GEOTECHNICAL DESKTOP STUDY FOR THE EIA PHASE OF THE CAPE PENINSULA STRENGTHENING PROJECT

TRANSMISSION POWER LINE FROM FIRGROVE SUBSTATION TO THE PROPOSED MITCHELL'S PLAIN SUBSTATION

AND

TRANSMISSION POWER LINE FROM THE PROPOSED MITCHELL'S PLAIN SUBSTATION TO THE PHILLIPI SUBSTATION

September 2010

(Revision of June 2010 Report)

PREPARED BY:

BKS (Pty) Ltd
PO Box 3173
Pretoria
0001

CONTACT PERSON

Mr J Ehlers
Tel No: 012 421 3614
E-mail: jacoe@bks.co.za

TITLE	***:***	***DESKTOP STUDY FOR THE EIA PHASE OF THE CAPE PENINSULA STRENGTHENING PROJECT***
Project Team	***:***	*BKS (Pty) Ltd*
Client	***:***	*Eskom*
BKS Project No	***:***	*J01289-003-03*
Status of Report	***:***	*Revision of June 2010 Report*
BKS Report No	***:***	*I08/934*
Key Words	***:***	*EIA, Cape Peninsula, Mitchell's Plain*
Date of this Issue	***:***	*September 2010*

For BKS (Pty) Ltd

Compiled by	:	J Ehlers		
		Initials & Surname	Signature	Date
Reviewed by	:	H Davis		
		Initials & Surname	Signature	Date
Approved by	:	H Davis		
		Initials & Surname	Signature	Date

EXECUTIVE SUMMARY

The Geotechnical Department of BKS (Pty) Ltd was appointed by Eskom Holdings Limited to carry out a desktop study relating to geological and geotechnical aspects of the EIA studies for two phases of the Cape Peninsula Strengthening Project:-

- **Firgrove to Mitchell's Plain Transmission Line**

  One, approximately 23km long, 400kV double circuit Transmission power line from the existing Firgrove substation to a proposed new substation in Mitchell's Plain. Alternatively a transmission line is proposed from Mitchell's Plain to the Stikland Substation to link into the 400kV Palmiet to Stikland Transmission Power Line.

- **Phillipi to Mitchell's Plain Transmission Line**

  One, approximately 7km long, 400kV single circuit Transmission power line from the proposed new substation in Mitchell's Plain to the existing Phillipi substation. It is proposed that the Phillipi substation be upgraded.

Both study areas are, mainly, underlain by Quaternary Deposits which generally comprise unconsolidated sands. However a small section of two of the Alternative Firgrove to Mitchell's Plain Transmission Line Routes are underlain by older, rocks of the Cape Supergroup and Cape Granite Suite.

The main problem for both transmission lines will be the presence of **collapsible soils** requiring, limited, removal and replacement for foundations. Some small areas may be underlain by heaving clays and by peaty soils. For the latter complete removal or re-location of bases has been recommended.

Some **instability of excavation sidewalls** can be expected under small sections of the Firgrove to Mitchell's Plain route that are underlain by Cape Supergroup rocks and residual soils as deeply dipping bedding planes may be present.

Groundwater is expected to be problematic close to the Zeekoevlei and a section east of the Phillipi substation.

According to the published **seismic hazard** map of South Africa, the Modified Mercalli Scale seismic intensity rating of the area is VII (*damage negligible in building of good design and construction)*. Cognisance needs to be taken of this during design.

Notwithstanding the above no geotechnical constraint is considered sufficiently severe, for either the Firgrove to Mitchell's Plain route or for the Mitchell's Plain to Phillipi route, such that the transmission line cannot be constructed. However site specific geotechnical investigations will be required as the information contained herein is from published information, only.

TABLE OF CONTENTS

FIGURES

1 INTRODUCTION

BKS Pty Ltd was appointed by Eskom Holdings Limited to carry out the EIA studies for two phases of the Cape Peninsula Strengthening Project:-

- **Firgrove to Mitchell's Plain Transmission Line**

  One, approximately 23km long, 400kV double circuit Transmission power line from the existing Firgrove substation to a proposed new substation in Mitchell's Plain. Alternatively a transmission line is proposed from Mitchell's Plain to the Stikland Substation to link into the 400kV Palmiet to Stikland Transmission Power Line

- **Phillipi to Mitchell's Plain Transmission Line**

  One, approximately 7km long, 400kV single circuit Transmission power line from the proposed new substation in Mitchell's Plain to the existing Phillipi substation. It is proposed that the Phillipi substation be upgraded.

The Geotechnical Department of BKS was appointed, as a sub consultant, to carry out a desktop study relating to the geological and geotechnical aspects of the project.

The desktop study will include an assessment of the:-

- expected rock and soil profiles
- expected geotechnical conditions
- potential seismic hazards

The brief for the work specifically excluded any topographic or hydrological studies, site investigation or visits to the site.

2 TRANSMISSION POWER LINE FROM FIRGROVE SUBSTATION TO THE PROPOSED MITCHELL'S PLAIN SUBSTATION

2.1 SITE DESCRIPTION

Please refer to Figure 1

Mitchell's Plain is situated to the south east of the Cape Town CBD in the Western Cape.

Three alternative sites have been proposed for the Mitchell's Plain Substation:-

- Mitchell's Plain Substation 1

  The proposed site is situated on the northern edge of the Mitchell's Plain suburb close to the Hospital.

- Mitchell's Plain Substation 2

  This alternative site is to the east of Cape Town International Airport and north of the suburb of Khayelitsha.

- Mitchell's Plain Substation 3

  This alternative site for the substation is situated approximately 1km south west of the Mitchell's Plain Substation 2 site.

Firgrove is situated to the east of Mitchell's Plain with the Substation being located to the north west of the suburb.

Four alternative routes have been proposed for the transmission of power from Mitchell's Plain to the Firgrove substation:-

- Alternative A

  This route goes east from the proposed Mitchell's Plain Substation 1 and crosses the N2 in the Khayelitsha area. The route then runs parallel to the N2, on the north side of the N2, until the route is to the east of the Zeekoevlei in the Firgrove area. The line then runs approximately north to the Firgrove Substation.

- Alternative B

  This route is the same as for Alternative A until just east of the intersection of the N2 and R310 where the line goes south and crosses the N2. The transmission route then runs approximately parallel to the N2, on the south side of the N2. The route then joins Alternative A in the vicinity of the Zeekoevlei.

- Alternative C

  Alternative C follows a completely different routing than that of Alternatives A and B. Alternative C runs from the Mitchell's Plains Substation 1 in a north easterly direction until close to Bellville South at which point it crosses the R102 and then travels north easterly until the Stikland Substation. The 400kV Palmiet to Stikland transmission line then runs from Stikland to the Firgrove Substation.

- Alternative D

  Alternative D runs north from the point at which Alternative A crosses the N2 in the Khayelitsha area. The route runs through the proposed Mitchell's Plain Substation 3 and then Mitchell's Plain Substation 2. The route then travels approximately north east to the proposed site of the Switching Station and then north and north west to the Stikland Substation. The 400kV Palmiet to Stikland transmission line then runs from Stikland to the Firgrove Substation

The alternative routes are all indicated on Figure 1.

2.2 SOURCES OF INFORMATION

The main sources of information were as follows:-

- 1: 250 000 published geological map Sheet 3318 Cape Town.
- Engineering geology of Southern Africa Volumes 1 to 4 by A.B.A Brink,
- Published topographical maps,
- Published seismic hazard maps

2.3 RESULTS OF INVESTIGATION

According to the 1:250 000 scale geological map the study area is underlain, mainly, by Quaternary Deposits with some of the underlying, much older, rocks being present as "small pockets". (Figure 3). The generalised stratigraphy of the area is shown in Table 1 and the approximate percentage of the four proposed alternative transmission line routes underlain by the different rock types is indicated therein.

All three alternative sites for the proposed Mitchell's Plain substation are underlain by deposits of the Witzand Formation.

According to the published seismic hazard map of South Africa, the Modified Mercalli Scale seismic intensity rating of the area is VII. The definition of this is as follows:-

Modified Mercalli Scale VII

Difficult to stand; furniture broken; damage negligible in building of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken. Noticed by people driving motor cars.

TABLE 1 TRANSMISSION POWER LINE FROM FIRGROVE SUBSTATION TO THE PROPOSED MITCHELL'S PLAIN SUBSTATION : GEOLOGY ALONG THE ROUTE

Map Reference	Generalised Stratigraphy			Generalised rock/soil types	Approximate percentage of the route underlain by each stratigraphic unit	
					Alternative A and B	Alternative C and D
Qb	Quaternary deposits		Formation name not yet designated	Brackish calcareous soil	10%	0%
Qw			Witzand Formation	Unconsolidated white sand with shells locally along beaches	63%	100%
Ql			Langebaan Formation	Limestone and calcrete with calcified dune sand.	5%	0%
Qs			Springfontyn Formation	Light grey to pale red sandy soil. Occasionally peaty soils occur.	15%	0%
Nt	Cape Supergroup	Malmesbury Group	Tygerberg Formation	Greywacke, phyllite, quartzitic sandstone occasionally with interbedded lava and tuff	5%	0%
N-Ck	Cape Granite Suite		Kuils River to Heidelberg Pluton	Granite and Granitic rocks	<2%	0%

2.4 GEOTECHNICAL EVALUATION

The Quaternary deposits generally comprise sandy soils. Much of the expected settlement in these sands will be elastic/immediate settlement which will occur during construction. However these sands are prone to collapse settlement and are termed collapsible soils. A collapsible soil is a partially saturated material which exhibits additional settlement upon wetting up. This, generally, occurs without any increase in applied pressure. Structures founded on collapsible material may exhibit no signs of distress for many years until an inundation of some sort occurs and produces sudden, unexpected, settlement. This sudden settlement is associated with a change in soil structure. Essentially the soil structure collapses in on itself thereby inducing settlement.

In addition these Quaternary sands are, generally, unconsolidated and, hence, have a relatively low in situ bearing capacity.

Occasionally peaty soils are evident in the Springfontyn Formation. Should these peaty soils be encountered it is likely that they will be highly compressible and that there will be a shallow water table associated with their occurrence. It is possible for peat to compress to as little as 10% of its original volume under load. Water from peat deposits is usually highly acidic and aggressive to concrete. When the water table is lowered and the peat is allowed to dry out, spontaneous combustion may occur.

The Malmesbury Group is characterised by variations in rock type. These variations often occur within a very short distance such that there may be a variation under individual foundations. The rocks are, also, often very steeply dipping and this can lead to problems when excavating for foundations as there may be instability within the sidewalls should the excavation intercept unfavourably dipping rock.

The residual soils formed by the in situ weathering of the Malmesbury Group are variable in composition. However the soils generally comprise stiff silts and clays which are not, generally, expansive. However the transported soils, derived from the residual Malmesbury soils, have been found to be expansive.

Instability in excavations through the residual Malmesbury soils has been noted. This is probably due to the silt/clay composition which may be affected by the relict bedding which may form steep surfaces along which "release" surfaces may form. This is, of course, aggravated by the presence of a shallow water table or seepage.

The granite and granitic rocks of the Cape Granite Suite, generally, weather to silts and clays along the coastal region as the weathering has, mainly, been chemical. The soils are, generally, not expansive but occasionally small pockets of expansive soils are found.

2.5 RECOMMENDATIONS

Founding masts and poles

Along over 90% of Alternative Route A and B and for 100% of Alternative Route C and D, the presence of collapsible soils is the main geotechnical "problem" that will be encountered. However, the most common way of dealing with the presence of such materials, in an excavation, is as follows:-

- Remove the in situ material to a width and depth equal to 1.5B where B is the width of the foundation. In general 1 : 1 side slopes are stable for the short term case providing the sands are dry in situ. Flatter side slopes would be required should any seepage be encountered.
- Compact the base of the excavation to approximately 93% Mod AASHTO at -1% to +2% of optimum moisture content.
- Place the removed material back into the excavation in layers of 150mm each one being compacted to at least 95% of Mod AASHTO at -1% to +2% of the optimum moisture content.

Compaction with the addition of water will effectively break down the collapsible fabric of the soil and will increase the bearing capacity of the material immediately below the footings.

The areas underlain by peaty soils are expected to be limited in extent and the options available are either to completely remove the peaty layer or to simply place the foundation for the mast or pole at a different location.

Should expansive soils be encountered along the route an assessment would need to be carried out of the amount of expected heave. Providing the clays and silts are not highly expansive, then removal of a certain thickness of clay/silt and replacing it with layers of imported well compacted fill would allow the masts and poles to be suitably founded. However the efficacy of this would have to be analysed for individual bases, materials and founding conditions.

Foundation trench stability

Problems may be experienced in foundation trenches intercepting Malmesbury Group rocks and residual soils due to the, often, steeply dipping bedding planes and relict planes. In addition the clayey/silty nature of the soils affects the sidewall stability especially where there is seepage or a shallow water table. Care, therefore, needs to be exercised in these materials.

However, most of the foundation trenches for Alternative A and B and all the trenches for Alternative C and D will be in Quaternary sands. Few problems with sidewall stability are expected providing a sidewall batter of 1 : 1 is used for the temporary case. This would need to be verified for individual bases and flattened should any seepage be evident.

Seismicity

The area can be classified as being Category VII on the Modified Mercalli Scale. Negligible damage would be expected in a building of good design. Provided cognisance is taken of this in the design of the foundations, masts and poles, negligible damage would be expected should the areas be affected by a seismic event.

Groundwater

Both Alternative A and B run very close to the Zeekoevlei. In these areas a high water table can be expected and the founding requirements for poles and masts will have to take this into account. Removal and replacement of the in situ material and, perhaps, temporary dewatering will be required should it not be possible to relocate individual bases out of the vlei area.

3 TRANSMISSION POWER LINE FROM PROPOSED MITCHELL'S PLAIN SUBSTATION TO PHILLIPI SUBSTATION

3.1 SITE DESCRIPTION AND REGIONAL GEOLOGY

Please refer to Figure 2

Mitchell's Plain is situated to the south east of the Cape Town CBD in the Western Cape. Phillipi is located north west of Mitchell's Plain with the substation being located to the north of the suburb in the Hanover Park area.

Three alternatives have been proposed for the transmission line:-

- Alternative 1

  This route essentially follows the R300, on the southern side of the R300, from the Phillipi substation to the proposed substation at Mitchell's Plain.

- Alternative 2

  This route travels southwards from the Phillipi substation and cuts across the Phillipi suburb. The route joins Alternative 1 as the R300 starts going east towards Mitchell's Plain

- Alternative 3

  This is a short deviation from Alternative 1 which goes through the suburb of Mitchell's Plain instead of along the R300.

3.2 SOURCES OF INFORMATION

The main sources of information were as follows:-

- 1: 250 000 published geological map Sheet 3318 Cape Town.
- Engineering geology of Southern Africa Volumes 1 to 4 by A.B.A Brink,
- Published topographical maps,
- Published seismic hazard maps

3.3 RESULTS OF INVESTIGATION

According to the 1:250 000 scale geological map the study area is underlain by Quaternary Deposits. The generalised stratigraphy of the area is shown in Table 2 and the approximate percentage of the transmission line route underlain by the different rock types is indicated therein.

According to the published seismic hazard map of South Africa, the Modified Mercalli Scale seismic intensity rating of the area is VII. The definition of this is as follows:-

Modified Mercalli Scale VII

Difficult to stand; furniture broken; damage negligible in building of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken. Noticed by people driving motor cars.

TABLE 2 TRANSMISSION POWER LINE FROM THE PROPOSED MITCHELL'S PLAIN SUBSTATION TO PHILLIPI SUBSTATION : GEOLOGY ALONG THE ROUTE

Map Reference	Generalised Stratigraphy		Generalised rock/soil types	Approximate percentage of Alternative Routes 1, 2 and 3 underlain by each stratigraphic unit
Qw	Quaternary Deposits	Witzand Formation	Unconsolidated white sand with shells locally along beaches	60%
Ql		Langebaan Formation	Limestone and calcrete with calcified dune sand.	10%
Qs		Springfontyn Formation	Light grey to pale red sandy soil. Occasionally peaty soils occur.	30%

3.4 GEOTECHNICAL EVALUATION

The Quaternary deposits generally comprise sandy soils. Much of the settlement in these sands will be elastic /immediate settlement and will occur during construction. However these sands are prone to collapse settlement and are termed collapsible soils. A collapsible soil is a partially saturated material which exhibits additional settlement upon wetting up. This, generally, occurs without any increase in applied pressure. Structures founded on collapsible material may exhibit no signs of distress for many years until an inundation of some sort occurs and produces sudden, unexpected, settlement. This sudden settlement is associated with a change in soil structure. Essentially the soil structure collapses in on itself thereby inducing settlement.

In addition these Quaternary sands are, generally, unconsolidated and, hence, have a relatively low in situ bearing capacity.

Occasionally peaty soils are evident in the Springfontyn Formation. Should these peaty soils be encountered it is likely that they will be highly compressible and that there will be a shallow water table associated with their occurrence. Indeed it is possible for peat to compress to as little as 10% of its original volume under load. Water from peat deposits is usually highly acidic and aggressive to concrete. When the water table is lowered and the peat is allowed to dry out, spontaneous combustion may occur.

3.5 RECOMMENDATIONS

Founding masts and poles

Over the entire route the presence of collapsible soils is the main geotechnical “problem” that will be encountered. However, the most common way of dealing with the presence of such materials, in an excavation, is as follows:-

- Remove the in situ material to a width and depth equal to 1.5B where B is the width of the foundation.
- Compact the base of the excavation to approximately 93% Mod AASHTO at -1% to +2% of optimum moisture content.

- Place the removed material back into the excavation in layers of 150mm each one being compacted to at least 95% of Mod AASHTO at -1% to +2% of the optimum moisture content.

Compaction with the addition of water will effectively break down the collapsible fabric of the soil and will increase the bearing capacity of the material immediately below the footings.

The areas underlain by peaty soils are expected to be limited in extent and the options available are either to completely remove the peaty layer or to simply place the foundation for the mast or pole at a different location.

Expansive soils are not expected to be encountered along the route.

Foundation trench stability

The foundation trenches will be in Quaternary sands, few problems with sidewall stability are expected providing a sidewall batter of 1 : 1 is used for the temporary case. This would need to be verified for individual bases and should any seepage be evident.

Seismicity

The area can be classified as being Category VII on the Modified Mercalli Scale. Negligible damage would be expected in a building of good design. Provided cognisance is taken of this in the design of the foundations, masts and poles, negligible damage would be expected should the areas be affected by a seismic event.

Groundwater

To the east of the existing Phillipi substation, dams are indicated on the topographical map. In this area a high water table can be expected and the founding requirements for poles and masts will have to take this into account. Removal and replacement of the in situ material and, perhaps, temporary dewatering will be required should a shallow water table be evident in this area.

4 CONCLUSIONS

The information and recommendation contained herein are based entirely on published information. This information must therefore be regarded as being of a preliminary nature.

It is recommended that site specific geotechnical site investigations be carried out for each of the transmission routes and substations to enable an optimum design to be completed.

Notwithstanding the above no geotechnical constraint is considered sufficiently severe, for either the Firgrove to Mitchell's Plain route or for the Mitchell's Plain to Phillipi route, such that the transmission line cannot be constructed.

5 REFERENCES

BRINK. A.B.A (1983)

Engineering geology of Southern Africa. Building Publications Pretoria. Volume 2 and 4.

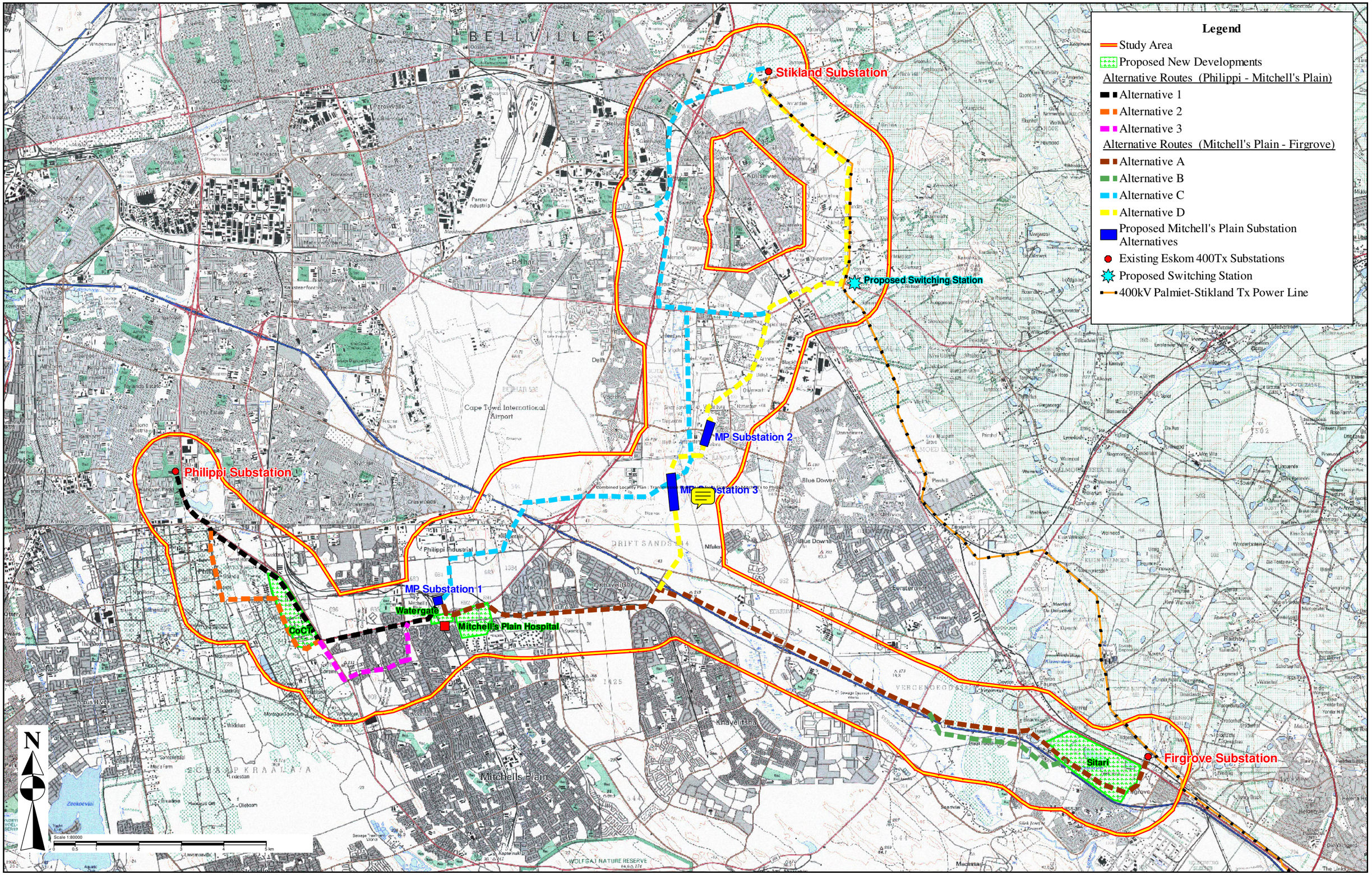
JOHNSON. M.R, ANHAEUSSER C.R. AND THOMAS R.J. (2006),

Geology of South Africa, Council for Geoscience and Geological Society of South Africa, Pretoria.

FERNANDEZ L.M. and GUZMAN J.A. (1979)

Earthquake hazard in Southern Africa, Department of Mines, Pretoria.

FIGURES



BKS	Project Name : **FIRGROVE - MITCHELL'S PLAIN AND MITCHELL'S PLAIN - PHILLIPI ESKOM TRANSMISSION POWERLINES**	FIGURE 1 **COMBINED LOCALITY MAP SCOPING PHASE**	**Figure 1** Drawn: M Steenkamp Checked: B. Gordhan Approved: Date: 2010-08-30 Map Ref: Firgrove-Mitchells Plan.map View Ref: Locality plan_New data_Rev1 Project No: J01289

Geology Map (Scanned from 1:250 000 Geological Map)

LEGEND

Quaternary Deposits	Qb	Undifferentiated
	Qw	Witzand Formation
	Ql	Langebaan Formation
	Qs	Springfontyn Formation
Cape Supergroup	Nt	Tygerberg Formation, Malmesbury Group.
	N-Ck	Cape Granite Suite

N

2.5km

Figure 2 : Regional Geology