Geotechnical investigation for the rehabilitation of Albert's Farm Dam – Braamfontein West Water Management Unit

Reference: 504630-G3-00

Report No: 12239

Revision: 00

26 July 2019

aurecon

Bringing ideas to life

Document control record

Document prepared by:

Aurecon South Africa (Pty) Ltd
Reg No 1977/003711/07
Aurecon Centre
Lynnwood Bridge Office Park
4 Daventry Street
Lynnwood Manor 0081
PO Box 74381
Lynnwood Ridge 0040
South Africa

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

Document control						aurecon
Report title		Geotechnical investigation for the rehabilitation of Albert's Farm Dam – Braamfontein West Water Management Unit				
Document ID		12239	**Project number**		504630-G3-00	
File path		**P:\Projects\504630 JRA Dams\5 DEL DES\505 Field Investigations\Geotech\Alberts Farm Dam Geotech**				
Client		Johannesburg Roads Agency (JRA)				
Client contact		Salona Moodley	**Client reference**		JRA – 18 - 107	
Rev	**Date**	**Revision details/status**	**Author**	**Reviewer**	**Verifier** (if required)	**Approver**
00	26 July 2019		A Nxumalo	G Davis	M Wainstein	G Davis
Current revision		**00**				

Coordinates	Latitude: 26° 9'18.18"S Longitude: 27°58'17.07"E
Keywords	Geotechnical investigation, Albert's Farm, dam, fill material, transported soils, test pits, permeability, direct shear test, Orange Grove Formation, Basement rocks, Halfway House granite

Approval			
Author signature		Approver signature	
Name	A Nxumalo Pr Sci Nat	Name	G Davis Pr Sci.Nat
Title	Engineering geologist	Title	Technical Director

Executive Summary

The Johannesburg Roads Agency (JRA) was appointed by the Environment and Infrastructure Services Department (EISD), the implementing agent for the Water and Biodiversity Project, for rehabilitation of a number of dams within the Braamfontein West Water Management Unit in the City of Johannesburg. As part of this appointment JRA appointed Aurecon for the design of the remedial works. Aurecon Ground Engineering conducted geotechnical investigations for these dams; the findings of the investigations into Albert's Farm Dam, are presented in this report.

The field investigation was conducted on the 29th of May 2019 and comprised excavation of four test pits across the site. Four other planned test pits were not excavated due to their location in a conservation area.

Representative samples were taken from selected horizons and submitted to SANAS accredited laboratory, Civilab, to determine the material's geotechnical properties. The results are summarised and discussed in the report and full laboratory test result sheets attached to Appendix D.

A visual assessment of the surface conditions across the site was also conducted prior to and during the test pitting noting features that might have an impact on the proposed design and rehabilitation.

The objectives of the geotechnical investigation were:

- To characterise the materials in the embankment and immediate environs, with a view to assessing their use in the embankment,
- To provide such inputs to the dam design team,
- To appraise geotechnical factors that might influence the dam condition, as well as re-design and construction, and
- To provide generic geotechnical related considerations and recommendations.

According to the geological map of the area (West Rand 2626, 1:250 000 geological map), the site is underlain by quartzite and shale of the Orange Grove Formation of the West Rand Group, Witwatersrand Supergroup which is intruded by younger diabase rocks. Outcrops of quartzite occur some 100m northwest of the dam. No major faults occur in the general area.

Assessment of the embankment showed that previously the dam wall had been breached and this breach is now plugged using sand bags, but flow was noted. This was noted at the vicinity of AFD TP7. Further visual assessment showed erosion of the dam wall on the upstream side. The wall has very narrow crest, 3m at most. The embankment's downstream face is grassed. It must be noted that no survey data of the dam was available at the time of the investigation.

The soils comprising the embankment typically consist of sandy / silty clay which are soft to firm, containing quartzite and ferricrete gravel. On the natural slopes defining the dam basin, the colluvium (occasionally ferruginised) consists of fine to coarse, angular quartzite gravel and ferricrete nodules. The finer component comprises silty clay / clayey silt and sandy clay. According to the Unified Soil Classification System the embankment fill material classifies as SM while the colluvial soils classify as CL.

Based on laboratory test results, the material encountered on site has high shear strength properties and is suitable for use in a homogenous embankment.

Seepages into test pits were only encountered at AFD TP2, at the proposed spillway position, at 1.2m from surface.

Although the embankment material on site is suitable for re-use in the raising of the embankment, quantities will depend on how much can be extracted from excavations. It is not anticipated that materials can be sourced at the park due to nature of the facility. Rip-rap material would certainly be sourced from commercial sources.

Failure to access the downstream side of dam meant assessment of these areas was only limited to a distant visual observation of the vicinity. This therefore limited assessments of the downstream side of the embankment, as well as the conditions at the toe and along the spillway canal.

Contents

Figures

Tables

Appendices

1 Introduction

The Johannesburg Roads Agency (JRA) was appointed by the Environment and Infrastructure Services Department (EISD), the implementing agent for the Water and Biodiversity Project, for rehabilitation of a number of dams within the Braamfontein West Water Management Unit in the City of Johannesburg. As part of this appointment JRA appointed Aurecon for the design of the remedial works. Aurecon Ground Engineering conducted geotechnical investigations for these dams, with the findings for Albert's Farm Dam presented in this report.

The field investigations were conducted on the 29th of May 2019 comprising test pitting and sampling.

Albert's Farm Dam is located in Northcliff suburb, Johannesburg, at the intersection of De La Rey Road and Zulu Street.

The objectives of the geotechnical investigation were:

- To characterise the materials in the embankment and immediate environs, with a view to assessing their use in the embankment,
- To provide such inputs to the dam design team,
- To appraise geotechnical factors that might influence the dam condition, as well as re-design and construction, and
- To provide generic geotechnical related considerations and recommendations.

The following works are planned as part of the rehabilitation:

- Repair of the breach section on the embankment,
- Raising the embankment by a nominal 500 mm,
- Reinstatement of the upslope protection,
- Placing material on the downstream slope,
- Construction of the spillway channel with a concrete overflow sill, and
- Placing Reno mattresses for erosion immediately downstream of the sill for about 3m.

2 Available information

The available information comprised:

- The 1:250 000 scale geological map of the area (Sheet 2626 West Rand, Council for Geoscience, 1986).
- An electronic file (KMZ) showing the site.

It must be noted that no geotechnical reports of any previous investigations were able to be sourced and it is unlikely that earlier geotechnical investigations were ever conducted. The desk study comprised a review of geological maps.

3 Site location and description

Albert's Farm Dam is located in Northcliff suburb at the intersection of De La Ray Road and Zulu Street making for easy vehicular access. The site location is shown in Figure 1 below. The park, which includes the dam, is a recreational facility open to the public and is predominantly used as a dog park.

The dam comprises an earth embankment (Figure 2) and is approximately 200m in length. The results of the dam survey show the embankment crest to be 1085mm and the height of the embankment is 5.4m and slopes at 60 degrees.

The dam is eroded on the upstream side and a previous failure of the wall was observed (Figure 3) in the vicinity of AFD TP7. Sand bags have been used to plug the breach, but flow was noted. Natural slopes around the dam are moderately sloping. The area downstream of the dam is understood to be a conservation area (*pers. comm. City Parks officials*).

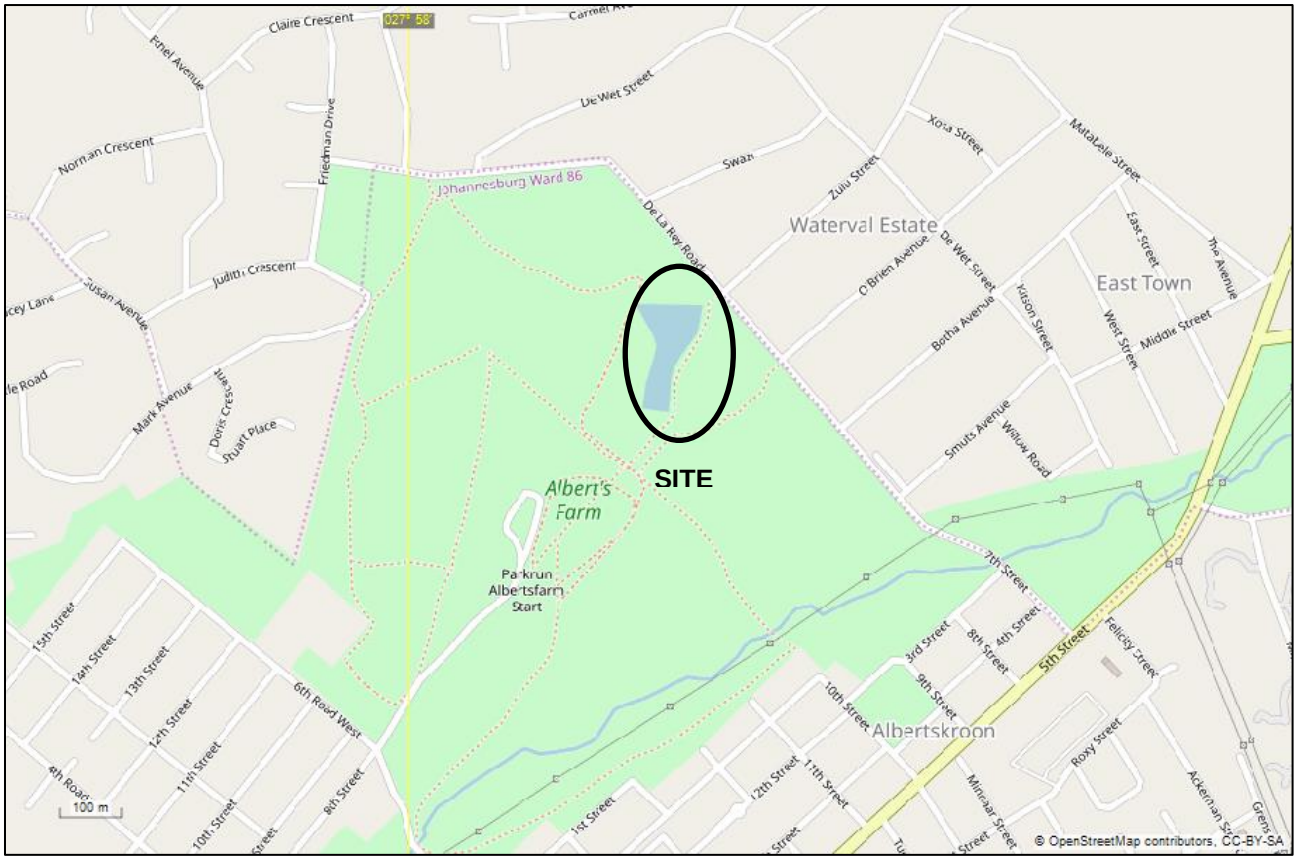


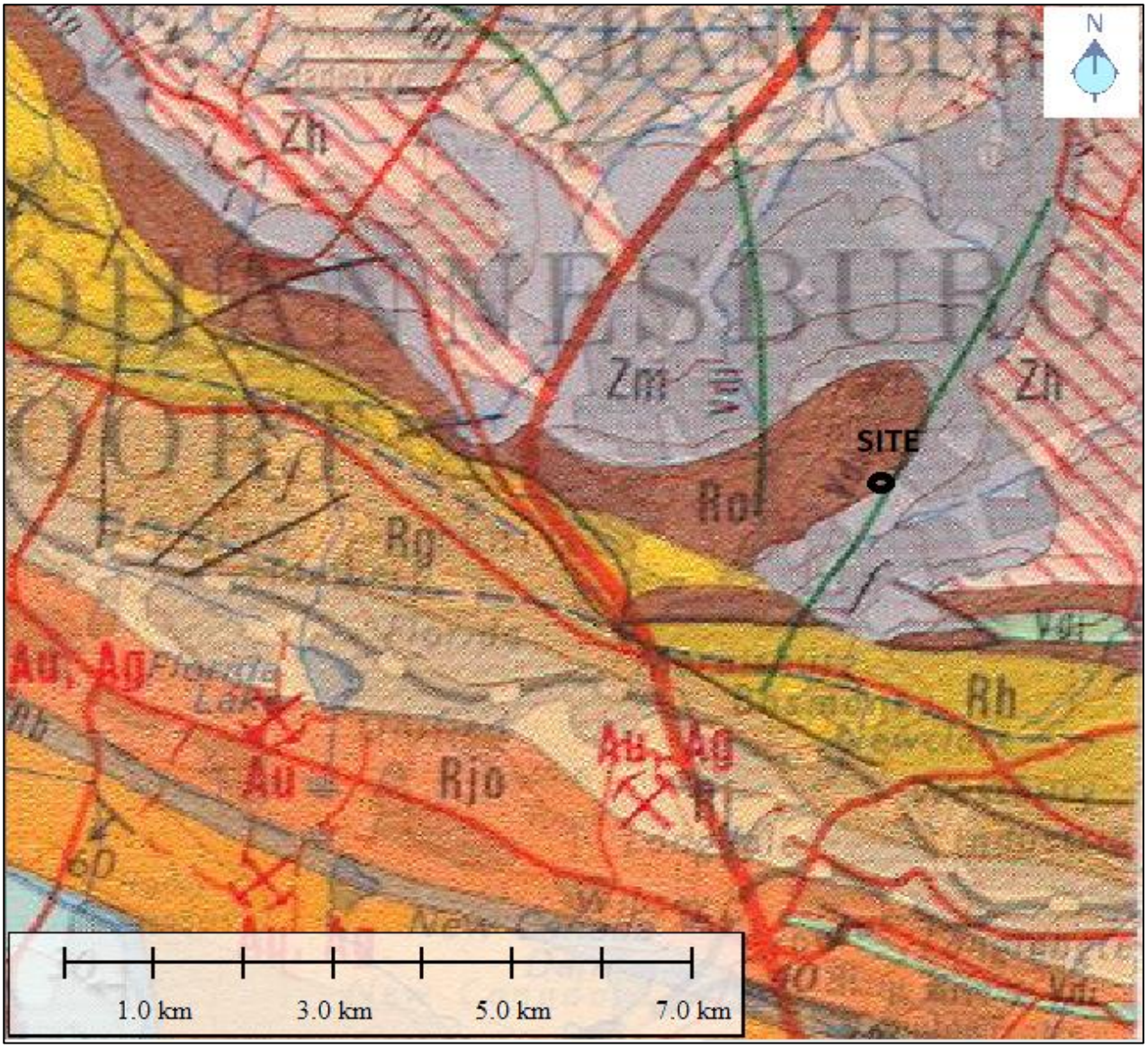
Figure 1: Location of the site

Figure 2: View of the dam from the north (approximate centre line and position of breach are shown by yellow line and arrow, respectively)

Figure 3: Close up view of the breach section – in the vicinity of AFD TP7. Arrows indicating approximately where water flow was noted – although clear view is obstructed by vegetation

4 Geology

According to the 1:250 000 scale geological map (Sheet 2626 West Rand, Council for Geoscience, 1986), the area is underlain by quartzite and shale of the Orange Grove Formation of the West Rand Group, Witwatersrand Supergroup. This sequence is underlain, regionally, by basement rocks, i.e. mafics and ultramafics and the intrusive Johannesburg Dome formerly Halfway House granite and intruded by younger diabase rocks. Quartzite outcrop is recorded about 100m to the northwest of the dam. The outcrop is just under 400 m in extent and is annotated in drawing 504630-0000-DRG-G3-0001 (Appendix C). The geological setting of the site is shown in Figure 4 below. There are no major faults in the general area of the Albert's Farm Dam.



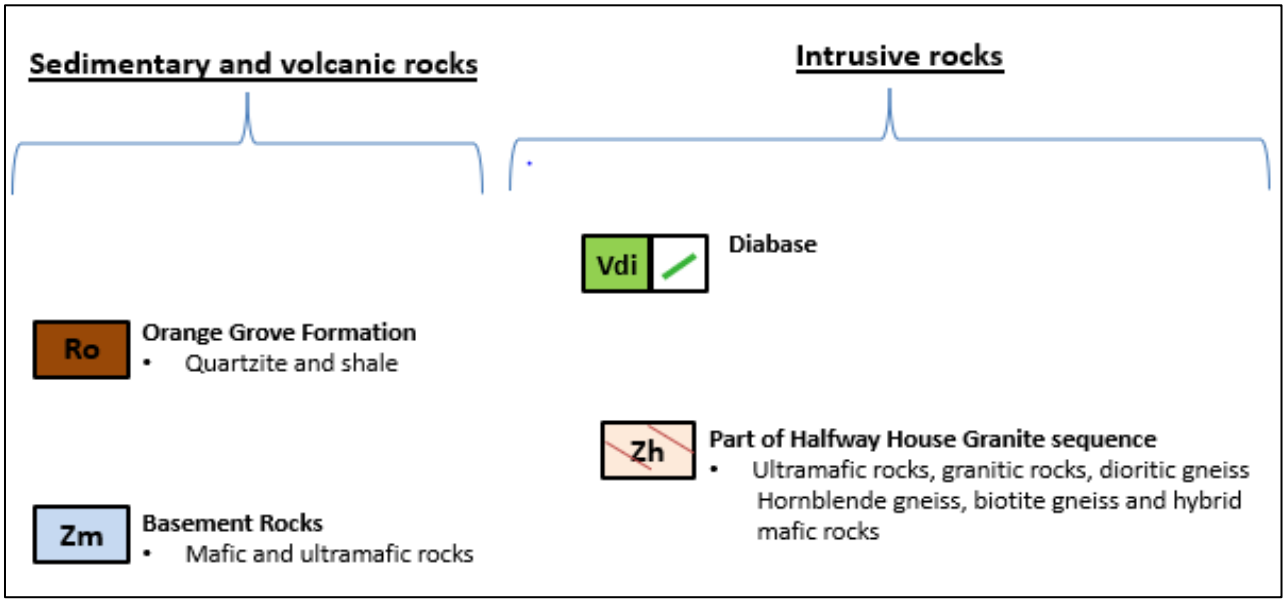


Figure 4: Regional geological setting of the site and stratigraphy (from published 1:250 000 geological map; Sheet 2626 West Rand, Council for Geoscience, 1986)

5 Climate

The site is in an area with a Weinert N-value (Weinert, 1980) less than 5 but not less than 2, which indicates chemical decomposition of the underlying bedrock is the main mode of weathering. The shallow soil profiles tended to comprise fill material and transported colluvial soils; however, no residual soils were observed. Ferricrete concretions were noted in test pits excavated on the natural slopes indicating moist soil conditions associated with the climate of the area, and a seasonally-fluctuating water table.

6 Seismicity

The greater Johannesburg area is affected by natural, and induced seismic activities related to mining in the Witwatersrand. Albert's Farm Dam is therefore associated with a seismic hazard considered moderate to high. A Peak Ground Acceleration (PGA) of about 0.2g (SANS 10160-4:2011) can be associated with the area, with a 10% probability of being exceeded in a 50-year period. The seismic map below (Figure 5), from SANS 10160-4:2011, shows the relative position of the site to the defined seismic zones.

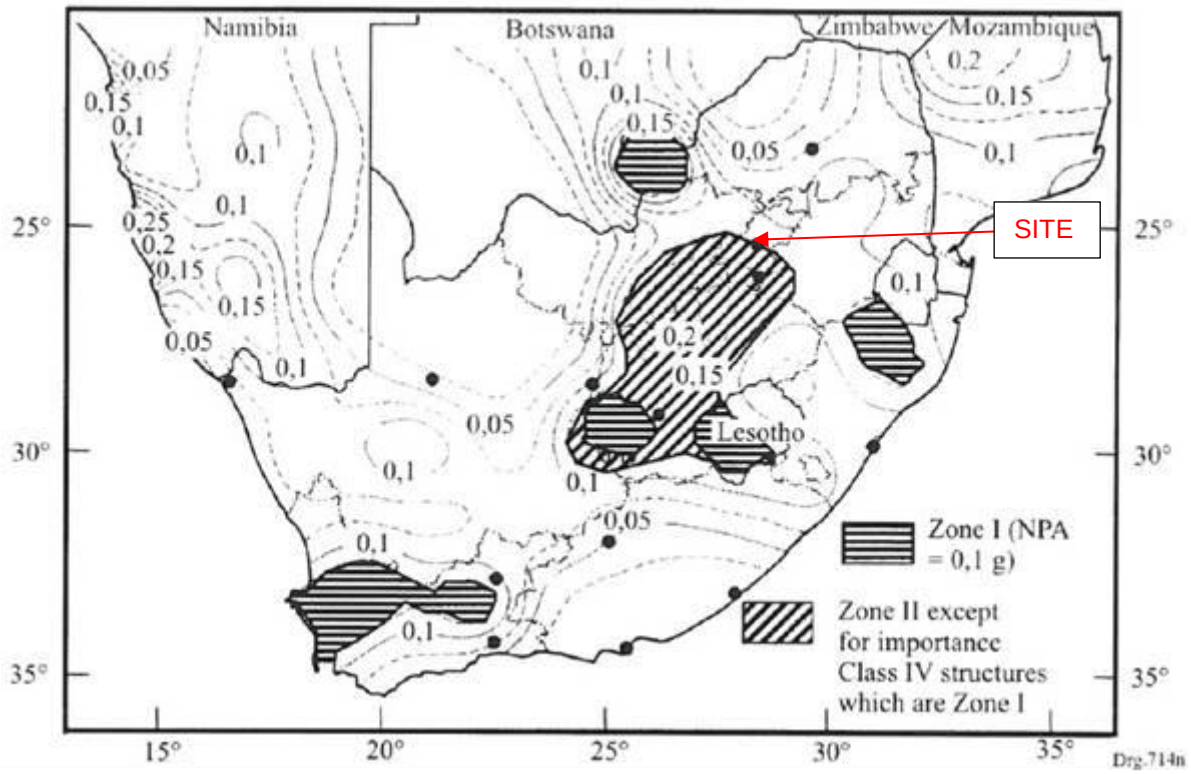


Figure 5: Seismic hazard map showing peak ground acceleration (g) with 10% probability of being exceeded in a 50 year period (after SANS 10160-4:2011).

7 Site investigation rationale and methodology

These investigations are considered high level investigations aimed at providing geotechnical information for the design of the remedial works. Shallow test pitting and sampling was therefore undertaken, and no deep investigations (drilling) or other investigations were included. The investigation methodology is expanded below.

The site investigation commenced with a review of all available information of the area such as geological maps. The desktop study was followed by a site walk-over survey, test pitting and sampling.

A health and safety file was compiled as part of compliance to the South African Occupational Health and Safety Act, OHS (Act 85 of 1993) to ensure a safe working environment for Aurecon staff on site and the sub-contractors. Part of the documents contained in the file is the safe working procedures document which covers the assessment of test pits by an appointed excavation competent person prior to entry into the test pit. An inspection checklist cited in this document was used to assess the safety of the test pit excavations.

A site walk-over and the test pitting were conducted on the 29th of May 2019. Civilab was appointed for the test pitting (both machine and hand-dug) as well as the laboratory testing. Test pits AFD TP1 and AFD TP2 were excavated to depths of 2.5m and 1.6m respectively using a New Holland B90B Tractor Loaded Backhoe (TLB). Test pit AFD TP2 was terminated due to seepage occurring at 1.2m. Test pits AFD TP3 and AFD TP5 were hand excavated to a maximum depth of 1.5m. The locations of the test pits are indicated on Drawing 504630-0000-DRG-G3-0001 in Appendix C. Four planned test pits (AFD TP4, AFD TP6, AFD TP7 and AFD TP8) were not excavated during the investigation as these are falling within a conservation area. The test pit positions were recorded on site using a hand-held GPS.

The test pits were profiled by engineering geologists in accordance with the guidelines proposed by Jennings, Brink and Williams (1973). A summary of the test pit data is given in Table 1 and detailed ground profile descriptions are attached in Appendix B of this report.

Representative samples were taken from the test pits and submitted to SANAS-accredited laboratory, Civilab (Pty) Ltd, for classification and geotechnical testing. Tests conducted included:

- Foundation indicator tests (comprising of grading and hydrometer analyses, Atterberg limits and Linear Shrinkage);
- Proctor compaction including Maximum Dry Density (MDD) and Optimum Moisture Content (OMC);
- Quick direct shear tests; and
- Falling head permeability tests.

Laboratory test results are summarised in Section 9 and detailed test results sheets attached to Appendix D.

Table 1: Summary of test pit positions

Test Pit No.	SA Lo 29 WGS84		Depth (m)	Remarks
	X	Y		
AFD TP1	2894431	102846	2.5	Target depth reached, test pit located at proposed spillway
AFD TP2	2894444	102848	1.6	Terminated due to seepage – excavation unsafe; test pit located at proposed spillway
AFD TP3	2894465	102845	1.5	Target depth reached, test pit located at the crest
AFD TP4	2894484	102878	-	Test pit not excavated

Test Pit No.	SA Lo 29 WGS84		Depth (m)	Remarks
	X	Y		
AFD TP5	2894527	102875	1.5	Target depth reached, test pit located at slope of embankment
AFD TP6	2894511	102862	-	Test pit not excavated
AFD TP7	2894579	102889	-	Test pit not excavated
AFD TP8	2894508	102817	-	Test pit not excavated

8 Investigation results

8.1 Site walk-over

During the site walk-over outcrop of Orange Grove Formation quartzite was noted approximately 100m northwest of the dam. The outcrop was not assessed further but was noted as a probable indication of the underlying geology. Quartzite gravel is scattered on the surface in the vicinity of AFD TP1 and AFD TP2. The previous dam wall breach was also noted (Figure 3). Erosion of the upstream slope is also noted as a result of wave action against the embankment. It is understood that protection of this upstream face of the embankment is proposed as part of the remedial works.

8.2 Soil profile

Embankment fill material and colluvium (occasionally ferruginised) were encountered in the test pits. The colluvium was encountered on the natural slopes to the north of the dam (at AFD TP1 and AFD TP2). The fill material is predominantly clayey containing quartzite gravel and scattered ferricrete nodules. The quartzite and ferricrete gravel are also encountered in the natural slopes. The details of the horizons in each test pit are summarised in the table below.

Table 2: Summary of the ground profiles present in the test pits

Test Pit No.	Embankment fill (m)	Colluvium (m)	Ferruginised colluvium (m)
AFD TP1		0.0 - 0.5	0.5 - 2.5+
AFD TP2		0.0 - 1.6+	
AFD TP3	0 0 - 1.5+		
AFD TP5	0.0 - 1.5+		

8.2.1 Embankment fill material

The embankment fill material comprises slightly moist to moist, soft and firm, sandy and / silty clay containing occasional to abundant fine and medium to coarse, angular, quartzite gravel and scattered ferricrete concretions. A 0.65m thick layer of slightly moist, medium dense, clayey sand was encountered at a depth of 0.95m below the sandy / silty clay at AFD TP3.

The different fill layers are of various thicknesses, ranging between 0.15 to 0.65m with a maximum thickness of 1.25m recorded at Test Pit AFD TP5, the slightly moist to moist, soft sandy clay with occasional medium to coarse angular and scattered ferricrete nodules.

8.2.2 Colluvium

Colluvium was encountered at Test Pit AFD TP1 from surface to 0.5m and at Test Pit AFD TP2 from surface to 1.6m. The coarser fraction comprises gravel described as fine to coarse, angular, closely packed, hard quartzite gravel in a matrix of slightly moist, silty clay with abundant rootlets. The overall consistency is medium dense. While fine colluvium comprises silty clay / clayey silt and sandy clay.

8.2.3 Ferruginised colluvium

The ferruginised colluvium was encountered at Test Pit AFD TP1 from 0.5 to 2.5m. comprising moist, soft, silty clay with significant medium to coarse, angular, quartzite gravel and ferricrete nodules. A pinholed structure was noted in this layer.

8.3 Groundwater / seepage

Seepage was encountered at AFD TP2, the test pit located at the proposed spillway position. The seepage occurred at a depth of 1.2m below surface. The test pit was actually moved from the proposed position due to wet conditions being noted. Thus, the general area is defined by such conditions which possibly results from overflow.

9 Laboratory test results

The laboratory test results are summarised and discussed below, and the detailed test results are attached in Appendix D.

9.1 Foundation indicator test results

Disturbed soil samples of representative horizons were taken for laboratory testing to confirm the compositions of the materials. The results are summarised in the table below.

Table 3: Summary of foundation indicator tests

TP No	Depth (m)	Material type	Particle Size %				Atterberg Limits %			GM	AASHTO/ USCS classification; expansion potential
			Clay	Silt	Sand	Gravel	LL	PI	LS		
AFD TP1	1.50-2.50	Ferruginised colluvium	25	34	29	12	41	17	9.0	0.69	A-7-6 (9) / CL; Medium
AFD TP5	0.25-1.50	Fill material	19	17	26	38	51	20	7.5	1.56	A-7-5 (2) / SM; Low

AASHTO – American Association of State Highway and Transportation Officials
USCS – Unified Soil Classifications System
LL – Liquid Limit
PI – Plasticity Index
LS – Linear Shrinkage
GM – Grading Modulus
SM – Silty sands, sand-silt mixtures
CL– Inorganic clays of low to medium plasticity

gravelly clays, sandy clays, silty clays, lean clays

Based on the table above, the results show the following:

- The results show that the **ferruginised colluvial soils** contain 25% clay and 34% silt. The coarse fractions consist of 29% sand and 12 gravel. According to the Unified Soil Classification System (USCS) the material classifies as CL. In accordance to the method proposed by Van der Merwe (1973) this material has a medium potential for expansion.
- The **embankment fill material** is classified as SM according to the Unified Soil Classification System (USCS). The material consists of 19% clay and 17% silt. The gravel component constitutes 38% of the coarse fraction while sand makes up 26%. In accordance to the method proposed by Van der Merwe (1973) this material has a low potential for expansion. The USCS grouping of soils is useful in providing estimations of friction angles of the materials as well as other parameters, i.e. unit weight. These parameters are presented below for the materials encountered on site.

Table 4: Parameters related to USCS groups

Test Pit No.	Material origin	USCS group	Classification	Unit weight (kN/m^3)	Friction angle (°)	Cohesion (kPa)
AFD TP1	Ferruginised colluvium	CL	Clayey sand, many fines	20 (± 1.5)	27 (± 4)	20 (± 10)
AFD TP5	Embankment fill material	SM	Silty sand; many fines	20 (± 2.0)	34 (± 3)	0

Note: The soil classes and estimated properties have been adapted from Krahenbuhl and Wagner (1983).

9.2 Compaction test results

Compaction tests were also conducted on selected samples to determine the compaction properties of the materials and the results are summarised in the table below.

Table 5: Summary of compaction test results

TP No.	Material type	Depth (m)	Standard Proctor	
			MDD (kgm^3)	OMC %
AFD TP05	Embankment fill material	0.25-1.50	1572	22.9

MDD – Maximum Dry Density
OMC – Optimum Moisture Content

According to the table above, embankment fill material has a Maximum Dry Density (MDD) of 1572 kg/m^3 with an Optimum Moisture Content (OMC) of 22.9%. These values reflect typically near-minimum MDD values for a homogeneous embankment, while the corresponding OMC is naturally near the maximum desirable. Note it is assumed that the existing structure is a homogeneous embankment. This is not confirmed.

9.3 Shearbox test results

Quick undrained shear testing was conducted on a disturbed sample of embankment fill material to determine the strength parameters of these materials. The test was conducted on a sample remoulded to 90% standard Proctor compaction. The results are summarised as follows:

Table 6: Summary of shearbox test results

TP No.	Material type	Depth (m)	Shear strength parameters	
			Cu (kPa)	N_u (deg)
AFD TP05	Fill material	0.25-1.50	60.5	45.3

Cu = Cohesion intercept
N_u = Angle of shearing resistance

Based on the table above, the results show that the embankment fill material exhibit high shear strengths. It must be noted that the material contains a high gravel content.

9.4 Falling head permeability test results

Falling permeability testing was conducted on a disturbed soil sample of embankment fill material remoulded to 90% standard Proctor compaction. The sample was saturated and tested under a load of 100kPa. Densities are reported under this load.

Table 7: Summary of falling head permeability test results

TP No.	Material type	Depth (m)	Dry density (kg/m^3)	Coefficient of Permeability (m/s)		
				Minimum	Maximum	Average
AFD TP05	Fill material	0.25 - 1.50	1326	1.0E-08	1.6E-08	1.2E-08

An average coefficient of permeability value of 1.2 E-08m/s was recorded which would be suitable for a homogeneous embankment.

10 Geotechnical considerations

10.1 Foundation permeability

The embankment fill material recorded an average coefficient of permeability value of 1.2 E-08 indicative of practically impervious material. No seepage occurred at test pits located on fill material. Seepage was noted on the test pit located at the proposed spillway (AFD TP2).

10.2 Erodibility of downstream areas

The area downstream of the dam was not accessed during the investigation because it is regarded as a conservation area, and possible evidence of erosion could not be observed. The area downstream is however well vegetated. Any embankment that is overtopped for a sufficient duration, by a significant flow, must be considered erodible.

10.3 Construction materials

The laboratory test results indicate the materials encountered on site have a well distributed mix of fines and coarse fractions. Further test results, i.e. shearbox and permeability show that the embankment fill material has high shear strength properties and practically impervious. These materials of the existing embankment would therefore be suitable for re-use within the rehabilitated homogeneous embankment.

Investigation for rip-rap material did not form part of the scope of these investigations. Environmental constraints will surely not entertain sourcing rip-rap from the local outcrop, and commercial sources would be the only logical option.

10.4 Stability of slopes

The natural slope to the north of the dam is characterised by a moderate gradient with scattered gravel on surface in some places. It is well grassed, though the grass was cut at the time of the investigation. No evidence of instability was observed, and none is expected.

10.5 Excavatability

The excavation conditions across the site can be described as “Soft Excavation” according to SABS 1200 DA-1998 specification; at least in terms of the depths attained by the shallow test pits. With outcrop in the vicinity it might be expected that deeper excavations might encounter rock that would require blasting.

10.6 Stability of excavations

Sidewall collapse was encountered in one of the test pits, AFD TP2, during the investigation, and this was linked to seepage.

It must be noted that this assessment is based on shallow excavation which was backfilled immediately. As part of safe practice during construction, assessment of the stability of excavations would be required by an appointed competent geotechnical person.

11 Closing remarks

It must be noted that these investigations have been quite limited as a result of the access restrictions. As a consequence, the information gathered, and the information gathered is also sparse.

Although obvious, it is worth stating that during the re-construction programme, a comprehensive laboratory testing schedule is implemented to confirm the materials used comply with specifications.

It is worth emphasizing that with the shallow water table in places, particularly if the dam level is not lowered, that the stability of excavations might be compromised. Great caution must be exercised in this regard, and slope stability must be assessed regularly by a geotechnical-competent person.

12 Limitations of report

1. Aurecon Ground Engineering has prepared this report for the use of our Client, Johannesburg Roads Agency (JRA) and our Aurecon dam design colleagues. The report has not been prepared for use by parties other than the Client, and the Client's respective consulting advisors.
2. This report has been written with the express intent of providing enough information for the design of the remedial works. The investigation has been conducted in accordance with generally accepted engineering practice, and the opinions and conclusions expressed in the report are made in good faith based on the information available to Aurecon Ground Engineering at the time of preparing this report.
3. There are always some variations in subsurface conditions across a site due to geological conditions that cannot be defined fully even by exhaustive investigation. Hence, it is possible that the measurements and values obtained from sampling and testing during the investigation may not represent the extremes of conditions which exist within the site. The precision with which subsurface conditions are identified depends on the method of excavation, the frequency and recovery of samples, the method of sampling, and the uniformity of the subsurface conditions. Subsurface conditions at other than the test pit positions may vary from the conditions encountered in the test pit locations.
4. Further, subsurface conditions, including groundwater levels can change over time. The groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These conditions may vary seasonally or as a consequence of construction activities in the area. This should be borne in mind, particularly if the report is used after a protracted delay or a period of protracted climatic conditions.
5. Should conditions exposed at the site during subsequent investigation or construction works vary significantly from those provided in this report, we request that Aurecon Ground Engineering be informed and have the opportunity to review any of the findings or conclusions of this report. It is highly recommended that during construction the site conditions be inspected by a representative of Aurecon Ground Engineering to confirm the geotechnical interpretations in this report.
6. Unless otherwise stated, this report does not address potential environmental hazards, or groundwater contamination that may be present. In addition to soil variability, fill material of variable physical and chemical composition can be present over portions of the site or on adjacent properties
7. The test pit logs represent the subsurface conditions at the specific test location only. Boundaries between zones on the logs are not often distinct, but rather are transitional and have been interpreted. The soil descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice, as stated in this report. Classification and identification of soil involves judgement, and Aurecon Ground Engineering infers accuracy in the classification and identification methods to the extent that is common in current geotechnical practice, and within the limitations of the ground investigation that was performed.
8. It is recommended that further geotechnical input from Aurecon Ground Engineering should be sought as the project moves into the next phase to confirm that the geotechnical assumptions made in this report are compatible with the structural performance requirements and are being applied appropriately.

13 References

- Jennings, J. E. B, Brink, A.B.A and Williams, A. A. B, (1993). Revised Guide to Soil Profiling for Civil Engineering Purposes in Southern Africa. The Civil Engineer in SA, p 3-12. January 1973.
- Kranehbuhl, J. and Wagner, A (1983). Survey, design, and construction of trial suspension of bridges for remote areas, SKAT, Swiss Center for Appropriate Technology in St Gallen, Switzerland.
- SABS 1200D: 1988 Standardised specification for civil engineering construction. D: Earthworks, South African Bureau of Standards, Pretoria.
- SANS 10160-4:2009 (2011). South African National Standard: Basis of structural design and actions for buildings and industrial structures. Part 4: Seismic actions and general requirements for buildings. ISBN 978-0-626.
- Terzaghi, K. Peck, R. B and Mesri, G, (1996). Soil Mechanics in Engineering Practice. 3rd edition. John Wiley and Son Inc.
- Weinert (1980). The natural road construction materials of southern Africa. National Institute for Transport and Road Research Pretoria.

Appendix A:
Soil and rock profile description terminology

STANDARD DESCRIPTIONS USED IN SOIL PROFILING

1. MOISTURE CONDITION

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

2. COLOUR

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

3. CONSISTENCY

3.1 Non-Cohesive Soils

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

3.2 Cohesive Soils

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

4. STRUCTURE

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

5. SOIL TYPE

5.1 Particle Size

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

6. ORIGIN

6.1 Transported Soils

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

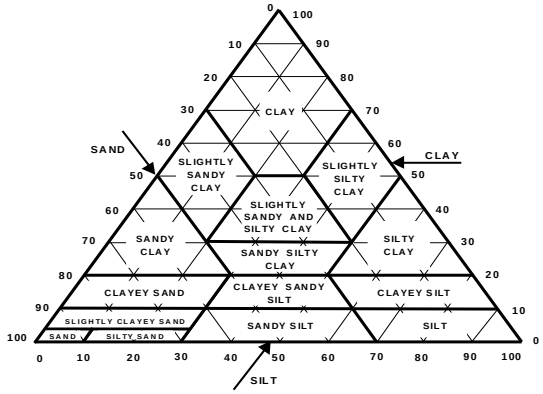
6.2 Residual soils

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

6.3 Pedocretes

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

5.2 Soil Classification



SUMMARY OF DESCRIPTIONS USED IN ROCK CORE LOGGING

1. WEATHERING

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

2. HARDNESS

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

3. COLOUR

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

4. FABRIC

4.1 Grain Size

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

4.2 Discontinuity Spacing

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

5. ROCK NAME

Classified in terms of origin:

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

6. STRATIGRAPHIC HORIZON

Identification of rock type in terms of stratigraphic horizons.

Appendix B:
Test pit profiles

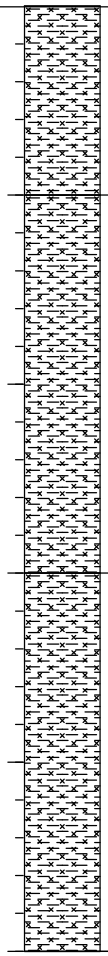
aurecon

Johannesburg Road Agency
Geotechnical Investigation for
Alberts Farm Dam

HOLE No: **AFDTP01**
Sheet 1 of 1

JOB NUMBER: **504630**

Scale 1:20



Disturbed sample

0.00 — Fine to coarse, angular, closely packed, hard quartzite gravel in a matrix of slightly moist, dark brown, silty CLAY with abundant rootlets. Overall consistency MEDIUM DENSE. Colluvium.

0.50 — Moist, dark yellow orange, speckled black, SOFT, intact, silty CLAY with abundant ferricrete nodules and significant angular medium to coarse gravel and rootlets. Ferruginised Colluvium.

1.50 — Moist, dark yellow orange, speckled black, SOFT, intact, silty CLAY with less abundant ferricrete nodules. Ferruginised Colluvium.

2.50

NOTES:

Final depth at 2.5m on ferruginised colluvium
Dislodgement of coarse gravel into test pit
No groundwater or seepage encountered
FI sample taken at 1.5-2.5m
Coarse gravel in vicinity of hole

CONTRACTOR:		*INCLINATION:*		*ELEVATION:*	
MACHINE:	New Holland B90B TLB	*DIAM:*		*X COORD:*	2894431
PROFILED BY:	A. Nxumalo & P. van Helsdingen	*DATE DRILLED:*	5/29/2019	*Y COORD:*	102846
TYPE SET BY:		*DATE PROFILED:*	5/29/2019		
	ALBERTS FARM DAM.GPJ				

HOLE No: **AFDTP01**

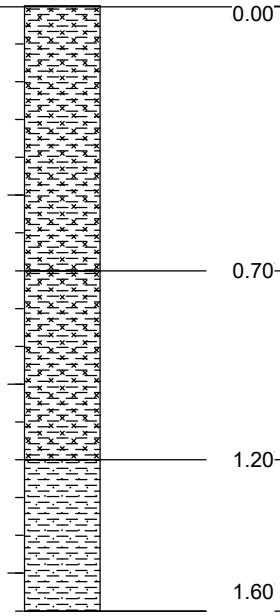
aurecon

Johannesburg Road Agency
Geotechnical Investigation for
Alberts Farm Dam

HOLE No: **AFDTP02**
Sheet 1 of 1

JOB NUMBER: **504630**

Scale 1:20



0.00 Coarse to fine, angular, closely packed, hard quartzite gravel with a matrix of slightly moist, silty CLAY with abundant rootlets. Colluvium.

0.70 Slightly moist, orange brown, silty CLAY/clayey SILT. Colluvium.

1.20 Very moist to wet, yellow brown, sandy CLAY. Colluvium.

1.60

NOTES:

Test pit terminated at 1.6m on colluvium
Seepage encountered at 1.2m
Sidewalls unstable (collapsing)
Test pit not entered due to unsafe conditions - material profiled from stockpile
Test pit moved 8m from the original position

CONTRACTOR:		*INCLINATION:*		*ELEVATION:*	
MACHINE:	New Holland B90B TLB	*DIAM:*		*X COORD:*	2894444
PROFILED BY:	A. Nxumalo & P. van Helsdingen	*DATE DRILLED:*	5/29/2019	*Y COORD:*	102848
TYPE SET BY:		*DATE PROFILED:*	5/29/2019		
	ALBERTS FARM DAM.GPJ				

HOLE No: **AFDTP02**

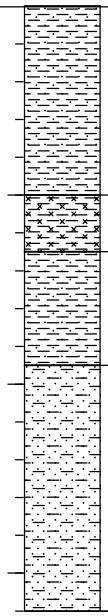
aurecon

Johannesburg Road Agency
Geotechnical Investigation for
Alberts Farm Dam

HOLE No: **AFDTP03**
Sheet 1 of 1

JOB NUMBER: **504630**

Scale 1:20



0.00	Slightly moist, yellow brown, SOFT, slightly sandy CLAY with abundant fine gravel (angular quartzite gravel and ferricrete) and roots. Fill.
0.50	Slightly moist (dry), dark reddish brown to red brown, SOFT, silty CLAY with roots. Fill.
0.65	Slightly moist, dark grey, FIRM, sandy CLAY with roots. Fill.
0.95	Slightly moist, dark brown, MEDIUM DENSE, clayey SAND with roots. Fill.
1.60	

NOTES:

Final depth at 1.6m on fill
Sidewall stable
No groundwater or seepage encountered

CONTRACTOR:
MACHINE: Hand dug
PROFILED BY: A. Nxumalo & P. van Helsdingen
TYPE SET BY:
ALBERTS FARM DAM.GPJ

INCLINATION:
DIAM:
DATE DRILLED: 5/29/2019
DATE PROFILED: 5/29/2019

ELEVATION:
X COORD: 2894465
Y COORD: 102845

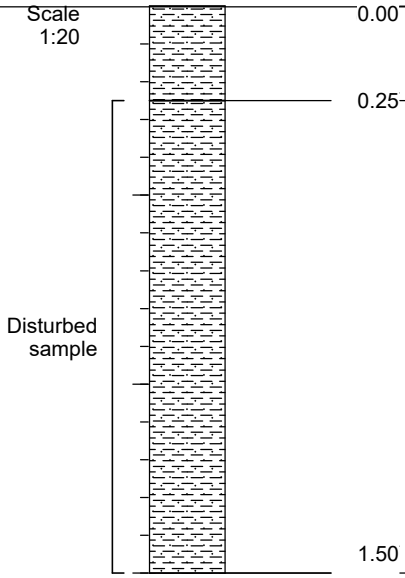
HOLE No: **AFDTP03**

aurecon

Johannesburg Road Agency
Geotechnical Investigation for
Alberts Farm Dam

HOLE No: **AFDTP05**
Sheet 1 of 1

JOB NUMBER: **504630**



0.00 Slightly moist, dark olive, SOFT, sandy CLAY. Fill.

0.25 Slightly moist, dark yellow orange, SOFT, sandy CLAY with occasional angular medium to coarse quartzite gravel and scattered ferricrete nodules. Fill.

1.50

NOTES:

Final depth at 1.5m on fill
Sidewall stable
No groundwater or seepage encountered
FI, proctor, shearbox and permeability sample taken at 0.25-1.5m
Test pit on embankment slope

CONTRACTOR:		*INCLINATION:*		*ELEVATION:*	
MACHINE:	Hand dug	*DIAM:*		*X COORD:*	2894527
PROFILED BY:	A. Nxumalo & P. van Helsdingen	*DATE DRILLED:*	5/29/2019	*Y COORD:*	102875
TYPE SET BY:		*DATE PROFILED:*	5/29/2019		
	ALBERTS FARM DAM.GPJ				

HOLE No: **AFDTP05**

Appendix C: Drawing (504630-0000-DRG-G3-0001 - Plan of Albert's Farm Dam with test pit positions)

COORDINATES Lo29 WGS84		
TEST PIT ID	Y	X
AFDTP1	102846.136	2894430.583
AFDTP2	102848.351	2894444.039
AFDTP3	102845.314	2894465.161
AFDTP4	102847.968	2894483.687
AFDTP5	102875.417	2894526.652
AFDTP6	102861.648	2894511.497
AFDTP7	102888.910	2894579.417
AFDTP8	102817.274	2894508.044

aurecon
www.aurecongroup.com

CLIENT

Joburg

JRA

REV	DATE	REVISION DETAILS	APPROVED
A	07/2019	ISSUE FOR REVIEW	

SCALE	SIZE
AS SHOWN	A1

DRAWN: S. NKOSI
DESIGNED: A. NXUMALO
CHECKED: G. DAVIS

DESIGN
NOT FOR CONSTRUCTION

APPROVED

PROJECT: REHABILITATION OF ALBERT'S FARM DAM
BRAAMFONTEIN WEST WATER MANAGEMENT UNIT

TITLE: GEOTECHNICAL INVESTIGATION
LAYOUT OF TEST PITS
-

DRAWING No.

PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
504630	0000	DRG	G3	0001	A

Appendix D: Laboratory test results

144 Edward Street, Hennopspark, Centurion 0157
PO Box 7661, Centurion 0046
Tel: +27 (0)12 653 1818 Fax: +27 (0)12 653 0997
E-mail: adminhennops@civilab.co.za
Website: www.civilab.co.za

sanas T0661

Civilab

Civil Engineering Testing Laboratories

Client	:	AURECON SA (PTY) LTD			
Address	:	P O BOX 74381	**Client Reference**	:	
	:	LYNWOOD RIDGE	**Order No.**	:	Ayanda
	:	400			
Attention	:		**Date Received**	:	04/06/2019
Facsimile	:	086 558 8805	**Date Tested**	:	04/06/2019 - 04/07/2019
E-mail	:	creditors.za@aurecongroup.com	**Date Reported**	:	04/07/2019
Project	:	Rehabilitation Albert`s Farm Dam			
Project No.	:	2019-H-397	**Report Status**	:	Final
			Page	:	1 of 2

Herewith please find the test report(s) pertaining to the above project. All tests were conducted in accordance with prescribed test method(s). Information herein consists of the following:

Test(s) conducted / Item(s) measured	Qty.	Test Method(s)	Authorized By**	Page(s)
Atterberg Limits <0.425mm	1.000	SANS 3001 GR10	G Meyer	2
Sieve Analysis 0.075mm	1.000	SANS 3001 GR1	G Meyer	2
Hydrometer Analysis	1.000	SANS 3001 GR3	G Meyer	2

Any test results contained in this report and marked with * in the table above are "not SANAS accredited" and are not included in the schedule of accreditation for this laboratory.

Any information contained in this test report pertain only to the areas and/or samples tested. Documents may only be reproduced or published in their full context.

While every care is taken to ensure that all tests are carried out in accordance with recognised standards, neither Civilab (Proprietary) Limited nor its employess shall be liable in any way whatsoever for any error made in the execution or reporting of tests or any erroneous conclusions drawn therefrom or for any consequences thereof.

All interpretations, Interpolations, Opinions and/or Classifications contained in this report falls outside our scope of accreditation.

The following parameters, where applicable, were excluded from the classification procedure: Chemical modifications, Additional fines, Fractured Faces, Soluble Salts, pH, Conductivity, Coarse Sand Ratio, Durability (COLTO: G4-G9).

The following parameters, where applicable, were assumed: Rock types were assumed to be of an Arenaceous nature with Siliceous cementing material.

Unless otherwise requested or stated, all samples will be discarded after a period of 3 months.

This report is completely confidential between the parties (Civilab and Civilab`s client) and shall not be disclosed to anybody else, unless agreed upon in writing or made publicly available by the client or required to make available by law.

Deviations in Test Methods:
None.

Technical Signatory:	Gerhard Meyer
Signature:	

**All results are authorized electronically by approved managers and/or technical signatories.

144 Edward Street, Hennopspark, Centurion 0157
PO Box 7661, Centurion 0046
Tel: +27 (0)12 653 1818 Fax: +27 (0)12 653 0997
E-mail: adminhennops@civilab.co.za
Website: www.civilab.co.za

sanas T0661

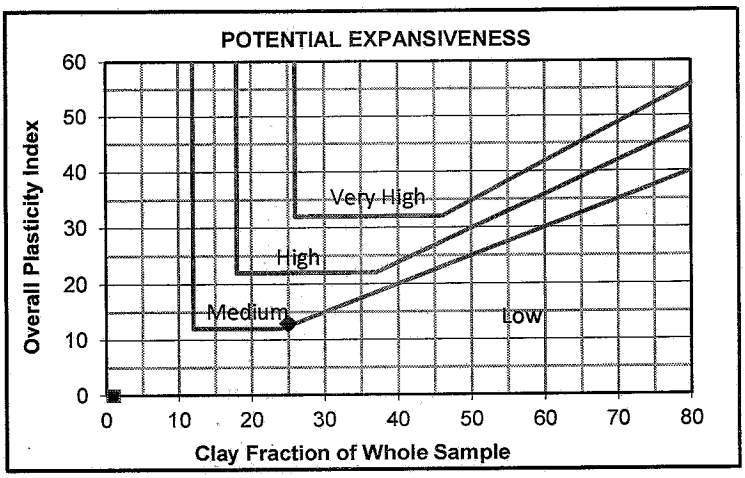
Civilab

Civil Engineering Testing Laboratories

Client	:	AURECON SA (PTY) LTD	Date Received:	04/06/2019
Project	:	Rehabilitation of Albert`s Farm Dam	Date Reported:	04/07/2019
Project No	:	2019-H-397	Page No. :	2 of 2

FOUNDATION INDICATOR

Laboratory Number		1 ◆	■
Field Number		AFD TP1	
Client Reference			
Depth (m)		1.5 - 2.5	
Position			
Coordinates	X		
	Y		
Description		Alberts Farm	
Aditional Information			
Calcrete / Crushed			
Stabilizing Agent			

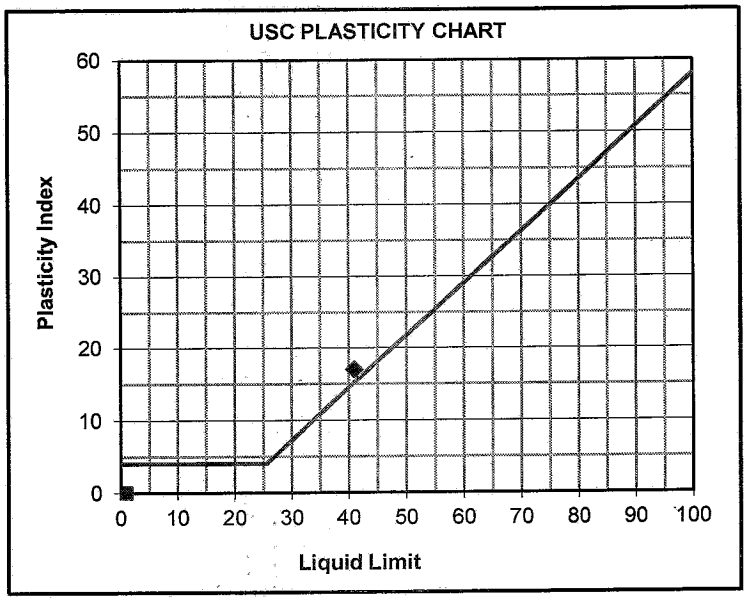


Moisture Content & Relative Density

Moisture Content (%)		
Relative Density (S.G.)		

Sieve Analysis (Wet Prep) — **SANS 3001 GR1**

Percentage Passing	100 mm	100	
	75 mm	100	
	63 mm	100	
	50 mm	100	
	37.5 mm	100	
	28 mm	100	
	20 mm	100	
	14 mm	100	
	5 mm	96	
	2 mm	88	
	1 mm	84	
	0.425 mm	79	
	0.250 mm	72	
	0.150 mm	69	
	0.075 mm	64	
Grading Modulus		0.69	



Hydrometer Analysis — **SANS 3001 GR3**

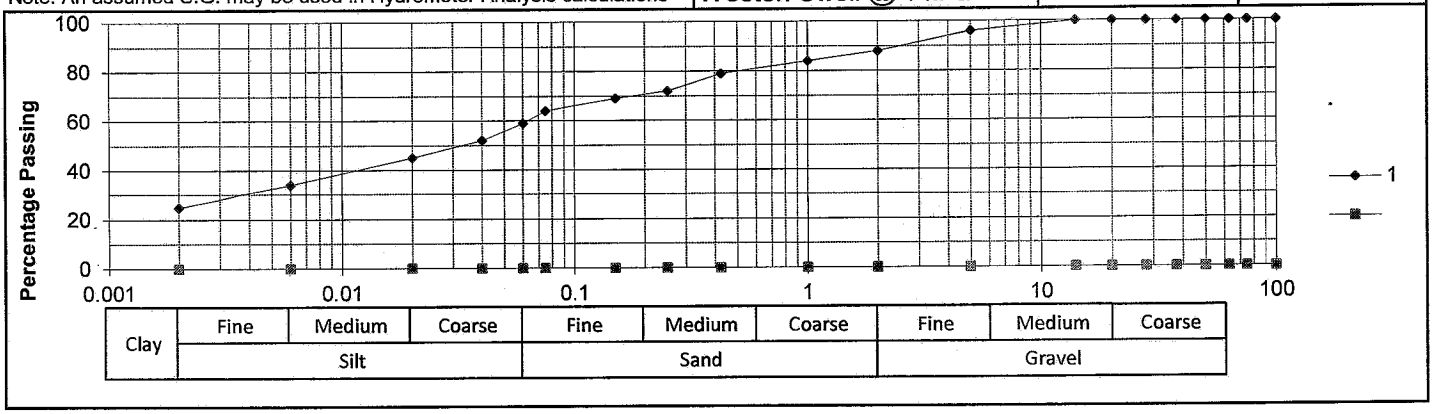
Percentage Passing	0.060 mm	59	
	0.040 mm	52	
	0.020 mm	45	
	0.006 mm	34	
	0.002 mm	25	
Gravel	%	12	
Sand	%	29	
Silt	%	34	
Clay	%	25	

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

Laboratory Number		1 ◆	■
Atterberg Limits -425µ		**SANS 3001 GR10**	
Liquid Limit	%	41	
Plasticity Index	%	17	
Linear Shrinkage	%	9.0	
Overall PI	%	13	

Classifications

HRB (AASHTO)	A-7-6(9)	
Unified (ASTM D2487)	CL	
Weston Swell @ 1 kPa		



144 Edward Street, Hennopspark, Centurion 0157
PO Box 7661, Centurion 0046
Tel: +27 (0)12 653 1818 Fax: +27 (0)12 653 0997
E-mail: adminhennops@civilab.co.za
Website: www.civilab.co.za

sanas T0661

Civilab

Civil Engineering Testing Laboratories

Client	: AURECON SA (PTY) LTD	Date Received	: 04/06/2019 -
Project	: Rehabilitation of Albert`s Farm Dam	Date Reported	: 04/07/2019
Project No	: 2019-H-397		

SAMPLING PLAN and METHODS

Lab. No.	Field No. / Depth (m)	Sample Type/ Delivery	Client Ref. No.	Position	Description	Additional Information	Sampling: Method	Sampling: Date	Sampling: Time	Remarks, Deviations etc.	Image
1	AFD TP1 / 1.5 - 2.5				Alberts Farm			?			

36 Fourth Street, Booysens Reserve, Johannesburg 2091
PO Box 82223, Southdale 2135
Tel: +27 (0)11 835 3117•Fax: +27 (0)11 835 2503
E-mail: jhb@civilab.co.za•Website: www.civilab.co.za

sanas Testing Laboratory T0062

Civilab

Civil Engineering Testing Laboratories

Client	:	CIVILAB (PTY) LTD - CENTURION			
Address	:	P O BOX 7661	**Client Reference**	:	
	:	CENTURION	**Order No.**	:	
	:	46			
Attention	:		**Date Received**	:	06/06/2019
Facsimile	:	012-653-0997	**Date Tested**	:	06/06/2019 - Current
E-mail	:	adminhennops@civlab.co.za	**Date Reported**	:	05/07/2019
Project	:	Rehabilitation of Braamfontein West Water Management Unit- Alberts Farm			
Project No.	:	2019-B-840	**Report Status**	:	Final
			Page	:	1 of 5

Herewith please find the test report(s) pertaining to the above project. All tests were conducted in accordance with prescribed test method(s). Information herein consists of the following:

Test(s) conducted / Item(s) measured	Qty.	Test Method(s)	Authorized By**	Page(s)
Moisture Density Relationship	1.000	ASTM D698	S Pullen/B Mvubu	3-3
Relative density of soil (SG)	1.000	SANS 3001 AG23	B Mvubu	2-2
Atterberg Limits <0.425mm	1.000	SANS 3001 GR10	S Pullen/B Mvubu	2-2
Sieve Analysis 0.075mm	1.000	SANS 3001 GR1	S Pullen/B Mvubu	2-2
Hydrometer Analysis	1.000	SANS 3001 GR3	S Pullen/B Mvubu	2-2
Falling Head Permeability	1.000	K H Head	J Marques	1File; 1Page
Direct Shearbox	1.000	BS 1377 Part 5	J Marques	1 File; 1Page

Any test results contained in this report and marked with * in the table above are "not SANAS accredited" and are not included in the schedule of accreditation for this laboratory.

Any information contained in this test report pertain only to the areas and/or samples tested. Documents may only be reproduced or published in their full context.

While every care is taken to ensure that all tests are carried out in accordance with recognised standards, neither Civilab (Proprietary) Limited nor its employess shall be liable in any way whatsoever for any error made in the execution or reporting of tests or any erroneous conclusions drawn therefrom or for any consequences thereof.

All interpretations, Interpolations, Opinions and/or Classifications contained in this report falls outside our scope of accreditation.

The following parameters, where applicable, were excluded from the classification procedure: Chemical modifications, Additional fines, Fractured Faces, Soluble Salts, pH, Conductivity, Coarse Sand Ratio, Durability (COLTO: G4-G9).

The following parameters, where applicable, were assumed: Rock types were assumed to be of an Arenaceous nature with Siliceous cementing material.

Unless otherwise requested or stated, all samples will be discarded after a period of 3 months.

This report is completely confidential between the parties (Civilab and Civilab`s client) and shall not be disclosed to anybody else, unless agreed upon in writing or made publicly available by the client or required to make available by law.

Deviations in Test Methods:

Technical Signatory:	
Signature:	

**All results are authorized electronically by approved managers and/or technical signatories.

36 Fourth Street, Booysens Reserve, Johannesburg 2091
PO Box 82223, Southdale 2135
Tel: +27 (0)11 835 3117•Fax: +27 (0)11 835 2503
E-mail: jhb@civilab.co.za•Website: www.civilab.co.za

sanas Testing Laboratory T0062

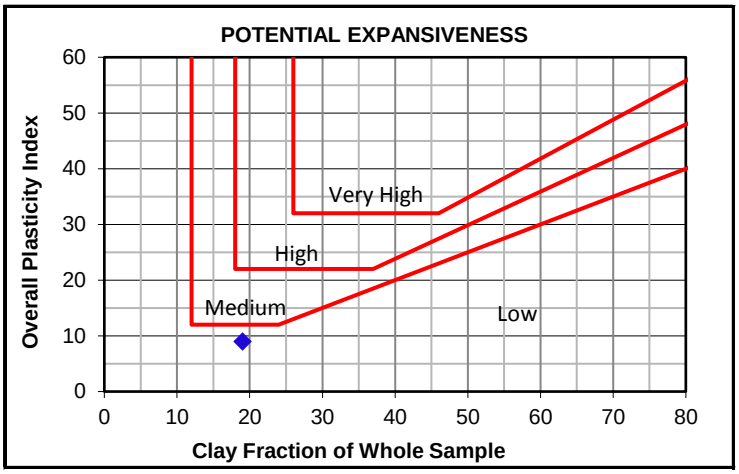
Civilab

Civil Engineering Testing Laboratories

Client	:	CIVILAB (PTY) LTD - CENTURION	Date Received:	06/06/2019
Project	:	Rehabilitation of Braamfontein West Water Management Unit	Date Reported:	04/07/2019
Project No	:	2019-B-840	Page No. :	2 of 5

FOUNDATION INDICATOR

Laboratory Number		1 ◆	■
Field Number		TP5	
Client Reference		AFD	
Depth (m)		0.25-1.50	
Position			
Coordinates	X		
	Y		
Description			
Aditional Information		Alberts Farm	
Calcrete / Crushed Stabilizing Agent			

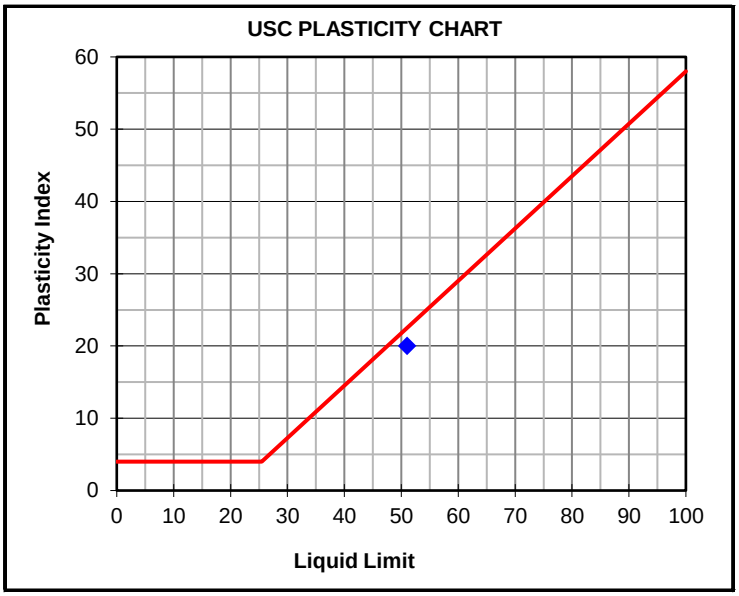


Moisture Content & Relative Density

Moisture Content (%)	
Relative Density (S.G.)	2.932

Sieve Analysis (Wet Prep) — **SANS 3001 GR1**

Percentage Passing	100 mm	100
	75 mm	100
	63 mm	100
	50 mm	100
	37.5 mm	100
	28 mm	100
	20 mm	100
	14 mm	89
	5 mm	69
	2 mm	62
	1 mm	58
	0.425 mm	46
	0.250 mm	42
	0.150 mm	39
	0.075 mm	36
Grading Modulus		1.56



Hydrometer Analysis — **SANS 3001 GR3**

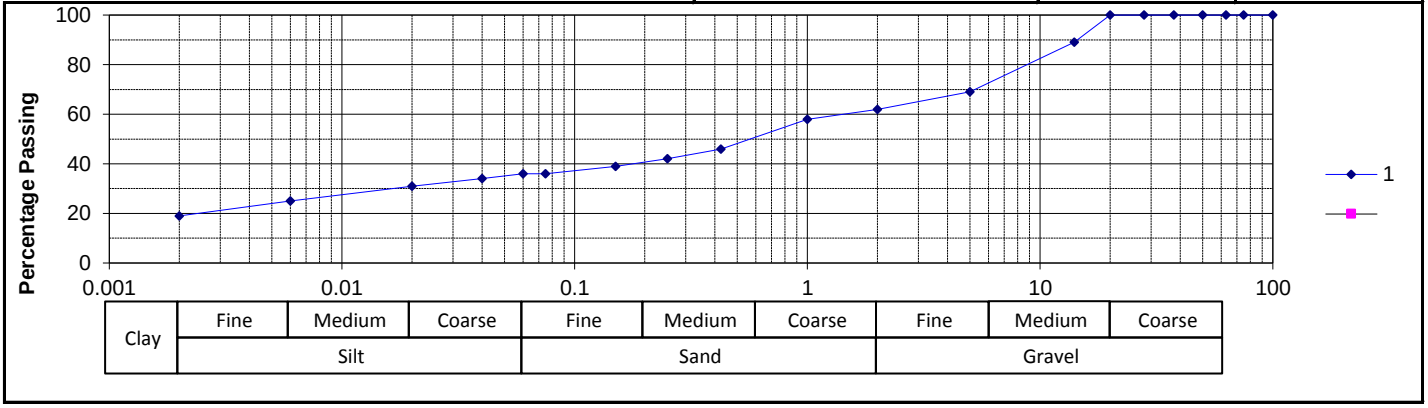
Percentage Passing	0.060 mm	36
	0.040 mm	34
	0.020 mm	31
	0.006 mm	25
	0.002 mm	19
Gravel	%	38
Sand	%	26
Silt	%	17
Clay	%	19

Note: An assumed S.G. may be used in Hydrometer Analysis calculations

Laboratory Number		1 ◆	2 ■
Atterberg Limits -425µ		**SANS 3001 GR10**	
Liquid Limit	%	51	
Plasticity Index	%	20	
Linear Shrinkage	%	7.5	
Overall PI	%	9	

Classifications

HRB (AASHTO)	A-7-5(2)	
Unified (ASTM D2487)	SM	
Weston Swell @ 1 kPa		



36 Fourth Street, Booysens Reserve, Johannesburg 2091
PO Box 82223, Southdale 2135
Tel: +27 (0)11 835 3117•Fax: +27 (0)11 835 2503
E-mail: jhb@civilab.co.za•Website: www.civilab.co.za

sanas Testing Laboratory T0062

Civilab
Civil Engineering Testing Laboratories

Client :	CIVILAB (PTY) LTD - CENTURION	Date Received:	06/06/2019
Project :	Rehabilitation of Braamfontein West Water Management Unit	Date Reported:	04/07/2019
Project No:	2019-B-840	Page No. :	7 of 5

MOISTURE DENSITY RELATIONSHIP

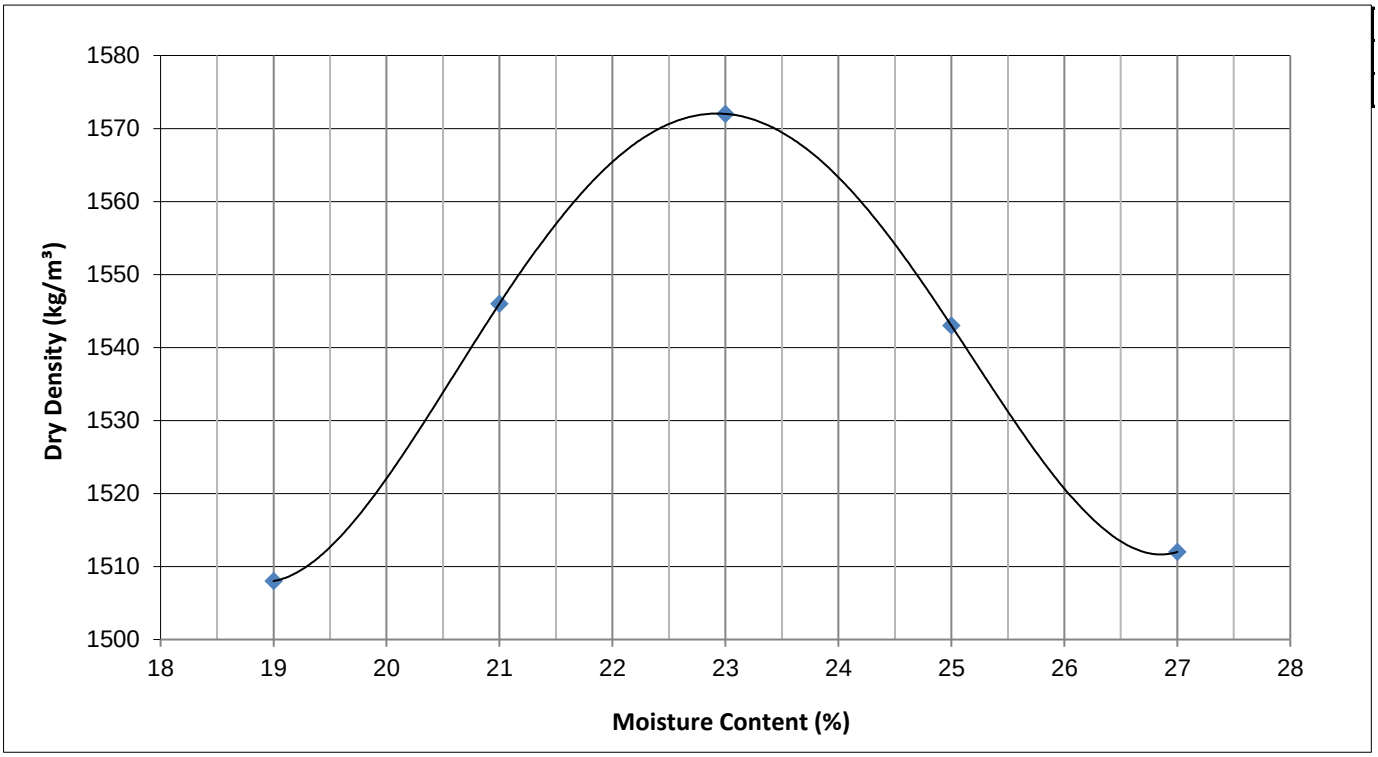
Laboratory Number		1
Field Number		TP5
Client Reference		AFD
Depth (m)		0.25-1.50
Position		
Coordinates	X	
	Y	
Description		
Additional Information		Alberts Farm
Calcrete / Crushed Stabilizing Agent		

Maximum Dry Density & Optimum Moisture Content - ASTM D698

Compactive Effort:	Standard Proctor

Dry Density	kg/m³	1508	1546	1572	1543	1512	
Moisture Content	%	19	21	23	25	27	

Max. Dry Density	kg/m³	1572
Optimum Moisture	%	22.9



36 Fourth Str.,Booysens Reserve,Johannesburg 2091
PO Box 82223,Southdale 2135
Tel:+27 (0)11 835 3117
E-mail: jhb@civilab.co.za Website: www.civilab.co.za

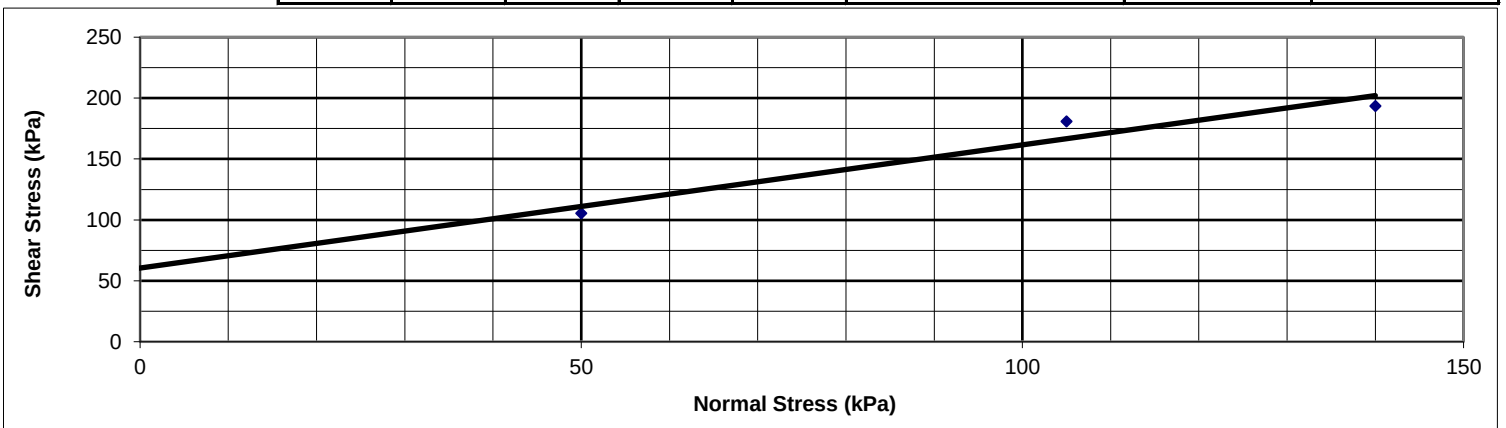
Civilab
Civil Engineering Testing Laboratory

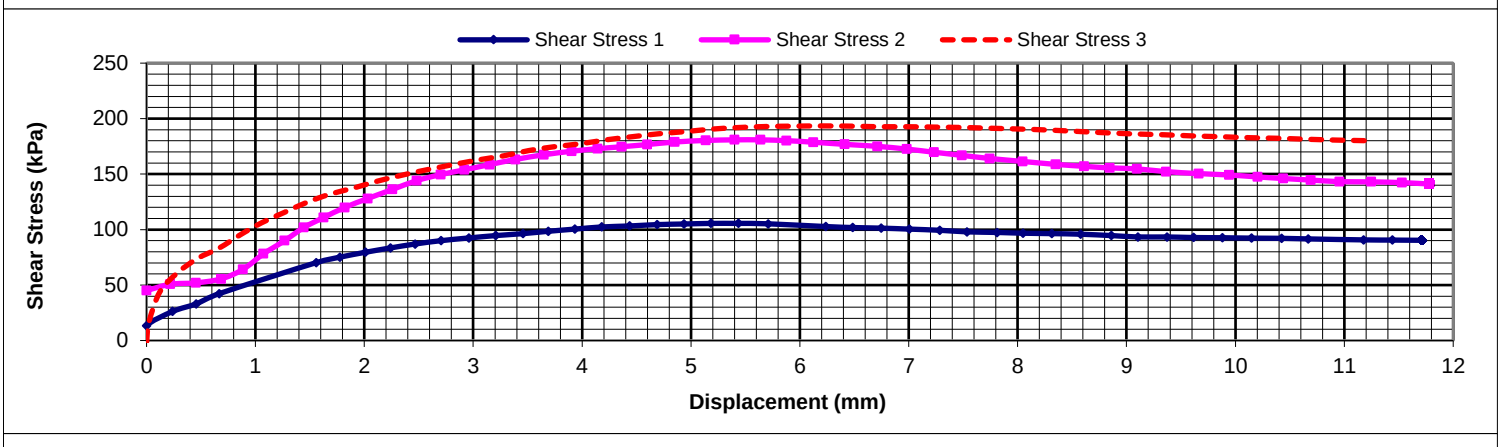
Direct Shear Test Results

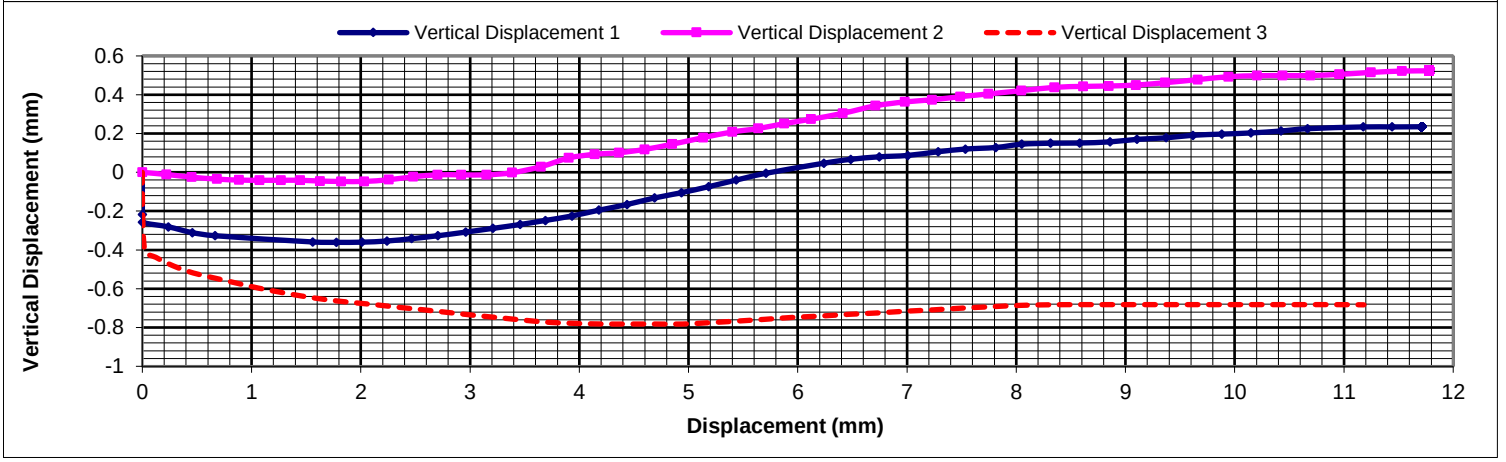
Project: **REHABILITATION OF BRAAMFONTEIN WEST WATER MANAGEMENT UNIT** Date Tested: **25/6/2019**
Batch No.: **2019-B-840** Laboratory Number: **1**
Field Sample Number: **TP 5 (Alberts Farm)** Depth (m): **0.25 - 1.50**
Remark: **A quick undrained test on a sample remoulded to approximately 90% Proctor.**

		Height mm	Area mm^2	Moisture Content %	Dry Unit Weight	Void Ratio e	Saturation %	Normal Stress kPa	Peak Shear Stress kPa	Peak Shear Displacement mm
Test 1	Initial	18.20	2851.04	22.4	1.39	1.102	59.6	50.0	105.5	5.44
	Final			22.2						
Test 2	Initial	18.20	2851.04	22.8	1.39	1.109	60.4	105.0	180.8	5.64
	Final			21.2						
Test 3	Initial	18.20	2851.04	23.1	1.39	1.114	60.9	140.0	193.4	6.21
	Final			21.0						

Box Type	Rate of shear (mm/min) Test 1	Test 2	Test 3		Specific Gravity	**Internal Friction (deg)**	**Cohesion (kPa)**
ROUND	1.1732	1.2291	1.1373		2.932	**45.3**	**60.5**







36/38 Fourth Street, Booysens Reserve, Johannesburg 2091
P O Box 82223, Southdale 2135
Tel: +27 (0)11 835-3117 • Fax: +27 (0)11 835-2503
E-mail: jhb@civilab.co.za • Website: www.civilab.co.za

Civilab

Civil Engineering Testing Laboratories

Falling Head Permeability Test Results

Project:	REHABILITATION OF BRAAMFONTEIN WEST WATER MANAGEMENT UNIT		
Project No:	2019-B-840	Date:	04-Jul-19

Lab. Sample Reference	Field Sample Reference	Depth (m)	Moisture Contents		Dry density Kg/m^3		Coefficient of Permeability (m/s)		
			Before Test (%)	After Test (%)	Initial	As tested	Range Minimum	Range Maximum	Average
840-1	TP 5 (Alberts Farm)	0.25 - 1.50	22.3	27.0	1326	1461	1.0E-08	1.6E-08	**1.2E-08**

Remarks: Samples remoulded to approximately 90% Proctor.
Saturated and tested under a load of 100kPa.
Densities reported are under a load of 100kPa.

Document prepared by

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

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

PO Box 74381
Lynnwood Ridge 0040
South Africa

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

aurecon

Bringing ideas to life

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