Environmental Impact Assessment (EIA) for the Proposed Construction, Operation and Decommissioning of a Sea Water Reverse Osmosis Plant and Associated Infrastructure Proposed at Lovu on the KwaZulu-Natal South Coast

FINAL EIA REPORT

CHAPTER 9: TERRESTRIAL ECOLOGY

ABBREVIATIONS, UNITS & GLOSSARY

CVI	Coastal Vulnerability Index
DEA	Department of Environmental Affairs
DP	Drift potential
EIA	Environmental Impact Assessment
Edaphic	Pertaining to soils
ESR	Environmental Scoping Report
ICMA	Integrated Coastal Management Act
Mesic	"dry", terrestrial environments
Perigeal	When the moon is most proximal to the Earth
Psammosere	Succession stages of a particular stage associated with a dune environment
RDD	Resultant Drift Direction (a vector addition of wind directions)
SLR	Sea level rise
Seral	Pertaining to succession
Supra-tidal	Above the normal high water mark
TWINSPAN	Two Way Indicator Species Analysis

EXECUTIVE SUMMARY

Umgeni Water is considering the establishment of desalination plants at Illovo and Tongaat, within the eThekwini Municipal boundary. These projects entail the abstraction of sea water via a pump system from the marine environment and transfer to a desalination plant, where salts are removed from the water, rendering a potable and consumable product that may be transferred to the water service providers within the region for onward sale to consumers. Brine, a bi-product of the desalination process will be returned to the sea.

As a component of the EIA for these proposed projects, a Terrestrial Ecological Assessment has been undertaken to evaluate the likely impacts of the construction, operations and decommissioning phases of the plants in the prevailing terrestrial environments. This report details the findings of the Terrestrial Ecological Assessment undertaken for the Lovu Desalination Plant, positioned in the south of eThekwini.

Impact Assessment and mitigation

- The terrestrial or mesic portions assessed as part of this study exclude wetland and estuarine components, but include portions of the Sea Water Reverse Osmosis Plant sites (Preferred and Alternative sites), the 132 kV powerline and the nearshore coastal environment (beach and dune) where the pump station and seawater intake and brine discharge pipelines are proposed to be constructed.
- The most significant ecological component, within the mesic environment, relates to the beach – dune continuum, where significant physical dynamism is apparent.
- The most significant impact, predicted to be of **high** significance prior to the implementation of mitigations, was assessed to be associated with disturbance to the frontal dune during the construction of the seaward sections of the intake and brine discharge pipelines. Trenching of these sections of the proposed pipelines through the dunes will also lead to long term secondary impacts (i.e. indirect impacts) such as increased mobility (or the potential to mobilise) within the dune system which may only be addressed through a sea defence system and/or further stabilisation. The latter may in turn alter sediment and beach dynamics.
- Given the complex nature and dynamics of the frontal dune system as well as the number of inter-related processes associated with this environment, the proposed trenching of the marine pipelines through the dune cordons, although not a fatal flaw, would lead to a number of significant direct and indirect impacts on the dune system and surroundings. These impacts are also mostly considered to be of low reversibility. It is therefore **strongly recommended** to **pipe jack** the proposed seawater intake and brine discharge pipelines under the dunes, with specific consideration towards maintaining a narrow working corridor. A terrestrial ecologist should be involved in the engineering design to confirm the entry and exit location of the pipeline under the dunes. This change in the design of the proposed project would be expected to lead to much more acceptable impacts (**low** significance) on the dune system and associated surroundings.

- It is also recommended to undertake a monitoring initiative on the dune-beach frontage, prior to construction, in order to assess the extent of the dune toe, back beach and intertidal zone using a number of parameters, i.e. highest tidal extremes (HATOY) and movement of estuary mouth.
- Following the effective implementation of the recommended key mitigation actions, all impacts on terrestrial ecosystems associated with the proposed project are predicted to be of **medium to low** significance, with the exception of impacts associated with the disturbance of the general surface environment at the proposed Alternative site which are anticipated to be of **high** significance.
- In general, the dune form around the proposed pump station is showing increased mobility, associated with both natural and anthropogenic factors.
- The SWRO should be positioned on the Preferred site or the lower lying site. At this point cut and fill earthworkds operations will be reduced and alteration of the landscape in general will be reduced.
- Some mitigation measures may be employed to reduce impacts arising from the development and transformation of the dune and beach, however such areas are open to the vagaries of short term meteorological and maritime influences, as well as longer term climate change factors
- Other factors that should be addressed, should the project proceed, include the provision of bird flight diverters (BFDs) on all powerlines, with BFD's being positioned strategically along the line route. The redress of exotic invasion and general vegetative and ecological management interventions will be an important component of the post construction and operational management regime.

The following key design and management actions are recommended for the coastal environment:

Design Phase:

- Construction establishment should be subject to direct evaluation on site, in order to refine the final layout, e.g.
    - the pump station should be established at a point landward of the frontal dune cordon in order to maintain dune frontal dynamics (beyond the recommended set back line),
    - the proposed seawater intake and brine discharge pipelines should be pipe jacked under the dunes, with specific consideration towards maintaining a narrow working corridor,
- pipelines from and to the pump station should not be dug within the natural forest in the vicinity of the proposed pump station but rather pipe jacked below the ground surface to avoid vegetation clearing or disturbance.Limit the amount of infrastructure placed in and around the dune / beach environment during final design of the pumping facility, in particular hard surfaces; Limit the pump station footpring to 50m x 50m.
- Ensure an adequate stormwater design.
- Position key infrastructure requiring regular maintenance (e.g. venting and purge valves) so as to avoid undue movement onto the dune cordon or into the beach/shore environment.

Construction Phase:

- Limit construction footprint to the absolute minimum required.
- Ensure that construction is undertaken when the mouth of the Lovu River does not train north, to reduce the necessity to breach the estuary mouth.
- If breaching of the mouth of the Lovu River is necessary, it should be undertaken as far south as possible. Advice from suitably qualified and experience estuarine ecologists should be sought on the authorization, timing, duration, nature and location of the breach. Authorisation and permits in that regard will be required from the relevant authorities.
- Ensure that within the beach and supratidal beach environment, such pipes are laid at a depth greater than 5m below mean sea level.
- Minimise activities in these environments through the management of entry to the beach and dune environment for all activities (i.e. cordoning off the area).
- Sculpting and stabilization re-vegetation of the dune face and the beach / supratidal environment to allow it to revert to its natural state of dynamism and align it with the prevailing topography

Operation Phase:

- If and where possible, avoid the use of engineering defenses or other engineering means, and address erosion and mobilisation of dune system through sculpting and revegetation and/or use of geofabric materials.
- Stabilise and upgrade existing access point to beach in order to allow for traffic on the beach, if required. A temporary access point can be established and stabilised using geofabric materials.
- Implement a traffic management protocol for all staff to avoid undue entry to the beach of staff and in particular, the use of vehicles on the beach.
- Limit and manage the mobility of the dune form to allow for natural processes to control such dynamism.

The following key design and management actions are recommended for other mesic environments:

Construction Phase:

- Ensure that soil horizons (O, A and B) be identified and stockpiled according to prevailing horizons during excavation and backfilling.
- Following the clearance of vegetation, open and bare areas not identified for the continuance of cultivation should be subject to re-vegetation using a rapid germination species such as a mix of graminoids (*Digitaria* spp ; *Eragrostis* spp) or active vegetation with appropriate herb and woody species.
- Where possible, use of geofabric stabilising materials or re-vegetation of embankments to address erosion.
- Where extensive cut and fill operations are required (i.e. slopes >18˚), appropriate engineering interventions should be considered to address potential erosion risks.

- Monitoring of untoward variation in the topography should be undertaken by management following the cessation of the construction phase. Possible infilling or rectification of extensive depressions or variations in topography to be addressed.
- Prudent alignment of all pipelines to ensure the avoidance of potential faunal refugia, including steeper slopes and thickets of vegetation.
- Preliminary review of sites prior to construction to identify fauna that may be traversing or be present within particular areas.

Operation Phase:

- Generalised land management regimen, including exotic weed control, habitat and vegetation management regimen.
- Monitoring and management of pipeline and powerline servitudes for secondary seral growth to facilitate management and maintenance operations, while also allowing for the preservation and enhancement of natural seral processes.
- Install bird flight diverters where powerlines traverse valleys or extensive open fields, are proximal to open water or wetland environments and lie adjacent to scarps.

Given the generally transformed nature of the receiving environment, the medium level nature of the overall level of impact arising from the development and providing that the recommended key mitigation measures are effectively implemented, it is evident that the siting of a desalination project in the manner proposed cannot be precluded on the grounds of impacts on the terrestrial/mesic environment.

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9 TERRESTRIAL ECOLOGICAL ASSESSMENT

This chapter presents the terrestrial ecology specialist study undertaken by Mr Simon Bundy from Sustainable Project Developments cc as part of the Environmental Impact Assessment for the proposed 150 Ml Seawater Reverse Osmosis Plant and associated infrastructure in Lovu, KwaZulu Natal.

9.1 INTRODUCTION

This Terrestrial Ecology Specialist Study forms part of the Environmental Impact Assessment process for the proposed desalination facility at Lovu and provides a review of the terrestrial ecological components of the proposed Lovu development site as well as of the immediate zone of the proposed seawater intake and brine discharge pipelines. In addition, the impact of powerlines and related infrastructure on the terrestrial ecology are considered.

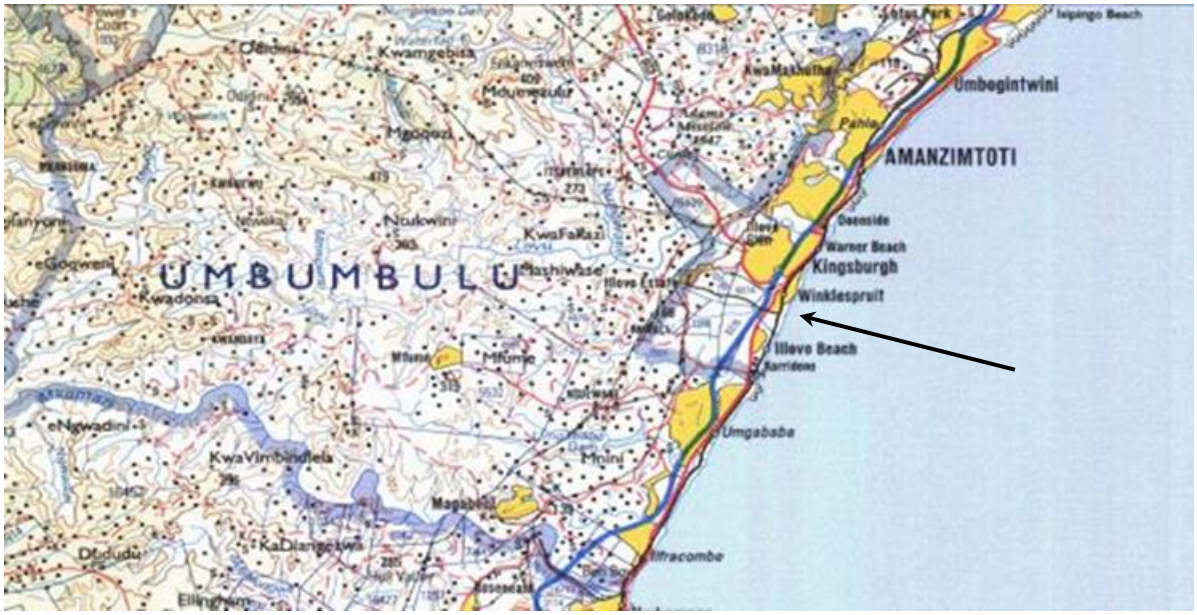

Figure 9.1 Map with arrow indicating the site of the proposed Lovu Desalination plant. (Surveyor General 1:250000).

9.1.1 Scope of Work

The scope of work for this terrestrial ecology study is outlined below.

1. Consideration was afforded to the findings included in the Final Environmental Scoping Report (CSIR, 2015) in respect of the terrestrial ecological investigation. Such information included:
    a. The nature of the landscape associated with the SWRO plant, the pump station and associated pipelines and infrastructure.

b. Habitat and related matters identified in the Final Scoping Report.

c. Recommendations for specific investigations and interrogations to be undertaken in the EIA Report, these being in particular the undertaking of a detailed review of the frontal dune cordon at Lovu.

2. In view of the above, specific consideration was afforded to the coastal dune environment as well as the avi-faunal impact of the proposed powerline routes that would service the desalination plant. Such evaluation included:

   a. A review of pertinent literature, as per the references provided below.

   b. Consideration of aerial imagery pertaining to the proposed site from relevant years was undertaken whereby changes in habitat form, morphology or other variations were noted and interpreted.

   c. A site review was undertaken to evaluate and support or dismiss interpretations emanating from evaluation of aerial imagery. Such site review also served to identify any ecological features of significance, and where identified, such features were logged.

3. Following interpretation of the nature of the receiving environment and the ecological processes inherent within the sites, consideration was given to the anticipated impacts that may arise from the establishment of the proposed plant. Such interpretation included the possible consideration of "fatal flaws", whereby impacts were extremely severe and could not be mitigated.

4. Impacts were rated according to accepted practice which included gauging the level of impact, its duration and extent, as well as the ability to reverse or re-establish the *status quo* should the development be decommissioned.

5. Some consideration was given to applicable legislation as it may relate to the receiving environment, as well as the level and severity of the impacts identified and the legal ramifications thereof

6. With the identification of impacts, possible options for mitigation were identified including design and technology alternatives, construction methods and variations to the operations of the plant as well as the possible option of maintenance of the status quo and the abandonment of the project on the site in question, if fatal flaws were identified.

7. Specific consideration of rehabilitation and mitigation options were identified and proposed in respect of the terrestrial environment that would be both directly and indirectly affected by the implementation of the desalination project.

9.1.2 Study Approach

Significant field reconnaissance had been carried out over the proposed development footprint during the ecological investigation undertaken during the Scoping Process. This preliminary report highlighted a number of key bio-physical components of the Lovu region that would be subject to further transformation should the desalination plant proposal proceeds in this region.

During the EIA process, the estuarine and wetland components have been subject to independent, specialised investigations (refer to Chapter 7 and 8), while this report deals with the terrestrial

components, particularly in respect of the supratidal beach and dune environments. Other areas of specific consideration within the terrestrial environment included those portions of the proposed powerline routes serving the SWRO Plant that fell within the terrestrial environment. While much of these areas also constitute sugar cane lands, the impact on avifauna was given due consideration.

Given the nature of the environment in question, it is evident that focus on the psammoseral or *beach-dune interface* was required at an advanced level of investigation, on account of the natural dynamism associated with these habitats and the suggested ecological and socio-economic significance of this environment. The area is also subject to specific legal jurisdiction through the Integrated Coastal Management Act (Act 24 of 2008) (ICMA).

The approach to this investigation was to review the present understanding of, in particular the psammoseral environment at a local level and proceed to analyse any temporal changes that may have arisen. The focus of the investigation was to consider the ecological processes inherent within the subject environment, identify the drivers within such environment and therefore evaluate and predict responses to any perturbations that may arise on site. The "significance" of the affected habitats would also be determined and allow for the further evaluation of the ecological impacts upon the receiving environment.

9.1.3 Information Sources

The following information sources were used for the evaluation of the Lovu site:

1. Review of specific literature as indicated in the reference section below. Specific consideration was given to dune and coastal issues.
2. Historical aerial imagery as sourced from the Surveyor General's office.
3. Data sourced from the National Oceanic and Atmospheric Administration (NOAA) website (www.noaa.gov/slrtrends.html).
4. Further specific sSite reconnaisance on 6 April 2015 and 1 May 2015. in addition to site reconnaisance undertaken 23 February 2015 and during the period August 2013 to September 2013.
5. Process information that was sourced from the client.

9.1.4 Assumptions and Limitations

All effort was made to reduce the level of assumption applied to this assessment, however:

1. This assessment was undertaken utilizing both primary data and sourced data. Primary data was obtained during the summer of 2013 and autumnof 2015, thus providing some seasonal diversity in respect of floral and faunal species encountered. However, other seasonal variations in species presence and population dynamics may be linked to other seasonal factors.
2. A conceptual plan of the proposed desalination plant was provided by Umgeni Water. The impacts arising from the proposed project, particularly in and around the dune and beach environments are likely to vary over very short timeframes (from hours) to periods greater than a decade, and as such, the information below is based upon that collated intermittently

and over the short term. In addition, changes in the design and placement of structures, even if only considered minor, may alter predicted impacts.

3. Some consideration of other projects envisaged for the area has been undertaken. Such projects to date include :
    a. Proposed sea defence on neighbouring property "The Boardwalk".
    b. Proposed change in land use on Illovo Caravan Park.

9.2 PROJECT DESCRIPTION:

The proposed desalination plant will have a capacity to produce 150 ML/day of potable water and will be located at Lovu, near the town of Winkelspruit, south of Amanzimtoti within the eThekwini Municipality (as shown in Figure 9.1 above).

The proposed development entails the construction of a pump station at a selected point in close proximity to the beach, enabling sea water to be be abstracted via offshore conduits connected to an intake structure about 1000m offshore. At Lovu, the pump station will be situated in a landward portion of the dune cordon, while the SWRO will lie some 2.7 km inland, to the west of the pump station (Figure 9.2). The sea water pipeline at Lovu (between the pumpstation and the desalination plant) will have a diameter of about 1.8 m and will be about 3 km long.

The SWRO desalination plant is proposed to occupy an area of approximately 7 ha within which construction would also take place. Intake water will be treated by reverse osmosis at the proposed plant, with potable water being transferred to reservoirs, through connection to an existing bulk supply line. Two potential locations are identified for the SWRO plant, located on either side of the R 102 roadway.

Brine, a product of the desalination process, will be returned to the marine environment via a pipeline that would run from the SWRO plant back out to the sea, discharging via a diffuser located a distance of about 400m offshore.

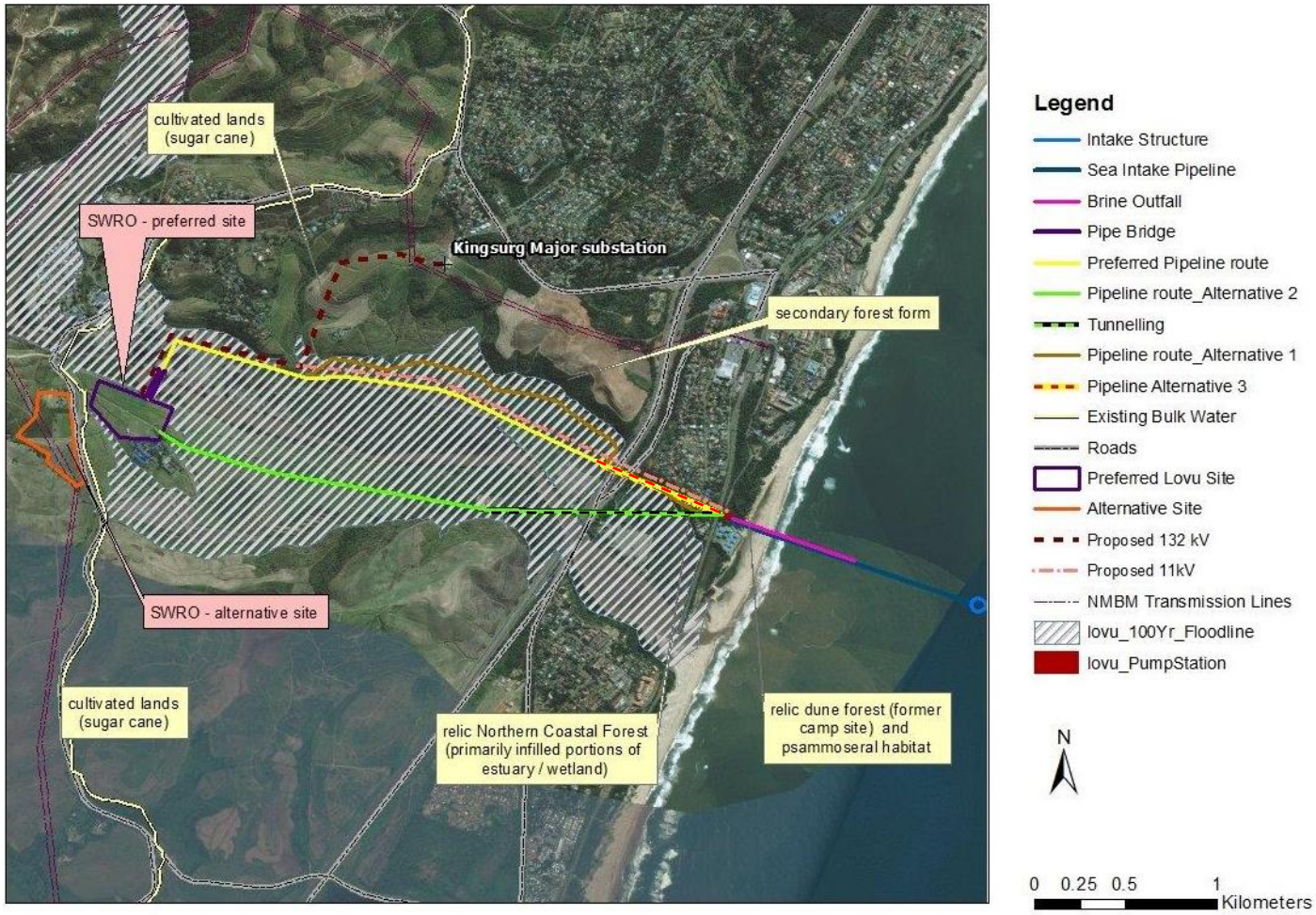

Figure 9.2 Aerial overlay of the proposed Lovu desalination plant and prevailing landscape with estuary highlighted. Mesic environments lie outside of the hatch.

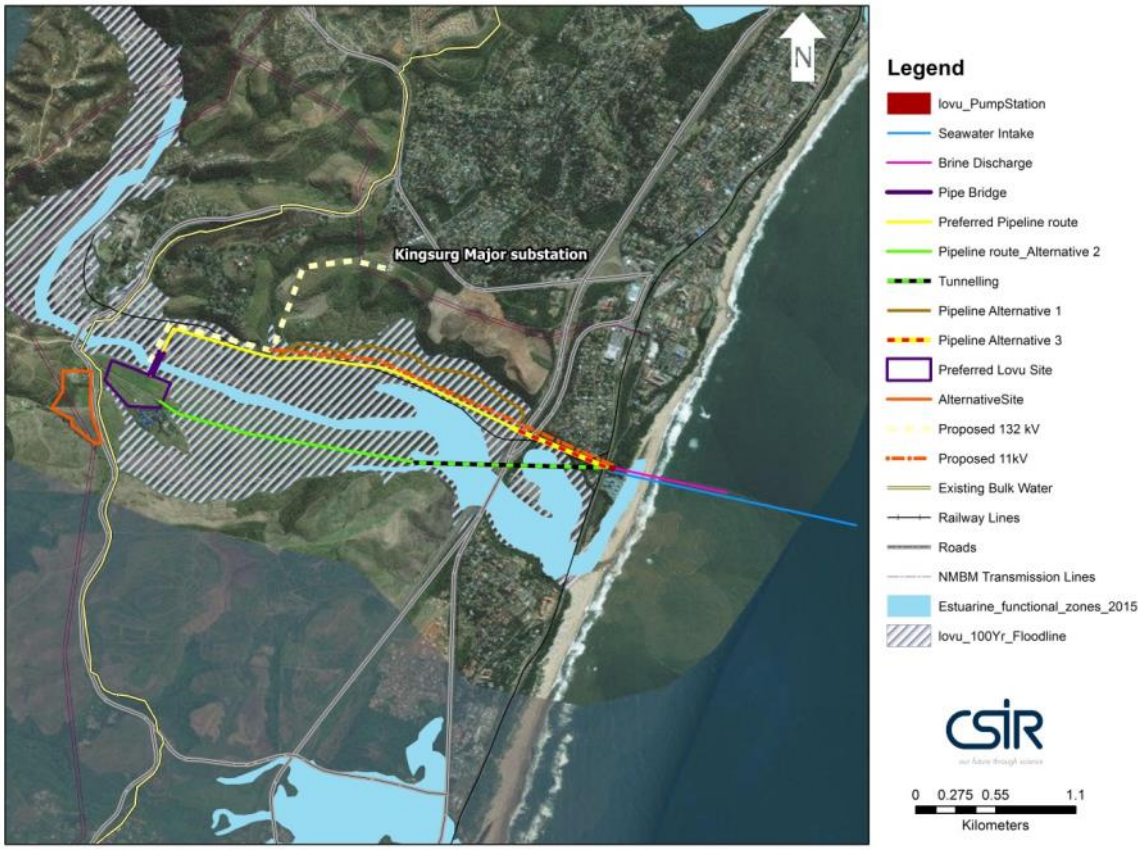

Figure 9.3 Diagrammatic representation of the proposed Lovu Desalination plant (Source : CSIR, 2015).

There are four proposed routes for the seawater intake and brine discharge pipelines from the SRWO plant to the pump station as identified in Figures 9.2 and 9.3. The Preferred pipeline route and the Alternative 1 pipeline route will be established through trenching and burial at a maximum depth of 4m. The Alternative 3 pipeline route follows the preferred route but would be tunnelled for the first section. The Alternative 2 route will traverse the iLovu estuary on the south of the channel (by means of 1100m of tunnelling under the estuary, to a depth of up to 65m, followed by conventional pipe laying thereafter to the desalination plant). The installation of the pipe systems through the dune cordon, supratidal and intertidal environment (seaward sections of the seawater intake and brine discharge pipelines) will be the same for all alternatives and will be undertaken by excavation and blasting of rock material,and where required, by pipe jacking or by tunneling (i.e. under roads or railways).

The Powerlines

The expected power supply to the SWRO plant is the Kingsburgh Major substation, situated some 2.5km away. The powerline is a 132kV tranmission line established on lattice towers, which will step down to an 11kV supply at a sub station positioned near the SWRO plant (Figure 9.2). An 11kV supply from this substation will serve the pump station positioned to the east.

9.3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The proposed Lovu SWRO and its associated infrastructure fall extensively within the estuarine environment of the Lovu River and associated wetland systems, which are the subject of habitat specific investigations as per Chapters 7 and 8. Mesic environments are those environments that are considered to be neither wetland or estuarine (i.e. part of the riverine system of the iLovu) and receive a reasonable level of moisture, derived either from the ground or through precipitation. Much of the southern KwaZulu Natal habitat can be described as "mesic".

Mesic environments (i.e. environments with a balanced supply of moisture) are found at the coastline, lying upon the frontal dune cordon, immediately north of the Lovu River mouth, and at the proposed positions of the desalination plant (Figure 9.4). The powerlines serving the desalination plant will also traverse portions of the mesic environment (Figure 9.5). As such, the components of the mesic environment that would be affected by the proposed project include:

1. The supratidal and littoral active zone, including the frontal primary dune and secondary dune forms.
2. Portions of the pipeline route, traversing in close proximity to the existing railway line near the proposed pump station.
3. Portions of caneland and secondary vegetated areas associated with the seawater intake and brine discharge pipelines from the pump station to the reverse osmosis plant.
4. Portions of caneland associated with the powerlines serving the SWRO plant.

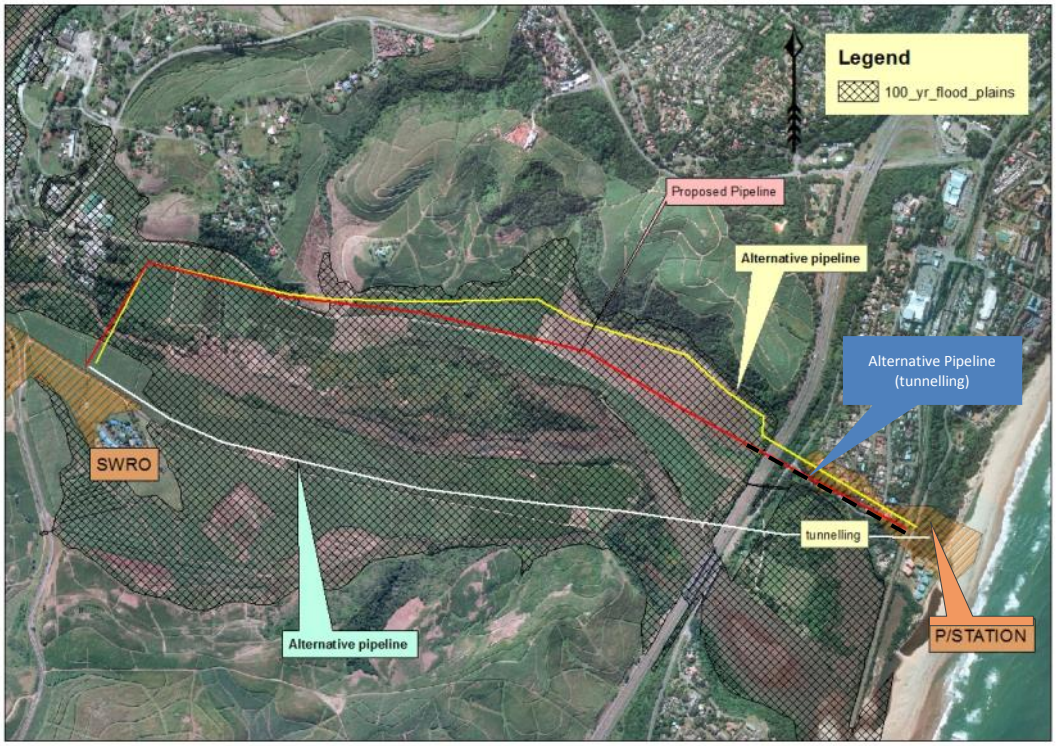

Figure 9.4 Image indicating position of pipelines and preferred location of the proposed SWRO plant in respect of flood line of iLovu and the mesic environments (orange areas) (source eThekweni Municipality).

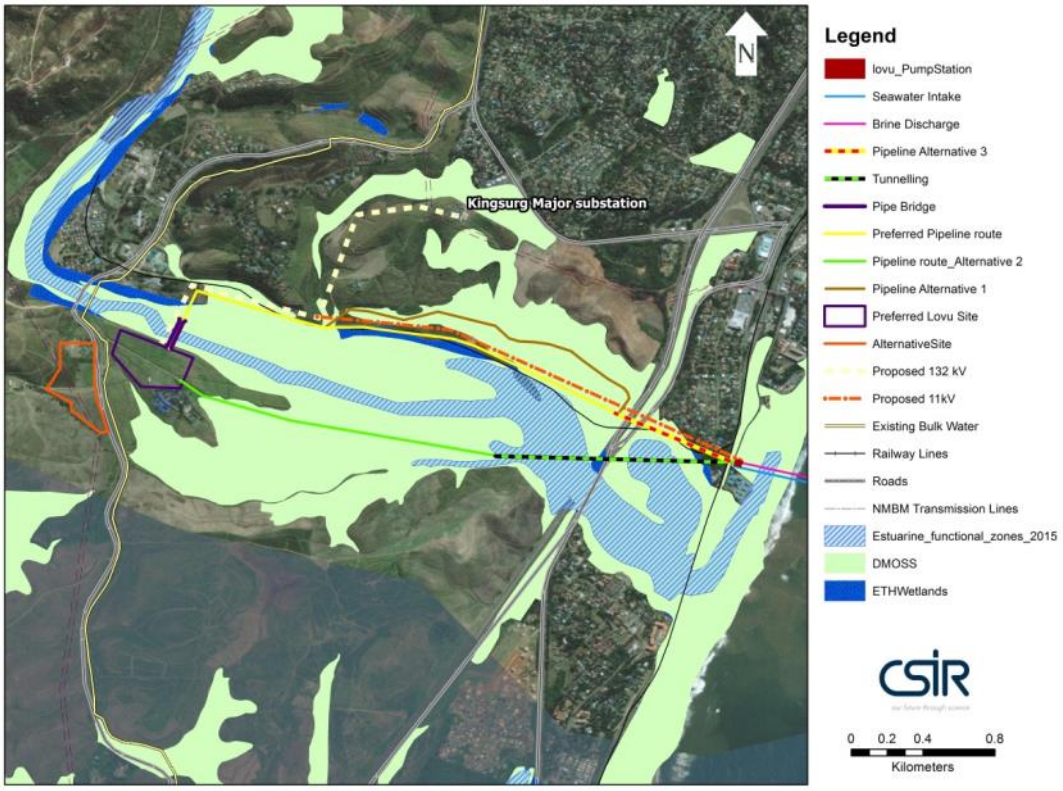

Figure 9.5 Image indicating the preferred location of the proposed SWRO and powerline infrastructure as well as the position of open space and NFEPA wetlands / estuarine areas, which comprise most of the study area.

Of the above, the coastal component is considered to be of the greatest ecological significance on account of:

- The highly dynamic nature of the coastline in general (Tinley 1980 ; Tsoar et al. 2009 ; Yan 2015)
- The susceptibility of soft coastlines to changes in sediment and vegetation states with concomitant "*knock on effects*" (Yan 2015, Lancaster 2007, Ranwell 1940) that alter beach and dune dynamics at other points of the coastline.
- The evident proximity and relationship of the affected portion of dune cordon with the identified (intermittent) mouth of the Lovu River.
- The dune cordon, although disturbed and somewhat transformed, shows the highest plant species diversity within the study area (CSIR 2015).

Given the above factors, specific consideration will be given to the dune systems affected by the proposed project. The affected environment is described below.

9.3.1 The Dune Cordon and Beach

The dune and beach environment is a dynamic interface between the sea and land that is shaped primarily by wind and sediment fluxes, with vegetation and other factors dictating stability and morphology. Figure 9.6 below indicates a general profile through the beach – dune continuum and indicates the typical eco-geomorphology of beach and dune systems in Kwa Zulu Natal

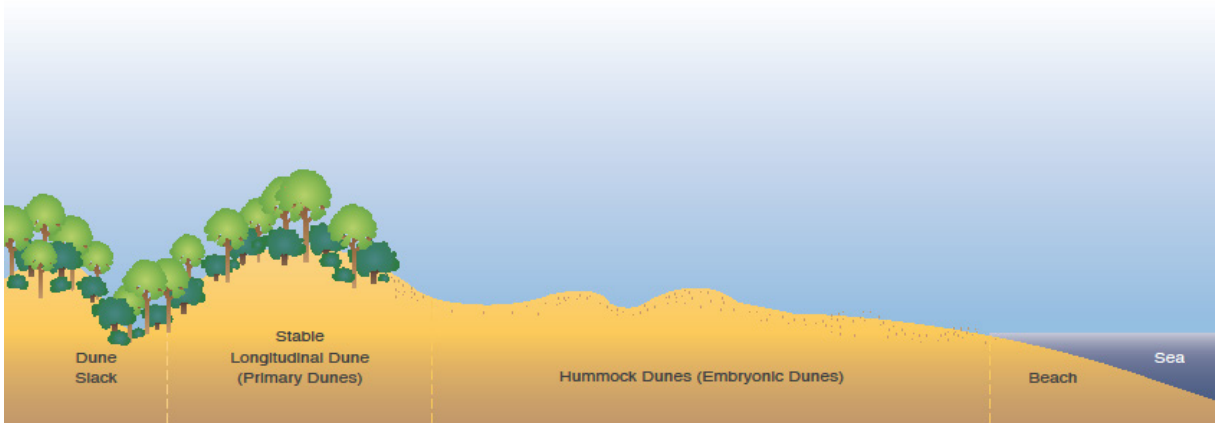

Figure 9.6 Typical profile of beaches and dunes in Kwa Zulu Natal

The pump station and marine intake and outfall pipelines are proposed to be positioned on a presently, vacant piece of land off Eastern Glen Road (see Figure 9.7).

The psammoseral and beach environment around the study site can be described as being highly dynamic and subject to both natural and anthropogenic transformation. The main pump station will be positioned on secondary dune form, previously occupied by a caravan park / camping or recreational ground. Prior to the establishment of this facility, which appears to have occurred sometime after 1954, the area consisted of typical *dune forest* at the more landward edge of the dune, with expected psammoseral vegetation being common at more seaward points.

The camping facility was abandoned during the 1980s and much of the area has since been subject to secondary vegetative growth. However, it is apparent from review of the former camping site that sediment dynamism and dune mobility was a significant problem faced by the operators of the camping facility. To address such impacts it is evident that the managers of the land in question undertook to stabilize areas of high mobility through the use of *Casuarina equisetifolia* an exotic tree that effectively stabilized mobile sands (Figure 9.8). Relict specimens of these trees are evident across the site and are testimony to the attempts by land managers to reinstate a stable regime, following over zealous clearance of vegetation on dune systems.

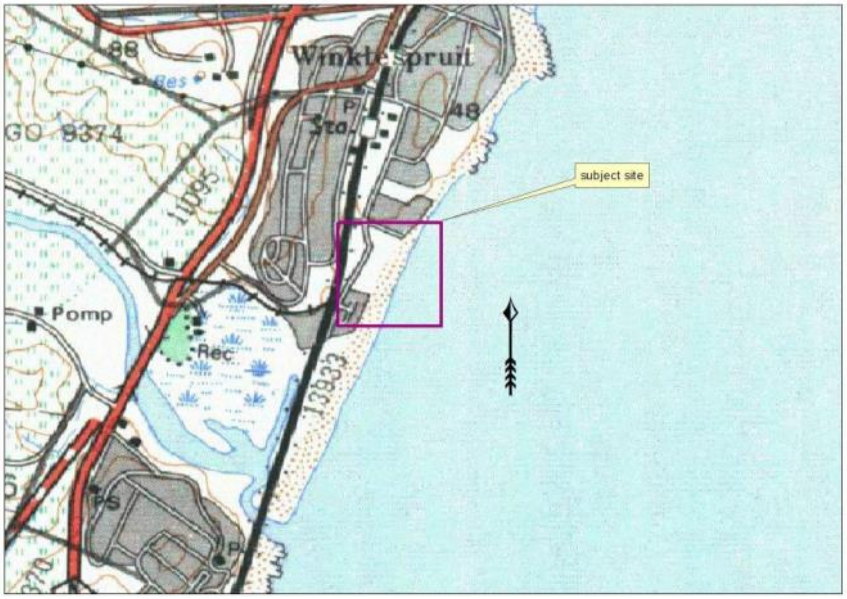

Figure 9.7 Topographic map indicating dune and beach environment of the study area

Figure 9.8 Image of frontal dune cordon at Illovo Beach. Note *Casuarina equisetifolia* present on crest of dune. Note mobile state of frontal dune.

Given the above, some comparison of the dynamism evident in the study area is considered prudent. Georeferenced aerial imagery of the site of the proposed pump station in 1937, 1984 and 2012 was used to that effect (Figure 9.11). Notably, these images spanning nearly 80 years indicate that:

1. While the beach is evidently "wide" (up to 40m), no embryonic or hummock dune systems are generally evident. Hummock or embryonic dunes are important precursors of dune formation and growth (Arens 2006). This suggests that while sediment may be available on the beach, a number of over-riding factors may be preventing the formation and growth of hummock dunes. Such influences may include the mouth dynamics associated with the Lovu River, high marine surf inundation on a regular basis, or an exceptionally high drift potential

(DP[1]) within sediments associated with this portion of beach. In addition, it is evident that the resultant drift direction (RDD[2]) of the wind regime, which in this region is bi-modal (Figure 9.9), may also play a significant role in preventing the construction of hummock dunes. This situation suggests that there is regular recharge of sediment from the frontal dune environment to the beach, giving rise to a mobile dune.

Other factors that may be influencing the formation of hummock dunes include rainfall patterns (Tsoar 2009), grain size and the nature of the sediment arising in the intertidal and supratidal environment. Anthropogenic influences (Lancaster 2007) where human traffic may be high is also considered a significant factor.

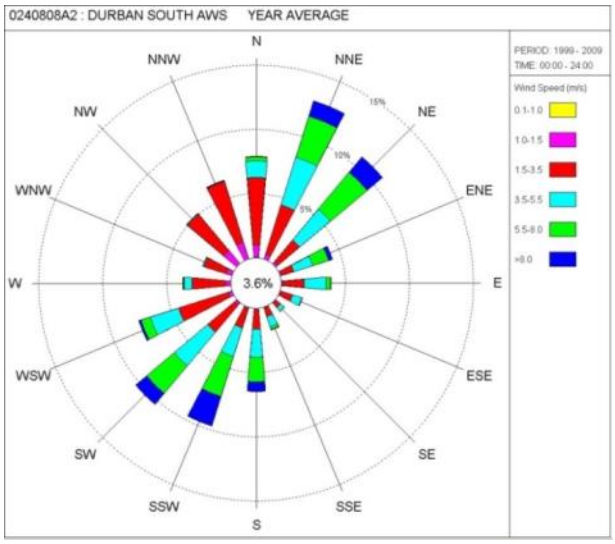

Figure 9.9 Annual Wind Rose 1999 to 2009 for "Old Durban Airport Weather Station" indicating general bi-modal pattern.

2. The frontal dune was subject to closed canopy vegetation cover in 1937 with the frontal vegetated portions of the dune lying approximately and on average 46 m seaward of their present position. With the advent of the camp site / recreation facility, vegetation was cleared and human traffic increased at this point. By 1984 the dune toe had retreated by between 37m and 40m.

3. With the abandonment of the camp site / recreation facility, some recovery in the psammosere is evident; however there is more recent evidence of increased destabilization. A preliminary calculation using the geo-referenced information presented below indicates that dune mobility increased between 1937 and 2012 at a rate of 18m^2 / m of shoreline.

4. Notably, other factors are affecting or have affected this dune system over time, including:

    a. At least three or more major marine storm events, where wave heights exceeded 8m which occurred in 1954, 1971 and 2007 (Smith et al 2007). These storm events showed the coastline of KwaZulu-Natal to be prone to episodic periods of erosion that are tied primarily to the 18 year lunar nodal cycle (LNC) as well as the lunar perigeal events (Smith *et al* 2011). Elliot *et al* (2010) has shown that periodic erosion can be expected on a 4.5 year return period, often culminating in the abovementioned LNC

[1] Drift Potential is an indication of the strength and direction of the dominant sediment movement
[2] Resultant Drift Direction is a vector addition of all the winds within a particular area

erosion period. The above stated, other meteorological phenomena, primarily "cut off lows" may arise at any time and with a combination of this and other conditions , may give rise to coastal erosion episodes.

b. A railway bridge was established across the Lovu River, within the estuarine functional zone and proximal to the beach berm of the river, which may have altered hydrodynamics and mouth dynamics.

c. Effective reclamation of the seashore by an adjacent property in order to establish residential dwellings has been undertaken during the construction of these properties in the 1980s and immediately post 2007 (this reclamation exercise was addressed through the courts by the eThekwini Municipality in 2008 (source: A Mather – *pers. comms*). Such actions affected the frontal dune vegetation and its inherent stability and by extension, may have affected sediment dynamics in the immediate vicinity.

d. At some point following the 2007 storm, the iLovu River mouth started to track north. This tracking ran parallel to the dune and resulted in the undermining of the dune toe and the establishment of slip faces on the frontal dune cordon. The northward movement of the mouth of the river may have arisen in the past but was most recently associated with the post 2007 marine storm period, where beach and dune sediment states were in disequilibria. The 2012 image on Figure 9.11 indicates the mouth tracking northwards and an attempt to divert such movement through the use of berms clearly evident in this image. It is apparent that the northward tracking of the river mouth plays a significant role in establishing a scarp at the dune toe, which results in the formation of a slip face on the dune and leads to further erosion of the frontal dune.

The above factors indicate that the selected pump station site area is showing a slow transformation from a stable dune to a transgressive system. Cooper (1995) in his evaluation of the impacts of sea level rise (SLR) on the shoreline of KwaZulu-Natal suggested (using the Bruun Rule method of SLR evaluation), that the beach to the north of the Lovu River can be expected to narrow, but "*due to the expected high level of sediment in the area, the beach will act as a buffer to properties and mitigate the effects of sea level rise and coastal erosion*" (Cooper 1995). It is evident from Figure 9.10 below that this assumption can be disputed, primarily on account of the fact that Cooper (1995) did not identify the apparent training of the river in a northward direction, parallel to the dune cordon.

Figure 9.10 Image of dune, seaward of proposed pump station. Note mobile nature of dune face and relic channel of river mouth within beach.

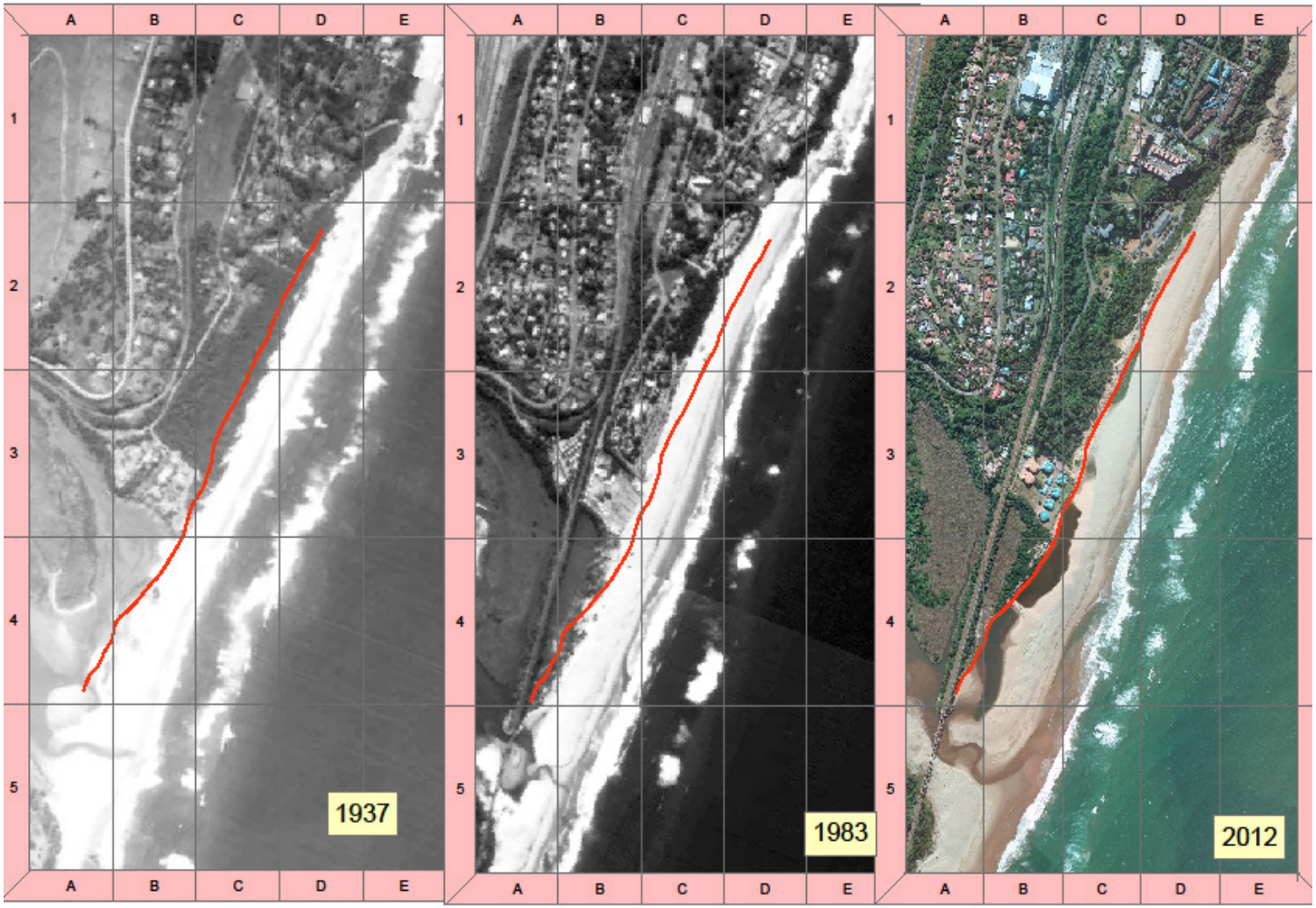

Figure 9.11 Comparative imagery of the proposed project site in 1937, 1983 and 2012 showing variation in dune cordon. Red line is the 2012 dune toe

Using the DSAS (USGS) data, rate of retreat / progradation of stable dune is evaluated between 1937 and 2012. This indicates the general trend towards the mobilisation or stabilisation of dunes over time, and a linear regression rate is thus evaluated. Regression (0.47 m/yr) at the proposed pump site and across the bay is evident as per Figures 9.12 and 9.13.

Figure 9.12 Variation of Dune cordon (vegetation edge) over the years and 1937 Transects

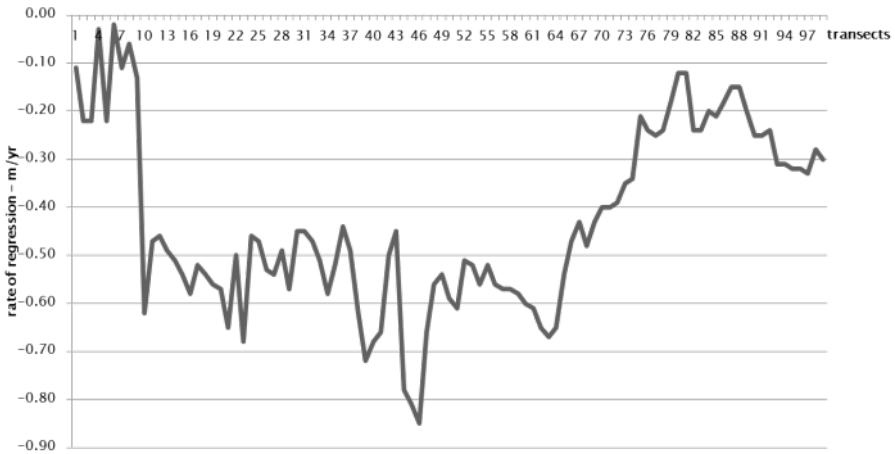

Figure 9.13 Linear rate of retreat (DSAS, USGS)

Using the 0.47m/yr rate at T13 an expected rate of retreat of 11.75m (12m) under the normal prevailing state, can be extrapolated over the next 25 years which is the suggested lifetime of the proposed infrastructure. Additional disturbance to site recommends a suggested increase in mobilisation at this point, leading to a "buffer" accommodating a doubling of the rate to be added. Therefore the recommended set back for the proposed location of the pump station, assuming increased traffic and other disturbances, is 24m (Figure 9.14).

Figure 9.14 Image indicating proposed set back of significant infrastructure at Illovo (24m from edge of present vegetation extent)

Further consideration of the eThekwini Municipality's SLR / coastal vulnerability planning map (Figure 9.15), supports in general, the identification of the subject area as potentially dynamic in the face of maritime forces that may act upon the coastline. The eThekwini Coastal Vulnerability Index (CVI) indicates variable levels of SLR, lying between 300mm and 1000mm over the next century. While SLR for the Durban region is now considered to approximately 1.23mm/annum (www.noaa) (which effectively indicates a projected SLR of approximately 123 mm over the next century – just over 30% of the minimum SLR anticipated in the Municipal CVI), the CVI does indicate Bruun Rule aligned impacts on the coastline associated with an accelerated SLR. Under such conditions one may expect dune responses to include reversion to a more mobile state (Tsoar 2007) and landward regression. Blowout parabolic dunes may also arise under this situation (Yan 2015).

The Department of Agriculture and Environmental Affairs' CVI has utilized an approach to assess the vulnerability of the coastline to marine storm events by evaluating *inter alia* bathymetry (depth of closure), width of beach, width and state of dunes and other factors. Such information was utilized to class portions of coastline as either *moderate, high risk* or *very high risk* areas in respect of their propensity to erode under a marine storm situation. Figure 9.16 below indicates that the subject site is considered to be a low risk area, however the parameters utilized in this evaluation are similar to those utilised in the eThekweni Municipality's CVI and have not accounted for dune mobility and the influence of the estuary mouth.

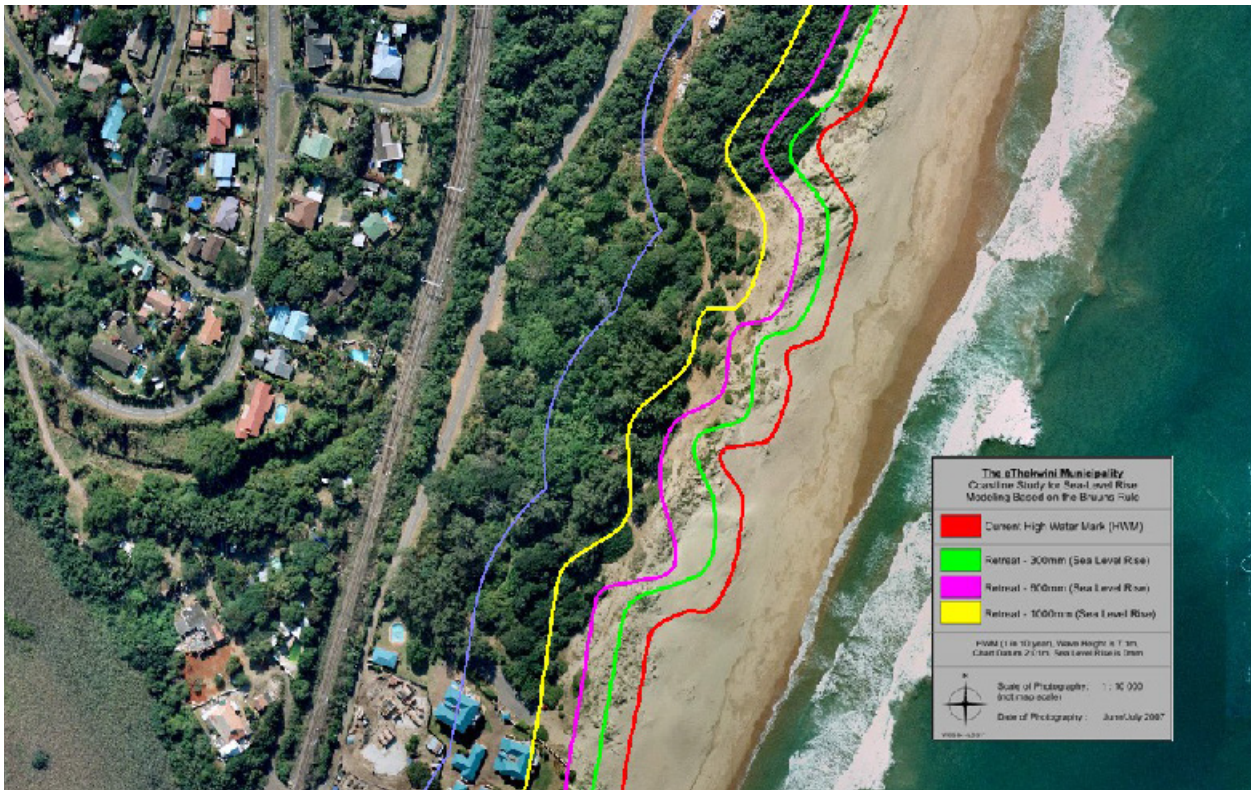

Figure 9.15 Image indicating expected marine inundation under accelerated SLR state as projected by eThekwini Municipality. Red: Current – High Water Mark (HWU); Green: Retreat – 300 mm (SLR); Pink: Retreat – 900 mm (SLR); Yellow: Retreat – 1000 mm (SLR) (eThkweni CVi and SLR GIS tool ; eThekweni Municipality)

Figure 9.16 Image indicating CVI data for the Lovu area, establishing the subject site (white block) as a "high risk" area. Orange = "moderate risk", red = "high risk"

In addition, it should be stated that dune mobility is noted as being a significant factor associated with climate change (Yan *et al* 2015) and indeed is an issue that should be given greater consideration when evaluating developments that affect the shoreline.

9.3.2 Other mesic environments

Pump station, SWRO plant and seawater intake and brine pipelines

Much of the route of the seawater intake pipeline between the pump station and the SWRO traverses either wetland or estuarine environments (Figure 9.17), which are the subject of separate specialist assessments (refer to Chapters 7 and 8 of the Draft EIA Report). However, some consideration of the mesic environments can be gleaned from primary information collated during the environmental scoping process. In essence "other mesic environments" can be identified at three locations (refer to Figure 9.17), namely:

1. The area between the pump station (P/station) and the western extent of the existing caravan park.
2. Portions of the freeway, where wetland has been infilled
3. The two proposed SWRO plant sites located to the west.

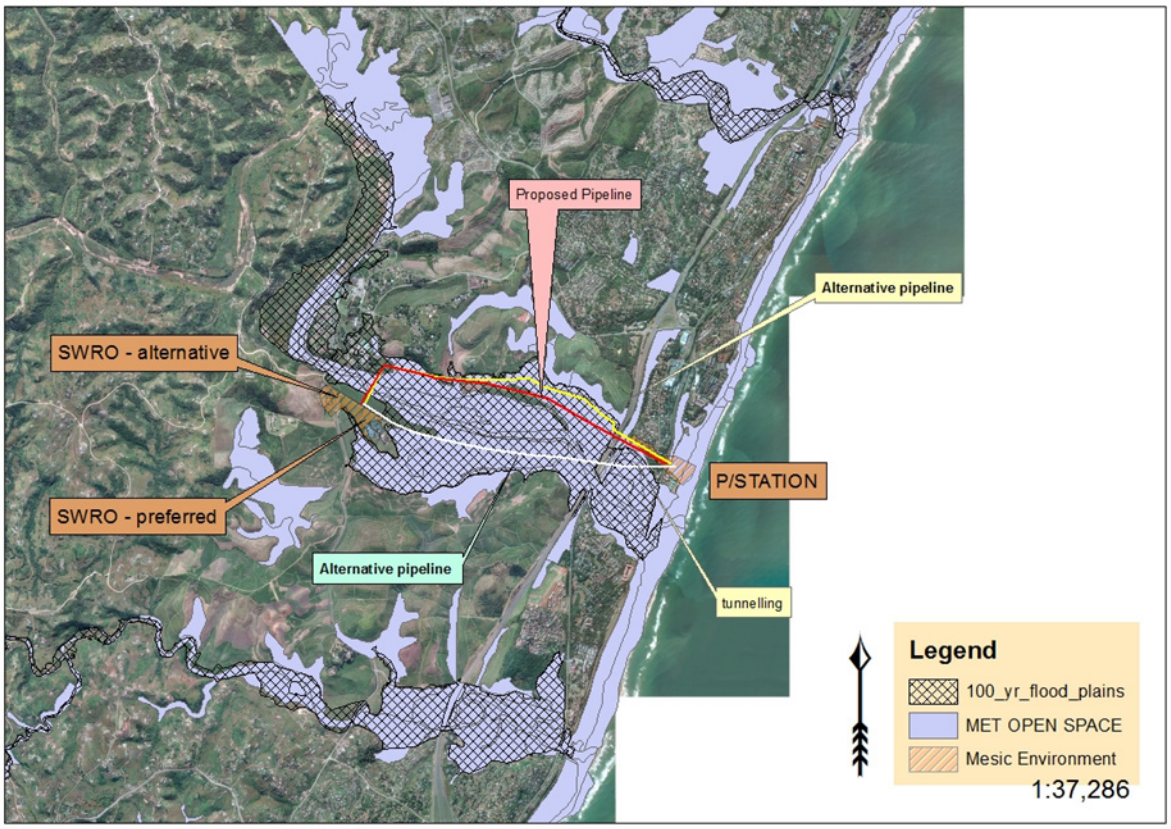

Figure 9.17 Image of study site indicating mesic environments in east and west. Light orange areas represent mesic environments.

During the initial sampling of vegetation and habitat form, at selected sites across the study area, a comparative evaluation of the vegetation form and cover was compiled. The sample sites are identified in Figure 9.18 below. The results of this evaluation are depicted graphically in Figure 9.19 below.

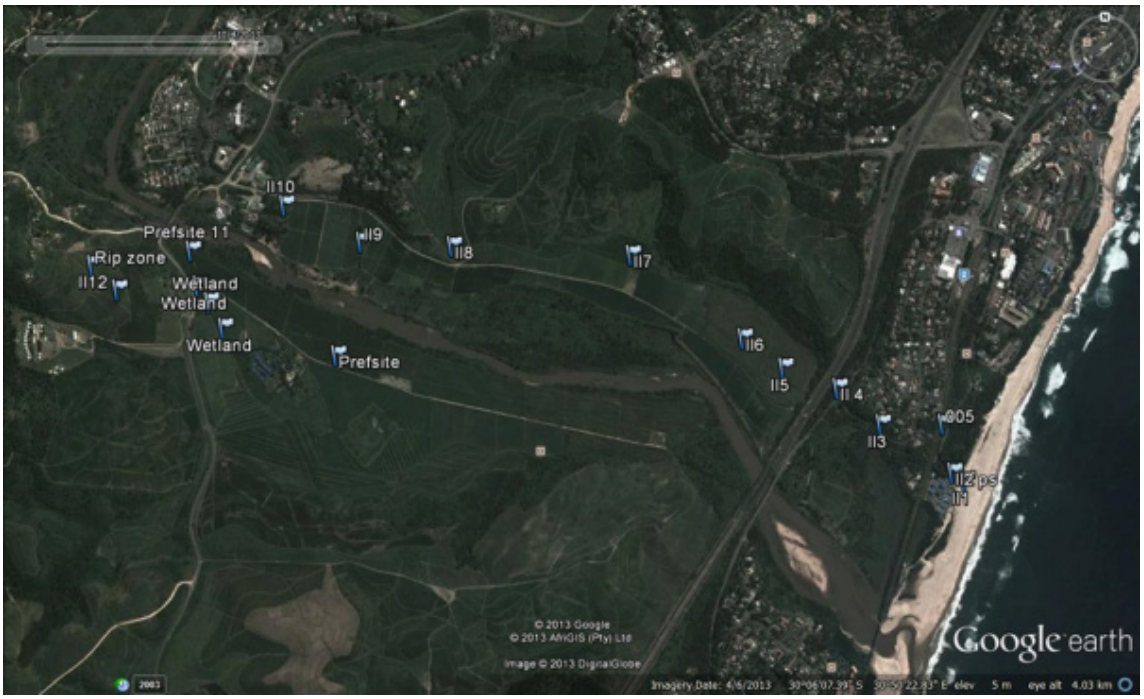

Figure 9.18 Image indicating sample sites where dominant species were recorded (source image Google Earth 2011).

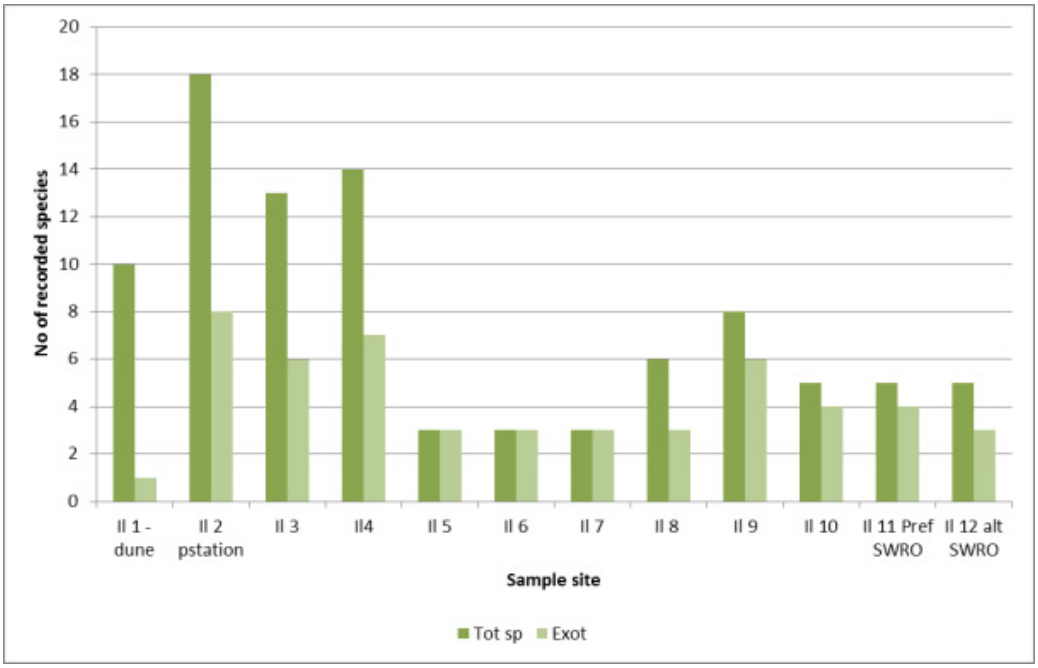

Figure 9.19 Graphic representation of data indicating species numbers (diversity) and exotic species components at sampled sites along route.

The results of the above evaluation and analysis using Two Way Species Indicator Analyses software, indicated that there are 3 mesic habitat forms encountered in the study site:

1. The coastal environment, including the dune and pump station site.
2. The inland mesic environment, which included the caravan park and mesic areas around the R102 and N2 roadways.
3. The transformed canelands of the western extent of the study area at and around the proposed SWRO plant locations (i.e. preferred and alternative sites).

The highest plant species diversity is located in and around the pump station, proximal to the beach, however the western areas show little diversity on account of the cultivation underway in or proximal to most of the sampling points. Much of the plant species diversity encountered in and around the pump station site and the caravan park comprises of horticultural specimens that are both exotic and indigenous.

Of significance is the prevalence of secondary and exotic vegetation. Species such as the exotic tree Melia azedarach (Syringa) and Litsea glutinosa (Indian laurel), are noted to be common to the drier areas, and are indicative of disturbance. Figure 9.20 below identifies the high level of exotic plant prevalence across the study area.

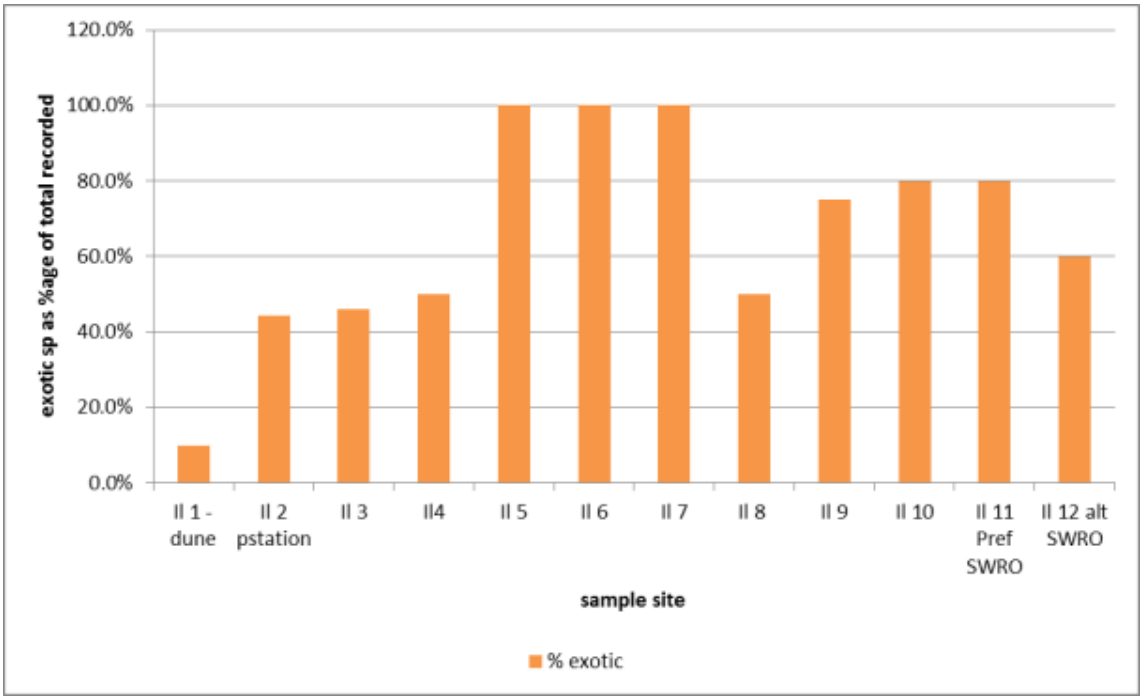

Figure 9.20 Graphic indication of exotic vegetation recorded at sample sites as a percentage of total species recorded.

Notable from Figure 9.21 is that exotic vegetation abundance does not fall below 40% of the vegetation recorded on site (with the exception of Sample Site 1). Sample sites 5, 6 and 7, which lies within the floodplain and proximal to the old railway that traverses the flood plain, show extensive (100%) dominance of exotic species. Such dominance is as a result of both continued disturbance arising from agricultural activities and urban settlement. Irregular flood inundation has also identified this area as being prone to disturbance. In addition, the SWRO sites show high levels of exotic plant dominance on account of cultivation within the areas concerned, as well as the planting of horticultural specimens, at points.

Evidently, the SWRO plant sites are of limited ecological value due to their high level of transformation (Figure 9.21 and 9.22). Both sites are primarily under sugar cane cultivation (Figure 9.21), while the "alternative" SWRO site shows steep topography, not generally conducive to construction of a large facility such as the SWRO Plant

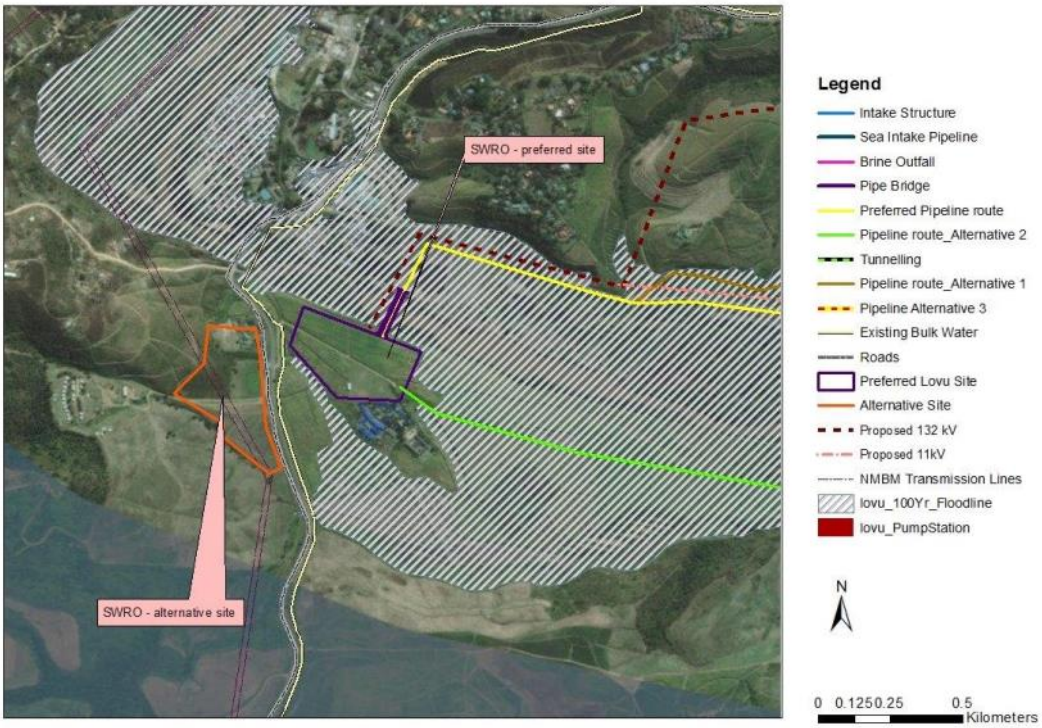

Figure 9.21 Image indicating "alternative" and "preferred" SWRO sites and the extensive transformation evident upon them (2012 aerial imagery)

Figure 9.22 Image indicating general nature of habitat in and around proposed alternative and preferred SWRO plant sites. The areas are dominated by sugar cane and occassional secondary plants or agricultural weeds.

It is evident from the above that the habitat significance of the above mesic environments can be summarised as follows:

- The entire footprint of the SWRO and pump station have been subjected to high levels of transformation, effectively removing any primary habitat form.
- The pump station, although showing occassional woody specimens (*Mimusops caffra, Trichelia dregeana*), as well as secondary dune forest species, has been subject to transformation for the purposes described above.
- It follows that the DMOSS designation identified for the psammoseral environment is signficant in identifying primarily the ecological function of the frontal dune, rather than habitat associated with the secondary dune form. As such, its identification for preservation as open space, relates to its dynamism and signficance as an interface with the marine environment, as discussed above.

The Powerlines

The affected environment traversed by the 132kV supply is noted by SANBI as being *Indian Ocean Coastal Belt* (veld type *KwaZulu Natal Coastal Belt - CB3*). CB3 is considered "endangered", primarily on account of the extensive transformation of this habitat form that has arisen through agricultural practices and urban development (Mucina and Rutherford 2006).

Figure 9.5 shows the eThekwini Municipality's metropolitan open space system (DMOSS) which identifies areas within the municipality that should be subject to formal conservation. Consideration of Figure 9.5 indicates that the 132kV and 11kV powerlines are likely to intersect with DMOSS areas that are primarily associated with the floodplain of the iLovu. It must however be noted that most of these DMOSS areas have already been transformed and support sugar cane cultivation. The balance of the 132kV line will traverse cultivated lands in which the Kingsway substation lies, while the 11kV line will follow the pipeline route..

Given the above, it is evident that limited habitat is likely to be affected by the establishment of the powerlines along the routes proposed, however some consideration of the presence of fauna within the SWRO site and associated with its supporting infrastructure should be considered.

Fauna

As an essentially peri-urban and transformed region (Figure 9.23), the presence of significant faunal species in the subject area is considered to relate primarily to avifauna, although some smaller vertebrates and invertebrates may be affected by the establishment of the proposed plant.

EKZN Wildlife's database of species identified within CB3 and the Threatened or Protected Species list indicates that 6 species are considered to be associated with the region and require particular consideration. Table 9.1 below identifies these species and provides comment on their presence, or the likelihood of their presence within the subject site.

Figure 9.23 Photo indicating the general nature of the receiving environment near the iLovu. The SWRO sites are proposed for establishment in the foreground.

Table 9.1 Species listed by EKZN Wildlife as being of significance within the subject area

Species	**Taxa**	**Habitat requirement**	**Comment and threat from development**
Edouardia conulus	Mollusc Conical bark snail	Forest – primarily Zululand	Low likelihood as at southern limit of range and habitat is deficient.
Gullela separate	Mollusc.	Primarily highly humic forested areas	Low likelihood on account of transformation of environment.
Doratogonis infragilis	Millipede	Prefers wooded environments	Possible presence. Appears to be restricted in southern areas around Oribi.
Doratogonis montanus	Millipede	Mountain environments	Highly unlikely – recorded from Drakensberg.
Cochitoma semigranosa	Mollusc	Prefers stony environments	Highly unlikely – recorded from southern KZN / Northern Eastern Cape.
Centrobolus anulatus	Millipede Red fire millipede	Forest understory	Likely to be present. Regularly recorded in Durban region and northwards.

Table 9.1 indicates that of the 6 species considered to be of conservation significance that may be encountered in the subject area, only *Centrobolus anulatus*, a millipede is likely to occur. None of the above species are identified in terms of R151 of section 56(1) of the National Environmental Management Biodiversity Act (10 of 2004). *C anulatus* (the red fire millipede) is a relatively common invertebrate which is associated with leaf litter and fruit, however as much of the area is subject to regular disturbance, its presence along the line route will be transitory.

Although no avifauna are listed within the NEMBA species considered to be associated with the study area, some consideration of the avifauna present should be provided. Notably, the iLovu River and estuary were considered by Forbes and Demetriades (2010) as being "the third most important wader habitat in the Municipal area" and recorded in 2007 / 2008, 31 species of waterbird. Forbes and Demetriades indicated that in their survey of 2007 / 2008, "waders were common" a situation noted by Begg (1978) in his review of the estuaries of Natal. These authors also suggest that as a suitable "wader habitat", the iLovu should be subject to some form of protection.

The above information indicates that while transformation of habitat on account of the establishment of the plant in this area is unlikely to lead to significant impacts on fauna, a precautionary approach should be implemented in respect of avifauna within the region. As the 132kV powerlines are to traverse the estuary and align perpendicular to some minor valleys associated with the north bank of the iLovu River, some of the larger birds that forage within the estuary may be affected through collissions with such powerlines. Species such as Grey Heron (*Ardea cinerea*) noted within the flood plain in 2013, have extensive wingspans of over 1.5m and may be predisposed to collisions with obstacles, such as powerlines. Forbes and Demetriades recorded the presence of the Goliath Heron (*A goliath*) in 2007/ 2008, another heron that may be susceptible to collisions with larger aerial structures, either directly during flight or alighting from towers following perching. It follows that diversionary mechanisms should be placed along any large conductors that are established in close proximity to the estuary. The placement of bird flight divertors on the 11kV line is however not seen as being a requirement.

9.4 IDENTIFICATION OF KEY ISSUES AND POTENTIAL IMPACTS

9.4.1 Identification of Key issues during the Scoping Phase

The following key issues relating to ecological components sensitivities were identified during the scoping phase:

Construction phase

- The nature and structure of the frontal dune cordon, particularly in relationship to the mouth dynamics of the ILovu River, sea level rise and storm inundation scenarios.
- Potential destabilisation of the frontal dune cordon due to excavation and effects of stabilization on the northern and southern coastal dynamics.
- Wetland and estuarine zone habitat. Impact on slope stability due to the removal of natural forest and potential subsequent water quality issues.
- The estuarine functional zone, particularly where cultivation is the present land use, may be affected primarily by water quality and turbidity issues.

Operational phase

- Stabilisation requirements and effect of the pump station and marine pipelines on beach and dune cordon dynamics and subsequent stability / instability.
- Rehabilitation and stewardship of the estuarine functional zone, including associated forest components. The effect of exotic plant invasion and changes in edaphic processes will alter site specific ecology with some alteration on local ecology.

9.4.2 Key issues identified during public consulation

The following key terrestrial ecological issues have been identified during the public consultation:

- The removal of natural habitats, in particular dune forest (Department of Agriculture Forestry and Fisheries)
- The quantification of the loss of natural habitat for primarily offset or rehabilitation purposes.
- Rehabilitation and mitigation measures to address loss of natural habitat

In addition, further potential impacts, as identified during the terrestrial ecological investigation are presented below.

9.4.3 Key issues identified during terrestrial specialist investigation

Key issues can be classified according to the affected environments, as provided below.

9.4.3.1 The Dune Environment

The dune and beach environment is considered to be that eco-geomorphological unit within the study area, most susceptible to further transformation on account of the present state of dynamism and the expected intrusion of structures into the psammosere and beach environment. Some consideration of these dynamics in relation to the environment between the proposed pump station and marine pipelines is provided below.

1. The frontal dune, seaward of the pump station is considered to be in a state of transition from a stable to transgressive system. Such transition is brought about by a combination of natural and anthropogenic factors. Further disturbance of this system is likely to

    a. Exacerbate the transgressive state of the dune form; and

    b. Possibly alter mouth dynamics of the Lovu Estuary which may alleviate or exacerbate present erosion states associated with the dune face and toe.

2. It is expected that the construction of the seawater intake pipeline across the beach environment at a shallow level (suggested as between 1 -5m below the natural beach profile) will affect the natural littoral and supra-tidal sediment dynamics, as well as the present tracking of the iLovu River mouth. Some consideration of these impacts is provided below.

    a. **Littoral processes**. Under an inflated beach regime the pipeline is unlikely to prove a perturbation to beach sediment dynamics and such processes are likely to proceed

unhindered. However, under a deflated beach regime, particularly following a significant storm or where an erosion cycle predominates, the pipeline may be exposed and with such exposure, littoral drift will be interrupted, particularly as the beach moves towards a state of equilibrium.

b. **Mouth dynamics** may also be affected if the pipelines between the marine environment and the pump station are placed at a shallow depth. Such situation may have significant ramifications, if these structures give rise to the pooling of water at points on the beach. Such pooling will lead to undermining of the dune toe and slips will arise on the dune face.

3. The dynamic nature of the dune cordon may result in the requirement to defend or stabilize the dune, particularly in the medium to long term. This situation has ramifications for dune and beach processes and sediment dynamics within the immediate area. If the psammoseral environment continues to move from a stable to transgressive state, as current information suggests and is likely under a rising sea level, then it is likely that there will be a need to stabilize the dune form and possibly defend that portion of coastline associated with the pump station. Such actions will serve to:

    a. Alter both beach and dune sediment dynamism.

    b. Predispose adjacent properties to possibly, exacerbated levels of erosion.

    c. Establish, in the medium to long term, the pump station or portion thereof on a promontory that may intrude into the beach environment.

Based on the above, the potential impacts identified in this Terrestrial Ecology Assessment during the EIA are:

Construction Phase

- Disturbance of the frontal dune on account of excavations leading to slumping and aeolian driven transgression.
- Disturbance of the supratidal beach environment on account of excavation leading to variations in beach sediment dynamics.
- Retardation of the northward movement of the iLovu River mouth leading to pooling of water or change in sediment dynamics that may impact on adjacent properties, in particular those properties to the south of the pump station.
- High levels of traffic across the dune face at the present access to the beach may see increased slumping and transgression on the dune face at this point and changes in the beach profile.

Operational Phase

- Medium to long term operations may see increased dune transgression and occasional or regular periods of beach and dune erosion. With the level of investment in such infrastructure, the expected management response is likely to be defence of the beach and dune environment. This is likely to give rise to exacerbated erosion on the sea face of adjacent properties as the immediate coastal environment adjusts to a new state of equilibrium.

- High levels of pedestrian traffic and the movement of construction equipment onto the beach may see continued transgression at the access point, as well as minor changes in dune profile and sediment dynamics on the beach.

Decommissioning Phase

- Should the proposed project be decommissioned at the end of the life span of the plant, the removal of the infrastructure associated with the pump station and the marine intake and outfall pipes will see short term disturbance to beach and dune environments, whereby the beach profile will be exposed to short term disturbance, before returning to a state of equilibrium, while the dune environment will take a longer period of time to return to a natural regime. The latter may show a significant increase in transgression with an increased rate of frontal erosion, particularly if sea defence structures have been set in place and are subsequently removed.
- Should areas landward of the frontal dune remain open and un-vegetated following demolition of infrastructure, there is a high likelihood of further transgression of the dune arising and should such movement be exacerbated by increased resultant drift direction, driven by localised wind dynamics, then secondary dune formation and sediment drift is likely to arise. Such movement may have negative consequences for both existing vegetated environments, as well as infrastructure in the immediate vicinity.

Cumulative impacts

- Further disturbance and variation of littoral and psammoseral environments at a sub-regional and regional level. The Lovu River mouth and the immediate dune and beach environment to the north of the mouth have been subject to significant transformation since the 1980s. The pump station and associated pipelines will be an extension of such transformation along the coastline with increased hardpanning of the secondary dune environment.
- With the establishment of the pump station, increased pedestrian traffic is expected within the beach environment. Presently, human traffic may be considered "low" and although there may be a requirement to access the beach environment for management and maintenance purposes on an irregular basis, there is likely to be a small but positive increase in human presence on the beach and psammoseral environment.

9.4.3.2 Other mesic environments

Only the proposed SWRO plant (preferred and alternative site) and portion of the 132kV powerline serving the proposed desalination plant lie within mesic components of the landscape, outside of the wetland and estuarine areas. A portion of the existing caravan park, a highly transformed urban area is proposed to carry a small portion of the pipeline between the wetland / estuarine component and the railway line, before enterring the fontral dune environments. Although these areas are considered to be primarily highly transformed, agricultural lands, some negative impacts of an ecological nature are evident. The impacts below therefore only apply to these components of the proposed project.

Construction Phase

- Disturbance of the general surface environment. Alteration of edaphics at depth may result in variation in soil nutrient levels, permeability and related factors.
- Disturbance of surface areas will alter general seral traits (vegetation succession) within sites not presently under cultivation or intended to be under cultivation, following construction. As such, these areas may be predisposed to exotic weed invasion.
- Where topography is altered and a more significant grade is established on slopes, erosion may arise.
- Where soils are collapsible, the immediate topography along pipeline routes may alter to establish a *low lying depression*. Such topographic variance will also serve to alter localised ecological traits in and around these areas.
- Localised fauna may be ousted from refugia or mortalities may arise on account of general land clearance activities, excavation activities, increased traffic and other actions associated with the construction phase (e.g. poaching by workers, noise and general human presence etc.).

Operational Phase.

- Much of the established pipeline lying within mesic areas to the east and around the SWRO will not be subject to significant management interventions during the operational phase. As such, those mesic portions of the affected land are likely to revert to a secondary vegetation form unless returned to cultivation or placed under another land use.
- Areas in and around the SWRO are likely to be subject to ecological change on account of the increase in anthropogenically driven disturbance associated with the operations of the facility. This includes impacts associated with the operations and in particular, movement of persons around the facility. Such changes are likely to impact primarily upon existing cultivated lands, which are likely to be abandoned and would give rise to secondary seral growth forms.
- Noise factors arising from the plant may have unknown or indeterminate impacts on fauna, affecting either energy budgets, reproductive success and long term survival (Radle 2007). "Noise" is the subject of a specific specialist investigation in the EIA process (refer to Chapter 11).
- Powerlines may affect avian behaviour and give rise to the death or injury of birds which may roost or alight from conductors.

Decommissioning Phase.

- The removal of the infrastructure associated with the pipeline in the mesic environment will give rise to a deficit in edaphic material and would require the import of material to address such deficit. As per the construction and operation phase, a further alteration of the seral processes associated with the surface vegetative cover is likely to arise should the pipeline and SWRO be removed / demolished.

Cumulative impacts

- The bulk of the affected mesic environment presently lies under cultivated lands. Such lands are subject to regular and catastrophic disturbance effectively placing them under a dynamic regime which establishes an early seral stage and a secondary coastal habitat. The pipelines are unlikely to alter such regimen, while the SWRO is expected to alienate a portion of agricultural land from the prevailing land use of agriculture and as such remove such lands from any natural seral or ecological process. As such, cumulative impacts will relate to the loss of unencumbered farmlands to urban / service infrastructure.

9.5 PERMIT REQUIREMENTS

The proposed layout and development of the desalination plant is considered to elicit a requirement for compliance with the following legislation in terms of this terrestrial ecology study.

9.5.1 The Integrated Coastal Management Act (Act 24 of 2008 & Act 36 of 2014) (ICMA)

The ICMA seeks to govern various activities in and around the coastal zone of South Africa. The term "coastal zone" is prescribed in the Act to include the exclusive economic zone, "coastal public property" and "coastal protection zone". The Act is relatively new and is complex in both interpretation and implementation, with an evident inability to integrate coastal science with legislation. A number of regulations are associated with the Act and the Act has recently been amended (Act 36 of 2014), of particular relevance is Section 1 of the Act, which gives consideration to the reclamation of the seashore and coastal property. In particular this Section states that "no organ of state may reclaim land for the development of state infrastructure, unless authorised by the Minister". The following is also pertinent to the proposed desalination plant:

- Outfalls: Requirement for a coastal authorization in terms of Section 69 of the ICMA. The permitting of marine outfalls or discharge of materials into the sea from a terrestrial source requires a discharge permit in terms of Section 69 of the ICMA. The nature of the discharge and other requirements must be considered by the Coastal and Biodiversity Management Sub-Directorate of the KZN Department of Economic Development, Tourism and Environmental Affairs (KZN DEDTEA) prior to the issuing of a permit. This permitting process is undertaken by the KZN DEDTEA

9.5.2 The Conservation of Agricultural Resources Act (43 of 1983)

The control of agricultural land and its transformation to other land uses fall under the jurisdiction of this Act. An application for the release of agricultural land, particularly in respect of the establishment of the SWRO plant, will require the authorization of the Minister. An application should be sent to the Department of Agriculture Forestry and Fisheries.

9.5.3 The National Forest Act (Act 84 of 1998)

This Act serves to manage forests and forest products at a National level. Permitting for the following actions are required:

- **Protected Trees**. Protected trees, (in particular *Mimusops caffra* and *Sideroxylon inerme*), which are listed in terms of the Act, require permit applications if they are to be removed. Such specimens are to be identified in respect of the final layout of the proposed pump station, to identify whether there is a need to apply for such permit.
- **Clearance of Natural Forest**. Where "three or more indigenous trees form a contiguous canopy" the legal definition of "forest" applies. If "forest" is to be disturbed then a permit is required prior to such disturbance. In this regard, a permit is likely to be required in and around the proposed pump station and in association with the caravan park, as well as other points along the proposed pipeline routes.

9.5.4 The KZN Provincial Conservation Act (Act 29 of 1992)

This Provincial Act identifies a number of threatened or protected species that require consideration and permitting, before their removal or destruction. Such permit requirements will apply to, in particular, species within the wetland environments. No species proclaimed in the Provincial TOPS have been identified. If a permit is required from the Provincial conservation body, EKZN Wildlife should be contacted (refer to EMP for details).

The study area has been identified as "southern coastal grassland" by the Provincial authority and is considered to be critically endangered. However, as demonstrated above, this area is primarily wetland / estuarine in nature, with mesic components showing habitat such as relic and transformed dune forest and in particular cultivated canelands. No "grassland" components were identified within the study area and as such, the study area does not align with its classification as "southern coastal grassland" in any way.

9.5.5 The National Environmental Management Biodiversity Act (Act 10 of 2004)

The NEM Biodiversity Act seeks to safeguard the biodiversity of South Africa, through various provisions including the listing of species and habitats that should be protected. The list of threatened or protected species (TOPS), published in 2004, identifies those species that should be subject to protection within the country. No species identified on site, or with the potential to be present on site in respect of the NEMBA listed species, are contained within this listing.

While the National List of Threatened Ecosystems also identifies "southern coastal grasslands" as being critically endangered, it is evident as per 6.5.4 above, that conservation safeguards in terms of NEMBA do not apply to the study site.

9.5.6 Off Road Vehicles Regulations of 1998 (GN 1379)

The control of vehicles within the coastal zone is governed by the ORV regulations of NEMA, published in 2001 GN 1379 December 2004. These regulations serve to govern the operation of

vehicles on the beach and dune forms of the coast. A permit will be required in order to place a vehicle on the beach.

9.6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

From Section 6.4, the following provides some further consideration of the impacts that have been identified and the possible measures that can be taken to address negative impacts or externalities at the design stage of the project, as well as the management interventions that can be instituted. Refer to Chapter 4 of the Draft EIA Report for a description of the methodology adopted for the assessment of impact significance.

A summary of the overall impact significance rating with and without mitigation is given in Section 9.7 (Table 9.2).

9.6.1 The Coastal Environment

9.6.1.1 Potential Impact 1 (Construction Phase)

Disturbance of the frontal dune system on account of excavations of the seaward sections of the seawater intake and brine discharge pipelines, leading to slumping and Aeolian driven transgression.

As discussed above, it is highly probable that further slumping and destabilisation of the frontal dune as a consequence of the construction phase and in particular the establishment of the proposed marine intake and outfall pipelines sections, seaward of the pumpstation. Such collapse may be seen to be of limited consequence over the immediate temporal phase of the project, but in the medium to long term such disturbance has significant ramifications for the general stability of the affected area. The impact will also be localised to the dune system from a visual perspective but may have some "downstream" cumulative impacts in terms of sand budgets etc.This impact is therefore anticipated to be of high potential intensity.

Given the above, without additional mitigation, the impacts associated with disturbance to the frontal dune during the construction of the seaward sections of the intake and brine discharge pipelines are predicted to be of **high significance**. Section 6.3 of the report has identified the impacts associated with trenching of the pipeline from the pump station to the marine outfall. It has been explained that there will be short term repurcussions if trenching is pursued, however the long term repuscussions involve increased mobility (or potential to mobilise) of the dune system which can only be addressed through defence and further stabilisation, which in turn alters sediment and beach dynamics.

Therefore, given the complex nature and dynamics of the frontal dune system as well as the number of interelated processes associated with this environment, the proposed trenching of the marine pipelines through the dune cordons, although not a fatal flaw, would lead to a number of **significant** direct and indirect impacts on the dune system and surroundings. These impacts are also mostly considered to be of very low reversibility, with some anticipated to be irreversible. It is therefore **strongly recommended** to **pipe jack** the proposed seawater intake and brine discharge pipelines under the dunes, with specific consideration towards maintaining a narrow working corridor. A terrestrial ecologist should be involved in the engineering design to confirm the entry and exit location of the pipeline under the dunes. This change in the design of the proposed project would be expected to lead to much more acceptable impacts (**low** significance) on the dune system and

associated surroundings. This applies to all the potential impacts on the coastal environment assessed in this section.

It is also recommended to undertake a monitoring initiative on the dune-beach frontage, prior to construction, in order to assess the extent of the dune toe, back beach and intertidal zone using a number of parameters, i.e. highest tidal extremes (HATOY) and movement of estuary mouth.

The following key mitigation measures are recommended in the event of trenching:

Key Mitigation Action: Limit the construction footprint to the minimum required.

It is also to establish the pump station at a point landward of the frontal dune cordon in order to maintain dune frontal dynamics, i.e. beyond the recommended setbackline (refer to Figure 9.14) and to limit the pump station footprint to 50m x 50m.

The following management actions are recommended following construction activities:

- Sculpting of the dune face to allow it to revert to its natural state of dynamism.
- Vegetation that lies seaward of the proposed pump station should be maintained and possibly enhanced through both cordoning and planting of the area in order to prevent undue destabilisation of the dune frontage. This action in itself has ramifications for the equilibrial state of the dune beach interface, however given the transformed nature of the frontal dune system such actions should be undertaken within the ambit of a dune management protocol.

Additional Management Actions: Horticultural interventions may be utilised to enhance and stabilise the dune form, including the temporary cladding of the dune frontage with geofabric materials, irrigation and planting of vegetation to prevent destabilisation. These interventions are however short term in effectiveness and bring with them their own ecological issues as they are in effect forms of stabilisation.

With the effective implementation of the key mitigation measures proposed, the impacts associated with disturbance to the frontal dune during the construction of the seaward sections of the seawater intake and brine discharge pipelines are predicted to be of **medium** significance. It must be noted that from a coastal process perspective dune structure will continue to be transformed by the activity.

9.6.1.2 Potential Impact 2 (Construction Phase)

Disturbance of the supra-tidal beach environment on account of excavation of the seaward sections of the seawater intake and brine discharge pipelines, leading to variations in beach sediment dynamics.

While disturbance of the supratidal beach environment is not considered to be of a similar significance to disturbance of the dune form, it remains highly probable and it is assessed to be of medium intensity as these two eco-geomorphological components are interdependent. It is therefore recommended that disturbance of this environment should be limited, where possible. The affected beach area associated with the action will remain localised around the pump station and associated beach, however both "zones" will respond in a synergistic manner to such disturbance. From a superficial perspective, the beach may return to a stable state under a beach inflation state, however if scouring arises on the same beach, the pipeline, if not established at a suitable depth, will affect coastal processes. It is also expected that such disturbance would occur on a medium term basis.

Without mitigation, the impacts associated with disturbance to the supratidal beach environment during the construction phase are predicted to be of a **medium** negative significance.

Key Management Actions: Limit the construction footprint to the minimum required.

Ensure that construction is undertaken when the mouth of the Lovu River does not train north, to reduce the necessity to breach the estuary mouth.

Ensure that within the beach and supratidal beach environment, such pipes are laid at a depth greater than 5m below mean sea level.

With the effective implementation of the key mitigation measures proposed, the significance of impacts associated with disturbance to the supratidal beach environment during the construction phase remains **medium** negative.

9.6.1.3 Potential Impact 3 (Construction Phase)

Retardation of the northward movement of the Lovu River mouth leading to pooling of water or change in sediment dynamics that may impact on adjacent properties, in particular those properties to the south of the proposed pump station.

The establishment of the proposed marine pipelines (i.e. seawater intake and brine discharge pipelines) across the beach will not only affect beach – dune geophysical dynamics but may also impact upon the Lovu River mouth dynamics as the pipelines will directly bisect the (presently normal) northward movement of the mouth of the Lovu River (refer to Section 6.4). The retardation of the mouth of the iLovu, particularly where flow is significant would have significant ramifications for the stability of the dune cordon. Under a construction regime, where the pipelines are being laid across the beach by excavation, the mouth, *should* it train north, will have to be diverted through a breaching of the beach berm, south of the construction site. If necessary, such breaching is to be considered moderately reversible as the impact of a breach on the estuarine system will always entail some "knock on" effects of a biological nature within the estuarine system. Other impacts that may be evident include changes in sediment dynamics along the beach – dune interface, which will also give rise moderately reversible negative impacts.

The breaching option as discussed above may be implemented, however this may have some ramifications for coastal properties to the south of the site. The impacts of breaching will depend upon "where" such breaching occurs, i.e. to the south, central or northern points of the mouth. If pursued, this option will require authorisation from the relevant authorities, including Ezemvelo KZN Wildlife and the provincial Department Economic Development, Tourism and Environmental Affairs.

Without additional mitigation, the impacts associated with the retardation of the northward movement of the Lovu River during the construction phase are predicted to be of a **medium** negative significance.

Key Management Actions:

Limit the construction footprint to the minimum required.

If breaching of the mouth of the Lovu River is necessary, it should be undertaken as far south as possible. Advice from suitably qualified and experience estuarine ecologists should be sought on the authorization, timing, duration, nature and location of the breach. Alternatively, ensure that construction is undertaken when the mouth of the Lovu River does not train north, to reduce the necessity to breach the estuary mouth.

The following management actions are recommended following construction activities:

- Sculpting of the beach / supratidal environment to align it with the prevailing topography.
- Stabilisation of the beach-dune interface environment with vegetation to local dynamics of the system and/or geofabric materials or other engineering means.

With the effective implementation of the key mitigation measures proposed, the impacts associated with the retardation of the northward movement of the Lovu River during the construction phase are predicted to be of a **low** negative significance.

9.6.1.4 Potential Impact 4 (Construction Phase)

Disturbance of coastal/dune forest habitat is expected with the establishment of the proposed pump station and associated pipelines. The pump station, although showing occasional woody specimens (Mimusops caffra, Trichelia dregeana), as well as secondary dune forest species, has been subject to transformation. The impact is likely to be of low intensity on account of the secondary nature of this environment, although any alteration of the landscape around the pump station will have a long term duration. Given the above, the disturbance of the secondary forest habitat associated with the construction of the proposed station is anticipated to be of **medium** significance.

Key Management Actions: The final alignment of the proposed pipelines (to and from the pump station) should avoid the natural forest habitats located in the vicinity of the pump station. Following comments received from the Department of Agriculture (Letter dated 16 February 2016), it is recommended to pipe jack the proposed pipeline from and to the pump station under the forest and to limit the pump station footprint to 50m x 50m.

Additional Management Actions: The condition of the natural forest situated adjacent to the proposed pump station site should be improved by eradicating alien invasive plants and planting indigenous trees.

The protected Milkwood trees occurring adjacent to the pump station footprint should not be disturbed. Should there be a need to disturb indigenous trees in a natural forest, a licence should be obtained from DAFF offices in Pietermaritzburg. The compensation ratio for each tree disturbed/cut should be 1:5

With the effective implementation of the above recommendations, disturbance of the coastal/dune forest habitat is expected to be of **low** significance.

9.6.1.5 Potential Impact 5 (Construction Phase)

High levels of traffic across the dune face at the present access to the beach may result in increased slumping and transgression on the dune face at this point and changes in the beach profile.

Disturbance of dune crusting (induration) as well as trampling of vegetation will facilitate dune instability and increase dune mobility. As a localised impact associated only with the dune and beach environment, such impacts are to be considered to be of long term duration and may be manifest for a reasonble period of time following construction (i.e. destabilised portions of the dune and back

beach). Such impacts are to be considered probable, but will be dictated by the nature of construction employed (tunnelling vs. trenching), as well as threshold levels sustained by human and construction traffic in the affected beach-dune environment.

The impacts associated with high levels of traffic and movement of personnel during the construction phase are predicted to be of a **medium** negative significance without the implementation of mitigation measures.

> **Key Management Actions:** Activities in these environments should be actively minimised through the management of entry to the beach and dune environment for all activities (i.e. cordonning off the area). It is also proposed that only the most essential working corridor be identified and utilised during the construction phase.

The impacts associated with high levels of traffic and movement of personnel during the construction phase are predicted to be of a **low** negative significance with the effective implementation of the above mitigation measures.

9.6.1.6 Potential Impact 6 (Operations Phase)

Long term operation of the proposed plant may result in increased dune transgression and occasional or regular periods of beach and dune erosion due to the destabilisation of the frontal dune system during the construction phase.

With the level of investment in such infrastructure, it is highly probable that the expected management response will be "defence of assets on the beach and dune environment". This is likely to give rise to exacerbated erosion at other adjacent properties in the long term as the immediate coastal environment adjusts to a new state of equilibrium.

Unfortunately, such impacts can only be considered moderately reversible as engineering inputs to defend the structures will, as outlined above, give rise to their own "knock on" or "downstream" effects. The impact associated with increased dune transgression and occasional or regular periods of beach and dune erosion during the operational phase is therefore predicted to be of a **medium** negative significance without the implementation of mitigations.

> **Key Management Actions:**
>
> If and where possible, avoid the use of engineering defences and address erosion and mobilisation of dune system through sculping and revegetation.

Given that both negative and positive feedback may be expected as a result of interventions to "mitigate" increased transgression, the significance of this impact is predicted to remain **medium** negative following implementation of the above key mitigations. Any mitigation will result in an equilibrial shift in sediment dynamics and dune stability at the affected area.

9.6.1.7 Potential Impact 7 (Operations Phase)

Pedestrian traffic onto the beach may see continued transgression at the access point as well as minor changes in dune profile and sediment dynamics on the beach.

While dependent upon the final design of the project, it is presumed that low to moderate levels of incursion by staff and personnel from the desalination facility will be required (e.g. for maintenance purposes). It can thus be suggested that negative impacts will thus be probable in nature and highly reversible through both natural responses to disturbance an planning, design and management

responses to this negative externality. Such impacts, where they do arise, will be site specific in nature and should only be identifiable in and around the infrastructure associated with the pump and marine pipelines.

> **Key Management Actions**: During the design phase of the project, the positioning of key infrastructure such as venting valves and purge valves should be established with some insight into the necessity to avoid undue movement onto the dune cordon or into the beach environment. While such factors are often dictated by engineering design and physical parameters, it is proposed that structures requiring regular maintenance (such as purge valves) should not be sited in the dune cordon or shore as these will lead to regular movement and traffic across these areas.
>
> During the operational phase of the project, access to the beach environment will be required from time to time. An existing access point is present; however such access requires stabilisation and upgrade in order to allow for the passage of vehicles, if required. A temporary access point can be established and stabilised using geofabric materials.
>
> While access to the beach is a given requirement, such access should be subject to a specific management protocol for all staff to avoid undue entry to the beach of staff and in particular, the use of vehicles on the beach.
>
> **Additional Management Actions:** The monitoring of the beach and psammoseral environment around the structure should be undertaken on a regular basis.

The impact associated with high levels of pedestrian traffic and movement of plant during the operational phase is predicted to be of a **low** negative significance, both without and with the implementation of key mitigation measures.

9.6.1.8 Potential Impact 8 (Decommissioning Phase)

The removal of the infrastructure associated with the pump station and the marine intake and outfall pipes will result in disturbance to beach and dune environments, whereby the beach profile will be exposed to short term disturbance, before returning to a state of equilibrium, while the dune environment will take a longer period of time to return to a natural regime**. The latter may show a significant increase in transgression with an increased rate of frontal erosion, particularly if sea defence structures have been set in place and are subsequently removed**. If the marine pipelines are removed in their entirety, the coastline will respond to the removal of such infrastructure through the establishment of a responsive "beach - dune" equilibrium state.

It is therefore assumed that the marine pipelines will remain in situ and will not be removed during the decommissioning phase. While dependent upon various factors at the time of removal, the impacts associated with the removal of infrastructure (e.g. pump station) associated with the proposed project are considered to be short term with rapid natural and coastal responses arising from such removal, localised to areas in and around the pump station and pipeline and within the littoral active zone. Without additional mitigation, the disturbance to beach and dune environments associated with the removal of infrastructure (excluding the marine pipelines) during the decommissioning phase is predicted to be of a **low** negative significance.

> **Key Management Actions:**. It is recommended to keep the seawater intake and brine discharge pipelines *in situ*.
>
> Upon demolition or removal of the infrastructure from the beach and dune environment, it is expected that the beach / supratidal environment will be sculpted to align with the prevailing

topography. The dune face will also be subject to sculpting and should be stabilised using vegetation, which in turn will be allowed to revert to its natural state of dynamism.

Due to the highly variable eco-goemorphological interface of soft coastlines and the assumption that any interventions performed will be disruptive at some scale to natural coastal processes inherent at site, the significance of this impact is predicted to remain **low** negative following the effective implementation of the key mitigation measures proposed.

9.6.1.9 Potential Impact 9 (Decommissioning Phase)

Should areas landward of the frontal dune remain open and un-vegetated following demolition of infrastructure, there is a probability of further transgression of the dune arising and should such movement be exacerbated by increased resultant drift direction, driven by localised wind dynamics, then secondary dune formation and sediment drift is likely to arise. Such movement may have negative consequences for both existing vegetated environments as well as infrastructure in the immediate vicinity. Nonetheless, it is evident that such an impact is of low significance from a coastal ecological perspective, although from a social and socio-economic perspective, sediment drift and changes in the dune and littoral active zone may affect residents and authorities within the region. It is therefore probable that such impacts will arise, affecting localised properties and environments, although with interventions, such effects are highly reversible.

> **Key Management Actions**: Upon closure of the operational stage of the project and demolition or removal of the infrastructure from the beach, these areas should be subject to topographic sculpting and the stabilisation of the frontal dune face through the use of vegetation. Temporary use of brushwood and drift fences may be considered given the status of the environment at that time.

Secondary dune formation and sediment drift following decommissioning of the plant is predicted to be of a **low** negative significance with the implementation of the above key mitigation measures. As above, due to the eco-geomorphological dynamis inherent within site, anthropogenic interventions are likely to alter natural dynamic processes within the coastline at a localised level and result in minor but inforeseen variations in such dynamism.

9.6.1.10 Potential Impact 10 (Cumulative Impacts)

Disturbance and variation of littoral and psammoseral environment.

The Lovu River mouth and the immediate dune and beach environment to the north of the mouth have been subject to significant transformation since the 1980s. The proposed pump station and associated marine pipelines will be an extension of such transformation along the coastline with increased hardpanning of the secondary dune environment. The continued transformation of coastlines, is a significant factor affecting the coastal environment, with short and long term change being manifest. Such changes can be described as probable and long term on account of the unpredicatbility of such impacts, with the impacts from the desalination plant being considered local due to the small area occupied by the development, although its impact will be identified off-site. Cumulative, coastal impacts are to be considered moderately reversible, as there is no general predictability of their nature, and can be further ameliorated by project design and management methods and interventions.

> **Key Management Actions**: Limitations on the area placed under hardpan and the amount of infrastructure placed in and around the dune / beach environment should be practised in the final design of the pumping facility. The approach to design in this area should be

"minimalist" with avoidance of unnecessary infrastructure. Percolation of surface water onto site should be incorporated into stormwater design.

Maintenance of a natural process based upon the acceptance of marine, sediment and ecological interactions should be incorporated into the management regime associated with this area. While it is understood that the mobility of the dune form should be limited, such mobility should be managed to allow for natural processes to control such dynamism.

The cumulative impact associated with the disturbance and variation of littoral and psammoseral environment is predicted to be of a **low** negative significance, both without and with the implementation of additional mitigation measures.

It is also recommended to institute a monitoring program of marine cells to identify changes in dune stability, dune mobility and beach dynamics.

9.6.1.11 Potential Impact 11 (Cumulative Impacts).

With the establishment of the proposed pump station, **increased pedestrian traffic is expected within the beach environment**. Presently, human traffic may be considered "low" and although there may be a requirement to access the beach environment for management and maintenance purposes on an irregular basis, there is likely to be a small but positive increase in human presence on the beach and psammoseral environment. Such impacts can be considered to be of low significance and highly reversible, on account of the fact that low human intrusion is likely to arise in comparison to other beach environments and such intrusions on account of maintenance and management, are likely to be intermittent. If impacts are identified during operations, it is highly likely that such impacts can be reversed by increasing management protocols around access to the beach.

Key Management Actions: Management of staff access to the beach should be set in place during the operational phase, with an emphasis on the restriction of access to the beach and frontal dune environment.

The cumulative impact associated with increased pedestrian traffic is predicted to be of a **low** negative significance with the effective implementation of the key mitigation measures proposed.

9.6.2 Other mesic Environments

As described previously, the preferred and alternative sites for the proposed SWRO plant are highly transformed from an ecological perspective, comprising primarily of agricultural lands under the commercial cultivation of sugar cane. The preferred site lies adjacent to an existing school / community facility (Figure 9.2), while the alternative site lies on an exceptionally steep portion of land, west of the main road. The two SWRO sites lie outside of wetland / estuarine landscape components. These sites are, as identified above, highly transformed, being primarily cultivated lands. The western or alternative SWRO site will require significantly greater excavation to be undertaken comparative to the preferred location which would give rise to lesser alteration in terms of the physical state of the subject site, with concomitantly less impacts in terms of bio physical processes both on site and adjacent to the SWRO.

The section of the proposed seawater intake and bring discharge pipelines located between the pump station and the N2 follows the same route for the Preferred and Alternative 1 and 3 pipeline routes. This section (hereafter referred to as ***Section A*** of the pipeline route) traverses mesic environments associated with the railway line and some portions of the R102 and is assessed in this section. The

balance of the Preferred route and Alternative 1 and 3 routes as well as the proposed Alternative 2 route are located within a wetland / estuarine environment and have been assessed as part of the Estuarine and Aquatic ecology assessment in Chapter 7 and 8.

As demonstrated above (Figure 9.20), the 11kV powerline serving the pump station follows a similar route to the Preferred seawater/brine pipeline, while the 132kV line traverses the Lovu River as well as existing canelands upon which the Kingsburgh Main substation has been established.

9.6.2.1 Potential Impact 12 (Construction Phase)

Disturbance of general surface environment. Alteration of edaphics at depth may result in variation in soil nutrient levels, permeability and related factors. The disturbance associated with the Preferred site will comparatively be less than that associated with the Alternative site, primarily on account of the significant slope associated with the Alternative site. The requirements of cut and fill operations on the Alternative site will be significantly greater than these of the Preferred site, which would also lead to greater edaphic disturbance of this area. These impacts can be considered highly reversible and of medium term duration if the structures are dismantled and the affected area reinstated. It is however doubtful that the Alternative site, if selected, could be reinstated to its present state on account of the need for extensive earthmoving operations - this impact is therefore assessed to be irreversible and of a permanent duration for the Alternative site. The construction of the proposed pipelines and powerline will also lead to disturbance of general surface in the affected mesic environments, although such areas are generally minor in extent and urban in nature.

Without mitigation actions, the significance rating of impacts associated with the disturbance of general surface environment for the Preferred site, Section A of the pipeline route (Preferred and Alternative 1 and 3 routes) and powerline route is anticipated to be **low**, while the significance of these impacts for the Alternative site is predicted to be **high**.

> **Key Management Actions:** During the excavation component of the construction phase, particularly in respect of the trenching for pipelines, it is expected that soil horizons (O, A and B) should be identified and stockpiled accordingly. During backfilling, stockpiled materials should be re-established in accordance with the prevailing horizons.
>
> **Additional Management Actions**: The sculpting of those areas subject to excavation may also be undertaken to ensure that there are no physical anomalies arising within mesic environments (e.g. depressions arise that establish a maturing wetland system within a primarily mesic area).

With the effective implementation of the key mitigation measures proposed, the impacts associated with the disturbance to the general surface environment during the construction phase are predicted to be of a **low** negative significance for the Preferred site, for the proposed pipeline routes (preferred and alternative routes) and for the powerline route. These are however anticipated to remain of **high** significance for the Alternative site.

Removal/disturbance of indigenous vegetation during construction activities

The proposed desalination plant site is currently used for agriculture and most of the proposed pipeline and powerline routes run along current infrastructural service lines. Thus, impacts on surrounding vegetation are expected to be minimal. Furthermore, with the exception of some secondary forests in the vicinity of the proposed pump station, the recommended route is located within cane lands which are of limited conservation significance. The loss of some

indigenous species is however, considered probable and this results in an overall **low** significance.

Key Management Actions: Undertake a search and rescue of indigenous species.

Following the installation of the proposed pipelines and powerline, re-vegetate the surface with an appropriate graminoid seed mix.

With the effective implementation of the above key mitigation measures, the overall significance of this impact remains **very Low**.

9.6.2.2 Potential Impact 13 (Construction Phase)

Disturbance of surface areas will alter general seral traits (vegetation succession) within sites not presently under cultivation or intended to be under cultivation following construction. As such these areas may be predisposed to exotic weed invasion. It is understood that exotic weed invasion is driven by disturbance and it is evident within the area that there is a high level of exotic plants prevalent across the affected environment, driven primarily by urban and agricultural activities. Accordingly, the development of infrastructure of the nature contemplated has a high probability of giving rise to extensive weed invasion, that may have long term impacts, unless managed. The potential intensity of such impacts is considered low as the affected areas are generally isolated and as sound vegetation management can address such impacts, they may be considered highly reversible.

Without mitigation, the potential for exotic weed invasion within disturbed areas is anticipated to be of **medium** significance for all components of the proposed project (preferred and alternative site and pipeline route).

Key Management Actions: Following the clearance of vegetation, open and bare areas not identified for the continuance of cultivation should be subject to re-vegetation using a rapid germination species such as a mix of graminoids (*Digitaria* spp ; *Eragrostis* spp) or active vegetation with appropriate herb and woody species.

The impacts associated with the disturbance of surface areas during the construction phase are predicted to be of a **low** negative significance with the effective implementation of the mitigation measures proposed.

9.6.2.3 Potential Impact 14 (Construction Phase)

Where topography is altered and a more significant grade is established on slopes, erosion may arise.

This impact may be applicable across the development footprint but is considered to be of low significance on account of the generally level terrain and "cohesive soils" encountered across most of the environment, as well as the expected advent of re-vegetating and stabilisation of disturbed areas, either through seral process or through a managed intervention. Such impacts must however be considered probable as some areas within the various development footprints will be affected, i.e. areas with slopes >12˚ are likely to be prone to erosion if not suitably stabilized. For the Alternative site, erosion will largely depend on the stability of the surrounding soils and / or the grade of cut. Such impacts are assessed to be highly reversible through managed interventions and of a short temporal

duration. Without mitigation actions, the significance of these impacts is therefore predicted to be **low** for all components of the proposed project, except for the Alternative site for which it is anticipated to be **medium**.

> **Key Management Actions:** Where extensive cut and fill operations are evident and it is clear that slopes will be excessive (approximately >18˚), appropriate engineering interventions should be considered to address potential erosion risks.
>
> Where slopes are not subject to redress by engineering interventions, the use of geofabric stabilising materials or re-vegetation of embankments should be set in place.

The impacts associated with increased erosion during the construction phase at the preferred and alternative SWRO plant sites, along section A of the proposed pipeline route and along the proposed powerline route are predicted to be of a **low** negative significance following the effective implementation of proposed mitigation measures.

9.6.2.4 Potential Impact 15 (Construction Phase)

Where soils are collapsible, the immediate topography along construction areas may alter to establish a low lying depression. Such topographic variance will also serve to alter general ecological traits in and around these areas.

As indicated above, although the alternative SWRO site is of limited ecological significance, extensive cut operations on the site will alter bio physical factors around it, including the disposal of surface water run off. Less significant impacts are likely to arise on the preferred site due to its generally level grade and the reduced requirement for earthworks in the establishment of the plant on this site. Notably, neither of these areas show evidence of collapsible soils. However in proximity to the pump station, more collapsible soils can be expected. In these areas, infilling of areas along the pipeline routes and around the pump station, may see minor variations in the prevailing topography as soils settle over time. Such topographic variations tend to alter ecological process. Such impacts are considered to be of short term duration if natural processes are allowed to act upon these aberrations, and although probable in occurrence across at least some parts of the development footprint, these impacts can be deemed highly reversible if interventions are forthcoming. Without mitigation actions, the significance rating of topographic variance and associated alternation of ecological traits is anticipated to be **low** for all components of the proposed desalination project project (i.e. preferred and alternative site, powerline, and, preferred and alternative pipeline routes).

> **Key Management Actions**: Monitoring of untoward variation in the topography should be undertaken by management following the cessation of the construction phase. Possible infilling or rectification of extensive depressions or variations in topography to be addressed.

The impacts associated with the disturbance of topography during the construction phase are predicted to be of a **low** negative significance with the effective implementation of the mitigation measures proposed.

9.6.2.5 Potential Impact 16 (Construction Phase)

During construction, localised fauna may be ousted from refugia and potential mortalities may arise.

Local fauna are evidently associated with some portions of the development footprint. Such fauna will have adapted to the urban – agricultural environment that prevails and have a high probability of being associated directly with areas such as the pump station site, the caravan park and cane-lands on

and around the proposed SWRO sites (preferred and alternative sites). Larger fauna, particularly smaller mammals, as well as some reptiles (*Varanus nilotica* – water monitor) may reside in the dense refugia that lie within the wetland environments and as such, the removal of such refugia may affect their presence within the mesic environments. This impact is considered to be of short term duration as it will only last for the duration of the construction phase. Due to the limited prevalence of natural refugia, particularly within the mesic environment, it is evident that such impacts are of a **low** significance for all component of the proposed project (i.e. preferred and alternative site, powerline, and, preferred and alternative pipeline routes).

Key Management Actions:

The prudent alignment of all pipelines to ensure the avoidance of potential faunal refugia including steeper slopes and thickets of vegetation (if and where such associations are identified, no matter how small), may reduce the incidence of mortalities or ousting of species from specific areas.

A preliminary review of sites prior to construction will allow for the identification of fauna that may be traversing or be present within particular areas, prior to the commencement of construction. Depending upon the nature of species that may be identified, specific actions can be taken to address any faunal presence that arises within the development footprint.

The impacts associated with disturbance of fauna refugia during the construction phase are predicted to be of a **low** negative significance with the effective implementation of the mitigation measures proposed.

9.6.2.6 Potential Impact 17 (Operations Phase)

Most of the pipeline and powerline routes proposed will not be subject to management interventions during the operational phase. **However, where required, such interventions will alter seral processes. It is probable that the affected land will revert to a secondary vegetation form** unless management interventions are not undertaken during the operational phase or if the affected area is returned to cultivation. Most of the affected pipeline and powerline routes will, under normal operating procedures be returned to farmers for continued cane operations, while the balance of the mesic environment is considered to revert to urban states. Those lands not falling under cultivation or "urban development" will be subject to ongoing management by the operator which may include cutting and felling of vegetation that affects line servitudes and avoids the establishment of vegetation that may affect pipeline or powerline operations. Some level of management is therefore important. Without the implementation of management actions, the impact significance rating of undertaking servitude vegetation management is anticipated to be low. Some key management interventions to be employd in respect of vegetation management are presented below.

Key Management Actions: It is recommended to monitor and manage pipeline and powerline servitudes and land under the management of the SWRO operator, for secondary seral growth to facilitate management and maintenance operations, while also allowing for the preservation and enhancement of natural seral processes.

The impacts associated with the disturbance of vegetation during the operational phase are predicted to be of a **low** negative significance with the effective implementation of the mitigation measures proposed.

9.6.2.7 Potential Impact 18 (Operations Phase)

Areas in and around the proposed SWRO plant are likely to be subject to ecological change on account of the increase in anthropogenically driven disturbance associated with the operations of the facility. This includes impacts associated with the operations and in particular movement of persons around the facility. Such changes are probable and likely to impact primarily upon existing cultivated lands, which are likely to be abandoned and would give rise to secondary seral growth forms. Other factors may include electrical light pollution (ELP). This aspect is dealt with as part of the Visual Impact assessment study (refer to Chapter 10).

Without the implementation of mitigation actions, the potential ecological change in areas around the proposed SWRO plant is anticipated to be of **low** significance for both, the preferred and the alternative site.

> **Key Management Actions**: Management of lands not under cultivation but falling within the management jurisdiction of the proposed SWRO plant should be subject to a generalised land management regimen, including exotic weed control, habitat and vegetation management regimen.

The impacts associated with anthropogenic disturbance as a result of the operation of the proposed SWRO plant (preferred and alternative site) are predicted to be of a **low** negative significance with the effective implementation of the key mitigation measures proposed.

9.6.2.8 Potential Impact 19 (Operations Phase)

Noise, arising in particular from the proposed SWRO plant may have a negative impact on animal behaviour, breeding and give rise to stressed faunal populations within the region. While indeterminate, such impacts are to be noted. As mentioned above, the impacts of the proposed project on the surrounding noise sensitive areas and sensitive human receptors is the subject of a separate specialist study (Chapter 11 of this Draft EIA Report). From an ecological perspective the issue of noise arising from the SWRO sites in particular is considered to be of a low-medium intensity, on account of the already highly transformed nature of the site. Species that are sensitive to noise and in particular to specific frequencies may be affected by the operation of the SWRO. Such impacts will of course arise for the duration of the lifetime of this project (i.e. long term) and mitigation will be dependent only upon the ability to abate such noise.

> **Key Management Actions**: Noise abatement measures should be implemented accordingly. Refer to Chapter 11 Noise specialist study for further details.
>
> **Additional Management Actions:** Possible monitoring for behavioural changes in local fauna could be undertaken.

The impacts of noise on fauna resulting from the operation of the proposed SWRO plant (preferred and alternative site) are predicted to be of a **low** negative significance without and with the implementation of key management actions.

9.6.2.9 Potential Impact 20 (Operations Phase)

The powerlines serving the facility are likely to pose a potential hazard to, in particular, avian species. Such structures have a high probability of giving rise to the death or injury of primarily large birds that roost or perch on or near conductors. Bird flight behaviour may also alter as a consequence of the placement of powerlines, particularly where such lines traverse flight corridors such as valleys.

The 132kV lines will traverse a valley perpendicularly. Given the presence of a relatively high number of larger avian species within the floodplain of the iLovu, the potential impact of the proposed 132kV line on local avian populations is anticipated to be of medium to low intensity and will be of long term duration. The impact can be mitigated through the use of bird fligh diverters, while some adaptation from resident populations to the presence of such structures may arise over time. The impacts on avifauna as a result of the operation of the transmission lines are predicted to be of a **medium** negative significance without mitigation measures.

> **Key Management Actions:** Bird flight diverters should be positioned where powerlines traverse valleys or extensive open fields, are proximal to open water or wetland environments and lie adjacent to scarps.

The impacts on avifauna as a result of the operation of the transmission lines are predicted to be of a **low** negative significance with the effective implementation of proposed mitigation measures.

It is also recommended to undertake monitoring for behavioural changes and avian mortalities along powerlines. Such monitoring would include walking the line on a regular basis (weekly / monthly) and performing avian counts and assessments within the estuary itself.

9.6.2.10 Potential Impact 21 (Decommissioning Phase)

The removal of the infrastructure associated with the proposed desalination plant will give rise to a deficit in edaphic material and would require the import of material to address such deficit**. As per the construction and operation phase, a further alteration of the seral processes associated with the surface vegetative cover is likely to arise should the pipeline and SWRO plant be removed / demolished.**

It is evident that the Alternative site for the SWRO will entail significant volumes of earth movement in order to return this site to its status quo, prior to construction. Within the Preferred site, the import of material and topographic resculpting of the site following decommissioning will not be as significant as that of the Alternative site. Given this state, the lifetime of the project and the volumes of material required to re-establish the present topography on site, it is likely that alternative land uses to those prevailing today, will be implemented at decommissioning. The impacts associated with the decommissioning of the SWRO sites (preferred and alternative site) are therefore anticipated to be of short term duration and of **low** negative significance.

The same status can be attributed to the powerlines and pipelines, which upon decommissioning will probably revert to the prevailing cane cultivation that is in place today, or alternatively to another form of land use.

Although the decommissioning of infrastructure will arise at a point expected to be in excess of 25 years from establishment, thus making predictions and forecasts of this nature highly uncertain, some mitigation measures are presented below.

> **Key Management Actions:** Management of lands following decommissioning should be undertaken to allow for reversion of land to cultivation, an alternate land use or reversion to a sere in line with local vegetation dynamics.

The impacts on surface vegetation as a result of the removal of infrastructure during the decommissioning phase are predicted to be of a **low** negative significance without and with the effective implementation of the mitigation measures proposed.

9.6.2.11 Potential Impact 22 (Cumulative Impacts)

The bulk of the affected mesic environment presently lies under cultivated lands. Such lands are subject to regular and catastrophic disturbance effectively placing them under a dynamic regime which establishes an early seral stage of a secondary coastal habitat. The pipeline and powerline routes that traverse mesic areas are unlikely to alter such regimen, while the SWRO plant is expected to alienate a portion of agricultural land from the prevailing land use of agriculture and as such remove such lands from any natural seral or ecological process. As such, cumulative impacts will relate to the loss of unencumbered farmlands to urban / service infrastructure.

Without the mitigation actions, the significance rating of this impact is anticipated to be of **low** significance.

9.7 IMPACT ASSESSMENT SUMMARY

Table 9.2 Impact assessment summary table

#	Impact description	Status	Extent	Duration	Reversibility	Potential Intensity	Probability	Significance (without mitigation)	Mitigation	Significance (with mitigation)	Confidence level
CONSTRUCTION PHASE											
The Dune / Beach environment (Pump station and marine pipeline)											
Pump station and section of pipeline seaward of the pump station											
1	Disturbance of the frontal dune system due to excavations of the seaward sections of the seawater intake and brine discharge pipelines, leading to slumping and Aeolian driven transgression (Direct impact). Long term disturbance has significant ramifications for the general stability of the affected area (Indirect impact)	Negative	Local (2)	Permanent (5)	Irreversible	High (8)	Highly probable (0.75)	High	Limit the construction footprint to the minimum required. The pump station should be established at a point landward of the frontal dune cordon in order to maintain dune frontal dynamics (beyond the recommended set back line). Sculpting of the dune face to allow it to revert to its natural state of dynamism. Maintain and enhance vegetation seaward of pump station through both cordoning and planting of the area in order to prevent undue destabilisation of the dune frontage.	Medium	High
2	Disturbance of the supra-tidal beach environment due to excavation leading to variations in beach sediment dynamics (Direct and Indirect Impacts). If the pipeline is not burried at a suitable depth, the potential for impacts on coastal processes in the event of scouring on the beach exists (Indirect Impact).	Negative	Local (2)	Long Term (4)	Low reversibility	Medium (4)	Highly probable (0.75)	Medium	Limit the construction footprint to the minimum required. Ensure that construction is undertaken when the mouth of the Lovu River does not train north, to reduce the necessity to breach the estuary mouth. Ensure pipeline is buried at depth greater than 5m below amsl within the beach and supratidal beach environment.	Medium	High
3	Retardation of the northward movement of the Lovu river mouth leading to pooling of water or change in sediment dynamics that may impact on adjacent properties, in particular those properties to the south of the pump station (Direct and Indirect Impacts).	Negative	Local (2)	Long Term (4)	Moderate reversibility	Medium (4)	Probable (0.5)	Medium	Limit the construction footprint to the minimum required. If breaching of the mouth of the Lovu River is necessary, it should be undertaken as far south as possible. Alternatively ensure that construction is undertaken when the mouth of the Lovu River does not train north, to reduce the necessity to breach the estuary mouth. Sculpting of the beach / supratidal environment to align it with the prevailing topography. Stabilisation of the beach-dune interface environment with vegetation to local dynamics of the system and/or geofabric materials or other engineering means.	Low	High
4	Increased slumping and transgression on the dune face and changes in the beach profile due to high levels of traffic (Direct impact). Disturbance of dune crusting (induration) as well as trampling of vegetation will facilitate dune instability and increase dune mobility (Direct and Indirect Impacts).	Negative	Local (2)	Long Term (4)	Low reversibility	Medium (4)	Probable (0.5)	Medium	Manage pedestrian traffic through dune cordon and collate traffic to stabilised points. Only use the most essential working corridor.	Low	Medium
5	Disturbance of the natural coastal dune forest	Negative	Local (2)	Long Term (4)	Moderate reversibility	Low (1)	Definite (1)	Medium	The final alignment of the proposed pipelines (to and from the pump station) should avoid the natural forest habitats located in the vicinity of the pump station - Pipe jack the proposed pipeline from and to the pump station under the forest. Limit the pump station footprint to 50m x 50m	Low	

#	Impact description	Status	Extent	Duration	Reversibility	Potential Intensity	Probability	Significance (without mitigation)	Mitigation	Significance (with mitigation)	Confidence level
Other Mesic Environments											
Preferred SWRO site, pipeline and powerline routes											
12a	Disturbance of general surface environment. Alteration of edaphics at depth may result in variation in soil nutrient levels, permeability and related factors (Direct Impact)	Negative	Site specific (1)	Medium Term (3)	Highly reversible	Low (1)	Highly probable (0.75)	Low	Stockpile soil horizons (O, A and B) accordingly during excavation and backfill stockpiled materials in accordance with the prevailing horizons	Low	High
	Removal/disturbance of indigenous vegetation during construction activities (Direct Impact)	Negative	Local (2)	Short Term (2)	Moderate reversibility	Medium-Low (2)	Probable (0.5)	Low	Undertake a search and rescue of indigenous species. Following the installation of the proposed pipelines and powerline, re-vegetate the surface with an appropriate graminoid seed mix	Very Low	High
13	Disturbance of surface areas will alter general seral traits (vegetation succession) within sites not presently under cultivation or intended to be under cultivation following construction. As such these areas may be predisposed to exotic weed invasion (Direct and Indirect Impacts).	Negative	Site specific (1)	Long Term (4)	Highly reversible	Low (1)	Highly probable (0.75)	Medium	Following the clearance of vegetation, open and bare areas not identified for the continuance of cultivation should be subject to re-vegetation using a rapid germination species such as a mix of graminoids (*Digitaria spp ; Eragrostis spp*) or active vegetation with appropriate herb and woody species	Low	Medium
14a	Where topography is altered and a more significant grade is established on slopes, erosion may arise (Direct Impact)	Negative	Site specific (1)	Short Term (2)	Highly reversible	Low (1)	Probable (0.5)	Low	Stabilised slopes with engineering or horticultural intervention	Low	High
15	Where soils are collapsible, the immediate topography along pipeline routes may alter to establish a low lying depression. Such topographic variance will also serve to alter general ecological traits in and around these areas (Direct Impact)	Negative	Site specific (1)	Short Term (2)	Highly reversible	Low (1)	Probable (0.5)	Low	Monitoring of untoward variation in the topography should be undertaken by management following the cessation of the construction phase. Possible infilling or rectification of extensive depressions or variations in topography to be addressed	Low	Medium
16	During construction, localised fauna may be ousted from refugia and potential mortalities may arise (Direct and Indirect Impacts)	Negative	Local (2)	Short Term (2)	Moderate reversibility	Low (1)	Highly probable (0.75)	Low	The prudent alignment of pipelines to ensure the avoidance of potential faunal refugia including steeper slopes and thickets of vegetation. Preliminary review of sites prior to construction to identify fauna present on site	Low	Medium
Alternative SWRO site											
12b	Disturbance of general surface environment. Alteration of edaphics at depth may result in variation in soil nutrient levels, permeability and related factors (Direct Impact)	Negative	Site specific (1)	Permanent (5)	Irreversible	High (8)	Highly probable (0.75)	High	Limit construction footprint to minimum required Ensure adequate stormwater management, prevention of erosion	High	High
	Removal/disturbance of indigenous vegetation during construction activities (Direct Impact)	Negative	Local (2)	Short Term (2)	Moderate reversibility	Medium-Low (2)	Probable (0.5)	Low	Undertake a search and rescue of indigenous species. Following the installation of the proposed pipelines and powerline, re-vegetate the surface with an appropriate graminoid seed mix	Very Low	High
14b	Where topography is altered and a more significant grade is established on slopes, erosion may arise (Direct Impact)	Negative	Site specific (1)	Short Term (2)	Highly reversible	High (8)	Probable (0.5)	Medium	Stabilised slopes with engineering or horticultural intervention	Low	High
15	Where soils are collapsible, the immediate topography along pipeline routes may alter to establish a low lying depression. Such topographic variance will also serve to alter general ecological traits in and around these areas (Direct Impact)	Negative	Site specific (1)	Short Term (2)	Highly reversible	Low (1)	Probable (0.5)	Low	Monitoring of untoward variation in the topography should be undertaken by management following the cessation of the construction phase. Possible infilling or rectification of extensive depressions or variations in topography to be addressed	Low	Medium

#	Impact description	Status	Extent	Duration	Reversibility	Potential Intensity	Probability	Significance (without mitigation)	Mitigation	Significance (with mitigation)	Confidence level
16	During construction, localised fauna may be ousted from refugia and potential mortalities may arise (Direct and Indirect Impacts)	Negative	Local (2)	Short Term (2)	Moderate reversibility	Low (1)	Highly probable (0.75)	Low	The prudent alignment of pipelines to ensure the avoidance of potential faunal refugia including steeper slopes and thickets of vegetation. Preliminary review of sites prior to construction to identify fauna present on site	Low	Medium
OPERATIONAL PHASE											
The Dune / Beach environment (Pump station and marine pipeline)											
Pump station and section of pipeline seaward of the pump station											
6	Long term operations may see increased dune transgression and occasional or regular periods of beach and dune erosion due to the destabilisation of the frontal dune system during the construction phase (Direct and Indirect Impacts). Exacerbated erosion at other adjacent properties in the long term (Indirect Impact)	Negative	Local (2)	Long Term (4)	Moderate reversibility	Medium (4)	Highly probable (0.75)	Medium	If and where possible, avoid the use of engineering defence and address erosion and mobilisation of dune system through sculpting and revegetation.	Medium	Medium
7	Pedestrian traffic onto the beach during the operational phase may see continued transgression at the access point as well as minor changes in dune profile and sediment dynamics on the beach (Direct Impact).	Negative	Site specific (1)	Long Term (4)	Highly reversible	Medium-Low (2)	Probable (0.5)	Low	Reduce disturbance on dune frontage and beach through the sitting of key infrastructures requiring regular maintenance (i.e. venting and purge valves), outside the dune cordon or shore environments. Manage pedestrian traffic through dune cordon and collate traffic to stabilised points. Implement a traffic protocol to avoid undue entry/regulate entry to the beach. Stabilise access points appropriately (e.g. geofabric materials).	Low	Medium
Other Mesic Environments											
SWRO (Preferred and Alternative site)											
18	Areas in and around the **SWRO** are likely to be subject to ecological change due to the increase in anthropogenically driven disturbance associated with the operations of the facility. Such changes are likely to impact primarily upon existing cultivated lands, which are likely to be abandoned and would give rise to secondary seral growth forms (Direct Impact).	Negative	Site specific (1)	Long Term (4)	Highly reversible	Low (1)	Probable (0.5)	Low	Vegetation management with emphasis on exotic weed control	Low	Medium

#	Impact description	Status	Extent	Duration	Reversibility	Potential Intensity	Probability	Significance (without mitigation)	Mitigation	Significance (with mitigation)	Confidence level
19	Noise, arising in particular from the SWRO plant may have a negative impact on animal behaviour, breeding and give rise to a stressed population within the region (Direct and Indirect Impacts).	Negative	Local (2)	Long Term (4)	Low reversibility	Medium-Low (2)	Probable (0.5)	Low	Establishment of noise abatement procedures at the proposed SWRO plant	Low	Low
Pipeline and powerline routes											
17	Potential for the **pipeline and powerline routes** to revert to secondary vegetation form if management interventions are required (Direct Impact).	Negative	Site specific (1)	Medium Term (3)	Moderate reversibility	Low (1)	Probable (0.5)	Low	Implement vegetation management regime with exotic weed control measures	Low	Medium
20	The powerlines serving the facility are likely to pose a potential hazard to, in particular, avian species (i.e. death or injury of primarily large birds) (Direct Impact).	Negative	Local (2)	Long Term (4)	Moderate reversibility	Medium-Low (2)	Highly probable (0.75)	Medium	Establish bird flight diverters where powerlines traverse valleys or extensive open fields, are proximal to open water or wetland environments and lie adjacent to scarps.	Low	High
DECOMMISSIONING											
The Dune / Beach environment (Pump station and Section A of marine pipeline)											
Pump station and section of pipeline seaward of the pump station											
8	Potential significant increase in transgression of the dune with an increased rate of frontal erosion, particularly if sea defence structures have been set in place and are subsequently removed (Direct and Indirect Impacts).	Negative	Local (2)	Short Term (2)	Moderate reversibility	Medium-Low (2)	Probable (0.5)	Low	It is recommended to keep the seawater intake and brine discharge pipelines in situ. Upon demolition or removal of the infrastructure from the beach and dune environment, it is expected that the beach / supratidal environment will be sculpted to align with the prevailing topography. The dune face will also be subject to sculpting and should be stabilised using vegetation, which in turn will be allowed to revert to its natural state of dynamism.	Low	Medium
9	Should areas landward of the frontal dune remain open and un-vegetated following demolition of infrastructure, there is a high likelihood of further transgression of the dune arising and should such movement be exacerbated by increased resultant drift direction, driven by localised wind dynamics, then secondary dune formation and sediment drift is likely to arise (Direct and Indirect Impacts).	Negative	Local (2)	Medium Term (3)	Highly reversible	Medium-Low (2)	Probable (0.5)	Low	Topographic sculpting and stabilisation of dune systems. Allow for reversion to natural psammoseral state	Low	High
Other Mesic Environments											
Preferred and Alternative SWRO site, pipeline and powerline routes											
21	The removal of the infrastructure associated with the pipeline will give rise to a deficit in edaphic material and would require the import of material to address such deficit. A further alteration of the seral processes associated with the surface vegetative cover is likely to arise should the pipeline and SWRO be removed / demolished. (Direct and Indirect Impacts)	Negative	Site specific (1)	Short Term (2)	Highly reversible	Low (1)	Probable (0.5)	Low	Management of lands following decommissioning should be undertaken to allow for reversion of land to cultivation, an alternate land use or reversion to a sere in line with local vegetation dynamics	Low	Medium

#	Impact description	Status	Extent	Duration	Reversibility	Potential Intensity	Probability	Significance (without mitigation)	Mitigation	Significance (with mitigation)	Confidence level
CUMULATIVE IMPACTS											
The Dune / Beach environment (Pump station and Section A of marine pipeline)											
Pump station and section of pipeline seaward of the pump station											
10	Disturbance and variation of littoral and psammoseral environment.	Negative	Local (2)	Long Term (4)	Moderate reversibility	Medium-Low (2)	Probable (0.5)	Low	Limitations on the area placed under hardpan and the amount of infrastructure placed in and around the dune / beach environment should be practised in the final design of the pumping facility. The approach to design in this area should be "minimalist" with avoidance of unnecessary infrastructure. Percolation of surface water onto site should be incorporated into stormwater design. Maintenance of a natural process based upon the acceptance of marine, sediment and ecological interactions should be incorporated into the management regime associated with this area. While it is understood that the mobility of the dune form should be limited, such mobility should be managed to allow for natural processes to control such dynamism	Low	Low
11	Increased pedestrian traffic is expected within the beach environment following implementation of the proposed project.	Negative	Site specific (1)	Long Term (4)	Highly reversible	Low (1)	Probable (0.5)	Low	Manage pedestrian traffic through dune cordon and collate traffic to stabilised points	Low	Medium
Other Mesic Environments											
Preferred and Alternative SWRO site, pipeline and powerline routes											
22	The bulk of the affected mesic environment presently lies under cultivated lands. Such lands are subject to regular and catastrophic disturbance effectively placing them under a dynamic regime which establishes an early seral stage of a secondary coastal habitat. The pipelines are unlikely to alter such regimen, while the SWRO is expected to alienate a portion of agricultural land from the prevailing land use of agriculture and as such remove such lands from any natural seral or ecological process. As such, cumulative impacts will relate to the loss of unencumbered farmlands to urban / service infrastructure.	Negative	Local (2)	Long Term (4)	Low reversibility	Medium-Low (2)	Probable (0.5)	Low	--	Low	Low

9.8 CONCLUSION AND RECOMMENDATION

Most, if not all of the development footprint, which includes pipelines and related infrastructure, is to be placed upon land that is subject to some form of recent transformation. Of this transformed land, only a minor portion can be considered to be "mesic", i.e. excluding wetlands, riparian and estuarine zones. Of the mesic landforms, the most significant is the supratidal beach and dune form located to the north of the Lovu River mouth.

The seashore and dune form in and around the proposed pump station at Lovu has been demonstrated to be highly dynamic and in recent times, has shown increased mobility. This state is brought about primarily on account of both climatic and anthropogenic incursions into the subject area, as well as possible off site disturbances.

The mesic environment, inland of the dune form is considered to be *highly transformed*, comprising of primarily existing cultivated lands, a railway servitude and an existing caravan park. These areas are generally considered to be *of low ecological* significance and depending upon the preferred land use, require management input in order to improve the natural ecological function and state of the areas in question. The proposed powerline routes, located along the identified corridors, traverse a number of riparian, wetland and secondary grassland areas.

The most significant impact, predicted to be of **high** significance without the implementation of mitigation measures, was assessed to be associated with disturbance to the frontal dune during the construction of the seaward sections of the intake and brine discharge pipelines. Trenching of these sections of the proposed pipelines through the dunes will also lead to long term secondary impacts (i.e. indirect impacts) such as increased mobility (or the potential to mobilise) within the dune system, which can only be addressed through a sea defence and/or further stabilisation. The latter may in turn alter sediment and beach dynamics.

Therefore, given the complex nature and dynamics of the frontal dune system as well as the number of interelated processes associated with this environment, the proposed trenching of the marine pipelines through the dune cordons, although not a fatal flaw, would lead to a number of **significant** direct and indirect impacts on the dune system and surroundings. These impacts are also mostly considered to be of very low reversibility, with some anticipated to be irreversible. It is therefore **strongly recommended** to **pipe jack** the proposed seawater intake and brine discharge pipelines under the dunes, with specific consideration towards maintaining a narrow working corridor. A terrestrial ecologist should be involved in the engineering design to confirm the entry and exit location of the pipeline under the dunes. This change in the design of the proposed project would be expected to lead to much more acceptable impacts (**low** significance) on the dune system and associated surroundings. It is also recommended to undertake a monitoring initiative on the dune-beach frontage, prior to construction, in order to assess the extent of the dune toe, back beach and intertidal zone using a number of parameters, i.e. highest tidal extremes (HATOY) and movement of estuary mouth.

Following the effective implementation of the recommended key mitigation actions, all impacts on terrestrial ecology, associated with the proposed project are predicted to be of **medium to low** significance, with the exception of impacts associated with the disturbance of the general surface environment at the proposed Alternative site which are anticipated to be of **high** significance. The most significant impacts associated with the line routes are the potential to impact upon avian behavior and in some cases, avian populations. Habitat associated with bird corridors (valleys, wetlands and riverine environments) that are traversed by powerlines should have mitigation measures to reduce bird strikes and electrocution established on the conductors.

Such impacts can to a certain extent be mitigated but, as in the case of the dune and beach environment, the mitigation measures may elicit other "knock on effects" while also exacerbating other problems. Monitoring and management of the coastline is thus an important management aspect of the operations of this desalination plant.

The following key design and management actions are recommended for the coastal environment:

Design Phase:

- Construction establishment should be subject to direct evaluation on site, in order to refine the final layout, e.g.
    - the pump station should be established at a point landward of the frontal dune cordon in order to maintain dune frontal dynamics (beyond the recommended set back line),
    - the proposed seawater intake and brine discharge pipelines should be pipe jacked under the dunes, with specific consideration towards maintaining a narrow working corridor,
    - pipelines from and to the pump station should not be dug within the natural forest in the vicinity of the proposed pump station but rather pipe jacked below the ground surface to avoid vegetation clearing or disturbance..
- Limit the amount of infrastructure placed in and around the dune / beach environment during final design of the pumping facility, in particular hard surfaces, Limit the pump station footpring to 50m x 50m.
- Ensure an adequate stormwater design.
- Position key infrastructure requiring regular maintenance (e.g. venting and purge valves) so as to avoid undue movement onto the dune cordon or into the beach/shore environment.

Construction Phase:

- Limit construction footprint to the absolute minimum required.
- Ensure that construction is undertaken when the mouth of the Lovu River does not train north, to reduce the necessity to breach the estuary mouth.
- If breaching of the mouth of the Lovu River is necessary, it should be undertaken as far south as possible. Advice from suitably qualified and experience estuarine ecologists should be sought on the authorization, timing, duration, nature and location of the breach. Authorisation and permits in that regard will be required from the relevant authorities.
- Ensure that within the beach and supratidal beach environment, such pipes are laid at a depth greater than 5m below mean sea level.
- Minimise activities in these environments through the management of entry to the beach and dune environment for all activities (i.e. cordoning off the area).
- Sculpting and stabilization re-vegetation of the dune face and the beach / supratidal environment to allow it to revert to its natural state of dynamism and align it with the prevailing topography

Operation Phase:

- If and where possible, avoid the use of engineering defenses or other engineering means, and address erosion and mobilisation of dune system through sculpting and revegetation and/or use of geofabric materials.
- Stabilise and upgrade existing access point to beach in order to allow for traffic on the beach, if required. A temporary access point can be established and stabilised using geofabric materials.
- Implement a traffic management protocol for all staff to avoid undue entry to the beach of staff and in particular, the use of vehicles on the beach.
- Limit and manage the mobility of the dune form to allow for natural processes to control such dynamism.

The following key design and management actions are recommended for other mesic environments:

Construction Phase:

- Ensure that soil horizons (O, A and B) be identified and stockpiled according to prevailing horizons during excavation and backfilling.
- Following the clearance of vegetation, open and bare areas not identified for the continuance of cultivation should be subject to re-vegetation using a rapid germination species such as a mix of graminoids (*Digitaria* spp ; *Eragrostis* spp) or active vegetation with appropriate herb and woody species.
- Where possible, use of geofabric stabilising materials or re-vegetation of embankments to address erosion.
- Where extensive cut and fill operations are required (i.e. slopes >18˚), appropriate engineering interventions should be considered to address potential erosion risks.
- Monitoring of untoward variation in the topography should be undertaken by management following the cessation of the construction phase. Possible infilling or rectification of extensive depressions or variations in topography to be addressed.
- Prudent alignment of all pipelines to ensure the avoidance of potential faunal refugia, including steeper slopes and thickets of vegetation.
- Preliminary review of sites prior to construction to identify fauna that may be traversing or be present within particular areas.

Operation Phase:

- Generalised land management regimen, including exotic weed control, habitat and vegetation management regimen.
- Monitoring and management of pipeline and powerline servitudes for secondary seral growth to facilitate management and maintenance operations, while also allowing for the preservation and enhancement of natural seral processes.
- Install bird flight diverters where powerlines traverse valleys or extensive open fields, are proximal to open water or wetland environments and lie adjacent to scarps.

Given the generally transformed nature of the receiving environment, the medium level nature of the overall level of impact arising from the development and providing that the recommended key mitigation measures are effectively implemented, it is evident that the siting of a desalination project in the manner proposed cannot be precluded on the grounds of impacts on the terrestrial/mesic environment.

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