1 SPECIALIST REPORTS

1.1 Dune Geomorphology (Appendix E2)

This specialist study investigates environmental impacts related to dune dynamics for the nuclear power station ('Nuclear-1') that Eskom proposes to build. There are three sites under consideration: Duynefontein, Bantamsklip and Thyspunt. Aerial photographs from 1942 to 2007 were analysed to assess the dune morphology and dynamics of the mobile dunefields and vegetated dunefields at the three sites. Available literature on the subject was perused, including diverse reports prepared for Eskom, and various environmental specialists were consulted. Site visits were made, including visits with the wetlands and botany specialists.

Duynefontein

The dunes at Duynefontein form part of the Atlantis corridor dunefield. The dune varieties found are mobile transverse dunes, transverse dunes artificially stabilised with alien vegetation such as Rooikrans, and naturally vegetated parabolic dunes. Groundwater only "daylights" at Duynefontein in one or two small ephemeral interdune hollows, so there are no significant impacts related to the interaction between groundwater and dune dynamics at this site.

Access roads and transmission lines can be built across the mobile dunes with operational impacts ranging from medium to low. Access roads and transmission lines can be built across the vegetated dunefields with operational impacts ranging from low to insignificant.

Topsoil and spoils stockpiles located on the mobile dunes will have medium operational impacts. Topsoil and spoils stockpiles located on the vegetated dunefields will have low operational impacts.

At Duynefontein, 25% of the specific variety of mobile dunes will be lost if the proposed NPS site is used, and although it would be preferable not to lose these mobile dunes, this is not a fatal flaw in terms of their geomorphologic conservation value. The artificially vegetated dunes have no conservation value. A small proportion of the Late Holocene parabolic dunes will be lost; this is of low conservation significance.

Bantamsklip

Transgressive dunefields occur along the coast in the Bantamsklip area. They consist mainly of transverse dunes, which are mostly artificially stabilised with alien vegetation such as Rooikrans and some indigenous species. There are no currently mobile dunes on the site itself. There are some much older naturally vegetated fossil parabolic dunes formed during the previous interglacial (~ 120 000 years ago). Groundwater does not "daylight" at the site and so there are no impacts related to the interaction between groundwater and dune dynamics at the site.

Access roads and transmission lines can be built across the artificially vegetated dunefields with low operational impacts. Access roads and transmission lines can be built across the older naturally vegetated parabolic dunes with low operational impacts after careful rehabilitation.

Topsoil and spoils stockpiles located on the artificially vegetated dunefields or on the older naturally vegetated parabolic dunes will have low operational impacts.

The geomorphologic conservation value of the dunefields at the Bantamsklip site is low, considering that other examples of dunefields of their type are hardly impacted

Thyspunt

The dune varieties found at Thyspunt are mobile dunefields of the headland-bypass dunefield variety (the Oyster Bay dunefield), and vegetated parabolic dunes and hairpin parabolic dunes. In addition, sidewalls of previously mobile dunefields form long, vegetated dune ridges. Parts of the mobile dunefields have been artificially stabilised with alien vegetation such as Rooikrans. The mobile dunefields are very dynamic.

At Thyspunt groundwater "daylights" in many interdune areas within the Oyster Bay dunefield to form ponds in the interdune areas (also known as dune slacks), where wetlands are often found. The behaviour and flow characteristics of groundwater and surface water were investigated to help determine the viability, in respect of dune dynamics, of building transmission lines and an access road to Thyspunt from the north, across the Oyster Bay dunefield.

Mobile dune dynamics at Thyspunt were investigated in detail. An access road, transmission lines and a temporary conveyor belt or haul road could potentially be built across the mobile dunes of the Oyster Bay dunefield at Thyspunt. ***Further groundwater monitoring work on surface water and shallow groundwater flow as required was completed at the end of 2010 and the results thereof have been incorporated in the revised Freshwater Ecology (Wetlands) Report.***

The access road can be built either using an aerodynamically smooth road slightly raised above the interdune surface with frequent culverts, or with an aerodynamically shaped bridge that crosses the mobile dunes and interdune wetlands to allow sand to be transported below the road without causing sand build-up. The aerodynamically shaped bridge design would have a lower operational impact.

Transmission lines can be built across the mobile Oyster Bay dunefield. The operational impacts of towers spaced at 300 - 400 m intervals would range from medium in the case of access roads being used for construction, to low in the case of helicopters being used for construction. Using towers spaced at 800 m intervals, the whole mobile dunefield could be crossed with no activities or structures being located within the mobile dunes, and thus without any impacts whatsoever.

A temporary conveyor belt or haul road can be built across the mobile Oyster Bay dunefield to carry spoils to the "panhandle" in the north of the site. The environmental impact would be low after the conveyor belt or haul road is removed and rehabilitation is completed. However, rehabilitation would be slow.

Access roads, transmission lines and a temporary conveyor belt or haul road could be built across the vegetated dunefield with low operational impacts. Installing the conveyor belt foundations using low-diameter piles instead of concrete foundations will reduce impacts further. Terraforce or similar blocks must be used to stabilise the sides of the cut and fill, as rehabilitation by vegetating the slopes will be difficult and slow.

Topsoil and spoils stockpiles cannot be located on the mobile Oyster Bay dunefield at Thyspunt. Topsoil and spoils stockpiles can be located on the vegetated dunefield at Thyspunt with medium operational impacts.

The geomorphologic conservation value of the headland-bypass dunefields at Thyspunt is high, as they are the only remaining large dunefields of this type that are still active in South Africa. The headland-bypass dunefields at Cape St. Francis are unique on a local, regional and probably global scale. The vegetated dunefield is a classic, almost pristine example of a suite of Holocene and Pleistocene dune ridges with a variety of origins: parabolic dunes, hairpin parabolic dunes, and sidewalls of previously mobile headland-bypass dunefields, including fairly unique examples of such sidewalls. Overall, the dunefields at Thyspunt has high interpretive value for elucidating coastal dune dynamics.

Climate change

The possible effects of climate change on dune dynamics are:

Retreat of the coastline in response to higher sea level may shift or create new sandy beaches that supply wind-blown sand to dunes. Mobile dunes and dunefields may thus be created in areas that are currently vegetated.

Rainfall decrease and temperature increase at Duynefontein and Bantamsklip will stress vegetated dunes, so it will be easier for blowouts to form. At Thyspunt, rainfall is not expected to change, but temperature will increase, so it will be somewhat easier for blowouts to form, but not as much as at the other sites.

Wind speed increase is not expected to have any significant environmental impact.

1.2 Geological Hazard Assessment (Appendix E3)

In general the impact of a Nuclear Power Station on the geological environment is smaller compared to the potential impact that the geological environment may have on the proposed ***Nuclear Power Station***. Geological investigations are guided by Nuclear Regulatory Codes, especially U.S. Nuclear Regulations, which are regarded as the ***leading*** international regulatory framework, and geoscientific investigations which are guided by the increasing resolution in consecutive regulatory radii of 1, 8, 40 and 320 km around each proposed site.

A number of different geological factors are considered here, including:

- Locally induced (by the steam turbines) vibratory ground motion at the site;
- Surface rupture;
- Subsurface stability; and
- Volcanic risk.

Available geological data on the three sites being considered for installation of a nuclear power plant, Thyspunt, Bantamsklip and Duynefontein, has been reviewed regarding the above-mentioned risk factors. This showed that the geological risk regarding the above-mentioned risk factors is low at all three proposed sites. However, additional neotectonic studies still need to be completed and the results submitted to the National Nuclear Regulator as part of the Site Safety Report submissions. These studies, which will be done separately from the EIA process, may impact and even change conclusions reached to date, and therefore no final conclusions can be made about site suitability.

Geologically, there are no sensitive areas that need to be avoided at the Bantamsklip and Duynefontein Sites. At the Thyspunt site the foundation of critical structures should not cross the contact between the Goudini and Skurweberg Formations.

A decision not to proceed with a Nuclear Power Station will have no impact on the geology at the Thyspunt, Bantamsklip or Duynefontein sites. A minor risk to subsurface stability exists at the proposed Duynefontein site.

1.3 Seismic Risk Assessment (Appendix E4)

In general the impact of a Nuclear Power Station on the geo-scientific environment is insignificant compared to the potential impact that the geo-scientific environment may have on the proposed Nuclear Power Station. Geo-scientific investigations for nuclear sites are guided by Nuclear Regulatory Codes, especially U.S. Nuclear Regulations, which are regarded as the most comprehensive international regulatory framework, and requires geological and geophysical investigations of increasing resolution in concentric regulatory radii of 320, 40 and 8 km around each proposed site.

Seismic Hazard Analysis (SHA) entails estimating the expected level of ground motion at the site during the active and decommissioned life of the plant, based on a model of the regional and local seismicity (size and locations of earthquakes). All seismic hazard analyses require the same fundamental input data; a model for the occurrence of earthquakes (seismic *source* model) and a model for the estimation of the ground motions at a given location as a result of each earthquake scenario (ground-motion model). The seismic source and ground-motion models are combined, either probabilistically or deterministically, to obtain the ground motions to be considered for design. Probabilistic Seismic Hazard Analysis (PSHA) uses advanced statistical methodologies which enable the consideration of uncertainties.

Site specific SHA were previously undertaken for the three sites by the Council for Geoscience (CGS), employing a methodology called the Parametric-Historic SHA.

Using this methodology, median PGA values of 0.16 g, 0.23 g and 0.30 g were calculated for the Thyspunt, Bantamsklip and Duynefontein sites, respectively and these values constitute the current seismic hazard levels for the sites.

These results were accepted by the National Nuclear Regulator (NNR). The NNR however, imposed the condition that current state of the art for SHA should be used in the evaluation of the sites when formal applications are made for a construction and operating licence. In order to meet this requirement, Eskom has decided to follow the regulations of the United States Nuclear Regulatory Commission (or US NRC), which is considered to be the most stringent, detailed, tried and tested set of regulations in the world, and therefore describes international best practice for the SHA and the proposed licensing process with the NNR. Additionally, the United States, like South Africa, is a member state of the International Atomic Energy Association (IAEA), and as such their national legislation is compatible with the IAEA regulations.

The present Chapter of the EIR describes the work carried out to date on the seismic hazard assessment of the three sites, and provides the current positions regarding their suitability for locating nuclear power plant installations.

1.4 Geotechnical Suitability Assessment (Appendix E5)

Eskom Holdings Limited (Eskom) proposes to construct Nuclear Power Stations and associated infrastructure, either in the Eastern or Western Cape Province. Three site alternatives are considered:

- Thyspunt (Eastern Cape – West of Port Elizabeth near Oyster Bay)
- Bantamsklip (Western Cape – 5 km south-east of Pearly Beach)
- Duynefontein (Western Cape – adjacent to the existing Koeberg Power Station, Cape Town)

The choice of suitable sites will be influenced by the Environmental Impact Assessment (EIA) process, in terms of which numerous physical, biophysical, oceanographical and engineering aspects are being investigated. This report considers the Geotechnical Engineering aspects of the sites.

The report is based on a desk study of historical information as well as on extensive data gathered through intrusive field investigations. These data sources have identified the following fundamental geotechnical characteristics at the sites:

Thyspunt

- The site soil profile varies considerably in thickness as one moves inland, ranging from 0 m thick (at the sea) to almost 60 m thick within the dune area;
- The geotechnical properties of these soils are consistent across the site and random calcrete zones are encountered;
- An intergranular aquifer exists at the site, the groundwater table daylights at the sea and there is a variance in depth to the groundwater table in the dune area;
- The soils have no cohesion and when saturated, will require innovative slope stabilisation techniques for any proposed excavations;
- Two dominant geological formations are encountered under the soils, namely the Skurweberg and Goudini formations;
- The Skurweberg Formation is located nearer the sea and the Goudini Formation more inland;
- The quartzitic sandstone Skurweberg Formation is marginally more competent (harder and more resistant to erosion) than the carbonaceous sandstone Goudini Formation;
- An historical erosion depression containing cobbles exists in the Goudini Formation and this cobble layer influences groundwater flow direction in a South Easterly direction.

Bantamsklip

- The site soil profile varies less in thickness than the Thyspunt site as one moves inland, ranging from 0 m thick (at the sea) to almost 20 m thick within the dune area;
- The geotechnical properties of these soils are consistent across the site and significant calcretised zones are encountered;
- The groundwater table is situated just above the bedrock;
- The soils have no cohesion and when saturated, will require innovative slope stabilisation techniques for any proposed excavations, but the presence of calcrete will provide some assistance in this regard;
- The bedrock is dominated by quartzitic sandstones of the Peninsula Formation;
- These quartzitic sandstones are highly jointed, but competent and present a more competent wave cut platform than at Thyspunt;

Duynefontein

- The site soil profile differs from Thyspunt and Bantamsklip in that it is almost homogeneously 20 m thick everywhere on the site;
- The geotechnical properties of these soils are relatively consistent across the site;
- The groundwater table is elevated on this site and occurs between 4 and 10 m below natural ground level;
- The soils have no cohesion and when saturated, will require innovative slope stabilisation techniques for any proposed excavations;
- The overburden sands are underlain by Malmesbury rocks consisting of a succession of greywacke, hornfels, mudstone, siltsone and shale, all of varying competence;
- The greywacke and hornfels are more competent than the mudstone, siltstone and shale, which are all more prone to weathering.

No-go option

Should it be decided to not construct a nuclear power station none of the above impacts associated with construction of a nuclear power station will be introduced. All associated negative impacts will therefore be removed. However, Eskom could sell the Thyspunt and Bantamsklip sites, and possibly parts of the Duynefontein site under this scenario and there could therefore be other unforeseen negative impacts arising from different property development scenarios.

Environmental impacts that could alter the functioning of the natural geotechnical environment are related to:

- Slope instability in rocks and soils during and post construction resulting in safety risks to people and to a lesser extent the environment;
- Geotechnical conditions (and specifically overburden thickness and groundwater profiles) dictating that large site disturbances will occur in excavations (that will need to be battered back to angles in the range of 20º);
- The disposal of excavation spoil.

The impacts related to slope stability imposing safety risks without mitigation measures have low significance at all of the sites, as slope stability design techniques will be employed to deal with these issues. Standard slope stabilisation techniques in sands will almost certainly mean that excavated slopes will need to be battered back to flat angles (i.e. cut back to acute angles in the range of 20º) to limit the potential for slope failure. This leads to the overriding impact (resulting from flat slope angles) of larger volume excavations being required, leading to larger rexcavation footprint disturbances and a need for disposal of greater volumes of spoil. The impacts associated with this ***(without mitigation)*** are of ***medium*** significance at ***Duynefontein and Thyspunt and low significance at Bantamsklip. With mitigation, which essentially involves locating the excavations near the sea at Bantamsklip and Thyspunt, the significance of associated impacts are reduced to low and low – medium at Duynefontein and Thyspunt respectively. At Bantamsklip, the significance of these impacts are low – corresponding to less overburden on this site.*** Site sensitivity maps depicting ***the significance of these excavation-related impacts*** are presented in this report.

1.5 Hydrological Assessment (Appendix E6)

This Environmental Impact Report (EIR) covers the impacts and mitigation measures associated with the construction and operation of a proposed conventional Nuclear Power Station (NPS) and associated infrastructure at one site in the Eastern Cape and two in the Western Cape. The sites were originally identified as a result of site investigations undertaken since the 1980s and from the EIA Scoping Study. This specialist study covers Hydrology and was carried out by SRK Consulting.

Eskom proposes to construct a NPS of the Pressurised Water Reactor type technology, with a capacity of ~4 000 MWe. The proposed NPS will include nuclear reactor, turbine complex, spent fuel, nuclear fuel storage facilities, waste handling facilities, intake and outfall basin and various auxiliary services infrastructure.

All three proposed sites at Thyspunt, Bantamsklip and Duynefontein are located on the coast.

The study has covered regional aspects based on the surrounding quaternary catchments and a study area of 20 km radius. From the regional assessment it was determined that no potable surface water resources are available at any of the sites. Alternative water supply sources or treatment of sea water must therefore be considered. Desalination is discussed in the Fresh Water Supply specialist study report.

For the currently proposed corridor for nuclear plant and auxiliary buildings of the sites there is a potential flood hazard at low points along the coastal frontage of the corridor in the event of an unusually high water level. A flooding hazard due to ponding also exists at each of the sites at the construction phase, due to the open excavations for the plant foundations.

Potential sea level rise due to global warming has little effect on the NPS and climate change should also have a minor effect on ***the hydrology of the surface water bodies*** considering the absence of major watercourse on the sites.

Due to hardening of surfaces at the plant and auxiliary works the stormwater run-off volumes and peaks are expected to increase by about 25 to 40 times when compared to the pre-development conditions. All impacts can, however, be reduced with the implementation of mitigatory measures.

The major characteristics that differentiate the impacts on the environment at the three sites mainly relate to rainfall, the presence of seasonal wetlands and non-perennial watercourses. Thyspunt has the highest rainfall as well as seasonal wetlands and a non-perennial water course. At Duynefontein the impact on the seasonal wetlands is less since the rainfall is the lowest of the three sites. Rainfall at Bantamsklip is higher than Duynefontein, but there are no sensitive environmental features or any ecologically sensitive wetlands. The direct hydrological impacts at all three sites are *low* in significance rating with a *low* consequence.

Should no Nuclear Power Station be built (no-go option) at any of the sites, Eskom would sell the Bantamsklip and Thyspunt properties and possibly ***also*** superfluous land ***at*** Duynefontein. The sites may then be developed for other purposes with less strict controls and regulation than those for Nuclear Installations. This may lead to increased runoff from the developments. If the impacts are then not well managed they may have negative consequences. However, the impact on the Duynefonetin site would be positive.

The Best Management Practices approach is adopted for the identification of structural and non-structural mitigation measures.

The structural mitigation measures include:

- Diversion berms;
- Silt traps;
- Energy dissipation structures; and
- Dirty water containment dams.

The non-structural measures include:

- Drawing-up stormwater control measures maintenance programmes; and
- Production of control measures operational manuals.

There are no fatal flaws at any of the sites regarding surface water impacts.

Existing information should be supplemented on the following aspects:

Detailed footprint and layout of plant area and ancillary works;
Locality and extent of possible future residential / commercial developments; and
Quantification of the rainfall difference due to climate change at each of the sites.

1.6 Geohydrological Assessment (Appendix E7)

This Environmental Impact Report (EIR) covers the impacts and mitigation measures associated with the construction and operation of a conventional Nuclear Power Station (NPS) and associated infrastructure at three sites in the Eastern (1) and Western (2) Cape. The sites were originally identified as a result of site investigations undertaken since the 1980s and from this EIA Scoping Study. This specialist study covers Geohydrology and was carried out by SRK Consulting, ***with assistance from the Institute for Groundwater Studies at the UOFS on the numerical modelling.***

This impact study comprises the baseline information and an impact assessment for the following sites:

1. Duynefontein;
2. Bantamsklip; and
3. Thyspunt.

The study provides an overall assessment of the impact of a nuclear facility on the aquifer hydrodynamics and vice versa. The Terms of Reference (ToR) for the specialist Geohydrological Assessment are to investigate:

- The existence and location of regional / local aquifers and other relevant geohydrological units relative to the sites, e.g. aquitards, fractures, boundaries;
- Groundwater observations including information about hydraulic conductivity (K) / transmissivity (T), groundwater levels and their fluctuations, monitoring of groundwater chemistry and resistance of soil-cement foundations to chemical attack;
- The possibility of groundwater contamination, flooding by groundwater and material degradation due to groundwater attack;
- The effect of withdrawal of groundwater from neighbouring areas on flow of groundwater at the sites;
- A 3D conceptual geohydrological model showing aquifers, groundwater levels, aquifer boundaries, and groundwater flow directions;
- A 3D numerical flow model to simulate regional, local and site specific response of the groundwater system to natural and manmade influences, e.g. seasonality, dewatering during construction, abstraction from wellfields;
- A contaminant transport model to simulate the fate of any contaminants introduced into groundwater systems from operation of the sites; and
- A risk assessment of the impacts of the NPSs on the receiving environment.

Extensive and detailed work has been carried out at all three sites as part of this EIR, including a hydrocensus, surface geophysics, drilling, test pumping, packer tests, chemical analysis, numerical flow and transport modelling and monitoring.

Six potential environmental impacts involving groundwater have been identified, *viz.*:

- Flooding by groundwater;
- Depletion of local aquifers;
- Degradation of wetlands / phreatophytes/ seeps / springs;
- Contamination;
- Degradation of infrastructure; and
- Contamination of the shore zone ***by sea water intrusion.***

The three sites are all located in coastal environments with so-called EIA Corridors within which the NPS and related infrastructure will be located. There are, therefore, certain key geohydrological characteristics that are likely to govern groundwater occurrence and behaviour at the sites. These are:

- There ***is unlikely to*** be any downstream groundwater use;
- Groundwater at the site will be near / at the end of its flow path;
- There will be a component of groundwater flow towards the water table (i.e. upwards);
- Groundwater levels will be near the ground surface;
- The bedrock may comprise a wave-cut platform;
- The receiving environment / downstream receptor of any contamination will be the shore zone / sea;

- There is likely to be a two aquifer system at the site, with an upper intergranular and a lower fractured rock aquifer;
- These two aquifers are likely to be in hydraulic connection but may be separated by a weathered zone in the bedrock possibly constituting an aquitard;
- Local recharge may only affect the upper aquifer. Deeper aquifers may be recharged further inland, possibly many kilometres ***from each*** site;
- Groundwater quality may be relatively poor because of a combination of the length of the flow path, time for interaction with aquifer materials and proximity to the sea (sea-water intrusion, wind-blown salts);
- Groundwater flow rates are likely to be relatively slow because of low hydraulic gradients;
- There will be an interface between 'fresh' groundwater from inland and saline groundwater in the shore-zone;
- Groundwater may feed coastal springs / seeps which may support sensitive ecosystems; and
- Leaks of radioactivity will not affect existing groundwater users directly. However, any air emissions could be transported inland by prevailing winds and contaminate the groundwater by being incorporated into rainfall recharge.

These characteristics have been taken into account in the approach and execution of this study and played a major role in the impact assessment ratings. At the Bantamsklip site it has been established that no viable aquifers are present, whereas viable aquifers are present at Thyspunt (primary and secondary) and Duynefontein (secondary, primary further inland).

The impact rating of the potential environmental impacts is summarised as follows for the construction and operational phases:

- Flooding by groundwater: ***Medium*** at all three sites with mitigation and ***Low*** without mitigation;
- Depletion of local aquifers: ***Medium*** at Thyspunt and ***Low-Medium*** at Bantamsklip and Duynefontein without mitigation and ***Low*** at all three sites with mitigation;
- Degradation of wetlands / seeps / springs: ***Medium*** at Thyspunt and Duynefontein and ***Low-Medium*** at Bantamsklip without mitigation and ***Low*** at all three sites with mitigation.;
- Non-radioactive contamination: ***Medium*** at all three sites with mitigation and ***Low*** without mitigation;
- Degradation of infrastructure: Duynefontein overall index slight to serious corrosion and minor scaling. Bantamsklip overall index slight to serious corrosion and minor scaling. Thyspunt overall index non corrosive to corrosive and scaling.
- Contamination with radioactive material: ***Low-Medium*** at all three sites without mitigation and ***Low*** with mitigation;
- No-go option: ***Low*** impact at Bantamsklip and ***High*** at Thyspunt and Duynefontein without mitigation, and ***Low*** at Bantamsklip and ***Medium*** at Thyspunt and Duynefontein with mitigation.

The low ratings are largely a function of the sites being situated in coastal zones with groundwater being at/near the end of its flow path and minimal downstream receptors. Site sensitivity is rated as follows:

- Bantamsklip: Low;
- Duynefontein: Low along the coast increasing in sensitivity inland;
- Thyspunt: Mostly low to medium and high in wetland areas.

Essential mitigation measures include the following:

- Use of a sea water desalination plant to supply construction and operational fresh water requirements;
- Setting up of a suitably designed groundwater monitoring network to cover water levels and quality in all aquifers/wetlands;
- Use of cut-off barriers around excavations to limit the spread of drawdown during construction;
- Use of managed artificial recharge of groundwater pumped from excavations during dewatering to maintain wetlands/springs/seeps and phreatophytes;
- Siting of the NPS on the site within the EIA Corridor such that the impacts identified can be reduced in significance, e.g. avoiding faults/fracture zones, >500 m from wetlands, >300 m from coastal seeps/wetlands (assumes groundwater control mitigation measures in place). Setting the footprint back from the coast is in line with Eskom's plans to reduce plant corrosion;
- Use of corrosion-resistant foundations, pipes and fittings where infrastructure will be located below the water table;
- Use of nuclear reactor design(s) meeting the National Nuclear Regulator's requirements for normal operational dose emissions and containment of accident emissions;

- Development of a remediation/mitigation protocol prior to construction so that measures are documented and in place to deal rapidly with any on-site contamination incidents or signs that predicted drawdown levels have been exceeded.

Based on the geohydrological assessment presented in this specialist report, all three sites are environmentally acceptable, in terms of groundwater, for the development of an NPS.

The confidence level of all information presented in this specialist report is high.

1.7 Fresh Water Supply Assessment (Appendix E8)

This Environmental Impact Report (EIR) covers the impacts and mitigation measures associated with the construction and operation of a conventional Nuclear Power Station (NPS) and associated infrastructure at three sites in the Eastern (1) and Western (2) Cape. The sites were originally identified as a result of site investigations undertaken since the 1980s and from the EIA Scoping Study. This specialist study covers Fresh Water Supply and was carried out by SRK Consulting.

Water requirements for a 4 000 MWe NPS are the following:

- Normal requirement : 70 L/s
- Construction peak : 104 L/s
- Site establishment : 23 L/s

Water supply is required for potable and construction purposes during NPS construction and for potable, demineralised and fire protection purposes during NPS operation.

This EIR is based on a desk study and site investigation involving the following:

- Department of Water Affairs and Forestry (DWAF) reports;
- Review of Atomic Energy Corporation/Eskom reports on the three sites from the 1980s and 1990s;
- Review of relevant legislation;
- Detailed site investigations for this EIR, including a census of existing water users/sources, drilling and testing of boreholes, water sample chemical analyses;
- Information supplied by various local authorities.

Water supply options for all three sites are as follows:

- Municipal or DWAF supply from existing local or regional schemes, mainly sourced from surface water/dams but also possibly from groundwater;
- Development of new dams by Eskom or local authorities;
- Development of groundwater resources; and
- Desalination of sea water (Eskom preferred option).

Conclusions from this specialist study

Thyspunt

- There is extensive use of groundwater in the surrounding area;
- There are coastal springs at the site;
- The surrounding towns are supplied with water from the Churchill and Impofu dams and from groundwater;
- There is scope for further development of local groundwater resources for construction supply both on-site and in the surrounding area;

- Local and regional surface water resources are under stress and additional draw-off to supply a NPS would exacerbate this situation;
- The main option for surface water supply with least local and regional impact is import of water from the Orange River Scheme;
- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change; and
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This option would have the least environmental impact and is Eskom's preferred option for fresh water supply.

Bantamsklip

- There are no viable aquifers in the area;
- Local and regional surface water sources are fully utilized;
- The surrounding towns are supplied with surface water from Kraaibosch Dam and groundwater from springs and boreholes;
- Local and regional surface water resources are under stress and additional draw-off to supply a NPS would exacerbate this situation;
- The only option for surface water supply is import of water from the Riviersonderend-Bree scheme;
- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change; and
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This option would have the least environmental impact and is Eskom's preferred option for fresh water supply.

Duynefontein

- There is extensive use of groundwater in the surrounding area;
- The Aquarius Wellfield was previously developed to supply groundwater to the Koeberg Nuclear Power Station (KNPS) but has not been used recently because of quality constraints. This wellfield requires extensive rehabilitation but could supply the required construction and partial operational demand;
- KNPS is connected to the municipal water supply scheme;
- Additional surface water supply from existing municipal supply sources cannot be guaranteed;
- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change; and
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This option would have the least environmental impact and is Eskom's preferred option for fresh water supply.

No-go option

- In the event that the sites are not developed for NPSs, Eskom will sell the Bantamsklip and Thyspunt properties and non-essential parts of Duynefontein could also be sold. In this scenario the impact is seen to be low intensity, neutral consequence and low significance for the Bantamsklip site (no aquifers) but of medium intensity, negative consequence and high significance for the Thyspunt and Duynefontein sites as local groundwater resources could be exploited by private land owners/developers. The main mitigation measure for this scenario would be strict enforcement of conditions applicable to any approved future development of the sites.
- It is recommended that desalination of sea water is implemented at the chosen site for fresh water supply. The main mitigation measures required for this supply option are:

- Brine produced as a by-product of the desalination process must be discharged in the surf zone during the construction phase (up to 156 L/s) to facilitate mixing;
- Brine produced as a by-product of the desalination process must be mixed with the cooling water discharge from the NPS during operation;
- A marine ecologist must monitor the discharge areas to assess impacts on marine ecology.

1.8 Position of the 1 in 100 Floodline (Appendix E9)

A number of specialists working on the Nuclear-1 EIA have requested that the 1:100 year flood line due to flooding from the sea be estimated. This relates to the width of the coastal corridor and the siting of the nuclear terrace within the defined Nuclear Installation Corridor.

The 1:100 year flood line is a combination of surface elevations caused by a number of coastal processes. Specifically the elevations due to:

- Tides
- Sea level rise (where applicable)
- Storm surge
- Wave run-up

The dominant process is seen to be the maximum elevation calculated for the wave run-up. As the run-up is highly dependant on the slope of the coastal feature, the wave height and water depth, it is necessary to discretize the area under study into a number of regularly spaced beach normal profiles.

The total flood elevation is calculated by summation of the tide, storm surge and wave run-up for each of the profiles and then interpolated onto a digital elevation map of the site topography. The 1:100 year flood line is then the intersection of the calculated surface elevation and the surfaced topography.

For the evaluation of the 1:100 year flood line for 2075 the influence of climate change is calculated on both the hydrographic parameters and the local topography.

The shoreline also undergoes an adjustment based on the increase in sea level. Erosion occurs at progressively higher levels up the beach. The beach, in profile, is expected to translate vertically, an amount equal to the sea level rise and erode into the hinterland a distance proportional to the local beach slope.

In order to calculate a flood line for a future period, it is necessary to apply the above mentioned shoreline changes to the topography before the interpolation of the increased calculated surface elevation onto the modified surface.

The 1:100 year flood lines have been calculated for each site for the present day and 2075. These may be used by other specialists working on the coastal corridor and the siting of the nuclear terrace within the defined Nuclear Installation Corridor.

1.9 Air Quality Assessment (Appendix E10)

Eskom proposes to construct a nuclear power station in South Africa with a power generation capacity of up to 4 000 MWe. In this EIA, the project is known as Nuclear-1, which includes the assessment of three sites. As a preliminary indication of the schedule, it was given that site access and terrace preparation for Nuclear-1 is proposed for January 2013, and would continue for 6-12 months. Construction of the nuclear power station would last for 7-9 years

The proposed sites for these power stations include:

- Duynefontein (Western Cape) located adjacent to the existing Koeberg Power Station, Cape Town;
- Bantamsklip (Western Cape) located 10 km south-east of Pearly Beach; and
- Thyspunt (Eastern Cape) located west of Port Elizabeth and approximately 15 km west of Cape St. Francis.

The Scoping Phase of this Environmental Impact Assessment (EIA) process has recommended that the two sites in the Northern Cape (Brazil and Schulpfontein) be excluded from further investigation during the EIA phase.

Eskom proposes to utilise Pressurised Water Reactor (PWR) technology. However, a final vendor specific plant design has not been decided on as yet. This assessment was therefore based on a generic nuclear power station, with atmospheric release information that provided an envelope of different reactor designs. In all cases, the worst-case impacts were assessed. The assessment therefore includes the maximum radionuclide emission from the nuclear power station during routine operation for its entire lifetime and design basis accident (DBA[1]) scenarios based on different reactor design technologies, which are being considered by Eskom.

AIRSHED PLANNING PROFESSIONALS (Pty) Ltd was appointed by ARCUS GIBB (Pty) Ltd to undertake an Air Quality Impact and Climatology Assessment for the proposed construction, operation and decommissioning of the nuclear power station and associated infrastructure.

Methodology

The main objective of the study was to determine the potential air pollution impacts associated with the construction, operation and decommission of the proposed nuclear power station on the surrounding environment. To accomplish this, the first step was to establish the baseline conditions of the proposed three sites through measurement of local meteorology. The next step was to determine all air emissions which are expected to result during the different phases. Whilst great care was taken to estimate emissions expected during the construction phase, it is anticipated that some minor differences may eventually exist with the final construction plan. The impact during the decommissioning phase was qualitatively evaluated using a proforma decommissioning plan. The atmospheric dispersion of emissions of all potential air pollutants during the operational phase was included in the assessment. These included non-radionuclides and radioactive emissions. Air concentrations and fallout rates were simulated using meteorological data recorded on site[2] and from the closest South African Weather Services (SAWS) meteorological stations with adequate historical data. For non-radioactive air releases, ambient air quality guidelines were used to compare against predicted concentrations, which serve to provide a screening health risk[3]. The impact of radionuclides was assessed in a similar fashion as non-radioactive substances, i.e. comparison to a “dose limit”. However, the predicted nuclide activities (“concentrations”) and

[1] A postulated accident that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to assure public health and safety. Design Basis Accidents, which could include pipe ruptures, component failure, etc. must be controlled by the safety facilities in such a way that effects on the environment are kept below the specified planning values of the NNR, i.e. the effective dose to a worker or members of the public is less than 50 mSv.

[2] Onsite meteorological data at Thyspunt and Bantamsklip was only available for a few months at the outset of the impact assessment. On subsequent review of the assessment, more than a year’s onsite meteorological data became available and a comparison to the SAWS data revealed small differences, which would not change the conclusions of the assessment.

[3] The air concentrations and deposition of non-radionuclide pollutants were compared to health risk limits developed by international institutions, such as the World Health Organisation (WHO), to represent safe levels below which no health risk effects are observed. Exceedances of a limit would flag for additional mitigation of emissions.

surface deposition rates were first converted to an effective dose[4]. The study focused only on inhalation, immersion in a cloud and irradiation from surface soils. The ingestion pathway (water and food) is dealt with in the overall health risk study using the air concentration and deposition rates results derived from this study.

For the purposes of this assessment, a 40 km by 40 km study area was defined for the local dispersion calculations. No specific study area was defined for long-range transport since these were based on the distances typically travelled by the pollutants over a three-day period.

Assumptions and Limitations

The lack of knowing the specific vendor for the nuclear power station is considered to be a gap. This is specifically important with regards to the radionuclide emission source term. However, in order to account for the possible radionuclide emissions from the proposed nuclear power station, the source terms from two candidate vendors were included in the assessment. These source terms provides an envelope of different reactor designs. These emissions included both normal and upset conditions. The assessment was therefore based on the most conservative results from these two vendors. It should be noted that in order to comply with NNR requirements, the proposed nuclear power station will have to remain within the emission levels stipulated in its licence.

Catastrophic incidents were not part of the plan of study for the assessment since these incidents are within the jurisdiction and mandate of the NNR. The NNR will evaluate the safety case for the proposed nuclear power station to determine compliance with the requirements contained in Government Notice R388 of 28 April 2006, "Safety Standards and Regulatory Practices". The NNR process has not start yet, but will follow after the specific PWR vendor has been selected as part of the procurement process . Thus accident scenarios have not been expressly dealt with in this assessment.

Although the relatively short, one-year period of meteorological data recorded at Thyspunt and Bantamsklip may also be regarded as a limitation to the dispersion modelling results, a comparison of the onsite data with the longer records at Cape St. Francis and Hermanus, respectively, indicate that the prevailing meteorological parameters (i.e. wind speed, wind direction, rainfall and ambient air temperatures) are comparable and result in similar conclusions. Although a more extended onsite monitoring period would provide slight adjustments to the results, it is not anticipated that the conclusions, given below, would change with any significance.

Decommissioning plans for PWRs are similar and consequently the decommissioning plan of Koeberg was use in this assessment. Furthermore, the impact would have to comply with the dose limits stipulated by the National Nuclear Regulator (NNR).

Whilst the study included baseline air quality monitoring for non-radionuclides, a radiological baseline study was not included. The NNR requires that a baseline monitoring campaign of radionuclides be conducted prior to construction. Furthermore, the dose limits stipulated by the NNR applies to the incremental dose calculated for the proposed nuclear power station. The conclusions would therefore not change, even once the natural radioactivity has been established at the three sites.

This assessment utilised air quality limits which have been given by the Department of Environmental Affairs (DEA) for non-radionuclide emissions and by the NNR for radionuclide emissions, respectively. The assessment of health risks is therefore considered to be at a screening level. The results from this assessment will be used as input into the Health Risk

[4] Effective dose is an estimate of the effect that a non-uniform radiation dose has on a human. (The unit for effective dose is the Sievert (Sv)). Dose conversion coefficients (Sv/(Bq/m³)) obtained from the International Commission on Radiological Protection (ICRP), as contained in ICPR Publication 72 were used. The ICRP 72 is the latest revision. These dose conversion coefficients allow the calculation of age-dependent doses to the members of the public from the intake of and exposure to radionuclides. Dose conversion coefficients are available for all radionuclides.

Assessment for this EIA which will be a qualitative assessment of the impact of radionuclides on human health and ecology.

Although a comprehensive sensitivity analysis of the dispersion model was not completed, the most important features were tested, which included the treatment of land-sea interaction and topography. In all cases, the most conservative option was selected to complete the assessment. A more detailed comprehensive evaluation of the quality of data and model sensitivities will be part of the application for a licence from the NNR.

Conclusions

The predicted impacts would be similar at all three sites. Furthermore, based on the predicted impacts of both non-radioactive and radionuclide air pollution, the assessment concludes that none of the sites need to be discarded for the proposed nuclear power station.

Specific mitigation is recommended during the construction phase only. Due to the predicted low impact of radionuclide emissions under normal operation, no additional mitigation would be required for radionuclide emissions.

Construction Phase

The sources of impacts during construction would be fugitive dust emissions from general construction activities (clearance, excavation, scraping, road surfaces etc) and emissions emanating from vehicles and equipment. Construction phase impacts will have a HIGH *significance* if no or limited mitigation measures are applied. This impact can be reduced to LOW *significance* if unpaved roads are surfaced (i.e. tarred) and with implementation of an air quality management plan.

Operational Phase

Potential sources of non-radioactive air emissions during the operational phase include:

- Carbon, sulfur and nitrogen oxides in the exhaust gases from engines of the backup electricity generators;
- Formaldehyde and carbon monoxide emitted by the insulation when installations go back into operation after servicing; and
- Ammonia discharged as the temperature rises in the steam generators during start-up.

The predicted impacts of these non-radiological pollutants were predicted to be very low when compared to human health risk and vegetation impact criteria.

During normal operation, trace quantities of radiological materials will be released to the environment. Ignoring the ingestion pathway, the predicted effective dose from these pathways indicates LOW *significance*. This rating applies to all three sites.

The predicted impacts of non-radioactive emissions during the operational phase at Bantamsklip and Thyspunt were shown to have a LOW *significance*. Currently, no industrial, commercial or significant residential developments exist in these two areas. This was confirmed through a three-month sampling campaign during which ambient air sulfur dioxide and nitrogen dioxide concentration levels were measured. The cumulative air pollution impact would therefore essentially only be that of the proposed nuclear power station.

In contrast, Duynefontein is located in an area where there is the potential for slightly elevated air pollution levels due to the proximity to Cape Town. However, based on background measurements, the impact of other air pollution sources[5] in the vicinity of Duynefontein was

[5] No industrial air pollution sources other than the Koeberg Nuclear Power Station exist in the immediate Duynefontein area. Industrial processes are present at Atlantis (Open Cycle Gas Turbine Power Station, brickworks and other smaller commercial activities) about 9 km northeast, landfill operations at Vissershok (5 km southeast) and a petroleum refinery (approximately 21 km south-southeast). Vehicles along the main roads (e.g. R27) and nearby residential areas also contribute to the airshed,

shown to be limited. The predicted cumulative impact of air pollution at the Duynefontein site is considered to be of LOW *significance*.

The dispersion simulations included a number of identified DBA. The predicted highest whole body dose at 1 km downwind from the nuclear power station following such accidental releases was shown to be below the maximum acceptable limit of 50 mSv for a single event, as stipulated by the NNR.

Decommissioning Phase

The exposure to radiation, based on the decommissioning plan developed for Koeberg, be kept to a minimum and below the required dose stipulated by the National Nuclear Regulator (NNR). Since these dose limits are based on safe exposure levels, it is expected that the radiation exposure during commissioning would be low. The plan consists of six phases. At the end of the last phase (*Phase 6*), the sub-surface radionuclide concentrations would again be verified to meet site release requirements.

"No-Go" Option
Duynefontein Site

Without the proposed nuclear power station at the Duynefontein site, the "no-go" option would be the same as the current air quality impact, which is considered to be of LOW significance for non-radioactive compounds and MEDIUM significance for radionuclide emissions.

Bantamsklip and Thyspunt Sites

The current air quality at the Bantamsklip site is regarded very clean with regards to non-radioactive criteria pollutants, such as oxides of nitrogen, sulphur dioxide and carbon monoxide. Any alternative developments on the site which would increase vehicle numbers, introduce combustion sources (ovens, boilers, heaters, etc.) or human population could have the potential of increasing the levels of these criteria pollutants. The significance depends on the alternative options, and could result in a HIGH significance.

Since the current baseline dose at these two sites are not known, it is not quantitatively possible to provide an accurate "no-go" impact rating for radioactivity. Given the low dose limits set by the NNR, normal emission would result in dose levels within naturally occurring radiation levels. However, in the event of an accidental release, it is expected that the dose would be above the naturally occurring radioactivity at the site and as such, unless radioactive material is used in any alternative developments, the radio nuclear impact of the "no-go" option would be rated lower.

especially oxides of nitrogen. Unfortunately, no historical air quality monitoring data is available for Duynefontein. However a relatively short, three-monthly sulfur dioxide and nitrogen dioxide air sampling campaign was conducted from March to May 2009. These data indicated low sulfur dioxide and nitrogen dioxide concentrations.

Recommendations

- The predicted impacts of unmitigated emissions during the construction phase were shown to have a HIGH significance.
    - A comprehensive list of recommendations has been provided in Section 5.2.1.
    - This impact can be reduced to LOW significance with management plans and emission controls in place.
    - An emission minimisation plan is regarded essential in the situation where construction activities are conducted very close to residential and other sensitive receptors.
    - The most significant source (between 80% and 90%) of fugitive dust emissions was shown to be wheel entrainment on unpaved roads. It is, therefore, recommended to have the initial focus on the reduction of emissions from road surfaces. This can be achieved through regular watering of unpaved surfaces, applying chemical dust suppressants, or most preferably, tarring of road surfaces.
    - In areas where tarring is not a practical option the management plan should have, as a minimum, watering schedules of unpaved roads and other activities that could be mitigated with water sprays.
    - In addition to road surface treatment, it is recommended to utilise the construction mitigation management checklist given in Appendix D, or a suitably modified version thereof.
- The recommended air quality monitoring programme provided in Section 5.2.1 should preferably be initiated a year prior to construction. This would provide an adequate baseline air concentration trend which would incorporate all seasons. This programme must include both non-radionuclide and radionuclide compounds (as stipulated by the NNR);
- No additional mitigation measures are required for routine operational emissions of radionuclides. However, once the final reactor technology has been decided, Eskom needs to confirm that the emissions from the selected technology conforms to the envelope used in this assessment and that such emissions can be maintained throughout the nuclear power station's lifecycle. This includes a thorough assessment of the reliability and maintenance of the high efficiency particulate air (HEPA) filters which would be used to control radiological air emissions from the nuclear power station;
- Similarly, the successful technology supplier must illustrate how incidental and accidental releases would conform to the NNR's requirements and how these would be kept As Low As Reasonably Achievable (ALARA);
- The impact during the decommissioning phase was qualitatively assessed based on the assumption that the decommissioning plan would be the same as that developed for the Koeberg nuclear power station. A site-specific decommissioning plan must be developed according to the most recent requirements stipulated by the NNR.
- It is recommended to ensure that the emissions from the backup power generators perform according to the vendor specifications, which the assessment was based on. Although continuous emissions monitoring (CEM) would be preferred for particulates and oxides of nitrogen, regular stack sampling campaigns would be adequate given the intermittent nature of operation. It is recommended that the first three isokinetic sampling campaigns should also include sulfur dioxide analysis.
- Air dispersion modelling must be repeated using the source terms for normal and upset emissions of the successful vendor and onsite meteorological data prior to construction of the nuclear power station. The simulations must be repeated for both non-nuclear and radionuclide air emissions. Furthermore, the methodology for calculating the dose must be done according to the latest international standards and NNR requirements.

1.10 Floral Assessment (Appendix E11)

Eskom intends applying for approval to erect a nuclear power station on each of three sites: Duynefontein, on the Cape West Coast, Bantamsklip on the western Agulhas Plain east of Pearly Beach, and Thyspunt, just west of Cape St. Francis in the Eastern Cape.

As a part of the Environmental Impact Assessment process, two of the specialist studies, combined in this report, were botany and dune ecology.

This study had the following key aims for each site:

- Analysis of representative soil samples;
- Mapping and description of dominant plant communities;
- Development and analysis of comprehensive plant species lists;
- Develop rarity and sensitivity indices and their implications;
- For each site, assess the impacts of a proposed nuclear power station, internal powerlines, heavy voltage yards and access roads;
- Develop mitigatory measures for potential impacts;
- Develop approaches which would minimise impacts; and
- Make proposals whereby Eskom could be part of wider conservation initiatives, including management of land for conservation, at each site.

Alternative Sites

Duynefontein

Attributes

Two vegetation types (Cape Flats Dune Strandveld and Cape Flats Sand Fynbos) are found on the site, both of which are Endangered. Eleven plant communities were identified, with general correlation between soil characteristics and plant community, but with major grouping into calcareous dunes and non-calcareous sand plain fynbos. Habitat rarity is moderate for the proposed footprint. The dune and sand plain flora was shown to be distinctive to the site, yet linked with the wider West Coast flora. Of the 380 species found on the site, 34 are rare. Species rarity is highest in the sand plain fynbos, as is localised endemism, but is substantially lower on the transverse dunes and this is echoed in the low endemism there. However, both habitat and species rarity rises appreciably when the sand plain fynbos vegetation is crossed for the planned powerlines. Sensitivity is locally high due to the presence of mobile and potentially mobile dune sand, with fire proneness being high in the sand plain fynbos. Conversely, vegetation resilience is low. The transverse dune system at Duynefontein is endemic, with this system type poorly represented on the Cape West Coast.

Impacts

Negative impacts revolve mainly around the construction of a nuclear facility on the site and this could lead to the loss of habitat as well as much of a rare mobile transverse dune system. Construction of powerlines over the transverse dunes and the sand plain fynbos would also potentially cause local losses in habitat, and rare species.

Climate change is likely to lead to a rise in sea level of some 1.1 m by 2075, and this could have major impacts on the primary and transverse dunes at the coast.

Cumulative impacts would be caused by any activity fragmenting the natural systems, compromising ecosystem functioning, as well as leading to the permanent loss of rare and quality habitat. This applies in particular to the transverse dunes (NPS) and sand plain fynbos (powerlines). Impacts from the possible construction of a PBMR facility should also be factored in.

Mitigation

A coastal corridor is recommended which would avoid any impacts from the present EIA corridor and HV yard by siting the facility to the east of the transverse dunes, to avoid this rare and endemic system. Realignment of the powerline route would also be required to avoid or minimise the impact on the transverse dunes and the sand plain fynbos.

Inlet and outlet pipes should be buried in previously disturbed areas in the south (just north of the present NPS) and, where excavated, the surface rehabilitated with indigenous species.

Spoil should be dumped in areas which have been disturbed in the past. Such areas should be rehabilitated with indigenous species once the spoil is distributed elsewhere.

Search and rescue operations should relocate any rare and/or useful plants to areas which will enjoy long-term protection. All disturbed areas should be rehabilitated with indigenous plants. The current EMP needs to be updated to include new areas and new objectives such as these.

A monitoring programme needs to be instituted which would measure the success or otherwise of rehabilitation.

Bantamsklip

Attributes

Nine vegetation types were found on the site. Together with their conservation status, these are: Agulhas Limestone Fynbos (Least Threatened), Agulhas Sand Fynbos (Vulnerable), Cape Lowland Freshwater Wetlands (V), Cape Seashore Vegetation (LT), Elim Ferricrete Fynbos (Endangered), Overberg Dune Strandveld (LT), Overberg Sandstone Fynbos (LT), Southern Coastal Forest (LT) and Western Coastal Shale Band Vegetation (LT). Within these, 16 plant communities were identified, and included terrestrial (dryland) as well as wetland and riverine habitats. Soil patterns closely parallel differences in plant communities, and there is a clear separation between calcareous and non-calcareous habitats.

An extremely high proportion of 50 Red Data out of a total of 463 plant species was found, and this echoes the high localised endemism for the site. There is a clear separation of local floras within the site, and this is driven by the calcareous or non-calcareous nature of the substrate, and whether communities are pioneering or climax. A key factor is the moisture regime of the soil, with riverine and wetland habitats separating from the other flora. Most of this rarity is found to the north of the R43, except for the coastal limestones, and to a certain extent the coastal sands. Habitat rarity is also greater north than south of the road, again, the exception in the coastal limestones.

High sensitivity in terms of erosion potential occurs on mobile and semi mobile dune systems at the coast, as well as the sandy plain and the river and wetlands. Fire is also a key factor with high proneness related to the presence of fynbos over most of the site. Correspondingly, low resilience of the area is governed very closely by the presence of inland and coastal limestones, river and wetland systems and the transverse dunes. The dune systems at Bantamsklip are well-represented elsewhere along this coastline and are thus neither rare nor endemic.

Impacts

Negative impacts are mainly focused around the construction of a nuclear facility, particularly if the coastal limestones were to be developed and the primary dunes impacted. A key positive impact would be the creation of a nature reserve for the non-developed portion of the site, thus improving the conservation status of certain of the vegetation types on the Agulhas coastal plain.

Cumulative impacts would be caused by any activity fragmenting the natural systems, comprising ecosystem functioning, as well as leading to the permanent loss of rare and quality habitat. This would apply in particular to the coastal limestones.

Mitigation

Key mitigation should be repositioning of the footprint to avoid any coastal limestones, although due to high maintenance requirements of being located within a mobile transverse dune, it is recommended that this system be avoided.

Inlet and outlet pipes should be buried and, where excavated, the surface rehabilitated with indigenous species.

Spoil should be dumped on areas which have been disturbed in the past. Such areas should be rehabilitated with indigenous species once the spoil is distributed elsewhere.

Search and rescue operations should relocate any rare and/or useful plants to areas which will enjoy long-term protection. All disturbed areas should be rehabilitated with indigenous plants. An EMP, which will be required for the proposed conservation area, needs to be developed to manage these areas and new objectives such as these.

Thyspunt

Attributes

Five major vegetation types occur on the site (conservation status in brackets): Algoa Dune Strandveld (Least Threatened), Southern Cape Dune Fynbos (LT), Tsitisikama Sandstone Fynbos (Vulnerable), Cape Seashore Vegetation (LT) and Cape Lowland Freshwater Wetlands (V). This translates into nine major plant communities with six wetland types and a river system. 383 plant species have been recorded from the site, with a very low rare species count (14 or 3.7%), compared with other coastal areas which might exhibit >5% (perrs.obs.). Analysis of on site floras shows a clear distinction between calcareous and non-calcareous habitats, and with total soil carbon playing a key role as one moves inland from the coast, through primary dunes, stable dunes and forest.

Species rarity is generally low, with the exception of one or two habitats. Likewise habitat rarity is fairly low except for the transverse dunes, coastal limestones and wetlands. Endemism is also low, with only one local endemic found there. Sensitivity is greatest on both mobile and stable dunes, with most of the site showing high tolerance to droughting. All fynbos communities would show high proneness to burning. Habitat resilience would be lowest for the mobile dunes, coastal limestones and wetlands. The headland bypass dune system at Thyspunt is endemic to the area and the biggest on the South African coastline.

Impacts

Negative impacts at the proposed EIA corridor for the nuclear facility would be chiefly on the partially mobile dunes. However, impacts on the wetlands on the coast, as well as the Langefontein, would be of the most concern. Crossing of the transverse dunes by powerlines would also be a potential and major impact, as would construction of a road linking the power station with the HV Yard. Two other access roads, from the east and west, would potentially impact both the transverse dunes and associated inland wetlands. The HV Yard is likely to be located in degraded sandstone fynbos and should cause minimal impact. A key positive impact would be the creation of a nature reserve for the site, in particular if a conservation area could be formed which protected the Oyster Bay-Cape St. Francis headland bypass dune. Eskom should be a key player in this process and would need to liaise with adjacent landowners. This system is presently protected only in part and is being impacted by residential development along its length.

Although long-term impacts from the proposed inlet and outlet pipes are likely to be minimal as they would be buried, these should be constructed in such a way as to minimise impacts on the coastal habitats and species.

Cumulative impacts would be caused by any activity fragmenting the natural systems, compromising ecosystem functioning, as well as leading to the permanent loss of rare and quality habitat. A key concern is the permanent fragmentation, loss of quality habitat and reduction in ecosystem functioning of the transverse dunes, as well as the coastal wetlands and the Langefontein.

Mitigation

Key mitigation should be in aligning the NPS footprint so as to cause the least impact on the identified rare and sensitive systems, notably the coastal wetlands and the Langefontein. A route for powerlines across the transverse dunes is not supported. The eastern access road should be aligned to cause a minimum of impact on the dunes and wetlands. The western access road is problematic as it would cross the western end of the northern transverse dunes as well as several associated wetlands; mitigation would require keeping to the existing dirt track as closely as possible, and avoidance of mobile dunes and wetlands. A road across the northern transverse dunes, linking the NPS and HV Yard is not supported as very little mitigation can contain the resultant impacts on this endemic system. The HV Yard should cause minimum impact as long as it is constructed on severely degraded sandstone fynbos.

Inlet and outlet pipes should be buried and, where excavated, the surface rehabilitated with indigenous species.

Spoil should be dumped on areas which have been disturbed in the past. Such areas should be rehabilitated with indigenous species once the spoil is distributed elsewhere. One suggestion is that spoil is placed on degraded sandstone vegetation and possibly left there. This will need special rehabilitation attention. Better still, sand should be pumped in a slurry out to sea, avoiding any impacts on land.

Search and rescue operations should relocate any rare and/or useful plants to areas which will enjoy long-term protection. All disturbed areas should be rehabilitated with indigenous plants. The current EMP needs to be updated to include new areas and new objectives such as these.

General mitigation measures

Where loss of habitat is unavoidable, search and rescue operations should remove suitable plant material for translocation into safe areas; In addition, appropriate species should be grown in an on site nursery. This would be closely linked with a rehabilitation programme which seeks to address areas previously degraded or disturbed during the construction process. Key elements of the rehabilitation plan are removal and stockpiling of topsoil, selection of appropriate species, a two year growth period prior to planting, production of mulch from locally removed acacias and ongoing maintenance of planted areas.

A crucial mitigation is for the setting of an ecologically defendable coastal setback line and coastal corridor of minimum 200 m width for Bantamsklip and Thyspunt. Due to the presence of a sensitive and endemic dune system, this distance will increase to nearly 2 km inland for Duynefontein.

Development footprints should be adjusted so that natural habitat is avoided or habitat loss is minimised. Where possible, habitats should not be fragmented as this leads to reduced viability, mainly due to decrease in size, and where shape becomes linear as opposed to round Where fragmented, habitat connectivity should also be maintained, and this can be accomplished for example through astute rehabilitation.

Recommended monitoring and evaluation programme

Rehabilitation and monitoring

A comprehensive rehabilitation and monitoring programme should be drawn up for each site. Such a programme would foster the development of a nursery at each site, and would focus on the propagation of locally occurring indigenous species. All plants suitable for growing on, as well as highly threatened species, should be included. A key part of the rehabilitation programme is the removal of invasive alien acacias and these can be used for producing mulch. Success or otherwise of plantings needs to be evaluated on a three monthly basis and dead plants replaced where appropriative.

Species should be grown on at least two years' prior to any construction commencing.

Coastal corridor and setback line

A coastal corridor of minimum 200 m width, but protecting the sensitive coastal dunes, limestones and wetlands should be formulated and maintained for each site. Sensitive dunes, notably the primary dunes and unvegetated and partially vegetated transverse dunes should be buffered by 100 m so that these systems are permitted to function in as normal a way as possible. A buffer should also be determined for the Langefontein wetland.

Conservation areas

With the exception of Duynefontein where there is an existing nature reserve, each site should be declared a nature reserve in perpetuity with the aim of conserving all habitats and species on that particular site. In the event of decommissioning, Eskom should maintain the area as a reserve or, failing which, the land should be handed over to a responsible conservation body. In the case of Duynefontein, resourcing should continue to be provided for the Koeberg Nature Reserve, and every effort made to extend the conservation area to the north, in partnership with Groot Springfontein Farm. For Thyspunt, Eskom should enter into a partnership with adjacent landowners within a view to protecting the headland bypass dune system between Oyster Bay and Cape St. Francis.

Each site should have a conservation manager who would manage that site and be responsible for drawing up a management plan.

Conclusions

Duynefontein

Location of the planned facility in the sensitive and mobile transverse dunes is not supported unless the footprint is moved to inland of this endemic system. Crossing of the rare and sensitive sand plain fynbos is also a concern and this should be avoided by realigning the powerline routes or crossing this habitat with longer spans.

Bantamsklip

It is assumed that no development will take place north of the Gansbaai road. The present location of the NPS site impacts on rare and sensitive coastal limestone fynbos and also would likely affect the functioning of the primary dunes at the coast, the transverse dune to the west, and even the small transverse system to the east. Given their common occurrence along this coastline, loss of transverse dunes is not viewed as a key issue, but development in these mobile systems would have major implications for maintenance of built structures.

The main mitigation measure is therefore for the NPS footprint to be located to the north and east of the present site, and preferably to be located totally in the less rare and sensitive coastal sand fynbos habitat. Loss of habitat would be offset through creation of a conservation area in the remainder of the site.

Where possible, powerline routes should not cross the site, given its high rarity, endemicity and sensitivity. Rather, adjacent existing and disturbed land should be sought.

Thyspunt

Location of a nuclear facility on the coast would lead to loss of habitat, for which there is no mitigation, other than indirectly through providing an offset elsewhere on the site or in another area.

Complicating the siting of the facility is the presence of sensitive, and extremely rare and endemic wetlands both at the coast and inland at the Langefontein. These wetlands should be in no way compromised by the planned development, either in the construction or operational phases. Loss of habitat would be offset through creation of a conservation area in the remainder of the site.

Alignments of powerline and access road routes would also need to be fine-tuned so as to avoid sensitive and rare habitats. The eastern approach in particular must show sensitive alignment given the importance and endemicity of the longitudinal wetlands draining towards Cape St. Francis, whilst the western alignment poses problems for the maintenance of the western extremity of the northern transverse dune system, as well as impacts on mobile parabolic dunes; here astute mitigation is required to avoid mobile dunes and wetlands. The northern access road is viewed as too difficult to mitigate and should not be constructed.

The location of the HV Yard in degraded sandstone fynbos is considered acceptable, providing the footprint is realigned to occupy previously farmed land. However, the idea of a powerline servitude between the coast and the HV yard here is not supported. A key aspect is the crossing of the mobile and semi-mobile transverse dunes by the powerline, and this will need careful consideration, and preferably avoidance. In tandem with this is a service road linking the NPS with the HV Yard; as this is likely to compromise the functioning of the northern transverse dune system, this route is not supported at all.

Sites that were proposed development cannot be mitigated or that have low confidence for mitigation

For **Duynefontein,** construction in an endemic transverse dune system should be excluded as a possibility for a NPS if the footprint is not moved to outside this habitat, to the east of this system.

For **Bantamsklip**, provided that there is a major amendment to the location and design of the footprint to avoid the sensitive coastal systems, a NPS could be constructed.

If compromising the functioning of the wetlands at **Thyspunt** cannot be avoided, then this is regarded as a fatal flaw, especially as these systems are endemic to this coast, and the Langefontein is a "one-of-a-kind" system. Crossing of the transverse dunes to the north is not supported, whilst the location of the western access road requires astute mitigation.

In summary

All sites have potential for development provided stringent mitigation – as detailed in the report and summarised above - is applied. However, with no strong mitigation, none of the sites is deemed suitable for construction of a nuclear facility.

1.11 Freshwater Ecology (Wetland) Assessment (Appendix E12)

Introduction

This section is intended to provide a short summary of the major implications of the proposed Nuclear Power Station (NPS) development for wetlands at three alternative sites – Duynefontein, Bantamsklip and Thyspunt. All of the site alternatives include in their boundaries and immediate surroundings wetland systems that are of high ecological importance, relatively unimpacted and considered to be either among the last (in the case of Duynefontein) remnants of particular wetland habitats that have been lost from large areas or, in the case of Bantamsklip and particularly Thyspunt, they are considered unique systems that are unlikely to be represented in their present form and complexity elsewhere in the world. The conservation status of all three sites, from a wetlands perspective, is extremely high and any threats to their integrity are viewed as of high negative significance.

The report on which this summary is based has taken cognisance of the outcomes of a year of intensive groundwater and surface water monitoring and analysis (Visser *et al*. 2011) which have resulted in higher levels of confidence being accorded to predictions of the impacts of proposed activities associated with the development of a NPS, on wetlands at each of the three potential sites. Some of the conclusions of this report have thus changed substantially from those reflected in previous versions (e.g. Day 2009 and 2010).

Impacts associated with the proposed NPS

Duynefontein

The main impacts associated with development of a single phase NPS at this site comprise a low likelihood of potential degradation of or disturbance to the artificial wetlands in the north west of the site, the transient duneslack wetlands of the mobile dune and an isolated seasonal wetland potentially in the vicinity of a proposed access road. The “recommended” (or least sensitive) development area for the proposed plant lies well away from the most sensitive wetlands on the site – that is, the duneslack depressional wetlands in the south western portion of the site. Groundwater modelling associates a low level of draw-down risk to both these and other wetlands on the site, as a result of dewatering.

Without the implementation of mitigation measures, the implications of development of a single NPS at Duynefontein have been assessed as of medium negative significance from a wetland perspective.

Bantamsklip

The “recommended” (or least sensitive) development area for the proposed EIA and HV corridors at this site lie to the south of the R43 road through the site. The road itself acts as a barrier to the northern portion of the site, within which the critically important Groot Hagelkraal River and its associated hillslope seeps and valley bottom wetland tributaries occur. A major assumption of the EIA assessment of this site is that activities associated with the construction and operational phases of a NPS would be confined to the area south of the R43. This means that impacts to wetland systems resulting from the proposed project would be largely avoided.

The following are the main areas of concern:

- Increased traffic on the R43, leading to fragmentation of wetland corridors
- Potential wetland degradation depending on the siting of NPS administration buildings
- Potential side-effects of increased development in the Pearly Beach area.

Of these, assessment of the latter falls outside of the scope of this study. The issue is nevertheless redflagged.

The geohydrological study (Visser et al. 2011) indicated that although the radius of draw-down associated with dewatering of this site could extend close to the Groot Hagelkraal and Koks River systems it was however unlikely to affect either of them.

Without the implementation of any mitigation measures, the cumulative implications of development of a single NPS at Bantamsklip were assessed as of at least medium negative significance from a wetland perspective.

Thyspunt

Development at this site would, in the absence of mitigation measures, be associated with the greatest number, intensity and complexity of impacts to important wetland systems. The main impacts assessed include:

- Permanent loss and degradation of coastal seep wetlands as a result of dewatering / groundwater diversion, concentration of groundwater flows and proposed new roads;
- Some risks of impacts to the Langefonteinvlei as a result of possible draw-down effects: the likelihood of risk was however considered low, given the findings of Visser *et al*. (2011), namely that the Langefonteinvlei is perched above the groundwater table in its southern and western extents. Hence draw-down impacts would need to extend to the northern and eastern portions before they had an effect on wetland hydrology;
- Fragmentation, infilling and physical disturbance to duneslack wetlands in the Oyster Bay mobile dune system as well as to wetlands immediately north of the Oyster Bay dunefield, as a result of impacts associated with the proposed passage of transmission lines, roads and potential options for sediment transport across the dunes;
- Potential infilling and fragmentation of important valley bottom wetlands to allow the construction of access routes to the site, as well as laying of water pipelines;
- Degradation of depressional and other wetlands as a result of transporting excess spoil over the dunes to the HVY platform.

The above impacts are likely to result in significant degradation of a system that presently exists as a relatively unimpacted mosaic of terrestrial and wetland habitats, with high levels of interconnectivity and high overall biodiversity value, to which the wetland systems make a significant contribution. The cumulative impacts of the proposed development of a single NPS at the Thyspunt site without implementation of mitigation measures have been assessed as of high negative significance.

Key mitigation measures proposed for each site

Duynefontein

Avoidance mitigation of impacts to wetlands is considered feasible at this site. Mitigation measures focus on effective management of dust, stormwater and road construction processes, and the location of the NPS and its infrastructure in the least sensitive areas of the development envelopes. Within the EIA and HV corridors, retention of the mobile dunes as a viable system is recommended, to ensure maintenance of wetland functions within and to the north of the dunes. Wetlands on the Duynefontein site that lie outside of the “recommended development area” have, along with their terrestrial margins and interlinking corridors, been identified as “no development” areas.

Bantamsklip

Essential mitigation measures for this site would require:

- Management of the site to the north of the R43 as a conservation area, with provision for the long-term conservation of the site (after the life span of the NPS)

In addition, the report noted the desirability of:

- Enlarging of the culverts at the Groot Hagelkraal crossing under the R43
- Adhering to certain development restrictions at Pearly Beach.

These recommendations affect areas outside of the direct control of Eskom and thus cannot be conditions of authorisation.

The cumulative impact of a NPS at this site, with mitigation, would be a positive impact of high significance, based on the opportunity entailed in the development for securing the long-term conservation of the wetland systems to the north of the R43.

Thyspunt

Essential mitigation measures at this site would comprise the following:

- Recognition of various “no-go” development areas and ecological setbacks – implementation of the latter would require that the proposed “recommended development area” on the site should be drawn towards the west, to accommodate the recommended (surface) Langefonteinvlei buffer;
- Management of the whole site, apart from the NPS footprint within the “recommended” development area as a formal conservation area;
- Purchase of all erven potentially crossed by the proposed eastern access road to the east of the Thyspunt site as far as the western boundary of The Links, and the management of the dunefields and wetlands thus acquired as a dedicated conservation area.

Mitigation against the risk of draw-down related impacts to the Langefonteinvlei include the incorporation of cutoff walls, semi-permeable membranes or other appropriate devices into dewatering design such that they effectively limit the radius of drawdown to the NPS excavation site itself, and prevent any risk of drawdown impacts affecting the Langefonteinvlei.

Mitigation measures against impacts to the coastal seeps centre on inclusion in the dewatering design of mechanisms that will allow the long-term redistribution and spread of diverted / dewatered groundwater back into the aquifer, such that it can feed the coastal seeps downstream, taking cognisance of projected increases in sea level that are likely to result in salinisation of groundwater levels just above present sea level.

Other recommended mitigation measures at this site would entail:

- The northern access road should not be used, and the western access road should be re-aligned northwards so as to avoid a number of coastal seeps;
- Access roads should allow for bridging of wetlands that are unavoidably crossed by the routes;
- Transmission lines should not include any maintenance / access roads across the mobile dunes, and provision should be made for access by helicopter or (potentially) quad bike only;
- Mitigation of impacts associated with the transport of sand across the mobile dunes is possible, if a conveyor system is utilised, but with substantial restrictions being imposed on construction / maintenance roads and sediment control.

Even with implementation of all of the mitigation measures outlined above, the cumulative outcome is still considered of net high negative significance, as a result of the residual impact to presently largely unimpacted wetlands across a large area, and the definite and unmitigable degradation of a limited area of unimpacted coastal seep wetlands.

Offset mitigation is however possible, and would involve conservation of areas that include both the Eastern Valley Bottom wetlands and the Oyster Bay dunefield itself, as far as the impacted area at the upstream boundary of The Links golf course. The required measure assumes that securing of all erven along the proposed eastern access road takes place before these are developed, thus securing a large expanse of wetland and dune system, that would otherwise be permanently impacted (but not destroyed) by development. This does not mitigate against the loss of coastal seep wetlands, but the opportunity for large-scale active management and conservation of wetland ecosystems as a whole is believed to offset the loss of some of these important wetlands, while retaining the Langefonteinvlei and duneslack wetlands in an unimpacted condition. In the event that full mitigation as well as offset measures were implemented, the net impact to wetlands on the Thyspunt site is likely to be one of positive significance, and a preferable scenario to the assessed no development alternative.

This said, however, it is acknowledged that ideally, none of the wetlands within and associated with the Oyster Bay dunefield should form part of any development offset. In the event that a no development alternative was available that provided adequate funding opportunities for alien control, and did not include piecemeal fragmentation of the area into multiple small developments, then such an option would clearly be preferred from an ecological perspective, to any development of a nuclear power facility at this site.

1.12 Vertebrate Faunal Assessment (Appendix E13)

At Duynefontein, the amount of land that is available for development, and that is not of high faunal sensitivity, is limited but sufficient to allow for Nuclear-1. However, further future expansion of power-generating facilities within the present Eskom property, to the north of KNPS, should not be considered.

Development of Nuclear-1 at Duynefontein would have significant negative impacts, mainly because of the direct impacts on faunal habitats within the footprint areas. Duynefontein would benefit from the no-development option because the land is already managed as part of a private nature reserve. Opportunities for on-site conservation offsets are limited.

At Bantamsklip, the amount of land on the coastal side of the R43, available for development and that is not of high faunal sensitivity, is more than sufficient to allow for Nuclear-1. The portion of the property inland of the R43 is highly sensitive and should not be developed at all.

Development of Nuclear-1 at Bantamsklip would have significant negative impacts, mainly because of the direct impacts on faunal habitats within the footprint areas. However, highly significant potential offsets are possible at Bantamsklip if undeveloped land is declared a nature reserve and is effectively managed as such. This would depend especially on the protection and management of the inland portion, as well as an adequate coastal corridor.

The no-development option at Bantamsklip is not positive because it can be assumed that it will lead to a change of land ownership and probable residential and/or resort development at the coast, and a possible increase in intensity of agricultural exploitation on the inland portion.

The amount of land that is available for development, and that is not of high faunal sensitivity, is severely constrained and not sufficient to allow for Nuclear-1. However, if additional land were purchased adjacent to the pan-handle portion of the property, this deficit could be overcome.

Development of Nuclear-1 at Thyspunt would have significant negative impacts, mainly because of (a) the direct impacts on faunal habitats within the footprint areas, (b) the development of three major new access roads, and (c) the need for a development corridor across a large field of mobile dunes, making this site highly problematic with respect to fauna and faunal habitats. On the other hand, highly significant potential offsets are possible at Thyspunt if undeveloped land is declared a nature reserve and is effectively managed as such. Such offsets could be significantly strengthened by acquisition of additional land.

The no-development option at Thyspunt is not positive because it can be assumed that it will lead to a change of land ownership and probable residential and/or resort development at the coast, and a probable increase in intensity of agricultural exploitation on the inland portion.

An important negative factor is the lack of definitive information on whether adequate engineering solutions are available to avoid serious negative impacts on groundwater flows and sensitive wetlands at Thyspunt. There are similar needs for more information on the dynamics of the mobile-dune field, and better mapping of dune forests and thickets of alien vegetation. It is essential that the necessary studies be carried out as a matter of urgency to inform the EIA process.

From the perspective of faunal conservation, the following overall conclusions are reached:

- Given the present uncertainty around groundwater and wetlands as well as other aspects of the biophysical environment, and the inadequate amount of suitable land for development, the proposal for development at Thyspunt is currently flawed. This situation must be improved by completion of relevant studies, and acquisition of additional land, if necessary.
- Outstanding issues at Thyspunt should be satisfactorily resolved before final decisions are made and in time for full specification of necessary mitigation measures. This may have the effect of postponement of development at Thyspunt.
- Nuclear-1 could be developed at either Duynefontein or Bantamsklip, without further faunal EIA investigations.

Impacts

The identified impacts are similar for the three site alternatives, Duynefontein, Bantamsklip and Thyspunt, although the severity of the impacts varies from site to site. The identified impacts are:

i. Destruction of natural habitats and populations
ii. Reduction in populations of Threatened species
iii. Fragmentation of natural habitats and patterns of animal movement
iv. Road mortality
v. Mortality associated with overhead-transmission lines and substations
vi. Disturbance of sensitive breeding populations
vii. Dust pollution beyond the building site
viii. Pollution of soil and water beyond the building site
ix. Light pollution beyond the building site
x. Alteration of surface and groundwater levels and flows, effects on local wetlands
xi. Poaching of local wildlife
xii. Problem-animal scenarios
xiii. Accumulation of radioisotopes in the environment and in the bodies of wild animals
xiv. Cumulative impacts
xv. Improved conservation status of undeveloped land (positive impact).

Mitigation Measures

Recommended mitigation measures are similar for the three site alternatives, Duynefontein, Bantamsklip and Thyspunt, although the details vary from site to site.

i. **Mitigation of destruction of natural habitats and populations**

- Restrict development to a recommended footprint.
- Restrict the footprint of the development to the smallest area possible.
- Dispose of spoil at sea.
- Create laydown areas in previously disturbed areas.
- Use natural topographical features as boundaries.
- Clear the site in a logical sequence.
- Mark off the affected area.
- Rehabilitate affected areas, where possible.
- Compensate for loss of habitats. (See below.)

ii. **Mitigation of reduction in populations of Threatened species**

- All of the mitigations listed under (i) (above).
- Facilitate search-and-rescue operations before and during site clearance.
- Facilitate collection of scientific material and information before and during site clearance.

iii. **Mitigation of fragmentation of natural habitats and patterns of animal movement**

- Most of the mitigations listed under (i) (above).
- Make provision for ecological corridors.
- Construct under- and overpasses across roads.
- Keep roads as far away from wetlands as possible.
- Use recommended types of security fencing.
- Wherever possible, place pipelines and cables underground, and rehabilitate.
- Reduce the number of roads and tracks and place them carefully.
- Make roads off limits for fixed periods every day.

iv. **Mitigation of road mortality**

- Reduce the number of roads and tracks and place them carefully.
- Keep roads as far away from wetlands as possible.
- Construct under- and overpasses across roads.
- Restrict speed on roads.
- Make roads off limits for fixed periods every day.
- Place warning signage in appropriate places.
- Use appropriate curb designs.

v. **Mitigation of mortality associated with overhead-transmission lines and substations**

- Fit standard devices on all new routes (e.g., “flappers” or reflectors or “balls”).
- Monitor routes and installations.

vi. **Mitigation of disturbance of sensitive breeding populations**

- Determine location and extent of sensitive bird and other areas.
- Quarantine sensitive bird and other areas.
- Restrict the timing of blasting.
- Create wide buffer zones.
- Restrict air traffic.
- Restrict water traffic.
- Enforce all restrictions.
- Institute a programme of monitoring.

vii. **Mitigation of dust pollution beyond the building site**

- Apply standard mitigation measures, e.g., damping down with freshwater, use of cloth or brush barrier fences, covering dumps with plastic sheeting, etc.
- Do not use seawater.

viii. **Mitigation of pollution of soil and water beyond the building site**

- Apply standard mitigation measures.
- Remove all polluted soil and water from site.
- Dispose of brine from desalination into the sea.
- Dispose of sewage in a sustainable manner.

ix. **Mitigation** of light pollution beyond the building site

- Reduce exterior lighting.
- Use only long-wavelength lights.
- Use directional fittings.
- Screen interior lighting.

x. Mitigation of alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands

- Avoid sites where major damage to wetlands is inevitable.
- Do not use wetlands or groundwater as sources of freshwater.
- Engineer solutions to the flow of groundwater.
- Carry out additional studies at Thyspunt.

xi. Mitigation of poaching of local wildlife

- Educate workers.
- Patrol the area.
- Control materials.
- Control firearms.
- Control after-hours access.
- Control access to non-construction areas.

xii. Mitigation of problem-animal scenarios

- Do not allow feeding of wild animals.
- Keep attractive resources out of reach.
- Exercise rigorous control of edible refuse.
- Eliminate feral cats and dogs.
- Do not allow pets on site.

xiii. Mitigation of accumulation of radioisotopes in the environment and in bodies of wild animals

- No mitigations, beyond those required by human health and safety regulations, are recommended.

xiv. Mitigation of cumulative impacts

The recommended mitigations that will contribute most are:

- choice of a suitable development footprint
- rehabilitation of degraded areas, post construction
- use of a suitable design for boundary fences
- use of suitable exterior lighting
- avoidance and mitigation of impacts on groundwater
- enforcement of restrictions on disturbance and poaching of wildlife
- monitoring of sensitive populations to aid environmental management
- monitoring of radioisotope pollution to aid environmental management.

xv. Mitigation/offset of impacts through improved conservation of undeveloped land

- Elevation of legal status of undeveloped portions to statutory nature reserves
- Replacement of unsuitable mesh fences with palisade fences
- Increased spending on the removal of invasive alien plants
- Installation of two or three strategically located underpasses to facilitate animal movements across busy roads

- Commissioning of detailed surveys of poorly surveyed animal groups, viz., reptiles, amphibians and small mammals
- Commissioning of a programme to monitor the populations of sensitive species.

Recommended monitoring and evaluation programme

An appropriate monitoring and auditing programme should be put in place to track the efficacy of the mitigation measures. Most of this monitoring must be built into the auditing procedures of the EMPs for the construction, operational and decommissioning phases, but input during the design phase is also important for the demarcation of sensitive areas. The programme should include monitoring directed specifically at sensitive faunal populations.

1.13 Invertebrate Faunal Assessment (Appendix E14)

Background

The potential impacts of Eskom's proposed Nuclear 1 power station on the terrestrial invertebrate communities at the Duynefontein, Bantamsklip and Thyspunt alternative sites were investigated.

Evaluation of the sensitivity of the invertebrate communities at these sites was based on:

1. the initial assessment presented in the specialist report produced for the Nuclear 1 EIA scoping report ("terrestrial invertebrates scoping report"),
2. an additional desktop assessment of the butterfly communities,
3. brief field surveys of butterfly diversity by visual searches and netting at each of the sites in late August/early September 2008 followed by a more detailed butterfly survey of the main habitats on each site in late March 2009,
4. brief field surveys of ant diversity by collection of twenty 15-minute timed active search samples at each of the sites in late August/early September 2008,
5. very superficial field surveys in late August/early September 2008 for several indicator taxa including some of those evaluated in the terrestrial invertebrates scoping report and
6. Detailed on-site inspections of the most likely preferred footprints (based on combined biophysical specialist conclusions) and similar on-site habitats at each site in December 2009 / January 2010.

Limitations of the study

This study was commissioned at a very late stage during the Nuclear 1 EIA process, allowing only three weeks in 2008 to complete the field surveys, analyses, impact assessments and reporting. Only a very superficial survey was thus possible at that time, with approximately two days being available to inspect each of the three sites, which have a combined area of 5 885 hectares (ha). The limitations resulting from the very short duration of the field surveys were further exacerbated by inappropriate timing (the majority of the field visits being between 25 August and 2 September), as most invertebrate species present exhibit very low levels of activity at this time of year. The extreme time and seasonal constraints on the surveys carried out in 2008 introduced uncertainty to the site sensitivity ranking and prevented sufficiently detailed coverage of the sites to enable selection, from a terrestrial invertebrate conservation perspective, of preferred areas for development within the sites. The additional butterfly studies carried out in March 2009 went some way toward rectifying this, but both the taxonomic and seasonal scope of these surveys were also very limited. The sensitivity mapping and recommendations regarding preferred infrastructure locations must therefore be regarded as tentative as they do not take into account the vast majority of the invertebrate groups present on the sites. The additional detailed inspections of consensus preferred footprint areas in December 2009 / January 2010 further mitigated the limitations and allow firmer conclusions to be drawn regarding impacts and mitigation, but do not eliminate the need for detailed investigations of invertebrate fauna of the selected site prior to construction; Eskom has committed to carrying out such studies.

Results of field surveys

Very few butterflies were observed during the initial field surveys (one species each at Duynefontein and Bantamsklip, seven at Thyspunt), but observations of the habitats and food plants aided in refining the desktop assessment of probable species diversity. Ant diversity was fairly low but consistent with the coastal position of the sites and their location within the Cape Floristic Region, with the highest estimated diversity at Duynefontein (27 spp.), followed closely by Thyspunt (26 spp.), and Bantamsklip having rather lower estimated diversity (21 spp.). A summer survey would probably yield higher diversity estimates.

In addition to specimens of a number of species of millipedes, several monkey beetle species, three scorpion species, two baboon spider species and several terrestrial gastropods, several invertebrate finds of higher significance were recorded during the various surveys. The most significant finds were:

1. A probably undescribed trapdoor spider species of the genus *Spiroctenus* at Bantamsklip;
2. A possibly undescribed ant species (*Leptogenys* sp.) at Bantamsklip;
3. Two undescribed (*Tetramorium* sp. and *Monomorium* sp.) ant species at Duynefontein;
4. A rare and possibly undescribed trapdoor spider species of the genus *Pionothele* at Duynefontein
5. A velvet worm (Onchyophora) found by the vertebrate fauna team at Thyspunt;
6. One undescribed ant species (*Monomorium* sp.), two possibly undescribed ant species (*Tetramorium* sp. and *Camponotus* sp.) and a restricted and extremely rarely encountered endemic ant species (*Diplomorium longipenne*) at Thyspunt.

Sensitivity analysis

Conclusions regarding both the relative sensitivity of the sites from a terrestrial invertebrate conservation perspective, as well as the optimal positioning of the proposed NPS within sites, must be regarded as tentative due to the inappropriate timing of field surveys as well as their extremely short duration and restricted taxon coverage.

The results of the field surveys and butterfly desktop assessment suggest that in contrast to the predictions of the terrestrial invertebrates scoping report, the Thyspunt site probably supports the most species-rich invertebrate community. However, due to the larger diversity of rare and relictual species predicted at the Bantamsklip site, and the discovery of a population of an undescribed and potentially restricted ant species as well as a probably undescribed trapdoor spider species here, the latter is considered to have the most valuable invertebrate community from a conservation perspective, and is considered the most sensitive of the three sites. Duynefontein had the lowest butterfly diversity, but ant diversity slightly greater than that of Thyspunt, and probably has an intermediate overall invertebrate diversity; with very few rare or relictual species observed or predicted, this site was considered the least sensitive.

The additional site inspections carried out in December 2009 / January 2010 confirmed that, in the case of Bantamsklip and Thyspunt, whatever the sensitivity of the habitats within the proposed footprint areas, there is sufficient scope for protecting adequate amounts of similar habitat elsewhere on the site. At Duynefontein, while similar habitat outside the proposed footprint area is very limited, we are confident that the majority of invertebrate species within the proposed footprint will be adequately represented in other habitat types on the site. For all three sites, the recommendations made here regarding preferred footprints are however made on the express understanding that thorough invertebrate surveys of the site(s) selected for NPS construction will be carried out prior to commencement of any construction activities to confirm that no unique species or communities will be threatened.

Impact identification and recommended mitigation

The most important potential **negative** impacts of the proposed NPS development on the terrestrial invertebrate communities of the three sites and the basic recommended mitigation measures are indicated in Table A.

Table A: Most significant potential negative impacts and recommended mitigation measures

Impact	Outline of basic mitigation recommendations
Direct habitat destruction	1. Carry out more detailed invertebrate surveys of all three sites to enable sound recommendations to be made regarding the most suitable portions of the sites for development; 2. Minimise development footprint and restrict all development activities to the recommended areas; and 3. Dispose of spoil off-site and keep temporary stockpiles as small as possible.
Reduction in populations of rare / threatened / protected species	1. Minimise development footprint and restrict all development activities to the recommended areas; 2. implement all measures required to minimise impacts of road mortality and light pollution.
Light pollution	1. Externally visible lighting should be kept to an absolute minimum and 2. wherever possible long-wavelength light sources should be used.
Spread of alien invasive invertebrate species	1. Institute strict control over materials brought onto site; 2. Rehabilitate disturbed areas as quickly as possible; and 3. Institute monitoring and eradication programmes to detect and control alien invasive species.

The most important potential **positive** impact of the proposed NPS development on the terrestrial invertebrate communities of the three sites will be enhanced protection and conservation-oriented management of the sites by Eskom. Evaluation of the negative and positive impacts of the proposed development suggests that for Bantamsklip and Thyspunt a net positive impact is achievable. It could further be argued that construction of one NPS at each of these sites would result in a greater net positive impact at a national level than would construction of one or more at only one site.

Recommended monitoring programmes

Outlines of the monitoring programmes recommended for evaluating the effectiveness of and aiding in the implementation of important mitigation measures are presented in Table B.

Table B: Summary of recommended invertebrate monitoring programmes

Monitoring programme	Duration of monitoring	Reporting	Management objectives
1. Invertebrate mortality caused by external lighting	Life of project: commence prior to construction to obtain baseline, continue throughout construction and operational phases.	3-monthly until target reached, annually thereafter	Reduction of light-induced mortality to insignificant levels; no measurable impact of light pollution on surrounding invertebrate populations.
2. Invasion by alien invertebrate species	Life of project: commence prior to construction to obtain baseline, continue throughout	Annual	Detection of establishment of alien species to allow early intervention in terms of eradication / control.

	construction and operational phases.		
3. Diversity and community structure of selected indicator groups such as ants and leafhoppers	Commence prior to construction to obtain baseline values and continue throughout construction (including post-construction rehabilitation of disturbed areas) and decommissioning phases.	Annual	Diversity and species composition of selected indicator taxa return to baseline values after successful rehabilitation.

Environmental assessment

Assessment of the unmitigated and mitigated expected impacts indicated that at all three sites the significance of most impacts could be reduced by mitigation to low or medium, but for direct habitat destruction and reduction in populations of rare / threatened / protected species this was not possible and an offset may be required to alleviate this. Such an offset is readily identifiable in mitigation of the potential positive impact described above, if conservation-oriented management is enhanced, possibly by additional properties being incorporated into the reserve areas.

Conclusions and Recommendations

While every effort was made to provide as complete an assessment as possible, the limitations resulting from the inadequate duration and inappropriate timing of the invertebrate assessment surveys must be seen as a major impediment. A thorough objective assessment of such a large area (5 885 ha in total) is not possible under such circumstances and in order to increase confidence in the sensitivity ranking, identify specific impacts in more detail, and provide more valid input into the selection of least sensitive areas within sites, it is strongly recommended that additional surveys of the invertebrate fauna of the three sites be carried out. Such studies should cover a broad spectrum of taxonomic groups with differing ecological roles and ideally be carried out over at least a full active season, allowing field surveys to be carried out at least during spring/early summer, mid/late summer and late summer / early autumn, with butterfly surveys covering the months of October, November and February as a minimum. These surveys should include a component specifically aimed at finding male specimens of the probable new trapdoor spider species (*Spiroctenus* sp.) found at Bantamsklip so that its identity can be confirmed, as well as determining its distribution on the site and in surrounding areas to aid in selecting preferred locations for NPS development while ensuring conservation of the species. Full surveys of the ant fauna of the site(s) selected for development should be carried out prior to construction to provide a baseline for monitoring both of rehabilitation (especially of spoil stockpile areas) and potential invasion by alien ant species, as well as providing input to detailed sensitivity assessments and assessing the conservation status of the new species identified from each site.

While we do not view any of the sites as fatally flawed, we believe that, from the perspective of the terrestrial invertebrate groups investigated, development of the Duynefontein site would have the least negative impact and of Bantamsklip the most. Conversely, due to the currently conserved status of the Duynefontein property, this site would also have the least to gain from positive impacts in terms of site protection and management, and both Bantamsklip and Thyspunt stand to gain far more from continued or enhanced management as conservation areas under Eskom stewardship. Although further studies may yield findings that increase the sensitivity assessments of all of the sites, with more significant negative impacts as a result, there would most likely be a concomitant increase in positive impacts which would more than offset the negative aspects.

It should however be borne in mind that the above assessment is based on the assumption that a nuclear accident resulting in significant radioactive contamination of the environment will never occur. The risk of potentially disastrous negative impacts on the surrounding invertebrate communities would need to be balanced against the positive impacts described above. Although the reactor designs under consideration should be able to ensure that there is virtually zero risk of major radioactive release, if an accident risk assessment concludes that such an event does have a significant probability of occurrence, the sensitivity assessment of the sites would probably change and from the perspective of invertebrate conservation the consequences of such an event would be expected to be least significant at Duynefontein and most significant at Bantamsklip.

We feel that an NPS development at Bantamsklip would probably have the least impact on terrestrial invertebrate communities if it is positioned as far to the north-east of the EIA corridor as possible, at Duynefontein as far south as possible in the EIA corridor (adjacent to the existing Koeberg Power Station) and at Thyspunt we recommend NPS placement roughly in the centre of the EIA corridor.

1.14 Marine Ecology Assessment (Appendix E15)

This specialist study was undertaken to assess the possible impacts of a 4 000 MW capacity power station on the marine environment at one of three potential sites along the Eastern and Western Cape coasts. Such a development at Duynefontein, Bantamsklip or Thyspunt will have a variety of potential impacts.

Impacts

- Disruption of surrounding marine habitats. When associated with the construction of the cooling water intake and outfall system, this effect will be focused within the construction phase and will be localised, of medium duration and significance. When associated with the discarding of spoil, disruption to the marine environment is significant. When mitigated by disposing spoil offshore (and by using only a medium pumping rate at Thyspunt), the impact is reduced to one of medium consequence and medium significance The temporal and spatial limitations of the impacts associated with the disposal of spoil on chokka squid at Thyspunt will have limited impact on the overall squid stock, when taken within the context of the extensive area over which this species spawns.
- The entrainment and death of organisms associated with the intake of cooling water. At Duynefontein and Thyspunt entrainment it is not anticipated to have important ecological impacts. However, at Bantamsklip larval entrainment may have significant negative effects on local stocks of the abalone *Haliotis midae*.
- The release of warm water used for cooling purposes. A tunnelled design of the release system mitigates potential negative impacts, through multiple points of release to aid dissipation of excess heat, by releasing cooling water above the sea bottom to minimise effects on the benthic environment and by utilising a very high flow rate at the point of release to maximise mixing with cool surrounding water. Comprehensive oceanographic modelling has demonstrated that the effects of elevated temperature are expected to be focused on the open water habitat. This is of particular relevance at Bantamsklip and to a lesser degree at Thyspunt, as it would help to mitigate impacts on abalone and chokka squid egg capsules respectively. While chokka squid at the Thyspunt site are expected to avoid water temperatures elevated above their thermal tolerance range, the area predicted to be affected represents less than one percent of the coastal spawning ground. It is strongly recommended that at Bantamsklip an offshore tunnel outfall be utilised for the release of warmed water in an effort to mitigate impacts on abalone. Importantly a nearshore release system at this site is considered to pose an unacceptable risk to abalone populations.
- The release of desalination effluent. During construction limited volumes of hypersaline effluent will be released directly into the surf zone, where high energy

water movement will result in adequate mixing with surrounding seawater to ensure minimal impact on the marine environment. During the operational phase the desalinisation effluent will be co-released with cooling water. As brine will be diluted to undetectable levels prior to release no impact on the marine environment is predicted from this effluent during this phase of the development.

- The unintentional release of radiation emissions. Technical design of the cooling system has minimised this risk, so that this impact is rated as having low consequence and low significance.
- The additional protection of marine organisms from exploitation due to a safety exclusion zone. The only site which would benefit from such an exclusion zone would be Bantamsklip, as this could be of great benefit to what are currently illegally harvested abalone populations. However, for such a benefit to be realised adequate enforcement of the exclusion zone should be provided.
- The release of treated sewage effluent. This effluent will meet the standards set by the Department of Water Affairs and Forestry and, as such, no significant impact on the marine environment is expected.
- Pollution of the marine environment by the discharge of groundwater polluted by organic, bacterial or hydrocarbon compounds. As this impact is unlikely to occur and will be spatially and temporally restricted, it is considered to be of low consequence and significance.

Besides the impacts of the proposed development on marine habitats, organisms in the marine environment may also impact on the development. This would take the form of fouling of cooling water pipes. This impact is anticipated to be most significant at Duynefontein, due to its location along the west coast, where jellyfish blooms appear to be increasing in frequency.

1.15 Oceanography Assessment (Appendix E16)

In South Africa economic growth and social needs are resulting in substantially greater energy demand to meet the power generation requirements. Eskom therefore proposes to construct a Nuclear Power Station (NPS) with a power generation capacity of up to 4000 MW using Pressurised Water Reactor (PWR) technology.

This report examines the impacts on the physical marine environment brought about by the construction and operation of the NPS at the three possible sites, namely; Duynefontein, Bantamsklip and Thyspunt. In addition to the impacts of the NPS on the physical marine environment, impacts of storm events, global warming and natural disasters such as tsunamis affecting the operation and safety of the NPS were considered.

Oceanographic impacts related to the construction phase are considered to be of low significance and relatively uniform across each of the three potential sites.

The extent of the thermal plume at each of the sites is highly variable and dependant on the wind and wave conditions at any particular time. Analysis of the thermal plume dispersion at each of the sites indicates that relatively unfavourable dispersion takes place at Thyspunt, where the plume is seen to hug the coastline and shallow near shore areas. The most efficient dispersal of the thermal plume is seen at Duynefontein.

Impacts to the NPS caused by the physical marine environment will arise from flooding from the sea and the interruption of the cooling water supply. Interruption of the cooling water was considered to be of low significance at each of the alternative sites due to the depth of the intake and the mitigation measures incorporated in the design of the cooling water intake system.

There is the potential for water levels to exceed the proposed elevation of the NPS at all three sites should a tsunami coincide with extreme meteorological conditions (a meteo-tsunami event). The occurrence of a tsunami is, however, improbable given the low risk of seismic activity in the surrounding ocean. Thyspunt is the only site where extreme high water levels resulting purely from meteorological factors are predicted to exceed + 10 m MSL during the expected lifetime of the installation. Consequently, the predicted water levels at Thyspunt during a meteo-tsunami are also significantly higher than at Bantamsklip and Duynefontein.

Appropriate mitigation measures are recommended for each of the potentially significant oceanographic issues that have been identified.

1.16 Economic Assessment (Appendix E17)

Eskom proposes to construct a nuclear power station with a power generation capacity of up to 4,000 MW on each of three sites, namely Thyspunt in the Eastern Cape, Bantamsklip in the Western Cape and Duynefontein in the Western Cape. The objective of the study is to analyse the economic cost-effectiveness of the three sites from a broader community prospective. This includes the capital and operational costs of the service provider as well as the costs to the community, taking into account the positive and negative externalities on the economy and the environment. The study also considers the broader macroeconomic impact of the three sites on their relevant provincial economies.

The study approach consisted of a combination of desk research, field interviews and the application of data collected to macroeconomic modelling.

The Duynefontein site is located in a far more developed and sophisticated area than are the other two sites (Bantamsklip and Thyspunt). The Cape Town metropolitan economy would find it far easier to absorb and service a nuclear power station and its staff than would be the case at Thyspunt or Bantamsklip.

Perceptions regarding a nuclear power station are frequently based on a lack of scientific information about perceived impacts. Our field interviews revealed that the public's level of concern is lower in the area around Duynefontein because of their experience with Koeberg; by contrast, there is significant opposition to a nuclear power station at the other two sites. In general, the business sectors around all three sites see opportunities arising from the establishment of a nuclear power station, quite apart from the importance of stabilising the electricity supply.

The two most sensitive industries in terms of their perceptions about the impacts of Nuclear-1 on their activities are fishing and tourism. However, the analysis shows that any negative impacts are likely to be slight and that in fact there would be overall positive impacts on tourism.

The macroeconomic impact analysis gives mixed results for the construction and operational phases at the three sites. Macroeconomic indicators favour the Western Cape sites but household and social indicators favour Thyspunt. The cost-effectiveness analysis indicates that Thyspunt has a very slight edge over Duynefontein and a somewhat larger edge over Bantamsklip. ***The difference between Thyspunt and Bantamsklip is R6.388 billion, and expressed as a percentage the difference is 5.93% in favour of Thyspunt. Between Thyspunt and Duynefontein the difference is R570 million, or 0.53% in favour of Thyspunt.*** Thus, the order of preference (from most to least preferred) is Thyspunt, Duynefontein and Bantamsklip. However, the differences are slight, and all the sites would have large positive economic impacts both on the local area and the province in which they are situated.

Mitigation measures proposed relate to operation and maintenance (particularly the skills issues), public perceptions and concerns, and compensation.

1.17 Social Impact Assessment (Appendix E18)

Background

Octagonal Development cc (Alewijn Dippenaar) has been appointed to conduct a Social Impact Assessment (SIA) for the proposed construction of a nuclear power station and associated infrastructure, on three sites with one being located in the Eastern Cape and a further two in the Western Cape Provinces. The three alternative sites identified are referred to as:

- Thyspunt;
- Bantamsklip and
- Duynefontein.

The report related to the SIA is divided into four chapters, viz.:

- Section 1: Introduction;
- Section 2: Description of the affected environment;
- Section 3: Impact identification, assessment and mitigation/optimisation measures; and
- Section 4: Conclusions and recommendations

The Project (Nuclear Power Station)

Eskom proposes to construct a Nuclear Power Station, referred to as Nuclear-1, with a power generation capacity of up to 4 000 MW, using the Pressurised Water Reactor technology (PWR). In many ways the structure of the nuclear plant resembles that of a conventional thermal power plant. The difference between nuclear and conventional fossil fired power plants is the fuel source and the manner in which heat is produced. In a fossil plant oil, gas or coal is fired in the boiler, which means that the chemical energy of the fuel is converted into heat. In a nuclear power station the fuel source is enriched uranium and energy from the nuclear fission chain reaction is utilised.

A typical construction programme for Nuclear-1 could take up to 9 years to complete and includes aspects regarding site establishment, bulk excavation, civil works, access roads and construction of the reactor.

Information provided by Eskom (September, 2008) details the proposed accommodation required for the Nuclear-1 nuclear power station. It must be emphasised that the detail of accommodation requirements, and the integration into existing communities and towns, still need to be negotiated with respective municipalities and other role-players where relevant. The exact location of a possible construction village still needs to be determined after the preferred site has been identified.

The areas of the land will be finalised in terms of the residential densities prescribed by the Spatial Development Plan for the properties that are available. Eskom must provide rezoned land for the Vendor to build a Construction Village for migrant workers. It is Eskom's responsibility to facilitate the EIA process.

In addition, Eskom may provide serviced residential stands for the Vendor to build staff accommodation (Staff Village). The accommodation will be finalised once the Vendor is appointed, and the development of the land will be included in the overall community integration strategy for the Eskom residential developments.

Purpose of the report

The purpose of this report is to provide the findings of the SIA, specifically as it relates to the three sites, viz. Thyspunt, Bantamsklip and Duynefontein. It represents an in-depth assessment of the possible social impacts, including a rating of impacts as required by the EIA Regulations, the significance thereof and measures for mitigation through the enhancement of positive impacts and the mitigation of negative impacts.

Assumptions and Limitations

The following assumptions and limitations are taken into account in this report:

- The South African Government will continue with their intention to actively pursue nuclear energy over the next two decades as indicated in The Nuclear Energy Policy and Strategy for the Republic of South Africa (DME, 2007);
- Different people tend to view the realities of life differently and therefore the impact that may be perceived negatively by one individual or community could be perceived as the best and most positive impact by the next individual;
- Consultation with people, in order to gain an understanding of the issues, does have limitations, primarily due to the fact that individuals/parties are not always willing to attend and participate in discussions and consultation sessions. Often people are hesitant to contribute openly in group meetings and the conducting of individual interviews are not always possible or feasible;
- Although Statistics SA provides certain statistical updates on a regular basis, gaps do exist in the official data obtainable from this institution. Although this lack of more recent area-specific data has been a limiting factor, these limitations have not been insurmountable as a fair, if not relatively accurate, estimate, can be obtained by plotting the available data against updated Provincial and National trends;
- While every attempt was made to provide an opportunity for all affected and interested parties to participate in this study, the results of the study cannot be generalised to the entire research population. Therefore, in analysing the results, conclusions are drawn with regard to the characteristics and views of those interested and affected parties (I&APs) who participated in the study;
- The impact assessment tables pose a limitation for the social impacts in the sense that the tables do not allow for a comparison between the impacts with a weight attached and those without. Not all impacts have the same value and it is not part of the impact tables to assess the relative value of each impact towards an index figure.

Methodology and Study Approach

A recognised methodology in the form of triangularisation, was applied in gathering and analysing data during this study, as was an accepted impact assessment technique.

The methodology employed for the SIA is in accordance with the International Association for Impact Assessment (IAIA) and guidelines outlined in the Western Cape Department of Environmental Affairs and Development Planning's Guidelines for involving Social Specialists in an EIA.

A mixed quantitative and qualitative methodological approach is employed and, in line with this methodology.

For each of the two primary project phases, viz. construction and operation, the existing and potential future impacts and benefits, associated only with the proposed development, were described and assessed, both prior too and after mitigation/optimisation, according to prescribed assessment criteria.

Impact identification and assessment for construction and operational phase

The following social impacts were identified and assessed:

- Accommodation of staff and construction workers;
- Influx of job seekers;
- Increase in number of informal illegal dwellings;
- Creation of employment opportunities;
- Business opportunities;
- Impact on criminal activities;
- Risk of STDs, HIV and AIDS;
- Municipal services;
- Traffic impacts;
- Noise and dust impact;
- Loss of employment after construction;
- Visual impacts;
- Impact on social infrastructure and facilities;
- Impact on sense of place;
- Future land use planning;
- Perceived risks associated with nuclear incidents;
- Assessment of no development option.

The assessment was based on a review of:

- Issues identified during the Scoping Process;
- Planning and policy documents pertaining to the area;
- Interviews with key interested and affected parties;
- Social issues associated with similar developments; and
- The experience of the author in the field of SIAs.

Each of these impacts is now briefly discussed.

Accommodation of staff and construction workers

Large numbers of workers will place tremendous strain on the provision of temporary and permanent accommodation. The Vendor and Eskom staff implicates an estimated influx of 3 837 workers (peak period) and their families to the nuclear power station project area. The total population influx is estimated at 10 500 people, to be accommodated on an area of approximately 167.2 ha.

The Construction Village will be required to accommodate approximately 3 750 people. The positioning of the Construction Village still needs to be determined, and is a sensitive issue with valuable opportunities and benefits, but also the potential for negative impacts on human well-being.

Mitigation measures for the provisioning of sufficient accommodation should be implemented.

Influx of job seekers

This impact deals with the influx of job seekers to the site during the construction phase. These job seekers, including those from areas outside the “local” area, enter the area with the hope of securing employment. When they do not secure employment, the potential exists that they will contribute to problems experienced with informal settlement, pressure on existing resources, services and infrastructure. The possibility further exists that they may contribute towards crime and other social problems such as alcohol abuse and prostitution.

Mitigation measures are aimed at minimising the number of job seekers staying in the area.

Informal Development and Settlements

An increase in unplanned development and informal settlements surrounding the nuclear power station site is associated with perceived economic opportunities. If not carefully managed, this type of uncontrolled development is also likely to result in an increase in an array of social pathologies such as crime, prostitution and alcohol and drug abuse.

Mitigation measures are aimed at controlling the threat of an increase in unplanned development and the rise of informal settlements.

Creation of Employment Opportunities

The nuclear power station offers the potential for unemployed people to gain meaningful employment during the construction phase. It is estimated that the construction phase could take up to 9 years from the commencement of construction until commissioning. During this period it is foreseen that an estimated 8 737 staff, including construction workers, will be employed on site. It is envisaged that at least 25% of the construction workers will be sourced from the local labour force.

Optimisation measures are aimed at enhancing the benefits of employment creation.

Business Opportunities

A significant number of business opportunities will be created for local companies / service providers and SMME's.

The utilisation of local suppliers and service providers must be promoted through local procurement and pro-active targeting processes via an open and transparent tender process for all construction related activities.

Impact on Criminal Activities

The result of a large influx of people into the area as employees or in search of work, could result in an increase in criminal activities. It is also possible that, during the construction phase of the project, an opportunistic criminal element may take advantage of increased activities in certain areas around construction sites.

Mitigation measures are aimed at reducing the risk of crime.

Risk of STDs, HIV and AIDS

This impact refers to an increase in the risk of STDs and HIV and AIDS. It is well documented that an increase in the risk of STDs, HIV and AIDS is associated with an influx of workers, particularly migrant workers, and/or any increase in truck traffic into or through an area.

Mitigation measures are aimed at managing the risks associated with STDs, HIV and AIDS.

Municipal Services

This impact deals with the probability of the new nuclear power station placing strain on municipal services such as water, sanitation, roads, waste and refuse removal.

Mitigation measures are aimed at provision of required services.

Roads and Transport

The concern is the capacity of roads and transportation infrastructure required for the construction and operations of the nuclear power station.

Mitigation measures are aimed at planning, funding and developing roads and transportation infrastructure as required for the construction and operations of the nuclear power station, in addition to roads and transportation infrastructure to the residential areas to be developed to accommodate the staff and construction workers.

Waste and Refuse Removal

This concerns the capacity of Land Fill Sites and Waste Transportation required for the construction and operations of the nuclear power station, as well as the services and infrastructure to the residential areas to be developed to accommodate the staff and construction workers.

Mitigation measures are aimed at providing sufficient Land Fill Sites and Waste Transportation for the construction and operations of the nuclear power station, as well as refuse removal services to the residential areas to be developed to accommodate the staff and construction workers

Traffic impacts

Increased vehicular movement during the construction phase may influence daily living and movement patterns of community members in the surrounding communities.

Mitigation measures are aimed at optimising vehicular movement during the construction phase to minimize traffic congestion problems in the area, which in turn influences daily living and movement patterns of community members in the surrounding communities who make use of these roads.

Noise and Dust Impacts

Increased levels of noise and dust may impact negatively on the quality of life of people living close to the proposed nuclear power station site.

Mitigation measures are aimed at limiting disturbance and the psychological effects of noise and dust pollution.

Loss of Employment after Construction

A number of jobs will be lost once construction of the nuclear power station has been completed.
Mitigation measures are aimed at minimising the extent of jobs lost after construction

Visual impacts

The nuclear power station will change the visual character and quality of the setting according to the Visual Specialist Study (September 2009).

Mitigation measures are aimed at limiting the negative effects and the disturbance on the sense of place that the nuclear power station may impose. The solution would be the implementation of the mitigation measures suggested by the visual impact study.

Impact on Social Infrastructure / Facilities

This impact refers to the likelihood of the proposed nuclear power station placing strain on existing infrastructure such as medical facilities, police, schools and sport facilities.

Mitigation measures are aimed at making provision for adequate social infrastructure and facilities for growth in number people.

Impact on sense of place

The proposed nuclear power station will possibly result in a change to the local sense of place.

This concern relates to the possibility that the nuclear power station may contribute negatively to the current characteristics, or feeling / perception held by people. Communities experience that their place have a special and unique character.

Mitigation measures are aimed at limiting the negative effects and the disturbance on the sense of place that the project may have on the environment.

Future Land Use (Planning)

The proposed nuclear power station will impact on future land use and planning in the area. Mitigation measures are aimed at minimising the impact of the proposed nuclear power station on future land use and planning.

Perceived Risks Associated with Nuclear Incidents

During the process of public consultation, it was stated clearly by various participants that they fear the impact of possible risks related to nuclear incidents. These risks are related to the following:

- Design safety;
- Nuclear accidents;
- Potential terrorist acts;
- Capacity and capability of people operating the nuclear power station;
- Strikes and labour unrest affecting daily management; and
- Reliability of communication flow, especially with reference to perception on potential risks and negative impacts on good health.

Mitigation measures are aimed at ensuring that communities receive correct and reliable information regarding the real and perceived risks of nuclear power.

1.18 Visual Impact Assessment (Appendix E19)

Eskom intends building new nuclear power stations on all three sites. One site is located on a coastal promontory known as Thyspunt between Oyster Bay and Cape St. Francis, approximately 70 km south-east of Port Elizabeth. The second site is located near Bantamsklip between Pearly Beach and Quoin Point on the southern western Cape coast east of Gansbaai and the third is Duynefontein located north and adjacent to the Koeberg Nuclear Power Station (NPS), due west of the Town of Atlantis on the Western Cape Coast.

This report evaluates the potential visual impact of the Nuclear Power Station on the surrounding natural and human-modified environment of each site.

Visual risk sources for all three sites relate primarily to the increase in visual intrusion of the Nuclear Power Station as an entity and in combination with ancillary elements such as the construction offices, sheds, access roads, switch yards, transmission lines, masts and spoil dumps. At Duynefontein site the visual risk sources relate primarily to the increase in visual intrusion in combination with Koeberg Nuclear Power Station adjacent to the southern boundary of the site and the proposed Pebble Bed Modular Reactor Demonstration Power Plant adjacent on the southern side of Koeberg. The additional risks for each site have been identified as the accommodation of the large volume of excavated material, the alteration of areas surrounding the site during construction and the new access roads for the Thyspunt site specifically.

Each site is discussed and rated according to the visual criteria of visibility from roads and the general surrounding landscape, the possible visual intrusion on landscape character and sense of place and the visual association with the new transmission lines. The visual impact of the transmission lines are the subject of a separate EIA; viz. the Transmission EIA.

Each site is assessed according to a set of rating criteria set for visual intrusion and visibility impact. The finding is that the Thyspunt NPS, Bantamsklip NPS and Duynefontein NPS have an intensity of visual intrusion that is rated as significant, particularly the night scene.

Using set criteria the visual impact is assessed for each of the NPS sites.

Impacts

The conclusion drawn is that the Thyspunt Nuclear Power Station, Bantamsklip Nuclear Power Station and Duynefontein Nuclear Power Station will exert a significant visual impact on the existing visual condition and character of the local setting within a radius of 5 km. The meteorological and radio masts will be clearly visible on a cloudless day from at least 10 km away. The red light on top of the 120m high meteorological mast will be visible at night from beyond 10 km. The climatic conditions will influence the masts' visibility as cloudy or misty conditions can almost totally obscure these elements. Particular visual aspects that relate to site are as follows:

Thyspunt

The visibility is contained along the coast by east-west orientated dune fields. This limits the visual exposure of the Thyspunt NPS to the towns of Oyster Bay and Cape St. Francis.

The main aspect that influenced the above conclusion is the presence of the visually dominant Thyspunt NPS and the associated transmission lines and buildings, all of which are visible to some degree from within a 10 km radius of the site, but mainly along the coastal edge. This is due to the landform that includes vegetated and moving dunes that trend east-west, almost parallel to the coastline and the extended visibility at night due to intense illumination of that site. However the general existing coastal night scene is disturbed by the intense incandescent lights on the 'chokka' boats as they fish for squid near the shore. The light intensity varies according to the season for chokka fishing. The visual intrusion on the landscape character will be increased by the HV Yard, the transmission lines and proposed northern access road that all become visually prominent in the panhandle of the property north of the high sand dune.

Bantamsklip

The main aspect that influenced the above conclusion is the presence of the visually dominant Bantamsklip NPS and the associated transmission lines and buildings, all of which are visible to some degree from within a 10 km radius of the site. This is due to the landform that slopes towards the coastline and the prominent seaward location of the site on a coastal terrace. This visibility will be extended at night by the illumination of the plant.

Duynefontein

The finding is that the Duynefontein NPS has an intensity of visual intrusion that is rated as significant, particularly at night. This in association with the scale and proximity of the Koeberg NPS and possible future Pebble Bed Modular Reactor Demonstration Power Plant (PBMR DPP) will as a group extend the existing visual impact of Koeberg NPS on the surrounding landscape and communities.

The visually dominant Duynefontein NPS and the associated infrastructure will be visible to some degree from within a 10 km radius of the site. This is due to the landform that slopes gently towards the coastline and the extended visibility at night due to illumination of that site.

The cumulative visual impact of three large power generating facilities within 3 km of the coast will have a high visual intrusion on views, visual character and visual quality.

The new Opened Cycle Gas Turbine Power Station is completed in Atlantis, approximately 10 km inland from the proposed site. This add another large scale structure to the regional landscape.

Ancillary structures and features were also assessed for their influence on the visual sense of place and their visual intrusion. These elements are the meteorological mast (120m) and the radio mast (95m), the transmission lines within the EIA corridor, the spoil and rock dumps and the access roads to the site from the provincial road.

Findings

- The masts will be visible from further away than for the NPS, particularly at night, due to the flashing red light at the top. The mast will be slender, which will reduce its visual intrusion;
- The transmission lines within the EIA corridor will add to the visual intrusion of the project by their height and number;
- The access roads for Bantamsklip and Duynefontein will have negligible visual intrusion on the sense of place;
- The roads for Thyspunt will have the most negative impact on the sense of place, with the northern route identified as having the least negative impact as a result of it being visually integrated with the highly visible transmission lines,2 x 400kV out and 1 x 132kV line in, as well as the HV Yard;
- The spoil dumps are very large and have been considered to be placed within the EIA corridor. This position will result in the dumps being dominant visually within this area and can serve as large screens of the NPS in views from the provincial roads.

Mitigation Measures

The following Generic Mitigation measures are proposed to reduce the visual impact of the NPS.

Colour

It is recommended that a light blue-grey is used for the large structures (namely the Turbine-Generator Building), with the stack (chimney) a very light grey. The NPS is a concrete structure, which will have a light grey colour. A darker band around the large structures will reduce their vertical scale. The masts should be a grey colour which will be the result of their galvanised finish. However this may be in conflict with the regulatory requirements that they are red and white bands.

Screens

Temporary screens in the form of shade cloth on fences around the construction site, working areas and lay-down areas must be used to obstruct views of most of the construction elements at the level of the fence.

Earth berms of significant proportions must be created along the site boundary nearest to sensitive land uses, e.g. residential areas and roads, to screen portions of the structures. However, consideration should be given to the associated impacts caused during their construction and stabilisation, such as dust, noise, rehabilitation and the destruction of existing coastal flora. A thorough assessment should be carried out on site before any decision is made regarding a screen berm. This is necessary in the context of possible residential land uses in the coastal area east of the Thyspunt NPS site and west of Cape St. Francis, as well as east of Bantamsklip NPS, which may result from the extension of the R43 to link with Bredasdorp.

Lighting

The lighting of the structures and areas within the NPS site should be designed by a suitably experienced person with the objective to reduce “light spill”. Aspects to be incorporated will be down lighting, lighting colour, extent of necessary illumination, light fittings that direct the light and elimination of the visible light source.

Spoil dumps

Large spoil dumps must be integrated into the selected setting by varying their form and side slopes to fit the scale of existing landforms. In addition their re-vegetation with typical indigenous species of the surrounding landscape is essential to create a visual fit of the dump’s elements to the existing landscape character.

A Landscape Architect should be appointed to the design team to advise on the visual integration of the project on a detailed level during the phases of design and construction and operation.

The dilemma of placing a new large scale facility in an area that is relatively undisturbed and remote or near build-up areas to reduce the visual intrusion intensity remains. The question is whether to increase, but contain the visual impact locally or to visually impact another (already impacted) location, but not to the same degree.

The conclusion is that the NPS on any of the three sites will have a high visual impact on the character and sense of place of the existing setting. However, with attention to detailed aspects of all mitigation measures proposed, the visual impacts can be reduced. To achieve this considerable effort will need to be spent on this aspect during the site design and construction stage of the project.

1.19 Heritage Impact Assessment (Appendix E20)

The Archaeology Contracts Office of the University of Cape Town was appointed by Arcus Gibb (Pty) Ltd on behalf of Eskom Holdings to undertake the heritage component of an environmental impact assessment of three proposed sites for a 4000 MW nuclear power station and associated infrastructure. Authorisation is sought for all three sites. The sites are situated close to the existing nuclear power station at Duynefontein (Western Cape), a second at Bantamsklip between Pearly Beach and Die Dam (Western Cape) and a third at Thyspunt between Cape St. Francis and Oyster Bay in the Eastern Cape. This study, which has involved extensive background and primary research followed by field assessment, has identified heritage sensitivities at all three sites.

All three sites contain significant heritage resources, being situated in areas which are known to be archaeologically and palaeontologically sensitive and in scenic areas with strong wilderness qualities. The findings of the study are summarised thus:

Duynefontein

- Impacts to ephemeral Late Stone Age heritage will be minimal.
- Duynefontein is palaeontologically highly sensitive. Extensive mitigation will be required which, if done appropriately, will benefit palaeontological research.

- In cultural landscape terms the nuclear industrial presence is already established and accepted as a landmark by most Capetonians. Any additions to this will be additions to an already established identity.

Bantamsklip

- By Western Cape standards the preservation and volume of archaeological sites is exceptional. Extensive mitigation will be required.
- The natural heritage landscapes of the place are excellent and make a contribution to sense of place in the region. Together with the archaeological material they represent a largely intact precolonial cultural landscape. Given the mass and bulk of the proposed activity, un-mitigatable cultural landscape impacts are expected.

Thyspunt

- The archaeological and palaeontological heritage is diverse and prolific. Mitigation without excessive impacts is going to be technically difficult to achieve due to the character of the site and difficulties with respect to accessibility, however the final location of the proposed facility will play a role in the degree of impact expected.
- The wilderness qualities of this portion of the coast ***in contiguity with the archaeological heritage*** are exceptional and make a substantial contribution to the character of the region. Given the mass and bulk of the proposed activity, un-mitigatable cultural landscape impacts are expected.

1.20 Agricultural Assessment (Appendix E21)

A survey undertaken within a 16km radius of all three sites showed that agriculture around Thyspunt is based substantially on milk production; fynbos prevails in the Bantamsklip area although there is some dairy as well as beef, sheep and game farming; while the Duynefontein area is based on mixed farming.

Given the information gathered in the agricultural study, it was estimated that the current annual value of farm production in 2008 was R150 million in the Thyspunt area, R29 million for Bantamsklip and R75 million for Duynefontein.

The major impacts of a nuclear power station on agriculture would be the generation of dust during the construction phase, labour shortages and wage increases, and market effects. The estimated impact on produce markets showed that the gross value of production in the Bantamsklip area ***could potentially*** increase by up to 5% and in the Thyspunt area by 10 to 15%, while no change is anticipated in the Duynefontein area.

From an agricultural production perspective Duynefontein is a mature site because grape and wheat production in the area has progressed alongside the construction and operational phases of the existing Koeberg Nuclear Power Station. Dust during construction of the new plant will have little effect on farm lands because the prevailing winds during the dry summer months are in line with the coastal strip.

Impacts

In summary, the impacts on agriculture at the three sites are as follows:

Duynefontein

- No significant impact on agriculture during construction and normal operations. No increase in agricultural production during operation.

Thyspunt

- ***short term*** negative impact on agriculture in terms of dust during the construction phase. However, there is potential for a positive impact on production by increasing the size of the local market for fresh produce as a result of the influx of population (Nuclear-1 employees and their families as well as construction workers) to the area.

Bantamsklip

- ***short term*** negative impact on agricultural production with regard to dust during the construction phase. There is an estimated potential of less than 5% to increase the market for local agricultural produce because of water limitations that restrict expansion.

In terms of the impact on agriculture, there are no fatal flaws in respect of any of the three sites, and all of them would be suitable to accommodate Nuclear-1.

1.21 Tourism Assessment (Appendix E22)

This study evaluates the tourism industry at each of the three sites defined in Eskom's Nuclear-1 programme, namely, Thyspunt, Bantamsklip and Duynefontein. The tourism market at each site is described and assessed in the following terms:

- A description of the status quo in terms of the current tourism industry and an outline of current proposed developments in each area
- A definition and value of the change in the tourism asset that would occur as a result of the construction and operation of a nuclear power station in each area
- The identification and recommendation of mitigation measures to reduce or offset the perceived negative impacts on the tourism asset

Each site was investigated with a thorough desktop study followed by a field visit. Various prominent tourism stakeholders and authorities were identified, contacted and interviewed. The complex nature of the tourism industry as a whole and the variable influence of perception and image in tourism marketing, destination branding and decision-making, makes averaging the value of tourism difficult. It was therefore decided that the best indication of tourism performance and the most comparable rand figure for each area would be the value of bed-nights spent there. This is calculated for each research area by the approximate number of beds multiplied by the average annual occupancy rate multiplied by the average cost per night.

The tourism asset at each area was then described according to specialist observation and the perceptions of the consulted stakeholders. Following a specialist review of the field data, a weighted matrix of tourism impacts was set up and annual values of the indicative impacts on tourism were calculated using the bed-night figures. A summary is depicted in the table below.

		Construction Phase (yrs 1-6)		Operational Phase (yrs 7-20)	
	Current Tourism Value (Rands)	Annual Impact (Rands)	Impact (%)	Annual Impact (Rands)	Impact (%)
Duynefontein	497,827,951	0	0.00%	7,111,828	1.43%
Bantamsklip	62,247,100	3,112,355	5.00%	5,335,466	8.57%
Thyspunt	77,745,000	-6,108,536	-7.86%	0	0.00%

The Thyspunt and Bantamsklip communities have expressed the most adamant opposition to the proposed nuclear power station. Thyspunt has expressly highlighted the premium nature of the top-end coastal vacation destination, and Bantamsklip has emphasised the new and fragile nature of the developing tourism product and the local dependence thereon. The difference in size and type of tourism at these two sites explains why the short-term impact at Thyspunt is shown to be negative; a loss of some of the current holiday market might not be entirely offset by the growth of business tourism at Thyspunt, whereas business tourism is likely to significantly increase the size of the smaller market at Bantamsklip. While some Duynefontein tourism stakeholders have personal objections to the construction and operation of another nuclear power station, they recognise the potential for increased business and promote a generally positive outlook for tourism.

The main mitigation measure is an aggressive community-orientated and comprehensive public relations campaign to address popular misconceptions, specifically the impacts of nuclear power generation on the marine and immediate environment. An expressed and comprehensive integration of the relevant tourism agencies and organisations into Eskom's nuclear intentions and activities at each site, will facilitate a timely adaptation of the destination marketing and tourism branding initiatives, thereby expediting the acclimatisation of each site's tourism products and destination image toward the potential new nuclear environment; as emphasised by the commercial buy-in and stakeholder support experienced for the Koeberg NPS.

Impacts

In summary, the impacts on tourism at the three sites are as follows:

- Duynefontein – most easily absorbed into the local economy; no short-term discernible impact on tourism; small-scale, long-term discernible positive impact on tourism;
- Bantamsklip – small-scale, short-term and long-term positive discernible impact on tourism;
- Thyspunt – small-scale, short-term, negative discernible impact on tourism; no overall discernible long-term impact on tourism.

In terms of the impact on tourism, there are no fatal flaws in respect of any of the three sites, and all of them would be suitable to accommodate Nuclear-1.

1.22 Noise Impact Assessment (Appendix E23)

A specialist study was conducted into the potential impact of noise emanating from the proposed establishment of a Nuclear Power Station (Nuclear-1), with a maximum electrical generation capacity of 4 000 MW, at three different locations. The three locations are on the Koeberg (Duynefontein) site immediately north of the existing Koeberg Nuclear Power Station (KNPS), Western Cape; at Bantamsklip approximately 5 km east of Pearly Beach, Western Cape; and Thyspunt, east of Oyster Bay, Eastern Cape.

No quantitative noise emission data of machinery and equipment to be installed on site was available. This data, provided by the manufacturers of the respective machines/equipment, is usually only available at the tender and detail design stage once the manufacturers and specific machinery/equipment have been selected.

The maximum 4 000 MW electrical power capacity of Nuclear-1 would be 2,2 times greater than the 1 800 MW of the existing KNPS. It is clarified in this report that if there were to be an associated 2,2 times increase in sound power emitted (in watts) this would not be audible to humans. Such differences are considered insignificant in national and international standards relating to the assessment of environmental noise. It was thus considered justified to use the results of detailed sound measurements conducted at the KNPS to calculate the approximate noise levels on land surrounding the proposed Nuclear-1 at the three alternative sites. This provided the best available data for predicting the potential impact of noise from the proposed Nuclear-1 nuclear power station.

The results of the study indicated that there would be no noise impact on land surrounding any of the three properties during construction and operation of the proposed nuclear power station. No noise mitigation procedures would therefore be required. Noise during the operational phase would thus not have a bearing on the selection of any of the three alternative sites.

No noise impact associated with the construction of new roads to the alternative sites was anticipated, excepting the western access road to the Thyspunt site that would pass within 230 m of the Umzamowethu township. In the latter instance the following recommendations are made:

- Construction processes and machinery/vehicles with the lowest noise emission levels available are utilised;
- A well planned and co-ordinated “fast track” procedure is implemented to complete the total construction process in the shortest possible time; and
- Construction work near residences only takes place during normal daytime working hours.

The impact of noise associated with transportation of materials & equipment to site would have a low impact on the nearest residences located along the R27 leading to the Duynefontein site. The noise impact on the nearest residences along the R43 to the Bantamsklip site would be medium. The noise impact on a small number of residences in the nearest informal settlements along the R330 at sea Vista near the Thyspunt site would be medium. In all instances no noise mitigation would be required in terms of the Noise Control Regulations (NCR).

The transportation of heavy machinery on extra-heavy-duty vehicles traveling very slowly on roads within 1000 m of residences is likely to result in a noise impact of medium intensity but of very short duration. Little can be done to reduce the levels of noise emitted by extra-heavy-duty vehicles. In order to minimize the noise impact on affected communities it is recommended that they be informed prior to any such transportation taking place.

1.23 Human Health Risk Assessment (Appendix E24)

The Eskom Nuclear-1 project involves the licensing of three candidate sites along the west and south coasts of South Africa for the establishment of nuclear power stations. The sites are:

- The Thyspunt site, situated in the Eastern Cape Province in the region west of Port Elizabeth between Cape St Francis and Oyster Bay;
- The Bantamsklip site, located in the Western Cape in the area between Danger Point and Quoin Point;
- The Duynefontein site, situated on the Cape West Coast, approximately 30 km north of Cape Town, adjacent to the current Koeberg Nuclear Power Station.

The establishment of a nuclear power station includes a number of activities, which require authorisation in terms of the Environmental Impact Assessment (EIA) Regulations promulgated under the National Environmental Management Act (No. 107 of 1998), as amended. The EIA process is administrated by the Department of Environmental Affairs (DEA). However, following a co-operative agreement between the DEA and the National Nuclear Regulator (NNR), it was agreed that the NNR will be the responsible authority regarding the assessment of all matters relating to impacts of ionising radiation on human health. This environmental impact report on the assessment of potential health risks associated with nuclear power stations at the candidate sites will thus be submitted to the NNR for approval. The report has been prepared by INFOTOX (Pty) Ltd in conjunction with SRK Consulting.

Radiological protection in the low dose range is concerned primarily with protection against radiation-induced cancer and heritable disease. These effects are interpreted as stochastic, with no threshold, and they increase in frequency in proportion to the radiation dose. Radiation exposure has been demonstrated to increase the risk of other diseases, particularly cardiovascular disease, in persons exposed to high radiological doses, such as in radiotherapy and also in atomic-bomb survivors exposed to high radiation doses. However, there is no direct evidence of increased risk of non-cancer diseases at doses below about 100 millisieverts (mSv). This dose level is two orders of magnitude higher than the NNR dose limit for public exposure. Protection against the development of radiogenic cancer is considered to be adequate for protection against hereditary effects and any other radiation-associated diseases.

Human beings are exposed daily to natural background radiation from environmental soil, building materials, air, food, cosmic rays, and even from radioactive elements within the human body. There is no general property that makes the effects of man-made radiation different from those of naturally-occurring radiation.

In Government Notice No. R. 388, the Department of Minerals and Energy specifies an annual effective dose limit of 1 mSv for members of the public from all authorised actions. Dose limit means “the value of effective dose or equivalent dose to individuals from actions authorised by a nuclear installation license, nuclear vessel license or certificate of registration, that must not be exceeded”. In addition, the NNR stipulates a dose constraint of 0.25 mSv specific to an authorised action, to ensure that the sum of the doses received by the average member of the critical group from all controlled sources would be smaller than the dose limit. A dose constraint is “a prospective and source-related restriction on the individual dose arising from the predicted operation of the authorised action which serves exclusively as a bound on the optimisation of radiation protection and nuclear safety”.

The NNR requires that any exposure above the natural background radiation should be kept as low as reasonably achievable (the ALARA principle). Dose limits and dose constraints must always be interpreted as upper bound limits in conjunction with the ALARA principle, inferring that exposures from authorised activities in practice would be lower than the dose limits and dose constraints.

Reactor technologies have not been selected for the Nuclear-1 project at this time and the current assessment is based on the concept of a technology envelope (TE), which sets an upper limit on radiological discharges, requiring that radiological doses to the average member of the critical group at any of the sites under consideration would not exceed the NNR regulatory requirements. For a selected power generation capacity at a site, combinations of reactors may be considered, as long as radiological discharges would not exceed the TE. The health impact assessment presented in this report has been based on the premise that the

NNR will issue a license for a site only if full compliance with regulatory requirements is demonstrated. This would take into account not only the radiological dose assessment for normal operation of the nuclear power station, which will be submitted to the NNR in the form of a site safety report (SSR), but all the other studies that are required for the assessment of the overall safety case.

This environmental impact report outlines the methodologies for quantification of radiological exposure and places the NNR regulatory requirements in context with potential risks to human health. The approach considers site-specific scenarios for multiple pathways of exposure. The quantified radiological doses determined for the SSR will be assessed in terms of regulatory requirements of the NNR. The assessments for the candidate sites must not only demonstrate compliance with the NNR dose limits and dose constraints, but must also take into consideration the principles of ALARA. Should a calculated dose be within the acceptable NNR requirements, it can be concluded that the cancer risk would be within the *de minimis* lifetime risk range, which represents a level of health risk that is regarded as insignificant or trivial. Protection against the development of radiogenic cancer is considered to be adequate for protection against hereditary effects and other radiation-associated diseases.

The impact assessment has highlighted that there is extensive mitigation built into reactor design for safety and that there are multiple precautionary defenses against the consequences of failures in materials and equipment and human error.

For purposes of the EIA, it is acknowledged that the NNR will issue a license for the establishment of a nuclear power station at any particular site only if full compliance with the radiological dose limits and dose constraints is demonstrated, taking into account the principles of ALARA and all other matters relating to the overall safety case. Considering the methodologies for dose assessment that are presented in this report, it is recommended that the approach be accepted as adequately protective against adverse health effects to members of the community.

1.24 Transportation Assessment (Appendix E25)

Arcus GIBB (Pty) Ltd (Arcus GIBB) was appointed by Eskom Holdings Limited (Eskom) to undertake an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the proposed construction of a nuclear power station and associated infrastructure on one of three selected sites that are located in the Eastern and Western Cape Provinces, namely:

- Thyspunt – Eastern Cape ;
- Bantamsklip – Western Cape;
- Duynefontein (Existing Koeberg Site) – Western Cape.

Two further sites in the Northern Cape, namely Brazil and Schulpfontein, were excluded from further study in the Scoping Phase of the EIA process

This report details the Impact Assessment Phase of Nuclear-1's Transport Specialist Study.

The aim of this Assessment Phase Transport Specialist Study is to determine the transport impact on the existing transport network during all development phases, i.e. construction, operation and decommissioning, of the proposed nuclear power station.

The **Duynefontein** site requires no significant upgrades during the construction and operational phases of Nuclear-1 with regard to intersection upgrades and heavy load transport road upgrades. Duynefontein, however, requires a significant number of stand-by evacuation vehicles to ensure safe evacuation of construction workers if an accident does occur at the adjacent Koeberg Nuclear Power Station during the construction period. These vehicles can be used to shuttle the construction workers to and from the site during the AM and PM peak periods.

Bantamsklip has a significant impact on the transport network, with upgrades required to the public transport system, heavy load routes and road upgrades required for emergency evacuation purposes. Due to the Bantamsklip site's isolated location, transporting heavy loads by road will require significant upgrades and the alternative transport by sea should be considered. A suitable site on the beach near to Bantamsklip will have to be identified and a landing with loading / off-loading facilities will have to be constructed.

Thyspunt requires significant transport upgrades with regard to public transport and access during the construction phases. The R330 is proposed to be used for heavy load transport and may require pavement structure upgrades to cope with the increased heavy loads. The Oyster Bay Road is proposed to be upgraded to a surfaced road to be used during the construction and operational phase for surrounding staff access, construction traffic and as a required emergency evacuation route for areas such as Oyster Bay.

1.25 Emergency Response Assessment (Appendix E26)

This Environmental Impact Report (EIR) covers the impacts and mitigation measures associated with the construction and operation of a conventional Nuclear Power Station (NPS) and associated infrastructure at three sites in the Eastern (1) and Western (2) Cape. The sites were originally identified as a result of site investigations undertaken since the 1980s and from the EIA Scoping Study. This specialist study covers Emergency Response and was carried out by Mogwera Khoathane/SRK Consulting.

This assessment aims to demonstrate the emergency planning feasibility ***(nuclear related)*** within the study area. Emergency Planning Assessments provide decision makers with information that will guide their decision on final site choice.

Emergency preparedness in the context of an NPS can be defined as the measures that enable individuals and organisations to stage a rapid and effective emergency response in the context of nuclear emergencies. Protective actions include measures to limit the exposure of the public to radioactive contamination through external exposure, inhalation and ingestion. The objectives of these actions are to prevent deterministic effects (early mortality) and to reduce stochastic effects (principally cancer)..

For nuclear emergencies, two sets of requirements have to be fulfilled.

Functional (response) requirements; and
Infrastructure (preparedness) requirements

Functional response requirements refer to the "capability" to perform an activity. The "capability" includes having in place the necessary authority and responsibility, organisation, personnel, procedures, facilities, equipment and training to effectively perform the task or function when needed during an emergency.

The "capability" includes having in place the necessary authority and responsibility, organization, personnel, procedures, facilities, equipment and training to perform the task or function when needed during an emergency. In this context, infrastructure means transport and communications networks, industrial activities and, in general, anything that may influence the rapid and free movement of people and vehicles in the region of the site.

In demonstrating the feasibility of the emergency plan, many site related factors should be taken into account. The most important factors are:

Population density and distribution, distances from population centres, groups of population difficult to shelter or to evacuate in the event of an emergency;
Special geographical features, such as islands, mountains terrains, rivers, capabilities of local transport and communication network;
Agricultural activities that are sensitive to possible discharges of radionuclides, and
Disastrous external events or foreseeable natural phenomena.

Findings

The key findings and recommendations of this Emergency Response study can be summarised as follows:

Infrastructure Considerations

The Duynefontein Site includes the existing Koeberg Nuclear Power Station, therefore the emergency response infrastructure and systems are in place. However, the outcomes of the Safety Analyses, done prior to commissioning as part of the Safety Analysis Report will determine if the current infrastructure would be adequate to cope with the demands of the additional and proposed Nuclear-1 Power Station.
The Bantamsklip and Thyspunt sites will require upgrading of infrastructure since they are in remote areas as indicated by the land use studies done by Eskom.

Population Distribution

The siting process for a NPS generally consists of a study and investigation of a large area to select one or more candidate sites (see IAEA Safety Guide 50-SG-S9 on Site Survey) followed by a detailed evaluation of those sites.

Major factors considered are:

- Effect of the region of the site on the plant
- Effect of the plant on the region
- Population

In the course of the "selection" phase, during which a regional analysis is performed, sites in zones having the highest population densities are eliminated from the search; it is in effect reasonable, all other things being equal, to prefer sparsely populated zones to highly urbanised zones. The Thyspunt and Bantamsklip sites are satisfactory in this respect.

The Thyspunt and Bantamsklip sites are acceptable for emergency planning considerations since the newly adopted EUR approach followed by Eskom for emergency planning suggests that an NPS can be built in South Africa without the need for *off-site* short-term emergency interventions like sheltering, evacuation or iodine prophylaxis (i.e. no urgent countermeasures). The EUR requirements prescribe that modern nuclear power plants should have no or only minimal need for emergency interventions (e.g. evacuation) beyond 800 m from the reactor, and provide a set of criteria which a reactor must meet in order to demonstrate that it can be built without such emergency planning requirements.

1.26 Site Control Assessment (Appendix E27)

This report investigates the impacts and required mitigation measures associated with the construction and operation of a Conventional Nuclear Power Station (NPS) and associated infrastructure at one site in the Eastern Cape and two sites in the Western Cape. The sites have been identified based on site investigations undertaken since the 1980s. This EIR covers Site Control and was carried out by SRK Consulting.

Eskom proposes to construct an NPS of the Pressurised Water Reactor type technology, with a capacity of ~ 4 000 MWe. The proposed NPS will include nuclear reactor, turbine complex, spent fuel, nuclear fuel storage facilities, waste handling facilities, intake and outfall structures and various auxiliary services infrastructure. The plant will have a commercial lifespan of ~60 years.

All three proposed sites, at Thyspunt (Eastern Cape), Bantamsklip and Duynefontein (Western Cape), are located on the coast. The first two are greenfield sites while the existing Koeberg Nuclear Power Station (KNPS) is located on the latter site.

The Terms of Reference (ToR) for the specialist Site Control study is to assess various aspects with respect to site control, including the following:

- Site security;
- Access control (entry and exit of, both during the construction and operational stages); and
- Owner-controlled areas.

The methodology followed for the Site Control EIR has entailed a desk study and site reconnaissance based on:

- Relevant Sections of Eskom's Technical Specifications for Nuclear Sites Investigations (Eskom 2006, 2009);
- Relevant legislation;
- Relevant chapters of the Koeberg Site Safety Report (Eskom 2006, 2009);
- Site control measures at the KNPS (Eskom 2006);
- Site investigations; and
- Pebble Bed Modular Reactor Demonstration Power Plant (on the Duynefontein site).
- Environmental Impact Assessment Specialist Study: Site Security (Malepa Holdings 2007).

Findings

Based on the above information and impact assessment, the following conclusions can be drawn:

Duynefontein

- The site is already developed as a NPS with full access and site control, which has been in place since commissioning in 1979 and prior to this during construction;
- It has full visitor facilities with a Visitor's Centre;
- Koeberg Nature Reserve has been developed on the site;
- Walking and mountain bike trails exist;
- Access will be via new access control points and upgraded existing roads leading off the R27;
- There will be minimal additional or cumulative impacts with development of Nuclear-1; and
- The impact rating is low for intensity, consequence and significance, at a mostly high level of confidence and there will be no impact on irreplaceable resources. There are no fatal flaws.

Thyspunt

- It is a greenfield site;
- Sensitive wetland ecosystems and heritage features present will be preserved by the implementation of site control measures;
- Access to the site is currently limited and controlled by fencing and electronic/locked gates;

- A new access control point will be developed on the western or eastern owner-controlled boundary and at the outer and inner security fence; and
- The impact rating is low for intensity, consequence and significance, at a mostly high level of confidence and there will be no impact on irreplaceable resources. There are no fatal flaws.

Bantamsklip

- It is a greenfield site;
- Access to the site is currently limited and controlled by fencing and gates. However, the R43 tarred road passes through the site;
- Access will be via an access control point/roads from the R43 and access control points at the outer and inner security fence; and
- The impact rating is low for intensity, consequence and significance, at a mostly high level of confidence and there will be no impact on irreplaceable resources. There are no fatal flaws.

No-go Option

- Eskom will sell the Thyspunt and Bantamsklip sites;
- The impact rating is low for intensity with neutral consequence and low significance for Duynefontein and medium for intensity, negative consequence and high significance for the Thyspunt and Bantamsklip sites.

Climate change and a desalination plant will not have any bearing on this Site Control impact assessment.

Mitigation Measures

The following mitigation measures are proposed:

- Clearly communicate access policy for the properties to the public, using notice boards on access gates and by directly communicating with the communities nearby;
- Consider providing permits to allow access for fishing activities and whale watching in any coastal exclusion zone;
- Maintain public access to the R43 where it traverses the Bantamsklip site;
- Implement mitigation measures recommended in the visual impact assessment report;
- Establish a nature reserve within the owner-controlled area and provide access for scientific research;
- Maintain or re-establish indigenous vegetation;
- Retain and maintain environmental features on sites such as wetlands;
- Preserve heritage features;
- Facilitate a review of site control issues raised in this EIR on National Key Points via the Minister of Police;
- Confirm the availability of any required support for site control from the relevant police, military, naval and coastal management agencies;
- Integrate the site specific control measures with existing local and regional security measures;
- Develop an Environmental Management Plan prior to construction. Define mitigation measures, monitoring parameters, target 'goals' and responsibilities in the EMP; and
- Appoint an Environmental Control Officer.

An Environmental Management Plan must be drawn-up prior to construction in consultation with Eskom. Responsibilities, mitigation measures and monitoring of the effectiveness thereof must be clearly defined.

1.27 Eskom Grid Planning / Transmission Integration (Appendix E28)

Eskom is considering building a new fleet of nuclear power stations to meet the national demand for electricity and diversify the source of base load generation away from predominantly coal fired generation. The first phase of this nuclear programme is referred to as Nuclear 1 which will consist of either three 1100MW units or two 1600MW units, giving a total of between 3200MW to 3300MW. Eskom had already identified five potential sites on the Cape coast and the Environmental Impact Assessment (EIA) study has been undertaken to determine the potential impact of a 3300MW nuclear power station at the five sites.

To give an overall view of the power transfers that will occur as nuclear generation is integrated into the Cape transmission network can be simplified into a number of main transmission power corridors. This is illustrated in Figure 1 which shows the main Cape power corridors (labelled A, B, C1, C2 and C3) and the proposed nuclear sites (labelled B, D, T, S and Z). The corridors C1, C2 and C3 indicate the existing transmission corridors while A and B indicate new transmission corridors that would need to be established.

The transmission integration requirements at the five sites are as follows:

Thyspunt
This is a stand alone site and provides a base load generation injection into the Southern Grid (Eastern Cape) which will consist primarily of the Coega, Port Elizabeth and East London loads. The integration will link into the existing Cape power corridors C3 and C1.

The initial Nuclear 1 phase at Thyspunt will require the following transmission integration to meet the planning criteria:

- 2x Thyspunt-Dedisa 400kV lines
- 1x Thyspunt-Grassridge 400kV line
- New 400/132kV Port Elizabeth Substation (PE S/S)
- 2x Thyspunt - New PE S/S 400kV lines
- 1x New PE S/S - Dedisa 400kV line
- 1x New PE S/S- Grassridge 400kV line

Bantamsklip and Duynefontein
These two sites will inject into the Greater Cape Peninsula area of the Western Grid (western Cape) which will consist of the loads from Saldahna, Cape Town and right down to Mossel Bay. From a Transmission MW Demand balance view they can be considered to be in the same area. The integration of these two sites will link into the existing Cape power corridors C2 and C1.

The Bantamsklip site is relatively remote from any major load centre and a strong 765kV interconnection network with the Eskom network will have to be constructed. Almost all the power will be transported to the 765kV network via the new Kappa 765/400kV substation near Wolseley for further distribution.

The initial Nuclear 1 phase at Bantamsklip will require the following:

- 3x 765kV Bantamsklip-Kappa 765kV lines
- 2x Bantamsklip – Bacchus 400kV lines (instead of one line to Proteus as in original report)

The proposed Duynefontein site is just north of the existing Koeberg power station. The new Omega 765/400kV MTS substation will be established close to Koeberg as part of the Cape Strengthening projects. Some of the Nuclear 1 power will be directly integrated into the Cape Peninsula 400kV network to supply the growing load and the excess power will be transported to the main Eskom network via Omega for further distribution or export to the north.

The initial Nuclear 1 phase at Duynefontein will require the following:

- 3x Duynefontein - Omega 400kV lines
- 2x Duynefontein - Stikland 400kV lines
- Loop in of Acacia-Muldersvlie 400kV line into Omega and Duynefontein

The EIA process indicated that the originally proposed Duynefontein-Philippi 400kV line was not possible and the integration plan was subsequently changed to the second line to Stikland and the loop in of the existing Acacia-Muldersvlei line instead.

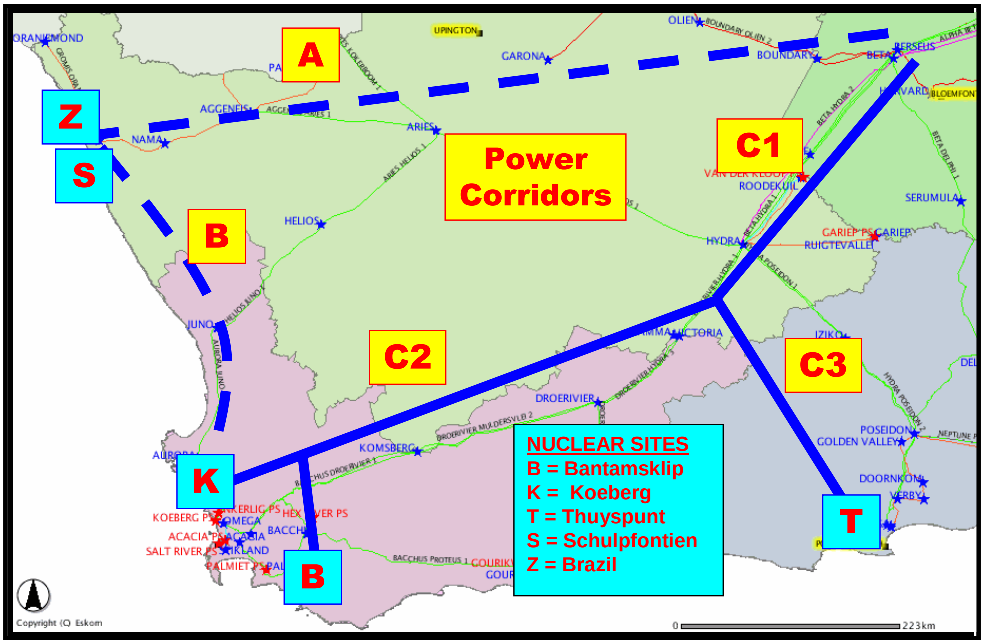

FIGURE 1: Map of the Proposed Nuclear Site Locations and Major Cape Power Corridors

1.28 Risk of Debris Flow, Liquefaction and Flooding of the R330 at the Thyspunt Site (Appendix E29)

This specialist study investigates alleged debris flows and debris flow deposits in the Sand River, quicksands and liquefaction of sand, the November 2007 flood that damaged the R330 at St Francis Bay Village and potential for flood damage where the R330 crosses the Sand River. These issues were raised at a key stakeholder workshop held at St. Francis Bay on 25 May 2010 as part of the EIA for a nuclear power station ('Nuclear-1') that Eskom proposes to build.

The possible threats that such events could have on the possible nuclear power station and its associated infrastructure at the Thyspunt site are assessed. The findings are presented in this Addendum Report to the Dune Geomorphology Report.

Available literature on the subject was perused, including diverse reports prepared for Eskom. Various local residents and environmental specialists were consulted. Detailed contour maps and aerial photographs from 1942 to 2007 were analyzed to investigate the behaviour of the Sand River and floodwater flow paths.

Debris flows and debris flow deposits

There are no debris flows or debris flow deposits in the Sand River. There are no other environmental conditions in the Cape St. Francis area that are conducive to the formation of debris flows. Thus debris flows cannot pose a threat to a possible nuclear power station and its associated infrastructure at the Thyspunt site.

Quicksands and liquefaction of sand

Quicksands often occur in the Oyster Bay dunefield. They are usually formed when loosely consolidated sand is inundated. Vehicles would not be engulfed in quicksands in the Oyster Bay dunefield unless they drive on the bed of the Sand River or around interdune ponds. Vehicles travelling on the R330 are not in any danger of being engulfed in quicksands.

The proposed “eastern access route” that would cross vegetated dunes and wetlands would be built to correct engineering specifications to accommodate any poor foundation conditions so that vehicles can safely use the road. The possible nuclear power station would be founded on solid rock and so quicksands or liquefaction of sand could not have any effect on it.

The November 2007 flood

The November 2007 flood that damaged the R330 is estimated to be a 1:200 year event. The main erosional damage resulted from erosion of sediments by floodwaters flowing down the steep V-drain along the R330. Damage was also caused by the deposition of sediment in the area from the R330 along Lyme Road into the adjacent part of the St. Francis Bay Golf Course. The deposit is an alluvial fan, not a debris flow deposit.

Ninham Shand has proposed improvements to stormwater drainage that would considerably reduce the chances of such damage occurring again. Some of these improvements have been undertaken.

Potential for flood damage where the R330 crosses the Sand River

The R330 crosses the Sand River via a box culvert constructed when the road was rebuilt to its current standard in 1989/1990. The most extensive damage to the R330 since then was in the flood of November 1996, when the wing walls on either side of the culvert were damaged and there was some erosion of the tarred surface by water flowing over the road. The road was still wide enough to accommodate two directions of traffic flow. Other floods caused less or no damage.

Thus the R330 has been damaged by some of the numerous floods of the Sand River but damage was minor in that vehicular access was never interrupted. It is recommended that the culvert be strengthened if necessary, be well-maintained, be checked regularly to see that it is not blocked by sand; and any debris that is caught across it during floods be removed.

1.29 Impacts of Nuclear Waste (Appendix E30)

The Environmental Impact Assessment (EIA) process for the proposed Nuclear-1 Nuclear PowerStation can be separated into a Scoping Phase and an Impact Assessment Phase. During the Scoping Phase, several issues were identified for consideration in the Impact Assessment Phase.

The purpose of the this study is to address those issues identified during the Scoping Phase related to the management of the radioactive waste that will be generated during the operation and decommissioning of the Nucllear-1 Nuclear Power Station. The Terms of Reference for the study requires a description of the following:

- The sources, quantities, and level of radioactivity of all radiological waste (liquid, gaseous, and solid) estimated to be generated by the proposed Nuclear-1 Nuclear Power Station.
- The manner in which all the radiological waste is likely to be managed for the Nucllear-1 Nuclear Power Station based on the cradle to grave principle.
- How radiological waste may be processed and the potential for processing of radiological waste generated by the Nucllear-1 Nuclear Power Station.
- An estimate of the amount of low and intermediate level radioactive waste likely to be generated by the Nucllear-1 Nuclear Power Station and the source (clothing etc.) of this waste.
- The manner in which low and intermediate level radiological waste is currently transported to Vaalputs from the Koeberg Nuclear Power Station site.
- The manner in which low and intermediate level radiological waste (LILW) from the Nuclear-1 Nuclear Power Station is intended to be transported to Vaalputs.
- The available capacity for LILW disposal at Vaalputs.
- The manner in which LILW is disposed of at Vaalputs.
- International trends and policies with respect to the disposal of high-level radioactive waste (HLW);
- The South African policy and strategy on HLW and how this policy compares with international policies.
- The manner in which HLW is managed at the existing Koeberg Nuclear Power Station site. and
- The proposed manner in which HLW from the Nuclear-1 Nuclear Power Station will be managed on-site.

The main conclusions drawn from the study are:

- The Nuclear-1 Nuclear Power Station generates liquid, gaseous and solid radioactive waste as by-products of operational conditions and decommissioning activities. The solid radioactive waste is divided further into compactable waste, non-compactable waste, abnormal waste and spent fuel. Waste other than radiological waste that will be generated can be divided into conventional and hazardous waste.
- Radioactive waste management practices envisaged for the Nuclear-1 Nuclear Power Station are consistent with the IAEA guidelines for a Radioactive Waste Management Programme for nuclear power stations, from generation to disposal.
- The Nuclear-1 Nuclear Power Station strives to minimise production of all solid, liquid and gaseous radioactive waste, both in terms of volume and activity content, as required for new reactor designs. This is being done through appropriate processing, conditioning, handling and storage systems. In addition, production of radioactive waste is minimised by applying good practices for radiological zoning, provision of active drainage and ventilation, appropriate finishes and the use of current best practices for the handling of solid radioactive waste. Where possible, the Nuclear-1 Nuclear Power Station reuses or recycles materials.
- Processing of gaseous and liquid waste is aimed at reducing activity levels in the reactor building and in effluent generated as part of operational conditions. It also ensures that radiation doses to members of the public due to discharges to the environment (i.e., controlled discharges) do not exceed a fraction of the dose limit for the public (dose constraint). For this purpose, Authorised Discharge Quantities (AADQ) is defined for these waste steams. Compliance monitoring will be done at the source and in the environment. Processing of solid waste is aimed at reducing the volume of waste (e.g., compaction), containing dispersible activity (e.g. immobilisation), or reducing the activity of abnormal waste (e.g. decontamination). The proposed processing and conditioning of solid waste are conducive to safe storage and consistent with the Vaalputs waste acceptance criteria.
- Systems are designed store processed solid radioactive waste for a period of up to three years within the facility. The storage containers are consistent with the requirements for the disposal of solid waste at the radioactive waste disposal facility at Vaalputs. The waste unsuitable for disposal at Vaalputs will be stored on site until a suitable facility is available.

- The transfer and associated transport of the waste to Vaalputs will be done in conjunction with waste shipments from the Koeberg Nuclear Power Station. This will be done according to the appropriate provisions of the IAEA Regulations for the Safe Transport of Radioactive Material, subject to a graded approach. The objective of the Regulations is to protect persons, property, and the environment from the effects of radiation during the transport of radioactive material. In terms of the Regulations, the transport process is subject to radiation protection, emergency response, quality assurance, and compliance assurance programmes.
- The concept for the disposal of solid waste at Vaalputs consists of near-surface trenches using metal containers for low-level waste and concrete containers for intermediate level waste. The long-term safety of the facility, which complies with international best practices for the disposal of low and intermediate level waste, has been demonstrated for a national inventory of radioactive waste. The inventory derived for this purpose, included waste of the proposed Nuclear-1 Nuclear Power Station. Vaalputs therefore has more than enough capacity to dispose of the solid waste estimated to be generated by the Nuclear-1 Nuclear Power Station.
- The Fuel Handling and Storage System proposed for management and storage of Nuclear-1 Nuclear Power Station spent fuel will have sufficient capacity to safely store all the spent fuel produced throughout the life of the plant and to store the spent fuel for a further 10 years after decommissioning if needed. It is thus only after 70 years that the storage facility on site (or elsewhere) will have to be upgraded to store and manage spent fuel. This should provide sufficient time to define and develop a long-term management strategy for the Nuclear-1 Nuclear Power Station spent fuel, e.g. a central geological disposal facility or an alternative.
- While reprocessing of spent fuel is not excluded as an option for spent fuel management, there is no intention to reprocess the Nuclear-1 Nuclear Power Station spent fuel at present. The main reason being the very high cost associated with spent fuel reprocessing.
- International trends and policies with respect to spent fuel and high-level waste management is based on the provisions of the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management. Internationally, this waste is currently being stored (usually above ground), awaiting the development of geological repositories. While the arrangements for storage have proved to be satisfactory and have been operated without problems, it is generally agreed that these arrangements are interim and do not represent a final solution.
- The two basic challenges in perfecting a system of radioactive waste isolation is choosing an appropriate geological barrier (host medium) and designing an effective engineered barrier. Underground research laboratories made a very positive contribution to waste isolation research, while public acceptance of radioactive waste isolation projects remains one of the major challenges.
- The National Radioactive Waste Management Policy and Strategy is consistent with international practice for the management of HLW. However, additional, more detailed regulations are needed on specific issues relevant to long-term management and geological disposal of HLW. A summary of internationally accepted requirements for geological disposal have recently been established (IAEA, 2006d). These requirements should be supplemented from the experiences of several national programs that are within a decade of operating a geological repository for HLW and spent fuel, notably Finland, Sweden, and the USA.
- The potential environmental impacts identified and assessed include all potential types of radioactive wastes expected to be generated by the proposed Nuclear-1 Nuclear Power Station. The assessment results indicate that with the implementation of appropriate mitigation measures all potential impacts are low.