GEOTECHNICAL ASPECTS REGARDING FOUNDATION CONDITIONS AT GAMMA SUBSTATION'S TWO PROPOSED SITES

1. Introduction

Two sites for the Gamma Substation are under consideration – that is the Kleinfontein site adjacent to the N1 and the "inland" site on Uitvlugtfontein, some 3km due west of the above site.

The terms of reference of this section of the investigation are to assess and compare the following aspects of the two sites, namely:-

i) site soils and geology
ii) access
iii) drainage, ponding and flooding
iv) presence of groundwater
v) foundation conditions, i.e. bearing capacity, excavatability and permeability
vi) concrete aggregate
vii) pavement layer construction materials

2. Information Sources

2.1 Scoping report LL1290 by Engeolab CC submitted in August 2006.
2.2 Drive-over survey conducted in May 2007.
2.3 Topographical maps of the site provided by ESKOM.

3. Site Soils and Geology

Both sites are underlain by greyish-blue shale of the Beaufort Group intruded by NW trending dolerite dykes which form prominent landmarks in the otherwise flat topography of the two site's immediate surroundings – see Plate 1 below.

Plate 1: dolerite ridge on adjacent farm Schietkuil

At the Kleinfontein site, the shale bedrock is blanketed by a layer of brown sandy colluvium with abundant flaky shale fragments, some 0.3m thick, sequentially underlain by highly weathered shale bedrock intercalated with dark grey to black carbonaceous lenses – see Plate 2 on the following page.

It must be noted that the most likely site for the substation on Kleinfontein was covered by construction debris and surplus shale bedrock excavated from a local cutting on the N1 motor way.

Plate 2: Shale exposed in N1 road cutting adjacent to proposed site

The Uitvlugtfontein site is blanketed by ivory coloured, partially to well cemented calcrete, some 1.0 to 1.5m thick, sequentially underlain by shale bedrock in various stages of weathering. As indicated by the local borrow pits, road cuttings, access roads and drainage courses, the immediate surroundings of the Uitvlugtfontein site are blanketed by calcrete – see Plate 3 below.

PLATE 3: Calcrete exposed in cutting in tarred road near Uitvlugtfontein.

4. ***Access***

Main access roads to the two sites are tarred and in good condition. However, the existing gravel road at Kleinfontein will only be passable in the dry part of the year whilst having calcrete as a wearing course on Uitvlugtfontein, better access is expected in all weather conditions. Both access roads are initially fairly flat with the Kleinfontein's site undulating in the easterly section near the site, most probably requiring substantial filling in places.

5. ***Drainage, Ponding and Surface Run-off***

Drainage of the immediate areas surrounding both sites is controlled by a NW trending dolerite dyke on the farm Schietkuil which separates the two sites. To this end, run-off from Kleinfontein forms the headwaters of the Burgerspruit whilst Uitvlugtfontein falls within the catchment of the

Brakrivier. The confluence of these drainage channels is located some 5km down stream from the two sites, characterized by a wetland.

The Kleinfontein site is located down-slope from a local but dubiously constructed, small earth embankment dam and very close to the confluence of two local, non-perennial drainage courses. Based on visual observations of the site, it is quite obvious that it is susceptible to flooding and drainage precautions will be required with possibly some up-slope flood protection.

At Uitvlugtfontein, the terrain is flat and topographically well-suited for the proposed substation and the possibility of flooding seems remote.

6. ***Groundwater***

Generally, boreholes drilled into the shale bedrock normally have very low to low yields – that is <0.2 *l/s* whilst higher yields and better quality groundwater are associated with dolerite/shale contact zones.

Kleinfontein and the adjacent farm Schietkuil do have a number of motorized boreholes as well as some windmills and water for construction and consumption purposes may be purchased from the owners. Uitvlugtfontein's boreholes are equipped with handpumps and if substantial volumes of water are required for construction and consumption purposes, a borehole will have to be drilled at this site.

No springs were noticed on either of the sites and ponding was absent. However, deeper pools in the non-perennial drainage courses may yield some water for pavement layer construction purposes.

7. ***Foundation Conditions***

The shale bedrock exposed in the road cutting near the Kleinfontein site appears to be medium weathered and founding within the competent shale with a bearing capacity of 500KPa is expected at an average depth of 0.5m on this site. Consolidation settlement is expected to be < 5mm and only to occur during the construction period. No heave is expected as the materials are too gravelly. Good site drainage is required.

The shale bedrock at the Uitvlugtfontein site is blanketed by partially to well cemented calcrete, some 1.0m thick and more in places. The ivory coloured calcrete is partially to well cemented with an estimated bearing capacity of 150KPa and negligible consolidation settlement. However, where the profile is dominated by powdery, partially cemented calcerous soils, some densification will be required. Alternatively, the structures should found on competent shale bedrock below the calcrete. No heave is expected as the materials are too gravelly.

Excavation of loose topsoil, partially cemented calcrete and weathered shale will require light powered machinery – i.e. tractor-loader-bucket excavators whilst well cemented calcrete and medium weathered shale are classified as intermediate, requiring more powerful machinery.

The topsoil, calcrete and bedrock horizons are low permeable and French drain systems can only be implemented where loads are low – i.e. five to eight adults. During peak construction periods, alternative systems will, have to be considered – such as chemical toilets, conservancy tanks and enzyme absorbent systems.

8. Concrete Aggregate

Inspection of the dry drainage courses, borrow pits and road cuttings revealed the absence of fine aggregate (sand). Concrete stone may be produced on site using dolerite boulders crushed and screened with mobile crushers.

Alternatively, these materials will have to be imported from an approved source. Both fine and course aggregate may be obtained in Port Elizabeth, with concrete stone from De Aar. According to local sources, the Graaff Reinet crusher provides concrete stone to KPA roads only.

9. Pavement layer Construction Materials

Good quality pavement layer construction material at the Kleinfontein site is rather scarce and unless a borrow pit can be developed within the dolerite dyke on the neighbouring farm Schietkuil, materials will have to be imported from elsewhere.

Abundant calcrete ostensibly suitable for the construction of wearing courses, to selected and perhaps sub base layers – that is at least G5 class pavement construction material is available on Uitvlugtfontein.

10. *Conclusions*

i) Although both site are underlain by fairly competent founding material – that is shale bedrock, the Uitvlugtfontein site's calcrete can be used not only as a founding medium but also for construction of pavement layers.
ii) Access to both sites are good, but Kleinfontein will require some filling and depending on the route and site locality, some stockpiled material will have to be removed.
iii) In terms of drainage, ponding and surface run-off, the Uitvlugtfontein site does not require any additional preparations/precautions whereas Kleinfontein is located down-slope from a small earth embankment dam and precautions are required to prevent flooding due to over topping of two drainage courses, their confluence located in the vicinity.

iv) Ample groundwater and surface water are available at Kleinfontein whilst Uitvlugtfontein will, depending on the yield, most probably require one or more boreholes.
v) Foundation conditions are more or less similar on the two sites, but deeper bedrock and possible loose cover materials on the Uitvlugtfontein will require some attention. Excavation of material deeper than – say 1.5m will require powerful excavators and very hard ripping. Deep excavations >2.0m will require blasting. Due to low permeable bedrock, French drain system applications are limited and alternative waste disposal systems will be required during peak construction periods.
vi) Concrete aggregate (fine and course) will have to be imported from as far as De Aar and Port Elizabeth.
vii)Good quality pavement layer construction material is available on Uitvlugtfontein, whereas Kleinfontein's material will have to be imported.

11. Recommendations

Based on these observations, it is recommended that the Gamma Substation be located on Uitvlugtfontein. However, prior to the commencement of any planning or construction, it is recommended that the groundwater sources be investigated and if required, boreholes drilled pump tested and the water quality analysed.

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