GEOTECHNICAL DESKTOP STUDY REPORT

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WESKUSFLEUR SUBSTATION –400/132kV 500MVA

Title: GEOTECHNICAL DESK TOP STUDY REPORT– WESKUSFLEUR (KOEBERG) SUBSTATION.

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1. INTRODUCTION

Eskom Transmission plans to construct a new 400/132 kV/500MVA Substation in the Western Cape Region, Koeberg to replace the existing GIS substation. A Site for the planned development is urgently required in the area near the existing Koeberg GIS substation.

The main aim of this investigation is to conduct a desk study, where a total number of five sites were identified for evaluation of the most suitable site for the proposed substation development.

For the selection of these possible sites during the desk study, factors such as the geology, topography & drainage, vegetation, were considered.

Information collected during this investigation is suitable for site selection purposes, and once the final design is required, a detailed Geotechnical Investigation will be required to provide design parameters and confirm findings of this investigation.

1.1 Proposed Development.

The project involves the construction of a Transmission 400/132kV 500MVA substation in Koeberg area. The land area required for the proposed substation is approximately 700m x 300m. The proposed development would include the installation of the following typical equipments:

(i). Electrical Transformers.
(ii). Circuit breakers or line termination structures.
(iii). High Voltage Switchgear.
(iv). Low Voltage switchgear.
(v). Surge and Lightning protection equipment.
(vi). Control and metering equipment.
(vii). Office and ancillary buildings.
(viii). Platforms.
(ix). Access roads

1.2 Objective of the Investigation.

The primary objective of this investigation is to conduct intensive desk studies of the five sites selected to determine the most suitable site for the proposed substation.

2. SITE DESCRIPTION

2.1 Location

The five sites identified are: Option 1; Option 2; Option 3; Option 4, and Option 5 are approximately located at:

Site	Latitude (S)	Longitude (E)
Option-1 400kV Yard	33° 40' 15.73"	18° 26' 1.39"
Option-1 132kV Yard	33° 40' 26.64"	18° 26' 11.39"
Option 2	33° 40' 48.14"	18° 26' 10.34"
Option 3	33° 40' 34.95"	18° 26' 32.81"
Option 4	33° 40' 00.54"	18° 28' 17.32"
Option 5	33° 41' 55.68"	18° 30' 48.50"

- **Site 1:**

  The site is located at the North east corner of the Koberg Nuclear power Station for the proposed 400kV yard and the proposed 132kV yard located at the southern part of the parking area south of the incoming 400kV lines, as shown in figures 1a, 2a & 3a below.

- **Site 2:**

  The site is located at the South eastern corner of the existing Koeberg Nuclear power Station where part of the PBMR was planned, as shown in figures 1a, 2a & 3b below.

- **Site 3:**

  The site is located on the corner of the main access road just east of the road to the conservation offices and north of the main access road, south of the incoming 400kV lines, as shown in figure 1a, 2a & 3c below.

- **Site 4:**

  The site is located east of the R27 road as shown in figure 1a, 2b & 3d below.

- **Site 5:**

  The site is located east of the R305 road, just south east of an existing forest and approximately 1400m north of the 400Kv lines as shown in figure 1b, 2b below.

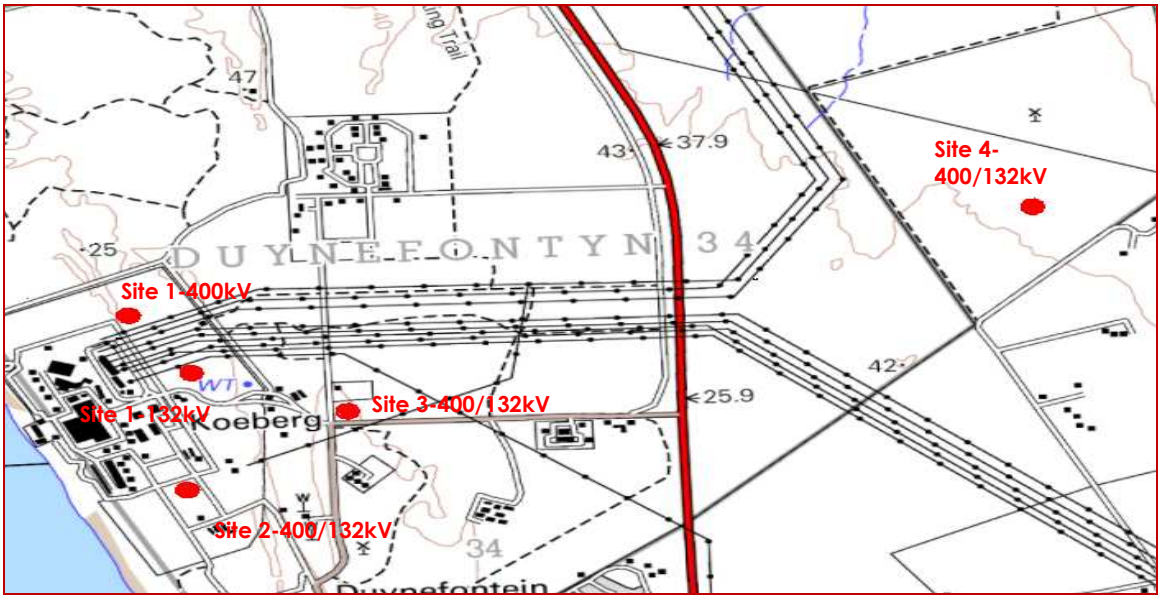

Figure 1a: Sites Locality Plan Scale:(NTS)

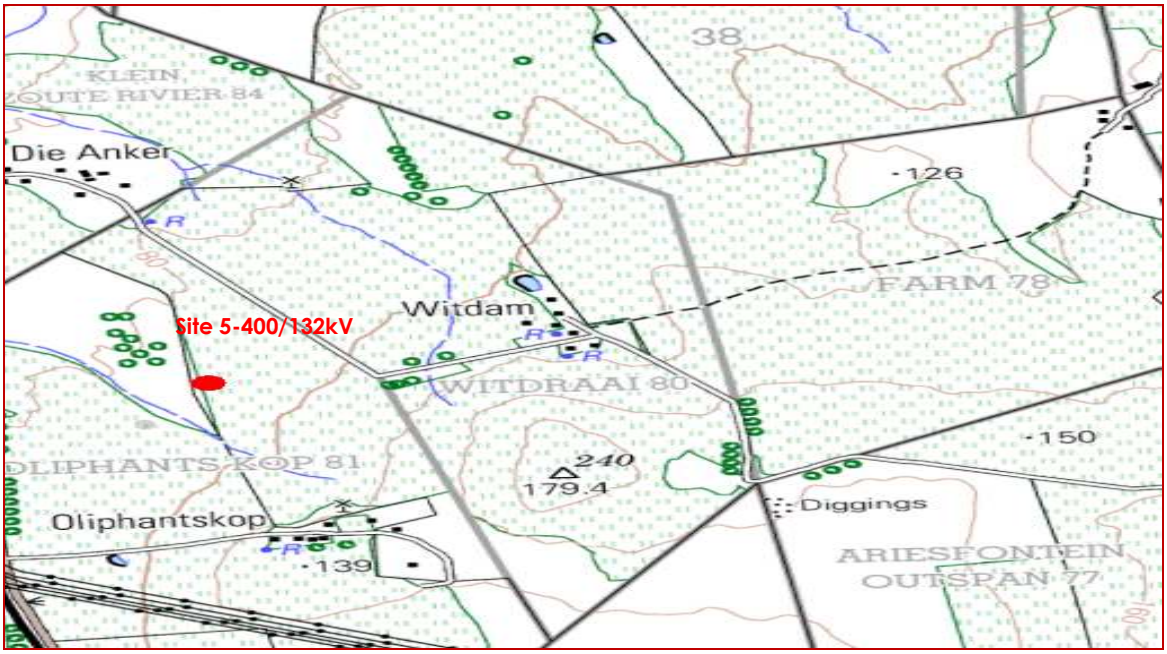

Figure 1b: Sites Locality Plan Scale:(NTS)

Figure 2a: Satelite Imagery: Site Option 1, 2 & 3

Figure 2b: Satelite Imagery: Site Option 4 & 5

Figure 3a: Site Layout Pictures: Site Option 1,

Figure 3b: Site Layout Pictures: Site Option 2,

Figure 3c: Site Layout Pictures: Site Option 3,

Figure 3d: Site Layout Pictures: Site Option 4,

2.2 Topography and drainage

- **Site 1:**

The study area slope is generally flat with a gradient of approximately 1.0%-1.5%.
The area earmarked for the proposed substation development occurs at heights varying between 19m and 24m above mean sea- level. The proposed development footprint would cut into the above slope.

No natural surface drainage features are evident in the area and much of the surface run-off would seep into the underlying gravels and migrate down gradient beneath the surface.

- **Site 2:**

The study area slope is generally flat with a gradient of approximately 1.2%. The area earmarked for the proposed substation development occurs at heights varying between

10m and 15m above mean sea- level. The proposed development footprint would cut into the above slope.

No natural surface drainage features are evident in the area and much of the surface run-off would seep into the underlying dune sand and migrate down gradient beneath the surface.

- **Site 3:**

The study area slope is generally flat with a gradient of approximately 1.5%. The area earmarked for the proposed substation development occurs at heights varying between 20m and 23m above mean sea- level. The proposed development footprint would cut into the above slope.

No natural surface drainage features are evident in the area and much of the surface run-off would seep into the underlying dune sand and migrate down gradient beneath the surface.

- **Site 4:**

The study area slope is generally flat, with a gradient of approximately 2%. The area earmarked for the proposed substation development occurs at heights varying between 40m and 46m above mean sea- level. The proposed development footprint would cut into the above slope.

No natural surface drainage features are evident in the area and much of the surface run-off would seep into the underlying dune sand and migrate down gradient beneath the surface.

The loose nature of the surface sands makes vehicular access outside of the existing roads almost impossible without four wheel drive capability.

- **Site 5:**

The study area slope is generally flat, with a gradient of approximately 3%. The area earmarked for the proposed substation development occurs at heights varying between 90m and 95m above mean sea- level. The proposed development footprint would cut into the above slope.

According to the 1:50000 3318DA Philadelphia Topographic Map, there is a dry watercourse running through the site, the watercourse will have to be rerouted during construction of the proposed development.

2.3 Vegetation

- **Site1:**

The study area consists of light vegetation of grass and shrubs of different species and there is very little vegetation that will require clearing during construction.

- **Site 2:**

The study area consists of light vegetation of grass and shrubs of different species and there is very little vegetation that will require clearing during construction.

- **Site 3:**

The study area consists of medium dense vegetation consisting of fynbos shrubs and other shrubs of different species. The clearing of fynboss shrubs should be done in accordance with environmental regulations and relevant authorities should be consulted.

- **Site 4:**

The study area consists of medium to dense vegetation of different tree species. Vegetation on the selected site would have to be cleared during construction for the proposed development. The tree cutting should be done in accordance with environmental regulations and relevant authorities should be consulted.

- **Site 5:**

The study area is located on agricultural land. The site will have to be cleared during construction of the proposed development.

2.4 Climate

The "Weinert N-Value" that describes the climatic environment of the area is approximately 3.7, *Where "N" is greater than "5",* mechanical *disintegration is the predominant mode of rock weathering, and where "N" is less than "5",* chemical decomposition predominates.*Where "N" is less than "5",* chemical decomposition predominates.

In this study area (N=3.7), rocks are particularly deeply weathered, often to depths of several tens of meters, and chemical decomposition is pronounced.

2.5 Seismicity

The SANS code (*Seismic actions and general requirements for buildings)*" SANS 10160-4:2011, shows that the five sites are situated in the area where the peak ground acceleration with a 10% probability of being exceeded in 50 year period is 0.15g . Figure 3a also shows the zone (Zone I) where compliance with the minimum requirements is specified by the code. Zone I is defined as "Regions of natural seismic activity".

A more recent data produced by the Council of Geoscience, (CGS)) is presented in Figure 3b, showing peak ground accelerations with a 10% probability of being exceeded in 50 years. On this figure, the three sites are classified with a ground accelerations of 0.15g (or 147cm/sec^2).

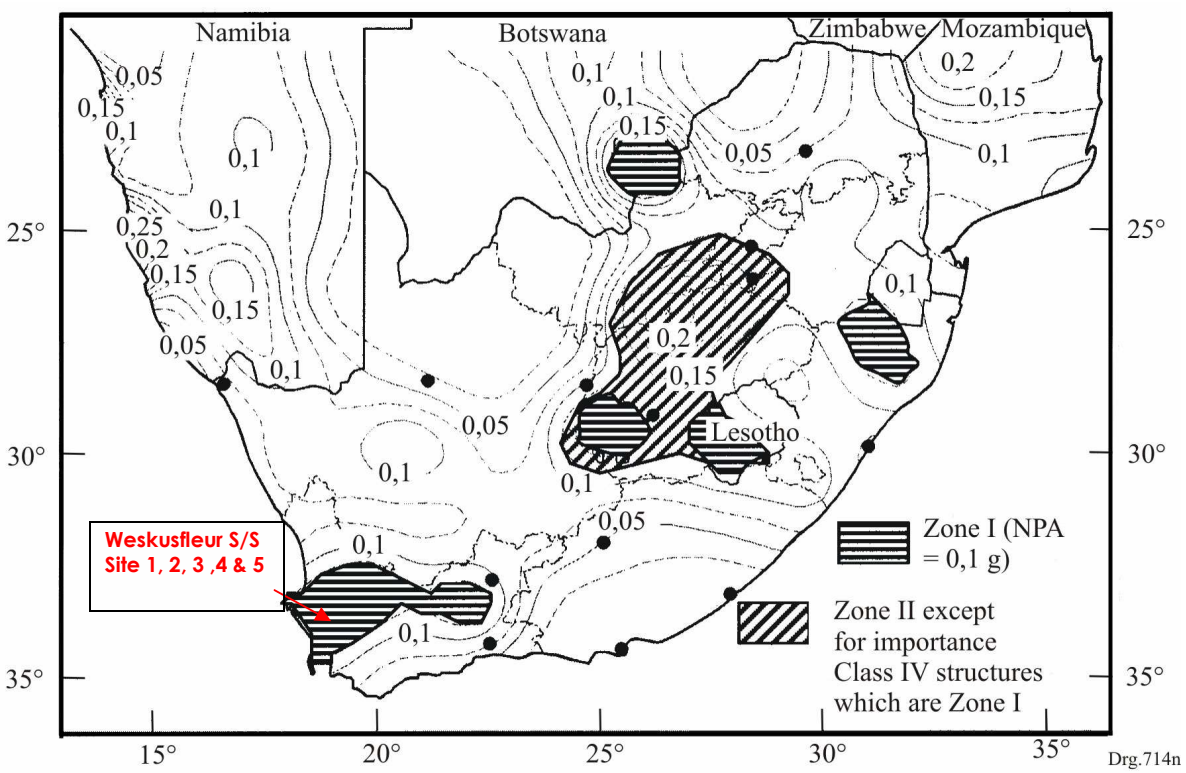

Figure 3a: Seismic Hazard map and Zones

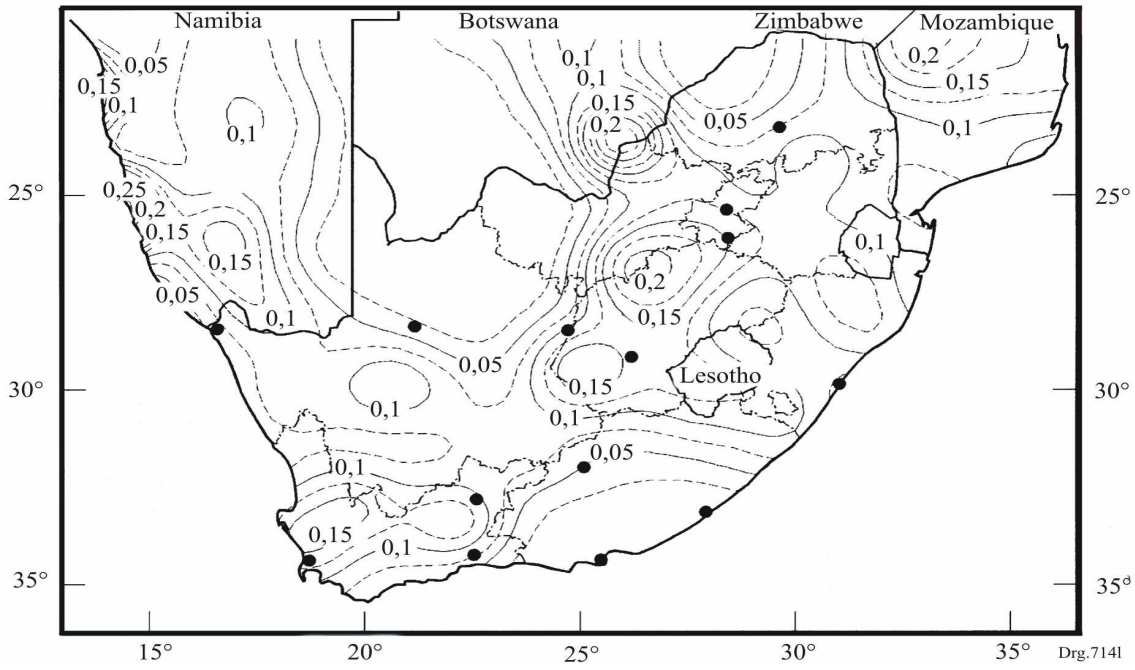

Figure 3b: A recent seismic hazard map (2003) obtained from the Council for Geoscience

3. REGIONAL GEOLOGY AND GROUND WATER

3.1 Geology

According to the available geological maps, 1:250 000 Geological Series 3318 CAPETOWN map the regional geology of the sites comprise of light grey calcified dune sand and calcrete **(Ql) on Site Option 1 & 2** and becoming white to light grey calcareous sand**(Qw)** bordering to **Qs** on **Site Option 3 ;** light grey to pale-red quartzose sand and dune sand**(Qs)** on **Site Option 4 & 5.**

According to CGS, figure 4 below all sites are underlain by Aeolian dune sand which are up to several depths of metres. From the author's experience, this layer could be up to to +-35m below the surface. Below this layer (>35m), clayeys soils with low to medium potential of expansiveness may be expected but this will have no effect on the proposed development as the horizon depth and thickness contribute towards determining the amount of surface movement (expansion and contraction).

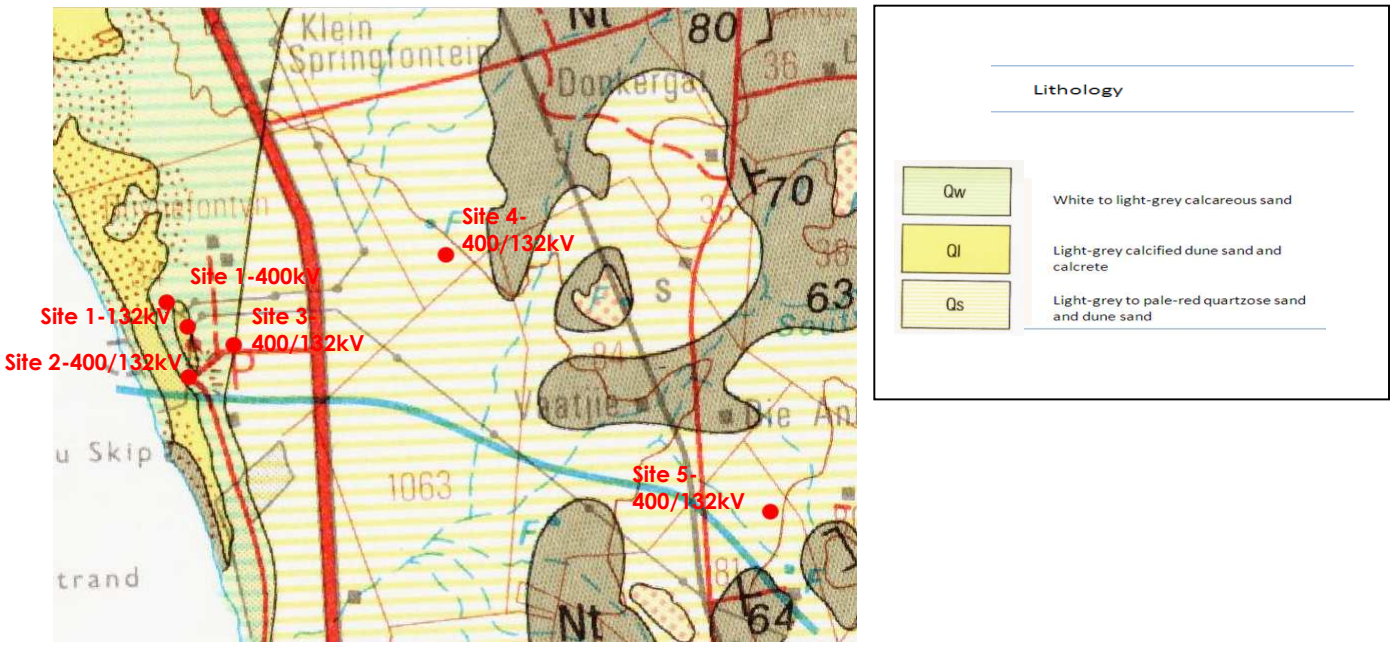

Figure 4: Regional Geology - Koeberg Substation

3.2 Groundwater

Shallow water table may be expected at Site Options 1 & 2 according to studies done by CGS, figure 6 below and this will have effect on the proposed development. Adequate subsoil drainage system would have to be catered for in the design phase.

There is no groundwater information available for Site Options 3 , 4 & 5 but a shallow perched water may develop due to seasonal fluctuations.

The actual depth of the water level can only be confirmed during a detailed geotechnical investigation phase.

4. GEOTECHNICAL PROPERTIES INFLUENCING THE DEVELOPMENT

4.1 Soil Properties

According to the available geotechnical maps, 1:50 000 Geotechnical Series 3318 CB-MELKBOSSSTRAND map published by the Council for Geoscience the sites fall in the class with the least engineering geological problems which is the most desirable developmental option but Option 1 and 2 may need some precautionary measures to overcome some engineering geological problems.

The developmental class for the sites is denoted by "**H2-Site 4 &5; H3-Site 3; M7- Site1&2; M11-Site 1** and description of each code is illustrated in Table 1 and figure 5 below:

Table1: Geotechnical properties influencing development

Code	Geotechnical Property	Description	Severity Class	Resulting Cost Implication
Per3-Per4	Permeability	Permeability measures the flow of water through saturated soil. This is determined by the grain size and the shape and the degree of compaction of the soil	Medium to high permeability>$3x10^{-5}$ cm/s	Low
Per2			Low permeability<$3x10^{-5}$ cm/s	Low
Aci	Aggressive Soil	Acidic soils. The chemical composition of these soils increases corrosion of metalliferous materials and causes deterioration of reinforced concrete	Moderately aggressive	Low to medium
WE	Loose Sand (Water Erosion)	Loose surface soil susceptible to wind erosion. The sands are mainly of Aeolian origin and they are non-cohesive.		Low to medium
CON	Loose Sand (Consolidation)	Material susceptible to excessive consolidation when used as foundation horizon without improvement.		Low to medium
COL	Collapse potential	Collapsible soils are open textured, sandy to Silty soils with low clay content. The soils may consolidate rapidly when under load and near saturation point		Moderate
SHA	Shallow water table	Water table occurring at shallow depth		Moderate

Act2-Act3	Active Clay	The degree of expansion experienced when dry clayey soils are moistened to full saturation.	Low to medium	Moderate

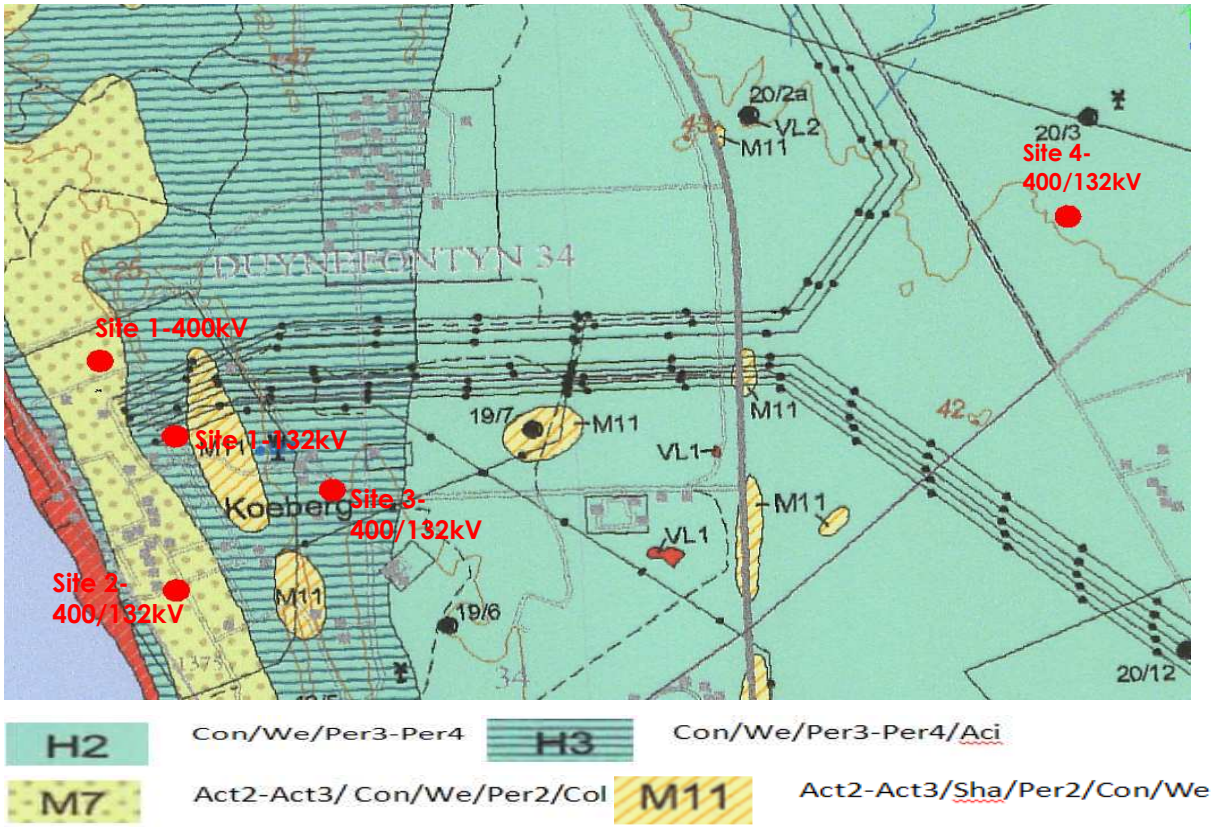

Figure 5: Geotechnical Series Map - Koeberg Substation

4.2 Potential Corrosiveness of in-situ soil

Corrosion is defined as the degradation of a material or its properties due to a reaction with the environment. Corrosion exists in virtually all materials, but is most often associated with metals. According to soil resistance map published by CGS, figure 6, the sites are situated in the area where soil resistivity is > 2000 ohm. This indicates that the soil in the area is moderately corrosive towards concrete and metals and the concrete in contact with the soil should be protected.

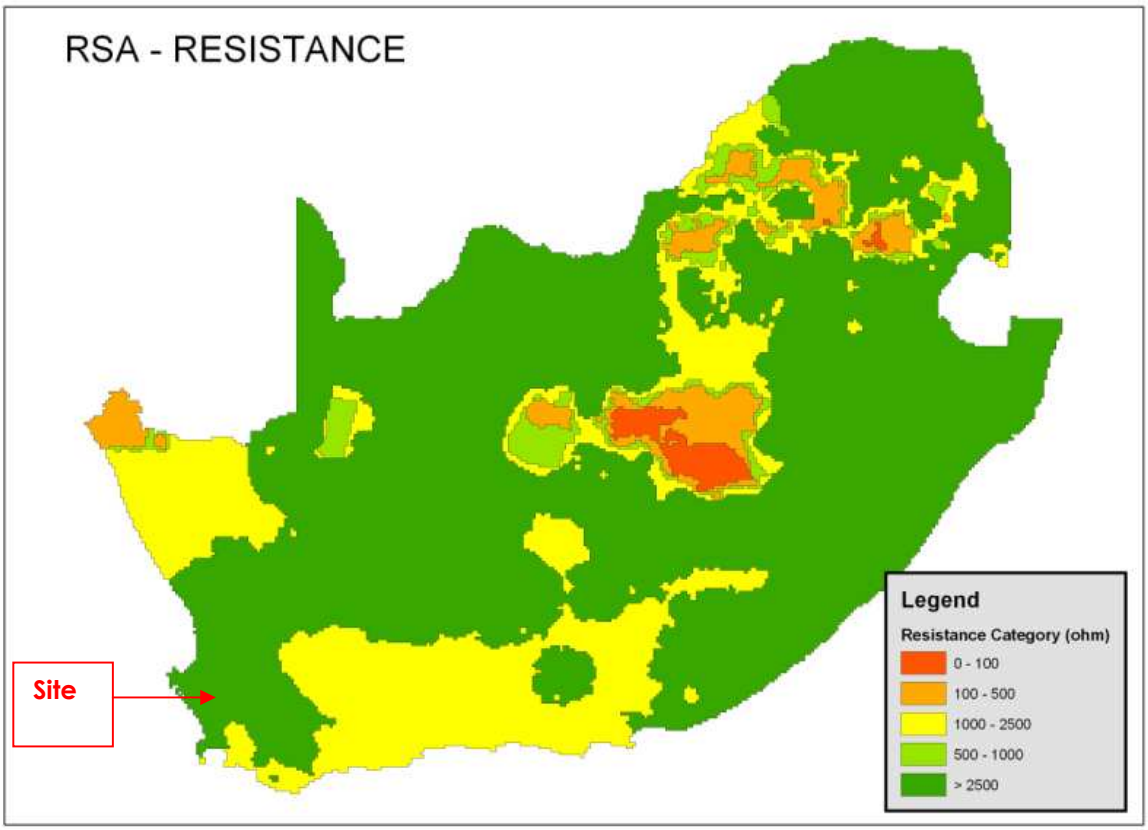

Figure 6: Soil Resistivity Map - Koeberg Substation

5. EXISTING STRUCTURES NEARBY SITE

There is an existing Koeberg GIS substation near sites Option 1. There was no existing geotechnical report available for the substation at the time of preparing this report. There was no visual sign of ground disturbance or distress on the existing structures that was noticed on the structures around site option1.

6. CONCLUSION AND RECOMMENDATION

Based on the information obtained during this desktop study, all sites are underlain by loose aeolian sands which are collapsible in their natural state and the surface soil susceptible to wind erosion. Soil improvement on these soils will have to be done prior to placing foundations or any structures.

Based on the performance of the existing engineered structures around Site Option 1, this site is considered feasible for the proposed new substation.

The land area available on Site Option 2 may be inadequate to locate the proposed 700mx300.
The fynboss vegetation observed on site Option 3 makes this site not suitable from an environmental perspective.

Based on the information obtained from the desktop study the soil properties on Site Options 4 & 5 fall in the class with the least engineering geological problems which is the most desirable developmental option but the gradient of Site Option 5 is moderately steep compared to the other sites and this would make the earthworks volumes (cut and fill) costly during development.

In conclusion, it is recommended that Site Options 1 followed by 4 be considered for further preliminary geotechnical investigations. The preliminary geotechnical investigation should entail carrying out topographical survey on the preferred sites, followed by excavation of test pits and sampling to determine the soil properties and preliminary geometric designs to obtain construction cost estimates for each site.

It also recommended that deep in-situ testing like Dynamic Probe Super Heavy (DPSH)tests and rotary cored boreholes with SPT "N" tests, undisturbed Shelby Samples to determine collapse potential of the material be undertaken during a detailed geotechnical investigation phase on a preferred site.

7. REPORT PROVISION

This desktop study is aimed at providing general information for site selection purposes and should never be used for design or any other purpose other than that intended for. Once a site is selected, a detailed geotechnical investigation should be carried out in order to facilitate the design.

8. REFERENCES

1. 1:50 000 Geotechnical series Map, 3318CB **MELKBOSSTRAND** , published by Council for Geoscience, Pretoria.
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