4 PROJECT ALTERNATIVES

4.1 Introduction

In terms of the EIA Regulations published in Government Notice R543 of 2 August 2010 in terms of Section 24 of the National Environmental Management Act (Act No. 107 of 1998), feasible and reasonable alternatives have to be considered within the Environmental Scoping Study, including the 'No Go' option. All identified, feasible and reasonable alternatives are required to be identified in terms of social, biophysical, economic and technical factors.

The consideration of project alternatives is a key requirement of an EIA as it provides a basis for choice for the competent authority. The NEMA EIA Regulations of 2010 define alternatives in relation to a proposed activity as "*different means of meeting the general purpose and requirements of the activity which may include alternatives to the:*

(a) property on which or location where it is proposed to undertake the activity;
(b) type of activity to be undertaken;
(c) design or layout of the activity;
(d) technology to be used in the activity;
(e) operational aspects of the activity; and
(f) option of not implementing the activity."

Alternatives are considered as a means of reaching the same need and purpose as the originally proposed project in a way that minimises its negative and maximises its positive impacts.

A key challenge of the EIA process is the consideration of alternatives. Most guidelines use terms such as 'reasonable', 'practicable', 'feasible' or 'viable' to define the range of alternatives that should be considered. Essentially there are two types of alternatives:

- Incrementally different (modifications) alternatives to the Project; and
- Fundamentally (totally) different alternatives to the Project.

Fundamentally different alternatives are usually assessed at a strategic level, and EIA practitioners recognise the limitations of project-specific EIAs to address fundamentally different alternatives.

Different substation technologies (GIS and AIS) and alternative sites were considered and assessed during the Scoping Phase of this EIA.

4.2 The 'no go' alternative

In the context of this project, the no-go alternative implies that the new 400/132kV substation (Weskusfleur Substation) that will improve the existing 400kV reliability and cater for load growth on the 132 kV network for the 20-year horizon will not be constructed.

The no-go alternative can be regarded as the baseline scenario against which the impacts of the substation are evaluated. This implies that the current biophysical and social/tourism conditions associated with the proposed sites will be used as the benchmark against which to assess the possible changes (impacts) to these conditions as a result of the substation.

In most cases, the no-go alternative will imply that the identified negative impacts of proceeding with the project will not be incurred. Conversely, selection of the no-go alternative will also result in the benefits (including the potential economic development and related job creation, and increased security of electricity supply) of the project not being realised. One of the most important aspects that will not be realised is the increased security of electricity supply.

The 'no go' alternative will, however, be investigated further in the EIA phase as an alternative as required by the EIA Regulations.

4.3 Substation Technology Alternative

There are several technologies that can be used in a substation development, although for certain of the site alternatives only one technology type is currently investigated. A variety or combination of designs is also likely to be utilised for construction of the substation, depending on the characteristics and needs of the land and communities concerned. This section details the types of designs that could be placed along the development. The final substation design will be decided based on the selected site.

Gas Insulated Substation/Switchgear (GIS)

Gas Insulated Substation uses sulphur hexafluoride (SF6) gas which has superior dielectric properties used at moderate pressure for phase to phase and phase to ground insulation. In GIS the high-voltage conductors, circuit breaker interrupters, switches, current transformers, voltage transformers and lightning arresters are encapsulated in SF6 gas inside grounded metal enclosures

The (GIS) contains the same compartments as in the conventional outdoor substations. All the live parts are enclosed in metal housings filled with SF6 gas. The live parts are supported on cast resin insulators. Some of the insulators are designed as barriers between neighbouring modules such that the gas does not pass through them. The entire installation is sub divided into compartments which are gas tight with respect to each other. Thereby the gas monitoring system of each compartment can be independent and simpler.

Essential Parts of GIS as illustrated in figure 4.1 below

1. Current Breaker
2. Spring operated mechanism
3. Disconnector
4. High speed earthing switch
5. Low Speed earthing switch
6. Current Transformation
7. Cable connection

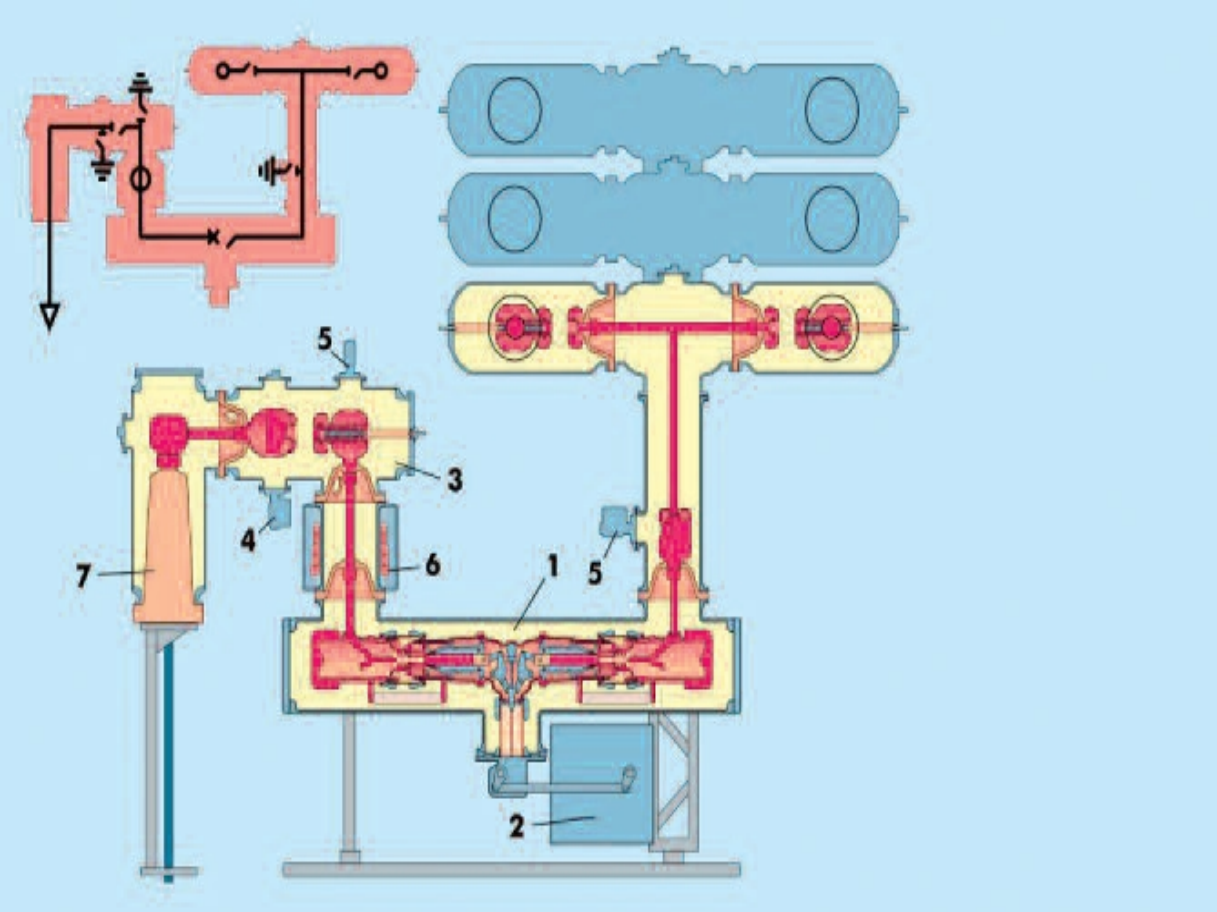

Figure 4.1: Essential parts of GIS

Figure 4.2: Gas insulated Substation

Source: http://kiran111.hubpages.com/hub/Gas-Insulated-Substation 24-06-2013

Advantages of GIS

- Occupies less space ;
- Is preferable in area where space is an issue e.g. cities;
- It has less fault outages;
- Reduced impact on Nature .e.g. construction size dimensions will be minimised and thus less impact;
- Less noisy as all the equipment is enclosed and the SF_6 is an efficient noise absorber;
- Electric fields are negligible in the immediate vicinity of the substation due to the shielding effect of the earthed enclosure.
- Less seismic vulnerable

Limitations of GIS

- Not easily expandable;
- Not easily accessible for repairs, a compartment needs to be completely broken to reach the faulty part.
- All parts are manufactured by the same manufacturer, thus they have an equal life expectancy.

Locations where Gas Insulated Substation is preferred:

- Large cities and towns
- Under ground stations
- Highly polluted and saline environment Indoor GIS occupies very little space
- Substations and power stations located Off shore
- Mountains and valley regions

Air Insulated Substation (AIS)

AIS is a conventional open space substation that is constructed according to standardized minimal distances (clearance) between phase and earth. Normally used for outdoor substations and in very few cases used for indoor substations. The substation is based on single power system equipment's and thus replacement of single equipment by equipment's from other manufacturers is possible. The substation is easily accessible and expandable.

Figure 4.3: Air Insulated Substation *(Source: http://www.foxitsoftware.com)*

Advantages of AIS

- Air is used as a dielectric
- Easily expandable
- Excellent overview, simple handling
- Easy access for repair,
- Life of station is longer, the older parts can be easily replaced. Not all parts of the station age at the same time

Limitations of AIS

- Circuit breakers cause a high level of momentary noise when operated;
- Large construction dimensions due to statutory clearances thus more impact on Nature;

- Insulation deterioration with ambient conditions and susceptibility to pollutants;
- Electric field levels inside the substation fence are more or less the same intensity as the electric fields associated with outgoing and incoming transmission lines;
- Seismic instable, more vulnerable to damage by earthquakes;
- Regular station maintenance required;
- Uses a large area/space;
- Life of steel structures degrades

4.4 Technical Details of Tower Design

There are several tower design options available for use in the transmission line development. A variety or combination of tower designs are likely to be utilised for construction of the lines, depending on the characteristics and needs of the land and communities concerned. The **Figure 4.4** below illustrates the proposed tower design for the 500kV transmission lines for the project at alternative 4 for example. At *alternative 4* there is a longer distance from Koeberg which means longer lines from generation transformers to the new yard which will require two new lines need to be built at 500kV level to accommodate construction outage requirements

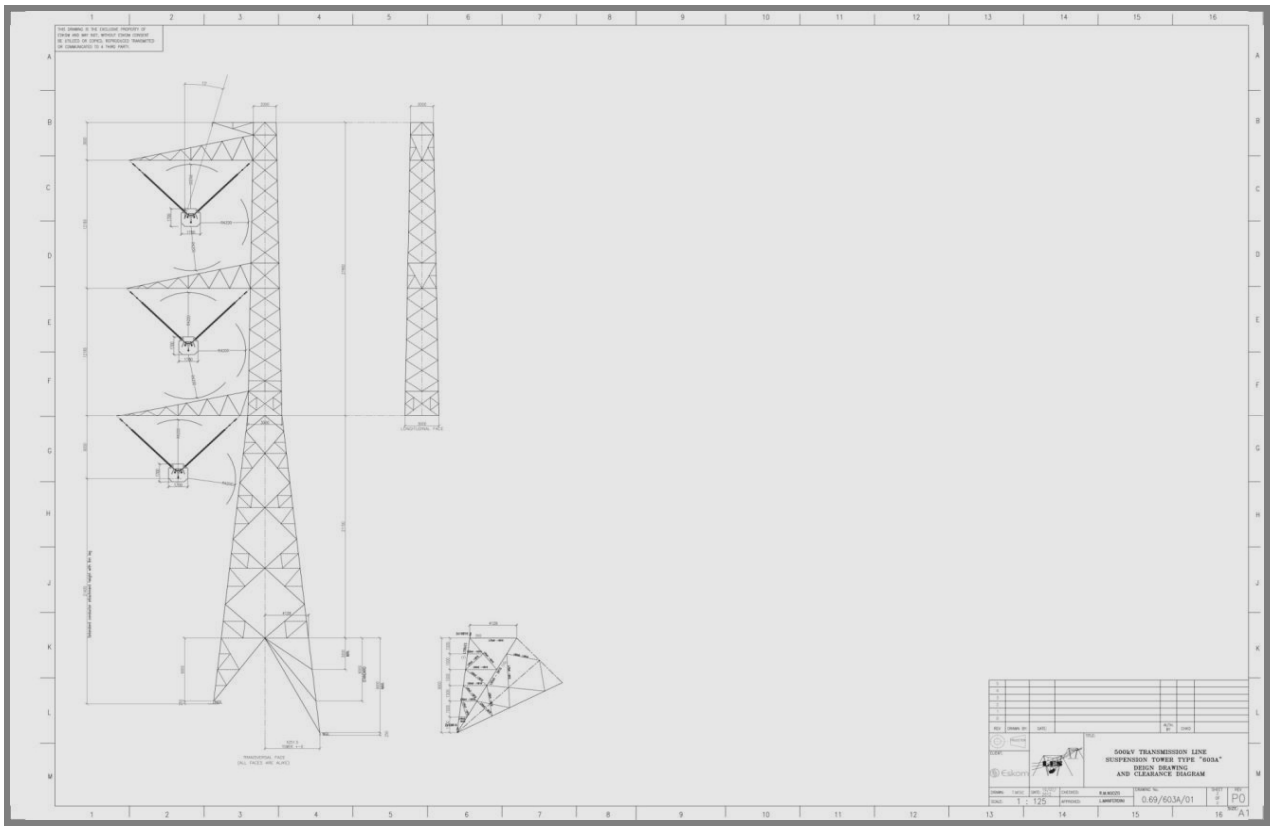

Figure 4.4: Proposed transmission line suspension tower

The height of the 500kV tower is approximately 50m. The standard conductor attachment height is 21.4m with a 6m leg. Please refer to **Appendix M** for the A3 drawing of the 500kV tower with dimensions. The final design and layout will be assessed in the EIA phase.

4.5 Access Road

All of the identified alternatives have accessible roads. *Alternative 1-3* are accessible through the Koeberg power station existing roads and *Alternative 4* can be accessed through the farm roads (there has to be an agreement with the farmers) and *Alternative 5* is also accessible through the roads of the Sterrekus (Omega) Substation.

4.6 Alternatives Sites

The proposed new substation is a 400/132kV substation (Weskusfleur Substation) that will improve the existing 400kV reliability and cater for load growth on the 132 kV network for the 20-year horizon. Once the most suitable site(s) has been recommended and authorised, the exact alignment of the substation within the site(s) will be finalised.

Location Alternatives

- **Alternative 1** – Located at the north-east corner of the KNPS for the 400kV yard and the southern part of the parking area south of the incoming 400kVlines for the 132kV yard.
- **Alternative 2** – The area at the south eastern corner of the KNPS where part of the PBMR was planned.
- **Alternative 3** – The area 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 400 kV lines.
- **Alternative 4** – Offsite option to the east of the R27 on the farm Brakke Fontein 32.
- **Alternative 5** – Offsite option, just east of the R304 next to the existing Sterrekus (Omega) Substation.

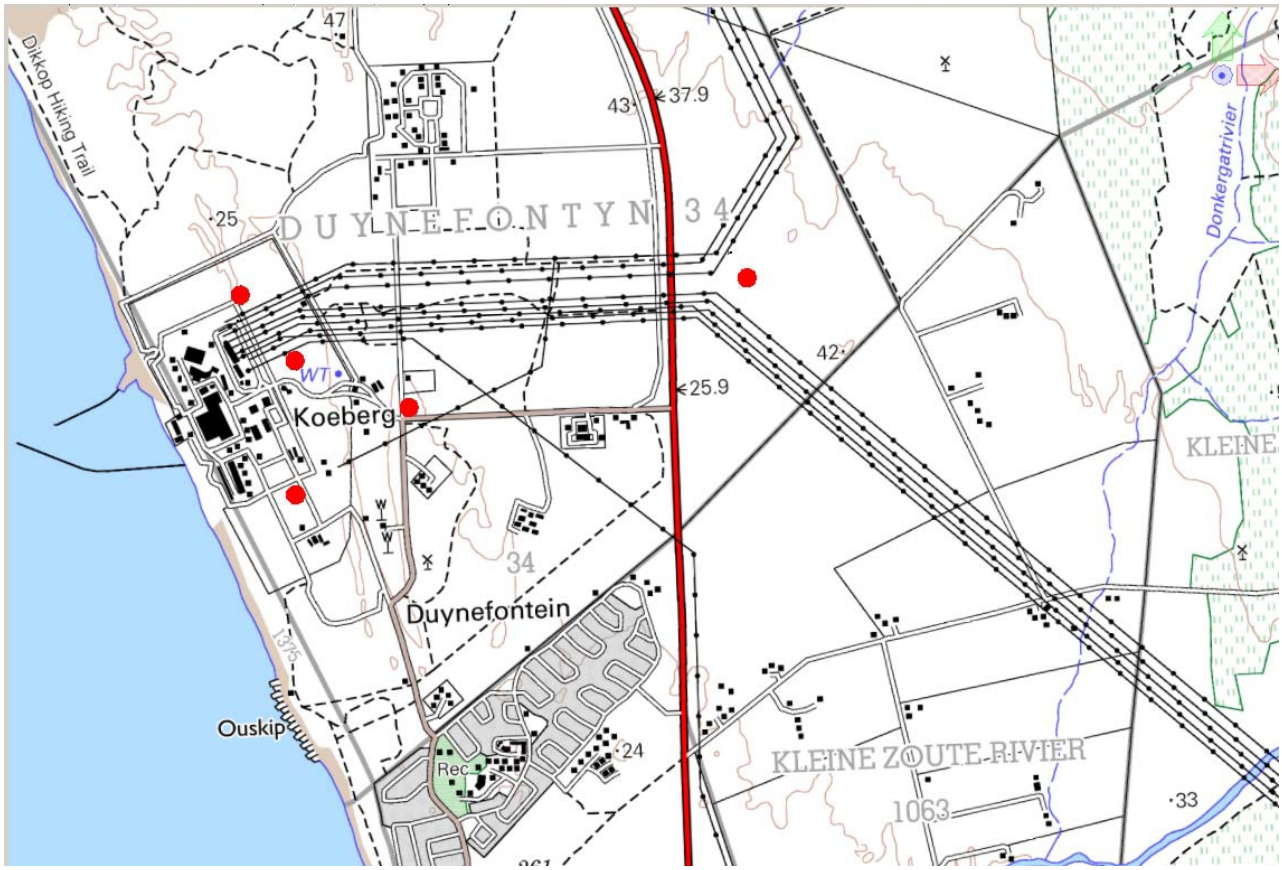

Figure 4.5: Proposed Study Area within which Alternative sites were to be identified

An initial site analysis has been completed by Eskom whereby the different locations indicated above have been investigated including the different technology options (GIS and AIS) described above.

The proposed substation is a 2x2500MVA; 400/132kV substation. The system will be operated at 400kV and 132kV, however the 400kV yard will be insulated at 550kV and the 132kV yard will be insulated at 275kV levels. This was put as a requirement due to the high marine pollution in the area which requires higher insulation levels and the next range of standard equipment freely available to facilitate this is manufactured to the 550 and 275kV levels.

Table 4.1 overview of the physical/technical requirements

Substation option	Approx. Size (m)	Distance between gantries
400kV + 132kV AIS	760 x 550	75 (400kV) and 50 (132kV)
400kV + 132kV GIS	400 x 180	50 (400kV) and 40 (132kV)
Line size	Servitude width (m)	
400/500kV	45 - 55	
132kV	30	

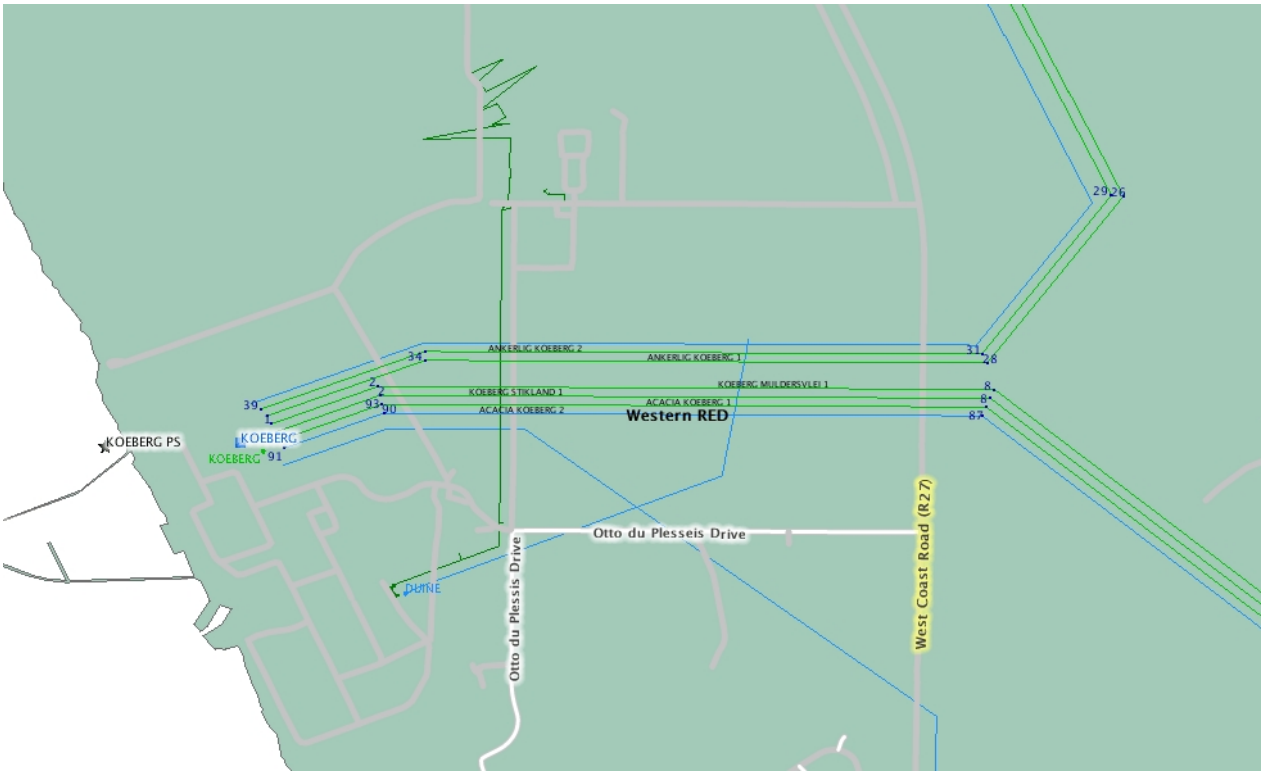

Figure 4.6: Existing transmission lines in the area (TxSIS).

4.7 Alternative Description

F**igure 4.7** shows the locality of all the alternatives.

- **Alternative 1** is shown as a blue box for the 400kV AIS Yard and another **blue** box for the 132kV AIS Yard. The **yellow** box indicates the 400kV & 132kV GIS yard alternative north of the existing Koeberg GIS yard. 400kV lines deviations are shown in **pink** (**Figure 4.7, 4.10 AIS & 4.11 GIS**).
- **Alternative 2** is shown as a **blue** box for the 400kV and 132kV combined AIS yard, as well as a **yellow** box indicating the 400kV &132kV GIS yard alternative, south of Koeberg. 400kV lines deviations are shown in **pink** (**Figure 4.7, 4.12 GIS & AIS**)
- Al**ternative 3** is shown as a **blue** box for the 400kV and 132kV combined AIS yard, as well as a **yellow** box indicating the 400kV & 132kV GIS yard alternative east of Koeberg. 400kV lines deviations are shown in **pink** (**Figure 4.7, 4.13 GIS & AIS**)
- **Alternative 4** is shown as a **blue** box for the 400kV and 132kV combined AIS Yard east of the R27 on the farm Brakke Fontein 32. GIS is not technically viable at this option but us being assessed in terms of environmental considerations. 400kV lines deviations are shown in **pink**. 500kV connection to generator transformers are shown in **red** and the 400kV cable/overhead gantry connection are shown in **blue**. Future 400kV Ankerlig Sterrekus line is shown in **yellow** and 132kV lines shown in **green** (**Figure 4.8**).
- **Alternative 5** is shown as a **blue** box for the 400kV and 132kV combined AIS Yard at the Sterrekus substation location **(Figure 4.7).**

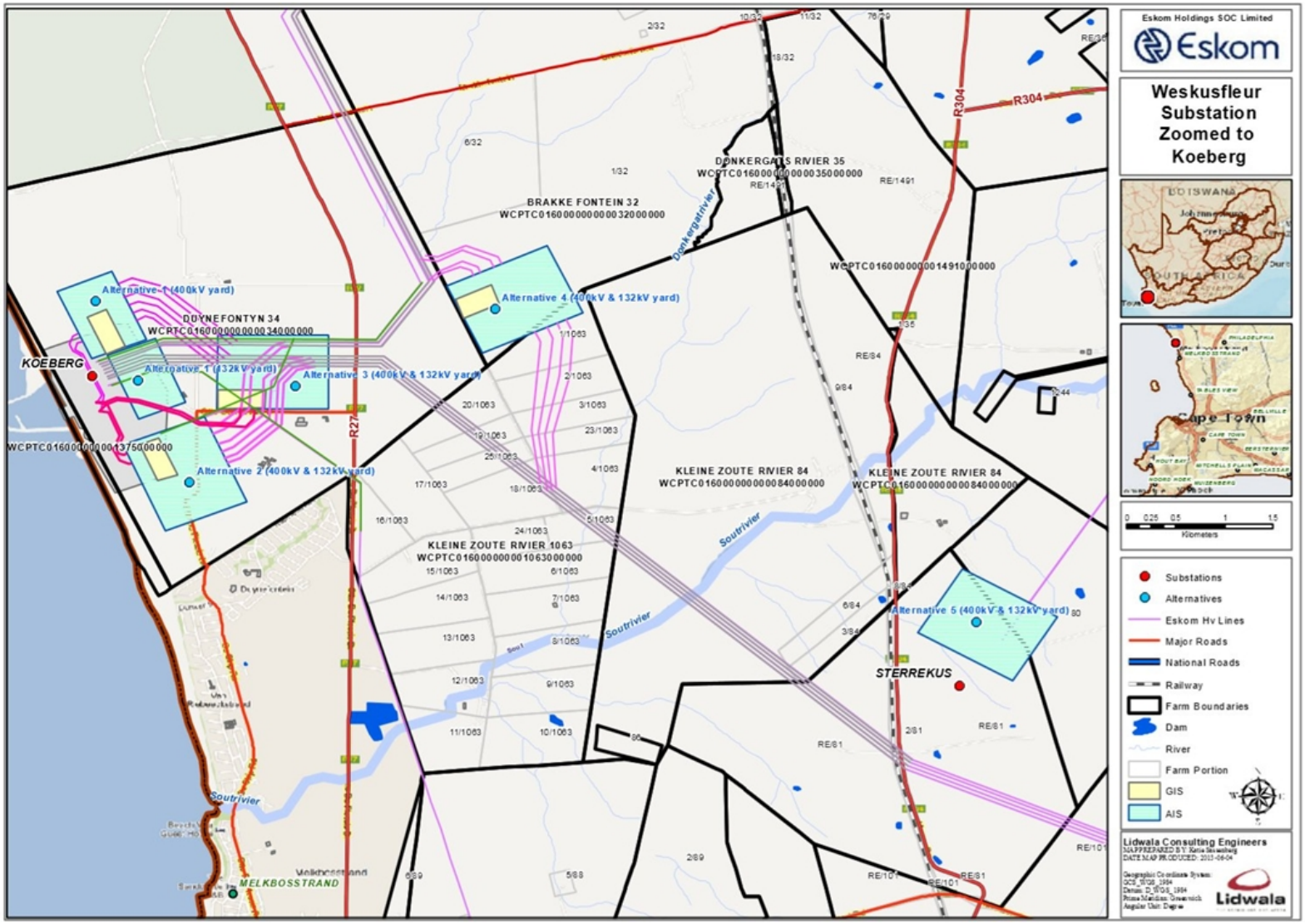

Figure 4.7: Locality map indicating all the alternatives (Note that the extent of the AIS on the map is larger than required at 950 x 750 m, the actual required size is 760 x 550 m)

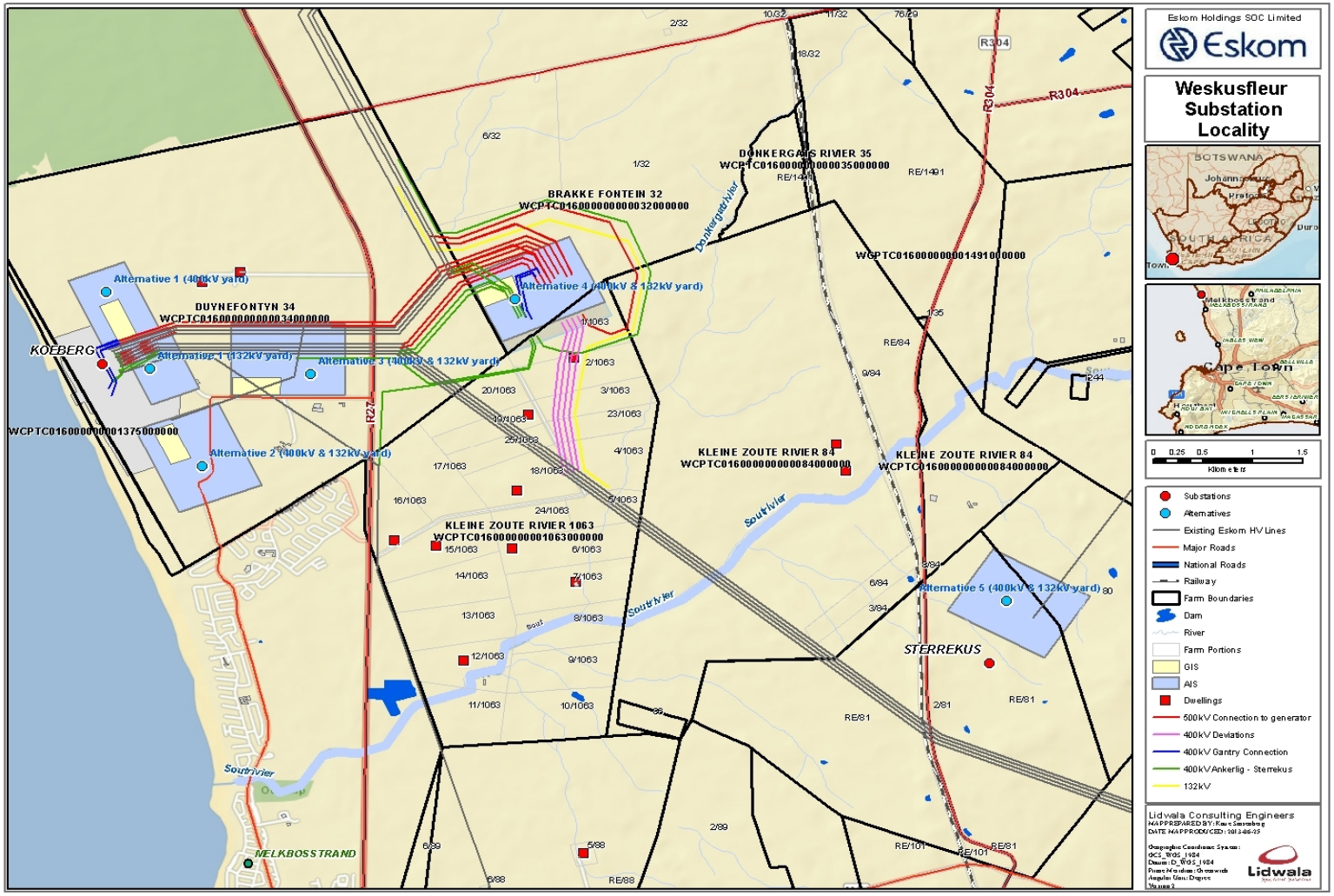

Figure 4.8: Locality map showing the proposed turn in including additional line arrangements for alternative 4 (Note that the extent of the AIS on the map is larger than required at 950 x 750 m, the actual required size is 760 x 550 m)

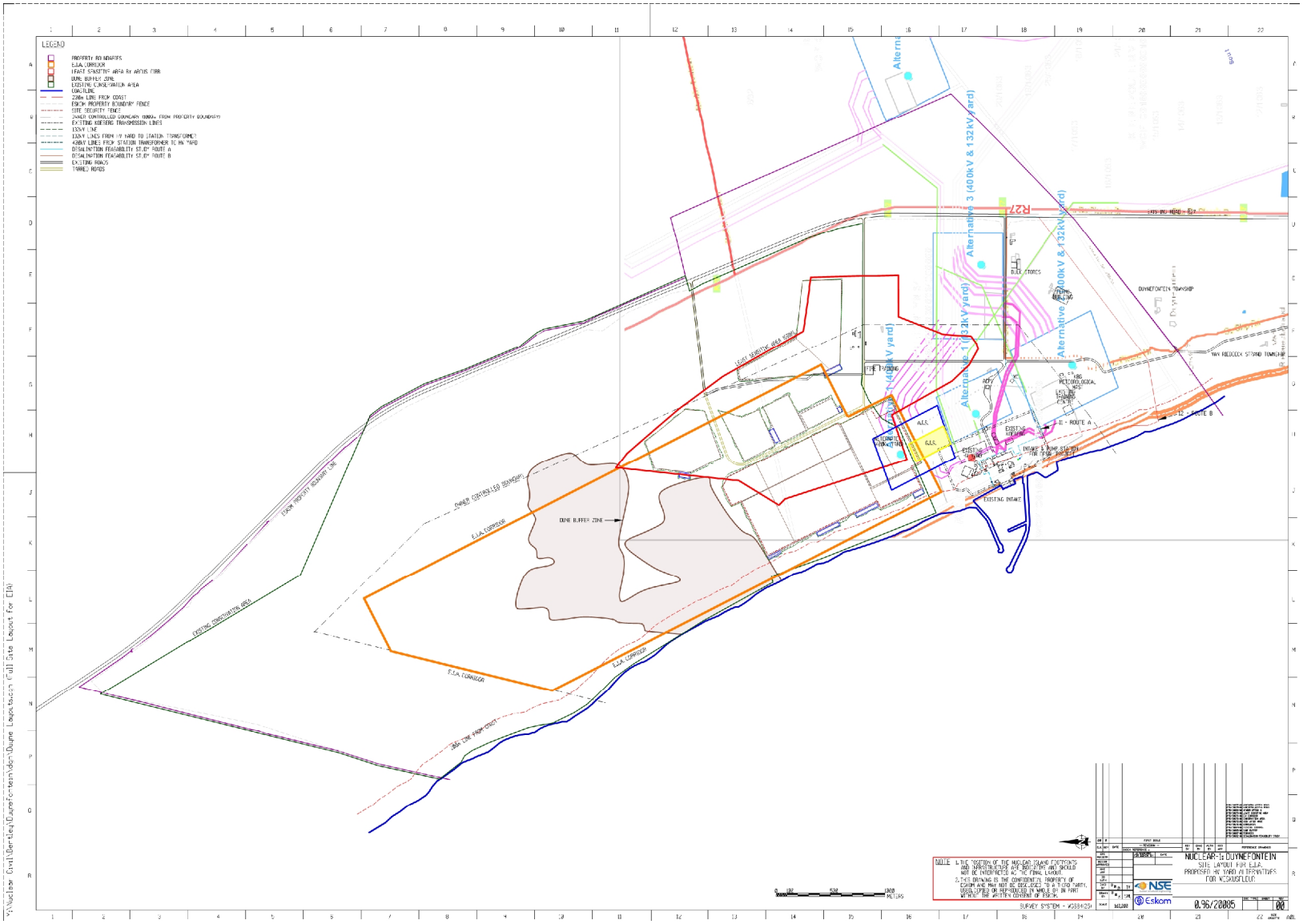

Figure 4.9: A map showing the alternatives and their relation to the proposed Nuclear 1. Please refer to **Appendix M** for an A3 map.

Figure 4.10: Alternative 1 AIS option – blue squares

Figure 4.11: Alternative 1 GIS option – yellow square

Figure 4.12: Alternative 2 GIS(Yellow) and AIS(Blue)option

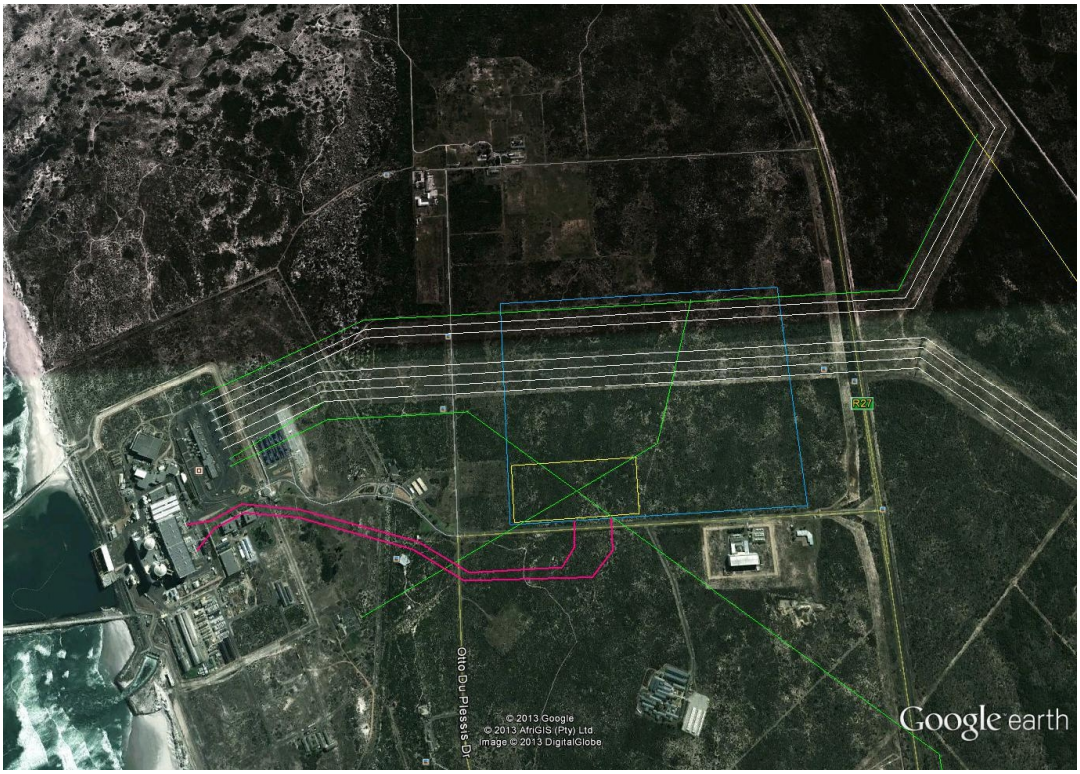

Figure 4.13: Alternative 3 GIS (Yellow) and AIS (Blue)

With all these alternatives, the biggest problem is the site constraints and the sites were evaluated based on the sizes for the substation and line servitudes given in **Table 4.1**.

The above mentioned sites were assessed to determine the best location from a line design perspective to integrate with the substation. The pros and cons are listed in **Table 4.2**. The cost is estimated at R 4 400 000 per kilometre of 400/500kV line although the cost of site establishment, transport of equipment to the site camp etc. can add approximately R14 000 000 to the project cost. These are estimated values for comparative purposes only.

Table 4.2: Eskom's descriptions of the of the five alternatives

Alternative	Location and GPS Co-ordinates	Description
1	At North east corner of the KNPS for the 400kV yard and the southern part of the parking area south of the incoming 400kV lines for the 132kV yard 400kV yard: 33°40'15.73"S 18°26'1.39"E 132kV yard: 33°40'26.64"S 18°26'11.32"E	• Located approximately 250 m from the Koeberg Power Station and a part of the site is partially transformed. This site is the closest to Koeberg power station with an existing HV yard, thus line deviations will be shorter • All lines will come from one side, thus lines will stay almost completely within the Koeberg security area • No crossing of transmission lines will be necessary • Utilises a large portion of the existing lines which has known reliability. • 400KV and 132KV substations split AIS configuration as well as GIS combined configuration. <u>Disadvantages</u> • Limited space for future lines and narrow servitude means taller structures. • Little useable land left for future expansion (especially because of close proximity to ocean which blocks lines on west side) • Space constraints are increased because it is not allowed to construct underneath existing lines: Construction underneath the existing lines is not viable because the current vertical clearance underneath the 400kV lines is 8.1m as per SABS 10280 specification. The height of the 500kV gantries proposed for the AIS will infringe the phase-to-earth clearances causing flashovers. Picking up AIS equipment with cranes or truck-mounted cranes will also infringe on the required phase-to-earth clearances and will lead to serious injury or death of the workers. Similarly construction

		of buildings (for housing the GIS) underneath the lines will infringe on the clearance requirements. The following also have reference in terms of this disadvantage: A GIS alternative in the parking area has been proposed by the City of Cape Town. Contrary to the initial perception, as raised during the Focus Group meeting on 13 August 2013, construction of the GIS on the parking area is not an option as the existing power lines cross the entire parking area and an equally large area to the north of the parking area. • Marine pollution and heavy corrosion • The 400kV AIS yard, as well as the combined 400kV and 132kV GIS yards, enters the sand dune area • The large 400kV AIS yard enters the sand dune area extensively; hence a buffer would have to be designed in order to prevent the sand from covering the yard stone in the Substation. • The area surrounding Koeberg has high levels of ground water. • The 400kV AIS yard extends over the proposed Nuclear 1 site and has a very large footprint (**Figure 4.9**). <u>Pre-requirements</u> • Move of existing parking lot, security gates and buildings etc. • Connection space for overhead connection to generators is limited and the connection type should be checked for acceptance from the NNR. • Outage requirements will be at least one week per out-going line for swap over during construction as well as a month per generator transformer for the swap over to the cable/overhead gantry connections. • The AIS alternative will have massive implications during constructability phase on security at Koeberg, cost implications due to move of parking lot, entrance gates etc. and is therefore not viable due to constructability concerns. • The GIS alternative is a viable alternative due

		to the small size and deviation of lines which is constructible.
2	The area at the south eastern corner of the KNPS where part of the PBMR was planned 33°40'48.14"S 18°26'10.34"E	• Site is located partially transformed land to the south of the Power Station • 400KV and 132KV substations combined AIS configuration as well as GIS combined configuration. • All lines can come from one side thus sequence of events can be clearly planned • No crossing of transmission lines will be necessary • Utilises a large portion of the existing lines which has known reliability <u>Disadvantages</u> • Little useable space for future expansion due to close proximity to the ocean • Limited space for future lines and also long distance from existing lines – longer line deviations than option 1 • AIS will too large and will clash with Duine Substation and the research centre • The GIL ducts for a GIS substation will be too long • Extremely high marine pollution and heavy corrosion • Limited space for the overhead line route from the Gen Transformers to the new 400kV yard. • Limited space for the overhead line route from the Station Transformers to the new 132kV yard. <u>Pre-requirements</u> • Connection space for overhead connection to generators is limited and the connection type should be checked for acceptance from the NNR as well as move of buildings etc. • Move of Duine station and Research station is required. • Outage requirements will be at least one week per out-going line for swap over during construction as well as a month per generator transformer for the swap over to the cable/overhead gantry connections. • The site will have massive implications during constructability phase on security at Koeberg, cost implications due to move of various

		stations, research centres etc. and is therefore not viable due to constructability concerns.
3	The area 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 400 kV lines 33°40'34.95"S 18°26'32.81"E	• Site is located east of the main Koeberg Power Station • 400KV and 132KV substations combined AIS configuration as well as GIS combined configuration. • Is in close proximity with existing power lines • Utilises a large portion of the existing lines which has known reliability Disadvantages • There is not enough space to turn in the lines and construction underneath the existing lines poses a high safety risk and the alternative is therefore not technically viable for the AIS option. • Exporting of power on distribution lines difficult due to space constraints of AIS • No useable land left for future expansion. • The GIL ducts for a GIS substation will be too long • Large visual impact on the nature reserve (Koeberg nature reserve) • New Lines are required for the Gen Transformer and Station Transformer connections. • Line crossings <u>Pre-requirements</u> • The site is not technically viable
4	Offsite option to the east of the R27 on the farm Brakke Fontein 32 33°40’00.54” S 18°28’17.32” E	• Site is located on private property that has been intensively invaded by alien vegetation. • 400KV and 132KV substations combined AIS with existing GIS combination or 400KV and 132KV with AIS only • Very few transmission line crossings are needed but there is a lot more space to accommodate this. • Further from the R27, thus less visual impact. • Sufficient space • Provides possibility of keeping existing GIS after integration with the new AIS and swap between the AIS and GIS if there is a problem with one. • Suitable overhead line route for the

		connection from the Gen Transformers to the new 400kV yard. (New lines might be required due to the 400kV insulation level requirement) • Existing 400kV lines can be used for the connection from the Station Transformers to the new 132kV yard. • The AIS only options without the existing GIS will allow for the removal of a few lines after completion of the project when the new yard has proven reliability. • Within the 5km restriction zone of Koeberg and allowed since it supports the operation of Koeberg. <u>Disadvantages</u> • Longer distance from Koeberg means longer lines from generation transformers to the new yard (two new lines need to be built at 500kV level to accommodate construction outage requirements as well as the move of the 132kV dedicated supply line). • Longer deviations from existing lines to the South. • The GIL ducts to substation will be too long. • New Lines might be required for the Gen Transformer connections due to the 400kV insulation requirements. • Only AIS is viable <u>Pre-requirements</u> • 132kV Koeberg-Ankerlig line will have to be shifted North of current position to accommodate 2 (or 3 for future reactor) 500kV line servitudes of 45m each. This will have to be done before construction of the other lines start as this will be the dedicated supply line. The dedicated supply line will have to feed into the new HV yard and can thus be a temporary line until it is turned into the new yard. The last piece of the dedicated line will be cable where it crosses underneath the generator and station transformer lines. • The 400kV Ankerlig Sterrekus line will have to be deviated around the yard's position to minimize line crossings. In its current position it will cross underneath 14 lines and after

		deviation will cross underneath only 3 lines. This might be possible before the line construction starts. • The connection of the generator transformers via overhead lines will have to be further investigated with an accurate survey to avoid the use of 400kV cables as far as possible. • 132kV double circuit Koeberg-Dassenberg line will have to be deviated around site. • Outage requirements will be at least one week per out-going line for swap over during construction as well as a month per generator transformer for the swap over to the cable/overhead gantry connections.
5	Offsite option next to the existing Sterrekus (Omega) Substation 33°41'55.68" S 18°30'48.50" E	• Site 5 is situated on the farm Groot Oliphantskop and its surrounding terrain is one of gently sloping hills covered with wheat fields. It is situated alongside the R304 and the Mamre Road. There are a few hills that stand out above the rest. • 400KV and 132KV substations combined AIS configuration • Suitable overhead line route for the connection from the generator transformers to the new 400kV yard. (New lines might be required due to the 400kV insulation level) • Existing 400kV lines can be used for the connection from the Station Transformers to the new 132kV yard although the swop between the existing GIS and new AIS will not be possible. <u>Disadvantages</u> • Blocks negotiated route for 765kV Kappa – Sterrekus line which will be in construction shortly (2014). • Longer distance from Koeberg means longer lines from generation transformers to the new yard which will severely impact on the performance in the high marine pollution environment leading to possible faults on the generator transformers. • Swap between AIS and GIS not possible • Far from Koeberg means performance problems on connections from the generator transformers.

		• Due to above mentioned reasons the site is not deemed technically viable.

4.8 Preferred Alternatives for consideration in the EIA phase

Except for the 'no go' *alternative* which will, however, be investigated further in the EIA phase as an *alternative* as required by the EIA Regulations. **Table 4.3** presents a summary of all the alternatives that have been considered to date. A technical analysis of all the *alternatives* was also undertaken the same period when the scoping studies were undertaken. During the scoping public participation process I&APs have been allowed to comment on all the proposed *alternatives*. The preferred alternatives that will be taken into the EIA phase include **alternative 1 GIS** and **alternative 4 AIS**. The final positioning, design and layout of these alternatives will be considered in the EIA phase. The other *alternatives* have been deemed technically and/or ecologically unviable. A *GIS alternative* in the parking area has been proposed by the City of Cape Town during the Focus Group meeting on 13 August 2013 although they indicated in their consolidated comment that construction of the GIS on the parking area is not an option as the existing power lines cross the entire parking area and an equally large area to the north of the parking area. This has also been confirmed in Eskom's descriptions of the *alternatives* in **Table 4.2** above for *alternative 1*.

Through the public participation process undertaken during the review of the Draft Scoping Report it was requested by the City of Cape Town that other alternatives should preferably be brought forward in the FSR that is technically viable and has a lower impact on the natural environment. The final positioning, design and layout of the preferred alternatives will be considered in the EIA phase which will provide more information in terms of their viability and impact on the environment. A range of alternatives have been brought forward from the inception of this project and various technologies and options (for example 400KV and 132KV substations split AIS configuration as well as GIS combined configuration at *alternative 1* – to reduce the footprint on undisturbed areas in order to have a lower environmental impact) have been technically analysed (**Table 4.2 & 4.3**).

Table 4.3: Alternative Summary - Technical Analysis

Issue		1	2	3	4	5
Proximity to Koeberg power station		Next to KNPS	Next to KNPS	700m	2.8km	7km
Space for expansion		Limited - ocean etc.	Limited – ocean etc.	Limited – existing lines etc	enough	enough
Transmission Line crossing		none	none	√	√	Not determined
Land Use		Eskom - Rural	Eskom - Rural	Eskom - Rural	Private Utility/residential/Agriculture	Eskom - Agriculture
Access		Good	Good	Good	Good	Good
AIS		Not technically viable Due to constructability (cost to move parking lot, entrance gates etc.) and security concerns	Not technically viable AIS will be too large & will clash with Duine Substation and research centre. Not enough space to turn in the lines	Not technically viable Not enough space to turn in the lines & construction underneath existing lines safety risk	Viable Sufficient space, few line crossings and within 5km restriction zone of KNPS and allowed as it support KNPS	Not technically viable Blocks route for 765kV Kappa–Sterrekus Line & long distance from KNPS (long lines from Gen transformers will impact performance
GIS		Viable Due to small size and deviation of lines which is constructible	Not technically viable Due to GIL ducts for GIS substation will be too long	Not technically viable Due to GIL ducts for GIS substation will be too long	Not technically viable Due to GIL ducts for GIS substation will be too long	Not technically viable Due to GIL ducts for GIS substation will be too long
Footprint	GIS	400x180m	400x180m	400x180m	400x180m	
	AIS	760X550 m	760X550 m	760X550 m	760X550 m	760X550 m
Marine pollution		Heavy Corrosion	Heavy Corrosion	medium	medium	medium