

## 8 DESCRIPTION OF THE EXISTING ENVIRONMENT

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### 8.1 Physical environment: Duynefontein

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#### 8.1.1 Geology

The stratigraphy for Duynefontein is typical of the Cape Peninsula and the southern West Coast. The existing NPS at Duynefontein is underlain by the Neoproterozoic rocks of the Malmesbury Group, intruded by the late Neoproterozoic Cape Granite Suite and Cretaceous dolerite dykes. Some 40 km to the south, the high topography of the Cape Peninsula is composed of the overlying Palaeozoic rocks of the Table Mountain Group. Most of the coastal plain around the site is covered with Cenozoic-age sand (**Figure 8-1** with legend depicted in **Figure 8-2**)

Only the Tygerberg, Moorreesburg and Franschhoek Formations of the Malmesbury Group crop out within the Duynefontein Site Vicinity. The Moorreesburg Formation consists of a succession of gritstone, limestone, quartz schist and some greywacke that are complexly deformed. The Tygerberg Formation constitutes a relatively monotonous succession of deepwater, turbiditic meta-sediments folded into simple folds, and is generally highly weathered. The Franschhoek Formation is confined to the south-eastern part of the Site Vicinity, between Malmesbury and Klipheuwel

A swarm of dykes traverse the coastline between Milnerton and Bloubergstrand and a dyke also occurs within the Site Area of Duynefontein. These form part of extensive suite of dolerite dykes that intruded throughout the southwestern Cape and along the Atlantic margin during the Early Cretaceous.

#### 8.1.2 Seismological risk

The primary hazard considered in terms of Seismological risk is 'Local vibratory ground motion' resulting from geological events (fault rupture), which, in terms of its potential consequences, constitutes the most serious geo-scientific threat to a NPS. The geo-scientific assessment<sup>1</sup> that forms part of this EIA therefore aims to provide evaluations to obtain an estimate of the seismic hazard including safe shutdown earthquake ground motion, the hazard for deformation at or near the surface and permit adequate engineering solutions to actual and potential geologic and seismic effects at the three proposed sites.

The existing Koeberg NPP has a 320 km regulatory radius (in terms of Seismological risk) which includes both Bitterfontein and Oudtshoorn, and implies that its regional area of investigation contains some of the most faulted parts of the Cape Fold Belt, namely the western branch and the syntaxis, with current prominent seismicity in the Ceres–Tulbagh area.

The site further lies within 20 km of one of the most important NW-SE trending zones of faulting in the SW Cape, namely the Vredenburg-Stellenbosch fault zone and its related faults, many of which are of appreciable displacement. These faults have been active from the Saldanian Orogeny (ca. 550 Ma – 500 Ma ago) to the Mesozoic breakup of Gondwana.

Seismic Hazard Analysis was previously undertaken for the three sites (including Duynefontein) by the Council for Geoscience (CGS), employing a probabilistic SHA (PSHA) methodology called the Parametric-Historic PSHA.

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<sup>1</sup> Geo-scientific investigations are guided by Nuclear Regulatory Codes, especially U.S. Nuclear Regulations, which is regarded as the most rigorous and conservative international regulatory framework available, and requires geological and geophysical investigations of increasing resolution in concentric regulatory radii of 320, 40 and 8 km around each proposed site.

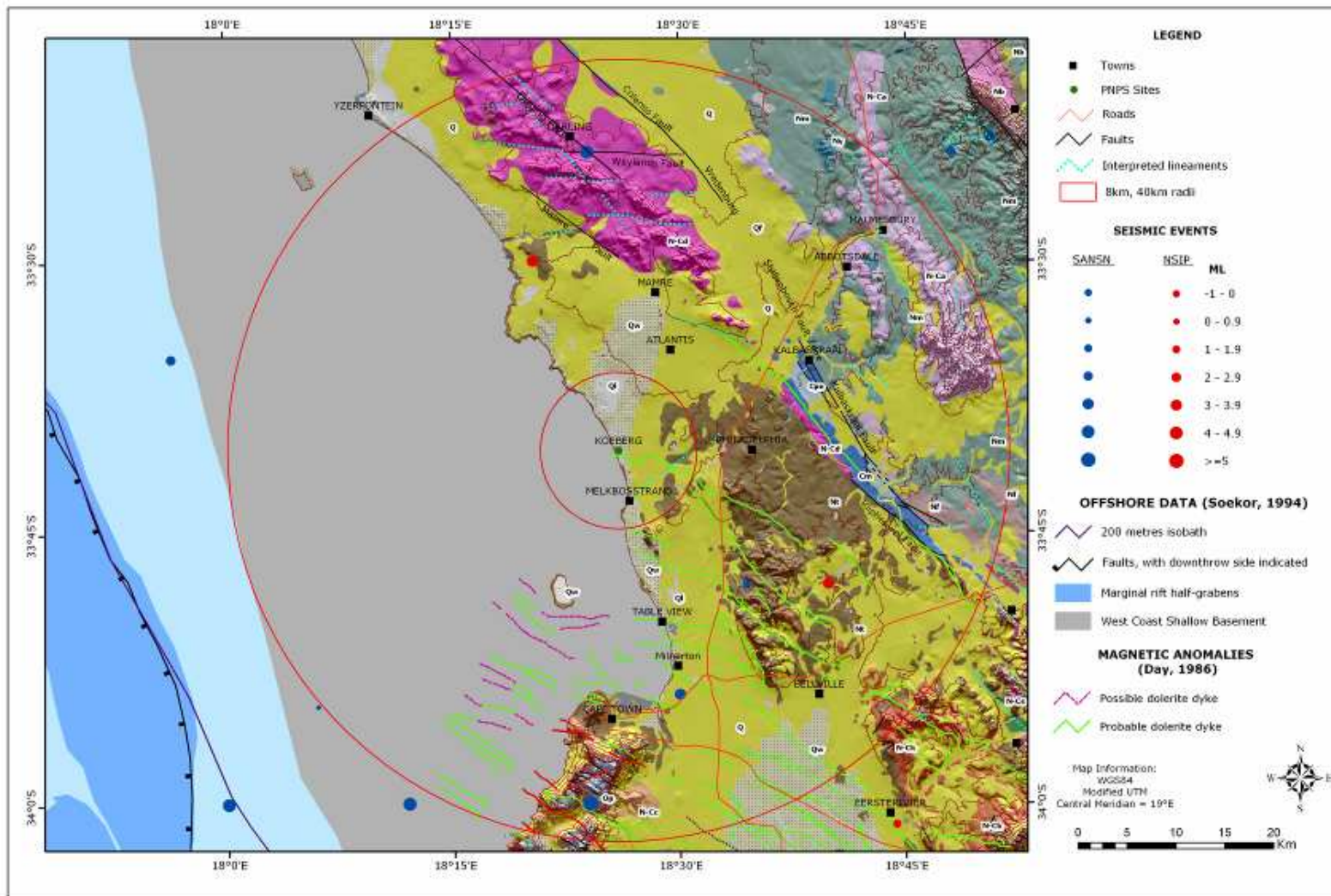
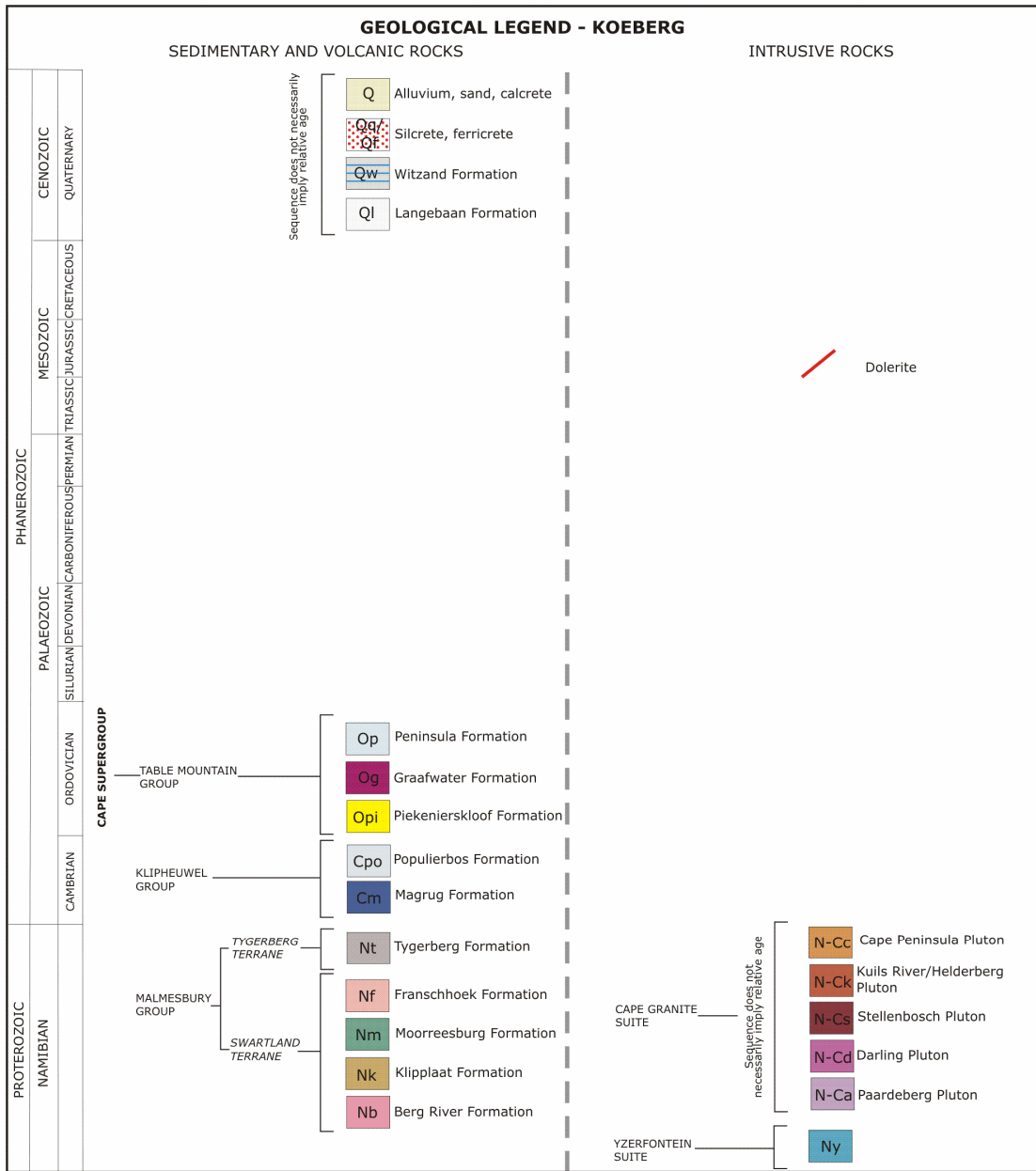


Figure 8-1: Geological map of Dwynefontein and environs



**Figure 8-2: Legend for the Duynefontein geological map**

The development of the Parametric- Historic PSHA methodology by the CGS was motivated by the uncertainty and incompleteness of the seismic catalogue. Following a review of this methodology, it was pointed out that the Parametric-Historic SHA methodology used to calculate these baseline figures does not fully conform to the latest guidelines set out by the US Nuclear Regulatory Commission (USNRC). The review therefore required that an appropriate PSHA be carried out as defined by the Senior Seismic Hazard Analysis Committee (SSHAC) in the United States. After the conclusion of a SSHAC Level 3 study the results will form the new baselines in an updated Chapter of a Site Safety Report (SSR). However, the baseline values which are presently available to rank the sites for suitability are the results obtained from the Parametric-Historic methodology, with a PGA value of 0.3 g calculated for the Duynefontein site.

The value does not exceed the PGA of 0.3 g typically used in the seismic design of NPSs, although the value at the Duynefontein site at the 0.3 g threshold. This will necessitate additional geological investigations and implementation of an advanced PSHA that will follow internationally accepted practice, and in particular, will conform to the requirements of a Level 3 study as defined in the SSHAC Guidelines. The above will not only confirm the reliability of the above result, but may increase or decrease this value.<sup>2</sup>

### 8.1.3 Geotechnical suitability

Geotechnically speaking, Duynefontein is characterised by the following:

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

### 8.1.4 Dune geomorphology

There is a large dunefield at Duynefontein that forms part of the Atlantis corridor dunefield ( **Figure 8-3**), which formed during the Holocene. The dunefield is mostly naturally vegetated, consisting of parabolic dunes. The patches of mobile transverse dunes are naturally unvegetated. The transverse dunes move northward, driven by the dominant southerly wind. The alternation of vegetated and unvegetated dunes is due to sand being supplied to the dunefield in pulses. The patches of mobile transverse dunes have been artificially vegetated in places, mostly in the southern end. The Duynefontein EIA corridor lies at the southern end of this dunefield. Koeberg NPS was constructed on the southern extremity of the dunefield during the mid-1980s. This has to some extent disturbed the dunefield dynamics and cut off the source of sand in the southern portion of the dunefield.

### 8.1.5 Hydrology

The site is located within the Berg River Water Management Area and within the West Coast Rivers sub area. This catchment has negligible yield from surface water and is entirely reliant on groundwater and water transfers. Uncertainties include the groundwater potential as well as the possible impacts of coastal resorts on the primary aquifers (use and pollution). Furthermore, the recharge of these aquifers is low due to the low precipitation in the area. Saline intrusion from over-abstraction near the coast is a potential threat. The stressed nature of the catchment would require that alternative sources of water be found for the both construction and operation.

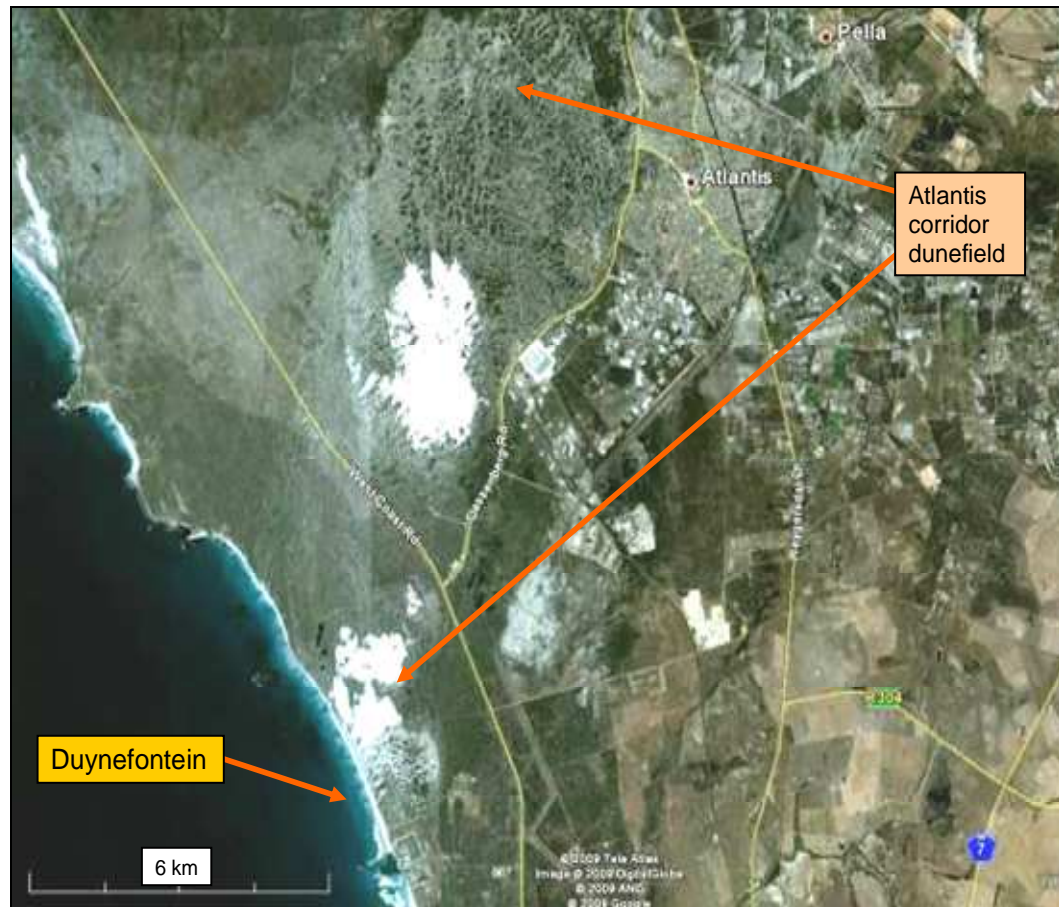
The following general comments relating to surface water features (and their potential use) can be made:

- The area is characterised with a low rainfall (mean annual precipitation less than 500 mm) and besides the Salt River, Diep River and minor pans and dams, there are no notable surface water features; and
- The drainage lines are non-perennial and flow manifests as sheet flow during major storm events.

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<sup>2</sup> This is true for all sites.

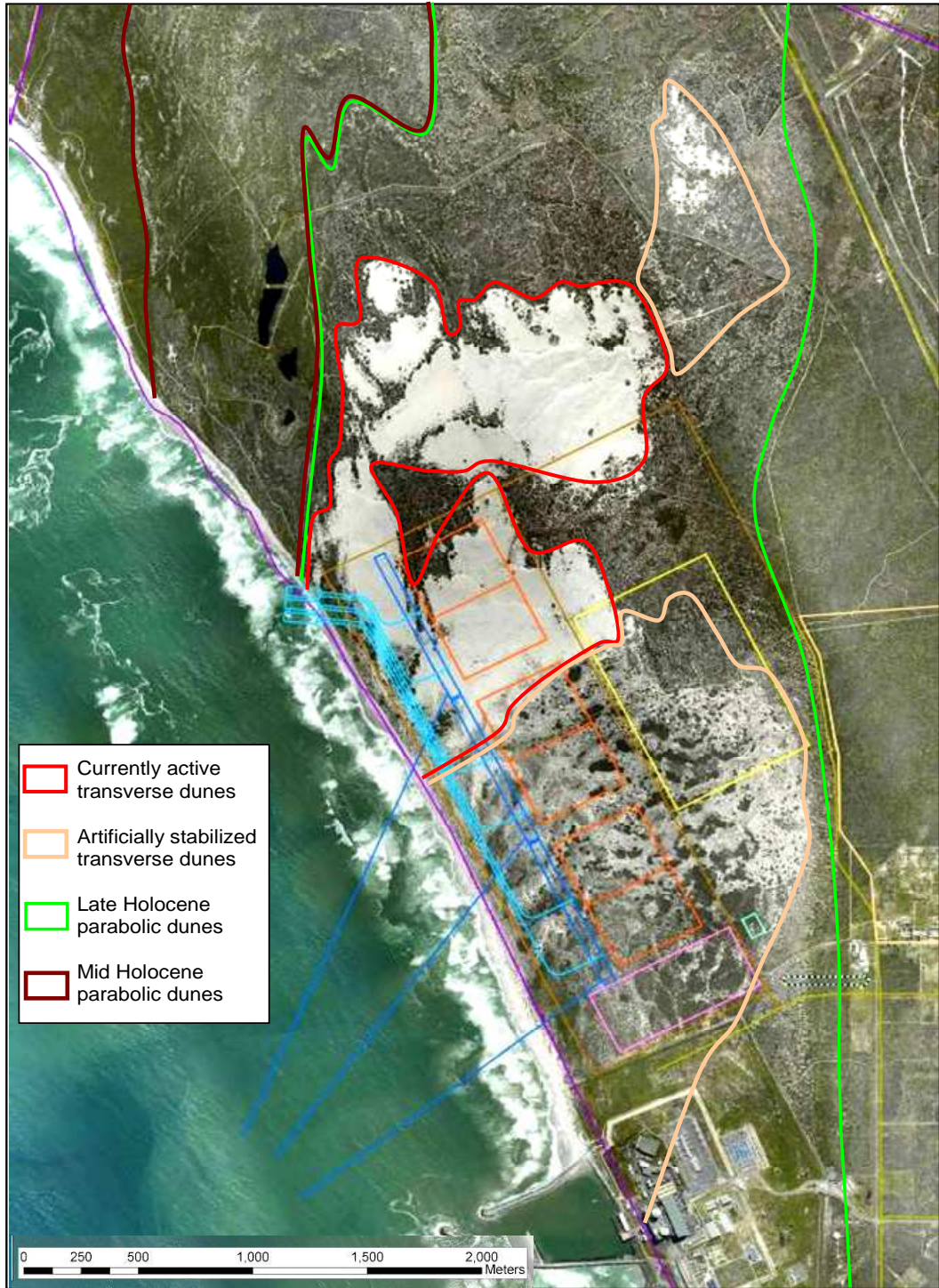
Based on an analysis of extreme high water levels, and taking into account possible climate change, it is recommended that the floor level of the plant should not be lower than 8.9 m amsl.



**Figure 8-3: Atlantis corridor dunefield in relation to the Duynefontein site**

### 8.1.6 Geohydrology

The site overlies two aquifer systems, namely the southern extent of the upper intergranular Atlantis Primary Aquifer (Atlantis Aquifer) and the deeper weathered, fractured-rock (secondary) aquifer system of the Malmesbury Group. The thickness of the primary aquifer at the site varies between 17 and 25 m, as the rest groundwater level is some 2 to 5 m below ground level (mbgl) and the overall thickness of the sediments is between 14 and 27 m. The results of the various drilling programmes at the site indicate a profile consisting of 3 to 4.5 m of slightly calcareous sand, becoming organic rich with shell fragments below 7.5 m. The lower profile consists of pebbly sand grading into gravels. The secondary aquifer is a semi-confined system which is considered to be in hydraulic connection with the overlying primary aquifer. These two aquifer systems are generally separated by a weathered (clay) zone in the bedrock. The clay horizon constitutes an aquitard, as it has a low permeability that retards and restricts the vertical movement of groundwater, but does not prevent the movement of the groundwater.



**Figure 8-4: Dune varieties in the Atlantis corridor dunefield at Duynefontein**

The Atlantis Aquifer is an important and significant primary aquifer with two wellfields (Witzand and Silwerstroom) managed by the City of Cape Town. The Witzand Wellfield is situated 3 km north-east of the site and supplies water to the surrounding towns, predominantly to Atlantis. This wellfield is situated in the most productive portion of the Atlantis Aquifer system. The Silwerstroom Wellfield is situated 9.5 km north of the site. Other than production boreholes at the Witzand and Silwerstroom Wellfields, there are many other existing boreholes in the area, including private production and monitoring boreholes.

Borehole yields of >10 L/s are obtained from production boreholes in the primary aquifer. Replacement boreholes in the Witzand Wellfield drilled during 1996 yielded between 16 and 18 L/s. Boreholes drilled into sands along the areas north-east of the site were reported to yield in excess of 5 L/s (Parsons,2002). Borehole yields in the range of 0.5 to 5 L/s are common in the sands underlying the existing KNPS. It is generally accepted that boreholes drilled into the secondary aquifer yield considerably less than the primary aquifer, i.e. <2 L/s.

The water table ranges between 2 and 5 m below ground level. The depth to groundwater mimics surface topography. Seasonal and tidal impacts are the dominant factors influencing local groundwater level fluctuations. Groundwater flows in a south-westerly direction towards the coast.

According to the DWA *Quality Guidelines for Domestic Water Supplies* (DWA 1998), the electrical conductivity ranges for groundwater from the site are classified as ideal to marginal for drinking purposes and represents slightly saline conditions. There appear to be no existing sources of groundwater contamination in the EIA Corridor Area.

### 8.1.7 Freshwater supply

The following conclusions regarding freshwater supply were reached in the freshwater supply study for Duynfontein:

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

### 8.1.8 Oceanography

Duynfontein is a highly exposed section of sandy coastline. The site is characterised by a shallow sloping sandy beach with a reasonably stable sediment transport regime. The site is underlain by the rocks of the Malmesbury Group of Precambrian age at a depth of between 5 and 12m below Chart Datum (CD) (PRDW, 2008e).

#### a) Beach profile and bathymetry

The characteristic profile is a steep drop off at the beach edge followed by a gradually sloping area reaching 30 m approximately 3 km from the shoreline. The bathymetry adjacent to the site is shown in **Figure 8-5**.

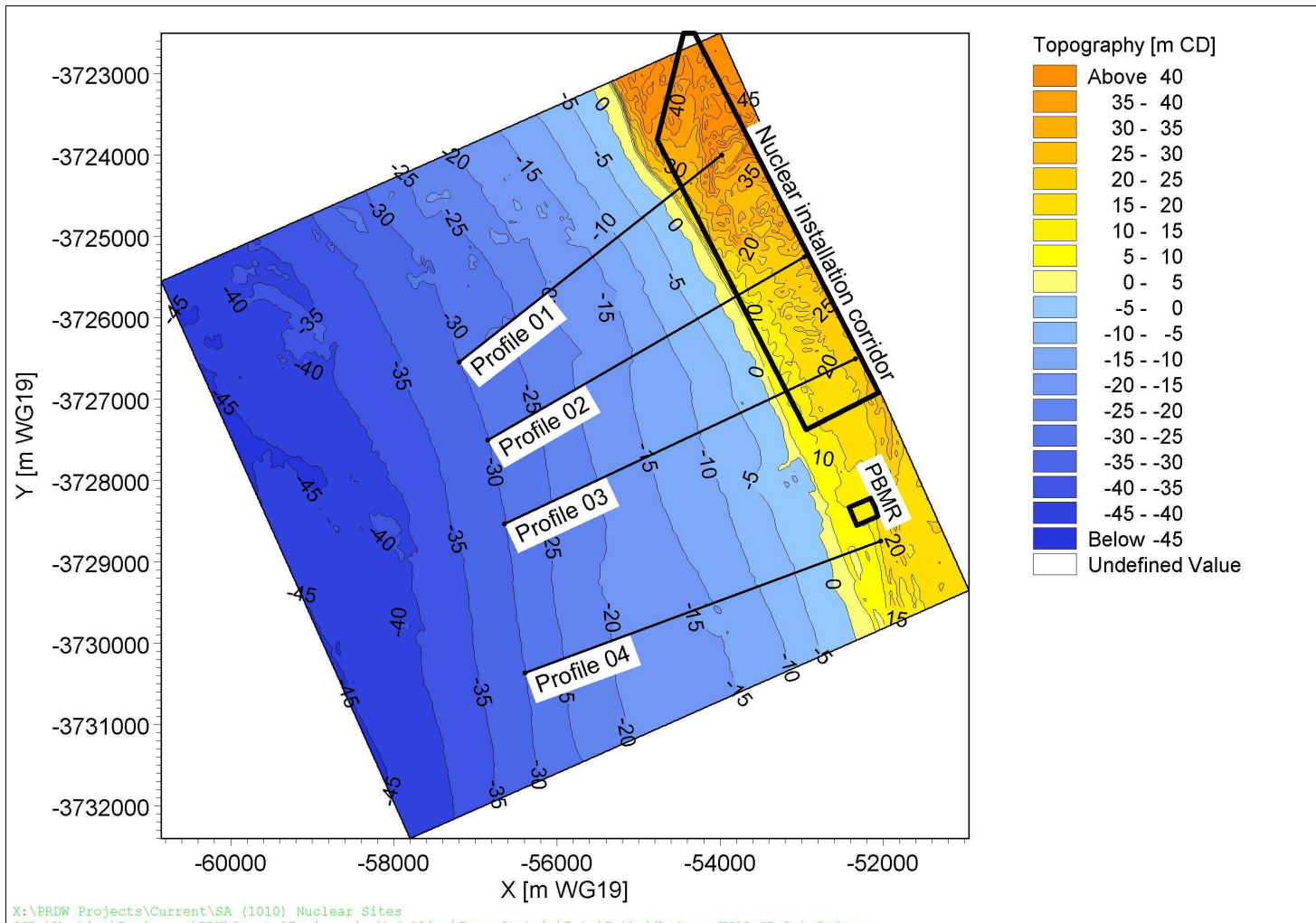
## **b) Currents**

The currents at Duynefontein are predominantly wind-driven. The currents near the surface reach 1 m/s and have a dominant direction of 340°, in response to the dominant southeasterly winds. The currents near the seabed are weaker and the directions are more evenly distributed between northward and southward.

## **c) Coastal erosion**

Three contour lines (the vegetation line, the high water mark and the +5 m MSL contour line) were digitised on each of the available geo-referenced aerial photographs. Generally, the beaches to both the north and south of the existing Koeberg site appear to be dynamically stable for the period of observation from the aerial photographs. An accretional trend is evident on the northern section of Van Riebeeckstrand, while some erosion is evident on the Ou Skip north beach.





**Figure 8-5: Profile locations and bathymetry for Bantamsklip**

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## 8.2 Physical environment: Bantamsklip

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### 8.2.1 Geology

The geology at Bantamsklip (**Figure 8-6** with legend in **Figure 8-7**) is typical of the Cape Peninsula and the southern West Coast. resistant Palaeozoic quartz arenites of the Table Mountain Group build the mountainous topography to the north of the site, whereas the low-lying areas are underlain by poorly exposed, low-grade metasedimentary (locally metavolcanic) rocks of the Malmesbury Group that are extensively covered by sand along the coast. There are apparently no dolerite dykes in the area, but a suite of Late Cretaceous-age alkaline rock types occurs offshore to the SE of the site.

There are five main geological sequences exposed in the Site Vicinity Area, namely the:

- Poorly exposed, late Precambrian-age Malmesbury Group;
- Intrusive Cambrian-age Cape Granite Suite, which is associated with the Malmesbury sediments and crop out in the deeply incised valleys and plains;
- Early Palaeozoic-age Cape Supergroup which extends over the largest part of the map area;
- Mesozoic-age Enon Formation in the Elim area; and
- Late Cenozoic-age Bredasdorp Group along the coast and vicinity.

### 8.2.2 Seismological risk

The Bantamsklip site is situated in a fractured part of the Cape Fold Belt, called the syntaxis where NE–SW trending faults dominate. NW-SE to WNW-ESE trending faults are less common and occur near the northern boundary of the 40 km regulatory radius, as well as NE of the site. Much evidence for neotectonic activity was found in previous investigations but only some of this evidence has been verified. The extensive sand cover and lack of good outcrops over known faults of Mesozoic age within 8 km radius inhibits surficial palaeoseismic investigations. There is therefore currently no measurable evidence available of Quaternary activity and large ( $M > 6$ ) events on any faults in the radius of the site.

The seismicity in the Bantamsklip area thus seems to be very low compared to many other parts of the CFB. The only event recorded in the immediate vicinity of Bantamsklip is located east of Hermanus and may be related to activity along a major E-W fault in that area. This was an ML 0.7 event on 4 July 2000 along the Walker Bay coastline. The maximum credible earthquake for each seismogenic zone in the Cape Low province formed part of the deterministic seismic hazard for Bantamsklip and shows that the main seismic hazard contribution comes from the background seismicity of the Cape Low. From this it was determined that the maximum credible earthquake of magnitude  $6.60 \pm 0.3$  can occur at the Bantamsklip site.

In terms of the Seismic Hazard Analysis undertaken by the CGS, the PGA for the Bantamsklip site is 0.23 g.

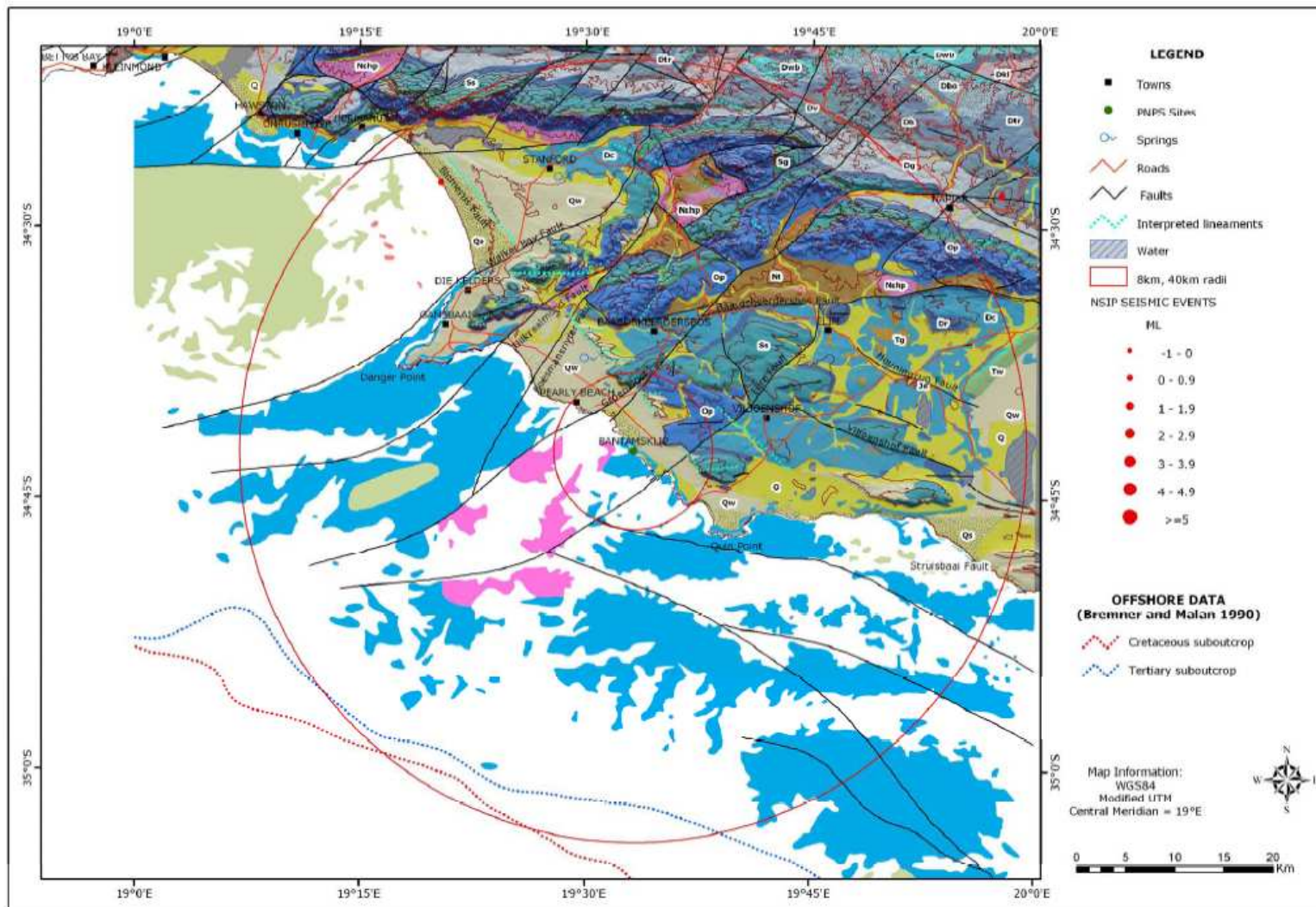


Figure 8-6: Geological map of Bantamsklip and environs



### 8.2.3 Geotechnical suitability

Geotechnically speaking, Bantamsklip is characterised by the following:

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

### 8.2.4 Dune geomorphology

Transgressive dunefields occur along the coast in the Bantamsklip area (Figure 8-8). They consist mainly of transverse dunes, which are mostly artificially stabilised with alien vegetation such as Rooikrans and some indigenous species. There are no currently mobile dunes on the site. There are some much older naturally vegetated fossil parabolic dunes formed during the previous interglacial (~ 120 000 years ago). There are no interdune wetlands in the dunefield at Bantamsklip and groundwater does not “daylight” at the site. Thus there are no impacts related to the interaction between groundwater and dune dynamics at this site.

### 8.2.5 Hydrology

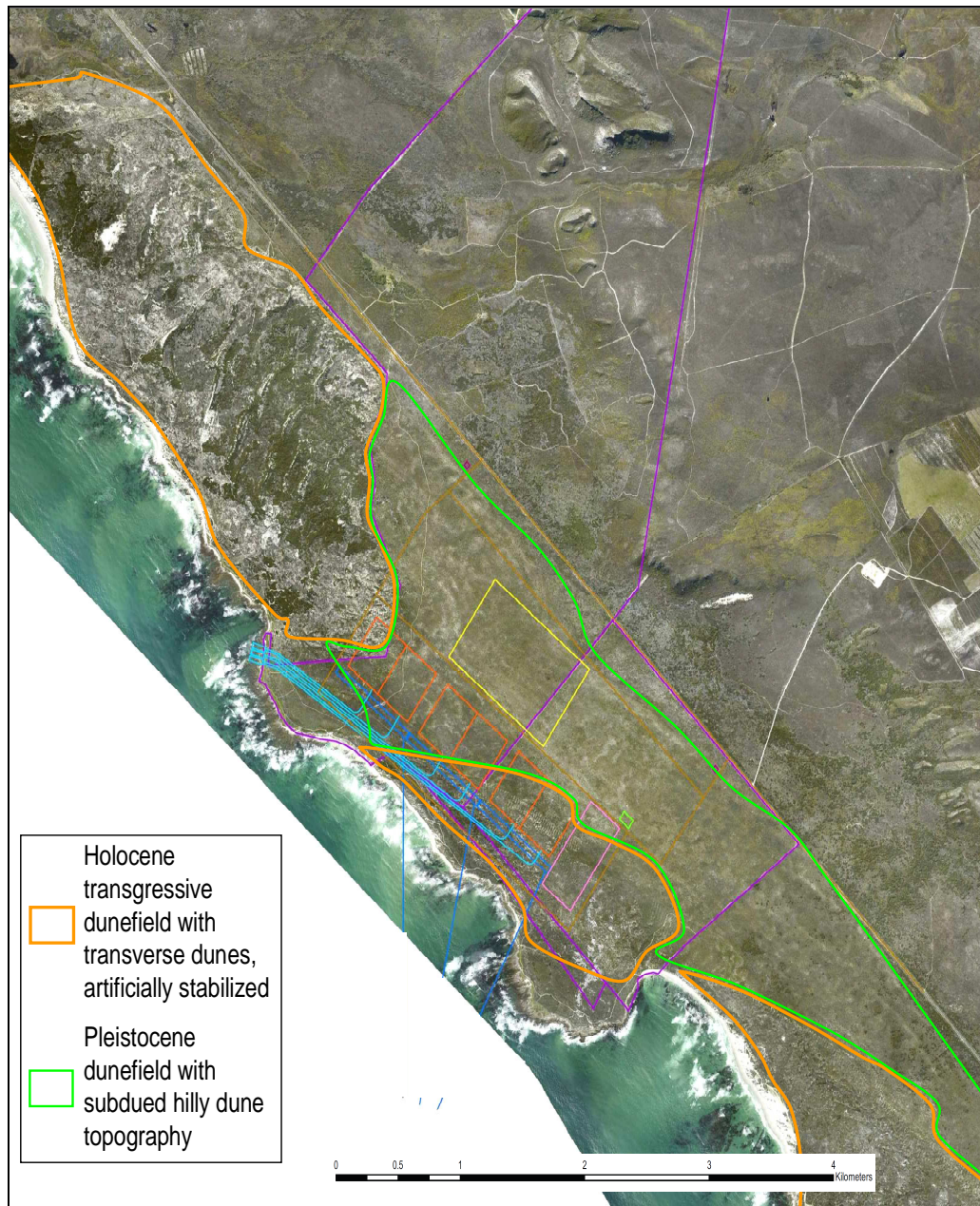
Bantamsklip is located within the Breede River Water Management Area and within the Overberg East sub area as is defined in the Integrated Strategic Perspective (ISP) for the Breede River Water Management Area. The stressed nature of the catchment would require that alternative sources of water are found for both construction and operation. Development opportunities exist but need to be further investigated with the DWA. Water quality needs to be investigated when possible suitable sources are identified

The following general comments relating to surface water features (and their potential use) can be made at this preliminary stage:

- The area is characterised with a low rainfall (MAP less than 600 mm) and besides the Haelkraal, Koks, Wolfgat and Ratel Rivers, and surrounding marshes, there are no further notable surface water features.
- The drainage lines are non-perennial and flow as sheet flow during major storm events.

No long-term precipitation records are available at Bantamsklip, but gauges were installed in January 2008. These records do not present sufficiently long data records to be included in this study. Records from nearby weather stations indicate a mean annual precipitation of between 447 to 546 mm.

Based on an analysis of extreme high water levels, and taking into account possible climate change, it is recommended that the floor level of the plant should not be lower than 8.9 m amsl.



**Figure 8-8: Dune varieties at Bantamsklip**

### 8.2.6 Geo-hydrology

Three aquifers occur in the Bantamsklip area.

Firstly, the Bredasdorp Group of semi-consolidated aeolian sand with calcrete lenses (Waenhuiskrans Formation) is deposited on a wave-cut platform of Table Mountain Group rocks. Unconsolidated sand with shell fragments (Strandveld Formation) occurs along the beaches. The Waenhuiskrans Formation varies in thickness from 4-6 m at the coast, to ~20 m at the R43 turn off to Pearly Beach and ~30 m in the north-eastern corner of the site. The majority of boreholes drilled into the Bredasdorp Aquifer were dry.

Secondly, the Table Mountain Group Aquifer consists mainly of quartzitic sandstone of the Peninsula Formation. These rocks are exposed along the coast and in the more elevated area to the northeast of Pearly Beach. \

Thirdly, the Cape Granite Suite Aquifer occurs as outcrops of the Hermanus Granite Pluton at the Donkergat headland at the eastern edge of Pearly Beach and further inland along the Hagelkraal River on the farm Groot Hagelkraal.

The Bredasdorp Aquifer and Table Mountain Group aquifers are both classed as having median borehole yields of 0.5 to 2.0 L/s, excluding the dry boreholes. Groundwater is encountered in the fractured and weathered granite, but yields are low and are generally not more than 1 L/s.

Groundwater levels in the Bredasdorp Aquifer range from ~3 m bgl close to the coast, to between ~7 and 8 mbgl inland and to between ~0 and 3 m bgl near the Hagelkraal River north of the R43. Groundwater in the Table Mountain Group Aquifer is generally of a deep inland but on the coastal plain and wave cut platform at the site the groundwater levels are within ~5 m of ground surface. Groundwater levels range between 2.9 mbc at the shoreline to 48.1 mbc further inland.

Over most of the study area, groundwater quality in terms of EC is in the range of 70 to 300 mS/m. Better quality groundwater (EC <70 mS/m) is associated with the TMG in the mountains to the north. Based on site work carried out during the EIR, there appear to be no existing sources of contamination at the site, which is located in a pristine area. As there are no existing contamination threats, the quality of groundwater at the site represents ambient conditions.

### **8.2.7 Freshwater supply**

The following conclusions regarding freshwater supply were reached in the freshwater supply study for Duynfontein:

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

### **8.2.8 Oceanography**

Bantamsklip is situated on a coastal plain with an elevation of less than the 60m amsl, situated to the south west of a discontinuous line of hills which lies parallel to the coast at a distance of 4 to 5 km.

The Bantamsklip site is situated on a highly exposed section of rocky coastline and is stable with respect to marine sediment dynamics. The two rocky headlands form an isolated cell with no sediment feeds or losses into or out of the cell. There are no rivers feeding significant sand volumes in the vicinity and despite the high wave energy and extensive offshore sandy seabed, the actual net long shore transport rate is expected to be negligible due to the near perpendicular approach of deep sea waves to the coastline. A redistribution of sand deposits

is expected to occur under storm conditions and high concentration of sediments in the breaker zone.

**a) Beach profile and bathymetry**

A number of cross-sections have been taken along the Bantamsklip site coastline. Beach slopes for each of the cross-sections have been assessed (**Figure 8-9**).

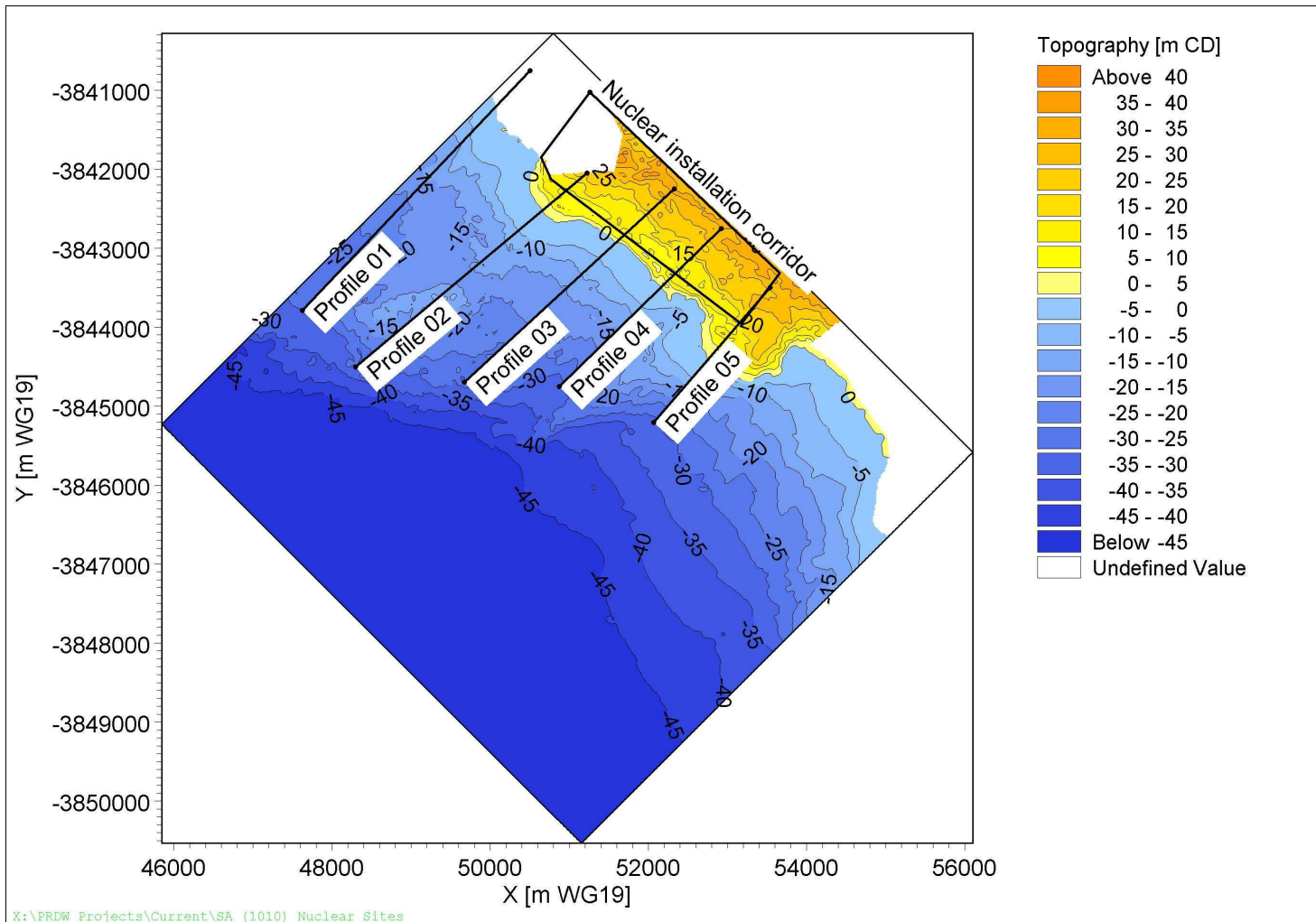
**b) Currents**

The currents show evidence of forcing by winds, waves and tides. The current speeds are moderate with a maximum speed of 0.73 m/s measured to date. Currents near the seabed are approximately half as strong as near the surface. The current direction show a high degree of variability, including predominantly north-westerly current near the surface to easterly current near the seabed.

**c) Coastal erosion**

Three contour lines (the vegetation line, the high water mark and the +5 m MSL contour line) were digitised on each of available geo-referenced aerial photographs. Though signs of both erosion and accretion are noticed in the analysis of the aerial photographs, these are believed to be indications of long term variations about dynamically stable beach shapes.





**Figure 8-9: Profile locations and bathymetry for Bantamsklip**

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## 8.3 Physical environment: Thyspunt

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### 8.3.1 Geology

The geology of the Thyspunt site (

**Figure 8-10** with legend in **Figure 8-11**) is typical of most south-eastern Cape coastal regions with a broad, raised marine platform of Miocene and Pliocene age cut into older rocks of variable resistance. None of the Precambrian rocks (i.e. Gamtoos Group and Cape Granites) outcrop in the Thyspunt Site Vicinity, but form the floor, or basement, to the mapped formations. The Gamtoos Group is unconformably overlain by the Table Mountain Group, which comprises the basal unit of the Cape Supergroup. It is predominantly composed of supermature quartzose sandstone and accumulated through marine, glacial and fluvial depositional process during the Ordovician and Silurian Periods. It is conformably superseded by the argillaceous Bokkeveld Group with the basal Ceres Subgroup unit found north of St. Francis Bay. The Cape Supergroup was intensely distorted by the Permo-Triassic Cape Orogeny, a compressional deformation event which produced the Cape Fold Belt mountain chain along the southern coast of South Africa. The northerly-directed compression resulted in widespread flexural-slip folding, commonly with fold asymmetry and décollement occurring in the upper stratigraphic units.

### 8.3.2 Seismological risk

The Humansdorp-Thyspunt area is relatively fault-free compared with other sectors of the Cape Fold Belt. The closest on-land major faults are the Gamtoos and Kouga faults, which are respectively 39-45 km and 42 km from the site. Offshore geological coverage obtained indicates two potentially hazardous offshore faults within the 40 km radius from the site. The Plettenberg fault, a 100 km long, steeply SW dipping normal fault with a throw of some 5600 m extends to within 18 km of the site.

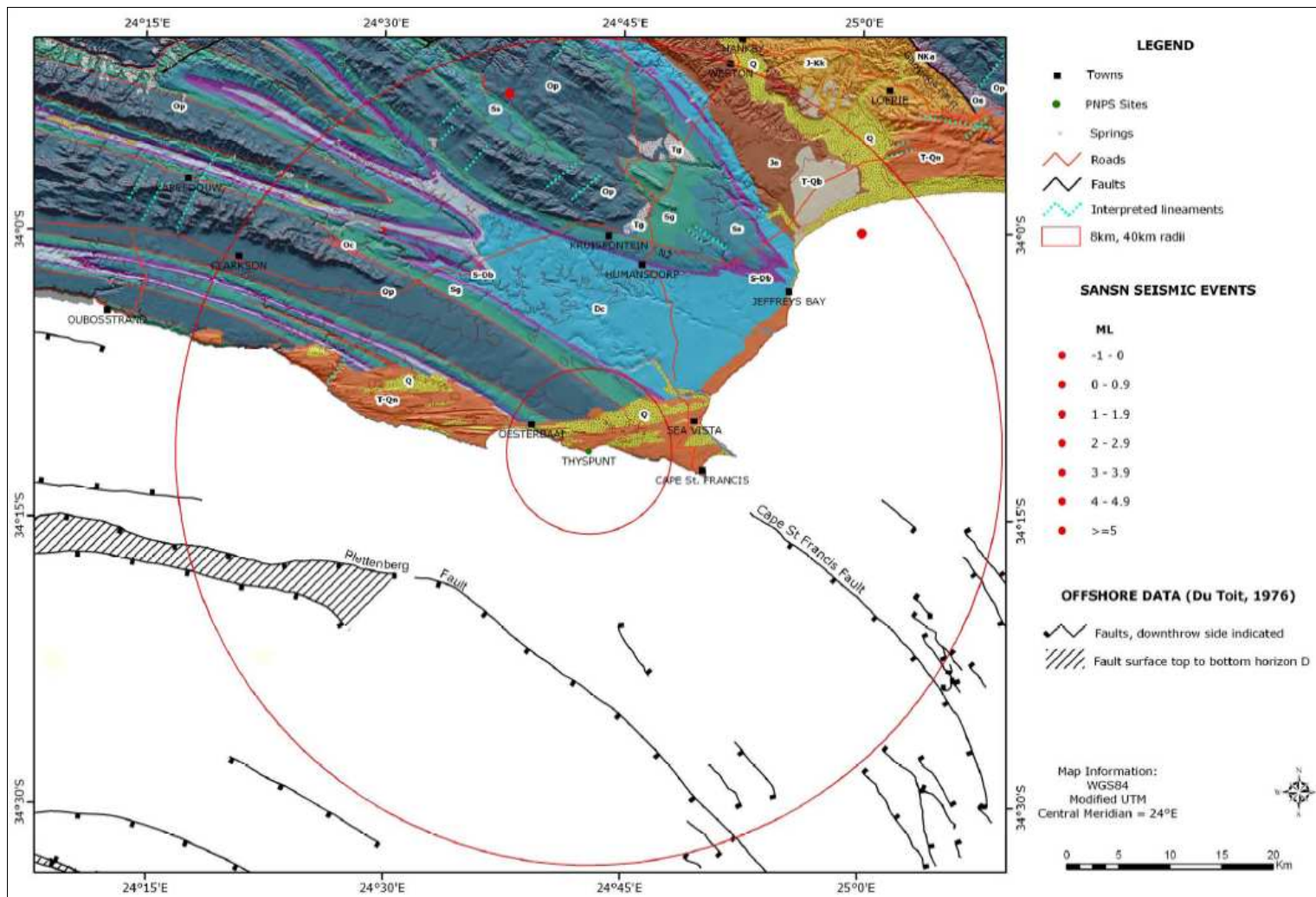
The baseline PGA value determined during the Seismic Hazard Analysis undertaken by the CGS for the Thyspunt site is 0.16 g. In the light of the uncertainty of whether the revised PSHA, as discussed in section 8.1.2, will find PGA values below 0.3 g, Thyspunt is the site with the biggest margin to accommodate change to this value. .

### 8.3.3 Geotechnical suitability

Geotechnically speaking, the site is characterised by the following:

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

- An historical erosion depression containing cobbles exists in the Goudini Formation and this cobble layer influences groundwater flow direction in a South Easterly direction.



**Figure 8-10: Geological map of Thyspunt and environs**

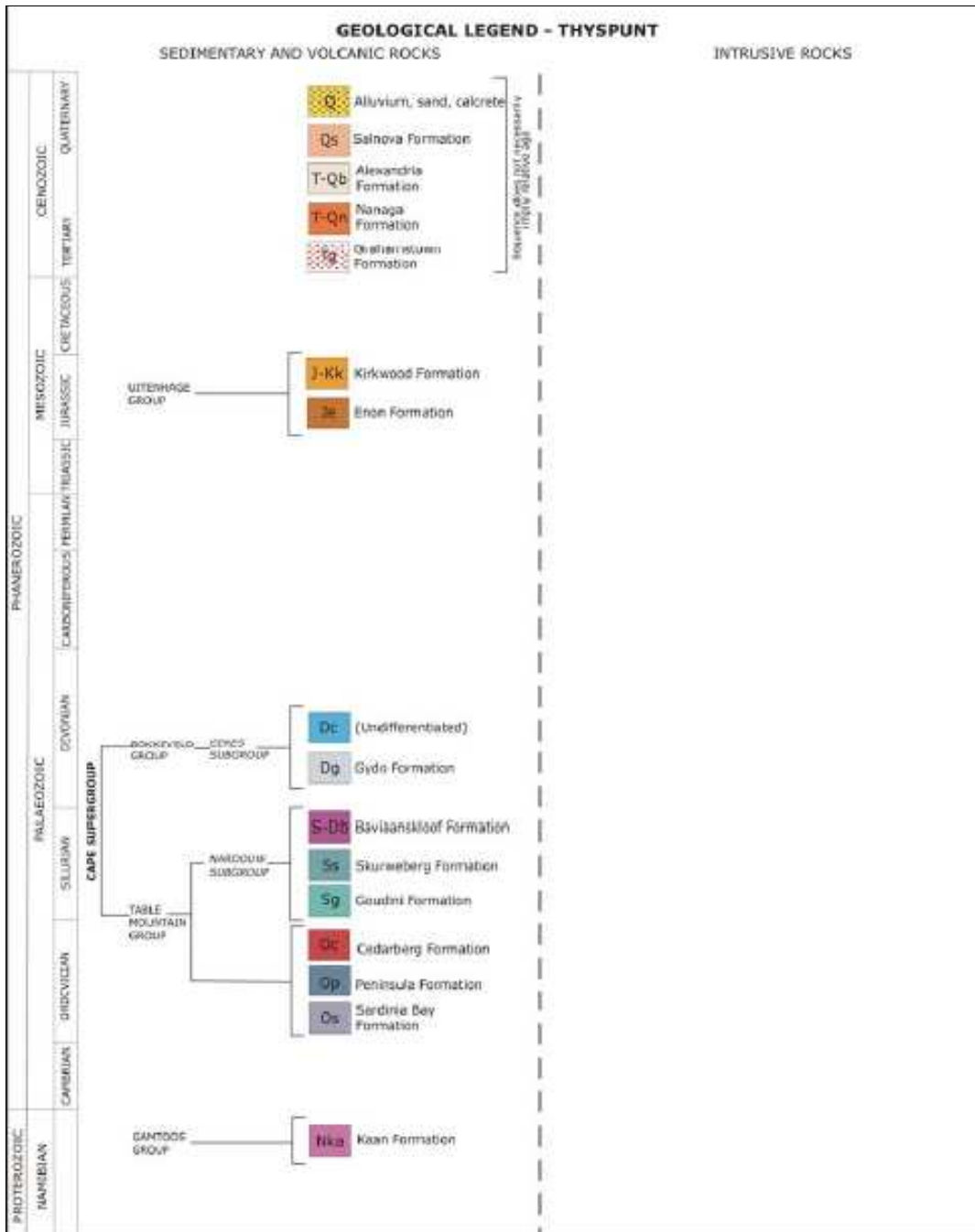


Figure 8-11: Legend for the Thyspunt geological map

### 8.3.4 Dune geomorphology

The low-relief Cape St. Francis headland hosts the most spectacular and last two remaining active examples of large-scale mobile headland-bypass dunefields on the south coast of South Africa (Figure 8-12). The corridors of transverse dunes run parallel to the dominant westerly to south-westerly wind. The mobile dunefields are very dynamic. A feature of the Cape St. Francis dunefields is the formation of pans, often 1-2 m deep, in the interdune areas during high rainfall events. The eastern third quarter of the dunefield is drained by the Sand River, which flows episodically during periods of high rainfall. Floods transport appreciable

volumes of sand to the Kromme estuary. Sand moves from west to east through these dunefields, due to the predominantly westerly winds.

Since 1942 the dunefield has become progressively more vegetated, both within the dunefield and along the northern margin. This is caused mostly by various invasive alien *Acacia* species, predominantly Rooikrans. Dune height varies along the length of the dunefield. Dunes are on average 20 m high in the west, and gradually become smaller towards the east, where the average height is 5 m.

There is only one fairly permanent river channel in the westward sloping portion of the dunefield. This is a short channel of the Penny Sands River (name introduced in this EIA process), which soaks away in the high dunes in this area. In wetland terminology this is a "channelled valley bottom wetland". The other short channels shown in the westward sloping portion of the dunefield only exist for short periods of time after high rainfall events. Groundwater "daylights" in many interdune areas within the Oyster Bay dunefield at Thyspunt to form ponds and wetlands in the interdune areas (also known as dune slacks).

### 8.3.5 Hydrology

The site is located within the Fish to Tsitsikamma Water Management Area and within the Krom-Seekoei sub area as is defined in the Integrated Strategic Perspective (ISP) for the Fish to the Tsitsikamma Water Management Area.

The following general comments relating to surface water features (and their potential use) can be made:

- The total yield from the sub-area was calculated as 47.4 Mm<sup>3</sup>/annum after transfers and return flows and the total user requirements as 46.2 Mm<sup>3</sup>/annum. The sub area is therefore approximately in balance. The 1.2 Mm<sup>3</sup> surplus is due to a surplus in the upper Krom River, which indicates additional capacity to the Nelson Mandela Metro;
- The stressed nature of the catchment would require that alternative sources of water are found for both the construction and operation phases. Development opportunities do exist but need to be further investigated with DWA. It should be noted that an NPS is classified as a strategic water user and hence would get preference over any other developments in the catchment;
- The area is characterised by a few dams on the Krom River. The most notable of these dams is the Impofu Dam. The available surface water in this region is allocated to Port Elizabeth and Humansdorp; and
- On a local scale, the site has a number of wetland areas, which are fed primarily by groundwater.

No long-term precipitation records are available at Thyspunt, with gauges only having been installed in January 2008. These records do not present sufficiently long-term data records to be included in this study. Records from nearby weather stations indicate a mean annual precipitation of between and 558 and 694 mm.

Based on an analysis of extreme high water levels, and taking into account possible climate change, it is recommended that the floor level of the plant should not be lower than 14.9 m amsl.

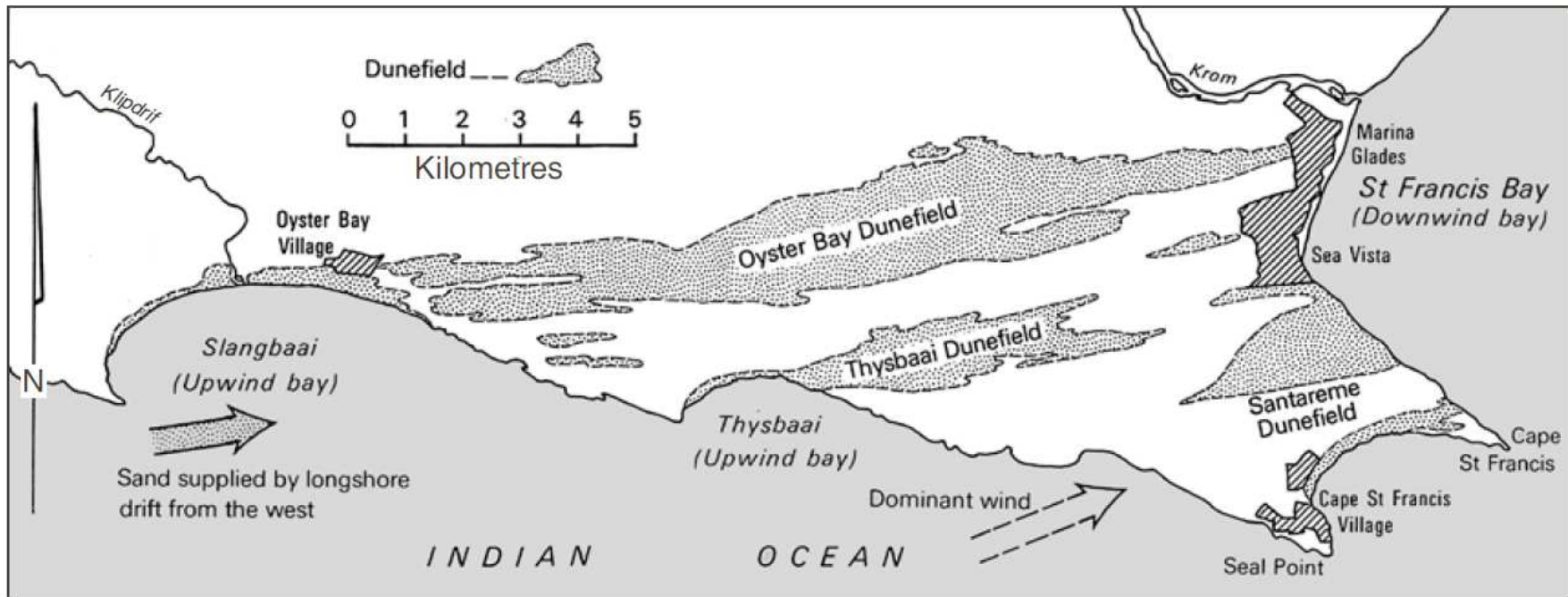


Figure 8-12: Illustration of the St. Francis headland bypass dunefield system

### 8.3.6 Geo-hydrology

The superficial deposits of the Algoa Group (the primary aquifer of the study area) are classified as a primary or intergranular aquifer. Groundwater flow and storage takes place within the original pore spaces between constituent grains. The upper boundary of the aquifer is the water table and this aquifer is therefore unconfined. Due to the rapid flow of groundwater through the Algoa Group sediments, the proximity to the coast and relative impermeability of the fractured rock aquifer, limited interconnection between the intergranular aquifer and fractured rock aquifer is envisioned in the Thyspunt area.

The detailed geohydrological study at the site has revealed evidence that the intergranular aquifer can be characterised as an economically viable aquifer. As such this aquifer can be utilised as a potential water supply source during construction and possibly as a domestic water supply source for the proposed nuclear power station.

Boreholes drilled in the Algoa Aquifer revealed high blow yields ranging from 5 to 10 L/s, especially where the basal cobble layer is well developed. In comparison, boreholes that only intersected the fine grained sand revealed much lower blow yields, from 0.1 to 0.8 L/s. Yield testing of the latter boreholes, however, also showed that much larger volumes of water can be abstracted from the aeolian sands. Boreholes with aeolian sands, as well as the cobble layer gave moderate to high yields (from 2 to 5 L/s).

Formations in the Table Mountain Group yielded moderate to high yields. The Nardouw Aquifer, for instance, was intersected just below the Algoa Group. This aquifer is highly fractured with water bearing fractures encountered at depths varying from about 20 to about 110 m below ground level. The fractures are moderate to high yielding, ranging from 2 to less than 5 L/s.

There appear to be no existing sources of contamination within the EIA Corridor. However, there may be potential sources up-gradient and to the north, e.g. fertilisers, animal wastes, septic tanks, etc. The site is located in a pristine area. As there are no existing contamination threats, the quality of groundwater at the site therefore represents ambient conditions. Measured electrical conductivity values in the groundwater vary from 51 mS/m to 82 mS/m (relatively good quality) and the pH values are neutral to slightly alkaline, varying from 7.1 to 7.9. There was no indication of a freshwater-saline interface that should theoretically be present at the coast.

### 8.3.7 Freshwater supply

The following conclusions regarding freshwater supply were reached in the freshwater supply study for Thyspunt:

- There is extensive use of groundwater in the surrounding area;
- There are coastal springs at the site;
- The surrounding towns are supplied with water from the Churchill and Impofu Dams and from groundwater;
- There is scope for further development of local groundwater resources for construction supply both on-site and in the surrounding area;
- Local and regional surface water resources are under stress and additional draw-off to supply a NPS would exacerbate this situation;
- The main option for surface water supply with least local and regional impact is import of water from the Orange River Scheme;
- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change; and
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This option would have the least environmental impact and is Eskom's preferred option for fresh water supply.



### 8.3.8 Oceanography

The Thyspunt site is located on an exposed section of coastline that faces towards the prevailing south westerly deep sea swell. This is a highly stable section of coastline with respect to marine sediment dynamics. The significant headlands of Seal Point and Cape St. Francis form an isolated coastal cell with sediment feeds or losses unlikely to occur into or out of the cell from the adjacent sections of coastline. There are no major rivers discharging into this section of coastline.

#### a) Beach profile and bathymetry

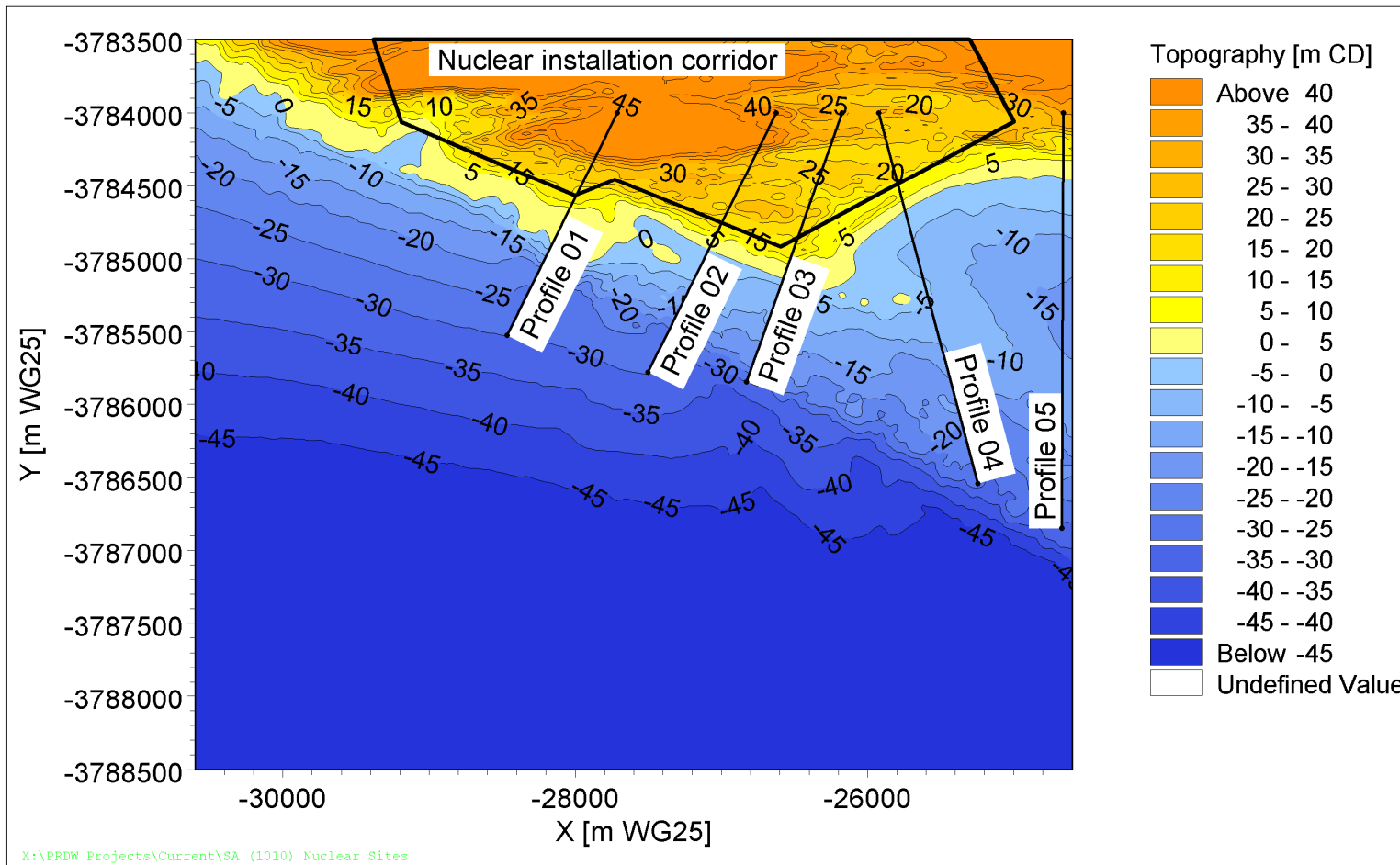
A number of cross-sections have been taken along the Thyspunt site coastline. The Bathymetry of the seabed adjacent to the Nuclear Installation Corridor is shown in **Figure 8-13**.

#### b) Currents

Currents have been measured at the Thyspunt site starting in February 2008 at two sites. The dominant current direction is towards the east and the current speeds are moderate near the surface and low near the seabed.

#### c) Coastal erosion

Three contour lines (the vegetation line, the high water mark and the +5 m MSL contour line) were digitised on each of the available geo-referenced aerial photographs. For Slangbaai and Thysbaai, the closest beaches to the nuclear installation corridor, though signs of both erosion and accretion are noticed in the analysis of the aerial photographs, these are believed to be indications of long term variations about dynamically stable beach shapes.



**Figure 8-13: Profile locations and bathymetry for Thyspunt**

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## 8.4 Biophysical environment: Duynefontein

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### 8.4.1 Air quality and climate

#### a) Land use and topography

Land use in the immediate vicinity of the Duynefontein site is characterised by industrial activity in the form of Koeberg (an existing NPS). No industrial air pollution sources other than the Koeberg NPS exist in the immediate Duynefontein area. Industrial processes are present at Atlantis (Open Cycle Gas Turbine Power Station, brickworks and other smaller commercial activities) about nine km northeast, landfill operations at Vissershok (5 km southeast) and a Petroleum refinery (21 km south-southeast of the Duynefontein site). Vehicles along the main roadways (e.g. R27) and nearby residential areas also contribute to the airshed, especially oxides of nitrogen. Large tracts of cultivated land extend ~5 km to the east of the site. The closest river to the site is the Diep River ~25 km to the south.

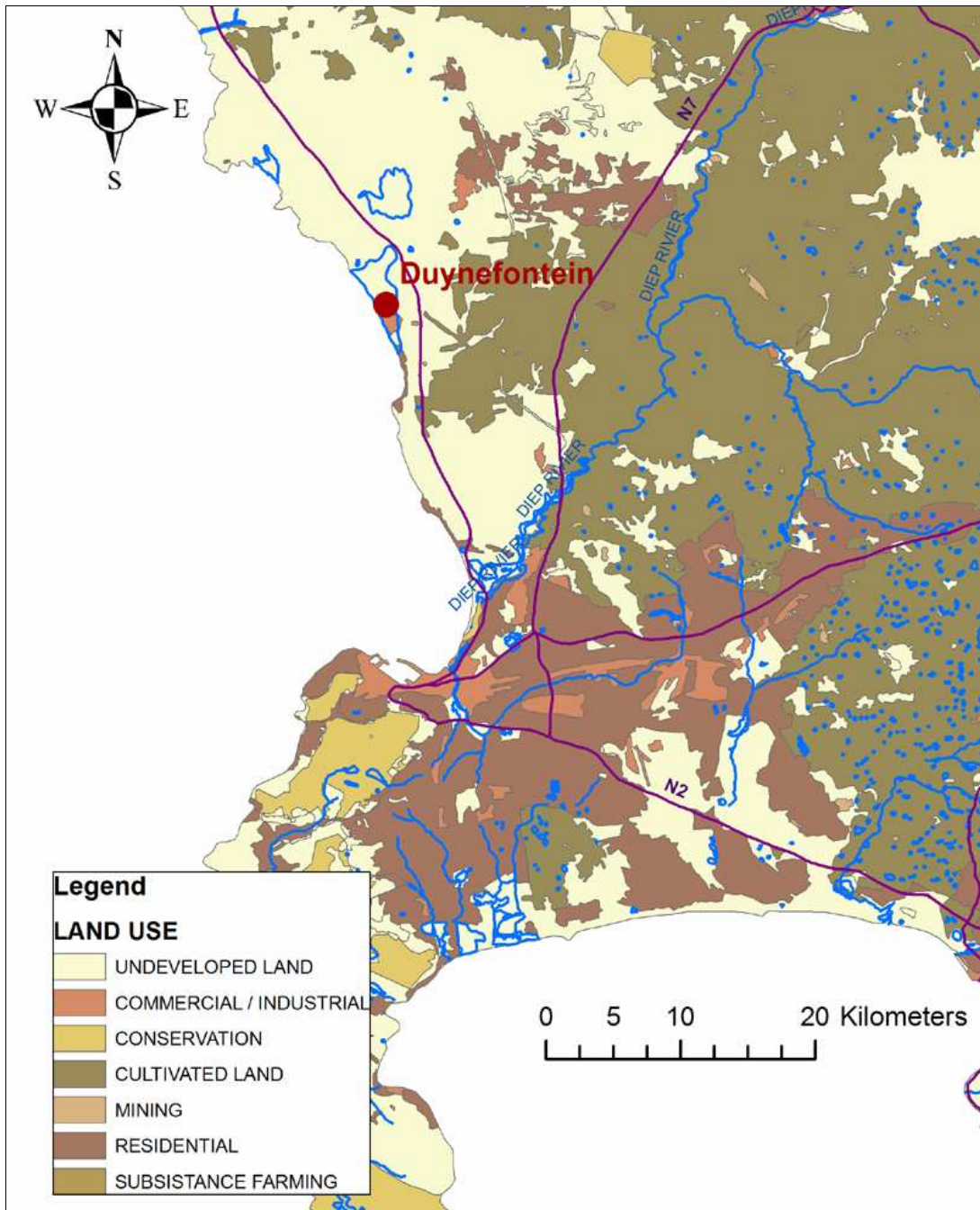
Residential areas (**Figure 8-14**) in the vicinity of the proposed operations include Duynefontein (2 km south) and Melkbosstrand (~5 km southeast). Larger residential developments within a 15 km radius are Atlantis and Milnerton. It is clear that the immediate area has a population density of less than 500 people per km<sup>2</sup> (Census data 2007, Statistics South Africa).

Although within the immediate vicinity of the site the topography is relatively undulating, the topography further away rises towards the north east (Atlantis, 200 m) with the Dassenberg to the north of the site and east (Olifantskop, 360 m) to southeast (Kanonberg, 430 m).

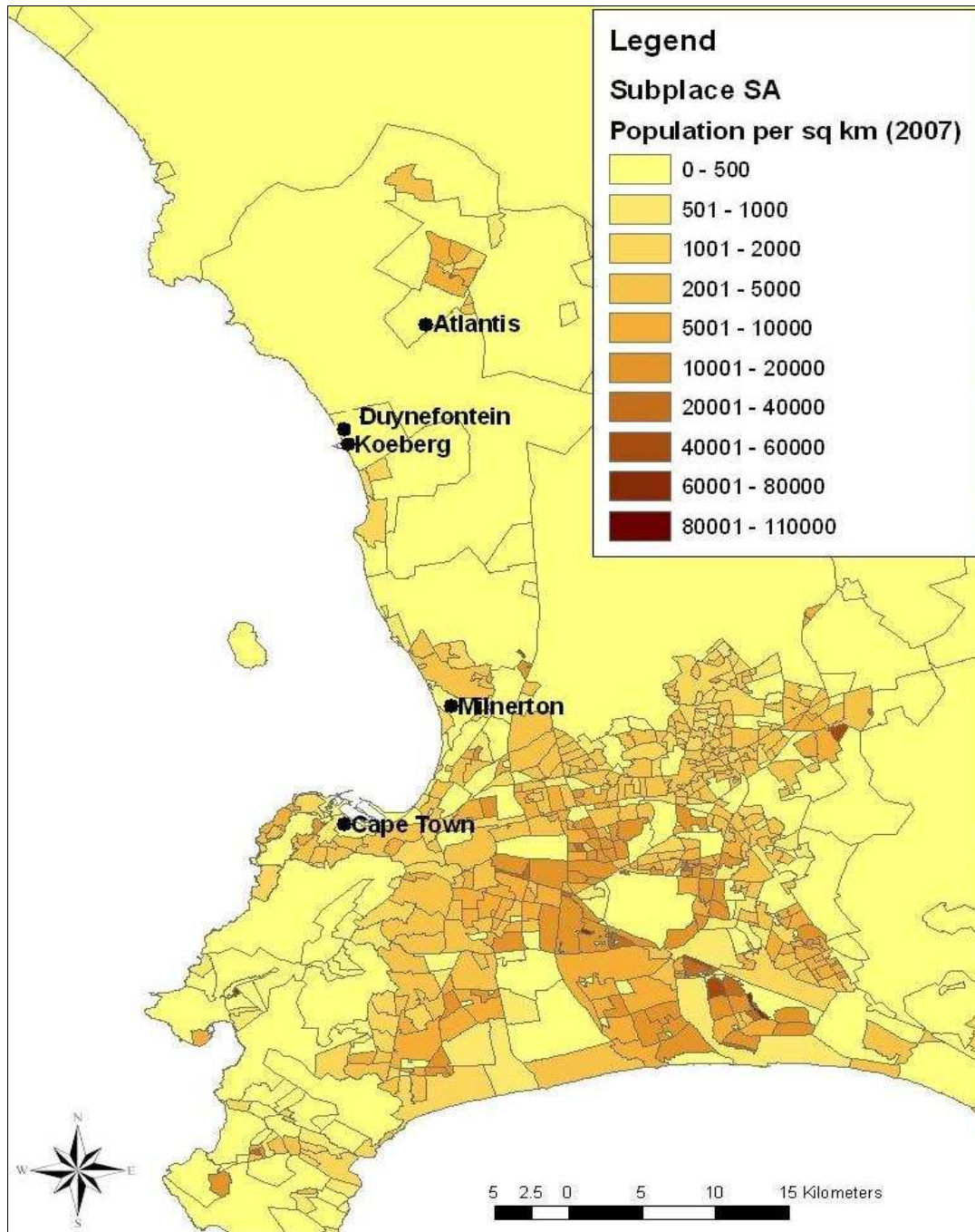
#### b) Meteorology

##### Wind Field

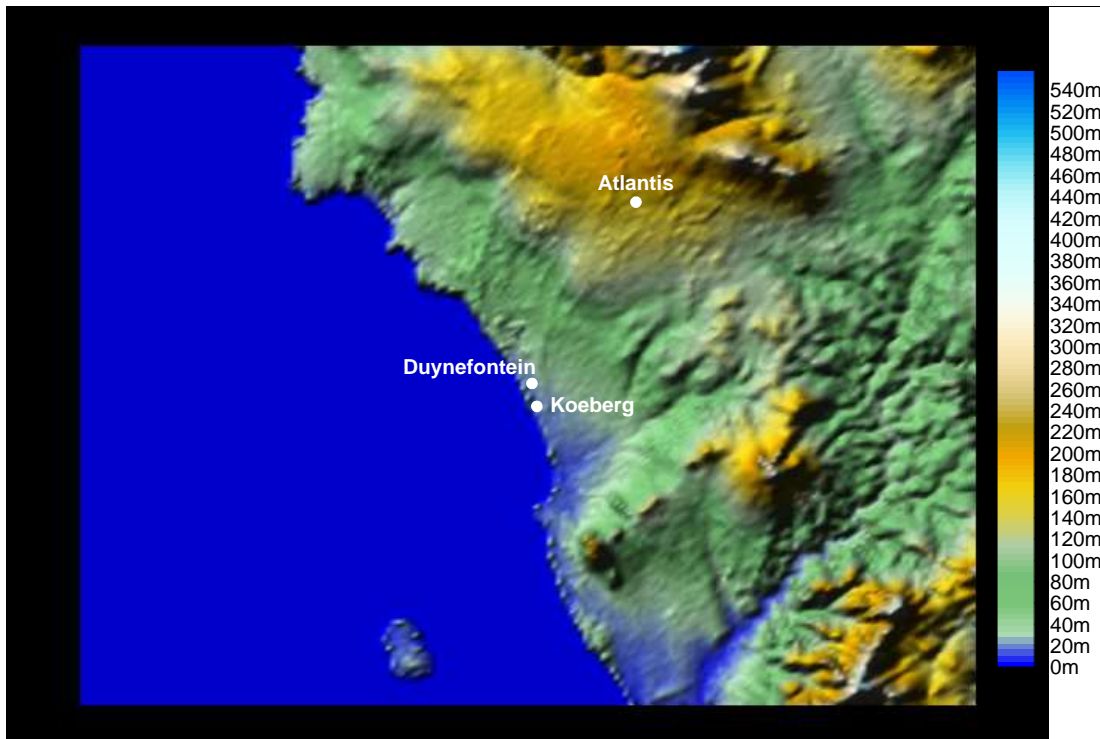
The wind roses reflecting day and night-time conditions at the Duynefontein site are given in **Figure 8-17**. The wind regime largely reflects the synoptic scale circulation. The flow field is dominated by south-easterly wind, clearly reflecting the South Atlantic High Pressure anticyclonic circulation which dominates the region throughout much of the year. Differential heating and cooling of the air along the coastline (due to the ocean and land mass) provides a characteristic diurnal shift in the wind field. Calm periods with an increase in east-northeasterly off-shore flow are more prevalent during the night-time. In contrast, an increase in westerly (on-shore) winds is observed during day-time conditions.



**Figure 8-14: Land use in the vicinity of the Duynefontein site**



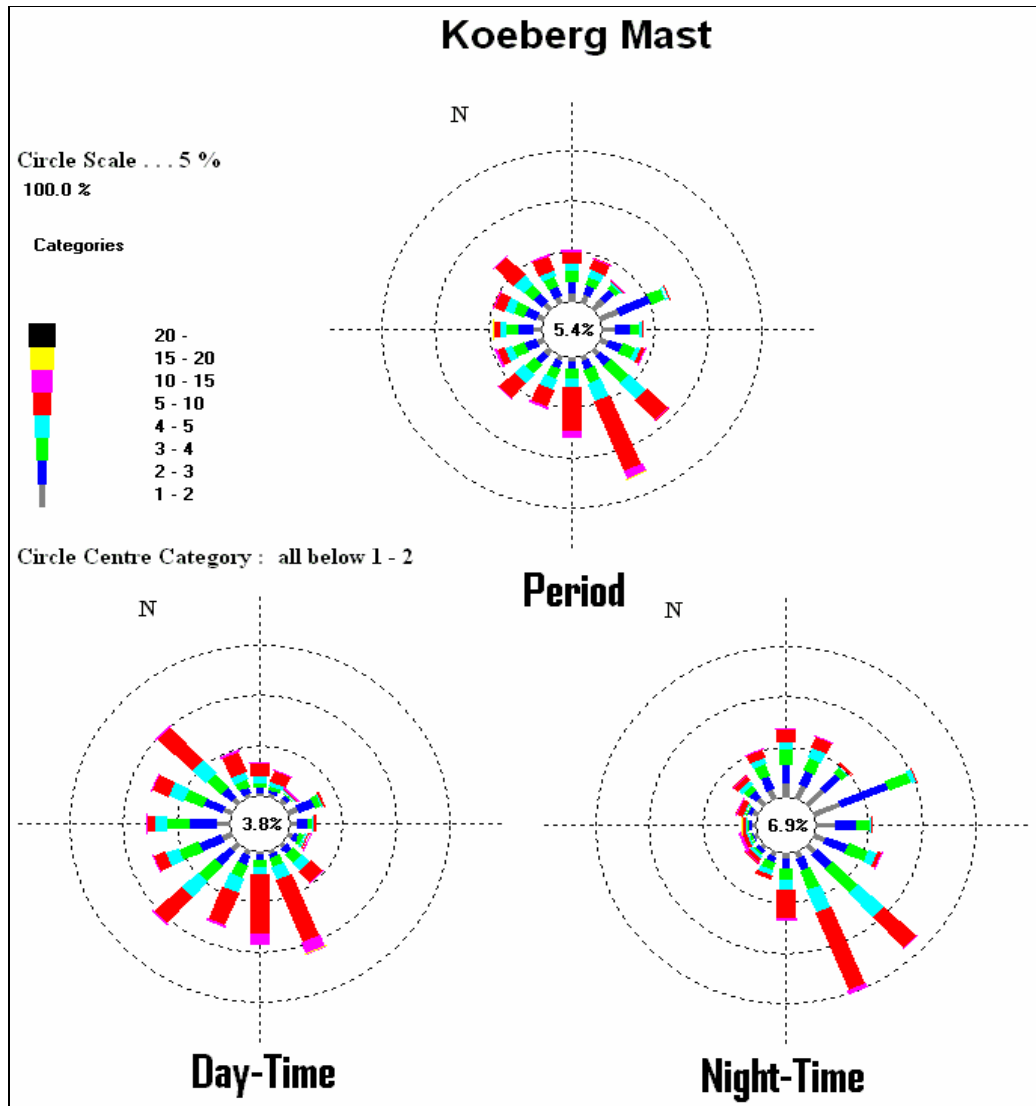
**Figure 8-15: Population density in the vicinity of the Dwynefontein site**



**Figure 8-16: Shaded relief profile of the Duynefontein study area**

During winter months (July to August), an increase in frequency of east-northeasterly winds occur (**Figure 8-17**). An increase in the frequency of southerly winds during summer months (December to February) is observed with a greater number of moderate to strong winds (5 - 10 m/s). Autumn months are associated with a greater frequency of calm wind conditions, with the smallest number of calms occurring during winter and spring months. Note the high percentage of winds from the southerly sector in summer in contrast to the northerly winds, which dominate in winter.

South-south-easterly winds dominate, with approximately 13% occurrences during a year. This wind direction also experiences the highest frequency of strong winds, i.e. winds in excess 12 m/s occurring 0.2% of the year. Although most of the strong winds occur from the south to south-easterly sector (~1.5% above 10 m/s), relatively frequent strong winds are also evident from the west-north-west to the north-north-west (~0.3% above 10 m/s). Winds from the north-east to easterly sector are average the lowest (~2.5 m/s), compared to the average of 5.6 m/s from the south to south-easterly sector. The average wind speed of the west-north-west to the north-north-west sector is about 4.4 m/s.



**Figure 8-17: Period, day- and night-time wind roses for Duynefontein**

Atmospheric Stability

On an annual basis, the highest frequency of stability class occurrence is neutral (30.7%) followed by slightly stable (26.1%). The mean wind speeds with these two stability classes are 3.1 m/s and 2.3 m/s, respectively. Extremely unstable conditions occur 20% of the time with a mean wind speed of 3.2 m/s, while extremely stable conditions occur only 5.5% of the time with a mean wind speed of 1.3 m/s.

Ambient Air Temperature

As indicated in

**Table 8-1**, dry-bulb temperatures measured at Duynfontein site are largely influenced by the close proximity of the cold ocean current, which has a moderating effect on the temperatures. The temperatures are measured at a height of 10 m, which also has a moderating effect. The lowest temperature recorded at the Duynfontein site was above freezing (2.2°C on 2 August 1981) and the maximum was 38.2°C (13 September 2005).



**Table 8-1: Means and extremes of dry-bulb temperature at the Duynefontein site measured at 10 m above ground level (1980 to 2007)**

Month	Average Daily Maximum (°C)	Extreme Maximum (°C)	Average Daily Minimum (°C)	Extreme Minimum (°C)
January	25.4	38.1	15.9	10.5
February	25.5	38	16.1	9
March	24.3	36.6	15.3	9
April	21	35.5	13.3	5.5
May	19.1	33.6	11	5.7
June	19.4	31.4	9.6	4.1
July	19.5	29	9.2	2.8
August	17.2	32	8.2	2.2
September	19.7	38.2	10.4	2.3
October	20.4	37.2	11.6	5.4
November	22.6	36.3	13.6	6.3
December	22.9	37.4	14.5	9.3
Annual	21.4	38.2	12.4	2.2

#### Atmospheric Moisture

No record of relative humidity is available for Duynefontein.

#### Precipitation

Duynefontein occurs in a winter rainfall season area. Precipitation falls throughout the year but generally summers are dry while the winters are wet. Mean Annual Precipitation (MAP) at Duynefontein for the period 1980 to 2007 is 374.8 mm. Thunder and hail are not recorded at the Duynefontein site.

#### Snow and Frost

Although there has been no evidence of snow at the Duynefontein site, records obtained from Cape Town International Airport indicate that there is a possibility Frost has been observed on occasions during the months of June until late August.

### **c) Air quality**

#### Current Non-Radionuclide Air Quality Levels

The Duynefontein site experiences urban air pollution, including dioxide (potential sources include Chevron refinery, boilers and motor vehicle exhaust pipes), oxides of nitrogen (all combustion sources with a significant contribution from motor vehicle exhaust pipes), particulate matter (due to emissions from the petroleum refinery, boilers, other combustion sources, diesel vehicles, bush and open fires, paved and unpaved haul roads, areas exposed to wind erosion and domestic fires), and volatile organic compounds (such as benzene, toluene, xylene). Quantifications of these levels are available in the air quality specialist report (Airshed 2010).

The long-term sulfur dioxide levels are generally low when compared to the annual average World Health Organisations (WHO) guideline of 50 µg/m<sup>3</sup> (see Appendix A for summary of air quality guidelines). However, the monitoring results report regular transgressions of the WHO short-term, 10 minute guideline of 500 µg/m<sup>3</sup>. These exceedances are normally associated with southerly wind directions, i.e. blowing over Chevron refinery and other industrial areas of Cape Town. There appears to be a neutral long-term trend in sulfur dioxide concentration over this period (**Figure 8-18**). The onsite sulfur dioxide measurements (0.92 to 1.78 µg/m<sup>3</sup>) are considerably lower than the observations at Table View.

In contrast to sulfur dioxide, there is a clear upwards trend in ambient PM<sub>10</sub> particulate air concentrations (**Figure 8-19**). An extrapolation of this trend indicates the potential to significantly exceed the annual average SANS 1929:2004 limit of 30 µg/m<sup>3</sup>. Although the

proposed NPS site is further to the north (approximately 14 km from the monitoring location), it is expected that the current levels of ambient particulate air concentrations would be fairly significant.

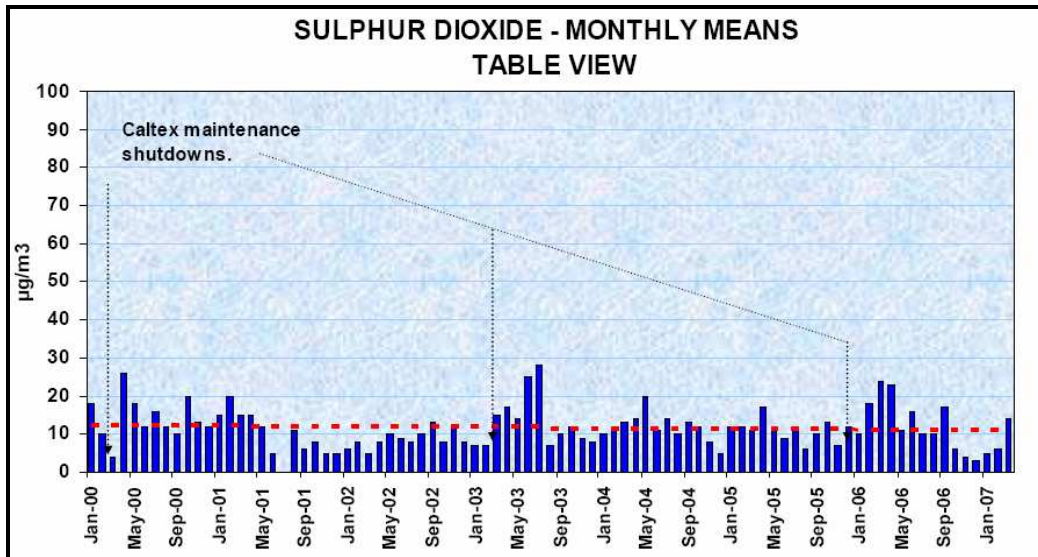


Figure 8-18: Recorded monthly mean sulfur dioxide levels in Table View. The red line indicates the linear trend

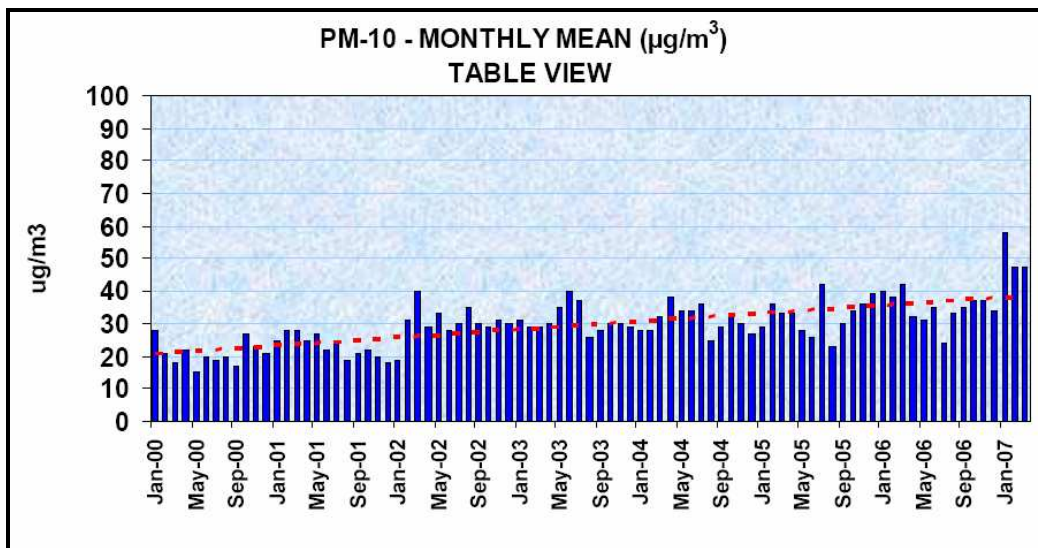
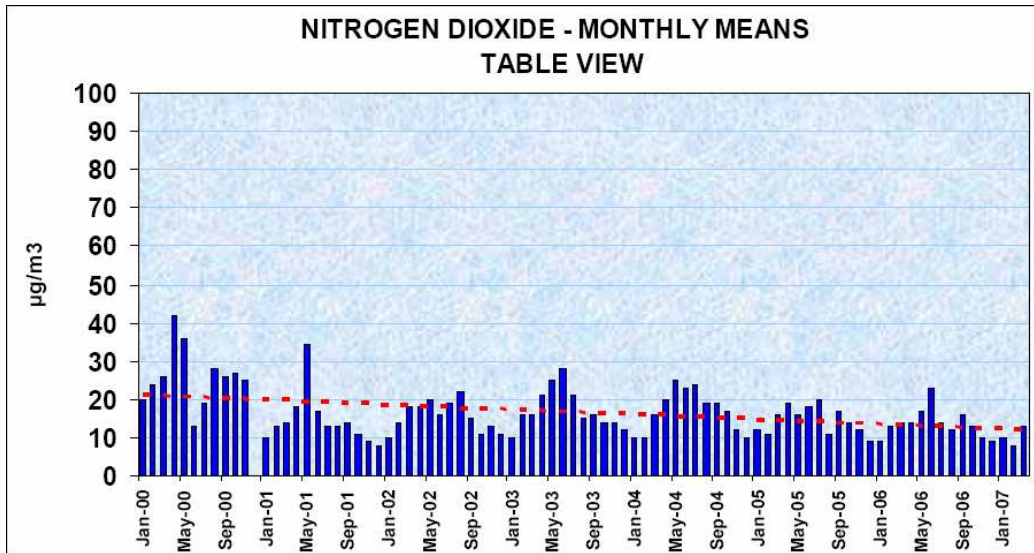


Figure 8-19: Recorded monthly mean PM10 particulate matter levels in Table View. The red line indicates the linear trend



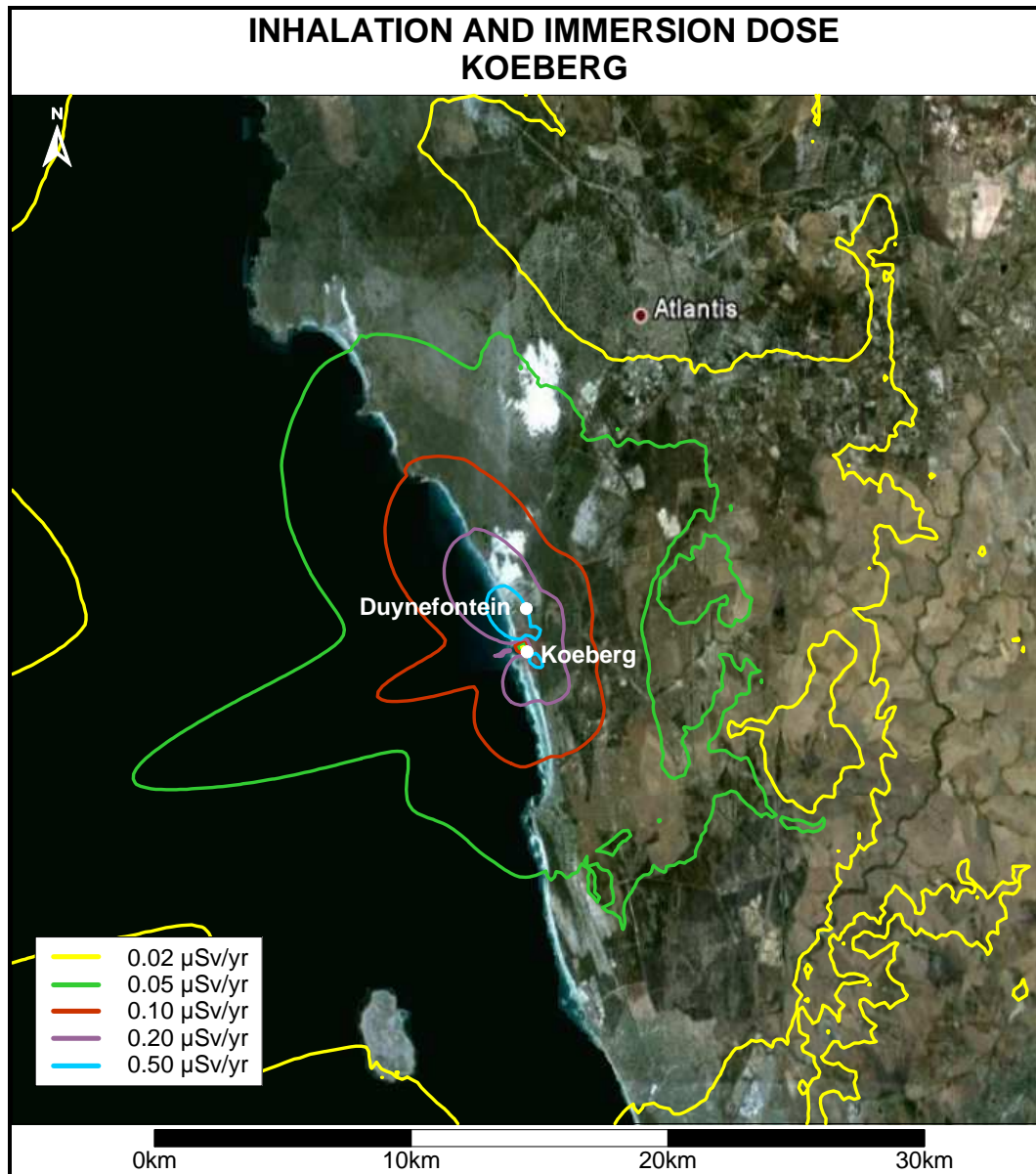
**Figure 8-20: Recorded monthly nitrogen dioxide levels in Table View. The red line indicates the linear trend**

A downwards trend is observed in the nitrogen dioxide concentrations from 2000 to 2007, as shown in **Figure 8-20**. This is especially interesting since motor vehicle exhausts contribute a significant portion of this pollutant. The annual average guideline provided by the World Health Organisation is 40 µg/m<sup>3</sup> (Appendix A). The measurements have been below this limit. The onsite nitrogen dioxide measurements, ranging between 6.2 and 11.4 µg/m<sup>3</sup> are relatively similar to the latest observations at Table View.

Radionuclide Dispersion Model Results

Based on the measured nuclide emission releases for Koeberg for the period 1984 – 2003), the spatial radiation dose per annum was predicted. **Figure 8-21** illustrates the highest dose distribution.

The highest on-site inhalation and immersion radiation dose for the current Koeberg NPS is predicted to be 1.8 µSv, approximately 875 m north-northwest of Koeberg. The highest inhalation and immersion radiation dose predicted in a radius of 2 km from Koeberg is 0.7 µSv, also north-northwest of the power station. Based on the NNR regulations, the highest predicted dose is less than 0.2% of the annual effective dose limit of 1000 µSv for members of the public and about 0.7% of the dose constraint of 250 µSv. Similarly, the maximum predicted dose at a distance of 2 km from Koeberg NPS is less than 0.1% of the annual effective dose limit and less than 0.3% of the dose constraint.

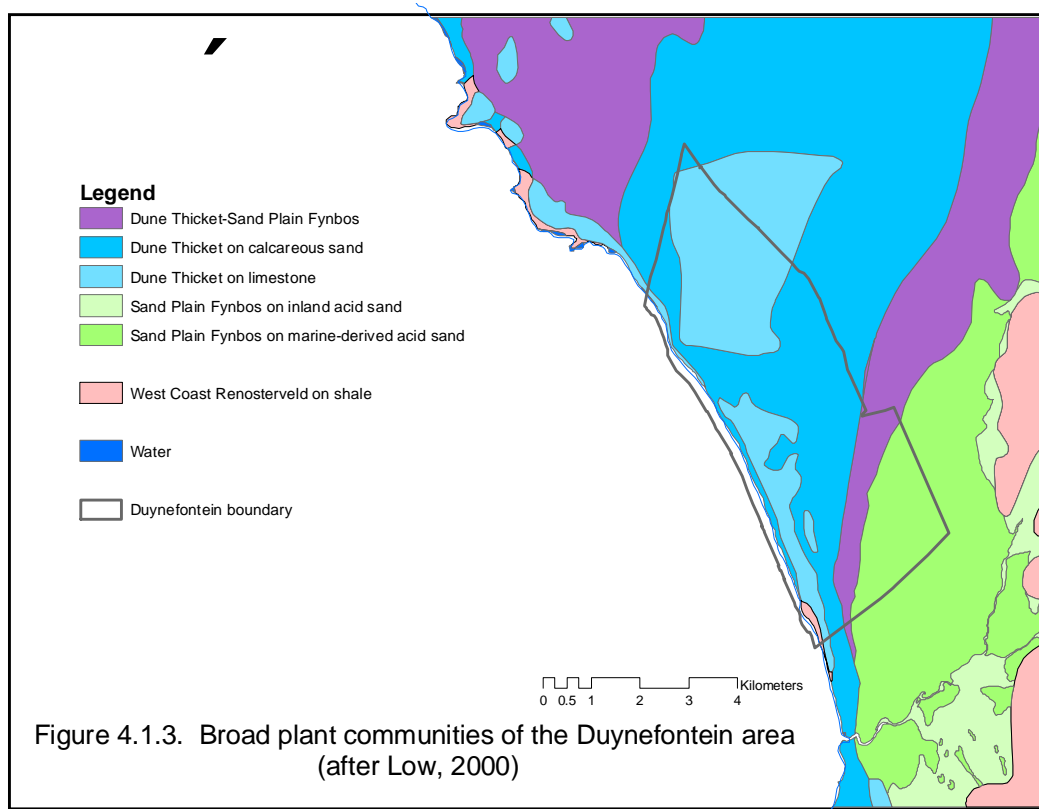


**Figure 8-21: Predicted maximum annual inhalation and immersion radiation dose ( $\mu\text{Sv}$ ) for Koeberg**

#### 8.4.2 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 latter, one was a small wetland. There is general correlation between soil characteristics and plant community, but with the grouping into calcareous dunes and non-calcareous sand plain fynbos. Both vegetation types are rare and have an Endangered status. Habitat rarity is also moderate for the proposed footprint. The dune and sand plain flora was shown to be distinctive to the site, yet linked with West Coast floras. Of the 280 species found on the site, 32 are rare. Species rarity is highest in the sand plain fynbos, as is localised endemism, but is substantially lower on the transverse dunes and this is echoed in the low endemism there. However, both habitat and species rarity rises appreciably when the sand plain fynbos vegetation is crossed for the planned powerlines. Sensitivity is locally high due to the presence of mobile and potentially

mobile dune sand, with fire proneness being high in the sand plain fynbos. Conversely, vegetation resilience is low. The transverse dune system at Duynefontein is endemic, with this system type poorly represented on the Cape West Coast.



**Figure 8-22: Broad plant communities of the Duynefontein site**



**Figure 8-23: A view of the affected environment at the Duynefontein site, looking south towards Koeberg Nuclear Power Station**

### 8.4.3 Wetlands

The wetlands at Duynefontein are all classified **wetland depressions**, which occur within a largely flat landscape, indicative of a plain landscape setting. Two categories of such wetlands were identified, namely **seasonal wetlands** and **artificial wetlands**. Seasonal wetlands are mostly 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 duneslack wetland. **Artificial wetlands**, which are the product of past human activities on the site, are represented by one seasonally inundated depression created along the main NPS access road, but mainly comprise permanently inundated to saturated wetlands which occur in the vicinity of the existing Koeberg NPS, in places along internal roads, along the boundary fence line and in the northern portion of the site, just north of the dune field.

### 8.4.4 Vertebrate fauna

The Duynefontein site currently houses the Koeberg Nuclear Power Station (KNPS), and the Koeberg Private Nature Reserve lies immediately to the north, although all undeveloped parts of the Koeberg site are managed as part of nature reserve. This Nature Reserve was identified as one of 11 priority conservation sites in a study encompassing the region along the West Coast between Blouberg and Silwerstroomstrand, inland to the N7 National Road.

#### a) Habitats

The faunal habitats within the footprint of the proposed Nuclear-1 are generally in fair to good condition because they have been cleared of alien vegetation and rehabilitation of the habitats is well advanced

#### b) Amphibians

There are 9 possible species, 8 of which are of probable or confirmed occurrence. One Threatened species, the Cape Caco *Cacosternum capense* (Vulnerable), could possibly breed in seasonal wetlands, but it is unlikely to occur within the proposed footprint. However, its possible occurrence is an indication that seasonal wetlands should be protected wherever possible. Rose's Rain Frog *Breviceps rosei* is a Western Cape endemic species confined to coastal dune habitats. Maintenance of a coastal corridor is considered important to prevent fragmentation of this species' distribution range.

#### c) Reptiles

There are 53 possible species, 40 of which are of probable or confirmed occurrence. Two provisionally Red Listed species, Gronovi's Dwarf Burrowing Skink *Scelotes gronovii* (Near Threatened) (**Figure 8-25**) and Southern Adder *Bitis armata* (Vulnerable), are of probable occurrence, and one, Blouberg Dwarf Burrowing skink *Scelotes montispectus* (Near Threatened), is of confirmed occurrence. Local impact on these species is likely to occur within the footprint. As with Rose's Rain Frog, these species are Western Cape endemics confined to coastal habitats. Maintenance of a coastal corridor is important to prevent fragmentation of their distribution ranges.



Figure 8-24: Duynefontein wetlands map

#### d) Mammals

There are 56 possible species, 39 of which are of probable or confirmed occurrence. The only Threatened species which may occur are the Whitetailed Mouse *Mystromys albicaudatus* (Endangered) and Honey Badger *Mellivora capensis* (Near Threatened; Friedmann and Daly 2004). Local research suggests that the mouse is more likely to occur on heavy soils than on sandy soils, so its occurrence at Koeberg may be limited to relatively small patches of suitable habitat, and these are not likely to be situated near to the coast (C. Dorse *pers. comm.*). The Honey Badger has been recorded at Blaauwberg (C. Dorse *pers. comm.*), but it is less likely to occur in coastal areas such as Duynfontein. It is a species that should be able to easily escape from the construction site during site clearance. Four species of bat that have the status of Near Threatened, are likely to be only visitors to Duynfontein, with their roosting and breeding sites elsewhere. The Bontebok (Vulnerable), is an introduced species which need not be directly impacted by the proposed developments, unless it is poached.



**Figure 8-25: The Bloubaai Dwarf Burrowing Skink *Scelotes montispectus*, a recently described and potentially threatened species found at Duynfontein (Photo: M. Burger)**

#### e) Birds

There are 203 possible species, 158 of which are of probable or confirmed occurrence. Several Threatened seabird species occur on the coast, e.g., Crowned Cormorant *Phalacrocorax neglectus* (Vulnerable), Bank Cormorant *Phalacrocorax coronatus* (Near Threatened), Caspian Tern *Hydroprogne caspia* (Near Threatened). However, these are unlikely to be negatively impacted by the proposed Nuclear-1 because, in light of the experience at KNPS, the power station will have a negligible impact on the marine environment.

The relatively protected environment in and around Koeberg harbour provides excellent habitat for seabirds and shorebirds to roost and even breed. Swift Terns *Sterna bergii* and African Black Oystercatchers *Haematopus moquini* (Near Threatened), in particular, have been recorded breeding in numbers and these represent regionally important breeding colonies. It is essential that disturbance of these colonies is kept to an absolute minimum.



Nuclear-1 will not be using or affecting Koeberg harbour, but construction activities in the vicinity have the potential to cause damaging disturbance.

Several Threatened species of raptor occur on site. The Black Harrier *Circus maurus* (Near Threatened) is known to breed at Duynefontein, and the Marsh Harrier *C. ranivorus* (Vulnerable) may breed in the large coastal wetland area in the northern part of Duynefontein. It is unlikely that either of these species breed on the proposed Nuclear-1 footprint.

#### f) Sensitive areas

The mapping of faunal sensitivity (**Figure 8-26**) was based primarily on (a) scarce habitats important to the maintenance of faunal diversity, (b) areas important for ecological corridors, and (c) areas occupied by particularly sensitive species. In the case of Duynefontein, the areas identified as having high faunal sensitivity were:

- All wetlands, with a 100 m buffer. Wetlands have a central role in maintaining faunal diversity and faunal populations. Buffers are essential to provide semi-aquatic species with terrestrial habitat and corridors of access for terrestrial species.
- The coastal corridor (200 m above the projected 2075 100-year high-water line). A coastal corridor provides fauna with access to coastal resources and allows movement along the coast. The width of the corridor needs to take future sea-level rise into account.
- A 100-m corridor between KNPS and the Nuclear-1 development corridor. This corridor prevents an unbroken wall of development separating inland habitats from coastal habitats.
- The mobile-dune field. The ecology of the dune field is highly dynamic and easily disrupted by alteration of patterns of sand movement, therefore obstructions – especially at the coastal point of origin – need to be avoided. Such disruption has already occurred with the construction of KNPS, but the balance of the dune field needs to be protected as far as possible.
- Areas to the north have greater conservation value because their long-term prospects of protection are better, and the Koeberg Private Nature Reserve could potentially be expanded to the north.



**Figure 8-26: Dwynefontein faunal sensitivity map**

## 8.4.5 Invertebrate fauna

### a) Ant species

Twenty-two ant species were collected, with an estimated total diversity of approximately 27 species. No invasive Argentine Ant (*Linepithema humile*) specimens were found, but these may prove to occur on the site closer to the existing developments, where no surveys were carried out during the present survey. Another widespread tramp species, *Hypoponera eduardi*, was found, but this species is not yet considered of major conservation concern.

Two undescribed ant species of special interest were collected at Duynfontein. These were:

- *Tetramorium* sp. (an undescribed species related to *T. flaviceps*) found in the Dune Thicket on Transverse Dunes. However, attempts to locate this species again during fieldwork in January 2010 were unsuccessful; and
- *Monomorium* sp. (an undescribed species related to *M. damarense*) found in the Dwarf Dune Thicket.



**Figure 8-27: An undescribed *Tetramorium* ant species found at Duynfontein**

### b) Butterflies

The summed probable total species count for Duynfontein is low (at 23.1) with a very low Red List species probability of 0.01, but it must be borne in mind that these figures can be compared directly only to the other sites surveyed during this study. There are three main vegetation types of relevance to butterflies at the site – Atlantis Sand Fynbos (ASF) in the south-eastern corner of the site and Cape Flats Dune Strandveld (CFDS) over most of the rest of the site, with a transitional zone in between.

A total of 12 species were found on Duynfontein. None of these are local endemic species, six are regional endemic species and two are South African endemic species.

### c) Other invertebrates

A summary of the other invertebrates on the site, besides ants and butterflies, is listed below:

- **Velvet worms** (Onchyophora): none found.
- **Spiders:** One specimen of *Harpactira atra* (Theraphosidae), a protected baboon spider species common in the south-western Cape was observed during the survey; another was also seen by the terrestrial vertebrate fauna investigation team. A trapdoor spider, probably of the Nemesiid genus *Pionothele* was found during January 2010. *Pionothele* is a monotypic genus previously recorded from only two localities, so whether the Duynfontein is the same as the previously described species, or a

new species (this has not yet been determined), this is a rare discovery and further research is warranted.

- **Scorpions** (Arachnida: Scorpiones): A West Coast endemic scorpion species, *Uroplectes variegates*, was found to be abundant in the proposed footprint area (it is likely to be found over the entire site).
- **Soldier flies** (Mydidae): none found.
- **Heelwalkers** (Mantophasmatodea): none found.
- **Monkey beetles** (Hopliini): several specimens of 1 species found; most were inactive and hiding under rocks.
- **Millipedes** (Myriapoda): - 3 species were found.
- **Jewel beetles** (Buprestidae): none found.
- **Spoonwing lacewings** (Nemopteridae): none found.
- **Horseflies** (Tabanidae): none found. The only long-tongued flies observed were *Australoechus hirtus* (Bombyliidae).

The area of the KNPS footprint appears to be significant in terms of the invertebrate diversity it is expected to maintain, and this is supported by the fact that the only known specimen of an undescribed ant species (*Tetramorium* sp.) was previously collected in this area.

However, prior to construction of the KNPS, this area was an unvegetated dune field. Stabilisation of the dunes by planting of grass and invasion by *Acacia cyclops*, in combination with the KNPS preventing natural inflow of sand from the south, have resulted in the establishment of the plant communities now present. This in turn will have resulted in establishment of a very different invertebrate community from that which was present prior to construction of the KPS. Significant species such as the undescribed *Tetramorium* would probably have established themselves here subsequent to the development of vegetation cover, and they would presumably have moved in from surrounding vegetated areas. It can therefore be assumed that this species will also be found in surrounding areas.

Thus, while the particular pattern of dune structure and vegetation within the proposed footprint that provides habitat for invertebrate species may be unique on the Dwynefontein site and also not well-conserved in neighbouring areas, 1) this is not the natural state of the area and 2) most indigenous species present can be assumed to have colonised from other natural areas and to be represented in such areas.

#### 8.4.6 Marine biology

The area under consideration is located north of Melkbosstrand on the west coast towards the southern limit of the relatively uniform Namaqua marine biogeographic region, which extends north as far as southern Namibia.

This region is dominated by the cold Benguela Current system, in which high biological productivity is supported by the upwelling of cool nutrient rich waters. However, this section of coast is characterised by low marine species richness and very low endemism. Nonetheless, some south coast species extend to this site, giving it slightly elevated species richness and endemism rates, when compared to northern areas along this coast. No sites of special biological significance occur within the area.

This site is typified by long sandy beaches, interspersed with short stretches of rocky-shore. Such beaches are notable for the low number of species they support, and the fact that they are physically controlled. As a result of the dominance of physical parameters, such as water movement, these beaches are very resilient to disturbance. All the beach species found here have extensive geographical distributions. There are no sites of special conservation value for marine species within the immediate area.

While the South African west coast supports highly productive fisheries, these are focused offshore. Nearshore fish productivity remains high, but diversity is low. A number of fish have been recorded in the harbour of KNPS, the most common of which are the Southern hanger *Liza richardsoni* and the catshark *Poroderma africanum*. While a number of marine mammals

are known to frequent the west coast, only the South African fur seal *Arctocephalus pusillus pusillus* has been recorded spending extended periods in the immediate area of the power station. Dusky dolphin *Lagenorhynchus obscurus*, Long-beaked common dolphin *Delphinus capensis* and less frequently, individual Southern right whales *Balaena glacialis* and Humpback whales *Megaptera novaeangliae* are also seen in the vicinity.

The marine environment demonstrates relatively high tolerance to disturbance and is thus rated as having low sensitivity.

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## 8.5 Biophysical environment: Bantamsklip

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### 8.5.1 Air quality and climate

#### a) Land use and topography

Due to the absence of any industrial activities in the vicinity of the Bantamsklip site, current air pollution levels are very low. The closest source of potentially significant air pollution is Hermanus, approximately 44 km northwest of the site.

Conservation land use extends ~7 km to the north and northwest of Bantamsklip (**Figure 8-28**). The main rivers in the area are the Hagelkraal River (~5 km north of the site) and Kok River (~8 km northeast of the site).

The area is generally characterised by sparse population, with most of the region falling within a population density of less than 500 people per km<sup>2</sup> (**Figure 8-29**) (Census data 2007, Statistics South Africa). Larger residential areas in greater the region of the proposed operations include Gansbaai (~25 km northwest), Hermanus (~44 km northwest), Struisbaai (east-northeast 47 km) and Bredasdorp (~60 km east northeast). Smaller residential developments closer to the proposed site include Pearly Beach (~10 km northwest) and Die Dam (~10 km southeast). The region is relatively undeveloped, with most of the agricultural activities towards Pearly Beach and Gansbaai.

The topography near the coastline is relatively flat, becoming undulating further inland with Buffeljagsberg (298 m) to the east and the Koude Mountains (450 m) to the north. To the east of Gansbaai, the topography becomes more mountainous with the Duinefonteinberg (318 m) directly east of the Gansbaai residential area (**Figure 8-30**).

#### Wind Field

Early recordings done by Eskom (1987 to 1989) indicate that the wind direction in this region is from the west-northwest to northwest. A secondary wind direction is from the east to east-southeast. Wind typically have an alongshore flow pattern.

Wind roses for Hermanus prepared from SAWS for the period 2001 to 2008 are given in **Figure 8-31**. The wind roses also include an analysis of the wind data recorded on site at Bantamsklip (January 2008 to September 2009). The wind flow at Hermanus is similar to the Eskom and the Bantamsklip observations, i.e. predominantly easterly and westerly.

During winter months (July to August), an increase in the frequency of east-northeasterly winds occur. An increase in the frequency of westerly winds during summer months (December to February) is observed with a greater number of moderate to strong winds (5 - 10 m/s). Autumn months are associated with a greater frequency of calm wind conditions (12.6%), with the smallest number of calms occurring during spring and summer months.

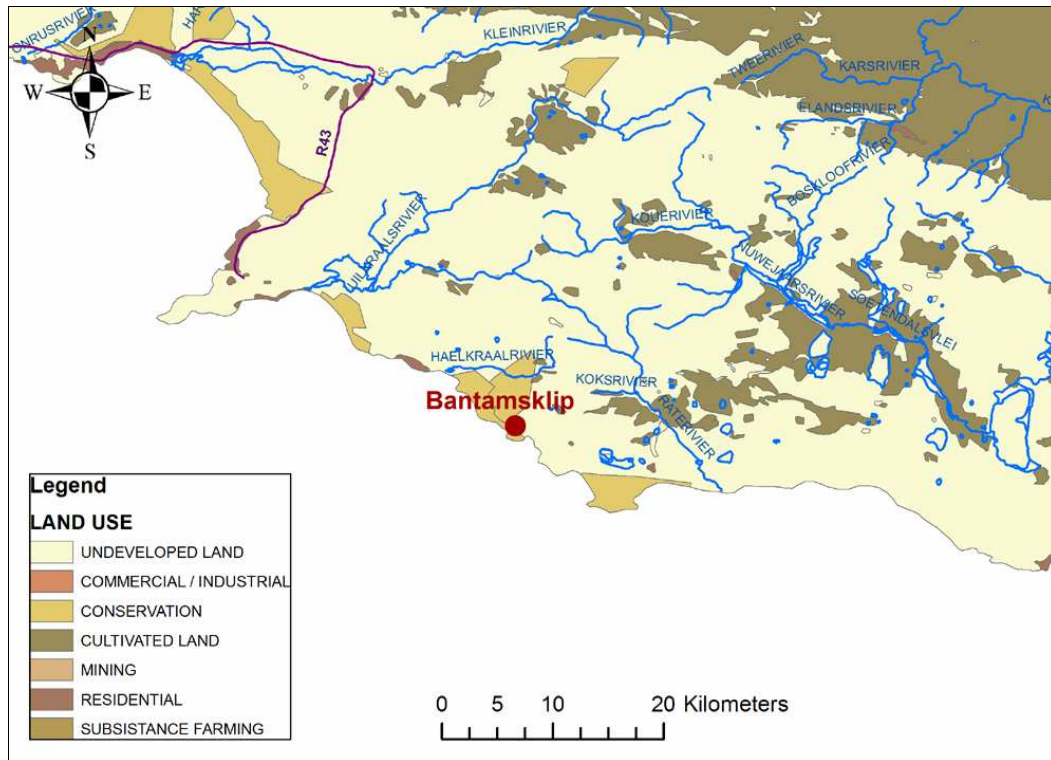


Figure 8-28: Land use in the vicinity of the Bantamsklip site

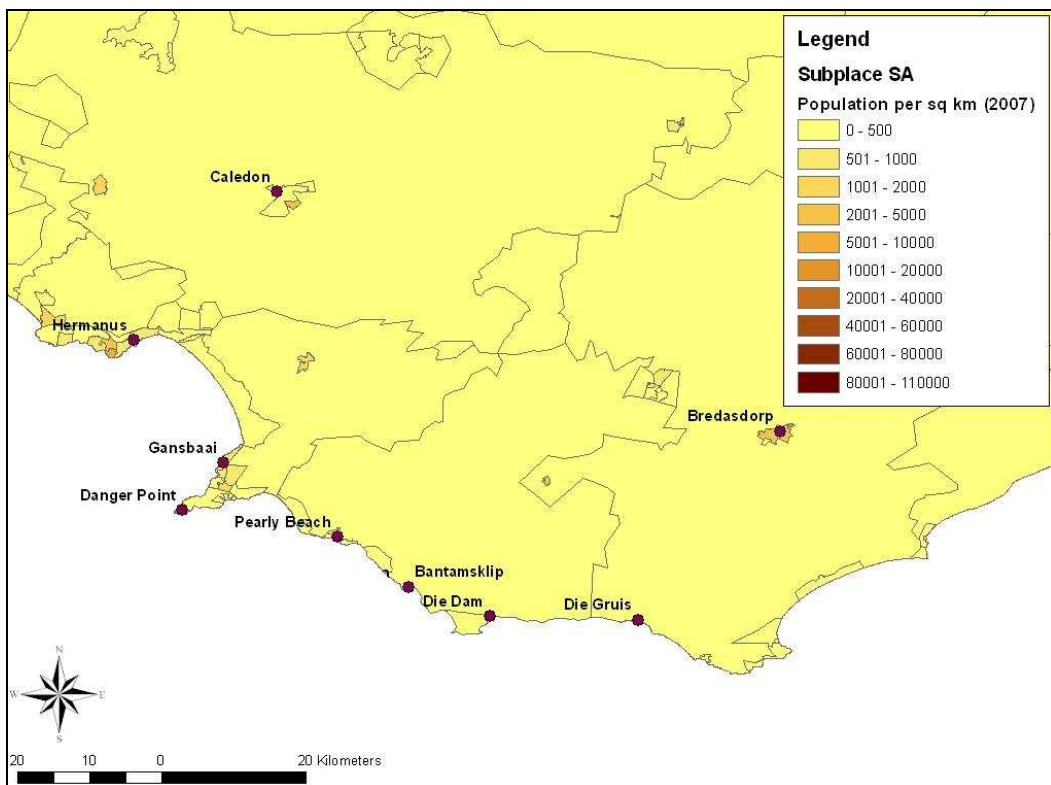


Figure 8-29: Population density in the vicinity of the Bantamsklip site



**Figure 8-30: Shaded relief profile of the Bantamsklip study area**

## b) Meteorology

### Atmospheric Stability

On an annual basis, the highest frequency of stability class occurrence is neutral (58.7%) followed by slightly stable 16.0%. The mean wind speeds with these two stability classes are 5.8 m/s and 5.7 m/s, respectively. Extremely unstable conditions occur 5.3% of the time with a mean wind speed of 2.2 m/s, while extremely stable conditions occur only 7.0% of the time with a mean wind speed of 1.2 m/s.

### Ambient Air Temperature

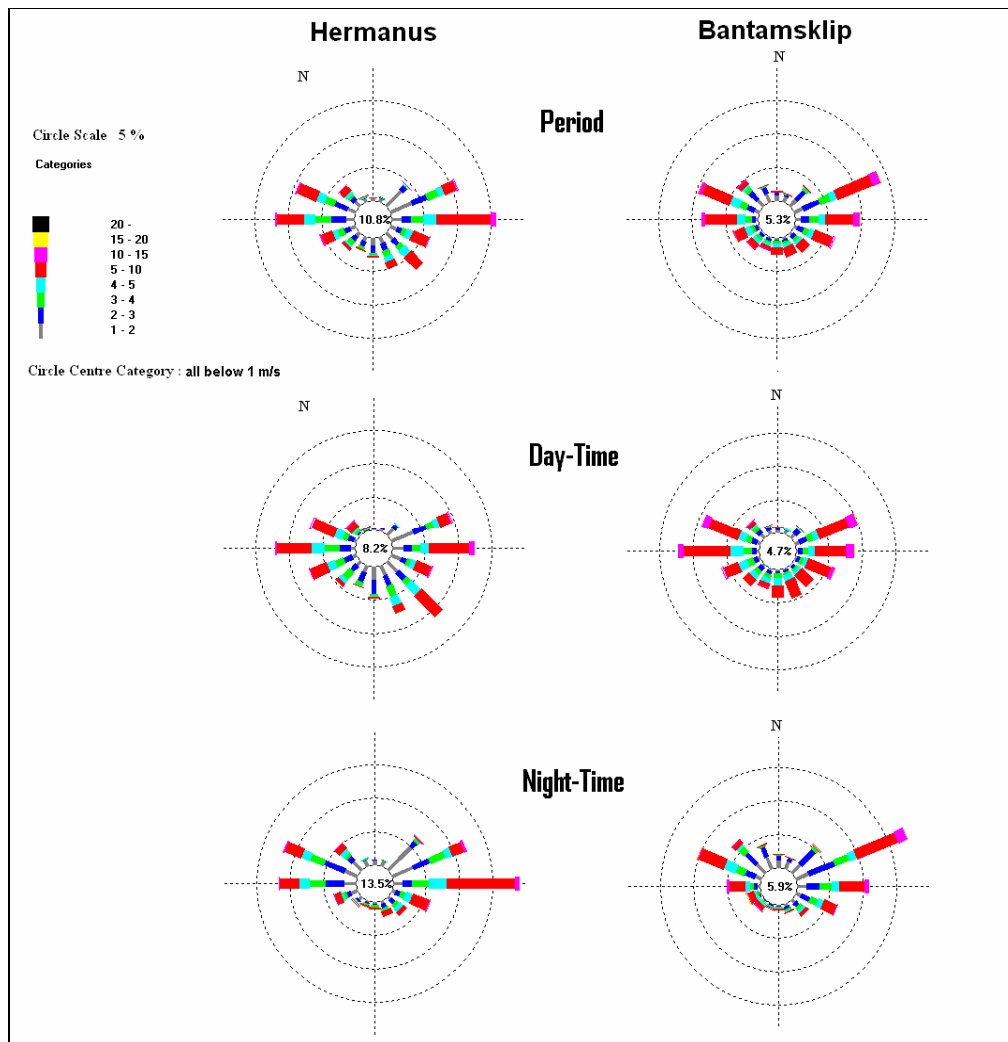
The recorded dry-bulb temperatures at Bantamsklip for the period January 2008 to August 2008 is summarised in **Table 8-2**. The highest maximum temperature (33.2 °C) was recorded during March 2008 with the lowest (3.6 °C) during August 2008.

### Precipitation

The rainfall season for the Bantamsklip area is similar to the Duynefontein site, and is classified as a winter rainfall season area. Rainfall observations are made at the SAWS stations in Hermanus and Struisbaai. The annual average recording for this period is 533.2 mm at Hermanus and 385.9 mm at Struisbaai.

Rainfall measurements at Bantamsklip were only initiated in January 2008 and therefore not statistically adequate. However, based on these measurements, it appears that rainfall at Bantamsklip appears is higher than at Hermanus and Struisbaai. The total for the 8-month period up to August 2008 is 880.5 mm.





**Figure 8-31: Comparison of wind roses between Hermanus and at Bantamsklip**

**Table 8-2: Dry-bulb temperature observations at Bantamsklip (January 2008 to September 2009)**

Month	Daily Average (°C)	Daily Maximum (°C)	Daily Minimum (°C)
January	20.3	30.1	11.9
February	20.2	32.7	10.2
March	19.4	33.2	8.9
April	17.0	33.2	9.5
May	16.2	30.5	7.9
June	14.0	26.0	6.2
July	13.1	26.8	4.5
August	13.4	27.9	3.6
September	13.8	32.4	2.8
October	15.6	25.5	5.8
November	17.0	28.4	8.1
December	19.4	29.1	8.6

### Snow and Frost

Based on long-term observations at Danger Point, frost appears to be absent from Bantamsklip. No snow has been recorded.

### **c) Air quality**

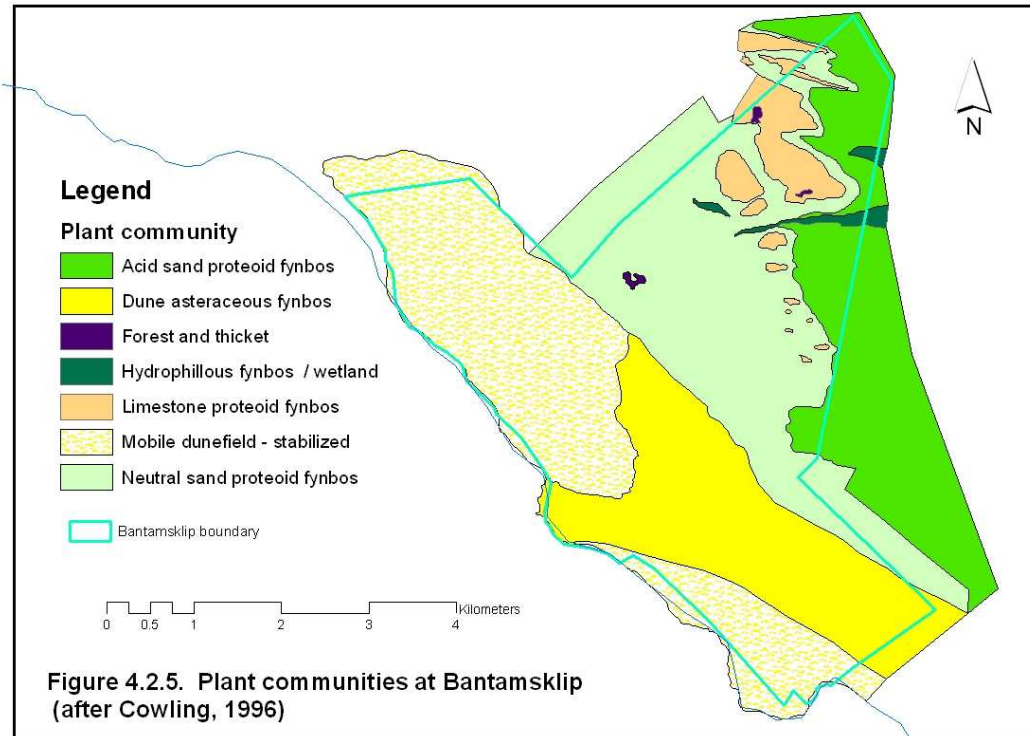
No ambient air quality monitoring network exists at the Bantamsklip site and therefore no historical data are available. A relatively short air sampling campaign was completed for a three-month period from March to May 2009. The observed monthly average sulfur dioxide and nitrogen dioxide concentrations were 0.63 µg/m<sup>3</sup> and 1.76 µg/m<sup>3</sup>, respectively.

These concentrations reflect the conditions in the absence of any industrial activities in the vicinity. The closest source of potential industrial air pollution is Hermanus, approximately 44 km northwest of the site. Local sources of air pollution include vehicle emissions from the nearby Pearly Beach and along the R43, fires (both domestic and runaway) and any activities that can generate fugitive dust emissions (e.g. farming activities).

## **8.5.2 Flora**

Nine vegetation types are found on the site. Together with their conservation status, these are: Agulhas Limestone Fynbos (Least Threatened), Agulhas Sand Fynbos (Vulnerable), Cape Lowland Freshwater Wetlands (V), Cape Seashore Vegetation (LT), Elim Ferricrete Fynbos (Endangered), Overberg Dune Strandveld (LT), Overberg Sandstone Fynbos (LT), Southern Coastal Forest (LT) and Western Coastal Shale Band Vegetation (LT). Within these 16 plant communities were identified, and included terrestrial (dryland) as well as wetland and riverine habitats. Soil patterns closely parallel differences in plant communities, and there is a clear separation between calcareous and non-calcareous habitats. There is an extremely high proportion of 50 Red Data out of a total of 463 plant species recorded in the study, and this echoes the high localised endemism for the site. There is a clear separation of local floras within the site, and this is driven by the calcareous or non-calcareous nature of the substrate, and whether communities are pioneering or climax.

A key factor is the moisture regime of the soil, with riverine and wetland habitats separating from the other flora. Most of this rarity is found to the north of the R43, except for the coastal limestones, and to a certain extent the coastal sands. Habitat rarity is also greater north than south of the road, again, the exception in the coastal limestones. High sensitivity in terms of erosion potential occurs on mobile and semi mobile dune systems at the coast, as well as the sandy plain and the river and wetlands. Fire is also a key factor with high proneness related to the presence of fynbos over most of the site. Correspondingly, low resilience of the area is governed very closely by the presence of inland and coastal limestones, river and wetland systems and the transverse dunes. The dune systems at Bantamsklip are well-represented elsewhere along this coastline and are thus neither rare nor endemic.



**Figure 8-32: Plant communities of Bantamsklip**



**Figure 8-33: View of eastern portion of Bantamsklip**

### 8.5.3 Wetlands

The vast majority of the wetland systems at Bantamsklip are situated north of the RE43 road and originate on the Groot Hagelkraal property. The Groot Hagelkraal River flows as an unchannelled valley bottom wetland, as far as its confluence with the channelised Klein Hagelkraal River, downstream of the R43 road. Shortly downstream of this confluence, the river broadens out, forming a wide, coastal lake known as Pearly Beach Marsh. This marsh is in ecologically excellent conditions, and provides habitat to a large diversity of wetland-associated fauna, including mongooses, otters, African Fish Eagle, numerous passerine birds and waterfowl. The Groot Hagelkraal River downstream of the R43 lies outside of the Bantamsklip EIA corridor, as the EIA corridor lies south of the R43, but the wetland systems could potentially be affected by activities within its upstream catchment area. The site's wetland systems are regarded as unique and have been recommended for protection as a Site of Special Scientific Interest.

The wetlands on the Bantamsklip site are considered highly sensitive to changes in water quality (particularly changes in pH, salinity and nutrient concentrations), any of which could impact on the plant communities that provide the basic structure for and underpin the function of the wetlands. The wetlands are also considered vulnerable to physical disturbance, particularly any disturbance that results in concentrations of flow into downstream areas, impoundment, increased vulnerability to alien invasion as a result of clearing or exposure of open substrate.

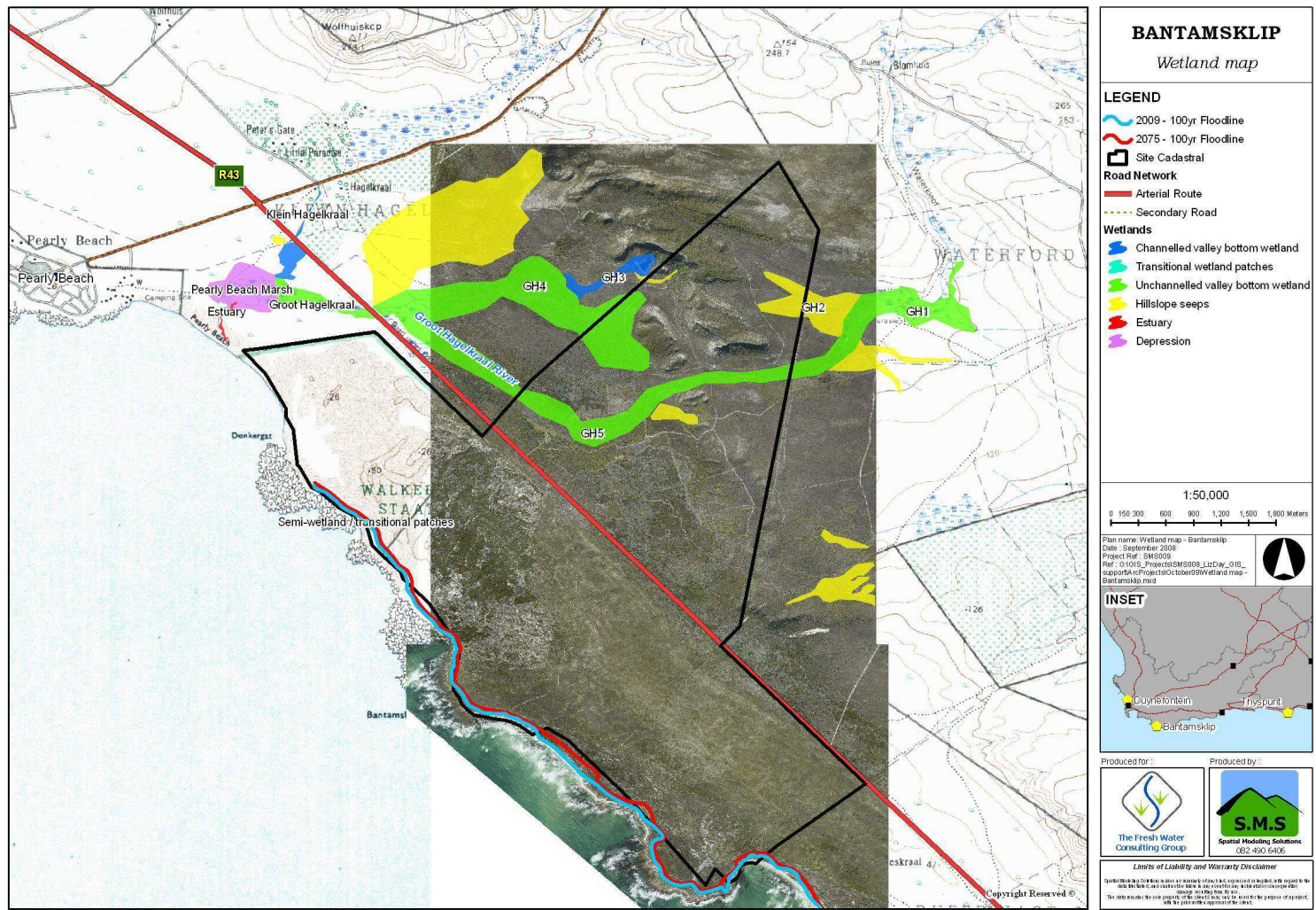


Figure 8-34: Wetland communities at Bantamsklip

## 8.5.4 Vertebrate fauna

In the discussions that follow, it should be noted that it is the coastal portion of the Bantamsklip site, south of the R43, contains the entirety of the proposed development footprint. It is, therefore, the fauna of this portion, and the likely impacts on this portion, that received the most attention during specialist investigations.

### a) Habitats

The Bantamsklip site lies within the Cape Floristic Region Cape Floristic Region (CFR) which is largely restricted to the Western Cape and Eastern Cape. This is an exceptionally biodiverse region with very high levels of species endemism. The CFR is regarded as a global Biodiversity Hotspot.

The site is bisected by the R43, creating a coastal and an inland portion (the latter on the farm Hagelkraal), which are distinct from each other in terms of dominant habitats and biotic communities. The farm Hagelkraal is registered with the DEA as a Natural Heritage Site.

Both portions of the Bantamsklip site are in good condition with only limited disturbance and invasive alien vegetation. There is, however, evidence of abalone-poaching activities at the coast. The site, as a whole, is exceptionally varied in its habitats and can be expected to contain a rich diversity of fauna. The inland portion, in particular, includes some Threatened habitat types which are important to some equally sensitive species. The site has impressive scenic qualities, especially on the inland portion.

### b) Amphibians

On the coastal portion of Bantamsklip, there are 14 possible amphibian species, four of which are of probable or confirmed occurrence. While several Threatened species are known to occur and breed on the farm Hagelkraal (inland portion), including the Micro Frog *Microbatrachella capensis* (Critically Endangered), Cape Platanna *Xenopus gilli* (Endangered) and Western Leopard Toad *Amietophrynus pantherinus* (Endangered). These species are only of possible to unlikely occurrence on the coastal portion, and then only at the western extreme, close to the Hagelkraal River. The area covered by the proposed footprint is occupied by Rose's Rain Frog *Breviceps rosei*, which is a Western Cape endemic species confined to coastal dune habitats. Maintenance of a coastal corridor is important to prevent fragmentation of this species' distribution range.

### c) Reptiles

On the coastal portion of Bantamsklip, there are 42 possible reptile species, 34 of which are of probable or confirmed occurrence. One provisionally Red Listed species and Western Cape endemic species, the Southern Adder *Bitis armata* (Vulnerable), is likely to occur. This species occupies coastal thicket and lowland fynbos. Ecological corridors will help to prevent its coastal distribution from being fragmented. A number of other endemic species, such as the Silvery Dwarf Burrowing Skink *Scelotes bipes*, will similarly benefit from the provision of corridors.



**Figure 8-35: The Critically Endangered Micro Frog found on Hagelkraal on the northern portion of the site (unaffected by the NPS footprint)**

#### **d) Mammals**

On the coastal portion of Bantamsklip, there are 60 possible species, 37 of which are of probable or confirmed occurrence. Red Listed species of probable occurrence include Fynbos Golden Mole *Amblysomus corriae* (Near Threatened), White-tailed Mouse *Mystromys albicaudatus* (Endangered), four species of Near Threatened bat (non-breeding individuals only), and Honey Badger *Mellivora capensis* (Near Threatened; Friedmann & Daly 2004). The proposed developments are not likely to affect important breeding populations of any of these species, and the provision of ecological corridors will help to ensure their continued presence on site.

#### **e) Birds**

On the coastal portion of Bantamsklip, there are 187 possible bird species, 72 of which are of confirmed occurrence. A sensitive group of birds occurring on and near to the site comprises Threatened and Near Threatened seabirds which roost and forage at the coast: Cape Cormorant *Phalacrocorax capensis* (Near Threatened), Bank Cormorant *P. neglectus* (Endangered), Crowned Cormorant *P. coronatus* (Near Threatened), African Black Oystercatcher *Haematopus moquini* (Near Threatened), and Damara Tern *Sterna balaenarum* (Endangered). A number of sensitive seabird sites have been identified near the development site. Many other parts of the rocky coastline are also used by cormorants, gulls and terns for roosting. Most of the coastline can be considered sensitive for breeding pairs of oystercatchers. An important wetland with numerous breeding waterbirds is situated on the Hagelkraal River, close to its mouth. Blue Cranes have been recorded breeding in unusual habitat in the dunes at the western end of the Bantamsklip site. Sensitive terrestrial species include Black Harrier *Circus maurus* (Near Threatened), Denham's Bustard *Neotis denhami* (Vulnerable) and Blue Crane *Anthropoides paradiseus* (Vulnerable), all of which are likely to breed on site. Denham's Bustard and Blue Crane are also vulnerable to fatal collisions with overhead transmission cables, and Denham's Bustard is notoriously sensitive to disturbance while breeding. The whole of the coastline needs to be considered as a sensitive habitat where construction impacts and disturbance need to be kept to an absolute minimum. The maintenance of a wide coastal corridor is an essential mitigation in this regard.

**f) Sensitive areas**

The mapping of faunal sensitivity (**Figure 8-36**) was based primarily on (a) scarce habitats important to the maintenance of faunal diversity, (b) areas important for ecological corridors, and (c) areas occupied by particularly sensitive species. In the case of Bantamsklip, the areas identified as having high faunal sensitivity were:

- All wetlands, with a 100 m buffer. Wetlands have a central role in maintaining faunal diversity and faunal populations. Buffers are essential to provide semi-aquatic species with terrestrial habitat and corridors of access for terrestrial species. The wetlands on the inland portion hold several Threatened species of amphibian;
- The coastal corridor (200 m above the projected 2075 100-year high-water line). A coastal corridor provides access to coastal resources and allows movement along the coast. The width of the corridor needs to take future sea-level rise into account;
- The western dune field. This dune field provides a relative diversity of microhabitats and is sensitive to mechanical disturbance and destabilization.
- The whole of the inland portion (above the R43). This area is highly sensitive because of wetlands, rare habitat types and broken topography;
- All other areas are of medium sensitivity; and
- No areas are of low sensitivity because all are in relatively natural, unspoilt condition.



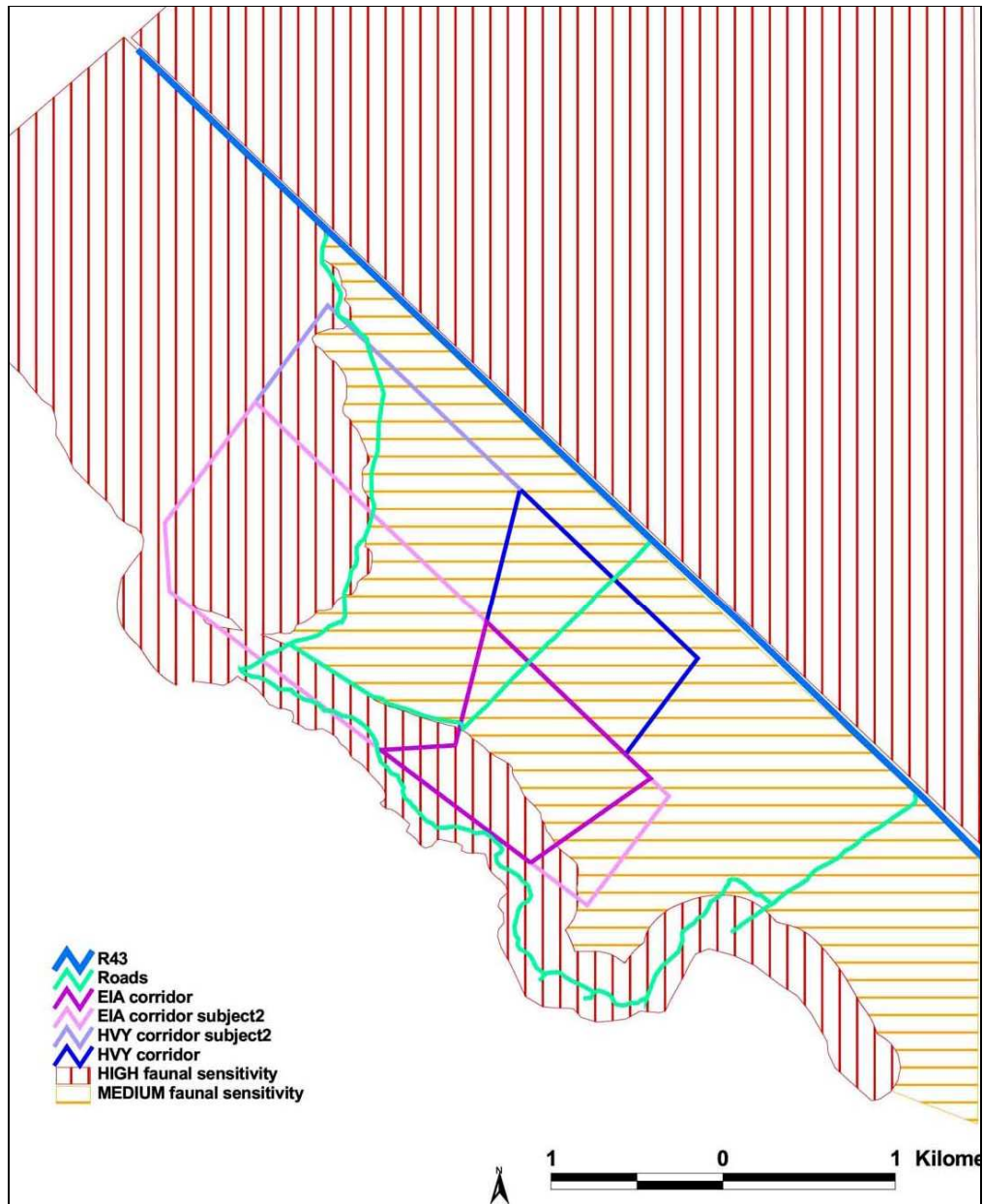


Figure 8-36: Faunal sensitivity map for Bantamsklip

### 8.5.5 Invertebrate fauna

#### a) Ant species

Eighteen species were collected in total with an estimated diversity of approximately 21 species. No invasive Argentine Ant (*Linepithema humile*) specimens were found and it is considered unlikely that this species is present on the site.

*Leptogenys* sp. was identified from the samples collected in areas of Limestone Fynbos) and Dune Thicket. Initially this was thought to be an undescribed species, but it now appears likely that these specimens simply represent an atypical form of *L. peringueyi*. Specimens from other localities matching those found at Bantamsklip were located in the South African

Museum ant collection in Cape Town in November 2009, so even if this is eventually confirmed to be a species distinct from *L. peringueyi*, it is clearly not threatened by development at Bantamsklip.

## b) Butterflies

The summed probable total species count of butterflies for Bantamsklip is moderate at 28.2 with a significant Red List species probability of 0.15, but it must be borne in mind that these figures can be compared directly only to the other sites surveyed during this study. A total of 14 butterfly species were samples. Of these, none are local endemics, 8 are regional endemics and one is a South African endemic.

## c) Other invertebrates

- **Velvet worms** (Onchyophora): none found.
- **Spiders:** One baboon spider species (a small *Harpactira* species) was found. A significant find was numerous specimens of a possibly undescribed trapdoor species of the genus *Spiroctenus* (Nemesiidae).
- **Scorpions** (Arachnida: Scorpiones): two scorpion species (*Opisthophthalmus macer* and *Uroplectes lineatus*) were found on the Bantamsklip site; both species are fairly common and widespread in the Western Cape. **Soldier flies** (Mydidae): none found.
- **Heelwalkers** (Mantophasmatodea): none found.
- **Monkey beetles** (Hopliini): none found.
- **Millipedes** (Myriapoda): - 5 species were found.
- **Jewel beetles** (Buprestidae): none found.
- **Spoonwing lacewings** (Nemopteridae): none found.
- **Horseflies** (Tabanidae): none found.

The trapdoor species of the genus *Spiroctenus* (**Figure 8-37**) appear fairly widely but very patchily distributed on the site (being extremely abundant in patches but absent from most areas), but was not seen in the Proteoid Fynbos along the north-eastern boundary, appearing to favour the more sandy soils closer to the coast. No species in this genus have previously been recorded from the Bantamsklip/Agulhas area, and most species of this southern African endemic genus have very limited distributions and are known only from single localities. It is thus likely that the Bantamsklip specimens represent an undescribed species, but adult male specimens are needed to confirm this, and none were found during these surveys. Thus further surveys may be required. Although they are abundant on the Bantamsklip site, the possibility that this species has a limited distribution along the southern Cape coast must be considered.

This species has the highest density concentration (up to an estimated 25 burrows per m<sup>2</sup>) in an area of Limestone Fynbos on the western side of the EIA corridor. The areas of highest density are indicated in **Figure 8-38**.



Figure 8-37: A possibly undescribed *Spiroctenus* trapdoor spider found on Bantamsklip, with burrows shown on the right

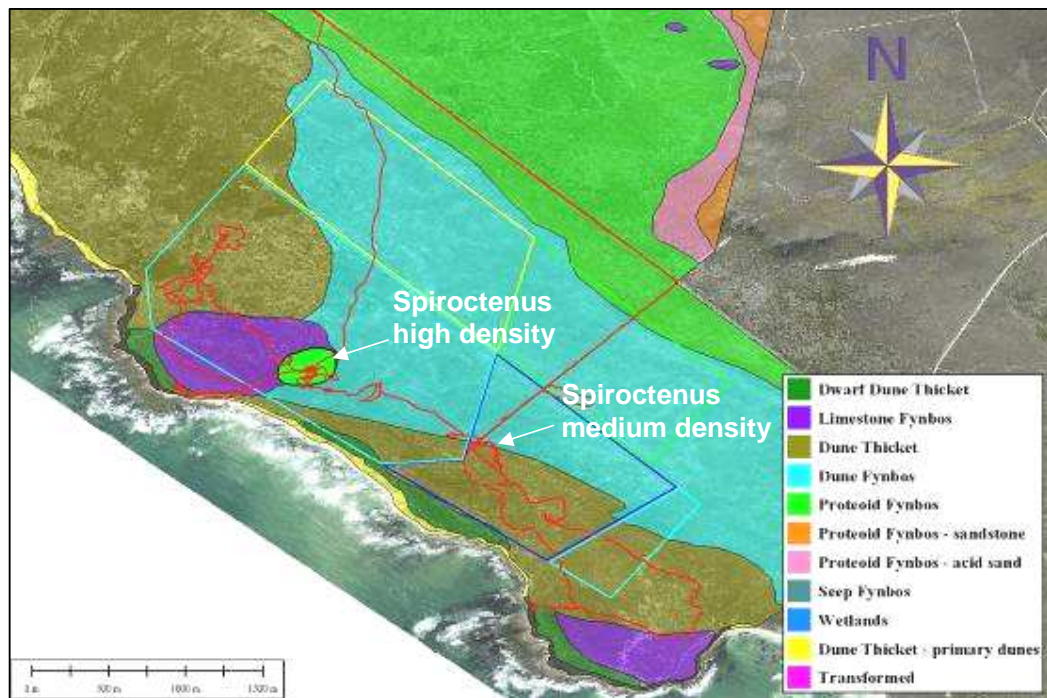


Figure 8-38: Areas of highest density of the undescribed *Spiroctenus* spider at Bantamsklip

### 8.5.6 Marine biology

This site falls within the Agulhas marine bioregion. Marine invertebrate species richness in this region is dramatically higher than that along the west coast (and the Duynfontein site), but somewhat lower than in the Thuyspunt region. Very few range-restricted species are reported from this region and no rare or endangered marine species are known from this location. Besides the important Dyer Island seal and bird colonies, which lie approximately 10 km to the west of Bantamsklip, no sites of special biological significance are known from the area.

The shoreline at Bantamsklip consists of strongly-dissected exposed rocky shores, interspersed with small pocket beaches, upon which large quantities of kelp wrack are cast ashore. This kelp originates from the dense beds of *Ecklonia maxima* and *Laminaria pallida*, which dominate shallow subtidal areas at this site. The broader region supports a number of significant fisheries (e.g. anchovy, sardine, abalone and lobster), as well as marine tourism activities such as white shark diving and whale watching. Much of this activity is centred at Gansbaai, 20 km west of the site.



**Figure 8-39: A pocket beach at Bantamsklip**

The rich diversity of fish along the Southern Cape coast supports both commercial line and pelagic species, as well as significant recreational fishing activities. As the pelagic fisheries (such as those for Pilchards and Anchovy) occur offshore, they are not likely to be impacted by the development of a power station at Bantamsklip. The commercial lineboat fishery, as well as shore anglers, target species such as Kob (*Argyrosomus hololepidotus*), White steenbras (*Lithognathus lithognathus*), Musselcracker (*Sparodon durbanensis*), Galjoen (*Dichistius capensis*), Cape salmon (*Atractoscion aequidens*) and Yellowtail (*Seriola lalandi*). All of these species have extensive ranges along the South African coast and none breed in the area around Bantamsklip, but most are considered to be overexploited, some severely so.

Since the protection of White sharks (*Carcharodon carcharias*) in 1991, the area between the Bantamsklip site and Gansbaai has become one of three shark cage diving sites along the South African coast. In particular, the area around Dyer Island, which supports a large seal colony, is a common viewing spot. Although no recent assessment has been completed of the numbers of White sharks in South African coastal waters, over 1200 different individual sharks have been identified in the Gansbaai area between 1998 and 2005..

Four marine mammals, the Southern right whale (*Balaena glacialis*), Indo-Pacific bottlenosed dolphin (*Tursiops aduncus*), Long-beaked common dolphin (*Delphinus capensis*) and South African fur seal (*Arctocephalus pusillus pusillus*), are regularly observed near Bantamsklip. While no major calving area occurs close to Bantamsklip, Walker Bay (to the west) has been identified as an important mating ground for Southern right whales.. Although Indo-Pacific bottlenosed and Long-beaked common dolphin occur close to the shore, their distribution extends to the edge of the continental shelf, and they move great distances and are common both along the South African coast and internationally. Two breeding colonies of South African fur seal occur in the vicinity of Bantamsklip, those at Geysers Rock (adjacent to Dyer Island) and Quion Rock to the east. Although five breeding colonies exist along the south coast the

abundance of this species is much lower in this region than along the west coast. Numbers of individuals on the islands peak during the breeding season, which runs from late November to early January (Barker 1988). It is during breeding time from late November to January when these colonies are most sensitive to disturbance.

The open water environment is considered to have a low sensitivity due to its dynamic nature and high tolerance to disturbance.

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## 8.6 Biophysical environment: Thyspunt

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### 8.6.1 Air quality and climate

#### a) Land Use and Topography

At Thyspunt, the land use in the local study area (typically less than 10 km) includes a large portion of vacant land. From approximately 2.5 km north of the site, the land use type consists of large tracts of cultivated land (**Figure 8-40**). Farming activities mainly include fodder for dairy cows, sheep (predominantly beyond 10 km, northwest of the site) and cattle (meat). Limited game farming occurs towards the north of the site, with wheat fields present to the west and north of the site. The N2, which extends in an east-west direction, is ~20 km north of the site with the Klipdrif River and the Krom River ~7 km to the west and north of the site, respectively.

The absence of any industrial activities in the vicinity of Thyspunt results in very low current air pollution levels. Cape St. Francis is located 13 km east of the site, and Humansdorp, which is relatively more industrialised, is located approximately 18 km north of the site. However, the prevailing winds, i.e. easterly and westerly, offer little opportunity to carry air pollution from Humansdorp to the site.

Larger residential areas in the vicinity of the proposed operations include Humansdorp (~17 km north northeast), Jeffreys Bay (~25 km northeast), St. Francis Links (~10 km east), Sea Vista (~12 km east) and Cape St. Francis (~12 km, east-southeast), (Figure 8-30). Smaller residential developments closer to the proposed site include Oyster Bay (~3 km west), Amaninzi (10km northeast) and Klippepunt (~10 km west).

The population density is predominantly less than 500 people per square kilometre (**Figure 8-41**). Increased densities are shown for Humansdorp and Jeffreys Bay (2 000 to 5 000 per km<sup>2</sup>).

Resistant rock structures in the vicinity of the Thyspunt site are visible in the increase in relief extending from the northwest to the southeast between layers of lower relief (**Figure 8-42**).

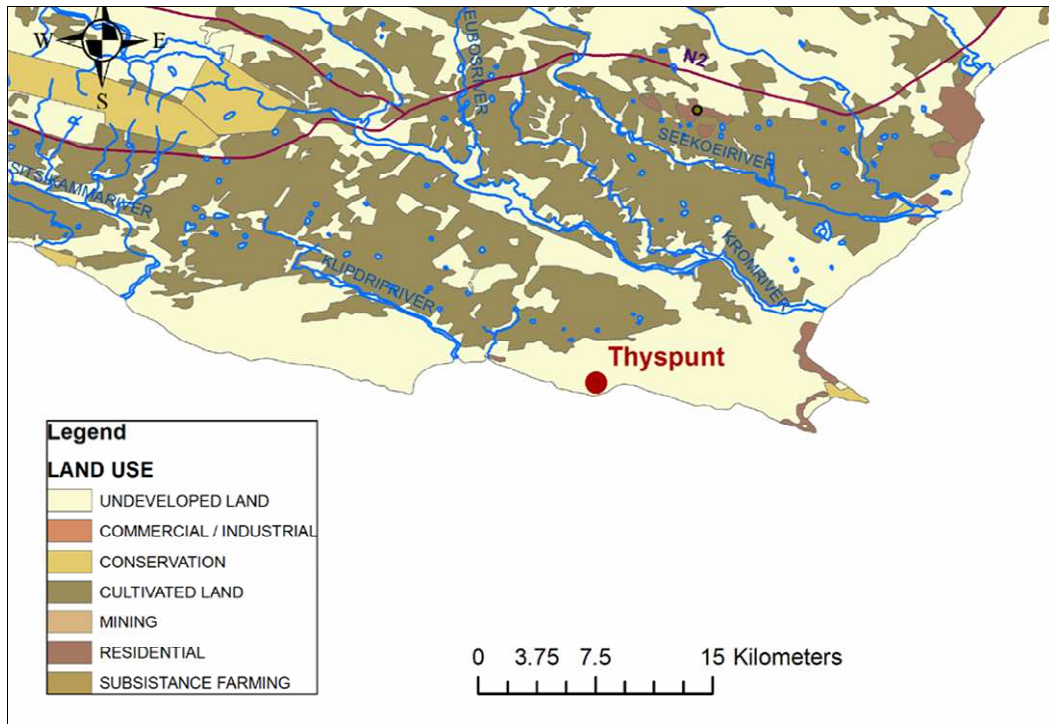


Figure 8-40: Land use in the vicinity of the Thyspunt site

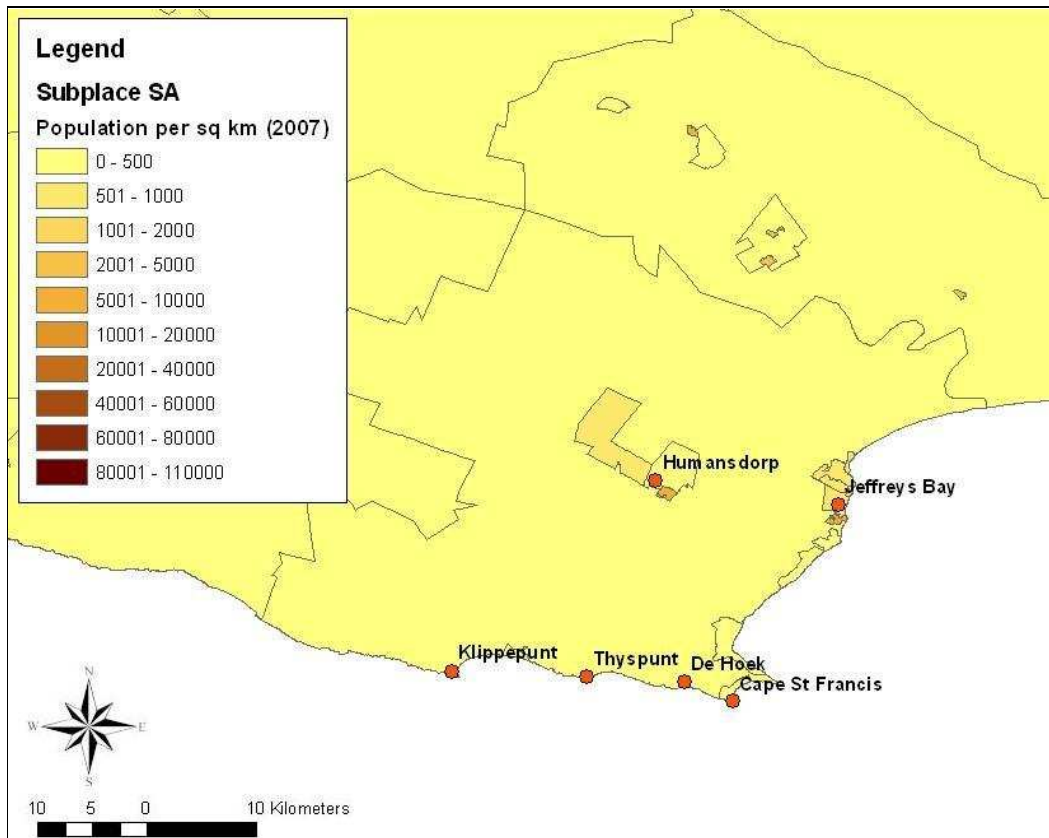


Figure 8-41: Population density in the vicinity of the Thyspunt site

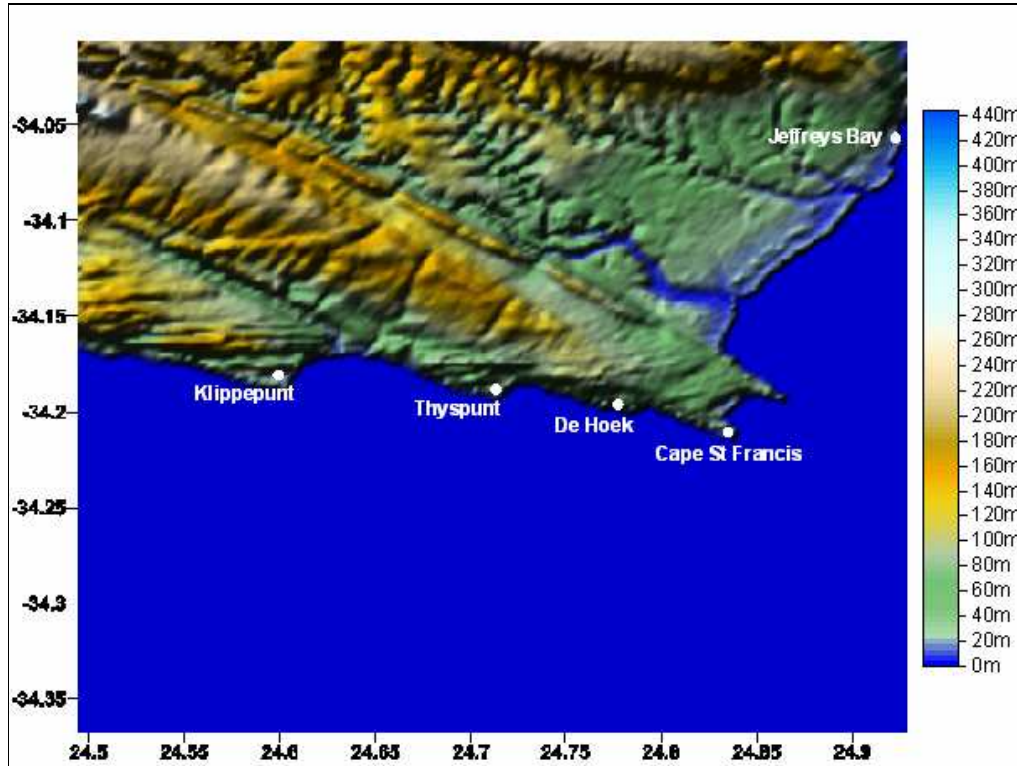


Figure 8-42: Shaded relief profile of the Thyspunt site

## b) Meteorology

### Wind Field

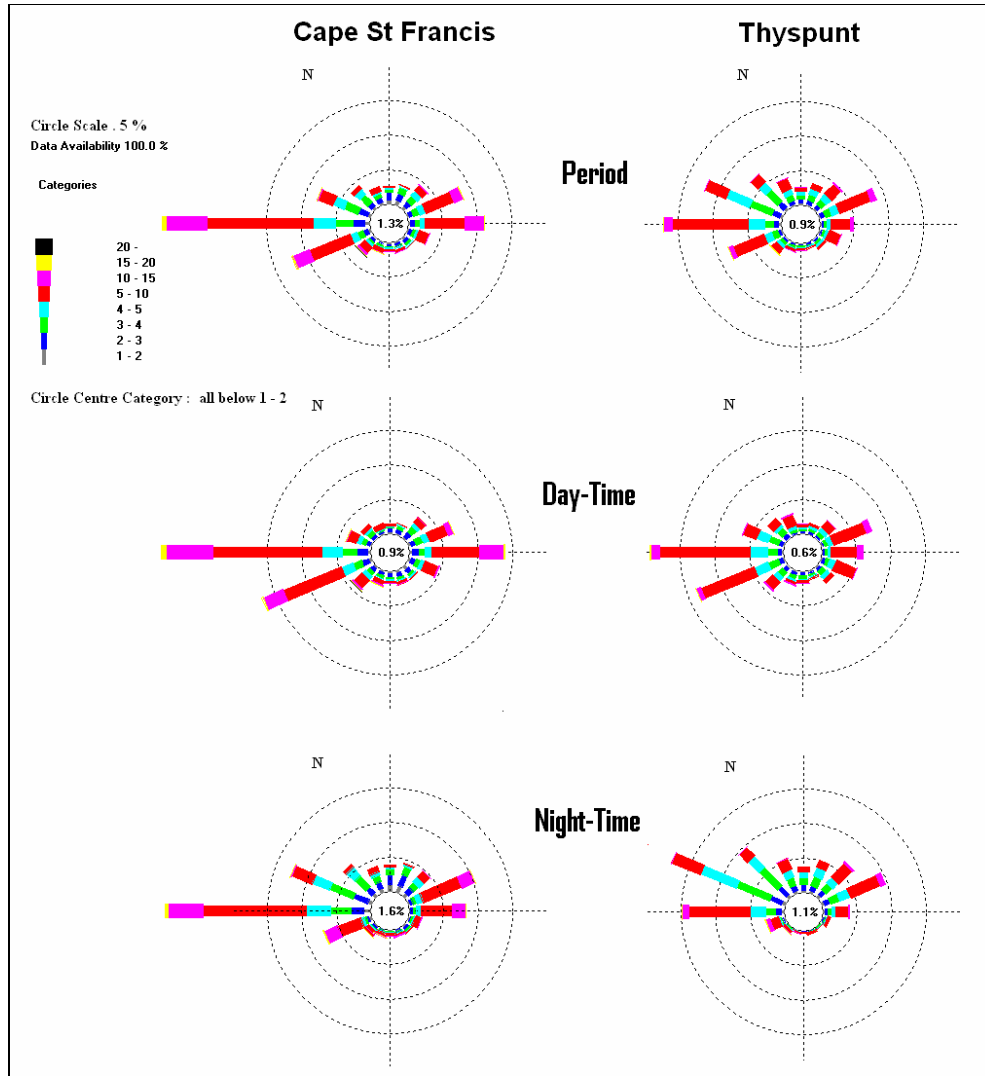
From the historical dataset produced by Eskom (1987), it is clear that the most dominant wind direction in this region is from the west northwest to northwest. The western sites of Brakke duine and Klippepunt are characterised by winds of a greater northerly direction than Thyspunt and De Hoek. Off-shore wind flows occur about 30 % of the time at all the sites. It is important to also note the very low frequency of calm wind conditions (~2 %). More frequent stronger winds come from a west northwest to northwest direction. Some noticeable mild winds also occur from the northeast direction but these are infrequent. The wind speed tends to increase to mid afternoon as the instability is highest at around 14h00. Furthermore, the frequency of frontal systems and coastal low pressure systems forces a variable daily surface wind speed at all the sites. The offshore flow, i.e. northerly winds are characterised by slow wind speeds and somewhat frequent occurrence (much less than the north-westerly winds but noticeable) indicating the effect of land breezes. The occurrence of onshore flow i.e. southerly winds is negligible at all sites in this region.

According to the 21-month observations at Thyspunt, westerly winds dominate, with approximately 20.5% occurrences during the period. This wind direction also experiences the highest frequency of strong winds, i.e. winds in excess 10 m/s occurring 1.5% of the year. Winds in excess of 15 m/s occur 0.1% of the period. Strong winds in excess of 15 m/s also occur from the west-south-west (~0.03%) and south-west (~0.02%). Winds from the north-north-east to northerly sector are on average the lowest (~3.9 m/s), compared to the average of 6.2 m/s from the east-north-east and eastern sector, and 5.8 m/s from the west-south-west to western sector.

The western wind component is prevalent during all four seasons (**Figure 8-43**). However, the eastern wind component is more prevalent during spring and summer. The frequency of



strong westerly winds increases during winter months (July to August). Winter also witnesses an increased amount of wind from the west-north-west.



**Figure 8-43: Comparison of wind roses between Cape St. Francis and onsite, Bantamsklip data**

Atmospheric Stability

On an annual basis, the highest frequency of stability class occurrence is neutral (68.2%) followed by slightly stable 11.6%. The mean wind speeds with these two stability classes are 5.9 m/s and 5.7 m/s, respectively. Extremely unstable conditions occur 3.1% of the time with a mean wind speed of 2.9 m/s, while extremely stable conditions occur only 1.8% of the time with a mean wind speed of 2.4 m/s.

Ambient Air Temperature

The ambient air temperature statistics for Cape St. Francis are summarised in **Table 8-3**. The table contains the average daily maximums, minimums and extreme maximums and minimums. The average daily maximum and minimum temperature recorded at Cape St. Francis were 22.8°C (January and February) and 11.2°C (July), respectively. The extreme maximum and minimum were 36.5°C (May) and 5.0°C (August), respectively.

**Table 8-3: Means and extremes of temperature for Cape St. Francis for the period 2004 to 2007**

Month	Average Daily Maximum (°C)	Extreme Maximum (°C)	Average Daily Minimum (°C)	Extreme minimum (°C)
January	22.8	27.4	18.5	12.9
February	22.8	28.3	18.4	14.1
March	21.8	25.5	16.7	12.9
April	19.6	25.3	14.7	9.1
May	19.4	36.5	13.3	7.1
June	18.8	29.0	11.7	6.8
July	18.1	28.0	11.2	6.6
August	17.9	30.5	11.6	5.0
September	18.1	24.4	12.9	7.0
October	19.2	25.5	14.2	8.5
November	20.9	31.1	15.9	11.2
December	22.0	25.0	17.4	12.6
Annual	20.1	36.5	14.7	5.0

Atmospheric Moisture

Relative humidity has been recorded since January 2008. The average relative humidity appears to be the same as at Bantamsklip, i.e. around 78% with the lowest recording during August, i.e. 9.9 %.

Precipitation

The rainfall season for the Thyspunt area is classified as all year round. The mean annual precipitation is expected to be between 600 mm and 800 mm,. The rainfall observations made at the weather station in Cape St. Francis recorded an annual average of 610.9 mm for the period 2004 (June) to 2007. Ignoring 2004, the mean annual average rainfall is 587.9 mm.

Snow and Frost

No snow or frost has been recorded at Thyspunt.

**c) Air quality**

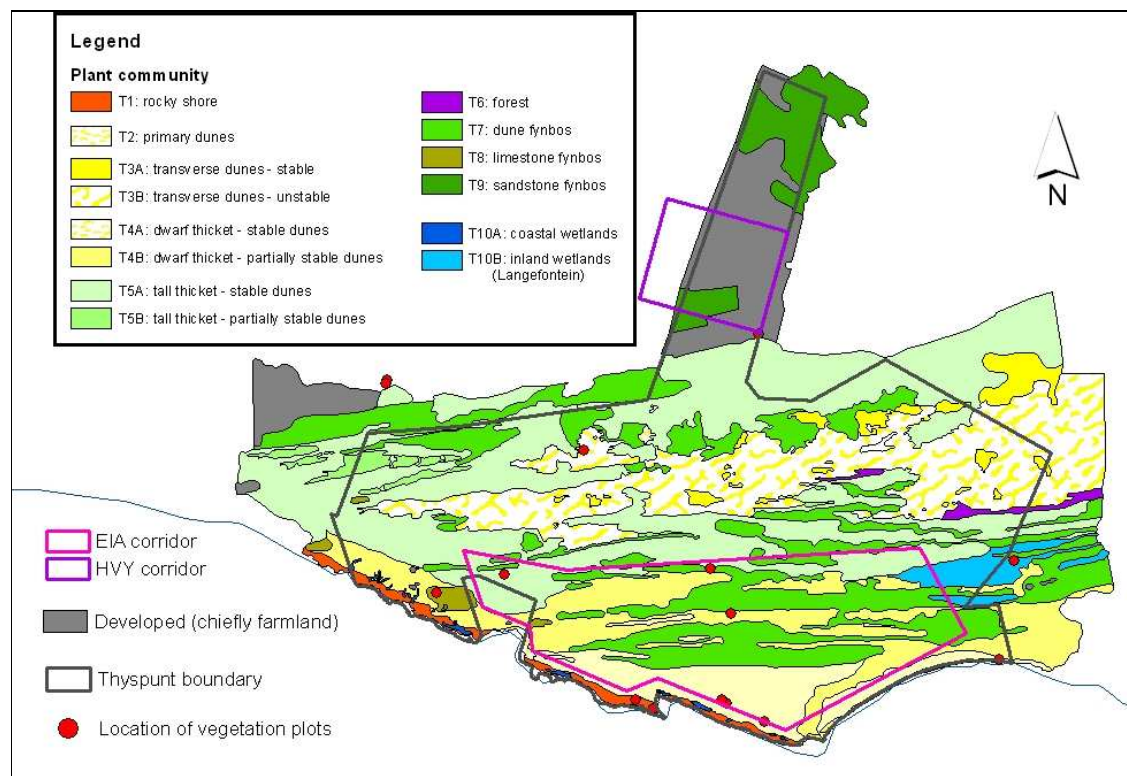
Similar to Bantamsklip, no ambient air sampling data are available to provide historical air pollution concentration quantities at Thyspunt. A three-month sampling exercise was completed during March to May 2009. The observed monthly average sulfur dioxide and nitrogen dioxide concentrations were 0.40 µg/m<sup>3</sup> and 1.51 µg/m<sup>3</sup>, respectively. These concentrations are considered to be low and typical of conditions away from air pollution generating activities.

The closest source of potential air pollution is Oyster Bay, approximately 3 km from the site. The air emissions typically include fugitive dust from building activities and unpaved road surfaces, and combustion products from domestic fires and vehicle emissions. Due to the sparse population, these emissions are not considered significant.

The increased human activities at Cape St. Francis would result in increased levels of air pollution. However, it is located 13 km east of the site and would therefore have minimal impact at the site. The relatively more industrialised Humansdorp is located approximately 18 km north of the site, but with the easterly and westerly prevailing winds, offer little opportunity to carry air pollution to the proposed NPS site.

## 8.6.2 Flora

Five major vegetation types occur on the site (conservation status in brackets): Algoa Dune Strandveld (Least Threatened), Southern Cape Dune Fynbos (LT), Tsitisikama Sandstone Fynbos (Vulnerable), Cape Seashore Vegetation (LT) and Cape Lowland Freshwater Wetlands (V). This translates into nine major plant communities with six wetland types and a river system. Three hundred and eighty three plant species were recorded on site, with a very low rare species count (14 or 3.7%), compared with other coastal areas which might exhibit >5%. Analysis of on site floras shows a clear distinction between calcareous and non-calcareous habitats, and with total carbon playing a key role as one moves inland from the coast, through primary dunes, stable dunes and forest. Species rarity is generally low, with the exception of one or two habitats. Likewise habitat rarity is fairly low except for the transverse dunes, coastal limestones and wetlands. Endemism is also low, with only one local endemic found there. Sensitivity is greatest on both mobile and stable dunes, with most of the site showing high tolerance to droughting. All fynbos communities show high proneness to burning. Habitat resilience is lowest for the mobile dunes, coastal limestones and wetlands. The headland bypass dune system at Thyspunt is endemic to the area and the biggest on the South African coastline.



**Figure 8-44: Botanical communities of Thyspunt**

## 8.6.3 Wetlands

The Thyspunt site is characterised by extensive mobile dunefields, which are closely associated with the wetland systems. The wetlands occur mostly in the low-lying interdune "slack" areas. The eastern quarter of the Oyster Bay dunefield drains into the Sand River – an "episodic" river, which comprises largely shallow subsurface flow, save during flood episodes, when it carries runoff and subsurface flow from the dunes and surrounding farmland and other developed areas into the Krom River.

Groundwater interactions play an important role in determining the function and distribution of many of the wetlands on and in the vicinity of Eskom's Thyspunt site. describe groundwater flows across the site as predominantly from north-west to south east, with discharge along the beaches and rocky outcrops into the ocean, and into the Sand River aquifer in the east.

Three types of wetlands occur on the site:

- **Wetland depressions** within the mobile dunefields – these wetlands are also referred to as **duneslack wetlands**. These are depressions that occur in an otherwise sloped terrain. The wetlands form against the leeward toe of the mobile dunes and collectively comprise an extensive band of seasonally (or at least non-permanently) inundated pools, ranging from less than 30cm in depth to over 2 m. They are aligned in a west-east direction, becoming more extensive in the east.
- **Permanently to seasonally saturated hillslope seeps** (including the Langefonteinvlei wetland complex on the eastern boundary of the site); and
- **Permanently to seasonally saturated valley bottom wetlands.**

There is a high degree of certainty about the mechanisms that feed the hillslope seeps like Langefonteinvlei (they are fed from aquifers). However, there is still a degree of uncertainty about the mechanisms feeding the duneslack wetlands. Several hypotheses have been proposed for the latter, but no conclusion has been reached.