power tools for excavation.

4. STRUCTURE

Term	Description
Intact	Absence of fissures or joints
Fissured	Presence of closed joints
Shattered	Presence of closely spaced air-filled joints giving cubical fragments
Micro-shattered	Small scale shattering with shattered fragments the size of sand grains
Slickensided	Polished planar surfaces representing shear movement in soil
Bedded Folitated	Many residual soils show structures of parent rock.

5. SOIL TYPE

5.1 Particle Size

Term	Size (mm)
Boulder	>200
Pebbles	60 – 200
Gravel	60 – 2
Sand	2 – 0,06
Silt	0,06 – 0,002
Clay	<0,002

6. ORIGIN

6.1 Transported Soils

Term	Agency of Transportation
Colluvium	Gravity deposits
Talus	Scree or coarse colluvium
Hillwash	Fine colluvium
Alluvial	River deposits
Aeolian	Wind deposits
Litoral	Beach deposits
Estuarine	Tidal – river deposits
Lacustine	Lake deposits

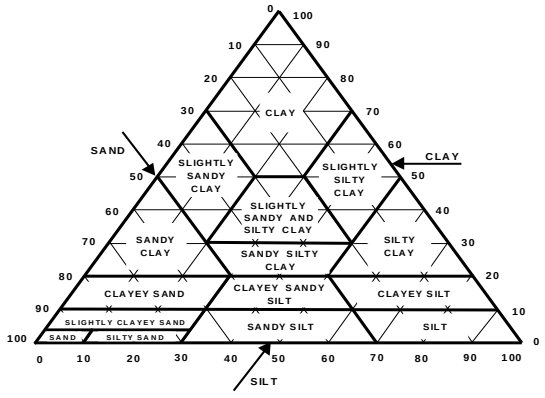
6.2 Residual soils

These are products of in-situ weathering of rocks and are described as e.g. Residual Shale

6.3 Pedocretes

Formed in transported and residual soils etc.
calcrete, silcrete, manganocrete and ferricrete.

5.2 Soil Classification



SUMMARY OF DESCRIPTIONS USED IN ROCK CORE LOGGING

1. WEATHERING

Term	Symbol	Diagnostic Features
Residual Soil	W5	Rock is discoloured and completely changed to a soil in which original rock fabric is completely destroyed. There is a large change in volume.
Completely Weathered	W5	Rock is discoloured and changed to a soil but original fabric is mainly preserved. There may be occasional small corestones.
Highly Weathered	W4	Rock is discoloured, discontinuities may be open and have discoloured surfaces, and the original fabric of the rock near the discontinuities may be altered; alternation penetrates deeply inwards, but corestones are still present.
Moderately Weathered	W3	Rock is discoloured, discontinuities may be open and will have discoloured surfaces with alteration starting to penetrate inwards, intact rock is noticeably weaker than the fresh rock.
Slightly Weathered	W2	Rock may be slightly discoloured, particularly adjacent to discontinuities, which may be open and will have slightly discoloured surfaces, the intact rock is not noticeably weaker than the fresh rock.
Unweathered	W1	Parent rock showing no discolouration, loss of strength or any other weathering effects.

2. HARDNESS

Classification	Field Test	Compressive Strength Range MPa
Very Soft Rock	Can be peeled with a knife. Material crumbles under firm blows with the sharp end of a geological pick.	1 to 3
Soft Rock	Can be scraped with a knife, indentation of 2 to 4 mm with firm blows of the pick point.	3 to 10
Medium Hard Rock	Cannot be scraped or peeled with a knife. Hand held specimen breaks with firm blows of the pick.	10 to 25
Hard Rock	Point load tests must be carried out in order to distinguish between these classifications	25 - 70
Very Hard Rock	These results may be verified by uniaxial compressive strength tests on selected samples.	70 - 200
Extremely Hard Rock		>200

3. COLOUR

The predominant colours or colour combination are described including secondary colouration described as banded, streaked, blotched, mottled, speckled or stained.

4. FABRIC

4.1 Grain Size

Term	Size (mm)
Very Coarse	>2,0
Coarse	0,6 – 2,0
Medium	0,2 – 0,6
Fine	0,06 – 0,2
Very Fine	< 0,06

4.2 Discontinuity Spacing

Description for: Bedding, foliation, laminations	Spacing (mm)	Descriptions for joints, faults, etc.
Very Thickly Bedded	> 2000	Very Widely
Thickly Bedded	600 – 2000	Widely
Medium Bedded	200 – 600	Medium
Thinly Bedded	20 – 60	Closely
Laminated	6 – 20	Very closely
Thinly Laminated	<6	

5. ROCK NAME

Classified in terms of origin:

IGNEOUS	Granite, Diorite, Gabbro, Syenite, Diabase, Dolerite, Trachyte, Andesite, Basalt.
METAMORPHIC	Slate, Quartzite, Gneiss, Chert, Sandstone
SEDIMENTARY	Shale, Mudstone, Siltstone, Sandstone, Dolomite, Conglomerate, Tillite, Quartzite, Limestone.

6. STRATIGRAPHIC HORIZON

Identification of rock type in terms of stratigraphic horizons.

Appendix B

Test pit profiles

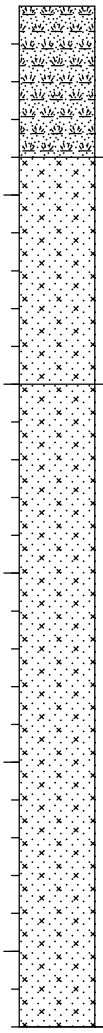
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **MTP01**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



FI & MOD CBR

0.00 Dry, dark brown, LOOSE, intact, silty SAND. Topsoil

0.40 Slightly moist, yellowish orange, LOOSE, intact, silty SAND. Aeolian Sand

1.00 Slightly moist, yellowish orange, MEDIUM DENSE to DENSE, intact, silty SAND. Aeolian Sand

2.70

NOTES:

Final depth at 2.7m on Aeolian sand
No refusal
No groundwater or seepage encountered
Sidewalls stable
Big sample bag taken at 1.0-2.7m

CONTRACTOR:	Thomas	*INCLINATION:*		*ELEVATION:*	
MACHINE:		*DIAM:*		*X COORD:*	696803
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/20/2019	*Y COORD:*	6967226
TYPE SET BY:		*DATE PROFILED:*	6/20/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **MTP01**

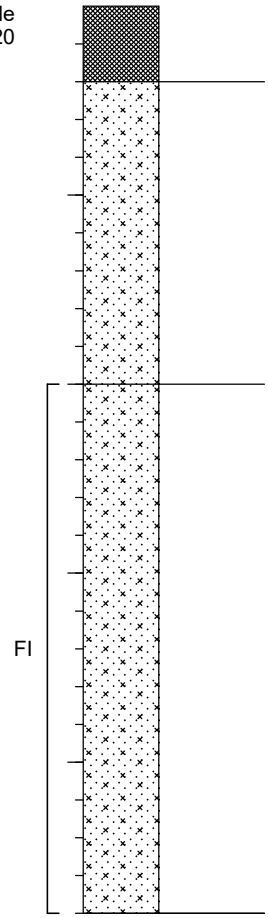
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **MTP03**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



0.00 Dry, dark brown, LOOSE, intact, silty SAND. Fill

0.20 Slightly moist, yellowish orange, LOOSE, intact, silty SAND. Aeolian Sand

1.00 Slightly moist, yellowish orange, MEDIUM DENSE to DENSE, intact, silty SAND. Aeolian Sand

FI

2.40

NOTES:

Final depth at 2.4m on Aeolian sand
No refusal
No groundwater or seepage encountered
Sidewalls stable
Small sample bag taken at 1.0-2.4m

CONTRACTOR:	Thomas	*INCLINATION:*		*ELEVATION:*	
MACHINE:		*DIAM:*		*X COORD:*	697159
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/20/2019	*Y COORD:*	6968163
TYPE SET BY:		*DATE PROFILED:*	6/20/2018		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **MTP03**

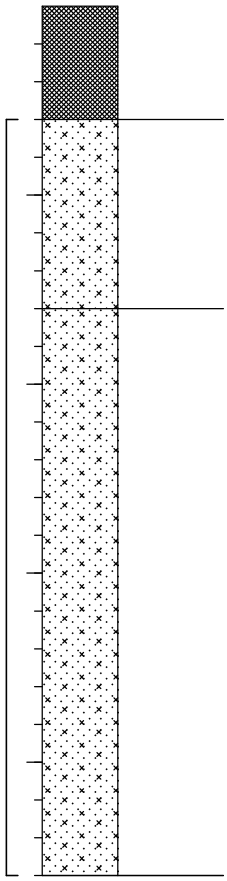
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **MTP05**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



0.00 Dry, dark brown to black, LOOSE, intact, silty SAND. Fill

0.30 Slightly moist, yellowish orange, LOOSE, intact, silty SAND. Aeolian Sand

0.80 Slightly moist, yellowish orange, DENSE, intact, silty SAND. Aeolian Sand

2.30

NOTES:

Final depth at 2.3m on Aeolian sand
No refusal
No groundwater or seepage encountered
Sidewalls stable
Big sample bag taken at 0.3-2.3m

CONTRACTOR: Thomas
MACHINE:
PROFILED BY: S. Nyathi & T. Mofokeng
TYPE SET BY:

INCLINATION:
DIAM:
DATE DRILLED: 6/21/2019
DATE PROFILED: 6/21/2019

ELEVATION:
X COORD: 697505
Y COORD: 6969104

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **MTP05**

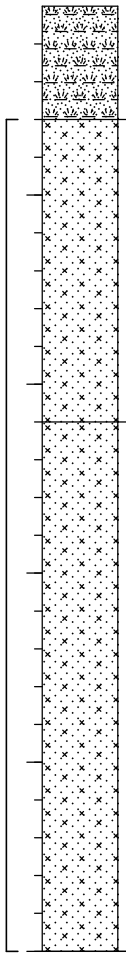
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **MTP06**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



FI

0.00 Dry, light brown, LOOSE, intact, silty SAND with occassional roots. Topsoil

0.30 Slightly moist, yellowish orange, LOOSE, intact, silty SAND. Aeolian Sand

1.10 Slightly moist, yellowish orange, MEDIUM DENSE to DENSE, intact, silty SAND. Aeolian Sand

2.50

NOTES:

Final depth at 2.5m on Aeolian sand
No refusal
No groundwater or seepage encountered
Sidewalls stable
Small sample bag taken at 0.3-2.5m

CONTRACTOR:	Thomas	*INCLINATION:*		*ELEVATION:*	
MACHINE:		*DIAM:*		*X COORD:*	697512
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/21/2019	*Y COORD:*	6969714
TYPE SET BY:		*DATE PROFILED:*	6/21/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **MTP06**

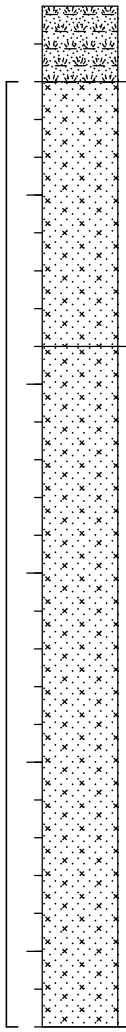
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **MTP07**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



FI

0.00 Dry, brown, LOOSE, intact, silty SAND with rootlets. Topsoil

0.20 Slightly moist, yellowish orange, LOOSE, intact, silty SAND. Aeolian Sand

0.90 Slightly moist, yellowish orange, DENSE, intact, silty SAND. Aeolian Sand

2.70

NOTES:

Final depth at 2.7m on Aeolian sand
No refusal
No groundwater or seepage encountered
Sidewalls stable
Small sample bag taken at 0.2-2.7m

CONTRACTOR:	Thomas	*INCLINATION:*		*ELEVATION:*	
MACHINE:		*DIAM:*		*X COORD:*	697431
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/21/2019	*Y COORD:*	6970212
TYPE SET BY:		*DATE PROFILED:*	6/21/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **MTP07**

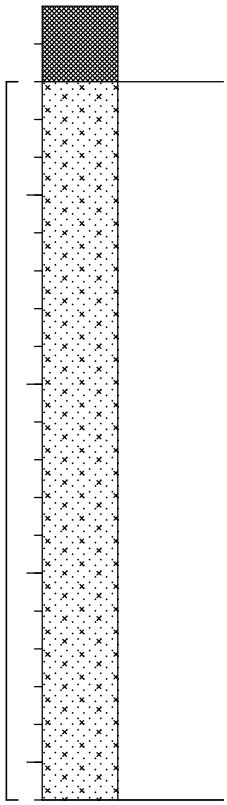
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **MTP09**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



0.00 Dry, brown, LOOSE, intact, silty SAND. Fill

0.20 Slightly moist, yellowish orange, DENSE, intact, silty SAND. Aeolian Sand

2.10

NOTES:

Refusal at 2.1m on very dense to very soft rock calcrete
No groundwater or seepage encountered
Sidewalls stable
Big sample bag taken at 0.2-2.1m

CONTRACTOR:	Thomas	*INCLINATION:*		*ELEVATION:*	
MACHINE:		*DIAM:*		*X COORD:*	696768
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/21/2019	*Y COORD:*	6970089
TYPE SET BY:		*DATE PROFILED:*	6/21/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **MTP09**

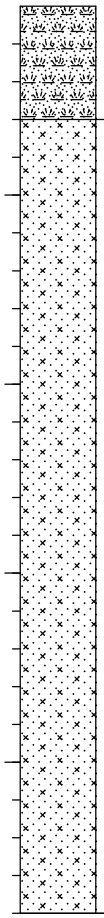
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **MTP11**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



0.00 Dry, dark brown, LOOSE, intact, silty SAND. Topsoil

0.30 Dry, yellowish orange, DENSE to VERY DENSE, intact, silty SAND. Aeolian Sand

2.40

NOTES:

Partial refusal at 2.4m on very dense Aeolian sand
No groundwater or seepage encountered
No sample taken
Sidewalls stable

CONTRACTOR:	Thomas	*INCLINATION:*		*ELEVATION:*	
MACHINE:		*DIAM:*		*X COORD:*	696981
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/21/2019	*Y COORD:*	6969569
TYPE SET BY:		*DATE PROFILED:*	6/21/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **MTP11**

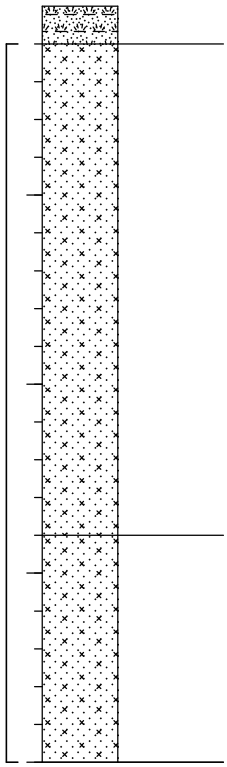
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **MTP14**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



0.00 Moist, brown, LOOSE, intact, silty SAND. Topsoil

0.10 Moist, yellowish orange, LOOSE, intact, silty SAND. Aeolian Sand

1.40 Slightly moist, yellowish orange, MEDIUM DENSE to DENSE, intact, silty SAND. Aeolian Sand

2.00

NOTES:

Final depth at 2m on Aeolian sand
No refusal
No groundwater or seepage encountered
Sidewalls stable
Small sample bag taken at 0.1-2.0m

CONTRACTOR:	Thomas	*INCLINATION:*		*ELEVATION:*	
MACHINE:		*DIAM:*		*X COORD:*	697160
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/21/2019	*Y COORD:*	6969090
TYPE SET BY:		*DATE PROFILED:*	6/21/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **MTP14**

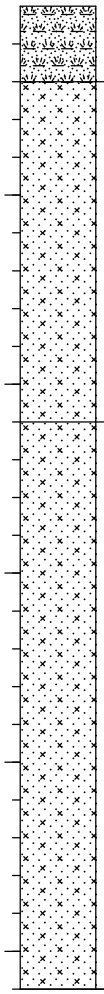
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **MTP15**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



0.00 Dry, light brown, LOOSE, intact, silty SAND with rootlets. Topsoil

0.20 Slightly moist, yellowish orange, LOOSE, intact, silty SAND. Aeolian Sand

1.10 Slightly moist, yellowish orange, MEDIUM DENSE to DENSE, intact, silty SAND. Aeolian Sand

2.60

NOTES:

Final depth at 2.6m on Aeolian sand
No refusal
No groundwater or seepage encountered
No sample taken
Sidewalls stable

CONTRACTOR:	Thomas	*INCLINATION:*		*ELEVATION:*	
MACHINE:		*DIAM:*		*X COORD:*	697391
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/21/2019	*Y COORD:*	6969888
TYPE SET BY:		*DATE PROFILED:*	6/21/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **MTP15**

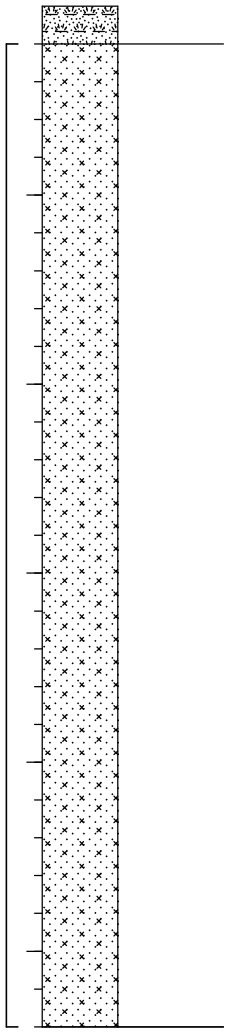
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **MTP16**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



0.00 Dry, brown, LOOSE, intact, silty SAND with roots. Topsoil

0.10 Dry, yellowish orange, DENSE, intact, silty SAND. Aeolian Sand

2.70

NOTES:

Final depth at 2.7m on Aeolian sand
No refusal
No groundwater or seepage encountered
Sidewalls stable
Big sample bag taken at 0.1-2.7m

CONTRACTOR:	Thomas	*INCLINATION:*		*ELEVATION:*	
MACHINE:		*DIAM:*		*X COORD:*	697055
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/21/2019	*Y COORD:*	6969830
TYPE SET BY:		*DATE PROFILED:*	6/21/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **MTP16**

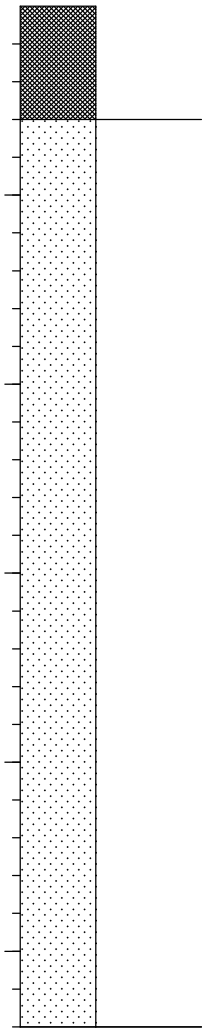
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **WTP03**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



0.00 Dry, black, DENSE, manganese gravel and sand. Fill material (in a stockpile area)

0.30 Moist, yellow brown, LOOSE, intact, SAND. Aeolian sand

2.70

NOTES:

Final depth at 2.7m on Aeolian sand
No refusal
No groundwater or seepage encountered
No sample taken
Sidewalls unstable

CONTRACTOR:	Daniel	*INCLINATION:*		*ELEVATION:*	
MACHINE:	Volvo BL61B	*DIAM:*		*X COORD:*	683738
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/18/2019	*Y COORD:*	6998777
TYPE SET BY:		*DATE PROFILED:*	6/18/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **WTP03**

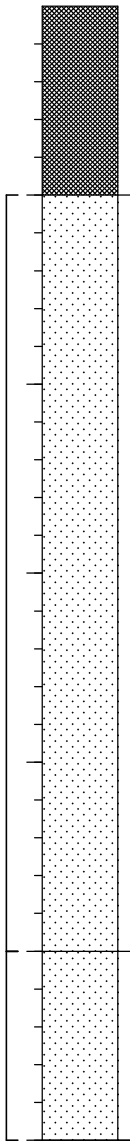
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **WTP04**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



FI & MOD CBR

FI

0.00 Fill material, manganese gravel compacted for/by the stockpile area.

0.50 Moist, orange brown, MEDIUM DENSE to DENSE, intact, SAND. Aeolian sand

2.50 Moist, off-white and orange brown, MEDIUM DENSE to DENSE, SAND with calcrete concretions

3.00

NOTES:

Final depth at 3m on pedogenic material
No refusal
No groundwater or seepage encountered
Sidewalls stable
Big sample bag taken at 0.5-2.5m
Small sample bag at 2.5-3.0m

CONTRACTOR:	Daniel	*INCLINATION:*		*ELEVATION:*	
MACHINE:	Volvo BL61B	*DIAM:*		*X COORD:*	683927
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/19/2019	*Y COORD:*	6999232
TYPE SET BY:		*DATE PROFILED:*	6/19/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **WTP04**

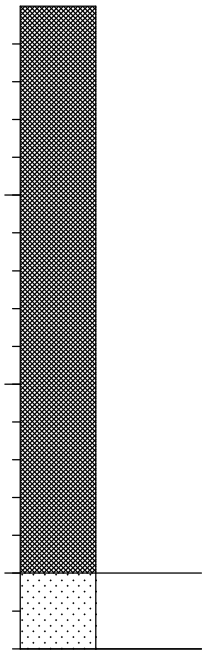
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **WTP05**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



0.00 Slightly moist, black, compacted to VERY DENSE, manganese gravel and cobbles. Fill material

1.50 Moist, orange brown, MEDIUM DENSE, intact, SAND. Aeolian sand

1.70

NOTES:

TLB refusing to break through the well compacted fill
No groundwater or seepage encountered
No sample taken
Sidewalls stable
It's likely sand to 3.0m

CONTRACTOR:	Daniel	*INCLINATION:*		*ELEVATION:*	
MACHINE:	Volvo BL61B	*DIAM:*		*X COORD:*	684111
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/19/2019	*Y COORD:*	6999672
TYPE SET BY:		*DATE PROFILED:*	6/19/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **WTP05**

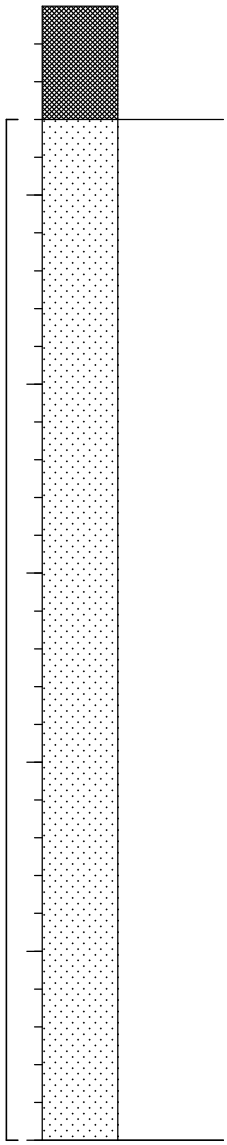
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **WTP08**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



0.00 Fill material, manganese, gravel compacted by the stockpile area.

0.30 Moist, orange brown, MEDIUM DENSE, intact, SAND. Aeolian sand

3.00

NOTES:

Final depth at 3.0m on Aeolian sand
No refusal
No groundwater or seepage encountered
Sidewalls stable
Small sample bag taken at 0.3-3.0m

CONTRACTOR:	Daniel	*INCLINATION:*		*ELEVATION:*	
MACHINE:	Volvo BL61B	*DIAM:*		*X COORD:*	684501
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/19/2019	*Y COORD:*	6999228
TYPE SET BY:		*DATE PROFILED:*	6/19/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **WTP08**

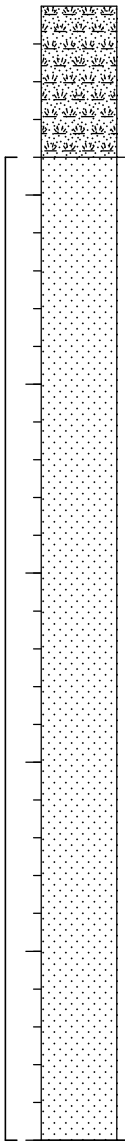
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **WTP11**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



FI & MOD CBR

0.00 Slightly moist, dark brown, LOOSE, intact, SAND with roots. Topsoil

0.40 Moist, orange brown, MEDIUM DENSE, intact, SAND. Aeolian sand

3.00

NOTES:

Final depth at 3.0m on Aeolian sand
No refusal
No groundwater or seepage encountered
Sidewalls stable
Big sample bag taken at 0.4-3.0m
It is around rubbish dump areas

CONTRACTOR:	Daniel	*INCLINATION:*		*ELEVATION:*	
MACHINE:	Volvo BL61B	*DIAM:*		*X COORD:*	684549
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/19/2019	*Y COORD:*	6999692
TYPE SET BY:		*DATE PROFILED:*	6/19/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **WTP11**

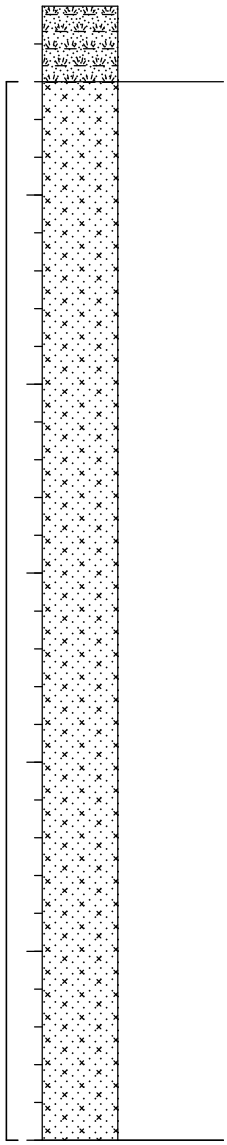
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **WTP15**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



FI & MOD CBR

0.00 Dry, brown, LOOSE, intact, silty SAND with roots. Topsoil.

0.20 Dry, yellowish orange, MEDIUM DENSE to DENSE, intact, silty SAND. Aeolian sand.

3.00

NOTES:

Final depth at 3m on Aelian sand
No refusal
No groundwater or seepage encountered
Side walls stable
Big sample bags taken at 0.2-3.0m

CONTRACTOR:	Daniel	*INCLINATION:*		*ELEVATION:*	
MACHINE:	Volvo BL61B	*DIAM:*		*X COORD:*	684877
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/19/2019	*Y COORD:*	6999191
TYPE SET BY:		*DATE PROFILED:*	6/19/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **WTP15**

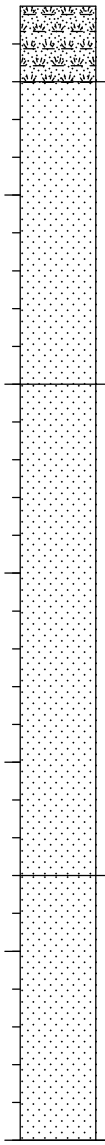
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **WTP16**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



0.00 Dry, dark brown, LOOSE, intact, silty SAND with roots. Topsoil

0.20 Dry to slightly moist, yellow brown, LOOSE to MEDIUM DENSE, intact, SAND. Aeolian sand

1.00 Slightly moist, yellow brown, DENSE, intact, SAND. Aeolian sand

2.30 Slightly moist, off-white, DENSE, intact, calcritised SAND with minor calcrete gravels/nodules. Pedogenic/Aeolian sand

FI MOD CBR

3.00

NOTES:

Final depth at 3.0m on pedogenic material / Aeolian sand
No refusal
No groundwater or seepage encountered
Sidewalls stable
Big sample bag taken at 2.3-3.0m
Small sample bag taken at 2.3-3.0m

CONTRACTOR:	Daniel	*INCLINATION:*		*ELEVATION:*	
MACHINE:	Volvo BL61B	*DIAM:*		*X COORD:*	684475
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/18/2019	*Y COORD:*	6998919
TYPE SET BY:		*DATE PROFILED:*	6/18/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **WTP16**

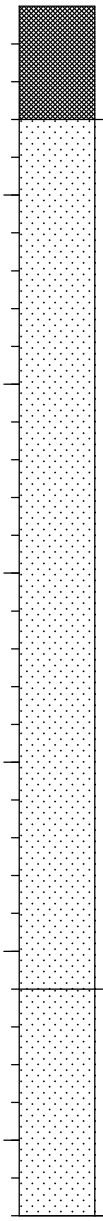
aurecon

SOUTH32
Rapid Rail LOS Upgr Wessels & Mamatwan

HOLE No: **WTP18**
Sheet 1 of 1

JOB NUMBER: **504733**

Scale 1:20



0.00 Fill material, manganese gravel compacted for/by the stockpile area.

0.30 Moist, orange brown, MEDIUM DENSE to DENSE, intact, SAND. Aeolian sand

2.60 Moist, off-white and orange brown, MEDIUM DENSE to DENSE, intact, calcritised SAND with calcrete concretions/gravels. Pedogenic material

FI & MOD CBR

3.20

NOTES:

Final depth at 3.2m on pedogenic material
No refusal
No groundwater or seepage encountered
Sidewalls stable
Big sample bag taken at 2.6-3.2m

CONTRACTOR:	Daniel	*INCLINATION:*		*ELEVATION:*	
MACHINE:	Volvo BL61B	*DIAM:*		*X COORD:*	684259
PROFILED BY:	S. Nyathi & T. Mofokeng	*DATE DRILLED:*	6/19/2019	*Y COORD:*	6999321
TYPE SET BY:		*DATE PROFILED:*	6/19/2019		

WESSELS&MAMATWAN LOGS.GPJ

HOLE No: **WTP18**

Appendix C

Laboratory test results

FOUNDATION INDICATOR TEST RESULTS

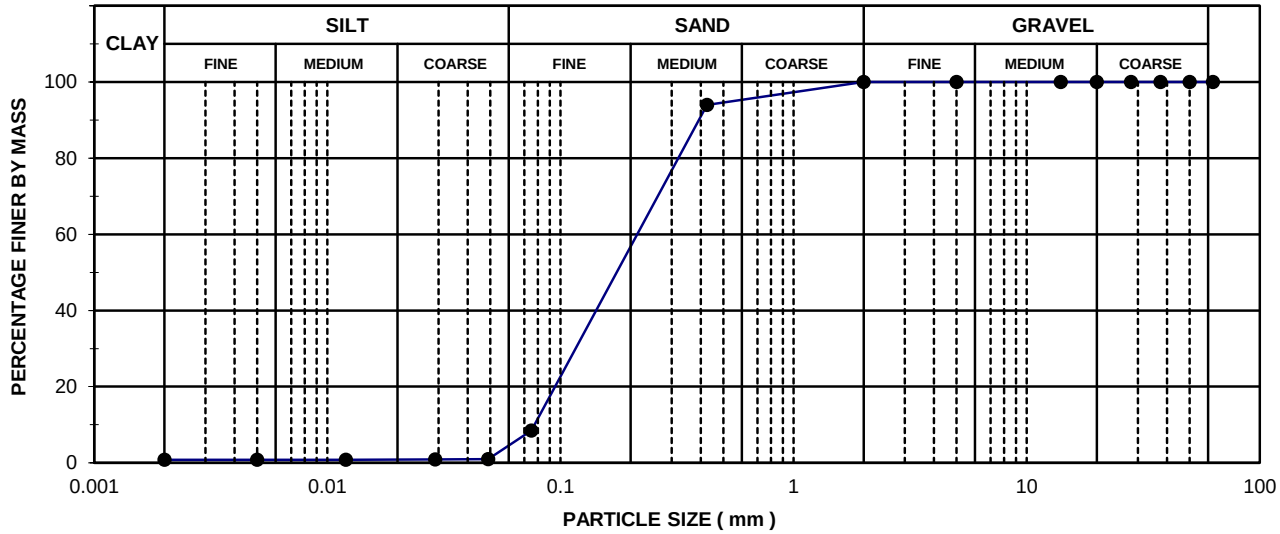
TEST LOCATION	WTP04	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	0.5-2.5 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**94**
50.000	**100**	0.075	**9**
37.500	**100**	0.049	**1**
28.000	**100**	0.029	**1**
20.000	**100**	0.012	**1**
14.000	**100**	0.002	**1**
5.000	**100**	0.000	**0**
2.000	**100**	0.000	**0**

ATTERBERG LIMITS		
Liquid limit	(%)	**18.0**
Plastic limit	(%)	**18**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**0.98**
Uniformity coefficient		**3**
Coefficient of curvature		**1.1**

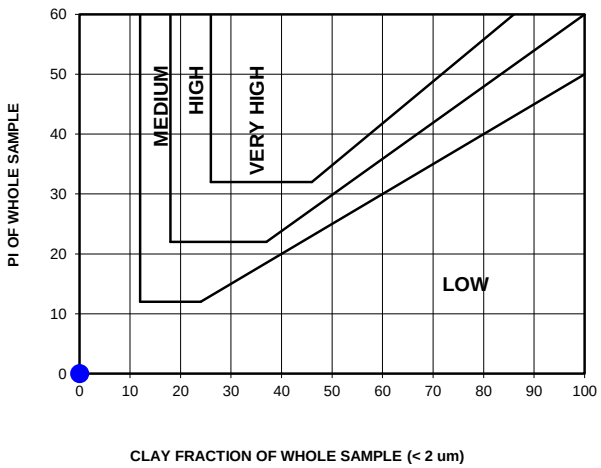
SOIL CLASSIFICATION	
% Gravel	**0**
% Sand	**92**
% Silt	**8**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SP-SM**
TRB Classification	**A - 3**

PARTICLE SIZE DISTRIBUTION

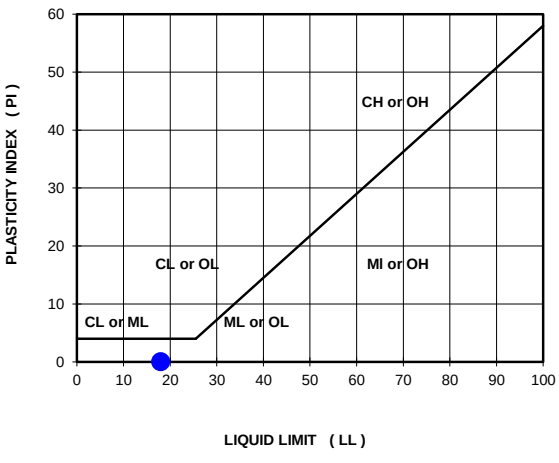


POTENTIAL EXPANSIVENESS

Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

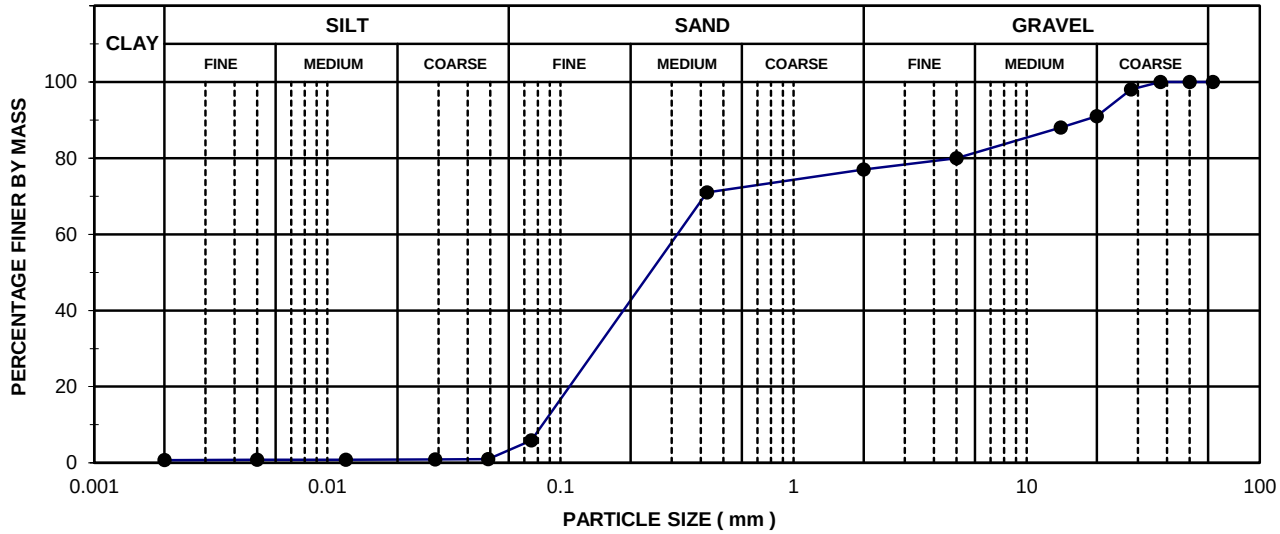
TEST LOCATION	WTP04	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	2.5-3.0 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**71**
50.000	**100**	0.075	**6**
37.500	**100**	0.049	**1**
28.000	**98**	0.029	**1**
20.000	**91**	0.012	**1**
14.000	**88**	0.002	**1**
5.000	**80**	0.000	**0**
2.000	**77**	0.000	**0**

ATTERBERG LIMITS		
Liquid limit	(%)	**18.0**
Plastic limit	(%)	**18**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**1.46**
Uniformity coefficient		**4**
Coefficient of curvature		**1.2**

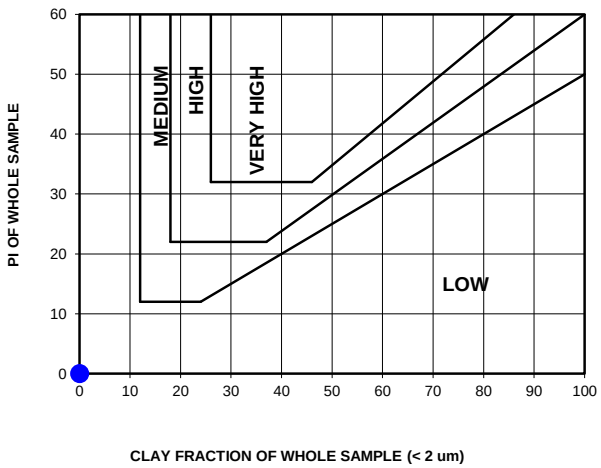
SOIL CLASSIFICATION	
% Gravel	**23**
% Sand	**71**
% Silt	**5**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SP-SM**
TRB Classification	**A - 3**

PARTICLE SIZE DISTRIBUTION

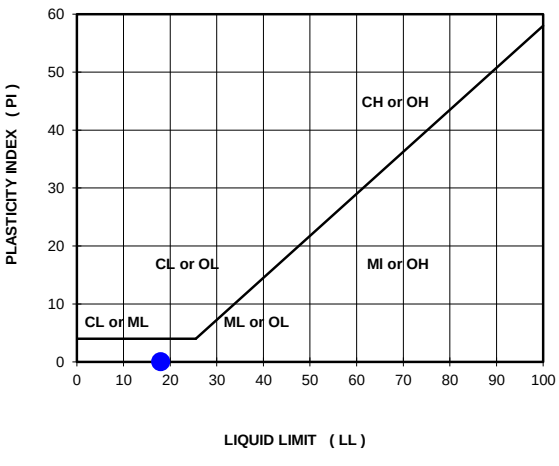


POTENTIAL EXPANSIVENESS

Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

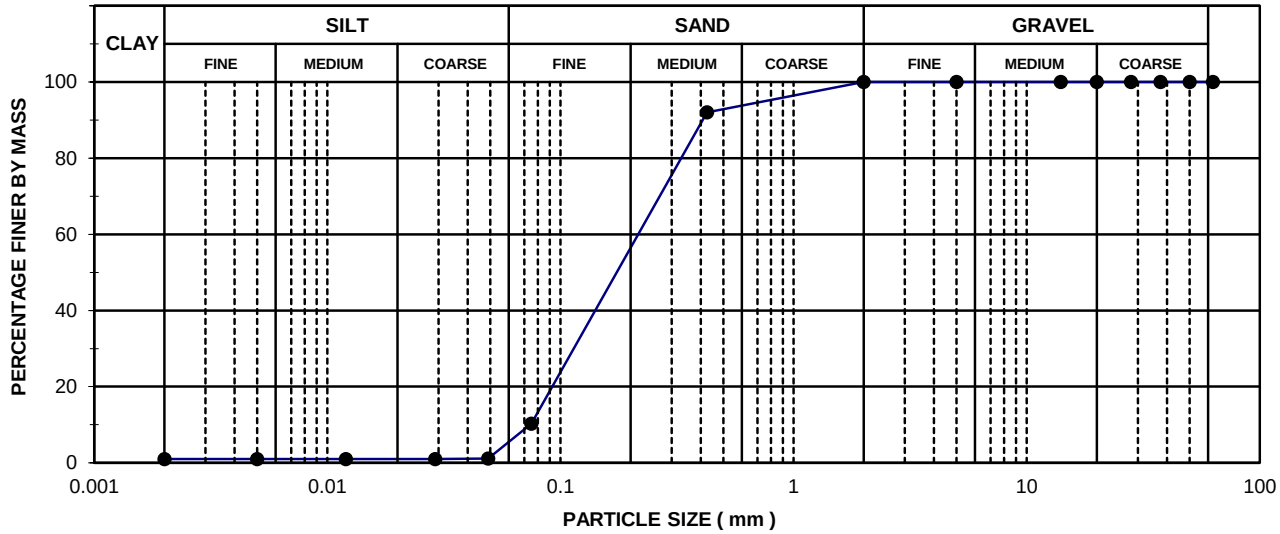
TEST LOCATION	WTP11	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	0.4-3.0 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**92**
50.000	**100**	0.075	**10**
37.500	**100**	0.049	**1**
28.000	**100**	0.029	**1**
20.000	**100**	0.012	**1**
14.000	**100**	0.002	**1**
5.000	**100**	0.000	**0**
2.000	**100**	0.000	**0**

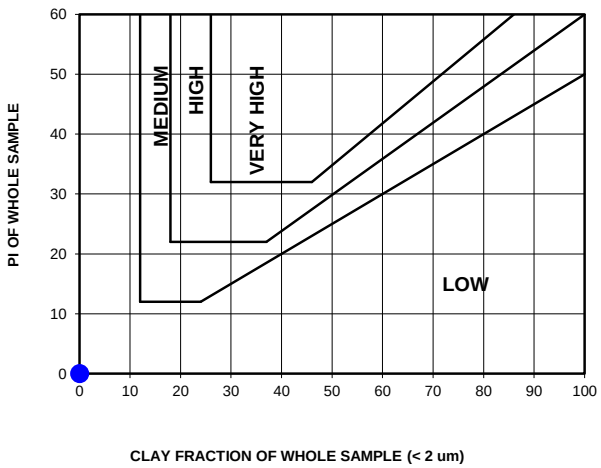
ATTERBERG LIMITS		
Liquid limit	(%)	**16.0**
Plastic limit	(%)	**16**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**0.98**
Uniformity coefficient		**4**
Coefficient of curvature		**1.2**

SOIL CLASSIFICATION	
% Gravel	**0**
% Sand	**90**
% Silt	**9**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SP-SM**
TRB Classification	**A - 2 - 4**

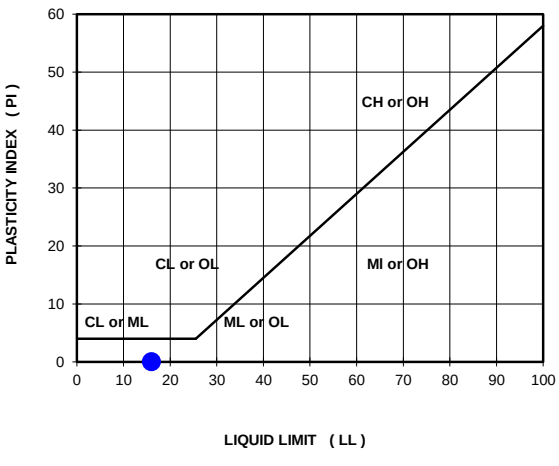
PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

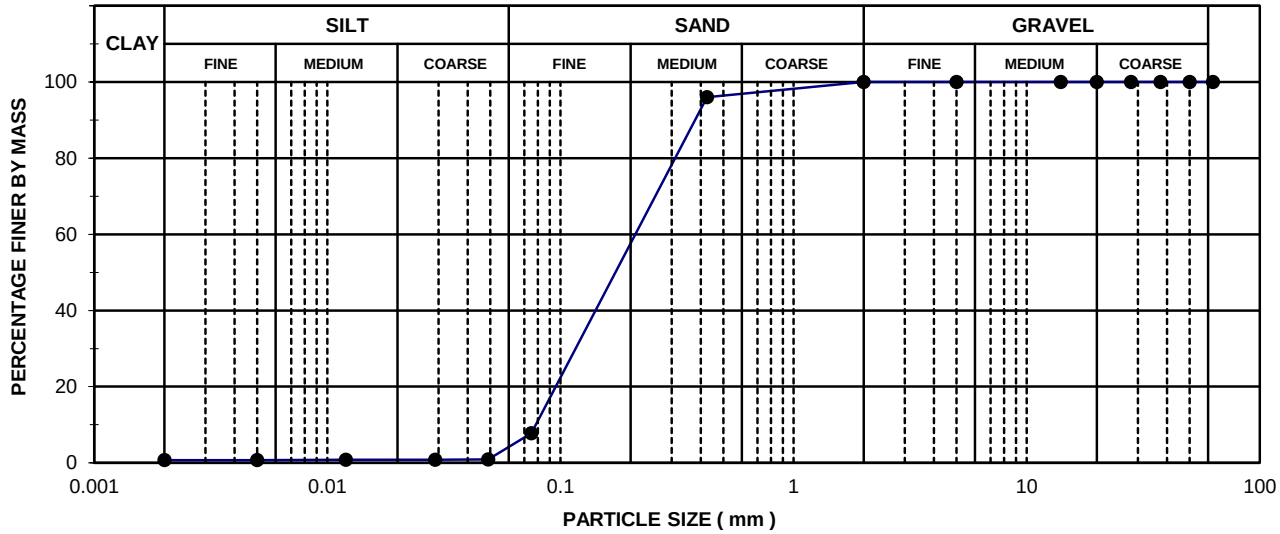
TEST LOCATION	WTP15	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	0.2-2.6 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**96**
50.000	**100**	0.075	**8**
37.500	**100**	0.049	**1**
28.000	**100**	0.029	**1**
20.000	**100**	0.012	**1**
14.000	**100**	0.002	**1**
5.000	**100**	0.000	**0**
2.000	**100**	0.000	**0**

ATTERBERG LIMITS		
Liquid limit	(%)	**16.0**
Plastic limit	(%)	**16**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**0.96**
Uniformity coefficient		**3**
Coefficient of curvature		**1.1**

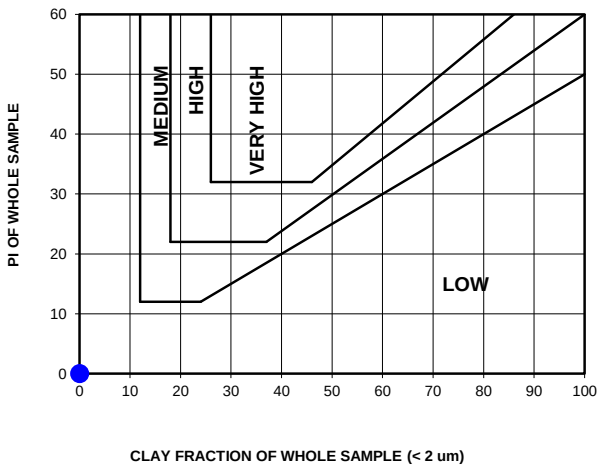
SOIL CLASSIFICATION	
% Gravel	**0**
% Sand	**92**
% Silt	**7**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SP-SM**
TRB Classification	**A - 3**

PARTICLE SIZE DISTRIBUTION

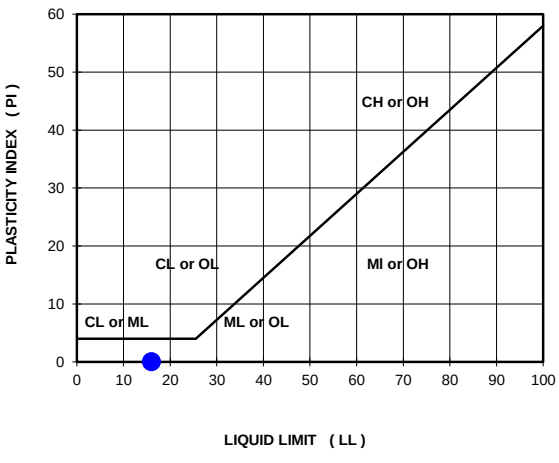


POTENTIAL EXPANSIVENESS

Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

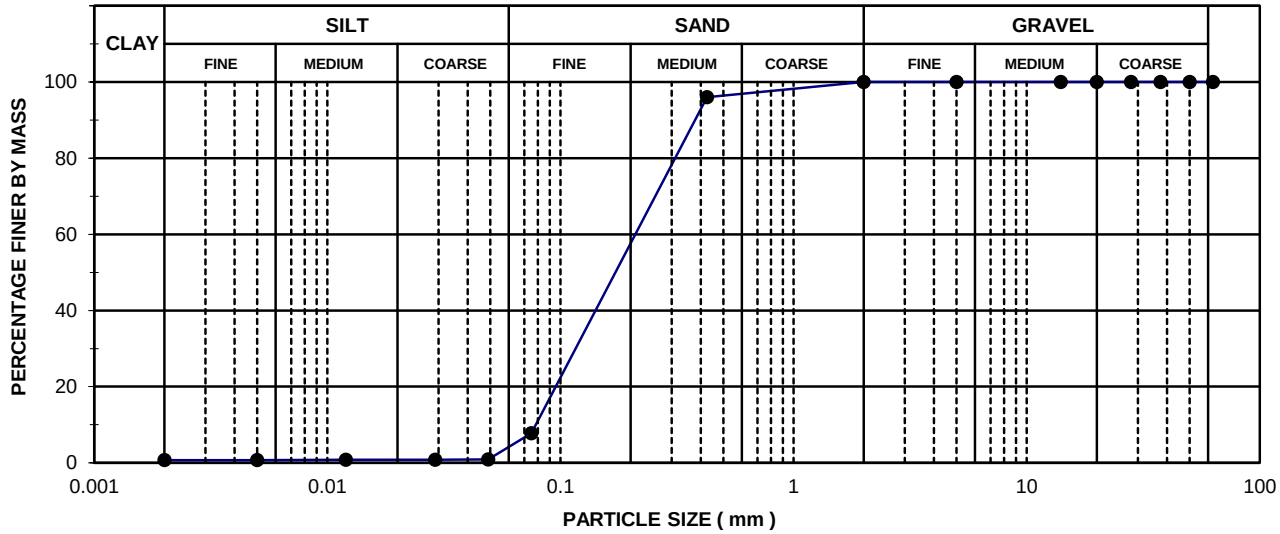
TEST LOCATION	WTP16	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	2.3-3.0 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**96**
50.000	**100**	0.075	**8**
37.500	**100**	0.049	**1**
28.000	**100**	0.029	**1**
20.000	**100**	0.012	**1**
14.000	**100**	0.002	**1**
5.000	**100**	0.000	**0**
2.000	**100**	0.000	**0**

ATTERBERG LIMITS		
Liquid limit	(%)	**16.0**
Plastic limit	(%)	**16**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**0.96**
Uniformity coefficient		**3**
Coefficient of curvature		**1.1**

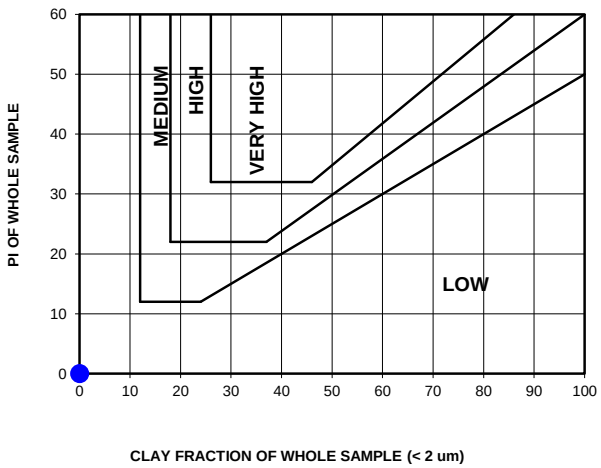
SOIL CLASSIFICATION	
% Gravel	**0**
% Sand	**92**
% Silt	**7**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SP-SM**
TRB Classification	**A - 3**

PARTICLE SIZE DISTRIBUTION

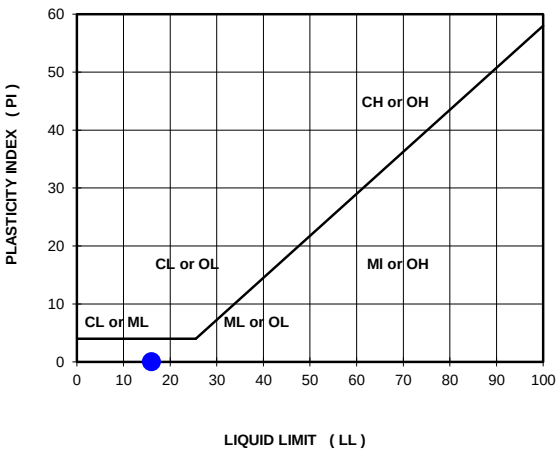


POTENTIAL EXPANSIVENESS

Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

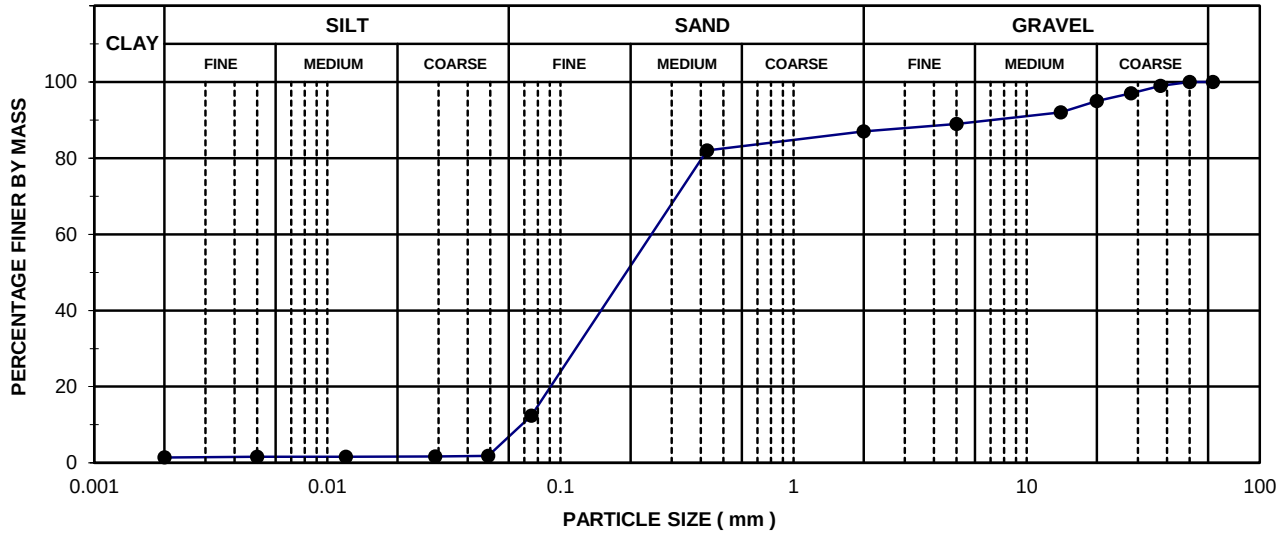
TEST LOCATION	WTP18	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	2.6-3.2 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**82**
50.000	**100**	0.075	**12**
37.500	**99**	0.049	**2**
28.000	**97**	0.029	**2**
20.000	**95**	0.012	**2**
14.000	**92**	0.002	**1**
5.000	**89**	0.000	**0**
2.000	**87**	0.000	**0**

ATTERBERG LIMITS		
Liquid limit	(%)	**17.0**
Plastic limit	(%)	**17**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**1.19**
Uniformity coefficient		**4**
Coefficient of curvature		**1.2**

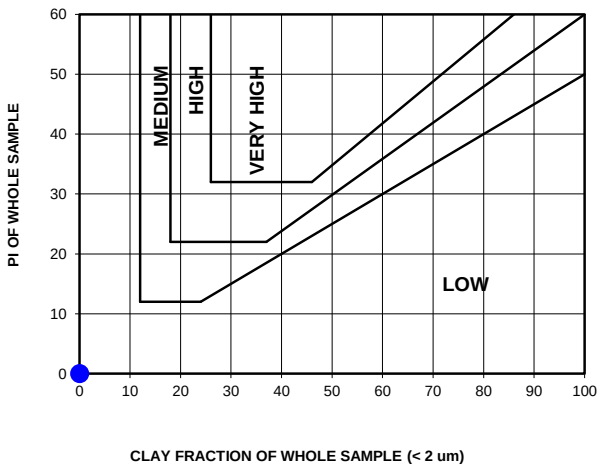
SOIL CLASSIFICATION	
% Gravel	**13**
% Sand	**75**
% Silt	**11**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SM**
TRB Classification	**A - 2 - 4**

PARTICLE SIZE DISTRIBUTION

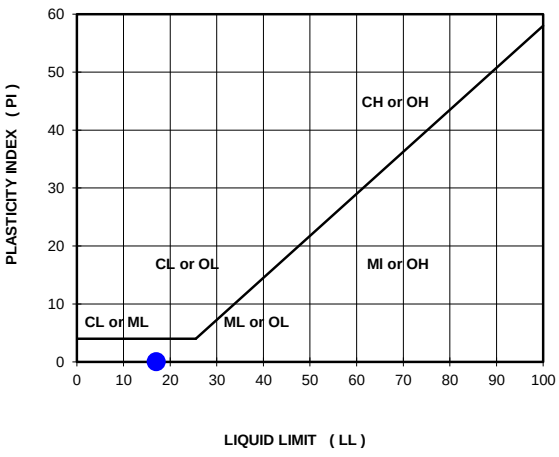


POTENTIAL EXPANSIVENESS

Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

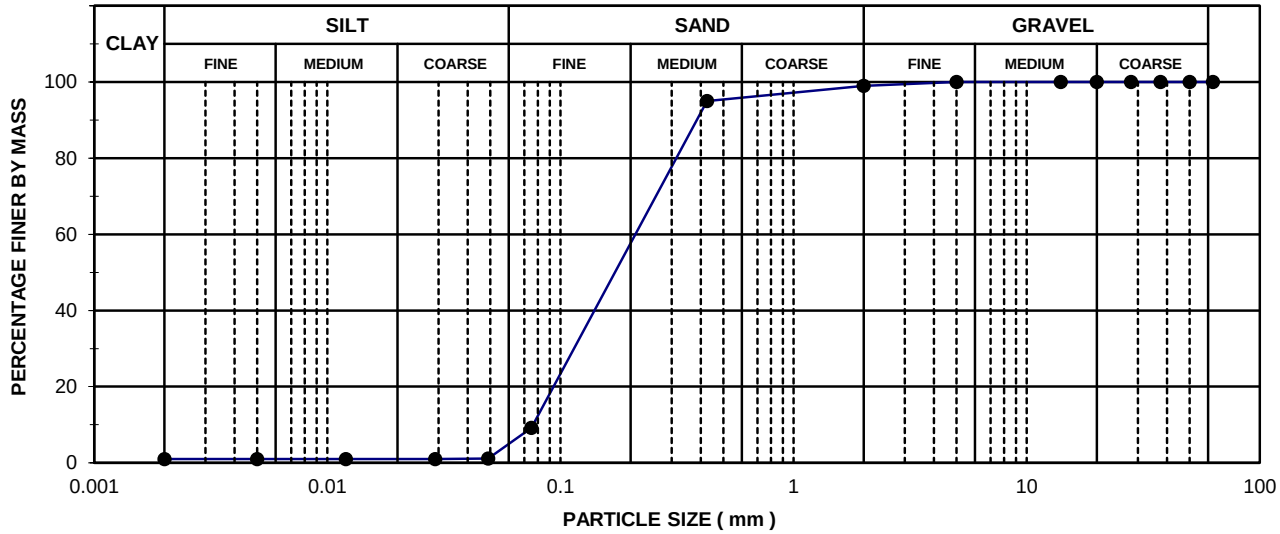
TEST LOCATION	WTP08	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	0.3-3.0 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**95**
50.000	**100**	0.075	**9**
37.500	**100**	0.049	**1**
28.000	**100**	0.029	**1**
20.000	**100**	0.012	**1**
14.000	**100**	0.002	**1**
5.000	**100**	0.000	**0**
2.000	**99**	0.000	**0**

ATTERBERG LIMITS		
Liquid limit	(%)	**16.0**
Plastic limit	(%)	**16**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**0.97**
Uniformity coefficient		**4**
Coefficient of curvature		**1.2**

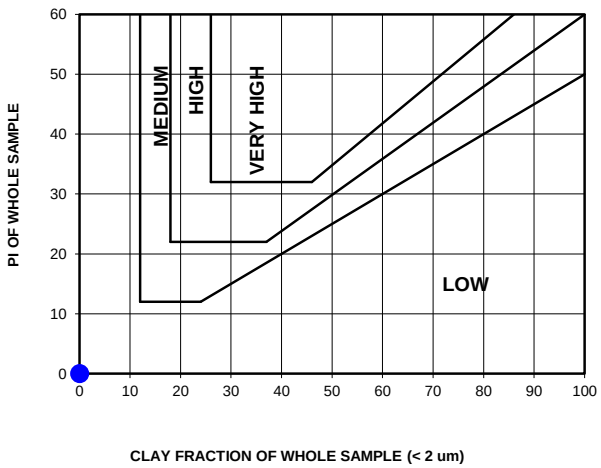
SOIL CLASSIFICATION	
% Gravel	**1**
% Sand	**90**
% Silt	**8**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SP-SM**
TRB Classification	**A - 3**

PARTICLE SIZE DISTRIBUTION

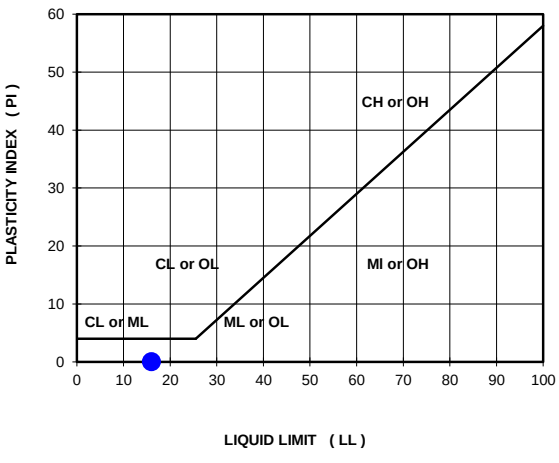


POTENTIAL EXPANSIVENESS

Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

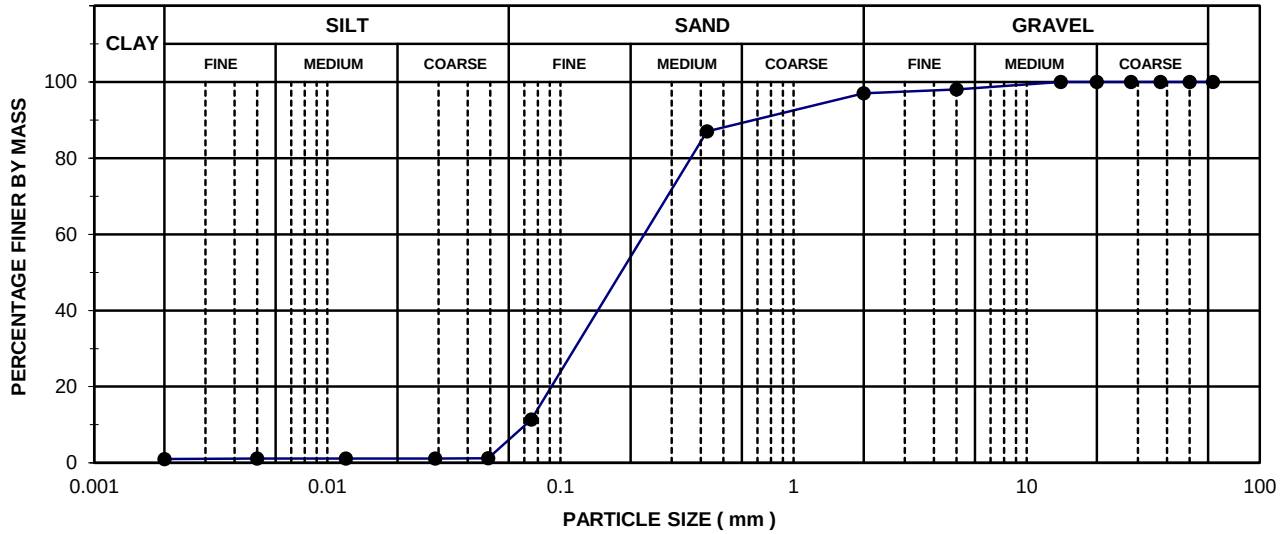
TEST LOCATION	MTP03	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	1.0-2.4 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**87**
50.000	**100**	0.075	**11**
37.500	**100**	0.049	**1**
28.000	**100**	0.029	**1**
20.000	**100**	0.012	**1**
14.000	**100**	0.002	**1**
5.000	**98**	0.000	**0**
2.000	**97**	0.000	**0**

ATTERBERG LIMITS		
Liquid limit	(%)	**16.0**
Plastic limit	(%)	**16**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**1.05**
Uniformity coefficient		**4**
Coefficient of curvature		**1.2**

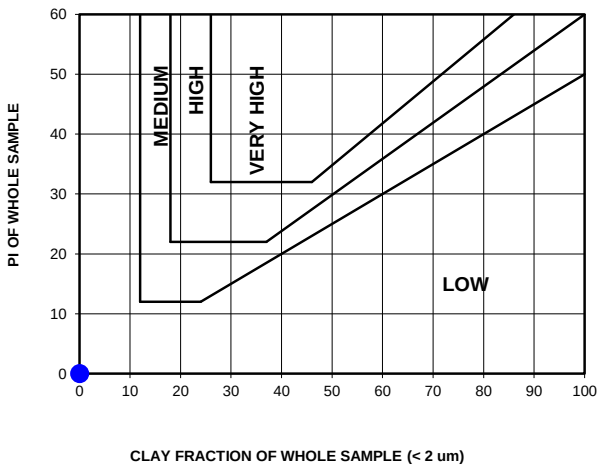
SOIL CLASSIFICATION	
% Gravel	**3**
% Sand	**86**
% Silt	**10**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SP-SM**
TRB Classification	**A - 2 - 4**

PARTICLE SIZE DISTRIBUTION

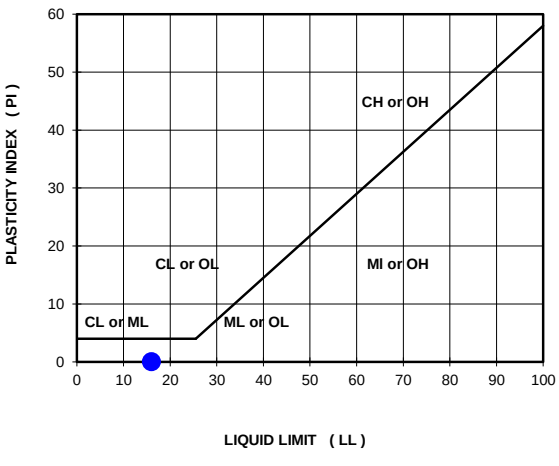


POTENTIAL EXPANSIVENESS

Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

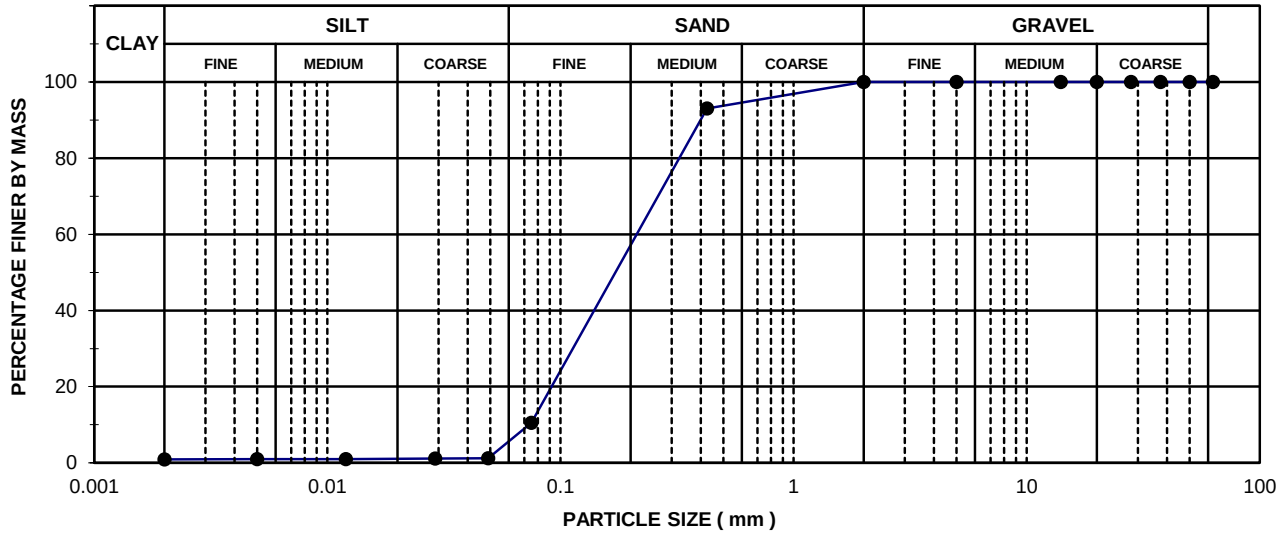
TEST LOCATION	MTP14	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	0.1-2.0 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**93**
50.000	**100**	0.075	**11**
37.500	**100**	0.049	**1**
28.000	**100**	0.029	**1**
20.000	**100**	0.012	**1**
14.000	**100**	0.002	**1**
5.000	**100**	0.000	**0**
2.000	**100**	0.000	**0**

ATTERBERG LIMITS		
Liquid limit	(%)	**16.0**
Plastic limit	(%)	**16**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**0.97**
Uniformity coefficient		**4**
Coefficient of curvature		**1.2**

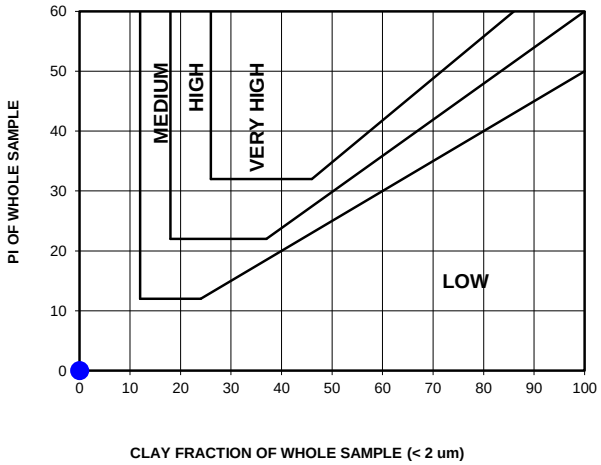
SOIL CLASSIFICATION	
% Gravel	**0**
% Sand	**90**
% Silt	**10**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SP-SM**
TRB Classification	**A - 2 - 4**

PARTICLE SIZE DISTRIBUTION

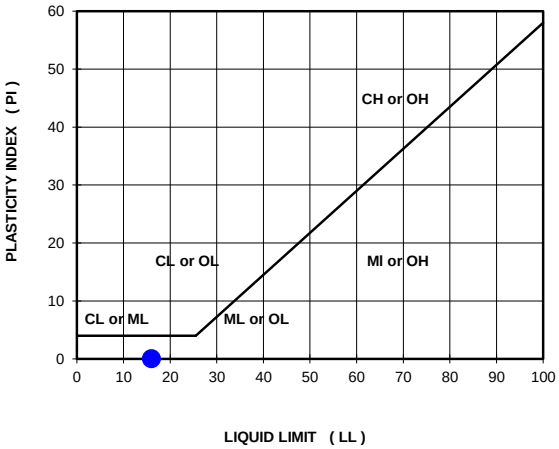


POTENTIAL EXPANSIVENESS

Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

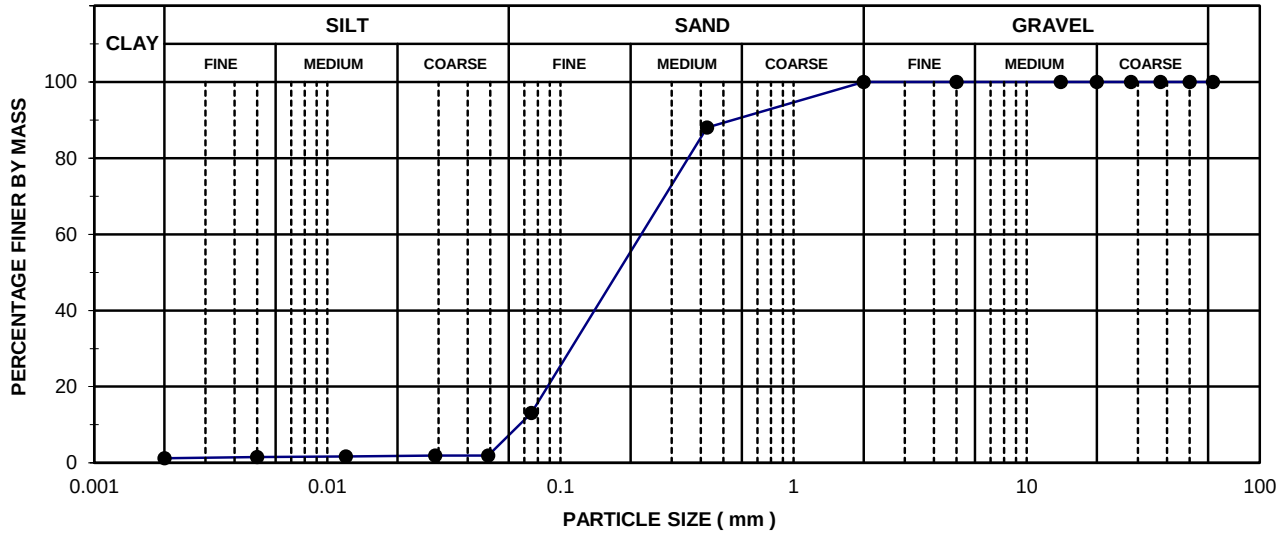
TEST LOCATION	MTP07	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	0.2-2.7 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**88**
50.000	**100**	0.075	**13**
37.500	**100**	0.049	**2**
28.000	**100**	0.029	**2**
20.000	**100**	0.012	**2**
14.000	**100**	0.002	**1**
5.000	**100**	0.000	**0**
2.000	**100**	0.000	**0**

ATTERBERG LIMITS		
Liquid limit	(%)	**16.0**
Plastic limit	(%)	**16**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**0.99**
Uniformity coefficient		**4**
Coefficient of curvature		**1.2**

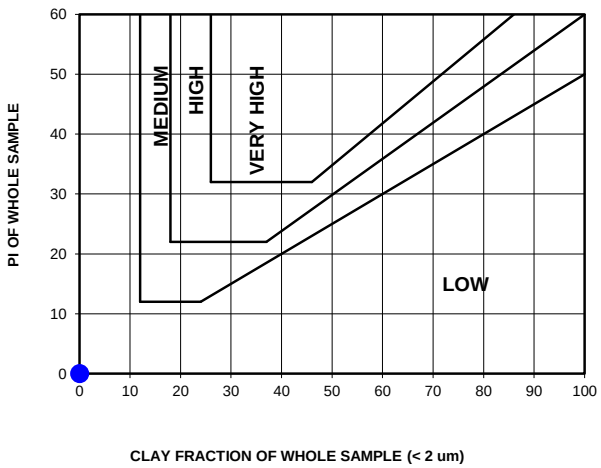
SOIL CLASSIFICATION	
% Gravel	**0**
% Sand	**87**
% Silt	**12**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SM**
TRB Classification	**A - 2 - 4**

PARTICLE SIZE DISTRIBUTION

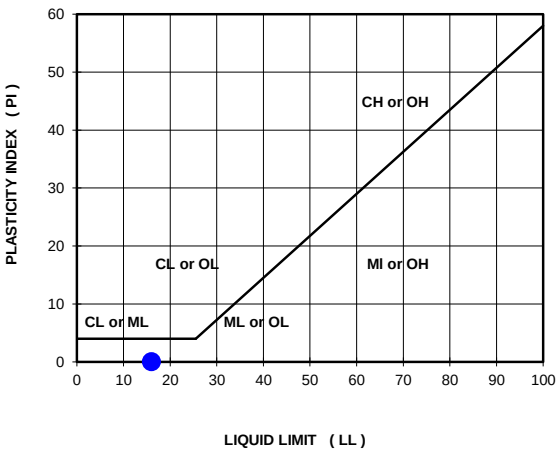


POTENTIAL EXPANSIVENESS

Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

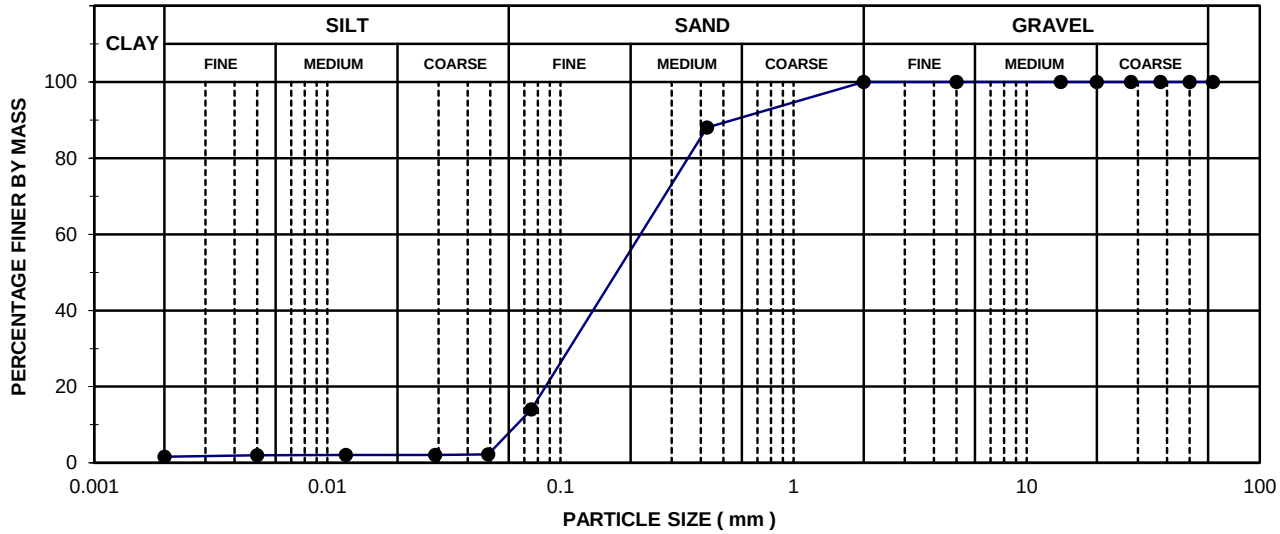
TEST LOCATION	MTP06	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	0.3-2.5 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**88**
50.000	**100**	0.075	**14**
37.500	**100**	0.049	**2**
28.000	**100**	0.029	**2**
20.000	**100**	0.012	**2**
14.000	**100**	0.002	**2**
5.000	**100**	0.000	**0**
2.000	**100**	0.000	**0**

ATTERBERG LIMITS		
Liquid limit	(%)	**17.0**
Plastic limit	(%)	**17**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**0.98**
Uniformity coefficient		**4**
Coefficient of curvature		**1.2**

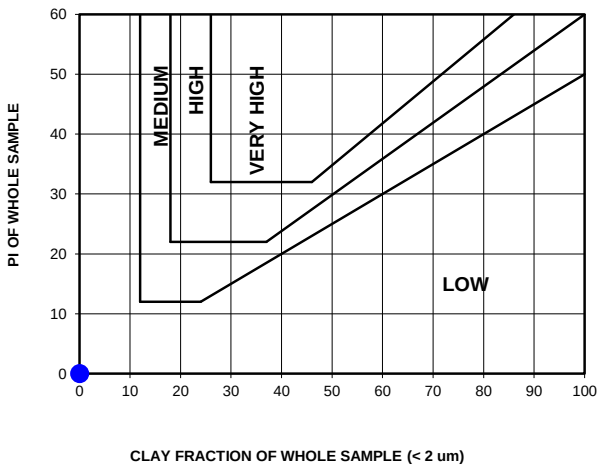
SOIL CLASSIFICATION	
% Gravel	**0**
% Sand	**86**
% Silt	**12**
% Clay	**2**
Activity	**0.0**
Unified Classification	**SM**
TRB Classification	**A - 2 - 4**

PARTICLE SIZE DISTRIBUTION

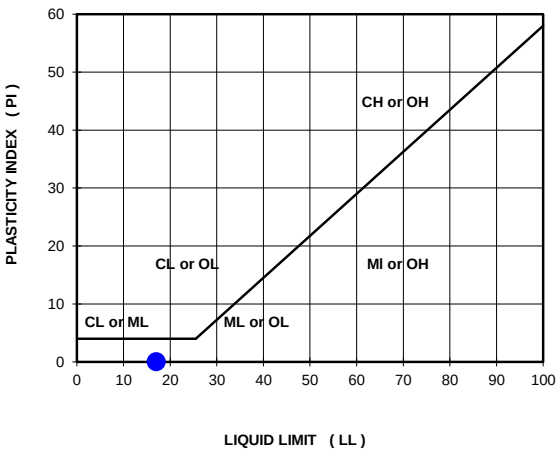


POTENTIAL EXPANSIVENESS

Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE

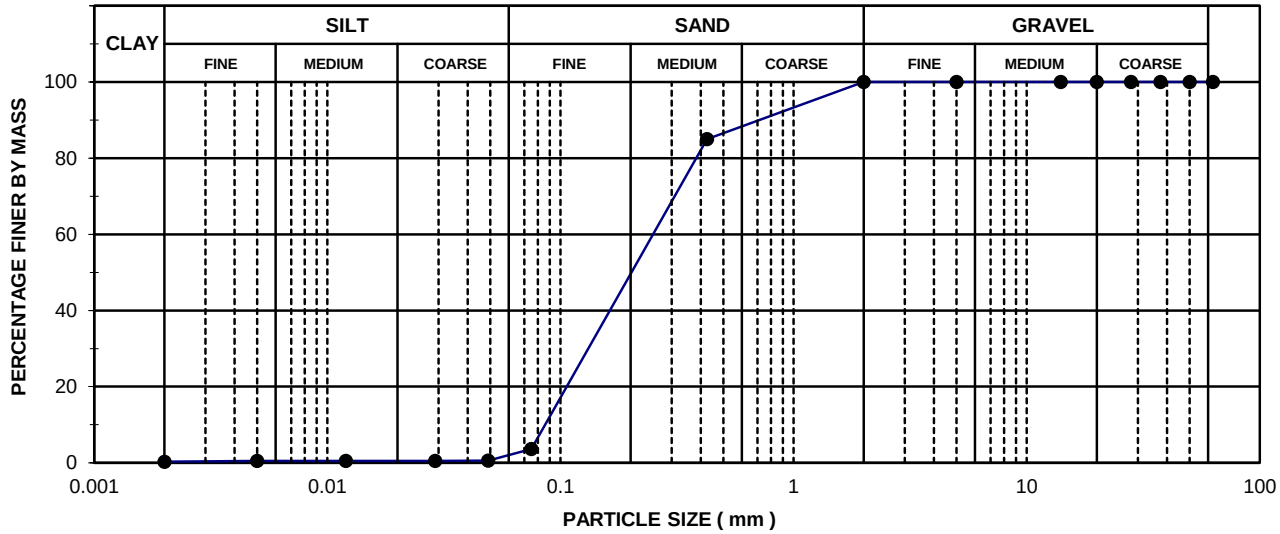


FOUNDATION INDICATOR TEST RESULTS

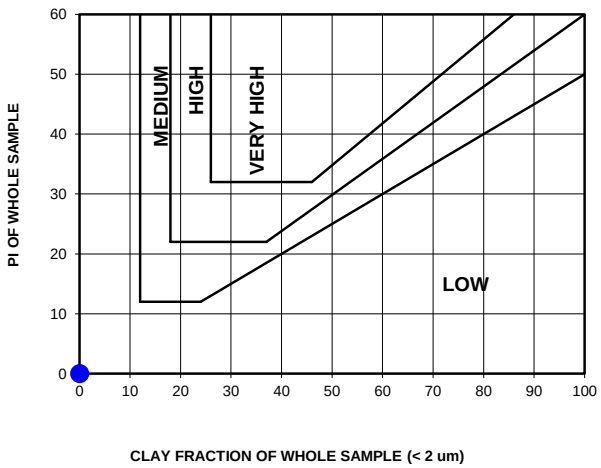
TEST LOCATION	MTP01	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	1.0-2.7 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS				ATTERBERG LIMITS			SOIL CLASSIFICATION	
Sieve (mm)	% Passing	Sieve (mm)	% Passing					
63.000	**100**	0.425	**85**	Liquid limit	(%)	**19.0**	% Gravel	**0**
50.000	**100**	0.075	**4**	Plastic limit	(%)	**19**	% Sand	**96**
37.500	**100**	0.049	**1**	Plasticity Index	(%)	**0**	% Silt	**3**
28.000	**100**	0.029	**1**	Weighted PI	(%)	**0**	% Clay	**0**
20.000	**100**	0.012	**1**	Linear Shrinkage	(%)	**0.0**	Activity	**0.0**
14.000	**100**	0.002	**0**	Grading Modulus		**1.11**	Unified Classification	**SP-SM**
5.000	**100**	0.000	**0**	Uniformity coefficient		**3**	TRB Classification	**A - 3**
2.000	**100**	0.000	**0**	Coefficient of curvature		**1.1**		

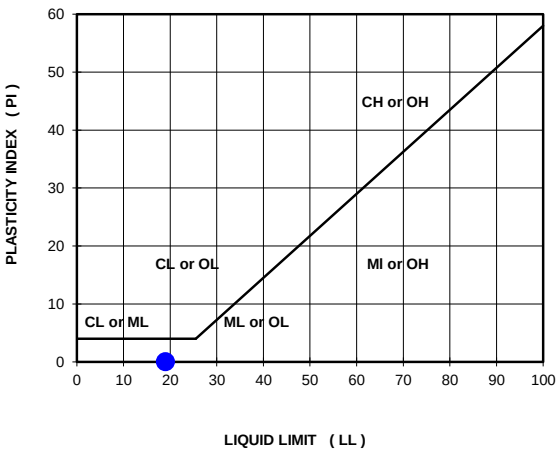
PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

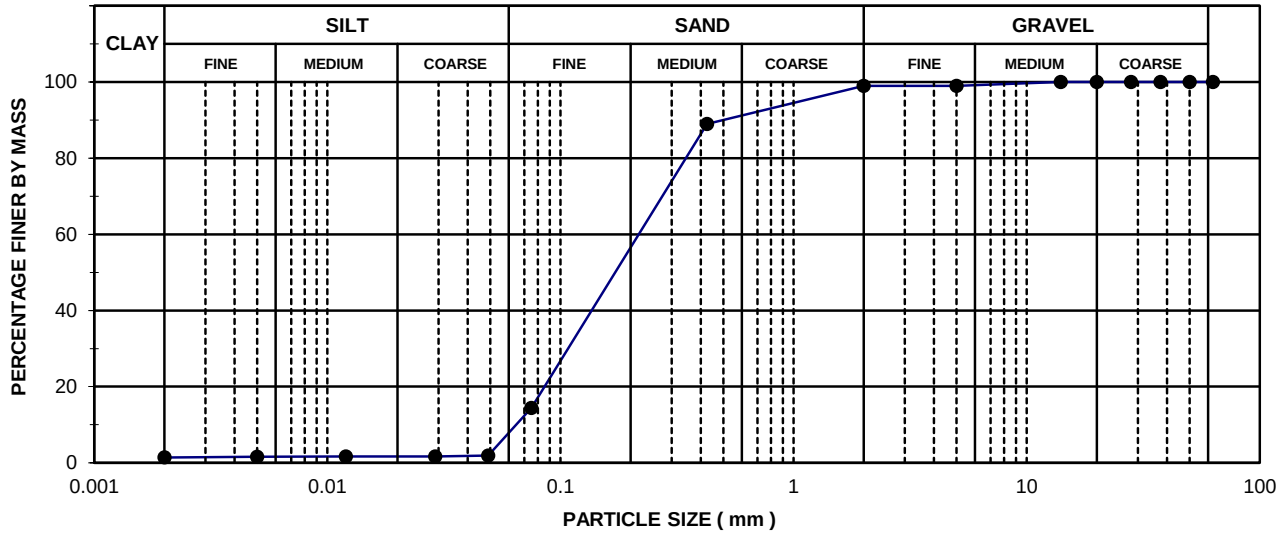
TEST LOCATION	MTP05	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	0.3-2.3 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**89**
50.000	**100**	0.075	**14**
37.500	**100**	0.049	**2**
28.000	**100**	0.029	**2**
20.000	**100**	0.012	**2**
14.000	**100**	0.002	**1**
5.000	**99**	0.000	**0**
2.000	**99**	0.000	**0**

ATTERBERG LIMITS		
Liquid limit	(%)	**15.0**
Plastic limit	(%)	**14**
Plasticity Index	(%)	**1**
Weighted PI	(%)	**1**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**0.98**
Uniformity coefficient		**4**
Coefficient of curvature		**1.2**

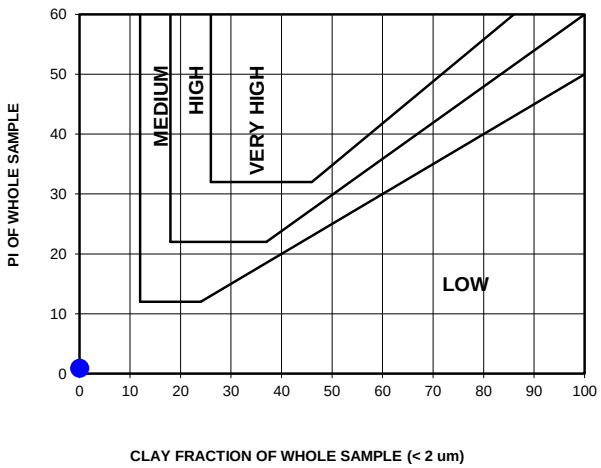
SOIL CLASSIFICATION	
% Gravel	**1**
% Sand	**85**
% Silt	**13**
% Clay	**1**
Activity	**0.7**
Unified Classification	**SM**
TRB Classification	**A - 2 - 4**

PARTICLE SIZE DISTRIBUTION

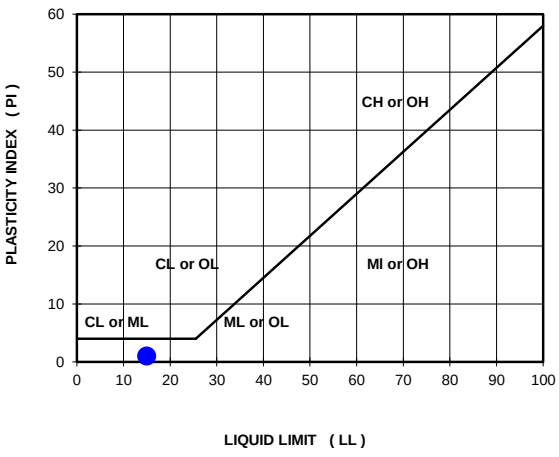


POTENTIAL EXPANSIVENESS

Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

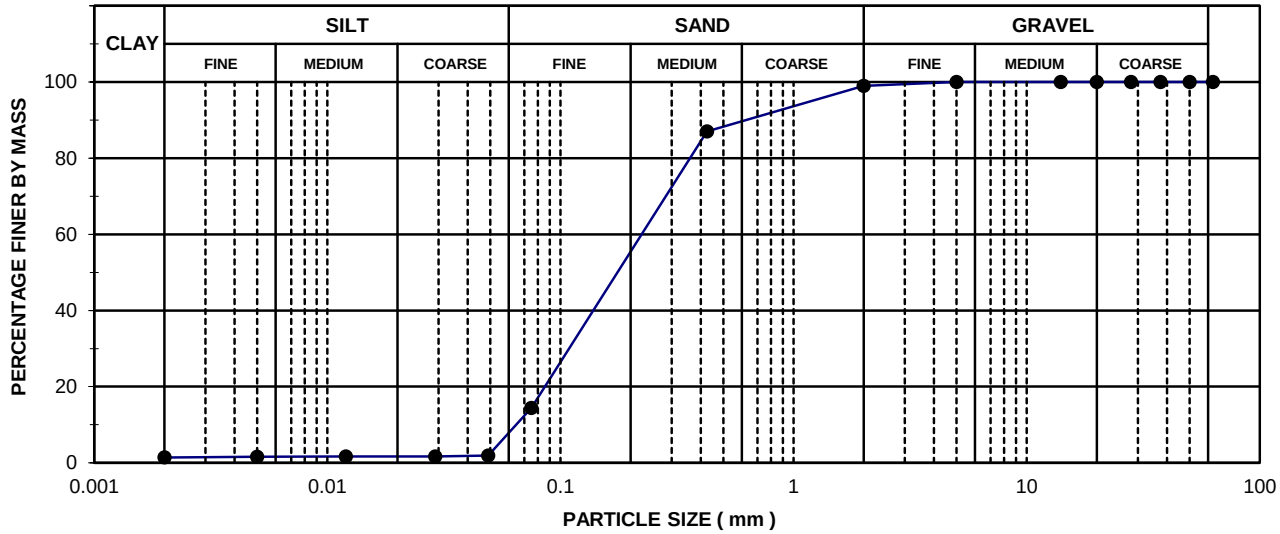
TEST LOCATION	MTP09	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	0.2-2.1 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**87**
50.000	**100**	0.075	**14**
37.500	**100**	0.049	**2**
28.000	**100**	0.029	**2**
20.000	**100**	0.012	**2**
14.000	**100**	0.002	**1**
5.000	**100**	0.000	**0**
2.000	**99**	0.000	**0**

ATTERBERG LIMITS		
Liquid limit	(%)	**16.0**
Plastic limit	(%)	**16**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**1.00**
Uniformity coefficient		**4**
Coefficient of curvature		**1.2**

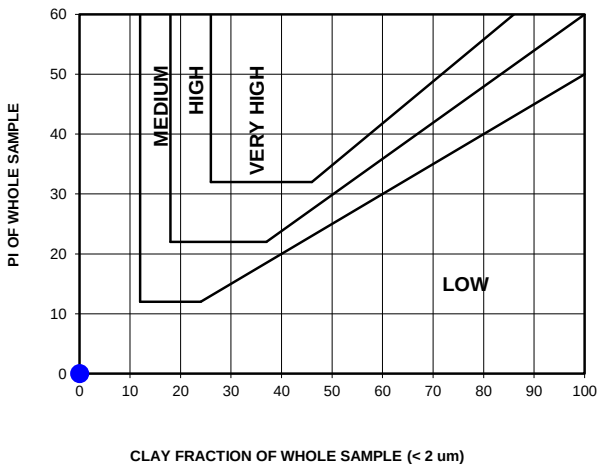
SOIL CLASSIFICATION	
% Gravel	**1**
% Sand	**85**
% Silt	**13**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SM**
TRB Classification	**A - 2 - 4**

PARTICLE SIZE DISTRIBUTION

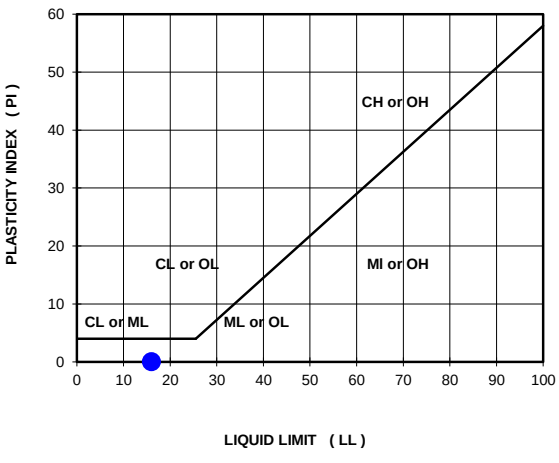


POTENTIAL EXPANSIVENESS

Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



FOUNDATION INDICATOR TEST RESULTS

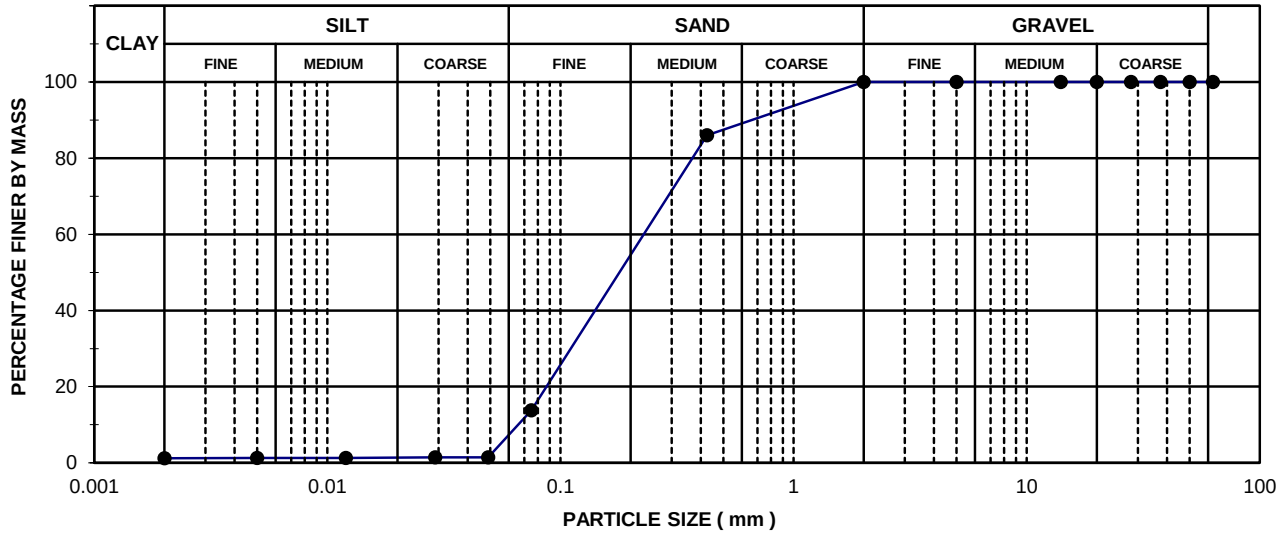
TEST LOCATION	MTP16	PROJECT	Project raptor
SAMPLE NO.		PROJECT NUMBER	504733
DEPTH	0.1-2.7 m	SITE	Wessels and Mamatwan mines

SIEVE ANALYSIS			
Sieve (mm)	% Passing	Sieve (mm)	% Passing
63.000	**100**	0.425	**86**
50.000	**100**	0.075	**14**
37.500	**100**	0.049	**1**
28.000	**100**	0.029	**1**
20.000	**100**	0.012	**1**
14.000	**100**	0.002	**1**
5.000	**100**	0.000	**0**
2.000	**100**	0.000	**0**

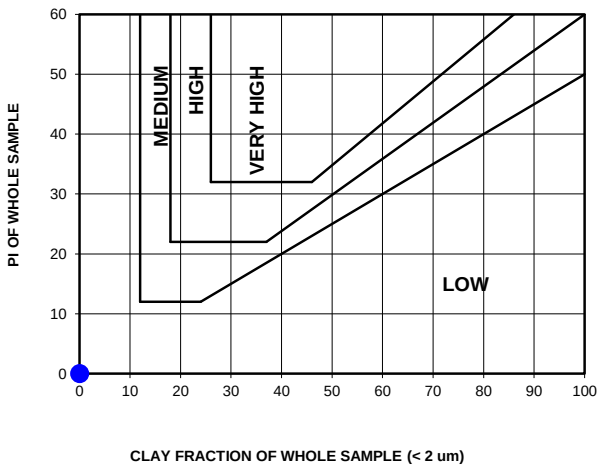
ATTERBERG LIMITS		
Liquid limit	(%)	**16.0**
Plastic limit	(%)	**16**
Plasticity Index	(%)	**0**
Weighted PI	(%)	**0**
Linear Shrinkage	(%)	**0.0**
Grading Modulus		**1.00**
Uniformity coefficient		**4**
Coefficient of curvature		**1.2**

SOIL CLASSIFICATION	
% Gravel	**0**
% Sand	**86**
% Silt	**13**
% Clay	**1**
Activity	**0.0**
Unified Classification	**SM**
TRB Classification	**A - 2 - 4**

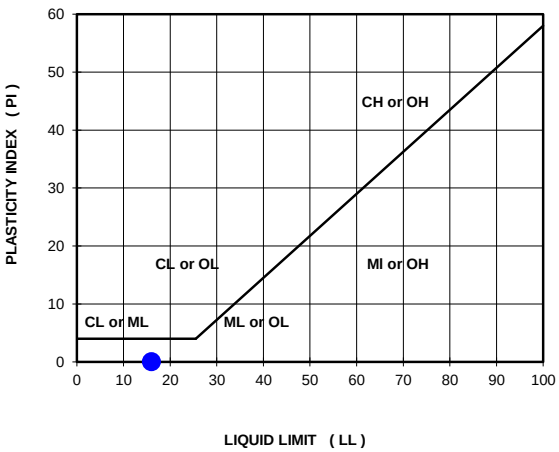
PARTICLE SIZE DISTRIBUTION



POTENTIAL EXPANSIVENESS
Van der Merwe's Activity Chart



CASAGRANDE 'A' LINE



SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Job Request No.: RS4161
Aurecon SA (Pty) Ltd
P O Box 416
Kimberley
8300
Attention : Mr Siya

Client Ref.No.: None

Date Reported : 08/07/2019

Project : Wessles & Mamatwan Mine

Test Pit SANS 3001

SAMPLE INFORMATION AND PROPERTIES

SAMPLE NO.	SS5156	SS5157	SS5158	SS5159
HOLE NO./ Km / CHAINAGE	WTP04 @ 0.5 - 2.5 m	MTP01 @1.0 - 2.7m	MTP05 @ 0.3 - 2.3m	MRP 09 @ 0.2 - 2.1m
ROAD NO./ NAME	Wessels Mine	Mamatwan Mine	Mamatwan Mine	Mamatwan Mine
LAYER TESTED/SAMPLED	Test Pit	Test Pit	Test Pit	Test Pit
DATE SAMPLED	21/06/2019	21/06/2019	21/06/2019	21/06/2019
COLOUR OF SAMPLE	Not Specified	Not Specified	Not Specified	Not Specified
TYPE OF SAMPLE	Aeolian Sand	Aeolian Sand	Aeolian Sand	Aeolian Sand

GRADING ANALYSIS - % PASSING SIEVES *(SANS 3001-GR1:2010, SANS 3001-GR2:2010)

SIEVE ANALYSIS (GR 1) % PASSING	100.0 mm				
	75.0 mm				
	63.0 mm				
	50.0 mm				
	37.5 mm				
	28.0 mm				
	20.0 mm				
	14.0 mm			100	
	5.0 mm			99	100
	2.0 mm	100	100	99	99
	0.425 mm	94	85	89	87
	0.075 mm	8	4	14	16
GRADING MODULUS		1.0	1.1	1.0	1.0

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	6	15	10	13
COARSE FINE SAND	0.425 - 0.250	18	24	16	16
MEDIUM FINE SAND	0.250 - 0.150	37	26	26	25
FINE FINE SAND	0.150 - 0.075	30	32	34	31
SILT CLAY	0.075	8	4	14	16

ATTERBERG LIMITS ANALYSIS - *(SANS 3001-GR10:2010, SANS 3001-GR11:2010)

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT				
	PLASTICITY INDEX	NP	NP	SP	NP
	LINEAR SHRINKAGE				
CLASSIFICATION	H.R.B.	A-2-4(0)	A-2-4(0)	A-2-4(0)	A-2-4(0)
	COLTO	G9	G9	G8	G9
	TRH 14	G10	G10	G9	G10

CALIFORNIA BEARING RATIO - *(SANS 3001-GR30:2010, SANS 3001-GR40:2010)

MOD AASHTO SANS GR30	OMC %	5.9	6.0	6.9	6.9
	MDD (kg/m³)	1860	1899	1966	1992
	COMP MC %	5.9	6.0	6.8	7.0
SWELL % @	MOD | NRB | PRO	0.00 | 0.00 | 0.00	0.00 | 0.00 | 0.00	0.00 | 0.00 | 0.00	0.00 | 0.00 | 0.00
C.B.R. SANS GR40	100 %	27	20	22	22
	98 %	19	15	17	17
	97 %	16	13	15	15
	95 %	12	10	12	12
	93 %	8	7	10	9
	90 %	5	5	7	6

STABILISER IN LAB				
STABILISER ON SITE				
TEST TYPE	Mod, CBR, Ind	Mod, CBR, Ind	Mod, CBR, Ind	Mod, CBR, Ind
SAMPLING METHOD	THM5	THM5	THM5	THM5

Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB
Civil Engineering Materials Testing Laboratory
Established 2011

Laboratories
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Client : Aurecon SA (Pty) Ltd

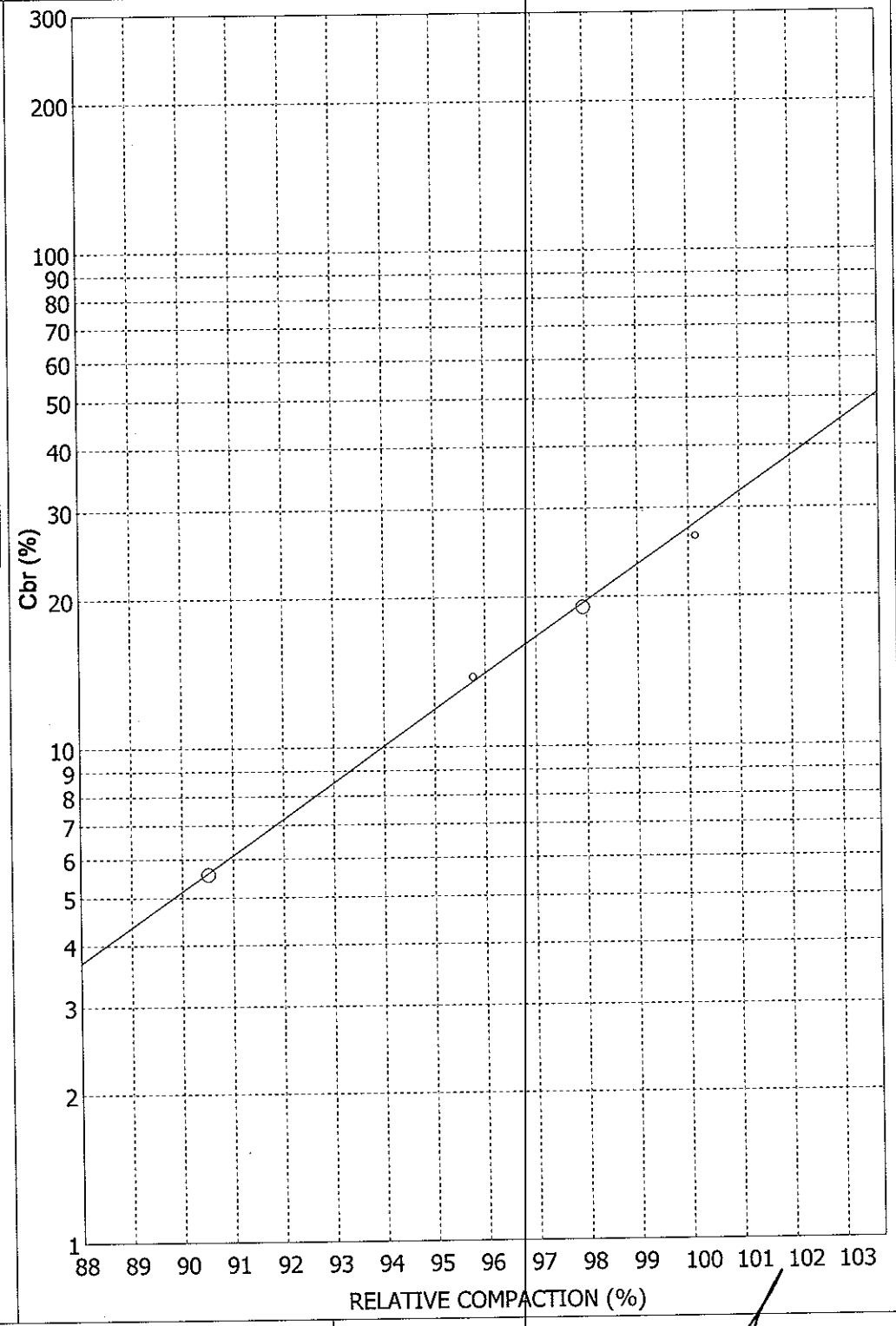
Job Request No.: RS4161

Sample No.: : SS5156

CBR versus RELATIVE COMPACTION

	Pro	Nrb	Mod
Comp.(%)	90.5	95.7	100.1
Cbr (%)	5.6	13.8	26.3
Swell (%)	0.00	0.00	0.00

Compaction (%)	Cbr (%)
100	27.0
98	19.0
97	16.0
95	12.0
93	8.4
90	5.2



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Job Request No.: RS4161
Aurecon SA (Pty) Ltd
P O Box 416
Kimberley
8300
Attention : Mr Siya

Client Ref.No.: None

Date Reported : 08/07/2019

Project : Wessles & Mamatwan Mine

Test Pit SANS 3001

SAMPLE INFORMATION AND PROPERTIES

SAMPLE NO.	SS5160	SS5161	SS5162	SS5163
HOLE NO./ Km / CHAINAGE	WTP11 @ 0.4 - 3m	WTP15 @ 120mm - 2700	WTP16 @ 2.3 - 3m	MTP 16 @ 0.1 - 2.7m
ROAD NO./ NAME	Wessels Mine	Wessels Mine	Wessels Mine	Mamatwan Mine
LAYER TESTED/SAMPLED	Test Pit	Test Pit	Test Pit	Test Pit
DATE SAMPLED	21/06/2019	21/06/2019	21/06/2019	21/06/2019
COLOUR OF SAMPLE	Not Specified	Not Specified	Not Specified	Not Specified
TYPE OF SAMPLE	Aeolian Sand	Aeolian Sand	Aeolian Sand	Aeolian Sand

GRADING ANALYSIS - % PASSING SIEVES *(SANS 3001-GR1:2010, SANS 3001-GR2:2010)

SIEVE ANALYSIS (GR 1) % PASSING	100.0 mm				
	75.0 mm				
	63.0 mm				
	50.0 mm				
	37.5 mm				
	28.0 mm				
	20.0 mm				
	14.0 mm				
	5.0 mm				
	2.0 mm	100	100	100	100
	0.425 mm	92	96	96	86
	0.075 mm	10	8	8	14
GRADING MODULUS		1.0	1.0	1.0	1.0

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	7	4	4	14
COARSE FINE SAND	0.425 - 0.250	15	18	18	16
MEDIUM FINE SAND	0.250 - 0.150	39	48	40	26
FINE FINE SAND	0.150 - 0.075	29	23	30	30
SILT CLAY	0.075	10	8	8	14

ATTERBERG LIMITS ANALYSIS - *(SANS 3001-GR10:2010, SANS 3001-GR11:2010)

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT				
	PLASTICITY INDEX	NP	NP	NP	NP
	LINEAR SHRINKAGE				
CLASSIFICATION	H.R.B.	A-2-4(0)	A-2-4(0)	A-2-4(0)	A-2-4(0)
	COLTO	G9	G9	G9	G10
	TRH 14	G10	G10	G10	G10

CALIFORNIA BEARING RATIO - *(SANS 3001-GR30:2010, SANS 3001-GR40:2010)

MOD AASHTO SANS GR30	OMC %	5.8	5.8	6.3	6.0
	MDD (kg/m³)	1852	1834	1809	1908
	COMP MC %	5.7	5.7	6.5	6.0
SWELL % @	MOD | NRB | PRO	0.00 | 0.00 | 0.00	0.00 | 0.00 | 0.00	0.00 | 0.00 | 0.00	0.00 | 0.00 | 0.00
C.B.R. SANS GR40	100 %	22	23	25	11
	98 %	17	17	19	8
	97 %	15	14	16	7
	95 %	11	10	12	6
	93 %	8	8	9	4
	90 %	6	5	6	3

STABILISER IN LAB				
STABILISER ON SITE				
TEST TYPE	Mod, CBR, Ind	Mod, CBR, Ind	Mod, CBR, Ind	Mod, CBR, Ind
SAMPLING METHOD	THM5	THM5	THM5	THM5

Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Client : Aurecon SA (Pty) Ltd

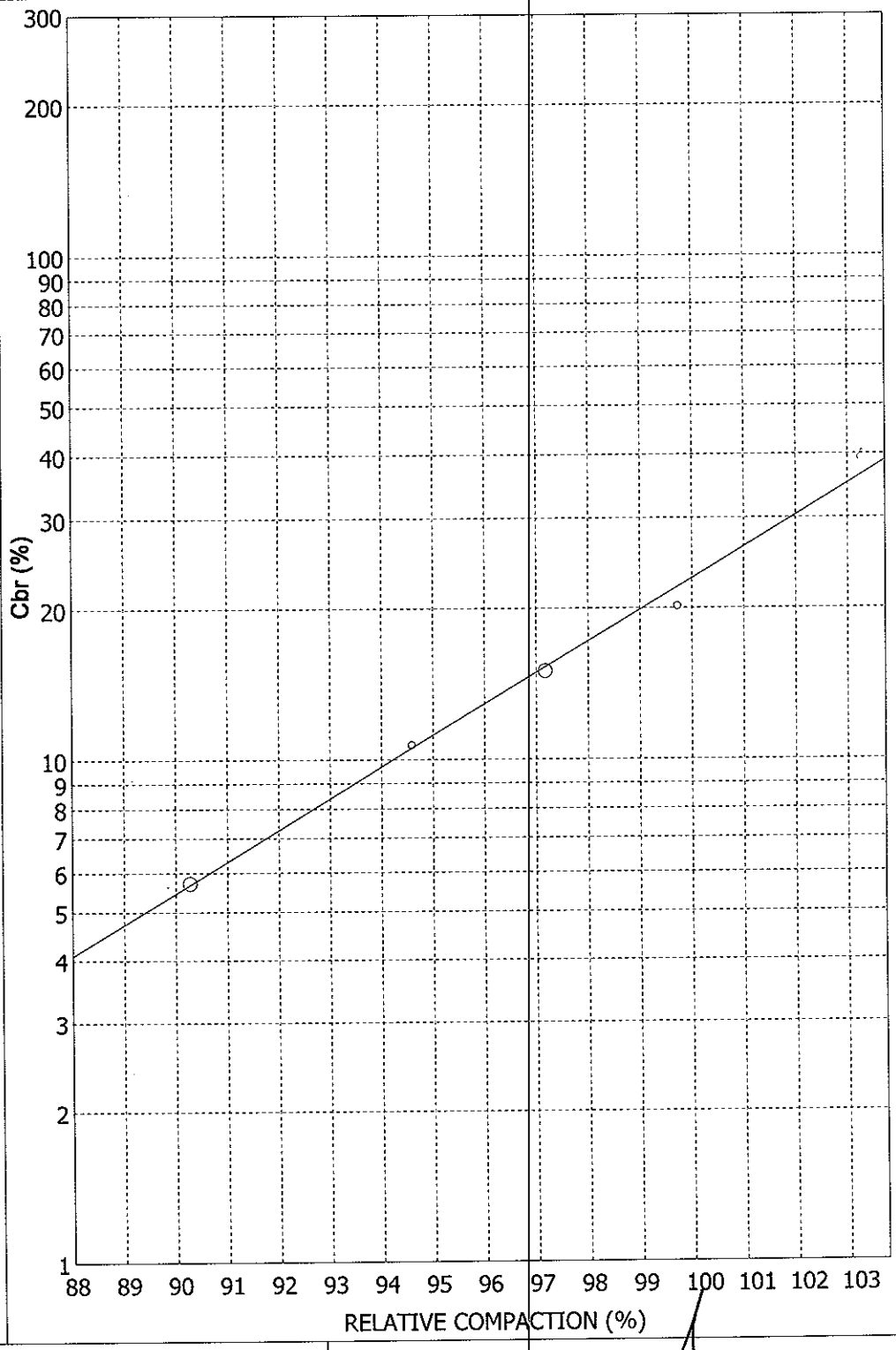
Job Request No.: RS4161

Sample No.: : SS5160

CBR versus RELATIVE COMPACTION

	Pro	Nrb	Mod
Comp.(%)	90.3	94.6	99.7
Cbr (%)	5.7	10.7	20.2
Swell (%)	0.00	0.00	0.00

Compaction (%)	Cbr (%)
100	22.0
98	17.0
97	15.0
95	11.0
93	8.4
90	5.5



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Client : Aurecon SA (Pty) Ltd

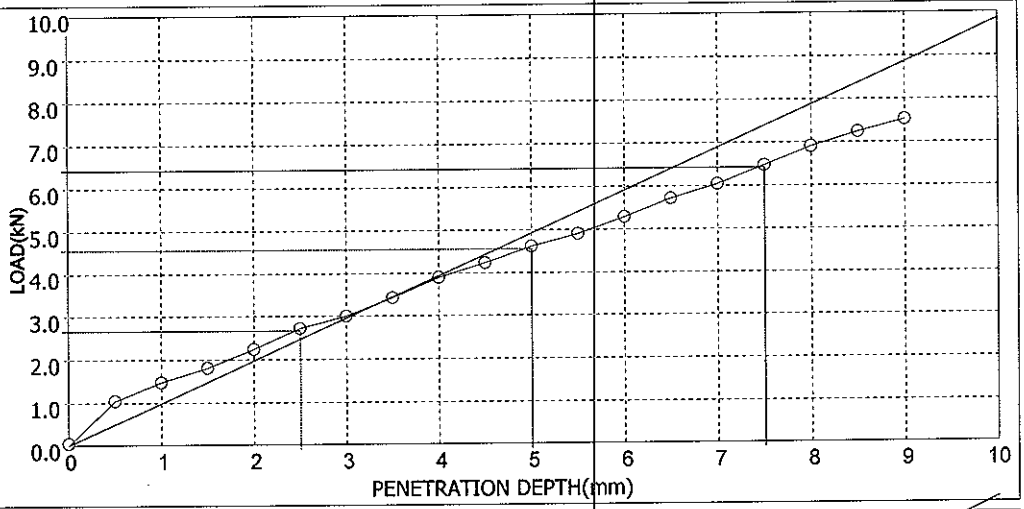
Job Request No.: RS4161

Sample No.: : SS5160

Penetration Graph

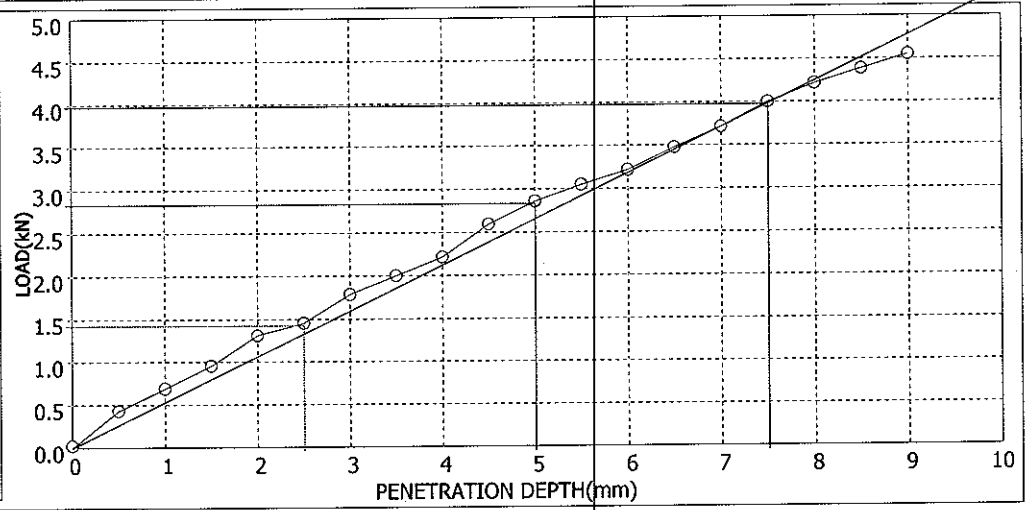
Depth (mm)	Load (kN)	Cbr (%)
2.50	2.68	20
5.00	4.56	23
7.50	6.42	25

Depth (mm)	Load (kN)
0.500	0.98
1.000	1.42
1.500	1.78
2.000	2.20
2.500	2.68
3.000	2.94
3.500	3.36
4.000	3.84
4.500	4.20
5.000	4.56
5.500	4.88
6.000	5.22
6.500	5.66
7.000	6.02
7.500	6.42
8.000	6.88
8.500	7.18
9.000	7.48



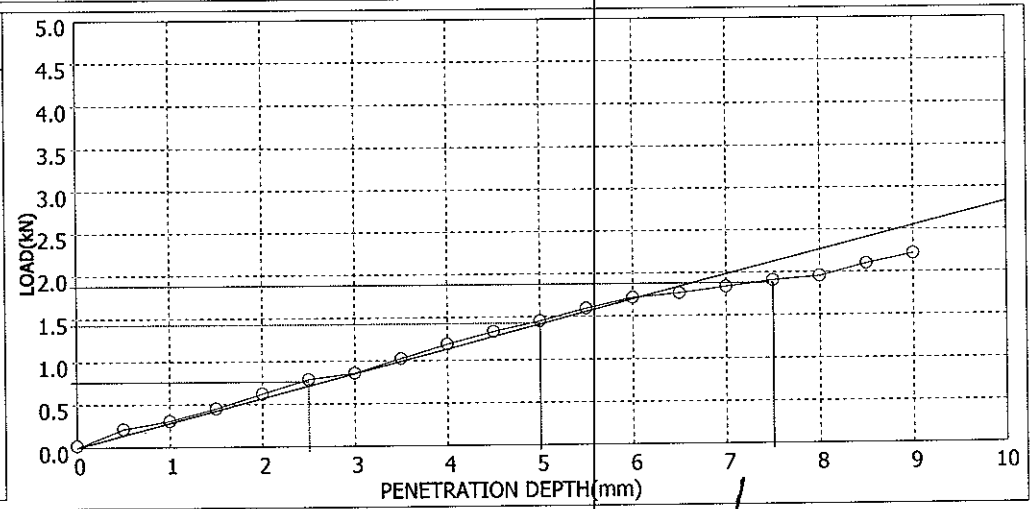
Depth (mm)	Load (kN)	Cbr (%)
2.50	1.42	11
5.00	2.84	14
7.50	3.98	16

Depth (mm)	Load (kN)
0.500	0.40
1.000	0.66
1.500	0.94
2.000	1.28
2.500	1.42
3.000	1.76
3.500	1.98
4.000	2.20
4.500	2.58
5.000	2.84
5.500	3.02
6.000	3.20
6.500	3.46
7.000	3.70
7.500	3.98
8.000	4.18
8.500	4.36
9.000	4.52



Depth (mm)	Load (kN)	Cbr (%)
2.50	0.76	5.7
5.00	1.44	7.2
7.50	1.88	7.4

Depth (mm)	Load (kN)
0.500	0.18
1.000	0.28
1.500	0.42
2.000	0.60
2.500	0.76
3.000	0.84
3.500	1.00
4.000	1.16
4.500	1.32
5.000	1.44
5.500	1.56
6.000	1.68
6.500	1.74
7.000	1.80
7.500	1.88
8.000	1.94
8.500	2.06
9.000	2.18



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:
Established 2011

Client : Aurecon SA (Pty) Ltd

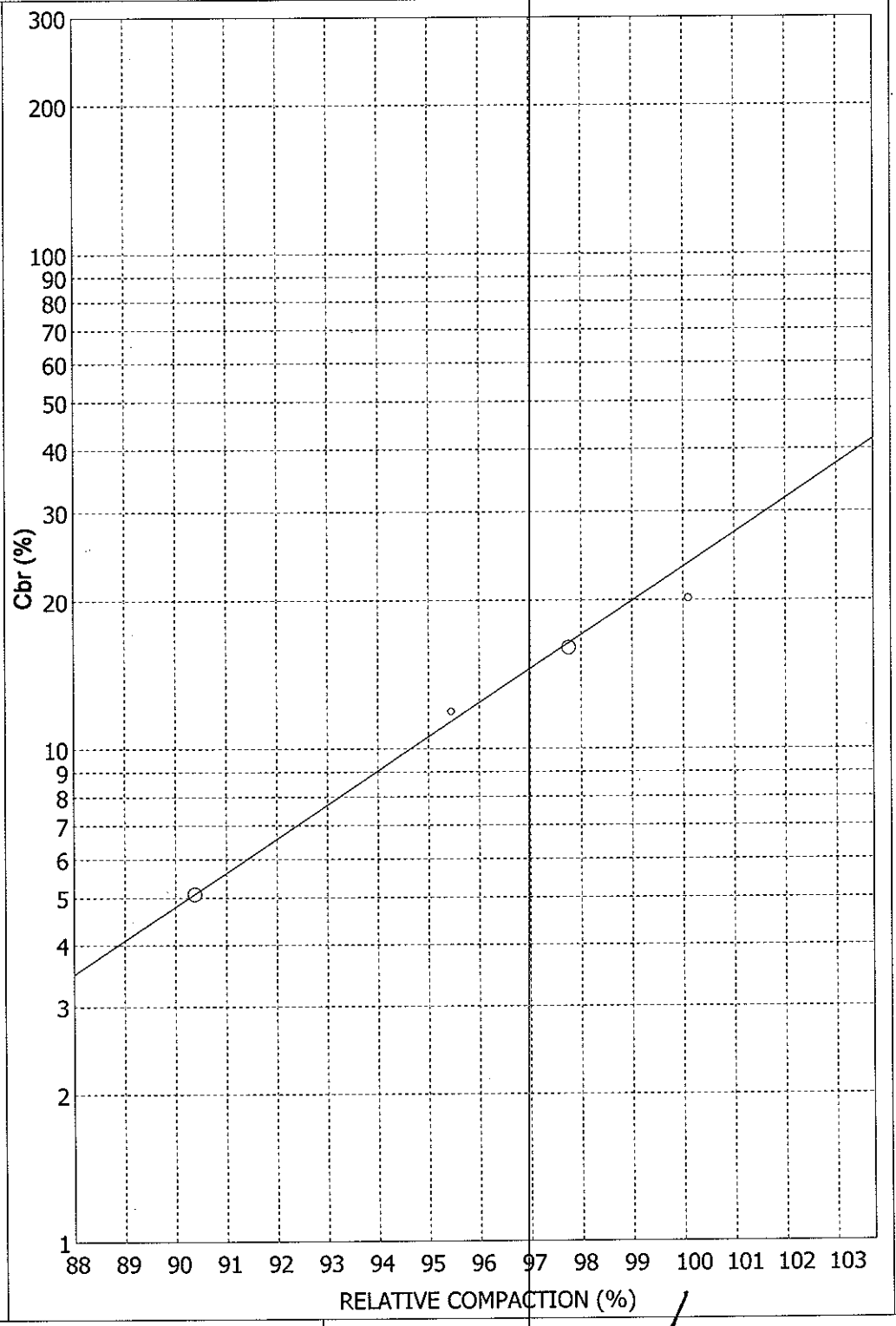
Job Request No.: RS4161

Sample No.: : SS5161

CBR versus RELATIVE COMPACTION

	Pro	Nrb	Mod
Comp.(%)	90.4	95.4	100.1
Cbr (%)	5.1	11.9	20.2
Swell (%)	0.00	0.00	0.00

Compaction (%)	Cbr (%)
100	23.0
98	17.0
97	14.0
95	10.0
93	7.6
90	4.8



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Client : Aurecon SA (Pty) Ltd

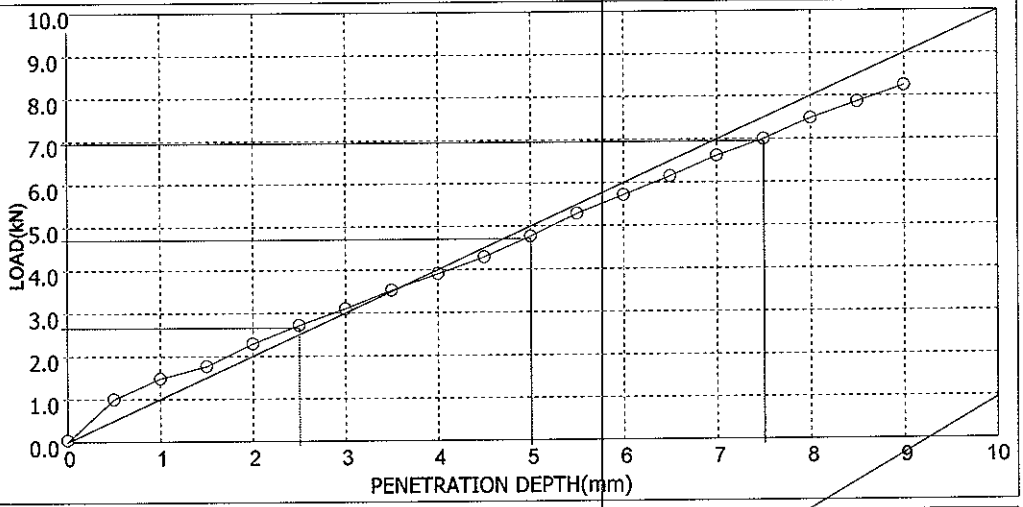
Job Request No.: RS4161

Sample No.: : SS5161

Penetration Graph

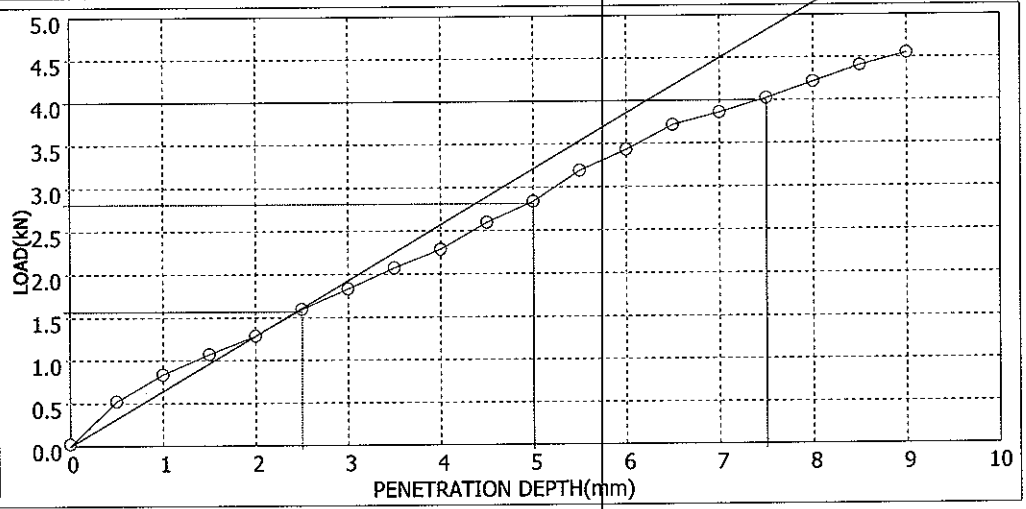
Depth (mm)	Load (kN)	Cbr (%)
2.50	2.68	20
5.00	4.70	24
7.50	6.94	27

Depth (mm)	Load (kN)
0.500	0.94
1.000	1.42
1.500	1.70
2.000	2.24
2.500	2.68
3.000	3.04
3.500	3.46
4.000	3.88
4.500	4.24
5.000	4.70
5.500	5.24
6.000	5.68
6.500	6.10
7.000	6.58
7.500	6.94
8.000	7.44
8.500	7.82
9.000	8.18



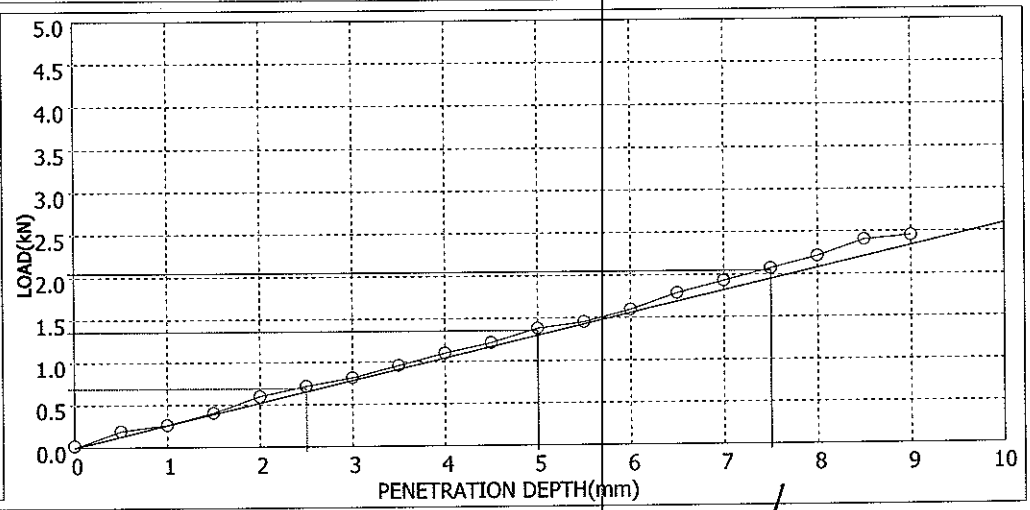
Depth (mm)	Load (kN)	Cbr (%)
2.50	1.58	12
5.00	2.80	14
7.50	4.00	16

Depth (mm)	Load (kN)
0.500	0.50
1.000	0.82
1.500	1.04
2.000	1.26
2.500	1.58
3.000	1.80
3.500	2.04
4.000	2.26
4.500	2.58
5.000	2.80
5.500	3.16
6.000	3.40
6.500	3.68
7.000	3.84
7.500	4.00
8.000	4.18
8.500	4.38
9.000	4.52



Depth (mm)	Load (kN)	Cbr (%)
2.50	0.68	5.1
5.00	1.36	6.8
7.50	2.04	8.1

Depth (mm)	Load (kN)
0.500	0.16
1.000	0.24
1.500	0.38
2.000	0.56
2.500	0.68
3.000	0.78
3.500	0.94
4.000	1.08
4.500	1.20
5.000	1.36
5.500	1.42
6.000	1.58
6.500	1.76
7.000	1.90
7.500	2.04
8.000	2.20
8.500	2.38
9.000	2.44



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:
Established 2011

Client : Aurecon SA (Pty) Ltd

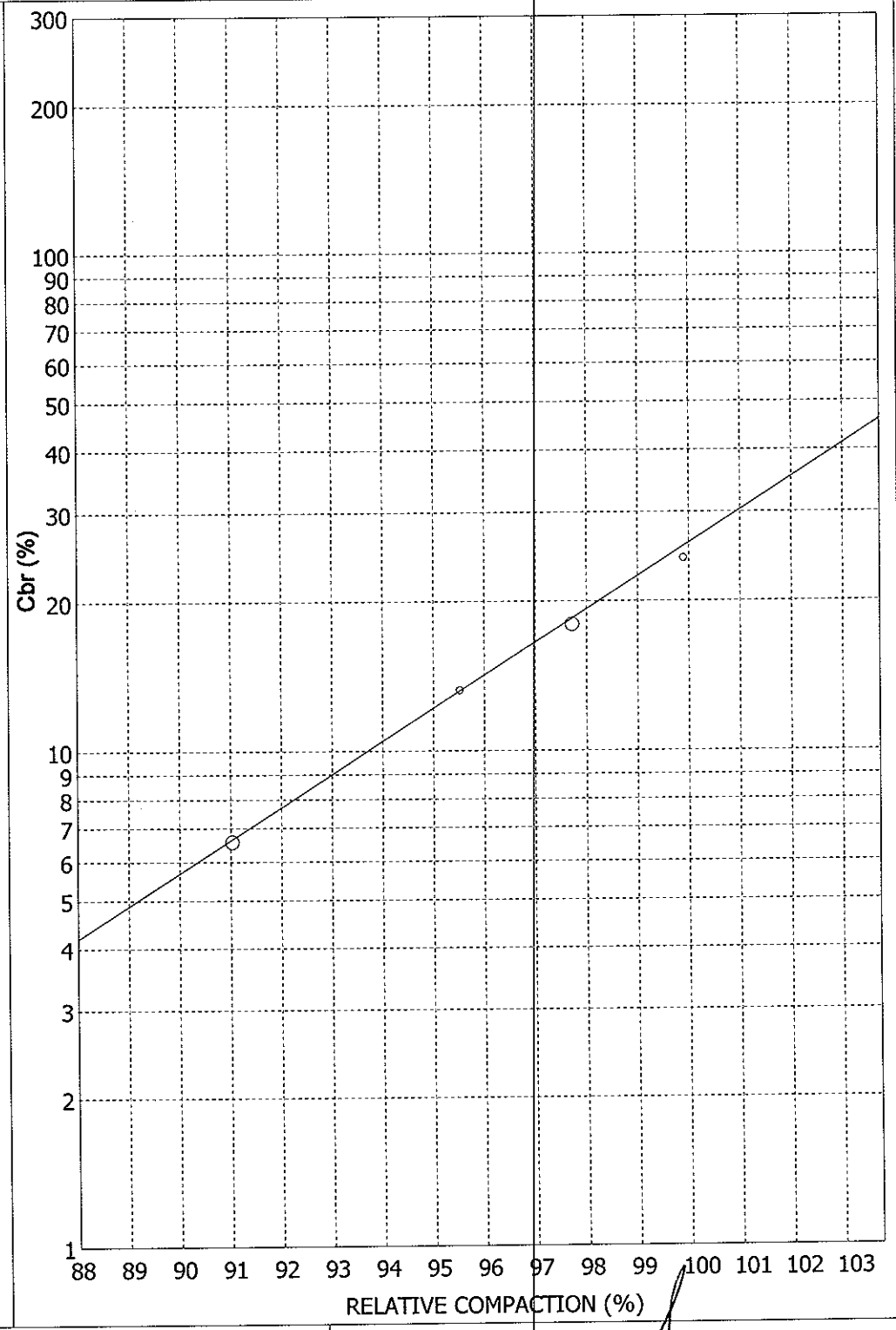
Job Request No.: RS4161

Sample No.: : SS5162

CBR versus RELATIVE COMPACTION

	Pro	Nrb	Mod
Comp.(%)	91.0	95.5	99.9
Cbr (%)	6.6	13.2	24.4
Swell (%)	0.00	0.00	0.00

Compaction (%)	Cbr (%)
100	25.0
98	19.0
97	16.0
95	12.0
93	8.9
90	5.7



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Client : Aurecon SA (Pty) Ltd

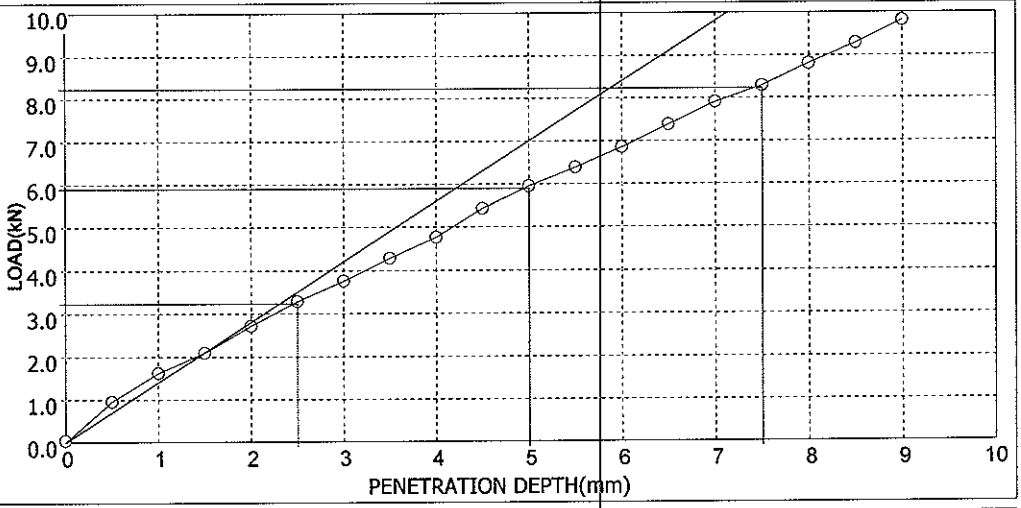
Job Request No.: RS4161

Sample No.: : SS5162

Penetration Graph

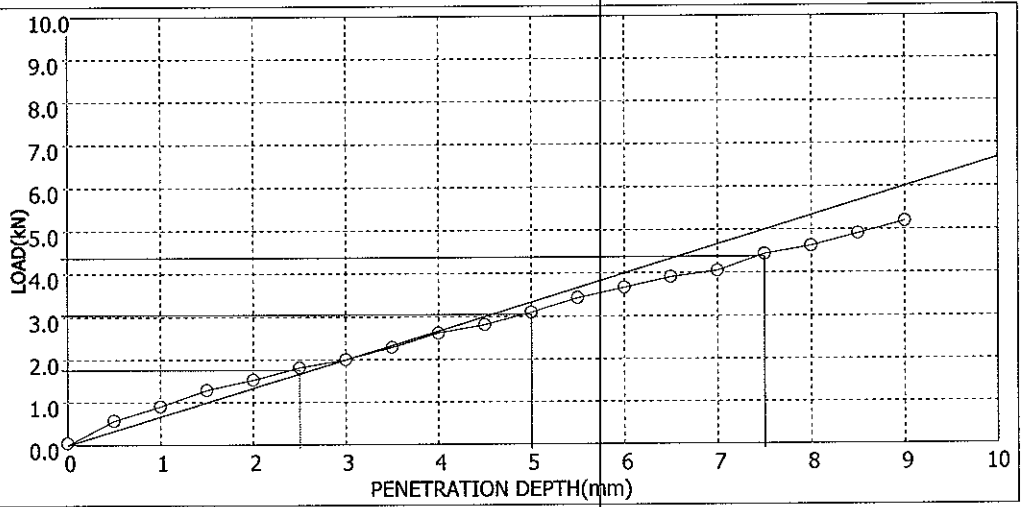
Depth (mm)	Load (kN)	Cbr (%)
2.50	3.24	24
5.00	5.90	30
7.50	8.22	33

Depth (mm)	Load (kN)
0.500	0.90
1.000	1.56
1.500	2.04
2.000	2.66
2.500	3.24
3.000	3.72
3.500	4.24
4.000	4.70
4.500	5.38
5.000	5.90
5.500	6.34
6.000	6.80
6.500	7.32
7.000	7.84
7.500	8.22
8.000	8.76
8.500	9.22
9.000	9.74



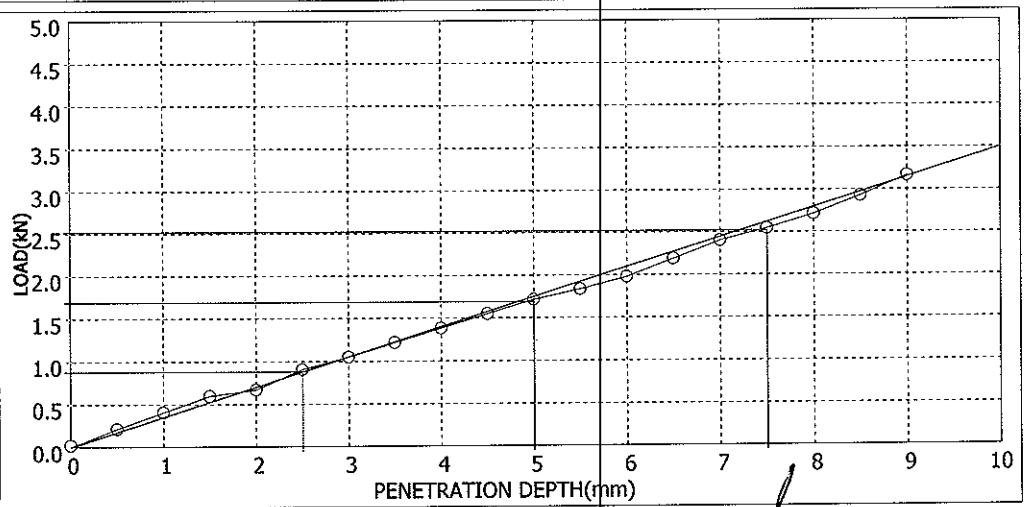
Depth (mm)	Load (kN)	Cbr (%)
2.50	1.76	13
5.00	3.06	15
7.50	4.38	17

Depth (mm)	Load (kN)
0.500	0.52
1.000	0.84
1.500	1.26
2.000	1.48
2.500	1.76
3.000	1.94
3.500	2.26
4.000	2.58
4.500	2.74
5.000	3.06
5.500	3.36
6.000	3.60
6.500	3.84
7.000	4.02
7.500	4.38
8.000	4.56
8.500	4.88
9.000	5.16



Depth (mm)	Load (kN)	Cbr (%)
2.50	0.88	6.6
5.00	1.68	8.4
7.50	2.52	10

Depth (mm)	Load (kN)
0.500	0.20
1.000	0.38
1.500	0.56
2.000	0.64
2.500	0.88
3.000	1.02
3.500	1.18
4.000	1.36
4.500	1.52
5.000	1.68
5.500	1.80
6.000	1.96
6.500	2.16
7.000	2.38
7.500	2.52
8.000	2.68
8.500	2.90
9.000	3.14



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011

HEAD OFFICE
Tel: Fax:
Email:
Web:

Job Request No.: RS4161
Aurecon SA (Pty) Ltd
P O Box 416
Kimberley
8300
Attention : Mr Siya

Client Ref.No.: None

Date Reported : 08/07/2019

Project : Wessles & Mamatwan Mine

Test Pit SANS 3001

SAMPLE INFORMATION AND PROPERTIES

SAMPLE NO.	SS5164				
HOLE NO./ Km / CHAINAGE	WTP18 @ 2.6 - 3.2m				
ROAD NO./ NAME	Wessels Mine				
LAYER TESTED/SAMPLED	Test Pit				
DATE SAMPLED	21/06/2019				
COLOUR OF SAMPLE	Not Specified				
TYPE OF SAMPLE	Aeolian Sand				

GRADING ANALYSIS - % PASSING SIEVES *(SANS 3001-GR1:2010, SANS 3001-GR2:2010)

SIEVE ANALYSIS (GR 1) % PASSING	100.0 mm					
	75.0 mm					
	63.0 mm					
	50.0 mm	100				
	37.5 mm	99				
	28.0 mm	97				
	20.0 mm	95				
	14.0 mm	92				
	5.0 mm	89				
	2.0 mm	87				
	0.425 mm	82				
	0.075 mm	12				
GRADING MODULUS		1.2				

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	5				
COARSE FINE SAND	0.425 - 0.250	15				
MEDIUM FINE SAND	0.250 - 0.150	36				
FINE FINE SAND	0.150 - 0.075	30				
SILT CLAY	0.075	14				

ATTERBERG LIMITS ANALYSIS - *(SANS 3001-GR10:2010, SANS 3001-GR11:2010)

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT					
	PLASTICITY INDEX	NP				
	LINEAR SHRINKAGE					
CLASSIFICATION	H.R.B.	A-2-4(0)				
	COLTO	G9				
	TRH 14	G10				

CALIFORNIA BEARING RATIO - *(SANS 3001-GR30:2010, SANS 3001-GR40:2010)

MOD AASHTO SANS GR30	OMC %	6.5				
	MDD (kg/m³)	1815				
	COMP MC %	6.7				
SWELL % @	MOD | NRB | PRO	0.00 | 0.00 | 0.00				
C.B.R. SANS GR40	100 %	26				
	98 %	18				
	97 %	16				
	95 %	11				
	93 %	8				
	90 %	5				

STABILISER IN LAB					
STABILISER ON SITE					
TEST TYPE	Mod, CBR, Ind				
SAMPLING METHOD	THM5				

Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Manager

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Client : Aurecon SA (Pty) Ltd

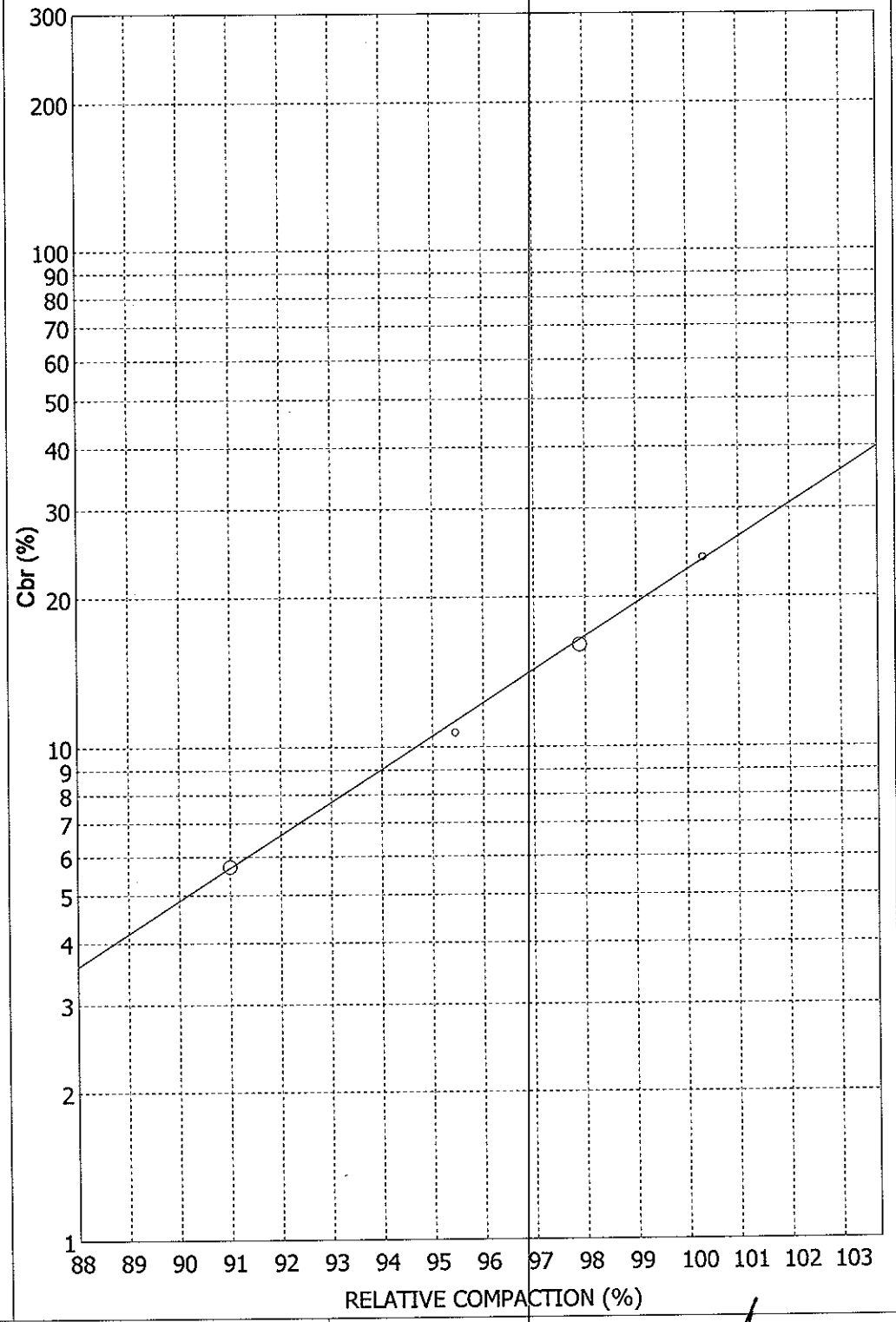
Job Request No.: RS4161

Sample No.: : SS5164

CBR versus RELATIVE COMPACTION

	Pro	Nrb	Mod
Comp.(%)	91.0	95.5	100.3
Cbr (%)	5.7	10.7	23.9
Swell (%)	0.00	0.00	0.00

Compaction (%)	Cbr (%)
100	22.0
98	16.0
97	14.0
95	10.0
93	7.7
90	4.9



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Client : Aurecon SA (Pty) Ltd

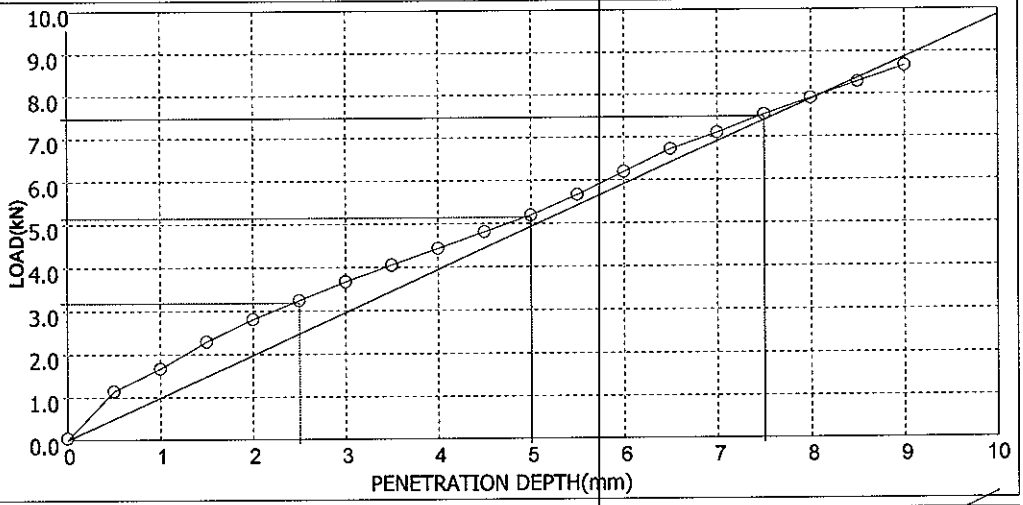
Job Request No.: RS4161

Sample No.: : SS5164

Penetration Graph

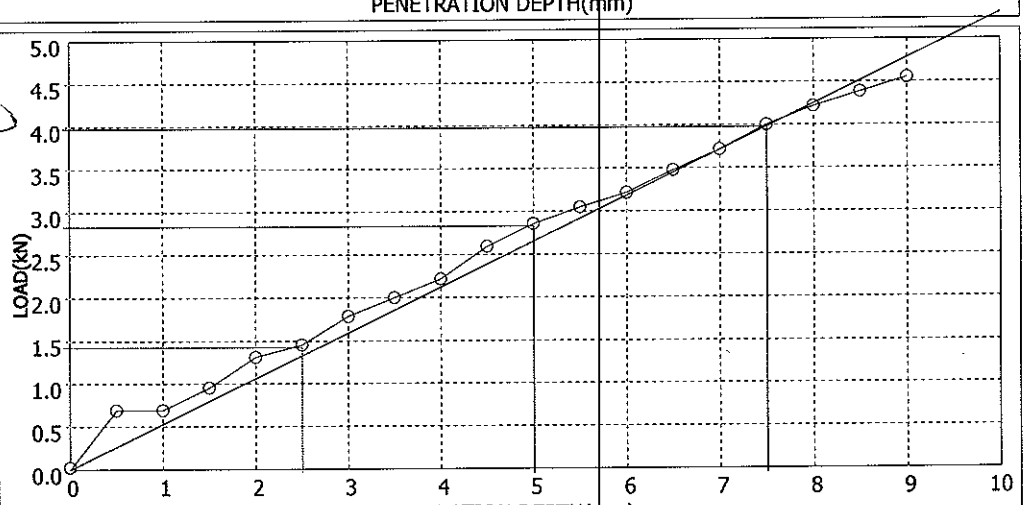
Depth (mm)	Load (kN)	Cbr (%)
2.50	3.18	24
5.00	5.16	26
7.50	7.46	30

Depth (mm)	Load (kN)
0.500	1.10
1.000	1.62
1.500	2.22
2.000	2.76
2.500	3.18
3.000	3.64
3.500	4.02
4.000	4.38
4.500	4.76
5.000	5.16
5.500	5.62
6.000	6.14
6.500	6.68
7.000	7.04
7.500	7.46
8.000	7.88
8.500	8.24
9.000	8.62



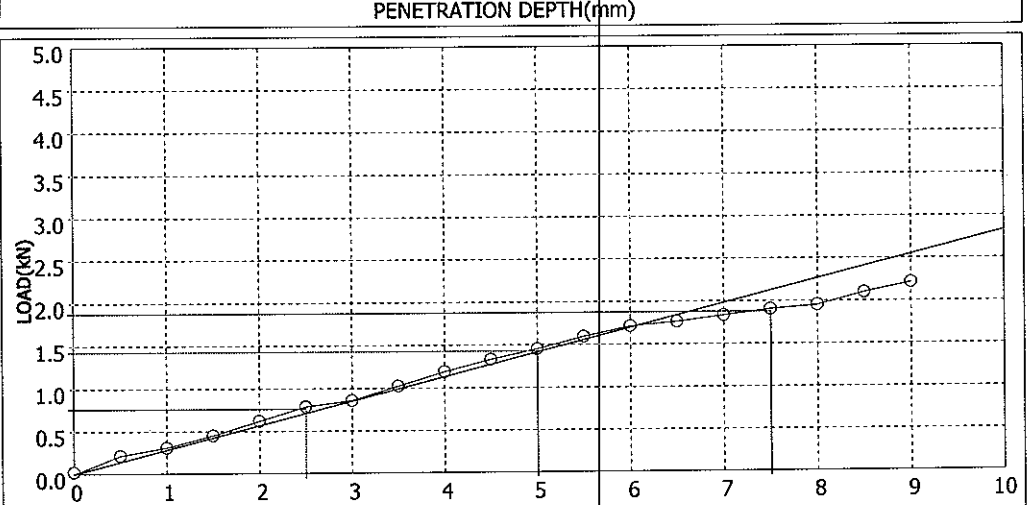
Depth (mm)	Load (kN)	Cbr (%)
2.50	1.42	11
5.00	2.84	14
7.50	3.98	16

Depth (mm)	Load (kN)
0.500	0.66
1.000	0.66
1.500	0.94
2.000	1.28
2.500	1.42
3.000	1.76
3.500	1.98
4.000	2.20
4.500	2.58
5.000	2.84
5.500	3.02
6.000	3.20
6.500	3.46
7.000	3.70
7.500	3.98
8.000	4.18
8.500	4.36
9.000	4.52



Depth (mm)	Load (kN)	Cbr (%)
2.50	0.76	5.7
5.00	1.44	7.2
7.50	1.88	7.4

Depth (mm)	Load (kN)
0.500	0.18
1.000	0.28
1.500	0.42
2.000	0.60
2.500	0.76
3.000	0.84
3.500	1.00
4.000	1.16
4.500	1.32
5.000	1.44
5.500	1.56
6.000	1.68
6.500	1.74
7.000	1.80
7.500	1.88
8.000	1.94
8.500	2.06
9.000	2.18



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB
Civil Engineering Materials Testing Laboratory
Established 2011

Laboratories
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Job Request No.: RS4161
Aurecon SA (Pty) Ltd
P O Box 416
Kimberley
8300
Attention : Mr Siya

Client Ref.No.: None

Date Reported : 08/07/2019

Project : Wessels Mine & Mamatwan

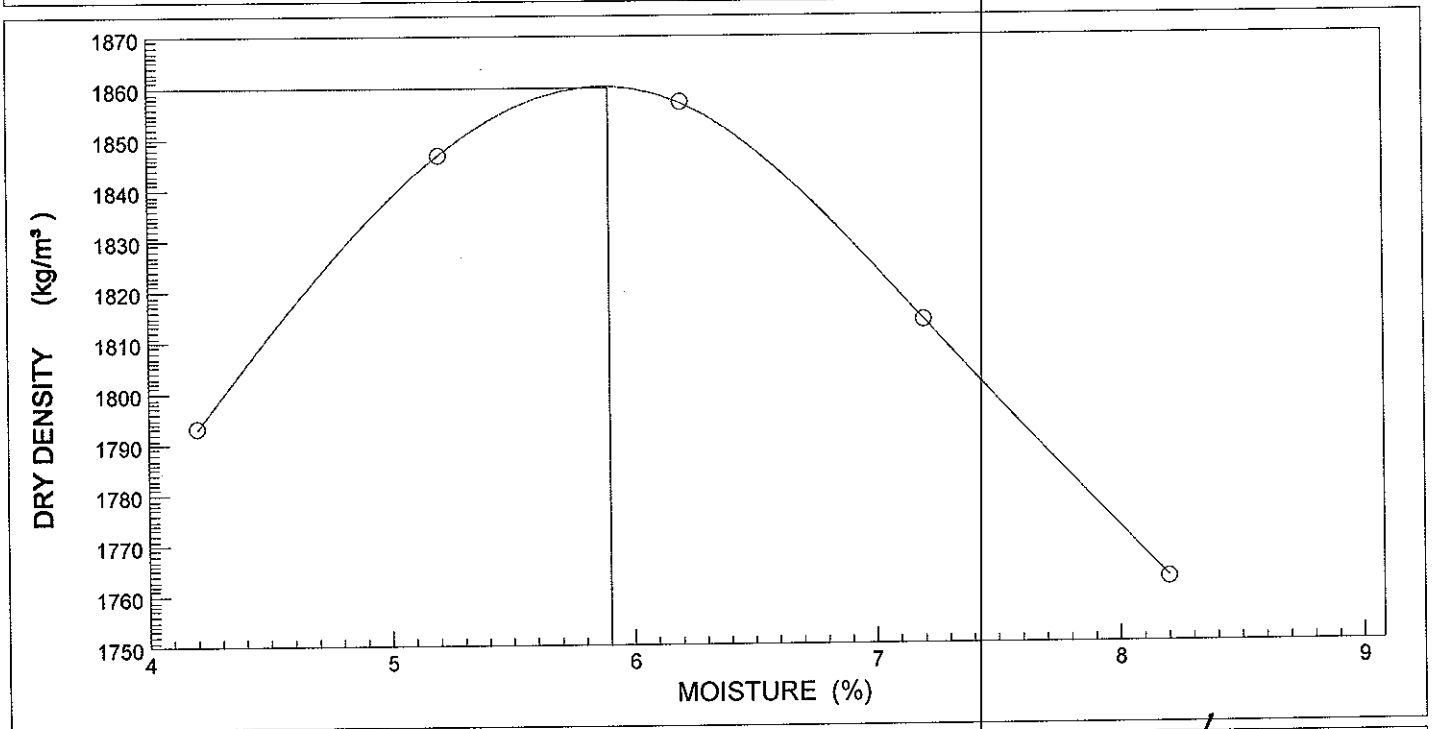
WTP04 @ 0.5 - 2.5m
SANS 3001

SAMPLE NO.	SS5156
CONTAINER FOR SAMPLING	Plastic Black Bag
SIZE / APPROX. MASS OF SAMPLE	70KG
MOISTURE CONDITION OF SAMPLE	Slightly Moist
LAYER TESTED / SAMPLED FROM	Test Pit
MATERIAL DESCRIPTION	Aeilian Sand
HOLE NO./ km / CHAINAGE	WTP04 @ 0.5 - 2.5m
ROAD NO.	Wessels Mine
DATE RECEIVED	21/06/2019
DATE SAMPLED	21/06/2019
CLIENT MARKING	None
COLOUR AND TYPE	Not Specified

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m³)	1793	1847	1857	1814	1763			
MOISTURE (%)	4.2	5.2	6.2	7.2	8.2			

MAXIMUM DRY DENSITY (kg/m³) : 1860

OPTIMUM MOISTURE CONTENT (%) : 5.9



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Job Request No.: RS4161
Aurecon SA (Pty) Ltd
P O Box 416
Kimberley
8300
Attention : Mr Siya

Client Ref.No.: None

Date Reported : 08/07/2019

Project : Wessels Mine & Mamatwan

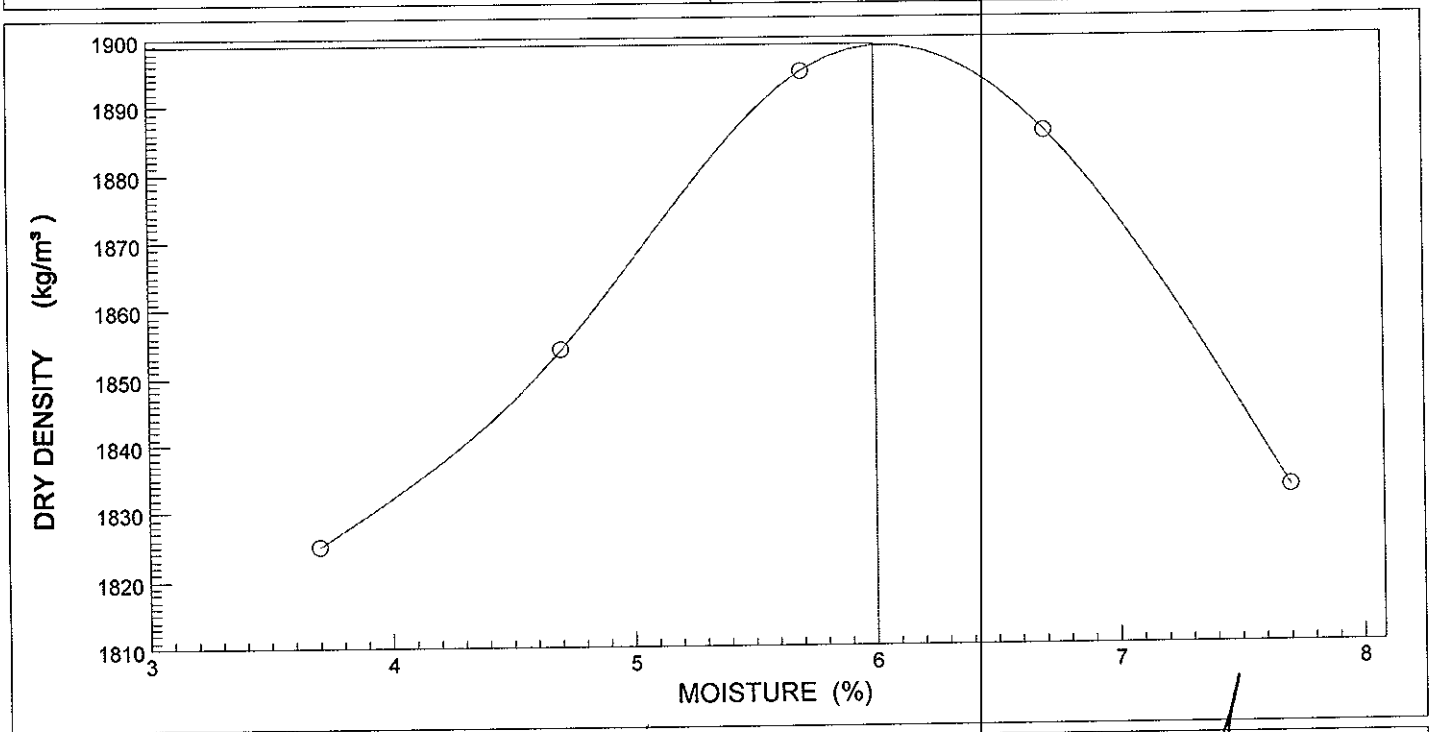
MTP01 @ 1.0 - 2.7m
SANS 3001

SAMPLE NO.	SS5157
CONTAINER FOR SAMPLING	Plastic Black Bag
SIZE / APPROX. MASS OF SAMPLE	70KG
MOISTURE CONDITION OF SAMPLE	Slightly Moist
LAYER TESTED / SAMPLED FROM	Test Pit
MATERIAL DESCRIPTION	Aeolian Sand
HOLE NO./ km / CHAINAGE	MTP01 @ 1.0 - 2.7m
ROAD NO.	Mamatwan Mine
DATE RECEIVED	21/06/2019
DATE SAMPLED	21/06/2019
CLIENT MARKING	None
COLOUR AND TYPE	Not Specified

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m³)	1825	1854	1895	1886	1833			
MOISTURE (%)	3.7	4.7	5.7	6.7	7.7			

MAXIMUM DRY DENSITY (kg/m³) : 1899

OPTIMUM MOISTURE CONTENT (%) : 6.0



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:
Established 2011

Job Request No.: RS4161
Aurecon SA (Pty) Ltd
P O Box 416
Kimberley
8300
Attention : Mr Siya

Client Ref.No.: None

Date Reported : 08/07/2019

Project : Wessels Mine & Mamatwan

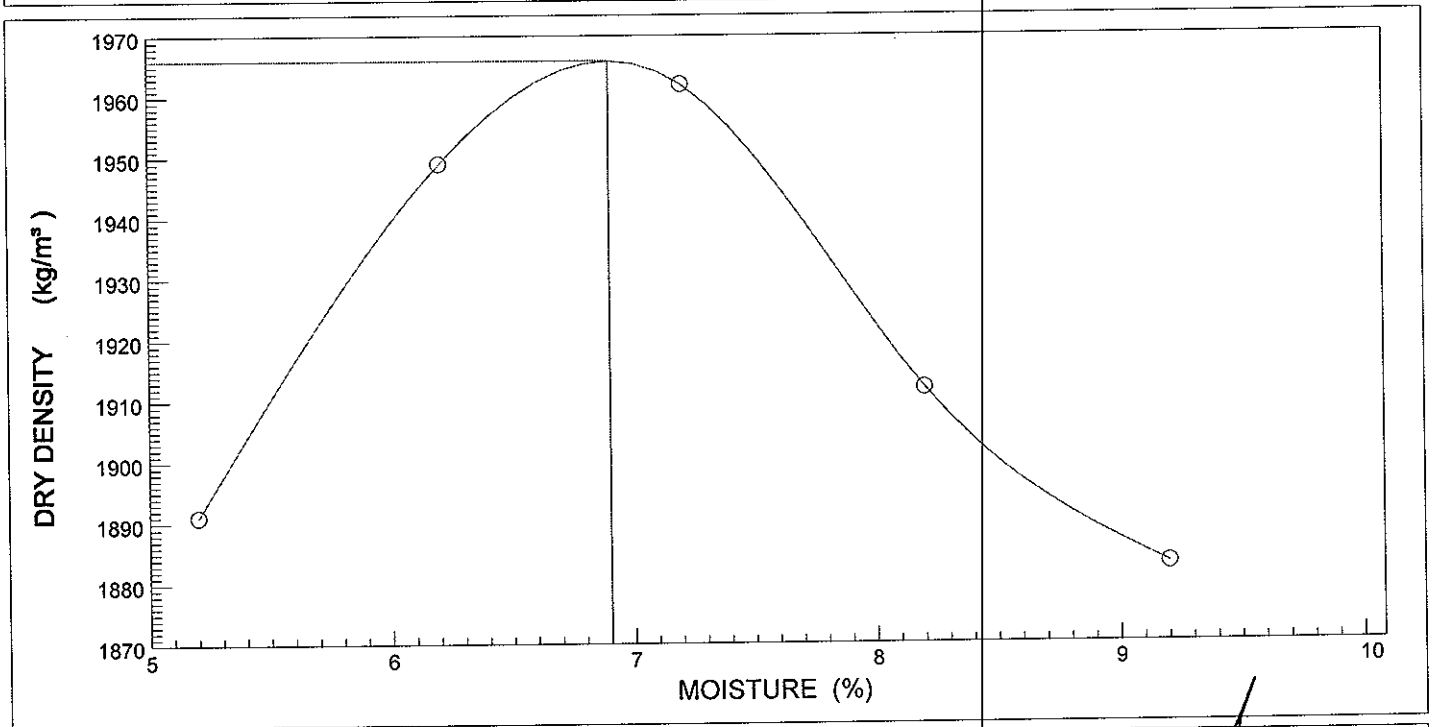
MTP01 @ 0.3 - 2.3m
SANS 3001

SAMPLE NO.	SS5158
CONTAINER FOR SAMPLING	Plastic Black Bag
SIZE / APPROX. MASS OF SAMPLE	70KG
MOISTURE CONDITION OF SAMPLE	Slightly Moist
LAYER TESTED / SAMPLED FROM	Test Pit
MATERIAL DESCRIPTION	Aeolian Sand
HOLE NO./ km / CHAINAGE	MTP05 @ 0.3 - 2.3m
ROAD NO.	Mamatwan Mine
DATE RECEIVED	21/06/2019
DATE SAMPLED	21/06/2019
CLIENT MARKING	None
COLOUR AND TYPE	Not Specified

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m³)	1891	1949	1962	1912	1883			
MOISTURE (%)	5.2	6.2	7.2	8.2	9.2			

MAXIMUM DRY DENSITY (kg/m³) : 1966

OPTIMUM MOISTURE CONTENT (%) : 6.9



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Job Request No.: RS4161
Aurecon SA (Pty) Ltd
P O Box 416
Kimberley
8300
Attention : Mr Siya

Client Ref.No.: None

Date Reported : 08/07/2019

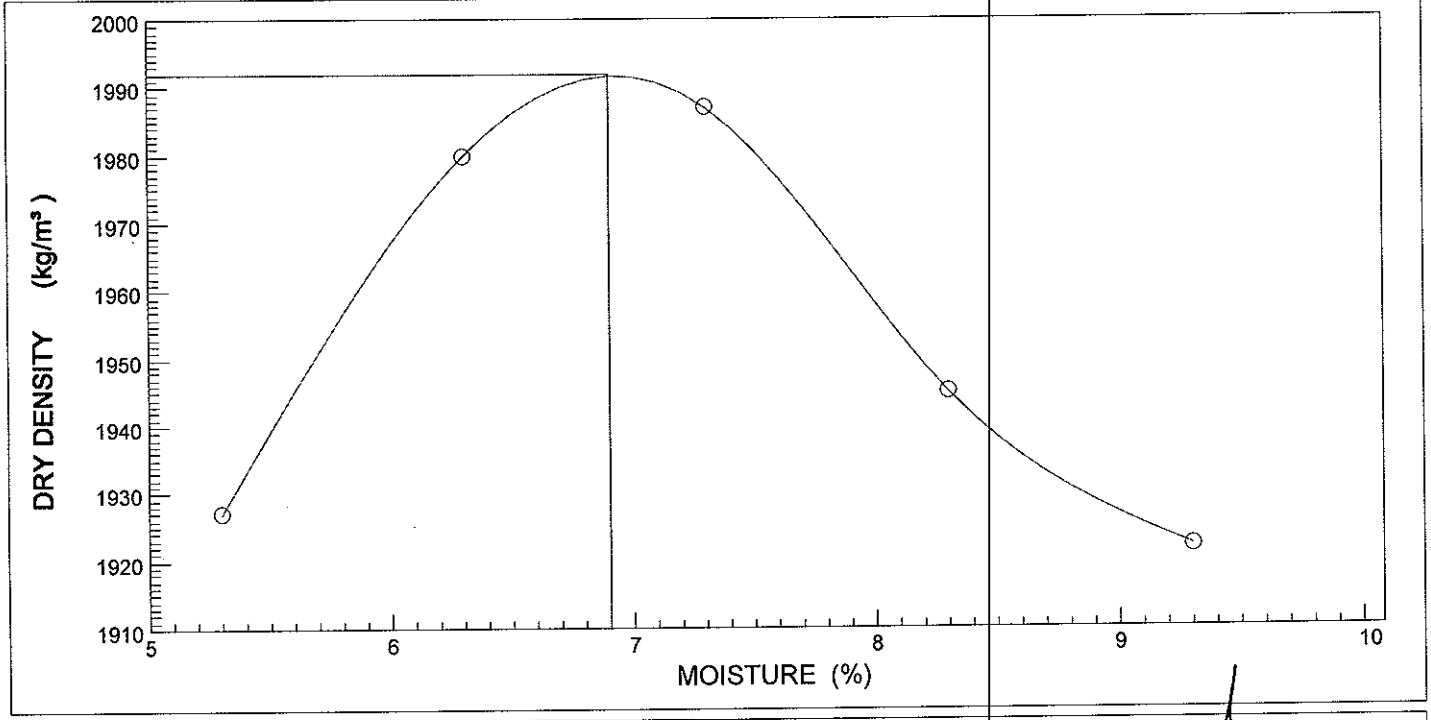
Project : Wessels Mine & Mamatwan

MTP09 @ 0.2 - 2.1m
SANS 3001

SAMPLE NO.	SS5159
CONTAINER FOR SAMPLING	Plastic Black Bag
SIZE / APPROX. MASS OF SAMPLE	70KG
MOISTURE CONDITION OF SAMPLE	Slightly Moist
LAYER TESTED / SAMPLED FROM	Test Pit
MATERIAL DESCRIPTION	Aeolian Sand
HOLE NO./ km / CHAINAGE	MTP09 @ 0.2 - 2.1m
ROAD NO.	Mamatwan Mine
DATE RECEIVED	21/06/2019
DATE SAMPLED	21/06/2019
CLIENT MARKING	None
COLOUR AND TYPE	Not Specified

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m³)	1927	1980	1987	1945	1922			
MOISTURE (%)	5.3	6.3	7.3	8.3	9.3			

MAXIMUM DRY DENSITY (kg/m³) : 1992	OPTIMUM MOISTURE CONTENT (%) : 6.9



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Job Request No.: RS4161
Aurecon SA (Pty) Ltd
P O Box 416
Kimberley
8300
Attention : Mr Siya

Client Ref.No.: None

Date Reported : 08/07/2019

Project : Wessels Mine & Mamatwan

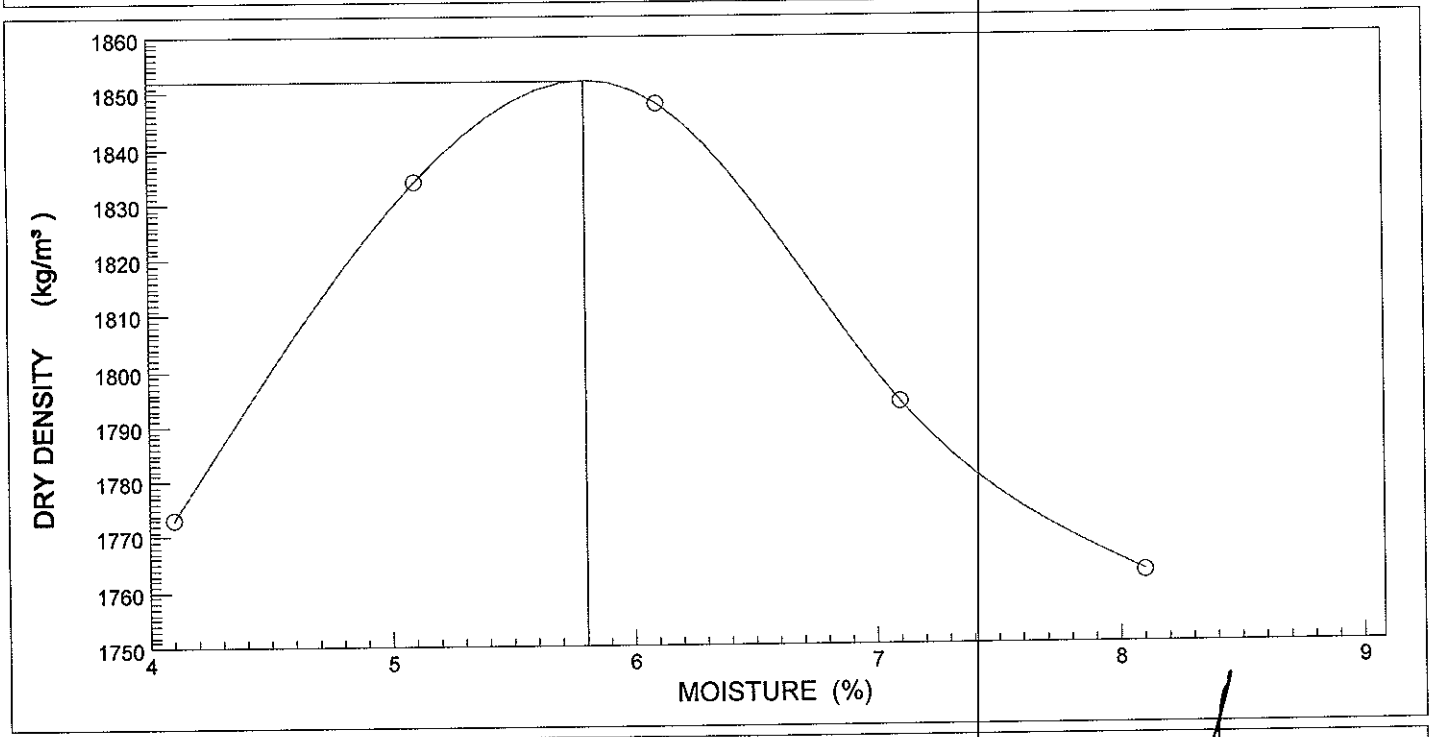
WTP11 @ 0.4 - 3m
SANS 3001

SAMPLE NO.	SS5160
CONTAINER FOR SAMPLING	Plastic Black Bag
SIZE / APPROX. MASS OF SAMPLE	70KG
MOISTURE CONDITION OF SAMPLE	Slightly Moist
LAYER TESTED / SAMPLED FROM	Test Pit
MATERIAL DESCRIPTION	Aeolian Sand
HOLE NO./ km / CHAINAGE	WTP11 @ 0.4 - 3m
ROAD NO.	Mamatwan Mine
DATE RECEIVED	21/06/2019
DATE SAMPLED	21/06/2019
CLIENT MARKING	None
COLOUR AND TYPE	Not Specified

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m³)	1773	1834	1848	1794	1763			
MOISTURE (%)	4.1	5.1	6.1	7.1	8.1			

MAXIMUM DRY DENSITY (kg/m³) : 1852

OPTIMUM MOISTURE CONTENT (%) : 5.8



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:
Established 2011

Job Request No.: RS4161
Aurecon SA (Pty) Ltd
P O Box 416
Kimberley
8300
Attention : Mr Siya

Client Ref.No.: None

Date Reported : 08/07/2019

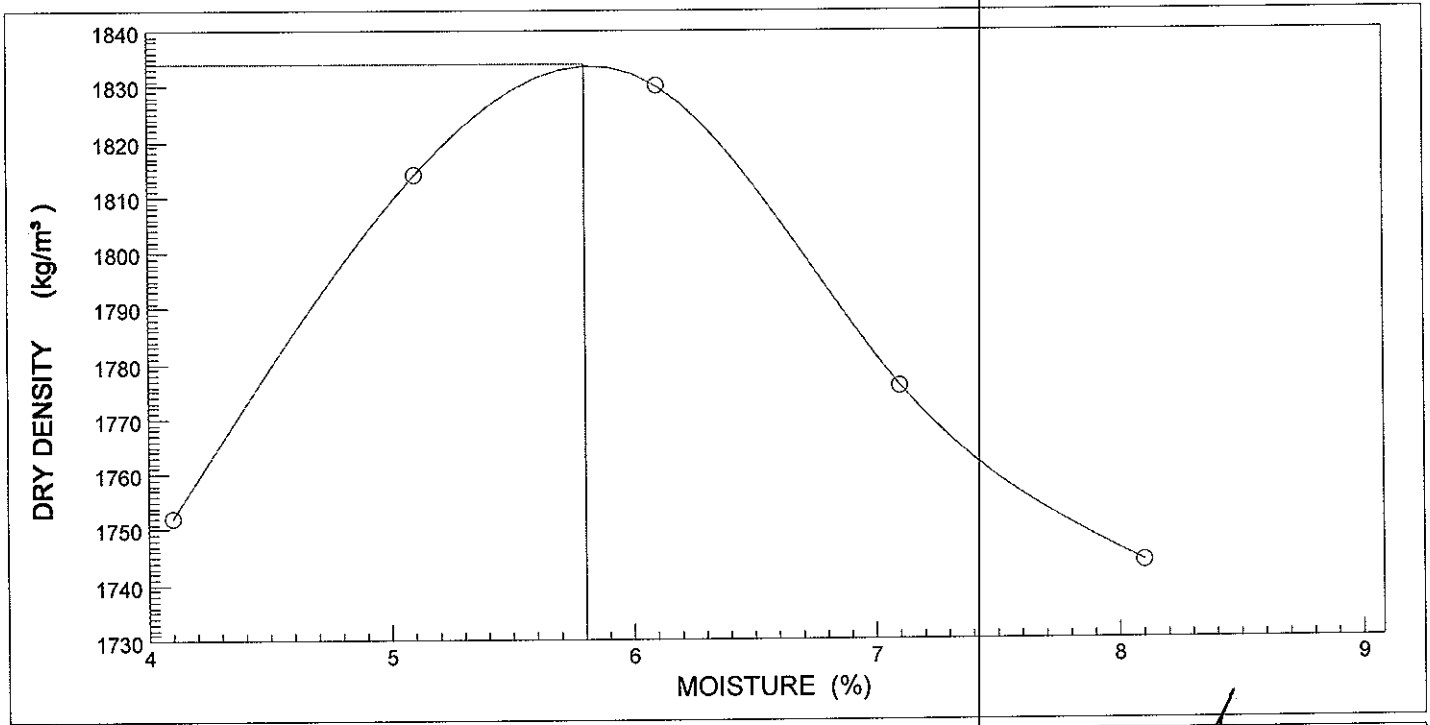
Project : Wessels Mine & Mamatwan

WTP15 @ 120mm - 2700mm
SANS 3001

SAMPLE NO.	SS5161
CONTAINER FOR SAMPLING	Plastic Black Bag
SIZE / APPROX. MASS OF SAMPLE	70KG
MOISTURE CONDITION OF SAMPLE	Slightly Moist
LAYER TESTED / SAMPLED FROM	Test Pit
MATERIAL DESCRIPTION	Aeolian Sand
HOLE NO./ km / CHAINAGE	WTP15 @ 120mm - 2700mm
ROAD NO.	Wessels Mine
DATE RECEIVED	21/06/2019
DATE SAMPLED	21/06/2019
CLIENT MARKING	None
COLOUR AND TYPE	Not Specified

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m³)	1752	1814	1830	1776	1744			
MOISTURE (%)	4.1	5.1	6.1	7.1	8.1			

MAXIMUM DRY DENSITY (kg/m³) : 1834	OPTIMUM MOISTURE CONTENT (%) : 5.8



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Roadlab Civil Engineering Materials Laboratory Pty Ltd
Established 2011
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Job Request No.: RS4161
Aurecon SA (Pty) Ltd
P O Box 416
Kimberley
8300
Attention : Mr Siya

Client Ref.No.: None

Date Reported : 08/07/2019

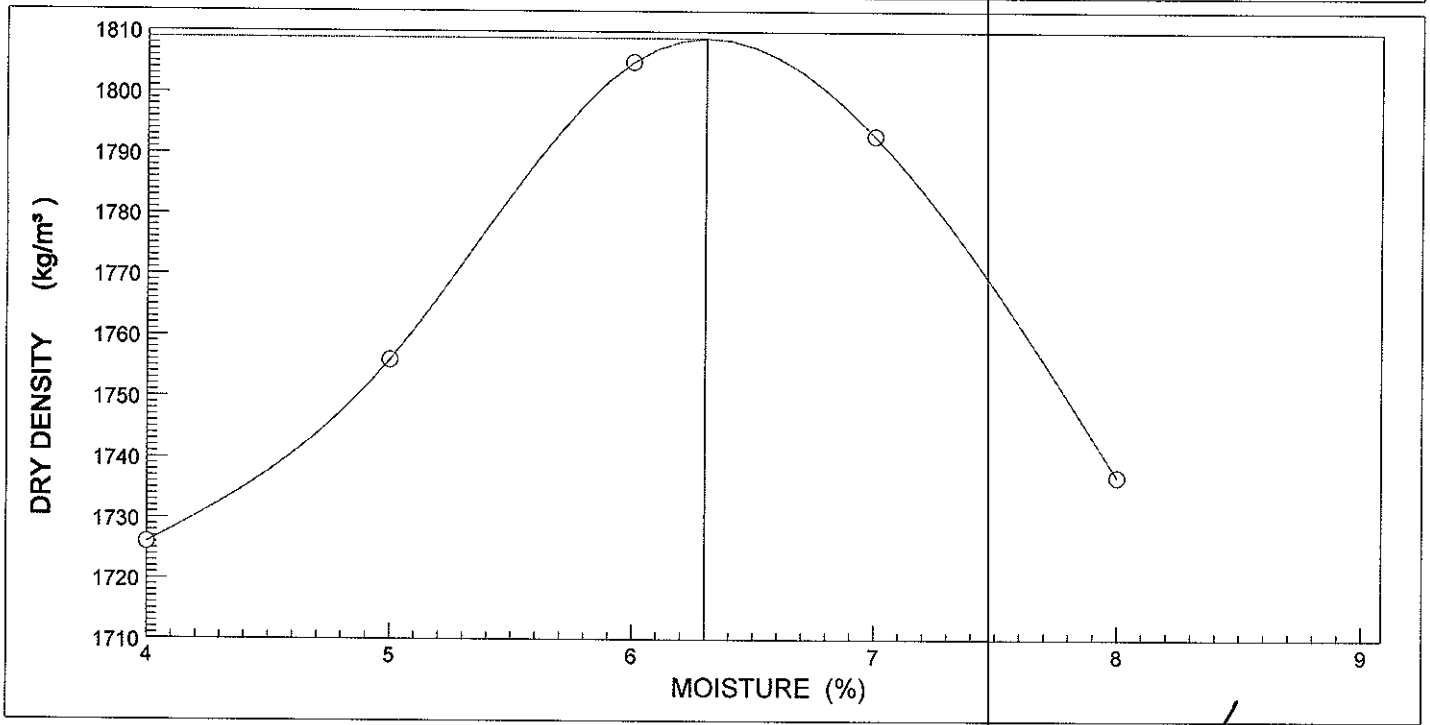
Project : Wessels Mine & Mamatwan

WTP16 @ 2.3m - 3m
SANS 3001

SAMPLE NO.		SS5162
CONTAINER FOR SAMPLING		Plastic Black Bag
SIZE / APPROX. MASS OF SAMPLE		70KG
MOISTURE CONDITION OF SAMPLE		Slightly Moist
LAYER TESTED / SAMPLED FROM		Test Pit
MATERIAL DESCRIPTION		Aeolian Sand
HOLE NO./ km / CHAINAGE		WTP16 @ 2.3m - 3m
ROAD NO.		Wessels Mine
DATE RECEIVED		21/06/2019
DATE SAMPLED		21/06/2019
CLIENT MARKING		None
COLOUR AND TYPE		Not Specified

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m³)	1726	1756	1805	1793	1737			
MOISTURE (%)	4.0	5.0	6.0	7.0	8.0			

MAXIMUM DRY DENSITY (kg/m³) : 1809	OPTIMUM MOISTURE CONTENT (%) : 6.3



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Job Request No.: RS4161
Aurecon SA (Pty) Ltd
P O Box 416
Kimberley
8300
Attention : Mr Siya

Client Ref.No.: None

Date Reported : 08/07/2019

Project : Wessels Mine & Mamatwan

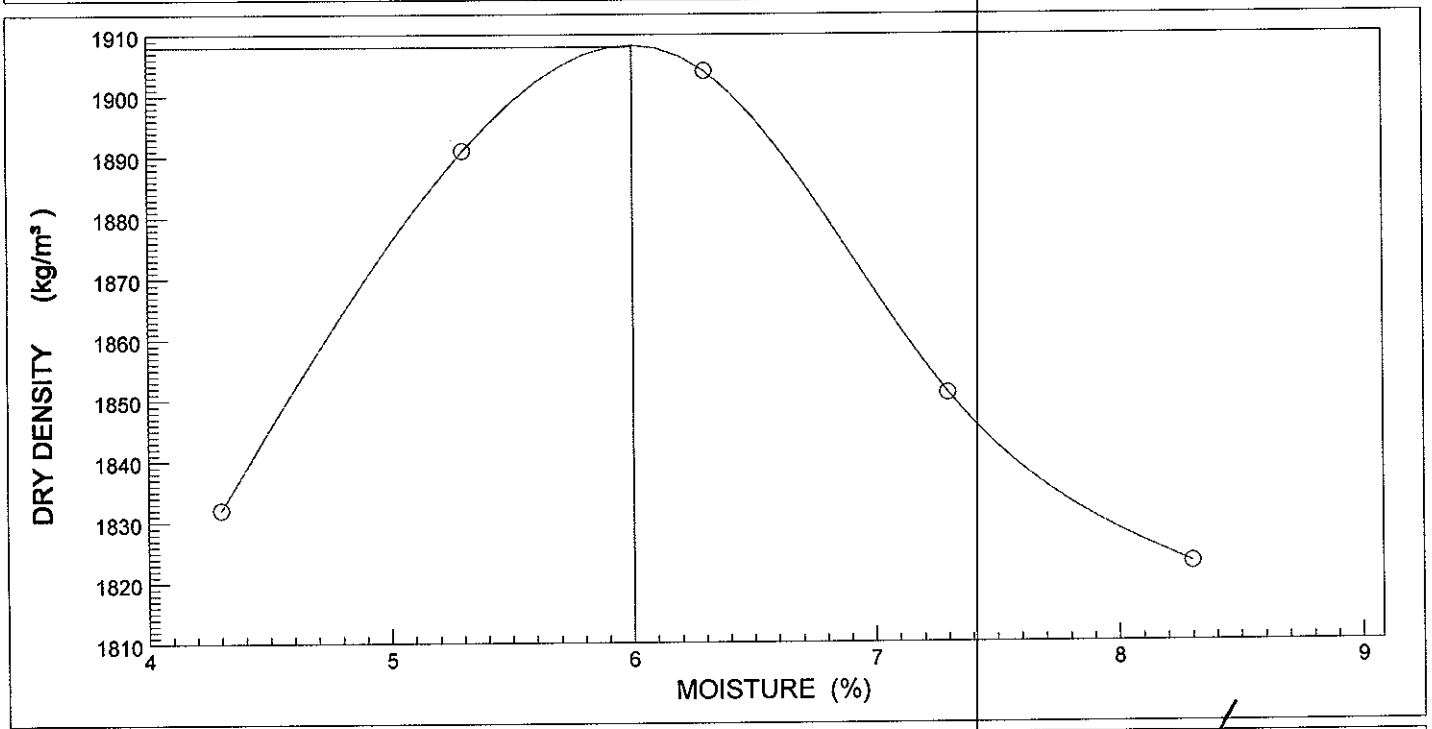
MTP16 @ 0.1m - 2.7m
SANS 3001

SAMPLE NO.	SS5163
CONTAINER FOR SAMPLING	Plastic Black Bag
SIZE / APPROX. MASS OF SAMPLE	70KG
MOISTURE CONDITION OF SAMPLE	Slightly Moist
LAYER TESTED / SAMPLED FROM	Test Pit
MATERIAL DESCRIPTION	Aeolian Sand
HOLE NO./ km / CHAINAGE	MTP16 @ 0.1m - 2.7m
ROAD NO.	Mamatwan
DATE RECEIVED	21/06/2019
DATE SAMPLED	21/06/2019
CLIENT MARKING	None
COLOUR AND TYPE	Not Specified

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m³)	1832	1891	1904	1851	1823			
MOISTURE (%)	4.3	5.3	6.3	7.3	8.3			

MAXIMUM DRY DENSITY (kg/m³) : 1908

OPTIMUM MOISTURE CONTENT (%) : 6.0



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

SOUTH AFRICA
ROADLAB Laboratories
Civil Engineering Materials Testing Laboratory
Established 2011
Roadlab Civil Engineering Materials Laboratory Pty Ltd
8 Kalk Street
Kathu 8446
Tel: 053 723 1802 Fax:
Email: sishen@roadlab.co.za
Web:

Job Request No.: RS4161
Aurecon SA (Pty) Ltd
P O Box 416
Kimberley
8300
Attention : Mr Siya

Client Ref.No.: None

Date Reported : 08/07/2019

Project : Wessels Mine & Mamatwan

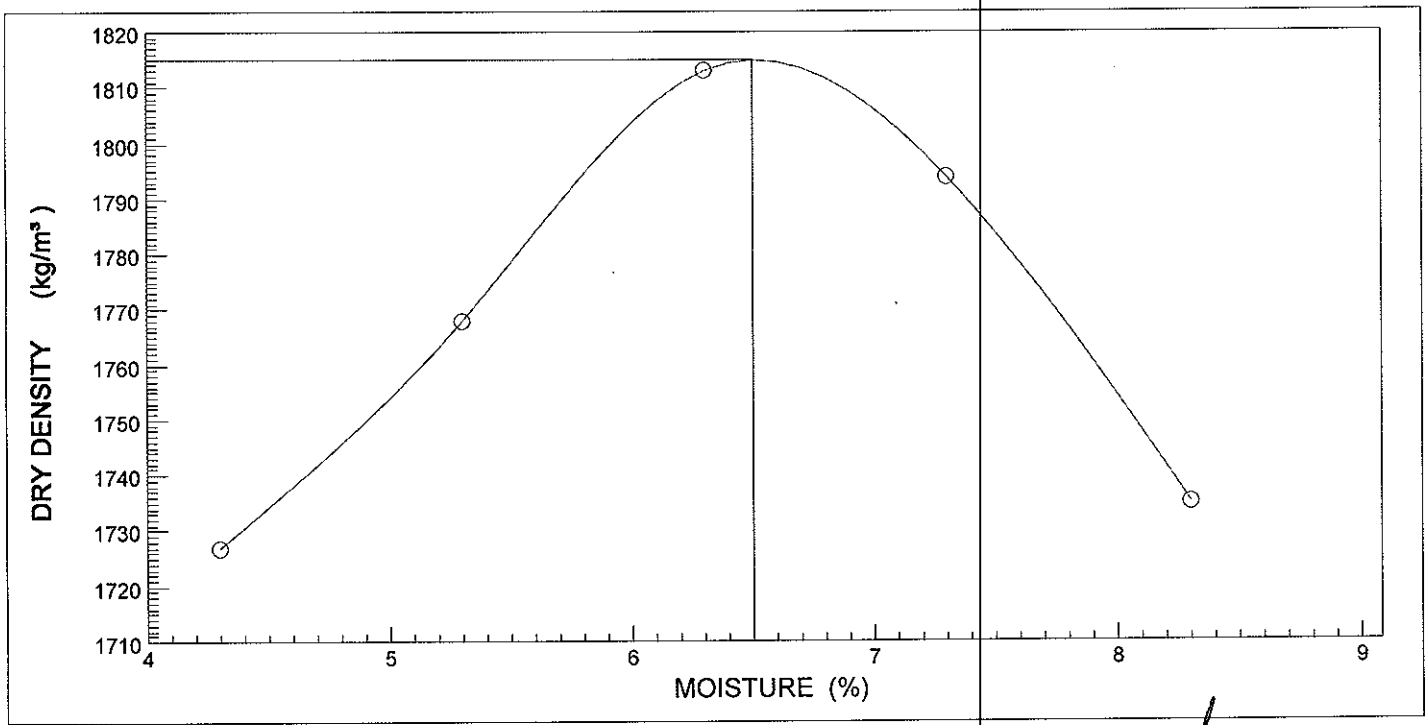
MTP16 @ 0.1m - 2.7m
SANS 3001

SAMPLE NO.	SS5164
CONTAINER FOR SAMPLING	Plastic Black Bag
SIZE / APPROX. MASS OF SAMPLE	70KG
MOISTURE CONDITION OF SAMPLE	Slightly Moist
LAYER TESTED / SAMPLED FROM	Test Pit
MATERIAL DESCRIPTION	Aeolian Sand
HOLE NO./ km / CHAINAGE	WTP18 @ 0.2.6m - 3.2m
ROAD NO.	Wessels Mine
DATE RECEIVED	21/06/2019
DATE SAMPLED	21/06/2019
CLIENT MARKING	None
COLOUR AND TYPE	Not Specified

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m³)	1727	1768	1813	1794	1735			
MOISTURE (%)	4.3	5.3	6.3	7.3	8.3			

MAXIMUM DRY DENSITY (kg/m³) : 1815

OPTIMUM MOISTURE CONTENT (%) : 6.5



Non accredited Facilities
Opinions and Interpretations are not included in our schedule of accreditation.
The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
The test results reported relate to the samples tested.
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context.
Report compiled by : Bernice Crafford

Prog.ver 9.5 (2019/05/24)

Technical Signatory

ROADLAB
LABORATORIES (PTY) LTD
Civil Engineering Material Testing Laboratory
VAT NO: 4670261090 REG NO: 2011/005423/07

HEAD OFFICE
207 Rietfontein Rd Primrose Germiston 1401
P O Box 1476 Germiston 1400
Tel: 011 828 0279 Fax: 011 828 0273
E-mail: info@roadlab.co.za
www.roadlab.co.za

RS4161 2019/07/05

Aurecon

Siya

Test Report : **WESSELS MINE / MANATWAN MINE - pH & CONDUCTIVITY TEST RESULTS**

Clients Marking: None
Sample Number: S/3218-S/3223
Sample delivered to: Roadlab

Date Sampled: 2019-07-01
Date Received: 2019-07-01

Sample Number	Layer / Road :	Temperature (°C) : Conductivity	Conductivity (ms/m)	Temperature (°C) : pH	pH Value
S3218	MTP14: 0.1-2.0m	24,0	5,0	24,0	6,55
S3219	WTP4: 0.5-2.5m	24,0	33,0	24,0	7,88
S3217	MTP09: 0.2-2.1m	24,0	22,0	24,0	7,58
S3221	WTP18: 2.6-3.2m	24,0	37,0	24,0	7,74
S3216	MTP03: 1.0-2.4m	24,0	12,0	24,0	7,65
S3220	WTP8: 0.3-3.0m	24,0	9,0	24,0	6,56

Remarks :

The samples were subjected to analysis according to TMH 1
The results reported relate only to the sample tested
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context
Compiled By : Chanel van Biljon

Appendix D

Drawings

Document prepared by

Aurecon South Africa (Pty) Ltd
Reg No 1977/003711/07

Aurecon Centre
Lynnwood Bridge Office Park
4 Daventry Street
Lynnwood Manor 0081

PO Box 74381
Lynnwood Ridge 0040
South Africa

T +27 12 427 2000
F +27 86 556 0521
E tshwane@aurecongroup.com
W aurecongroup.com

aurecon

Bringing ideas to life

Aurecon offices are located in:
Angola, Australia, Botswana, China, Ghana, Hong Kong, Indonesia, Kenya, Lesotho, Macau, Mozambique, Namibia, New Zealand, Nigeria, Philippines, Qatar, Singapore, South Africa, Swaziland, Tanzania, Thailand, Uganda, United Arab Emirates, Vietnam.