APPENDIX D_3

Geotechnical Report

Geotechnical Report for Maselspoort Recirculation Pipeline

Bloemfontein to Philip Saunders, Free State

June 2015 REF: JG0014/06/2015/2580

Report to:

GladAfrica
CONSULTING (PTY) LIMITED

SMEC REPORT
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1. INTRODUCTION AND TERMS OF REFERENCE

1.1 Introduction and Project Description

This report presents the findings of a geotechnical investigation along the proposed alignment of a 26km long, 1,5m diameter GRP water pipeline, from Bloemspruit Maturation Ponds to the Mockes Dam. The development will also include a pump station at the Eastern Waste Water Treatment Works (WWTW) and some concrete structures at the outlet at Mockes Dam incorporating a possible mini-hydroelectric power station and energy dissipators. Additional investigative work was conducted at these locations. Two other “branches” of the proposed pipeline were also investigated; One branch connects the Eastern Waste Water Treatment works with the pump station at Renosterspruit (approximately 900m). The other branch connects the main pipeline to the Maselspoort Dam.

1.2 Terms of Appointment

The work was carried out as part of ***SMEC South Africa (Pty) Ltd*** appointment by Glad Africa, dated 3rd March 2015, and in accordance with our ammended quote no. Q873.

This report summarises the interpretation of the laboratory and site testing results and provides founding recommendations.

1.3 Aims and Methodology

The objectives of the study are:

- To identify geotechnical factors that may influence the design and construction of the pipeline.
- To analyse the geotechnical conditions present and make recommendations for site works which includes the assessment of the side slope stability of the pipe trenches.
- Comment on the suitability of the in-situ material for use as bedding/selected backfill.
- To propose measures that need to be taken at stream crossings or where the route crosses existing roads.
- To assess the excavatability of materials encountered on site and determine the quality of these according to the SANS1200 (SABS1200).
- To provide foundation recommendations for the proposed structures and to comment on geotechnical factors that would have an impact on the development.

- To identify relevant ground-related features and determine the variability of ground conditions and the effect of such variability on the proposed development.

The following methodology was adopted to realise the aims of the study:

- Review of available geological records and site plans.
- Undertaking of a geotechnical site investigation including trial pits and the profiling of soils, investigate soil strengths/capacities and identify potential problem soils on site.
- Undertaking of laboratory tests and DCP testing to establish geotechnical and design parameters of the soils.

1.4 Codes of Practices and Standards

The investigation was carried according to standard practice codes and guidelines including:

- The 2010 SAICE Geotechnical Division Site Investigation Code of Practice.
- SANS 1200 :1986 (SABS1200) Standardised specification for civil engineering construction.

1.5 Limitations of Assessment

The services performed by ***SMEC South Africa*** were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession practising under similar conditions in the locality of the project. Variations in what is reported here may become evident during construction and it is thus imperative that a Competent Person inspects all excavations to ensure that conditions at variance with those predicted do not occur and to undertake an interpretation of the facts supplied in this report.

This report has been prepared for the exclusive use of the client, with specific application to the proposed project.

2. SITE LOCATION AND DESCRIPTION

The proposed pipeline is situated to the east of Bloemfontein and mostly follows the road from Bloemfontein to the Mockes Dam (Philip Saunders Holiday Resort).

From the west, the pipeline commences at the existing maturation ponds at Bloemspruit and follows a route eastwards towards the north eastern water treatment works and pump station at Renosterspruit. From the pump station at Renosterspruit the alignment follows the route to the Mockes Dam. The area is characterised by a relatively flat to gently rolling topography, with cattle grazing farmland and small holdings the most common land use in the area. The

pipeline route crosses the Bloemspruit, Renosterspruit and several stream tributaries of the Modder River.

The main pipeline route also crosses several roads and existing services including:

- National Route N8
- Bloemfontein – Maselspoort Road
- S1066 and Renoster Avenue (Renosterspruit Area)
- Dreyer Avenue, Oudam Avenue and Conradie Avenue (Riverside Small Holdings area).
- Riverside Avenue (Roodewal Small Holdings area)
- A dirt road towards Braklaagte
- Several other access roads

The site is situated at an altitude of about 1350m to 1310m above mean sea level. Drainage is in the form of sheetwash.

A locality map is given as Diagram 2.1 and some site photos are included below.

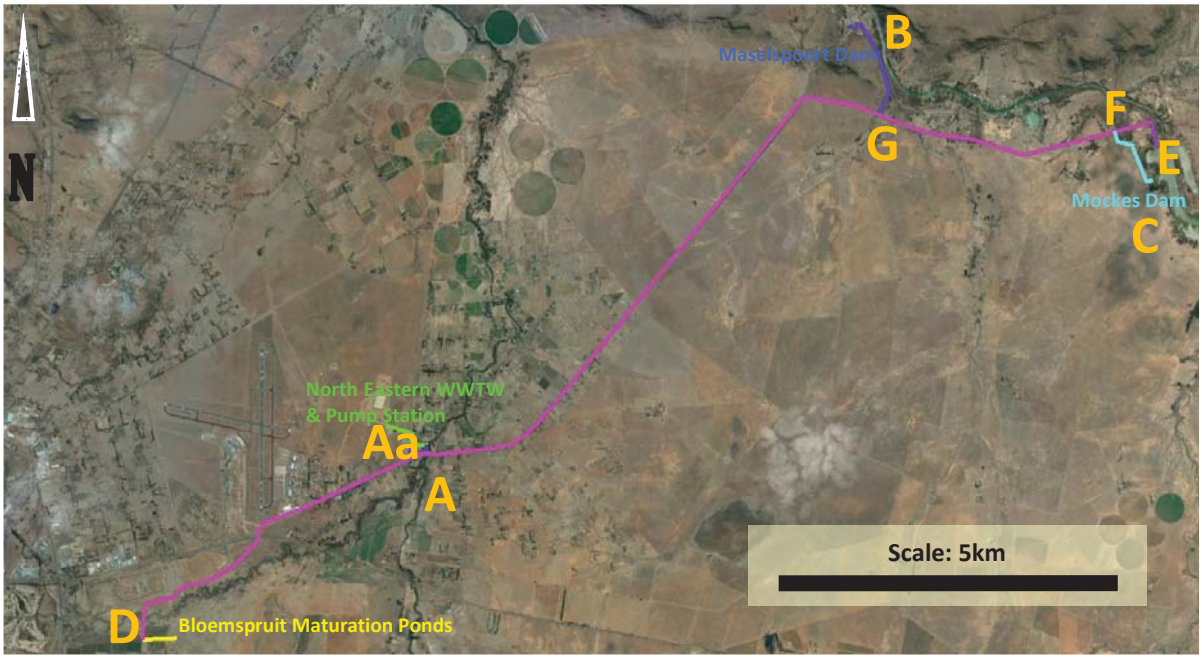


Diagram 2.1: Locality Map

The proposed pipeline was divided into 6 sections and areas along its alignment. The sections and areas were chosen geographically. The location of the 6 sections and areas are summarised in Table 2.1.

Table 2.1: Section/ Area along the pipeline

Section/Area Designation	Start of section (Point Indicated on Diagram 2.1)	End of section (Point Indicated on Diagram 2.1)	Approximate Length
Section DA	Bloemspruit Maturation Ponds (Point D)	Pump station at Renosterspruit (Point A)	6.3 km
Renosterspruit Area	North Eastern WWTW (Point Aa)	Pump Station at Renosterspruit (Point A)	0.9 km
Section AG	Pump station at Renosterspruit (Point A)	Split to Maselspoort Dam (Point G)	10.6 km
Section GB	Split to Maselspoort Dam (Point G)	Maselspoort Dam (Point B)	1.7 km
Section GF	Split to Maselspoort Dam (Point G)	Split to Mockes Dam (Point F)	4.0 km
Mockes Dam Area	Split to Mockes Dam (Point F)	Mockes Dam (Points C & E)	2.2 km

The coordinates of the points mentioned in Table 2.1 are summarised in Table 2.2.

A chainage is also drawn along the main pipeline and is drawn from point D (km 0), through points A, G & F and ends at point E. Chainage distance approximations are also provided in Table 2.2

Table 2.2: Coordinates of reference points along the route

Point	Coordinates (WGS 84)		Coordinates (WGS 84 & Lo 27)		Chainage Approximation (km)
	Latitude	Longitude	X	Y	
A	S 29°05'44.7"	E 26°19'53.6"	3220066	65073	6.3 km
Aa	S 29°05'34.4"	E 26°19'27.6"	3219755	65778	N/A (Separate section)
B	S 29°01'59.9"	E 26°24'21.0"	3213108	57878	N/A (Separate section)
C	S 29°03'22.7"	E 26°27'32.9"	3215630	52673	N/A (Separate section)
D	S 29°07'29.3"	E 26°16'53.5"	3223315	69923	0 km
E	S 29°03'04.5"	E 26°27'35.8"	3215069	52598	N/A (Separate section)
F	S 29°02'56.5"	E 26°27'08.7"	3214827	53330	20.9 km
G	S 29°02'47.7"	E 26°24'39.6"	3214575	57367	16.9 km

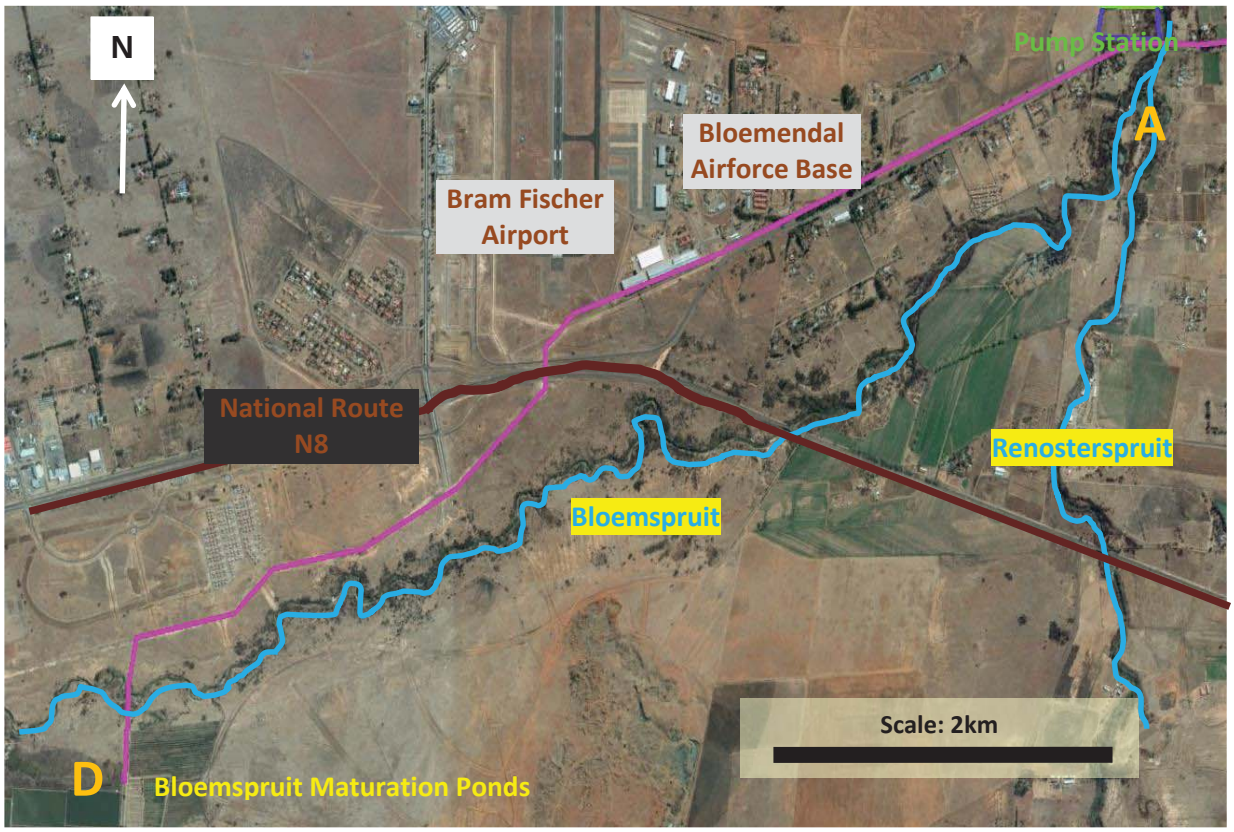
Photo 2.1: Showing the generally flat landscape

Photo 2.2: Showing typical small holdings land use

2.1 Section DA

Section DA (indicated in Diagram 2.2) starts at the Bloemspruit Maturation Ponds and after it crosses the Bloemspruit slopes up to the North Eastern WWTW and the pump station at the Renosterspruit over an approximate length of 6.3km.

Diagram 2.2. Section DA

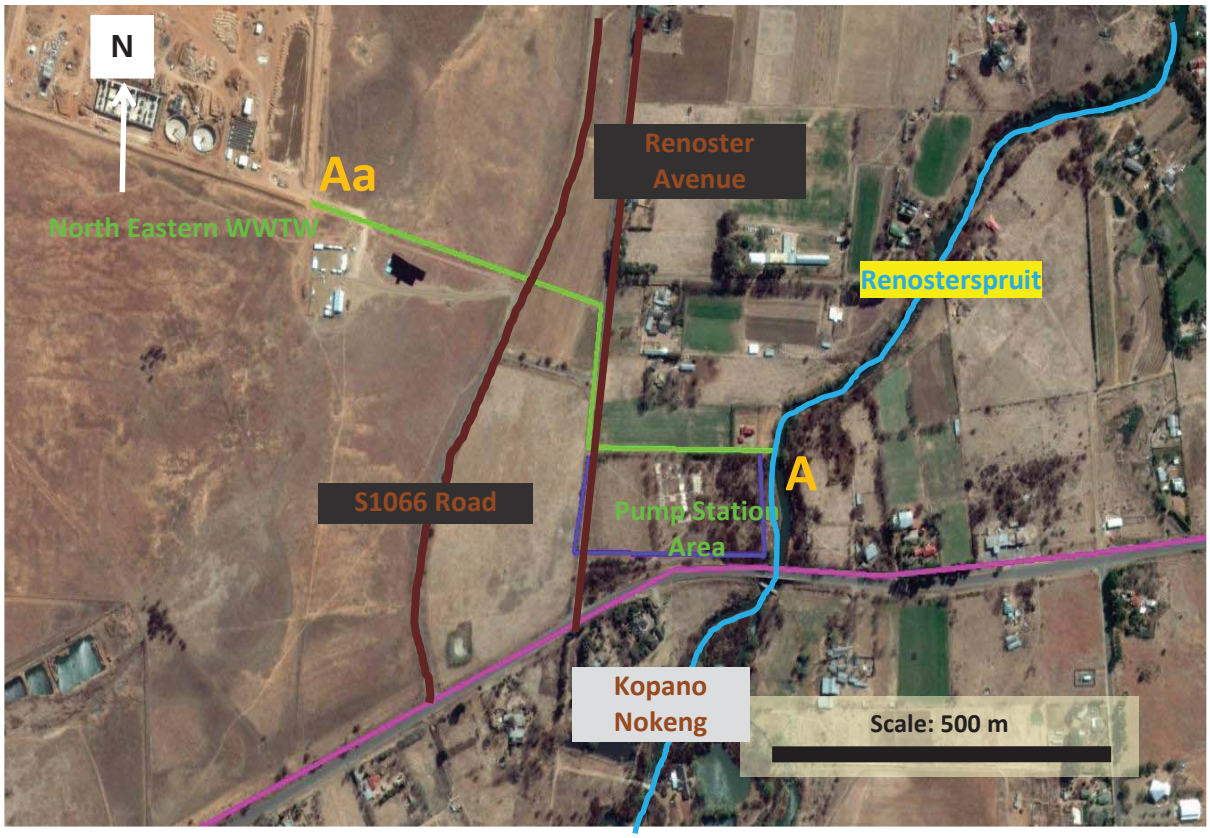


After crossing the Bloemspruit, the route runs roughly parallel the stream for about 1.8km, it then crosses the N8 National Route. After crossing the N8 the proposed route follows the Bloemfontein – Maselspoort road. The alignment passes south of the Bram Fischer Airport and the Bloemspruit Airforce Base.

2.2 Renosterspruit Area

Area A (indicated in Diagram 2.3) is the area between the North Eastern WWTW (Aa) and the proposed pump station (A) at Renosterspruit. At the time of the writing of this report the exact location of the pump station, the size of proposed structure and thus the exact pipeline location was not known. The distance between the proposed pump station and the WWTW is approximately 0.9 km (depending on the exact location of the pump station). The area for the proposed pump station is bound on the east by the Renosterspruit and the area was previously a school yard. The proposed pipeline alignment crosses the S1066 and Renoster Avenue. The area lies between small holdings and undeveloped land to the north and west. The area is generally flat, sloping slightly towards the Renosterspruit in the east.

Diagram 2.3. Area A



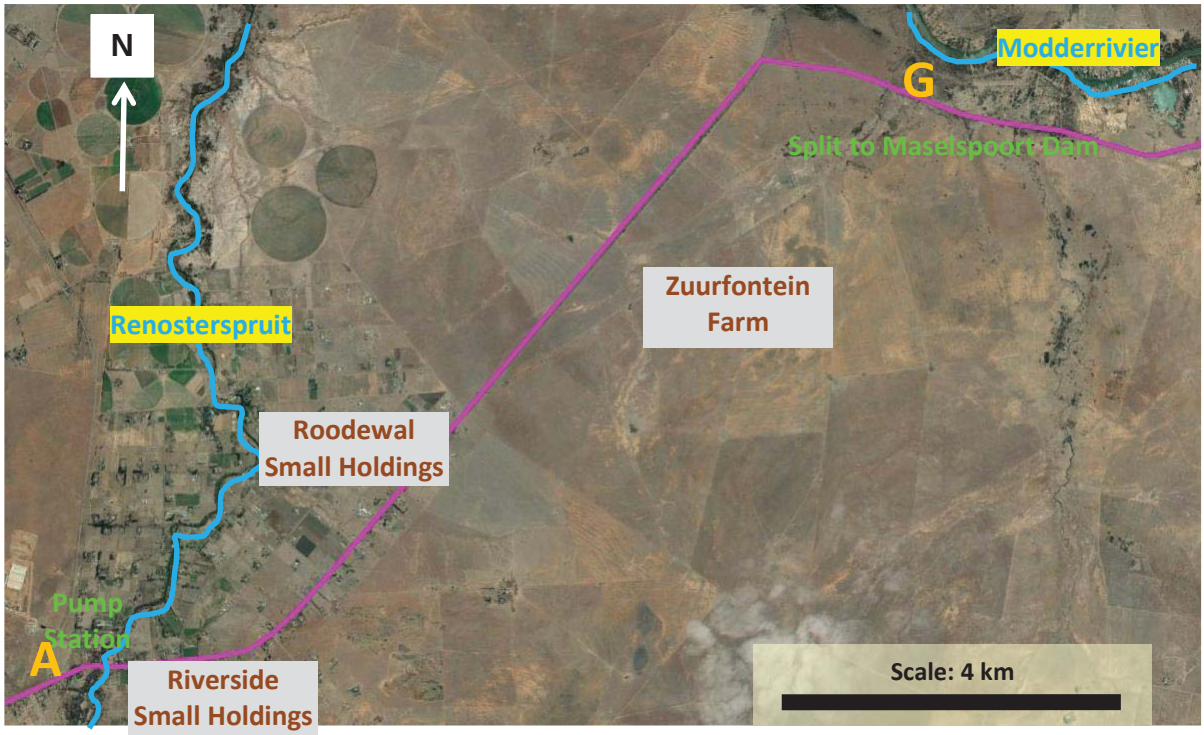
2.3 Section AG

Section AG (indicated in Diagram 2.4) starts at the Renosterspruit pump station and extends to point G. At point G there is connection from the main pipeline that leads to Maselspoort Dam (Section GB). Section AG is approximately 10.6km in length.

From the pump station, the pipeline crosses the Bloemfontein – Maselspoort Road close to Kopano Nokeng Conference venue. The pipeline then crosses the Renosterspuit. From there the pipeline alignment is on the southern side of the Maselspoort road up to the Philip Saunders crossing. At the crossing, the pipe alignment turns eastwards (in the direction of Philip Saunders Holiday Resort).

The initial approximately 5km of this section falls in the Riverside and Roodewal small holding areas. This area is characterised by a rolling topography and a couple of small stream tributaries. The rest of the section (up to point G) lies adjacent to the Zuurfontein farm. Mostly the Zuurfontein farm area is flat and slopes slightly towards the north-east at a gradient of less than 0.5%. In the north eastern corner of the section the topography slopes at a gradient of 2.3% towards a major stream tributary of the Modderrivier in the north-eastern corner of the Zuurfontein farm.

Diagram 2.4. Section AG



2.4 Section GB

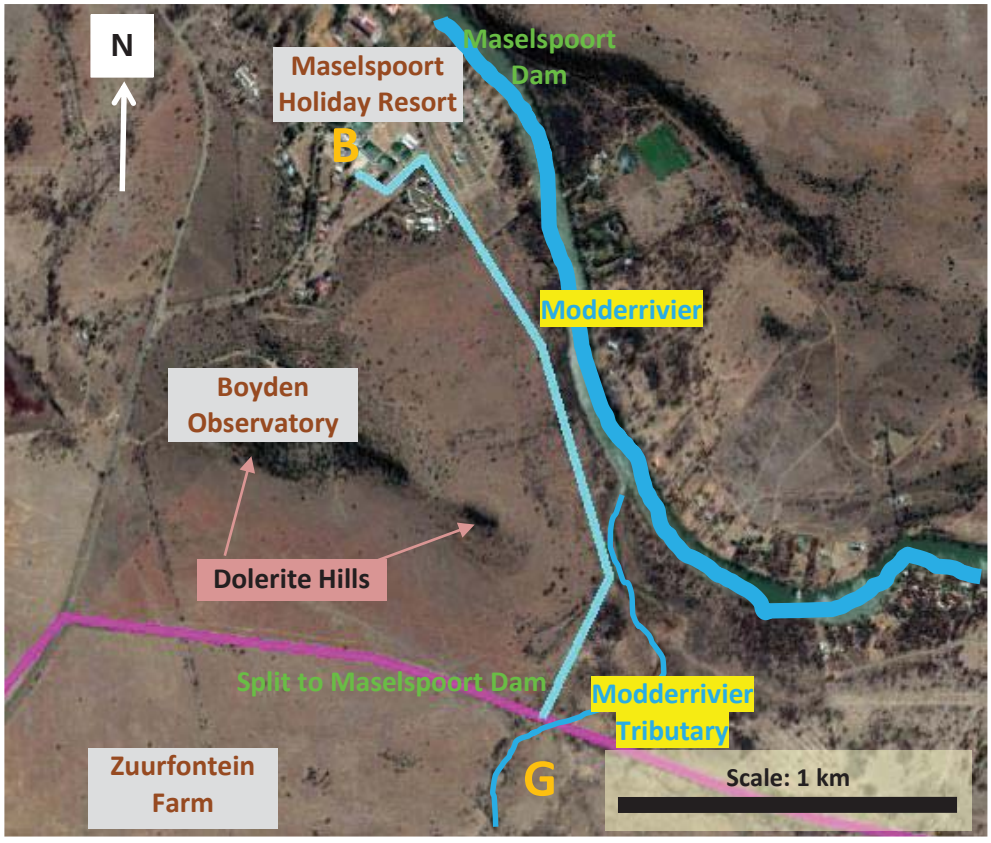
Section GB (indicated in Diagram 2.5) starts at the position where the connection between the main pipeline and the Maselspoort dam is located (point G). The section is approximately 1.7km in length and ends close to the Maselspoort dam.

From the connection point at G, the alignment crosses the road to Philip Saunders Holiday Resort, from there it generally traverses the tributary mention in section AG. To the west of the proposed route is a dolerite hill. The Boyden Observatory can be seen at the top of the hill.

The average slope of the first 1.5km is approximately 1%. The slope of the final 200m is approximately 4%. The topography slopes towards the east and north west in the direction of the tributary and the Modderrivier.

The section finishes close to the Maselspoort dam, just to the south west of the Maselspoort Holiday resort. Apart from the Maselspoort Holiday Resort and the Boyden observatory the area is generally undeveloped farmland used for cattle grazing. The test pits that were excavated along section GB were excavated approximetly 50m east of the proposed pipeline. Test pit positions were adjusted due to access problems into the dense vegetation surrounding the tributuary.

Diagram 2.5. Section GB



2.5 Section GF

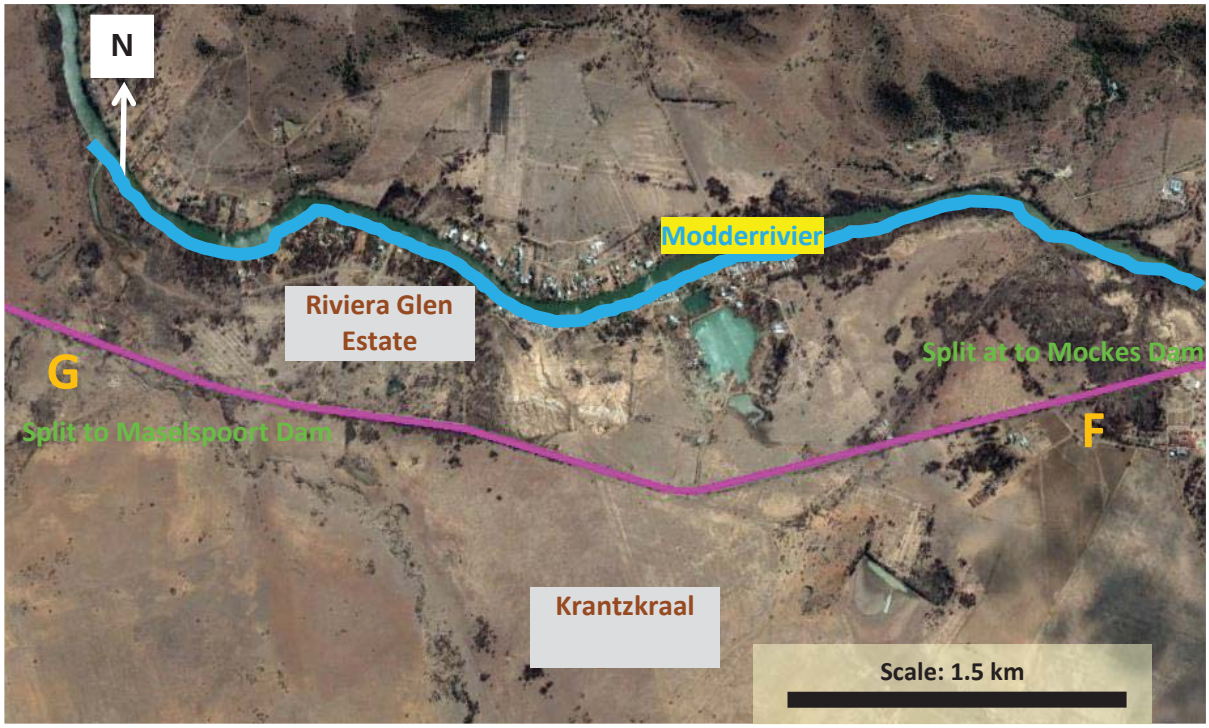
Section GF (indicated in Diagram 2.6) starts at the position where the connection between the main pipeline and the Maselspoort dam is located (point G) and finishes at point F which is close to the Mockes dam. Section GF is approximately 4km in length.

From point G the alignment follows the road to Philip Saunders Holiday Resort, with the pipeline to the south of the road. The route crosses a couple of stream tributaries leading to the Modderrivier. To the south of this section of the route is Krantzkraal farm, which is used for cattle grazing, and to the north of the road are a couple of game farms and the Riviera Glen Estate.

Although the area is generally flat, with an average slope of about 1%, there is slightly more dense vegetation in the area, mostly consisting thorn-bushes. The area generally slopes north and slightly west, towards the Modderrivier.

To the south west of point F are a couple of residential buildings.

Diagram 2.6. Section GF



2.6 Mockes Dam Area

The Mockes Dam area (indicated in Diagram 2.7) comprises the following:

A pipeline connecting point F with point E (as indicated on the diagram)

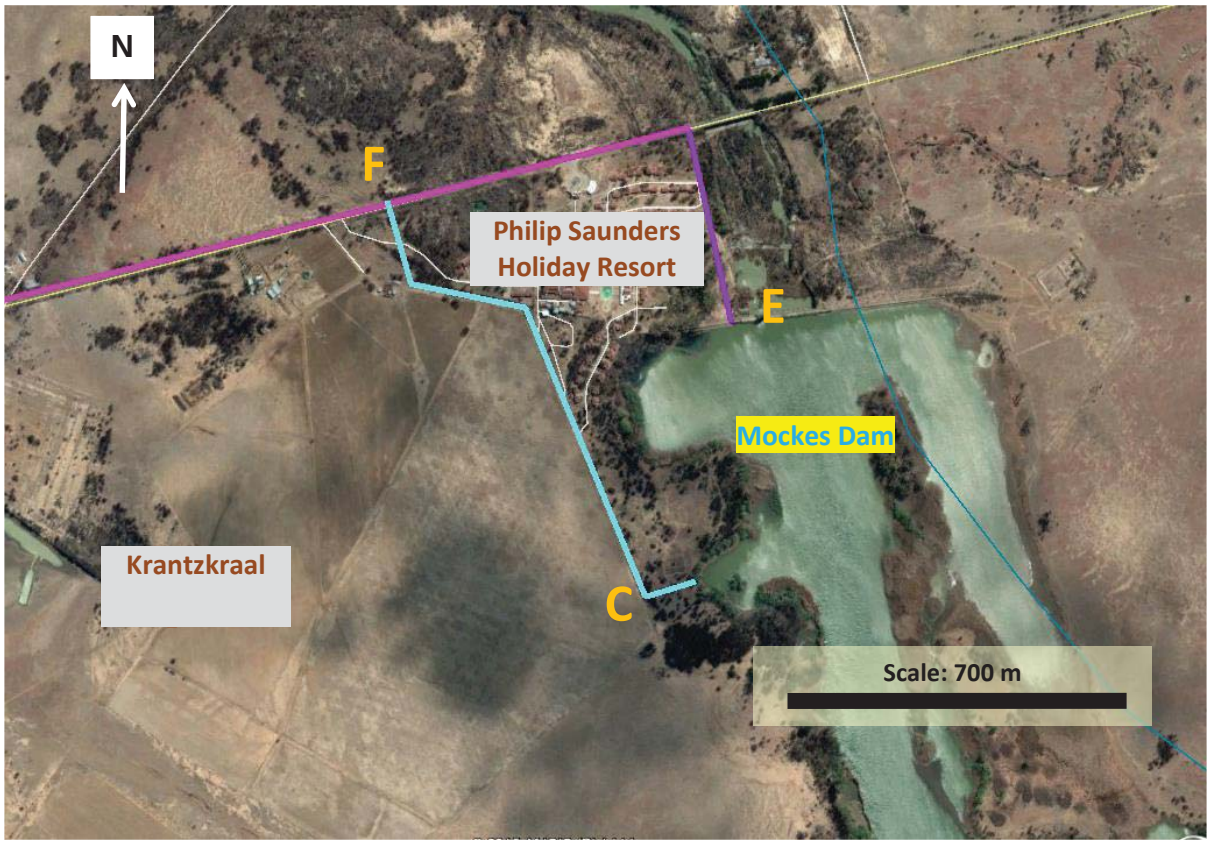
A pipeline connecting point F with point C (as indicated on the diagram)

Structures to be placed at points C & E.

To the south and east of the area is the Krantzkraal farm and both sections of the pipeline goes through the Philip Saunders Holiday Resort.

At the time of writing of this report the exact location and size of structures are not known and the area will be described in general.

Diagram 2.7 Mockes Dam Area



3. CLIMATE

The site is located in the dry, warm temperate climatic zone, which is characterised by hot summers and cool winters. The average maximum daily temperatures vary from 31ºC in January to 15ºC in June. Corresponding minimum temperatures for these months are 17ºC and -2ºC. Rainfall occurs throughout the year, but most of the precipitation occurs in the summer months and averages about 470mm per annum.

Climate determines the mode of weathering and rate of weathering. The effect of climate on the weathering process (i.e. soil formation) is determined by the climatic N-value defined by Weinert. The N-value for the site is 5.3.

The implication of the N-value in general (for an N>5 area) is that the soil profile is likely to be formed by both physically disintegrated and chemically decomposed soils, but predominantly disintegration.

4. GEOLOGY

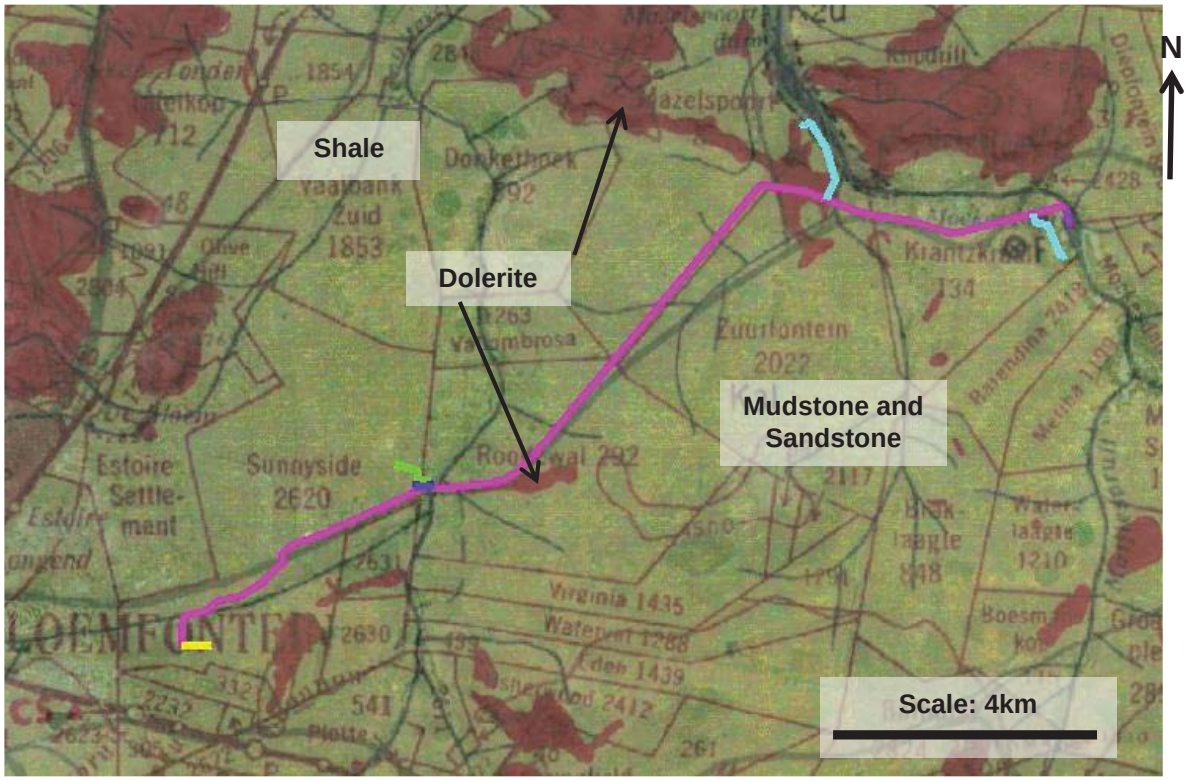
The geological map of Bloemfontein (sheet no. 2926, scale 1:250 000) shows the site to be underlain by sandstone, mudstone and shale of the Adelaide Subgroup, Beaufort Group, Karoo Supergroup. The Karoo sediments have been extensively intruded by dolerite dykes and sills. Diagram 4.1 indicates the local geology of the area in the vicinity of the pipeline.

The sediments of the Adelaide Subgroup mostly consists of mudstone and sandstone which was deposited in deltaic, meandering fluvial environments in floodplains. Mudstone associated with this subgroup is generally green-grey in colour with red-brown interbeds and light grey sandstone.

Most dolerite intrusions in the Karoo Supergroup are horizontal (sheet-like) and the thickness of the dolerite varies from 1m to about 300m thickness. Dolerite is divided into six classes of weathering. Solid unweathered dolerite is hard to extremely hard and generally requires blasting for excavation. As dolerite weathers down it weathers to fractured-, boulder-, and gravel dolerite. The dolerite then weathers down to granular (sugar) dolerite and eventually to residual dolerite soil. Calcrete is often encountered where N>5 (where disintegration is the primary mechanism of weathering).

An extract of the local geology is shown in Diagram 4.1.

Diagram 4.1. Extract from Bloemfontein 2926 Geological Map



5. SITE INVESTIGATION

The investigation comprised the following:

- The fieldwork was undertaken from 30 March to 9 April, and comprised the excavation of 76 test pits along the alignment of the proposed pipeline, the alignment of the proposed separate branches of the pipeline and the structures associated with the development. The aim was to excavate test pits at intervals of between 250m and 500m, depending on the variability of the geology, with some additional test pits at the proposed associated structures and at certain critical points (such as directly next to roads and streams, major changes in topography etc). The test-pits were excavated with a JCB 3CX TLB to refusal or 3m depth. The positions of the test-pits were recorded and coordinates are given in Table 6.1 and on each individual profile sheet. Test pits were logged to standard practice, the logs are provided in Appendix A and the logging parameters used are provided in Appendix B.

  Test pits along the alignment are numbered, with the prefix of each test pit number refering to the section in which the test-pit was excavated and then numbered generally from the south west to the north east. For example testpit AG6 was excavated in section

AG and is the 6th test pit from the start (south-west) of the section. The test pits at the proposed structures are however numbered in a separate fashion.

- Dynamic Cone Penetrometer (DCP) tests were conducted adjacent to or in selected test pits. DCP testing was only performed in the areas of the proposed structures. DCP results are plotted as “equivalent SPT-N” values on the profile sheets in Appendix A.
- Laboratory tests were undertaken on a variety of materials to confirm material properties and geotechnical characteristics of the soils encountered. Laboratory tests performed on samples obtained from the alignment of the pipeline included foundation indicator tests, chemical testing and some tests performed to determine the shear strength parameters of samples obtained in the vicinity of the proposed structures.
- Additional fieldwork was conducted on 6 May and comprised the excavation of 4 additional test-pits excavated with a 20 – ton excavator. Samples obtained from this additional testing were also scheduled for laboratory testing. The additional test pitting was conducted to establish soil conditions at depths greater than those achieved by the normal test-pitting and to determine the soils excavatability at the position of interest. The additional test-pitting was conducted in the vicinity of the proposed road crossings and in the areas where the development of other structures are planned. Generalised profiles are provided in Table 6.1, with full profiles provided in Appendix A. Test pits excavated with the 20ton excavator are indicted by having a suffix “X” within the test pit number.

6. TEST PIT PROFILES

The test pits were excavated to depths of up to 3m or refusal across the site with the JCB 3CX TLB. Additional test pits were excavated to depths of up to 5.8m.

The generalised profiles are as summarised in Table 6.1 hereunder. The detailed logs are provided in Appendix A and the profiling and logging parameters in Appendix B. The Google Earth images with the locations of the test pits and included in Appendix F.

Table 6.1: Summary of Trial Pits

Test Pit No.	Co-ordinates (WGS84 Lo27)		Observations	Comments
	X	Y		
DA01	3223275	69356	Loose to medium dense transported, silty sand overlying residual shale/mudrock.	Excavation terminated due to difficult excavation in soft rock shale at 2.65m.
DA02	322718	69875	Transported silty sand topsoil overlying calcified silty clay. Clay has slickensided structure, with scattered calcrete nodules.	Excavation terminated due to difficult excavation in highly calcified material at 2.3m.

Table 6.1: Summary of Trial Pits

Test Pit No.	Co-ordinates (WGS84 Lo27)		Observations	Comments
	X	Y		
DA03	3222632	69404	Transported silty sand topsoil overlying medium dense silty sand with occasional gravel. Alluvium. Slightly calcified.	Excavation terminated due to difficult excavation in soft rock shale at 2.8m.
DA04	3223364	67358	Alluvial silty sand (Bloemspruit).	Excavation terminated at maximum reach of TLB.
DA05	3222177	68522	Thin veneer of transported silty sand overlying slightly calcified sandy clay to 1.5m and medium dense silty sand.	Excavation terminated at maximum reach of TLB.
DA06	3221852	68159	Soft silty clay overlying calcified silty sand. Distinct change in colour in silty sand layer at 1.9m. Possibly some ferruginisation below 1.9m.	Excavation terminated at maximum reach of TLB.
DA07	3221669	67965	Thin veneer of transported silty sand overlying shale/mudrock at shallow depth.	Refusal on shale/mudrock at shallow depth. Not clear whether shale/mudrock is transported boulders from adjacent workings or actual bedrock.
DA07A	3221663	67941	Thin veneer of transported silty sand overlying shale/mudrock at shallow depth	Refusal on shale/mudrock at shallow depth. Not clear whether shale/mudrock is transported boulders from adjacent workings or actual bedrock.
DAX2	3221669	67938	Veneer of transported silty sand overlying soft rock shale in highly calcified sand matrix to 2.9m. Less calcified sand with depth. From 2.9m soft rock shale.	Excavation terminated at maximum reach of 20 ton excavator in soft rock shale at 5.8m.
DA07B	3222718	67932	Thin veneer of transported silty sand overlying soft rock shale at 0.5m. Residual shale is highly calcified.	Refusal on shale at 1.8m
DAX3	3221509	67966	Veneer of transported silty sand overlying soft rock shale in calcified sand matrix to 3.3m. Less calcified sand with depth. From 3.3m soft rock shale.	Excavation terminated at maximum reach of 20 ton excavator in soft rock shale at 5.7m.
DA08	3221506	67964	Light brown, transported silty sand overlying a layer that consists of soft rock shale and calcrete at 1.8m.	Excavation terminated at maximum reach of TLB.
DA09	3221390	67718	Soft to firm clay overlying a calcified sand layer to 1.8m and soft rock shale to 2.75m.	Excavation terminated due to difficult excavation in medium hard rock shale at 2.75m.
DA10	3221247	67365	Transported layer of silty sand and sandy silt overlying cemented to strongly cemented calcrete at from 1.1m.	Refusal on strongly cemented calcrete at 1.4m
DA11	3220970	66953	Transported sandy silt overlying cemented to strongly cemented calcrete to 2.7m, soft rock shale from 2.7.	Termination of excavation at maximum reach of TLB in soft rock shale.
DA12	3220873	66661	Transported layer of silty sand and sandy silt overlying cemented to strongly cemented calcrete from 0.6m.	Excavation terminated due to difficult excavation in strongly cemented calcrete at 2.2m.
DA13	3220652	66222	Alternating layers of sandy and clayey material overlying soft rock shale at 1.8m.	Refusal on shale at 2.85m.
DA14	3220534	66006	Clayey and silty sand. Loose material close to surface becoming dense at greater depth. Highly calcified between 0.95m and 1.35m. Scattered calcrete cobbles at greater depth. Residual Shale from 1.6m	Excavation terminated at maximum reach of TLB.

Table 6.1: Summary of Trial Pits

Test Pit No.	Co-ordinates (WGS84 Lo27)		Observations	Comments
	X	Y		
DA15	3220425	65787	Firm to stiff clay overlying calcified silty sand from 0.45m. Abundant sub-rounded calcrete nodules at 0.8m. Residual shale from 1.6m.	Excavation terminated at maximum reach of TLB in residual shale.
DA16	3220365	65639	Firm to stiff silty clay which is calcified from 0.6m. Completely weathered shale from 1.8m, with occasional gravel sized calcrete nodules.	Excavation terminated at maximum reach of TLB in residual shale.
A01	3220191	65348	Transported sand which is calcified from 0.7m overlying a calcified clay layer with a slickensided structure from 1.4m. Scattered calcrete gravel in calcified clay layer.	Excavation terminated at maximum reach of TLB.
A02	3220188	65235	Transported sand which is calcified from 0.6m overlying a calcified clay layer with a slickensided structure from 1.2m. Scattered calcrete gravel in calcified clay layer.	Excavation terminated at maximum reach of TLB.
AX1	3220193	65237	Transported sand which is calcified from 0.35m overlying a calcified clay layer with a slickensided structure from 1.4m. Scattered calcrete gravel in calcified clay layer. Less calcification with increasing depth.	Excavation terminated at maximum reach of 20-ton excavator at 5.6m. No seepage. No indication of bedrock.
A03	3220141	65170	Transported Aeolian sand underlain by rubble at 0.3m, overlying a calcified clay layer with a slickensided structure from 1.4m. Scattered calcrete gravel in calcified clay layer.	Excavation terminated at maximum reach of TLB.
A04	3220073	65173	Transported Aeolian silty sand, overlying a calcified clay layer with a slickensided structure from 0.2m. Scattered calcrete gravel in calcified clay layer.	Excavation terminated at maximum reach of TLB.
A05	3220083	65238	Transported Aeolian silty sand, overlying a calcified clay layer with a slickensided structure from 0.4m. Scattered calcrete gravel in calcified clay layer.	Excavation terminated at maximum reach of TLB.
A06	3220089	65311	Transported Aeolian silty sand, overlying a calcified clay layer with a slickensided structure from 0.7m. Scattered calcrete gravel in calcified clay layer to 2.5.	Excavation terminated at required depth.
A07	3219985	65355	Transported Aeolian silty sand, overlying a calcified clay layer with a slickensided structure from 0.8m. Scattered calcrete gravel in calcified clay layer	Excavation terminated at maximum reach of TLB.
A08	3219893	65493	Transported Aeolian silty sand, overlying a calcified clay layer with a slickensided structure from 0.5m. Scattered calcrete gravel in calcified clay layer	Excavation terminated at maximum reach of TLB.
A09	3219802	65659	Transported Aeolian silty sand, overlying a calcified clay layer with a slickensided structure from 0.8m. Scattered calcrete gravel in calcified clay layer	Excavation terminated at maximum reach of TLB.
AG01	3220294	65180	Transported Aeolian silty sand, overlying a calcified silty sand layer from 0.6m. Scattered calcrete gravel between 1.2m to 1.8m	Excavation terminated at maximum reach of TLB.
AG02	3220230	64737	Transported Aeolian silty sand, overlying a calcified silty sand layer from 0.45m.	Excavation terminated at maximum reach of TLB.

Table 6.1: Summary of Trial Pits

Test Pit No.	Co-ordinates (WGS84 Lo27)		Observations	Comments
	X	Y		
			Scattered calcrete gravel between 0.8m to 2.2m.	
AG03	3220163	64207	Soft to firm sandy clay overlying residual soft rock dolerite from 0.9m.	Refusal on medium hard rock dolerite at 1.5m.
AG04	3220102	63764	Transported silty sand underlain by residual very soft rock shale from 0.35m.	Refusal on soft rock shale at 1.4m.
AG05	3219900	63378	Dolerite outcrop on surface.	
AG06	3219789	63260	Transported silty sand underlain by residual very soft rock shale from 1.5m.	Refusal on soft rock shale at 2.8m.
AG07	3219445	62919	Soft to firm slightly calcified sandy clay overlying completely weathered silty sand residual shale from 1.5m. Intact structure present.	Termination of excavation in weathered shale at 2.6m.
AG08	3219117	62717	Soft to firm slightly calcified sandy clay overlying completely weathered silty sand residual shale from 1.2m. Residual shale is highly calcified.	Termination of excavation at required depth. (2.8m)
AG09	3218814	62354	Transported silty sand overlying very soft rock shale from 0.3m. Decreasing degree of weathering with increasing depth.	Termination of excavation due to difficult excavation in soft rock shale at 2.5m.
AG10	3218458	62085	Transported silty sand overlying very soft rock shale from 0.3m. Decreasing degree of weathering with increasing depth.	Refusal of excavation on medium hard rock shale at 0.5m.
AG11	3218161	61852	Soft to firm sandy clay overlying residual shale from 1.45m. Residual shale is completely weathered and breaks to an angular gravel in a sand matrix.	Refusal on soft rock shale at 2.4m.
AG12	3217827	61580	Soft to firm sandy clay overlying residual shale from 1.3m. Residual shale is completely weathered and breaks to an angular gravel in a sand matrix.	Refusal on soft rock shale at 2.3m.
AG13	3217672	61416	Soft to firm sandy clay overlying residual shale from 0.5m. Residual shale is completely weathered and breaks to an angular gravel in a sand matrix.	Termination of excavation due to difficult excavation in soft rock shale at 1.7m.
AG14	3217564	61314	Loose transported sandy silt, overlying calcified silty clay between 0.3m and 1.9m, very soft rock shale from 1.9m.	Refusal on soft rock shale at 2.9m.
AG15	3217289	61099	Loose transported sandy silt, overlying calcified silty clay between 0.4m and 2.6m, very soft rock shale from 2.6m. Soft rock shale highly calcified.	Refusal on hardpan calcrete at 2.9m.
AG16	3217103	60654	Loose transported sandy silt, overlying calcified silty clay between 0.4m and 1.3m, cemented to strongly cemented calcrete from 1.3m.	Termination of excavation at required depth.
AG17	3216729	60629	Medium dense to dense transported silty sand overlying very soft rock shale from 1.5m.	Termination of excavation in difficult excavation in soft rock shale at 2.8m.
AG18	3216352	60309	Loose to medium dense transported sandy silt overlying very soft rock shale from 0.5m.	Termination of excavation in difficult excavation in medium hard rock shale at 2.4m.

Table 6.1: Summary of Trial Pits

Test Pit No.	Co-ordinates (WGS84 Lo27)		Observations	Comments
	X	Y		
AG19	3216132	60126	Soft to firm calcified sandy clay overlying very soft rock to soft rock shale from 2m.	Termination of excavation in difficult excavation in medium hard rock shale at 2.4m.
AG20	3215965	59983	Soft to firm calcified sandy clay overlying very soft rock to soft rock shale from 1.5m.	Termination of excavation in difficult excavation in medium hard rock shale at 2.5m.
AG21	3215582	59661	Transported sandy silt to 0.6m overlying weakly cemented to cemented calcrete up to 2.1m, very soft rock shale to 2.8m.	Termination of excavation in difficult excavation in medium hard rock shale at 2.8m.
AG22	3215195	59333	Transported sandy silt to 1.2m overlying weakly cemented to cemented calcrete up to 1.4m, very soft rock shale to 2.5m	Termination of excavation in difficult excavation in medium hard rock shale at 2.5m.
AG23	3214827	59018	Thin veneer of transported silty sand overlying residual dolerite.	Refusal on medium hard rock dolerite at 1.2m
AG24	3214432	58706	Transported sandy silt to 1.3m overlying weakly cemented to cemented calcrete up to 1.6m, very soft rock shale to 2.7m	Termination of excavation in difficult excavation in medium hard rock shale at 2.7m.
AG25	3214350	58425	Transported silty sand overlying soft rock shale bedrock at shallow depth.	Refusal on soft rock shale at 0.4m.
AG26	3214418	57919	Transported sandy silt to 1.5m overlying weakly cemented to cemented calcrete up to 2.5m, very soft rock shale.	Termination of excavation at required depth.
AG27	3214567	57466	Loose to medium dense silty sand. Becoming denser with depth. Some calcification between 1.5m and 2m. Alluvium.	Termination of excavation at required depth.
GB01	3214661	57152	Loose to medium dense silty sand. Becoming denser with depth. Some calcification between 1.1m and 2.6m. Alluvium	Termination of excavation at maximum reach of TLB.
GB02	3214181	57252	Veneer of medium dense transported silty sand overlying residual dolerite. Dolerite breaks to cobbles and gravel in sand matrix.	Termination of excavation in difficult excavation in medium hard rock dolerite at 2.3m.
GB03	3213999	57258	Veneer of medium dense transported silty sand overlying residual dolerite. Dolerite breaks to cobbles and gravel in sand matrix.	Termination of excavation in difficult excavation in medium hard rock dolerite at 1.5m.
GB04	3213603	57371	Veneer of medium dense transported silty sand overlying residual dolerite at 0.5m. Dolerite breaks to cobbles and gravel in sand matrix.	Termination of excavation in difficult excavation in medium hard rock dolerite at 2.8m.
GB05	3213418	57459	Veneer of medium dense transported silty sand overlying residual dolerite at 0.55m. Dolerite breaks to cobbles and gravel in sand matrix.	Termination of excavation in difficult excavation in medium hard rock dolerite at 2.15m.
GF01	3214661	57152	Veneer of loose transported silty sand overlying medium dense to dense clayey sand. Slightly calcified with scattered calcrete nodules. Slickensided structure.	Termination of excavation at required depth.
GF02	3214831	56664	Veneer of loose transported silty sand overlying firm to stiff silty clay. Slightly calcified with scattered calcrete nodules. Slickensided structure.	Termination of excavation at required depth.
GF03	3214927	56150	Medium dense silty sand overlying shale boulders and cobbles at shallow depth.	Refusal on shale boulders and cobbles at 0.3m.

Table 6.1: Summary of Trial Pits

Test Pit No.	Co-ordinates (WGS84 Lo27)		Observations	Comments
	X	Y		
GF03A	3214927	56128	Veneer of loose transported silty sand overlying firm to stiff silty clay. Slightly calcified with scattered calcrete nodules. Slickensided structure.	Refusal on shale boulders and cobbles at 2.3m.
GF04	3214983	55733	Veneer of loose transported silty sand overlying firm to stiff silty clay. Slightly calcified with abundant calcrete nodules. Slickensided structure.	Termination of excavation at required depth (2.7m).
GF05	3215107	55297	Veneer of loose transported silty sand overlying firm to stiff slightly calcified silty clay to 1.05m, loose to dense clayey sand (increasing density with depth) to 2.9m.	Termination of excavation at required depth (2.9m).
GF06	3215197	54780	Veneer of loose transported silty sand overlying firm to stiff slightly calcified silty clay to 1.4m, loose to dense clayey sand (increasing density with depth) to 2.65m.	Termination of excavation at required depth (2.65m).
GF07	3215084	54290	Veneer of loose transported silty sand overlying loose to dense clayey sand (increasing density with depth) to 2.9m.	Termination of excavation at required depth (2.9m).
GF08	3214952	53788	Veneer of loose transported silty sand overlying loose to dense silty sand (increasing density with depth) to 3.1m.	Termination of excavation at required depth (3.1m).
FC01	3214920	53415	Veneer of loose transported silty sand overlying firm stiff slightly calcified silty clay to 1.6m, loose to dense silty sand (increasing density with depth) to 2.95m.	Termination of excavation at required depth (2.95m).
FC02	3215023	53122	Veneer of loose transported silty sand overlying firm to stiff slightly calcified silty clay to 1.3m, loose to dense silty sand (increasing density with depth) to 2.75m.	Termination of excavation at required depth (2.75m).
FC03	3215250	52959	Veneer of loose transported silty sand overlying firm to stiff highly calcified silty clay to 1.2m, loose to dense silty sand (increasing density with depth) to 2.9m.	Termination of excavation at required depth (2.9m).
FC04	3215647	52792	Veneer of loose transported silty sand overlying firm to stiff highly calcified silty clay to 1.2m, loose to dense silty sand (increasing density with depth) to 3.1m.	Termination of excavation at required depth (3.1m).
CXO	3215647	52800	Veneer of loose transported silty sand overlying firm to stiff calcified silty clay to 1.05m, loose to dense silty sand (increasing density with depth) to 5.7m.	Termination of excavation at maximum reach of 20 ton excavator at 5.7m depth.
FE01	3214771	53104	Veneer of loose transported silty sand overlying firm to stiff slightly calcified silty clay to 1.3m, loose to dense silty sand (increasing density with depth) to 2.9m.	Termination of excavation at required depth (2.9m).
C-Dam	3215569	52689	Veneer of loose transported silty sand overlying firm to stiff slightly calcified silty clay to 1.05m, loose to dense silty sand (increasing density with depth) to 2.95m.	Termination of excavation at required depth (2.9m).
E-Dam	3214993	52665	Veneer of loose transported silty sand overlying firm to stiff slightly calcified silty clay to 1.1m, loose to dense silty sand (increasing density with depth) to 3.1m.	Termination of excavation at required depth (3.1m).

7. LABORATORY TEST RESULTS

Laboratory tests were scheduled to confirm the on-site investigation and establish engineering parameters for the soils. Tests were undertaken by two different SANAS accredited laboratories; Soillab (Pty) Ltd in Pretoria and Simlab (Pty) Ltd in Bloemfontein. The various tests and pertinent information from these tests are highlighted below and the detailed test results are included as Appendix C. Tests undertaken include:

- 37 Foundation Indicator tests (including full grading).
- 15 pH and Conductivity tests.
- 9 Chloride and Sulphate Content tests
- 2 Consolidated Undrained Triaxial tests
- 1 Shearbox test
- 5 Maximum dry density and optimum moisture content tests

Particle size analyses (full grading) and indicator tests were undertaken on representative samples of the materials on site are summarised in Table 7.1 below. “Source” mentioned in Table 7.1 refers to the types of material that were encountered, a description of these are provided in Section 8.1.1.

Table 7.1: Foundation Indicator Results

Position	Depth of sample (m)	Material Type	Source	GM	Clay %	Silt & Sand%	Gravel %	PI	LL	Expansiveness classification*
DA01	1.4	Clayey SAND	Residual Shale	0.49	25	72	3	11	34	Low
DA05	2	Silty SAND	Transported	0.71	15	80	5	16	31	Medium
DA06	1.1	Silty SAND	Calcified	0.48	18	82	0	18	36	Medium
DAX1	1.8	Silty SAND	Transported	0.54	26	66	8	27	55	High
DAX1	3.4	Clayey SAND	SAND	0.47	31	67	2	16	42	Medium
DAX2	1.2	Gravelly SAND	Residual Shale	1.58	4	64	32	10	33	Low
DAX3	1.5	Sandy GRAVEL	Residual Shale	1.61	10	48	42	16	34	Low
DA07B	1.4	Sandy SILT	Residual Shale	0.53	21	71	8	25	45	Medium
DA11	1.3	Gravelly SAND	Calcified	1.37	10	64	26	16	31	Low
DA13	1.2	Silty SAND	Calcrete	0.7	18	76	6	24	46	Medium
DA13	2.2	Gravelly SAND	Residual Shale	1.21	14	60	26	16	38	Low
A01	2.4	Clayey SAND	Calcified	0.5	25	75	2	12	38	Low
AX1	3.2	Silty SAND	Calcified	0.65	18	74	8	12	28	Low

Table 7.1: Foundation Indicator Results

Position	Depth of sample (m)	Material Type	Source	GM	Clay %	Silt & Sand%	Gravel %	PI	LL	Expansiveness classification*
A02	2.9	Clayey SAND	Calcified	0.52	16	70	14	8	30	Low
A04	1.1	Sandy GRAVEL	Residual Shale	1.25	19	49	32	16	36	Low
A05	1.8	Sandy CLAY	Calcified	0.33	29	70	1	18	35	Medium
A05	2.6	Clayey SAND	Calcified	0.49	17	80	3	18	40	Medium
A06	1.3	Clayey SAND	Residual Shale	0.59	21	76	3	6	26	Low
A08	1.8	Sandy CLAY	Calcified	0.29	35	62	3	19	43	Medium
AG01	2.4	Clayey SAND	Calcified	0.62	30	63	7	16	38	Low
AG06	1.1	Clayey SAND	Transported	0.27	30	70	0	13	42	Low
AG06	2.3	Clayey SAND	Residual Shale	1.33	9	71	20	14	33	Low
AG08	1.4	Sandy CLAY	Calcified	0.34	39	60	1	33	56	High
AG12	2.1	Clayey SILT	Residual Shale	0.23	28	72	0	17	32	Medium
AG15	2.1	Clayey SAND	Calcified	0.63	29	61	10	19	40	Medium
AG17	1.2	Sandy CLAY	Calcified	0.4	38	62	0	23	47	Medium
AG17	2.6	Clayey SAND	Residual Shale	0.38	18	79	3	16	38	Medium
AG19	1.2	Clayey SAND	Calcified	0.42	27	72	1	15	38	Medium
AG23	1.2	SAND	Residual Dolerite	1.28	6	84	10	14	30	Low
GB04	1.8	Gravelly SAND	Residual Dolerite	1.61	0	74	26	NP	-	Low
GB06	1.7	Gravelly SAND	Residual Dolerite	1.56	1	67	32	7	26	Low
GF01	1.8	Silty SAND	Calcified	0.49	26	69	4	20	36	Medium
GF04	1.8	Silty CLAY	Calcified	0.23	45	54	1	25	51	Medium
GF08	1.9	Silty SAND	Sand	0.44	12	88	0	11	23	Low
FC03	1.8	Silty SAND	Sand	0.44	20	80	0	11	27	Low
E-Dam	2.6	Silty SAND	Sand	0.61	4	96	0	SP	-	Low
CXO	2.9	Sandy SILT	Sand	0.46	23	76	1	18	31	Medium

*- Reported as AX0 on laboratory results

pH, conductivity and other chemical tests were performed on several samples and the results are summarised in Table 7.2.

Table 7.2: pH and Conductivity & Chemical Testing Results

Test Pit No	Depth of Sample (m)	pH	Conductivity (S/m)	Cl Content %	Soluble SO_3 (%)
DA06	1.1	8.06	0.0453	0.0064	0.0096
DAX1	1.8	8.73	0.5349	-	-
DAX1	3.4	8.65	0.3209	-	-
DAX2	1.2	8.19	0.2529	-	-
DAX3	1.5	8.5	0.2626	-	-
DA13	1.2	8.09	0.0947	0.0035	0.0151
AX1*	3.2	8.37	0.3598	-	-
AG08	1.4	8.19	0.308	0.0376	0.0405
AG12	2	8.49	0.196	0.0177	0.0079
GB06	1.7	8.44	0.0466	0.0039	0.0057
GF04	1.8	7.88	0.35	0.0401	0.0335
GF08	1.9	7.86	0.345	0.0383	0.0441
FC03	1.8	8.04	0.0854	0.0145	0.0113
E-Dam	2.6	8.43	0.0882	0.0131	0.0099
CXO	2.9	8.33	0.2820	-	-

*- Reported as AX0 on laboratory results

Shear strength parameters of representative samples were obtained by 2 consolidated undrained triaxial tests and one drained shearbox test. Strength parameter tests were performed on samples obtained in the vicinity of where the proposed structures are to be placed.

A summary of the shear strength parameters are provided in Table 7.3.

Table 7.3: Shear Strength Parameter Determination (Consolidated Undrained Triaxial and Drained Shearbox Results)

Test Pit No	Depth of Sample (m)	Test	Remoulded Density (kg/m^3)	Remoulded Moisture (%)	ϕ' (º)	c' (kPa)
AG01	2.4	CU Triaxial	1600	12.2	24.6	8.8
E-Dam	2.6	CU Triaxial	1430	10.6	31.3	0
FC03	1.8	Shearbox	1465	9	31.4	3.9

Maximum dry density (Mod AASHTO) and optimum moisture content tests were performed on 5 samples. The aim was to perform at least one maximum dry density and optimum moisture content test on each of the types of material.

* - Reported as AX0 on laboratory results

Table 7.4: Maximum dry density and optimum moisture content tests

Position	Depth of sample (m)	Material Type	Source	Maximum Dry Density (kg/m³)	Optimum Moisture Content (%)
DAX1	1.8	Silty SAND	Transported	1750	15.7
DAX1	3.4	Clayey SAND	SAND	1690	5.6
DAX3	1.5	Sandy GRAVEL	Residual Shale	1931	10.1
AX1*	3.2	Silty SAND	Calcified	1862	8.6
CXO	2.9	Sandy SILT	Sand	1820	7.1

8. GEOTECHNICAL EVALUATION

8.1 Ground Conditions

Profiles obtained from test pitting generally correspond well with the geologic map and anticipated conditions for the area.

8.1.1 Types of material encountered

From test pit profiles and laboratory test results, broadly speaking, 6 types of materials were identified. Appendix D provides the Potential Expansiveness Graphs for each type of material.

- Transported Soil

  Clay, silt and sand of transported origin were encountered across the site. Alluvial deposits were encountered close to the river streams and in tributaries, while Aeolian and colluvium deposits were encountered in different areas across the site. Various colours are encountered.

  Very little emphasis was placed on testing the transported soil, owing to the fact that the transported deposits are generally just a thin veneer of material and will be removed prior to construction.

- Calcified, sandy clay and clayey sand (Referred to as “Calcified” in Table 7.1)

  Represents the sandy clay and clayey sand underlying the transported material across most of the site. Varying degrees of calcification were encountered and in a few areas calcification was absent. (Due to the fact that the horizon is mostly calcified and for ease

of explanation the horizon is referred to as “calcified”) A slickensided structure is often encountered within this material, especially where clay particles are abundant. Scattered to abundant areas of subrounded calcrete gravel were also encountered in some test pits. The material in this layer is generally dark brown to black, with most of the areas speckled and/or blotched white due to the calcification. The calcrete gravel is white in colour.

Laboratory testing generally indicates the material from this area to have a fairly low GM and is classified as being “medium” expansive according to van der Merwe’s expansiveness classification.

One consolidated undrained triaxial was performed on material obtained from this layer. Shear strength parameters of φ’ = 24.6^0 and c’ = 8.8 kPa were obtained. The values obtained correspond well with typical parameters for this soil type obtained from literature and can be used for the foundation design of the proposed structures in the Renosterspruit Area.

Laboratory results indicated the calcified material to have an average pH of 8.11, resistivity of 540 Ohm/m, Cl content of 0.0218% and a soluble SO_3 content of 0.0093%.

- Dolerite

  The residual dolerite soil that was encountered, was encountered almost exclusively in the north western area of the development, particularly along section GB and is associated with the small dolerite hill in the area. The dolerite typically weathers to a reddish sandy gravel, although light brown material was also encountered. “Onion skin” cobbles were encountered in the area close to the hill. The depth of the soil profile (to bedrock) generally increases in depth towards the lower lying areas down the hill.

  Laboratory results indicate the residual dolerite to be a gravelly sand with a very low PI, rendering it to be classified as “low” in terms of its expansiveness classification.

  Due to the limited occurrence of dolerite only one dolerite sample was submitted for chemical testing. Laboratory results indicate the dolerite to have a pH of 8.44, resistivity of 2146 Ohm/m, Cl content of 0.0039% and a soluble SO_3 content of 0.0058%.

- Calcrete

  Cemented to strongly cemented calcrete was encountered in some test pits. Generally the calcrete layer comprised subrounded cobble and gravel sized fragments of calcrete within a sandy material matrix. Although refusal occurred on hardpan calcrete in a couple of test pits, it is believed that this calcrete will be excavatable with a larger excavator (i.e a 20 ton excavator).

Due to the limited occurrence of calcrete, a very limited amount of laboratory testing was conducted on this type of material. The only foundation indicator test performed on a calcrete sample indicated a fairly high GM, but with a PI of 24 and hence was classified as having "medium" expansiveness according to van der Merwe's expansiveness classification.

Laboratory results indicated the calcrete to have a pH of 8.09, resistivity of 1056 Ohm/m, Cl content of 0.0035% and a soluble SO_3 content of 0.0151%.

- Residual Shale (Includes very soft rock shale and soft rock shale)

  As described the area is mostly underlain by shale. Soft rock shale was encountered in most of the test pits. The colour of the residual shale varies between orange, grey, light brown, olive and in some cases purple. A significant amount of the residual shale has been calcified. The residual shale generally breaks to angular to subrounded gravel and cobbles within a soil matrix. The GM of the residual shale varies significantly due to varying degrees of states of weathering of samples obtained. Laboratory results indicate the residual shale to have a PI of between 15 and 20, with only a few outliers. Depending on the variance in grading of samples obtained, the material is classified as "low" to "medium" expansive.

  Laboratory results indicated the residual shale to have an average pH of 8.24, resistivity of 429 Ohm/m, Cl content of 0.0177% and a soluble SO_3 content of 0.0079%.

- Sand

  This specifically refers to the light brownish orange sand encountered in the north eastern corner of the pipeline and the same/similar type of material surrounding Mockes dam. The material generally underlies the "Calcified" layer in areas where shale and dolerite bedrock is absent. Pedogenesis is not common in the material encountered and the material generally classifies as medium dense to dense, although in certain areas (particularly close to Mockes Dam) it is classified as loose.

  Laboratory testing indicates the material to be a silty sand with a fairly low GM and a low PI, rendering it to be classified as "low" in terms of the potential expansiveness classification.

  Consolidated undrained triaxial testing indicate the soil to have a friction angle of about 31^0 with a very low cohesion. Even though testing indicates a fairly high friction angle, one must be cognisant of the loose material encountered in the vicinity of the Mockes dam and that excessive differential settlement might occur when structures are placed on this material.

Laboratory results indicated the sand horizon to have an average pH of 8.26, resistivity of 652 Ohm/m, Cl content of 0.022% and a soluble SO_3 content of 0.0218%.

8.1.2 Summary of ground conditions for each section or area

Geological longitudal sections were drawn across each section and area described in Section 2 of this report. The sections are provided as drawings in Appendix E to this report. The locations of the test pits for each section are provided in Appendix F.

As indicated on the geological map, the site is generally underlain by shale, with the occurrence of dolerite in isolated areas and along section GB. Calcified soils are commonly encountered throughout the area, but as described above varies in host material soil type, consistency and the degree of calcification. Deep soil horizons are encountered in the north-eastern part of the site, particularly in the area close to the Mockes Dam.

- Section DA (Drawing No DA in Appendix E)

  Owing to the variance in topography along Section DA there is a significant variance in the geological conditions along the section. The site is generally underlain by transported material of various origins overlying the calcified layer. The residual shale bedrock is encountered mainly between DA07 and DA11, where refusal of the TLB was encountered at DA07 and DA07A. Alluvial deposits were encountered in the Bloemspruit area.

- Renosterspruit Area (Drawing No RA in Appendix E)

  Conditions were found to be very consistent in the Renosterspruit area. The transported material overlies the calcified layer. AX1 was excavated by a larger excavator and indicated that the calcified layer extends to at least 5.6m depth.

- Section AG (Drawing No AG in Appendix E)

  The geological conditions over AG varies slightly, but section AG is generally underlain by very soft rock to soft rock shale. Scattered areas of calcified material overlying the shale was encountered along the section. Refusal on the shale was uncommon but was observed in a few test pits.

- Section GB (Drawing No GB in Appendix E)

  The section is characterised by a veneer of transported material overlying residual dolerite and dolerite bedrock. All but 1 of test pits along this section refused on the medium hard rock dolerite.

- Section GF (Drawing No GB)

The section is divided into 2 parts. GF1 to GF4 indicated a typical profile that was observed in the Renosterspruit area (transported soil overlying the calcified layer). From GF5 to GF8 the orange brown sand layer is encountered to depths greater than the reach of the TLB.

- Mockes Dam area (Drawing No FC)

  Conditions along section FC and the Mockes Dam area are consistent. A thin veneer of transported material overlies the calcified layer. The calcified material overlies the orange brown sand layer. At CX0 the test pit was excavated up to a depth of 5.7m without any sign of bedrock.

8.2 Excavatability

With the exception of the dolerite along section GB and a few isolated test-pits, which refused at shallow depth on shale and highly calcified material/calcrete, all areas will classify as “soft” according to the SABS 1200 D Earthworks classification or as “Soft class 2” (materials which can readily excavated with the aid of a pick) according to Department of Works, (Watermeyer, 1997).

Where the proposed pipeline crosses the N8, highly calcified material is underlain by soft rock shale. The soft rock shale was excavated with a 20ton excavator to more than 5.5m depth without any difficulty (DAX2 & DAX3). Test pits excavated during the original investigation with a TLB refused on the soft rock shale encountered to the south of the N8 at fairly shallow depth (DA07, DA07A & DA07B). It was however established that the shale is excavatable with a larger excavator. Diagram F7 in Appendix F indicates the test pits that were excavated in this area.

Where the proposed pipeline crosses the Bloemfontein – Maselspoort road the area is underlain by the calcified layer and residual shale. None of the test-pits excavated in this area (A02, AX1 & AG1) indicated refusal. Test pit AX1 was excavated to 5.6m without encountering bedrock. Diagram F8 in Appendix F indicates the test pits that were excavated in this area.

Pipe-jacking will be suitable at both crossings. It is important that all works should adhere to the SANS 2001-DP8 specification. Most of the crossings occur in areas of shale and no problems are anticipated. However it must be accepted that this investigation was normally limited to 2 or 3 test pits adjacent to the crossings and no test pits were excavated in the centre of the roads to confirm the consistency of the profile over the crossing.

Refusal did occur at some places especially in the areas where dolerite was encountered. Larger excavators might be sufficient to excavate some of these areas; in some places blasting might however be required.

8.3 Stability of Trenches

The side walls of the trial pits remained stable during the investigations. In general, and where such trenches are dry and not below the water table, excavations to 1.2m depth can be excavated vertically. Excavations deeper than this will need to be shored or battered. It must however be noted that the trial pits excavated during the geotechnical investigation will give an optimistic indication of the stability of long trench excavations. It remains the responsibility of the contractor and engineer on site to ensure that excavations are safe.

8.4 Groundwater

Groundwater was not encountered on this site with the prevailing permanent water table anticipated at depth. Perched water tables can form particularly on the contact between the granular soils and underlying clayey soils and rock after periods of heavy or continuous rain.

8.5 Chemical Testing

pH testing conducted indicated the soil throughout the site to be slightly basic and the conductivity tests show the soils to be corrosive towards buried steel. It is however understood that a GRP-material is to be used for the pipeline. The fabric of the GRP material is not susceptible to corrosion, thus the pipeline itself will not be influenced by the soil's corrosivity. Precautions may however be required in the areas where structures are to be placed.

A cross section indicating the corrosivity of the material encountered along the route is not provided. This is due to the fact that the corrosivity is material dependant and a summary of the corrosivity of each material has already been provided.

8.6 Bedding Material

SANS 1200 Section LB (SABS 1200) has been used for the evaluation of potentially suitable material for pipe bedding and cradle. The criteria are as follows:

SABS Criteria: Grading Max % retained on 37.5mm = 0%
Max % retained on 19mm = 5%
Min % retained on 0.425mm = 95%

Compactability Factor (CF)	
<0.1	suitable for bedding
0.1 – 0.4	suitable for bedding (extra care with compaction for flexible pipes and saturated conditions)
>0.4	unsuitable

All the tested material failed the grading requirements. An additional sample was obtained from an old unused-quarry in the area. Although this material had a CF of 0.38, the material

also failed the grading requirement and is thus also not suitable. The laboratory result can be found in Appendix G.

Using material obtained from the dolerite hill in the north western corner might be considered. Amongst other potential problems using this material, a full EIA will however be required and it is thought that this alone will render this option unfeasible.

Pipe bedding and cradle material will thus have to be imported. Existing commercial sources have been identified in the vicinity of the pipeline. The owners of the closest source was consulted and although they do not have a material readily available that passes the grading requirements, they might be able to assist once quantities are known. Philip Venter at Galactic Sand can be contacted on 0724144118 once quantities are known.

Laboratory testing results on the samples tested specifically for the use of identifying suitable bedding material are attached in Appendix G.

8.7 Structures

The exact location, type and size of structures are not known. The only information provided was that there will be a pump station constructed close to Renosterspruit and several structures in the Mockes dam area.

Renosterspruit Area: The area is characterised by a layer of +- 0.5m to 1m of transported soil underlain by calcified silty clay. The allowable bearing pressure on the calcified layer is 50kPa. Bedrock was not encountered in any of the test pits in the area. Should higher pressures be required more sophisticated founding solutions will need to be investigated. The design of such foundations will most likely require further investigative work. Detail as to the exact location, type and nature of the development will be required.

Mockes Dam Area: Although conditions vary slightly across the area. The area is generally underlain by a layer of transported soil, and in places calcified material, by a loose to medium dense silty sand. Although a fairly high friction angle was obtained from laboratory testing, the material is believed to be highly compressible. Depending on the size and nature of the development, further investigation may be required for any loads exceeding 100kPa.

8.8 Stiffness moduli

Although not part of the original scope the client requested that stiffness parameters for the soils encountered be calculated from laboratory results. This request was however only submitted on the 2nd of June 2015. Subsequently a short report was provided to the client, where stiffness parameters were calculated from the consolidation stage of the consolidated undrained triaxial tests. The letter is provided as Appendix H.

9. GENERAL

In summary the investigation revealed the following:

- Soil conditions are generally favourable for the development of the proposed pipeline. No clays indicating severely expansive behaviour were encountered below 1.5m. No collapsible sands were encountered, although the sand in the Mockes Dam area is very loose and most probably highly compressible.
- Soil conditions in the Renosterspruit area and Mockes Dam area are not favourable for the development of large structures. Further investigation might be required depending on the size and the type of the structures.
- Laboratory tests show >85% of the soil to be finer than 0.425mm in each of the samples and this is too fine for use as bedding material. These materials can however be used as general fill over the pipeline. Bedding material will have to be imported to site. The closest possible source have been identified and the information included in this report.
- Apart from the dolerite encountered along section GB, laboratory results indicate the material across site to be corrosive towards steel. Although the pipeline is to be constructed of GRP material, the soils' corrosivity will need to be considered in the areas where structures are to be placed and precautions are required.
- In some instances, refusal of the TLB occurred at shallower than 3m (often on shale bedrock, but also on dolerite and highly calcified material/calcrete). It is believed that the shale and calcified material/calcrete will be excavatable with a larger excavator. Blasting might be required where dolerite is encountered at shallow depths. Apart from section GB, dolerite outcrop and dolerite at shallow depth is encountered at less than 5% of the route.
- Difficult excavation conditions are anticipated at stream crossings and low lying areas. Shoring of excavation trenches deeper than 1.2m will be required and allowance made for dewatering of excavations. Elsewhere conventional construction, with shoring or battering of excavations deeper than 1.5m is expected over most of the route.
- Streams and seasonal flooding of tributary areas will cause the bedding and cradle material to be washed away and thus causing problems with the structural support. Due to the flexible nature of the pipe, it is recommended that the pipeline be enclosed in concrete and properly supported across the span of these areas.

It is important to note that SMEC were appointed to undertake an investigation of the site and report on the geotechnical conditions encountered. We have provided generalised

recommendations on feasible foundation options. However, the feasibility and appropriateness of the recommendations contained herein must be considered by the design engineers as they apply to the actual design and proposed infrastructure.

We trust that this report will be found to be complete and adequate for your consideration. Should further elaboration be required for any portion of this project, we would be pleased to provide assistance.

Respectfully submitted,

SMEC South Africa (Pty) Ltd

Appendix A

Trial Pit Profiles

TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA01
X COORD: 3 223 275
Y COORD: Lo27 69 356
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose to medium dense, silty SAND with clay Slightly moist, light brown, transported, slightly calcified.	
0.5	0.60		
		Soft rock, SHALE/MUD ROCK Dark brown, becoming light greyish to olive, stained white, moderately weathered, calcified at shallow depth, less weathering with depth. Breaks to 35mm avg, angular to subrounded gravel. Gravel matrix supported in clayey sand soil matrix.	
1.0			
1.5			
2.0			
2.5	2.65		
		Termination in difficult excavation in mud/shale rock	
		End of Log	
3.0			

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I testing at 1.4m.
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA02
X COORD: 3 222 718
Y COORD: Lo27 69 875
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND with clay** Slightly moist, light brown, transported, slightly calcified.	
	0.40		
0.5		**Soft silty CLAY and occasional sand** Slightly moist, dark brown, speckled white, slickensided structure, calcified. Calcification increasing with depth.	
1.0			
1.5			
2.0			
	2.30		
		Termination in difficult excavation in highly calcified material	
2.5		End of Log	
3.0			

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA03
X COORD: 3 222 632
Y COORD: Lo27 69 404
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
		0.00	Ground Surface	
0.0			**Loose to medium dense, silty SAND with clay** Slightly moist, light brown, transported, slightly calcified.	
		0.40		
0.5			**Medium dense, silty SAND and occasional gravel** Slightly moist, yellowish orange, stained white. Abundant angular shale gravel at 2.5m, slight calcified.	
1.0				
1.5				
2.0				
2.5				
		2.80		
			Excavation terminated in difficult excavation on soft rock SHALE	
3.0			End of Log	

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
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Template: SMEC TP04

TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA04
X COORD: 3 223 364
Y COORD: Lo27 67 358
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			Loose to medium dense, silty SAND Slightly moist, light brown, transported. Alluvium. Scattered areas of calcification from 2.2m	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0		3.10		
			Excavation terminated at maximum reach of TLB	
			End of Log	
3.5				

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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Template: SMEC TP04

TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA05
X COORD: 3 222 177
Y COORD: Lo27 68 522
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Slightly moist, light brown, transported. Alluvium. Scattered areas of calcification from 2.2m	
	0.35		
0.5		**Soft to firm, slightly sandy CLAY** Slightly moist, dark brown to black, slightly calcified at 1.3-1.5m.	
1.0			
	1.50		
1.5		**Medium dense, silty SAND** Moist, orange and black with mottled areas of grey material, possibly slightly ferriginised.	
2.0			
2.5			
3.0			
	3.10	**Excavation terminated at maximum reach of TLB**	
		End of Log	
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
CHECKED BY:
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA06
X COORD: 3 221 852
Y COORD: Lo27 68 159
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00 Ground Surface	
0.0	**Soft to firm, silty sandy CLAY** Slightly moist, dark brown to black.	
0.5		
	0.70	
	Medium dense, silty SAND Moist, greyish black, blotched white. Abundant calcificaton.	
1.0		
1.5		
	1.90	
	Medium dense, silty SAND Moist to very moist, grey and light reddish brown, mottled black and orange. Possibly slighty ferruginised.	
2.0		
2.5		
	2.90	
	Termination at maximum reach of TLB	
3.0	End of Log	
3.5		

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I and chemical testing at 1.1m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
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Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA07
X COORD: 3 221 669
Y COORD: Lo27 67 965
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
		0.20	**Loose to medium dense, silty SAND** Slightly moist, reddish brown, transported.	
			Refusal on SHALE/ MUD ROCK boulders	
			End of Log	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				
3.5				

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA07A
X COORD: 3 221 663
Y COORD: Lo27 67 941
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
		0.10	**Loose to medium dense, silty SAND** Slightly moist, reddish brown, transported.	
			Refusal on SHALE/ MUD ROCK boulders	
			End of Log	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				
3.5				

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:

DATE PROFILED: 07/04/2015
PROFILED BY: T.G
CHECKED BY:

Prof Reg:
Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA07B
X COORD: 3 222 718
Y COORD: Lo27 67 932
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00 Ground Surface	
	Loose to medium dense, silty SAND Slightly moist, reddish brown, transported.	
0.5	0.50	
	Very soft rock, SHALE/MUDROCK Light brownish olive. Breaks to sub-rounded mudrock gravel, moderately to completely weathered. Less weathering with depth, slightly calcified. Mudrock within sandy silt soil matrix.	
1.0		
1.5	1.80	
	Refusal on SHALE/ MUD ROCK	
	End of Log	
2.0		
2.5		
3.0		
3.5		

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I at 1.4m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA08
X COORD: 3 221 506
Y COORD: Lo27 67 964
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00 Ground Surface	
	Loose to medium dense, clayey, silty SAND Slightly moist, light brown, transported, some calcification.	
1.80	**Very soft rock, SHALE** Abundant areas of calcrete	
2.95	**Excavation terminated at maximum reach of TLB**	
	End of Log	

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA09
X COORD: 3 221 390
Y COORD: Lo27 67 718
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Soft to firm , silty Clay** Slighty moist, brownish black, transported.	
	0.30		
0.5		**Loose to medium dense, silty SAND** Slightly moist, light reddish brown. Abundant areas of calcified shale.	
1.0			
1.5			
	1.80		
2.0		**Very soft to soft rock, SHALE** Light brownish olive, less calcification with depth. Breaks to angular to subrounded pieces of gravel.	
2.5			
	2.75		
		Terminaton in difficult excavation in medium hard rock, SHALE	
3.0		End of Log	
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
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Prof Reg:
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA10
X COORD: 3 221 247
Y COORD: Lo27 67 365
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, sandy SILT** Slightly moist, reddish brown , transported.	
	0.45		
0.5		**Loose to medium dense, silty SAND** Slightly moist, light reddish brown. Abundant areas of calcified shale.	
1.0			
	1.10		
		Cemented to strongly cemented, Calcrete Slightly moist, cemented to strongly cemented calcrete, breaks to agglomeration of 90mm avg, sub-rounded, some weathered shale visible. Some angular greyish olive shale visible.	
	1.40		
1.5		**Refusal on strongly cemented calcrete**	
		End of Log	
2.0			
2.5			
3.0			
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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Template: SMEC TP04

TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA11
X COORD: 3 220 970
Y COORD: Lo27 66 953
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, sandy SILT** Slightly moist, reddish brown , transported.	
0.5			
1.0			
1.5	1.50	**Cemented to strongly cemented, Calcrete** Slightly moist, cemented to strongly cemented calcrete, breaks to agglomeration of 90mm avg, sub-rounded, some weathered shale visible. Light browninsh colour at 1.5-1.8m.	
2.0			
2.5	2.70	**Soft to very soft rock, SHALE** Light yellow, speckled white, mottled grey, slightly calcified.	
3.0	3.10	**Termination at maximum TLB reach**	
		End of Log	
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
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Prof Reg:
Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA12
X COORD: 3 220 873
Y COORD: Lo27 66 661
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			Loose to medium dense, silty SAND Slightly moist, red brown, transported. Roots to 0.5m.	
0.5		0.60		
			Cemented to strongly cemented CALCRETE Slightly moist, cemented to strongly cemented calcrete, breaks to agglomerations of 90mm avg, subrounded, some weathered shale visible.	
1.0				
1.5				
2.0		2.20		
			Termination in difficult excavation in CALCRETE	
			End of Log	
2.5				
3.0				
3.5				

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA13
X COORD: 3 220 652
Y COORD: Lo27 66 222
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, clayey SAND wih silt** Slightly moist, blackish brownish.	
0.5	0.50	**Medium dense, silty SAND with some gravel** Slightly moist, light brown, transported. highly calcified at greater depth.	
1.0	1.20		
1.5		**Firm to stiff, sandy CLAY** Slightly moist, dark brown, abundant calcrete nodules nodules avg 45mm.	
	1.80		
2.0		**Very soft rock, SHALE** Greyish olive, breaks into angular gravel	
2.5	2.85		
		Refusal in very soft rock, SHALE	
3.0		End of Log	
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I and chemical testing at 1.2m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA14
X COORD: 3 220 534
Y COORD: Lo27 66 006
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, clayey SAND wih silt** Slightly moist, blackish brownish.	
0.5			
	0.95		
1.0		**Loose to medium dense, silty SAND** Slightly moist, light brown, transporte. highly calcified between 0.95 and 1.35m.	
1.5			
	1.60		
		Medium dense to dense, silty SAND Slightly moist, blotched reddish black, residual. Scattered calcrete cobbles.	
2.0			
2.5			
3.0			
	3.10		
		Termination at required depth	
		End of Log	
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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Template: SMEC TP04

TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA15
X COORD: 3 220 425
Y COORD: Lo27 65 787
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Firm to stiff, slity CLAY** Slightly moist, black, spekled, stained white, highly calcified scattered boulders.	
	0.45		
0.5		**Loose to medium dense, silty SAND** Slightly moist, light brown, transporte. Abundant calcrete nodules around 0.8m.	
1.0			
1.5			
	1.60		
		Medium dense to dense, silty SAND Slightly moist, blotched black, residual. Scattered calcrete cobbles.	
2.0			
2.5			
	2.90		
3.0		**Termination at required depth**	
		End of Log	
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DA16
X COORD: 3 220 365
Y COORD: Lo27 65 639
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Firm to stiff, slity CLAY** Slightly moist, black, stained white, highly calcified with scattered nodules.	
0.5	0.60	**Firm to siff, silty CLAY** Slightly moist, black, stained white, highly calcified with scattered calcrete nodules.	
1.0			
1.5	1.80	**Medium dense to dense, silty SAND** Slightly moist, orange brown, residual. Abundant calcrete gravel and cobbles.	
2.0			
2.5	2.80	**Termination at required depth**	
3.0		End of Log	
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 07/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: AX1
X COORD: 3 220 193
Y COORD: Lo27 65 237
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose to mediium, silty SAND and occasional shale cobble and boulders Slightly moist, light brown.	
0.5	0.80		
		Medium dense to dense, silty SAND Moist, speckled to blotched white, light brown, slickensided from 1.4m, less calcification with depth, calcified to 2.0m.	
1.0			
1.5			
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			
5.5	5.60		
		Excavation terminated at the maximum reach of excavator	
6.0		End of Log	

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: Volvo 20 ton excavator
DIAM: Test pit
FILE REF:
DATE PROFILED: 06/05/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DAX2
X COORD: 3 221 669
Y COORD: Lo27 67 938
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
0.0 – 1.20		**Loose, silty SAND** Slightly moist, light grey to white, calcrete sand, no cementation.	
1.20 – 4.20		**Medium dense to dense, sandy GRAVEL** Slightly moist, olive to light grey, residual, calcified to 2.9m. Shale, less weathering with depth.	
4.20 – 5.80		**Medium dense to dense, sandy GRAVEL** Slightly moist to moist, light browninsh grey, intact, residual. Shale	
5.80		**Excavation terminated at the maximum reach of excavator** End of Log	

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 06/05/2015
PROFILED BY: T.G
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Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION DA

HOLE NO: DAX3
X COORD: 3 221 509
Y COORD: Lo27 67 966
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
0.0 – 1.30		**Loose to mediium, silty SAND** Slightly moist, reddish brown, transported.	
1.30 – 5.70		**Medium dense to dense, sandy GRAVEL and COBBLES** Moist, greyish olive, intact, residual, no calcification from 3.3m. larger gravel between 3.0 and 3.45m, less calcification with depth, mudrock gravel in white calcified sand, abundant calcrete gravel particularly at 1.2-2.5m.	
5.70		**Excavation terminated at the maximum reach of excavator** End of Log	

0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: Volvo 20 ton excavator
DIAM: Test pit
FILE REF:
DATE PROFILED: 06/05/2015
PROFILED BY: T.G
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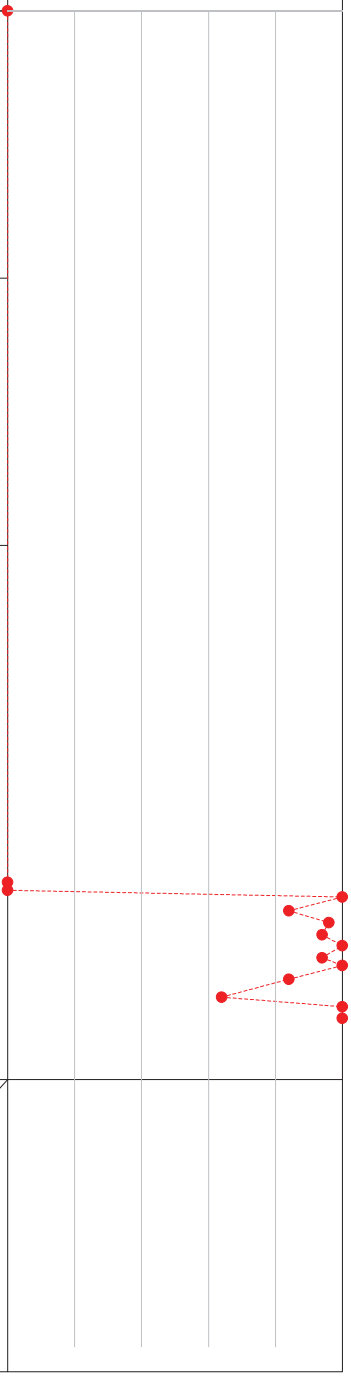
TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: RENOSTERSPRUIT AREA

HOLE NO: A01
X COORD: 3 220 191
Y COORD: Lo27 65 348
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Transported. Aeolian	
0.5	0.70	**Medium dense, silty SAND with gravel** Slightly moist, light brownish red, speckled and blotched white areas. Calcified, with scattered nodules. Nodules avg 10mm. Nodules subrounded to rounded.	
1.0	1.40	**Stiff, Silty CLAY** Dark brown, speckled and blotched white, scattered calcrete nodules, clay has slickensided structure where calcrete is absent.	
1.5			
2.0			
2.5	2.80	**Termination of excavation at required depth**	
3.0		End of Log	
3.5			



NOTES 1: DCP at 2.8
2: No seepage
3: No sidewall collapse
4: Sample taken for F.I at 2.4m

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 30/03/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: RENOSTERSPRUIT AREA

HOLE NO: A02
X COORD: 3 220 188
Y COORD: Lo27 65 235
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Slightly moist light brownish red, Transported. Aeolian.	
0.5	0.60		
		Medium dense, silty SAND with gravel Slightly moist light brownish red, speckled and blotched white areas. Calcified, with scattered nodules. Nodules avg 10mm. Nodules subrounded to rounded.	
1.0	1.20		
		Stiff, silty CLAY Dark brown, speckled and irregularly blotched white, scattered calcrete nodules, cementation in layer due to calcification. Abundant calcrete nodules at 1.5m. Silty sand between 1.9 & 2.3m. Less calcification with depth, clay has slickensided structure where calcrete is absent.	
1.5			
2.0			
2.5			
3.0			
	3.30		
		Termination of excavation at required depth	
3.5		End of Log	

NOTES 1: Roots at 0.7m
2: No seepage
3: No sidewall collapse
4: Sample taken for F.I at 2.9m

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 30/03/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: RENOSTERSPRUIT AREA

HOLE NO: A03
X COORD: 3 220 141
Y COORD: Lo27 65 170
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Slightly moist red, transported. Aeolian	
	0.30		
		Fill Rubble, plastic, glass & bricks.	
0.5			
1.0			
	1.40		
1.5		**Stiff, silty CLAY** Dark brown, speckled and irregularly blotched white, scattered calcrete nodules, cementation in layer due to calcification. Clay has slickensided structure where calcrete is absent.	
2.0			
2.5			
	2.90		
3.0		**Termination of excavation at required depth**	

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 30/03/2015
PROFILED BY: T.G
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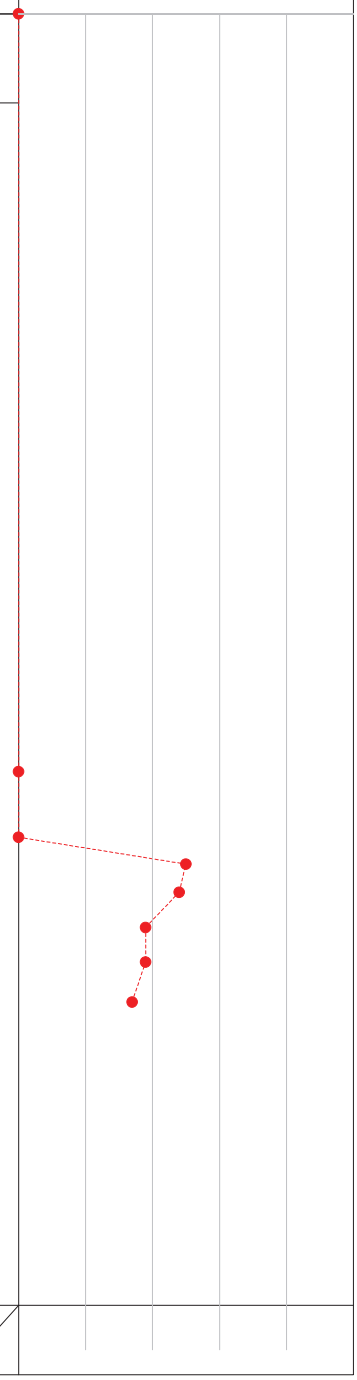
TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: RENOSTERSPRUIT AREA

HOLE NO: A04
X COORD: 3 220 073
Y COORD: Lo27 65 173
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Slightly moist light brownish red, Transported. Aeolian.	
	0.20	**Stiff, silty CLAY** Dark brown, speckled and blotched white, scattered calcrete nodules, cementation in layer due to calcification. Abundant calcified gravel @1.5m, sub-rounded to rounded gravel of avg 60mm, less cementation between 0.2-1.5m. lay has slickensided structure where calcrete is absent.	
0.5			
1.0			
1.5			
2.0			
2.5			
	2.90	**Termination of excavation at required depth**	
3.0			



NOTES 1: No seepage
2: No sidewall collapse
3: DCP at 1.5m
4: Sapmle for F.I taken at 1.4m

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 30/03/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: RENOSTERSPRUIT AREA

HOLE NO: A05
X COORD: 3 220 083
Y COORD: Lo27 65 238
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose to medium dense, silty SAND Slightly moist light brownish red, transported. Aeolian.	
	0.40		
0.5		**Stiff, silty CLAY** Greyish brown, speckled and blotched white, scattered calcrete nodules, cementation in layer due to calcification. Abundant calcified gravel. Sub-rounded to rounded gravel of avg 60mm, clay has slickensided structure where calcrete is absent.	
1.0			
1.5			
2.0			
2.5			
	2.70		
		Termination of excavation at required depth	
		End of Log	
3.0			

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken at 1.8 and 2.6m for F.I testing
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 30/03/2015
PROFILED BY: T.G
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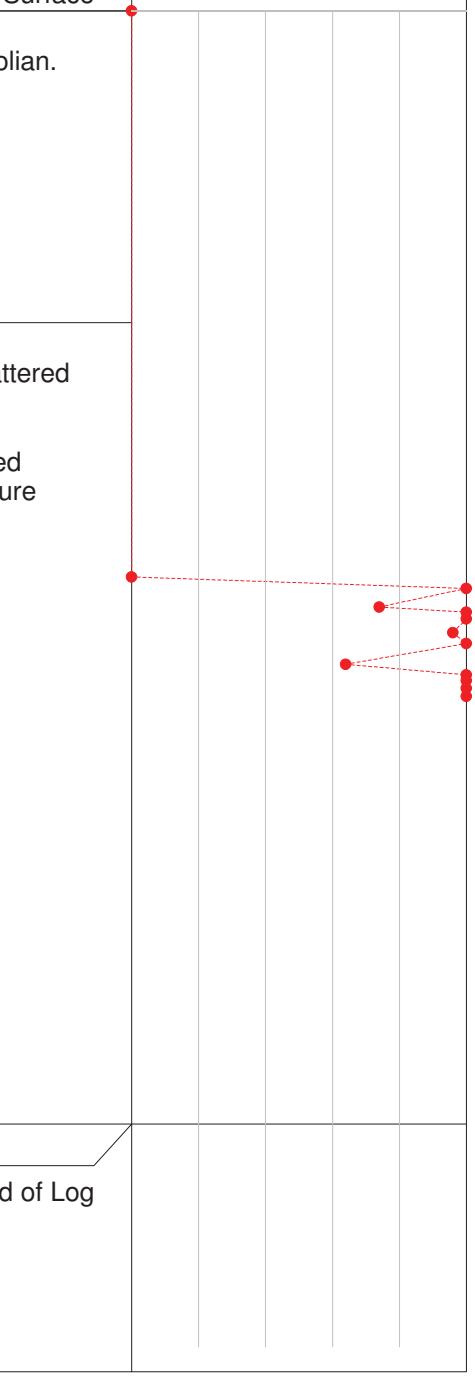
TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: RENOSTERSPRUIT AREA

HOLE NO: A06
X COORD: 3 220 089
Y COORD: Lo27 65 311
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.0	**Loose to medium dense, silty SAND** Slightly moist light brownish red, transported. Aeolian.	
0.70	**Stiff, silty CLAY** Greyish brown, speckled and blotched white, scattered calcrete nodules, cementation in layer due to calcification. Abundant calcified gravel, sub-rounded to rounded gravel of avg 60mm, clay has slickensided structure where calcrete is absent.	
2.50	**Termination of excavation at required depth**	
	End of Log	



NOTES 1: No seepage
2: No sidewall collapse
3: DCP at 1.1
4: Sample taken at 1.3 for F.I testing

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 30/03/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: RENOSTERSPRUIT AREA

HOLE NO: A07
X COORD: 3 219 985
Y COORD: Lo27 65 355
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose to medium dense, silty SAND Slightly moist light brownish red, transported. Aeolian.	
0.5			
	0.80		
		Stiff, silty CLAY Dark brown, speckled and irregularly blotched white, scattered calcrete nodules, calcrete nodules 10mm average, cementation in layer due to calcification between 1.8m and 2.3 m hardpan calcrete, cemented to strongly cemented calcrete, clay has slickensided structure where calcrete is absent.	
1.0			
1.5			
2.0			
2.5			
	2.90		
3.0		**Termination of excavation at required depth**	

NOTES 1: No seepage
2: No sidewall collapse
3: Roots at 1.1m
4: DCP at 1.3m

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:

DATE PROFILED: 30/03/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: RENOSTERSPRUIT AREA

HOLE NO: A08
X COORD: 3 219 893
Y COORD: Lo27 65 493
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Slightly moist light brownish red, transported. Aeolian.	
0.5	0.50	**Stiff, Silty clay** Dark brown, speckled and irregularly blotched white, scattered calcrete nodules cementation in layer due to calcification, between 1.2m and 1.8 m hardpan calcrete, cemented to strongly cemented calcrete, less calcification with depth, clay has slickensided structure where calcrete is absent.	
1.0			
1.5			
2.0			
2.5	2.70	**Termination of excavation at required depth** End of Log	
3.0			

NOTES 1: No seepage
2: Roots at 0.8m
3: Sample taken for F.I at 1.8m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 30/03/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: RENOSTERSPRUIT AREA

HOLE NO: A09
X COORD: 3 219 802
Y COORD: Lo27 65 659
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose to medium dense, silty SAND Slightly moist light brownish red, transported. Aeolian.	
0.5			
	0.80		
		Stiff, silty CLAY Dark brown, speckled and irregularly blotched white, scattered calcrete nodules cementation in layer due to calcification, between 1.2m and 1.8 m hardpan calcrete, cemented to strongly cemented calcrete, less calcification with depth, clay has slickensided structure where calcrete is absent.	
1.0			
1.5			
2.0			
2.5			
	2.80		
		Termination of excavation at required depth	
3.0		End of Log	

NOTES 1: No seepage
2: Roots at 0.8m
3:
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 30/03/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG01
X COORD: 3 220 294
Y COORD: Lo27 65 180
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Transported. Aeolian.	
0.5	0.60		
		Medium dense, silty SAND with gravel Slightly moist, light brownish red, speckled and blotched white areas. Calcified, with scattered nodules. Nodules avg 10mm. Nodules subrounded to rounded, slightly calcified at 1.2-1.8m.	
1.0			
1.5			
2.0			
2.5			
3.0	3.10		
		Termination at maximum reach of TLB	
		End of Log	
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4: Sample taken at 2.4m for F.I and triaxial testing

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG02
X COORD: 3 220 230
Y COORD: Lo27 64 737
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Transported. Aeolian.	
	0.45		
0.5		**Medium dense, silty SAND with gravel** Slightly moist, light brownish red, speckled and blotched white areas. Calcified, with scattered nodules. Nodules avg 10mm. Nodules subrounded to rounded, slightly calcified form 0.8-2.2m.	
1.0			
1.5			
2.0			
2.5			
	2.80		
		Termination of excavaton at required depth	
3.0		End of Log	
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG03
X COORD: 3 220 163
Y COORD: Lo27 64 207
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Soft to firm, silty, sandy CLAY and occassional gravel** Slightly moist, brown-black, transported. Calcification from 0.9m, sub-rounded calcrete black gravel.	
0.5			
	0.90		
1.0		**Soft rock, DOLERITE** Completetly weathered, light yellowish. Weathered to matrix of dolerite gravel and cobbles of 50mm.	
1.5	1.50	**Refusal on medium hard rock, DOLERITE**	
		End of Log	
2.0			
2.5			
3.0			
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 31/03/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG04
X COORD: 3 220 102
Y COORD: Lo27 63 764
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00 Ground Surface	
	Loose to medium dense, silty SAND Slightly moist, light brown, transported.	
	0.35	
0.5	**Soft rock SHALE** Highly to completely weathered, dark brown, speckled red, less weathering with increasing depth, breaks to angular gravel. Horizontally orientated.	
1.0		
	1.40	
1.5	**Refusal on soft rock, SHALE**	
	End of Log	
2.0		
2.5		
3.0		
3.5		

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 30/03/2015
PROFILED BY: T.G
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Prof Reg:
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG05
X COORD: 3 219 900
Y COORD: Lo27 63 378
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			DOLERITE Dolerite outcrop on surface.	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				
3.5				

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 31/03/2015
PROFILED BY: T.G
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Prof Reg:
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG06
X COORD: 3 219 789
Y COORD: Lo27 63 260
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to mediun dense, silty SAND** Slightly moist, red brown, transported.	
0.5			
1.0			
1.5	1.50	**Very soft rock to soft rock SHALE** Greyish olive, horizontally orientated, less weathering with depth, breaks to angular to subrounded gravel, calcified at shallow depth.	
2.0			
2.5	2.80	**Termination at medium hard rock SHALE**	
3.0		End of Log	
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4: Sample taken for F.I testing at 1.1 and 2.3m

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 31/03/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG07
X COORD: 3 219 445
Y COORD: Lo27 62 919
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Soft to firm, silty sandy CLAY** Slightly moist, dark brown to black, speckled white, transported, slightly calcified.	
0.5			
1.0			
1.5	1.50	**Dense, silty SAND with gravel** Slightly moist, light brown, intact. Residual shale gravel in sand matrix.	
2.0			
2.5	2.60	**Termination in weathered SHALE (difficult excavation)**	
		End of Log	
3.0			
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 31/03/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG08
X COORD: 3 219 117
Y COORD: Lo27 62 717
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Soft to firm, silty sandy CLAY** Slightly moist, dark brown to black, slightly calcified at greater depth.	
0.5			
1.0			
	1.20		
1.5		**Medium dense, silty SAND with gravel** Slightly moist, light browninsh red, speckled and blotched white areas. Calcified, with scattered nodules. Nodules avg 10mm. Nodules subrounded to rounded, slight calcified at 1.2-1.8m.	
2.0			
	2.30		
2.5		**Loose to medium dense, clayey, silty SAND** Slightly moist, light brown, white. Abundant calcrete gravel.	
	2.80		
		Termination at required depth	
3.0		End of Log	
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I testing at 1.4m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG09
X COORD: 3 218 814
Y COORD: Lo27 62 354
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Slightly moist, light brown, transported.	
	0.30	**Very soft rock, SHALE** Hightly to completely weathered, purple, becoming greyish olive with increasing depth, horizontally orientated, weatheres to angular gravel and cobbles, less weathering and increasing fragment size with increasing depth.	
0.5			
1.0			
1.5			
2.0			
	2.50	**Termination due to difficult excavation in soft rock SHALE**	
2.5		End of Log	
3.0			
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG10
X COORD: 3 218 458
Y COORD: Lo27 62 085
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose to medium dense, silty SAND Slightly moist, light brown, transported.	
	0.30	**Very soft rock SHALE** Completely to moderately weathered, purple, becoming yellowish olive with increasig depth, horizontally orientated, less weathering with depth, breaks to coarse angular small cobbles.	
0.5	0.50	**Refusal on soft rock SHALE**	
		End of Log	
1.0			
1.5			
2.0			
2.5			
3.0			
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG11
X COORD: 3 218 161
Y COORD: Lo27 61 852
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
0.0		**Soft to firm, silty sandy CLAY** Slightly moist, dark brown and black, speckled white, transported, slightly calcified, more calcification at greater depth.	
1.45		**Dense, silty SAND with gravel** Slightly moist, light brown to olive, intact. Residual shale gravel in sand matrix. Angular gravel.	
2.40		**Termination in difficult excavaton in residual SHALE** End of Log	

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 31/03/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG12
X COORD: 3 217 827
Y COORD: Lo27 61 580
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose to medium dense, silty SAND Slightly moist, light brown, speckled white, transported, slightly calcified.	
1.30			
		Very soft rock, SHALE Highly to completely weathered, slightly gey becoming yellowish olive with increasing depth, breaks to angular gravel, less weathering with depth.	
2.30			
		Refusal on soft rock, SHALE	
		End of Log	

0.5 1.0 1.5 2.0 2.5 3.0 3.5

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I at 2.1m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 31/03/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG13
X COORD: 3 217 672
Y COORD: Lo27 61 416
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.0 – 0.50	**Loose to medium dense, silty SAND** Slightly moist, light brown, speckled white, transported, slightly calcified. Aeolian.	
0.50 – 1.70	**Very soft rock, SHALE** Highly to completely weathered, slightly grey becoming yellowish olive with increasing depth, breaks to angular gravel, less weathering with depth. Calcrete nodules of 30mm avg.	
1.70	**Termination in difficult excavation in residual SHALE** End of Log	

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG14
X COORD: 3 217 564
Y COORD: Lo27 61 314
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.0	**Loose, clayey, sandy SILT** Slightly moist, dark brown, transported. Aeolian.	
0.30	**Firm to stiff, silty CLAY with calcrete** Slightly moist, dark brown to black, speckled white, pedocretes, calcified nodules of 50mm avg. Irregular bands of highly calcified material, calcrete nodules sub-rounded to rounded. Abudant calcrete gravel at 1.2m deep.	
0.5		
1.0		
1.5		
1.90	**Very soft rock, SHALE** Completely weathered, light greyish olive, speckled black, slightly rough, very fine grained, scattered calcified areas, less calcification with depth. Breaks to angular gravel fragments, less weathering with depth.	
2.0		
2.5		
2.90	**Refusal on soft rock, SHALE**	
3.0	End of Log	
3.5		

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG15
X COORD: 3 217 289
Y COORD: Lo27 61 099
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose, clayey, sandy SILT** Slightly moist, dark brown, transported. Aeolian.	
	0.40		
0.5		**Firm to stiff, silty CLAY with calcrete** Slightly moist, dark brown to black, speckled white, pedocretes, calcified nodules of 50mm avg. Irregular bands of highly calcified material, calcrete nodules sub-rounded to rounded. Abudant calcrete gravel at 1.2m deep.	
1.0			
1.5			
2.0			
2.5	2.60		
		Very soft rock, SHALE Completely weathered, light greyish olive, speckled black, slightly rough, very fine grained, scattered calcified areas, less calcification with depth. Breaks to angular gravel fragments, less weathering with depth.	
	2.90		
3.0		**Refusal on hardpan, CALCRETE**	
		End of Log	
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I testing at 2.1m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 01/04/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG16
X COORD: 3 217 103
Y COORD: Lo27 60 654
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose, clayey, sandy SILT** Slightly moist, dark brown, transported. Aeolian.	
	0.40		
0.5		**Medium dense to dense, silty CLAY with calcrete** Slightly moist, dark brown to black, speckled white, pedocretes, calcified nodules of 50mm avg. Irregular bands of highly calcified material, calcrete nodules sub-rounded to rounded. Abudant calcrete gravel at 1.2m deep.	
1.0			
	1.30		
1.5		**Cemented to strongly cemented CALCRETE** Slightly moist, whitish grey, breaks to sub-angular gravel in sandy matrix. Abundant areas of greyish olive residual shale, angular shaped.	
2.0			
2.5			
	2.80	**Termination at required depth**	
3.0		End of Log	
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 01/04/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG17
X COORD: 3 216 729
Y COORD: Lo27 60 629
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Medium dense to dense, silty SAND** Slighly moist, light brown, transported, slightly calcified.	
0.5			
1.0			
	1.20		
		Medium dense to dense, silty SAND Slightli moist, red brown.	
1.5	1.50		
		Very soft rock SHALE Completely weathered, light greyish olive, speckled black, slightly rough, very fine grained, scattered calcified areas, less calcification with depth. Breaks to angular gravel fragments, less weathering with depth.	
2.0			
2.5			
	2.80		
		Termination in difficult excavation	
3.0		End of Log	
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I testing at 1.2 and 2.6m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 01/04/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG18
X COORD: 3 216 352
Y COORD: Lo27 60 309
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, clayey, sandy SILT** Slightly moist, dark brown, transported. Aeolian. Scattered areas of calcification.	
0.5	0.50	**Very soft rock SHALE** Completely weathered, light greyish olive, speckled black, slightly rough, very fine grained, scattered calcified areas, less calcification with depth. Breaks to angular gravel fragments, less weathering with depth.	
1.0			
1.5			
2.0			
	2.40	**Termination in difficult excavation in medium hard rock, SHALE**	
2.5		End of Log	
3.0			
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 01/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG19
X COORD: 3 216 132
Y COORD: Lo27 60 126
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.0	**Soft to firm, sandy CLAY with some silt** Slightly moist, dark brown and black, speckled white, transported, slightly calcified.	
2.00	**Very soft rock SHALE** Completely weathered, light greyish olive, speckled black, slightly rough, very fine grained, increasing fragment size.	
2.40	**Termination in difficult excavation in hard to very hard rock, SHALE**	
	End of Log	

0.5 1.0 1.5 2.0 2.5 3.0 3.5

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I testinf at 1.9m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 01/04/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG20
X COORD: 3 215 965
Y COORD: Lo27 59 983
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00 Ground Surface	
	Soft to firm, sandy CLAY with some silt Slightly moist, dark brown and black, speckled white, transported, slightly calcified.	
1.5	1.50	
	Very soft rock SHALE Completely weathered, light greyish olive, speckled black, slightly rough, very fine grained, increasing fregment size. Breaks to small pieces of angular gravel.	
2.5	2.50	
	Termination in difficult excavation	
	End of Log	
3.0		
3.5		

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:

DATE PROFILED: 01/04/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG21
X COORD: 3 215 582
Y COORD: Lo27 59 661
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, sandy SILT** Slightly moist, dark brown, transported. Aeolian	
0.5	0.60	**Weakly cemented to cemented CALCRETE** Slighlty moist, black and greyish whited, pedocretes, weakly to cemented calcrete. Abundant 30mm nodules.	
1.0			
1.5			
2.0	2.10	**Very soft rock SHALE** Compeletely weathered, light grey, speckled black, slightly rough, very fine grained, some calcification evident, less calcification with depth.	
2.5	2.80	**Termination in difficult excavation**	
3.0		End of Log	
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 01/04/2015
PROFILED BY: T.G
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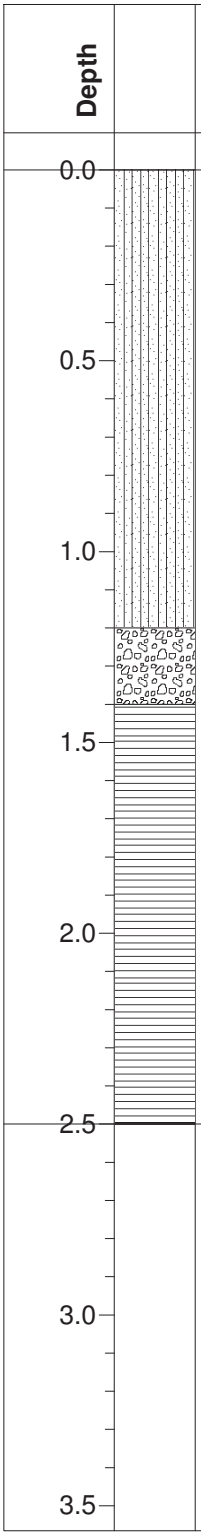
TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG22
X COORD: 3 215 195
Y COORD: Lo27 59 333
ELEVATION:



Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.00 – 1.20	**Loose to medium dense, sandy SILT** Slightly moist, dark brown, transported. Aeolian.	
1.20 – 1.40	**Weakly cemented to cemented CALCRETE** Slighlty moist, black and greyish whited, pedocretes, weakly to cemented calcrete. Abundant 30mm nodules.	
1.40 – 2.50	**Very soft rock SHALE** Compeletely weathered, light yellowish grey, slightly rough, very fine grained, some calcification evident, less calcification with depth.	
2.50	**Termination in difficult excavation**	
	End of Log	

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG23
X COORD: 3 214 827
Y COORD: Lo27 59 018
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Slightly moist, brownish red, transported.	
	0.40		
0.5		**Medium dense to dense, SAND** Slightly moist. light yellow, residual structure. Residual dolerite.	
1.0			
	1.20	**Refusal on medium hard rock, DOLERITE**	
		End of Log	
1.5			
2.0			
2.5			
3.0			
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I testing at 1.2m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 01/04/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG24
X COORD: 3 214 432
Y COORD: Lo27 58 706
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, sandy SILT** Slightly moist, dark brown, transported. Aeolian.	
0.5			
1.0			
	1.30		
1.5		**Weakly to cemented CALCRETE** Slighlty moist, black and greyish whited, pedocretes, weakly to cemented calcrete. Abundant 30mm nodules.	
	1.60		
2.0		**Very soft rock SHALE** Compeletely weathered, light grey, speckled black, slightly rough, very fine grained, some calcification evident, less calcification with depth.	
2.5			
	2.70		
		Termination in difficult excavation in soft rock, SHALE	
3.0		End of Log	
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:

DATE PROFILED: 01/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG25
X COORD: 3 214 350
Y COORD: Lo27 58 425
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			Loose, silty SAND Slightly moist, light brown, transported. Aeolian.	
		0.40		
0.5			**Refusal on soft rock, SHALE**	
			End of Log	
1.0				
1.5				
2.0				
2.5				
3.0				
3.5				

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 01/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG26
X COORD: 3 214 418
Y COORD: Lo27 57 919
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose, silty SAND Slightly moist, light brown, transported. Aeolian.	
1.5	1.50	**Weakly cemented to cemented, CALCRETE** Slightly moist, black and greyish white, pedocretes. Abundant 30mm nodules.	
2.5	2.50	**Soft rock SHALE** Completely weathered, greyish, purple, slightly rough, very fine grained. Less weathering with depth, breaks to angular gravel.	
3.0	3.10	**Termination at required depth**	
		End of Log	

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 01/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION AG

HOLE NO: AG27
X COORD: 3 214 567
Y COORD: Lo27 57 466
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose, silty SAND** Slightly moist, light greyish brown, transported. Alluvium.	
0.5			
1.0			
1.5	1.50	**Weakly cemented to cemented, CALCRETE** Slightly moist, black and greyish white, pedocretes. Abundant 30mm nodules.	
2.0	2.00	**Medium dense, silty SAND** Slightly moist, dark brown.	
2.5			
3.0	3.10	**Termination at maximum TLB reach**	
		End of Log	
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 01/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GB

HOLE NO: GB01
X COORD: 3 214 661
Y COORD: Lo27 57 152
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose, silty SAND** Slightly moist, yellowish, transported. Alluvium.	
0.5			
1.0	1.10		
		Weakly cemented to cemented, CALCRETE Slightly moist, black and greyish white, pedocretes. Abundant 30mm nodules.	
1.5			
2.0			
2.5	2.60		
		Medium dense, silty SAND Slightly moist, dark brown.	
3.0	3.10		
		Termination at maximum TLB reach	
		End of Log	
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 02/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GB

HOLE NO: GB02
X COORD: 3 214 181
Y COORD: Lo27 57 250
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Medium dense, silty SAND with some clay** Slightly moist, dark brown, yellowish.	
	0.20	**Medium dense, sandy GRAVEL and COBBLES** Slightly moist, light yellow, blackish brown, residual Dolerite, sub-rounded cobbles of 80mm avg. "Onion skin" structure visible.	
0.5			
1.0			
1.5			
2.0			
	2.30	**Termination on difficult excavation in DOLERITE**	
2.5		End of Log	
3.0			
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 02/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GB

HOLE NO: GB03
X COORD: 3 213 999
Y COORD: Lo27 57 258
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00 Ground Surface	
	Medium dense, silty SAND with some clay Slightly moist, dark brown, yellowish.	
	0.20 **Medium dense, sandy GRAVEL and COBBLES** Slightly moist, light yellow, blackish brown, residual Dolerite, sub-rounded cobbles of 80mm avg. "Onion skin" structure visible.	
0.5		
1.0		
1.5	1.50 **Termination on difficult excavation in DOLERITE** End of Log	
2.0		
2.5		
3.0		
3.5		

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 02/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GB

HOLE NO: GB04
X COORD: 3 213 603
Y COORD: Lo27 57 371
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Medium dense, silty SAND with some clay** Slightly moist, dark brown, yellowish.	
0.5	0.50	**Dense, sandy GRAVEl** Slighty moist, light yellowish brown, residual structure. Residual, breaks to coarse sand. Less weathering with depth.	
1.0			
1.5			
2.0			
2.5			
	2.80	**Termination on difficult excavation in DOLERITE**	
3.0		End of Log	
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I testing at 1.8m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 02/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GB

HOLE NO: GB05
X COORD: 3 213 418
Y COORD: Lo27 57 459
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose, to medium dense, silty SAND Sllightly moist, light reddish brown. Transported.	
0.5	0.55	**Loose to meiudm dense, slighty SAND** Slightly moist, light orange, residual dolerite. Roots 1m, gravel at greater depth. Less weathering with increasing depth.	
1.0			
1.5			
2.0	2.15	**Termination of excavation in DOLERITE**	
		End of Log	
2.5			
3.0			
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I testing at 1.7m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 02/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GF

HOLE NO: GF01
X COORD: 3 214 661
Y COORD: Lo27 57 152
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.0	**Loose to medium dense, silty SAND** Slightly moist, dark brown, transported.	
0.40		
0.5	**Medium dense to dense, silty SAND** Slightly moist, dark brown to black, speckled white, slickensided structure, scattered calcrete nodules.	
1.0		
1.5		
2.0		
2.5		
2.85	**Termination of excavation at required depth**	
3.0	End of Log	
3.5		

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for F.I testing at 1.8m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GF

HOLE NO: GF02
X COORD: 3 214 831
Y COORD: Lo27 56 664
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Slightly moist, dark brown, transported.	
	0.40		
0.5		**Firm to stiff, silty CLAY** Slightly moist, dark brown to black, speckled white, slickensided strucutre, scattered calcrete nodules.	
1.0			
1.5			
2.0			
2.5			
	2.85		
		Termination of excavation at required depth	
3.0		End of Log	
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:

DATE PROFILED: 08/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GF

HOLE NO: GF03
X COORD: 3 214 927
Y COORD: Lo27 56 150
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			Loose to medium dense, silty SAND Slightly moist, dark brown, transported.	
		0.30	**Refusal on SHALE boulders/cobbles**	
			End of Log	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				
3.5				

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:

DATE PROFILED: 08/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GF

HOLE NO: GF03A
X COORD: 3 214 927
Y COORD: Lo27 56 128
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose to medium dense, silty SAND Slightly moist, dark brown, transported.	
0.5	0.55	**Firm to stiff, silty CLAY with calcrete** Slightly moist, dark brown to black, speckled white, pedocretes, Slightly ferruginised.	
1.0			
1.5			
2.0	2.30	**Refusal on SHALE boulders/cobbles**	
2.5		End of Log	
3.0			
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GF

HOLE NO: GF04
X COORD: 3 214 983
Y COORD: Lo27 55 733
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Slightly moist, dark brown, transported.	
	0.45		
0.5		**Firm to stiff, silty CLAY with calcification** Slightly moist, dark brown to black, speckled white, pedocretes, calcified nodules of 50mm avg. Irregular bands of highly calcified material, calcrete nodules sub-rounded to rounded. Abudant calcrete gravel at 1.2m deep.speckled white between 0.45m and 1.2m, sandy at 1.2-1.5m.	
1.0			
1.5			
2.0			
2.5	2.70		
		Termination of excavation at required depth	
		End of Log	
3.0			
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GF

HOLE NO: GF05
X COORD: 3 215 107
Y COORD: Lo27 55 297
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.0	**Loose to medium dense, silty SAND** Slightly moist, dark brown, transported.	
0.60	**Firm to stiff, silty CLAY** Slightly moist, dark brown to black, speckled white, calcified nodules of 50mm avg.	
1.05	**Loose, medium dense to dense, clayey SAND, more dense with increasing depth** Slightly moist, yellowish orange, slightly ferruganised.	
2.90	**Termination of excavation at required depth**	
	End of Log	

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GF

HOLE NO: GF06
X COORD: 3 215 197
Y COORD: Lo27 54 780
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose to medium dense, silty SAND** Slightly moist, dark brown, transported.	
	0.45		
0.5		**Firm to stiff, silty CLAY** Slightly moist, dark brown to black, speckled white, pedocretes, calcified nodules of 50mm avg. Less weathering with increasing depth.	
1.0			
	1.40		
1.5		**Loose, medium dense to dense, clayey SAND, more dense with increasing depth** Slightly moist, yellowish orange. Ferruginised.	
2.0			
2.5			
	2.65		
		Termination of excavation at required depth	
		End of Log	
3.0			
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GF

HOLE NO: GF07
X COORD: 3 215 084
Y COORD: Lo27 54 290
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.0	**Loose to medium dense, silty SAND** Slightly moist, dark brown, transported. Roots from 1.2-1.3m.	
0.50		
0.5	**Loose, medium dense to dense, clayey SAND, more dense with increasing depth** Slightly moist, yellowish orange.	
1.0		
1.5		
2.0		
2.5		
2.90		
3.0	**Termination of excavation at required depth**	
	End of Log	
3.5		

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION GF

HOLE NO: GF08
X COORD: 3 214 952
Y COORD: Lo27 53 788
ELEVATION:

Depth			Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0		0.00	Ground Surface	
			Loose to medium dense, silty SAND Slightly moist, dark brown, transported. Roots from 1.2-1.3m.	
0.5		0.60		
			Loose, medium dense to dense, silty SAND, slightly clayey Slightly moist, light yellow, orange.Roots to 0.6m.	
1.0				
1.5				
2.0				
2.5				
3.0		3.10		
			Termination of excavation at required depth	
			End of Log	
3.5				

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 08/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: MOCKES DAM AREA

HOLE NO: CX01
X COORD: 3 215 647
Y COORD: Lo27 52 800
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
0.0		**Loose to mediium, silty SAND with clay** Slightly moist, light brown, transported. Farmland.	
1.0	1.05		
1.0		**Medium dense to dense, clayey, silty SAND** Moist, dark brown, transported, slightly calcified.	
5.5	5.70		
6.0		**Termination of excavatation at required depth** End of Log	

NOTES 1: No seepage
2: No sidewall collapse
3:
4:

MACHINE: Volvo 20 ton excavator
DIAM: Test pit
FILE REF:
DATE PROFILED: 06/05/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: MOCKES DAM AREA

HOLE NO: FE01
X COORD: 3 214 771
Y COORD: Lo27 53 104
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose, silty SAND** Slightly moist, light brown, transported. Aeolian.	
0.5	0.60	**Medium dense to dense, silty CLAY** Slightly moist, dark brown to black, speckled white, calcified nodules of 50mm avg.	
1.0	1.30	**Loose to medium dense, silty SAND** Moist, yellowish orange, coarse sand.	
1.5			
2.0			
2.5	2.90	**Termination at required depth**	
3.0		End of Log	
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 09/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: MOCKES DAM AREA

HOLE NO: C-DAM
X COORD: 3 215 569
Y COORD: Lo27 52 689
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00 Ground Surface	
	Loose, silty SAND with some clay Slightly moist, light. Farmland	
0.5	0.60	
	Firm to stiff, silty CLAY Slightly moist, dark brown to black, speckled white, calcified nodules of 50mm avg.	
1.0	1.05	
	Loose to medium dense, silty SAND Moist, yellowish orange, coarse sand.	
1.5		
2.0		
2.5		
	2.95	
3.0	**Termination at required depth**	
	End of Log	
3.5		

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:

DATE PROFILED: 09/04/2015
PROFILED BY: T.G
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TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: MOCKES DAM AREA

HOLE NO: E-DAM
X COORD: 3 214 993
Y COORD: Lo27 52 665
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00 Ground Surface	
	Loose, silty SAND with some clay Slightly moist, light brown, transported. Roots to 0.9m.	
1.0	1.10	
	Firm to stiff, silty CLAY Slightly moist, dark brown to black, speckled white, calcified nodules of 50mm avg, calcrete nodules sub-rounded to rounded.	
2.0	2.10	
	Loose to medium dense clayey, silty SAND Slightly moist, yellowish orange, coarse sand. Increasing density with depth.	
3.0	3.10	
	Termination of excavation at required depth	
	End of Log	
3.5		

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for Triaxial, F.I and chemical testing at 2.6m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 09/04/2015
PROFILED BY: T.G
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Template: SMEC TP04

TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION FC

HOLE NO: FC01
X COORD: 3 214 920
Y COORD: Lo27 53 415
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Soft to firm, silty, sandy CLAY** Slightly moist, dark brown and black, transported.	
0.5	0.60		
		Firm, silty CLAY Slightly moist, dark brown to black, speckled white, calcified nodules of 50mm avg. Nodules subrounded and abundant at 0.8-1.4m. Highly cacified between 0.8-1.2m.	
1.0			
1.5	1.60		
		Loose, to medium dense, clayey, silty SAND, more dense with depth Moist, yellowish orange.	
2.0			
2.5	2.95		
3.0		**Termination at required depth**	
		End of Log	
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 09/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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Template: SMEC TP04

TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION FC

HOLE NO: FC02
X COORD: 3 215 023
Y COORD: Lo27 53 122
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose, silty SAND with some clay** Slightly moist, light brown. Farmland	
0.5	0.60		
		Firm to stiff, silty CLAY Slightly moist, dark brown to black, speckled white, pedocretes, calcified nodules of 50mm avg.	
1.0	1.30		
		Loose to medium dense, clayey, silty SAND, more dense with depth Sligthlt moist, yellowish orange, scattered subrounded gravel.	
1.5			
2.0			
2.5	2.75		
		Termination at required depth	
		End of Log	
3.0			
3.5			

NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:

DATE PROFILED: 09/04/2015
PROFILED BY: T.G
CHECKED BY:

Prof Reg:
Prof Reg:

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Template: SMEC TP04

TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION FC

HOLE NO: FC03
X COORD: 3 215 250
Y COORD: Lo27 53 959
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
	0.00	Ground Surface	
0.0		**Loose, silty SAND with some clay** Slightly moist, light brown. Farmland	
	0.40		
0.5		**Firm to stiff, silty CLAY with calcrete** Moist, dark brown to black, speckled white in scattered areas.	
1.0			
	1.20		
1.5		**Loose, to medium dense, clayey, silty SAND, more dense with depth** Sligthlt moist, yellowish orange.	
2.0			
2.5			
	2.90		
3.0		**Termination at required depth**	
		End of Log	
3.5			

NOTES 1: No seepage
2: No sidewall collapse
3: Sample taken for Shear box, F.I and chemical testing at 1.8m
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:
DATE PROFILED: 09/04/2015
PROFILED BY: T.G
CHECKED BY:
Prof Reg:
Prof Reg:

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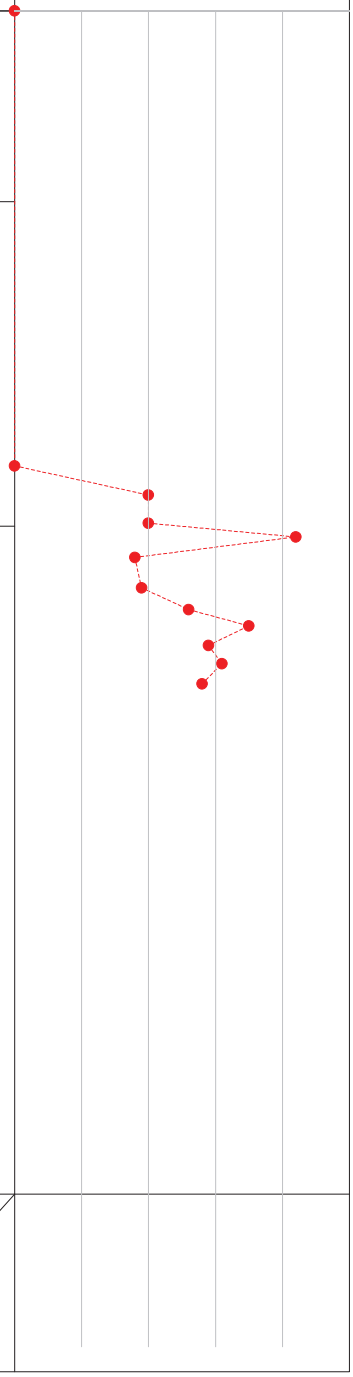
TRIAL PIT LOG

CLIENT: GLADAFRICA
PROJECT: MASELSPOORT PIPELINE
PROJECT NO: JG0014
SITE: SECTION FC

HOLE NO: FC04
X COORD: 3 215 647
Y COORD: Lo27 32 792
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.0	**Loose, silty SAND with some clay** Slightly moist, light brown. Farmland	
0.50	**Firm to stiff, silty CLAY** Slightly moist, dark brown to black, speckled white, pedocretes, calcified nodules of 50mm avg. Abudant calcrete gravel.	
1.35	**Loose to medium dense, clayey, silty SAND** Sligthlt moist, yellowish orange.	
3.10	**Termination in weathered SHALE**	
	End of Log	

0.5 1.0 1.5 2.0 2.5 3.0 3.5



NOTES 1: No sample
2: No seepage
3: No sidewall collapse
4:

MACHINE: JCB TLB 3CX
DIAM: Test pit
FILE REF:

DATE PROFILED: 09/04/2015
PROFILED BY: T.G
CHECKED BY:

Prof Reg:
Prof Reg:

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Template: SMEC TP04

Appendix B

Profiling and Logging Parameters

1. SOIL DESCRIPTIVE TERMS

DESCRIPTIVE ORDER:
1. CONSISTENCY 2. SOIL TYPE 3. MOISTURE CONDITION 4. COLOUR 5. SOIL STRUCTURE 6. ORIGIN

1.(a) CONSISTENCY: GRANULAR SOILS

S P T "N"	GRAVELS & SANDS Generally free draining soils		TYPICAL DRY DENSITY (kg/m^3)
< 4	VERY LOOSE	Crumbles very easily when scraped with geological pick	< 1450
4-10	LOOSE	Small resistance to penetration by sharp pick point	1450-1600
10-30	MEDIUM DENSE	Considerable resistance to penetration by sharp pick point	1600-1750
30-50	DENSE	Very high resistance to penetration by sharp pick point. Requires many blows of pick for excavation	1750-1925
> 50	VERY DENSE	High resistance to repeated blows of geological pick. Requires power tools for excavation	> 1925

1(b) CONSISTENCY: COHESIVE SOILS

S P T "N"	SILTS & CLAYS and combination with SANDS Generally slow draining soils		UCS (kPa)
< 2	VERY SOFT	Pick point easily pushed in 100mm. Easily moulded by fingers	< 50
2-4	SOFT	Pick point easily pushed in 30-40mm. Moulded by fingers with some pressure. Easily penetrated by thumb.	50-125
4-8	FIRM	Pick point penetrates up to 10mm. Very difficult to mould with fingers. Indented by thumb with effort. Spade just penetrates.	125-500
8-15	STIFF	Slight indentation by pushing in pick point. Cannot be moulded by fingers. Penetrated by thumbnail. Pick necessary to excavate.	250-500
15-30	VERY STIFF	Slight indentation by blow of pick point.. Requires power tools for excavation.	500-1000

2. SOIL TYPE

SOIL TYPE	PARTICLE SIZE (mm)
CLAY	< 0,002
SILT	0,002 – 0,06
SAND	0,06 – 2
GRAVEL	2 – 60*
COBBLES	60 – 200*
BOULDERS	> 200*

* Specify aver/max sizes, hardness, shape and proportion

3. MOISTURE CONDITION

DRY	No water detectable
SLIGHTLY MOIST	Water just discernable
MOIST	Water easily discernable
VERY MOIST	Water can be squeezed out
WET	Generally below the water table

4. COLOUR

Described at natural moisture content, as seen in profile (unless otherwise specified).

SPECKLED	Very small patches of colour < 2 mm
MOTTLED	Irregular patches of colour 2 – 6 mm
BLOTCHED	Large irregular patches 6 – 20 mm
BANDED	Approximately parallel bands of varying colour
STREAKED	Randomly orientated streaks of colour
STAINED	Local colour variations: associated with discontinuity surfaces
Described using bedding thickness criteria. (e.g. thickly banded, thinly streaked, etc.)	

5. SOIL STRUCTURE

INTACT	No structure present
FISSURED	Presence of discontinuities, possibly cemented
SLICKENSIDED	Very smooth, glossy, often striated discontinuity planes
SHATTERED	Presence of open fissures. Soil breaks into gravel size blocks
MICRO-SHATTERED	Small scale shattering, very closely spaced open fissures. Soil breaks into sand size crumbs
RESIDUAL STRUCTURES	Relict bedding, lamination, foliation, etc.

6. ORIGIN

TRANSPORTED	Alluvium, hillwash, talus, etc.
RESIDUAL	Weathered from parent rock e.g. residual granite
PEDOCRETES	Ferricrete, laterite, silcrete, calcrete, etc.

DEGREE OF CEMENTATION OF PEDOCRETES		UCS (MPa)
VERY WEAKLY CEMENTED	Some material can be crumbled between finger and thumb. Disintegrates under knife blade to a friable state.	0,1 – 0,5
WEAKLY CEMENTED	Cannot be crumbled between strong fingers. Some material can be crumbled by strong pressure between thumb and hard surface. Under light hammer blows disintegrates to friable state.	0,5 – 2
CEMENTED	Material crumbles under firm blows of sharp pick point. Grains can be dislodged with some difficulty by a knife blade.	2 – 5
STRONGLY CEMENTED	Firm blows of sharp pick point on hand-held specimen show 1-3mm indentations. Grains cannot be dislodged by knife blade.	5 – 10
VERY STRONGLY CEMENTED	Hand-held specimen can be broken by single firm blow of hammerhead. Similar appearance to concrete.	10 - 25

REFERENCE: Guidelines for Soil and Rock Logging (SAIEG – AEG – SAICE) (1990)

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2. ROCK DESCRIPTIVE TERMS

DESCRIPTIVE ORDER: 1. HARDNESS 2. ROCK TYPE 3. WEATHERING 4. COLOUR 5. FRACTURE SPACING 6. DISCONTINUITY SURFACE DESCRIPTION 7. GRAIN SIZE 8. ROCK FORMATION NAME

1. ROCK HARDNESS

HARDNESS	DESCRIPTION	UCS (MPa)
VERY SOFT	Material crumbles under firm blows of pick point. Can be peeled with a knife. SPT refusal. Too hard to cut triaxial sample by hand	1 – 3
SOFT ROCK	Firm blows with pick point: 2-4mm indents. Can just be scraped with a knife	3 - 10
MEDIUM HARD ROCK	Firm blows of pick head will break hand-held specimen. Cannot be scraped or peeled with a knife.	10 - 25

HARDNESS	DESCRIPTION	UCS (MPa)
HARD ROCK	Breaks with difficulty, rings when struck Point load or laboratory test results necessary to distinguish between categories	25 – 70
VERY HARD ROCK		70 – 200
VERY VERY HARD ROCK		> 200

2. ROCK TYPE

Quartzite, sandstone, granite, limestone, etc.

4. COLOUR

Described in the dry state unless otherwise indicated

3. WEATHERING

DEGREE OF WEATHERING	EXTENT OF DISCOLOURATION	FRACTURE CONDITION	SURFACE CHARACTERISTICS	ORIGINAL FABRIC	GRAIN BOUNDARY CONDITION
UNWEATHERED	None	Closed or stained	Unchanged	Preserved	Tight
SLIGHTLY WEATHERED	< 20% of fracture spacing on both sides of fracture	Discoloured, may contain thin filling	Partial discolouration. Often unweathered rock colour	Preserved	Tight
MODERATELY WEATHERED	>20% of fracture spacing on both side of fracture	Discoloured, may contain thick filling	Partial to complete discolouration. Not friable except poorly cemented rocks	Preserved	Partial opening
HIGHLY WEATHERED	Throughout	-	Friable, possibly pitted	Mainly preserved	Partial separation. Not easily indented with knife. Does not slake
COMPLETELY WEATHERED	Throughout	-	Resembles a soil	Partially preserved	Complete separation. Easily indented with knife. Slakes

5. DISCONTINUITY SPACING

SEPARATION (mm)	SPACING (foliation, cleavage, bedding, etc.)	SPACING (fractures, joints, etc.)
< 6	very intensely	very highly
6 – 20	intensely	
20 – 60	very thinly	highly
60 – 200	thinly	
200 – 600	medium	moderately
600 – 2000	thickly	slightly
> 2000	very thickly	very slightly

6. DISCONTINUITY SURFACE DESCRIPTION

6.1 JOINT FILLING

JOINT FILL TYPE	DEFINITION (wall separation specified in mm)
CLEAN	No fracture filling
STAINED	Colouration of rock only. No recognisable filling material
FILLED	Fracture filled with finite thickness filling material

6.2 DISCONTINUITY ORIENTATION

Discontinuity inclinations (i.e. of joints, bedding, faults

6.3 ROUGHNESS OF DISCONTINUITY PLANES

CLASSIFICATION	DESCRIPTION
SMOOTH	Appears smooth and is essentially smooth to the touch. May be slickensided *
SLIGHTLY ROUGH	Asperities on the fracture surface are visible and can be distinctly felt
MEDIUM ROUGH	Asperities are clearly visible and fracture surface feels abrasive
ROUGH	Large angular asperities can be seen. Some ridge and high side angle steps evident
VERY ROUGH	Near vertical steps and ridges occur on the fracture surface

* Where slickensides occur the direction of the slickensides should be recorded

7. GRAIN SIZE

CLASSIFICATION	SIZE (mm)	RECOGNITION
VERY FINE GRAINED	< 0.2	Individual grains cannot be seen with a hand lens
FINE GRAINED	0.2 – 0.6	Just visible as individual grains under hand lens
MEDIUM GRAINED	0.6 – 2	Grains clearly visible under hand lens, just visible to the naked eye
COARSE GRAINED	2 – 6	Grains clearly visible to the naked eye
VERY COARSE GRAINED	> 6	Grains measurable

8. ROCK FORMATION

Brixton Formation, Halfway House Granite Dome etc.

REFERENCE: Guidelines for Soil and Rock Logging (SAIEG – AEG – SAICE) (1990)

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Appendix C

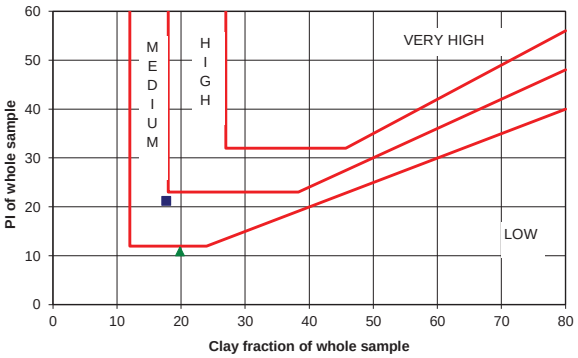
Laboratory Test Results

PARTICLE SIZE ANALYSIS

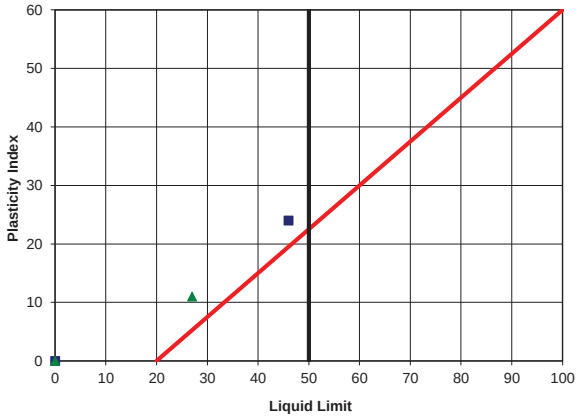
Sample No.	01	02
Soillab sample no.	2015-S-0502-1	2015-S-0502-2
Depth (m)	1.2	1.8
Position	DA13	FC03
Material Description	LIGHT OLIVE SILTY SAND	DARK RED BROWN SILTY SAND
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	100	100
4.75 mm	97	100
2.00 mm	94	100
0.425 mm	88	99
0.075 mm	48	58
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	39	44
0.027 mm	34	36
0.013 mm	27	30
0.005 mm	21	26
0.002 mm	18	20
% Clay	18	20
% Silt	26	32
% Sand	50	48
% Gravel	6	0
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	46	27
Plasticity Index	24	11
Linear Shrinkage (%)	11.0	5.0
Grading Modulus	0.70	0.44
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-7-6 (8)	A-6 (4)
Unified Classification	SC	CL
Chart Reference		

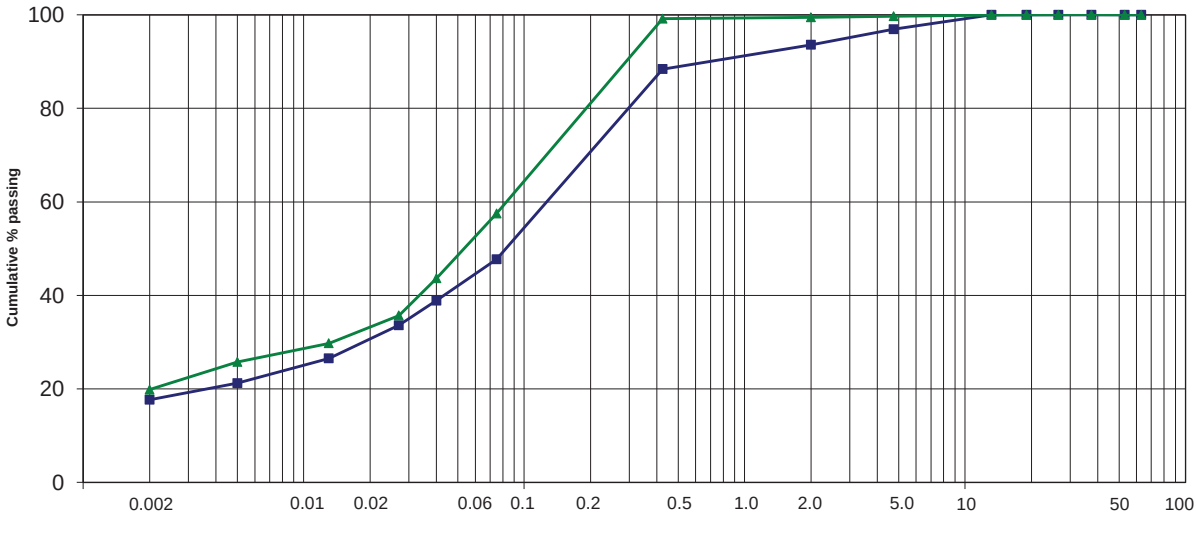
PROJECT : MASELSPOORT
JOB No. : 2015-S-0502
DATE : 13/04/2015

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

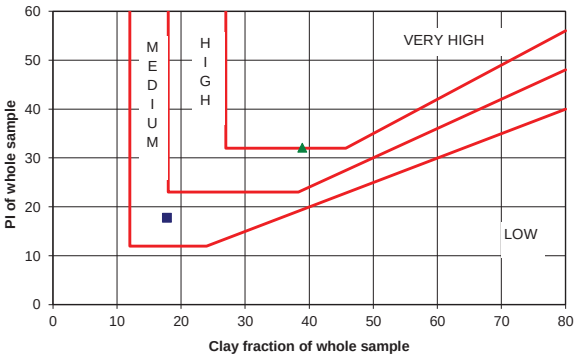
0502-02.xls

PARTICLE SIZE ANALYSIS

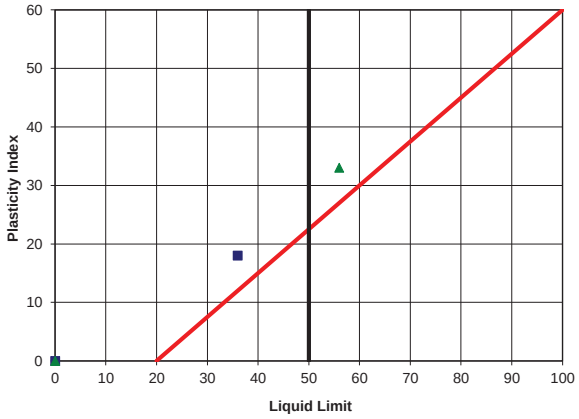
Sample No.	03	04
Soillab sample no.	2015-S-0502-3	2015-S-0502-4
Depth (m)	1.1	1.4
Position	DA06	AG08
Material Description	DUSKY BLUE SILTY SAND	LIGHT BROWN SANDY CLAY
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	100	100
4.75 mm	100	100
2.00 mm	100	99
0.425 mm	99	97
0.075 mm	53	70
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	40	62
0.027 mm	32	58
0.013 mm	26	54
0.005 mm	22	49
0.002 mm	18	39
% Clay	18	39
% Silt	30	28
% Sand	52	32
% Gravel	0	1
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	36	56
Plasticity Index	18	33
Linear Shrinkage (%)	8.0	13.5
Grading Modulus	0.48	0.34
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-6 (6)	A-7-6 (22)
Unified Classification	CL	CH
Chart Reference		

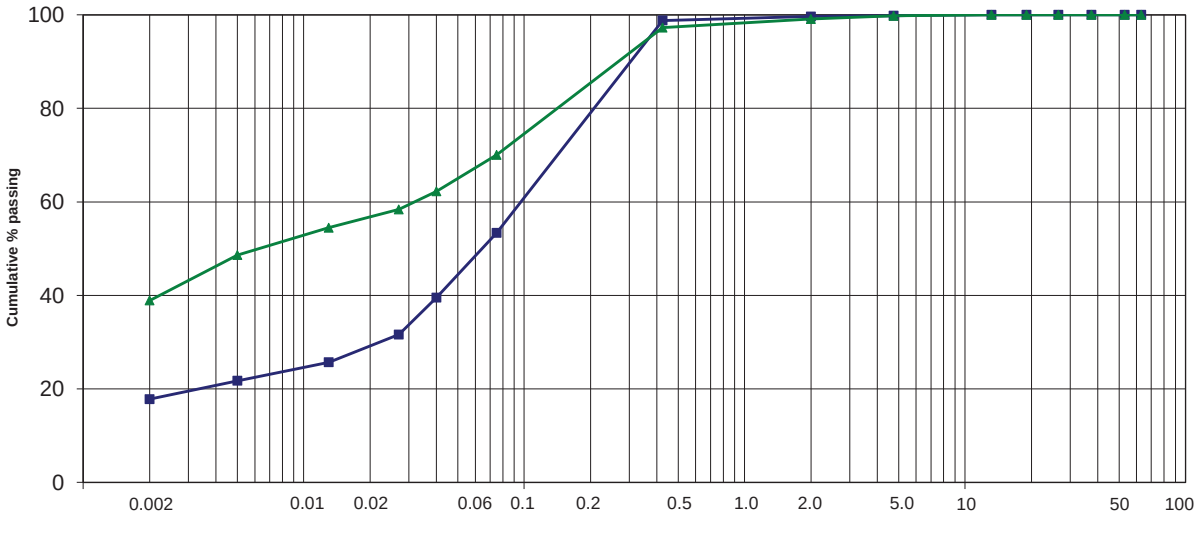
PROJECT : MASELSPOORT
JOB No. : 2015-S-0502
DATE : 13/04/2015

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





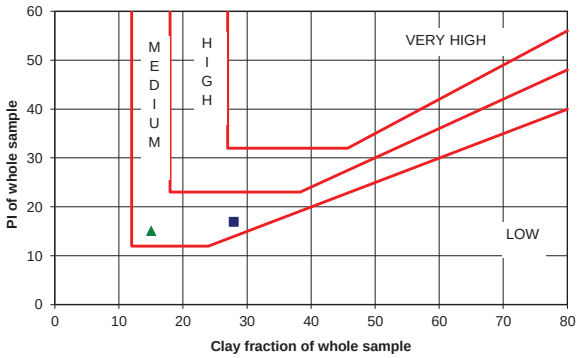
0502-03.xls

PARTICLE SIZE ANALYSIS

Sample No.	05	06
Soillab sample no.	2015-S-0502-5	2015-S-0502-6
Depth (m)	2.1	2
Position	AG12	DA05
Material Description	DARK RED BROWN CLAYEY SILT	DARK RED ORANGE SILTY SAND
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	100	99
4.75 mm	100	96
2.00 mm	100	95
0.425 mm	100	94
0.075 mm	78	40
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	68	28
0.027 mm	62	24
0.013 mm	48	23
0.005 mm	34	19
0.002 mm	28	15
% Clay	28	15
% Silt	46	20
% Sand	26	60
% Gravel	0	5
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	32	31
Plasticity Index	17	16
Linear Shrinkage (%)	8.0	7.0
Grading Modulus	0.23	0.71
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-6 (11)	A-6 (2)
Unified Classification	CL	SC
Chart Reference		

PROJECT : MASELSPOORT
JOB No. : 2015-S-0502
DATE : 13/04/2015

POTENTIAL EXPANSIVENESS



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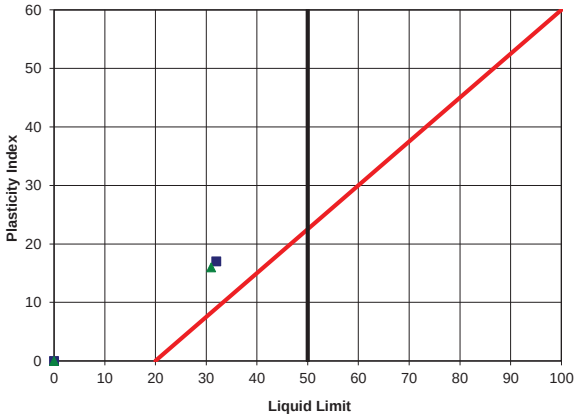
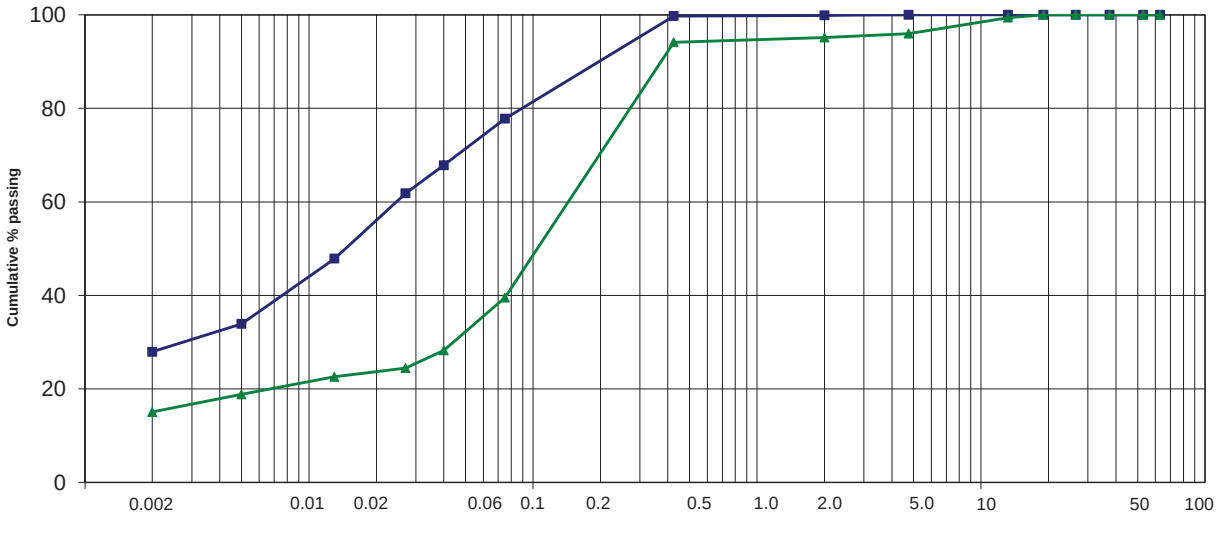




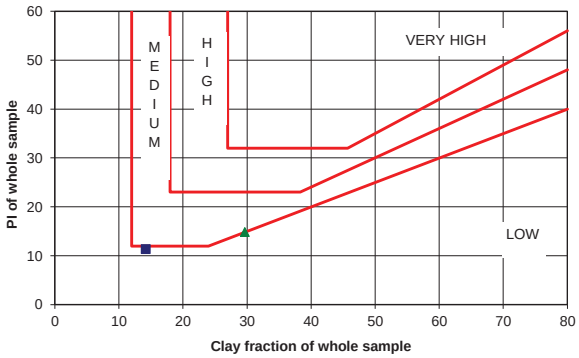
0502-04.xls

PARTICLE SIZE ANALYSIS

Sample No.	07	08
Soillab sample no.	2015-S-0502-7	2015-S-0502-8
Depth (m)	2.2	2.4
Position	DA13	AG01
Material Description	LIGHT OLIVE GRAVELLY SAND	DARK RED BROWN CLAYEY SAND
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	83	100
26.5 mm	81	100
19.0 mm	81	100
13.2 mm	80	99
4.75 mm	77	94
2.00 mm	74	93
0.425 mm	71	93
0.075 mm	34	52
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	26	43
0.027 mm	23	39
0.013 mm	20	37
0.005 mm	17	33
0.002 mm	14	30
% Clay	14	30
% Silt	16	18
% Sand	44	45
% Gravel	26	7
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	38	38
Plasticity Index	16	16
Linear Shrinkage (%)	7.0	8.0
Grading Modulus	1.21	0.62
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-2-6 (1)	A-6 (5)
Unified Classification	SC	CL
Chart Reference		

PROJECT : MASELSPOORT
JOB No. : 2015-S-0502
DATE : 13/04/2015

POTENTIAL EXPANSIVENESS



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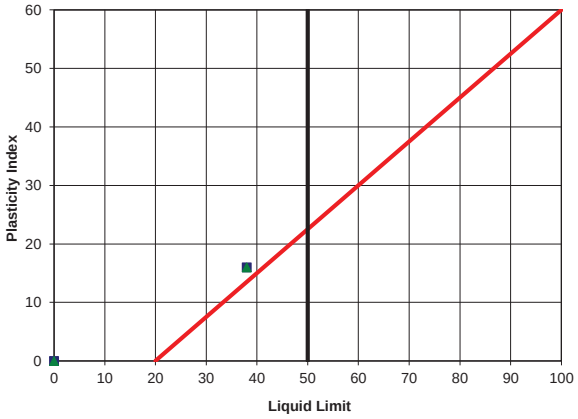
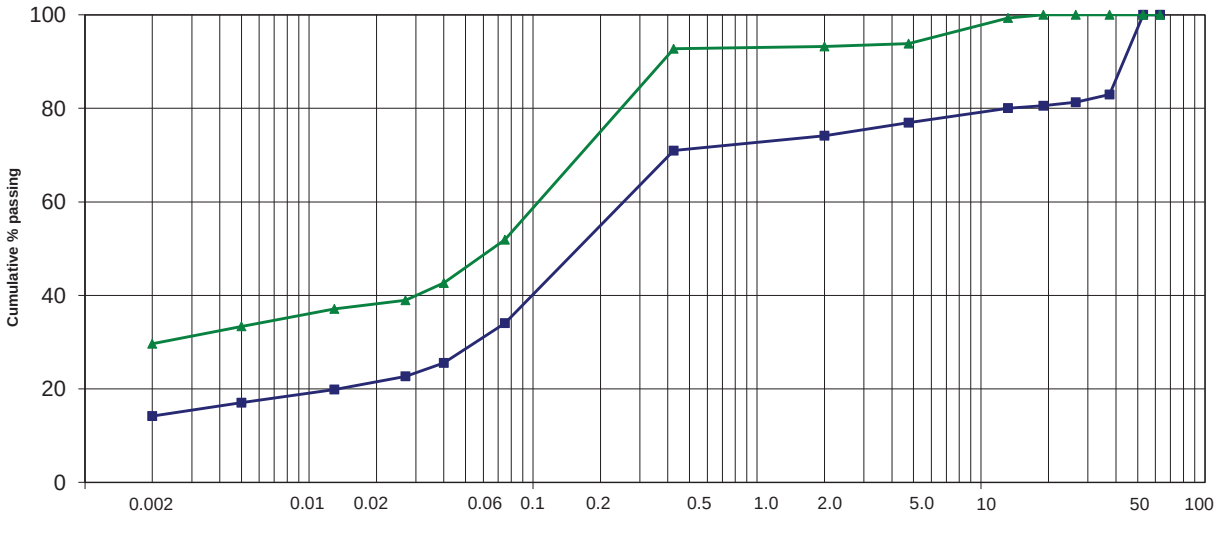




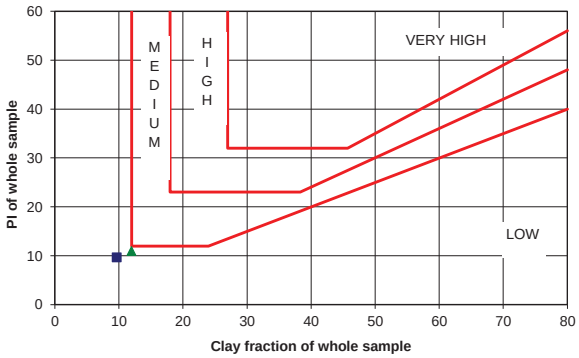
0502-05.xls

PARTICLE SIZE ANALYSIS

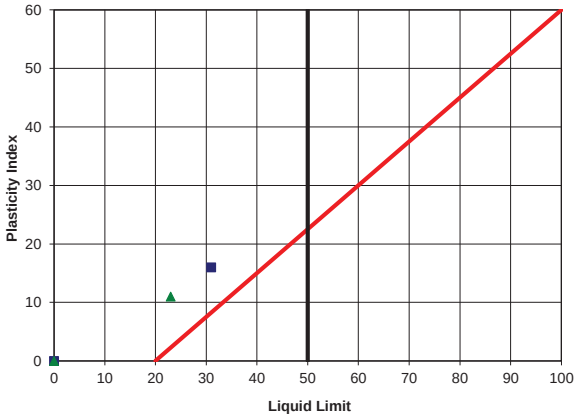
Sample No.	09	10
Soillab sample no.	2015-S-0502-9	2015-S-0502-10
Depth (m)	1.3	1.9
Position	DA11	GF08
Material Description	LIGHT OLIVE GRAVELLY SAND	DARK RED BROWN SILTY SAND
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	96	100
4.75 mm	84	100
2.00 mm	74	100
0.425 mm	60	100
0.075 mm	29	56
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	23	40
0.027 mm	21	30
0.013 mm	16	26
0.005 mm	13	16
0.002 mm	10	12
% Clay	10	12
% Silt	17	37
% Sand	47	51
% Gravel	26	0
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	31	23
Plasticity Index	16	11
Linear Shrinkage (%)	7.0	5.0
Grading Modulus	1.37	0.44
Uniformity coefficient	191	-
Coefficient of curvature	7.0	-
Classification	A-2-6 (1)	A-6 (3)
Unified Classification	SC	CL
Chart Reference		

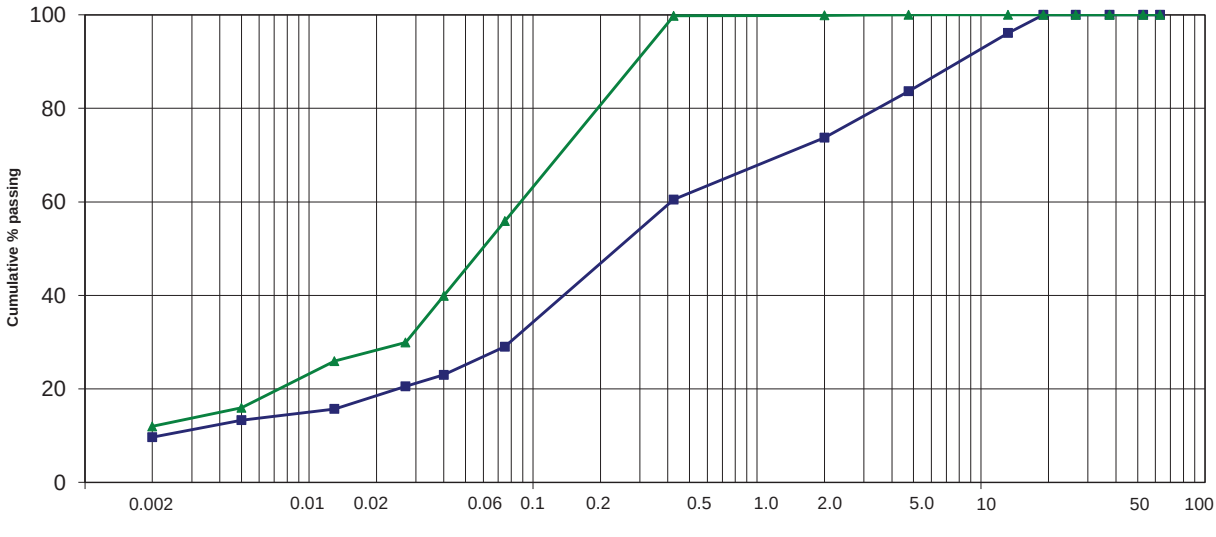
PROJECT : MASELSPOORT
JOB No. : 2015-S-0502
DATE : 13/04/2015

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





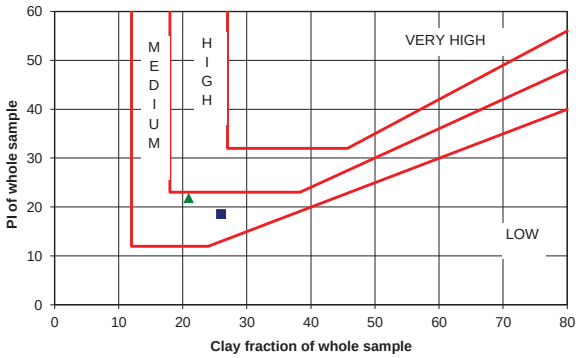
0502-06.xls

PARTICLE SIZE ANALYSIS

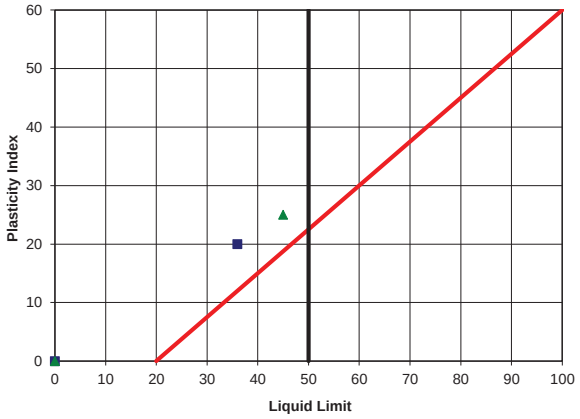
Sample No.	11	12
Soillab sample no.	2015-S-0502-11	2015-S-0502-12
Depth (m)	1.8	1.4
Position	GF01	DA07B
Material Description	DARK BROWN SILTY SAND	LIGHT RED BROWN SANDY SILT
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	98	99
4.75 mm	97	95
2.00 mm	96	92
0.425 mm	93	87
0.075 mm	63	68
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	52	63
0.027 mm	46	59
0.013 mm	37	44
0.005 mm	30	28
0.002 mm	26	21
% Clay	26	21
% Silt	32	45
% Sand	37	26
% Gravel	4	8
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	36	45
Plasticity Index	20	25
Linear Shrinkage (%)	10.0	10.5
Grading Modulus	0.49	0.53
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-6 (10)	A-7-6 (15)
Unified Classification	CL	CL
Chart Reference		

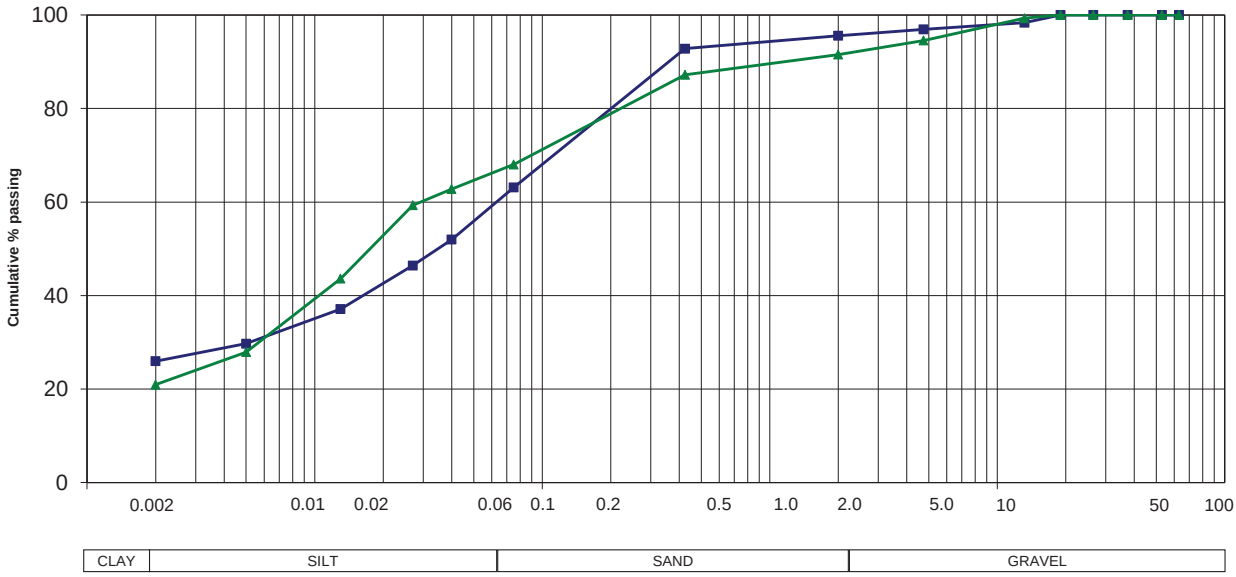
PROJECT : MASELSPOORT
JOB No. : 2015-S-0502
DATE : 13/04/2015

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





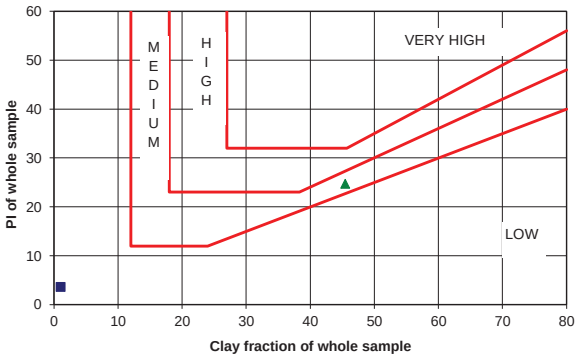
0502-07.xls

PARTICLE SIZE ANALYSIS

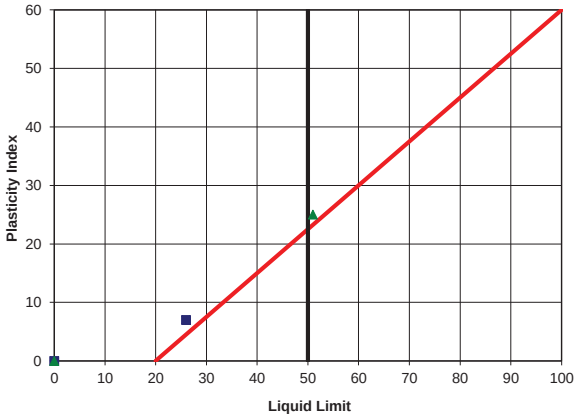
Sample No.	13	14
Soillab sample no.	2015-S-0502-13	2015-S-0502-14
Depth (m)	1.7	1.8
Position	GB06	GF04
Material Description	LIGHT RED GRAVELLY SAND	DARK BROWN SILTY CLAY
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	98	100
4.75 mm	95	100
2.00 mm	68	99
0.425 mm	52	99
0.075 mm	24	79
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	15	73
0.027 mm	10	71
0.013 mm	5	65
0.005 mm	2	53
0.002 mm	1	45
% Clay	1	45
% Silt	19	31
% Sand	48	23
% Gravel	32	1
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	26	51
Plasticity Index	7	25
Linear Shrinkage (%)	3.5	12.0
Grading Modulus	1.56	0.23
Uniformity coefficient	36	-
Coefficient of curvature	0.5	-
Classification	A-2-4 (0)	A-7-6 (21)
Unified Classification	SM & SC	CH
Chart Reference		

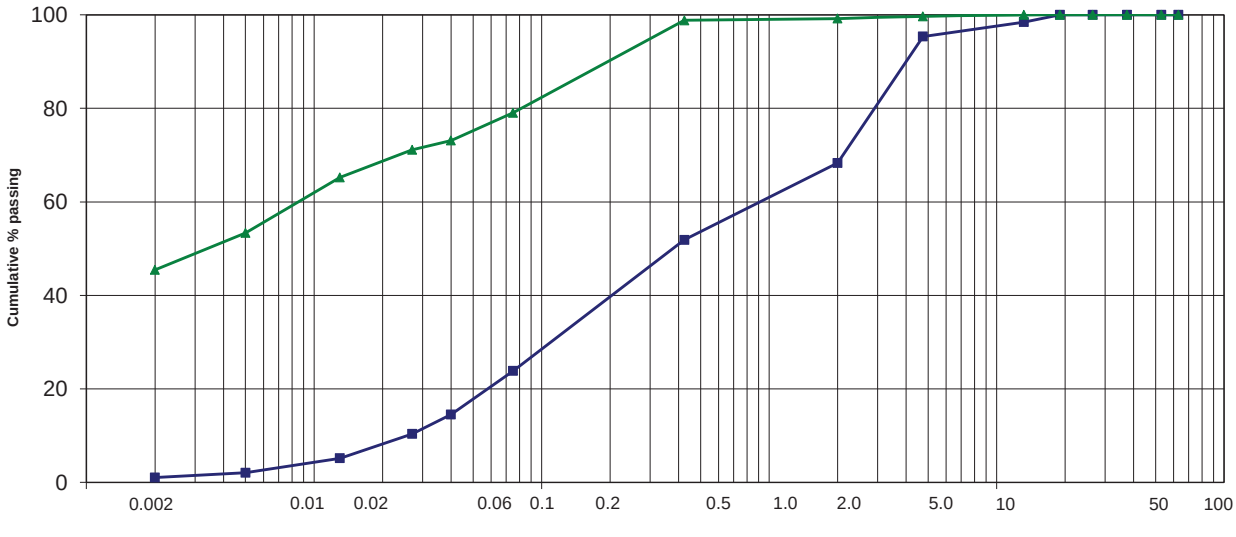
PROJECT : MASELSPOORT
JOB No. : 2015-S-0502
DATE : 13/04/2015

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





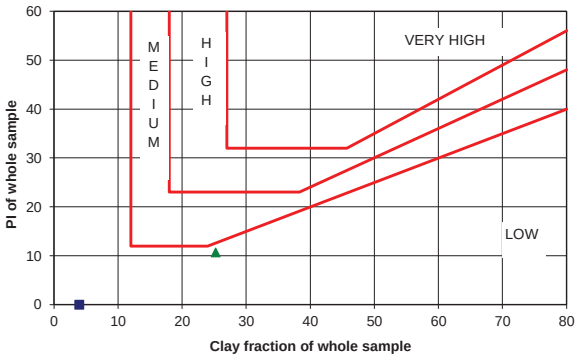
0502-08.xls

PARTICLE SIZE ANALYSIS

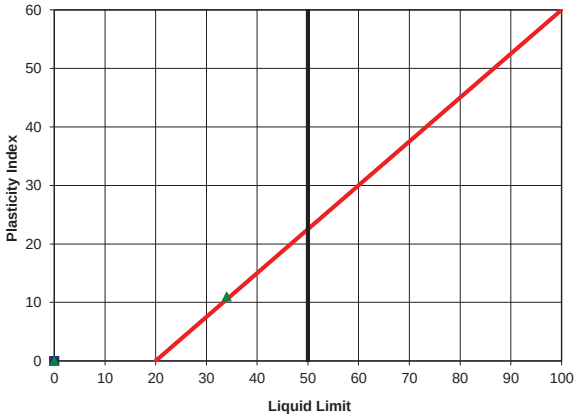
Sample No.	15	16
Soillab sample no.	2015-S-0502-15	2015-S-0502-16
Depth (m)	2.6	1.4
Position	E-DAM	DA01
Material Description	LIGHT BROWN SILTY SAND	DARK BROWN CLAYEY SAND
Moisture (%)		
Dispersion (%)		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	100	100
4.75 mm	100	98
2.00 mm	100	97
0.425 mm	99	97
0.075 mm	40	56
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	20	41
0.027 mm	16	35
0.013 mm	10	31
0.005 mm	8	29
0.002 mm	4	25
% Clay	4	25
% Silt	27	24
% Sand	69	48
% Gravel	0	3
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit		34
Plasticity Index	SP	11
Linear Shrinkage (%)	1.0	5.5
Grading Modulus	0.61	0.49
Uniformity coefficient	10	-
Coefficient of curvature	1.7	-
Classification	A-4 (0)	A-6 (4)
Unified Classification	SM	CL
Chart Reference		

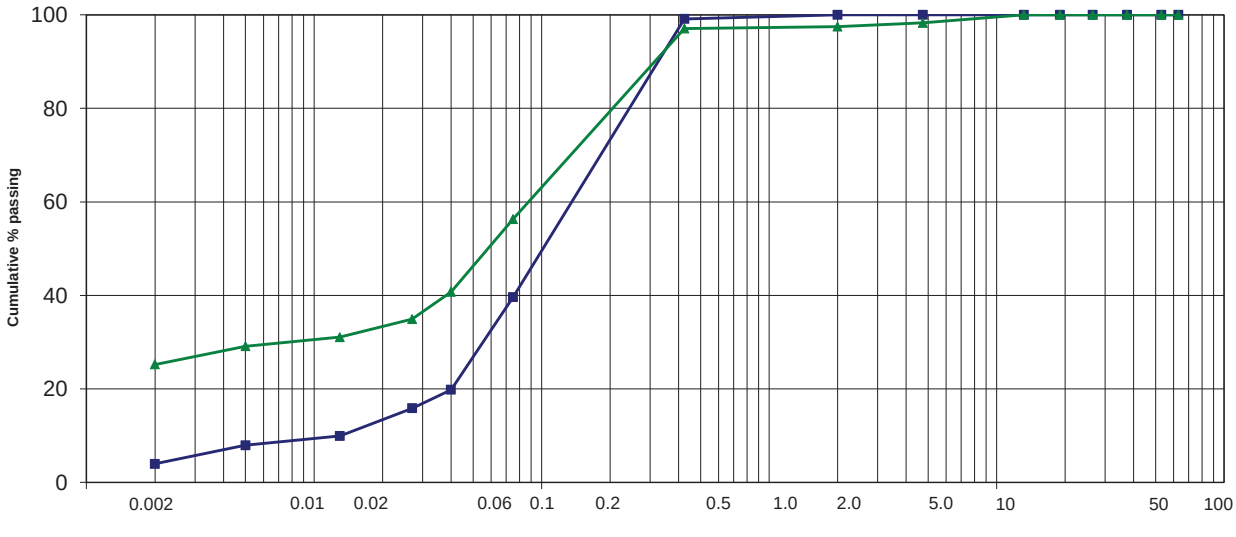
PROJECT : MASELSPOORT
JOB No. : 2015-S-0502
DATE : 13/04/2015

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





CLAY	SILT	SAND	GRAVEL

Client:	SMEC SA - GEOTECHNICAL
Project:	MASELSPOORT PIPELINE
Project No.:	2015-S-0502
Date:	2015-04-22

TEST RESULTS: CHEMICAL

Soillab No	Sample No	pH TMH 1 A20	Conductivity TMH 1 A21T	Cl content (%) *SABS 830	Soluble SO_3 (%) *TMH 1 B17T
2015-S-0502-01	DA13 1.2	8.09	0.0947	0.0035	0.0151
2015-S-0502-02	FC03 1.8	8.04	0.0854	0.0145	0.0113
2015-S-0502-03	DA06 1.1	8.06	0.0453	0.0064	0.0096
2015-S-0502-04	AG08 1.4	8.19	0.3080	0.0376	0.0405
2015-S-0502-05	AG12 2.0	8.49	0.1960	0.0177	0.0079
2015-S-0502-10	GF08 1.9	7.86	0.3450	0.0383	0.0441
2015-S-0502-13	GB06 1.7	8.44	0.0466	0.0039	0.0058
2015-S-0502-14	GF04 1.8	7.88	0.3500	0.0401	0.0335
2015-S-0502-15	E-DAM 2.6	8.43	0.0882	0.0131	0.0099

Note * Not Accredited

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Consolidated Undrained Triaxial

Results Summary

Project:	Maselspoort Pipeline
Client:	SMEC South Africa
Geolab Job Nr:	G15-0041
Test Method:	BS1377-8:1990

Sample Nr:	AG01
Sample Depth:	2.4m
Date:	2015/05/14

Results		
ϕ' =	**24.6**	**°**
c' =	**8.8**	**kPa**

Sampling Method:	Bag
Disturbed/Undist:	Disturbed
Remoulded To:	1600 kg/m³

Initial Sample Details	**1**	**2**	**3**	
Sample Length:	100	100	100	mm
Sample Diameter:	50	50	50	mm
Sample Mass:	313.8	314.2	314.1	g
Dry Density:	1421	1423	1420	kg/m³
Density:	1598	1600	1600	kg/m³
Void Ratio:	0.871	0.869	0.873	
Moisture Content:	12.2	12.2	12.4	%
Specific Gravity:		2.659		Mg/m³

Flush Stage	**1**	**2**	**3**	
Volume Change:	7.9	5.9	7.7	ml
% Volume Change:	4.0	3.0	3.9	%

Saturation Stage	**1**	**2**	**3**	
Final B Value	0.97	0.97	0.96	
Final Back Pressure	400	399	300	kPa

Consolidation Stage	**1**	**2**	**3**	
Effective Stress:	100	200	400	kPa
Volume Change:	29.88	28.861	34.537	ml
Height After Consolidation:	95.12	95.24	94.36	mm
Diameter After Consolidation:	48.32	48.14	47.82	mm
Void Ratio Before Consolidation:	0.946	0.925	0.946	
Void Ratio After Consolidation:	0.662	0.650	0.617	
Coef Of Volume Comp (m_{vi}):	2.847	1.373	0.823	m²/MN
Coefficient Of Consolidation (c_v):	0.028	0.038	0.034	m²/year

Shear Stage	**1**	**2**	**3**	
Rate of Shear:	0.00158	0.00218	0.00193	mm/min
Failure Criteria:		Maximum Stress Ratio		
Deviator Stress at Failure:	73.7	134.0	239.2	kPa
Stress Ratio at Failure:	3.3	2.8	2.6	
Strain at Failure:	5.5	5.8	5.9	%

Final Sample Details	**1**	**2**	**3**	
Dry Density:	1600	1612	1645	kg/m³
Density:	2049	2019	2025	kg/m³
Void Ratio:	0.662	0.650	0.617	
Moisture Content:	25.80	23.01	20.84	%

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Consolidated Undrained Triaxial

Consolidation Stage

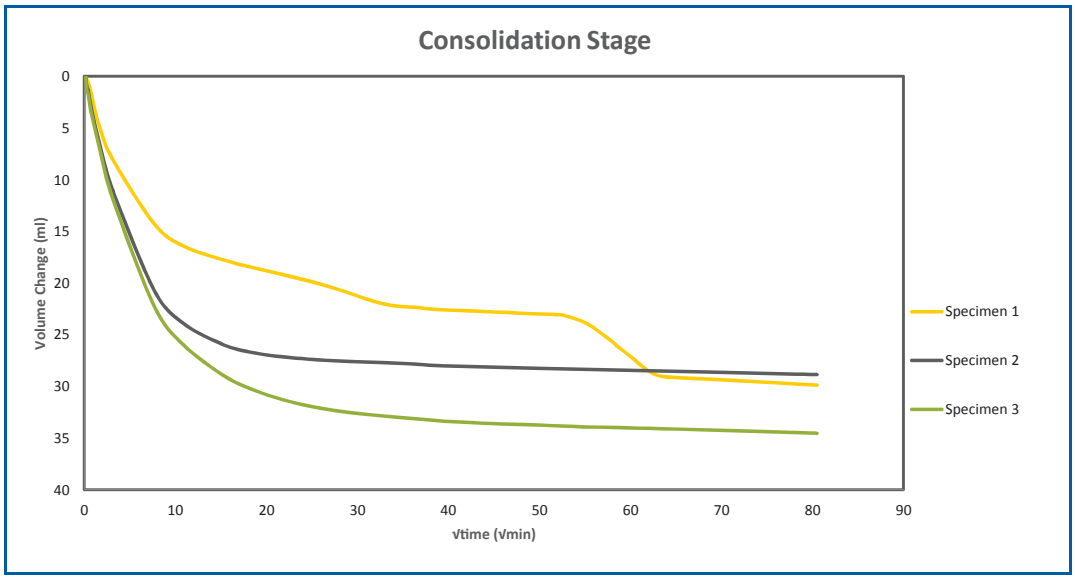
Project:	Maselspoort Pipeline
Client:	SMEC South Africa
Geolab Job Nr:	G15-0041

Sample Nr:	AG01
Sample Depth:	2.4m
Date:	2015/05/14

Initial Conditions	1	2	3	
Initial Cell Pressure:	600	700	800	kPa
Initial Back Pressure:	500	500	400	kPa
Void Ratio:	0.946	0.925	0.946	
Drainage Method:	From radial boundary and one end			

Final Conditions	1	2	3	
Volume Change:	29.9	28.9	34.5	
Volumetric Strain:	14.63	14.27	16.93	%
Corrected Length:	95.12	95.24	94.36	mm
Corrected Diameter:	48.32	48.14	47.82	mm
Void Ratio:	0.662	0.650	0.617	

Calculations and Parameters	1	2	3	
t_{100}:	1690	1216	1355	min
Coeff of Consolidation (c_v):	0.03	0.04	0.03	m²/year
Calculated Shear Speed:	0.0016	0.0022	0.0019	mm/min
Coeff of Volume Comp (m_{vl}):	2.847	1.373	0.823	m²/MN



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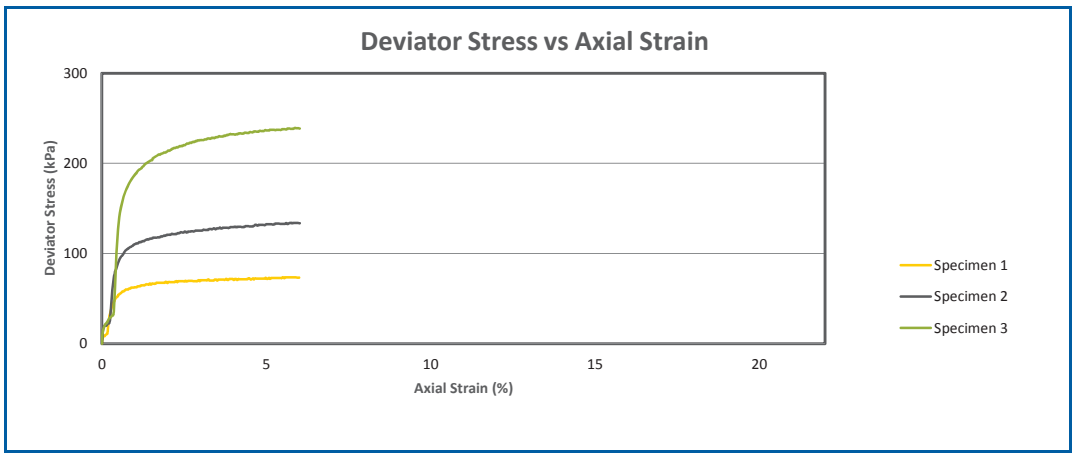
Consolidated Undrained Triaxial

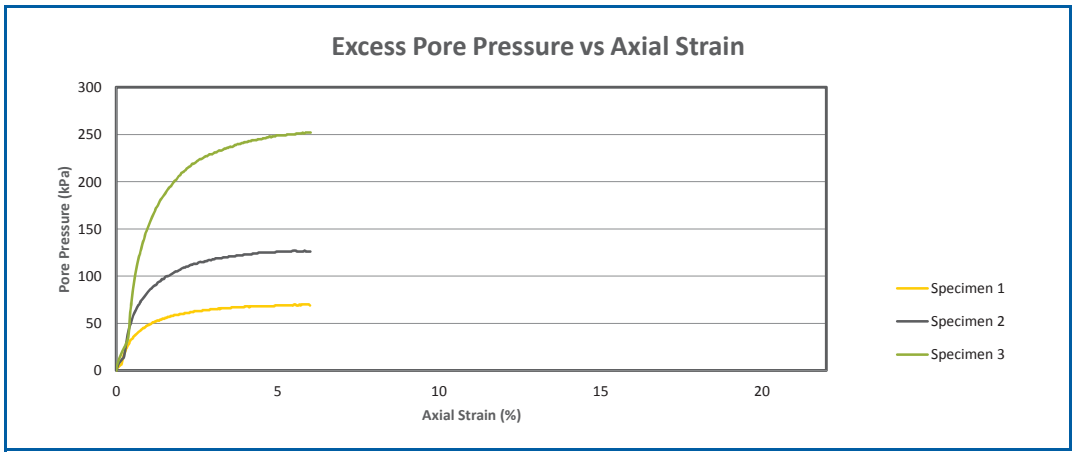
Shear Stage

Project:	Maselspoort Pipeline
Client:	SMEC South Africa
Geolab Job Nr:	G15-0041

Sample Nr:	AG01
Sample Depth:	2.4m
Date:	2015/05/14

Shear	**1**	**2**	**3**	
σ_1' at Failure:	105.7	209.0	387.2	kPa
σ_3' at Failure:	32.0	75.0	148.0	kPa
Failure Criteria:	Maximum Stress Ratio			
Deviator Stress at Failure:	73.7	134.0	239.2	kPa
Stress Ratio at Failure:	3.30	2.79	2.62	
Strain at Failure:	5.51	5.84	5.86	%
Calculated Shear Speed:	0.0016	0.0022	0.0019	mm/min
Actual Shear Speed:	0.0016	0.0022	0.0019	mm/min





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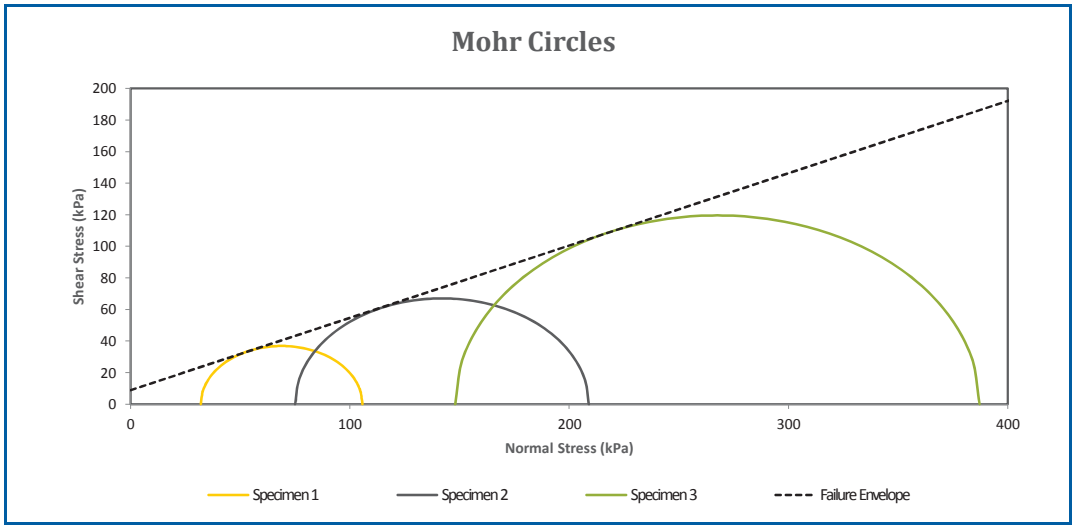
Consolidated Undrained Triaxial

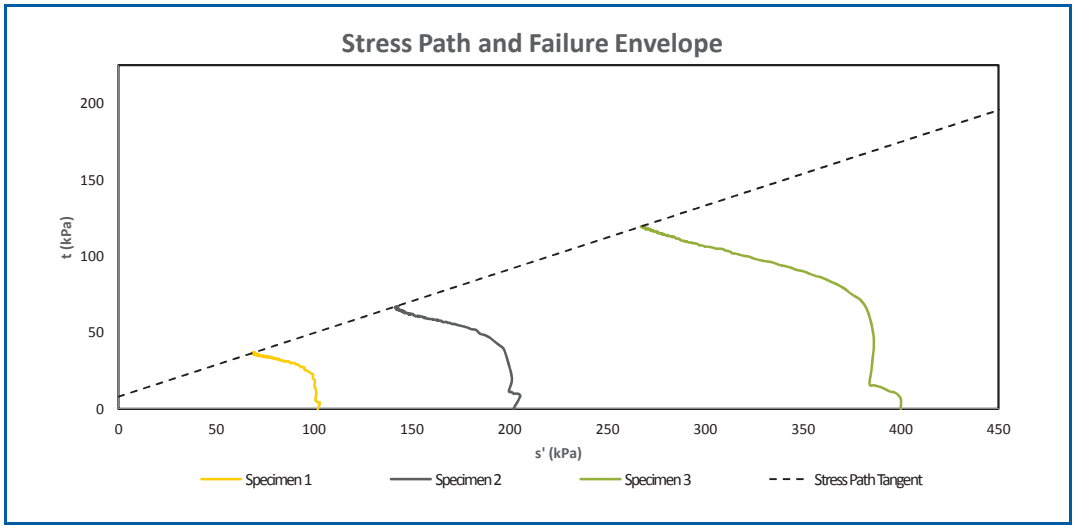
Shear Stage

Project:	Maselspoort Pipeline
Client:	SMEC South Africa
Geolab Job Nr:	G15-0041

Sample Nr:	AG01
Sample Depth:	2.4m
Date:	2015/05/14

Results			
θ=	**22.6**	**°**	*Stress Path Tangent*
t_0=	**8.0**	**kPa**	
ϕ' =	**24.6**	**°**	*Mohr-Coulomb Failure Envelope*
c' =	**8.8**	**kPa**	





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Consolidated Undrained Triaxial

Results Summary

Project:	Maselspoort Pipeline
Client:	SMEC South Africa
Geolab Job Nr:	G15-0041
Test Method:	BS1377-8:1990

Sample Nr:	E-dam
Sample Depth:	2.6m
Date:	2015/05/11

Results		
ϕ' =	**31.3**	**°**
c' =	**0.0**	**kPa**

Sampling Method:	Bag
Disturbed/Undist:	Disturbed
Remoulded To:	In-situ density

Initial Sample Details	**1**	**2**	**3**	
Sample Length:	100	100	100	mm
Sample Diameter:	50	50	50	mm
Sample Mass:	281.1	280.9	279.7	g
Dry Density:	1292	1295	1331	kg/m³
Density:	1432	1431	1425	kg/m³
Void Ratio:	1.073	1.068	1.012	
Moisture Content:	10.6	10.2	6.9	%
Specific Gravity:		2.678		Mg/m³

Flush Stage	**1**	**2**	**3**	
Volume Change:	3.3	2.4	2.3	ml
% Volume Change:	1.7	1.2	1.2	%

Saturation Stage	**1**	**2**	**3**	
Final B Value	0.97	0.97	0.97	
Final Back Pressure	600	599	600	kPa

Consolidation Stage	**1**	**2**	**3**	
Effective Stress:	100	200	400	kPa
Volume Change:	1.908	5.068	8.143	ml
Height After Consolidation:	99.68	99.15	98.63	mm
Diameter After Consolidation:	50.25	49.87	49.59	mm
Void Ratio Before Consolidation:	1.108	1.093	1.036	
Void Ratio After Consolidation:	1.088	1.039	0.953	
Coef Of Volume Comp (m_{vi}):	0.201	0.267	0.209	m²/MN
Coefficient Of Consolidation (c_v):	153.2	57.7	76.1	m²/year

Shear Stage	**1**	**2**	**3**	
Rate of Shear:	0.01685	0.01681	0.01681	mm/min
Failure Criteria:		Maximum Stress Ratio		
Deviator Stress at Failure:	15.3	34.8	94.6	kPa
Stress Ratio at Failure:	2.9	3.3	3.2	
Strain at Failure:	20.0	19.6	12.9	%

Final Sample Details	**1**	**2**	**3**	
Dry Density:	1283	1313	1371	kg/m³
Density:	1672	1703	1759	kg/m³
Void Ratio:	1.088	1.039	0.953	
Moisture Content:	27.84	27.21	25.83	%

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Consolidation Stage

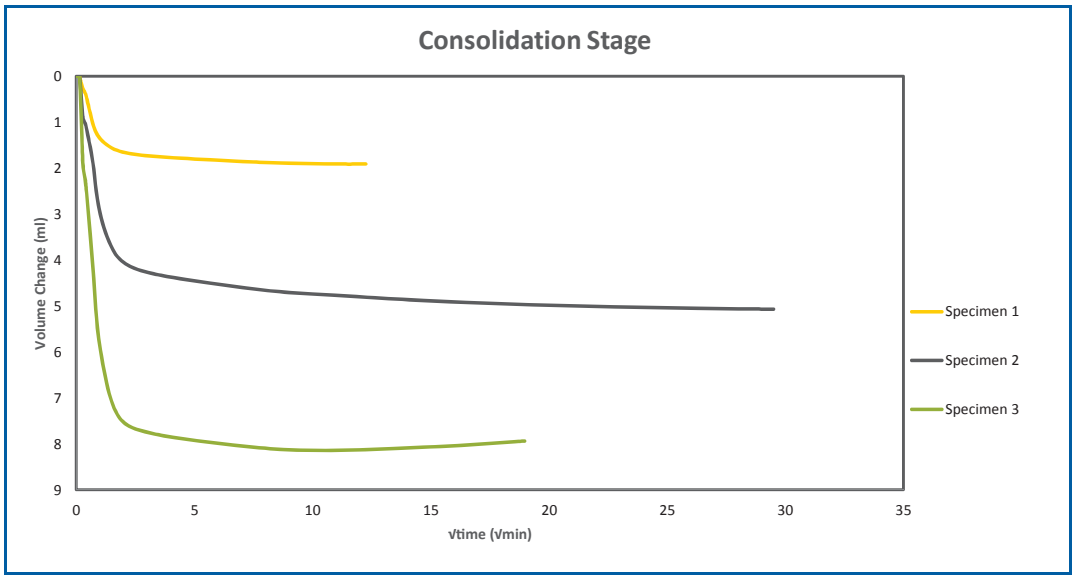
Project:	Maselspoort Pipeline
Client:	SMEC South Africa
Geolab Job Nr:	G15-0041

Sample Nr:	E-dam
Sample Depth:	2.6m
Date:	2015/05/11

Initial Conditions	1	2	3	
Initial Cell Pressure:	800	900	1000	kPa
Initial Back Pressure:	700	700	600	kPa
Void Ratio:	1.108	1.093	1.036	
Drainage Method:	From one end only			

Final Conditions	1	2	3	
Volume Change:	1.9	5.1	8.1	
Volumetric Strain:	0.96	2.55	4.10	%
Corrected Length:	99.68	99.15	98.63	mm
Corrected Diameter:	50.25	49.87	49.59	mm
Void Ratio:	1.088	1.039	0.953	

Calculations and Parameters	1	2	3	
t_{100}:	28	74	56	min
Coeff of Consolidation (c_v):	153.25	57.65	76.12	m²/year
Calculated Shear Speed:	0.0167	0.0167	0.0167	mm/min
Coeff of Volume Comp (m_{vl}):	0.201	0.267	0.209	m²/MN



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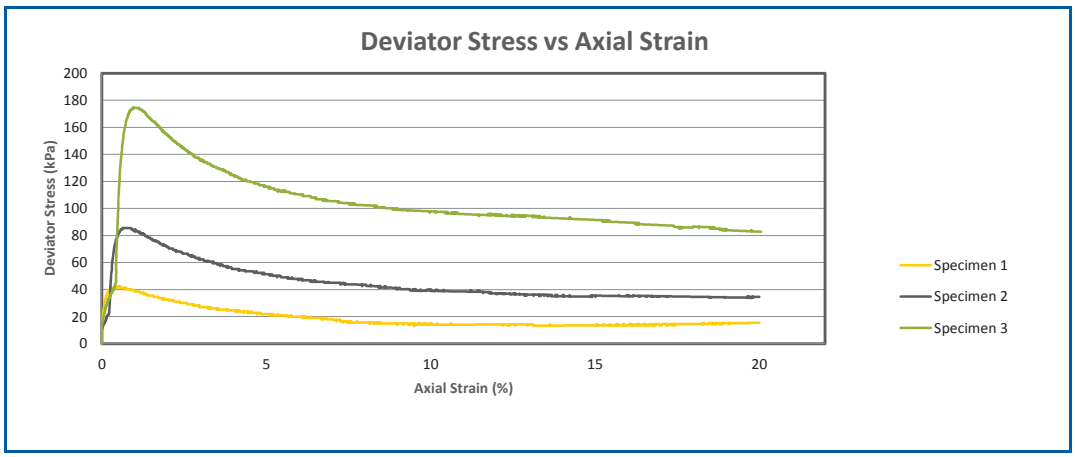
Consolidated Undrained Triaxial

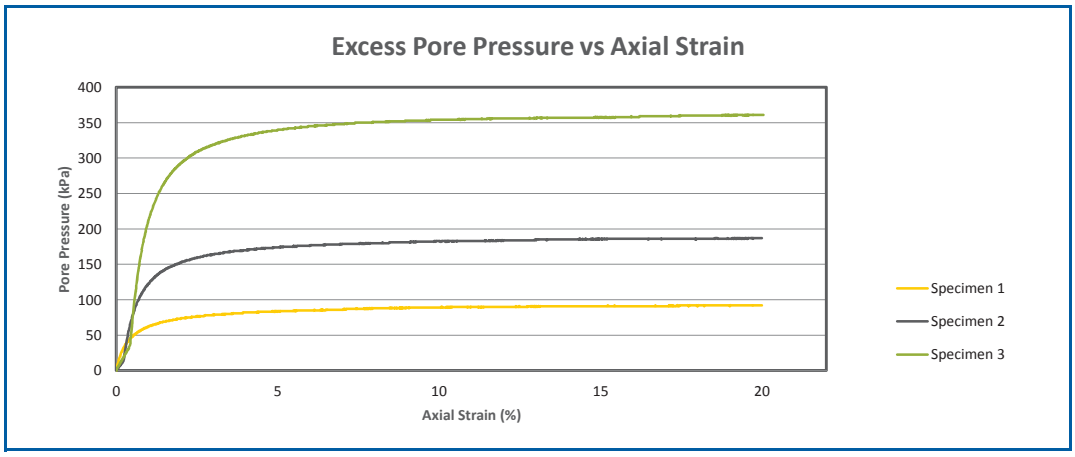
Shear Stage

Project:	Maselspoort Pipeline
Client:	SMEC South Africa
Geolab Job Nr:	G15-0041

Sample Nr:	E-dam
Sample Depth:	2.6m
Date:	2015/05/11

Shear	**1**	**2**	**3**	
σ_1' at Failure:	23.3	49.8	138.6	kPa
σ_3' at Failure:	8.0	15.0	44.0	kPa
Failure Criteria:	Maximum Stress Ratio			
Deviator Stress at Failure:	15.3	34.8	94.6	kPa
Stress Ratio at Failure:	2.92	3.32	3.15	
Strain at Failure:	19.95	19.64	12.95	%
Calculated Shear Speed:	0.0167	0.0167	0.0167	mm/min
Actual Shear Speed:	0.0168	0.0168	0.0168	mm/min





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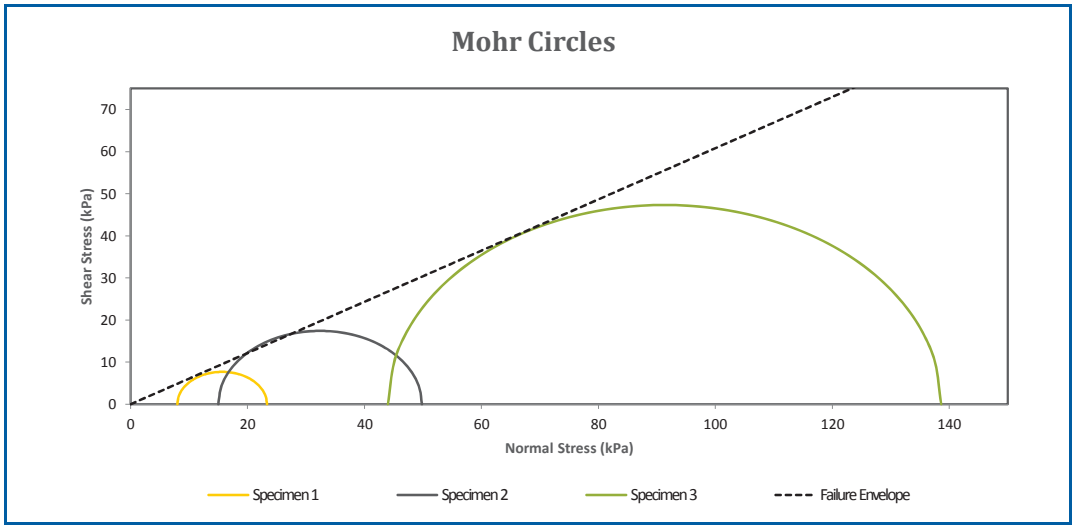
Consolidated Undrained Triaxial

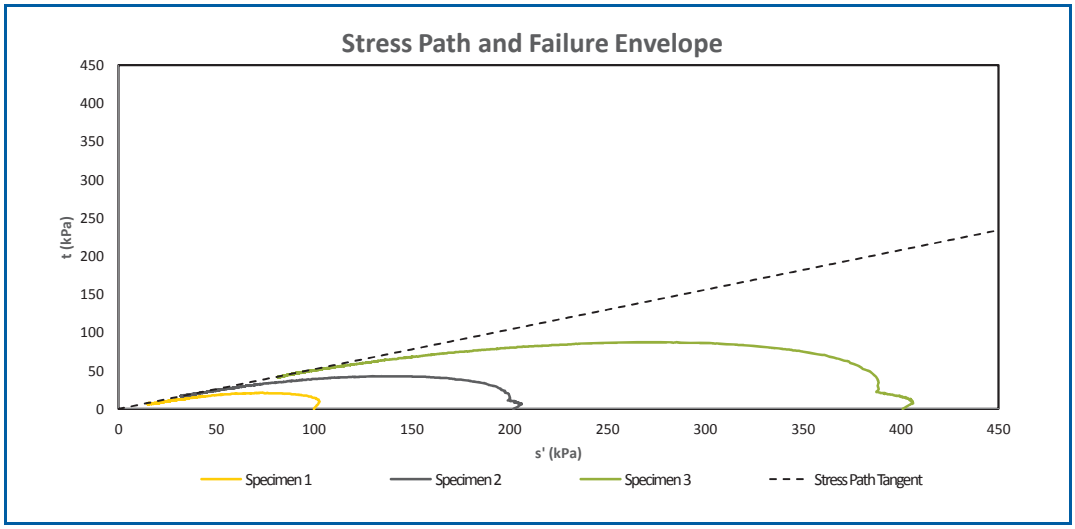
Shear Stage

Project:	Maselspoort Pipeline
Client:	SMEC South Africa
Geolab Job Nr:	G15-0041

Sample Nr:	E-dam
Sample Depth:	2.6m
Date:	2015/05/11

Results			
θ=	**27.5**	**°**	*Stress Path Tangent*
t_0=	**0.0**	**kPa**	
ϕ' =	**31.3**	**°**	*Mohr-Coulomb Failure Envelope*
c' =	**0.0**	**kPa**	





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Shearbox

Project:	Maselspoort Pipeline
Client:	SMEC South Africa
Geolab Job Nr:	G15-0041
Test Method:	ASTM 3080-72

Sample Nr:	FC03
Sample Depth:	1.8m
Date:	2015/05/14

Results		
ϕ' =	31.4	°
c' =	3.9	kPa

Sampling Method:	Bag
Disturbed/Undist:	Disturbed
Remoulded To:	In-situ density

Initial Sample Details	1	2	3	
Sample Height:	21	21	21	mm
Sample Diameter:	60	60	60	mm
Sample Mass	87.00	87.00	86.90	g
Dry Density:	1226.1	1256.4	1242.9	kg/m³
Density:	1465.2	1465.2	1463.6	kg/m³
Void Ratio:	1.150	1.098	1.121	
Moisture Content:	10.9	8.2	9.2	%
Specific Gravity		2.636		kg/m³

Shear Stage	1	2	3	
Rate of Shear:	0.003	0.003	0.003	mm/min
Normal Stress:	99.9	200.2	400.1	kPa
Max Shear Stress:	68.5	120.7	250.0	kPa
Strain at Failure:	15.49	11.22	11.94	%

Final Sample Details	1	2	3	
Sample Weight:	96.1	97.1	96.3	g
Moisture Content:	23.4	21.7	22.0	%

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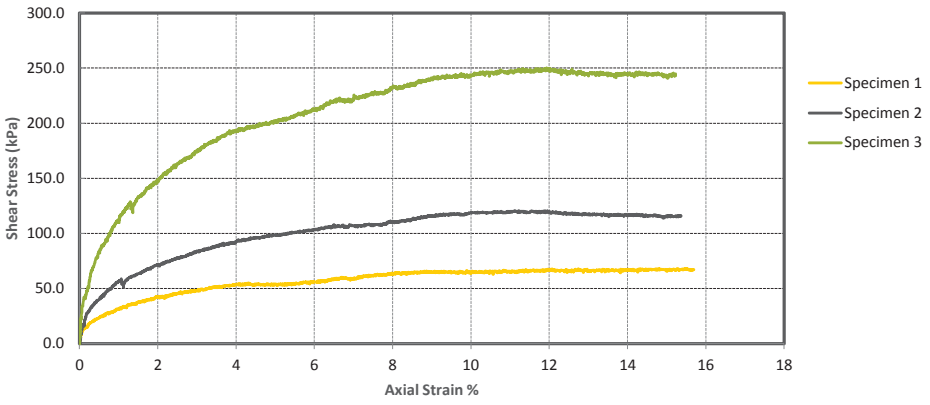
Shearbox

Project:	Maselspoort Pipeline
Client:	SMEC South Africa
Geolab Job Nr:	G15-0041
Test Method:	ASTM 3080-72

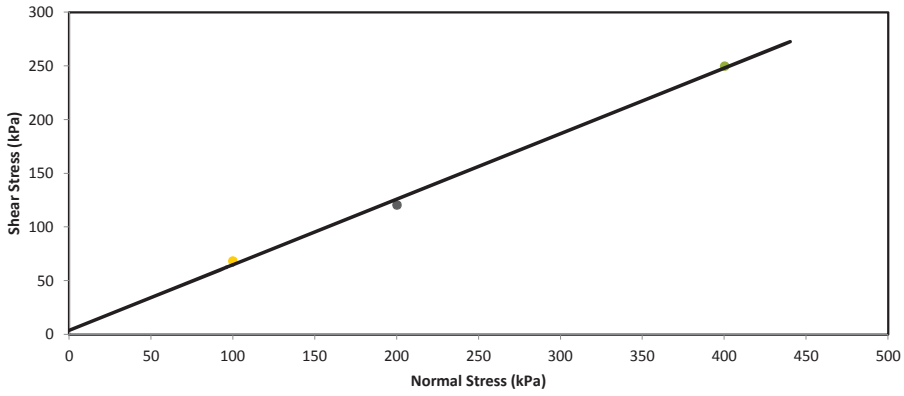
Sample Nr:	FC03
Sample Depth:	1.8m
Date:	2015/05/14

Results		
ϕ' =	31.4	°
c' =	3.9	kPa

Shear Stress vs Axial Strain



Failure Envelope



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CLIENT : **SMEC SOUTH AFRICA (PTY) LTD**
267 Kent Avenue
Ferndale
RANDBURG
2125

DATE : 10/06/2015
REFERENCE : SL / 2488
DOCUMENT No.: 015/1196 (b)
ORDER No.: -
NUMBER OF PAGES : 1 of 3

ATTENTION : Mr Tinus Grobler
PROJECT : Maselspoort Pipeline, Bloemfontein

TEST REPORT

SAMPLE / LABORATORY No. :	Sample 1 - 7: 015/1196 - 015/1202
DATE SAMPLE RECEIVED :	07/05/2015
DATE SAMPLE TESTED :	07/05/2015 - 04/06/2015
TESTING LABORATORY :	Simlab (Pty) Limited - Geotechnical Services (Bloemfontein)
SAMPLE REPORTED BY :	Zanelle van Eeden (Technical Assisstant)
DATE SAMPLED :	07/05/2015
LOCATION SAMPLED :	Maselspoort Pipeline, Bloemfontein
SAMPLE METHOD :	Sampled by client
ENVIRONMENTAL CONDITIONS DURING SAMPLING :	Not supplied
SAMPLE CONDITION :	Material in good condition.
CLIENT REFERENCE / MARKINGS :	Maselspoort Pipeline, Bloemfontein

TEST METHODS :

1.) The wet preparation and sieve analysis of gravel, sand and soil samples, TMH1 : 1986, Method A1(a)
2.) The determination of the liquid limit of soils by means of the flow curve method (One Point Method), THM1, 1986, Method A2
3.) The determination of the plastic limit and plasticity index of soils, TMH1 : 1986, Method A3
4.) The determination of the linear shrinkage of soils, THM1 : 1986, Method A4
5.) The determination of the percentage of material passing a 0.075mm sieve in a soil sample, TMH1 : 1986, Method A5
6.) *The determination of the grain size distribution in soils by means of a hydrometer, TMH1 : 1986, Method A6
7.) The determination of the maximum dry density and optimum moisture content of gravel, soil and sand, TMH1, 1986, Method A7
8.) *The determination of the moisture content of a field sample, TMH1 : 1986, Method A17
9.) *The determination of the potential expansiveness of soil according to Van Der Merwe's method.

REMARKS : * Tests marked "Not SANAS Accredited" in this report are not in the SANAS Schedule of Accreditation for this laboratory.
* The descriptions are left out by the clients request - SMEC South Africa (Pty) Limited.

NOTE : Report continues on next page, see attached sheet 2 of 2

Z VAN EEDEN (Technical Assisstant)
for : SIMLAB (PTY) LIMITED - GEOTECHNICAL SERVICES

BJ VAN VUUREN (Technologist)
(Technical Signatory)

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DOCUMENT No.: 015/1196 (b)

CLIENT & PROJECT : SMEC SOUTH AFRICA (PTY) LTD - Maselspoort Pipeline, Bloemfontein					DATE : 10/06/2015
HOLE No. / KM (Chainage)			DAX1	DAX1	DAX2	DAX3
MATERIAL DEPTH (mm)			1800	3400	1200	1500
SAMPLE / LABORATORY No.			015/1196	015/1197	015/1198	015/1199
MATERIAL DESCRIPTION						
* IN SITU FIELD MOISTURE (%)			21.3	22.9	8.9	8.2
UNIFIED SOIL CLASSIFICATION						
TRH14 / * COLTO CLASSIFICATION						
SIEVE ANALYSIS, PERCENTAGE OF MATERIAL PASSING 0.075 mm SIEVE (TMH 1 : 1986, METHOD A1 (a), A5) - % PASSING SIEVES						
SIEVE ANALYSIS		63.0 mm				
		53.0 mm				
		37.5 mm				100
		26.5 mm			100	93
		19.0 mm			97	88
		13.2 mm	100	100	92	80
		4.75 mm	96	99	78	65
		2.00 mm	92	98	68	58
		0.425 mm	88	97	47	48
		0.075 mm	66	58	27	33
		0.002 mm	26	31	4	10
SOIL MORTAR		COARSE SAND	5	1	30	17
		FINE SAND	2 / 5 / 16	6 / 13 / 22	11 / 8 / 11	5 / 8 / 14
		MATERIAL<0.075 mm	72	59	40	56
GRADING MODULUS (GM)			0.54	0.47	1.58	1.61
ATTERBERG LIMITS ANALYSIS (TMH 1 : 1986, METHOD A2, A3, & A4), PH VALUE & CONDUCTIVITY (TMH 1 : 1986, METHOD A20 & A21T)						
ATTERBERG LIMITS PASSING SIEVE 0.425mm		L.L (%)	55	42	33	34
		P.I. / L.S. (%)	27 / 12.8	16 / 8.0	10 / 4.6	16 / 7.7
POTENTIAL EXPANSIVENESS (mm)			High / 27.1	Medium / 39.7	Low	Low
pH VALUE / CONDUCTIVITY (Sm^{-1})			8.73 / 0.5349	8.65 / 0.3209	8.19 / 0.2529	8.05 / 0.2626
MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT, CALIFORNIA BEARING RATIO ANALYSIS (TMH 1 : 1986, METHOD A7 & A8) UNCONFINED COMPRESSIVE STRENGTH & INDIRECT TENSILE STRENGTH OF STABILISED MATERIAL (TMH 1 : 1986, METHOD A13T, A14 & A16T)						
CBR / UCS / ITS DETERMINATION	MOD AASHTO	MAX DRY DENSITY (kg/m^3)	1750	1690		1931
		OPT MOISTURE (%)	15.7	5.6		10.1
		COMP MOISTURE (%)				
		DRY DENSITY (kg/m^3)				
		CBR (%)				
		SWELL (%)				
		UCS (KPa)				
		ITS (KPa)				
	NRB	DRY DENSITY (kg/m^3)				
		CBR (%)				
	PROCTOR	MAX DRY DENSITY (kg/m^3)				
		OPT MOISTURE (%)				
		CBR (%)				
	CBR	100%				
		98%				
		95%				
		93%				
		90%				

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DOCUMENT No.: 015/1196 (b)

CLIENT & PROJECT : SMEC SOUTH AFRICA (PTY) LTD - Maselspoort Pipeline, Bloemfontein					DATE : 10/06/2015
HOLE No. / KM (Chainage)		AX1	CX01		
MATERIAL DEPTH (mm)		3200	2900		
SAMPLE / LABORATORY No.		015/1200	015/1201		
MATERIAL DESCRIPTION					
* IN SITU FIELD MOISTURE (%)		10.5	12.1		
UNIFIED SOIL CLASSIFICATION					
TRH14 / * COLTO CLASSIFICATION					
SIEVE ANALYSIS, PERCENTAGE OF MATERIAL PASSING 0.075 mm SIEVE (TMH 1 : 1986, METHOD A1 (a), A5) - % PASSING SIEVES					
SIEVE ANALYSIS	63.0 mm				
	53.0 mm				
	37.5 mm				
	26.5 mm				
	19.0 mm	100			
	13.2 mm	97			
	4.75 mm	94	100		
	2.00 mm	92	99		
	0.425 mm	89	96		
	0.075 mm	54	59		
	0.002 mm	18	23		
SOIL MORTAR	COARSE SAND	3	4		
	FINE SAND	4 / 9 / 26	10 / 10 / 18		
	MATERIAL<0.075 mm	58	59		
GRADING MODULUS (GM)		0.65	0.46		
ATTERBERG LIMITS ANALYSIS (TMH 1 : 1986, METHOD A2, A3, & A4), PH VALUE & CONDUCTIVITY (TMH 1 : 1986, METHOD A20 & A21T)					
ATTERBERG LIMITS PASSING SIEVE 0.425mm	L.L (%)	28	31		
	P.I. / L.S. (%)	12 / 6.2	18 / 8.8		
POTENTIAL EXPANSIVENESS (mm)		Low	Medium / 36.6		
pH VALUE / CONDUCTIVITY (Sm^{-1})		8.37 / 0.3598	8.33 / 0.2820		
MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT, CALIFORNIA BEARING RATIO ANALYSIS (TMH 1 : 1986, METHOD A7 & A8) UNCONFINED COMPRESSIVE STRENGTH & INDIRECT TENSILE STRENGTH OF STABILISED MATERIAL (TMH 1 : 1986, METHOD A13T, A14 & A16T)					
CBR / UCS / ITS DETERMINATION	MOD AASHTO	MAX DRY DENSITY (kg/m^3)	1892	1820		
		OPT MOISTURE (%)	8.6	7.1		
		COMP MOISTURE (%)				
		DRY DENSITY (kg/m^3)				
		CBR (%)				
		SWELL (%)				
		UCS (KPa)				
		ITS (KPa)				
	NRB	DRY DENSITY (kg/m^3)				
		CBR (%)				
	PROCTOR	MAX DRY DENSITY (kg/m^3)				
		OPT MOISTURE (%)				
		CBR (%)				
	CBR	100%				
		98%				
		95%				
		93%				
		90%				

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CLIENT : **SMEC SOUTH AFRICA (PTY) LTD**
Suite 122
Private Bag X01
BRANDHOF
9324

DATE : 10/04/2015
REFERENCE : SL / 404
DOCUMENT No.: 015/807 (a)
ORDER No.: -
NUMBER OF PAGES : 1 of 3

ATTENTION : Mr Tinus Grobler
PROJECT : Maselspoort Pipeline, Bloemfontein

TEST REPORT

SAMPLE / LABORATORY No. :	Sample 1 - 7: 015/807 - 015/813
DATE SAMPLE RECEIVED :	30/03/2015
DATE SAMPLE TESTED :	30/03/2015 - 10/04/2015
TESTING LABORATORY :	Simlab (Pty) Limited - Geotechnical Services (Bloemfontein)
SAMPLE REPORTED BY :	Zanelle van Eeden (Technical Assisstant)
DATE SAMPLED :	30/03/2015
LOCATION SAMPLED :	Maselspoort Pipeline, Bloemfontein
SAMPLE METHOD :	Sampled by client
ENVIRONMENTAL CONDITIONS DURING SAMPLING :	Not supplied
SAMPLE CONDITION :	Material in good condition.
CLIENT REFERENCE / MARKINGS :	A01, A02, A04 - A06, A08

TEST METHODS :

1.) The wet preparation and sieve analysis of gravel, sand and soil samples, TMH1 : 1986, Method A1(a)
2.) The determination of the liquid limit of soils by means of the flow curve method, THM1 : 1986, Method A2
3.) The determination of the plastic limit and plasticity index of soils, TMH1 : 1986, Method A3
4.) The determination of the linear shrinkage of soils, THM1 : 1986, Method A4
5.) The determination of the percentage of material passing a 0.075mm sieve in a soil sample, TMH1 : 1986, Method A5
6.) *The determination of the grain size distribution in soils by means of a hydrometer, TMH1 : 1986, Method A6
7.) *The determination of the moisture content of a field sample, TMH1 : 1986, Method A17
8.) *The determination of the potential expansiveness of soil according to Van Der Merwe's method.

REMARKS : * Tests marked "Not SANAS Accredited" in this report are not in the SANAS Schedule of Accreditation for this laboratory.
* The Unified Soil Classification are not included in the SANAS Accreditation for this laboratory.

NOTE : Report continues on next page, see attached sheet 2 of 2

Z VAN EEDEN (Technical Assisstant)
for : SIMLAB (PTY) LIMITED - GEOTECHNICAL SERVICES

BJ VAN VUUREN (Technologist)
(Technical Signatory)

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DOCUMENT No.: 015/807 (a)

CLIENT & PROJECT : SMEC SOUTH AFRICA (PTY) LTD - Maselspoort Pipeline, Bloemfontein					DATE : 10/04/2015
HOLE No. / KM (Chainage)		A01	A02	A04	A05
MATERIAL DEPTH (mm)		2400	2900	1100	2600
SAMPLE / LABORATORY No.		015/807	015/808	015/809	015/810
MATERIAL DESCRIPTION		Light brown sandy lean clay with shale	Brown sandy lean clay with shale	Light brown clayey sand with gravel	Dark brown sandy lean clay
* IN SITU FIELD MOISTURE (%)		12.3	11.2	13.1	13.9
UNIFIED SOIL CLASSIFICATION		CL	CL	SC	CL
TRH14 / * COLTO CLASSIFICATION					
SIEVE ANALYSIS, PERCENTAGE OF MATERIAL PASSING 0.075 mm SIEVE (TMH 1 : 1986, METHOD A1 (a), A5) - % PASSING SIEVES					
SIEVE ANALYSIS	63.0 mm				
	53.0 mm				
	37.5 mm				
	26.5 mm			100	
	19.0 mm			99	
	13.2 mm	100	100	91	100
	4.75 mm	98	92	73	98
	2.00 mm	98	86	68	97
	0.425 mm	96	82	63	93
	0.075 mm	56	50	44	61
	0.002 mm	25	16	19	17
SOIL MORTAR	COARSE SAND	2	6	7	5
	FINE SAND	1 / 17 / 22	2 / 11 / 23	3 / 8 / 18	1 / 12 / 19
	MATERIAL<0.075 mm	58	58	65	63
GRADING MODULUS (GM)		0.50	0.52	1.25	0.49
ATTERBERG LIMITS ANALYSIS (TMH 1 : 1986, METHOD A2, A3, & A4), PH VALUE & CONDUCTIVITY (TMH 1 : 1986, METHOD A20 & A21T)					
ATTERBERG LIMITS PASSING SIEVE 0.425mm	L.L (%)	38	30	36	40
	P.I. / L.S. (%)	12 / 6.3	8 / 4.3	16 / 7.8	18 / 9.0
POTENTIAL EXPANSIVENESS (mm)		Low	Low	Low	Medium / 34.4mm
pH VALUE / CONDUCTIVITY (Sm^{-1})					
MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT, CALIFORNIA BEARING RATIO ANALYSIS (TMH 1 : 1986, METHOD A7 & A8) UNCONFINED COMPRESSIVE STRENGTH & INDIRECT TENSILE STRENGTH OF STABILISED MATERIAL (TMH 1 : 1986, METHOD A13T, A14 & A16T)					
CBR / UCS / ITS DETERMINATION	MOD AASHTO	MAX DRY DENSITY (kg/m^3)				
		OPT MOISTURE (%)				
		COMP MOISTURE (%)				
		DRY DENSITY (kg/m^3)				
		CBR (%)				
		SWELL (%)				
		UCS (KPa)				
		ITS (KPa)				
	NRB	DRY DENSITY (kg/m^3)				
		CBR (%)				
	PROCTOR	MAX DRY DENSITY (kg/m^3)				
		OPT MOISTURE (%)				
		CBR (%)				
	CBR	100%				
		98%				
		95%				
		93%				
		90%				

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*** PAGE CONTINUES FROM PAGE 2

DOCUMENT No.: 015/807 (a)

CLIENT & PROJECT : SMEC SOUTH AFRICA (PTY) LTD - Maselspoort Pipeline, Bloemfontein DATE : 10/04/2015

HOLE No. / KM (Chainage)		A05	A06	A08	
MATERIAL DEPTH (mm)		1800	1300	1800	
SAMPLE / LABORATORY No.		015/811	015/812	015/813	
MATERIAL DESCRIPTION		Dark brown sandy lean clay	Dark orange silty, clayey sand	Dark brown lean clay with sand & shale	
* IN SITU FIELD MOISTURE (%)		15.2	10.7	18.0	
UNIFIED SOIL CLASSIFICATION		CL	SC-SM	CL	
TRH14 / * COLTO CLASSIFICATION					
SIEVE ANALYSIS, PERCENTAGE OF MATERIAL PASSING 0.075 mm SIEVE (TMH 1 : 1986, METHOD A1 (a), A5) - % PASSING SIEVES					
SIEVE ANALYSIS	63.0 mm				
	53.0 mm				
	37.5 mm				
	26.5 mm				
	19.0 mm		100		
	13.2 mm	100	99	100	
	4.75 mm	99	97	98	
	2.00 mm	99	97	97	
	0.425 mm	98	96	96	
	0.075 mm	70	48	78	
	0.002 mm	29	21	35	
SOIL MORTAR	COARSE SAND	1	1	1	
	FINE SAND	1 / 9 / 18	5 / 13 / 33	1 / 7 / 10	
	MATERIAL<0.075 mm	71	49	80	
GRADING MODULUS (GM)		0.33	0.59	0.29	
ATTERBERG LIMITS ANALYSIS (TMH 1 : 1986, METHOD A2, A3, & A4), PH VALUE & CONDUCTIVITY (TMH 1 : 1986, METHOD A20 & A21T)					
ATTERBERG LIMITS PASSING SIEVE 0.425mm	L.L (%)	35	26	43	
	P.I. / L.S. (%)	18 / 8.8	6 / 3.3	19 / 10.1	
POTENTIAL EXPANSIVENESS (mm)		Medium / 27.1mm	Low	Medium / 27.1mm	
pH VALUE / CONDUCTIVITY (Sm^{-1})					
MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT, CALIFORNIA BEARING RATIO ANALYSIS (TMH 1 : 1986, METHOD A7 & A8) UNCONFINED COMPRESSIVE STRENGTH & INDIRECT TENSILE STRENGTH OF STABILISED MATERIAL (TMH 1 : 1986, METHOD A13T, A14 & A16T)					
CBR / UCS / ITS DETERMINATION	MOD AASHTO MAX DRY DENSITY (kg/m^3)				
	MOD AASHTO OPT MOISTURE (%)				
	MOD AASHTO COMP MOISTURE (%)				
	MOD AASHTO DRY DENSITY (kg/m^3)				
	MOD AASHTO CBR (%)				
	MOD AASHTO SWELL (%)				
	MOD AASHTO UCS (KPa)				
	MOD AASHTO ITS (KPa)				
	NRB DRY DENSITY (kg/m^3)				
	NRB CBR (%)				
	PROCTOR MAX DRY DENSITY (kg/m^3)				
	PROCTOR OPT MOISTURE (%)				
	PROCTOR CBR (%)				
	CBR 100%				
	CBR 98%				
	CBR 95%				
	CBR 93%				
	CBR 90%				

Results reported relate only to the materials tested

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sanas Testing Laboratory T0455

REG. No. 1987/004282/07 NLA No. 2012/187

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+27 (0) 51 447 0224/5, +27 (0) 82 821 9435, +27 (0) 51 448 8329, simbfn@simlab.co.za

CLIENT : **SMEC SOUTH AFRICA (PTY) LTD**
267 Kent Avenue
Ferndale
RANDBURG
2125

DATE : 23/04/2015
REFERENCE : SL / 2488
DOCUMENT No.: 015/836 (a)
ORDER No.: -
NUMBER OF PAGES : 1 of 3

ATTENTION : Mr Tinus Grobler
PROJECT : Maselspoort Pipeline, Bloemfontein

TEST REPORT

SAMPLE / LABORATORY No. :	Sample 1 - 8: 015/836 - 015/843
DATE SAMPLE RECEIVED :	02/04/2015
DATE SAMPLE TESTED :	02/04/2015 - 16/04/2015
TESTING LABORATORY :	Simlab (Pty) Limited - Geotechnical Services (Bloemfontein)
SAMPLE REPORTED BY :	Zanelle van Eeden (Technical Assisstant)
DATE SAMPLED :	02/04/2015
LOCATION SAMPLED :	Maselspoort Pipeline, Bloemfontein
SAMPLE METHOD :	Sampled by client
ENVIRONMENTAL CONDITIONS DURING SAMPLING :	Not supplied
SAMPLE CONDITION :	Material in good condition.
CLIENT REFERENCE / MARKINGS :	Maselspoort Pipeline, Bloemfontein

TEST METHODS :

1.) The wet preparation and sieve analysis of gravel, sand and soil samples, TMH1 : 1986, Method A1(a)
2.) The determination of the liquid limit of soils by means of the flow curve method, THM1 : 1986, Method A2
3.) The determination of the plastic limit and plasticity index of soils, TMH1 : 1986, Method A3
4.) The determination of the linear shrinkage of soils, THM1 : 1986, Method A4
5.) The determination of the percentage of material passing a 0.075mm sieve in a soil sample, TMH1 : 1986, Method A5
6.) *The determination of the grain size distribution in soils by means of a hydrometer, TMH1 : 1986, Method A6
7.) *The determination of the moisture content of a field sample, TMH1 : 1986, Method A17
8.) *The determination of the potential expansiveness of soil according to Van Der Merwe's method.

REMARKS : * Tests marked "Not SANAS Accredited" in this report are not in the SANAS Schedule of Accreditation for this laboratory.
* The Unified Soil Classification are not included in the SANAS Accreditation for this laboratory.

NOTE : Report continues on next page, see attached sheet 2 of 2

Z VAN EEDEN (Technical Assisstant)
for : SIMLAB (PTY) LIMITED - GEOTECHNICAL SERVICES

B.J VAN VUUREN (Technologist)
(Technical Signatory)

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*** PAGE CONTINUES FROM PAGE 1

DOCUMENT No.: 015/836 (a)

CLIENT & PROJECT : SMEC SOUTH AFRICA (PTY) LTD - Maselspoort Pipeline, Bloemfontein DATE : 23/04/2015

HOLE No. / KM (Chainage)		AG08	AG08	AG20	AG24
MATERIAL DEPTH (mm)		1100	2300	2100	1200
SAMPLE / LABORATORY No.		015/836	015/837	015/838	015/839
MATERIAL DESCRIPTION		Black sandy lean clay with sand	Light yellowish clayey sand with gravel	Light yellowish sandy lean clay	Dark brown sandy lean clay
* IN SITU FIELD MOISTURE (%)		15.5	9.0	11.2	15.0
UNIFIED SOIL CLASSIFICATION		CL	SC	CL	CL
TRH14 / * COLTO CLASSIFICATION					
SIEVE ANALYSIS, PERCENTAGE OF MATERIAL PASSING 0.075 mm SIEVE (TMH 1 : 1986, METHOD A1 (a), A5) - % PASSING SIEVES					
SIEVE ANALYSIS	63.0 mm				
	53.0 mm				
	37.5 mm				
	26.5 mm		100		
	19.0 mm		99	100	
	13.2 mm		99	99	
	4.75 mm		97	95	
	2.00 mm	100	80	90	100
	0.425 mm	95	47	84	95
	0.075 mm	78	40	63	66
	0.002 mm	30	9	29	38
SOIL MORTAR	COARSE SAND	5	41	8	5
	FINE SAND	2 / 5 / 10	5 / 3 / 2	2 / 7 / 13	2 / 9 / 17
	MATERIAL<0.075 mm	79	49	70	66
GRADING MODULUS (GM)		0.27	1.33	0.63	0.40
ATTERBERG LIMITS ANALYSIS (TMH 1 : 1986, METHOD A2, A3, & A4), PH VALUE & CONDUCTIVITY (TMH 1 : 1986, METHOD A20 & A21T)					
ATTERBERG LIMITS PASSING SIEVE 0.425mm	L.L (%)	42	33	40	47
	P.I. / L.S. (%)	13 / 10.9	14 / 6.8	19 / 8.7	23 / 10.6
POTENTIAL EXPANSIVENESS (mm)		Low	Low	Medium / 30.1mm	Medium / 20.0mm
pH VALUE / CONDUCTIVITY (Sm^{-1})					
MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT, CALIFORNIA BEARING RATIO ANALYSIS (TMH 1 : 1986, METHOD A7 & A8) UNCONFINED COMPRESSIVE STRENGTH & INDIRECT TENSILE STRENGTH OF STABILISED MATERIAL (TMH 1 : 1986, METHOD A13T, A14 & A16T)					
CBR / UCS / ITS DETERMINATION	MOD AASHTO	MAX DRY DENSITY (kg/m^3)				
		OPT MOISTURE (%)				
		COMP MOISTURE (%)				
		DRY DENSITY (kg/m^3)				
		CBR (%)				
		SWELL (%)				
		UCS (KPa)				
		ITS (KPa)				
	NRB	DRY DENSITY (kg/m^3)				
		CBR (%)				
	PROCTOR	MAX DRY DENSITY (kg/m^3)				
		OPT MOISTURE (%)				
		CBR (%)				
	CBR	100%				
		98%				
		95%				
		93%				
		90%				

Results reported relate only to the materials tested

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*** PAGE CONTINUES FROM PAGE 2

DOCUMENT No.: 015/836 (a)

CLIENT & PROJECT : SMEC SOUTH AFRICA (PTY) LTD - Maselspoort Pipeline, Bloemfontein DATE : 23/04/2015

HOLE No. / KM (Chainage)		AG24	AG27	GB4	AG34
MATERIAL DEPTH (mm)		2600	1200	1800	1200
SAMPLE / LABORATORY No.		015/840	015/841	015/842	015/843
MATERIAL DESCRIPTION		Light yellowish lean clay with sand	Black sandy lean clay	Dark brown silty sand with gravel	Light brown clayey sand
* IN SITU FIELD MOISTURE (%)		10.6	12.2	6.4	6.0
UNIFIED SOIL CLASSIFICATION		CL	CL	SM	SC
TRH14 / * COLTO CLASSIFICATION					
SIEVE ANALYSIS, PERCENTAGE OF MATERIAL PASSING 0.075 mm SIEVE (TMH 1 : 1986, METHOD A1 (a), A5) - % PASSING SIEVES					
SIEVE ANALYSIS	63.0 mm				
	53.0 mm				
	37.5 mm				
	26.5 mm				
	19.0 mm				
	13.2 mm	100		100	100
	4.75 mm	99	100	98	94
	2.00 mm	97	99	74	90
	0.425 mm	91	97	47	53
	0.075 mm	74	63	19	29
	0.002 mm	18	27	0	6
SOIL MORTAR	COARSE SAND	6	2	36	41
	FINE SAND	3 / 4 / 10	2 / 9 / 23	11 / 12 / 16	8 / 9 / 10
	MATERIAL<0.075 mm	77	63	25	32
GRADING MODULUS (GM)		0.38	0.42	1.61	1.28
ATTERBERG LIMITS ANALYSIS (TMH 1 : 1986, METHOD A2, A3, & A4), PH VALUE & CONDUCTIVITY (TMH 1 : 1986, METHOD A20 & A21T)					
ATTERBERG LIMITS PASSING SIEVE 0.425mm	L.L (%)	38	38	-	30
	P.I. / L.S. (%)	16 / 8.4	15 / 7.4	N/P / 0.0	14 / 5.8
POTENTIAL EXPANSIVENESS (mm)		Medium / 34.4mm	Medium / 20.0mm	Low	Low
pH VALUE / CONDUCTIVITY (Sm^{-1})					
MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT, CALIFORNIA BEARING RATIO ANALYSIS (TMH 1 : 1986, METHOD A7 & A8) UNCONFINED COMPRESSIVE STRENGTH & INDIRECT TENSILE STRENGTH OF STABILISED MATERIAL (TMH 1 : 1986, METHOD A13T, A14 & A16T)					
CBR / UCS / ITS DETERMINATION	MOD AASHTO	MAX DRY DENSITY (kg/m^3)				
		OPT MOISTURE (%)				
		COMP MOISTURE (%)				
		DRY DENSITY (kg/m^3)				
		CBR (%)				
		SWELL (%)				
		UCS (KPa)				
		ITS (KPa)				
	NRB	DRY DENSITY (kg/m^3)				
		CBR (%)				
	PROCTOR	MAX DRY DENSITY (kg/m^3)				
		OPT MOISTURE (%)				
		CBR (%)				
	CBR	100%				
		98%				
		95%				
		93%				
		90%				

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Appendix D

Expansiveness Graphs

Diagram D.1. Potential Expansiveness of Transported layer

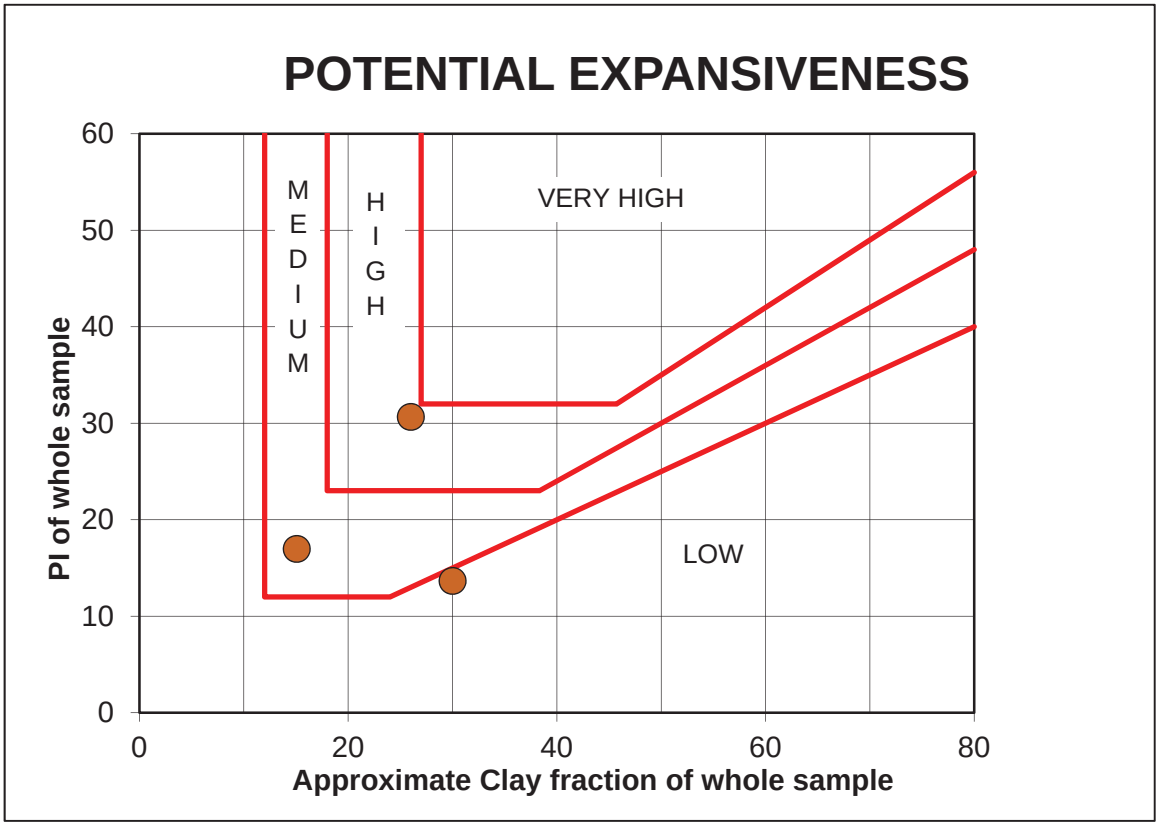


Diagram D.2. Potential Expansiveness of Calcified layer and calcrete

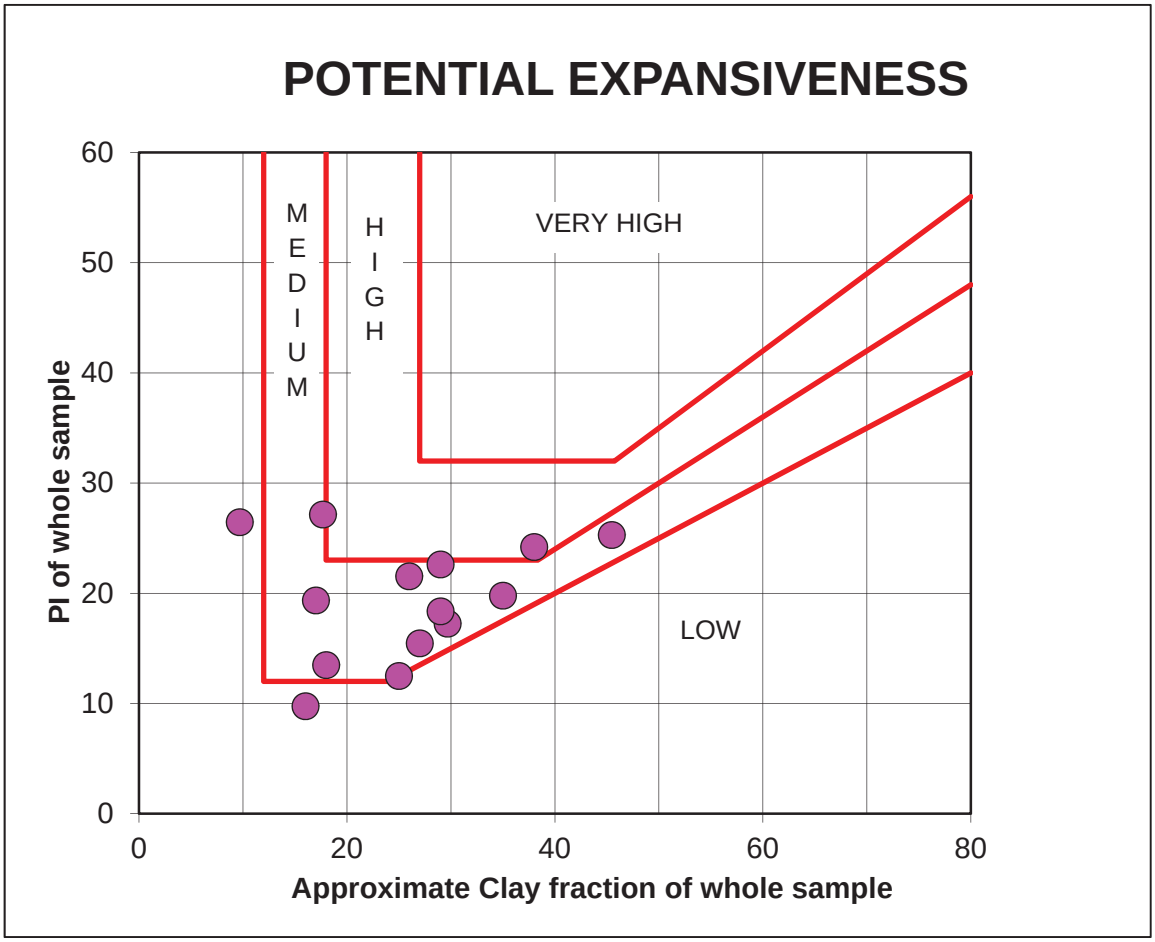


Diagram D.3. Potential Expansiveness of the “Sand” layer

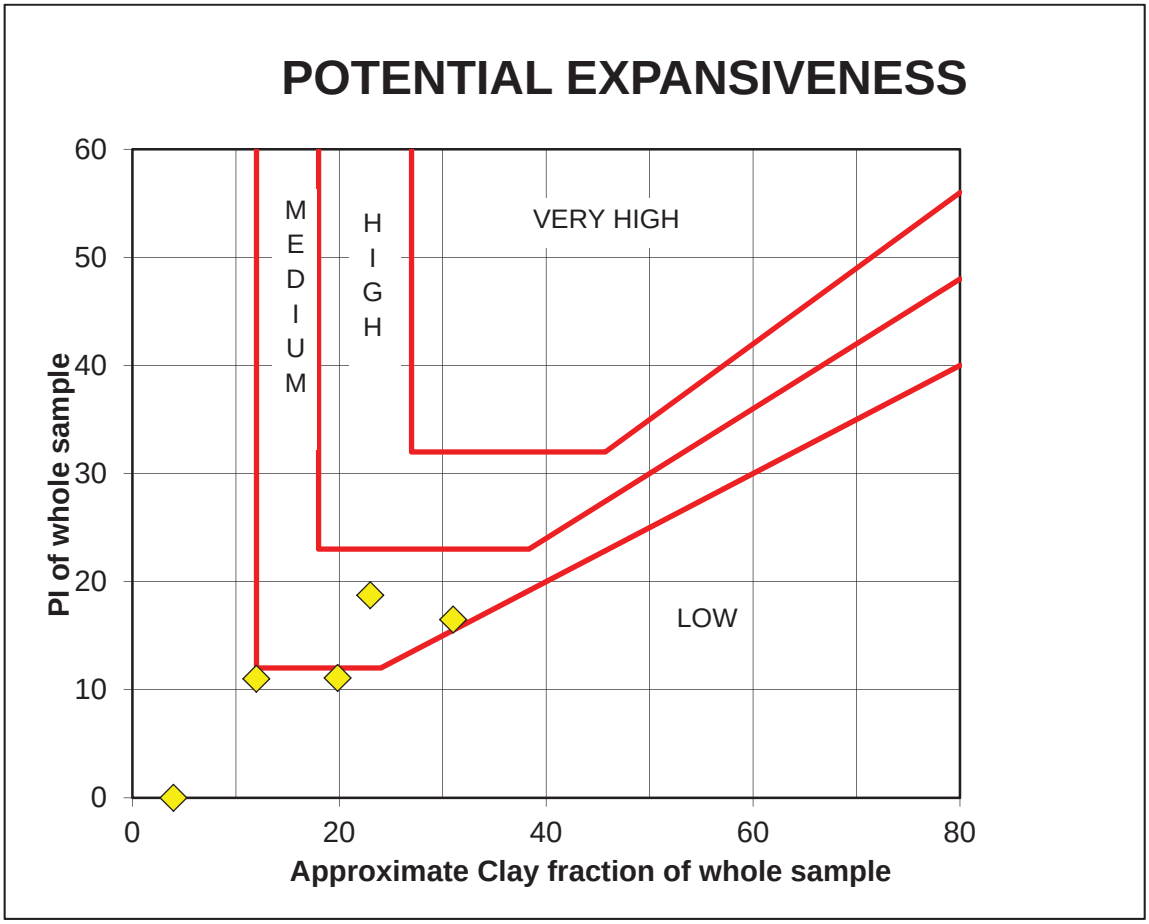


Diagram D.4. Potential Expansiveness of Dolerite

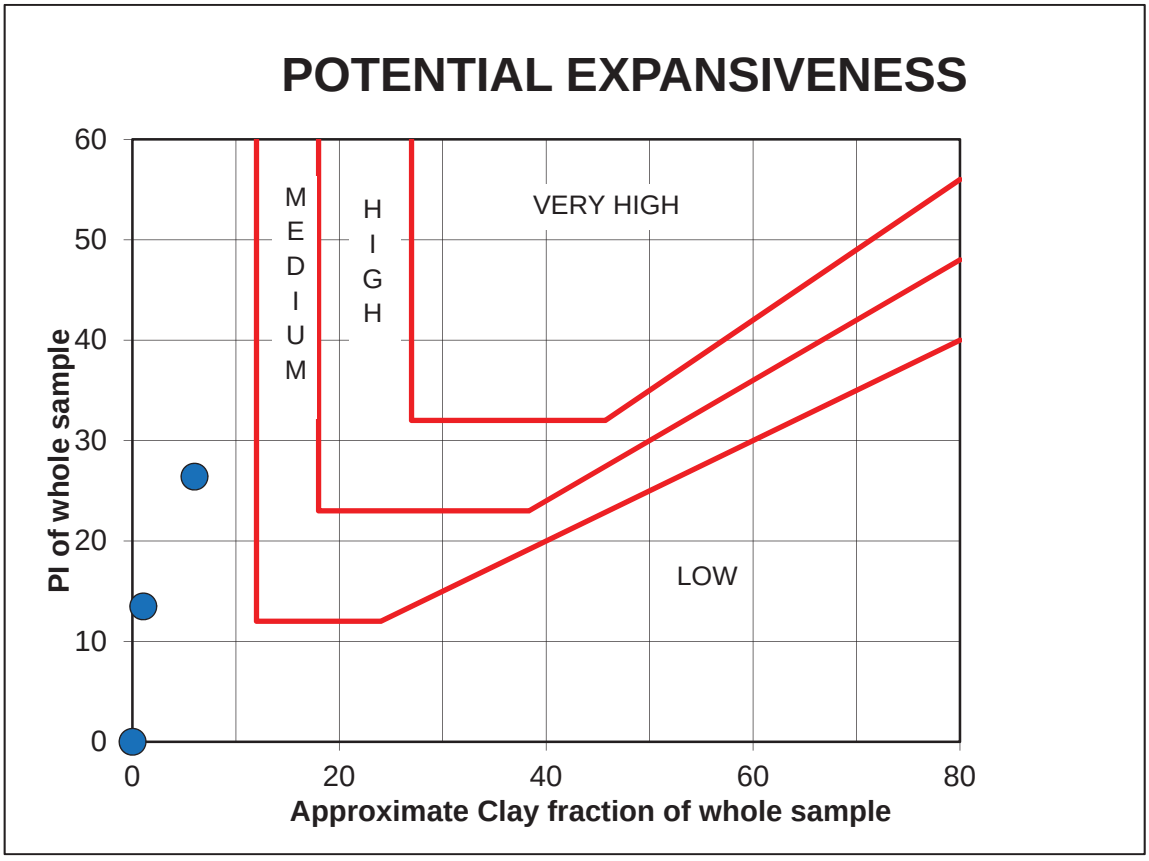
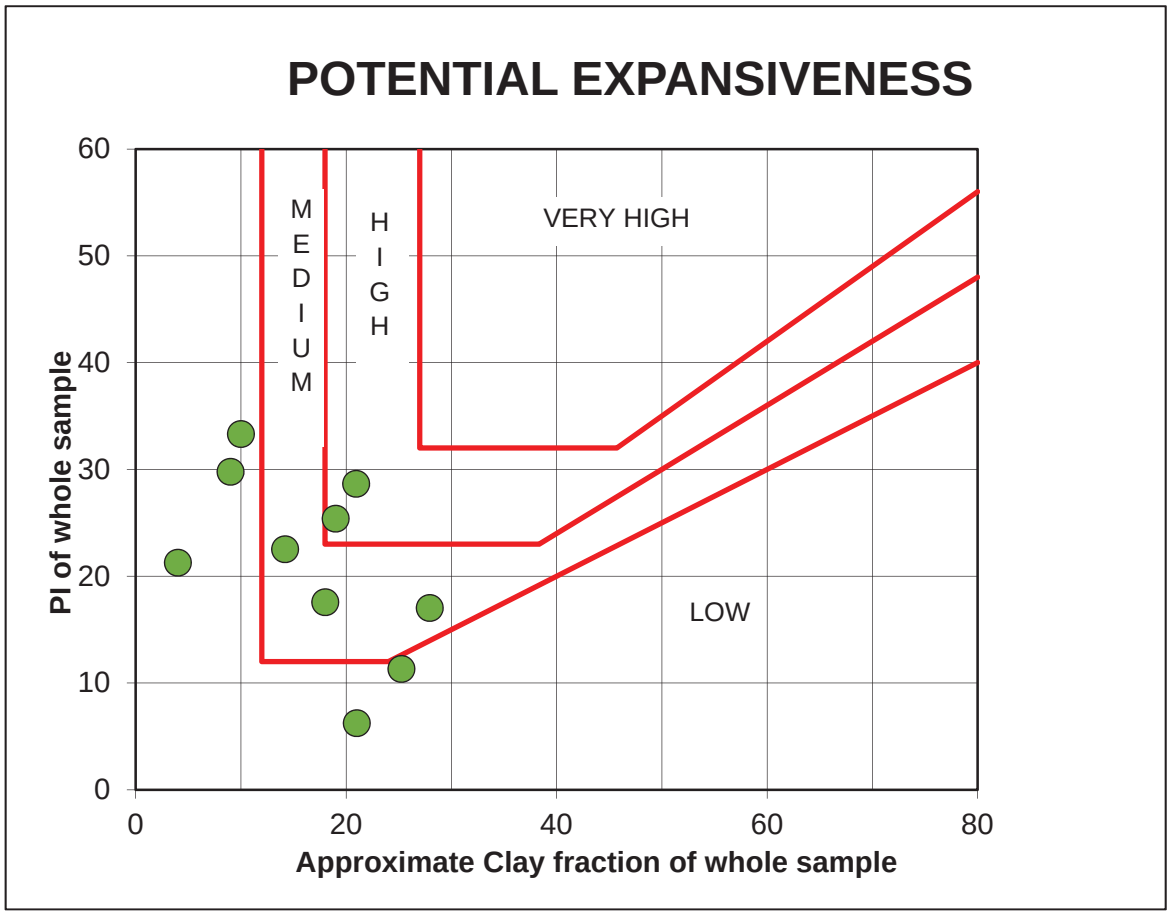


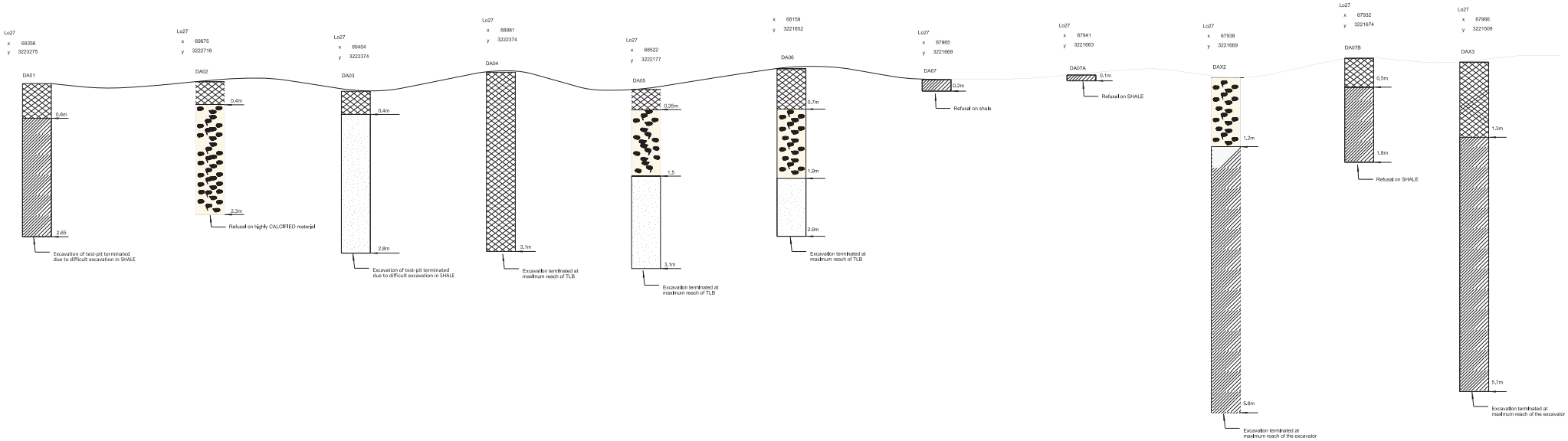
Diagram D.5. Potential Expansiveness of residual shale



Appendix E

Longitudal Sections

SECTION DA



LEGEND	GEOLOGICAL UNIT
	TRANSPORTED
	FILL
	CALCIFIED
	CALCRETE
	SAND
	DOLERITE
	RESIDUAL SHALE

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No.	REVISIONS	DATE

DRG SIZE	SCALE	DATE DRAWN
	NTS	
DESIGNED		CHECKED
T. GROBLER		T. GROBLER
DRAWN		CHECKED
K.MOGOTSI		T. GROBLER

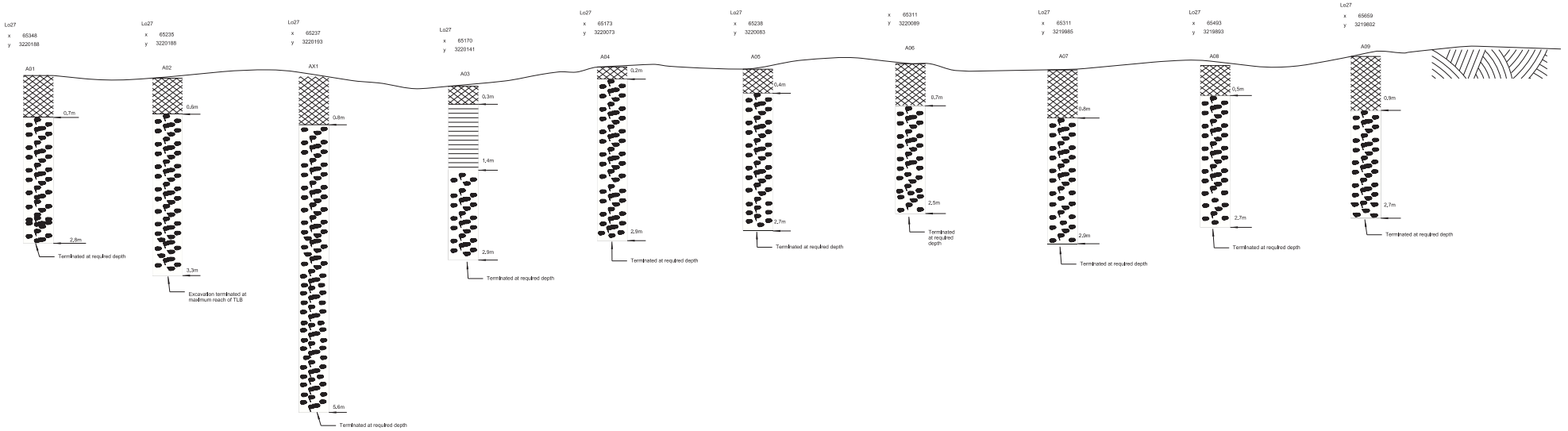
PROJECT
MASELSPOORT PIPELINE

DRAWING DESCRIPTION
SECTION DA

PROJECT NO	PHASE	DISCIPLINE	STAGE
J G 0 0 1 4			

DOC TYPE	DRAWING NUMBER					REVISION
	TYPE		LEVEL	NUMBER	L/O	
DWG				D A		0

RENOSTERPRUIT AREA



LEGEND	GEOLOGICAL UNIT
	TRANSPORTED
	FILL
	CALCIFIED
	CALCRETE
	SAND
	DOLERITE
	RESIDUAL SHALE

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K.MOGOTSI	T. GROBLER

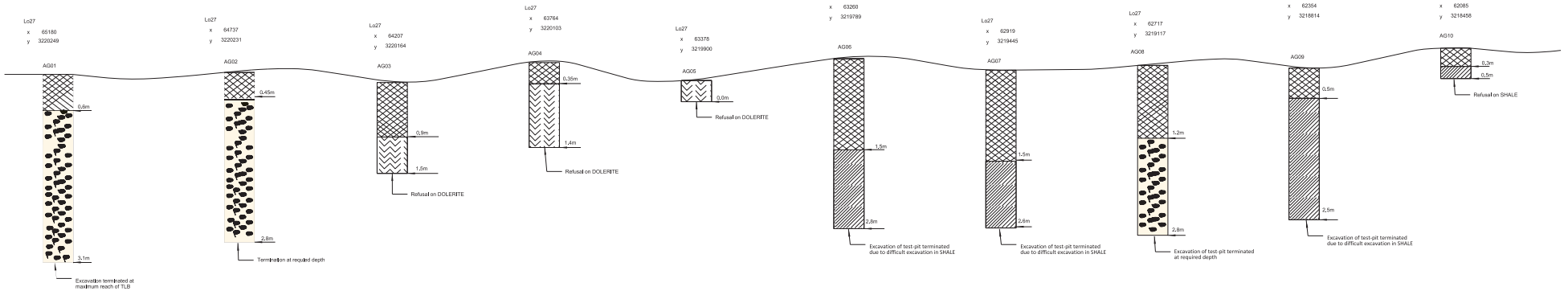
PROJECT
MASELSPOORT PIPELINE

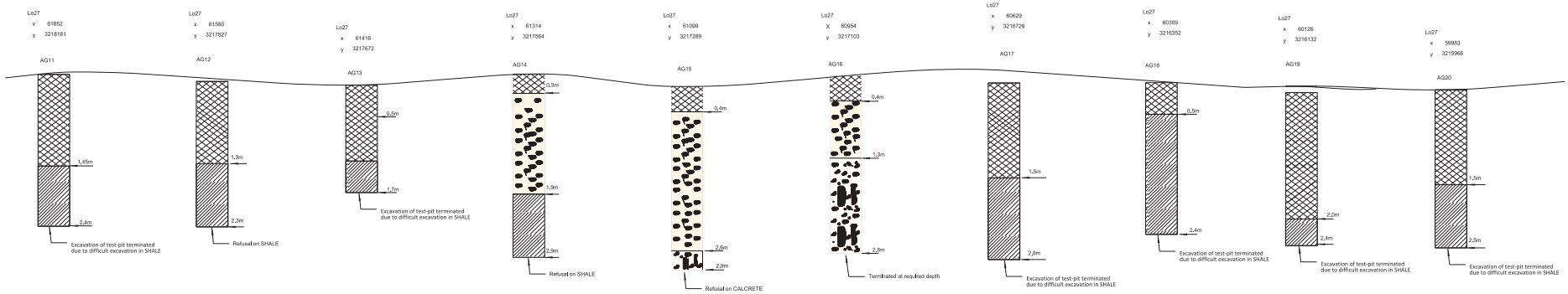
DRAWING DESCRIPTION
RENOSTERPRUIT AREA

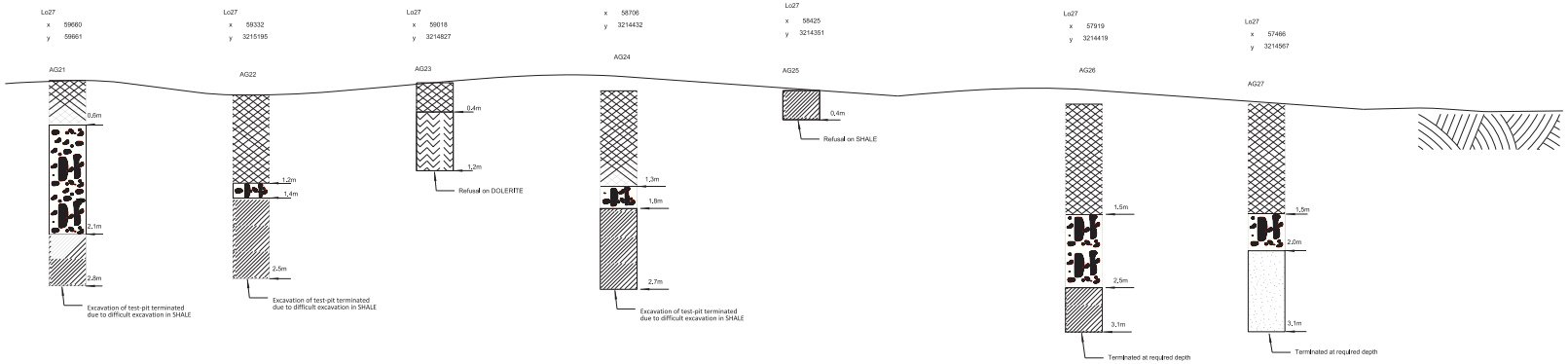
PROJECT NO	PHASE	DISCIPLINE	STAGE
J G 0 0 1 4			

DOC TYPE	DRAWING NUMBER					REVISION
	TYPE		LEVEL	NUMBER	L/O	
DWG				R A		0

SECTION AG







LEGEND	GEOLOGICAL UNIT
	TRANSPORTED
	FILL
	CALCIFIED
	CALCRETE
	SAND
	DOLERITE
	RESIDUAL SHALE

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DRG SIZE	SCALE	DATE DRAWN
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DRAWN		CHECKED
K.MOGOTSI		T. GROBLER

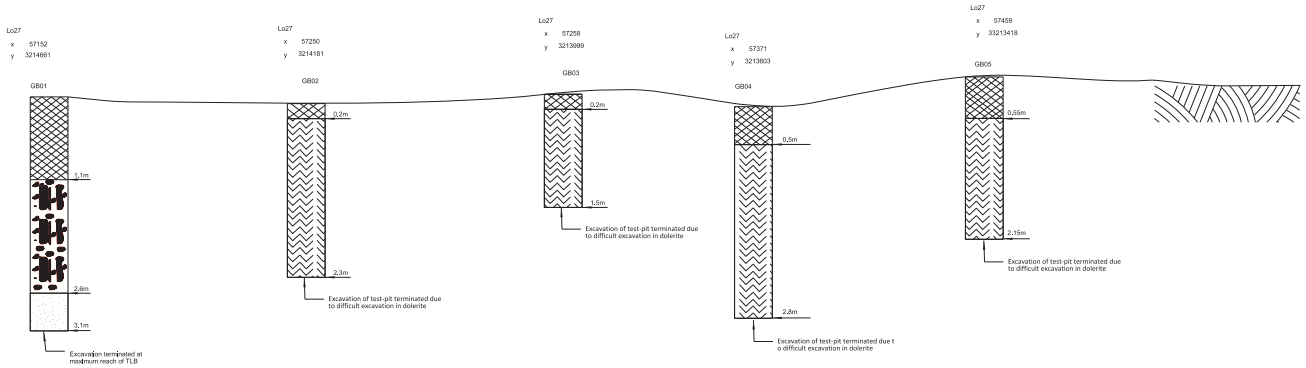
PROJECT
MASELSPOORT PIPELINE

DRAWING DISCRIPTION
SECTION AG

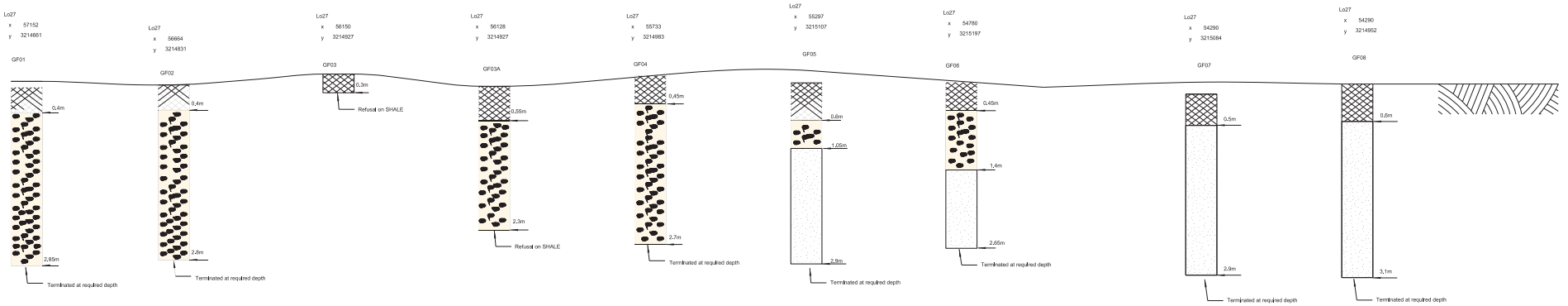
PROJECT NO	PHASE	DISCIPLINE	STAGE
J G 0 0 1 4			

DOC TYPE	DRAWING NUMBER					REVISION
	TYPE		LEVEL	NUMBER	L/O	
DWG				A G		0

SECTION GB



SECTION GF



LEGEND	GEOLOGICAL UNIT
	TRANSPORTED
	FILL
	CALCIFIED
	CALCRETE
	SAND
	DOLERITE
	RESIDUAL SHALE

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	NTS	
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DRAWN		CHECKED
K.MOGOTSI		T. GROBLER

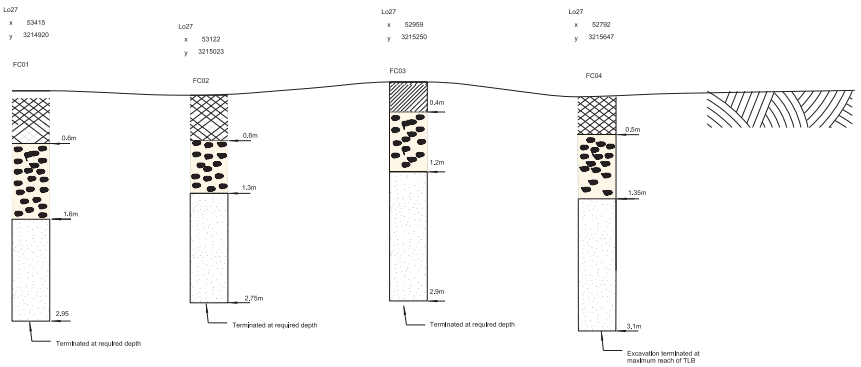
PROJECT
MASELSPOORT PIPELINE

DRAWING DESCRIPTION
SECTION GB AND
SECTION GF

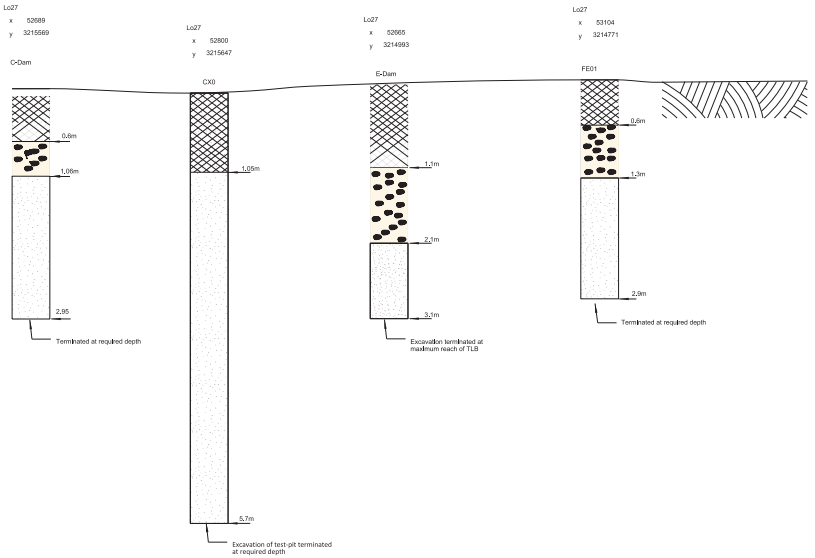
PROJECT NO	PHASE	DISCIPLINE	STAGE
J G 0 0 1 4			

DOC TYPE	DRAWING NUMBER					REVISION
	TYPE		LEVEL	NUMBER	L/O	
DWG				G B		0

SECTION FC



MOCKES DAM AREA



LEGEND	GEOLOGICAL UNIT
	TRANSPORTED
	FILL
	CALCIFIED
	CALCRETE
	SAND
	DOLERITE
	RESIDUAL SHALE

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No.	REVISIONS	DATE
△		

DRG SIZE	SCALE	DATE DRAWN
	NTS	
DESIGNED		CHECKED
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DRAWN		CHECKED
K.MOGOTSI		T. GROBLER

PROJECT
MASELSPOORT PIPELINE

DRAWING DESCRIPTION
SECTION FC AND MOCKES DAM AREA

PROJECT NO	PHASE	DISCIPLINE	STAGE
J G 0 0 1 4			

DOC TYPE	DRAWING NUMBER					REVISION
	TYPE		LEVEL	NUMBER	L/O	
DWG				F C		0

Appendix F

Test Pit Locations

Diagram F.1. Location of Test Pits along Section DA

Diagram F.2. Location of Test Pits in the Renosterspruit Area

Diagram F.3. Location of Test Pits along Section AG

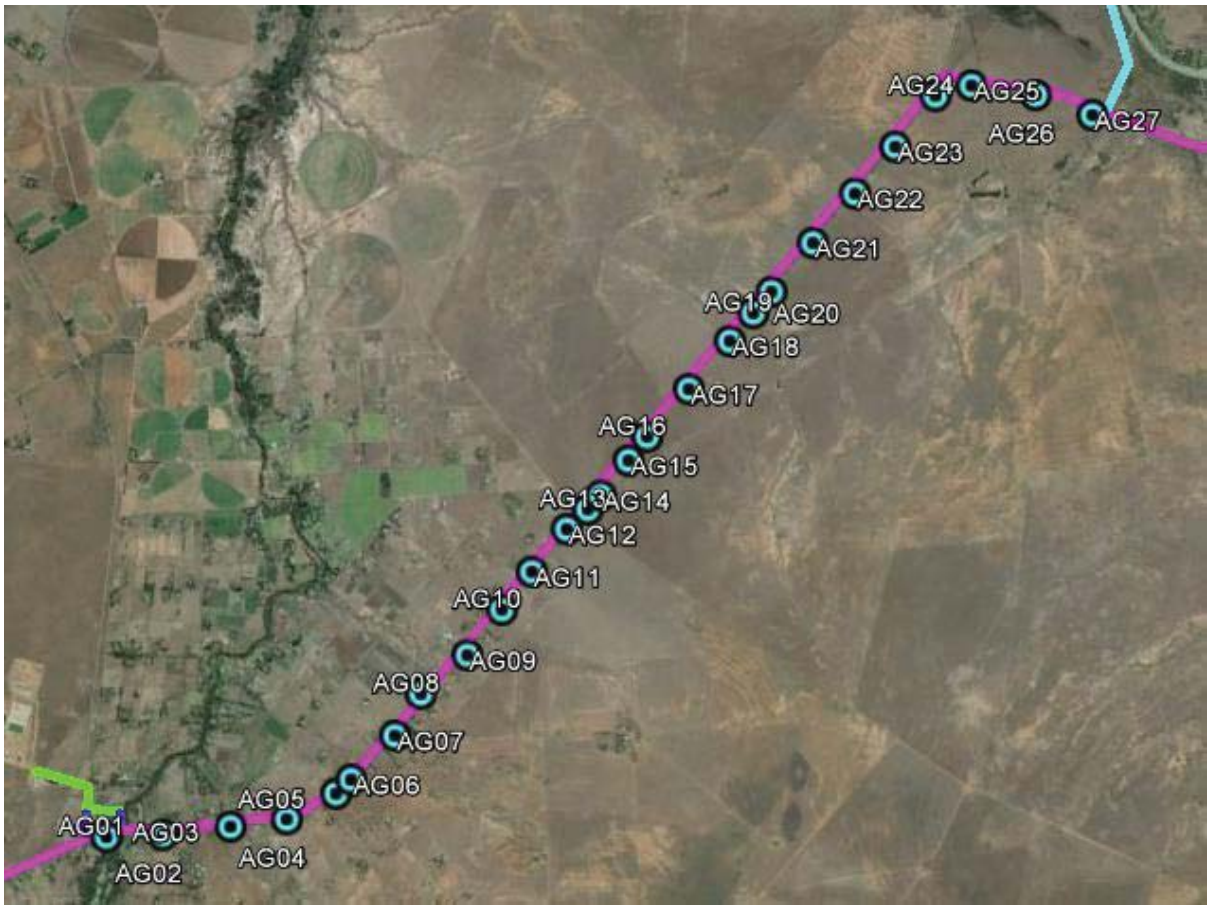


Diagram F.4. Location of Test Pits along Section GB

Diagram F.5. Location of Test Pits along Section GF

Diagram F.6. Location of Test Pits in the Mockes Dam area

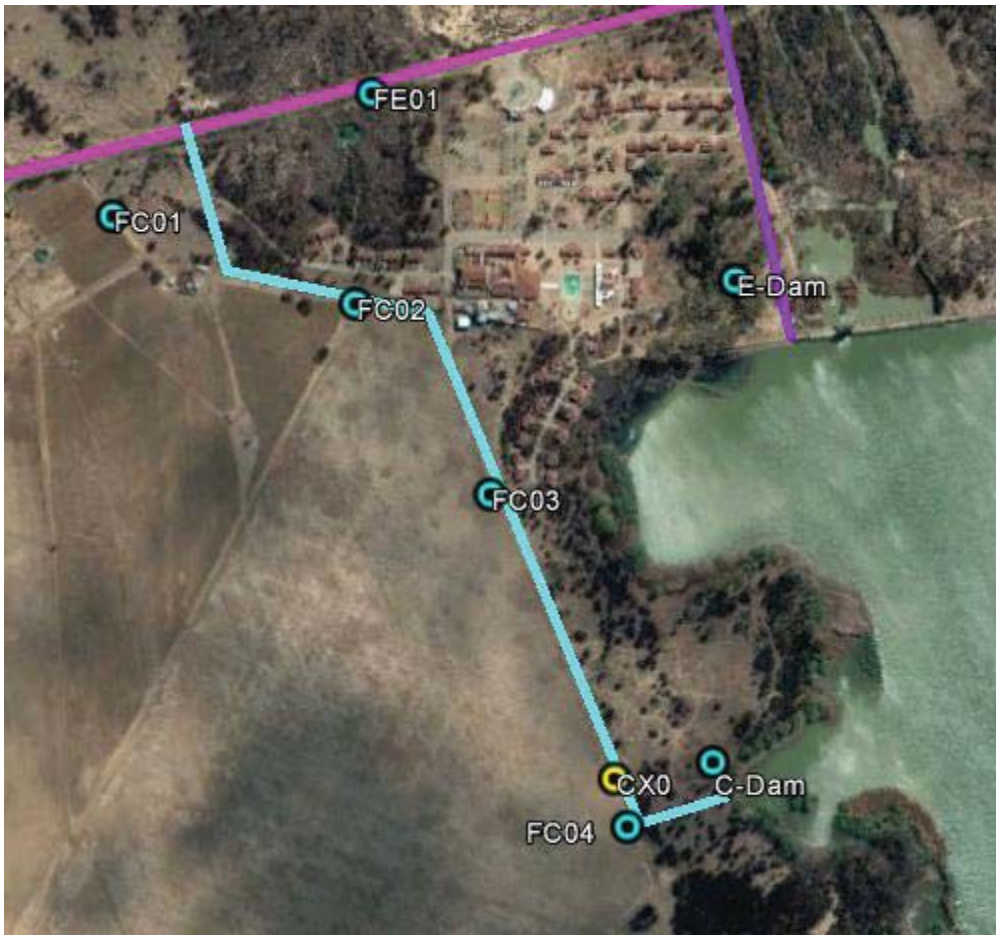


Diagram F.7. Test Pit Positions at the N8 crossing

Diagram F.8. Test Pit Positions at the Bloemfontein – Maselspoort crossing.

Appendix G

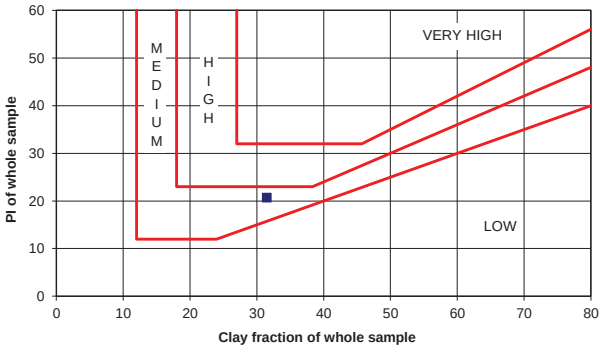
Laboratory Test Results For Bedding Material Investigation

PARTICLE SIZE ANALYSIS

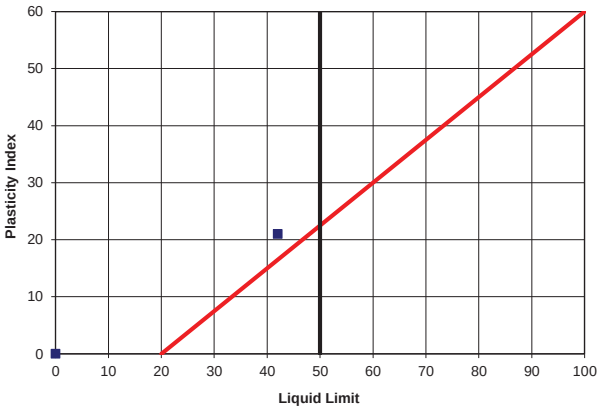
Sample No.	1	
Soillab Sample No.	2015-S-0642-01	
Depth (m)	-	
Position	MSP	
Material Description	PALE RED CLAYEY SILT	
Moisture (%)		
	0.38	
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	
53.0 mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	100	
4.75 mm	99	
2.00 mm	99	
0.425 mm	98	
0.075 mm	83	
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	61	
0.027 mm	55	
0.013 mm	47	
0.005 mm	41	
0.002 mm	32	
% Clay	32	
% Silt	42	
% Sand	25	
% Gravel	1	
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	42	
Plasticity Index	21	
Linear Shrinkage (%)	10.0	
Grading Modulus	0.20	
Uniformity coefficient	-	
Coefficient of curvature	-	
Classification	A-7-6 (18)	
Unified Classification	CL	
Chart Reference		

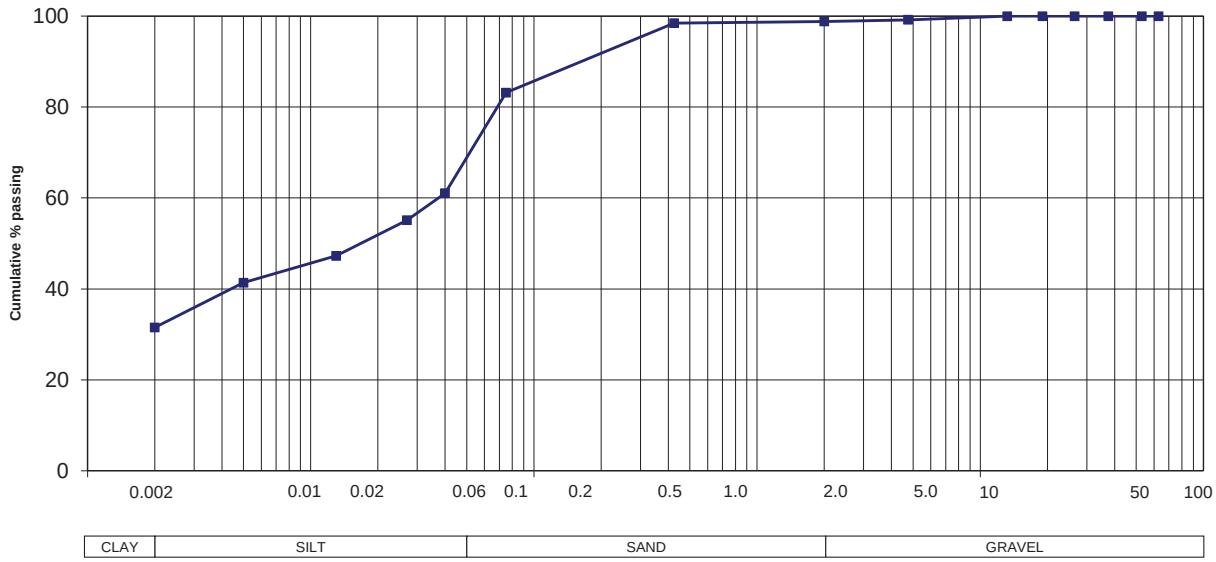
PROJECT : MASELSPOORT PIPELINE
JOB No. : 2015-S-0642
DATE : 15/05/2015

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





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Our Referrence: Galactic_Sand_Klip / P0600 / A / 15 / Ind Cbr **F3315** **Order No:** **21/04/2015**

Galactic Sand & Klip
Plot 16
Ribersdale
Bloemfontein
9301

ATTENTION: Mr. P Venter

Test Report : Franru Plant

Please find the attached test results for the sample/s as submitted to and tested by Roadlab / Prehab JV in Bloemfontein.
The unambiguous description of the sample/s as received are as follows :

SAMPLE No.		P0600/A	P0600/B		
CONTAINER USED FOR SAMPLING		Sampling Bags	Sampling Bags		
SIZE / WEIGHT OF SAMPLE		±70kg	±70kg		
SAMPLE ON ARRIVAL		Slightly moist	Slightly moist		
HOLE No. / Km. / CHAINAGE		Unsieved Gravel	Sieved Gravel		
COORDINATES					
LAYER TESTED / SAMPLED FROM					
DATE SAMPLED		9/04/2015	9/04/2015		
MATERIAL DESCRIPTION		Slightly moist yellow brown dense base - with fine weathered dolorite.	Slightly moist light red brown dense sandy clay.		
SIEVE ANALYSIS(mm) (TMH A1(a))	75.0				
	63.0				
	53.0	100			
	37.5	88			
	26.5	83			
	19.0	80			
	13.2	75	100		
	4,75	57	82		
	2,00	34	53		
	0.425	13	34		
	0,075	5	14		
	0,002	4	9		
ATTERBERG LIMITS (TMH A2 & A3)	LL%	40	30		
	P.I.	10	8		
	LS%	5.3	4.3		
GM - GRADING MODULUS		2.48	1.99		
MOD AASHTO (TMH A7)	MDD kg/m³	2123	2120		
	OMC%	6.6	8.0		
Moulded density	MD1	100.1	100.0		
	MD2	95.5	95.2		
	MD3	90.3	90.4		
Swell %	S1	0.1	0.1		
	S2	0.1	0.2		
	S3	0.1	0.2		
C.B.R (TMH A8)	100	97	22		
	98	74	17		
	97	64	15		
	95	49	11		
	93	37	9		
	90	25	6		
CLASSIFICATION	HRB				
	TRH 14				
	COLTO	G7	G9		

Kind Regards,

Wessel Badenhorst
FOR ROADLAB / PREHAB JV

Remarks :

- The samples were subjected to analysis according to TMH 1:1986 Methods A1(a), A2, A3, A5, A7, A8 and ASTM D422 unless stated otherwise.
- The results reported relate only to the sample tested
- Further use of the above information is not the responsibility or liability of Roadlab/ Prehab JV
- Documents may only be reproduced or published in their full context

Appendix H

Elastic Moduli From Triaxial Results

OUR REFERENCE: JG0014

4 June 2015

GladAfrica
GladAfrica House
Hertford Office Park
82 Bekker Road
Midrand
1686

RE: Maselspoort Recirculation Pipeline. Calculation of E-modulus for soils encountered.

1. INTRODUCTION

SMEC South Africa was appointed by Glad Africa for the proposed GRP pipeline between Bloemfontein and Mockes Dam (Maselspoort Area). Subsequently it has been requested that the E-modulus for soils encountered be calculated and provided whilst the final report is still pending. It is understood that the Young's modulus parameters of different soils are required for design purposes.

2. DETERMINATION OF YOUNG'S MODULUS FOR SOIL

The Young's modulus for soil can be determined by various methods. One of the methods is to use the isotropic consolidation data from effective stress triaxial testing results. This relates the isotropic compression to volumetric strain and provides a Bulk modulus parameter. By assuming a Poisson's ratio the Young's modulus can be calculated from the Bulk Modulus value.

There are also several correlations found in literature to calculate the Young's modulus, relating the modulus to:

- Soil type and consistency,
- Equivalent SPT-N values.

3. RESULTS

Two consolidated undrained triaxial tests were performed on samples retrieved during test-pitting. The one triaxial test was performed on a calcified sandy clay/ clayey sand obtained from test pit AG01 (Renosterspruit Area), the other triaxial was performed on a sand sample retrieved from the Mockes Dam area.

Directors: Dr NM Phosa (Chairman), Dr T Marshall (CEO), K Pillay,
G Munyai, NH Qegu, R Hitt, A McKendrick
Registration Number: 1989/007013/07

The shear strength parameters obtained are provided below and the triaxial test results will also be sent.

Test Pit No	Depth of Sample (m)	Test	Remoulded Density (kg/m³)	Remoulded Moisture (%)	ϕ' (°)	c' (kPa)
AG01	2.4	CU Triaxial	1600	12.2	24.6	8.8
E-Dam	2.6	CU Triaxial	1430	10.6	31.3	0

During an effective stress triaxial test 3 specimens per sample are consolidated to 3 different stresses. For this project confining stresses of 100kPa, 200kPa and 400 kPa were used.

Samples were re-compacted to conservative remoulding densities. Undisturbed sampling was unfortunately not possible. (When samples were submitted for laboratory testing it was also not known that elastic moduli of the soil was required.)

The coefficient of volume compressibility for isotropic consolidation (m_{vi}) are therefor determined at 3 different stresses. The Bulk modulus (B) can be calculated by relating the volumetric strain to the change in effective stress. Given the fact that the Young's modulus (E) is a uniaxial modulus, a Poisson's ratio needs to be estimated. For the purpose of these calculations a Poisson's ratio of 0.3 was assumed. Elastic moduli are summarised in the tables below.

Test Pit AG01				
	100kPa	**200kPa**	**400kPa**	
m_{vi}	2.847	1.373	0.823	1/MPa
B	0.35	0.73	1.22	MPa
E	0.42	0.87	1.46	MPa

Test Pit E – Dam				
	100kPa	**200kPa**	**400kPa**	
m_{vi}	0.201	0.267	0.209	1/MPa
B	4.98	3.75	4.78	MPa
E	5.97	4.49	5.74	MPa

4. CONCLUSION

This letter presents the findings of the calculation of the elastic moduli of 2 samples based solely on the isotropic consolidation of two consolidated undrained triaxial tests.
It is believed that the values provided should be seen as conservative estimates. Values are deemed to be conservative due to the following:

- Very low recompaction densities may render the samples to be more compressible during laboratory testing compared to the reaction of the soil in-situ.

- Bedding of the porous discs, membranes, side drains and individual sample layers will render larger volume changes during testing, compared to the volumetric strain of the soil itself.

It can be concluded that the laboratory results provided provides a conservative estimate of the elastic moduli of the soil samples, but that the factors mentioned above should be taken into consideration during design. Values obtained from empirical correlations from the profiles obtained during test-pitting and DCP testing will most likely provide higher and possibly more accurate moduli values.

We trust this information will assist in design of the project and we appreciate the opportunity of providing our services on this project. Please do not hesitate to contact us should you require clarity on any item.

Yours sincerely,

Tinus Grobler
Engineer

SMEC South Africa (Pty) Ltd
GEOTECHNICAL