Please note:

The National Department of Environmental Affairs requested the EAP to review the impact assessment methodology used in the Revised Draft Environmental Impact Report (Version 1), so as to simplify the criteria for assessment of significance and identification of a preferred site. In response, an approach has been developed that identifies and describes key decision-making issues contained in the individual specialist studies. These decision-making issues apply to both the acceptability of the proposed Nuclear Power Station as well as to the preferred site.

Readers are advised that this Chapter is completely reworked from the previous version but based on the same information. For readers wishing to review the previous version of this impact assessment chapter please refer to the “Chapter 10 Annexure”.

CHAPTER 10- THE IMPACT ASSESSMENT

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10 THE IMPACT ASSESSMENT

10.1 Introduction

The final component of an EIA is the assessment itself. The assessment derives from the characterization of the receiving environment and how that receiving environment will be changed as a result of the proposed Nuclear Power Station (NPS) and the activities that will be required to build and operate the same. The assessment presented here is sourced from the various specialist studies that were commissioned as part of the EIA process. These studies serve to provide a specialist assessment of the different elements of the Nuclear Power Station and its potential impact on the environment. Each of the specialist studies contains the assessment process together with impacts within that specialist domain as well as an ascription of significance to the impacts so identified.

The purpose of this chapter is to provide an *integrated* assessment of the proposed Nuclear Power Station. That integrated assessment must be clear and digestible to the decision-makers who must decide on the acceptability of both the proposed power station and the preferred site. Thirty-five specialist studies have been conducted on the proposed Nuclear Power Station and the requirement in this chapter is to present the findings of those specialist findings in a manner that provides for informed decision-making. To that end an approach has been developed that seeks to identify and describe key decision-making issues together with the significance of those issues for decision-making. Readers are reminded that the original specialist studies are available for review, should the detail contained in those studies be sought.

In the course of this chapter, an overall assessment of the proposed NPS project and the two proposed sites is presented. The chapter is structured to highlight for decision-makers what are deemed to be the residual risks that will be invoked should the proposed NPS be approved. Stated differently the chapter is structured so as to present to decision-makers what they will be approving *de facto* in terms of potential environmental consequences, if indeed they approve the project. The chapter has also been structured to try and present the potential impacts in a sequence that is reflective of the systems nature of the environment.

10.2 Environmental Costs versus Benefits

In making a decision, decision-makers need to understand the environmental benefits that will accrue and weigh those benefits up against the environmental costs that will be similarly associated with the proposed project. It is important to note that costs cannot always be traded off by benefits because certain costs may be untenable regardless of the associated benefits. What is required then is a means of articulating the costs and the benefits associated with the Nuclear Power Station to inform decision-makers as to the nature and scale of the benefits and the costs.

10.3 Defining the Implications of the Impacts for Decision-Making

In the specialist studies, impacts were defined as a potential change to the environment as a result of the construction or operation of the proposed Nuclear Power Station. From thirty-five specialist studies conducted for the EIA some 250 different potential impacts[1] were identified and significance ascribed to each of those impacts, as the EIA regulations require. The 250 impacts are listed in Table 1 below.

Table 1: Potential impacts at both sites (post mitigation or after optimisation) as identified in the specialist studies conducted for the EIA.

Impact category	Mitigated impact	Duynefontein	Thyspunt
Geotechnical suitability	Slope failure, leading to safety risks (Mitigated)	**Low**	**Low**
	Failure of rock slopes, leading to safety risks	**Low**	**Low**
	Excessive site disturbance, resulting in environmental damage	**Low**	**Low**
Seismic suitability	Impact of Vibratory Ground Motion on the power station structure	**Low**	**Low**
Geological risk	Surface Rupture: Capable faults that may cause surface deformation as result of tectonic faulting	**Low**	**Low**
	Subsurface Stability: Potential subsurface subsidence or uplift	**Low**	**Low**
	Volcanic Activity: Any recently active volcanoes within site vicinity	**Low - Medium**	**Low - Medium**
<u>Hydrological impacts of the proposed power station</u>	Increased run-off peaks due to hardened surface	**Low**	**Low - Medium**
	Increased run-off volume due to hardened surface	**Low - Medium**	**Low**
	Disruption during construction: Increased erosion potential	**Low**	**Low**
	Disruption during construction: Flooding of works	**Low**	**Low**
	Changes in flow paths	**Low - Medium**	**Low - Medium**
	Increased silt deposition due to barren soil	**Low**	**Low**
	Pollution of surface waters	**Low - Medium**	**Low - Medium**
	Sea level rise	**Low - Medium**	**Low - Medium**
Impacts of the hydrological environmental on a proposed power station	Rising Sea Level	**Low**	**Low**
	Highest astronomical tide	**Low**	**Low**
	Extreme high water level	**Low**	**Low**
	Frequent high rainfall events	**Low**	**Low**
Geohydrology (Construction)	Flooding of the excavated areas by groundwater during construction	**Low**	**Low**

[1] For details of each impact identified by each specialist study, readers are directed to "Chapter 10 Annexure" which is located before Appendix A of the Revised Draft Environmental Impact Report (Version 2).

Impact category	Mitigated impact	Duynefontein	Thyspunt
	Decreased yields of existing production boreholes during construction	Low	Low
	Drying up of coastal springs during construction	Considered in detail in the Wetlands Assessment	
	Degradation of wetlands during construction	Considered in detail in the Wetlands Assessment	
	Intrusion of saline water	Low	Low
	Hydrocarbon contamination of groundwater	Low	Low
	Hazardous waste contamination of groundwater	Low	Low
	Organic and bacteriological contamination of groundwater	Low	Low
Geohydrology (Operation)	Radioactive and toxic contamination of groundwater	Low	Low
	Hydrocarbon contamination of groundwater	Low	Low
	Organic and bacteriological contamination of groundwater	Low	Low
	Decreased yields of existing production boreholes	Low	Low
	Drying up of coastal springs and/or seeps	Considered in detail in the Wetlands Assessment	
	Degradation of wetlands	Considered in detail in the Wetlands Assessment	
	Intrusion of saline water	Low	Low
Freshwater Supply	Sea water intrusion during construction	Low	Low
	Installation of beach wells during construction	Low	Low
	Disposal of brine during construction	Low	Low
	Sea water intrusion during operation	Low	Low
	Disposal of brine during operation	Low	Low
Impacts on flora: Nuclear Power Station and Spoil	Loss of important vegetation communities	Medium	Medium
	Loss of endemic vegetation communities (locate outside of communities)	Medium	Medium
	Loss of locally occurring Red Data species (translocate or grow affected species)	Low	Low
	Loss of coastal habitat due to climate change and rise in sea level (coastal corridor and nuclear power station set back from the coast)	Low	Low
	Cumulative impact of loss of species, habitat and ecosystem functioning (locate footprint outside transverse dune)	Medium	Low
Impacts on flora at Thyspunt: Eastern Access	Loss of dune fynbos & thicket (no mitigation for habitat loss, but avoid good quality and rare sites)	n.a.	n.a

Impact category	Mitigated impact	Duynefontein	Thyspunt
Road	Loss of wetlands to east of the Langefontein (realign to avoid wetlands; bridge over wetland just east of the Langefontein) (realign away from sensitive wetlands)	**n.a.**	**n.a**
	Loss of locally occurring Red Data species (realign road to avoid RD species, and/or translocate or grow in nursery)	**n.a.**	**n.a**
	Loss of species, habitat and ecosystem functioning (locate road away from mobile dunes and wetlands)	**n.a.**	**n.a**
Impacts on flora at Thyspunt: Western Access Road	Loss of dune fynbos & thicket (no mitigation for habitat loss, but avoid good quality and rare sites)	**n.a.**	**Low - Medium**
	Loss of wetlands near Oyster Bay	**n.a.**	**Assessed in Wetlands Assessment**
	Loss of function of part of western transverse dune system & possibly some wetland function (realign away from sensitive dunes & wetlands)	**n.a.**	**Medium**
	Loss of locally occurring Red Data species (realign road to avoid RD species, and/or translocate or grow on in nursery)	**n.a.**	**Low**
	Loss of species, habitat and ecosystem functioning (difficult to mitigate totally, but where possible locate road away from mobile dunes and wetlands)	**n.a.**	**Medium**
Dune geomorphology impacts at Duynefontein	Dune dynamics of mobile dunes upwind of infrastructure (stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation)	**Negligible**	**n.a.**
	Mobile dunes downwind of infrastructure (none possible)	**Low-Medium**	**n.a.**
	Stability of the artificially vegetated dunes due to construction of infrastructure and access roads (stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation)	**Negligible**	**n.a.**
	Stability of the naturally vegetated late Holocene parabolic dunes - constructing infrastructure, transmission lines and access roads due to constructing infrastructure and access roads (stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation)	**Negligible**	**n.a.**
	impact on the artificially vegetated dunes due to topsoil stockpile placement on artificially vegetated dunes(stabilise with drift fences,	**Negligible**	**n.a.**

Impact category	Mitigated impact	Duynefontein	Thyspunt
	brushwood and with pioneer indigenous dune vegetation)		
	Impact on Holocene parabolic dunes due to topsoil stockpile placement on naturally vegetated Late Holocene dunes (stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation)	**Negligible**	**n.a.**
	Impact on Holocene parabolic dunes due to spoils stockpile on the naturally vegetated Late Holocene dunes (stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation)	**Negligible**	**n.a.**
Dune geomorphology impacts at Thyspunt	Formation of blowouts along Eastern and Western Access Roads across vegetated dune field (stabilise, rehabilitate)	**n.a.**	**Low – Medium**
	Usage of Eastern and Western Access Roads during operational phase (no mitigation)	**n.a.**	**Low - Medium**
	Constructing transmission lines with 300-400 spans across mobile dunes of Oyster Bay Mobilke Dune Field (Careful positioning of towers with ECO)	**n.a.**	**Medium**
	Constructing infrastructure and access roads (Use helicopters for construction)	**n.a.**	**Low - Medium**
	Transmission lines with 300-400 m span across mobile dunes and interdune wetlands of the Oyster Bay mobile dune field during operation (Use light vehicles for maintenance)	**n.a.**	**Negligible**
	Constructing transmission lines with 300-400 m spans and access road across vegetated dune field (locate towers on broad ridges and wide interridge valleys)	**n.a.**	**Medium**
	Constructing transmission lines with 300-400 m spans and access road across vegetated dune field (Use helicopters for construction)	**n.a.**	**Low – Medium**
	Transmission lines with 300-400 m span across vegetated dune fields Infrastructure and access roads - operation (Use light vehicles for maintenance)	**n.a.**	**Low - Medium**
	Destruction of dune vegetation & topography due to topsoil and spoils stockpile on naturally vegetated dune field (Re-create original topography)	**n.a.**	**Medium**
Impacts on dune geomorphology at all sites	Creation of new active mobile dune fields due to sea-level rise due to climate change (no mitigation)	**Medium**	**Medium**

Impact category	Mitigated impact	Duynefontein	Thyspunt
	Blowout increase due to rainfall decrease and temperature increase due to climate change (stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation)	**Low - Medium**	**Low - Medium**
Wetland impacts	Loss or degradation of wetlands resulting from dewatering during construction	**Low**	**n.a.**
	Loss or degradation of wetlands resulting from seawater contamination during construction, following dewatering	**Low - Medium**	**n.a.**
	Degradation of wetlands as a result of construction of internal access roads during construction	**Low**	**n.a.**
	Degradation and fragmentation of wetlands as a result of construction of internal roads	**Low**	**n.a.**
	Cumulative impacts	**Low - Medium**	**n.a.**
	Loss or degradation of wetlands as a result of other construction-related impacts on the site south of the R43 (mitigated)	**n.a.**	**n.a.**
	Degradation of wetlands as a result of physical disturbance to wetlands north of the R43 during construction (mitigated)	**n.a.**	**n.a.**
	Degradation of wetlands associated with the Groot Hagelkraal system through alien encroachment (mitigated)	**n.a.**	**n.a.**
	Increased fragmentation of wetlands up- and downstream of the Groot Hagelkraal system as a result of increased road use along the R43	**n.a.**	**n.a.**
	Impacts to wetland systems associated with indirect impacts of the proposed nuclear power station development	**n.a.**	**n.a.**
	Loss or degradation of the Langefonteinvlei and/or dune slack wetlands as a result of dewatering during construction (Mitigated)	**n.a.**	**Low - Medium**
	Loss or degradation of coastal seep wetlands as a result of interference with surface or groundwater flows, including dewatering activities during construction (Mitigated)	**n.a.**	**Medium**
	Degradation of coastal seep wetlands as a result of receipt of concentrated volumes of potentially sediment-rich water from dewatered areas during construction (Mitigated)	**n.a.**	**Low - Medium**
	Degradation of the Langefonteinvlei (western sector) and other non-coastal hillslope seep wetlands as a result of the proximal location of	**n.a.**	**Low**

Impact category	Mitigated impact	Duynefontein	Thyspunt
	stockpiles of topsoil during construction (Mitigated)		
	Degradation of coastal seep wetlands as a result of catchment hardening and runoff from laydown areas during construction	n.a.	**Low - Medium**
	Degradation / drainage / infilling of hillslope seeps and valley bottom wetlands north of the high dune fields during construction	n.a.	**Low**
	Operational Phase	n.a.	n.a.
	Loss or degradation of coastal seep wetlands as a result of interference with surface or groundwater flows during operation	n.a.	**Medium**
	Degradation of remnant coastal seepage wetlands as a result of receipt of stormwater runoff during operation	n.a.	**Low**
	Degradation of hillslope seeps and valley bottom wetlands north of the high dune fields during operation	n.a.	**Low**
	Degradation of dune slack wetlands as a result of increased vehicle passage across the dunes during operation	n.a.	**Low**
	Conservation of remaining dune slack, coastal seep and valley bottom wetlands on the site during operation	n.a.	**Medium**
	Treatment of sewage on site: water quality impacts to wetlands	n.a.	**Low – Medium**
	Wetland disturbance, fragmentation and disruption of through-flows as a result of access roads and transmission towers in or across wetlands: both options during operation (use of dual circuit transmission system)	n.a.	**Low - Medium**
	Alternatives 1 to 3: degradation of wetlands along pipeline routes or as a result of abstraction	n.a.	**Low**
	Wetland disturbance, fragmentation and disruption of through-flows as a result of access roads and transmission towers in or across wetlands: both options		**Low - Medium**
	All access routes: Construction phase wetland degradation as a result of disturbance, water quality changes, compaction	n.a.	**Low**
	All access routes: Operational phase: wetland fragmentation; disruption of faunal and hydrological corridors; degradation of wetlands as a result of water quality impacts and erosion; infilling and constriction of	n.a.	**Low – Medium**

Impact category	Mitigated impact	Duynefontein	Thyspunt
	wetlands at bridge crossings		
	Eastern Access Route: disturbance of the eastern valley bottom wetland at crossing point; localised impacts to flow	**n.a.**	**Low – Medium**
	Western Access Route: infilling of coastal and hillslope seep wetlands and disruption of through-flows	**n.a.**	**Low**
	Cumulative impacts associated with development, without incorporation of offset mitigation, but with all other mitigation in place	**n.a.**	**Medium**
Impacts on terrestrial fauna	Destruction of natural habitats and populations, resulting from site clearance, buildings, laydown areas and infrastructure	**Medium**	**Medium**
	Reduction in populations of Threatened species, resulting from habitat destruction and direct mortality	**Medium**	**Medium**
	Fragmentation of natural habitats and patterns of animal movement, resulting from buildings, infrastructure and fences	**Medium**	**Medium**
	Road mortality (road kills), resulting from traffic on roads through natural habitats	**Low - Medium**	**Low - Medium**
	Mortality associated with overhead-transmission lines and substations, resulting from collisions and electrocutions	**Low**	**Low**
	Disturbance of sensitive breeding populations, resulting from construction activities and direct human disturbance	**Low**	**Low**
	Dust pollution beyond the building site, resulting from drifting, airborne dust from construction site and roads	**Low - Medium**	**Low**
	Pollution of soil and water beyond the building site, resulting from spills of chemicals, fuel and sewage	**Low**	**Low**
	Light pollution beyond the building site, resulting from excessive outdoor lighting, and poor choice of lights and fittings	**Medium**	**Medium**
	Alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands, resulting from underground foundation structures and construction methods	**Low - Medium**	**Medium**
	Poaching of local wildlife during construction phase, resulting from hunting and trapping by workers and	**Low**	**Low**

Impact category	Mitigated impact	Duynefontein	Thyspunt
	employees, for sport and for the pot		
	Problem-animal scenarios, resulting mainly from human interaction with animals	**Low**	**Low**
	Accumulation of radioisotopes in the environment and in the bodies of wild animals, during operational phase, resulting from routine gaseous emissions from the reactors	**Low**	**Low**
	Cumulative impacts, resulting from addition of impacts to existing impacts, and the operation of impacts over time	**Medium**	**Medium**
	Improved conservation of undeveloped land, resulting from improved legal status and/or management	**Medium**	**High**
Impacts on invertebrate fauna	Direct habitat destruction	**Medium**	**Medium**
	Indirect habitat alteration by groundwater disturbance	**Low**	**Low**
	Habitat fragmentation	**Medium**	**Medium**
	Reduction in populations of rare/protected species	**Low**	**Low**
	Soil and water pollution	**Low - Medium**	**Low-Medium**
	Dust pollution	**Low - Medium**	**Low-Medium**
	Light pollution - construction phase (partially mitigated)	**Medium**	**Medium**
	Light pollution - operational phase (fully mitigated)	**Low - Medium**	**Low-Medium**
	Increased radiation levels	**Low - Medium**	**Low-Medium**
	Road mortality	**Medium**	**Medium**
	Increased risk of fire	**Medium**	**Medium**
	Spread of alien invasive invertebrate species	**Medium**	**Medium**
	Land invasion by employment seekers	**Low**	**Low**
	Cumulative impacts	**Medium**	**Medium**
	Climate change	**Medium**	**Medium**
	Positive contribution to conservation	**Medium**	**Medium**
	Impacts of access roads	**Medium**	**Medium**
	Impacts of terrestrial disposal of spoil	**Medium**	**Medium**
	Impacts of the no-go alternative	**Medium**	**Medium**
	Impacts of transmission lines between the power station and HV Yard	**n.a.**	**Low - Medium**

Impact category	Mitigated impact	Duynefontein	Thyspunt
Air quality impacts	Construction - Gaseous emissions	**Low**	**Low**
	Construction - PM_{10} emissions	**Low**	**Low**
	Construction - Fallout	**Low**	**Low**
	Operational - Non-radionuclide emissions	**Medium**	**Medium**
	Operational - Radionuclide emissions	**Medium**	**Medium**
	Cumulative impacts	**Medium**	**Medium**
Oceanographic impacts	Short term disruption of sediment transport during construction	**Low**	**Low**
	Short term disruption of sediment transport (Outfall Option 2)	**n.a.**	**n.a.**
	Beach erosion due to brine discharge during construction	**Low**	**Low**
	Disposal of spoil	**n.a.**	**Low**
	Long term disruption of sediment transport during operation	**Low - Medium**	**Low-Medium**
	Long term disruption of sediment transport by (Outfall Option 2) during operation	**n.a.**	**n.a.**
	Extreme sea levels affecting operation of nuclear power station during operation	**Low - Medium**	**Low-Medium**
Impacts on surf breaks	Effect of sediment dumping on surf conditions at Seal Point (Mitigated - deep disposal site)	**n.a.**	**Low**
	Effect of sediment dumping on Bruce's Beauties (Mitigated - Shallow Disposal Site)	**n.a.**	**Low**
Marine impacts	Disruption during construction: Due to construction of the cooling water intake and outflow systems	**Medium**	**Low-Medium**
	Disruption during construction due to discarding of spoil (mitigated by discarding of spoil at a deep offshore site)	**Medium**	**Medium**
	Abstraction of cooling water & entrainment of organisms	**Low-Medium**	**Low-Medium**
	Impact on marine organisms due to release of warmed cooling water	**Medium**	**Medium**
	Release of desalination effluent during the construction phase	**Low-Medium**	**Low-Medium**
	Release of radiation emissions	**Low**	**Low**
	Unintentional discharge of polluted groundwater	**Low**	**Low**
Heritage	Impact on Miocene palaeontology	**Medium**	**Low**
	Destruction of Pleistocene archaeology and palaeontology	**Low- Medium**	**Low**
	Destruction of Holocene archaeology	**Low**	**Low**
	Destruction of Colonial Heritage	**Low**	**Low**

Impact category	Mitigated impact	Duynefontein	Thyspunt
	Destruction of Landscape	High	High
	Cumulative impacts	Medium	Medium
	Positive contribution to conservation	Medium	Low-Medium
Noise	Noise impacts of oil cooler fans during operation	Low	Low
	Noise impacts of road construction	Low	Low
	Noise impacts of site works and construction	Low	Low
	Impact of transportation noise	Low	n.a.
	Impact of transportation noise 10 m from the R330	n.a.	Medium
	Impact of transportation noise 70 m from the R330	n.a.	Low
Tourism	Impact on hospitality systems	Low	Medium
	Impacts on general infrastructure used by tourists	Low	Low
	Impact on visual amenity enjoyed by tourists	Low	Medium
	Impact on sense of place from tourism point of view	Low	Medium
	Impact on marine assets used by tourists	Low	Low
	Impact on social amenity	Low	Medium
	Impact on terrestrial assets used by tourists	Low	Low
Agricultural impacts	Dust pollution	Low	Low
	Availability/ Cost of labour	Low	Medium
	Change in market condition (Optimised)	Low	Medium
Economic impacts	Construction phase macroeconomic impacts – Local (positive)	High	High
	Construction phase macroeconomic impacts – Regional (positive)	Medium	Medium
	Construction phase macroeconomic impacts –National (positive)	Medium	Medium
	Operational phase macroeconomic impacts – Local (positive)	Medium	Medium
	Operational phase macroeconomic impacts – Regional (positive)	Low	Low
	Operational phase macroeconomic impacts – national (positive)	Low	Low
	Loss of income arising from loss of part of fishing grounds	n.a.	Medium
	Loss of income arising from loss of access to part of whale watching area	n.a.	n.a.
Site control	Restricted access to site during construction	Low - Medium	Low - Medium
	Restricted access to site during operation	Low - Medium	Low

Impact category	Mitigated impact	Duynefontein	Thyspunt
Visual impacts	Visual intrusion of drill rigs and ancillary equipment during pre-construction	**Low**	**Low**
	Visual degradation of vegetation clearance, access roads and site camps during pre-construction	**Low**	**Low**
	Degradation of Sense of Place during pre-construction	**Low**	**Low**
	Visible dust during construction	**Low**	**Low**
	Degradation of visual quality resulting from change to vegetation and landform during construction	**Medium**	**Medium**
	Visual clutter resulting from structures, site offices, laydown areas and site accommodation during construction	**Low**	**Low**
	Visual alteration of night scene by lighting during construction	**Medium**	**Medium**
	Visual change to Sense of Place during construction	**Medium**	**Medium**
	Visual change to Sense of Place of local coastal and inland area due to large scale and extent of structures during operation	**Medium**	**Medium**
	Change in visual quality of local area caused by new landforms and roads during operation	**Medium**	**Medium**
	Change in visual quality of local night scene by lighting during operation	**Medium**	**Medium**
	Visible dust during decommissioning	**Low**	**Low**
	Visual clutter resulting from structures, site offices and on site accommodation during decommissioning	**Low**	**Low**
	Visual change to local landscape due to earthworks during decommissioning	**Medium**	**Medium**
	Visual nuisance of heavy traffic on local roads during decommissioning	**Low**	**Low**
Social impacts	Impact on accommodation during the construction phase (construction)	**Medium**	**Medium**
	Influx of job seekers (construction)	**Medium**	**Medium**
	Increase in informal illegal dwellings (construction)	**Low**	**Low**
	Creation of employment opportunities (construction)	**High**	**High**
	Increase in business opportunities (construction)	**Medium**	**Medium**
	Increase in criminal activities (construction)	**Low**	**Medium**
	Increase in sexually transmitted diseases (construction)	**Medium**	**Medium**
	Impact on water & sanitation (construction)	**Low**	**Low**
	Impact on roads & transport	**Low**	**Low**

Impact category	Mitigated impact	Duynefontein	Thyspunt
	(construction)		
	Impact on waste and refuse (construction)	Low	Low
	Traffic impact (construction)	Low	Low
	Noise impact (construction)	Medium	Medium
	Loss of employment (construction)	Medium	Medium
	Visual impact (construction)	Medium	Medium
	Impact on medical infrastructure (construction)	Low	Low
	Impact on law enforcement (construction)	Low	Medium
	Impact on schools (construction)	Low	Low
	Impact on sport infrastructure (construction)	Low	Low
	Impact on sense of place (construction)	Medium	Medium
	Impact on future land use (construction)	Medium	Medium
	Creation of employment opportunities (operation)	Medium	Medium
	Creation of business opportunities (operation)	Medium	Medium
	Increase in criminal activities (operation)	Low	Low
	Impact on water & sanitation (operation)	Low	Low
	Impact on roads & transport (operation)	Low	Low
	Impact on waste and refuse (operation)	Low	Low
	Visual impact (operation)	Medium	Medium
	Impact on medical infrastructure (operation)	Low	Low
	Impact on schools (operation)	Low	Low
	Impacts on sport infrastructure (operation)	Low	Low
	Impact on sense of place (operation)	Medium	Medium
	Impact on future land use planning (operation)	Medium	Medium
	Perceived risk of nuclear incidents (operation)	Medium	Medium
	Impact of the no-development option (operation)	Medium	Medium
Nuclear and non-nuclear waste	Contamination of water resources due to the release of radioactivity contained in liquid waste (Commissioning, Operational and Decommissioning Phase)	Low	Low

Impact category	Mitigated impact	Duynefontein	Thyspunt
	Contamination of the atmosphere due to the release of radioactivity contained in gaseous waste (Commissioning, Operational and Decommissioning Phase).	**Low**	**Low**
	Contamination of water resources due to the release of radioactivity contained in LILW or HLW stored at the Power Station (Commissioning, Operational and Decommissioning Phases)	**Low**	**Low**
	Contamination of water resources by radioactivity due to disposal of LILW at Vaalputs (Operational Phases)	**Low**	**Low**
	Contamination of water resources by radioactivity due to accidental spillage of radioactive waste during transport (Operational Phase)	**Low**	**Low**

Various comments received from both interested and affected parties and the authorities in particular have indicated that it is difficult to make sense of the multitude of impacts presented in Table 1. They have requested that the presentation of impacts be simplified without losing the essence of the specialist findings. In order to provide that simplification it is necessary to recognise that many of the impacts presented, are in fact a series of changes that result in one overarching consequence. For example in the invertebrate fauna assessment mortality of threatened species as a result of habitat loss, collision with motor vehicles, collision with overhead power lines, and off site pollution are all presented as separate impacts but the consequence of all the impacts is to potentially result in reduced populations of threatened species, which is itself listed as an impact. It is this consequence that is central to the decision making process.

As such the approach has been to interrogate the specialist studies and identify and describe the collective implications of all the impacts presented. In the process a distinction is then made between the collective implication of the various impacts (e.g. reduced threatened species populations) and the causes of the implication (e.g. loss of habitat, road mortality, power line mortality and off site pollution). These implications have then been presented as either potential environmental costs (where the implications are negative) or as potential environmental benefits (where the implications are positive).

10.4 Potential Environmental Costs

The following potential environmental costs have been identified from the specialist studies that were conducted for the EIA on the proposed Nuclear Power Station namely potential deterioration /reductions in:

- Public health and safety due to the Nuclear Power Station itself;
- Public health and safety due to activities associated with the Nuclear Power Station;
- Livelihoods;
- Marine water quality;
- Surface (fresh) water quality;
- Groundwater quality;
- Availability of water/groundwater;
- Populations of rare/sensitive species;
- Populations of species;
- Heritage resources;
- Wetland numbers; and,
- Wetland functioning (including fragmentation).

10.5 Potential Environmental Benefits

The following potential benefits have been identified from the specialist studies that were conducted for the EIA on the proposed Nuclear Power Station namely potential improvements / increases in:

- Electricity supply;
- Conservation of heritage resources;
- Jobs;
- Infrastructure upgrades;
- Conservation of biodiversity; and
- Livelihoods.

10.6 Ascribing Significance for Decision-Making

The best way of expressing these cost benefit implications for decision-making is to present them as risks. Risk is defined as the consequence (implication) of an event multiplied by the probability (likelihood)[2] of that event. Many risks are accepted or tolerated on a daily basis because even if the consequence of the event is serious, the likelihood that the event will occur is low. A practical example is the consequence of a parachute not opening, is potentially death but the likelihood of such an event happening is so low that parachutists are prepared to take that risk and hurl themselves out of an airplane. The risk is low because the likelihood of the consequence is low even if the consequence is potentially severe.

It is also necessary to distinguish between the event itself (as the cause) and the consequence. Again using the parachute example, the consequence of concern in the event that the parachute does not open is serious injury or death, but it does not necessarily follow that if a parachute does not open that the parachutist will die. Various contingencies are provided to minimise the likelihood of the consequence (serious injury or death) in the event of the parachute not opening, such as a reserve parachute. In risk terms this means distinguishing between the inherent risk (the risk that a parachutist will die if the parachute does not open) and the residual risk (the risk that the parachutist will die if the parachute does not open but with the contingency of a reserve parachute) i.e. the risk before and after mitigation.

10.6.1 Consequence

The ascription of significance for decision-making becomes then relatively simple. It requires the consequences to be ranked and likelihood to be defined of that consequence. In Table 2 below a scoring system for consequence ranking is shown. Two important features should be noted in the table, namely that the scoring doubles as the risk increases and that there is no equivalent ‘high’ score in respect of benefits as there is for the costs. This high negative score serves to give expression to the potential for a fatal flaw where a fatal flaw would be defined as an impact that cannot be mitigated effectively and where the associated risk is accordingly untenable. Stated differently, the high score on the costs, which is not matched on the benefits side, highlights that such a fatal flaw cannot be ‘traded off’ by a benefit and would render the proposed project to be unacceptable.

[2] Because ‘probability’ has a specific mathematical/empirical connotation the term ‘likelihood’ is preferred in a qualitative application and is accordingly the term used in this document.

Table 2: Ranking of consequence.

Environmental Cost	Inherent risk
Human health – morbidity / mortality, loss of species	High
Material reductions in faunal populations, loss of livelihoods, individual economic loss	Moderate – high
Material reductions in environmental quality – air, soil, water. Loss of habitat, loss of heritage, amenity	Moderate
Nuisance	Moderate – low
Negative change – with no other consequences	Low
Environmental Benefits	**Inherent benefit**
Net improvement in human welfare	Moderate – high
Improved environmental quality – air, soil, water. Improved individual livelihoods	Moderate
Economic Development	Moderate – Low
Positive change – with no other consequences	Low

10.6.2 Likelihood

Although the principle is one of probability, the term 'likelihood' is used to give expression to a qualitative rather than quantitative assessment, because the term 'probability' tends to denote a mathematical/empirical expression. A set of likelihood descriptors that can be used to characterise the likelihood of the costs and benefits occurring, is presented in Table 3,

Table 3: Likelihood categories and definitions

Likelihood Descriptors	Definitions
Highly unlikely	The possibility of the consequence occurring is negligible
Unlikely but possible	The possibility of the consequence occurring is low but cannot be discounted entirely
Likely	The consequence may not occur but a balance of probability suggests it will
Highly likely	The consequence may still not occur but it is most likely that it will
Definite	The consequence will definitely occur

10.6.3 Residual risk

The residual risk is then determined by the consequence and the likelihood of that consequence. The residual risk categories are shown in Table 4 where consequence scoring is shown in the rows and likelihood in the columns. The implications for decision-making of the different residual risk categories are shown in Table 5.

Table 4: Residual risk categories

		Residual risk				
Consequence	High	Moderate	High	High	Fatally flawed	
	Moderate – high	Low	Moderate	High	High	High
	Moderate	Low	Moderate	Moderate	Moderate	Moderate
	Moderate – low	Low	Low	Low	Low	Moderate
	Low	Low	Low	Low	Low	Low
		Highly unlikely	Unlikely but possible	Likely	Highly likely	Definite
		Likelihood				

Table 5: Implications for decision-making of the different residual risk categories shown in Table 4.

Rating	Nature of implication for Decision – Making
Low	Project can be authorised with low risk of environmental degradation
Moderate	Project can be authorised but with conditions and routine inspections
High	Project can be authorised but with strict conditions and high levels of compliance and enforcement
Fatally Flawed	The project cannot be authorised

10.7 Public Health and Safety Risk

10.7.1 Acute radioactive exposure

A key concern with any large-scale industrial facility is the risks that such a facility poses to public safety. In the case of a nuclear power station these concerns are even more serious due to the presence of radioactive material (enriched uranium) and the associated threat of large-scale release of radioactivity. The consequences of such release could be acute radioactive exposure (viz. exposure that would result in immediate human death or serious injury). Specialist assessments were conducted on a number of potential causes of acute radioactive exposure including loss of control of the nuclear process (fission) together with a range of possible causes of building damage or severing of access/escape routes during an emergency. At the same time there are also public safety risks potentially presented by the proposed NPS that are not a function of radiation releases, namely vehicle accidents and incidents related to criminal activities. The assessment is summarised in Table 6.

10.7.2 Loss of control of fission

For many stakeholders the major concern in respect of nuclear electricity generation is a loss of control of fission and an associated ‘meltdown’ of the reactor. The design of a modern nuclear power station is based accordingly on ‘defence-in-depth’ principles. Defence-in-depth (DiD)[3] refers to the presence of many forms of control each of which serve to provide an additional ‘layer’ of control so that if a control function fails, there is another control in place. The defence in depth principles, which are also described as system redundancy, serve to provide:

- sufficient independent reactivity control functions (viz. control of the fission process);
- sufficient independent heat removal functions (viz. control of the cooling process); and
- sufficient independent barriers for confinement of fission and activation products (viz. confinement of the radioactivity).

The design, operation, and maintenance of a Nuclear Power Station must ensure the highest level of integrity of the physical barriers to contain radioactivity. These physical barriers are the uranium fuel material matrix, the cladding of the fuel element tube containing the fuel material, the reactor vessel, and the Nuclear Power Station containment building (essentially a thick wall of concrete). The containment building also houses irradiated and spent fuel storage. The consequences of uncontrolled release of radiation would be nothing short of catastrophic with severe human mortality and morbidity consequences but it is ***highly unlikely*** that such a release would occur given the defence in depth principles in the design of a nuclear power station.

To further elaborate this point the NNR also stipulates that a mortality risk not exceeding 10^{-7} (1 in 10 million) fatalities per person per annum is established for all nuclear installations in South Africa combined. Conservatively assuming that there may be as many as ten nuclear facilities in South Africa during the operational lifetime of the proposed NPS, a factor of 0.1 must be applied to the mortality risk. What this means is that individual facilities such as the proposed NPS will not be allowed to exceed a risk limit of 10^{-8} (1 in 100 million) fatalities per person per annum for each site. Put plainly the proposed NPS will have to be designed to ensure that no more than 1 person per every 100 million people dies in the event of a process failure at the power station. In addition the NNR further stipulates an upper risk limit for an individual of 5×10^{-6} (1 in 5 million) fatalities per annum applicable cumulatively to all nuclear installations in the country. Again to express this plainly, if it were possible to distribute 5

[3] Refer to Text box 1 for more information on defence in depth.

million people so that they were all on the fence line of a nuclear facility in South Africa, in a hypothetical average year there should be no more than 1 fatality due to a nuclear event.

TEXT BOX 1:

WHAT IS DEFENCE IN DEPTH?

The principle of defence-in-depth (DiD) is fundamental to nuclear safety in order to comply with the fundamental safety functions. The objectives of DiD are:

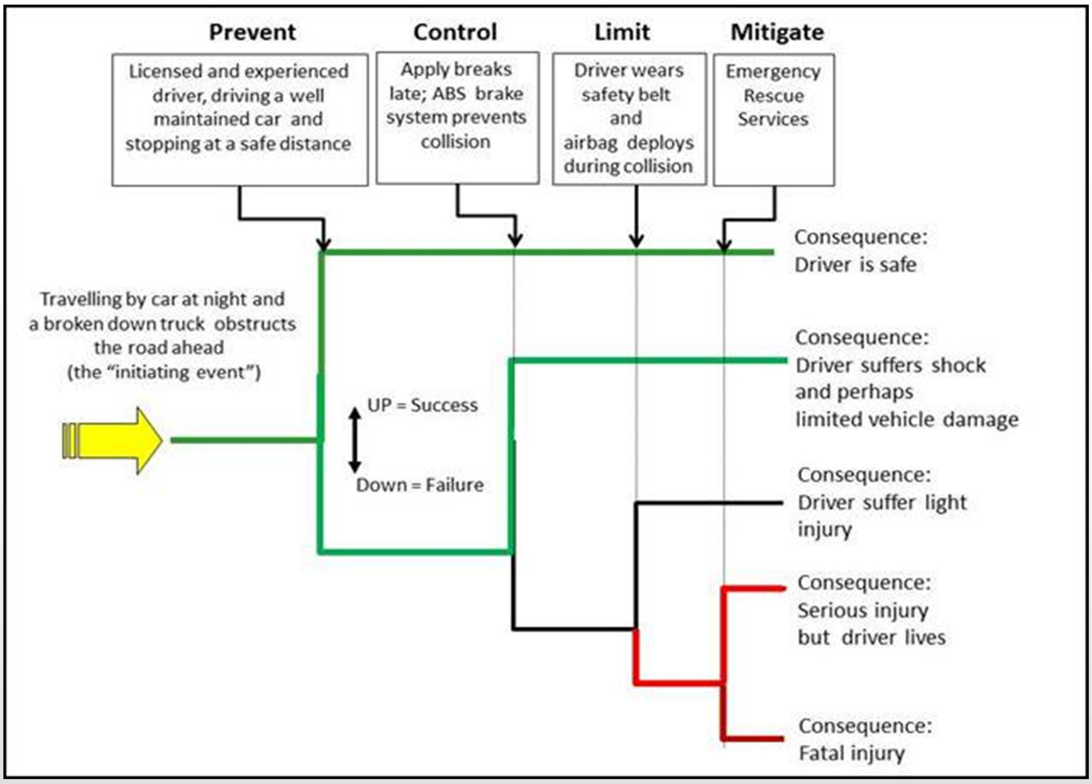
- to compensate for potential human and component failures;
- to maintain the effectiveness of the barriers by averting damage to the NPS and to the barriers themselves; and
- to protect workers, members of the public, and the environment from harm in accident conditions in the event that these barriers are not fully effective.

The application of the principle of DiD consists in a hierarchical deployment of different levels of structures, systems, components (SSCs), and procedures in order to maintain the effectiveness of physical barriers placed between radioactive materials and workers, the public, or the environment. DiD is a design and safety case principle applicable to has to be in place during normal operation, anticipated operational occurrences and, for some barriers such as building containment structures, during severe accidents. Application of the DiD principle results in the following NPS safety features :

- sufficient independent reactivity control functions;
- sufficient independent heat removal functions; and
- sufficient independent barriers for confinement of fission and activation products.

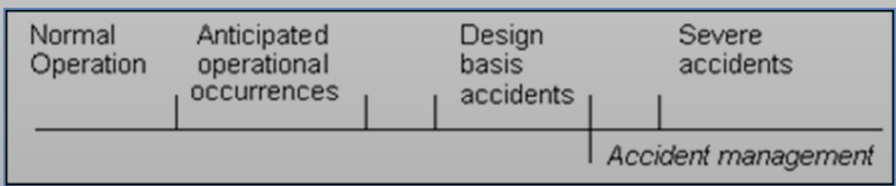
The safety philosophy underlying DiD is aimed primarily at the prevention of accidents but also gives attention to the mitigation of the consequences of accidents that could give rise to major radioactive material releases.

The DiD concept is illustrated by means of an event tree that shows the possible outcomes of hazardous conditions or of an “initiating event”. The scenario is that of a driver travelling in his car at night on a wet road. An initiating event is represented by a truck that broke down some distance ahead and is parked in an unsafe position, creating a hazardous situation for the driver. At each node (branch) of the event tree, there is a certain probability for entering a safe condition by going “up” in the event tree or entering an unsafe condition by going “down”; i.e. a safety system fails or a driver action is not carried out. Different layers of protection exist to prevent and control conditions so that an accident can be avoided, or if an accident does take place, limiting and mitigating systems exist to ensure that the driver survives the accident. The success or failure of the elements making up the layers of protection determines failure of the elements making up the layers of protection determine the outcomes of the possible sequences of events. The elements that constitute the layers of protection are some of the DiD provisions. These must be of high quality and reliability so that the probability of driver fatality is low.



In the design and operation of a GEN III NPS, these elements providing the layers of protections are of such a high standard that the most serious sequence of events (the bottom sequence in the figure above when all systems fail and the driver is fatally injured) is practically eliminated, i.e. a large release of radioactivity to the environment. Expressed in nuclear terminology, the aim is to reduce both the probabilities of the potential events beyond normal operation and to consider these events in the design basis, as well as successfully managing extremely low probability events, events that can be considered the design basis of a NPS.

The spectrum of operational states and accident conditions that are considered in NPS designs are illustrated in the figure below and an explanation of each term is provided.



Operational states: States defined for normal operation or anticipated operational occurrences.

Normal operation: Operation of a NPS within specified operational limits and conditions including starting up, power operation, shutting down, shutdown state, maintenance, testing, and refuelling.

Anticipated operational occurrences: All operational processes deviating from normal operation that are expected to occur once or several times during the operating life of the NPS and that, in view of appropriate design provisions, do not cause any significant damage to items important to safety nor lead to accident conditions.

Accident conditions: Deviations from operational states more severe than anticipated operational occurrences including design basis accidents and severe accidents.

Design basis accidents: Accident conditions against which the NPS is designed according to established criteria, and for which the damage to the fuel and the release of radioactive material are kept within prescribed limits.

Severe accidents: NPS states that are beyond-design-basis accidents and may result in significant reactor core degradation.

Accident management: Accident management is the way of taking a set of actions, during the evolution of an event sequence, before the design basis of the NPS is exceeded, or during severe accidents without reactor core degradation, or after core degradation has occurred to return the NPS to a controlled safe state and to mitigate any consequences of the accident.

DiD is applied at each operational state in the manner described in the Table below:

DiD and operational/accident states

Defence-in-Depth Level	Objective	Essential means of obtaining objective
Level 1: Normal operation	Prevention of NPS abnormal operation	Conservative, high quality and, as far as possible, proven design for NPS systems, structures, and components, as well as high quality in construction and operation.
Level 2: Anticipated operational occurrences	Control of NPS abnormal operation and detection of failures	Process control and limiting systems and other surveillance features and procedures to enable return the NPS to normal operation.
Level 3: **Design basis accidents**	Control of accidents within the NPS design basis	Provision of engineered and passive safety features and systems
Level 4: **Beyond-design-basis accidents**	Control of severe NPS conditions, including prevention of accident progression and mitigation of the consequences of severe accidents	Complementary measures, accident management, and on-site mitigation
Level 5: **Off-site emergency response**	Mitigation of radiological consequences of significant releases of radioactive materials from a NPS	Emergency response plans to protect the public and workers

10.7.3 Failure in the Structural Integrity of the Buildings

Potential causes of structural failure that could result in a loss of radioactivity confinement have been identified as geotechnical stability, flooding (hydrology), sea level change, tsunamis and debris flows.

10.7.3.1 Geo-Technical Stability

A key element in siting a nuclear power station is geotechnical stability. Much of the defence in depth principles are dependent on the power station structure remaining intact and so it is important to understand the:

- Integrity of the material on which the structures will be built; and,
- Earthquake occurrence (seismicity).

Despite both proposed sites requiring the construction of the NPS on thick sand, various well-tried and tested construction techniques can be used to ensure that there is negligible risk of structural failure. Risks of surface rupture, subsurface instability and volcanic activity have all been assessed to be negligible, as short-term changes in geology are considered ***highly unlikely***. As such the integrity of the underlying material is not considered a key differentiating factor between the two sites, nor a key decision-making issue and is not further considered in this chapter.

In respect of seismicity, Peak Ground Acceleration (PGA) is used to characterize the risk of structural damage. As opposed to measuring the intensity of earthquakes (which is what is done with the Richter scale), PGA is a measure of the degree to which the ground shakes during an earthquake and as such the risk of structural damage to buildings. PGA is measured in g, which is the acceleration due to gravity (similar also to g-force). For this assessment a threshold of 0.3 g has been used to define a safe seismic risk value for a standard NPS without the need for significant additional earthquake protection. The PGA value for Thyspunt has been determined at 0.16 g and for Duynefontein 0.3 g rendering the Thyspunt site preferable in terms of seismic risk but not disqualifying Duynefontein. On this basis a material seismic event (viz. a seismic event that could result in damage to the buildings) at both proposed sites for the NPS is ***highly unlikely***.

10.7.3.2 Flooding Risk (Hydrology)

Flood risk is principally a function of extreme rainfall events and so it is necessary to ascertain the likelihood of such events and to ensure that the NPS is designed for such events. The likelihood of extreme rainfall events is typically presented as a ‘return period’, which refers to the maximum amount of rainfall (both volume and intensity) that could occur in a defined period. For example, a bridge may be designed for a 1 in a 100-year flood, which means the maximum amount of rainfall that could fall in a 100-year period. Typically return periods of 1 in 10000 years are used in designing an NPS for the operational period of the power station, whereas shorter return periods can be used for the construction phase. The return periods become moot, however, as it is impossible to calculate the 1:10000 rain event and so attention turn to ensuring that the NPS is sited to avoid major water courses (drainage lines) that could otherwise potentially flood the power station. The absence of such watercourses at both Duynefontein and Thyspunt render the risk of structural or operational failure at the sites as a result of flooding to be ***highly unlikely***. Corrosion through groundwater exposure or indeed the proximity to the marine environment is ***likely*** and as such can be designed for to ensure that corrosion prevents no risk of radioactivity release.

10.7.3.3 Sea Level Change and Tsunamis

The risk of sea level change is accounted for by designing for extreme sea levels and tsunamis. Such design requirements mean that the base levels of the two proposed sites should be at least 10.54 and 14,9 meters above mean sea level (mamsl) for Duynefontein and Thyspunt respectively. Provided the base levels are at or above these levels the risk of flooding as a result of high seas is considered to be ***highly unlikely*** even though a tsunami could occur at either site.

10.7.3.4 *Debris flows*

Stakeholders identified a risk of debris flows on the access roads to the proposed NPS in the Thyspunt area specifically raising the concern that a debris flow could sever access to the proposed power station during an emergency. An independent assessment concluded that it was ***highly unlikely*** that debris flows would occur; leave alone that they would result in the hindering of accessing routes. The table below therefore summarises public health and safety risk viz the residual risk of acute radiological exposure as a function of the various potential causes of that risk.

Table 6: The residual risk of acute radiological exposure as a function of the various potential causes of that risk

Potential Environmental Cost	**Acute radioactive exposure**	
Inherent risk	**High**	
Causes of risk	**Likelihood of causes**	
	Thyspunt	**Duynefontein**
Loss of control of fission	Highly unlikely	Highly unlikely
Surface rupture	Highly unlikely	Highly unlikely
Subsurface instability	Highly unlikely	Highly unlikely
Volcanic activity	Highly unlikely	Highly unlikely
Unstable soil/geological unit	Highly unlikely	Highly unlikely
Flooding	Highly unlikely	Highly unlikely
Flood damage to access routes	Highly unlikely	Highly unlikely
Soil liquefaction damage to access routes	Highly unlikely	Highly unlikely
Mobile dunes damaging access routes and infrastructure	Unlikely but possible	Highly unlikely
Meteo-Tsunami	Unlikely but possible	Unlikely but possible
Corrosion due to groundwater	Likely	Likely
Material seismicity	Highly unlikely	Highly unlikely
Likelihood of consequence	**Highly unlikely**	**Highly unlikely**
Residual risk	**Moderate**	**Moderate**

10.8 Non-radiological Risks of Death or Serious Injury

On a project of the scale of the proposed NPS project, the sheer size of the project brings about the risk of death or serious injury from vehicle accidents and incidents related to criminal activities. The assessment is summarised in Table 7.

10.8.1 Vehicle Accidents

Vehicle accident risk arises from the increase in traffic volumes that will occur during the construction phase in particular. At Duynefontein, no new off-site roads would be needed but abnormal loads would have to be transported during off-peak periods particularly at night (21h00-05h00) to limit the impact on the R27 road users. The increased traffic volumes will affect mainly Koeberg Nuclear Power Station (KNPS) employees. Considering the safety measures and signage in place at the KNPS this is not regarded as a significant additional risk.

Several off-site access roads will need to be constructed at Thyspunt including the Oyster Bay Road to the western access of Thyspunt and the R330 to the eastern access for transportation during the construction phase. These new roads will reduce the traffic congestion, noise and road safety risks during construction. If construction vehicles (normal heavy loads) and staff vehicles only use the upgraded Oyster Bay Road (DR1763) the impact of construction traffic on the existing network will be minimised. Abnormal construction vehicles would utilise the R330 during the night to minimise traffic disruption as a result of very slow speeds. Abnormal vehicles would need to use the eastern access (and the R330) because the alignment of the Western Access Road would not accommodate the wide turning circles of abnormal vehicles. The proposed new access routes to Thyspunt would largely mitigate the congestion that would otherwise have occurred due to the large project traffic volumes.

There is a potential for vehicle accidents to occur during evacuation periods due to abnormal operating conditions (loss of control of fission). The evacuation preparedness plans will address traffic constraints during these periods.

10.8.2 Incidents Related to Criminal Activities

A large influx of people into the areas proposed for the NPS, either as employees or work seekers 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. These criminal activities may adversely affect public safety in terms of violent crime. Measures will need to discourage in-migration of work seekers but also to ensure that policing and security is stepped up to match the increased risk of criminal activities.

Table 7: The residual risk of non-radiological death or serious injury as a function of the various potential causes of that risk

Potential Environmental Cost	Non-radiological risks of death or serious Injury	
Inherent risk	**High**	
Causes of risk	**Likelihood of causes**	
	Thyspunt	**Duynefontein**
Vehicle accidents	Likely	Likely
Incidents related to criminal activities	Likely	Likely
Likelihood of consequence	**Likely**	**Likely**
Residual risk	High	High

10.9 Public Health Risks Related to the Nuclear Power Station

As with public safety, any large-scale industrial facility such as a NPS also poses a risk to public health. Distinction is made between safety risk (events leading to potential injury or death in the short term and addressed in sections 10.7 and 10.8) and health risk, which implies the risk of adverse health effects (increased morbidity) over a much longer term. Such health risks could derive from chronic exposure to:

- Dust during construction of the proposed NPS; and,
- Radioactive emissions during operations of the proposed NPS.

In addition a large-scale work force which has a large expatriate element increases the risk of the spread of STDs including HIV / AIDS amongst both the workforce itself and local communities.

10.9.1 Airborne Dust

Atmospheric emissions during construction would be limited to non-radioactive emissions but such emissions still pose a potential health risk. Air emissions during construction include dust (airborne particulates including inhalable particulate matter – PM_{10}) and gaseous emissions from equipment and motor vehicles. Dust would pose a potentially higher impact simply due to the mass of the emissions. The key source of dust is likely to be wheel entrainment (movement of vehicles) on the construction site and unpaved roads, calculated to contribute about 83 % of the total expected dust load at Duynefontein and 89 % at Thyspunt. Excavation would also be a significant source contributing an estimated 13 % at Duynefontein and 7 % at Thyspunt of the total expected dust load.

The highest predicted dust concentration as a result of construction activities at Duynefontein is predicted (using a dispersion model) to occur along the unpaved access road. The daily average standard of 75 $\mu g/m^3$ limit (the standard that applies from 2015 onwards) is predicted to be exceeded up to 1.4 km from the road assuming no mitigation to control dust. Given that there will only be project staff exposure in that zone and that mitigation in the form of watering or chemical palliatives could reduce those concentrations further still, the risk of chronic human health effects from exposure to construction dust is considered to be ***highly unlikely***. Fallout of larger dust particles normally occurs near the generating source. The fallout rate permissible for residential and light commercial land use is 600 mg/m^2 per day and the predicted distance range of where this value will be exceeded is about 126 m from source. The predicted distance of where the SLIGHT fallout rate of 250 mg/m^2 per day will be exceeded is a further 100 m. Again these are areas where only project staff would be exposed and this together with the ability to reduce dust fallout through mitigation indicates that chronic health human effects are ***highly unlikely***.

The highest predicted dust concentration as a result of construction activities at Thyspunt is also predicted to occur along the unpaved access road but with a larger spatial dispersion than Duynefontein with the 75 $\mu g/m^3$ limit predicted to be exceeded for up to 2.1 km from the source. The fallout rate is also predicted to be more than at Duynefontein with the 600 mg/m^2 per day predicted to be exceeded for up to 600 meters from the source, and the 250 mg/m^2 per day threshold about 1.1 km from the source. Given that the dust concentrations to which the public could be exposed are predicted to be well within the defined ambient air quality standards, the likelihood of adverse health effects occurring as a result of air borne dust is considered highly unlikely at both proposed sites.

10.9.2 Radioactive emissions during operations

As previously described trace quantities of radiological materials will be emitted to atmosphere during operations of the proposed NPS. The amount to be released must have prior authorisation by NNR and only a certain amount (known as Authorised Annual

Discharge Quantities (AADQs)) is allowed to be discharged. The main source of these emissions is gaseous emissions from the coolant circuit. These gases are collected by the gaseous radioactive waste system and held for decay storage in an activated carbon bed delay system (in other words they are contained until they have decayed to the point of acceptable radioactivity levels). The emissions pass through a radiation monitor and are then discharged to the ventilation exhaust duct. The gaseous radioactive waste system is only used intermittently and remains inactive most of the time during operation. On the basis of these emissions the resultant effective doses that could be experienced by people were modelled with maximum inhalation and external effective doses being determined as 4.07 and 11.31 µSv / annum for Duynefontein and Thyspunt respectively.

An annual effective dose limit of 1 milli-Sievert (1 mSv/y) is specified by the National Nuclear Regulator (NNR) for any member of the public in South Africa from all potential sources of radioactivity combined. In order to ensure that the dose from combined sources is never exceeded, individual facilities such as the proposed NPS are limited to no more than 0.25 mSv/y, also expressed in micro-Sievert as 250 µSv/y. The highest predicted inhalation and external effective dose of 11.3 µSv (at Thyspunt) is therefore about 4.5 % of the dose constraint and about 1 % of the annual effective dose limit and even less at Duynefontein. In order to obtain a nuclear licence the NNR will need to be shown how the design of the proposed NPS will ensure that public radiation doses from the power station will not exceed 250 µSv/y for both:

- normal and continuous operational discharges for the lifetime of the NPS; and
- short-term contingency discharges that result from minor controlled operational deviations.

What this means is that for the proposed NPS to be licenced by the NNR, it would have to be proven that direct radiation from the proposed Nuclear Power Station would not be distinguishable from natural background radiation from the underlying geology that occurs at both proposed sites. The annual dose reported by the operating Koeberg Nuclear Power Station and based on allowable discharges of artificial nuclides, is a small fraction of the natural background dose, at < 0.010 mSv/y. The defence in depth principles of a Nuclear Power Station design, limit the amount of radiation the public will be exposed to during normal operating conditions and therefore the likelihood of public health being adversely affected by radiation releases from the Nuclear Power Station at either of the two sites is highly unlikely.

Radioactive liquid releases are discussed in the subsequent sections below. A cause of storing high level waste on site is potential chronic radioactive exposure. However the likelihood of this occurring is highly unlikely due to the storage techniques and storage vessels that will be used on site (refer to Chapter 3 of this EIR, for further details).

Table 8: The residual risk of increased morbidity as a function of chronic exposure risk

Potential Environmental Cost	Illness	
Inherent risk	**High**	
Causes of risk	**Likelihood of causes**	
	Thyspunt	**Duynefontein**
Chronic dust exposure	Highly unlikely	Highly unlikely
Chronic radioactive exposure	Highly unlikely	Highly unlikely
Likelihood of consequence	**Highly unlikely**	**Highly unlikely**
Residual risk	**Moderate**	**Moderate**

10.9.3 HIV / AIDS / STD's

Due to the influx of construction workers and transport workers into the area, it is likely that there will be an increase in the prevalence of sexually-transmitted diseases (STDs), including HIV and AIDS. It is well documented that an increase in the risk of STDs is associated with an influx of workers, particularly migrant workers, and/or any increase in truck traffic into or through an area. As such the risk of increased prevalence of HIV/AIDS is considered **likely** for both proposed sites. The use of local labour (in line with Eskom's procurement and supply management policy), campaigns to discourage the influx of work seekers, and a project level HIV/AIDS campaign will reduce the likelihood of this consequence.

Table 9: The residual risk of increased morbidity as a function of communicable disease risk

Potential Environmental Cost	Increased morbidity	
Inherent risk	**High**	
Causes of risk	**Likelihood of causes**	
	Thyspunt	**Duynefontein**
Increase in HIV/AIDS/STDs	Likely	Likely
Likelihood of consequence	**Likely**	**Likely**
Residual risk	**High**	**High**

10.9.4 The benefit of infrastructure upgrades

The proposed Nuclear Power Station will require supporting off-site infrastructure the establishment of which will result in amenity upgrades viz. water and sanitation networks, electricity infrastructure upgrades, roads, housing, medical and educational facilities, and more within the adjacent towns. The Thyspunt site will require significantly more infrastructure than at Duynefontein, which is already situated within an established urban environment where much of this infrastructure is already available. The development of such infrastructure will result in a net positive improvement in the prevailing levels of health, especially in the Thyspunt area but it is not possible to quantify this effect fully as much of the infrastructure will be needed to cater for the additional people that come into the area as a result of the project. Qualitatively, it can be argued, however, that such facilities would serve more than just project related personnel and as such people currently living in the area would also benefit from this new infrastructure.

10.10 Compromise in Quality of Fresh Water Resources

It should be noted that the fresh water resources of concern on both sites are the wetlands as described in Chapter 9, as there are no rivers / streams (freshwater resources) on the development sites themselves. The various activities that will be required for the proposed development of a NPS do, however, pose the risk of contamination of stormwater runoff from the sites with various potential consequences as detailed in other sections of this chapter (wetlands and marine environmental quality). The focus in this section is on the risk of poor quality stormwater runoff.

The most significant causes of a potential compromise in quality of stormwater runoff are:

- Radioactive contamination; and
- Hydrocarbon and hazardous chemical contamination.

10.10.1 Radioactive Contamination

As per the Radiological Assessment, contamination of groundwater and freshwater resources are negligible when compared to that of sea water. As per Section 10.9.2 people living near the proposed sites receive a background radiation dose that is estimated to be less than 2 mSv/year and therefore lower than the average global dose. The annual dose reported by the operating Koeberg Nuclear Power Station and based on allowable discharges of artificial nuclides, is a small fraction of the natural background dose, i.e. < 0.010 mSv/y. Therefore the defence in depth principles of a Nuclear Power Station design limit the amount of radiation the freshwater resources will be exposed to during normal operating conditions and therefore the likelihood of the quality of freshwater resources being affect by radiation releases from the Nuclear Power Station is **highly unlikely**.

10.10.2 Hydrocarbon and hazardous chemical contamination

Construction activities present an ongoing risk of spillages of especially hydrocarbons (petrol, diesel, lubricating and hydraulic oils) and other hazardous chemicals using during construction such as corrosion inhibiters. Such spillages present a risk of contamination of rainwater. High rainfall events could then result in runoff of potentially contaminated stormwater, which could flow into wetlands, the marine environment or potentially contaminate groundwater. The controls to prevent such occurrence lie in maintaining a strict regime that aims to prevent such spills including controlling refuelling, vehicle maintenance protocols, hydrocarbon handling, transport, storage and use and similar controls for other hazardous chemicals. It is also necessary to have countermeasures in place in the event that, despite the controls to prevent spillage there is a spill. Such countermeasures would serve to ensure that spills are quickly identified and removed should they occur. At the same time the construction site will be required to manage stormwater so that is does not present an erosion risk and that it is channelled away from areas where it could otherwise become contaminated such as vehicle wash bays and refuelling areas. Between the spill prevention initiatives and the countermeasures the risk of material hydrocarbon contaminated stormwater is considered to be ***unlikely but possible***.

Table 10: The residual risk of contaminated stormwater due to the various risk sources associated with the proposed NPS

Potential Environmental Cost	Contaminated stormwater	
Inherent risk	Moderate	
Causes of risk	**Likelihood of causes**	
	Thyspunt	**Duynefontein**
Radioactive contamination	Highly unlikely	Highly unlikely
Hydrocarbon contamination	Unlikely but possible	Unlikely but possible
Likelihood of consequence	**Unlikely but possible**	**Unlikely but possible**
Residual risk*	**Moderate**	**Moderate**

*Please note that the residual risk does not include radioactive contamination of stormwater as this is deemed highly unlikely.

10.11 Compromise in Quality of Groundwater Resources

The groundwater resources at the sites, share the following characteristics:

- There is unlikely to be any downstream groundwater use as the groundwater at the site will be near / at the end of its flow path;
- The receiving environment / downstream receptor of any contamination will be the shore zone / sea and not any human receptors;
- 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; and
- There will be an interface between 'fresh' groundwater from inland and saline groundwater in the shore-zone.

The most significant causes of a potential compromise in quality of groundwater resources are:

- Saline water / seawater intrusion;
- Radioactive contamination; and
- Hydrocarbon contamination.

10.11.1 Saline Water / Seawater Intrusion

In coastal areas there is an interface between fresh and saline water at the end of the flow path of groundwater. If the hydraulic pressure of the fresh water is reduced materially (for example pumping groundwater) the saline water boundary could move further inland replacing areas that currently have fresh water with saline water. No groundwater will be used during operations of the proposed nuclear power station at either of the possible sites but construction activities will interface with groundwater in two important ways. The first of these is during the early stages of construction before the desalination plant is established where construction water will be sourced from groundwater and the second is where deep excavations will need to be dewatered (viz. groundwater entering the excavations needs to be pumped out to keep the excavations dry and safe).

The boundary of this interface may be altered pending the amount of upstream abstraction that will occur. During the construction phase a small amount of groundwater may be abstracted until the temporary desalination plant is established but during the operational phase of the proposed NPS, only seawater will be used. It is intended to use hydrological cut-off walls that will be used to 'compartmentalise' the aquifer affected by the abstraction. These cut-off walls limit the extent of the drawdown of the water table so that abstraction is highly localised. Given the use of the hydrological cut-off walls together with the fact that there are no other groundwater users that would make this a cumulative effect it is ***highly unlikely*** that that the abstraction of groundwater would result in seawater intrusion and associated reduction in groundwater quality.

10.11.2 Radioactive Contamination of Groundwater Systems

The liquid effluent from the proposed NPS, namely cooling water that is returned to the sea, will contain trace quantities of radioactivity that is well below background levels as it is held in storage until the radioactivity is at a prescribed level until it is released. There is simply no feasible way in which this effluent discharge could affect groundwater and even if it could the radioactivity would be well below background levels. Atmospheric emissions have been described in section 10.9 where the radioactivity would also be well below background levels. The radioactivity so released could and probably would, end up in groundwater through the recharge process whereby rainfall percolates through into underground aquifers but given the very low levels of radiation, the radioactivity in the groundwater would be well less than that deriving from the local geology. Furthermore another cause of storing high level waste on site is potential radioactive contamination of groundwater resources. However the likelihood of this occurring is highly unlikely due to the storage techniques and storage vessels that will be used on site (refer to Chapter 3 of this EIR, for further details). As such it is ***highly unlikely*** that operations of the proposed NPS would result in a material change in radioactivity in the groundwater.

10.11.3 Hydrocarbon and hazardous chemical contamination of groundwater

The presence of hydrocarbons and other hazardous chemical on site during the construction phase presents the risk of spillage of these materials (as has been detailed in Section 10.10.2) and if such spillage occurs then the risk exists of groundwater being contaminated. As has been detailed this risk will need to managed through efforts to reduce spillage risk in combination with the availability of rapidly deployable countermeasures in the event that there is a spill. The reality of large-scale construction sites is that such spillages are likely but the spill remediation can be used to prevent such spills affecting ground water quality. Contamination of groundwater as a result of such spills is accordingly considered to be ***unlikely but possible.***

Table 11: The residual risk of contaminated groundwater due to the various risk sources associated with the proposed NPS

Potential Environmental Cost	Contaminated groundwater	
Inherent risk	Moderate	
Causes of risk	**Likelihood of causes**	
	Thyspunt	**Duynefontein**
Saline/seawater intrusion	Highly unlikely	Highly unlikely
Radioactive contamination	Highly unlikely	Highly unlikely
Hydrocarbon contamination	Unlikely but possible	Unlikely but possible
Likelihood of consequence	**Unlikely but possible**	**Unlikely but possible**
Residual risk*	Moderate	Moderate

*Please note that the residual risk does not include radioactive contamination of groundwater as this is deemed highly unlikely.

10.12 Availability of Groundwater Resources to Other Users

Groundwater is highlighted as a sensitive receptor for both sites and is an important component of the environmental system especially in relation to wetlands. For groundwater there are three key concerns namely; would the project potentially affect the quality of the resource (addressed in section 10.11), the quantity of the resource and /or change underground flow patterns, and in so doing potentially compromise the value of the resource. In this section potential impacts on groundwater quantity and underground flow are presented and assessed to determine whether the resource might be compromised by the activities associated with the proposed NPS. Potential impacts relating to a lowered water table include the threat of decreased yields of existing production boreholes / well points, drying up of wetlands, and subsidence, which could have a detrimental impact on land and buildings. Two well fields, the Witzand and Aquarius Well fields, are located in relatively close proximity to the Duynefontein site (the latter is located on site). However, the latter is only sparsely used and for a non-essential purposes. There are no groundwater users currently on the Thyspunt site.

The most significant causes of a potential reduction in the availability of groundwater to other users are:

- Depletion of groundwater; and
- Cut off or disruption of groundwater due to structures.

10.12.1 Abstraction of Groundwater

Dewatering (pumping water from excavations to keep them dry and safe) will see a lowering of the water table in the areas where the dewatering will take place but the issue is whether or not the primary aquifer system would be depleted. It is important to note that the aquifers are dynamic systems with recharge occurring (replenishment of the aquifer when it rains) so the assessment is based on whether the proposed abstraction quantities would exceed the recharge rates implying non-sustainable use of the resource. At Duynefontein, numerical modelling of the groundwater system and recharge rates indicates that a reduction in groundwater yields is unlikely especially with installation of hydrological cut-off walls. At the Thyspunt site, there are no cumulative impacts relating to depletion of the aquifer systems as there are no other significant developments and / or large-scale groundwater abstraction areas within the indicated area of influence of dewatering/ groundwater control. What this means is that groundwater could be used for start-up water supply at both Duynefontein and Thyspunt sites without reducing the aquifer potential. Such groundwater abstraction would be a short-term arrangement as a desalination plant is planned to provide water for most of the construction period and power station operations. It is therefore considered **highly unlikely** that the proposed NPS would deplete the volume of groundwater available to other users.

10.12.2 Cut-off or Disruption of Groundwater due to Structures

There are no downstream groundwater users at either site. In addition hydrological cut-off walls will be constructed so that the groundwater that is abstracted is drawn only from the area within the walls. This will have the effect of reducing the spread of the drawdown (where the water table will be lowered). Therefore the cut-off wall will compartmentalise and restrict the area of which the NPS affects the groundwater. The net effect is that the likelihood of reducing the availability of water to other groundwater users is **highly unlikely**.

Figure 1: Example of cut-off wall used at Coega Harbour

Table 12: The residual risk of reduced groundwater yields due to the various risk sources associated with the proposed NPS.

Potential Environmental Cost	Reduced groundwater yields	
Inherent risk	Moderate	
Causes of risk	**Likelihood of causes**	
	Thyspunt	**Duynefontein**
Abstraction	Definite	Definite
Changes in underground flow	Unlikely but possible	Unlikely but possible
Likelihood of consequence	**Highly unlikely**	**Highly unlikely**
Residual risk	Low	Low

10.13 Loss of Wetlands and Wetland Function

Section 10.16, will present the risk of reduced populations as a result of the proposed Nuclear Power Station principally as a result of habitat loss. In this section possible impacts on wetlands as a special type of habitat are considered.

10.13.1 Duynefontein Wetlands

The depressional wetlands that occur at Duynefontein can be divided into two categories:

- Seasonal wetlands, most of which are located in the south-western portion of the site where they are separated from the coast by a line of low dunes, and collectively comprise an extensive mosaic of seasonally inundated dune slack wetlands (linear depressions close to sea level in coastal dune systems); and,
- Artificial wetlands as a result of human activities on the site. The artificial wetlands include one seasonally inundated depression along the main NPS access road, but mainly comprise permanently inundated to saturated wetlands in the vicinity of the existing Koeberg NPS. These latter type wetlands occur in places along internal roads, along the boundary fence line and in the northern portion of the site, just north of the dune field.

10.13.2 Thyspunt Wetlands

At Thyspunt the following wetlands occur:

- Wetland depressions within the mobile dune fields – these wetlands are also referred to as dune slack wetlands;
- Permanently to seasonally saturated hillslope seeps; and
- Permanently to seasonally saturated valley bottom wetlands.

Thyspunt contains 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 sensitivity and conservation value of the wetlands at Thyspunt is therefore considered to be very high with reference to especially the Langefonteinvlei wetland. Any impacts on this wetland system would be potentially highly significant for decision-making purposes.

The most significant causes of potential wetland damage from the proposed NPS are:

- Transformation of land;
- Reduced water supply;
- Inflow of sediment rich water;
- Inflow of poor quality water; and
- Proximal placing of spoil dumps.

10.13.3 Physical destruction of wetlands

The simplest way of preventing the transformation of wetlands is avoiding them and for both proposed sites the layout of the proposed NPS has been done to avoid direct impact on the wetlands that occur on the respective sites. At Duynefontein the development area for the proposed NPS lies well away from the most sensitive wetlands on the site – that is, the dune slack depressional wetlands in the south western portion of the site. The higher sensitivity of the Langefonteinvlei wetland at Thyspunt must be recognised by decision-makers but there will no project activities that will result in direct physical transformation of that wetland either.

10.13.4 Reduced Water Supply

Dune slack wetlands are often fed by groundwater and the excavations needed for the proposed Nuclear Power Station would see the need to dewater these excavations (i.e. pump out groundwater to keep the excavations from flooding). The required dewatering has the potential to disrupt the flow of water to the wetlands. Due to the location of the Langefonteinvlei wetland within a perched water table at Thyspunt, it is ***highly unlikely*** that there would be a loss of wetland function due to reduced water supply. The perched water table means that it is a separate aquifer to that affected by the required excavations. Due to the positioning of the Nuclear-1 Power Station at the Duynefontein site, loss of wetland functioning as a result of reduced water supply is also considered ***highly unlikely***.

10.13.5 Inflow of Poor Quality Water

Construction activities present the risk of sediment laden stormwater or stormwater contaminated by hydrocarbons or other chemicals potentially flowing into the wetlands. The reduction in velocity in the wetland would see the deposition of the sediment and were hydrocarbons or hazardous chemicals to be present these would pose a toxicity risk. These deposition and toxicity effects would reduce the functionality of the wetland were they to occur. Given that there are no watercourses at either site that would channel stormwater from the construction areas to the wetlands the likelihood of loss of wetland function occurring due to sedimentation of wetlands as **highly unlikely**. In a similar vein, proper channelling of stormwater from the construction areas and demanding spill prevention and countermeasures in the event of a spill will ensure that loss of wetland function due to inflow of water of poor quality is ***highly unlikely***.

10.13.6 Placing of Spoil Dumps

Spoil dumps during construction are a key source of sediment risk and as such spoil dumps need to be located so as to minimise that risk. The proposed location of spoil dumps at both sites specifically avoids potential sedimentation of the wetlands. The loss of wetland functionality due to the imprudent placing of spoil dumps is therefore considered ***highly unlikely.***

Table 13: The residual risk of reduced wetland function due to the various risk sources associated with the proposed NPS

Potential Environmental Cost	Reduced wetland functioning	
Inherent risk	Moderate	
Causes of risk	**Likelihood of causes**	
	Thyspunt	**Duynefontein**
Physical destruction of wetlands	Highly unlikely	Highly unlikely
Reduced water supply	Highly unlikely	Highly unlikely
Inflow of poor quality water	Highly unlikely	Highly unlikely
Placing of spoil dumps	Highly unlikely	Highly unlikely
Likelihood of consequence	**Highly unlikely**	**Highly unlikely**
Residual risk	**Low**	**Low**

10.14 Reduced Marine Environment Quality

As both proposed sites for the NPS are coastal sites it is necessary to assess the potential impacts of the different project phases on the marine environment. A key element of interactions between the proposed power station and the marine environment will be the seawater exchange whereby cold seawater will be drawn from the ocean used for cooling purposes and then returned to the ocean. In addition freshwater will be sourced from a desalination plant, where seawater will be abstracted from the sea, processed for freshwater and then the remaining brine (concentred salts) will be discharge to the marine environment. During construction it is also intended to dispose of spoil (excess material) in the ocean. In the same way that the land provides habitat so too does the sea, so the question that must be asked is how will these various interactions potentially compromise the quality of the marine environment.

10.15 Important features of the marine environment

10.15.1 Duynefontein

10.15.1.1 The Intertidal Zone

Only a single species endemic to South African shores, the amphipod *Talorchestia quadrispinosa* was recorded during the marine survey, but the species ranges up the entire west coast. High-shore macrofaunal communities are dominated by crustaceans (isopods and amphipods), while lower down the shore communities become dominated by polychaete worms. The dynamic nature of exposed sandy shores implies a high tolerance to disturbance and is thus rated as low sensitivity habitats. The two Koeberg harbour breakwaters represent the largest section of hard substratum with very little natural rocky shore in the intertidal zone. The rocky shores are also considered low-sensitivity habitat although they are relatively more sensitive than the sandy shores.

10.15.1.2 The Benthic Environment

Both rocky and sandy bottoms occur in the nearshore environment in the immediate vicinity of Koeberg Nuclear Power Station with communities inhabiting rocky substrata off Koeberg being typical of the South African west coast and widely distributed. There are no species of special concern either in the sandy bottom communities and the area is considered of medium sensitivity to disturbance.

10.15.1.3 The Open Water Environment

The highly productive fisheries of the South African west coast are focused offshore with nearshore fish productivity being high but of low diversity. The South African fur seal spends extended periods in the immediate area of the existing power station with other marine mammals such as dolphins and whales being less common. This environment is considered to have high tolerance to disturbance and thus low sensitivity.

10.15.2 Thyspunt

10.15.2.1 The Intertidal Zone

Rocky shores at Thyspunt are steep and strongly dissected. Three rocky-shore endemic species occur but all have extensive ranges along the South African coast. No species of special conservation interest were recorded in the intertidal environment at Thyspunt, which is accordingly considered a low sensitivity habitat.

10.15.2.2 The Benthic Environment

Both sandy and rocky bottoms are present in the vicinity of Thyspunt with species composition and abundance typical of the region. The benthic environment is deemed moderately tolerant of disturbance and rated thus as medium sensitivity habitat.

10.15.2.3 The Open Water Environment

The chokka squid *Loligo reynaudii* is an important invertebrate species in the area surrounding the Thyspunt site and occurs from southern Namibia to approximately East London. Coastal spawning of chokka squid has been recently reported in areas east of Cape St Francis, with St Francis Bay appearing to support dense beds. The coastal jigging fishery for chokka squid is dependent on the formation of numerous large spawning aggregations for their catches. Marine mammals such as dolphins and whales are observed but are transient and there are no seal colonies near Thyspunt. The highly dynamic nature of the open water environment means low sensitivity to disturbance.

The most significant causes of a potential compromise in quality of the marine environment are:

- Heated water and brine disposal;
- Contaminated Run-off; and
- Sedimentation due to spoil disposal.

10.15.3 Heated Water and Brine Disposal

The discharge of heated water from the cooling systems and brine (liquid containing highly concentrated salts) into the marine environment presents the inherent risk of reduced marine species populations as a result of reduced seawater quality. To minimise the reduction of seawater quality the discharge system has several important attributes. The first of these is that the brine is mixed with the cooling water to dilute the brine. Thereafter the mixed brine and cooling water is discharged via a 3.5 km outfall pipeline that is constructed above the seabed. The last 400 m of the pipeline has a diffusion system which is a series of discharge points at 50 m intervals and the diffuser serves to reduce the size of the effluent pulse at a single point to smaller pulses at multiple points. Finally the discharge rate is kept high to maximise the mixing of the cooling water into the receiving water so that the heat is dissipated as quickly as possible. Comprehensive oceanographic modelling has demonstrated that the effects of elevated temperature will occur over a large area but in open water habitat where there is less sensitive species exposure. Horizontal abstraction inlets, a screen and a low abstraction rate of less than 1m/s, would serve to limit the entrainment of marine species in the incoming seawater.

During construction small 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 during this phase of the development. It is therefore considered **highly unlikely** that there would be a material reduction in marine water quality. These effects would be largely the same at both proposed sites with the construction of the cooling water intake and outflow system resulting in temporary disruption to the marine environment but with a later return to steady state conditions. Stakeholders have raised a particular concern about the potential impacts on chokka squid. An assessment of the potential impacts on the squid is presented in Section 10.18.4.

10.15.4 Contaminated Run-off

The potential for contaminated runoff is described in section 10.10 where during high rainfall events, surface water run-off would occur with a proportion of this stormwater runoff entering the marine environment. Were the stormwater to be contaminated by hydrocarbons or other hazardous chemicals then the same would pose the risk of reduced marine water quality and associated decrease in the quality of the marine environment. As presented in section 10.10 the risk of contaminated stormwater is considered to be ***unlikely but possible***. However the chances that such contaminated effluent would result in a material reduction in the quality of the marine environment is considered ***highly unlikely*** provided that hydrocarbon and hazardous chemical spill risk is effectively managed on site as detailed in section 10.10.

10.15.5 Spoil Disposal

As a result of the quantities of excess material (spoil) from excavations, it is intended to dispose of such spoil in the sea. The proposed marine disposal of spoil was assessed and deemed acceptable, providing certain mitigation is applied. This mitigation would include reducing the discharge rate, reducing the volume and / or disposing of the spoil in deeper water and ceasing disposal during stormy conditions where sediments are less likely to settle upon the seafloor. The most important mitigation is careful selection of the area where the spoil is to be deposited to ensure potentially sensitive areas would be avoided. Different spoiling scenarios were developed and assessed to find the optimum approach (lowest potential impact) for each site. Spoil disposal at a depth of 48 m, 6.5km into the sea at discharge rates of 2.06 m^3/s – 3.93 m^3/s would be acceptable for Duynefontein without significant reduction in habitat quality. Spoil disposal at a depth of 84 m, 6 km into the sea at a discharge rate of 2.06 m^3/s is considered acceptable at Thyspunt. If these spoiling criteria are observed then it is ***highly unlikely*** that marine spoil disposal would materially reduce the quality of marine habitat. Please see section 10.18.4 for an assessment of the possible impacts on chokka squid.

10.15.6 Possible impacts on chokka squid

Stakeholders have raised a particular concern about chokka squid and how marine effluent discharge and spoil disposal could negatively impact on chokka squid populations. An assessment of possible risks to chokka squid is presented in section 10.18.4.

Table 14: The residual risk of reduced marine environmental quality due to the various risk sources associated with the proposed NPS.

Potential Environmental Cost	Reduced marine environmental quality	
Inherent risk	Moderate	
Causes of risk	**Likelihood of causes**	
	Thyspunt	**Duynefontein**
Brine and heated water disposal	Definite	Definite
Contaminated runoff	Unlikely but possible	Unlikely but possible
Spoil disposal	Definite	Definite
Likelihood of consequence	**Highly unlikely**	**Highly unlikely**
Residual risk	**Low**	**Low**

10.16 Reduced Populations of Threatened Species

The construction of any large infrastructure can impact on flora and fauna in a variety of ways through the physical destruction of habitat but also through offsite pollution and others. For decision-making the concern is whether any rare or sensitive (threatened) fauna and flora will be so affected and if so whether there will be reductions in populations and in extreme cases, possible loss of species. Threatened species have been identified at both the Duynefontein and Thyspunt sites respectively and these are presented in the following section followed by an assessment of the possible causes of reduced populations and the significance of the same.

10.17 Threatened species

Both Threatened and Near Threatened species have been identified at the two sites and these are detailed in the section that follows.

10.17.1 Duynefontein

10.17.1.1 Fauna

- Gronovi's Dwarf Burrowing Skink (Near Threatened);
- Southern adder (Vulnerable);
- Blouberg Dwarf Burrowing Skink (Near Threatened);
- White-tailed Mouse (Endangered);
- Honey Badger (Near Threatened);
- African Black Oystercatcher (Near Threatened); and
- Black Harrier (Near Threatened).

10.17.1.2 Flora

Two vegetation types (Cape Flats Dune Strandveld and Cape Flats Sand Fynbos) are found on the site, whilst eleven plant communities were identified. Of the 280 species found on the site, 32 are rare. Species rarity is highest in the sand plain fynbos on the northern side of the proposed site, which also has high localised endemism, but is substantially less on the transverse dunes on the southern side of the proposed site which is also characterised by low endemism.

10.17.2 Thyspunt

10.17.2.1 Fauna

- FitzSimons' Long-tailed Seps (Vulnerable);
- Tasman's Girdled Lizard (Vulnerable);
- Elandsberg Dwarf Chameleon (Endangered);
- Fynbos Golden Mole (Near Threatened);
- Honey Badger (Near Threatened);
- Blue Duiker (Vulnerable);
- African Black Oystercatcher (Near Threatened);
- African Marsh Harrier (Vulnerable);
- Black Harrier (Near Threatened);
- White-bellied Korhaan (Vulnerable);
- Denham's Bustard (Vulnerable);
- Knysna Woodpecker (Near Threatened); and
- Knysna Warbler (Vulnerable).

10.17.2.2 Flora

Five major vegetation types occur on the site: Algoa Dune Strandveld (Least Threatened), Southern Cape Dune Fynbos (Least Threatened), Tsitisikama Sandstone Fynbos (Vulnerable), Cape Seashore Vegetation (Least Threatened) and Cape Lowland Freshwater Wetlands (Vulnerable). This translates into nine major plant communities with six wetland types and a river system. Three hundred and eighty three (383) plant species were recorded on site, with a <u>low rare species count</u> (14 or 3.7%),

The following could result in potentially reduced populations of these species:

- Loss and fragmentation of habitat;
- Road mortality;
- Mortality associated with overhead transmission lines/substations;
- Disturbance of breeding populations;
- Pollution of wetlands;
- Cooling water systems and Brine disposal; and
- Conservation brought about by site enclosure (positive cause).

10.17.3 Loss and Fragmentation of Habitat

The direct loss of habitat is a key reason for reduced populations of species globally and the proposed NPS will bring about a loss of habitat at both proposed sites. The footprint of the proposed Nuclear Power Station is 265 ha (Duynefontein) and 250 ha (Thyspunt) and this will result in both the direct loss, and potential fragmentation of habitat. Habitat loss will result from transformation of land for the actual Nuclear Power Station itself as well as from the HV yard, access roads (on and off-site) and land needed for the construction of the Nuclear Power Station. Where habitat is lost, inhabitant species, if they survive, cannot simply relocate to new habitat due to competition from their own species. The likelihood that threatened species habitat will be lost is certain at both sites and this effect will be more pronounced at Thyspunt because of the broader range of threatened species. The layouts of the proposed NPS have been modified at both sites to avoid the more sensitive habitats that occur at the two sites. It should also be noted that prior to commencement of construction that a search and rescue programme would serve to recover and transplant threatened vegetation species that would otherwise be destroyed.

10.17.4 Road Mortality

Road mortality refers to animals being hit and killed by motor vehicles as a result of roads traversing areas of habitat that would see fauna crossing the road. Given the size of the road area that will be constructed the likelihood of road mortality of threatened species is likely but given the small numbers likely to be killed it seems unlikely that there would be a material net reduction in population as a result of road mortality. However, in the absence of specific numbers to prove otherwise the inherent risk is still considered possible meaning that the likelihood of material reductions in populations of threatened species is considered ***unlikely but possible***. The broader range of species at Thyspunt would suggest a higher likelihood of threatened species mortality but not enough to imply a higher residual risk rating at Thyspunt than at Duynefontein.

10.17.5 Mortality Associated with Overhead Transmission Lines/ Substations

Mortality associated with overhead transmission lines refers to the risk of collision between threatened species and resultant mortality of such species as a result of that collision. Distinction also needs to be made between an electrocution (especially when a bird perches on a pylon or power line) and a collision with a power line, which does not necessarily result in electrocution but could still result in mortality. The importance of this distinction is that electrocution is more likely with the lower voltage distribution lines where conductors are closer together than on the high voltage distribution lines such as those that would be used to evacuate power from a power station. Of the threatened species identified at Duynefontein only two are birds and both are coastal dwellers. The likelihood of threatened species mortality is therefore considered ***unlikely but possible*** and the resultant risk of material reductions in populations similarly ***unlikely but possible***. At Thyspunt the risk of bird mortality is considered to be higher than at Duynefontein due to the range of threatened raptors identified which have a high likelihood of collision with power lines. As such the likelihood of threatened species mortality is considered ***likely*** but net reductions in species populations at Thyspunt ***unlikely but possible***.

10.17.6 Disturbance of breeding populations

Noise, visual disturbance, and especially an increased presence of human beings, all have the potential to disturb wild animals and possibly disrupt their normal behaviour patterns. This becomes particularly problematic when breeding of rare and sensitive species is disrupted. Impacts tend to be more intense during the construction phase when there are much higher levels of human activity, resulting in light, vibration, noise and vehicle movement. Blasting is a particular concern in respect of possible disruption of breeding patterns. Depending on the nature and timing of disturbances, their impacts can vary from local and moderate to regional and intense. Species likely to be affected at Duynefontein are seabirds roosting and breeding in the relatively protected environment in and around Koeberg harbour. These seabirds include Swift Terns, African Black Oystercatchers, Cape Cormorants, Crowned Cormorants, and Bank Cormorants. Construction activities of the proposed NPS will not use or affect Koeberg harbour directly, but will be close enough to the harbour to cause potential disturbance. Of these species only one (1) is classified as threatened, however. The disturbance of breeding populations at Duynefontein is accordingly considered to be ***likely***.

At Thyspunt, threatened (vulnerable and endangered) faunal species likely to be affected include Blue Duiker, African Black Oystercatcher, African Marsh Harrier, Black Harrier, Black-winged Lapwing, Denham's Bustard, White-bellied Korhaan, Blue Crane; Knysna Woodpecker and Knysna Warbler. Due to greater numbers of species at Thyspunt, the likelihood of breeding sites being disturbed during construction is greater than at Duynefontein. The layout of the NPS and associated infrastructure at Thyspunt has been specifically modified to largely avoid sensitive breeding sites. The revised layout and other forms of mitigation such as limiting the size of the footprint and strictly demarcating access reduce the likelihood of disturbance of breeding to ***unlikely but possible***.

10.17.7 Transformation of Wetlands

The presence of the Langefonteinvlei wetland at the Thyspunt site is a particular concern due to the habitat it provides for multiple species. Although there are wetlands at Duynefontein, the Langefonteinvlei wetland is considered to be more ecologically valuable and thus to have higher inherent risk. Concerns relate to possible physical damage/ destruction to/of the wetland and pollution especially during the construction phase. To address these concerns the proposed Nuclear Power Station and all construction activities have been positioned away from the wetland so that there is no risk of direct damage or pollution of the wetland. As such the likelihood of reductions in populations of species using the wetland as habitat is considered ***highly unlikely***. Similarly at Duynefontein the position of the proposed Nuclear Power Station mitigates the potential pollution of wetlands, which could result in reduced species populations.

10.17.8 Cooling water systems and Brine disposal

The effects of cooling water systems and brine disposal is presented in more detail in Section 10.15.3 where it is argued that this effluent discharge will not result in a material reduction in marine water quality. On that basis it is presented here that the cooling water and brine disposal is ***highly unlikely*** to result in material reductions in marine populations of threatened species. This assessment is based also on the fact that the marine environment that will be affected by the effluent is not deemed to be especially sensitive nor contain threatened species.

Table 15: The residual risk of reduced populations of threatened species populations as a function of various risk sources associated with the proposed NPS.

Potential Environmental Cost	Material reductions in threatened species populations	
Inherent risk	Moderate-high	
Causes of risk	**Likelihood of causes**	
	Thyspunt	**Duynefontein**
Loss and fragmentation of habitat	Definite	Definite
Road mortality	Likely	Likely
Mortality associated with overhead transmission lines	Likely	Likely
Disturbance of breeding populations	Unlikely but possible	Likely
Pollution of wetlands	Highly unlikely	Highly unlikely
Material reduction in marine water quality	Highly unlikely	Highly unlikely
Likelihood of consequence	**Unlikely but possible**	**Unlikely but possible**
Residual risk	**Moderate**	**Moderate**

10.17.9 The conservation benefit of site enclosure

The site of the proposed new nuclear power station at Duynefontein and the land surrounding it is currently managed by Eskom as an extension of the Koeberg Nature Reserve. As such were the proposed NPS to be established at Duynefontein there would be a net reduction in the area under conservation management (the loss of some 265 ha). This implies a decrease in conservation area at the Duynefontein site itself. The area of conservation loss at Duynefontein could be offset, however, at an alternative suitable site. At Thyspunt the site proposed for the NPS and the land surrounding it is currently owned by Eskom but has no particular conservation status. If Eskom retains ownership of the land and manages the natural, undisturbed parts as a private conservation area, there will be a significant improvement in the conservation status of the Thyspunt site. The effect would be to provide long term protection of that habitat ensuring at least the maintenance of current species populations in general and threatened species specifically and ensure no further decline at least in the area that would be included in the conservation zone.

10.18 Changes in Livelihoods

At its simplest, livelihood is defined as a 'means of securing the necessities of life' and there is concern that the proposed NPS will have the effect of reducing people's livelihood. This concern is especially acute at Thyspunt because the proposed NPS will be something very different to what has been in the area in that past whereas Duynefontein has had a NPS in that area for 30 years (Koeberg). Livelihoods at Thyspunt are based *inter alia* on agricultural, fishing and tourism and it is therefore necessary to assess how the proposed NPS might impact on those industries and potentially reduce the ability of people to earn a living.

The most significant causes of a potential reduction in livelihoods in the surrounding community are:

- Changing surf breaks and therefore reducing the appeal to surfers;
- Radiological contamination of agricultural resources;
- Change in sense of place;
- Reduction of chokka squid populations.

10.18.1 Spoil Disposal at Sea Altering Surf Breaks

This potential cause is specific to the Thyspunt site and Jeffery's Bay as a popular surfing destination. The concern is that offshore spoil disposal would change underwater topography with a resultant change in the surf break (a surf break is a permanent or semi-permanent obstruction such as a coral reef, rock, shoal, or headland that causes a wave to break, forming a wave that can be surfed). Hydrodynamic modelling was used to predict the movement of the dumped spoil based on reliable ocean current data. The modelling indicates that the spoil will not move as far as Jeffrey's Bay (a distance of 18 km from Cape St. Francis) and would at most; result in increased sediment thickness in the bay between Seal Point and Cape St Francis. This outcome is based on deep offshore spoil disposal as recommended earlier in this report. It is therefore considered highly unlikely that spoil disposal would change the Jeffery's Bay surf breaks and similarly highly unlikely that livelihoods based on the surfing appeal of Jeffery's Bay would be impaired.

10.18.2 Radiological Contamination of Agricultural Resources

Agricultural activities around the Thyspunt site consist mostly of dairy farming and associated agricultural production involving wheat and corn. No agricultural production occurs within 2.5 km of the site. Milk production is concentrated in the areas beyond the 5 km radius throughout the west-northwest to northeast sectors. Two areas, 5 km northwest and 7.5 km east-northeast, reflect higher than average milk production figures. The main cattle farming areas correspond closely with the areas in which milk production dominates. It should be clear from previously presented arguments on the very low levels of radioactivity that would originate from the proposed NPS, such levels being well less than naturally occurring levels, that radiological contamination of agricultural products is highly unlikely. Public awareness campaigns and initiatives may be carried out by the Nuclear-1 visitor's centre's staff to help educate the public about the reality of radiological contamination of NPS versus perceptions. There are no agricultural activities around the Duynefontein site within the EPZ areas as this falls within the Koeberg Nature Reserve.

10.18.3 Change in Sense of Place

The Duynefontein area is essentially desensitised to the presence of a Nuclear Power Station due to the presence of the existing nuclear power station at Koeberg. The area around Koeberg has seen positive growth and tourism development despite, and partly because of, the nuclear power station. The experience of the local communities of the current power station at Koeberg is part of the frame of reference within which a new NPS would be perceived. As such it is expected that the change would be perceived largely neutrally by people living in the area. It can also be argued that there would be a slight positive change in the long run due to the character of the NPS in itself offering a drawcard feature to tourists. Koeberg and the associated conservancy area is a tourist attraction with the existing power station receiving some 15 000 visitors a year.

As a result of the established premium tourism product offered in the Greater St Francis area, a nuclear power station would have a negative impact on the **perceived** attractiveness of the area. While it is likely that this negative perception will attenuate somewhat over time and even potentially become positive in the much longer term, it is simply impossible to estimate the duration of that process. As such it is ***highly likely*** that there would be a reduction in the number of tourists visiting the area as a result of the construction activities and ultimately the presence of the NPS. The reduction in the number of tourists would mean a reduction in revenues generated in tourist-based businesses such as accommodation, restaurants and others. As will be detailed later in this section these losses would be more than offset by the slew of other economic activities that are generated as a result of the project but it must be recognised that these would of course be different in nature.

10.18.4 Reducing Chokka Squid Populations

Concerns have been raised about the possible impacts on chokka squid at the Thyspunt site. In 2005 the Eastern Cape squid industry employed 2,300 fishing crew, 150 management staff and 1,500 factory staff with the industry generating approximately R 400 million in foreign exchange per annum. Fishing has significant linkages in terms of local employment and procurement of provisions, the effects of a potential decline in catches for labour and supplies would be serious. The industry at Port St. Francis consists largely of small, medium and micro enterprises which depend entirely on squid fishing and would not be able to divert their vessels so as to capture trawl and other (demersal or pelagic) revenue streams. The concerns about impacts on the squid industry as a result of the proposed NPS stem from the planned disposal of spoil at sea, the discharge of cooling water and brine and the exclusion area.

Over the last 20 years the annual catch has ranged between 2 000 – 14 000 tons in the Eastern Cape with an average of 7 000 tons. Port St. Francis-based companies average about 1 000 tons per annum with squid being the most viable fishing industry in the area and almost the entire catch being exported to the EU. Information supplied by the South African Squid Management Industrial Association (SASMIA), indicates that between 1999 and 2005 an average of 33,2% of the total annual Eastern Cape catch originated in the area between 10 nautical miles (18,52 km) east and west of the proposed Thyspunt nuclear power station site. The required security exclusion zone of 1 km width would potentially account for as much as 1.8% of the total average catch of 7 000 tons per annum (some 127 tons per annum). The concentration of squid, however, shifts according to month and weather conditions, and the catch fluctuates from year to year depending on sea temperature and wind conditions.

As detailed in section 10.15.3 the brine will be effectively diluted by the cooling water before being discharged in to the marine environment but as has been explained in section 10.15.3 there will be pockets of water that is relatively warmer than the surrounding water at the discharge point of the effluent pipeline. The specialist assessment indicated that the chokka squid would simply avoid areas where the water temperature is elevated above their thermal tolerance range. The disposal of spoil at the Thyspunt site will have an impact on the chokka squid breeding grounds through changing the benthic habitat and in particular egg beds but this impact will be small and certainly well **less than 1%** of the area over which this species spawns, meaning a very limited impact on the overall squid stock. The offshore disposal of spoil would result in turbidity which would drive adults away from the areas of turbidity, but this would be a temporary effect occurring only during the construction phase and with a recovery once the offsite spoil disposal ceases. On this basis a reduction in livelihoods as a result of reduced catches of squid as a result of the construction and operation of the proposed NPS is considered to be ***unlikely but possible.***

Table 16: The residual risk of reduced livelihoods due to the various risk sources associated with the proposed NPS

Potential Environmental Cost	Reduction in livelihoods	
Inherent risk	Moderate – High	
Causes of risk	**Likelihood of causes**	
	Thyspunt	**Duynefontein**
Change in surf breaks	Highly unlikely	NA
Radiological contamination of agricultural products	Highly unlikely	Definite
Change in sense of place	Definite	Unlikely but possible
Material reductions in chokka squid catches	Unlikely but possible	NA
Likelihood of consequence	**Highly likely**	**Unlikely but possible**
Residual risk	**Moderate**	**Moderate**

The most significant causes of a **potential improvement** in livelihoods in the surrounding community are:

- Increased Agricultural Production;
- Increased Business Opportunities; and
- New Job Opportunities.

10.18.5 Increased Agricultural Production

The presence of a large construction force during the construction phase (approximately 9000 at its peak); will increase local demand for various good and services including fresh produce. It is estimated that the stimulation of the agricultural economy would be greater at Thyspunt than at Duynefontein and manifest as a 10 % to 15 % increase (with a value of R 150 million per annum). At Duynefontein, it is estimated that there would be no stimulation of the agricultural sector because of the proximity of the proposed site to an ever-expanding urban area. Any possible stimulation of agricultural production would probably be negated by urban expansion, which reduces the available agricultural land. Therefore the likelihood that an increase in agricultural production will positively affect the livelihoods of the surrounding community is **highly likely** for the Thyspunt site and **highly unlikely** for Duynefontein site with specific reference to localisation.

10.18.6 Increased Business Opportunities

The construction and operation of the proposed NPS will create a significant number of business opportunities for local companies / service providers and small medium micro enterprises (SMMEs). The utilisation of local suppliers and service providers can also be promoted through local procurement and pro-active targeting of local business development to ensure that local economic development is maximised. Therefore the likelihood that increased business opportunities will positively affect the livelihoods of the surrounding community is ***highly likely***.

10.18.7 New Job 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 of the nuclear power station. It is envisaged that at least 25 % of the construction workers will be sourced from the local labour force. Therefore the likelihood that new job opportunities will positively impact the livelihoods of the surrounding community is ***highly likely***.

As stated in the Social Impact Assessment, majority of the population receives an income lower than R 76 800 per year. The largest portion of the population receives an income between R 9 601 and R 38 400, the second largest between R 4 801 and R 9 600 and the third has no income. A larger group of the population receives an income of R 153 601 to R 307 200. This could be attributed to the high income groups residing at locations such as Cape St. Francis and St. Francis Bay. 42% of the population is employed and 58% of the population is either unemployed or not economically active. The employed population is evenly spread amongst all wards. The non-economically active portion of the population is also evenly spread amongst all wards.

10.19 Heritage Resources

Nuclear power stations place a particular constraint on heritage management due to their unique requirements. The site selection must meet stringent requirements and the facility itself must be engineered to strict design specifications, which cannot be deviated from without a lengthy process of testing and re-licensing. Function and safety dictate the layout and form of the nuclear structures meaning that it is not possible to alter the design parameters such as form, architecture, bulk and height to suit aesthetic considerations or to be sympathetic to the surrounding landscape forms. In addition to how the proposed NPS would potentially change the heritage character of the area the potential destruction of heritage artefacts is also a key concern. Both Duynefontein and Thyspunt have significant heritage resources, being situated in areas, which are known to be archaeologically and paleontologically sensitive and Thyspunt particularly, in a scenic area with strong wilderness qualities. It should however be noted that the visitors centre proposed for Nuclear-1 makes provision for the storage and display of heritage artefacts that are affected by construction activities.

10.19.1 Duynefontein heritage features

Duynefontein is paleontologically highly sensitive (remnants of life existent prior to, and sometimes including, the start of the Holocene Epoch roughly 11,700 years before present). In cultural landscape terms the nuclear industrial presence is already established at Koeberg and accepted as a landmark by most Capetonians. Any additions to this will be additions to an already established identity.

10.19.2 Thyspunt heritage features

The archaeological and palaeontological heritage at Thyspunt is diverse and prolific but occurs in specific geographical areas most notably within the Oyster Bay Dune Field and within 300 m of the high water mark. The wilderness qualities of this portion of the coast in combination with the archaeological heritage are exceptional and make a substantial contribution to the character of the region. Such cultural landscapes are highly sensitive to cumulative impacts and large-scale development activities that change the character and public memory of a place. In terms of the NHRA a cultural landscape may also include a natural landscape of high rarity value and scientific significance and this would apply to the Thyspunt site.

The main cause of a loss of heritage resources is due to the destruction of heritage resources especially during construction.

10.19.3 Destruction of Heritage Artefacts

The positioning of the proposed NPS relative to the heritage sites is a key mitigating action. Extensive mitigation will be required at Duynefontein in respect of paleontological artefacts but if this mitigation is done appropriately it could be used to benefit paleontological research. The increase in the coastal set back zone from 60 m from the high water mark to 200 m at Thyspunt has substantially reduced the potential impacts on archaeological sites. Extensive surveys, including a trial excavation program, have shown that it is possible to position the proposed nuclear power station in such a way that physical impacts to archaeological heritage sites are minimised. Mitigation of any heritage material through sampling by controlled excavation, or creation of local exclusion areas is considered feasible with resources currently available but on site storage (such as a small museum) may be necessary such as display areas within the visitors centre. The risk of destruction of heritage artefacts is accordingly considered ***unlikely but possible***. Given the mass and bulk of the proposed activity, un-mitigatable cultural landscape impacts are expected.

Table 17: The residual risk of loss of heritage resources due to the various risk sources associated with the proposed NPS

Potential Environmental Cost	Loss of heritage resources	
Inherent risk	Moderate	
Causes of risk	**Likelihood of causes**	
	Thyspunt	**Duynefontein**
Destruction of heritage artefacts	Unlikely but possible	Unlikely but possible
Change in cultural landscape	Definite	Unlikely but possible
Likelihood of consequence	**Definite**	**Unlikely but possible**
Residual risk	**Moderate**	**Moderate**

10.20 Nuisance

Noise from construction activities, associated machinery / equipment of the power station will increase the ambient noise levels of the sites. Visual intrusion of the power station during the construction phase coupled with traffic congestion due to additional vehicles will result in frustrations and irritations to the surrounding residents.

The most significant causes of irritation and nuisance to surrounding residents are:

- Noise;
- Visual impact;
- Informal settlements due to Nuclear-1; and
- Traffic congestion.

10.20.1 Noise

There will be multiple noise sources associated with the proposed NPS. These noise sources include the many and varied construction activities including vehicle movement, plant and machinery operation, erection of structural steel, piling and so forth and during operations, noise produced by the turbines, electrical generators and associated machinery/equipment. No audible noise emanates from the nuclear reactor itself. The most powerful form of mitigation of noise is distance (the sound pressure levels reduce by 3 dBA with every doubling of distance from the source). Given the distances from the proposed project sites to the nearest receptors which is 2 km at Duynefontein (the R27) and 3 km at Thyspunt the likelihood that noise generated at the sites would be heard at the receptors is **highly unlikely**. The township of Umzamowethu would experience elevated noise levels due to the construction of the western access road. During the operational phase, the noise emanating from the power station would be inaudible. Therefore the likelihood of elevated noise levels resulting in frustrations and nuisance to surrounding residents is unlikely.

10.20.2 Visual impact

Visual risk sources for the two proposed 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 and masts. At the Duynefontein site the visual risk sources relate primarily to the increase in visual intrusion in combination with KNPS adjacent to the southern boundary of the site. 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 road/s for the Thyspunt site specifically. Even though the Thyspunt site is only visible from Oyster Bay and the Rebelsrus Nature Reserve, the proposed establishment of the NPS at Thyspunt will result in a significant change to the visual character of the area. The visual change will ameliorate somewhat once construction has been completed but the presence of the power station and associated infrastructure will change the visual character significantly and for at least the lifetime of the power station.

10.20.3 Informal Settlements due to Nuclear-1

The influx of job seekers to the site during the construction phase, including those from areas outside the “local” area, has the potential to result in the establishment of informal settlements which will 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. Due to Eskom’s procurement and supply management policy, 25 % of the labour force will be local residents (as far as possible). Therefore considering the total number of jobs that will be offered to local residents, the likelihood that informal settlements will be established and result in irritation of surrounding residents is ***likely***.

10.20.4 Additional Vehicular Traffic

Due to the construction phase, additional vehicular traffic will be experienced. Based on the various road upgrades and travel times proposed for the Thyspunt site this cause is likely to contribute significantly to irritation levels of the surrounding community. At Duynefontein the R27 users will be affected by the increase in traffic, however the R27 can cater for the additional vehicles; therefore this is not regarded as a cause of concern at the Duynefontein site.

Table 18: The residual risk of nuisance due to the various risk sources associated with the proposed NPS

Potential Environmental Cost	Nuisance	
Inherent risk	Moderate-low	
	Thyspunt	**Duynefontein**
Noise	Definite	Definite
Visual	Definite	Definite
Informal settlements	Likely	Likely
Traffic congestion	Likely	Likely
Likelihood of consequence	**Definite**	**Unlikely but possible**
Residual risk	**Moderate**	**Low**

10.21 Summary of Residual Risks

Residual Risk	Thyspunt	Duynefontein
Acute radioactive exposure	Moderate	Moderate
Non-radiological risks of deaths or serious injury	High	High
Illness	Moderate	Moderate
Increased morbidity	High	High
Contaminated stormwater	Moderate	Moderate
Contaminated groundwater	Moderate	Moderate
Reduced groundwater yields	Low	Low
Reduced wetland functioning	Low	Low
Reduced marine environmental quality	Low	Low
Material reduction in threatened species populations	Moderate	Moderate
Reduction in livelihoods	Moderate	Moderate
Loss of heritage resources	Moderate	Moderate
Nuisance	Moderate	Low

10.22 Comparing the Sites – A Strategic Overview of the Project

A project of the scale of the proposed NPS will result in a number of large-scale changes to the receiving environment. Although being assessed as part of a separate EIA, power stations also require large scale high voltage transmission lines to evacuate the power generated at the station, which span many tens of kilometres before entering the overall national transmission grid. As has been described the proposed NPS will also require additional infrastructure in the form of connecting roads and particularly at Thyspunt additional supporting infrastructure as detailed in Chapter 3 of this report. Whichever way the proposed NPS and its impacts are considered, the changes brought about in the receiving environment are large scale. Again these changes would be far greater for the Thyspunt site than they are for Duynefontein given the presence of the existing Koeberg NPS and the existing infrastructure that supports that station.

The establishment of the NPS at Duynefontein would occur against a backdrop of an existing NPS, large-scale transmission lines, and a far more urbanized environment than exists at Thyspunt. In these terms the changes and the perception of these changes will be far greater at Thyspunt than they will at Duynefontein. The proposed NPS and associated infrastructure will bring about a fundamental change in sense of place at Thyspunt whereas that change has already been experienced at Duynefontein and so were the NPS to be established at Duynefontein, the change would be experienced as a more intense form of the same. Decision-makers need to understand and be empathetic towards the extent of the change at Thyspunt which is deemed to be a high residual impact (as a cause) and which is broadly not possible to mitigate. It is only the passage of time that will steadily mitigate the huge sense of change that will experienced at Thyspunt and for some residents it is a change that they will never get used to. Many of the residents specifically live in that area due to the sense of place that prevails currently and the sense of being in a remote and peaceful environment.

It can of course be argued that the proposed NPS was planned for Thyspunt for at least since the 1980's, so people moving into the area would have known that a NPS was always a possibility at Thyspunt although the time scale for development may not have been clear. It simply cannot be argued that the idea of an NPS at Thyspunt was a 'bolt from the blue' and completely unexpected as Eskom has owned the property before the 1980's and that ownership has ensured no development in the direct and indirect footprints (buffer zone) of the Thyspunt site. The argument that the NPS cannot now go ahead simply because of the residential properties that have developed in the interim on the doorstep of the proposed site is tenuous and difficult to support. If the NPS had been proposed only after the large-scale residential developments then decision-makers would have been encouraged to be far more sympathetic to the lot of the people who have settled in the area seeking a rural coastal lifestyle.

The sheer size of the project and its associated footprint which extends well beyond the direct proposed site in the form of roads, other infrastructure and large-scale transmission lines means potentially significant transformation of land and habitat. The direct footprint of the proposed NPS is 265 ha at Duynefontein that will mean a direct loss of currently conserved land. The conservation area was directly premised on the establishment of the Koeberg NPS and has been judicious use of the land that is owned by Eskom and kept free of development for safety reasons, but that does not change the fact that a conservation area will be lost if the NPS is established at Duynefontein. The loss of that conservation area is material and an offset would need to be created to ensure that there is no net loss of ecological value if the NPS is established at Duynefontein.

The Thyspunt site is biologically more diverse than the Duynefontein site and there are more threatened species of fauna at Thyspunt and the Langefonteinvlei wetland is of special importance. As such the site proposed for the NPS at Thyspunt is more sensitive than that at Duynefontein and decision-makers are encouraged to recognize this sensitivity in their decision-making deliberations. Equally important in those deliberations is of course the fact that a good part of the reason for that higher sensitivity has been the protection afforded to the natural environment by the property not being available for development.

It is simply not possible to speculate as to how or even if the site would have been developed in other ways were it not to have been earmarked for a NPS but there is no doubt that the current ecological value of the site is because development has been prevented. The assessment is one of moderate residual risk of reduced threatened species populations because of the introduction of infrastructure that poses a mortality risk to such species especially roads and transmission lines. Threatened species mortality as a result of this infrastructure is likely and the various mitigation that will be applied, will serve to limit the extent of the mortality so that there is not a material reduction in threatened species populations.

The presence of wetlands at both sites, with an especially sensitive wetland at Thyspunt, presents the risk of the functionality of these wetlands being reduced through sedimentation or hydrocarbon or chemical contamination of stormwater. The planned layout of the sites including the judicious placing of stockpiles, hydrocarbon and chemical spill prevention and countermeasures, and that fact that there are not direct flow lines to the wetlands means that the loss of wetlands or the reduced functioning of wetlands is **highly unlikely**. At the same time the large buffer areas required for the NPS again provide an opportunity to continue to protect this important ecological area. The planned layout of the power station has been modified to ensure that the key sensitivities in the site area such as the dune headland system and the Langefonteinvlei wetland are avoided.

The proposed NPS could accordingly be developed without a material reduction in the ecological value of the site and the continued protection afforded to the property through the prevention of other developments must also be considered in the decision-making process. It must also be recognized that the most significant disruption will occur during the construction phase and thereafter the operations phase would see far lower level of impact on the natural environment. If the NPS is prevented from being established at Thyspunt it seems highly unlikely that the property would not be further developed but it would be wrong to try and argue that without the NPS that the ecological value of the area is doomed. All that is being argued here is that the ecological value will not be lost if the NPS is developed at Thyspunt an argument that may not necessarily hold true if the property were not to be used for a NPS.

The transmission lines that are required to evacuate the power pose a number of threats to the environment including direct land transformation, visual impact, and bird mortalities through collision or electrocution. In general terms collision risk tends to be higher on the transmission lines with lower risk of electrocution because of the distance between the conductors, than is the case with distribution lines. The transmission lines will also change the sense of place but can be developed in such a way as to prevent the risk of transformation of critical habitats, reduce the impacts on non-critical habitats, and through the adoption of various forms of mitigation reduce the risk of bird mortality. That notwithstanding, transmission lines do have a negative impact on the environment and this must be recognized in the decision-making process, and no power station in the world has yet been built without large-scale transmission lines to evacuate the power. Cumulatively the footprint of electricity generation and transmission is large.

In much the same way that the proposed NPS will result in a much greater change in the sense of place at Thyspunt than at Duynefontein so too there will be a greater return in benefits at Thyspunt. The construction project will result in a substantial injection of spending and employment opportunities and a resultant stimulation of the local economy. The effect of this would be relatively higher at Thyspunt than at Duynefontein because the proposed NPS project would introduce unprecedented economic development opportunities whereas the same cannot be said of Duynefontein. Many stakeholders would argue that they do not want such economic development in the area and that it would actually further spoil the area but the reality is that many other stakeholders in the area live in poverty or at least very low levels of income with few if any prospects for changing their lot. The proposed NPS will introduce not just direct economic benefits but large-scale knock on benefits as well. It would be hard to see that the proposed project would not result in a general level of improvement in human well-being for a large percentage of potentially affected stakeholders pretty much all in lower income brackets. Again this effect would be relatively more pronounced at Thyspunt than it would at Duynefontein given the generally better developed economy in the area of the latter.

The impact nature of electricity generation is one where the impacts are felt at the source of generation and along the transmission lines whereas the real benefits manifest at the end of the lines. This obviously excludes the local economic benefits that will derive from the construction activities and to a lesser extent the economic benefits associated with power station operations in the form of spending on local goods and services and the impact of salaried employees living and requiring goods and services of their own in the area. Therefore it must be recognized that the economic value of the electricity generated is significant but that is a value that will not accrue at a local level (viz. in the immediate vicinity of the power station) but rather nationally through use by industrial or other commercial users. The value of electricity is obviously significant too for domestic users.

Other cumulative effects would typically derive from atmospheric emissions, noise, wastewater discharge and resource consumption. At both Duynefontein and Thyspunt background air quality is generally good in the absence of significant other sources and the impact of the proposed NPS will not change that situation materially. Certainly mechanically generated dust will need to be effectively managed during the construction phase and there will be small scale emissions from backup power supply system's episodically but the proposed NPS will not result in material change in air quality at either of the sites. The same is true of noise although high noise pressure levels will be generated during the construction phase. The distance from the sites to the nearest sensitive receptors serves to ensure that there will not be material changes in background noise brought about by the combination of activities associated with the proposed NPS and other activities in the respective areas.

Public sentiment is one of deep concern regarding potential adverse health effects of the proposed NPS both at the level of a large scale accidental release with immediate possible fatalities or serious injuries or a long term serious illness risk. Were either or both to manifest the consequences would be highly severe and any risk of public mortality or morbidity has to be recognized as very significant and has been presented as such in the assessment. What makes the risk tolerable is the very low likelihood of it ever occurring due to the defence in depth principles that underpin the design and operation of a modern NPS. These defence in depth principles see high levels of redundancy in control and cooling systems supplemented by multiple levels of containment. The defence in depth principles serve to ensure that radioactivity releases from the power station are kept well below background levels of radioactivity under all circumstances and as such mortality or morbidity as a result of radioactive exposure is highly unlikely.

Non-radiological exposure risks of mortality and morbidly on the NPS would derive from motor vehicle accidents, potential increases in HIV/AIDS due to the presence of a large labour force and increased opportunities crime that could be violent. These various effects are inevitably associated with large-scale construction projects and the extent of the effects similarly constrained to the broader project area. Despite the various mitigation that has been proposed to minimize these mortality/morbidity risks, they are likely to occur albeit at a limited scale. The mitigation would only serve to limit the extent and not prevent them entirely. For decision-making purposes if the decision is to authorize the proposed NPS then it should be recognized that these non-radiological risks are likely to occur. Mechanically generated dust from the construction activities also poses a potential risk of human morbidity but dispersion modelling of the likely ambient concentrations of dust show that it will be well below the national ambient air quality standards that serve to protect human health.

Prevailing human health could also be improved by the additional infrastructure that would be established that would see additional medical facilities and improved water supply and sanitation being brought about by the project. To some extent this additional infrastructure would simply offset the additional pressure on such services brought about by an increased number of people but there would be definite carry over benefits for people who have always lived in the area. Again it should be noted that this benefit is likely to be more pronounced at

Thyspunt than it would be at Duynefontein because Duynefontein already has better developed services and infrastructure than Thyspunt.

Concerns have also been raised about the marine environment at both possible sites as a result of interaction of the project with the marine environment through water abstraction for cooling and drinking water purposes and discharge of heated cooling water and brine. Construction activities also pose the risk of contaminated stormwater being discharged from the site into the marine environment and excess spoil is also planned to be disposed in the sea. In all cases there will be controls that limit the risk of significant change to the marine environment. These controls include very specific operational parameters for the disposal of the spoil at sea, dilution of the brine form the desalination plants using cooling water and the use of a diffuser to limit the impact of heated water pulses into the marine environment. A reduction in the quality of the marine environment is deemed to be a low residual risk.

Finally but importantly there are multiple construction activities that could impact surface and ground water quality and groundwater yields. Such activities relate to the presence of hydrocarbons and other hazardous chemicals that could be spilled during construction activities. Although there are no perennial watercourses on either site such spillages could result in contamination of stormwater runoff, which could result in further potential impacts on wetlands, groundwater quality through percolation / recharge or marine discharge. Strict controls will be required not just to reduce the risk of spills but to ensure that there is rapid clean-up of the spill should it occur so as to prevent downstream risks of contamination. Large-scale spillages should be prevented by the proposed mitigation but smaller scale spills are an unfortunate reality of large construction sites. The initial use of groundwater required for both sites before the desalination plant is established is modelled not to result in a reduction in groundwater yields and the use of hydrological walls to cut off the areas affected by dewatering will limit the extent of the drawdown thereby also not impacting in any material ways on groundwater flows or quantity.

It is concluded that both sites are environmentally acceptable for a nuclear power station. The Thyspunt site is considered the preferred site and it is recommended that it be authorised by the DEA (with conditions) for Nuclear-1. Eskom must ensure that the required mitigation measures are effectively implemented. It is important to remember that none of the specialist assessments identified fatal flaws at any of the remaining sites, and both the proposed sites remain viable sites for nuclear power station development, either for Nuclear 1, which is now proposed, or for some future power station. As such, the site selected is the one that provides the greatest immediate return from an electricity supply point of view. Thyspunt will strengthen the eastern grid and help create a generation centre along the east coast.

10.23 Evaluation of Other Alternatives

10.23.1 Forms of power generation

The comparative assessment of energy generation technologies undertaken as part of the Scoping Phase gave rise to the following conclusions:

- Technological alternatives for power generation involving coal as a resource are not viable alternatives for power generation in coastal areas in South Africa as coal resources are concentrated in the Mpumalanga and Limpopo Provinces. Transmitting electricity from this region to the Eastern and Western Cape provinces results in significant line losses / efficiency due to the distance;
- Although Eskom remains committed to identifying ways in which renewable energy (e.g. wind and solar power) may be utilised to assist in the supply side of its operations, such technologies currently do not provide the capacity to provide a reliable base load (as per chapter 4) and easily integrate into the existing power network in South Africa;
- At present the only viable technology for large scale base load electricity production within the borders of South Africa, other than coal, is nuclear power; and
- Hydro-electric power is not considered a feasible alternative due to the scarcity of water in South Africa and the limited potential energy of our water resources. South Africa and Eskom are committed to work with Southern African countries for supply options that could potentially be derived from hydro-power. Realising such opportunities will take time and there is too much uncertainty currently to be able to plan effectively for such realisation.

Policy dictates that South Africa must make increasing use of nuclear power generation to reduce greenhouse gas emissions to comply with commitments made at the Copenhagen Climate Change Summit in December 2009. These commitments require South Africa to reduce CO_2 by 34 % by 2020. Over the full lifecycle greenhouse gas emissions from nuclear power generation is a fraction of those generated using coal. The Integrated Resource Plan (IRP) presents these arguments and accordingly includes 9 600 MW of Nuclear in the power generation mix. The continued use and further development of renewable energy technologies is in no way precluded by the choice of nuclear. As pointed out earlier in this EIR, nuclear generation is not seen as an alternative to renewable technologies in the IRP. Indeed the IRP presents that both technologies need to be developed in parallel. In addition to all existing and committed power plants (Medupi, Kusile and Ingula), the IRP presents that projected electricity demand in South Africa will be supplied using the following technology mix:

- 9.6 GW (9 600 MW) nuclear;
- 6.3 GW of coal;
- 11.4 GW of renewable energy; and,
- 11.0 GW of other generation sources.

10.23.2 Freshwater supply

10.23.2.1 Duynefontein

The Site falls within the Berg Water Management Area (WMA). According to the water requirement projections in Appendix D of the DWA's National Water Resource Strategy (DWAF 2004), there is no allowance for water requirements for power generation in this Water Management Area. Potential sources of freshwater, as discussed below, were considered.

Aquifer
The Aquarius Well field is located approximately 6 km north-east of Duynefontein. Water was previously abstracted from this well field and used as a source at Koeberg, but it is no longer being used as a result of the poor water quality. On-site use of groundwater is therefore not an option at Duynefontein.

Cape Town metropolitan water supply system
Koeberg currently receives water through the municipal supply line along Otto du Plessis Drive through Van Riebeeckstrand. The site receives the bulk of its water from one source via the local authority. Water to the Duynefontein nuclear power station can be supplied from the 500 mm diameter bulk feeder main along the West Coast Road (R27). However, based on the DWA's National Water Resource Strategy, it is unlikely that this water supply will be allocated to a nuclear power station and it is unlikely that it will sustain the nuclear power station for the duration of its lifetime.

Desalinisation
This alternative presents a guaranteed source of fresh water supply for the lifespan of the proposed nuclear power station without jeopardising the availability of freshwater to other users. A desalinisation plant is therefore the preferred alternative for the provision of fresh water at Duynefontein.

10.23.2.2 Thyspunt

The site falls within the Fish-Tsitsikamma Water Management Area, but large quantities of water are imported from the Upper Orange River Water Management Area. According to water requirement projections in Appendix D of the DWA's National Water Resource Strategy, DWAF (2004), there is no water allowance for power generation for this WMA. Potential alternative sources of freshwater, as discussed below, were considered.

Aquifer
According to Eskom (Services Report), large quantities of ground water are available in aquifers underlying the Thyspunt region. Existing boreholes are currently used as a source of potable water for the residential areas of Humansdorp, St. Francis Bay and Oyster Bay. Oyster Bay is totally reliant on groundwater as a source of freshwater. There are a number of existing licensed boreholes that could be used for water supply for the proposed NPS during the initial construction stages until freshwater supply can be provided via other sources.

Kouga Local Municipal water supply system
Water for the Thyspunt site can be drawn off the municipal feeder main at St Francis Bay, which will require the installation of a pipeline along the proposed access road to the Thyspunt site. There is a spare capacity of 79 l/s available on this line, and the portion of this capacity for use at the nuclear power station is still to be determined by the Kouga Municipality.

Orange River scheme
Another alternative is to source fresh water from the Orange River scheme via Port Elizabeth. However, the total capacity available for use for the proposed nuclear power station is currently unknown. In the event that this source is used for the proposed nuclear power station, it may be possible to place the reservoir at the existing St Francis reservoir rather than on the site.

Desalinisation
This alternative presents a guaranteed source of fresh water supply for the lifespan of the proposed nuclear power station without jeopardising the availability of freshwater to other users. A desalinisation plant is the preferred alternative for the provision of fresh water at the Thyspunt site.

10.23.3 Utilisation of Abstracted Groundwater

Groundwater will have to be abstracted at both alternative sites in order to allow the excavation for the construction of a platform for the Nuclear Island.

(a) Transfer to the municipal sewage system

Given that the abstraction of water will occur over a relatively short period of time, it is not feasible to construct pipelines to transfer the water to the local municipality. This alternative is neither sustainable, nor cost effective and is therefore not recommended.

(b) Storage and utilisation

The abstracted water can be stored in dams/ ponds on site and utilised during the construction phase of the nuclear power station for example, dust suppression. It should be noted that storage dams/ ponds exceeding 10 000 m^3 will require authorisation from the DWA. This is the preferred alternative, as it is allows for the effective utilisation of resources. Based on the amount of available space of low environmental sensitivity on the sites it may be possible to allow for some storage of groundwater.

(c) Discharge to sea

Should Eskom not be able to use the full volume of abstracted groundwater for human consumption or for construction, it will be discharged into the sea, which is then deemed the most judicious alternative.

10.23.4 Disposal of Brine

The following two potential alternatives for utilising/discarding the brine emanating from the desalinisation plant during the construction and operational phases of the nuclear power station are considered feasible:

- Disposal of brine at a disposal site; and
- Disposal of brine directly into the sea during construction and operation (preferred).

(a) Disposal of brine directly into the sea (during construction and operation)

During the construction phase, the brine will be released into the surf zone. The physical mixing with surrounding sea water will result in dilution to 1 g/ℓ above ambient salinity within 110 m from the point of release. According to the Marine Biological Assessment (**Appendix E15**), any ecological impacts will be focused within the water column due to the high energy of the surf zone. However, the long-term direct disposal of the brine into the ocean, without prior dilution, will induce a significant impact on the marine environment in the long term meaning that this alternative is acceptable for the construction phase only.

However it is the recommendation of this EIR that during construction, limited volumes of hypersaline effluent (brine) must be released beyond the surf zone via an angled diffuser, 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 high volume of 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 the operational phase.

10.23.5 Intake of seawater

(a) Utilise the existing intake structures located at KNPS

This alternative is applicable to the Duynefontein site only. It is proposed that the new nuclear power station will be located adjacent and to the north of the existing nuclear power station, which obtains water from an existing harbour. The utilisation of the harbour at KNPS is not considered feasible because the current KNPS intake structure does not have the capacity to support the proposed Nuclear-1.

(b) Installation of intake tunnels and inlet structure

This alternative entails the installation of undersea pipelines, which feed cooling water into a storage area (intake basin). According to the Marine Biology Assessment, (**Appendix E15**) this alternative is preferred, as the impacts are minimised in comparison with the development of a new harbour. In conclusion therefore, the installation of intake tunnels is the only feasible alternative for both alternative sites.

10.23.6 Marine outfall

(a) Near shore outfall structure

Nearshore release does not facilitate mixing of the water, while release outside of the surf zone allows the heated water to rise to the surface layer and spread laterally. Thus, nearshore cooling release is not recommended for the Duynefontein site. At Thyspunt, however, it has been confirmed by the marine specialist (Appendix E15) that a nearshore outlet would result in an acceptable level of mixing.

(b) Offshore outfall tunnels

Offshore outfall tunnels would prevent warmed water being released at a single point source (the more release points, i.e. the more outlet pipes and perforated openings, the better) and would release the cooling water above the sea bottom to minimise thermal pollution of the benthic environment. Mixing is further enhanced by the buoyancy of the warm water, which causes the water to rise. This design will have less potential impact on the benthic environment than a channel release and is therefore the preferred alternative. Offshore release is recommended for the Duynefontein site. All releases need to occur at the appropriate distances as described by the marine specialists.

Despite this assessment and the fact that the offshore and nearshore outlet pipes have an acceptable impact from a marine ecological point of view, it is the recommendation of the EAP that offshore outlet tunnels be authorised as part of the application in order to further limit the impact on the marine environment at Thyspunt and Duynefontein.

10.23.7 Management of spoil material

(a) Spoil discarded at sea

The spoil can be hydraulically pumped offshore, where it will be discarded into the sea. According to the marine biologist, discarding of a small portion of spoil that would affect only 3 km² is permissible at all three sites, since movement patterns in the sea would allow for sufficient dilution of the spoil (**Appendix E16**), provided that the recommended depth of disposal and pumping rates are adhered to.

(b) Use of spoil for development of rock retaining walls

The rock spoil can be used to construct rock retaining walls, which will serve to stabilise landforms. However, the quantity of spoil required to construct the rock retaining walls may be insignificant in comparison to the amount of spoil available for use. Thus, there will be an excess of spoil, which means that this alternative should be pursued in conjunction with other suitable alternatives.

(c) Use of spoil for development of terraces

The spoil can be used to construct the terraces of the nuclear plant. The terraces require engineered fills in order to create a stable platform that is not subject to wind erosion.

(d) Commercial uses for spoil

In accordance with the principle of optimal utilisation of resources, it may be possible to sell the spoil to landscapers or other potential buyers. However, due to the infestation of portions of the Nuclear-1 properties by invasive alien species such as Acacia cyclops (Rooikrans), this alternative may result in the exportation of propagules of these species to other areas.

In conclusion, based on the findings of the oceanographic modelling (Prestedge at al. 2009) and the marine impact assessment (**Appendix E15**), it is proposed that as much as possible fine spoil must be disposed of in the marine environment, according to the recommendations of the marine sediment study and the marine biology study. The recommendations of these studies with regards to the distance offshore and pumping rates must be strictly adhered to. The remainder, which cannot be pumped to sea, must be used for activities like levelling of the HV Yard to the greatest extent possible, to avoid the need to dispose of spoil in discard dumps on land (applicable to Thyspunt only).

10.23.8 Nuclear plant types

Pressurised Water Reactors are the most commonly used nuclear reactors both nationally and globally. The existing KNPS uses PWR technology and it is therefore a tested form of power generation that has been operating safely since 1984. Eskom is familiar with the technology from an environmental, health and safety and an operational perspectives.

10.23.9 Position of the nuclear power station on the sites

Preliminary envelopes, within which the power station footprints could be located, were developed for each site. These envelopes were provided to the specialists and were subsequently refined to address some of the issues and concerns that the specialist raised during the specialist integration workshop held on the 25 August 2008 and at a second integration meeting with a smaller group of specialists held on 26 September 2008. Areas of highest sensitivity were discussed with the specialists during the November 2009 integration meeting. Their sensitivity maps (refer to the individual specialist reports Appendices E2 to E27) were overlaid to produce composite sensitivity maps for the sites, shown below. The least sensitive areas of each of the alternative sites are indicated on these maps.

For the alternative sites, the area within 800 m from a public road was excluded from consideration in the EIA and HV Yard corridors as no public access is allowed within the Exclusion Zone (EZ) of the Emergency Planning Zone (EPZ), which is expected to be at least 800 m from the proposed nuclear power station.

From an environmental perspective the specialists collectively recommended that the following areas not be considered as suitable for the construction of a nuclear power station:

- The area between the low and high water mark and then 200 m inland from the high water mark to allow for the maintenance of ecological corridors, whilst also limiting

the potential impact on the sensitive mobile dunes and heritage features along the shoreline of all sites (refer to Section 5.5); and
- The area within 100 m from the high water's edge of any wetland.

Figures for the combined overlaid sensitivity maps for all the sites are contained in Chapter 9 and Appendix A.

At the Duynefontein site the area considered to be suitable for the construction, operation and decommissioning of a nuclear power station is a 156.51 ha area on the eastern side of the EIA and HV Yard corridor, adjacent to the existing KNPS. Only the flora and invertebrate specialists have indicated that this area is environmentally sensitive. From an invertebrate perspective the specialist has indicated that there is a high level of confidence that, while similar habitat outside the area is limited, the species present (including the undescribed ant species), are adequately represented in other habitats on the site.

The transverse dune system at Duynefontein is endemic, with this system being poorly represented on the Cape West Coast. However based on further studies and additional field work subsequently conducted at the Duynefontein site (2015 Botanical Dune Report – **Appendix E11**), suggested a reappraisal situation, due to the stabilisation of the mobile dunes in close proximity to the existing KNPS. Two factors are paramount to this reappraisal: (i) the substantial loss in dune mobility due to development in the south, coupled with increases in vegetal cover have meant the dune can no longer function in its pristine state and (ii) development would be localised to vegetated parts of the dune system, permitting the remaining small mobile system in the north to function in the long term, albeit artificially restricted. Therefore it is possible to encroach onto the southern portion of the dune system (closer to Nuclear-1 site), with certain provisos in place. However, to maximise the land use and to also be in line with the EIR approach to keep out of the mobile dunes habitat as much as possible, the mobile dune system will not be affected.

At the Thyspunt site the area considered to be suitable for a nuclear power station is 225 ha (174 ha for the main plant and 51 ha for the HV Yard). None of the specialists have indicated that the recommended footprint area for the power station is environmentally sensitive. The findings of the extensive surveys conducted, including a trial excavation program (2011) indicated that it is possible to position the proposed nuclear-1 power station in such a way that physical impacts to heritage sites of an archaeological nature are minimised.

It must be noted that the above are only recommendations regarding the areas suitable for the construction of a nuclear power station at any one of the alternative sites and that the final positioning will be determined taking the following aspects into consideration:

- Should the DEA authorise the construction of a nuclear power station at any one of the alternative sites, associated conditions of authorisation would need to be taken into account.
- Appointment of the vendor and results of any further detailed geological conditions.

10.23.10 The Potential for Additional Nuclear Power Stations per Site

The area of the footprint assessed in this EIA makes provision for the potential future expansion of the power station, should this be environmentally or technically feasible at that stage. It is estimated that the total footprint required for Nuclear-1 (4 000 MW) (this application) is 200 to 280 hectares and the current application for Environmental Authorisation is therefore for 4 000 MW only. If it were to be considered to add nuclear units or an entirely new power station, such additions would be subject to a separate EIA process.

It must be emphasized that the current application is for a single nuclear power station of two to three units with a total installed capacity not exceeding 4 000 MWe. The cumulative impacts of any additional nuclear power stations or additional nuclear units on a particular site (if authorised) would have to be confirmed in a new EIA process prior to any further development. If it were to be considered to add nuclear units or an entirely new power station, such additions would be subject to a separate EIA process.

10.23.11 Access to the Sites

Existing off-site access routes will be used and upgraded for the Duynefontein site, but the Thyspunt site will require significant upgrading of existing public roads. Three alternative on-site routes are under consideration at Thyspunt: an eastern, western and northern access route. The northern access road was rejected for environmental reasons. The environmental impacts associated with the route identification for Thyspunt's new access route formed part of this EIA process. Four options for the Western Access Road were initially considered, namely W1, W2, W3 and W4. W1 to W3 all originate to the west of Umzamowethu (between Umzamowethu and Oyster Bay), whilst W4 originates from the Humansdorp-Oyster Bay road to the east of Umzamowethu. W4 was initially rejected by the biophysical specialists on the basis of its potential impact on the western portion of the Oyster Bay Mobile Dunefield and associated sensitive ecosystems, its crossing of a drainage line and its length. Of W1, W2 and W3, W1 was preferred by the majority of the specialists.

In recognition of I&AP concerns about the western access road received during the 2011 round of public comments on the Revised Draft EIR (Version 1), new alternative alignments for the Western Access Road were investigated. These alternatives focused on aligning the Western Access Road to the east of Umzamowethu to prevent the road creating a divide between Umzamowethu and Oyster Bay. A number of alternative alignments to this road were investigated in late 2012 and the inland alternative furthest from Oyster Bay (IR2) has been subsequently recommended. This alignment has some biophysical impacts but not of such significance that they constitute fatal flaws.

As stated earlier the Thyspunt site requires transport route upgrades with regard to public roads, access and emergency evacuation during the construction phase. The R330 is now proposed to be used only for passenger vehicle traffic and abnormal load transport, and sections will require upgrading for this purpose. The Oyster Bay Road is now proposed to be upgraded to a surfaced road to be used during the construction and operations phases for staff access and heavy vehicle traffic and as an emergency evacuation route for areas such as Oyster Bay. The DR1762, which links the R330 and Oyster Bay Road is now proposed to be surfaced to provide improved east-west connectivity. Bypass roads to the east and west of Humansdorp are also now proposed to be constructed to reduce the traffic impact on central Humansdorp. Consequently heavy construction vehicles accessing the Thyspunt site will not have to travel through the centre of Humansdorp

10.24 No-go alternative

Given the urgent power demand based on economic growth in South Africa, the No-Go alternative is not considered to be a feasible and realistic alternative. As indicated in the need and desirability section (Chapter 4 of this EIR), there is a proven need to additional generation capacity in South Africa to ensure that there is sufficient electricity available over the next 20 years.

South Africa, would in all likelihood, have to adapt the IRP to develop more coal-fired power stations if the No-Go alternative for the proposed nuclear power station is adopted, as this is the only alternative proven base load generation option available in South Africa. It would not be economically viable (and difficult to finance these projects as banks are becoming reluctant to finance such projects) to develop more coal-fired power stations in the future, due to carbon taxes that are likely be imposed on countries that continue to emit greenhouse gases.

The No-Go alternative would imply that potential benefits, as listed below, that emanate from the proposed project would not be realised:

- The supply of base load power from diverse, secure, sustainable energy sources, which have relatively low greenhouse gas emissions;
- The reduction of coal fired contributions to power generation that would be in line with Eskom's long-term strategy to diversify its primary energy requirements, and reduce greenhouse gas emissions;
- Reduction in transmission line losses; and
- The use of uranium, which (apart from coal) is the only primary energy source in South Africa that is suitable and commercially available in sufficient quantities for base load power generation.

This EIR does not suggest that the current (No-Go) situation is without negative impacts of its own. Indeed, the majority of the biophysical specialists have indicated that there are significant current sources of environmental degradation around the sites that would be likely to continue. Thyspunt is a case in point, where recent development (in terms of urban development and golf estate development) have resulted in significant degradation and destruction of heritage sites, wetlands and portions of sensitive mobile dune systems. Analysis of these development trends, according to the specialists, shows no indication that the no-go alternative would result in these impacts slowing down or ceasing.

It should further be noted that should Eskom not utilise the sites for nuclear development, it is likely to sell the properties, pending a decision by the Eskom Board. The sale of the properties will be to a willing buyer at the market-related price, which would probably result in an alternative form of land use that may have environmental impacts of its own. Until the KNPS is decommissioned, the no-go alternative is also not a realistic alternative at Duynefontein.