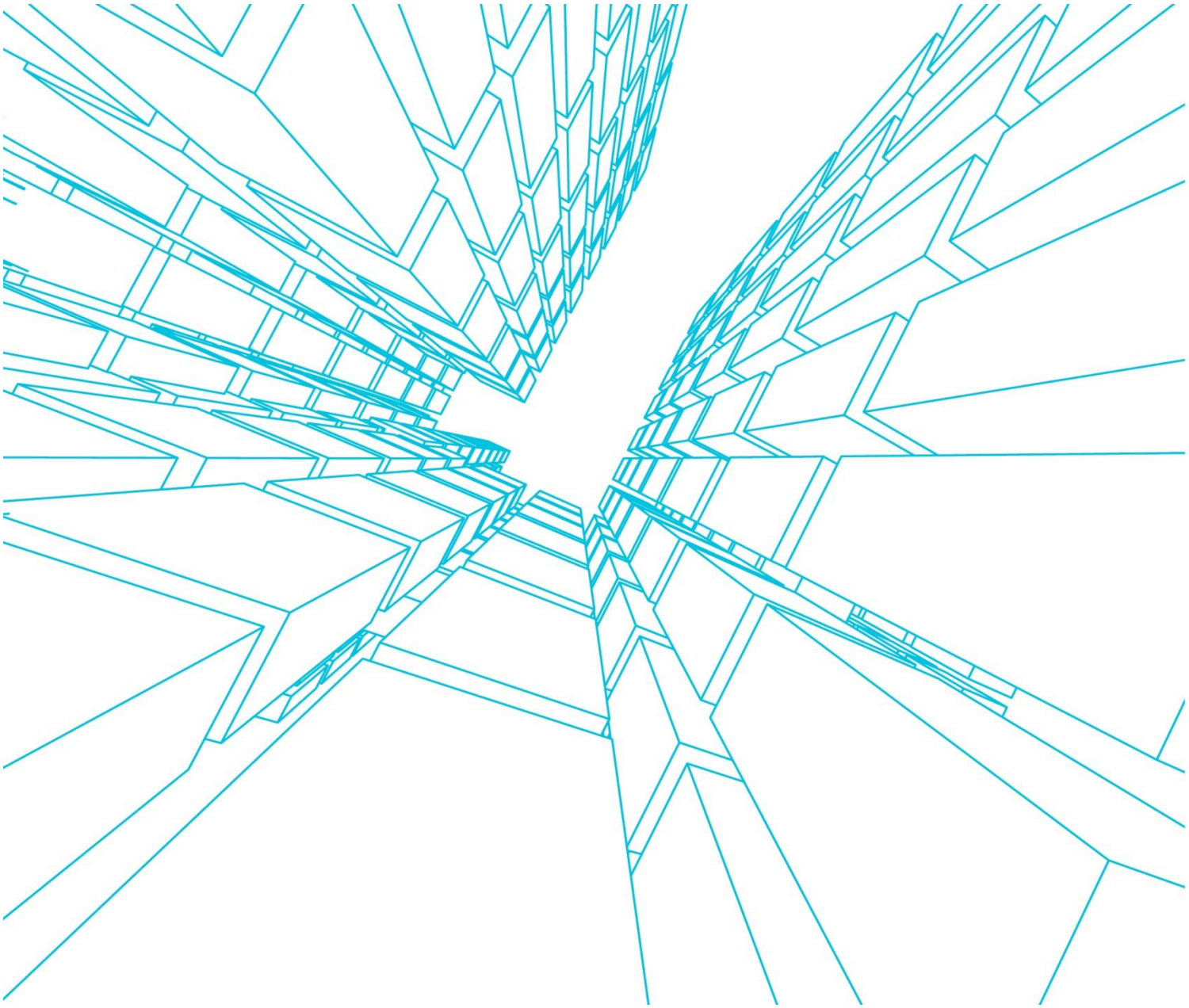
AECOM

September 2014

Atlantis SEZ Geotechnical Desk Study Report



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For AECOM SA (Pty) Ltd

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Contents

1. Introduction

AECOM (Pty) Ltd was requested to undertake a geotechnical desk study at the site of the proposed renewable energy project in Atlantis.

This desk study report will advise on the following aspects:

- Site Geology
- Site Geohydrology
- Typical Founding Conditions
- Excavation Conditions
- Materials Utilisation Potential

2. Information Available

The following information was provided:

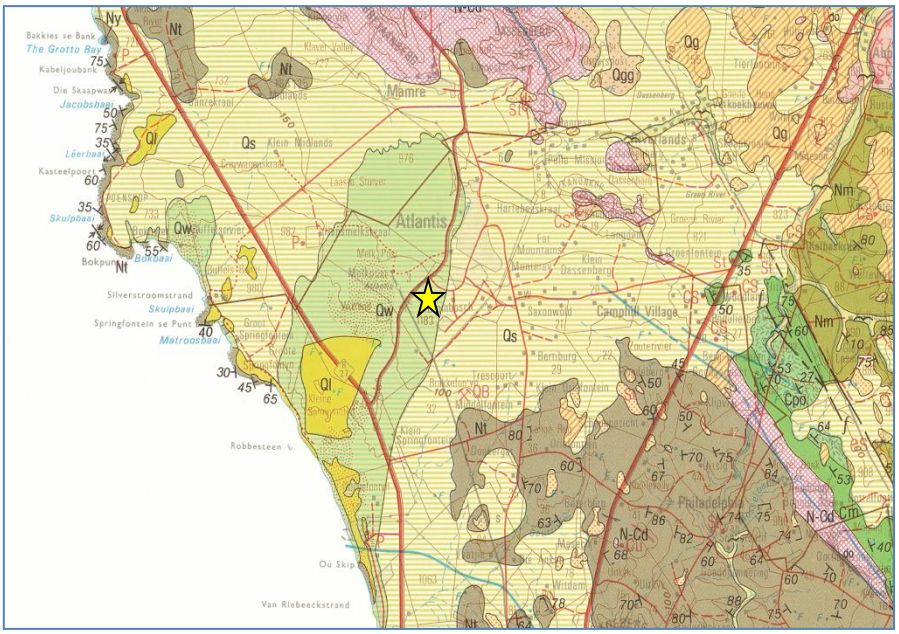
- 1:250,000 Geological Survey Series (Map Number 3318, Cape Town)
- Reference was also made to previous geotechnical investigations carried out by the writer in the Atlantis area.

3. Geotechnical Assessment

3.1 Regional Geology

Based on published geological data, the terrain is known to be underlain by thick deposits of Quaternary age sands, in turn underlain by sedimentary strata of the Malmesbury Group (Nt), which comprises of greywackes, mudrocks and shales.

The unconsolidated Quaternary sands comprise of the Witzand (Qw) and the Springfontein (Qs) Formations. These sands are known to vary between 10 to 15 metres in thickness in this area of Atlantis. The Quaternary material typically comprises of naturally deposited fine to medium grained sands with, locally, layers of more silty to clayey material. Due to the nature of transported soils, the consistency within the transported horizons can vary significantly.



Note: ☆ = Site Location; Nt = Greywacke, phyllite and quartzitic sandstone; Qw = Unconsolidated white sand with pebbles, shells locally; Qs = light grey to pale red sandy soil

Discontinuous horizons of pedogenic material (ferruginous and calcareous sand) can be formed irregularly within the transported soil horizons. These pedogenic materials can occur can typically occur in granular form or in various conditions of cementation.

3.2 Typical Subsoil Profile

The subsoil descriptions provided below are based on previous geotechnical investigations undertaken in the Atlantis area.

The near surface soils comprise of reworked sandy transported soils. The 'reworked' nature of these soils is as a result of natural elements such as the wind as well as by burrowing animal activity. The reworked soils tend to be in the order of 0.50 metres in thickness, predominantly loose in terms of soil consistency, variably organic, calcareous very slightly silty fine grained sand and/or fine grained sand.

Two different origins of naturally deposited transported material underlie the reworked soils, namely aeolian and alluvial subsoil types. It is noted that the transported soils are by their very nature, often highly variable in terms of thickness, consistency and composition. The transported soils are typically thicker on the western part of Atlantis and then tend to become thinner towards the east.

The aeolian (wind-blown) transported soils have been encountered in thicknesses varying from 0.50 to 4.00 metres in the immediate area. These soils are typically light yellowish white to light yellowish grey in colour with the soil consistency often loose becoming loose to medium dense with depth, variably calcareous fine grained sand.

The alluvial transported soils lie beneath the aeolian soils and essentially occur at various depths in this area of Atlantis. These subsoils are generally light grey brown and yellowish olive in colour and are generally denser in terms of soil consistency. The alluvial soils are typically classified as slightly silty to silty fine grained sands with occasionally lenses of fine grained sand.

3.3 Site Geohydrology

During previous investigations in this area of Atlantis no groundwater was encountered, probably as a result of the thicker free draining transported material which occurs in the western section of Atlantis.

Groundwater conditions at the site are regarded as favourable and not likely to be problematic during construction activities.

3.4 Excavation Conditions

Given the largely unconsolidated sandy nature of the site soils, no significant problems should be experienced in excavating the potential sandy transported soils using suitable earth moving equipment. It is anticipated in terms of SABS 1200D, that 'soft' excavation conditions will be encountered across the majority of the proposed site.

Should deep excavations be planned for the site, then measures to ensure both short and long term will need to be implemented at the site. These measures would typically comprise of suitable battering of the slopes to gradients not greater than 1v:2.0h or suitable shoring techniques installed.

It is further noted that this area is prone to wind erosion, especially when the vegetation is cleared and exposed to the elements. Measures need to be undertaken during earthwork activities to limit the extent of wind erosion, especially during the drier summer periods of the year.

Furthermore, long term stability of cut slopes must take into account erosion. Erosion protection in the form of vegetation measures such as a topsoil cover containing an erosion blanket should be installed on the slopes to provide erosion protection. Hydro-seeding or selected planting should be undertaken on the new cut slopes.

3.5 Materials Utilisation Potential

The materials utilisation potential of the soils likely to be encountered at the site is based on information from previous site investigations in the Atlantis area. The following table compares the characteristics of generally fine grained sandy soils and sandy soils containing high clay/silt content.

Soil Origin	Utilisation Potential	
	Selected Subgrade	**Selected Fill**
Fine grained sandy soils	suitable as G7 selected subgrade Once compacted to at least 98% of the Modified AASHTO density	suitable
Clayey/silty sandy soils	not suitable	not suitable due to variable fines content

Upper selected subgrade/subbase/base material will need to be imported to the site.

3.6 Foundation Conditions

In terms of the construction of light structures and given the often loose soil consistency of the near surface soils in this area, founding conditions are not considered to be favourable for founding at shallow depth due to the risk of differential settlement. Two founding conditions for light structures are considered below

Founding at shallow depth: clearly the option of shallow founding can only be considered where allowance is made for improvement of the loose near surface soils. Should the site conditions require shallow founding, then the near surface soils will need to be subjected to heavy vibratory compaction using a roller of at least 12 tonne capacity. Suitable tests will have to be undertaken by the Contractor to establish the depth of improvement.

In view of the above, foundations could then be constructed at a suitable shallow depth within the re-engineered/compacted fill. These soils would satisfactorily support conventional spread footings but should be dimensioned not to exceed a maximum permissible bearing pressure of 125 kPa.

Thickening of the surface beds for support of non-load bearing internal walls can be undertaken where the near surface soils are suitably improved or reinstated with engineered fill.

Founding at depth: the naturally deposited transported material at depth is considered competent founding material, suitable for support of conventional spread footings dimensioned not to exceed a maximum permissible bearing pressure of 175 kPa. In terms of founding depths, it is recommended that once earthwork activities are completed and final levels are established, that provision be made for a suitably qualified person to check the founding conditions.

Thickening of the surface beds for support of non-load bearing internal walls is not recommended where the near surface soils are not improved. These walls should accordingly also be provided with conventional footings founded at depth and not supported on thickenings of the surface beds.

4. RECOMMENDATIONS and CONCLUSIONS

1. The site is most likely underlain by naturally deposited generally sandy aeolian and alluvial soils. Generally, the near surface soils can be regarded as generally very loose to loose, improving in consistency with depth.

2. Groundwater is likely to be located at depth at this site due to the assumed thickness of the sandy 'permeable' soils at the site. Groundwater is not expected to be problematic at the site. Moisture within the respective soil horizons will fluctuate seasonally.

3. Hand labour and suitable earthmoving plant can be used for excavation purposes. Suitable battering of the side slopes will be required for areas in cut. In terms of long term slope stability, all cut slopes should be constructed to gradients not greater than 1v:2.0h and should allow for the inclusion of a suitable erosion blanket and planting. Suitable wind erosion measures will also be required in the drier summer periods during construction.

4. In terms of the material utilization potential the sandy transported soils are suitable as use as structural fill and as G7 selected subgrade once suitably compacted. Due to the variability in the clay/silt content within the transported soils, careful selection of suitable material may be required on site. Due to the fine grained nature of the site soils, soil moisture content needs to be carefully controlled.

5. In general, founding conditions for structures are regarded as unfavourable for conventional founding at shallow depth and will require improvement to ensure competent founding conditions. The naturally deposited transported soils at depth are suitable to support structures up to a minimum bearing pressure of 175 kPa.

6. The strength characteristics of the subsoils can only be adequately assessed with a site specific geotechnical investigation aimed at the assessment of the subsoils using intrusive investigative techniques such a trial pitting. Should heavy structural loading of the subsoils be anticipated then investigation of the subsoil characteristics at depth will be required to assess the risk of adverse settlement. Small diameter rotary boreholes (with Standard Penetration Testing) would be recommended for a deeper assessment of the subsoils.