Geotechnical Investigation for
Olien PV Solar Plant, Lime Acres, Northern Cape

REPORT TO
AE-AMD Renewable Energy

BY SMEC South Africa Consulting Engineers

REPORT NO.: PJ112/10/2013/04/2446      APRIL 2013
# SMEC REPORT

## QUALITY ASSURANCE ISSUE DATA

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<tr>
<th>Report Title:</th>
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<td>Client:</td>
<td>AE AMD Renewable Energy</td>
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<tr>
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<td>Olien PV Solar Plant</td>
</tr>
<tr>
<td>Report Number:</td>
<td>2446</td>
</tr>
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<td>Revision Number</td>
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## Revision History:

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<tr>
<td>12/04/2013</td>
<td>Final</td>
<td>R Roberts</td>
<td>F Pequeno</td>
<td>C Berrington</td>
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<td>AE AMD Renewable Energy</td>
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Approved by: [Signature]

Date: 11/4/2013
1. INTRODUCTION AND TERMS OF REFERENCE

1.1 Scope

This report presents the findings of a geotechnical investigation and soils resistivity survey undertaken near Lime Acres, Northern Cape. It is understood that the proposed development will comprise a photovoltaic solar plant with associated access tracks, roads, substation and maintenance depot (offices and stores). The proposed solar plant will cover an area of about 200Ha.

1.2 Terms of Appointment

The work was carried out for AE-AMD Renewable Energy, in accordance with our quote (Quote no. Q601B) dated 15 February 2013 and the instruction to proceed from Mr Charlie Berrington dated 15 February 2013.

1.3 Aims and Methodology

The objectives of the study are:

- To analyse the geotechnical conditions present, assess the general suitability of the site and to make recommendations for site works for the proposed development.
- To provide foundation recommendations for the proposed development and to comment on geotechnical factors that would have an impact on the development of the site to enable economic design and construction of the proposed development.
- To identify relevant ground-related features and determine the variability of ground conditions and the effect of such variability on the proposed development.

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

- Review of available geological records and site plans.
- Undertaking of a geotechnical site investigation comprising TLB excavated trial pits to profile soils, investigate soil strengths/capacities and identify potential problem soils on site.
- Undertaking of laboratory testing to establish geotechnical and design parameters of the soils.
- Identification of relevant ground-related features and their influence on the proposed development.
1.4 Codes of Practice and Standards

The investigation was carried according to standard practice codes and guidelines. Reference has specifically been made to:

- SAICE and IStructE Code of Practice for foundations of single storey masonry buildings
- The 2010 SAICE Geotechnical Division Site Investigation Code of Practice.

1.5 Limitations of Assessment

The investigation comprised a limited number of trial pits and is not likely to reveal the detail of the conditions that will become evident during construction. It is thus imperative that a Competent Person inspects all excavations to ensure that conditions at variance with those predicted do not occur and to undertake an interpretation of the facts supplied in this report to apply to on-site conditions as exposed during development of the site.

It is possible that certain indications of ground contamination or ground water levels were latent or otherwise not visible. Our opinions can only be based on what was visible at the time the visit was conducted.

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

2. DESCRIPTION OF SITE AND SURROUNDING AREA

2.1 Information Sources

The following information sources were consulted and made available;

- Geological Map, Sheet 2822 Postmasburg at a scale of 1:250 000
- General layouts provided by the client
- Published technical references (listed in Section 7 of this report)

2.2 Site Location and Description

The site for the proposed solar PV plant is located approximately 15km east of Lime Acres. The site centre has approximate coordinates of 28.339426° S and 23.625251° E. A site locality plan is given in Diagram 2.2.1 and proposed development areas in Diagram 2.2.2 below.
The site comprises two parcels or irregularly shaped land, split by the existing overhead powerline servitude and Olien substation. The western parcel of land has an approximate area of 134Ha and the eastern portion 60Ha. The site is generally flat and level and is strewn with calcrete gravel and cobbles with occasional outcrop visible. A railway line, which runs on a roughly north east – south west alignment defines the northern boundary of the site.
2.3 Drainage, Topography and Vegetation

Ground levels on the site are in the order of 1450masl. Drainage is generally in the form of sheetwash and the site is generally flat. Vegetation consists of grass over the western part of the site with scattered trees on the eastern part.

2.4 Surrounding Area

The area immediately surrounding the site comprises natural, undeveloped land on all sides. To the west of the site a non-perennial river flows on a roughly north – south alignment and is fed by drainage from a large pan (The Great Pan) approximately 1km to the north west of the site. This river joins the Klien-Riet River to the south east of the site.

2.5 Climate

The site lies within the dry, semi-arid grassland climatic zone, comprising hot summers and cool winters. Maximum average temperatures range between 32°C in January and 16°C in June, with corresponding average minimum temperatures of 16°C and 0°C respectively. Lime Acres normally receives about 246mm of rain per year, with most rainfall occurring mainly during summer. It receives the lowest rainfall (0mm) in July and the highest (59mm) in March.

Climate determines the mode of weathering and rate of weathering. The effect of climate on the weathering process (i.e. soil formation) is determined by the climatic N value defined by Weinert. The N-value for the area is 12, which implies a deficiency of water.

The implication of the N-value in general (for an N>5 area) is that the soil profile is likely to be shallow, and comprise physically disintegrated residual soils.

3. GEOTECHNICAL INVESTIGATION AND GROUND CONDITIONS

3.1 Overview

The geotechnical investigation, which comprised 45 trial pits, was carried out on 4th and 5th March 2013. Trial pits were profiled according to standard practice and soil samples were recovered from representative materials on site and submitted for laboratory testing.

3.2 Previous Investigations

The SMEC reports database was consulted. No previous site investigation reports have been undertaken in the area.
3.3 Geology

The geological map of Postmasburg shows the site to be underlain by surface limestone (calcrete) of Tertiary to Quaternary age. However, dolomitic limestone (puckered limestone) with subordinate coarsely crystalline dolomite (Ghaapplato Formation, Campbell Group, Griqualand West Sequence) is documented approximately 2.7km to the north east and 9km to the south west of the site. It is likely that the surface limestone lies on top of the dolomitic limestone. An extract of the geological map with the site and surrounding geology is given in Diagram 3.3 hereunder.

![Diagram 3.3. Extract from geological map Postmasburg 2822](image)

3.4 Ground Conditions

Diagram 3.4 below shows the location of the trial pits (test pits AE/O1-45). The trial pits were distributed across the site so as to provide an overall assessment of the in-situ conditions for the proposed development.
The trial pits showed conditions across the site to be consistent, and comprised a thin cover of gravelly topsoil overlying cemented to strongly cemented calcrete at very shallow depth. The TLB refused on the strongly cemented calcrete at depths of between 0.1m and 0.5m.

A photograph of the typical soil profile encountered on the site is given below. Trial pit profiles are included in Appendix A and an explanation of the logging parameters used is given in Appendix B.
Additional observations made were as follows:

**Excavatability:** Trial pits were excavated using a CAT 428F TLB up to 0.5m depth. All the trial pits refused on the strongly cemented calcrete.

**Stability of Trenches:** The side-walls of the trial pits were stable during excavation.

**Ground water seepage:** No ground water seepage occurred in any of the trial pits during the investigation.

**Made Ground/Fill:** Made ground/fill was not encountered on the site.

### 3.5 Earth Resistance Measurements

Earth resistance measurements were carried out adjacent to six of the trial pits. The measurements were made using the fall of potential, four pegs in a straight line method. The pegs were spaced 0.3m, 0.5m, 1m, 2m, 4m, 6m and 12m apart and readings taken at each location, with additional readings at 30m and 55m at the proposed substation site (AE/07 north-south and east-west). The soil was dry on the day that the measurements were made. The pegs were driven 150mm into the soil. These measurements should reflect the worst grounding conditions. The following table contains the results.
### Table 3.5. Earth Resistance Measurements

<table>
<thead>
<tr>
<th>Trial Pit</th>
<th>Ground Resistance (Ω) at spacing (m)</th>
<th>Soil Resistivity (Ω-m) at spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>AE/O7*</td>
<td>580</td>
<td>334</td>
</tr>
<tr>
<td>AE/O7#</td>
<td>652</td>
<td>372</td>
</tr>
<tr>
<td>AE/O4</td>
<td>845</td>
<td>170</td>
</tr>
<tr>
<td>AE/O13</td>
<td>790</td>
<td>230</td>
</tr>
<tr>
<td>AE/O25</td>
<td>770</td>
<td>260</td>
</tr>
<tr>
<td>AE/O45</td>
<td>410</td>
<td>610</td>
</tr>
<tr>
<td>AE/O42</td>
<td>640</td>
<td>380</td>
</tr>
<tr>
<td>AE/O36</td>
<td>810</td>
<td>410</td>
</tr>
</tbody>
</table>

* - North-south alignment    # - East-west alignment

The results of the resistivity testing are given in Appendix C.

#### 3.6 Laboratory Testing

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

- 7 Foundation Indicator tests (including full grading and moisture content)
- 7 pH and conductivity tests
- 7 Chemical tests (sulphide, sulphate, chloride and redox potential)

**Indicator Tests:**

Particle size analyses (full grading) and indicator tests were undertaken on representative samples of the materials on site. The tests showed the calcrete to be generally of low plasticity.

The calcrete subsequently test as “Low” potential expansive according to the van der Merwe method.

The test results are summarised in the table below:
Table 3.6.1 Foundation Indicator Results

<table>
<thead>
<tr>
<th>Trial pit No.</th>
<th>Depth of sample (m)</th>
<th>Material Type</th>
<th>Grading</th>
<th>Clay %</th>
<th>Silt %</th>
<th>Sand %</th>
<th>Gravel %</th>
<th>PI</th>
<th>Expansiveness classification*</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE/O1</td>
<td>0.1-0.3</td>
<td>Calcrete</td>
<td>1.67</td>
<td>0</td>
<td>20</td>
<td>48</td>
<td>32</td>
<td>7</td>
<td>Low</td>
</tr>
<tr>
<td>AE/O6</td>
<td>0.1-0.4</td>
<td>Calcrete</td>
<td>1.26</td>
<td>3</td>
<td>22</td>
<td>60</td>
<td>15</td>
<td>12</td>
<td>Low</td>
</tr>
<tr>
<td>AE/O16</td>
<td>0.1-0.5</td>
<td>Calcrete</td>
<td>1.38</td>
<td>5</td>
<td>20</td>
<td>59</td>
<td>16</td>
<td>16</td>
<td>Low</td>
</tr>
<tr>
<td>AE/O23</td>
<td>0.1-0.2</td>
<td>Calcrete</td>
<td>1.82</td>
<td>0</td>
<td>16</td>
<td>44</td>
<td>40</td>
<td>10</td>
<td>Low</td>
</tr>
<tr>
<td>AE/O35</td>
<td>0.1-0.2</td>
<td>Calcrete</td>
<td>1.71</td>
<td>0</td>
<td>15</td>
<td>51</td>
<td>34</td>
<td>5</td>
<td>Low</td>
</tr>
<tr>
<td>AE/O40</td>
<td>0.1-0.3</td>
<td>Calcrete</td>
<td>1.42</td>
<td>2</td>
<td>18</td>
<td>56</td>
<td>24</td>
<td>7</td>
<td>Low</td>
</tr>
<tr>
<td>AE/O44</td>
<td>0.1-0.4</td>
<td>Calcrete</td>
<td>1.87</td>
<td>0</td>
<td>13</td>
<td>46</td>
<td>41</td>
<td>5</td>
<td>Low</td>
</tr>
</tbody>
</table>

* According to van der Merwe

Redox Potential tests were undertaken on seven samples. The results are outstanding and will be issued as Addendum 1 to this report.

Chemical Tests were undertaken on eight samples. These comprised pH, conductivity, sulphate, chlorides and sulphides. The results showed the soil to be generally neutral, with a pH in the order of 6.5. The conductivity tests show the soils to be corrosive towards steel. The results for the sulphate, chlorides and sulphides testing are outstanding and will be issued as Addendum 1 to this report.

The results are summarised hereunder:

Table 3.6.2 Chemical Test Results

<table>
<thead>
<tr>
<th>Trial pit No.</th>
<th>Depth of sample (m)</th>
<th>Material Type</th>
<th>pH</th>
<th>Conductivity (S/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE/O1</td>
<td>0.1-0.3</td>
<td>Calcrete</td>
<td>6.72</td>
<td>0.002</td>
</tr>
<tr>
<td>AE/O6</td>
<td>0.1-0.4</td>
<td>Calcrete</td>
<td>6.41</td>
<td>0.001</td>
</tr>
<tr>
<td>AE/O16</td>
<td>0.1-0.5</td>
<td>Calcrete</td>
<td>6.83</td>
<td>0.003</td>
</tr>
<tr>
<td>AE/O23</td>
<td>0.1-0.2</td>
<td>Calcrete</td>
<td>6.30</td>
<td>0.002</td>
</tr>
<tr>
<td>AE/O35</td>
<td>0.1-0.2</td>
<td>Calcrete</td>
<td>6.39</td>
<td>0.000</td>
</tr>
<tr>
<td>AE/O40</td>
<td>0.1-0.3</td>
<td>Calcrete</td>
<td>6.49</td>
<td>0.002</td>
</tr>
<tr>
<td>AE/O44</td>
<td>0.1-0.4</td>
<td>Calcrete</td>
<td>6.62</td>
<td>0.010</td>
</tr>
</tbody>
</table>

From the above it can be seen that the results are generally consistent across the site.

4. GEOTECHNICAL INTERPRETATION AND SUMMARY

An evaluation of the impact of the geotechnical characteristics on the development, is discussed below and summarised in Section 5.

4.1 Ground Conditions

The ground conditions encountered within the trial pits comprise a thin cover of gravelly sand (topsoil), overlying cemented to strongly cemented calcrete.

However, the geological map indicates that dolomitic limestone (effectively dolomite) is present in the area and is likely to lie beneath the calcrete. Dolomite rock comprises,
essentially carbonates of magnesium and calcium. The groundwater in dolomite may be regarded as a weak carbonic acid. Dolomite goes into solution in this acid and is carried away as bicarbonates of magnesium and calcium. Downward percolation of the groundwater leads to erosion and widening of joints in the dolomite and can lead to the formation of slots extending down to the water table and, possibly, given the right combination of circumstances, to the formation of sinkholes (where these slots break through to surface).

Any development on dolomite must thus take into account the possibility of the formation of subsidences (sinkholes, etc). South African National Standard (SANS) 1936 provides regulations and norms to be applied whenever development on dolomite is contemplated. SANS1936 covers the investigations to be carried out prior to development, the design standards to be employed when planning development on dolomite and the risk management procedures to monitor the performance of services to minimise the risk of sinkhole formation.

Thus, any development on dolomite requires an intensive investigation to quantify the hazard presented by the dolomite stability conditions ruling on the site. The investigations include a gravimetric survey of the site followed by percussion drilling of features identified by the residual gravity anomalies. An analysis of the findings is then carried out and the site zoned in relation to its suitability for different types of development (housing, industrial, etc), including any zones classified as being unsuitable (too risky) for development. The dolomite stability report is submitted to the Council for Geoscience (CGS) and to a peer review panel who then approve/disprove the report and grant/withhold permission to develop the site. As part of this process a risk management plan must be developed to cater for the on-site conditions.

When construction commences, the geospecialist who prepared the risk management plan is required to monitor construction to ensure that this complies with the design and related risk-management procedures.

Depending on the type of development, on-going monitoring during the life of the project/development forms part of the risk management plan. This stage of the process usually applies to the stormwater management and performance of wet services installed as part of a residential development, so its application to a solar farm is questionable.

The solar project will have minimal wet services and people on site. Furthermore, the potentially thick calcrete over the dolomite will act as an aquiclude and prevent water ingress. Therefore, it is possible that a less onerous dolomite investigation process may
be acceptable to CGS. Very preliminary discussion with CGS has indicated that this may be a possibility and it is proposed to proceed as follows:

- **Phase 1**: Desk Study. CGS is (supposedly) the repository of all dolomite stability investigations. Its data bank was consulted to determine if any applicable data is available, but none was located.

- **Phase 2**: This phase would entail an investigation of the substation and office block area to SANS 1936 standards. To cater for the possibility of unsuitable areas being identified, a 5Ha area should be investigated. A gravity survey on a 30m grid will be undertaken, followed by percussion drilling of features identified by the gravity work. Allowance should be made for 8 boreholes to a maximum depth of 40m each. Stereographic study of large scale airphotos (better than 1:800 scale) will be undertaken to identify any subsidence (sinkhole) related features. Over the remainder of the site it is proposed to carry out a less intensive investigation comprising, firstly airphoto interpretation as above, followed by field mapping and a walk-over survey. Drilling of boreholes will be undertaken on any features identified. Allowance should be made for 12 boreholes to a maximum depth of 40m each.

### 4.2 Geotechnical Constraints to Development

Based on the investigations, conditions on the site are generally good (provided the dolomite conditions are found to be acceptable), and there appears to be no (geotechnical) reasons for the development of the site not to continue, provided that precautionary measures as discussed in this report are incorporated in the design and development of the site.

### 4.3 Foundations

It is understood that the preferred foundation solution for this development is a rammed pile. However, these are not recommended due to the presence of strongly cemented calcrete over the site, which will prevent installation at very shallow depth. Whilst bearing capacities on the strongly cemented calcrete will be high the shallow depth of penetration will mean that resistance to the required moment and uplift forces will not be achieved from the overlying soils alone.

Alternatively, two other foundation types may be considered:

1. Cast in situ concrete piles – it will be possible to adopt this foundation solution, as the holes at the pile positions would be formed by drilling using conventional shothole rigs.
This will overcome the problem of installation where strongly cemented calcrete is present.

2. Concrete block foundations – it should be possible to adopt this foundation solution, which will bear on the calcrete at shallow depth. A bearing capacity of 300kPa may be taken for the strongly cemented calcrete.

Normal spread foundations may be taken for any proposed structures at a nominal depth of 0.5m, bearing on the calcrete. A bearing capacity of 300kPa may be taken for the calcrete at this depth.

**Foundation Analysis and Design**

A conceptual analysis based on the findings of the investigation has been carried out to evaluate the likely piling depths required if using the recommended percussion-micropile. The type of tracking system that will eventually be used is at this stage unknown, and the design given below is thus purely theoretical in order to evaluate the feasibility of the recommendations given above and to allow the design engineers to develop a conceptual costing model.

**Foundation Loads**

Theoretical unfactored loads for tracker system have been utilised (based on previous project experience), as per the table below.

<table>
<thead>
<tr>
<th>Table 4.3.1. Non-factored pile loads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral (kN)</td>
</tr>
<tr>
<td>Tracker loads</td>
</tr>
</tbody>
</table>

**Geotechnical and site specific information**

No UCS testing was undertaken, Brink(1985) suggests that hardpan calcrete seldom exceeds 10MPa uniaxial compressive strengths, although it is estimated that the calcrete will conservatively have a strength exceeding 1-3MPa. The thickness of the calcrete is unknown. The Modulus of Subgrade reaction will be assumed to be 120MN/m$^3$ as an equivalent only value, as the Modulus of Subgrade Reaction is strictly speaking not applicable to the hardpan calcrete which has characteristics approaching a soft rock.

The following parameters have been utilised in the analysis:
Table 4.3.2: Preliminary Design Parameters

<table>
<thead>
<tr>
<th>Depth</th>
<th>Soil Description</th>
<th>ABP(^1) (kPa)</th>
<th>20 - 22</th>
<th>5 - 20</th>
<th>40 - 45</th>
<th>120</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>500+</td>
<td>Hardpan calcrete</td>
<td>&gt;1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Pile design - Compression

A single micropile is suggested below the foundations, this will be achieved by percussion drilling of a 250mm hole. Rigs to drill this size diameter hole are readily available in South Africa.

For the standardised soil profile presented in the previous section, the small pile diameter and the fact that very little overburden stress builds up in the top 0.5m, the capacity build-up is estimated to be 3.5kN, therefore majority of the compressive capacity will have to be built-up in rock socket capacity.

The rock socket frictional capacity can be determined by using the following equation and values for the variables provided by Tomlinson

\[ T_{\text{ave peak}} = \alpha \beta UCS \]

where \( \alpha \) = the reduction factor with respect to UCS (from Tomlinson, 1995),
\( \beta \) = the reduction factor with respect to rock mass effect

The rock socket frictional capacity is estimated to be some 90kPa. Therefore, using the strength limit state load, ignoring all capacity gained from the soil profile above the calcrete and that gained in end bearing, the results in socket lengths as summarised in Table 4.3.3.

Table 4.3.3. Pile Length For Compressive Load

<table>
<thead>
<tr>
<th>Position</th>
<th>Diameter</th>
<th>Required Length from top of existing ground level(m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracker loads</td>
<td>250 mm</td>
<td>3.9 (3.4)*</td>
</tr>
</tbody>
</table>

* socketed into medium hard to hard rock

These designs have to be checked for uplift as described in the next section.

Pile design – Uplift

As applicable to sedimentary rocks, it is recommended that the designs be checked for “piston-pullout” and liftout of a cone of calcrete. Both at ultimate strength state calculations and designed by using the following appropriate equations:
“Piston-pullout” : \[ R_{ug} = \varphi g \pi d L_{ave peak} \], and
Cone Liftout : \[ R_{ug} = \varphi g \pi L^2 \tau_{ave peak} \]

The pile length is adequate to withstand both piston pull-out and cone-liftout.

**Lateral loading**

Lateral loading will cause moments to developed in the pile, these moments will vary depending on the fixity of the pile head. Therefore both a free-head and fixed-head scenario were analysed in finite element software and are as summarised in the Diagrams below.

![Diagram showing fixed and free pile heads](image)

**Reinforcement**

Piles will be assumedly constructed from 30MPa grout. Cover to spiral reinforcement should be 50mm. It is recommended that the reinforcement in the 3.9m long piles, should consist of 8Y20 with a R8 spiral at 200mm with a fixed pile head.

**Summary**

Although purely conceptual, the above analysis shows the recommended micropile solution is feasible and results in pile lengths in the order of 3.5m based on theoretical (typical) loads.

**4.4 Roads and Materials**

Whilst insufficient calcrete was able to be excavated to facilitate materials testing, the surrounding gravel roads and access road for the existing Olien substation on site are constructed from calcrete. There appears to be an existing borrow pit / quarry at the site.
entrance from which it is assumed that the access road for the substation has been constructed. Given this, it is assumed that the calcrete on site will be suitable for construction of access roads and tracks. However, calcrete roads are notoriously dusty and this influence on the effectiveness of the PV panels should be borne in mind.

The calcrete outcrops on the site in several locations and is easily accessible for construction purposes. Therefore, it is recommended that this material be used for access roads within the site, although it must be noted that the calcrete must be inspected and any that is excessively soft/clayey material, if present, should not be used.

4.5 Drainage System

The main risk to the proposed development, with respect to water/drainage, is the potential erosion of soils from around the foundations of the solar panels, thus affecting their resistance to movement due to moment and uplift forces. Due to the consistent alignment of these panels across the site, rainwater will wash off the panels and be concentrated to specific channels, thus increasing the speed of soil erosion at these locations. This can be overcome with traditional concrete open drainage, which will collect this water and direct it away from the site.

4.6 Flooding Risk

The 1:50 and 1:100 year floodlines were not determined as it falls outside the scope of this report. It is not anticipated that the site is within a floodline due to the distance of perennial water bodies from the site, but it should be established as a matter of course.

4.7 Excavatability and Cable Trenches

As discussed above, the site is generally characterised by thin soil cover, observed as 0.1m in the trial pits, overlying cemented to strongly cemented calcrete.

However, due to the presence of strongly cemented calcrete at very shallow depth across the site, blasting or breaking out of the calcrete will have to be undertaken to allow for installation of the solar plant infrastructure, i.e. cables.

4.8 Stability of Trenches

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

The soils should be stable enough for the predrilled holes at the pile positions to remain open prior to filling with concrete.

4.9 Made Ground / Fill

Made ground/fill was not encountered on the site.

4.10 Groundwater

No groundwater seepage was encountered in the trial pits dug on site. Due to the lack of deeper investigation techniques, the natural groundwater table could not be determined, but it is anticipated to be well in excess of 10m deep. Perched water tables can form, particularly on the contact between the sand and underlying calcrete, after periods of heavy or continuous rain.

4.11 Earth Resistance

The results indicate that the design team will be able to create an effective earth using a combination of bare copper trench earth conductors and earth spikes. The earth resistance will have to be measured at each site and only thereafter will the engineer be able to design an effective earth system.

4.12 Seismic Evaluation

From the map below the site is located in an area with a peak ground acceleration of approximately 0.08g. Therefore, potential damage from an earthquake of this magnitude will be negligible.
4.13 Geotechnical Evaluation: Other

1. Confirmatory investigations comprising inspection of foundations and trenches during construction are according to Codes and Best Practices, mandatory.

2. **Mining activity and undermining.** No evidence of mining was observed on site and there are no known occurrences of economic mineral deposits on the site.

3. **Dolomite.** The site is a “dolomitic” site and the restrictions relating to development on dolomitic terrain are applicable.

4. **Slopes and cuttings;** the area to be developed is generally flat and no terracing is required.

5. **Contaminated soils (including tailings).** No made ground was evident during the fieldwork and the land is undeveloped. Therefore, the presence of contaminated soils is highly unlikely on this site.
4.14 Further Investigation

The foundation conditions encountered during the investigation were generally consistent and correspond well to the anticipated ground conditions for the area.

It was not possible to penetrate the calcrete but it is expected to extend to depth. Depending on the contractual model used, further investigations are generally not considered necessary, but could prove useful and could be used to mitigate against contractual claims related to ground risk.

Additional investigations to establish design parameters of the calcrete may also be useful to develop a more accurate foundation design and costing model, as the assumptions made above are generally considered conservative. This implies rotary core drilling over the site in order obtain core samples. Foundation load tests may also prove useful to verify designs.

Notwithstanding the above, a dolomite stability investigation (see 4.1 above) will be required.

5. GEOTECHNICAL RECOMMENDATIONS

Founding conditions are favourable for the proposed development and conventional construction methods can be implemented. Depending on the design and loads to be applied, the following recommendations are made;

1. A dolomite stability investigation (see 4.1 above) will be required. This will comprise studying of large scale airphotos, a gravity survey and borehole drilling.

2. Two foundation types may be considered
   - Cast in situ concrete piles – it will be possible to adopt this foundation solution, as the holes at the pile positions would be formed by drilling using conventional shothole rigs. This will overcome the problem of installation where strongly cemented calcrete is present.
   - Concrete block foundations – it should be possible to adopt this foundation solution, which will bear on the calcrete at shallow depth. A bearing capacity of 300kPa may be taken for the strongly cemented calcrete.

3. Normal spread foundations may be taken for any proposed structures at a nominal depth of 0.5m, bearing on the calcrete. A bearing capacity of 300kPa may be taken for the calcrete at this depth.
4. It is assumed that the calcrete encountered on the site is suitable for construction of access roads and tracks, based on the existing access road for the substation and the borrow pit on site.

6. CLOSING

We trust that this report will assist you in the design and construction of the proposed project. SMEC South Africa appreciate the opportunity of providing our services on this project and look forward to working with you on future projects as you see necessary. Should you have any questions, please do not hesitate to contact us.

Respectfully submitted,

SMEC South Africa (Pty) Ltd Consulting Engineers
7. REFERENCES


4. SANS 1936 Development on Dolomite SABS Standards Division, Pretoria.

5. VAN DER MERWE D.H. “The prediction of heave from the plasticity index and percentage clay fraction of soils”. SAICE 1964.
Appendix

A

Trial Pit Profiles
### TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

---

**HOLE NO:** AE/O1  
**X COORD:** 3,135,479  
**Y COORD:** Lo23 -60,674  
**ELEVATION:**

---

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<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
<tr>
<td>0.10</td>
<td><strong>Loose, silty, gravelly SAND</strong></td>
</tr>
<tr>
<td>0.30</td>
<td><strong>Strongly cemented CALCRETE</strong></td>
</tr>
<tr>
<td></td>
<td>Refusal on strongly cemented calcrete</td>
</tr>
</tbody>
</table>

---

**NOTES**  
1: No seepage  
2: Sample: AE/O1/1 @ 100 - 300mm  
3:  
4:  

**DATE PROFILED:** 4 March 2013

---

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**Template:** SMEC TP04
TRIAL PIT LOG

CLIENT: AE AMD Renewable Energy
PROJECT: Olien PV Power Plant
PROJECT NO: PJ112/10
SITE: Lime Acres, Northern Cape

HOLE NO: AE/O2
X COORD: 3,135,978
Y COORD: Lo23 -61,063
ELEVATION:

NOTES
1: No seepage
2: No samples
3:
4:

MACHINE: CAT 428F
DIAM: Trench
FILE REF: PJ112/10/Olien/Winlog

DATE PROFILED: 4 March 2013
PROFILES BY: R.Roberts
CHECKED BY:

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Consulting Engineers
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Depth | Description
--- | ---
0.0 | Ground Surface
0.10 | Loose, silty, gravelly SAND
| Strongly cemented CALCRETE
0.50 | Refusal on strongly cemented calcrete

Dynamic Probe Light Equivalent SPT-N

<table>
<thead>
<tr>
<th>Depth</th>
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<th>30</th>
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<tr>
<td>0.50</td>
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</tbody>
</table>

End of Log
### TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

**HOLE NO:** AE/O3  
**X COORD:** 3,135,659  
**Y COORD:** Lo23 -60,713  
**ELEVATION:**

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<tbody>
<tr>
<td>0.0</td>
<td><strong>Ground Surface</strong></td>
</tr>
</tbody>
</table>
| 0.10  | **Loose, silty, gravelly SAND**  
| 0.40  | **Strongly cemented CALCRETE** |
| 0.5   | **Refusal on strongly cemented calcrite** |

---

**MACHINE:** CAT 428F  
**DATE PROFILED:** 4 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**FILE REF:** PJ112/10/Olien/Winlog  
**CHECKED BY:**

---

**NOTES:**  
1: No seepage  
2: No samples  
3:  
4:  

---

**Template:** SMEC TP04  
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**Consulting Engineers**  
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## TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

### HOLE NO: AE/O4

| X COORD: | 3,135,611 |
| Y COORD: | Lo23 -60,902 |
| ELEVATION: |

### Description

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<td>0.00</td>
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</tbody>
</table>
| 0.10  | Loose, silty, gravelly SAND  
| 0.20  | Strongly cemented CALCRETE  
Refusal on strongly cemented calcrete |

**NOTES**  
1: No seepage  
2: No samples  
3:  
4:  

**MACHINE:** CAT 428F  
**DIAM:** Trench  
**FILE REF:** PJ112/10/Olien/Winlog  
**DATE PROFILED:** 4 March 2013  
**PROFILED BY:** R.Roberts  
**CHECKED BY:**  
**PROF REG:**  

### Dynamic Probe Light Equivalent SPT-N

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<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
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</tr>
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<td>0.20</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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## TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

**HOLE NO:** AE/O5  
**X COORD:** 3,135,876  
**Y COORD:** Lo23 -60,672  
**ELEVATION:**

### Depth vs. Description

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<tbody>
<tr>
<td>0.00</td>
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</tbody>
</table>
| 0.10  | **Loose, silty, gravelly SAND**  
**Refusal on strongly cemented calcrete**  
End of Log |

### Notes
1: No seepage  
2: No samples  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 4 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**CHECKED BY:**  
**FILE REF:** PJ112/10/Olien/Winlog  
**Prof Reg:**

---

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### TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

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<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
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</tbody>
</table>
| 0.10      | **Loose, silty, gravelly SAND**  
| 0.40      | **Cemented to strongly cemented CALCRETE**                                   |
| 0.5       | **Refusal on strongly cemented calcrete**                                    |
| 1.0       | End of Log                                                                   |

**Dynamic Probe Light Equivalent SPT-N**

- 10
- 20
- 30
- 40

**NOTES**

1: No seepage  
2: Sample: AE/O6/1 at 100 - 400mm  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 4 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R.Roberts  
**CHECKED BY:**  

**FILE REF:** PJ112/10/Olien/Winlog  
**PROF Reg:**  

---

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---

**Template:** SMEC TP04
### Depth vs. Description

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<td>Ground Surface</td>
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<tr>
<td>0.10</td>
<td><strong>Loose, silty, gravelly SAND</strong></td>
</tr>
<tr>
<td></td>
<td>Slightly moist, light brown. Calcrete gravel.</td>
</tr>
<tr>
<td></td>
<td>Fine medium and coarse. Topsoil.</td>
</tr>
<tr>
<td>0.30</td>
<td><strong>Strongly cemented CALCRETE</strong></td>
</tr>
<tr>
<td></td>
<td>Refusal on strongly cemented calcrete</td>
</tr>
<tr>
<td>0.5</td>
<td></td>
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<tr>
<td>1.0</td>
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<tr>
<td>1.5</td>
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</tr>
<tr>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td></td>
</tr>
</tbody>
</table>

#### Notes

1: No seepage  
2: No samples  
3:  
4:  

---

**MACHINE:** CAT 428F  
**DATE PROFILED:** 4 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**CHECKED BY:**  
**FILE REF:** PJ112/10/Olien/Winlog  
---

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TRIAL PIT LOG
CLIENT: AE AMD Renewable Energy
PROJECT: Olien PV Power Plant
PROJECT NO: PJ112/10
SITE: Lime Acres, Northern Cape

HOLE NO: AE/08
X COORD: 3,136,098
Y COORD: Lo23 -60,570
ELEVATION:

Depth | Description |
--- | --- |
0.0 | Ground Surface |
0.10 | Loose, silty, gravelly SAND Slightly moist, light brown. Calcrete gravel. Fine medium and coarse. Topsoil. |
0.30 | Strongly cemented CALCRETE Refusal on strongly cemented calcrete |

Dynamic Probe Light Equivalent SPT-N

10 20 30 40

NOTES
1: No seepage
2: No samples
3:
4:

MACHINE: CAT 428F
DIAM: Trench
FILE REF: PJ112/10/Olien/Winlog

DATE PROFILED: 5 March 2013
PROFILED BY: R. Roberts
CHECKED BY:

Prof Reg:

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Template: SMEC TP04
<table>
<thead>
<tr>
<th>Depth</th>
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</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10  | Loose, silty, gravelly SAND  
Cemented to strongly cemented CALCRETE |
| 0.50  | Refusal on strongly cemented calcrite  
End of Log |

**NOTES**
- 1: No seepage
- 2: No samples
- 3:
- 4:

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**FILE REF:** PJ112/10/Olien/Winlog  
**CHECKED BY:**  

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### TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

---

**HOLE NO:** AE/O10  
**X COORD:** 3,135,978  
**Y COORD:** Lo23, -61,063  
**ELEVATION:**

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### Depth vs. Description

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| 0.0   | Ground Surface  
| 0.10  | **Loose, silty, gravelly SAND**  
| 0.20  | Slightly moist, light brown. Calcrete gravel. Fine medium and coarse. Topsoil.  
|       | **Strongly cemented CALCRETE**  
|       | Refusal on strongly cemented calcrete  
|       | End of Log

---

**NOTES**  
1: No seepage  
2: No samples  
3:  
4: 

---

**MACHINE:** CAT 428F  
**DIAM:** Trench  
**DATE PROFILED:** 5 March 2013  
**PROFILED BY:** R. Roberts  
**CHECKED BY:**

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**Template:** SMEC TP04
### TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape  

**HOLE NO:** AE/O11  
**X COORD:** 3,135,926  
**Y COORD:** Lo23 -61,274  
**ELEVATION:**

**NOTES:**  
1: No seepage  
2: No samples  
3:  
4:  

---

#### Depth

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<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Ground Surface</td>
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</tbody>
</table>
| 0.10  | **Loose, silty, gravelly SAND**  
| 0.30  | **Strongly cemented CALCRETE**  
        | Refusal on strongly cemented calcrete |

---

#### Dynamic Probe Light Equivalent SPT-N

<table>
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**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**CHECKED BY:** Prof Reg:  
**FILE REF:** PJ112/10/ Olien/Winlog  
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Template: SMEC TP04
**TRIAL PIT LOG**

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

**HOLE NO:** AE/012  
**X COORD:** 3,136,337  
**Y COORD:** Lo23 -60,533  
**ELEVATION:**

---

**NOTES**  
1: No seepage  
2: No samples  
3:  
4:  

---

**MACHINE:** CAT 428F  
**DIAM:** Trench  
**DATE PROFILED:** 5 March 2013  
**PROF FILED BY:** R.Roberts  
**CHECKED BY:**  

---

**Description**

<table>
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</thead>
<tbody>
<tr>
<td>0.00</td>
<td><strong>Ground Surface</strong></td>
</tr>
<tr>
<td>0.10</td>
<td><strong>Loose, silty, gravelly SAND</strong></td>
</tr>
<tr>
<td>0.30</td>
<td><strong>Strongly cemented CALCRETE</strong></td>
</tr>
<tr>
<td></td>
<td>Refusal on strongly cemented calcrete</td>
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</tbody>
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**Template:** SMEC TP04

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<table>
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</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
<tr>
<td>0.10</td>
<td><strong>Loose, silty, gravelly SAND</strong></td>
</tr>
<tr>
<td>0.40</td>
<td><strong>Strongly cemented CALCRETE</strong></td>
</tr>
<tr>
<td>0.5</td>
<td><strong>Refusal on strongly cemented calcrete</strong></td>
</tr>
<tr>
<td></td>
<td>End of Log</td>
</tr>
</tbody>
</table>

**NOTES**
1: No seepage
2: No samples
3: 
4: 

**MACHINE:** CAT 428F  **DATE PROFILED:** 5 March 2013
**DIAM:** Trench  **PROFILED BY:** R. Roberts  **Prof Reg:**
**FILE REF:** PJ112/10/Olien/Winlog  **CHECKED BY:**  **Prof Reg:**

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**TRIAL PIT LOG**

CLIENT: AE AMD Renewable Energy  
PROJECT: Olien PV Power Plant  
PROJECT NO: PJ112/10  
SITE: Lime Acres, Northern Cape

**HOLE NO: AE/O14**  
X COORD: 3,136,190  
Y COORD: Lo23 -60,992  
ELEVATION: 

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</tbody>
</table>
| 0.10      | **Loose, silty, gravelly SAND**  
| 0.30      | **Strongly cemented CALCRETE**  
Refusal on strongly cemented calcrete |

**Dynamic Probe Light Equivalent SPT-N**

<table>
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<tr>
<td>0.30</td>
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<td></td>
</tr>
</tbody>
</table>

**NOTES**

1: No seepage  
2: No samples  
3:  
4:  

MACHINE: CAT 428F  
DIAM: Trench  
FILE REF: PJ112/10/Olien/Winlog  
DATE PROFILED: 5 March 2013  
PROFILED BY: R.Roberts  
CHECKED BY:  
Prof Reg:  
Prof Reg:  

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Template: SMEC TP04
## Trial Pit Log

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

### Hole No: AE/O15

- **X COORD:** 3,136,146  
- **Y COORD:** Lo23 -61,221  
- **ELEVATION:**

### Depth vs Description

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<tbody>
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</tr>
</tbody>
</table>
| 0.10  | **Loose, silty, gravelly SAND**  
| 0.30  | **Strongly cemented CALCRETE**  
       | Refusal on strongly cemented calcrete             |

### Dynamic Probe Light Equivalent SPT-N

<table>
<thead>
<tr>
<th>Depth (m)</th>
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<td>0.10</td>
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<td></td>
</tr>
<tr>
<td>0.30</td>
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<td></td>
<td></td>
</tr>
</tbody>
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### Notes

1: No seepage  
2: No samples  
3:  
4:  

---

**Machine:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R.Roberts  
**CHECKED BY:**  
**FILE REF:** PJ112/10/Olien/Winlog  
**PROF REG:**

---

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### TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10     | **Loose, silty, gravelly SAND**  
**Strongly cemented CALCRETE** |
| 0.50     | **Refusal on strongly cemented calcrite**                                   |

**NOTES**  
1: No seepage  
2: Sample: AE/O16 at 100 - 500mm  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**CHECKED BY:**  
**FILE REF:** PJ112/10/Olien/Winlog  
**PROF Reg:**  

**HOLE NO:** AE/O16  
**X COORD:** 3,136,566  
**Y COORD:** Lo23 -60,645  
**ELEVATION:**
## TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

### HOLE NO: AE/O17

**X COORD:** 3,136,468  
**Y COORD:** Lo23 -60,824  
**ELEVATION:**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Dynamic Probe Light Equivalent SPT-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
<td>10 20 30 40</td>
</tr>
<tr>
<td>0.10</td>
<td><strong>Loose, silty, gravelly SAND</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Slightly moist, light brown. Calcrete gravel. Fine to</td>
<td></td>
</tr>
<tr>
<td></td>
<td>medium. Topsoil.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Cemented to strongly cemented CALCRETE</strong></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td><strong>Refusal on strongly cemented calcrete</strong></td>
<td>End of Log</td>
</tr>
<tr>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### NOTES
1: No seepage  
2: No samples  
3:  
4:

**MACHINE:** CAT 428F  
**DIAM:** Trench  
**DATE PROFILED:** 5 March 2013  
**PROFILED BY:** R. Roberts  
**CHECKED BY:** Prof Reg

- **Prof Reg:**
- **DATE PROFILED:** 5 March 2013
- **MACHINE:** CAT 428F
- **DIAM:** Trench
- **FILE REF:** PJ112/10/Olien/Winlog

---

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## TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

### Depth

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10  | **Loose, silty, gravelly SAND**  
| 0.30  | **Strongly cemented CALCRETE**  
|       | Refusal on strongly cemented calcrete                                       |
| 3.0   | End of Log                                                                  |

### Dynamic Probe Light Equivalent SPT-N

<table>
<thead>
<tr>
<th>Depth</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes

1: No seepage  
2: No samples  
3:  
4:  

---

**MACHINE:** CAT 428F  
**DIAM:** Trench  
**FILE REF:** PJ112/10/Olien/Winlog  
**DATE PROFILED:** 5 March 2013  
**PROFILED BY:** R.Roberts  
**CHECKED BY:**  
**Prof Reg:**  
**X COORD:** 3,136,405  
**Y COORD:** Lo23 -61,040  
**ELEVATION:**  
**SMEC South Africa**  
**Consulting Engineers**

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Template: SMEC TP04
TRIAL PIT LOG

CLIENT: AE AMD Renewable Energy
PROJECT: Olien PV Power Plant
PROJECT NO: PJ112/10
SITE: Lime Acres, Northern Cape

HOLE NO: AE/O19
X COORD: 3,136,366
Y COORD: Lo23 -61,260
ELEVATION: 

NOTES
1: No seepage
2: No samples
3:
4:

MACHINE: CAT 428F
DIAM: Trench
FILE REF: PJ112/10/Olien/Winlog

DATE Profiled: 5 March 2013
PROFILED BY: R. Roberts
CHECKED BY:

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Template: SMEC TP04

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Dynamic Probe Light Equivalent SPT-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
<td>10 20 30 40</td>
</tr>
<tr>
<td>0.10</td>
<td>Loose, silty, gravelly SAND</td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td>Strongly cemented CALCRETE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Refusal on strongly cemented calcrete</td>
<td></td>
</tr>
</tbody>
</table>

End of Log
<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
<tr>
<td>0.20</td>
<td><strong>Loose, silty, gravelly SAND</strong> Slightly moist, light brown. Calcrete gravel. Fine to medium. Topsoil.</td>
</tr>
<tr>
<td>0.40</td>
<td><strong>Strongly cemented CALCRETE</strong></td>
</tr>
<tr>
<td>0.5</td>
<td><strong>Refusal on strongly cemented calcrete</strong></td>
</tr>
</tbody>
</table>

End of Log
# TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10  | **Loose, silty, gravelly SAND**  
**Strongly cemented CALCRETE** |
| 0.40  | **Refusal on strongly cemented calcrete**        |
| 0.5   |                                                   |
| 1.0   |                                                   |
| 1.5   |                                                   |
| 2.0   |                                                   |
| 2.5   |                                                   |
| 3.0   |                                                   |

**NOTES**  
1: No seepage  
2: No samples  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**FILE REF:** PJ112/10/Olien/Winlog  

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## TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

### HOLE NO: AE/O22
- **X COORD:** 3,136,650  
- **Y COORD:** Lo23 -61,099  
- **ELEVATION:**

### Depth | Description | Dynamic Probe Light Equivalent SPT-N
--- | --- | ---
0.0 | **Ground Surface**
0.10 | **Loose, silty, gravelly SAND**  
0.20 | **Strongly cemented CALCRETE**  
Refusal on strongly cemented calcrete

### NOTES
1: No seepage  
2: No samples
3: 
4: 

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**PROF Reg:**

**FILE REF:** PJ112/10/Olien/Winlog  
**CHECKED BY:**  
**Prof Reg:**

---

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**TRIAL PIT LOG**

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape  

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10  | **Loose, silty, gravelly SAND**  
| 0.20  | **Strongly cemented CALCRETE**  
Refusal on strongly cemented calcrete |

---

**NOTES**

1: No seepage  
2: Sample: AE/O23/1 at 100 - 200mm  
3:  
4: 

**MACHINE:** CAT 428F  
**DATE PROFITED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**CHECKED BY:**  

Template: SMEC TP04
## TRIAL PIT LOG

### CLIENT:
AE AMD Renewable Energy

### PROJECT:
Olien PV Power Plant

### PROJECT NO:
PJ112/10

### SITE:
Lime Acres, Northern Cape

### HOLE NO:
AE/O24

### X COORD:
3,136,911

### Y COORD:
Lo23 -61,087

### ELEVATION:

### NOTES:
1: No seepage
2: No samples
3:
4:

---

### Dynamic Probe Light Equivalent SPT-N

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Ground Surface</td>
</tr>
<tr>
<td>0.10</td>
<td>Loose, silty, gravelly SAND</td>
</tr>
<tr>
<td>0.20</td>
<td>Slightly moist, light brown. Calcrete gravel. Fine medium and coarse. Topsoil.</td>
</tr>
<tr>
<td>0.30</td>
<td>Strongly cemented CALCRETE</td>
</tr>
<tr>
<td>0.40</td>
<td>Refusal on strongly cemented calcrete</td>
</tr>
</tbody>
</table>

---

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R.Roberts  
**CHECKED BY:**  
**FILE REF:** PJ112/10/Olien/Winlog  
**PROF Reg:**  

---

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Template: SMEC TP04
**TRIAL PIT LOG**

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

**HOLE NO:** AE/O25  
**X COORD:** 3,136,784  
**Y COORD:** Lo23 -61,325  
**ELEVATION:**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td><strong>Ground Surface</strong></td>
</tr>
</tbody>
</table>
| 0.10     | **Loose, silty, gravelly SAND**  
| 0.30     | **Strongly cemented CALCRETE**  
Refusal on strongly cemented calcrete |

**Dynamic Probe Light Equivalent SPT-N**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES**

1: No seepage  
2: No samples  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 4 March 2013  
**DIAM:** Trench  
**PROFILES BY:** R. Roberts  
**FILE REF:** PJ112/10/Olien/Winlog  
**CHECKED BY:**  

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Template: SMEC TP04
### TRAIL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10  | **Loose, silty, gravelly SAND**  
| 0.30  | **Cemented to strongly cemented CALCRETE**  
Refusal on strongly cemented calcrete |

**NOTES**  
1: No seepage  
2: No samples  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**Prof Reg:**  
**FILE REF:** PJ112/10/Olien/Winlog  
**CHECKED BY:**  
**Prof Reg:**  

**HOLE NO:** AE/O26  
**X COORD:** 3,136,652  
**Y COORD:** Lo23 -61,558  
**ELEVATION:**  

---

**Dynamic Probe Light Equivalent SPT-N**

<table>
<thead>
<tr>
<th>Depth</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**End of Log**

---

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## Trial Pit Log

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape  

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10      | **Loose, silty, gravelly SAND**  
| 0.30      | **Strongly cemented CALCRETE**  
Refusal on strongly cemented calcrete |

<table>
<thead>
<tr>
<th>Dynamic Probe Light Equivalent SPT-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

**NOTES**  
1: No seepage  
2: No samples  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**Prof Reg:**  
**FILE REF:** PJ112/10/Olien/Winlog  
**CHECKED BY:**  
**Prof Reg:**  

**HOLE NO:** AE/O27  
**X COORD:** 3,137,045  
**Y COORD:** Lo23 -61,293  
**ELEVATION:**  

---

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# TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

## HOLE NO: AE/O28

- **X COORD:** 3,136,903  
- **Y COORD:** Lo23 -61,533  
- **ELEVATION:**

---

### TRIAL PIT LOG

**AE AMD Renewable Energy**  
**Olien PV Power Plant**  
**PJ112/10**  
**Lime Acres, Northern Cape**

---

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10  | Loose, silty, gravelly SAND  
|       | Cemented to strongly cemented CALCRETE |
| 0.40  | Refusal on strongly cemented calcrete |

---

**NOTES**  
1: No seepage  
2: No samples  
3:  
4:  

---

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R.Roberts  
**CHECKED BY:**

---

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**Consulting Engineers**  
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---

**Template:** SMEC TP04
## TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape  

**HOLE NO:** AE/O29  
**X COORD:** 3,137,109  
**Y COORD:** Lo23 -61,635  
**ELEVATION:**

### Depth

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10  | Loose, silty, gravelly SAND  
| 0.20  | Strongly cemented CALCRETE  
Refusal on strongly cemented calcrete |
| 0.30  | End of Log |

### Dynamic Probe Light  
**Equivalent SPT-N**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Equivalent SPT-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES**  
1: No seepage  
2: No samples  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**FILE REF:** PJ112/10/Olien/Winlog  
**CHECKED BY:**  

---

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---

**Template:** SMEC TP04
### Trial Pit Log

**HOLE NO:** AE/O30  
**X COORD:** 3,135,238  
**Y COORD:** Lo23 -61,649  
**ELEVATION:**

---

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

---

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10  | Loose, silty, gravelly SAND  
Cemented to strongly cemented CALCRETE |
| 0.50  | Refusal on strongly cemented calcrete  
End of Log |

---

**NOTES:**  
1: No seepage  
2: No samples  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R.Roberts  
**CHECKED BY:**  
**FILE REF:** PJ112/10/Olien/Winlog  
**PROF REG:**  

---

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---

Template: SMEC TP04
## TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

### HOLE NO: AE/O31

- **X COORD:** 3,135,239  
- **Y COORD:** Lo23 -61,819  
- **ELEVATION:**

### NOTES
1: No seepage  
2: No samples  
3:  
4: 

### MACHINE
CAT 428F  
DIAM: Trench  
FILE REF: PJ112/10/Olien/Winlog

### MACHINE
DATE PROFILED: 5 March 2013  
PROFILED BY: R.Roberts  
CHECKED BY: 

---

### DEPTH | DESCRIPTION |
--- | --- |
0.0 | Ground Surface |
0.10 | **Loose, silty, gravelly SAND**  
| **Cemented to strongly cemented CALCRETE** |
0.40 | **Refusal on strongly cemented calcrete**  
| **End of Log** |

### Dynamic Probe Light Equivalent SPT-N

| Depth | 10 | 20 | 30 | 40 |
--- | --- | --- | --- | --- |
0.0 |  |  |  |  |
0.10 |  |  |  |  |
0.40 |  |  |  |  |
## TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

### NOTES

1: No seepage  
2: No samples  
3:  
4: 

### MACHINE

CAT 428F  
Diam: Trench  
FILE REF: PJ112/10/Olien/Winlog

### DATE PROFILED

5 March 2013  
Profiled: R. Roberts  
Checked:  
Prof Reg:

---

### Depth | Description
--- | ---
0.0 | Ground Surface
0.10 | Loose, silty, gravelly SAND  
0.40 | Strongly cemented CALCRETE

### Dynamic Probe Light Equivalent SPT-N

<table>
<thead>
<tr>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
</table>

---

### Description

- **Ground Surface**
- **Loose, silty, gravelly SAND**
- **Strongly cemented CALCRETE**
- **Refusal on strongly cemented calcrete**

---

**HOLE NO:** AE/O32  
**X COORD:** 3,135,428  
**Y COORD:** Lo23 -61,504  
**ELEVATION:**

---

**AE AMD Renewable Energy**  
Olien PV Power Plant  
PJ112/10  
Lime Acres, Northern Cape

---

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---

**Template:** SMEC TP04
### TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Dynamic Probe Light Equivalent SPT-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Ground Surface</td>
<td></td>
</tr>
</tbody>
</table>
| 0.10  | **Loose, silty, gravelly SAND**  
**Strongly cemented CALCRETE**  
Refusal on strongly cemented calcrite |  
| 0.40  |  
End of Log |  

**NOTES**  
1: No seepage  
2: No samples  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**FILE REF:** PJ112/10/Olien/Winlog  
**CHECKED BY:**  

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## Trial Pit Log

**HOLE NO:** AE/O34  
**X COORD:** 3,135,427  
**Y COORD:** Lo23 -61,986  
**ELEVATION:**

**Notes:**
1. No seepage  
2. No samples  
3.  
4.  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**Prof Reg:**  
**FILE REF:** PJ112/10/Olien/Winlog  
**CHECKED BY:**  
**Prof Reg:**

---

### Depth Log

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10      | Loose, silty, gravelly SAND  
|           | Refusal on strongly cemented calcrete |
| 0.0       | End of Log |

---

### Log Details

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape  

**Depth** | **Description**
---|---
10 | Dynamic Probe Light Equivalent SPT-N
20 |  
30 |  
40 | 

---

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## Trial Pit Log

**Client:** AE AMD Renewable Energy  
**Project:** Olien PV Power Plant  
**Project No:** PJ112/10  
**Site:** Lime Acres, Northern Cape

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Ground Surface</td>
</tr>
<tr>
<td>0.10</td>
<td>Loose, silty, gravelly SAND</td>
</tr>
<tr>
<td>0.20</td>
<td>Slightly moist, light brown. Calcrete gravel. Fine medium and coarse. Topsoil.</td>
</tr>
<tr>
<td>0.20</td>
<td>Strongly cemented CALCRETE</td>
</tr>
<tr>
<td>0.20</td>
<td>Refusal on strongly cemented calcrete</td>
</tr>
<tr>
<td></td>
<td>End of Log</td>
</tr>
</tbody>
</table>

**Depth**

<table>
<thead>
<tr>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
</tr>
<tr>
<td>0.50</td>
</tr>
<tr>
<td>1.00</td>
</tr>
<tr>
<td>1.50</td>
</tr>
<tr>
<td>2.00</td>
</tr>
<tr>
<td>2.50</td>
</tr>
<tr>
<td>3.00</td>
</tr>
</tbody>
</table>

**Notes**

1: No seepage  
2: Sample: AE/O35/1 at 100 - 200mm  
3:  
4:

**Machine:** CAT 428F  
**Date Profiled:** 5 March 2013  
**Diam:** Trench  
**Profiled By:** R. Roberts  
**File Ref:** PJ112/10/Olien/Winlog  
**Checked By:**  

**Template:** SMEC TP04  
**SMEC South Africa Consulting Engineers**  
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<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Dynamic Probe Light</th>
<th>Equivalent SPT-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td>Loose, silty, gravelly SAND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td>Strongly cemented CALCRETE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES**
1: No seepage
2: No samples
3: 
4: 

**MACHINE:** CAT 428F  
**DATE ProfileD:** 5 March 2013
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**CHECKED BY:** Prof Reg

**FILE REF:** PJ112/10/Olien/Winlog  
**Template:** SMEC TP04

**HOLE NO:** AE/O36
**X COORD:** 3,135,611
**Y COORD:** Lo23 -61,763
**ELEVATION:**
### TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Dynamic Probe Light Equivalent SPT-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Ground Surface</td>
<td></td>
</tr>
</tbody>
</table>
| 0.10  | **Loose, silty, gravelly SAND**  
| 0.30  | **Strongly cemented CALCRETE**  
Refusal on strongly cemented calcrete |                                      |

**NOTES**  
1: No seepage  
2: No samples  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 4 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**Prof Reg:**  
**FILE REF:** PJ112/10/Olien/Winlog  
**CHECKED BY:**  
**Prof Reg:**  

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---

**HOLE NO:** AE/O37  
**X COORD:** 3,135,628  
**Y COORD:** Lo23 -62,001  
**ELEVATION:**
## TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

### HOLE NO: AE/O38

**X COORD:** 3,135,818  
**Y COORD:** Lo23 -61,165  
**ELEVATION:**

### NOTES

1: No seepage  
2: No samples  
3:  
4: 

---

### Depth | Description
--- | ---
0.0 | Ground Surface  
0.20 | **Loose, silty SAND**  
Slightly moist, light brown. Topsoil.  
0.50 | **Cemented to strongly cemented CALCRETE**  

---

### Dynamic Probe Light Equivalent SPT-N

<table>
<thead>
<tr>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
</table>

---

### MACHINE: CAT 428F  
**DIAM:** Trench  
**DATE PROFILED:** 5 March 2013  
**FILE REF:** PJ112/10/Olien/Winlog  
**PROFILED BY:** R.Roberts  
**CHECKED BY:**  
**Prof Reg:**  
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# Trial Pit Log

**Client:** AE AMD Renewable Energy  
**Project:** Olien PV Power Plant  
**Project No:** PJ112/10  
**Site:** Lime Acres, Northern Cape

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Ground Surface</td>
</tr>
<tr>
<td>0.10</td>
<td>Loose, silty SAND</td>
</tr>
<tr>
<td></td>
<td>Refusal on strongly cemented calcrite</td>
</tr>
</tbody>
</table>

**Notes:** 1: No seepage  
2: No samples  
3:  
4:  

**Machine:** CAT 428F  
**Date Profiled:** 5 March 2013  
**Profiled By:** R. Roberts  
**Prof Reg:**  
**File Ref:** PJ112/10/Olien/Winlog  
**Checked By:**  
**Prof Reg:**

---

**Hole No:** AE/O39  
**X Coord:** 3,135,820  
**Y Coord:** Lo23 -61,915  
**Elevation:**

---

**Dynamic Probe Light Equivalent SPT-N**

<table>
<thead>
<tr>
<th>Depth</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
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<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
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</tr>
<tr>
<td>0.60</td>
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<tr>
<td>0.70</td>
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<tr>
<td>0.80</td>
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<td></td>
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<tr>
<td>0.90</td>
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<tr>
<td>1.00</td>
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</tr>
<tr>
<td>1.50</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

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**Consulting Engineers**

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Template: SMEC TP04
### TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Dynamic Probe Light Equivalent SPT-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Ground Surface</td>
<td></td>
</tr>
</tbody>
</table>
| 0.10  | **Loose, silty SAND**  
| 0.30  | **Strongly cemented CALCRETE**  
Refusal on strongly cemented calcrete |                                      |

End of Log

---

**NOTES**  
1: No seepage  
2: Sample: AE/O40/1 at 100 - 300mm  
3:  
4:  

**MACHINE:** CAT 428F  
**DIAM:** Trench  
**DATE PROFILLED:** 5 March 2013  
**PROFILED BY:** R.Roberts  
**CHECKED BY:**  
**FILE REF:** PJ112/10/Olien/Winlog  
**CHECKED BY:** Prof Reg:

---

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## Trial Pit Log

**Client:** AE AMD Renewable Energy  
**Project:** Olien PV Power Plant  
**Project No:** PJ112/10  
**Site:** Lime Acres, Northern Cape

### Hole No: AE/O41

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Dynamic Probe Light Equivalent SPT-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Ground Surface</td>
<td></td>
</tr>
</tbody>
</table>
| 0.10  | Loose, silty SAND  
Refusal on strongly cemented calcrete | 10 | 20 | 30 | 40 |
| ...   | ...         |                                      |
| ...   | ...         |                                      |
| 3.00  | End of Log  |                                      |

### Notes
1: No seepage  
2: No samples  
3:  
4:  

**Machine:** CAT 428F  
**Date Profiled:** 5 March 2013  
**Profosed By:** R. Roberts  
**Prof Reg:**  
**File Ref:** PJ112/10/Olien/Winlog  
**Checked By:**  
**Prof Reg:**  

---

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### Trial Pit Log

**Hole No:** AE/O42  
**X Coord:** 3,136,280  
**Y Coord:** Lo23 -61,745  
**Elevation:**

**Client:** AE AMD Renewable Energy  
**Project:** Olien PV Power Plant  
**Project No:** PJ112/10  
**Site:** Lime Acres, Northern Cape

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Dynamic Probe Light Equivalent SPT-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
<td></td>
</tr>
</tbody>
</table>
| 0.1  | **Loose, silty SAND**  
**Strongly cemented CALCRITE** | 10  
20  
30  
40 |
| 0.4  | **Refusal on strongly cemented calcrete** | End of Log |

**Notes**  
1: No seepage  
2: No samples  
3:  
4:  

**Machinery:** CAT 428F  
**Date Profiled:** 4 March 2013  
**Profiled By:** R. Roberts  
**Prof Reg:**  
**File Ref:** PJ112/10/Olien/Winlog  
**Checked By:**  
**Prof Reg:**

---

Template: SMEC TP04
# TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape  

**HOLE NO:** AE/O43  
**X COORD:** 3,136,279  
**Y COORD:** Lo23 -61,989  
**ELEVATION:**

## Depth

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10  | Loose, silty SAND  
Cemented to strongly cemented CALCRETE |
| 0.40  | Refusal on strongly cemented calcrete |
| 3.0   | End of Log |

### Dynamic Probe Light Equivalents SPT-N

<table>
<thead>
<tr>
<th>Depth</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES**

1: No seepage  
2: No samples  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 5 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R.Roberts  
**FILE REF:** PJ112/10/Olien/Winlog  
**CHECKED BY:**  

---

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<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ground Surface</td>
</tr>
<tr>
<td>0.10</td>
<td>Loose, silty SAND</td>
</tr>
<tr>
<td>0.40</td>
<td>Cemented to strongly cemented CALCRETE</td>
</tr>
<tr>
<td>0.5</td>
<td>Refusal on strongly cemented calcrlte</td>
</tr>
<tr>
<td>2.0</td>
<td>End of Log</td>
</tr>
<tr>
<td>3.0</td>
<td></td>
</tr>
</tbody>
</table>

NOTES
1: No seepage
2: Sample: AE/O44/1 at 100 - 400mm
3: |
4: |

MACHINE: CAT 428F
DIAM: Trench
FILE REF: PJ112/10/Olien/Winlog

DATE PROFILED: 5 March 2013
PROFILED BY: R.Roberts
CHECKED BY: |

Template: SMEC TP04

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## TRIAL PIT LOG

**CLIENT:** AE AMD Renewable Energy  
**PROJECT:** Olien PV Power Plant  
**PROJECT NO:** PJ112/10  
**SITE:** Lime Acres, Northern Cape

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Ground Surface</td>
</tr>
</tbody>
</table>
| 0.10  | **Loose, silty SAND**  
| 0.30  | **Strongly cemented CALCRETE**  
Refusal on strongly cemented calcrete |

### Dynamic Probe Light Equivalent SPT-N

<table>
<thead>
<tr>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### NOTES

1: No seepage  
2: No samples  
3:  
4:  

**MACHINE:** CAT 428F  
**DATE PROFILED:** 4 March 2013  
**DIAM:** Trench  
**PROFILED BY:** R. Roberts  
**CHECKED BY:**  
**FILE REF:** PJ112/10/Olien/Winlog  
**PROF Reg:**

---

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---

Template: SMEC TP04
Appendix B

Profiling and Logging Parameters
1. SOIL DESCRIPTIVE TERMS

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

1(a) CONSISTENCY: GRANULAR SOILS

<table>
<thead>
<tr>
<th>SPT “N”</th>
<th>GRAVELS &amp; SANDS</th>
<th>TYPICAL DRY DENSITY (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4</td>
<td>VERY LOOSE</td>
<td>Crumbles very easily when scraped with geological pick</td>
</tr>
<tr>
<td>4-10</td>
<td>LOOSE</td>
<td>Small resistance to penetration by sharp pick point</td>
</tr>
<tr>
<td>10-30</td>
<td>MEDIUM DENSE</td>
<td>Considerable resistance to penetration by sharp pick point</td>
</tr>
<tr>
<td>30-50</td>
<td>DENSE</td>
<td>Very high resistance to penetration by sharp pick point. Requires many blows of pick for excavation</td>
</tr>
<tr>
<td>&gt; 50</td>
<td>VERY DENSE</td>
<td>High resistance to repeated blows of geological pick. Requires power tools for excavation</td>
</tr>
</tbody>
</table>

1(b) CONSISTENCY: COHESIVE SOILS

<table>
<thead>
<tr>
<th>SPT “N”</th>
<th>SILTS &amp; CLAYS and combination with SANDS</th>
<th>UCS (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2</td>
<td>VERY SOFT</td>
<td>Pick point easily pushed in 100mm. Easily moulded by fingers</td>
</tr>
<tr>
<td>2-4</td>
<td>SOFT</td>
<td>Pick point easily pushed in 30-40mm. Easily penetrated by thumb.</td>
</tr>
<tr>
<td>4-8</td>
<td>FIRM</td>
<td>Pick point penetrates up to 10mm. Very difficult to mould with fingers. Spade just penetrates.</td>
</tr>
<tr>
<td>8-15</td>
<td>STIFF</td>
<td>Slight indentation by pushing in pick point. Cannot be moulded by fingers.</td>
</tr>
<tr>
<td>15-30</td>
<td>VERY STIFF</td>
<td>Slight indentation by blow of pick point. Requires power tools for excavation.</td>
</tr>
</tbody>
</table>

2. SOIL TYPE

<table>
<thead>
<tr>
<th>PARTICLE SIZE (mm)</th>
<th>CLAY</th>
<th>SILT</th>
<th>SAND</th>
<th>GRAVEL</th>
<th>COBBLES</th>
<th>BOULDERS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 0,002</td>
<td>0,002 – 0,06</td>
<td>0,06 – 2</td>
<td>2 – 60*</td>
<td>60 – 200*</td>
<td>&gt; 200*</td>
</tr>
</tbody>
</table>

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

4. COLOUR

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

- SPECKLED: Very small patches of colour < 2 mm
- MOTTLED: Irregular patches of colour 2 – 6 mm
- BLOTCHED: Large irregular patches 6 – 20 mm
- BANDED: Approximately parallel bands of varying colour
- STREAKED: Randomly orientated streaks of colour
- STAINED: Local colour variations: associated with discontinuity surfaces

Described using bedding thickness criteria. (e.g. thickly banded, thinly streaked, etc.)

5. MOISTURE CONDITION

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

6. ORIGIN

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

DEGREE OF CEMENTATION OF PEDOCRETES

<table>
<thead>
<tr>
<th>UCS (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,1 – 0,5</td>
</tr>
<tr>
<td>0,5 – 2</td>
</tr>
<tr>
<td>2 – 5</td>
</tr>
<tr>
<td>5 – 10</td>
</tr>
<tr>
<td>10 - 25</td>
</tr>
</tbody>
</table>

2. ROCK DESCRIPTIVE TERMS

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

1. ROCK HARDNESS

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

<table>
<thead>
<tr>
<th>HARDNESS</th>
<th>DESCRIPTION</th>
<th>UCS (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HARD ROCK</td>
<td>Breaks with difficulty, rings when struck. Point load or laboratory test results necessary to distinguish between categories</td>
<td>25 – 70</td>
</tr>
<tr>
<td>VERY HARD ROCK</td>
<td></td>
<td>70 – 200</td>
</tr>
<tr>
<td>VERY VERY HARD ROCK</td>
<td></td>
<td>&gt; 200</td>
</tr>
</tbody>
</table>

2. ROCK TYPE

Quartzite, sandstone, granite, limestone, etc.

3. WEATHERING

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

4. COLOUR

Described in the dry state unless otherwise indicated

5. DISCONTINUITY SPACING

<table>
<thead>
<tr>
<th>SEPARATION (mm)</th>
<th>SPACING (foliation, cleavage, bedding, etc.)</th>
<th>SPACING (fractures, joints, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 6</td>
<td>very intensely</td>
<td>very highly</td>
</tr>
<tr>
<td>6 – 20</td>
<td>intensly</td>
<td>highly</td>
</tr>
<tr>
<td>20 – 60</td>
<td>very thinly</td>
<td>highly</td>
</tr>
<tr>
<td>60 – 200</td>
<td>thinly</td>
<td>moderately</td>
</tr>
<tr>
<td>200 – 600</td>
<td>medium</td>
<td>moderately</td>
</tr>
<tr>
<td>&gt; 600</td>
<td>very thickly</td>
<td>very slightly</td>
</tr>
</tbody>
</table>

6. DISCONTINUITY SURFACE DESCRIPTION

6.1 JOINT FILLING

<table>
<thead>
<tr>
<th>JOINT FILL TYPE</th>
<th>DEFINITION (wall separation specified in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLEAN</td>
<td>No fracture filling</td>
</tr>
<tr>
<td>STAINED</td>
<td>Colouration of rock only. No recognisable filling material</td>
</tr>
<tr>
<td>FILLED</td>
<td>Fracture filled with finite thickness filling material</td>
</tr>
</tbody>
</table>

6.2 DISCONTINUITY ORIENTATION

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

6.3 ROUGHNESS OF DISCONTINUITY PLANES

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

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

7. GRAIN SIZE

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>SIZE (mm)</th>
<th>RECOGNITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERY FINE GRAINED</td>
<td>&lt; 0.2</td>
<td>Individual grains cannot be seen with a hand lens</td>
</tr>
<tr>
<td>FINE GRAINED</td>
<td>0.2 – 0.6</td>
<td>Just visible as individual grains under hand lens</td>
</tr>
<tr>
<td>MEDIUM GRAINED</td>
<td>0.6 – 2</td>
<td>Grains clearly visible under hand lens, just visible to the naked eye</td>
</tr>
<tr>
<td>COARSE GRAINED</td>
<td>2 – 6</td>
<td>Grains clearly visible to the naked eye</td>
</tr>
<tr>
<td>VERY COARSE GRAINED</td>
<td>&gt; 6</td>
<td>Grains measurable</td>
</tr>
</tbody>
</table>

8. ROCK FORMATION

Brixton Formation, Halfway House Granite Dome etc.

Appendix

Earth Resistance Measurements
1 Earth resistance measurements. 2.05.2012

1.1 Method used

The Wenner fall of potential method was used to measure the soil resistivity on the site.

1.2 Meter used

ETS MEGGER Earth Tester. Frequency used is 126 Hz.

1.3 Date Calibrated

2011.12.07

1.4 Results

In tables below.

3 Measurements on site results

3.1 SITE SUBSTATION AE / O7 Centre of substation site (North South direction)

<table>
<thead>
<tr>
<th>Spacing of electrodes (cm)</th>
<th>Multiplier</th>
<th>Reading Dials</th>
<th>Ground Resistance</th>
<th>Soil Resistivity Ohm-cm</th>
<th>Ohm-m</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>1</td>
<td>5 8 0</td>
<td>580 Ω</td>
<td>109341.60</td>
<td>1093.42</td>
</tr>
<tr>
<td>50</td>
<td>1</td>
<td>3 3 4</td>
<td>334 Ω</td>
<td>104942.80</td>
<td>1049.43</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
<td>2 0 4</td>
<td>204 Ω</td>
<td>128193.60</td>
<td>1281.94</td>
</tr>
<tr>
<td>200</td>
<td>0.1</td>
<td>2 4 0</td>
<td>240 Ω</td>
<td>30163.20</td>
<td>301.63</td>
</tr>
<tr>
<td>400</td>
<td>0.1</td>
<td>1 2 7</td>
<td>127 Ω</td>
<td>31922.72</td>
<td>319.23</td>
</tr>
<tr>
<td>600</td>
<td>0.1</td>
<td>0 8 4</td>
<td>8.4 Ω</td>
<td>31671.36</td>
<td>316.71</td>
</tr>
<tr>
<td>1200</td>
<td>0.1</td>
<td>0 3 5</td>
<td>9.35 Ω</td>
<td>26392.80</td>
<td>263.93</td>
</tr>
<tr>
<td>3000</td>
<td>0.01</td>
<td>1 3 2</td>
<td>1.32 Ω</td>
<td>24884.64</td>
<td>248.85</td>
</tr>
<tr>
<td>5500</td>
<td>0.01</td>
<td>1 4 3</td>
<td>1.43 Ω</td>
<td>49423.66</td>
<td>494.24</td>
</tr>
</tbody>
</table>

![Soil Resistivity (Ω-cm) Site Substation AE / O7]
### 3.2 SITE SUBSTATION AE / O7 Centre of substation site (East West direction)

<table>
<thead>
<tr>
<th>Spacing of electrodes (cm)</th>
<th>Multiplier</th>
<th>Reading Dials</th>
<th>Ground Resistance</th>
<th>Soil Resistivity $\Omega$-cm $\rho=\pi r^2 \ar$</th>
<th>Ohm-m</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>1</td>
<td>6 5 2</td>
<td>652</td>
<td>122915.04</td>
<td>1229.15</td>
</tr>
<tr>
<td>50</td>
<td>1</td>
<td>3 7 2</td>
<td>372</td>
<td>116882.40</td>
<td>1168.82</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
<td>1 3 0</td>
<td>130</td>
<td>81692.00</td>
<td>816.92</td>
</tr>
<tr>
<td>200</td>
<td>0.1</td>
<td>2 5 2</td>
<td>252</td>
<td>31671.36</td>
<td>316.71</td>
</tr>
<tr>
<td>400</td>
<td>0.1</td>
<td>1 1 6</td>
<td>116</td>
<td>29157.76</td>
<td>291.58</td>
</tr>
<tr>
<td>600</td>
<td>0.1</td>
<td>0 7 6</td>
<td>76</td>
<td>28655.04</td>
<td>286.55</td>
</tr>
<tr>
<td>1200</td>
<td>0.1</td>
<td>0 1 1 1</td>
<td>011</td>
<td>8294.88</td>
<td>82.95</td>
</tr>
<tr>
<td>3000</td>
<td>0.1</td>
<td>0 2 1 021</td>
<td>2.10</td>
<td>39589.20</td>
<td>395.89</td>
</tr>
<tr>
<td>5500</td>
<td>0.1</td>
<td>0 3 2 032</td>
<td>3.20</td>
<td>110598.40</td>
<td>1105.98</td>
</tr>
</tbody>
</table>

**SOIL RESISTIVITY TESTS**

![Soil Resistivity (Ω-cm) Site AE / O7 Substation graph](image1)

### 3.3 AE / O4

<table>
<thead>
<tr>
<th>Spacing of electrodes (cm)</th>
<th>Multiplier</th>
<th>Reading Dials</th>
<th>Ground Resistance</th>
<th>Soil Resistivity $\Omega$-cm $\rho=\pi r^2 \ar$</th>
<th>Ohm-m</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>1</td>
<td>8 4 5</td>
<td>845</td>
<td>159299.40</td>
<td>1592.99</td>
</tr>
<tr>
<td>50</td>
<td>1</td>
<td>1 7 0</td>
<td>170</td>
<td>53414.00</td>
<td>534.14</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
<td>0 8 0</td>
<td>170</td>
<td>50272.00</td>
<td>502.72</td>
</tr>
<tr>
<td>200</td>
<td>1</td>
<td>1 1 9</td>
<td>119</td>
<td>149559.20</td>
<td>1495.59</td>
</tr>
<tr>
<td>400</td>
<td>1</td>
<td>0 6 4</td>
<td>64</td>
<td>160870.40</td>
<td>1608.70</td>
</tr>
<tr>
<td>600</td>
<td>1</td>
<td>1 3 0</td>
<td>130</td>
<td>490152.00</td>
<td>4901.52</td>
</tr>
<tr>
<td>1200</td>
<td>1</td>
<td>1 6 0</td>
<td>160</td>
<td>1206528.00</td>
<td>12065.28</td>
</tr>
</tbody>
</table>

**SOIL RESISTIVITY TESTS**

![Soil Resistivity (Ω-cm) Site AE / O4 graph](image2)
### 3.4 SITE AE / O13

#### SOIL RESISTIVITY TESTS

<table>
<thead>
<tr>
<th>Electrode Spacing (cm)</th>
<th>Multiplier</th>
<th>Reading Dials</th>
<th>Ground Resistance [Ω]</th>
<th>Soil Resistivity Ω-cm</th>
<th>Ohm-m</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>10</td>
<td>0 7 9</td>
<td>079 790.00 Ω</td>
<td>148930.80</td>
<td>1489.31</td>
</tr>
<tr>
<td>50</td>
<td>10</td>
<td>0 2 3</td>
<td>013 230.00 Ω</td>
<td>72266.00</td>
<td>722.66</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
<td>1 2 3</td>
<td>123 123.00 Ω</td>
<td>77239.20</td>
<td>772.93</td>
</tr>
<tr>
<td>200</td>
<td>1</td>
<td>0 4 2</td>
<td>042 42.00 Ω</td>
<td>52785.60</td>
<td>527.86</td>
</tr>
<tr>
<td>400</td>
<td>0.1</td>
<td>2 5 2</td>
<td>252 25.20 Ω</td>
<td>63342.72</td>
<td>633.43</td>
</tr>
<tr>
<td>600</td>
<td>0.01</td>
<td>1 0 2 4</td>
<td>210 2.10 Ω</td>
<td>7917.84</td>
<td>79.18</td>
</tr>
<tr>
<td>1200</td>
<td>0.01</td>
<td>4 1 1 0</td>
<td>410 4.10 Ω</td>
<td>30917.28</td>
<td>309.17</td>
</tr>
</tbody>
</table>

#### Soil Resistivity (Ω-cm) SITE AE / O13

![Graph](image)

### 3.5 SITE AE / O25

#### SOIL RESISTIVITY TESTS

<table>
<thead>
<tr>
<th>Electrode Spacing (cm)</th>
<th>Multiplier</th>
<th>Reading Dials</th>
<th>Ground Resistance [Ω]</th>
<th>Soil Resistivity Ω-cm</th>
<th>Ohm-m</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>1</td>
<td>7 7 0</td>
<td>770 770.00 Ω</td>
<td>145160.40</td>
<td>1451.60</td>
</tr>
<tr>
<td>50</td>
<td>1</td>
<td>2 6 0</td>
<td>260 260.00 Ω</td>
<td>81692.00</td>
<td>816.92</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
<td>1 4 8</td>
<td>148 148.00 Ω</td>
<td>93003.20</td>
<td>930.03</td>
</tr>
<tr>
<td>200</td>
<td>1</td>
<td>0 6 0</td>
<td>060 60.00 Ω</td>
<td>75408.00</td>
<td>754.08</td>
</tr>
<tr>
<td>400</td>
<td>1</td>
<td>0 6 0</td>
<td>060 60.00 Ω</td>
<td>150816.00</td>
<td>1508.16</td>
</tr>
<tr>
<td>600</td>
<td>10</td>
<td>0 1 0</td>
<td>010 100.00 Ω</td>
<td>377040.00</td>
<td>3770.40</td>
</tr>
<tr>
<td>1200</td>
<td>10</td>
<td>0 0 5</td>
<td>005 50.00 Ω</td>
<td>377040.00</td>
<td>3770.40</td>
</tr>
</tbody>
</table>

#### Soil Resistivity (Ω-cm) SITE AE / O25

![Graph](image)
### 3.6 SITE AE / O45

<table>
<thead>
<tr>
<th>Spacing of electrodes (cm)</th>
<th>Multiplier</th>
<th>Reading Dials</th>
<th>Ground Resistance [Ω]</th>
<th>Soil Resistivity ρ=2πar [Ω-cm]</th>
<th>Ohm-m</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>1</td>
<td>4 1 0</td>
<td>410</td>
<td>77293.20</td>
<td>772.93</td>
</tr>
<tr>
<td>50</td>
<td>1</td>
<td>6 1 0</td>
<td>610</td>
<td>191662.00</td>
<td>1916.62</td>
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<td>1</td>
<td>1 1 1 1</td>
<td>111</td>
<td>69752.40</td>
<td>697.52</td>
</tr>
<tr>
<td>200</td>
<td>1</td>
<td>0 3 6 036</td>
<td>36.00</td>
<td>45244.80</td>
<td>452.45</td>
</tr>
<tr>
<td>400</td>
<td>1</td>
<td>0 2 0 020</td>
<td>200.00</td>
<td>502720.00</td>
<td>5027.20</td>
</tr>
<tr>
<td>600</td>
<td>1</td>
<td>0 1 2 012</td>
<td>120.00</td>
<td>452448.00</td>
<td>452.48</td>
</tr>
<tr>
<td>1200</td>
<td>1</td>
<td>0 1 2 012</td>
<td>120.00</td>
<td>904896.00</td>
<td>904.896</td>
</tr>
</tbody>
</table>

#### Soil Resistivity (Ω-cm) SITE AE / O45

![Soil Resistivity Graph]

### 3.6 SITE AE / O42

<table>
<thead>
<tr>
<th>Spacing of electrodes (cm)</th>
<th>Multiplier</th>
<th>Reading Dials</th>
<th>Ground Resistance [Ω]</th>
<th>Soil Resistivity ρ=2πar [Ω-cm]</th>
<th>Ohm-m</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>1</td>
<td>0 6 4 064</td>
<td>64.00</td>
<td>120652.80</td>
<td>1206.53</td>
</tr>
<tr>
<td>50</td>
<td>1</td>
<td>0 3 8 038</td>
<td>38.00</td>
<td>119396.00</td>
<td>1193.96</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
<td>2 0 0 200</td>
<td>200.00</td>
<td>125680.00</td>
<td>1256.80</td>
</tr>
<tr>
<td>200</td>
<td>1</td>
<td>0 2 2 022</td>
<td>22.00</td>
<td>27649.60</td>
<td>276.50</td>
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<tr>
<td>400</td>
<td>1</td>
<td>4 2 2 422</td>
<td>42.00</td>
<td>1060739.20</td>
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<tr>
<td>600</td>
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<td>0 1 2 012</td>
<td>12.00</td>
<td>45244.80</td>
<td>452.45</td>
</tr>
<tr>
<td>1200</td>
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<td>2 9 2 292</td>
<td>292.00</td>
<td>2201913.60</td>
<td>22019.13</td>
</tr>
</tbody>
</table>

#### Soil Resistivity (Ω-cm) SITE AE / O42

![Soil Resistivity Graph]
### Soil Resistivity Tests

<table>
<thead>
<tr>
<th>Spacing of electrodes (cm)</th>
<th>Multiplier</th>
<th>Reading Dials</th>
<th>Ground Resistance (Ω)</th>
<th>Soil Resistivity (Ω-cm)</th>
<th>Ohm-m</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>10</td>
<td>0 8 1 081</td>
<td>810.00 Ω</td>
<td>152701.20</td>
<td>1527.01</td>
</tr>
<tr>
<td>50</td>
<td>1</td>
<td>4 1 0 410</td>
<td>410.00 Ω</td>
<td>128822.00</td>
<td>1288.22</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
<td>8 1 181</td>
<td>181.00 Ω</td>
<td>113740.40</td>
<td>1137.40</td>
</tr>
<tr>
<td>200</td>
<td>1</td>
<td>4 1 041</td>
<td>41.00 Ω</td>
<td>51528.80</td>
<td>515.29</td>
</tr>
<tr>
<td>400</td>
<td>1</td>
<td>0 9 109</td>
<td>109.00 Ω</td>
<td>273982.40</td>
<td>2739.82</td>
</tr>
<tr>
<td>600</td>
<td>10</td>
<td>0 3 003</td>
<td>30.00 Ω</td>
<td>113112.00</td>
<td>1131.12</td>
</tr>
<tr>
<td>1200</td>
<td>10</td>
<td>0 2 002</td>
<td>20.00 Ω</td>
<td>150816.00</td>
<td>1508.16</td>
</tr>
</tbody>
</table>

#### Soil Resistivity (Ω-cm)

![Soil Resistivity Graph](image-url)
Appendix

Laboratory Test Results
SAMPLE / LABORATORY No.: Sample AE/01 (013/0620), Sample AE/06 (013/0621), Sample AE/016 (013/0622), Sample AE/023 (013/0623), Sample AE/035 (013/0624), Sample AE/040 (013/0625), Sample AE/044 (013/0626)

DATE SAMPLE RECEIVED: 18/03/2013

DATE SAMPLE TESTED: 23/03/2013 - 05/04/2013

TESTING LABORATORY: Simalab (Pty) Limited (Kimberley)

SAMPLE REPORTED BY: Schantell Malan (Technical Assistant)

LOCATION SAMPLED: Olien Solar Plant

SAMPLE METHOD: Sampled by SMEC South Africa (Pty) Ltd

ENVIRONMENTAL CONDITIONS DURING SAMPLING: N/a

SAMPLE CONDITION: Sample in good condition, no deviations


TEST METHODS:
1.) The wet preparation and sieve analysis of gravel, sand and soil samples, TMH1 : 1986, Method A1(a)
2.) The determination of the liquid limit of soils by means of the flow curve method, THM1 : 1986, Method A2
3.) The determination of the plastic limit and plasticity index of soils, TMH1 : 1986, Method A3
4.) The determination of the linear shrinkage of soils, THM1 : 1986, Method A4
5.) The determination of the percentage of material passing a 0.075mm sieve in a soil sample, TMH1 : 1986, Method A5
6.) The determination of the grain size distribution in soils by means of a hydrometer, TMH1, 1986, Method A6

REMARKS:

NOTE: Report continues on next page, see attached sheet 2 of 2
<table>
<thead>
<tr>
<th>CLIENT &amp; PROJECT</th>
<th>SMEC SOUTH AFRICA (PTY) LTD - Construction of new Solar Plant in Lime Archers</th>
<th>DATE: 05/04/2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOLE No. / KM (Chainage)</td>
<td>AE/01 0.1 - 0.3 0.1 - 0.4 0.1 - 0.5 0.1 - 0.2</td>
<td>AE/06 AE/016 AE/023</td>
</tr>
<tr>
<td>MATERIAL DEPTH (mm)</td>
<td>0.1 - 0.3 0.1 - 0.4 0.1 - 0.5 0.1 - 0.2</td>
<td></td>
</tr>
<tr>
<td>SAMPLE / LABORATORY No.</td>
<td>013/0620 013/0621 013/0622 013/0623</td>
<td></td>
</tr>
<tr>
<td>MATERIAL DESCRIPTION</td>
<td>Light grey limestone gravel Light olive sand with limestone Light olive sand with limestone Light grey limestone gravel</td>
<td></td>
</tr>
<tr>
<td>* IN SITU FIELD MOISTURE (%)</td>
<td>3.7 6.3 10.2 2.7</td>
<td></td>
</tr>
</tbody>
</table>

UNIFIED SOIL CLASSIFICATION

<table>
<thead>
<tr>
<th>TRH14 / COLTO CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIEVE ANALYSIS, PERCENTAGE OF MATERIAL PASSING 0.075 mm SIEVE (TMH 1:1966, METHOD A1 (a), A10) - % PASSING SIEVES</td>
</tr>
<tr>
<td>63.0 mm 100 63</td>
</tr>
<tr>
<td>53.0 mm 99 58</td>
</tr>
<tr>
<td>37.5 mm 99 96</td>
</tr>
<tr>
<td>26.5 mm 97 95</td>
</tr>
<tr>
<td>19.0 mm 100 94</td>
</tr>
<tr>
<td>13.2 mm 100 94</td>
</tr>
<tr>
<td>4.75 mm 84 81</td>
</tr>
<tr>
<td>2.00 mm 75 73</td>
</tr>
<tr>
<td>0.425 mm 62 49</td>
</tr>
<tr>
<td>0.075 mm 53 48</td>
</tr>
<tr>
<td>0.022 mm 12 0</td>
</tr>
<tr>
<td>SOIL MORTAR</td>
</tr>
<tr>
<td>COARSE SAND 10 12 18 8</td>
</tr>
<tr>
<td>FINE SAND 04 / 18 / 26 9 / 19 / 28 10 / 17 / 22 7 / 16 / 39</td>
</tr>
<tr>
<td>MATERIAL &lt; 0.075 mm 33 32 33 31</td>
</tr>
<tr>
<td>GRADING MODULUS (GM) 1.67 1.26 1.38 1.62</td>
</tr>
<tr>
<td>L.L. (%) 40 53 33</td>
</tr>
<tr>
<td>P.I. / L.S. (%) 7 / 3.5 12 / 6.0 16 / 8.0 10 / 5.0</td>
</tr>
<tr>
<td>POTENTIAL EXPANSIVENESS (mm) Low Low Low Low</td>
</tr>
<tr>
<td>PH VALUE / CONDUCTIVITY (S/m) 5.72 / 0.002 6.41 / 0.001 6.83 / 0.003 6.30 / 0.002</td>
</tr>
</tbody>
</table>

MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT, CALIFORNIA BEARING RATIO ANALYSIS (TMH 1:1966, METHOD A7 & A8)

<table>
<thead>
<tr>
<th>UNCONFINED COMPRESSIVE STRENGTH &amp; INDIRECT TENSILE STRENGTH OF STABILIZED MATERIAL (TMH 1:1966, METHOD A13, A14 &amp; A19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBR / UCS / ITS DETERMINATION</td>
</tr>
<tr>
<td>MAX DRY DENSITY (kg/m³)</td>
</tr>
<tr>
<td>OPT MOISTURE (%)</td>
</tr>
<tr>
<td>COMP MOISTURE (%)</td>
</tr>
<tr>
<td>DRY DENSITY (kg/m³)</td>
</tr>
<tr>
<td>CBR (%)</td>
</tr>
<tr>
<td>SWELL (%)</td>
</tr>
<tr>
<td>UCS (kPa)</td>
</tr>
<tr>
<td>ITS (kPa)</td>
</tr>
<tr>
<td>DRY DENSITY (kg/m³)</td>
</tr>
<tr>
<td>CBR (%)</td>
</tr>
<tr>
<td>MAX DRY DENSITY (kg/m³)</td>
</tr>
<tr>
<td>OPT MOISTURE (%)</td>
</tr>
<tr>
<td>CBR (%)</td>
</tr>
<tr>
<td>CBR 100% 98% 95% 93% 90%</td>
</tr>
</tbody>
</table>
**CLIENT & PROJECT:** SMEC SOUTH AFRICA (PTY) LTD - Construction of new Solar Plant in Lime Archers  
**DATE:** 05/04/2013

<table>
<thead>
<tr>
<th>HOLE No. / KM (Channage)</th>
<th>AE/035</th>
<th>AE/040</th>
<th>AE/044</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATERIAL DEPTH (mm)</td>
<td>0.1 - 0.2</td>
<td>0.1 - 0.3</td>
<td>0.1 - 0.4</td>
</tr>
<tr>
<td>SAMPLE / LABORATORY No.</td>
<td>013/0624</td>
<td>013/0625</td>
<td>013/0626</td>
</tr>
<tr>
<td>MATERIAL DESCRIPTION</td>
<td>Light grey limestone gravel</td>
<td>Light grey sand with limestone</td>
<td>Dark brown sand with limestone</td>
</tr>
<tr>
<td>* IN SITU FIELD MOISTURE (%)</td>
<td>3.0</td>
<td>3.5</td>
<td>3.3</td>
</tr>
</tbody>
</table>

**TRH14 / COLTO CLASSIFICATION**

### SIEVE ANALYSIS

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>63.0 mm</td>
<td>100</td>
</tr>
<tr>
<td>53.0 mm</td>
<td>96</td>
</tr>
<tr>
<td>37.5 mm</td>
<td>100</td>
</tr>
<tr>
<td>28.5 mm</td>
<td>95</td>
</tr>
<tr>
<td>19.0 mm</td>
<td>94</td>
</tr>
<tr>
<td>13.2 mm</td>
<td>87</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>66</td>
</tr>
<tr>
<td>2.00 mm</td>
<td>60</td>
</tr>
<tr>
<td>0.425 mm</td>
<td>54</td>
</tr>
<tr>
<td>0.075 mm</td>
<td>15</td>
</tr>
<tr>
<td>0.022 mm</td>
<td>2</td>
</tr>
</tbody>
</table>

**SOIL MORTAR**

<table>
<thead>
<tr>
<th>Type</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>COARSE SAND</td>
<td>9</td>
</tr>
<tr>
<td>FINE SAND</td>
<td>10</td>
</tr>
<tr>
<td>MATERIAL &lt;0.075 mm</td>
<td>26</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.25mm</td>
<td>61/18/41</td>
</tr>
<tr>
<td>2.00mm</td>
<td>7/12/36</td>
</tr>
<tr>
<td>0.075mm</td>
<td>7/12/39</td>
</tr>
</tbody>
</table>

**MATERIAL <0.075 mm**

<table>
<thead>
<tr>
<th>% Passing</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
</tr>
</tbody>
</table>


### RESULTS

- **Max DRY DENSITY (kg/m³):**
- **Opt Moisture (%):**
- **Comp Moisture (%):**
- **Dry Density (kg/m³):**
- **CBR (%):**
- **Swell (%):**
- **UCS (MPa):**
- **ITS (MPa):**
- **Dry Density (kg/m³):**
- **CBR (%):**
- **Max Dry Density (kg/m³):**
- **Opt Moisture (%):**
- **CBR (%):**

**CBR**

- 100%
- 98%
- 95%
- 93%
- 90%

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