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# **VOLUME 1**

# Geotechnical Investigation Report Majuba

General Waste Landfill Site,
ESKOM Majuba Power Station



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**ESKOM Majuba Power Station** 

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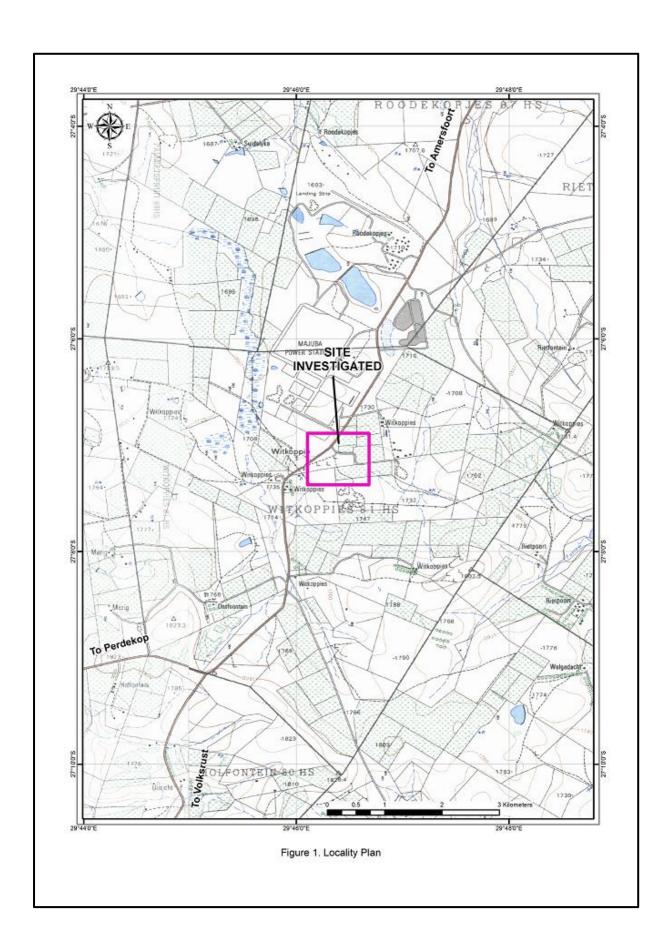
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P. G. Hansmeyer *Pr.Sci.Nat.*Date: 15<sup>th</sup> of May 2018



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#### **VOLUME 1**

#### Geotechnical Investigation

#### Majuba General Waste Landfill Site, ESKOM Majuba Power Station

#### 1. INTRODUCTION AND TERMS OF REFERENCE

Engeolab CC was appointed by BTW & Associates of Middelburg, Mpumalanga to conduct a geotechnical investigation for the Majuba General Waste Landfill Site at Majuba Power Station. The site is located on Portions 1 and 6 of the farm Witkoppies 81 HS on the southern side of Majuba Power Station – refer to the Locality Plan, Figure 1 in the beginning of the report.

The investigation's aim is to establish the geotechnical and geohydrological constraints of the proposed landfill site which will form part of the Basic Impact Assessment Report for the closure of the existing landfill site and the Scoping and Environmental Impact Report for the proposed new general waste disposal by landfill of G:C:B class.

The scope of work was outlined by quotation Q17-053, dated 3 March 2018. The appointment was confirmed by Mr. J.L. Bouwer Pr Eng. of BTW & Associates (PTY)Ltd on the 5<sup>th</sup> of March 2018 by means of an e-mail followed by additional correspondence indicating the area of investigation for the development.

The field work was conducted from Monday 9 April to Wednesday 11 April 2018 and on completion thereof, the soil samples were submitted to Letaba Lab, a soils laboratory in Witbank for testing. The water samples were submitted on the same day to Yanka Laboratories, a water laboratory located in Witbank. The results of the water sample tests were received on 16 April 2018 and the soil test results became available three weeks later on the 4<sup>th</sup> of May 2018.

The report is based on field observations, profiling, sampling, dynamic penetration tests and laboratory test results of representative disturbed soil samples and water samples that were taken from a small dam, a single borehole and four springs.

The report and its appendices are presented as Volume 1 and the drawings are contained in Volume 2.

#### 2. AVAILABLE INFORMATION

The following available information includes:

- Site plan showing layout of the proposed development and boundaries of the site as produced by BTW & Associates (PTY)Ltd,
- A 1:250 000 scale geological series, Sheet 2728 Frankfort, as compiled by South African Geological Survey, 1988,
- Garmap Africa 2008 series,
- Google Earth imagery of the site,
- Map showing Majuba Power Station monitor boreholes,

- Majuba Power Station Ash Disposal: Groundwater Scoping Study by Lidwala Consulting Engineers, October 2012,
- Minimum Requirements for Waste Disposal by Landfill. DWAF, Second Edition, 1998,
- Background Information Document 001 by BTW & Associates, dated 4 May 2018.

#### 3. SITE DESCRIPTION AND ASSUMPTIONS

The proposed new waste landfill site is a Category B listed activity which entails the disposal of general waste to land covering an area of some 50,100m<sup>2</sup> with the total capacity of 25,000 tons which equates to 970 tons per year and an expected lifespan of 45 years. The landfill site will be constructed with associated infrastructure with sorting and storage facilities, plant and machinery, security parking and servicing area and an access road. The facility will also be secured with an all-round palisade, access control gate and a guard house.

The site can be accessed by the D979 gravel district road from Amsterdam to Volksrust and is located at co-ordinates 27° 07' 09.4" S and 29° 46' 18.93"E. The site is bounded in the north by the gravel district road which passes close to the security fence along the southern portion of Majuba Power Station. The combination of the district road, an overhead Eskom powerline and steep topography in the south, confines the site to a sidehill fill along the sloping northerly face of a local hillock.

The main access road to the closed landfill site which turns off the gravel district road will most probably also provide access to the new site – refer to Figure 2, the Site Plan. The closed landfill site has been fenced off but at the time of the investigation the 2.5m high security fence was in a state of disrepair and the main gate was broken. The closed waste landfill site is blanketed by a layer of soil which was imported during the routine maintenance by the contractor. Top soil had been scraped off over quite a large area to the south and to the east of the site, leaving some areas barren with exposed bedrock which had been eroded in places – refer to Figure 2, the Site Plan.

Several abandoned borrow pits in close proximity to the site are indicated on the Locality Plan, Figure 1 in the beginning of the report. It is presumed that the borrow materials were imported to the power station at the time of its construction.

The area surrounding the site is characterised by historically cultivated areas which had been turned over to pastures that are still used by local cattle breeders. The water seeps and springs are seemingly utilised for stock watering only.

As indicated on Figure 2, the Site Plan, several hillslope seepage wetlands located along the verges of the closed landfill site and the proposed site adjacent and to the east thereof were recorded.

As a sidehill fill, the proposed 50,100m<sup>2</sup> site extends from the crest of a hillock to the district road located about 180m downslope at an even gradient and surface run-off will naturally follow the topography towards the northern boundary. A hillslope seepage wetland was recorded along the northwestern boundary of the closed landfill site, seemingly extending past the gravel district road in a northwesterly direction – refer to Figure 2, the Site Plan.

At the time of the investigation, the proposed site was undeveloped and covered by tall grass which made observations and moving about the site very difficult. The closed waste landfill site is partially overgrown with short grass, alien shrubs and a single Acacia Karoo sapling.

#### 4. METHODS OF INVESTIGATION

#### 4.1 Walk Over Survey

A walk-over survey was conducted to establish drainage features, access and to obtain a general overview of the site. An aerial photograph was used during the walk-over survey to assist in the site orientation, to determine the boundaries and its general outlay.

#### 4.2 Test Pits – Proposed and Closed Landfill Sites

Nine test pits, denoted as TP1 to TP9 were excavated using a CAT 422E tractor-loader-backhoe to refusal depths ranging between 0.5 and 2.6m below existing ground level. Test pits deeper than 1.5m were profiled from surface for safety reasons. The profiling included typical visual and tactile descriptions of moisture, colour, consistency, structure, soil type and origin. The soil profiles are attached as Appendix A and the positions of the test pits are indicated on Figure 2, the Site Plan.

The test pit distribution included the proposed site where six test pits were excavated (TP1 – TP6) and the closed landfill site where test pits TP,7, 8 & 9 were excavated.

#### 4.3 Soil Sampling and Laboratory Testing

Nine disturbed samples representative of the cover and in-situ soils inclusive of decomposed to highly weathered dolerite and shale were selected for laboratory testing to confirm the in-situ assessments of moisture, grading, plasticity, consistency, structure and to ascertain the engineering properties of each horizon.

The following tests were carried out on the samples: -

- Nine foundation indicator tests comprising particle size distribution analysis and Atterberg limit tests. In addition to this, the moisture content of each sample was also determined.
   These tests permit a basic classification of the soils and group them according to typical engineering properties.
- Three compaction tests comprising Modified AASHTO moisture/density relationships and California Bearing Ratio Values. These tests evaluate the compaction characteristics of the site soils and permit an evaluation of their suitability for use as construction materials.

Copies of the laboratory results are attached as Appendix B and for convenience, a summary of the laboratory test results is presented by TABLE 4.3.1 on the following page.

Table 4.3.1 Laboratory Test Results - Summary

TP No.	Origin	Sample No.	Sample Depth (m)	PI	GM	% Clay	% MC	Activity	Unified Soil Class	G Class
140.	Origini	140.	Deptii (iii)	• •	GIVI	70 Clay	70 IVIC	Activity	Jon Class	G Class
TP2	Clayey shale residuum	DS2A	0.7-0.9	25	0.41	31.8	33.5	М	MH	spoil*
	shale residuum with flaky									
TP4	shale fragments	DS4A	0.3-0.8	12	1.72	23.4	15.6	L	SC	<g9< td=""></g9<>
TP5A	hillwash	DS5A	0.1-0.3	20	0.59	15.5	26.6	L-M	CL	spoil*
TP5B	Sugary textured dolerite residuum	DS5B	0.3-0.9	9	2.33	2.9	7.5	L	SW/SC	G8*
TP5C	Weathered/fractured dolerite	DS5C	0.9-2.1	13	2.7	5.5	7.9	L	GW	G6*
TP6A	Sugary textured dolerite residuum	DS6A	0.4-0.9	6	2.1	3.4	9.2	L	SW/SM/SC	G8
ТР6В	Weathered/fractured dolerite	DS6B	0.9-1.8	6	2.39	2.9	6.1	L	SW/SM/SC	G6
TP9A	alluvium	DS9A	0.1-0.7	24	0.33	15.6	29.5	М	CL	spoil*
TP9B	Clayey dolerite residuum	DS9B	0.7-2.2	25	0.49	34.4	29.0	М	МН	spoil*
	*=inferred									

Abbreviations: GM – Grading Modulus, PI – Plasticity Index; - L, M, H = Low, Medium & High Activity

**Unified Soil Classification** = **CL** - Inorganic clays of low to medium plasticity/lean clays; **SW/SM/SC** = gravelly sands, sand-clay mixtures, sand-silt mixes; **MH** = silt-clays of low plasticity; **SC** = sand-clay mixes; **GW** = well-graded gravels or gravel-sand mixes with little or no fines.

It is interesting to note that the clayey soils derived from in-situ decomposed dolerite and shale as well as the transported soils – that is alluvium and hillwash - tend to have a fairly high moisture content (26 - 33%), whilst the sugary textured dolerite residuum and flaky shale residuum recorded much lower values (10 - 15%). The liquid limits of the tested soils are almost double the recorded moisture content of the site soils indicating that the soils are only partially saturated.

#### 4.4 Test pit and Topographical surveys

The test pit positions were surveyed using a Garmin Oregon 650 hand-held GPS and plotted on the drawing.

#### 4.5 Geophysical Surveys

Three geophysical traverses were conducted alongside the proposed landfill site – refer to Figure 2, the Site Plan. The geophysical survey comprised electromagnetic and magnetic surveys and the aim thereof was to determine local fault zones and dolerite/country rock contact zones. The field data is attached as Appendix C to the report.

Two prominent electro-magnetic anomalies were recorded on Traverses Majuba PS-1 and PS-3 which were carried out parallel to each other.

#### 4.6 Borehole and Spring Census

Five hillslope seepage wetlands were recorded on the site and another hillslope seepage along the toe of the closed landfill site. A 44.2m deep monitor borehole with a static water level at 9.7m below ngl was recorded near a small leachate (?) dam located on the north-western corner of the closed landfill site – refer to Figure 2, the Site Plan.

#### 4.7 Water Sampling

Three of the hillslope seepage wetlands, a single monitor borehole and a small dam (leachate?) were sampled and the samples were submitted to Yanka Water Laboratory in Witbank for chemical analyses. The test results are attached as Appendix D to the report.

Water quality data, Durov - and Piper diagrams of the water sample data are also included in Appendix D. Piper diagrams are graphical representations of the chemistry of the water samples whilst Durov diagrams are used to represent the dissolved constituents of natural water and show plausible hydrochemical processes.

#### **4.8** DCP's

Hand-held DCP's were carried out adjacent to each test pit and numbered accordingly. The DCP test data is attached as Appendix E to the report.

#### 5. GEOLOGY AND SITE SOILS

The site is underlain by sediments – that is shale and sandstone of the Vryheid Formation, intruded by Post-Karoo dolerite as sheets or sills, often capping the low hills in the area – see Figure 3A, Regional Geology and Figure 3B, the Site Geology as well as Table 5.1 below.

Shallow weathered and intensely fractured dolerite was exposed along the southern fringes of the closed landfill site as well as within the deeply eroded access road – refer to test pits TP1 and TP7. Elsewhere, the bedrock was blanketed by transported soils – that is hillwash and alluvium. The latter covers the area along the toe of the closed landfill site, extending across the district road in a north-westerly direction. Scattered sandstone outcrop was noticed further to the east as well as along the steeper southerly slope of the hillock. The soil and bedrock variations are also indicated on Figure 4, Soil Profiles.

LithologySub-GroupGroupSequenceDoleriteIntrusive- - -Post-KarooShale and sandstoneVryheidEccaKaroo Super Group

**Table 5.1: - Stratigraphic Sequence Of The Site** 

The site falls within a region with a Weinert N-Value of 1.3 indicating that chemical decomposition is the dominant mode of weathering.

A north-west trending structural lineament concealed by cover-rocks – thought to be either a fault line or a dolerite dyke - was inferred from the geophysical data and is indicated on Figure 3B, the Site Geology.

#### 6. GEO-ENVIRONMENTAL FACTORS

The southern boundary of the site more or less run along the ridge line, sloping towards the northern boundary along the gravel district road some 200m away. Several hillslope seepage wetlands were

identified – refer to Figure 5, Surface Hydrology. These wetlands ostensibly emanate at the dolerite/sedimentary bedrock contact zones to form spring lines at various elevations on and below the landfill terrain, draining away to form wetlands covered by thick stands of hydrophilic grasses and shrubs.

The water quality data of the hillslope seepage wetlands, the single monitor borehole and the small dam that were sampled on site has been used to determine the hydrochemical characteristics of the closed and proposed waste landfill site's groundwater.

The groundwater quality in terms of electrical conductivity and pH of the site's water sample points give an indication of the present status – refer to Table 6.1 below. In terms of the Class 1 (DWA) water quality, the pH may vary from 4.5 - 10.0 and the electrical conductivity (EC) should be less than 1000 mS/m.

SOURCE EC (mS/m) pН Spring 1 6,4 23,4 Spring 2 8,17 65,2 Spring 3 7,19 108 8,06 Spring 4 132 Dam 6,96 36,7 Monitor borehole 7,94 66,6

**TABLE 6.1 Water Quality Data** 

The existing hydrochemical data presented on the Piper Diagram suggests Ca-HCO<sub>3</sub> water type which is typical of recently recharged and shallow aquifers.

# 6.1 Proposed Landfill Site – Seepage, Surface Run-off and Drainage Conditions

The shallow spring line at 1742m AMSL could almost be in the leachate leakage at excavation refusal depth indicating potential development of phreatic surface within the fill – a design parameter that will have to be taken into consideration – refer to Figure 6 Excavatability. However, this will require minimal infiltration into the fill and good management of surface run-off, as well as continuous inter-layering and good fill - as well as site drainage management.

# 6.2 Closed Waste Landfill Site – Seepage, Surface Run-off and Drainage Conditions

A well-developed hillslope seepage wetland extends from the north-western toe of the fill, draining in a predominantly north-western direction. Although some seepage was recorded in the base of the 2.6m deep test pit (TP9) excavated near the toe of the closed waste landfill site, the static water level of the monitor borehole was recorded at 9,67m below ngl.

The current site drainage seems functional as erosion of the closed waste landfill site was observed appearing to be adequately vegetated. The main access road's erosion protection has been washed away, exposing shallow weathered bedrock. Where top soil material had been scavenged, weathered bedrock was exposed along the closed waste landfill site's southerly boundaries and beyond – refer to Figure 2, the Site Plan.

#### 7. GEOTECHNICAL APPRAISAL

#### 7.1 Excavatability and Foundation Type

The predicted excavatability of the site soils and bedrock is classified according to SANS 1200D and is presented by Table 7.1.1 below. The excavation refusal depths of the TLB recorded on site are indicated on Figure 6, the Excavation Plan. The average excavation depth on the proposed landfill site is 1.3m but ranging between 0.5 (TP1) and 2,2m (TP3). An estimated total of 65,130m<sup>3</sup> of soft excavatable material and some 15,000m<sup>3</sup> of intermediate excavatable material should be available for construction/backfilling/capping purposes. No boulder excavation is envisaged on site and hard rock excavation can be expected at TLB refusal depth.

**Sample Position** Simplified Description of Typical Material Properties Material that can be efficiently removed or loaded, without prior ripping, by Soft excavation means of a bulldozer, tractor-scraper, track type front-end loader or backacting excavator without the use of pneumatic tools such as paving breakers. Material that can be efficiently ripped by a bulldozer fitted with a single-tine ripper or with a back-acting excavator of flywheel power exceeding **0,10 kW Intermediate excavation** per mm of tined-bucket width or the use of pneumatic tools before removal by equipment equivalent to that specified above. Excavation in material that cannot, before removal, be efficiently ripped by a Hard rock excavation bulldozer. This is material that cannot be efficiently removed without blasting or without wedging and splitting. Excavation in material containing more than 40 % by volume boulders of size **Boulder excavation (Class A)** in the range of 0,03-20m3, in a matrix of soft material or smaller boulders. Excavation in material containing 40 % or less by volume boulders of size in the range of 0,03-20m3, in a matrix of soft material or smaller boulders and **Boulder excavation (Class B)** which require individual drilling and blasting in order to be loaded by a track type front-end loader or back-acting excavator.

Table 7.1.1: Excavation Classes (Modified SABS 1200D)

It is assumed that the proposed landfill site will be excavated to bedrock level which is present at an average depth of 1.3m. The foundation materials – both shale and dolerite bedrock are regarded as competent or stronger than fill materials and are therefore not subject to adverse pore pressure or adverse geological structures.

#### 7.2 On-Site Materials Suitability

#### 7.2.1 Cover Material & Other Material Sources

Waste must be covered daily to reduce odours, nuisance conditions, vermin, fires and scavengers. It should be ideal to obtain this material from or close to the site or even have this material stockpiled on site. Where this material is too clayey – such as the hillwash, alluvium and clayey dolerite and shale residuum, it may form horizontal impermeable layers or preferential flow paths that could surface on the side slopes the landfill. The ideal soils are the sandy soils - that is mainly the sugary textured dolerite residuum that was exposed in TP3, 5 and 6, generally about 0.6m thick with an estimated volume of 280m<sup>3</sup>.

Other sources of sandy material may be available in the borrow pits to the south of the site – refer to Figure 7, Other Material Sources.

#### 7.2.2 Liner Material & Other Material Sources

Material selection for the proposed landfill's lining system is confined to the area investigated. Ideally the site should be situated in an area with suitable clayey in-situ material which is ideal for landfill construction. As a guideline, the DWA "Minimum Requirements for Waste Disposal by Landfill" stipulates the following for a clay liner soil: -

- Plasticity Index >10%
- Particle Size <25mm
- Permeability <1x 10<sup>-6</sup> cm/s

This permeability rate is also highly dependent on the compaction of the material together with the moisture content and plasticity index and the following soils are anticipated as suitable for a clay liner: -

Table 7.2.2.1 Summary of Suitable Clay Liner Material
Permeability\* Thickness (m) Estimated Excavation

Horizon	PI	Permeability* (cm/s)	Thickness (m)	Estimated Volume (m <sup>3</sup> )	Excavation Class	Site Constraints
Hillwash	20	1.9E-0	0.3	4,500	soft	Grass roots to 0.1m
Alluvium	24	5.3E-07	0.6	240	soft	Shallow perched water table & grass roots to 0.1m
Shale residuum	12 - 25	5.0E-07	0.3	170	soft	-
Clayey dolerite residuum	25	5.9E-07	1.5	600	soft	Perched water table

<sup>\*</sup>inferred from soil test data – refer to 'ESTIMATED SOIL PROPERTIES' attached as Appendix B to the report.

An estimated volume of some 5,510m<sup>3</sup> of soft excavatable material suitable for a clay liner may be sourced from various horizons on – and in close proximity to the proposed landfill site. Other material sources suitable for the clay liner may be available in the low-lying flood plain of the local streams – refer to Figure 7, Other Material Sources.

As far as can be ascertained there is no clean sand available on site which could be used as the protection layer on top of a geomembrane and even as a leakage detection layer if the sand is of suitable quality and evenly grained.

#### 7.3 Compaction characteristics

Three disturbed representative soil samples were submitted for compaction tests and foundation indicators – refer to Table 4.3.1, Chapter 4.3. The volume of spoil exceeds the better-quality construction material (G6 – G9 class) which appears to limited on site and selected fill, base course and upper sub-base materials for pavement materials will need to be imported from yet unproven sources in the vicinity of the site or from commercial sources.

#### 7.4 Stability of Excavations

The stability of the test pit excavations was assessed by simple field tests such as: -

- the ease of excavation by the backhoe and;
- slumping/ravelling of the test pit side walls occurring within 30 minutes from time of excavation;
- stand-up times of the test pit excavations.

Although no shear strength tests were carried out at this stage of the investigation, the predominantly fine material together with the moderate to high plasticity thereof indicates that an average estimated angle of internal friction of some 25° can be anticipated. Although no slumping occurred within the test pits excavated on the proposed landfill site – that is TP1 to TP6 and the excavations were seemingly safe, it is recommended that the sidewalls of all excavations deeper than 1.5m should be shored or cut back to 60° from the horizontal. Furthermore, spoil from excavations should not be placed closer than the equivalent depth of the excavation to avoid unnecessary loading of the sidewalls, especially under very moist or saturated conditions as is expected on site. As the terrain dips towards the northern boundary, slope instability of soil berms/landfill containment walls can be expected and cognisance should be taken of the engineering characteristics of the site – and imported soils as well as the foundation bedrock.

It is recommended that excavations in excess of 1.5m be inspected by an experienced professional to assess the safety thereof. Notwithstanding this, the responsibility of safe excavations remains with the contractor who is in the best position to assess the stability thereof during construction.

#### 7.5 Site Drainage

A storm water management system should be designed to remove all surface water from the site and direct it to natural drainage lines. It is emphasised that the storm water system accommodates the removal of any accumulated surface water and it should also conform to drainage requirements of landfill sites in general.

#### 7.6 Closed Landfill Site

The closed landfill site has been capped as part of the routine maintenance procedures and the contractor used top soil material ostensibly obtained from site and areas in close proximity. The single test pit (TP8) excavated in the middle of the capped landfill site exposed industrial waste, domestic refuse and building rubble intercalated with imported soil layers. No seepage was recorded and the material was dry. Tension cracks related to sliding movements or settlement associated with highly compressible refuse were not detected and the sandy nature of the top soil layer prevented it from shrinking or expanding and the relatively smooth surface was seemingly undisturbed. No odours could be detected, there were no vermin or scavengers nor any fires. Some grasses, alien shrubs and a single Acacia Karoo sapling had sprouted on the top soil layer indicating a stable environment.

#### 8. DISCUSSIONS AND DEVELOPMENT RECOMMENDATIONS

#### 8.1 General

The closed - and proposed landfill sites are underlain by sedimentary bedrock intruded by a dolerite sill in various stages of decomposition. The bedrock is sequentially blanketed by

residuum and transported soils that can be applied as clay liner - and capping material. Excavation refusal depths within the sedimentary and intrusive bedrock vary on the terrain with the deeper excavation achieved within the weathered intrusive dolerite.

Whether the inferred 'fault' or 'dyke' referred to in Chapter 5 has created groundwater compartments or acts as a channel-way connecting the elevated water 'reservoirs' with the lower-lying three wetlands is unknown and can only be determined by drilling boreholes to assess the bedrock geology, to monitor and to model the groundwater regime and - flow direction(s) on the site.

#### 8.2 Closed Waste Landfill Site

The closed waste landfill site appears to be well-constructed and the routine maintenance has seemingly been done thoroughly. Erosion, settlement, tension cracks and downhill creep were not observed thereby indicating negligible to low failure hazard potential.

The seepage emanating along the toe of the fill is attributed to typical groundwater drainage rather than leachate from the landfill site.

#### 8.3 Surface Hydrology, Drainage and Monitoring

Several perennial and non-perennial hillslope seeps ostensibly emanating at the dolerite/sedimentary bedrock contact zones form spring lines at various elevations on and below the landfill terrain, draining away to form wetlands – refer to Figure 5, Surface Hydrology. The shallow spring line indicates a possible aquifer at 1742m AMSL which could almost be in the leachate leakage at excavation refusal depth indicating limiting potential of phreatic surface within the fill. However, this will require minimal infiltration into the fill and good management of surface run-off.

The following aspects will also have to be addressed, namely: -

- i) a sub-soil drainage system underneath the layer works;
- ii) monitor boreholes for groundwater modelling and water quality monitoring;
- iii) erosion protection and prevention;
- iv) storm water system.

#### 8.4 Excavatability

The excavation refusal depths presented by Figure 6, Excavatability, indicate a deeper excavation trend along the ridge and to the south-east which should be taken into account with the future investigation/planning of the site.

#### 8.5 Clay Liner and Capping Material

Site soils suitable for clay liner application and capping material required at the proposed landfill are present on site but not in sufficient quantities and additional material will have to be obtained elsewhere. Several alternative sites have been identified in close proximity to the site – refer to Figure 7; other options include the use of soil/ash mixes, geosynthetic clay liners or soil enhancement by mixing the on-site materials with bentonite or resins. The latter is very expensive and requires extensive laboratory testing to determine the required mixture to achieve the necessary permeability requirements to ensure consistent mixing, moisturising and placing.

#### 8.6 Sandy Protection Layers and Sandy Detection Layers

No clean, evenly graded sands of suitable quality that may be required for protection layers on top of a HDPE geomembrane and even as leakage detection layers were recorded on site but may be available in the floodplains of streams that drain the surrounding area.

#### 8.7 Topographical Surveys

It is recommended that a topographical survey be carried out for accurate on-site measurements for the design and operational control and planning of the proposed landfill site.

#### 9. ISSUES TO BE ADDRESSED

The followings aspects should be addressed during the detailed EIA phase to be carried out for both the closed and the proposed waste landfill sites, namely: -

9.1 Additional Water Sampling

Water samples are to be taken on a quarterly interval of springs, wetlands and drainage courses within a 1km radius of the site to assess the surrounding country side's ambient water quality more thoroughly.

9.2 Insufficient clay liner material is present on site and it is recommended that a GCL be used as the containment barrier of the landfill site.

#### 10. GENERAL

Variances in groundwater, soil and rock quality and quantity from those predicted may be encountered during construction and these should be recorded, however no warranty against these variations is expressed or implied, due to the geological changes that can occur over time due to natural processes, or human activity.

However, it is impossible under the constraints of a feasibility study of this nature to guarantee that zones of poorer geological materials or deeper excavation or better quality water were not identified that could have had a significant bearing on the outcomes thereof. The investigation has therefore attempted, through interpolation and extrapolation at known test locations, to identify problem issues of a geotechnical and groundwater nature on which this report is based.

Every effort was made during the feasibility study to ensure that generally accepted practices of our profession were used in the sub-surface evaluation of the site, and that the sampling and testing was representative of the soil/rock/water conditions observed on-site.

#### 11. BIBLIOGRAPHY

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#### 12. APPENDICES

- Appendix A Test Pit Profiles
- Appendix B Soil Test Data
- Appendix C Geophysical Data
- Appendix D Water Test Data
- Appendix E DCP's

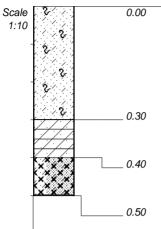


# Appendix A Test Pit Profiles



HOLE No: TP01 Sheet 1 of 1

JOB NUMBER: LL3034



Moist, dark brown, loose, intact, clayey SAND with grass roots; Transported Top Soil.

Moist, light beige, firm, intact, Sandy CLAY with angular and tabular shale fragments; Transporter Soils.

Moist, dark-khaki-brown, medium dense, intact, coarse surgery textured, clayey SAND derived from in-situ decomposed DOLERITE.

#### **NOTES**

- 1) No seepage
- 2) Refusal on fractured dolerite.



CONTRACTOR: ROTEK MACHINE: CAT422E DRILLED BY: Mandla PROFILED BY: PG Hansmeyer

TYPE SET BY: A. Nolan SETUP FILE: STANDARD.SET INCLINATION: Vertical

DIAM: DATE:

DATE: April 2018 DATE: 14/05/2018 09:47 TEXT: C\dotFILES\LL3034.txt **ELEVATION:** 

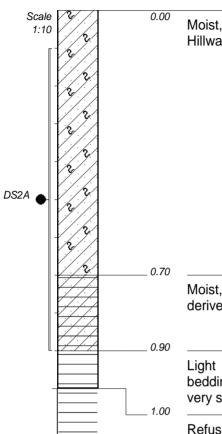
x-coord: \$27 07' 11.5" Y-COORD: E26 46' 23.3"

HOLE No: TP01



HOLE No: TP02 Sheet 1 of 1

JOB NUMBER: LL3034



Moist, dark brown, firm, intact, sandy CLAY with grass roots to 0.1m; Hillwash.

Moist, beige streaked yellowish-orange, firm to stiff, intact, sandy CLAY derived from in-situ decomposed SHALE.

Light beige streaked orange with some relict fracture surfaces and bedding planes, laminated to thinly bedded, closely to medium jointed very soft rock SHALE.

Refusal of backhoe on beige slightly weathered SHALE.

#### **NOTES**

- 1) No seepage
- 2) Sampled as follows: DS2A 0.1m--0.9m



CONTRACTOR: ROTEK MACHINE: CAT422E

DRILLED BY: Mandla PROFILED BY: PG Hansmeyer

TYPE SET BY: A. Nolan SETUP FILE: STANDARD.SET INCLINATION:

DIAM: DATE:

DATE: April 2018

DATE: 14/05/2018 09:47 TEXT: C\dotFILES\LL3034.txt **ELEVATION:** 

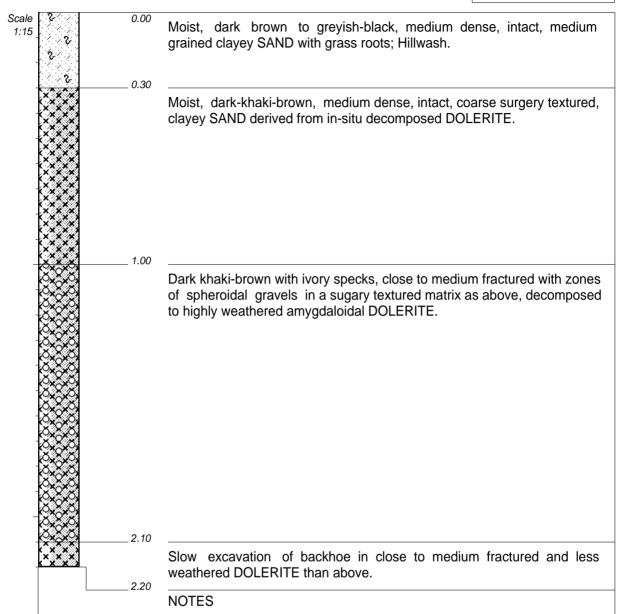
x-coord: \$27 07' 04.6" Y-COORD: E29 46' 21.8"

HOLE No: TP02



HOLE No: TP03 Sheet 1 of 1

JOB NUMBER: LL3034



1) No seepage



CONTRACTOR: ROTEK

MACHINE: CAT422E

DRILLED BY : Mandla PROFILED BY : PG Hansmeyer

TYPE SET BY : A. Nolan SETUP FILE : STANDARD.SET INCLINATION:

DIAM : DATE :

DATE: April 2018

DATE: 14/05/2018 09:47

TEXT: C\dotFILES\LL3034.txt

**ELEVATION**:

X-COORD: \$27 07' 07.2" Y-COORD: E29 46' 29.2"

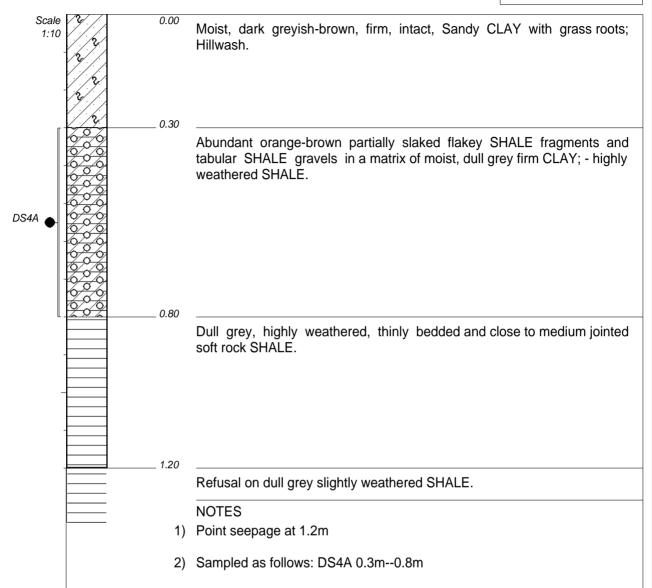
HOLE No: TP03

D096 ENGEOLAB CC dotPLOT 7022 PBpH67



HOLE No: TP04 Sheet 1 of 1

JOB NUMBER: LL3034





CONTRACTOR: ROTEK MACHINE: CAT422E

DRILLED BY: Mandla PROFILED BY: PG Hansmeyer

TYPE SET BY: A. Nolan SETUP FILE: STANDARD.SET INCLINATION:

DIAM: DATE:

DATE: April 2018 DATE: 14/05/2018 09:47

TEXT: C\dotFILES\LL3034.txt

**ELEVATION:** 

x-coord: \$27 07' 03.9" Y-COORD: E29 46' 31.7"

HOLE No: TP04



DRILLED BY: Mandla

TYPE SET BY: A. Nolan

PROFILED BY: PG Hansmeyer

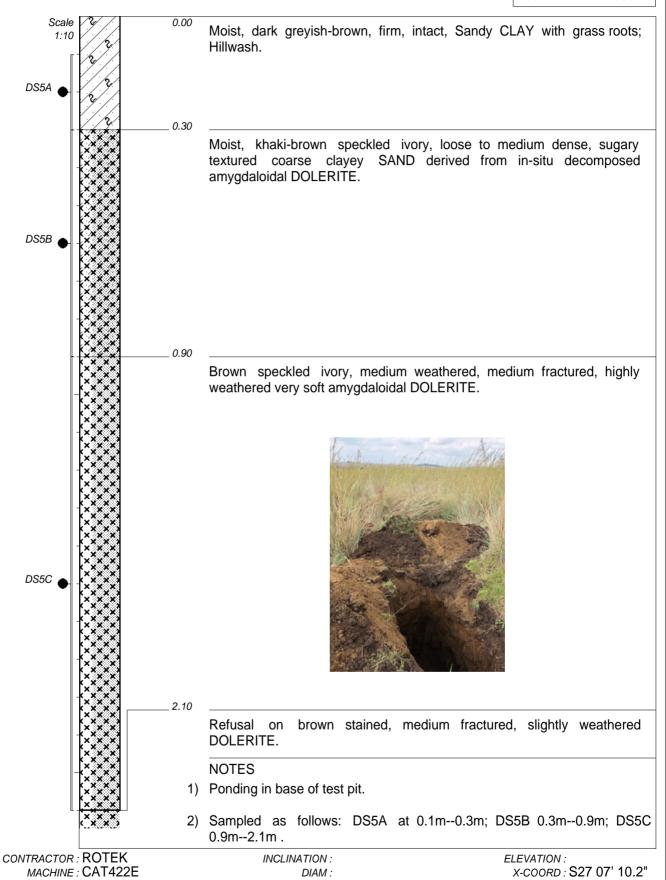
SETUP FILE: STANDARD.SET

BTW Associates Eskom Majuba HOLE No: TP05 Sheet 1 of 1

JOB NUMBER: LL3034

Y-COORD: E29 46' 33.1"

HOLE No: TP05



DATE: April 2018

DATE: 14/05/2018 09:47

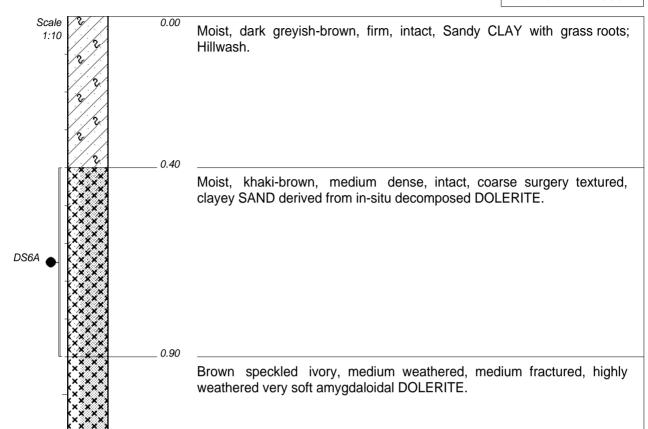
TEXT: C\dotFILES\LL3034.txt

DATE:



HOLE No: TP06 Sheet 1 of 1

JOB NUMBER: LL3034





1.80

Slow excavation from 1.7m in less weathered DOLERITE.

**NOTES** 

- 1) No seepage
- 2) Sampled as follows: DS6A at 0.4m--0.9

CONTRACTOR: ROTEK

MACHINE: CAT422E

DRILLED BY: Mandla

PROFILED BY: PG Hansmeyer

TYPE SET BY : A. Nolan
SETUP FILE : STANDARD.SET

INCLINATION : DIAM :

DIAM : DATE :

DATE: April 2018

DATE: 14/05/2018 09:47

TEXT: C\dotFILES\LL3034.txt

**ELEVATION**:

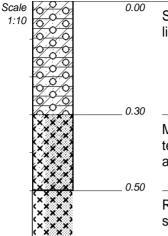
X-COORD: \$27 07' 07.6" Y-COORD: E29 46' 24.8"

HOLE No: TP06



HOLE No: TP07 Sheet 1 of 1

JOB NUMBER: LL3034



Shale fragments and tabular gravels loosely packed in a matrix of, moist, light beige-brown sandy CLAY derived from in-situ decomposed SHALE.

Moist, khaki-brown speckled ivory, loose to medium dense, sugary textured coarse clayey SAND derived from in-situ decomposed amygdaloidal DOLERITE.

Refusal on light grey DOLERITE with brown stained relict fracture surfaces.

#### **NOTES**

- 1) No seepage
- 2) DOLERITE outcrop ±5m north-west of test pit.



CONTRACTOR : ROTEK
MACHINE : CAT422E

DRILLED BY: Mandla PROFILED BY: PG Hansmeyer

TYPE SET BY : A. Nolan SETUP FILE : STANDARD.SET INCLINATION:

DIAM : DATE :

DATE : April 2018

DATE : 14/05/2018 09:47

TEXT : C\dotFILES\LL3034.txt

**ELEVATION**:

X-COORD: \$27 07' 13.4" Y-COORD: \$29 46' 16.3"

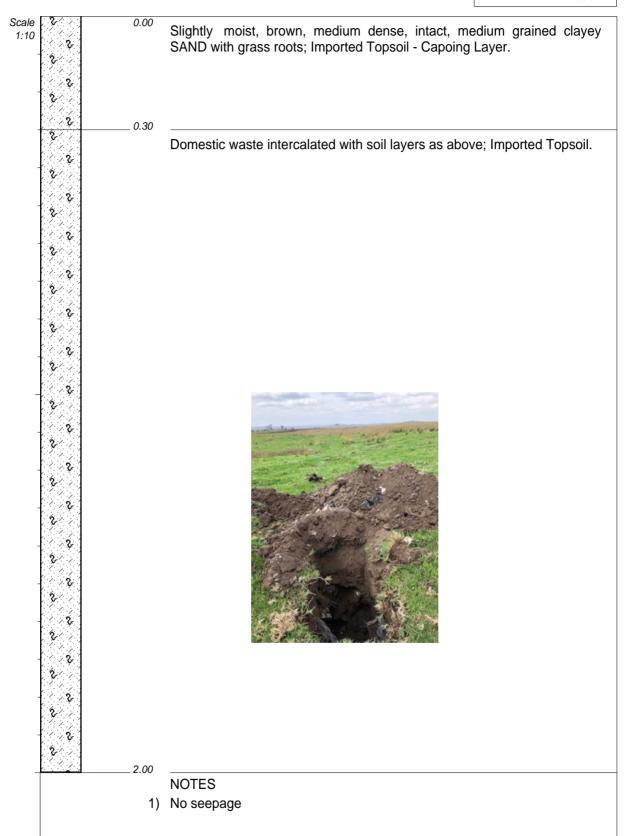
HOLE No: TP07



HOLE No: TP08 Sheet 1 of 1

JOB NUMBER: LL3034

x-coord: \$27 07' 08.9"



CONTRACTOR: ROTEK INCLINATION: ELEVATION

MACHINE: CAT422E DIAM:

 DRILLED BY : Mandla
 DATE :
 Y-COORD : E29 46' 19.0"

 PROFILED BY : PG Hansmeyer
 DATE : April 2018
 HOLE No: TP08

TYPE SET BY : A. Nolan

DATE : 14/05/2018 09:47

SETUP FILE : STANDARD.SET

TEXT : C\dotFILES\LL3034.txt



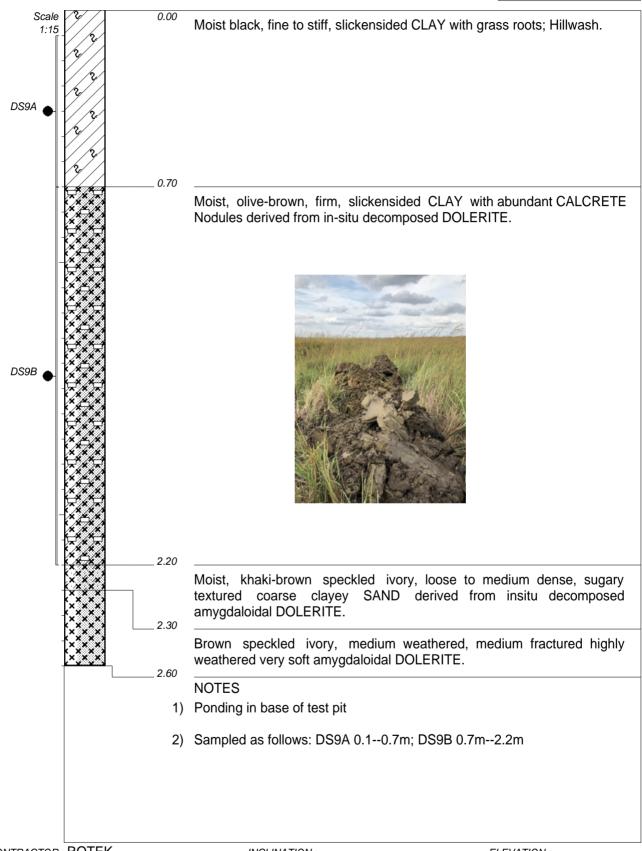
HOLE No: TP09 Sheet 1 of 1

JOB NUMBER: LL3034

x-coord: \$27 07' 05.4"

Y-COORD: E29 46' 14.2"

HOLE No: TP09



CONTRACTOR: ROTEK INCLINATION: **ELEVATION:** 

MACHINE: CAT422E DIAM: DATE:

DRILLED BY: Mandla PROFILED BY: PG Hansmeyer DATE: April 2018

TYPE SET BY: A. Nolan DATE: 14/05/2018 09:47 SETUP FILE: STANDARD.SET TEXT: C\dotFILES\LL3034.txt

D096 ENGEOLAB CC dotPLOT 7022 PBpH67



#### LEGEND Sheet 1 of 1

JOB NUMBER: LL3034

000	GRAVELS	{SA02}
	SAND	{SA04}
	SANDY	{SA05}
	CLAY	{SA08}
	CLAYEY	{SA09}
	SHALE	{SA12}
XXXX XXXX	HYPABYSSAL/anorthosite/syenite aplite	{SA18}
	GABBRO FAMILY	{SA42}
×××× ××××	DOLERITE	{SA18}{SA42}
	CALCRETE NODULES	{SA27}
	DISTURBED SAMPLE	{SA38}
2	ROOTS	{SA40}

CONTRACTOR:

MACHINE:

DRILLED BY:

PROFILED BY:

Name

TYPE SET BY : A. Nolan SETUP FILE : STANDARD.SET INCLINATION : DIAM : DATE : DATE :

DATE: 14/05/2018 09:47 TEXT: C\dotFILES\LL3034.txt ELEVATION: X-COORD: Y-COORD:

> LEGEND SUMMARY OF SYMBOLS



# Appendix B Soil Test Data



◆ Polokwane

◆ Tzaneen

**♦** Bloemfontein

♦ eMalahleni (Witbank)

♦ Mbombela (Nelspruit)

♦ Mashishing (Lydenburg)

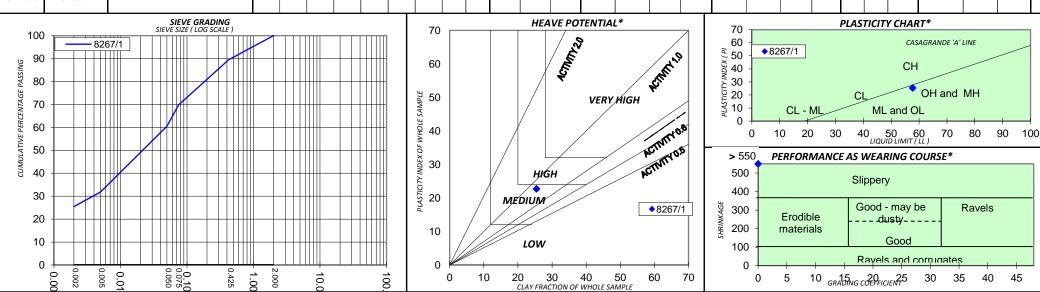
Tel. No: 087 285 0816 e-mail: letaba@letabalab.co.za www.letabalab.co.za

# **GRAVEL, SOIL AND SAND ANALYSIS**

TMH 1:1986 Method A1-A6,A7, A8 & A9\*

Client : Enge	olab CC	ddress: 4 Corridor Crescent, N4 Business Park	Date Sampled: 13-Apr-18
Contract:	LL3034 - Majuba Power Station		<b>Doc No:</b> 8267/1(i)
Description:	TP 2 DS2A from 0.1-0.9 m below existing ground level		Date Tested: 13-Apr-18

	Sieve analysis Cumulative percentage passing						Soil Mortar Analysis % of mat. <2,00 mm*				*	ef.*	.f. *	us*		erbe imits	_	Cla	ssifica	ations	*								
Depth ( m )	Sample No.	<b>Description</b> (Unified Soil Classification)	53,0 mm	37,5 mm	26,5 mm	19,0 mm	13,2 mm	4,75 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse - sand <2,0 >0,425mm	Fine-sand <0,425>0,075mm	Silt <0,05>0,005mm	Clay <0,005 mm	Effective size	Uniformity - co	Curvature coe	Grading modul	Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US.Highway	Group Index
0.1-0.9	8267/1	drk Olive Inorganic silt							100	89	70	60.5	31.8	25.5	10.5	19.7	28.7	31.8	<0.002	48.0	0.3	0.41	58	25	12.7	МН	N/A	A-7-5	16



Results marked \* in this report are not included in the SANAS Schedule of Accreditation for this laboratory
THIS MATERIAL IS NOT SUITABLE FOR WEARING COARSE AS THE SHRINKAGE PRODUCT IS GREATER THAN 550

\*\* tests done at eMalahleni (Witbank) branch

#### pH =7.31 , Electrical Conductivity =0.9243 mS/cm Moisture Content = 33.5%

Please note that test results are only relevant to the sample delivered to the lab by the client. Any results may only be reproduced in their entirety with the written consent of Letaba Lab (Pty) Ltd, and any opinions and interpretations as easily fall outside the scope of our accreditation.

Date Issued: 3/May/18

Technical signatory (Name):

1 of 1

H.P. du Preez

Signature:



♦ Polokwane

♦ Tzaneen

◆ Bloemfontein

♦ eMalahleni (Witbank)

Mbombela (Nelspruit)

♦ Mashishing (Lydenburg)

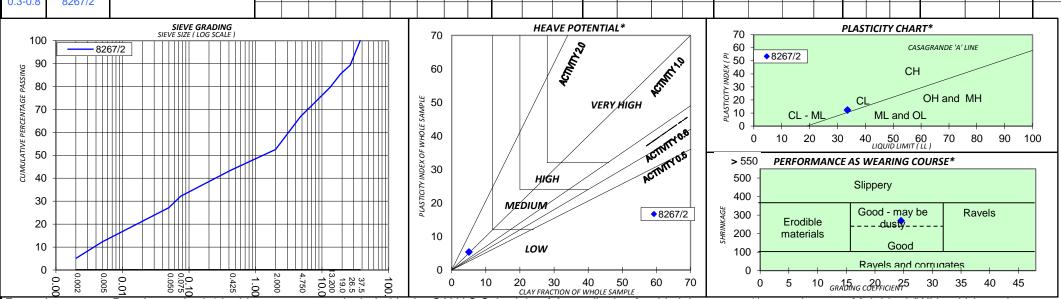
Tel. No: 087 285 0816 e-mail : letaba@letabalab.co.za www.letabalab.co.za

# **GRAVEL, SOIL AND SAND ANALYSIS**

TMH 1:1986 Method A1-A6,A7, A8 & A9\*

Client : Engeo	ab CC	ddress:	4 Corridor Crescent, N4 Business Park	Date Sampled	: 13-Apr-18
Contract:	LL3034 - Majuba Power Station			Doc No:	8267/2(i)
Description:	TP 4 DS4A from 0.3-0.8 m below existing ground level			Date Tested	: 13-Apr-18

	Sieve analysis Cumulative percentage passing						Soil Mortar Analysis % of mat. <2,00 mm*				*	ef.*	f.*	us*		erbe imits	_	Cla	ssific	ations	*								
Depth ( m )	Sample No.	<b>Description</b> (Unified Soil Classification)	53,0 mm	37,5 mm	26,5 mm	19,0 mm	13,2 mm	4,75 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse - sand <2,0 >0,425mm	Fine-sand <0,425>0,075mm	Silt <0,05>0,005mm	<i>Clay</i> <0,005 mm	Effective size	Uniformity - co	Curvature coe	Grading modul	Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US.Highway	Group Index
0.3-0.8	8267/2	drk Olive Clayey sand		100	89	85	80	67	53	43	32	27.1	12.3	5.1	17.3	21.5	28.2	23.4	0.004	840.5	0.3	1.72	34	12	6.2	SC	<g9< td=""><td>A-2-6</td><td>0</td></g9<>	A-2-6	0



Results marked \* in this report are not included in the SANAS Schedule of Accreditation for this laboratory

1 of 2

\*\* tests done at eMalahleni (Witbank) branch

pH =7.69, Electrical Conductivity =0.4917 mS/cm Moisture Content = 15.6%

Please note that test results are only relevant to the sample delivered to the lab by the client. Any results may only be reproduced in their entirety with the written consent of Letaba Lab (Pty) Ltd, and any opinions and interpretations are seed fall outside the scope of our accreditation.

scope of our accreditation.

Date Issued: 3/May/18

Remarks:

Technical signatory (Name):

H.P. du Preez

Signature:
W8267-2 CBR, F-ind TP4 Do-A 0.3-0.8m below

# LETABA LAB

#### CBR and Modified A.A.S.H.T.O Density data

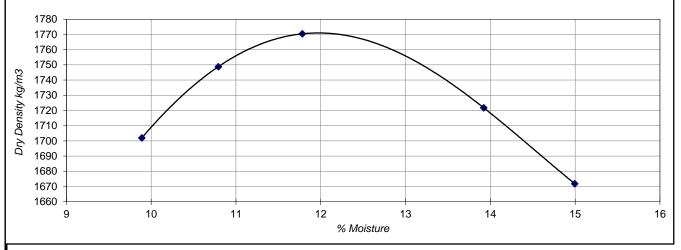
Engeolab CC Doc No: 8267/2(ii) *Date:* 13-Apr-18 Client: Contract:

LL3034 - Majuba Power Station

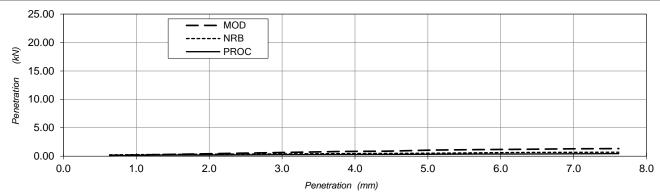
Sample no: **8267/2** 

Description: TP 4 DS4A from 0.3-0.8 m below existing ground level

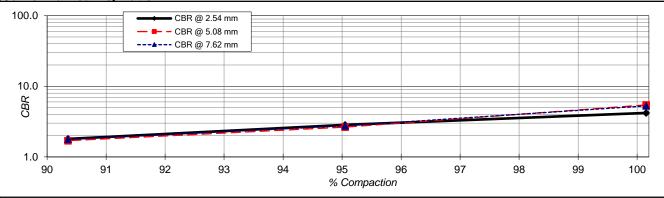
Maximum dry density =	1771 kg/m³
Optimum moisture content =	12.0 %



#### California Bearing Ratio (readings)



#### California Bearing Ratio



% Compaction	100	98	97	95	93	90				
CBR of 13.344 kN	4	4	3	3	2	2				
Briquette Info		Mod	ı	N.R.B.	Proc.					
Dry Density (kg/m³)		1774		1683	1600					
Compaction Moisture (%)		11.8		11.8	11.8					
Compaction (%)		100.2		95.1	9	0.4				
% Swell		0.94		1.51	2.	.19				

Please note that test results are only relevant to the sample delivered to the lab by the client. Any results may only be reproduced in their entirety with the written consent of Letaba Lab (Pty) Ltd, and any opinions and interpretations expressed fall outside the scope of our accreditation.

Date Issued:

03-May-18

Technical signatory (Name): H.P. du Preez

Signature:



♦ Polokwane

◆ Tzaneen

◆ Bloemfontein

♦ eMalahleni (Witbank)

◆Mbombela (Nelspruit)

♦ Mashishing (Lydenburg)

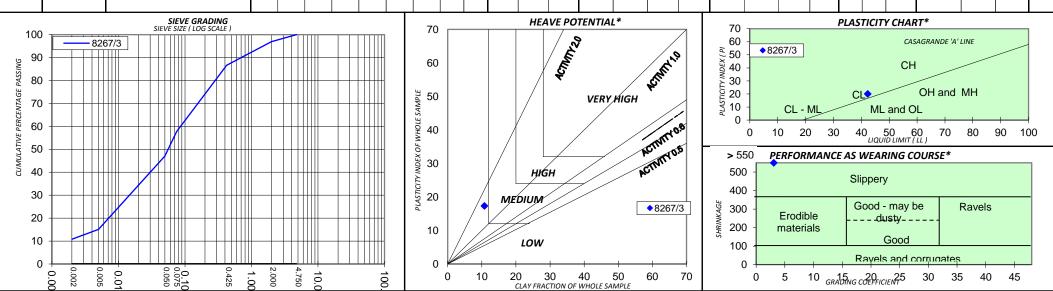
Tel. No: 087 285 0816 e-mail : letaba@letabalab.co.za www.letabalab.co.za

# **GRAVEL, SOIL AND SAND ANALYSIS**

TMH 1:1986 Method A1-A6,A7, A8 & A9\*

Client : Engeol	ab CC Ado	dress: 4 Corridor Crescent, N4 Business Park	Date Sampled: 13-Apr-18
Contract:	LL3034 - Majuba Power Station		<b>Doc No:</b> 8267/3(i)
Description:	TP 5 DS5A from 0.1-0.3 m below existing ground level		Date Tested: 13-Apr-18

) · O		2 3 2	ze   co	3 6	
Sample N. Sample N. Sample N. Sample N. Sample N. Sample N. S.	13,2 mm 4,75 mm 2,00 mm 0,425 mm 0,075 mm 0,05 mm*	Coarse - san <2,0 >0,425mn Fine-sand <0,425>0,075m Silt <0,05>0,005mm Clay	Effective si Uniformity - c	Grading mod Liquid Limit Plasticity Index Linear Shrinkage	Unified Soil COLTO US.Highway Group Index
0.1-0.3 8267/3 drk Olive Inorganic clay	100 97 87 58 47.1 15.1 10.8	10.6   29.9   33.0   15.5   <0	0.002 85.9 2.5	0.59 42 20 10.1	CL N/A A-7-6 9



Remarks: Results marked \* in this report are not included in the SANAS Schedule of Accreditation for this laboratory
THIS MATERIAL IS NOT SUITABLE FOR WEARING COARSE AS THE SHRINKAGE PRODUCT IS GREATER THAN 550

\*\* tests done at eMalahleni (Witbank) branch

#### pH =6.8, Electrical Conductivity =0.6237 mS/cm Moisture Content = 26.6%

Please note that test results are only relevant to the sample delivered to the lab by the client. Any results may only be reproduced in their entirety with the written consent of Letaba Lab (Pty) Ltd, and any opinions and interpretations expensed half outside the scope of our accreditation.

Scope of our accreditation.

Date Issued:

3/May/18

Technical signatory (Name):

1 of 1

H.P. du Preez

Signature:

W8267-3 F-ind TP5 DS5A 0.1-0.3m below EG



♦ Polokwane

♦ Tzaneen

◆ Bloemfontein

♦ eMalahleni (Witbank)

Mbombela (Nelspruit)

♦ Mashishing (Lydenburg)

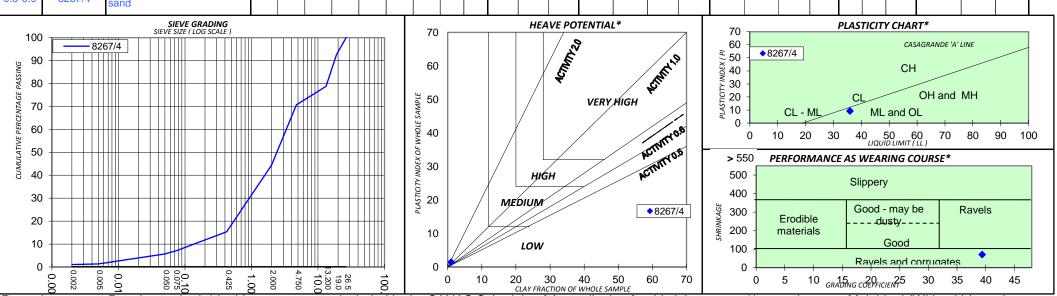
Tel. No: 087 285 0816 e-mail : letaba@letabalab.co.za www.letabalab.co.za

# **GRAVEL, SOIL AND SAND ANALYSIS**

TMH 1:1986 Method A1-A6,A7, A8 & A9\*

Client : <b>Engeo</b> l	ab CC Addres	ss: 4 Corridor Crescent, N4 Business Park	Date Sampled: 13-Apr-18
Contract:	LL3034 - Majuba Power Station		<b>Doc No:</b> 8267/4(i)
Description:	TP 5 DS5B from 0.3-0.9 m below existing ground level		Date Tested: 13-Apr-18

	Sieve analysis Cumulative percentage passing												Soil N % of I				*	ef.*	,f. *	us*	Atterberg Limits			Classifications*					
Depth ( m )	Sample No.	<b>Description</b> (Unified Soil Classification)	53,0 mm	37,5 mm	26,5 mm	19,0 mm	13,2 mm	4,75 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse - sand <2,0 >0,425mm	Fine-sand <0,425>0,075mm	Silt <0,05>0,005mm	Clay <0,005 mm	Effective size	Uniformity - co	Curvature coe	Grading modul	Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	C0F10	US.Highway	Group Index
0.3-0.9	9267/A	drk Olive Well graded clayey sand			100	93	79	71	44	15	7	5.7	1.3	1.1	65.4	18.5	9.8	2.9	0.138	24.2	1.9	2.33	36	9	4.6	sw/sc	N/A	A-2-4	0



Remarks: Results marked \* in this report are not included in the SANAS Schedule of Accreditation for this laboratory \*\* tests

1 of 1

\*\* tests done at eMalahleni (Witbank) branch

pH =7.88, Electrical Conductivity =0.5923 mS/cm Moisture Content = 7.5%

Please note that test results are only relevant to the sample delivered to the lab by the client. Any results may only be reproduced in their entirety with the written consent of Letaba Lab (Pty) Ltd, and any opinions and interpretations expressed all outside the

scope of our accreditation.

Date Issued:

3/May/18

Technical signatory (Name):

H.P. du Preez

Signature:

W8267-4 F-ind TP5 DS55 0.3-0.9m below EGI



◆ Polokwane

◆ Tzaneen

♦ Bloemfontein

♦ eMalahleni (Witbank)

Mbombela (Nelspruit)

♦ Mashishing (Lydenburg)

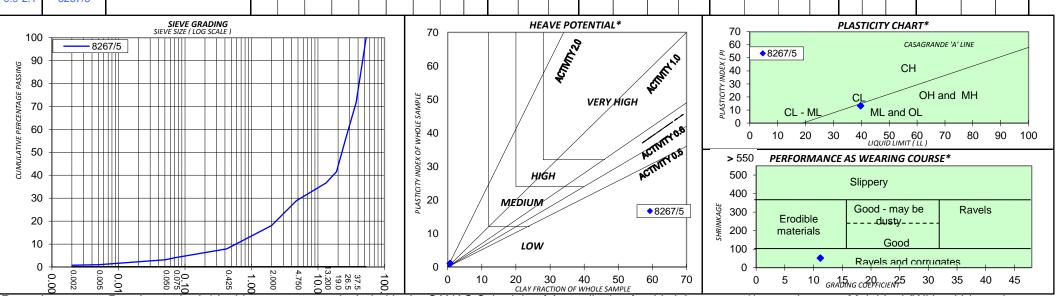
Tel. No: 087 285 0816 e-mail : letaba@letabalab.co.za www.letabalab.co.za

# **GRAVEL, SOIL AND SAND ANALYSIS**

TMH 1:1986 Method A1-A6,A7, A8 & A9\*

Client : Engeol	ab CC Addres	ss: 4 Corridor Crescent, N4 Business Park	Date Sampled: 13-Apr-18
Contract:	LL3034 - Majuba Power Station		<b>Doc No:</b> 8267/5(i)
Description:	TP 5 DS5C from 0.9-2.1 m below existing ground level		Date Tested: 13-Apr-18

	Sieve analysis Cumulative percentage passing														Analy: 2,00 m		*	ef.*	f.*	us*	Atterberg Limits			Classifications*					
Depth ( m )	Sample No.	<b>Description</b> (Unified Soil Classification)	53,0 mm	37,5 mm	26,5 mm	19,0 mm	13,2 mm	4,75 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse - sand <2,0 >0,425mm	Fine-sand <0,425>0,075mm	Silt <0,05>0,005mm	Clay <0,005 mm	Effective size	Uniformity - co	Curvature coe	Grading modul	Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	СОГТО	US.Highway	Group Index
0.9-2.1	8267/5	drk Olive Well graded gravel	100	72	57	42	37	29	18	8	4	3.1	1.0	8.0	56.3	20.6	11.7	5.5	0.586	48.8	1.8	2.70	40	13	6.6	GW	N/A	A-2-6	0
0.0 2.1	020170		I																								1 '		



Results marked \* in this report are not included in the SANAS Schedule of Accreditation for this laboratory \*\* tests done at e

1 of 1

\*\* tests done at eMalahleni (Witbank) branch

#### pH =7.84, Electrical Conductivity =0.879 mS/cm Moisture Content = 7.9%

Please note that test results are only relevant to the sample delivered to the lab by the client. Any results may only be reproduced in their entirety with the written consent of Letaba Lab (Pty) Ltd, and any opinions and interpret as expressed fall outside the scope of our accreditation.

Date Issued:

3/May/18

Technical signatory (Name):

H.P. du Preez

Signature:

W8267-5 F-ind 175 DS5C 0.9-2.1m below EG



Reg No. 1995/12513/07 Vat No. 4630157248 ♦ Polokwane

♦ Tzaneen

◆ Bloemfontein

♦ eMalahleni (Witbank)

Mbombela (Nelspruit)

♦ Mashishing (Lydenburg)

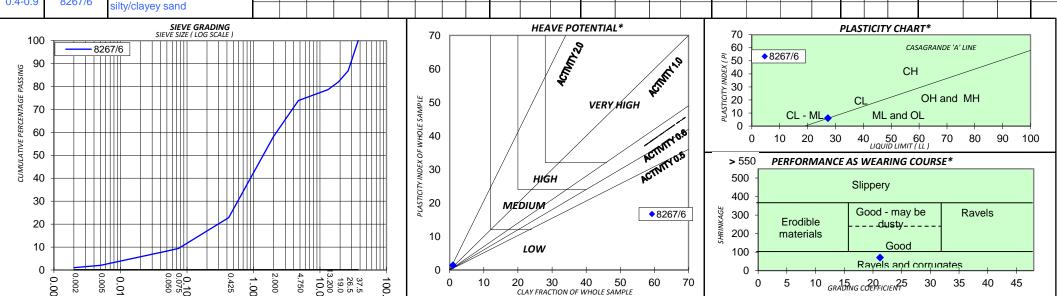
Tel. No: 087 285 0816 e-mail : letaba@letabalab.co.za www.letabalab.co.za

# **GRAVEL, SOIL AND SAND ANALYSIS**

TMH 1:1986 Method A1-A6,A7, A8 & A9\*

Client : Engeol	ab CC	Address:	4 Corridor Crescent, N4 Business Park	Date Sampled: 1	3-Apr-18
Contract:	LL3034 - Majuba Power Station			Doc No: 8	3267/6(i)
Description:	TP 6 DS6A from 0.4-0.9 m below existing ground level			Date Tested: 1	3-Apr-18

								alysis ercen		pas	sing					/lortar mat. <			*	ef.*	f. *	us*		erbe imit:	•	Cla	ssific	ations	*
Depth ( m )	Sample No.	<b>Description</b> (Unified Soil Classification)	53,0 mm	37,5 mm	26,5 mm	19,0 mm	13,2 mm	4,75 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse - sand <2,0 >0,425mm	Fine-sand <0,425>0,075mm	Silt <0,05>0,005mm	Clay <0,005 mm	Effective size	Uniformity - co	Curvature coe	Grading modul	Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US.Highway	Group Index
0.4-0.9	8267/6	drk Olive Well graded silty/clayey sand		100	87	82	79	74	58	23	9	8.3	2.0	1.0	60.8	23.0	10.8	3.4	0.081	27.4	1.9	2.10	27	6	3.1	sw/sm/sc	G8	A-1-b	0



Remarks: Results marked \* in this report are not included in the SANAS Schedule of Accreditation for this laboratory \*\* to

\*\* tests done at eMalahleni (Witbank) branch

#### pH =8 , Electrical Conductivity =0.4863 mS/cm Moisture Content = 9.2%

Please note that test results are only relevant to the sample delivered to the lab by the client. Any results may only be reproduced in their entirety with the written consent of Letaba Lab (Pty) Ltd, and any opinions and interrestations pressed fall outside the scope of our accreditation.

1 of 2

scope of our accreditation.

Date Issued: 3/May/18

Technical signatory (Name):

H.P. du Preez

Signature:
W8267-6 CBR, F-ind TPb = S6A 0.4-0.9m below EG

# LETABA LAB

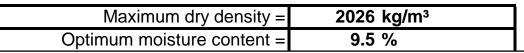
#### CBR and Modified A.A.S.H.T.O Density data

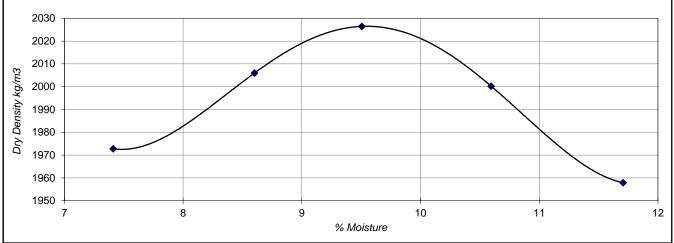
Engeolab CC 13-Apr-18 Client: Doc No: 8267/6(ii) Date:

LL3034 - Majuba Power Station Contract:

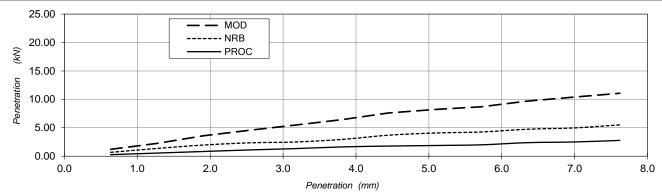
Sample no: **8267/6** 

Description: TP 6 DS6A from 0.4-0.9 m below existing ground level

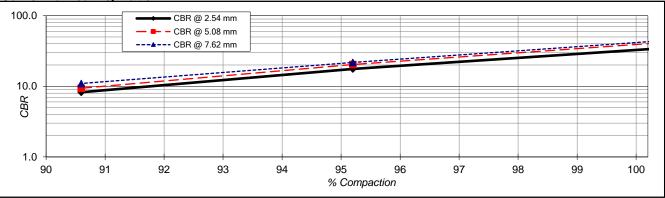




#### California Bearing Ratio (readings)



#### California Bearing Ratio



% Compaction	100	98	97	95	93	90
CBR of 13.344 kN	33	25	22	17	12	7
Briquette Info		Mod	ı	V.R.B.	Pi	oc.
Dry Density (kg/m³)	:	2033		1929	18	835
Compaction Moisture (%)		9.5		9.4	9	).4
Compaction (%)	1	100.3		95.2	9	0.6
% Swell		0.38		0.71	1	.21

Please note that test results are only relevant to the sample delivered to the lab by the client. Any results may only be reproduced in their entirety with the written consent of Letaba Lab (Pty) Ltd, and any opinions and interpretations expressed fall outside the scope of our accreditation.

Date Issued:

03-May-18

Technical signatory (Name): H.P. du Preez

Signature:



Reg No. 1995/12513/07 Vat No. 4630157248 ◆ Polokwane◆ Bloemfontein

◆ Tzaneen◆ eMalahleni (Witbank)

Mbombela (Nelspruit)

♦ Mashishing (Lydenburg)

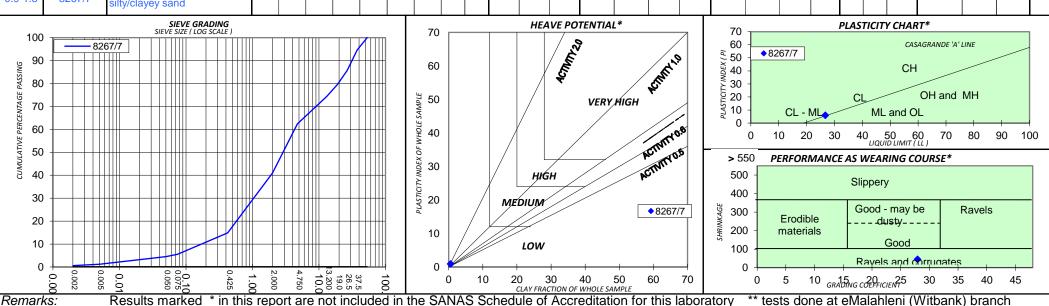
Tel. No: 087 285 0816 e-mail : letaba@letabalab.co.za www.letabalab.co.za

## **GRAVEL, SOIL AND SAND ANALYSIS**

TMH 1:1986 Method A1-A6,A7, A8 & A9\*

Client : <b>Engeo</b>	ab CC	Address:	4 Corridor Crescent, N4 Business Park	Date Sampled:	: 13-Apr-18
Contract:	LL3034 - Majuba Power Station			Doc No:	8267/7(i)
Description:	TP 6 DS6B from 0.9-1.8 m below existing ground level			Date Tested:	: 13-Apr-18

					Cum	Siev ulati				pass	ing						Analy: 2,00 m		*	ef.*	f.*	us*		erbe imits	_	Cla	ssifica	ations	*
Depth ( m )	Sample No.	<b>Description</b> (Unified Soil Classification)	53,0 mm	37,5 mm	26,5 mm	19,0 mm	13,2 mm	4,75 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse - sand <2,0 >0,425mm	Fine-sand <0,425>0,075mm	Silt <0,05>0,005mm	<i>Clay</i> <0,005 mm	Effective size	Uniformity - co	Curvature coe	Grading modul	Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US.Highway	Group Index
0.9-1.8	8267/7	drk Olive Well graded silty/clayey sand	100	95	86	80	74	62	41	15	6	4.5	1.2	0.6	63.8	22.7	8.1	2.9	0.172	25.0	1.5	2.39	27	6	3.0	sw/sm/sc	G6	A-1-a	0



pH =7.94, Electrical Conductivity =0.4483 mS/cm Moisture Content = 6.1%

Please note that test results are only relevant to the sample delivered to the lab by the client. Any results may only be reproduced in their entirety with the written consent of Letaba Lab (Pty) Ltd, and any opinions and interpretations are significantly scope of our accreditation.

scope of our accreditation.

Date Issued: 3/May/18

Technical signatory (Name):

1 of 2

H.P. du Preez

Signature:
W8267-7 CBR. F-ind TP Do6B 0.9-1.8m below EGL

# LETABA LAB

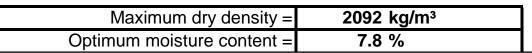
#### CBR and Modified A.A.S.H.T.O Density data

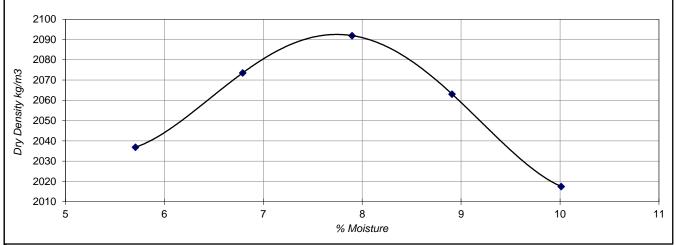
Engeolab CC 13-Apr-18 Client: Doc No: 8267/7(ii) Date:

LL3034 - Majuba Power Station Contract:

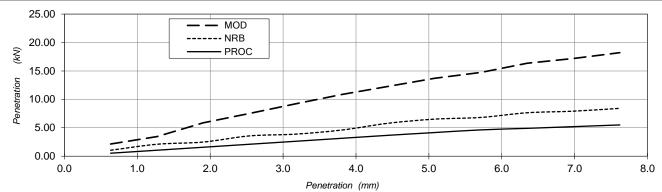
Sample no: 8267/7

Description: TP 6 DS6B from 0.9-1.8 m below existing ground level

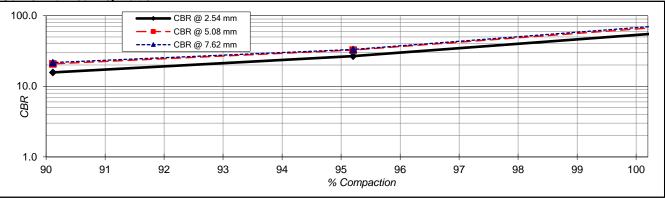




#### California Bearing Ratio (readings)



#### California Bearing Ratio



% Compaction	100	98	97	95	93	90
CBR of 13.344 kN	53	40	35	26	21	16
Briquette Info		Mod		N.R.B.	Pi	oc.
Dry Density (kg/m³)		2100		1992	18	885
Compaction Moisture (%)		7.9		8.0	8	3.0
Compaction (%)		100.4		95.2	9	0.1
% Swell		0.19		0.33	0	.63

Please note that test results are only relevant to the sample delivered to the lab by the client. Any results may only be reproduced in their entirety with the written consent of Letaba Lab (Pty) Ltd, and any opinions and interpretations expressed fall outside the scope of our accreditation.

Date Issued:

03-May-18

Technical signatory (Name): H.P. du Preez

Signature:



Reg No. 1995/12513/07 Vat No. 4630157248 ♦ Polokwane

♦ Tzaneen

◆ Bloemfontein

♦ eMalahleni (Witbank)

♠ Mbombela (Nelspruit)

♦ Mashishing (Lydenburg)

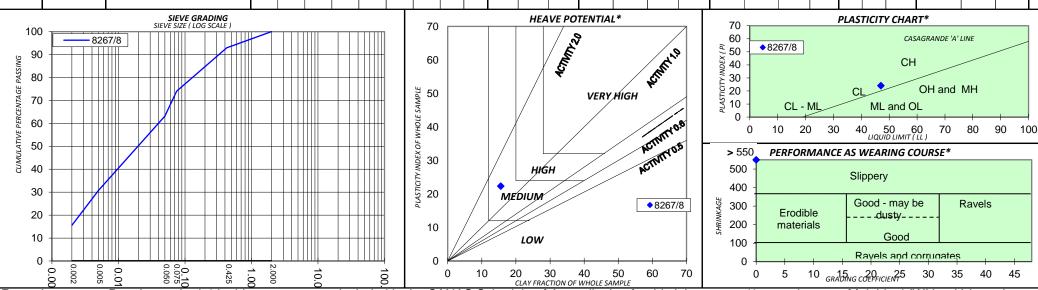
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## **GRAVEL, SOIL AND SAND ANALYSIS**

TMH 1:1986 Method A1-A6,A7, A8 & A9\*

Client : Engeol	ab CC Ad	Address: 4 Corridor Crescent, N4 Business Park	Date Sampled: 13-Apr-18
Contract:	LL3034 - Majuba Power Station		<b>Doc No:</b> 8267/8(i)
Description:	TP 9 DS9A from 0.1-0.7 m below existing ground level		Date Tested: 13-Apr-18

					Cun		e ana ve pe		s itage	pass	sing				Soil N % of I				*	ef.*	,f. *	us*		erbe imits	_	Cla	ssifica	ations	*
Depth ( m )	Sample No.	<b>Description</b> (Unified Soil Classification)	53,0 mm	37,5 mm	26,5 mm	19,0 mm	13,2 mm	4,75 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse - sand <2,0 >0,425mm	Fine-sand <0,425>0,075mm	Silt <0,05>0,005mm	<i>Clay</i> <0,005 mm	Effective size	Uniformity - co	Curvature coe	Grading modul	Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US.Highway	Group Index
0.1-0.7	8267/8	drk Grey Inorganic clay							100	93	74	63.2	30.7	15.6	7.0	19.0	32.5	30.7	<0.002	39.9	0.6	0.33	47	24	11.9	CL	N/A	A-7-6	15



Results marked \* in this report are not included in the SANAS Schedule of Accreditation for this laboratory
THIS MATERIAL IS NOT SUITABLE FOR WEARING COARSE AS THE SHRINKAGE PRODUCT IS GREATER THAN 550

\*\* tests done at eMalahleni (Witbank) branch

#### pH =8.31, Electrical Conductivity =0.9687 mS/cm Moisture Content = 29.5%

Please note that test results are only relevant to the sample delivered to the lab by the client. Any results may only be reproduced in their entirety with the written consent of Letaba Lab (Pty) Ltd, and any opinions and interroclations, pressed fall outside the scope of our accreditation.

Date Issued:

15/May/18

Technical signatory (Name):

1 of 1

H.P. du Preez

Signature:
W8267-8 F-ind\_TP9\_DS9A\_0.1-0.7m below EGL\_Re-do Hydrometer.



Reg No. 1995/12513/07 Vat No. 4630157248

♦ Polokwane

**♦** Bloemfontein

eMalahleni (Witbank)

**♦** Tzaneen

♦ Mbombela (Nelspruit)

♦ Mashishing (Lydenburg)

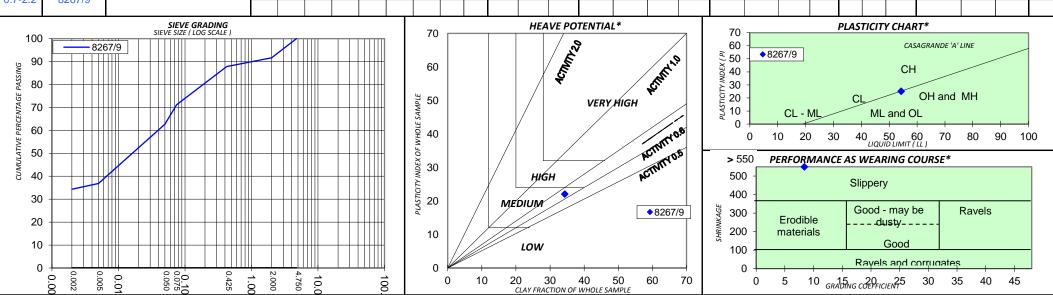
Tel. No: 087 285 0816 e-mail: letaba@letabalab.co.za www.letabalab.co.za

## **GRAVEL, SOIL AND SAND ANALYSIS**

TMH 1:1986 Method A1-A6,A7, A8 & A9\*

Client : Engeol	ab CC	Address:	4 Corridor Crescent, N4 Business Park	Date Sampled: 13-A	pr-18
Contract:	LL3034 - Majuba Power Station			<b>Doc No:</b> 8267.	7/9(i)
Description:	TP 9 DS9B from 0.7-2.2 m below existing ground level			Date Tested: 13-A	pr-18

					Cun			alysis ercen		pas	sing				Soil N % of I				*	ef.*	f.*	us*		erbe imit:	_	Cla	ssifica	ations	*
Depth ( m )	Sample No.	<b>Description</b> (Unified Soil Classification)	53,0 mm	37,5 mm	26,5 mm	19,0 mm	13,2 mm	4,75 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0.005 mm*	0.002 mm*	Coarse - sand <2,0 >0,425mm	Fine-sand <0,425>0,075mm	Silt <0,05>0,005mm	<i>Clay</i> <0,005 mm	Effective size	Uniformity - co	Curvature coe	Grading modul	Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US.Highway	Group Index
0.7-2.2	8267/9	It Grey Inorganic silt						100	92	88	71	62.7	36.8	34.3	4.1	18.2	28.2	40.2	<0.002	39.3	2.5	0.49	54	25	12.5	МН	N/A	A-7-6	16



\* in this report are not included in the SANAS Schedule of Accreditation for this laboratory Remarks: THIS MATERIAL IS NOT SUITABLE FOR WEARING COARSE AS THE SHRINKAGE PRODUCT IS GREATER THAN 550

\* tests done at eMalahleni (Witbank) branch

#### pH =8.41, Electrical Conductivity =1.108 mS/cm Moisture Content = 29.0%

Please note that test results are only relevant to the sample delivered to the lab by the client. Any results may only be reproduced in their entirety with the written consent of Letaba Lab (Pty) Ltd, and any opinions and interpretations. ssed fall outside the scope of our accreditation.

Date Issued: 15/May/18 Technical signatory (Name):

1 of 1

H.P. du Preez

Signature: W8267-9 F-ind TP9 DS9B 0.7-2

#### TYPICAL SOIL STRENGTH CHARACTERISICS

<u>COHESIONLESS SO</u>	<u>ILS</u>				Relative	Soil M	odulus E	(MPa)
Description	<b>Dry Density</b>	$(kg/m^3)$	N - '	Value	Density	Sand Gravel	Sand	Sandy Silt
Very Loose	0	1 450	0	5	< 0.2	25	12	6
Loose	1 450	1 600	5	10	0.2 - 0.4	50	25	12
Medium Dense	1 600	1 750	10	30	0.4 - 0.6	100	50	25
Dense	1 750	1 900	30	50	0.6 - 0.8	200	100	50
Very Dense	1 900	2 400	50	100	>0.8	400	200	100

<b>COHESIVE SOILS</b>	Undrain	ed Shear			Soil M	odulus E	(MPa)
Description	Strength	$(kN/m^3)$	N - '	Value	Sandy Silt	Silt	Silty Clay
Very Soft	0	20	0	2	6	3	2
Soft	20	40	2	4	12	6	3
Firm	40	80	4	8	25	12	6
Stiff	80	150	8	15	50	25	12
Very Stiff	150	350	15	30	100	50	25
•	UCS	$= 2 C_{\rm u}$	$C_u = Unc$	drained sl	near strength		

#### **COMPRESSIBILITY & COLLAPSE**

Carter, M and Bentley, S. P., Correlations of Soil Properties, 1991.

Coeff	vol. Compr. m <sub>v</sub>	$(m^2/kN)$	<b>Trouble Index</b>	Collapse	Potential	
V.High Compressibility		1.50E-03	Very Severe	> 20	0.1%	V.Highly Collapsible
High Compressibility	1.50E-03	3.00E-04	Severe	10.1%	20.0%	Highly Collapsible
Mod. Compressibility	3.00E-04	1.00E-04	Trouble	5.1%	10.0%	Mod. Collapsible
Low Compressibility	1.00E-04	3.00E-05	Mod. Trouble	1.1%	5.0%	Slightly Collapsible
V.Low Compressibilty	3.00E-05	1.00E-05	No problem	<	1%	V.Slightly Collapsible

#### TYPICAL ROCK/SOIL PROPERTIES & ESTIMATED BEARING CAPACITES

Rock / Soil Density Description	UCS (MPa)	Bearing Capacity	Mod. Ratio	E <sub>d</sub> (MPa)	Friction Angle ¢'	Cohesion Cu / C'	N-Value	Dry Unit Wt kg/m <sup>3</sup>
Extremely hard rock Very hard rock Hard rock Medium hard rock	200 150 100 50	Function of UCS & jointing intensity (j)	600 450 375 325	120 000 67 500 37 500 16 250	Rock joint / structure friction	Rock joint / structure cohesion	Refer to Schmidt hardness or point load index	> 40 35 - 40 30 - 35 27 - 30
Soft rock Very soft rock Very hard soil/decomp.	10 1 0.5	Functior	300 275 250	3 000 275 125	Rock mass friction	Rock mass cohesion	Refer to  V hardness O load i	25 - 27 23 - 25 21.5 - 23
Very dense sand/gravel Very dense silt/sand Very stiff clay/silt		400 300 200	250 225 200	100 68 40	44 40 22	- - 80 / 15	50 - 80 15-30	19.5-21.5 17.5
Dense sand/gravel Dense silt/sand Stiff clay/silt		300 200 150	225 200 175	68 40 26	40 36 20	- - 40 / 10	30-50 8 - 15	17.5-19.5 15.5-17.5
Medium dense sand/gravel Medium dense silt/sand Firm clay/silt		200 150 75	200 175 150	40 26 11	36 32 18	- - 20 / 5	10 - 30 4 - 8	15.5-17.5 14.0-15.5
Loose sand/gravel Loose silt/sand Soft clay/silt		150 75 35	175 150 125	26 11 4	32 28 17	- - 10/2	5 - 10 2 - 4	14.0-15.5 12.5-14.0
Very loose sand/gravel Very loose silt/sand Very soft clay/silt		75 35 20	150 125 100	11 4 2	28 24 16	- - <5/0	<5 <2	<14.0 <12.5

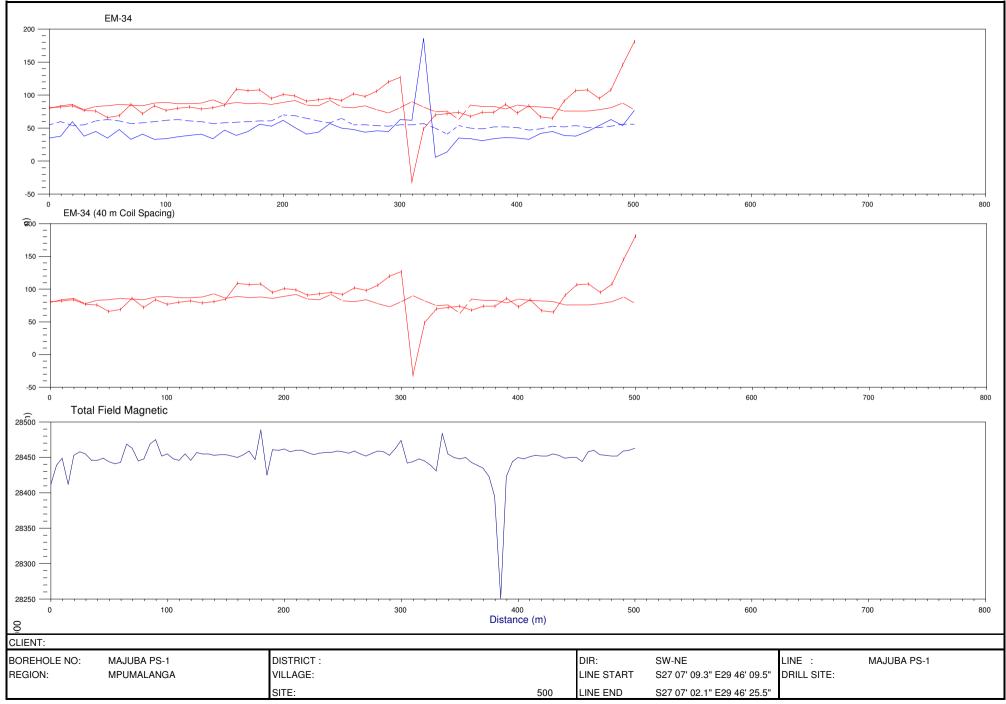
### **TYPICAL PROPERTIES of COMPACTED SOILS**

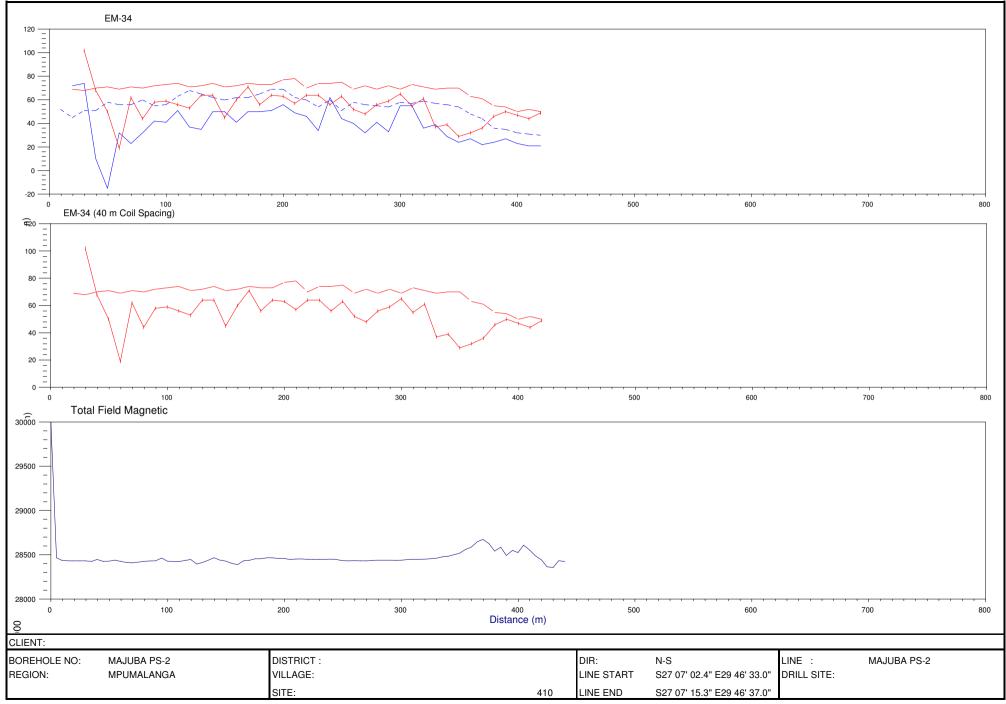
So	il	USC	AASHTO	Description	L	L	PI	min	LS		Range		Op	ot.	C' kPa	C' kPa		Permea	bility K	С	BR
Ту	ре	Symbol	*Symbol	'	min	max	ma	X	min m	ıax	Density	kN/m3	Moistu	ıre %	Nat	Sat	ø'	cn	1/s	min	max
	Soils	GW	A-1-a	Well graded clean gravels, gravel-sand mixtures	NP						19.6	21.2	11	8	NA	NA	>38		>10-2	40	80
	Gravelly	GP	A-1-a A-1-b	Poorly graded clean gravels, gravel-sand mixtures	NP						18.1	19.6	14	11	NA	NA	>37		>10-2	30	60
	જ	GM	A-1-b / A-2-4 A- 2-5 / A-2-7	Silty gravels, poorly graded, gravel-sand-silt mixtures	NP						18.9	21.2	12	8	NA	NA	>34	1.E-03	1.E-06	20	40
Coarse Grained Soils	Gravel	GC	A-2-6 A-2-7	Clayey gravels, poorly graded, gravel-sand-clay mixtures	<30						18.1	20.4	14	9	NA	NA	>31	1.E-06	1.E-08	20	40
Grain	S	SW	A-1-b	Well graded clean sands, gravelly sands	NP						17.3	20.4	16	9	NA	NA	38		>10-3	20	40
arse	y Soils	SP	A-1-b A-3	Poorly graded clean sands, sand- gravel mixtures	NP						15.7	18.9	21	12	NA	NA	37		>10-3	10	40
S	٠,	SM	2-5 / A-2-7	Silty sands, poorly graded, sand- silt mixtures	10	30					17.3	19.6	16	11	50	20	34	1.E-03	1.E-06	10	40
	Sands &	SM-SC	A-2-4 A-2-5 A-2-6 A-2-7	Sand-silt-clay mixes with slightly plastic fines	10	20					17.3	20.4	15	11	50	14	33	5.E-05	1.E-07	5	30
	Se	SC	A-2-4 A-2-6 A-2-7	Clayey sands, poorly graded, sand-clay mixtures	10	20	7	12	<6		16.5	19.6	19	11	74	11	31	1.E-06	1.E-08	5	20
	LL<50	ML	A-4 A-5	Inorganic silts and clayey silts	20	<50	<20		<6		14.9	18.9	24	12	67	9	32	1.E-03	1.E-06	<15	
	Clays I	ML-CL	A-4 A-5 A- 6 A-7-6	Mixtures of inorganic silts and clays							15.7	18.9	22	12	65	22	32	5.E-05	1.E-07		
Soils	۸X	CL	A-6 A-7-6	Inorganic clays of low to medium plasticity	20	<50	6	25	<10		14.9	18.9	24	12	86	13	28	1.E-06	1.E-08	<15	
Fine Grained Soils	50	OL	A-4 A-5	Organic silts and silt-clay mixes, low plasticity	20	>50	<20		<6		12.6	15.7	33	21				1.E-04	1.E-06	<5	
ine G	's LL>	МН	A-5 A-7-5	Inorganic silts, micaceous fine sandy silts, elastic silts		>50	<30		<12		11.0	14.9	40	24	72	20	25	1.E-04	1.E-06	<10	
	& Clay	СН	A-7-6	Inorganic clays with high plasticity	50	100	20	50	8	15	11.8	16.5	36	19	103	11	19	1.E-06	1.E-08	<15	
	(S	ОН	A-5 A-7-5	Organic clays with mediumto high plasticity		>50	<30		<12		10.2	15.7	45	21				1.E-06	1.E-08	<5	
		* * * *	robabla symbo	<u> </u>					<u> </u>									Table fr			

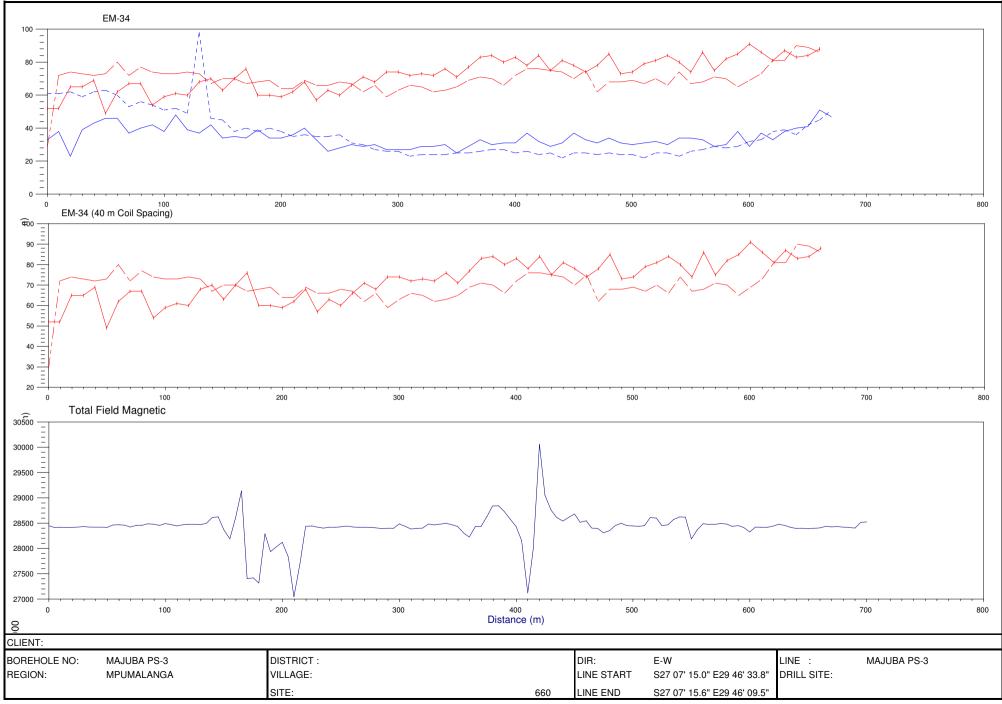
\* Most probable symbol class Table from NAVFAC DM7



# Appendix C Geophysical Data

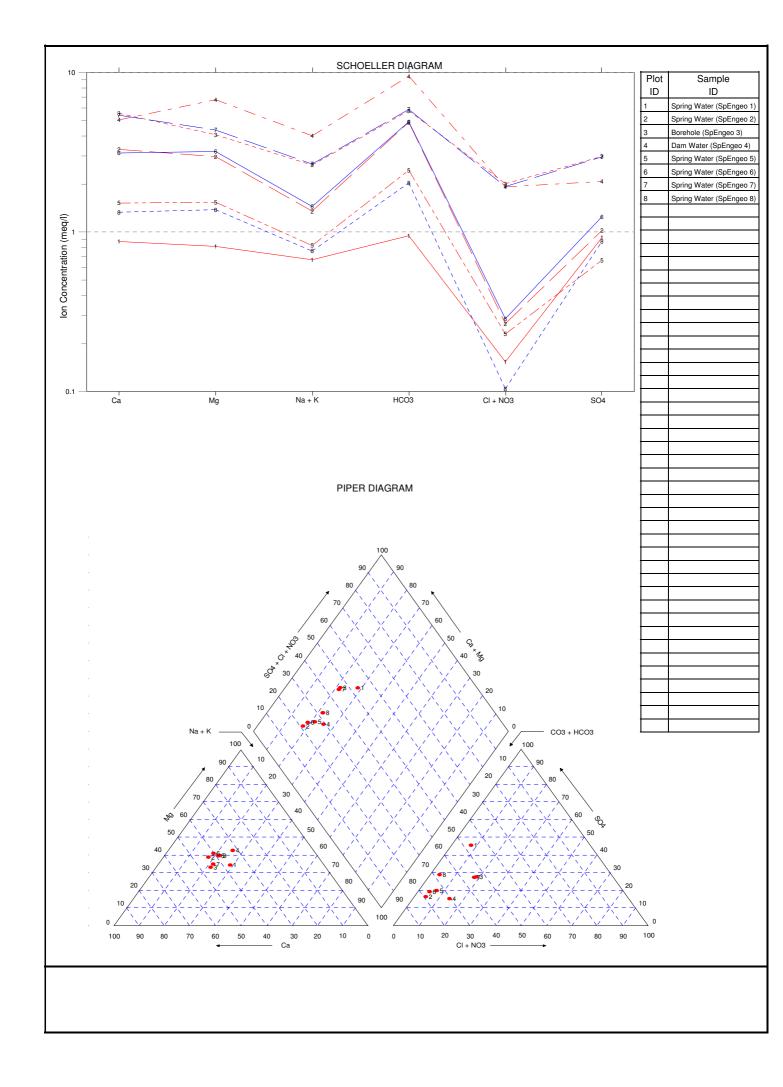








# Appendix D Water Test Data



Borehole No.:	Spring Water (SP Engeo 1)	CO-ORDINATES	
Project No.:	LL3034	Lat:	
Project Name:	Eskom Majuba	Long:	

INPUT IN	FORMATION	
SUBSTANCE	UNIT OF	TEST
Aldrin & Dieldrin	MEASURE	VALUE
Alkalinity		57.8
Aluminium Ammonia (N) **	mg/l NH3	0.45
Ammonia (NH3) Appearance	mg/l NH3	
Arsenic (As) *	mg/l As	
Cadmium (Cd) *	mg/l Cd	
Calcium (Ca)	mg/l Ca	17.5
Calcium (CaCo3)	mg/l CaCO3	203
Chloride (CI)*	mg/l Cl	4.9
Chlorine (Free) Chlorine (Total)		
Chloroform		
Colour		
Copper(Cu)		
Cyanide Electrical conductivity EC *	mS/m	23.7
Faecal coliform *	counts/100 ml	0.10
Fluoride (F) *	mg/l F	0.19
Iron (Fe) *	mg/l Fe	0.11
Lead Magnesium (Mg)	mg/l Mg	9.88
Magnesium (MgCo3) * Manganese (Mn) *	mg/I MgCO3 mg/I Mn	40.7 0.53
Mercury Nitrate (as N) *	and the	
Nitrate (as NO3) *	mg/l N mg/l N	
Nitrite (Soluble)	g	0.55
Odour & Taste		
Organic carbon(sol) pH *	pH units	6.4
Phenols		
Potassium (K) *	mg/l K	2.94
Precipitation Potential		
Selenium Sodium (Na) *	mg/l Na	13.7
Standard plate count	"55:	
Sulphate (SO4) *	mg/l SO4	44.4
Total Alkalinity Total Coliforms	mg/l	
Total Collorms  Total Dissolved Solids (TDS) *	(mg/l)	132
Total Hardness **	mg CaCO3/I	84.4
Trihalomethanes		
Turbidity	NTU	50
Zinc (Zn) *	mg/l Zn	

DWA	F
COMME	
COMME	
Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal quality	
Class 2: Water which is safe for	
short term use only Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal quality	
Class 0: Water of an ideal quality	#VALUE!
Class 1: Water of a good quality	#VALUE!
Class 0: Water of an ideal quality  Class 2: Water which is safe for	#VALUE!
short term use only	#VALUE:
Class 0: Water of an ideal quality	
Class 0: Water of an ideal quality	
Class 0: Water of an ideal quality	
Class 0: Water of an ideal quality	
Class 0: Water of an ideal quality Class 0: Water of an ideal	Moderately soft
quality	moderatory soft
Class 3: Water of an unacceptable quality	The presence of turbidity is one of the indicators of microbiological water quality and of inefficient water

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	COMM	ENTS	
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Class	1, Acce	ptable	
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Olas	, Acce	Pranie	
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	s II, Maxi		
	s II, Maxi able for		
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Class	s 1, Acces 1	ptable  ptable  ptable	
Class	s 1, Acces 1	ptable  ptable  ptable	

WATER TREATMENT				
Home	Conventional treatment	Advanced		
No treatment	Precipitation with sodium	lon exchange		
available	carbonate			
No treatment	No treatment available	Reverse osmosis,		
available		electrolysis, lon exchange		
		exchange		
	No treatment available	Desalination by ion		
		exchange or reverse		
		osmosis		
No treatment	No treatment available	lon exchange, Reverse		
available		osmosis or Adsorption of		
		activated alumina		
Add bleach and filter	Normal coagulation and flocculation sedimentation	lon exchange		
	and filtration Oxidation by			
	aeration and pH adjustment			
	or addition of chemical			
	oxidants, followed by sedimentation			
	Sedimentation			
No treatment	Lime treatment	lon exchange		
available		-		
Add bleach solution	Normal coagulation,	Coagulation and/or		
or pool "chlorine"	sedimentation and sand	oxidation by chlorine		
granules let stand to	filtration Coagulation and/or	compounds or potassiur		
settle and filter	oxidation by chlorine	permangate or ozone or		
	compounds or aeration	air. Zeolite softening		
No treatment	No treatment available	Anaerobic biological		
available	INO treatment available	reduction, reverse		
		osmosis or other		
		desalination techniques		
Neutralization with	pH adjustment by controlled	Controlled addition of a		
marble chips	addition of alkali such as	suitable acid/alkali		
	lime sodium carbonate,			
	carbon dioxide			
No treatment	No treatment available	Reverse osmosis,		
available		electrolysis, lon		
		exchange		
No treatment	No treatment available	Desalination by ion		
available		exchange or reverse		
		osmosis		
No treatment	No treatment available	Desalination by ion		
available	i caunent avallable	exchange or reverse		
		osmosis		
	Lime treatment	lon exchange		
		-		
Eleganistics and	Clow aand filtratian an	Samo as sanus-tii		
Flocculation and filtration	Slow sand filtration or flocculation, settlement and	Same as conventional		
duon	filtration			

Borehole No.:	Spring Water (SP Engeo 2)	CO-OI	RDINATES	
Project No.:	LL3034	Lat:		
Project Name:	Eskom Majuba	Long:		

INPUT INFORMATION				
	UNIT OF	TEST		
SUBSTANCE	MEASURE	VALUE		
Aldrin & Dieldrin Alkalinity		298		
Aluminium		20		
Ammonia (N) **	mg/I NH3	0.45		
Ammonia (NH3)	mg/l NH3			
Appearance Arsenic (As) *	mg/l As	+		
Cadmium (Cd) *	mg/I Cd			
Calcium (Ca)	mg/l Ca	66		
Calcium (CaCo3)	mg/l CaCO3	203		
Chloride (CI)*	mg/l Cl	8.91		
Chlorine (Free)				
Chlorine (Total)				
Chloroform Colour				
Copper(Cu)				
Cyanide				
Electrical conductivity EC *	mS/m	65.2		
Faecal coliform *	counts/100 ml			
Fluoride (F) *	mg/l F	0.17		
Iron (Fe) *	mg/l Fe	0.07		
Lead Magnesium (Mg)	mg/I Mg	36.1		
	mg/l Mg	30.1		
Magnesium (MgCo3) * Manganese (Mn) *	mg/l MgCO3 mg/l Mn	149 0.01		
Moreum				
Mercury Nitrate (as N) *	mg/l N	+		
Nitrate (as NO3) *	mg/l N			
Nitrite (Soluble)		0.55		
Odour & Taste				
Organic carbon(sol)		YE		
pH *	pH units	8.17		
Phenols				
Potassium (K) *	mg/l K	3.67		
Precipitation Potential				
Selenium				
Sodium (Na) *	mg/l Na	28.9		
Standard plate count				
Sulphate (SO4) *	mg/I SO4	49.2		
Total Alkalinity	mg/l			
Total Coliforms Total Dissolved Solids (TDS) *	(mg/l)	374		
Total Hardness **	mg CaCO3/I	313		
Trihalomethanes Turbidity	NTU	13		
Zinc (Zn) *	mg/l Zn			

DWA	AF
СОММЕ	NTS
Class 0: Water of an ideal quality	
Class 2: Water which is safe for	No health effects. Some
short term use only	scaling.
Class 3: Water of an unacceptable quality	No health effects. Some scaling.
Class 0: Water of an ideal quality	
Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal	#VALUE!
quality	
Class 0: Water of an ideal quality	#VALUE!
quanty	
Class 1: Water of a good quality	
Class 0: Water of an ideal quality	#VALUE!
Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal quality	
. ,	
Class 0: Water of an ideal quality	
Class 3: Water of an	Very hard
unacceptable quality	
Class 3: Water of an	The presence of turbidity is
unacceptable quality	one of the indicators of
	microbiological water quality and of inefficient water

SANS 2	MENTS
COM	VIENTO
Class 1, Acc	eptable
Class 1, Acc	eptable
Class 1, Acc	eptable
Class 1, Acc	eptable
Class 1, Acc	eptable
Class 1, Acc	eptable
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Class I, Acc	ертавіе
Class 1, Acc	eptable
Class 1, Acc	eptable
	r
Class 1, Acc	eptable
Class 1, Acc	eptable
	е

WATER TREATMENT				
Home	Conventional treatment	Advanced		
No treatment	Precipitation with sodium	lon exchange		
available	carbonate			
No treatment available	No treatment available	Reverse osmosis, electrolysis, Ion		
avaliable		exchange		
	No treatment available	Desalination by ion		
		exchange or reverse osmosis		
No treatment available	No treatment available	lon exchange, Reverse osmosis or Adsorption o		
		activated alumina		
Add bleach and filter	Normal coagulation and flocculation sedimentation	lon exchange		
	and filtration Oxidation by			
	aeration and pH adjustment			
	or addition of chemical oxidants, followed by			
	sedimentation			
No treatment	Lime treatment	lon exchange		
available	Lime deadnent	lon exchange		
Add bleach solution	Nammalaaaudatian	Coordation and/or		
or pool "chlorine"	Normal coagulation, sedimentation and sand	Coagulation and/or oxidation by chlorine		
	filtration Coagulation and/or	l		
111 1 611				
settle and filter	oxidation by chlorine compounds or aeration	permangate or ozone or air. Zeolite softening		
settle and filter	oxidation by chlorine	permangate or ozone or		
settle and filter	oxidation by chlorine	permangate or ozone or		
	oxidation by chlorine compounds or aeration	permangate or ozone or air. Zeolite softening		
No treatment	oxidation by chlorine	permangate or ozone or air. Zeolite softening  Anaerobic biological		
	oxidation by chlorine compounds or aeration	permangate or ozone or air. Zeolite softening		
No treatment	oxidation by chlorine compounds or aeration	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse		
No treatment	oxidation by chlorine compounds or aeration	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other		
No treatment available Neutralization with	oxidation by chlorine compounds or aeration  No treatment available  pH adjustment by controlled	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a		
No treatment available	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques		
No treatment available Neutralization with	oxidation by chlorine compounds or aeration  No treatment available  pH adjustment by controlled	air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a		
No treatment available Neutralization with marble chips	oxidation by chlorine compounds or aeration  No treatment available  pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali		
No treatment available Neutralization with	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as lime sodium carbonate,	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a		
No treatment available  Neutralization with marble chips	oxidation by chlorine compounds or aeration  No treatment available  pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali		
No treatment available  Neutralization with marble chips	oxidation by chlorine compounds or aeration  No treatment available  pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon		
No treatment available  Neutralization with marble chips  No treatment available  No treatment	oxidation by chlorine compounds or aeration  No treatment available  pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange		
No treatment available  Neutralization with marble chips  No treatment available	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse		
No treatment available  Neutralization with marble chips  No treatment available  No treatment available	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis		
No treatment available  Neutralization with marble chips  No treatment available  No treatment available  No treatment available	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion		
No treatment available  Neutralization with marble chips  No treatment available  No treatment available	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis		
No treatment available  Neutralization with marble chips  No treatment available  No treatment available  No treatment available	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse		
No treatment available  Neutralization with marble chips  No treatment available  No treatment available  No treatment available	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse		
No treatment available  Neutralization with marble chips  No treatment available  No treatment available  No treatment available	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis		
No treatment available  Neutralization with marble chips  No treatment available  No treatment available  No treatment available	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse		
No treatment available  Neutralization with marble chips  No treatment available  No treatment available  No treatment available	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis		
No treatment available  Neutralization with marble chips  No treatment available  No treatment available  No treatment available	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available  Lime treatment	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis		
No treatment available  Neutralization with marble chips  No treatment available  No treatment available  No treatment available	oxidation by chlorine compounds or aeration  No treatment available  PH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	permangate or ozone or air. Zeolite softening  Anaerobic biological reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis		

Borehole No.:	Spring Water (SP Engeo 3)	CO-ORDINATES	
Project No.:	LL3034	Lat:	
Project Name:	Eskom Majuba	Long:	

INPUT INFORMATION				
SUBSTANCE	UNIT OF	TEST		
	MEASURE	VALUE		
Aldrin & Dieldrin Alkalinity		351		
Aluminium		10		
Ammonia (N) **	mg/l NH3	0.45		
Ammonia (NH3)	mg/l NH3			
Appearance	mg/l As			
Arsenic (As) * Cadmium (Cd) *	mg/l Cd			
Calcium (Ca)	mg/l Ca	111		
Calcium (CaCo3)	mg/l CaCO3	203		
Chloride (CI)*	mg/l Cl	69.6		
Chlorine (Free)				
Chlorine (Total)				
Chloroform				
Colour				
Copper(Cu)				
Cyanide Electrical conductivity EC *	mS/m	108		
Faecal coliform *	counts/100 ml	0.00		
Fluoride (F) *	mg/l F	0.09		
Iron (Fe) *	mg/l Fe	0.09		
Lead				
Magnesium (Mg)	mg/l Mg	49.5		
Magnesium (MgCo3) * Manganese (Mn) *	mg/l MgCO3 mg/l Mn	204 0.05		
Mercury				
Nitrate (as N) *	mg/l N			
Nitrate (as NO3) *	mg/l N			
Nitrite (Soluble)		1.55		
Odour & Taste				
Organic carbon(sol) pH *	nH unite	7.19		
рп "	pH units	7.18		
Phenols	ma/LK	1 01		
Potassium (K) *	mg/l K	1.81		
Precipitation Potential				
Selenium				
Sodium (Na) *	mg/l Na	59.3		
Standard plate count				
Sulphate (SO4) *	mg/l SO4	143		
Total Alkalinity	mg/l			
Total Coliforms Total Dissolved Solids (TDS) *	(mg/l)	652		
Total Hardness **	mg CaCO3/I	481		
Trihalomethanes				
Turbidity	NTU	19.2		
Zinc (Zn) *	mg/l Zn			
	I			

DWA	AF
COMME	NTS
Class 0: Water of an ideal quality	
<del></del>	
Class 3: Water of an	No health effects. Severe
unacceptable quality	scaling problems.  No health effects. Severe
Class 3: Water of an unacceptable quality	No health effects. Severe scaling problems.
Class 0: Water of an ideal	
quality	
Class 1: Water of a good quality	
Class 0: Water of an ideal	#VALUE!
quality	
Class 0: Water of an ideal	#VALUE!
quality	
Class 1: Water of a good quality	
Class 1: Water of a good quality	#VALUE!
Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal	
quality	
Class 1: Water of a good quality	
Class 3: Water of an	Very hard
unacceptable quality	very naru
Class 3: Water of an	The presence of turbidity is
unacceptable quality	one of the indicators of microbiological water quality
	and of inefficient water treatment.

	IS 241:201
C	OMMENTS
Class 1	Accentable
Class 1,	Acceptable Acceptable
Class 1	Acceptable
Olass 1,	Acceptable
Class 1,	Acceptable
Class 1,	Acceptable
Class 1,	Acceptable
	_
Class 1,	Acceptable
Class 1,	Acceptable
Class 1,	Acceptable
Class 1,	Acceptable
Class 1,	Acceptable
Class 1,	Acceptable
Class 1,	Acceptable
Class 1,	Acceptable
Unaccep	table

WATER TREATMENT				
Home	Conventional treatment	Advanced		
No treatment	Precipitation with sodium	lon exchange		
available	carbonate			
No treatment	No treatment available	Reverse osmosis,		
available		electrolysis, lon		
		exchange		
	No treatment available	Desalination by ion exchange or reverse		
		osmosis		
N	N			
No treatment available	No treatment available	lon exchange, Reverse osmosis or Adsorption o		
		activated alumina		
Add bleach and filter	Normal coagulation and	lon exchange		
	flocculation sedimentation and filtration Oxidation by			
	aeration and pH adjustment			
	or addition of chemical			
	oxidants, followed by sedimentation			
No treatment available	Lime treatment	lon exchange		
available				
Add bleach solution	Normal coagulation,	Coagulation and/or		
or pool "chlorine" granules let stand to	sedimentation and sand filtration Coagulation and/or	oxidation by chlorine compounds or potassiur		
settle and filter	oxidation by chlorine	permangate or ozone or		
	compounds or aeration	air. Zeolite softening		
No treatment	No treatment available	Anaerobic biological		
available		reduction, reverse		
available		osmosis or other		
available		,		
		osmosis or other desalination techniques		
Neutralization with	pH adjustment by controlled	osmosis or other desalination techniques Controlled addition of a		
	addition of alkali such as lime sodium carbonate,	osmosis or other desalination techniques		
Neutralization with	addition of alkali such as	osmosis or other desalination techniques Controlled addition of a		
Neutralization with	addition of alkali such as lime sodium carbonate,	osmosis or other desalination techniques Controlled addition of a suitable acid/alkali		
Neutralization with marble chips	addition of alkali such as lime sodium carbonate, carbon dioxide	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon		
Neutralization with marble chips	addition of alkali such as lime sodium carbonate, carbon dioxide	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis,		
Neutralization with marble chips	addition of alkali such as lime sodium carbonate, carbon dioxide	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon		
Neutralization with marble chips  No treatment available  No treatment	addition of alkali such as lime sodium carbonate, carbon dioxide	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion		
Neutralization with marble chips No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse		
Neutralization with marble chips  No treatment available  No treatment	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion		
Neutralization with marble chips  No treatment available  No treatment available  No treatment	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion		
Neutralization with marble chips  No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis		
Neutralization with marble chips  No treatment available  No treatment available  No treatment	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse		
Neutralization with marble chips  No treatment available  No treatment available  No treatment	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse		
Neutralization with marble chips  No treatment available  No treatment available  No treatment	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse		
Neutralization with marble chips  No treatment available  No treatment available  No treatment	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse		
Neutralization with marble chips  No treatment available  No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available  No treatment available	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis		
Neutralization with marble chips  No treatment available  No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available  No treatment available	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis		
Neutralization with marble chips  No treatment available  No treatment available  No treatment available  Flocculation and	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available  No treatment available  Lime treatment	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis		
Neutralization with marble chips  No treatment available  No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available  No treatment available  Lime treatment	osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis		

Borehole No.:	Spring Water (SP Engeo 4)	CO-ORDINATES		
Project No.:	LL3034	La	at:	
Project Name:	Eskom Majuba	Lo	ong:	

UNIT OF MEASURE	TEST VALUE
MEASURE	VALUE
1	579 330
	330
mg/l NH3	0.45
mg/l NH3	
mg/LAs	
mg/l Ca	101
mg/l CaCO3	203
mg/l Cl	67.3
mS/m	132
counts/100 ml	
mg/l F	0.17
mg/l Fe	0.27
mg/l Mg	82
	200
mg/l Mn	0.04
Ing/I N	0.61
pH units	8.06
mg/l K	5.04
mg/LNIa	89.1
mg/i iva	09.1
mg/l SO4	99.6
mg/l	
(mg/l)	795
(1119/1)	190
mg CaCO3/I	590
NITH	45.5
NIU	45.5
mg/l Zn	
	mg/I As mg/I Cd mg/I Ca  mg/I CaCO3  mg/I CI  mS/m  mS/m  counts/100 ml mg/I F  mg/I Fe  mg/I Mg  mg/I MgCO3  mg/I Mn  mg/I N  mg/I N

DWA	F				
COMMENTS					
Class 0: Water of an ideal quality					
Class 3: Water of an	No health effects. Severe				
unacceptable quality	scaling problems.				
Class 3: Water of an unacceptable quality	No health effects. Severe scaling problems.				
Class 0: Water of an ideal					
quality					
Class 1: Water of a good quality					
o.aso 1. Water of a good quality					
Class 0: Water of an ideal	#VALUE!				
quality					
Class 2: Water which is safe for short term use only	#VALUE!				
Short term use only					
Class 2: Water which is safe for short term use only	Diarrhoea in sensitive				
-	users.				
Class 0: Water of an ideal quality	#VALUE!				
4.5)					
Class 0: Water of an ideal					
quality					
Class 0: Water of an ideal					
quality					
Class 0: Water of an ideal					
quality					
Class 0: Water of an ideal quality					
. ,					
Class 1: Water of a good quality					
Class 3: Water of an	Very hard				
unacceptable quality					
Class 2: Water of an	The presence of trutility				
Class 3: Water of an unacceptable quality	The presence of turbidity is one of the indicators of				
	microbiological water quality and of inefficient water				
	treatment				

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COMMENTS	
Class II, Maximum	
Allowable for 1 year Class 1, Acceptable	_
Class 1, Acceptable	
Class 1, Acceptable	
Class 1, Acceptable	_
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Class 1, Acceptable	
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Class 1, Acceptable	
Class 1, Acceptable	
Class II, Maximum	
Allowable for 7 years	_
Class 1, Acceptable	
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Class 1, Acceptable	_
CIGGO I. ALLECTACIE	
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Class 1, Acceptable	
Class 1, Acceptable	
Class 1, Acceptable	
Class 1, Acceptable	
Class 1, Acceptable  Class 1, Acceptable	
Class 1, Acceptable  Class 1, Acceptable	
Class 1, Acceptable  Class 1, Acceptable	
Class 1, Acceptable  Class 1, Acceptable	
Class 1, Acceptable  Class 1, Acceptable	
Class 1, Acceptable  Class 1, Acceptable	
Class 1, Acceptable  Class 1, Acceptable  Class 1, Acceptable	
Class 1, Acceptable  Class 1, Acceptable  Class 1, Acceptable	
Class 1, Acceptable  Class 1, Acceptable  Class 1, Acceptable	
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Class 1, Acceptable  Class 1, Acceptable  Class 1, Acceptable  Class 1, Acceptable	
Class 1, Acceptable  Class 1, Acceptable  Class 1, Acceptable	
Class 1, Acceptable  Class 1, Acceptable  Class 1, Acceptable  Class 1, Acceptable	

		SANS 241:2011			
COMME	NTS	COMMENTS	Home	Conventional treatment	Advanced
Class 0: Water of an ideal		Class II, Maximum Allowable for 1 year Class 1, Acceptable			
quality					
Class 3: Water of an unacceptable quality Class 3: Water of an	No health effects. Severe scaling problems. No health effects. Severe	Class 1, Acceptable	No treatment available	Precipitation with sodium carbonate	lon exchange
unacceptable quality Class 0: Water of an ideal quality	scaling problems.	Class 1, Acceptable	No treatment available	No treatment available	Reverse osmosis, electrolysis, Ion exchange
Class 1: Water of a good quality		Class 1, Acceptable		No treatment available	Desalination by ion
Class 1: Water of a good quality		Class 1, Acceptable		No treatment available	exchange or reverse osmosis
Class 0: Water of an ideal quality	#VALUE!	Class 1, Acceptable	No treatment available	No treatment available	lon exchange, Reverse osmosis or Adsorption of activated alumina
Class 2: Water which is safe for short term use only	#VALUE!	Class 1, Acceptable	Add bleach and filter	Normal coagulation and flocculation sedimentation and filtration Oxidation by aeration and pH adjustment or addition of chemical oxidants, followed by sedimentation	lon exchange
Class 2: Water which is safe for short term use only	Diarrhoea in sensitive users.	Class II, Maximum Allowable for 7 years	No treatment available	Lime treatment	lon exchange
Class 0: Water of an ideal quality	#VALUE!	Class 1, Acceptable	or pool "chlorine"	Normal coagulation, sedimentation and sand filtration Coagulation and/or oxidation by chlorine compounds or aeration	Coagulation and/or oxidation by chlorine compounds or potassiu permangate or ozone or air. Zeolite softening
		Class 1, Acceptable	No treatment available	No treatment available	Anaerobic biological reduction, reverse osmosis or other desalination techniques
Class 0: Water of an ideal quality		Class 1, Acceptable	Neutralization with marble chips	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide	Controlled addition of a suitable acid/alkali
Class 0: Water of an ideal quality		Class 1, Acceptable	No treatment available	No treatment available	Reverse osmosis, electrolysis, lon exchange
Class 0: Water of an ideal quality		Class 1, Acceptable	No treatment available	No treatment available	Desalination by ion exchange or reverse osmosis
Class 0: Water of an ideal quality			No treatment available	No treatment available	Desalination by ion exchange or reverse osmosis
Class 1: Water of a good quality		Class 1, Acceptable			
Class 3: Water of an unacceptable quality	Very hard			Lime treatment	lon exchange
Class 3: Water of an unacceptable quality	The presence of turbidity is one of the indicators of microbiological water quality and of inefficient water treatment.	Unacceptable	Flocculation and filtration	Slow sand filtration or flocculation, settlement and filtration	Same as conventional

Borehole No.:	Spring Water (SP Engeo 5)	CO-ORDINATES		
Project No.:	LL3034	L	_at:	
Project Name:	Eskom Majuba	L	_ong:	

INPUT INFORMATION		
SUBSTANCE	UNIT OF	TEST
Aldrin & Dieldrin	MEASURE	VALUE
Alkalinity		149
Aluminium		20
Ammonia (N) **	mg/l NH3	0.45
Ammonia (NH3)	mg/l NH3	
Appearance		
Arsenic (As) * Cadmium (Cd) *	mg/l As mg/l Cd	
Calcium (Ca)	mg/l Ca	30.4
Calcium (CaCo3)	mg/l CaCO3	203
Chloride (CI)*	mg/l Cl	7.6
Chlorine (Free)		
Chloreform		
Chloroform Colour		
Copper(Cu)		
Cyanide		
Electrical conductivity EC *	mS/m	36.7
Faecal coliform *	counts/100 ml	
Fluoride (F) *	mg/l F	0.23
Iron (Fe) *	mg/l Fe	0.18
Lead		
Magnesium (Mg)	mg/l Mg	18.7
Magnesium (MgCo3) *	mg/l MgCO3	77 0.01
Manganese (Mn) *	mg/l Mn	
Mercury	/I NI	
Nitrate (as N) * Nitrate (as NO3) *	mg/l N mg/l N	
Nitrite (Soluble)	mg/r r	0.55
Odour & Taste		
Organic carbon(sol)		
рН*	pH units	6.96
Phenols		
Potassium (K) *	mg/l K	4.82
Precipitation Potential		
Selenium Sodium (Na) *	mg/l Na	16.1
Standard plate count		
Standard plate count Sulphate (SO4) *	mg/I SO4	32
Total Alkalinity	mg/l	
Total Coliforms		
Total Dissolved Solids (TDS) *	(mg/l)	203
Total Hardness **	mg CaCO3/I	153
Trihalomethanes Turbidity	NTU	102
		102
Zinc (Zn) *	mg/l Zn	
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DWAF		
COMMENTS		
Class 0: Water of an ideal		
quality		
Class 0: Water of an ideal quality		
Class 2: Water which is safe for short term use only		
Class 0: Water of an ideal		
quality		
Class 0: Water of an ideal		
quality		
Class 0: Water of an ideal quality	#VALUE!	
Class 1: Water of a good quality	#VALUE!	
Class 1: water of a good quality	#VALUE!	
Class 0: Water of an ideal		
quality		
Class 0: Water of an ideal	#VALUE!	
quality		
Class 0: Water of an ideal		
quality		
Class 0: Water of an ideal		
quality		
Class 0: Water of an ideal		
quality		
Class 0: Water of an ideal		
quality		
Class 0: Water of an ideal		
quality Class 2: Water which is safe for	Moderately hard	
short term use only	INIOUEI ALEIY HAIU	
Class 3: Water of an	The presence of turbidity is	
unacceptable quality	one of the indicators of microbiological water quality and of inefficient water	
	and of monitolent water	

SANS 241:2011	
COMMENTS	
Class 1, Acceptable	_
Class 1, Acceptable	
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Class 1, Acceptable	
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Class 1, Acceptable	
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Class 1, Acceptable	_
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Class 1, Acceptable	
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Class 1, Acceptable	
Class 1, Acceptable	
Class 1, Acceptable	
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Class 1, Acceptable	
Class 1, Acceptable  Class 1, Acceptable	
Class 1, Acceptable	
Class 1, Acceptable	
Class 1, Acceptable	

	WATER TREATMENT		
Home	Conventional treatment	Advanced	
No treatment available	Precipitation with sodium carbonate	lon exchange	
avaliable	carbonate		
No treatment available	No treatment available	Reverse osmosis, electrolysis, Ion	
avanabio		exchange	
	No treatment available	Desalination by ion	
		exchange or reverse	
		osmosis	
No treatment	No treatment available	lon exchange, Reverse	
available	nto treatment available	osmosis or Adsorption of	
		activated alumina	
Add bleach and filter	Normal coagulation and flocculation sedimentation	lon exchange	
	and filtration Oxidation by		
	aeration and pH adjustment		
	or addition of chemical		
	oxidants, followed by sedimentation		
No treatment available	Lime treatment	lon exchange	
avaliable			
Add bleach solution	Normal coagulation,	Coagulation and/or	
or pool "chlorine" granules let stand to	sedimentation and sand	oxidation by chlorine	
settle and filter	filtration Coagulation and/or oxidation by chlorine	compounds or potassiur permangate or ozone or	
	compounds or aeration	air. Zeolite softening	
No treatment available	No treatment available	Anaerobic biological reduction, reverse	
available		osmosis or other	
		desalination techniques	
	pH adjustment by controlled	Controlled addition of a	
Neutralization with			
Neutralization with marble chips	addition of alkali such as	suitable acid/alkali	
	addition of alkali such as lime sodium carbonate,	suitable acid/alkali	
	addition of alkali such as	suitable acid/alkali	
marble chips  No treatment	addition of alkali such as lime sodium carbonate,	Reverse osmosis,	
marble chips	addition of alkali such as lime sodium carbonate, carbon dioxide	Reverse osmosis, electrolysis, lon	
marble chips  No treatment	addition of alkali such as lime sodium carbonate, carbon dioxide	Reverse osmosis,	
marble chips  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available	Reverse osmosis, electrolysis, lon exchange	
No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide	Reverse osmosis, electrolysis, lon exchange	
marble chips  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available	Reverse osmosis, electrolysis, lon exchange	
No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis	
No treatment available  No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available	Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion	
No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis	
No treatment available  No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse	
No treatment available  No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse	
No treatment available  No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse	
No treatment available  No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse	
No treatment available  No treatment available  No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available  No treatment available	Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis	
No treatment available  No treatment available  No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available  No treatment available  Lime treatment	Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis  lon exchange or reverse osmosis	
No treatment available  No treatment available  No treatment available  No treatment available	addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available  No treatment available	Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis	

Borehole No.:	Spring Water (SP Engeo 6)	CO-ORDINATES	
Project No.:	LL3034	Lat:	
Project Name:	Eskom Majuba	Long:	

INPLIT IN	FORMATION	
SUBSTANCE	UNIT OF	TEST
Aldrin & Dieldrin	MEASURE	VALUE
Alkalinity		299
Aluminium		30
Ammonia (N) **	mg/l NH3	0.45
Ammonia (NH3)	mg/l NH3	
Appearance Arsenic (As) *	mg/l As	
Cadmium (Cd) *	mg/l Cd	
Calcium (Ca)	mg/l Ca	62.7
Calcium (CaCo3)	mg/l CaCO3	203
Chloride (CI)*		10
Chloride (CI)	mg/l Cl	10
Chlorine (Free) Chlorine (Total)		
Chloroform		
Colour		
Copper(Cu) Cyanide		
Electrical conductivity EC *	mS/m	66.6
Faecal coliform *	counts/100 ml	
Faecal coliform * Fluoride (F) *	counts/100 ml mg/l F	0.14
Iron (Fe) *	mg/l Fe	0.07
Lead		20.0
Magnesium (Mg)	mg/l Mg	38.9
Magnesium (MgCo3) *	mg/l MgCO3	160
Manganese (Mn) *	mg/l Mn	0.01
Mercury		
Nitrate (as N) *	mg/l N	
Nitrate (as NO3) * Nitrite (Soluble)	mg/l N	0.16
Willite (Soldbie)		0.10
Odour & Taste		
Organic carbon(sol)		
pH *	pH units	7.94
Phenols	ma/LV	0.77
Potassium (K) *	mg/l K	2.77
Precipitation Potential		
Selenium Sodium (Na) *	ma/l No	31.6
Sodium (Na)	mg/l Na	31.6
Standard plate count		
Sulphate (SO4) *	mg/l SO4	59.9
Total Alkalinity	mg/l	
Total Coliforms Total Dissolved Solids (TDS) *	(mg/l)	386
Total Hardness **	mg CaCO3/I	317
Trihalomethanes		
Turbidity	NTU	18.2

DWAF		
COMMENTS		
Class 0: Water of an ideal quality		
Class 2: Water which is safe for	No health effects. Some	
short term use only	scaling.	
Class 3: Water of an unacceptable quality	No health effects. Some scaling.	
Class 0: Water of an ideal quality	,	
Class 0: Water of an ideal		
quality		
01 0 11 1 1 1 1 1	/0./A1.11E-	
Class 0: Water of an ideal quality	#VALUE!	
Class 0: Water of an ideal	#VALUE!	
quality	#VALUE!	
Class 1: Water of a good quality		
Class 1. Water of a good quality		
Class 0: Water of an ideal	#VALUE!	
quality		
Class 0: Water of an ideal		
quality		
Class 0: Water of an ideal		
quality		
Close Or Metar of an ideal		
Class 0: Water of an ideal quality		
Class 0: Water of an ideal		
quality		
Class 0: Water of an ideal		
quality Class 3: Water of an	Very hard	
unacceptable quality		
Class 3: Water of an unacceptable quality	The presence of turbidity is one of the indicators of	
	microbiological water quality	
	and of inefficient water	

	COMMENTS	
Class	s 1, Acceptable s 1, Acceptable	<b>!</b>
Class	1, Acceptable	<b>1</b>
Class	1, Acceptable	<b>!</b>
Class	1, Acceptable	1
Class	: 1, Acceptable	1
Class	1, Acceptable	'
Class	1, Acceptable	1
Class	1, Acceptable	1
Class	1, Acceptable	1
Class	1, Acceptable	! 
	ceptable	

Home	Conventional treatment	Advanced
No treatment	Precipitation with sodium	lon exchange
available	carbonate	
No treatment	No treatment available	Reverse osmosis,
available		electrolysis, lon exchange
		cxonange
	No treatment available	Desalination by ion
		exchange or reverse osmosis
No treatment	No treatment available	lon exchange, Reverse
available		osmosis or Adsorption o activated alumina
Add bleach and filter	Normal coagulation and	lon exchange
	flocculation sedimentation	
	and filtration Oxidation by aeration and pH adjustment	
	or addition of chemical	
	oxidants, followed by	
	sedimentation	
No treatment	Lime treatment	lon exchange
available		
Add bleach solution	Normal coagulation,	Coagulation and/or
or pool "chlorine"	sedimentation and sand	oxidation by chlorine
granules let stand to		compounds or potassiur
settle and filter	oxidation by chlorine compounds or aeration	permangate or ozone or air. Zeolite softening
	Compounds of aeration	all. Zeolite softerling
No treatment	No treatment available	Anaerobic biological
available		reduction, reverse osmosis or other
		desalination techniques
		'
Neutralization with	pH adjustment by controlled	Controlled addition of a
marble chips	addition of alkali such as	suitable acid/alkali
·	lime sodium carbonate,	
	carbon dioxide	
No treatment	No treatment available	Reverse osmosis,
available		electrolysis, lon
		exchange
No treatment	No treatment available	Desalination by ion
available		exchange or reverse osmosis
		031110313
No treatment	No treatment available	Desalination by ion
available		exchange or reverse
		osmosis
	Lime treatment	lon exchange
		]
Flocculation and	Slow sand filtration or	Same as conventional
filtration	flocculation, settlement and	
	filtration	

Borehole No.:	Spring Water (SP Engeo 7)	CO-ORDINA	ATES
Project No.:	LL3034	Lat:	
Project Name:	Eskom Majuba	Long:	

INPUT INFORMATION		
SUBSTANCE	UNIT OF	TEST
	MEASURE	VALUE
Aldrin & Dieldrin Alkalinity		358
Aluminium		10
Ammonia (N) **	mg/l NH3	0.02
Ammonia (NH3)	mg/l NH3	
Appearance		
Arsenic (As) * Cadmium (Cd) *	mg/l As mg/l Cd	
Calcium (Ca)	mg/l Ca	108
Calcium (CaCo3)	mg/l CaCO3	203
Chloride (CI)*	mg/l Cl	67.6
Chlorine (Free)		
Chlorine (Total)		
Chloroform		
Colour		
Copper(Cu) Cyanide		
Electrical conductivity EC *	mS/m	108
Facasi caliform *	counts/100 ml	
Faecal coliform * Fluoride (F) *	counts/100 ml mg/l F	0.09
Pidonde (F)	mg/i F	0.09
Iron (Fe) *	mg/l Fe	0.1
Lead		
Magnesium (Mg)	mg/l Mg	52.9
Magnesium (MgCo3) *	mg/l MgCO3	218
Manganese (Mn) *	mg/l Mn	0.03
Mercury		
Nitrate (as N) *	mg/l N	
Nitrate (as NO3) * Nitrite (Soluble)	mg/l N	0.74
Odour & Taste		
Organic carbon(sol)		
pH *	pH units	8.02
Phenols	0.14	1.01
Potassium (K) *	mg/l K	1.81
Precipitation Potential		
Selenium		
Sodium (Na) *	mg/l Na	60.3
Standard plate count		
Sulphate (SO4) *	mg/l SO4	142
Total Alkalinity	mg/l	
Total Coliforms	(mg/l)	051
Total Dissolved Solids (TDS) *	(mg/l)	651
Total Hardness **	mg CaCO3/I	488
Trihalomethanes		
Turbidity	NTU	16.8
Zinc (Zn) *	mg/l Zn	
- \/		<u> </u>

DWAF		
COMMENTS		
Class 0: Water of an ideal		
quality		
Class 3: Water of an	No health effects. Severe	
unacceptable quality Class 3: Water of an	scaling problems. No health effects. Severe	
unacceptable quality Class 0: Water of an ideal	scaling problems.	
quality		
Class 1: Water of a good quality		
Class 0: Water of an ideal	#VALUE!	
quality		
Class 1: Water of a good quality	#VALUE!	
Class 1: Water of a good quality		
Class 0: Water of an ideal quality	#VALUE!	
quanty		
Class 0: Water of an ideal quality		
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Class 0: Water of an ideal quality		
•		
Class 0: Water of an ideal quality		
-		
Class 0: Water of an ideal		
quality		
Class 1: Water of a good quality		
Class 3: Water of an	Very hard	
unacceptable quality		
Class 3: Water of an unacceptable quality	The presence of turbidity is one of the indicators of	
	microbiological water quality and of inefficient water	
	treatment	

	ANS 241:2011 COMMENTS
Class Class	1, Acceptable 1, Acceptable
Class	1, Acceptable
Class	1, Acceptable
Class	1, Acceptable
Class	1, Acceptable
Class	1, Acceptable
	ceptable

WATER TREATMENT			
Home	Conventional treatment	Advanced	
No treatment	Precipitation with sodium	lon exchange	
available	carbonate		
No treatment	No treatment available	Reverse osmosis,	
available		electrolysis, Ion	
		exchange	
	No treatment available	Decalination by is-	
	neament available	Desalination by ion exchange or reverse	
		osmosis	
No treatment	No treatment available	lon exchange, Reverse	
available	no treatment available	osmosis or Adsorption of	
Add bloom 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Name of an artificial	activated alumina	
Add bleach and filter	Normal coagulation and flocculation sedimentation	lon exchange	
	and filtration Oxidation by		
	aeration and pH adjustment		
	or addition of chemical oxidants, followed by		
	sedimentation		
No treatment	Lime treatment	lon exchange	
available	Line reamont	lon exertange	
Add bleach solution	Normal coagulation,	Coagulation and/or	
or pool "chlorine"	sedimentation and sand	oxidation by chlorine	
granules let stand to	, o	compounds or potassiun	
settle and filter	oxidation by chlorine compounds or aeration	permangate or ozone or air. Zeolite softening	
No treatment	No treatment available	Anaerobic biological	
No treatment available	No treatment available	Anaerobic biological reduction, reverse osmosis or other	
	No treatment available	reduction, reverse	
available	No treatment available	reduction, reverse osmosis or other	
available  Neutralization with	pH adjustment by controlled	reduction, reverse osmosis or other desalination techniques Controlled addition of a	
available	pH adjustment by controlled addition of alkali such as	reduction, reverse osmosis or other desalination techniques	
available  Neutralization with	pH adjustment by controlled	reduction, reverse osmosis or other desalination techniques Controlled addition of a	
available  Neutralization with marble chips	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali	
available  Neutralization with	pH adjustment by controlled addition of alkali such as lime sodium carbonate,	reduction, reverse osmosis or other desalination techniques	
Neutralization with marble chips	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis,	
Neutralization with marble chips	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon	
Neutralization with marble chips	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon	
Neutralization with marble chips  No treatment available	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse	
Neutralization with marble chips  No treatment available  No treatment	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion	
Neutralization with marble chips  No treatment available  No treatment available  No treatment	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion	
Neutralization with marble chips  No treatment available  No treatment available	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse	
Neutralization with marble chips  No treatment available  No treatment available  No treatment	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion	
Neutralization with marble chips  No treatment available  No treatment available  No treatment	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse	
Neutralization with marble chips  No treatment available  No treatment available  No treatment	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse	
Neutralization with marble chips  No treatment available  No treatment available  No treatment	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse	
Neutralization with marble chips  No treatment available  No treatment available  No treatment available	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available  No treatment available	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis	
Neutralization with marble chips  No treatment available  No treatment available  No treatment available	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available  No treatment available	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis	
Neutralization with marble chips  No treatment available  No treatment available  No treatment available  Flocculation and	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available  No treatment available  Lime treatment	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis	
Neutralization with marble chips  No treatment available  No treatment available  No treatment available	pH adjustment by controlled addition of alkali such as lime sodium carbonate, carbon dioxide  No treatment available  No treatment available  No treatment available	reduction, reverse osmosis or other desalination techniques  Controlled addition of a suitable acid/alkali  Reverse osmosis, electrolysis, lon exchange  Desalination by ion exchange or reverse osmosis  Desalination by ion exchange or reverse osmosis	

Borehole No.:	Spring Water (SP Engeo 8)	CO-ORDINATES	
Project No.:	LL3034	Lat:	
Project Name:	Eskom Majuba	Long:	

INPUT INFORMATION			
SUBSTANCE	UNIT OF	TEST	
	MEASURE	VALUE	
Aldrin & Dieldrin Alkalinity		124	
Aluminium		10	
Ammonia (N) **	mg/l NH3	0.45	
Ammonia (NH3)	mg/l NH3		
Appearance Arsenic (As) *	mg/l As		
Cadmium (Cd) *	mg/l Cd		
Calcium (Ca)	mg/l Ca	26.7	
Calcium (CaCo3)	mg/l CaCO3	203	
Chloride (CI)*	mg/l Cl	3.35	
Chlorine (Free)			
Chlorine (Total)			
Chloroform			
Colour Copper(Cu)			
Cyanide			
Electrical conductivity EC *	mS/m	33.1	
Faecal coliform *	counts/100 ml		
Fluoride (F) *	mg/I F	0.14	
, ,			
Iron (Fe) *	mg/l Fe	0.03	
Lead			
Magnesium (Mg)	mg/l Mg	16.8	
Magnesium (MgCo3) * Manganese (Mn) *	mg/l MgCO3 mg/l Mn	69.2 0.01	
Mercury Nitrate (as N) *	mg/l N		
Nitrate (as NO3) *	mg/l N		
Nitrite (Soluble)		0.35	
Odour & Taste			
Organic carbon(sol)			
pH *	pH units	7.43	
Phenols			
Potassium (K) *	mg/l K	3.16	
Precipitation Potential			
Selenium			
Sodium (Na) *	mg/l Na	15.6	
Standard plate count			
Sulphate (SO4) *	mg/l SO4	42	
Total Alkalinity	mg/l		
Total Coliforms			
Total Dissolved Solids (TDS) *	(mg/l)	183	
Total Hardness **	mg CaCO3/I	136	
Trihalomethanes			
Turbidity	NTU	19.9	
Zinc (Zn) *	mg/l Zn		
ZINC (ZN) "	μπg/ι ∠n	<u> </u>	

DWA	F
СОММЕ	
Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal	
quality	
Class 2: Water which is safe for short term use only	
Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal	#VALUE!
quality	#VALUE!
Class 0: Water of an ideal	#VALUE!
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Class 0: Water of an ideal	
quality	
Class 0: Water of an ideal	
quality Class 2: Water which is safe for	Slightly hard
short term use only	
Class 3: Water of an	The presence of turbidity is
unacceptable quality	one of the indicators of microbiological water quality
	and of inefficient water

WATER TREATMENT			
Home	Conventional treatment	Advanced	
No treatment	Precipitation with sodium	lon exchange	
available	carbonate		
No treatment	No treatment available	Reverse osmosis,	
available		electrolysis, lon	
		exchange	
	No treatment available	Desalination by ion	
		exchange or reverse	
		osmosis	
No treatment	No treatment available	lon exchange, Reverse	
available	nto troatinent available	osmosis or Adsorption of	
		activated alumina	
Add bleach and filter	Normal coagulation and	lon exchange	
	flocculation sedimentation		
	and filtration Oxidation by aeration and pH adjustment		
	or addition of chemical		
	oxidants, followed by		
	sedimentation		
No treatment	Lime treatment	lon exchange	
available	Line treatment	non exendinge	
Add bleach solution	Normal coagulation,	Coagulation and/or	
or pool "chlorine" granules let stand to	sedimentation and sand filtration Coagulation and/or	oxidation by chlorine compounds or potassium	
settle and filter	oxidation by chlorine	permangate or ozone or	
	compounds or aeration	air. Zeolite softening	
No treatment	No treatment available	Anaerobic biological	
available		reduction, reverse osmosis or other	
		desalination techniques	
Neutralization with	pH adjustment by controlled addition of alkali such as		
marble chips	lime sodium carbonate.	suitable acid/alkali	
	carbon dioxide		
No treatment	No treatment available	Reverse osmosis,	
available		electrolysis, lon exchange	
No treatment	No treatment available	Desalination by ion	
available		exchange or reverse osmosis	
		001110010	
No treatment	No treatment available	Desalination by ion	
available		exchange or reverse	
		osmosis	
	Lime treatment	lon exchange	
Flocculation and	Slow sand filtration or	Same as conventional	
	flocculation, settlement and		
	filtration		
Flocculation and filtration	flocculation, settlement and	Same as conventional	



# Appendix E DCP's





Project: Amajuba Power Station

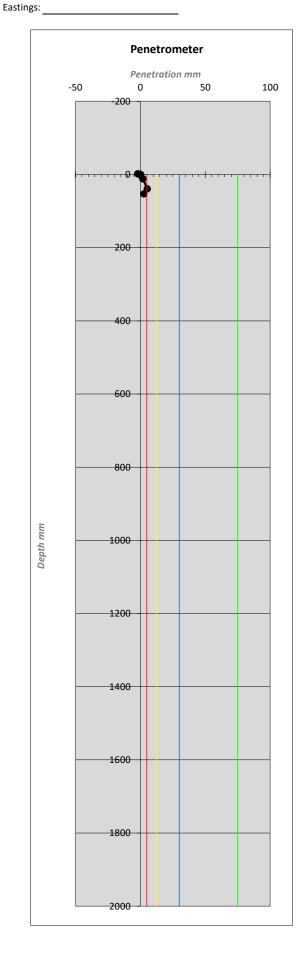
Job No: LL3034 Typed By: A Nolan

Test No: DCP 1 Location: -Performed By: Phiwa and Cyril Testing Date 2018/04/09

PO Box 4177, Witbank Route N4 Business Park, 4 Corridor Crescent, Ben Fleur X11, Witbank E-mail: info@engeolabcc.co.za Tel: 013 656 0719 Fax: 013 656 0737

Reg. No. 2002/014257/23 **Earth Science Consultants** 

	Southings:		
Penetration mm/blow	Actual Depth mm / 5 Blows	Penetration mm/Blows	Approximate in-situ CBR
0	-2	-2	110.00
5	0	0.4	110.00
10	-1	-0.2	110.00
15	1	0.4	110.00
20	2	0.2	110.00
25	12	2	110.00
30	39	5.4	51.05
35	53	2.8	110.00
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45			
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300			







Client: BTW Associates

Project: Amajuba Power Station Job No: LL3034

Typed By: A Nolan

Southings:

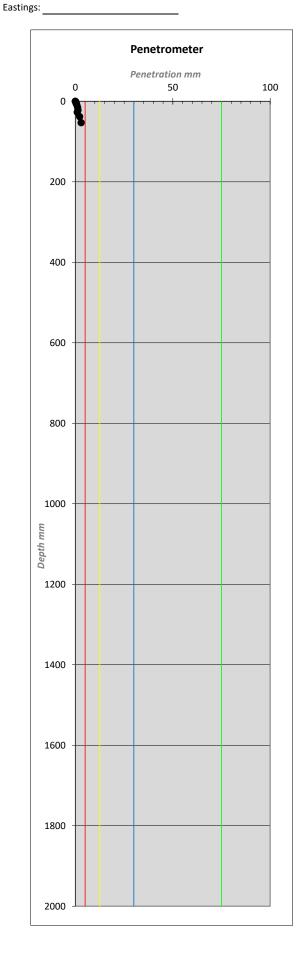
Test No: DCP 2 Location: -Performed By: Phiwa and Cyril Testing Date 2018/04/09

PO Box 4177, Witbank Route N4 Business Park, 4 Corridor Crescent, Ben Fleur X11, Witbank E-mail: info@engeolabcc.co.za

Reg. No. 2002/014257/23 **Earth Science Consultants** 

Tel: 013 656 0719 Fax: 013 656 0737

	Southings:		
Penetration	Actual Depth	Penetration	Approximate
mm/blow	mm / 5 Blows	mm/Blows	in-situ CBR
0	0	0	III SILU CDI
5	0	0	
10	1	0.2	110.00
15	3	0.4	110.00
20	5	0.4	110.00
25	9	0.8	110.00
30	15	1.2	110.00
35	22	1.4	110.00
40	27	1	110.00
45	38	2.2	110.00
50	53	3	110.26
55			
60			
65			
70			
75			
80			
85			
90			
95			
100			
105			
110			
115			
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300			
300			







11	BTW	Associates

Project: Amajuba Power Station Job No: LL3034

Typed By: A Nolan

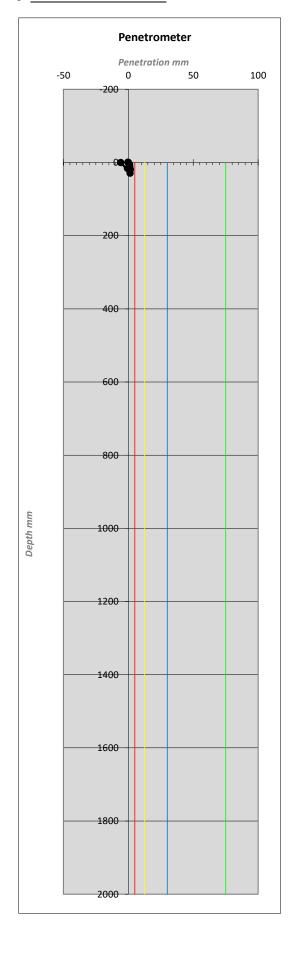
Test No: DCP 3 Location: -Performed By: Phiwa and Cyril Testing Date 2018/04/09 Eastings:

PO Box 4177, Witbank Route N4 Business Park, 4 Corridor Crescent, Ben Fleur X11, Witbank E-mail: info@engeolabcc.co.za Tel: 013 656 0719

Reg. No. 2002/014257/23 **Earth Science Consultants** 

Fax: 013 656 0737

Penetration mm/blow         Actual Depth mm/5 Blows         Penetration mm/Blows         Approximation in-situ CB mm/Blows           0         0         0         0           5         -1         -0.2         110.00           10         0         0.2         110.00           25         19         1.6         110.00           30         16         -0.6         110.00           35         22         1.2         110.00           40         29         1.4         110.00           45         0         -5.8         110.00           50         -5.8         110.00           55         60         -5.8         110.00           65         -70         -5.8         110.00           75         80         -5.8         110.00           85         90         -95	
0         0         0         110.00         15         -1         -0.2         110.00 </th <th></th>	
5         -1         -0.2         110.00           10         0         0.2         110.00           15         5         1         110.00           20         11         1.2         110.00           25         19         1.6         110.00           30         16         -0.6         110.00           35         22         1.2         110.00           40         29         1.4         110.00           45         0         -5.8         110.00           50         55         60         66           65         70         75         80           80         85         90         95           100         105         110         115           110         115         120         125           130         135         140         145           140         145         155         160           165         170         175         180           185         190         195         200         205           210         225         220         225           230         235         236	
10         0         0.2         110.00           15         5         1         110.00           20         11         1.2         110.00           25         19         1.6         110.00           30         16         -0.6         110.00           35         22         1.2         110.00           40         29         1.4         110.00           45         0         -5.8         110.00           50         -5.8         110.00           66         66         66         66           70         75         80         85           90         95         100         100           105         110         115         110           115         120         125         130         135           140         145         150         155         160         165         170         175         180         185         190         195         200         205         220         225         230         235         235         235         236         235         236         235         236         235         236         235	
15         5         1         110.00           20         11         1.2         110.00           25         19         1.6         110.00           30         16         -0.6         110.00           40         29         1.4         110.00           45         0         -5.8         110.00           50         55         60         66           65         70         75         80           80         85         90         95           100         105         110         115           120         125         130         135           140         145         150         155           160         165         170         175         180           185         190         195         200         205         210         225           230         225         230         235         235         235         236	
20     11     1.2     110.00       25     19     1.6     110.00       30     16     -0.6     110.00       35     22     1.2     110.00       40     29     1.4     110.00       45     0     -5.8     110.00       50     55     60     66       65     70     75     80       85     90     95     90       95     100     105     110       115     120     125     130       135     140     145     150       155     160     165     170       175     180     185     190       195     200     205     210       225     230     235     236	
25         19         1.6         110.00           30         16         -0.6         110.00           35         22         1.2         110.00           40         29         1.4         110.00           45         0         -5.8         110.00           50         55         60         60           65         70         75         80         85         90         95         90         95         95         90         95         95         90         95         95         90         95         95         90         95<	
30     16     -0.6     110.00       35     22     1.2     110.00       40     29     1.4     110.00       45     0     -5.8     110.00       50     55     60     60       65     70     75     80       85     90     95     90       95     100     105     110       115     120     125     130       135     140     145     150       155     160     165     170       175     180     195       200     205     210       215     220     225       230     235     236	
35	
40       29       1.4       110.00         45       0       -5.8       110.00         50            55            60            65            70            75            80            85            90            95            100            110            110            125            130            135            140             155              155	
45       0       -5.8       110.00         50	
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55       60         65       70         75       80         80       85         90       95         100       105         110       115         120       125         130       135         140       145         150       155         160       165         170       175         180       185         190       195         200       205         210       215         220       225         230       235	
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140  145  150  155  160  165  170  175  180  185  190  195  200  205  210  215  220  225  230  235	
140  145  150  155  160  165  170  175  180  185  190  195  200  205  210  215  220  225  230  235	
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180  185  190  195  200  205  210  215  220  225  230  235	
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Client: BTW Associates

Project: Amajuba Power Station

Job No: LL3034

Typed By: A Nolan

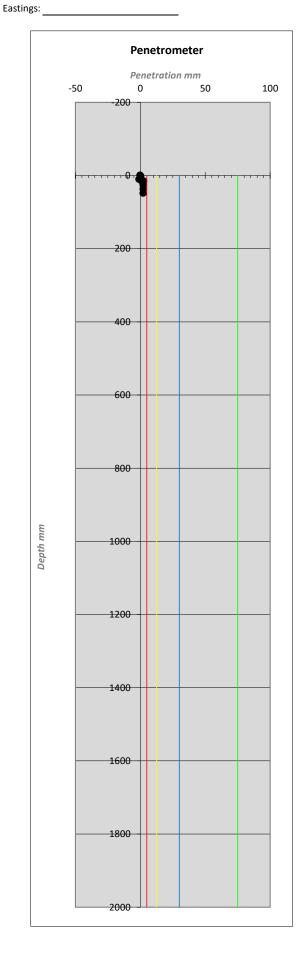
DCP 4
<u>-</u>
Phiwa and Cyril
2018/04/09

Reg. No. 2002/014257/23 Earth Science Consultants

PO Box 4177, Witbank Route N4 Business Park, 4 Corridor Crescent, Ben Fleur X11, Witbank E-mail: info@engeolabcc.co.za

Tel: 013 656 0719 Fax: 013 656 0737

Penetration mm/blow         Actual Depth mm/Blows         Penetration mm/Blows         Approximate in-situ CBR           0         0         0         0           5         0         0         10           10         -1         -0.2         110.00           25         15         2.6         110.00           30         10         -1         110.00           35         15         1         110.00           45         37         2.2         110.00           45         37         2.2         110.00           45         37         2.2         110.00           55         660         65	Southings:					
0         0         0           5         0         0           10         -1         -0.2         110.00           15         1         0.4         110.00           20         2         0.2         110.00           30         10         -1         110.00           35         15         1         110.00           40         26         2.2         110.00           45         37         2.2         110.00           50         48         2.2         110.00           55         60         66         65           70         75         80         85           80         85         90         95           100         105         110         115           120         125         130         135           130         135         140         145           140         145         150         155           160         165         170         175           180         185         190         195           200         205         210         225           220         225<						
5         0         0         110.00         -1         -0.2         110.00         110.00         110.00         120.2         110.00         20.2         110.00         20.2         110.00         20.2         110.00         30.0         10         -1         110.00         35.0         15         1         110.00         40.0         26         2.2         110.00         45.0         37.0         2.2         110.00         45.0         37.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         48.0         2.2         110.00         49.0         49.0         49.0         49.0         49.0         49.0         49.0         49.0         49.0         49.0				III-SILU CBK		
10         -1         -0.2         110.00           15         1         0.4         110.00           20         2         0.2         110.00           25         15         2.6         110.00           30         10         -1         110.00           40         26         2.2         110.00           45         37         2.2         110.00           55         60         60         65           65         70         75         80           85         90         95         95           100         105         100         105           110         115         120         125           125         130         135         140           140         145         150         155           160         165         170         175           180         185         190         195           200         205         210         225           210         225         230         235           240         245         250         255           260         265         270         275						
15         1         0.4         110.00           20         2         0.2         110.00           25         15         2.6         110.00           30         10         -1         110.00           40         26         2.2         110.00           45         37         2.2         110.00           50         48         2.2         110.00           55         60         66         65           60         65         5         70           75         80         85         85           90         95         100         105         110           115         120         125         130         135         140         145           140         145         140         145         150         155         160         165         170         175         180         185         190         195         200         205         220         225         230         235         240         245         250         255         260         265         270         275         280         285         285         285         285         285				110.00		
20         2         0.2         110.00           25         15         2.6         110.00           30         10         -1         110.00           35         15         1         110.00           40         26         2.2         110.00           45         37         2.2         110.00           50         48         2.2         110.00           55         60         60         65           60         65         70         75           80         85         90         99           95         100         95         100         105           110         115         110         115         110         115         110         115         110         115         110         115         110         115         110         115         110         115         110         115         110         115         110         115         110         115         110         115         110         114         114         114         114         114         114         114         114         114         114         114         114         114 <t< th=""><th></th><th></th><th></th><th></th></t<>						
25         15         2.6         110.00           30         10         -1         110.00           35         15         1         110.00           40         26         2.2         110.00           45         37         2.2         110.00           50         48         2.2         110.00           55         60         60         65           60         65         70         75           80         85         90         99           95         100         105         100           105         110         115         120         125           130         135         140         145         140         145         150         155         160         165         170         175         180         185         190         195         200         205         210         225         230         225         220         225         220         225         226         225         226         225         226         225         226         227         227         227         227         227         227         227         227         227         <						
30     10     -1     110.00       35     15     1     110.00       40     26     2.2     110.00       45     37     2.2     110.00       50     48     2.2     110.00       55     60     65     60       65     70     75     80       80     85     90     95       100     105     110     115       110     115     120     125       130     135     140     145       140     145     150     155       160     165     170     175     180       185     190     195     200       205     210     215     220       225     230     235     240       245     250     255     260       265     270     275     280       285     85     86     10.00     10.00						
35         15         1         110.00           40         26         2.2         110.00           45         37         2.2         110.00           50         48         2.2         110.00           55         60         66         65           60         65         70         75         80         80         85         80         85         90         99         95         95         90         99         95         95         90         99         95         95         90         99         95         90         99         95         90         99         95         90         99         95         90         99         95         90         99         95         90         99         95         90         99         95         90         90         99         95         90         90         99         95         90						
40						
45     37     2.2     110.00       50     48     2.2     110.00       55     60     60     65       70     75     80     85       80     85     90     99       95     100     105     110       115     120     125     130       130     135     140     145       140     145     150     155       160     165     170     175       180     185     190     195       200     205     210     215       220     225     230     235       240     245     250     255       280     285     85     86						
50     48     2.2     110.00       55     60     66       60     65     70       75     80     85       80     85     90       95     100     105       110     115     120       125     130     135       140     145     150       155     160     165       170     175     180       188     190     195       200     205     210       215     220     225       230     235     240       245     250     255       260     265     270       275     280     285						
55       60         65       70         75       80         80       85         90       95         100       105         110       115         120       125         130       135         140       145         155       160         165       170         175       180         185       190         195       200         205       210         215       220         225       230         235       240         245       250         255       265         270       275         280       285						
60		48	2.2	110.00		
65						
70 75 80 80 85 90 95 100 105 110 1115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 275 280 285						
75       80         85       90         95       100         105       110         115       120         125       130         135       140         145       150         155       160         165       170         175       180         185       190         195       200         205       210         215       220         225       230         235       240         245       255         260       265         270       275         280       285						
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85 90 95 100 105 110 1115 115 120 125 130 135 140 145 155 160 165 170 175 180 185 190 195 200 205 210 225 230 225 230 235 240 245 255 260 265 270 275 280 285 280 285						
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95   100   105   110   115   120   125   130   135   140   145   150   155   160   165   170   175   180   185   190   195   200   205   210   225   230   235   240   245   250   255   260   265   270   275   280   285   286   285   286   285   286   285   20   285   286   285   20   285   286   285   20   285   286   285   20   285   286   285   20   285   286   286   285   20   20   285   286   286   285   20   285   286   286   285   20   20   285   286   286   285   20   20   285   286   2						
100       105         110       115         120       125         130       135         140       145         150       155         160       165         170       175         180       185         190       195         200       205         210       215         220       225         230       235         240       245         250       265         270       275         280       285						
105       110         111       115         120       125         130       135         140       145         150       155         160       165         170       175         180       185         190       195         200       205         210       215         220       225         230       235         240       245         255       260         265       270         275       280         285       285						
110       115         120       125         130       135         140       145         150       155         160       165         170       175         180       185         190       195         200       205         210       215         220       225         230       235         240       245         255       260         265       270         275       280         285       88	100					
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120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285	110					
125       130         135       140         145       150         155       160         165       170         175       180         185       190         195       200         205       210         215       220         225       230         235       240         245       250         255       260         265       270         275       280         285       100         285       100         286       100         286       100         287       100         288       100         289       100         280       100         280       100         280       100         280       100         280       100         280       100         280       100         280       100         280       100         280       100         280       100         280       100         280       1	115					
130       135         140       145         150       155         160       165         170       175         180       185         190       195         200       205         210       215         220       225         230       235         240       245         250       255         260       265         270       275         280       285	120					
135       140         145       150         155       160         165       170         175       180         185       190         195       200         205       210         215       220         225       230         235       240         245       250         255       260         265       270         275       280         285       3	125					
140         145         150         155         160         165         170         175         180         185         190         195         200         205         210         215         220         225         230         235         240         245         250         255         260         265         270         275         280         285	130					
145         150         155         160         165         170         175         180         185         190         195         200         205         210         215         220         225         230         235         240         245         250         255         260         265         270         275         280         285	135					
150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285	140					
155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285	145					
160       165         170       175         180       185         190       195         200       205         210       215         220       225         230       235         240       245         250       255         260       265         270       275         280       285	150					
165         170         175         180         185         190         195         200         205         210         215         220         225         230         235         240         245         250         255         260         265         270         275         280         285	155					
170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285	160					
175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285	165					
180       185       190       195       200       205       210       215       220       225       230       235       240       245       250       255       260       265       270       275       280       285	170					
185         190         195         200         205         210         215         220         225         230         235         240         245         250         255         260         265         270         275         280         285	175					
190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285	180					
195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285	185					
200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285	190					
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Client: BTW Associates

Project: Amajuba Power Station Job No: LL3034

Typed By: A Nolan

	Test
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	Performed

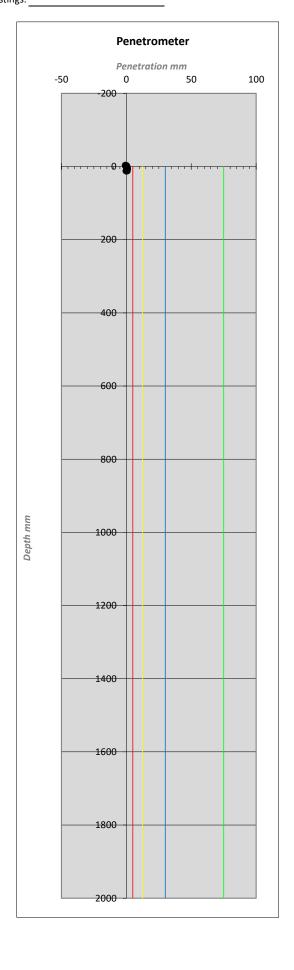
st No: DCP 5 ation: ed By: Phiwa and Cyril Testing Date 2018/04/09 Eastings:

PO Box 4177, Witbank Route N4 Business Park, 4 Corridor Crescent, Ben Fleur X11, Witbank E-mail: info@engeolabcc.co.za Tel: 013 656 0719

Reg. No. 2002/014257/23 **Earth Science Consultants** 

Fax: 013 656 0737

Southings:				
Penetration mm/blow	Actual Depth mm / 5 Blows	Penetration mm/Blows	Approximate in-situ CBR	
0	0	0	III-SILU CDI	
5	0	0		
10	-3	-0.6	110.00	
15	-2	0.2	110.00	
20	-1	0.2	110.00	
25	2	0.6	110.00	
30	6	0.8	110.00	
35	9	0.6		
40	12	0.6	110.00 110.00	
45	12	0.0	110.00	
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Project: Amajuba Power Station

Job No: LL3034 Typed By: A Nolan

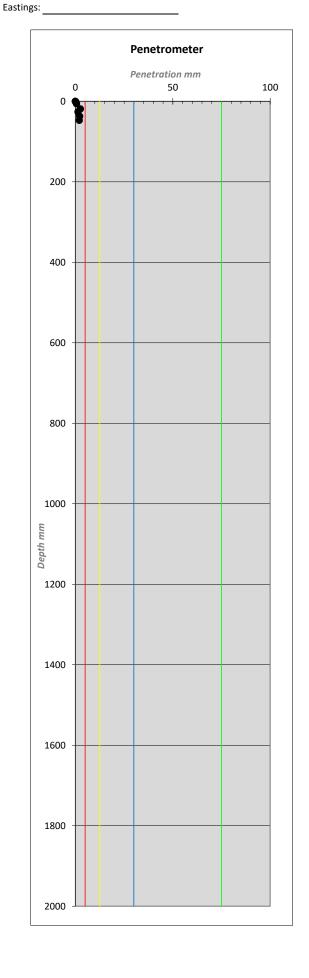
Test No: DCP 6 Location: -Performed By: Phiwa and Cyril Testing Date 2018/04/09

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Southings:				
Penetration	Actual Depth	Penetration	Approximate	
mm/blow 0	mm / 5 Blows	mm/Blows	in-situ CBR	
		0		
5 10	0	0.2	110	
			110	
15	3	0.4	110	
20	6	0.6	110	
25	19	2.6	110	
30	26	1.4	110	
35	37	2.2	110	
40	47	2	110	
45				
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Client: BTW Associates

Project: Amajuba Power Station Job No: LL3034

Typed By: A Nolan

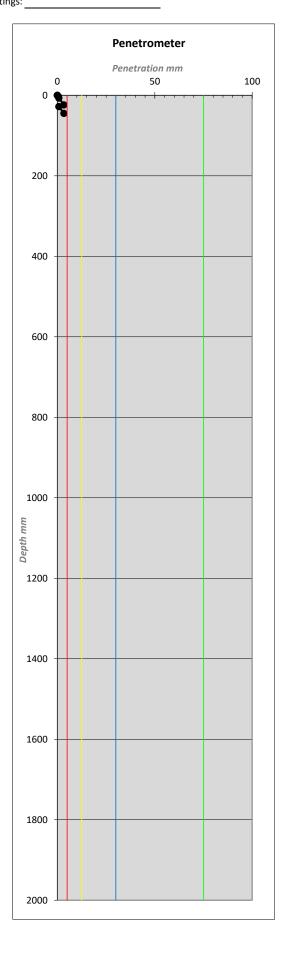
Southings:

Test No: DCP 7 Location: -Performed By: Phiwa and Cyril Testing Date 2018/04/09 Eastings:

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	Southings:		
Penetration	Actual Depth	Penetration	Approximate
mm/blow	mm / 5 Blows	mm/Blows	in-situ CBR
0	0	0	
5	0	0	
10	3	0.6	110.00
15	7	0.8	110.00
20	24	3.4	93.59
25	28	0.8	110.00
30	45	3.4	93.59
35			
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Project:	Amajuba Power Station
Job No:	LL3034

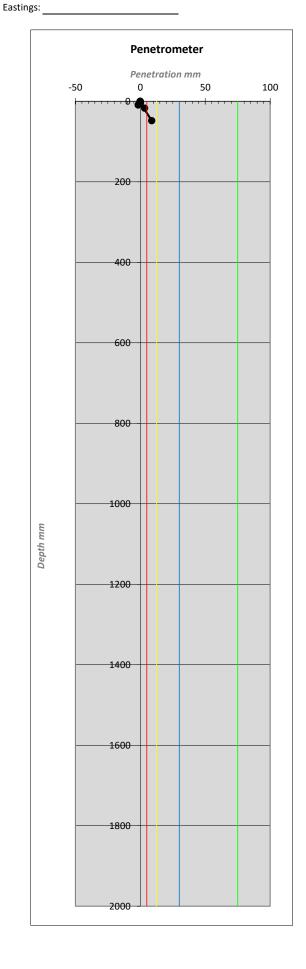
Typed By: A Nolan

Southings:

Test No: DCP 8	PO Box 4177, Witbank Route N4 Business Park,
Location:	4 Corridor Crescent, Ben Fleur X11, Witbank
Performed By: Phiwa and Cyril	E-mail: info@engeolabcc.co.za
<del></del>	Tel: 013 656 0719
Testing Date 2018/04/09	Fax: 013 656 0737

Reg. No. 2002/014257/23 **Earth Science Consultants** 

Southings:				
Penetration	Actual Depth	Penetration	Approximate	
mm/blow	mm / 5 Blows	mm/Blows	in-situ CBR	
0	0	0	III SILU CDI	
5	0	0		
10	0	0		
15	0	0		
20	17	3.4	93.59	
25	9	-1.6	110.00	
30	5	-0.8	110.00	
35	3	-0.4	110.00	
40	4	0.2	110.00	
45	4	0		
50	48	8.8	26.93	
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Client: BTW Associates

Project: Amajuba Power Station Job No: LL3034

Typed By: A Nolan

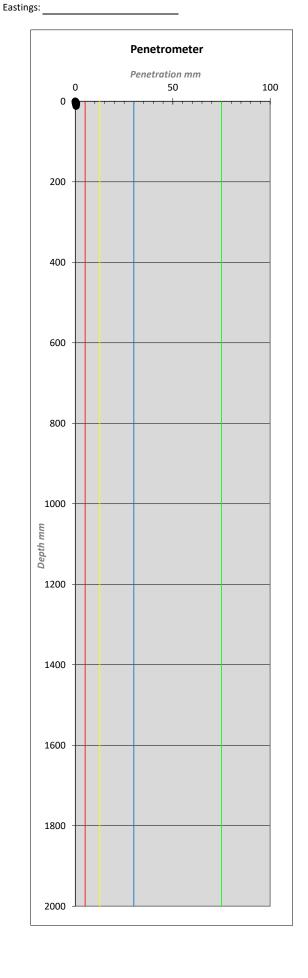
Test No: DCP 9 Location: -Performed By: Phiwa and Cyril Testing Date 2018/04/09

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	Southings:		
Penetration mm/blow	Actual Depth mm / 5 Blows	Penetration mm/Blows	Approximate in-situ CBR
0	0	0	III Situ CDI
5	0	0	
10	0	0	
15	1	0.2	110.00
20	4	0.6	110.00
25	4	0	110.00
30	7	0.6	110.00
35	8	0.0	110.00
40	10	0.4	110.00
45	12	0.4	
50	12	0.4	110.00
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# Geotechnical Investigation Majuba General Waste Landfill Site ESKOM Majuba Power Station

Volume 2

Project No: LL3034 Date: April 2018

Earth Science Consultants:



