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 8: AQUATIC ECOLOGY

ABBREVIATIONS, UNITS & GLOSSARY

DEA	Department of Environmental Affairs
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
GA	General Authorisation (in terms of the NWA)
m amsl	metres above mean sea level
m bmsl	metres below mean sea level
NWA	National Water Act
PES	Present Ecological State
WULA	Water Use Licence Application

EXECUTIVE SUMMARY

This chapter of the report focuses on freshwater (i.e. non estuarine) ecosystems only, and should be seen as complementary to the estuarine study (Chapter 7), with most of the aquatic ecosystems encountered in this study being estuarine, as defined (very broadly) by the area below the 5m contour. The freshwater ecosystems study assessed the likely implications for freshwater ecosystems of the desalination plant and its associated infrastructure (a pump station, pipelines and transmission lines) that have been proposed for construction at Lovu.

A number of freshwater ecosystems, all classified as watercourses, were identified as potentially affected by the proposed project. These include two degraded valley bottom wetlands that confluence and pass as channelized runoff onto the southern floodplain of the Lovu River, where they contribute to the formation of an extensive wetland area, just below the 1:100 year floodplain. This wetland (the "cultivated wetland") has, however, been almost wholly subsumed by sugar cane cultivation, with little remaining of its natural plant composition. On the northern floodplain, small patches of more naturally vegetated wetland habitat occur within the floodplain, and their flow is channelled across the estuarine floodplain via artificial channels and excavated depressions, into the Lovu Estuary open-water channel. Despite their level of degradation, both these and the wetlands on the southern floodplain are considered rehabilitable to a more natural condition. Two minor channelized watercourses, one of them considered wholly artificial, were also identified along the proposed transmission line, and would also be crossed by the northern two seawater intake and brine discharge pipeline route alternatives.

Of the various potential impacts to freshwater ecosystems that were identified, most would be associated with construction phase disturbance of freshwater ecosystems, generally entailing damage resulting from vehicle compaction, dewatering, sediment accumulation and removal of wetland vegetation. These impacts were rated of Medium significance where they affected the more natural wetlands on the northern floodplain (referred to as the "cane field wetlands"). Mitigation measures require slight deviations southward of the Preferred pipeline route, to run along the existing disturbed areas of the cane field, rather than through the extant wetland patches. Such avoidance mitigation is likely to be effective and would reduce impacts to **low** significance.

Although disturbance to the other watercourses would also be likely as part of the construction activities, this was generally considered of low significance only and mitigatable to even lower levels through standard best practice construction measures. Transmission line alternatives were similarly largely readily mitigatable, with the only area of some sensitivity and ecological concern being the proximity of the 11kV line to the cane field wetlands and trench. Disturbance rehabilitation measures were recommended, and likely to be effective, with additional measures to improve ecological connectivity between the cane field wetlands and the estuary channel also being recommended.

It must be noted that the wetland/aquatic systems assessed as part of this study and the estuarine system are in fact integrated, and should ideally be assessed as an integrated aquatic ecosystem. The overall biodiversity of the estuary and its associated floodplain wetlands would not be served by promoting significant negative impacts on the estuary to protect freshwater ecosystems.

Consideration of alternative site for the proposed desalination plant itself was complicated by the fact that this report focuses only on freshwater ecosystems, and the developer's Preferred site location, lying in close proximity to the estuarine channel, although above the 1:100 year floodline, would be associated with estuarine impacts, but has readily mitigatable impacts to the adjacent freshwater ecosystems, comprising the already highly degraded cultivated wetlands on the southern floodplain.

By contrast, the alternative site would lie in close proximity to the two valley bottom wetlands feeding into the cultivated wetlands, and would be likely to impact substantially on these systems, which would be considered sensitive to erosion and plant clearing. Impacts to these wetlands could however be mitigated from their assessed high significance rating without mitigation, to a **medium** significance rating, by setting the development back from the channel by at least 25m, and implementing rehabilitation measures prior to construction, to improve channel resilience to impacts.

The Estuarine study (Chapter 7) concluded that, without mitigation measures, the Alternative site would be preferred over the (developer's) Preferred site for siting of the proposed desalination plant due to slightly lower risk of being impacted by major floods and the presence of a larger ecological corridor between the development and the estuary channel. However, it recommended in mitigation a minimum ecological setback of 25m from the estuary channel (as measured from the indigenous riparian fringe or top of bank, whichever is the greater), and assessed this measure as likely to reduce the overall impact of the Preferred site, with mitigation, to the same (**Low**) level of negative significance as in the case of the Alternative site. Assuming such mitigation, the wetland ecosystem assessment concurs that the Preferred site would have the least level of impact from a freshwater ecosystem perspective.

Cumulative impact assessment took up the issue of the almost wholesale fragmentation and cultivation of natural freshwater wetlands on the floodplain. Mitigation measures proposed to address this issue comprised the measures already recommended as additional measures in this report – namely, the rehabilitation of the cane field wetlands in the north eastern corner of the floodplain, as well as the artificially excavated trench just upstream of the N2, to create a broad swathe of naturally vegetated wetland, as far as the estuarine channel, and the rehabilitation of a broad swathe of wetland, within the existing wetland in this area, that has been subject to long-term cultivation.

In conclusion, this report made the following recommendations regarding alternative selection:

- Seawater intake and brine discharge pipeline alternatives: Realignment of the preferred pipeline route, to run slightly more south in its reaches between the N2 and the crossing of watercourse 1, and with rehabilitation mitigation as outlined in this study;
- Site alternatives: (developer's) Preferred site providing the recommended mitigation is implemented (i.e. 25 m setback) or the Alternative site with impact mitigation and (strongly recommended) additional rehabilitation of a portion of the downstream cultivated wetland.

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8 AQUATIC ECOLOGY (RIVERS AND WETLANDS)

This chapter presents the aquatic ecology specialist study undertaken by Dr Liz Day from The Freshwater Consulting Group as part of the Environmental Impact Assessment for the proposed 150 Ml Seawater Reverse Osmosis Plant and associated infrastructure in Lovu, KwaZulu Natal.

8.1 INTRODUCTION

8.1.1 Scope of work and terms of references

The terms of reference for the aquatic ecology (rivers and wetlands) component of the project EIA phase, as finalized in the Scoping Document of May 2015, required the specialist to undertake the following activities:

- Conduct a comprehensive survey of the freshwater ecology aspects of the proposed pump station, desalination site, transmission line and the proposed pipeline corridors to the site, including ground-truthing of the mapped NFEPA wetland layer;
- Use the above information to provide a description of the baseline environment, including:
    - identification and mapping of wetland / river ecosystems;
    - comments on their sensitivity and importance/conservation significance, and
    - where appropriate, rapid assessments of Present Ecological State (PES) and/or Wetland Ecosystem Services;
- Determine and assess the potential negative as well as any positive impacts to freshwater ecosystems that could result from the proposed development and include mitigation measures to reduce negative impacts, where possible.
- Report on potential impacts and recommended mitigation measures in terms of
    - Pre-construction
    - Construction
    - Operational phases
- Describe cumulative impacts, and assess their significance;
- Provide recommendations for construction and operational phase monitoring.

Following a Specialist Integration Meeting in February 2015, it was noted that there was considerable overlap between the Estuarine and the Aquatic Ecology fields of study. In order to prevent repetition, it was agreed at this meeting that the Aquatic Ecology study (this study) would focus on wetlands and rivers associated with the proposed salt water pump station, the electricity transmission lines, the seawater intake and brine discharge pipelines and the proposed desalination site alternatives outside of the demarcated estuary area while the specialist Estuarine study (Chapter 7) would assess wetlands within the demarcated Estuary – usually taken as the area below the 5m contour, but in this case somewhat closer to the 4m contour, as ground-truthed by the estuarine specialist. This significantly reduced the scope of work of the Aquatic Ecology study, which effectively becomes a supporting document to the Estuarine Study.

For the purposes of this study, the estuarine area has been assumed to comprise the area below 5 m amsl. This includes a broad area of estuarine floodplain, and although much of this is "wetland" in terms of the National Water Act definition, estuaries are defined separately to watercourses in the National Water Act and the estuarine ecosystem is regarded, in this report, as a complete functional system, some of which is wetland in character. The area of vegetation mapped in Figure 7-2 of the Estuarine report corresponds approximately to this area, although the 5m contour in fact extends slightly wider across the northern estuarine floodplain.

8.1.2 Information sources, key definitions and approach to the study

8.1.2.1 Overall approach

The following activities were undertaken during the EIA phase of the project, with a view to meeting the Terms of Reference outlined above, namely:

- Attendance of a project team integration meeting and site visit in February 2015, during which time clarity was obtained from the project team as a whole and the project engineer Dr Mike Shand (Aurecon) in particular regarding the proposed alignments and design of the desalination infrastructure, as well as some of the proposed seawater intake and brine discharge pipeline alignments considered in the project feasibility stage;
- Desktop mapping and consideration of the proposed locations for the desalination plant and its associated infrastructure at Lovu;
- A second site visit was carried out in May 2015, during which time:
    - the two alternative sites for the proposed desalination plant were assessed, and (the few) wetlands on and associated with the site were identified and characterized in terms of the National Wetland Classification system and their Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS), using the methodologies outlined in Appendix A;
    - the alignments of the proposed 132kV and 11kV transmission lines were visually assessed – assessment entailed a combination of driving to appropriate high points from which to assess the route, as illustrated in engineering plans and during the February site visit, and accessing portions of the proposed alignment that were either readily accessible or which appeared, on the basis of desktop mapping, likely to pass in the vicinity of water courses of concern;
- Mapping of freshwater ecosystems of concern;
- Compilation of the current report.

8.1.2.2 Key Definitions

All reference to wetlands and water courses in this document were based on the following definitions of wetlands and water courses, as stipulated in the National Water Act (NWA) (Act 36 of 1998), namely:

> ***"watercourse"*** *means -*
> *(a) a river or spring;*
> *(b) a natural channel in which water flows regularly or intermittently;*
> *(c) a wetland, lake or dam into which, or from which, water flows; and*

(d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks;
***"wetland"** means -*
land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

8.1.2.3 Information sources

In addition to information gleaned during site assessments and in discussion with other specialists and project team members, the findings of this report were also informed by the following data sources:

- A review of GIS covers of freshwater ecosystems in the area, including:
  - SANBI wetland data, downloaded from BGIS, and including KZN Wetland Inventory data, fine scale planning data and Ezemvelo KZN Wildlife KwaZulu-Natal Provincial Pre-Transformation Vegetation Type Map (Scott-Shaw et al 2011)
  - the National Freshwater Ecosystems Priority Areas Assessment (NFEPA) (CSIR 2010)
  - the National Wetlands Cover
  - 1:50 000 and 1: 500 000 rivers National Rivers layers
  - National Ecoregion (Level 1) GIS covers
- Conservation planning reports and associated data, including Conservation Targets and Status for Vegetation Types in kwaZulu-Natal (Jewitt 2011)
- Consideration of the findings of the specialist Estuarine Report (Chapter 7 of the present document).

8.1.3 Assumptions and Limitations

The findings of this study should be considered in light of the following assumptions and limitations:

- Sections of the two transmission line alignments would pass through dense bush, and it was not possible to access the full alignments on foot, or to plot channel / watercourse alignments where these occurred in valley bottoms. Since the transmission lines are assumed to span over these lower-lying areas (see Inherent Mitigation 1, below), this issue is not considered of great consequence;
- The study assumes that the botanical specialist (Chapter 9) will provide input with regard to the identification of red data or other important wetland plants – it is however not likely that such will occur within the assessed area, which is highly disturbed;
- This study specifically excluded assessment of groundwater, marine or estuarine aquatic ecosystems, and focuses entirely on Inland Aquatic Ecosystems as defined by Ollis et al (2013), although the estuarine and aquatic ecosystem specialists have commented on and had access to each other's findings. The extent of estuary assumed in this study is that indicated in the mapped vegetation of Figure 7-2 in the Specialist Estuarine report (Chapter 7);
- Detailed delineation of wetland extent has not been allowed for in this study – outside of

the estuarine areas, only patchy wetlands within the cane fields, the hydrology and soil structure of which has long been altered, were encountered within the proposed transmission line and pipeline routes;

- No aquatic faunal assessment was allowed for in this study, other than in the form of SASS5 biomonitoring, which was inappropriate for any of the aquatic ecosystems assessed – again, the freshwater ecosystems assessed are unlikely to support fish or invertebrate species of conservation importance;
- Only wetlands and watercourses of relevance to the present study (e.g. along the transmission or pipeline alignments, and in the vicinity of the proposed desalination plants) have been assessed, and this report should not be interpreted as a general review of all freshwater ecosystem resources in the broader area;
- It is assumed that mitigation measures inherent to the project design, as described in the project description, would be implemented regardless of additional mitigation measures recommended by this study (i.e. ratings for impact 'without additional mitigation' is assumed to already include mitigation measures inherent to the design). Mitigation measures pertaining to this specific field of study that are assumed to be inherent to the project design include:
    - Mitigation 1: It is assumed that transmission line support towers would not be located on drainage lines, and would be spaced so as to allow the lines to span across low points, usually spanning distances from 300 – 400 m, but up to 600m if necessary. This means that, outside of broad floodplain or valley bottom wetlands wider than 600m, it is assumed that only the transmission lines would pass over the watercourses and that construction of towers within or even immediately abutting them would not take place.
    - Mitigation 2: It is assumed that the 132kV transmission line towers would span the whole 1:100 year floodplain, at the point where they would cross the Lovu Estuary (a distance of about 375m).

8.1.4 Acknowledgements

Input from the project team and in particular from Dr Mike Shand (Aurecon) during and after the February site visit is gratefully acknowledged.

8.2 PROJECT DESCRIPTION: RIVERS AND WETLANDS

The proposed desalination plant and its associated infrastructure include a wide array of activities and structures. Not all of these are however likely to have significance for freshwater ecosystems (i.e. rivers and wetlands) and this specialist study has focused only on those likely to be of relevance to these systems, namely:

- The footprint of the proposed desalination plants – two alternative sites have been identified, namely
  - a (developers') Preferred site on the south bank of Lovu Estuary channel, just outside of the 1:100 year floodline;
  - an alternative site, west of the Preferred site, on the hillslopes leading down to the floodplain

  Of these, the former is located within the Estuary, and this report defers comments / assessments regarding this site to the estuarine specialists (see Chapter 7).

- The alignment of the seawater intake pipeline from the high water mark to the proposed sea water pump station, at Winklespruit, and the pump station site itself;
- The alignments of four alternative seawater intake and brine discharge pipeline routes – again, most of their lengths would be routed through estuarine areas, and this report provides limited additional comment on their passage across minor watercourses only, outside of the area assessed by the estuarine specialists in Chapter 7. Note that the fourth alternative (Alternative 3) only differs from that of the preferred alignment in its reaches downstream of the N2. Wetland systems in the vicinity of this alignment have been assessed as estuarine, and thus have not been assessed in this study (see Chapter 7);
- The alignment of the proposed electricity transmission lines – a section of 132kV line as well as a section of 11kv line would be required. In the case of the transmission lines, most of their alignments would run outside of the estuarine area, and the transmission lines have thus been assessed in this report in their entirety.

Figure 8-1 illustrates the locations of natural drainage lines and watercourses identified in this study, using the information sources and visible evidence gained on site. They are shown in relation to the proposed alignments of key infrastructure, the impacts of which to freshwater ecosystems are discussed in Section 8.6.

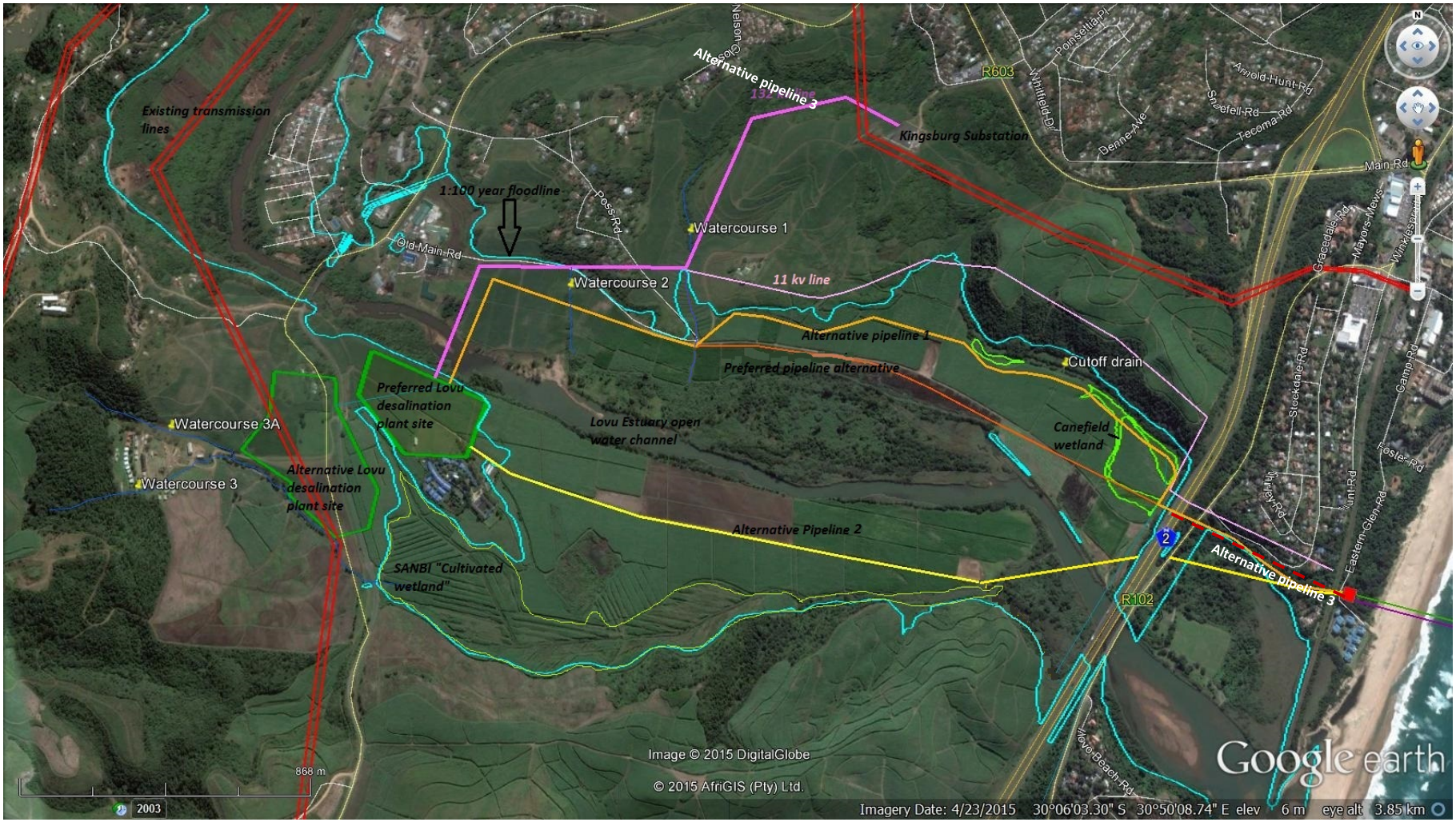

Figure 8-1 Map showing the four watercourses assessed in this study (watercourses 1-3 and 3A), as well as the cane field wetlands mapped in the floodplain above the estuary edge, in relation to proposed infrastructure. Note that transmission line alignment has been digitised from hard copy figures, and may thus be slightly inaccurate.

8.3 DESCRIPTION OF THE AFFECTED ENVIRONMENT: RIVERS AND WETLANDS

Information provided in this section has been presented specifically to reflect the specialist's understanding of the proposed project, and how it relates to freshwater aquatic ecosystems. The latter are thus described with specific relation to key components of the proposed project, with the impact of these components on freshwater ecosystems being described in Chapter 8-6.

8.3.1 Catchment and NFEPA context

National Freshwater Ecosystem Priority Area (NFEPA) data show that the project itself would be located in the Department of Water and Sanitation (DWS)'s Mvoti to Umzimkulu Water Management Area (WMA 14), in the Mgeni Sub WMA.

All of the proposed infrastructure and alternative desalination plants themselves under consideration in this study fall within the Lovu River catchment. NFEPA River data (Nel et al 2011) show that the Lovu River has been classified throughout its reaches as in a 1Present Ecological State (PES) Category C, indicative of rivers that have been Moderately Modified from their natural condition. NFEPA data also indicate that the upper reaches of the Lovu River are classified as a Fish Sanctuary for vulnerable or near threatened fish species. The species of concern is in fact *Amphilius natalensis* (Natal Mountain catfish), but its sanctuary area is well upstream of the reaches likely to be affected by the proposed desalination plant, which would affect the estuarine reaches of the main river only (see Chapter 7) and minor watercourses and wetlands associated with the lower catchment.

8.3.2 Ecoregion context

Ecoregions are groups of rivers that share similar physiography, climate, geology, soils and (under natural conditions) natural vegetation. The National Ecoregional Classification of Kleynhans (2005) classifies the Lovu River catchment as falling within Ecoregion 17 (North Eastern Coastal Belt). Rivers within this ecoregion are characteristically:

- Associated with a diversity of terrains, but usually occurring in closed hill and mountain terrain, at altitudes from sea level to 700 m amsl;
- Typically associated with Valley Thicket and a variety of Grassland and Bushveld types;
- Usually in areas where mean annual precipitation and temperatures are both high (MAP = 700-1000 mm and mean annual temperature =16-22°C).

[1] Present Ecological State is a measure of a river or wetland's condition, when compared to its natural and/or reference condition.

8.3.3 Freshwater aquatic ecosystems associated with the study area

8.3.3.1 General description of freshwater ecosystems in the study area

The Lovu Estuary is the dominant aquatic ecosystem in the lower Lovu River catchment affected by the proposed desalination project, comprising the portion downstream from the Old Main Road Bridge (see Figure 8-1) to the sea. The estuary itself has been described in Chapter 7, and includes open channel habitat, extensive reedbed marshes (mainly *Phragmites australis*) and areas of swamp, which form a large estuarine area, within the broader 1:00 year floodline of the river. Although the extent of the estuarine wetlands is driven by interactions between the sea and the Lovu River, a number of small drainage lines also feed into the floodplain, and under natural conditions would probably have comprised broad wetland areas that integrated with the estuarine zone. SANBI GIS vegetation type data, for example, indicate a large area of wetland along the **southern** bank of the estuary, just within the 1:100 year floodline and outside of the estuarine zone (see Figure 8-2).

The natural classification of this wetland would, using the KwaZulu-Natal Vegetation Types system, be "Alluvial Wetlands: Subtropical Alluvial Vegetation". It is however described in the above dataset as cultivated wetland, and the whole area lies under sugar cane cultivation, with artificially channelled trenches through the cane fields, supporting both sugar cane and, in places, particularly with distance east towards the estuary, indigenous *Phragmites australis* reedbeds (see Photo I). Assessment of Present Ecological State (PES) / wetland condition, Ecological Importance and Sensitivity (EIS) and Conservation Importance on the basis of the approaches outlined in Appendix A (Section 8.10), indicated the following results, namely:

- **PES: Category E**, indicating a system that has lost virtually all indigenous vegetation, has undergone significant changes to hydrology (channelization, drainage, eastward diversion of natural flows from lateral seepage zones into the estuary marshes), has been almost wholly cultivated by cane, is assumed to have been affected by poor water quality from upstream (see description of Watercourse 3) as well as any pesticides, fertilizers and herbicides used in the Illovo cane fields;
- **EIS: Low to marginal**, reflecting the degree to which the wetlands have been impacted by agricultural activities;
- **Conservation Importance**: Moderate, reflecting the rehabilitation potential of the wetlands, in theory, and their importance as links between the upstream catchment and the estuarine wetlands, in the event that rehabilitation could be achieved.
- **Functional role**: Despite its current level of impact, the wetland is still likely to play some role in terms of retention of water (and thus contribute to maintenance / extension of downstream low season flows) as well as in functions such as sediment trapping and nutrient uptake, at least along the channelized section, where dense plant growth throughout much of the year is likely to exert these functions.

The above cultivated wetland is fed by a combination of runoff / seepage from high lying ground immediately to the south, as well as (probably primarily) from discharge into the cane fields by two streams, which confluence upstream of the Old Main Road, and have been labelled Watercourse 3 and 3A in Figure 8-1. Of these, Watercourse 3 rises on the hillslopes above the Illovo workshop / administration / residential area, and passes along the steeply sloped south eastern fenced boundary

of this area (see Photo K). The stream flows as a channelized, eroded valley bottom wetland, which in its reaches from the fenced Illovo site downstream has lost virtually all indigenous vegetation and in fact, at the time of the site visit, appeared to have been impacted by activities / events resulting in dieback of the weedy / grassy plant component remaining along the channel. Although it is possible that herbicide use may have resulted in plant dieback, the quality of the water in the stream at the time of sampling suggested that it was affected by runoff of raw sewage, and it is assumed that the observed dieback in fact resulted from ammonium-rich runoff, leading to plant mortality (see Photos J and K) and undoubtedly severe impacts to aquatic invertebrate life as well.

The channel passes under two culverts, and into a deeper, steep-sided channel, with a slightly more natural riparian component, albeit still invaded by alien plants, including bugweed (*Solanum mauritianum*) and Brazilian Pepper Trees (*Schinus terebinthifolius*). Here it is joined by Watercourse 3A, which passes down the northern boundary of the Illovo site. This watercourse is in a more natural condition in its upper reaches, with Fever Trees (*Acacia xanthophloea*) occurring in stands along the watercourse, along with numerous weedy and/or invasive alien species (e.g. Brazilian Pepper Trees). Flow in the channel was too low for any useful assessment of aquatic macroinvertebrate fauna to be carried out, but it is assumed that, when not afflicted by polluted inflows from upstream, the channel supports a relatively low to moderate diversity of aquatic macroinvertebrate fauna, typical of small, wetland-associated systems.

With distance downstream, the watercourse passes along the edge of sugar cane fields, and is progressively more degraded from here, becoming steep-sided, eroded and lined in places with stone to control runoff from the cane fields. It joins Watercourse 3 downstream of a road culvert, and the two watercourses flow together through cane fields as a narrow, channelized system, bereft of most wetland valley bottom character and recently mown at the time of the site visit. The channel passes under Old Main Road within a culvert, daylighting as a narrow channel between dense cane fields, mapped in the SANBI vegetation layer as a cultivated wetland (as described above and illustrated in Photo L).

- **Watercourse 3** has been assessed as **PES Category E** in its reaches upstream of the confluence of the two systems, reflecting critically impacted water quality upstream, as well as near-complete loss of indigenous vegetation and changes in channel morphology – this category is maintained as far as the Old Main Road crossing, despite assumed improved water quality (as a result of dilution from Watercourse 3A), as a result of the near-complete loss of indigenous vegetation and wetland function. The system is however considered readily rehabilitable to a Condition D or even C, if water quality impacts are addressed and attention is paid to establishing an indigenous riparian and instream plant community.
- **Watercourse 3A** has been assessed as a **PES Category D** in its reaches upstream of Watercourse 3, with the reaches upstream of the cane fields being in an upper D/ C Category.
- Both watercourses have been assessed as of moderate conservation importance, reflecting their potential role as corridors and high rehabilitation importance, while their EIS was assessed as Low.

On the northern side of the estuary, two watercourses and two areas of mixed cultivated wetlands were identified in this study, upslope of the estuarine edge, and have been identified in Figure 8-1 as follows:

- **Watercourse 1**: this comprises a channelled valley bottom wetland, which passes through dense coastal forest vegetation higher up its slopes (see Photo C), but in its lower reaches, is surrounded by cane fields and passes as a deep, channelized trench, invaded with weedy grasses and cane (see Photo B), and occasional sparse *Phragmites australis* reeds, with distance towards the Lovu Estuary open water channel.
    - In its reaches in the cane fields, the watercourse has been assessed as a PES E to F, reflecting complete loss of indigenous wetland vegetation, channelization, changes in hydrology, loss of wetland characteristics and near 100% invasion by alien species. The channel would be rehabilitable to an improved condition, if it was allowed a broader setback from the encroaching cane fields;
    - EIS is considered low to marginal, but Conservation Importance is considered moderate, given its rehabilitation potential'
- **Watercourse 2**: This watercourse is an artificial channel, excavated to drain runoff from the upslope (northern) side of the access road through the cane fields, as well as to drain runoff from the steep wooded slopes immediately north of the start of the drainage line. This runoff is collected in a trench along the edge of the road, and passed in a culvert beneath the road, daylighting some 10m downstream in a broad vegetated (mainly alien) channel, which flows in a straight line to the Lovu Estuary open water channel (see Photo E).
    - PES assessment of this system is not appropriate, given its artificial nature;
    - Both EIS and Conservation Importance are considered **low**.
- **Cane field wetlands:** the wetlands mapped in the north eastern end of the floodplain, just upstream of the N2, comprise the only extent of freshwater wetlands identified in the floodplain outside of the estuary that included indigenous (albeit hardy, disturbance tolerant) vegetation, rather than sugar cane and alien weeds (see Photo H). These wetlands derive their flow from seepage from the slopes to the north, which would naturally probably have been diffused into broad wetlands edging the estuarine marshes. However, with most of the natural extent of floodplain wetlands having been converted to cane fields, runoff from the northern slopes in this area has been collected in a cutoff drain / trench, that runs along the edge of the floodplain at the base of the hillslope, and conveys runoff into a wide trench, running parallel with the N2 (see Photo G), which discharges this water ultimately into the Lovu estuary channel, via a series of artificially excavated openwater wetland areas, created upstream of the N2, which discharge via a pipe culvert into the channel (see Photo F). The mapped cane field wetlands appear to have been created as a result of lateral seepage through the cutoff drains, resulting in large swathes of land that are presumably supposed to comprise cane fields, instead supporting wetland vegetation, including *Phragmites australis* (in limited stands), *Carex* sp.; *Persicaria* sp., *Cladium mariscus* and numerous low growing herbaceous wetland plants. In part, these wetland plants have clearly grown up in parts of the cane fields where sugar cane has been harvested, allowing light to penetrate and promote growth of other plants. Aerial imagery shows however that there are clear swathes of such habitat,

connecting to the upslope cutoff drain. While these are assumed to be species poor and clearly are highly impacted from their natural condition, unlike the channelized systems described above, they comprise functional wetland habitat, with a high rehabilitation potential, connecting between upland slopes and the estuary along artificially induced freshwater channels, parallel with the N2.

- The wetlands have been assessed as providing the following low to moderate levels of wetland function:
  - Wetland habitat
  - Ecological connectivity through otherwise ecologically sterile cane fields
  - Stormflow attenuation (at least in early storms before the areas are inundated), allowing spreading of flows through vegetated, stable areas;
  - Contribution of sustained freshwater flows into the estuary, as a result of runoff attenuation and slow release through organic sediments;
  - Water quality filtration, affecting sediment and (potentially) nutrient concentrations.
- PES of these small wetland patches has been assessed as Category D, reflecting high levels of impact, but with high potential to improve wetland condition to Category C;
- EIS is considered Moderate and
- Conservation Importance has been assessed as moderate.

Key features of the freshwater aquatic ecosystems described above are illustrated in Photos A-L on the following pages, while their EIS and PES statuses have been summarised in Table 8-1.

Table 8-1 Summary of condition (PES), EIS and Conservation Importance in freshwater aquatic ecosystems identified in this section.

Site name	Present Ecological State (PES) / condition	Ecological Importance and Sensitivity (EIS)	Conservation importance	Functional Roles
Canefield wetlands	Category D	Moderate	Moderate	Low to moderate levels of wetland function, comprising provision of: ▪ Wetland habitat ▪ Ecological connectivity through otherwise ecologically sterile cane fields ▪ Stormflow attenuation (at least in early storms before the areas are inundated), allowing spreading of flows through vegetated, stable areas; ▪ Contribution of sustained freshwater flows into the estuary, as a result of runoff attenuation and slow release through organic sediments; ▪ Water quality filtration, affecting sediment and (potentially) nutrient concentrations
Cultivated wetland	Category E	Low to marginal	Moderate (high rehabilitation potential)	Water retention (thus contributing to maintenance / extension of downstream low season flows) as well as functions such as sediment trapping and nutrient uptake, at least along the channelized section, where dense plant growth throughout much of the year is likely to exert these functions
Watercourse 1	Category E - F	Low to marginal	Moderate (high rehabilitation potential)	• Surface water conveyance • Limited instream filtration • Very limited assumed role as a faunal corridor through agricultural areas to the estuary
Watercourse 2	Artificial – n/a	Low	Low	
Watercourse 3	Category E	Low	Moderate	• Surface water conveyance • Very limited assumed role as a faunal corridor through agricultural areas to the estuary
Watercourse 3A	Category D	Low	Moderate	

Photo A
Estuarine swamp marsh east (downstream) of N2

Photo B
Watercourse 1, looking upstream from access road

Photo C
Watercourse 1, in reaches that would be crossed by proposed 132 kV transmission line, looking south east

Photo D
Lovu estuary channel just upstream of proposed transmission line crossing, in vicinity of proposed joint crossing point for pipeline alternatives 1 and 2

Photo E
Artificial channel "Watercourse 2"

Photo F
Artificial wetland upstream of the N2 (north estuary bank), controlling passage of water from adjacent wetlands into the open channel of the estuary

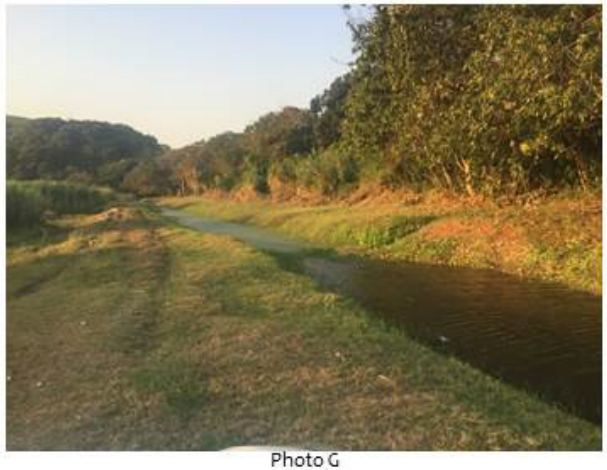

Photo G
Excavated channelled wetland parallel with (and just upstream of) the N2

Photo H
(mainly) indigenous wetland vegetation in wetland seeps, mapped in figure 8-1 as canefield wetlands

Photo I
Phragmites australis reedbed established in degraded channelised portion of cultivated wetlands south of the open estuary channel

Photo J
Highly polluted Watercourse 3 just downstream of the Illovo site

Photo K
Watercourse 3 - along Illovo fenceline, showing areas of dead vegetation along eroded channel.

Photo L
Channelised Watercourse 3 downstream of Old Main Road, showing close constriction by canefields.

8.3.3.2 Freshwater aquatic ecosystems associated with the proposed pump station and sea water line at Winklespruit

No natural freshwater aquatic ecosystems were found along this pipeline alignment or within the vicinity of the pump station, other than artificial road drains along the edges of existing roads.

8.3.3.3 Freshwater aquatic ecosystems associated with the proposed 11kV transmission lines

The 11kv line would pass in a westerly direction from the vicinity of the pump station, just north of the caravan park. It would cross the N2 and swing sharply north north-east, running between the artificial diversion channels / wetlands parallel with the N2, and the cane fields and cane field wetlands described in the previous section. The line has been located almost wholly outside of the 1:100 year floodline.

The line would join the 132kV line in the vicinity of Watercourse 1 (as shown in Figure 8-1 and described above).

8.3.3.4 Freshwater aquatic ecosystems associated with the proposed 132 kV transmission lines

This line would cross Watercourse 1 and Watercourse 2 along the existing access road. It would also cross the Lovu Estuary, south west of the Watercourse 2 road crossing. The line has been aligned almost wholly outside of the 1:100 year floodline, other than when it crosses the estuary to reach the proposed desalination plant sites.

8.3.3.5 Freshwater aquatic ecosystems associated with the proposed seawater intake and brine discharge pipelines ("the pipeline routes")

Chapter 7 has already described the routing of these pipelines through estuarine areas. While this study assessed Alternatives 1 and 2 as essentially the same, from a freshwater ecosystem perspective, there are important differences, namely:

- Alternative 1: From the pump station, this line would pass through disturbed areas abutting the caravan park, largely following an old railway line servitude through dense coastal forest. An extensive area of openwater swamp forest lies just south of the pipeline alignment – this is included in the estuarine assessment and described in SANBI datasets as (KZNVEGTYPE) Marine Saline Wetlands. Immediately upstream of the N2, the pipeline would veer north north east, to run between the (artificially created) channel parallel with the N2, and the cane field wetlands, described in the previous section, then turning to run in a west, north-westerly direction, through the mapped cane field wetlands, through cane fields to the west, and then cutting south west to cross Watercourse 1, followed by Watercourse 2 in the vicinity of the gravel access road, and then the Lovu Estuary and its open water channel, which would be bridged – this aspect is discussed in the estuarine report.

- Preferred route and Alternative 3: These routes would be essentially the same as that of Alternative 1 as far as the N2, with the exception that this first section of Alternative 3 would be tunnelled. Upstream of the N2, the Preferred and Alternative 3 pipeline routes would cut through the southern portion of the mapped canefield wetlands, then continue west, running roughly alongside the existing access road, and sharing an alignment with Alternative 1 from the crossing of Watercourse 1, onwards;
- Alternative 2 would run from the pump station, crossing through the edge of the saltwater swamps described in the previous section as just south of the caravan park, and be tunnelled beneath the estuary, so as to cross onto the southern estuarine floodplain, and pass along the road edge abutting existing cane fields, as far as the two desalination plant alternatives. The estuarine assessment strongly recommended against this alternative, and since its alignment is wholly estuarine, no further comment is passed in this report on this alternative.

8.3.3.6 Freshwater aquatic ecosystems associated with the proposed desalination plants

The developer's Preferred site lies just south of the Lovu estuarine channel, and has been assessed as the least preferred alternative by the estuarine specialists. It does not lie within wetland areas, but in very close proximity to the Lovu Estuary, and the open water channel in particular.

The Alternative Site lies immediately north of Watercourse 3, just downstream of the confluence with Watercourse 3A, and the site boundary lies less than 10m from the edge of the stream.

8.4 IDENTIFICATION OF KEY ISSUES AND POTENTIAL IMPACTS

8.4.1 Key Issues Identified During the Scoping Phase

The specialist report produced during the Scoping Phase of this project identified the following key issues at that time, noting that these were raised before any site visit had been carried out, and without interaction between estuarine and freshwater ecosystem specialists.

8.4.1.1 Key issues associated with the pipeline and other linear infrastructure

- Disturbance to channel banks and beds at crossing points;
- Potential to trigger headcut erosion by altering upstream gradients at wetland crossing points;
- Construction-related water quality impacts;
- Possible soil and/or water quality impacts associated with accidental leakage or breakage of the pipelines, and the resultant passage of seawater into freshwater wetlands; this impact would probably be of less significance in the event that it occurred in estuarine areas rather than other, freshwater wetlands.

8.4.1.2 Key issues associated with the desalination plant alternative sites

Both proposed desalination plant sites are located outsider of the 1:100 year floodline of the Lovu River. The (developer's) preferred alternative lies much closer to the river channel, however, and selection of this site would potentially affect the extent to which riverine buffers can be maintained or provided along the channel in the affected reaches. From this perspective, it is possible that the Alternative site may be associated with lower levels of impact from a freshwater ecosystem perspective. However, the latter site closely abuts and may in fact include a number of watercourses and associated wetlands, the importance of which must be established before further comment can be made as to the risks posed by the proposed development layout at this site.

In addition to issues of encroachment into river corridors and proximity to other watercourses, issues such as the management of stormwater runoff from hardened surfaces into water courses would also need to be considered.

In addition to the above impacts identified by the specialist during the Scoping Phase, comments from I&APs after release of the Scoping Document included the following issues relating to freshwater ecosystems:

- Review of the Environmental Planning and Climate Protection Department (EPCPD) GIS database has identified the presence of extensive wetland habitat associated with the Lovu River floodplain. The location of the Sea Water Reverse Osmosis (SWRO) plant is likely to impact on significant portions of this habitat. It is acknowledged that the wetland habitat is transformed; however the impact to this systems functionality must be addressed in detail by the relevant specialist assessments (comment from eThekwini's Environmental Planning and Climate Protection Department);
- The various pipeline and power line routes have the potential to impact on both wetland habitat and water courses. This Department proposed alignments for the intake and outfall lines presented require detailed assessment. Further alternatives must include the possibility of a route along the southern bank of the river and estuary. The excavation and modification of the Lovu Floodplain is likely to impact on lateral movement of freshwater into the estuary. The necessary avoidance and mitigation of these impacts must be addressed (comment from eThekwini's Environmental Planning and Climate Protection Department);
- Additional focus needs to be given to the following (comment by eThekwini's Environmental Planning and Climate Protection Department):
    - The pipeline reticulation routes will impact directly on floodplain wetland habitat. These impacts must be suitably addressed as part of the specialist assessments. Use of existing disturbance corridors (such as roads) is recommended.
    - The KZN Wetland Inventory and data held by Ezemvelo KZN Wildlife is significantly more accurate than the NEFEPA data sets and must be considered as part of this study (where applicable)

8.4.2 Identification of Potential Impacts

Based on the information highlighted during the Scoping Phase of this project, and more especially from information gathered during the site visits and assessments, the following potential direct impacts to aquatic freshwater ecosystems (i.e. rivers and wetlands) have been identified as likely to be associated with different parts of the proposed project, if implemented. These are listed below, noting that "construction phase" impacts include those associated with project design and layout, which would be manifest once construction commenced.

8.4.2.1 Construction Phase

Note that construction phase impacts in this report include impacts that relate to design and planning, and come into effect during construction, as well as those (usually short-term impacts) simply associated with construction.

- Potential Impacts associated with the seawater intake and brine discharge pipeline– Alternative 1 route
    - Potential impact 1: Disturbance to artificial trenched wetlands parallel with the N2 as well as cane field wetlands, including disruption of already limited ecological connectivity through cane field wetlands;
    - Potential impact 2: Disturbance of watercourses 1 and 2 including passage of sediment into the channels and its downstream transport;
- Potential Impacts associated with the seawater intake and brine discharge pipeline – Preferred and Alternative 3 routes
    - These would be as for Alternative 1, but would affect a smaller portion of both cane field Wetland and the artificially excavated wetland, linking flows to the outlet into the estuary channel,
- Potential Impacts associated with the seawater intake and brine discharge pipeline – Alternative 2 route
    - This alignment is wholly estuarine and has been assessed as part of the estuarine specialist study in Chapter 7. It has been associated with significant impacts to estuarine wetlands and is not assessed in this Chapter.
- Potential Impacts associated with the 11kV transmission line
    - Potential impact 3: Disturbance to artificial wetlands excavated along the N2, and adjacent to the cane field wetlands – it is assumed that at least two support towers would be required in this area;
- Potential Impacts associated with the 132kV transmission line
    - Potential impact 4: Disturbance to Watercourse 1 in upstream reaches, as a result of bush clearing to allow stringing of transmission lines between towers;

      No impacts likely at Watercourse 2 crossing or at Lovu channel crossing (see Section 8.1.3);

- Potential Impacts associated with the desalination plant – (Developers') Preferred site:

- Potential impact 5: Disturbance (sediment, compaction, passage of construction vehicles) of (highly transformed) cultivated wetlands on the edge of the southern floodplain;

- Potential Impacts associated with the desalination plant – Alternative site
  - Potential impact 6: Disturbance to Watercourses 3 and 3A (bank damage, diversion of flows, compaction, removal of vegetation, passage of construction vehicles, sedimentation) as well as runoff of sediment-rich and otherwise polluted, concentrated water into the cultivated wetland mapped on the southern bank of the estuary.

8.4.2.2 Operational Phase

- Potential Impacts associated with the seawater intake and brine discharge pipeline – Preferred route and Alternatives 1 and 3 routes.
  - Potential impact 7: Dieback of wetland plants (e.g. cane field wetland areas) as a result of occasional (accidental) leakage or rupture of saltwater pipeline;
- Potential Impacts associated with the seawater intake and brine discharge pipeline – Alternative 2
  - This alignment is wholly estuarine and has been assessed in Chapter 7 (Estuarine specialist study), as associated with significant impacts to estuarine wetlands. It is not assessed in this Chapter.
- Potential Impacts associated with the 11kV transmission line
  - None anticipated as outside of floodline and maintenance access to portions along N2 possible through existing cane field roads.
- Potential Impacts associated with the 132kV transmission line
  - None anticipated – ongoing bush clearing maintenance activities addressed in Impact 4, which is considered a repeated activity.
- Potential Impacts associated with the desalination plant – (Developers') Preferred site:
  - Potential impact 8: Degradation (erosion from concentrated flows) of (highly transformed) cultivated wetlands on the edge of the southern floodplain as a result of increased stormwater runoff from hardened surfaces;
- Potential Impacts associated with the desalination plant – Alternative site
  - Potential impact 9: Degradation (erosion from concentrated flows) of Watercourses 3 and 3A as well as downstream (highly transformed) cultivated wetlands on the edge of the southern floodplain as a result of increased stormwater runoff from hardened surfaces, as well as other edge-related impacts.

8.4.2.3 Decommissioning Phase

This assessment assumes that decommissioning would entail removal of buildings but that transmission lines and pipelines would remain in situ, for potential use in upgraded facilities.

- Potential Impacts associated with the desalination plant – both Alternatives

- Potential impact 10: Sedimentation of watercourses, compaction, loss of vegetation and general wetland and channel disturbance as a result of demolition activities in adjacent areas.

8.4.2.4 Cumulative impacts

- Permanent loss of opportunities to rehabilitate freshwater wetland to estuarine corridors within cane field environments in the Lovu estuary, through the destruction of remnant rehabilitable corridors and wetland fragments within these broad transformed landscapes.

8.5 PERMIT REQUIREMENTS

The following legislation has direct relevance to freshwater ecosystems, as described in this Section, noting that this is not intended to be an exhaustive relieve of legislation, but simply to highlight key legislation that must be considered, in addition to the National Environmental Management Act (NEMA) (Act 107 of 1998) on which the present EIA document is based:

- The **National Water Act** (Act 36 of 1998) must be considered with regard to any activity that entails a water use, with water uses further defined in Section 21 of the Act as follows:
  - 21(a): Taking water from a water resource;
  - 21(b): Storing water;
  - 21(c): Impeding or diverting the flow of water in a watercourse;
  - 21(d): Engaging in a stream flow reduction activity;
  - 21(e): Engaging in a controlled activity;
  - 21(f): Discharging waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit;
  - 21(g): Disposing of waste in a manner which may detrimentally impact on a water Resource;
  - 21(h): Disposing in any manner of water which contains waste from, or which has been heated in any industrial or power generation process.
  - 21(i): Altering the bed, banks, course or characteristics of a watercourse.
  - 21(j): Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.
  - 21(k): Using water for recreational purposes.
- Authorisation for any of the above activities would need to be obtained from the Department of Water Affairs and Sanitation through a Water Use Licence Application (WULA), where they are conducted within 500 m of a wetland.
- While certain uses (e.g. Section 21c and i uses) may be Generally Authorised in terms of the NWA, where they take place in rivers, rather than wetlands, and in excess of 500m from a wetland boundary, such uses would require Registration through the DWS;
- Activities that would definitely trigger either GA registration or WULA requirements would include:
  - Construction of the proposed desalination plant within 500m of a wetland – the

Lovu Estuary is associated with floodplain wetlands;
  - Excavation of pipelines through or within 500m of a wetland – this would apply to all alternatives;
  - Construction of transmission lines across wetlands or rivers;
  - Passage of pipelines across wetlands or rivers – the pipeline alternatives (preferred route and Alternatives 1 and 3) would both cross watercourse 1 (note that watercourse 2 is not considered natural and would thus not require authorization through the NWA);
- Consultation with DWS officials should take place during the EIA phase of the project, to obtain clarity as to the process to follow in this regard, noting that in practice there is often a wide discrepancy in the requirements imposed by different regional and national DWS officials in this regard.

8.6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

8.6.1 Construction Phase

8.6.1.1 Potential Impacts associated with the seawater intake and brine discharge pipelines (Preferred route and Alternative 1 and 3 routes)

- Potential impact 1: Disturbance to artificial trenched wetlands parallel with the N2 as well as cane field wetlands, including disruption of already limited ecological connectivity through cane field wetlands

  Laying of a pipeline in this area would require excavation of a trench through the cane field wetlands, as well as across and (in the case of Alternative 1) along the edge of the excavated wetland linking flows to the estuarine channel. In the event that excess soil was not removed, but either compacted over the pipeline or overlain to form a raised mound, loss of wetland function would occur. While the wetlands in the cane fields are fragmented and clearly impacted, they are nevertheless considered an important remnant of more natural extensive wetlands likely to occur on the Lovu estuarine floodplain, and their disturbance, with possible long-term sustained impacts, would be a negative impact. The fact that the pipeline would require at least one metre of soil cover means that the pipelines themselves are unlikely to affect shallow subsurface drainage through the wetland soils. However, further disturbance at least during construction would occur as a result of dewatering of the trenches – an activity likely to be necessary along the length of the pipeline, and additional impacts would include sediment-rich water passing in potentially concentrated flows into wetland areas.

Without implementation of mitigation measures, this impact would take place at a medium to high intensity, albeit at a site specific scale (along the pipeline corridor), with potentially permanent impacts that would have low reversibility (e.g. in the unlikely event that the pipeline was removed and the area rehabilitated) and the impacts are considered highly probable, affecting locally rare wetlands, albeit impacted and fragmented.

Key Mitigation

- Avoidance mitigation is strongly recommended, with routing of the Preferred pipeline to be aligned with the existing access road through the cane fields, just south of the current proposed alignment of the Preferred route – this amounts to a shift south of about 80 m initially, reducing back to the existing alignment over a distance north, north west of some 330m;
- Impact minimization should also be achieved, by the following:
  - Demarcation of cane field wetland areas as no go areas to all construction vehicles and workers;
  - Implementation of controls over construction camps and equipment and vehicle storage, such that they will not impact on wetland areas;
  - Control of dewatering activities, allowing water to dissipate into cane fields and not the more natural (mapped) wetland areas, which should be protected from sediment laden runoff;
  - The pipeline trenches should be backfilled to preconstruction levels, to prevent changes in surface flow on the floodplain;
  - Construction activities involving the movement of vehicles over wetland areas, dewatering, excavation or other forms of disturbance to the ground surface should be restricted to the dry season (winter) when the water table is low;
  - The disturbed diversion trench parallel with the N2 should be reinstated, and ideally planted and shaped to a more natural alignment in disturbed areas, to improve its functional role as an ecological corridor linking freshwater wetlands north of the floodplain with the estuary;

With key mitigation as described above, the impact significance would be expected to shift from **medium** (no mitigation) to **very low**.

Additional mitigation measures that would improve biodiversity in the cane fields would be the deliberate rehabilitation of the wetlands established in the north eastern corner of the floodplain and their incorporation into a wide corridor, linking with the (rehabilitated) trench along the N2, to provide a robust corridor of indigenous wetland in this intensively agricultural environment.

- Potential impact 2: Disturbance to watercourses 1 and 2 including passage of sediment into the channels and its downstream transport

This impact would occur in places where excavation of the pipeline trench requires excavation through these channels – it is assumed that at 1100 mm diameter the pipeline would be too large to be attached to the culverts. The activity would entail disturbance to channelized banks (e.g. excavation and devegetation), potentially passing sediments into the channel. This impact would be considered a site specific impact, taking place at a low intensity, with sediment likely to be trapped by vegetation in the channel before it reaches the estuary. Although the impact is highly probable, the affected natural and artificial watercourses (Watercourses 1 and 2 respectively) would only be temporarily affected by the impact, and the impact would have high reversibility – e.g. the channels could be dredged.

Key Mitigation: The above impacts are considered readily mitigable with standard best practice construction measures, that ensure that disturbed banks are reshaped and revegetated (ideally with indigenous vegetation that has good bank stabilising properties), and that construction takes place outside of the wet season, when destabilization of soils and their downstream transport is least likely. It is recommended to draw up a list of appropriate species in consultation with the botanical specialist.

With key mitigation as described above, the impact significance would be expected to shift from **low** (no mitigation) to **very low**.

8.6.1.2 Potential Impacts associated with the 11kV transmission line

- Potential impact 3: Disturbance to artificial wetlands excavated along the N2, and adjacent to the cane field wetlands.

It is assumed that at least two support towers would be required in this area, and their construction would be likely to result in disturbance (excavation into, dewatering into, and likely compaction and damage to adjacent cane field wetlands as a result of handling of transmission tower components, vehicle access and stringing operations. The impact is likely to be of medium intensity, but occurring on a site specific (confined to the section just west of the N2, parallel with the artificially excavated wetland trench. It would be readily reversible with rehabilitation interventions to address compaction, and although it is highly probable that the impact would occur, it would be of a temporary nature.

Key Mitigation

The above impacts are considered readily mitigable through rehabilitation activities, as follows:

- Disturbed wetland areas (both the artificially excavated channel and adjacent cane field wetland areas) should be ripped, if compacted, reshaped and revegetated (ideally with indigenous vegetation that has good bank stabilising properties);
- Construction should take place outside of the wet season;

- Cane field wetland areas should be demarcated as no go areas to all construction vehicles and workers, and should not be used to stockpile or lay towers or other construction items;
- Controls should be implemented over construction camps and equipment and vehicle storage, such that they will not impact on wetland areas;
- Dewatering activities should be controlled, allowing water to dissipate into cane fields and not the more natural (mapped) wetland areas, which should be protected from sediment laden runoff;
- All construction materials and waste should be removed from site after construction;
- Construction / disturbance and rehabilitation activities should be coordinated, such that installation of the transmission lines does not disturbs areas that have been rehabilitated as part of the pipeline construction mitigation activities.

With key mitigation as described above, the impact significance would be expected to shift from **low** (no mitigation) to **very low**.

8.6.1.3 Potential Impacts associated with the 132kV transmission line

- Potential impact 4: Disturbance to Watercourse 1 in upstream reaches, as a result of bush clearing to allow stringing of transmission lines between towers.

  This activity would take place at low intensity, apparently affecting only a small area of the (partially alien invaded) riparian corridor and not crossing over the whole watercourse. The impact would be ongoing, and therefore considered permanent, and increased light and disturbance could encourage the establishment of alien weedy species in the affected area. The impact would however be considered site specific, and is not viewed with concern in this study. Without mitigation, this impact is anticipated to be of **low** significance.

  Key Mitigation
  - Although the above impacts are of low significance only, avoidance mitigation is in any case recommended, such that the transmission line is turned towards the south just short of the riparian area, within the cane field zone.

  With key mitigation as described above, no impact would occur.

8.6.1.4 Potential Impacts associated with the desalination plants: Developer's Preferred site

- Potential impact 5: Disturbance to the (highly transformed) cultivated wetlands on the edge of the southern floodplain as a result of construction of the desalination plant at the (developer's) preferred alternative site.

The proximity of the development site to these wetland areas, coupled with the fact that the 2m contours show that runoff from the site would be largely into the wetland areas and not into the estuary channel, means that runoff of sediment-rich water from disturbed areas of the site would be towards the wetland area, and its proximity also means that accidental passage of vehicles, litter and other construction waste into the wetland would be likely. The wetland itself is highly transformed, being heavily infested with sugar cane, so the intensity of impacts on an assumed relatively low level of wetland functionality would be low, occurring at a local (and not site specific) scale, with probably temporary to short term duration.

Key Mitigation

In the event that this site is selected, the wetland impacts should be mitigated against through:

- Implementation of tight construction management controls, including fencing off of the construction area, to prevent the accidental passage of vehicles into wetland areas, and management of issues such as runoff through the construction of temporary settling ponds, adequately sized to control the movement of stormwater from the site;
- Contaminated construction waste water should be bunded and disposed of offsite or, if contaminating material can be removed by settling or other means, disposed of into the stormwater system;
- Allowance must be made for the rehabilitation of disturbed areas to their previous condition or better, noting that most of the wetland in this area in fact has been planted with sugar cane.

With key mitigation as described above, the impact significance would be expected to shift from **low** (no mitigation) to **very low**.

It is however noted that a more pressing impact in the opinion of this specialist is the location of the proposed site in the proximity of the estuary, affecting the likely quality of an ecological corridor or buffer area between this source of disturbance and the estuary. This issue is dealt with in Chapter 7, which assessed the unmitigated Alternative site as associated with less impacts than the Preferred site, due to its slightly lower risk of being impacted by major floods and the presence of a larger ecological corridor between the development and the channel.

However, the study recommended in mitigation against the Preferred site impacts that a minimum ecological setback of 25m from the estuary channel (as measured from the indigenous riparian fringe or top of bank, whichever is the greater) should be established and maintained, and assessed this measure as likely to reduce the overall impact of the Preferred site, with mitigation, to the same (Low) level of negative significance as in the case of the Alternative site. Assuming such mitigation, the wetland ecosystem assessment concurs that the Preferred site would have the least level of impact from a freshwater ecosystem perspective, noting that the separation of "estuary" and "freshwater aquatic ecosystems" is an artefact of the EIA process, and that these wetland ecosystems are interconnected and issues affecting their biodiversity and/or function should be considered holistically.

8.6.1.5 Potential Impacts associated with the desalination plant – Alternative site

- Potential impact 6: Disturbance to Watercourses 3 and 3A (bank damage, diversion of flows, compaction, removal of vegetation, passage of construction vehicles, sedimentation).

  The proposed site lies in close proximity to Watercourses 3 and 3A, with less than 10m between the top of bank of Watercourse 3 and the site boundary. It is unlikely that construction could take place in such close proximity without triggering significant degradation of systems which, while already significantly impacted, are considered sensitive to impacts such as concentrated flow and removal of vegetation, which would promote channel incision.

  Other impacts included in this assessment would be probable inflows of litter, and compaction as a result of vehicle passage across or near the watercourses. Runoff from the lower site would be into the cultivated wetland on the eastern side of Old Main Road, and would be likely to carry sediment in possibly concentrated flows. Given that the site would be located on sloping ground, erosion from runoff would be a greater risk than at the Preferred site, but issues such as dewatering from a (presumed) high water table would be lower.

  The above impacts would be considered of potentially high intensity, occurring at a local scale at least, and potentially affecting aquatic ecosystems irreversibly and permanently. The systems themselves are currently in poor condition, but have rehabilitation potential.

  Key mitigation:
  In the event that this site is selected, the aquatic ecosystem impacts must be mitigated against through:

  - Setback of the site by at least 25m from the edge of either watercourse, as measured from the top of the bank – this distance allows for some rehabilitation of steepened channels by reshaping of banks, while retaining a workable buffer area;
  - Active intervention in the upstream catchment of Watercourse 3 to address the source of organic pollution into the stream;
  - Active rehabilitation of at least channel 3 from the confluence with 3A, allowing for bank reshaping and stabilisation and planting with hardy, appropriate indigenous species that will effect bank stabilisation and improve valley bottom wetland function – this rehabilitation should ideally precede construction by some months, in order to ensure that the channel is sufficiently robust to withstand construction-phase impacts – a wetland ecologist should oversee rehabilitation design;

- A stormwater management plan must be designed, to allow for adequate control of the velocity, quantity and quality of runoff from the site, such that it will not impact negatively on aquatic ecosystems. The structural elements of this plan must be in place prior to the start of construction of the plant.

With key mitigation as described above, the impact significance would be expected to shift from **high** (no mitigation) to **medium**.

Development of a desalination plant at the Alternative site would be associated with more complex and more significant impacts to freshwater aquatic ecosystems than that at the developer's preferred site.

In the event that the mitigation measures proposed by the estuarine specialist for the (Developer's) Preferred alternative (Chapter 7) cannot be accommodated by the developer, then offset mitigation for the Alternative site should be required, to improve wetland – estuarine connectivity and condition, as follows:

- Rehabilitation of wetland function, condition and plant community composition should be carried out, and maintained, along a swathe of the Cultivated wetland, from the culverts of Watercourse 3 at Old Main Road, all the way along the mapped wetland shown in Figure 8-1, as far as the *Phragmites australis* reedbeds at the outlet into the estuary;
- The rehabilitated swathe should be at least 40m wide, and dominated by indigenous wetland species, with sugar cane being actively maintained outside of this swathe.

8.6.2 Operational Phase

8.6.2.1 Potential Impacts associated with the pipeline – Preferred route and Alternative 1 and 3 routes

- Potential impact 7: Dieback of wetland plants (e.g. cane field wetland areas) as a result of occasional (accidental) leakage or rupture of the seawater intake or brine discharge pipeline.

  This impact is considered unlikely, but a threat throughout the life of the plant (and thus long-term). It would have moderate reversibility in freshwater aquatic ecosystems, requiring long-term flushing with fresh water to remove salt water from soils.

  Key Mitigation Measures:
  - Selection of the mitigated re-alignment outlined for Impact 1 would remove the pipeline from the proximity of the most sensitive freshwater ecosystems;
  - Repair of such breakdowns should take place with immediate effect.

With mitigation as described above, the impact significance would be expected to shift from **low** (no mitigation) to **very low**.

8.6.2.2 Potential Impacts associated with the pipeline – Alternative 2

The wetlands affected by this alignment are wholly estuarine and have thus been assessed in Chapter 7. They are not assessed in this section.

8.6.2.3 Potential Impacts associated with the 11kV transmission line

None anticipated as outside of floodline and maintenance access to portions along N2 possible through existing cane field roads.

8.6.2.4 Potential Impacts associated with the 132kV transmission line

Ongoing bush clearing already addressed as part of Impact 4.

8.6.2.5 Potential Impacts associated with the desalination plant – (Developers') Preferred site

- Potential impact 8: Degradation (erosion from concentrated flows) of (highly transformed) cultivated wetlands on the edge of the southern floodplain as a result of increased stormwater runoff from hardened surfaces.

  This impact would be a permanent impact, probably occurring at a low to moderate intensity only, given the degree of impact already incurred to the affected wetlands, and taking place at a local level, with high probability.

  Key Mitigation Measures:
  - The development design must incorporate and maintain measures to address the quantity, velocity and quality of runoff from the site, such that downstream impacts to the wetland system do not occur. These should include implementation of so-called Sustainable Urban Design (SUD) principles (e.g. infiltrations areas, minimising hardened surfaces);
  - The ecological setbacks / buffer areas (e.g. the 25m minimum setback from the estuary channel / riparian area for the Preferred alternative) should be managed as ecological corridors, with no hardening of surfaces or countenance of any activities that would be likely to add to impacts into the estuary – thus areas for the treatment of stormwater should be allocated outside of the stipulated buffer areas;
  - Allowance must be made for the separate collection, storage and disposal of leaked saltwater on the site, outside of the stormwater system (i.e. so that it will not affect freshwater ecosystems or other areas (e.g. soils) sensitive to salinity).

  With mitigation as described above, the impact significance would be expected to shift from **medium** (no mitigation) to **low**.

8.6.2.6 Potential Impacts associated with the desalination plant – Alternative site

- Potential impact 9: Degradation (erosion from concentrated flows) of Watercourses 3 and 3A as well as downstream (highly transformed) cultivated wetlands on the edge of the southern floodplain as a result of increased stormwater runoff from hardened surfaces, as well as other edge-related impacts affecting wetland integrity (e.g. trampling of wetlands and channels, depositing of litter and waste in channels.

  The above impact would be a permanent impact, possibly occurring at moderate intensity, given the steep slopes and sensitivity of the (albeit impacted) system to runoff, and taking place at a local level, with high probability.

  Key Mitigation Measures:
  - The development design must incorporate and maintain measures to address the quantity, velocity and quality of runoff from the site, such that downstream impacts to the wetland system do not occur. These should include implementation of so-called Sustainable Urban Design (SUD) principles (e.g. infiltrations areas, minimising hardened surfaces);
  - The channel and its buffer area (25m from the edge of the current channel, but less in a rehabilitated context) must be maintained free of litter and dumped waste;
  - The channel and its buffer area must be maintained free of at least woody and shrubby aliens.

  With mitigation as described above, the impact significance would be expected to shift from **medium** (no mitigation) to **low**.

8.6.3 Decommissioning Phase

This assessment assumes that decommissioning would entail removal of buildings but that transmission lines and pipelines would remain in situ, for potential use in upgraded facilities.

8.6.3.1 Potential Impacts associated with the desalination plant – both Alternatives

- Potential impact 10: Sedimentation of watercourses, compaction, loss of vegetation and general wetland and channel disturbance as a result of demolition activities in adjacent areas.

  These impacts would be considered of similar intensity to those outlined for the Construction Phase, for both sites respectively. Assuming that mitigation of Construction Phase impacts for the Alternative Site had been implemented, the impacts at this site would however be as for the mitigated condition, which would make the system less sensitive to impact.

Key Mitigation:

- The wetlands including (in the case of the Alternative site) Watercourses 3 and 3A, must be treated as no-go areas during decommissioning and fenced off during this phase;
- Ecological setback lines should be respected during the decommissioning phase and included in the no-go area.
- Removal of built structures, rubble, waste must be carried out such that disturbed areas do not result in run off of sediment rich or otherwise contaminated water into adjacent sensitive areas;
- Following decommissioning, areas of bare soil must be revegetated, unless to be followed immediately by new construction.

With mitigation as described above, the impact significance would be expected to shift from **medium** (no mitigation) to **low**.

8.6.4 Cumulative impacts

Permanent loss of opportunities to rehabilitate freshwater wetland to estuarine corridors within cane field environments, through the destruction of remnant rehabilitable corridors and wetland fragments within these broad transformed landscapes. At present, although it is recognised that the freshwater wetlands in the vicinity of the Lovu Estuary have already been highly impacted, largely as a result of sugar cane farming activities, many of these are rehabilitable. The incremental loss of additional wetlands as a result of permanent development such as that proposed here, requiring infrastructure to be laid through wetland areas, potentially severing important opportunities for connectivity in the future with abutting estuarine areas, is considered of concern. The freshwater cane field wetlands on the northern bank of the estuary in particular offer an excellent opportunity to restore ecological connectivity between different aquatic ecosystem types, the loss of which, given the fact that previous development has already destroyed most of this wetland habitat in at least the Lovu River, assumes a higher level of cumulative significance than it would when assessed in the light of the development only.

Additional Mitigation measures that centre on re-establishment of wetland habitat and ecological connectivity on the floodplain support concerns over the above cumulative loss and degradation of habitat

If no mitigation measures that address the connectivity and condition of the interface between the estuarine and freshwater ecosystems are implemented (i.e. the additional measures recommended for Impacts 1 and 6), then the Cumulative Significance of the development, viewed against a backdrop of past development, would be an impact of high intensity, affecting the possibility of achieving such effects on a permanent and irreversible basis with resources that are rare at least at the catchment level.

With mitigation as described above (essentially offset mitigation), the impact significance would be expected to shift from **medium** (no mitigation) to **low-medium.**

8.7 IMPACT ASSESSMENT SUMMARY

Tables 8-2 to 8-5 summarise the impacts of the proposed desalination plant and its associated infrastructure, from a freshwater ecosystems perspective. The assessment rating methodology is as prescribed by the CSIR to specialists engaged in this project. Note that all impacts (with mitigation) considered the implementation of "key mitigations" unless otherwise stated.

Table 8-2 Impact assessment summary table for the Construction Phase

Impact description	Status	Extent	Duration	Reversibility	Potential Intensity	Probability	Significance (without mitigation)	Mitigation	Significance (with mitigation)	Confidence
Potential Impacts associated with the pipeline – Preferred route and Alternatives 1 and 3										
Potential Impact 1: Disturbance to artificial trenched wetlands and cane field wetlands, including disruption of ecological connectivity.	Negative	Site specific (1)	Permanent (5)	Moderate reversibility	Medium (4)	Highly probable (0.75)	Medium (7.5)	Avoidance mitigation by routing the pipeline further south; Construction phase demarcation of canefield wetland areas as no go areas and controls over construction camps etc.; dewatering activities to be managed to protect more natural wetlands from sediment laden runoff; pipeline to be backfilled to preconstruction levels; Construction restricted to the dry season; rehabilitation of disturbed diversion trench	Very Low (1.75)	Medium
Potential Impact 2: Disturbance of watercourses 1 and 2 including passage of sediment into the channels and its downstream transport	Negative	Site specific (1)	Temporary (1)	Highly reversible	Low (1)	Highly probable (0.75)	Low (2.25)	Implement standard best practice construction measures, that ensure that disturbed banks are reshaped and revegetated (ideally with indigenous vegetation that has good bank stabilising properties), and that construction takes place outside of the wet season, when destabilization of soils and their downstream transport is least likely.	Very Low (0.75)	Medium
Potential Impacts associated with the 11kV transmission line Inherent mitigations measures for the transmission lines include: - Mitigation 1: It is assumed that transmission line support towers would not be located on drainage lines, and would be spaced so as to allow the lines to span across low points, usually spanning distances from 300 – 400 m, but up to 600m if necessary. This means that, outside of broad floodplain or valley bottom wetlands wider than 600m, it is assumed that only the transmission lines would pass over the watercourses and that construction of towers within or even immediately abutting them would not take place.										

Impact description	Status	Extent	Duration	Reversibility	Potential Intensity	Probability	Significance (without mitigation)	Mitigation	Significance (with mitigation)	Confidence
Potential Impact 3: Disturbance to artificial wetlands excavated along the N2, and adjacent to the cane field wetlands – it is assumed that at least two support towers would be required in this area	Negative	Site specific (1)	Temporary (1)	Moderate reversibility	Medium-Low (2)	Highly probable (0.75)	Low (3)	Disturbed wetland areas to be ripped if compacted, reshaped and revegetated with indigenous vegetation; Construction to take place outside of the wet season; Cane field wetland areas to be demarcated as no go areas during construction and protected from sediment laden runoff; all construction materials and waste to be removed after construction; overall construction and rehabilitation activities to be co-ordinated, so that disturbance does not occur after rehabilitation of other activities	Very Low (1.5)	Medium
Potential Impacts associated with the 132kV transmission line Inherent mitigations measures for the transmission lines include: - Mitigation 1: It is assumed that transmission line support towers would not be located on drainage lines, and would be spaced so as to allow the lines to span across low points, usually spanning distances from 300 – 400 m, but up to 600m if necessary. This means that, outside of broad floodplain or valley bottom wetlands wider than 600m, it is assumed that only the transmission lines would pass over the watercourses and that construction of towers within or even immediately abutting them would not take place. - Mitigation 2: It is assumed that the 132kV transmission line towers would span the whole 1:100 year floodplain, at the point where they would cross the Lovu Estuary (a distance of about 375m).										
Potential Impact 4: Disturbance to Watercourse 1, as a result of bush clearing to allow stringing of transmission lines between towers	Negative	Site specific (1)	Permanent (5)	Moderate reversibility	Low (1)	Probable (0.5)	Low (3.5)	Transmission line to be turned towards the south just short of the riparian area, within the cane field zone.	AVOIDANCE – NO IMPACT	High
Potential Impacts associated with the desalination plant – (Developers') Preferred site										
Potential Impact 5: Disturbance (sediment, compaction, passage of construction vehicles) of (highly transformed) cultivated wetlands on the edge of the southern floodplain	Negative	Local (2)	Short Term (2)	Moderate reversibility	Medium-Low (2)	Probable (0.5)	Low (3)	Implementation of tight construction management controls, including fencing off of the construction area, and management of runoff through the construction of temporary settling ponds, adequately sized to control the movement of stormwater from the site; Contaminated construction waste water to be bunded and disposed of appropriately; allowance to be made for the rehabilitation of disturbed areas to their previous condition or better. Implementation of estuarine mitigation measures requiring a 25m minimum ecological setback from the top of channel / edge of indigenous riparian vegetation (Chapter 7)	Very Low (1.25)	Medium
Potential Impacts associated with the desalination plant – Alternative site										

Impact description	Status	Extent	Duration	Reversibility	Potential Intensity	Probability	Significance (without mitigation)	Mitigation	Significance (with mitigation)	Confidence
Potential Impact 6: Disturbance to Watercourses 3 and 3A (bank damage, diversion of flows, compaction, removal of vegetation, passage of construction vehicles, sedimentation) as well as runoff of sediment-rich and otherwise polluted, concentrated water into the cultivated wetland mapped on the southern bank of the estuary	Negative	Local (2)	Permanent (5)	Irreversible	High (8)	Highly probable (0.75)	High (11.25)	Setback the site by at least 25m from the edge of watercourses 3 and 3A; address source of organic pollution into the Watercourse 3; active rehabilitation of at least channel 3 from the confluence with 3A, allowing for bank reshaping and stabilisation and planting with hardy, appropriate indigenous species; rehabilitation to precede construction by some months; stormwater management plan to be designed and implemented to control the velocity, quantity and quality of runoff from the site; structural elements of this plan must be in place prior to the start of construction of the plant.	Medium (8.25)	Medium

Table 8-3 Impact assessment summary table for the Operational Phase

Impact description	Status	Extent	Duration	Reversibility	Potential Intensity	Probability	Significance (without mitigation)	Mitigation	Significance (with mitigation)	Confidence
Potential Impacts associated with the pipeline – Preferred route and Alternatives 1 and 3										
Potential Impact 7: Dieback of wetland plants (e.g. canefield wetland areas) as a result of occasional (accidental) leakage or rupture of saltwater pipeline;	Negative	Site specific (1)	Permanent (5)	Moderate reversibility	Medium (4)	Low Probability (0.25)	Low (2.5)	Selection of the mitigated re-alignment outlined for Impact 1; repair of leaks to take place with immediate effect	Very Low (1.75)	Medium
Potential Impacts associated with the desalination plant – (Developers') Preferred site:										
Potential Impact 8: Degradation (erosion from concentrated flows) of (highly transformed) cultivated wetlands on the edge of the southern floodplain as a result of increased stormwater runoff from hardened surfaces	Negative	Local (2)	Permanent (5)	Low reversibility	Medium-Low (2)	Highly probable (0.75)	Medium (6.75)	Design to incorporate and maintain measures to address the quantity, velocity and quality of runoff from the site; measures to include SUD principles; Allowance for separate collection, storage and disposal of leaked saltwater so that it will not affect freshwater ecosystems or other areas sensitive to salinity.	Low (4)	Medium
Potential Impacts associated with the desalination plant – Alternative site										

Impact description	Status	Extent	Duration	Reversibility	Potential Intensity	Probability	Significance (without mitigation)	Mitigation	Significance (with mitigation)	Confidence
Potential Impact 9: Degradation (erosion from concentrated flows) of Watercourses 3 and 3A as well as downstream (highly transformed) cultivated wetlands on the edge of the southern floodplain as a result of increased stormwater runoff from hardened surfaces, as well as other edge-related impacts	Negative	Local (2)	Permanent (5)	Low reversibility	Medium (4)	Highly probable (0.75)	Medium (8.25)	Design to incorporate and maintain measures to address the quantity, velocity and quality of runoff from the site; measures to include SUD principles; Allowance for separate collection, storage and disposal of leaked saltwater so that it will not affect freshwater ecosystems or other areas sensitive to salinity; The channel and its buffer area must be maintained free of litter and dumped waste; the channel and its buffer area must be maintained free of at least woody and shrubby aliens	Low (4)	Medium

Table 8-4 Impact assessment summary table for the Decommissioning Phase

Impact description	Status	Extent	Duration	Reversibility	Potential Intensity	Probability	Significance (without mitigation)	Mitigation	Significance (with mitigation)	Confidence
Potential Impact 10: Disturbance to cultivated wetlands (Dev's Preferred site) and Watercourses 3 and 3A (Alt Site)	Negative	Local (2)	Medium Term (2)	Moderate reversibility	Medium (4)	Probable (0.5)	Medium (4.5)	Wetlands including Watercourses 3 and 3A, to be treated as no-go areas and fenced off; Ecological setback lines to be respected and included in no-go area; Removal of built structures, rubble, waste such that disturbed areas do not result in run off of sediment rich or otherwise contaminated water into adjacent sensitive areas; areas of bare soil to be revegetated, unless followed immediately by new construction.	Low (2.5)	Medium

Table 8-5 Impact assessment summary table for Cumulative Impacts

Impact description	Status	Extent	Duration	Reversibility	Potential Intensity	Probability	Significance (without mitigation)	Mitigation	Significance (with mitigation)	Confidence
Permanent loss of opportunities to rehabilitate freshwater wetland to estuarine corridors within cane field environments in the Lovu estuary, through the destruction of remnant rehabilitable corridors and wetland fragments within these broad transformed landscapes.	Negative	Regional (3)	Permanent (5)	Irreversible	Medium (4)	Highly probable (0.75)	Medium (9)	Offset measures that address the connectivity and condition of the interface between the estuarine and freshwater ecosystems to be implemented - that is, additional mitigation for Impacts 1 and 6, which allow for rehabilitation of wetland corridors on both sides of the estuary	Medium (4.5)	Medium

8.8 CONCLUSION AND RECOMMENDATIONS

This study has assessed the likely implications for freshwater ecosystems of the desalination plant and its associated infrastructure (a pump station, pipelines and transmission lines) that have been proposed for construction at Lovu. The study should be seen as a supporting document to the estuary study (Chapter 7), with the Lovu Estuary itself comprising the most important aquatic ecosystem likely to be affected by the proposed project. A number of freshwater ecosystems, all classified as watercourses, have however been identified as potentially affected by the proposed project. These include two degraded valley bottom wetlands that confluence and pass as channelized runoff onto the southern floodplain of the Lovu River, where they contribute to the formation of an extensive wetland area, just below the 1:100 year floodplain. This wetland (the "cultivated wetland") has however been almost wholly subsumed by sugar cane cultivation, with little remaining of its natural plant composition. On the northern floodplain, small patches of more naturally vegetated wetland habitat occur within the floodplain, and their flow is channelled across the estuarine floodplain via artificial channels and excavated depressions, into the Lovu Estuary openwater channel. Despite their level of degradation, both these and the wetlands on the southern floodplain are considered rehabilitable to a more natural condition. Two minor channelized watercourses, one of them considered wholly artificial, were also identified along the proposed transmission line and the northern two seawater intake and brine discharge pipeline routes.

Of the various potential impacts to freshwater ecosystems that have been described in this study, most would be associated with construction phase disturbance of freshwater ecosystems, generally entailing damage resulting from vehicle compaction, dewatering, sediment accumulation and removal of wetland vegetation. These impacts were rated of **medium** significance where they affected the more natural wetlands on the northern floodplain (referred to as the "cane field wetlands"). Mitigation measures require slight deviations of the Preferred pipeline route, to run along the existing disturbed areas of the cane field, rather than through the extant wetland patches. Such avoidance mitigation is likely to be effective and would reduce impacts to low significance.

Although disturbance to the other watercourses would also be likely as part of the construction activities, this was generally considered of **low** significance only, and mitigable to even lower levels through standard best practice construction measures. Transmission line alternatives were similarly largely readily mitigable, with the only area of some sensitivity and ecological concern being the proximity of the 11kV line to the cane field wetlands and trench. Disturbance rehabilitation measures were recommended, and likely to be effective, with additional measures to improve ecological connectivity between the cane field wetlands and the estuary channel also being recommended.

It must be noted that the wetland/aquatic systems assessed as part of this study and the estuarine system are in fact integrated, and should ideally be assessed as an integrated aquatic ecosystem. The overall biodiversity of the estuary and its associated floodplain wetlands would not be served by promoting significant negative impacts on the estuary to protect freshwater ecosystems. Consideration of alternative site for the proposed desalination plant itself was complicated by the fact that this report focuses only on freshwater ecosystems, and the developer's Preferred site location, lying in close proximity to the estuarine channel, although above the 1:100 year floodline, would be

associated with estuarine impacts, but has readily mitigatable impacts to the adjacent freshwater ecosystems, comprising the already highly degraded cultivated wetlands on the southern floodplain.

By contrast, the alternative site would lie in close proximity to the two valley bottom wetlands feeding into the cultivated wetlands, and would be likely to impact substantially on these systems, which would be considered sensitive to erosion and plant clearing. Impacts to these wetlands could however be mitigated from their assessed high significance rating without mitigation, to a **medium** significance rating, by setting the development back from the channel by at least 25m, and implementing rehabilitation measures prior to construction, to improve channel resilience to impacts.

The Estuarine study (Chapter 7) concluded that, without mitigation measures, the Alternative site would be preferred over the (developer's) Preferred site for siting of the proposed desalination plant due to slightly lower risk of being impacted by major floods and the presence of a larger ecological corridor between the development and the estuary channel. However, it recommended in mitigation a minimum ecological setback of 25m from the estuary channel (as measured from the indigenous riparian fringe or top of bank, whichever is the greater), and assessed this measure as likely to reduce the overall impact of the Preferred site, with mitigation, to the same (**Low**) level of negative significance as in the case of the Alternative site. Assuming such mitigation, the wetland ecosystem assessment concurs that the Preferred site would have the least level of impact from a freshwater ecosystem perspective.

Cumulative impact assessment took up the issue of the almost wholesale fragmentation and cultivation of natural freshwater wetlands on the floodplain. Mitigation measures proposed to address this issue comprised the measures already recommended as additional measures in this report – namely, the rehabilitation of the cane field wetlands in the north eastern corner of the floodplain, as well as the artificially excavated trench just upstream of the N2, to create a broad swathe of naturally vegetated wetland, as far as the estuarine channel, and the rehabilitation of a broad swathe of wetland, within the existing wetland in this area, that has been subject to long-term cultivation.

In conclusion, this report made the following recommendations regarding alternative selection:

- Seawater intake and brine discharge pipeline alternatives: Realignment of the preferred pipeline route, to run slightly more south in its reaches between the N2 and the crossing of watercourse 1, and with rehabilitation mitigation as outlined in this study;
- Site alternatives: (developer's) Preferred site providing the recommended mitigation is implemented (i.e. 25 m setback) or the Alternative site with impact mitigation and (strongly recommended) additional rehabilitation of a portion of the downstream cultivated wetland.

8.9 REFERENCES

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8.10 APPENDICES

8.10.1 Assessment methodologies: Freshwater ecosystem assessment

8.10.1.1 Wetland Conservation Importance

In order to provide a more specific guide to the relative conservation importance of individual wetland patches on the present site, a methodology developed by Ractliffe and Ewart-Smith (2002) was utilised. This methodology assigns low, medium and high conservation importance ratings to individual wetlands, on the basis of the following criteria (note that the highest category applicable to any wetland, based on any one criteria, is the one accorded the wetland as a whole):

- **Low conservation importance:**
  - does not provide ecologically or functionally significant wetland habitat, because of extremely small size or degree of degradation, and/or
  - of extremely limited importance as a corridor between systems that are themselves of low conservation importance.
- **Moderate conservation importance:**
  - provides ecologically significant wetland habitat (e.g. locally important wetland habitat types), and/or
  - fulfils some wetland functional roles within the catchment, and/or
  - acts as a corridor for fauna and/or flora between other wetlands or ecologically important habitat types, and/or
  - supports (or is likely to support) fauna or flora that are characteristic of the region and/or provides habitat to indigenous flora and fauna, and/or
  - is a degraded but threatened habitat type (e.g. seasonal wetlands), and/or
  - is degraded but has a high potential for rehabilitation, and/or
  - functions as a buffer area between terrestrial systems and more ecologically important wetland systems, and/or
  - is upstream of systems that are of high conservation importance.
- **High conservation importance:**
  - supports a high diversity of indigenous wetland species, and/or
  - supports, or is likely to support, red data species; supports relatively undisturbed wetland communities, and/or
  - forms an integral part of the habitat mosaic within a landscape, and/or
  - is representative of a regionally threatened / restricted habitat type, and/or
  - has a high functional importance (e.g. nutrient filtration; flood attenuation) in the catchment, and/or
  - is of a significant size (and therefore provide significant wetland habitat, albeit degraded or of low diversity).

8.10.1.2 Environmental Importance and Sensitivity (EIS) protocol for wetlands

The method used to assess the EIS of wetlands is a refinement of the DWAF Resource Directed Measures for Water Resources: Wetland Ecosystems method (DWAF, 1999b). It includes an assessment of ecological (e.g. presence of rare and endangered fauna / flora), functional (e.g. groundwater storage / recharge) and socio-economic criteria (e.g. human use of the wetland).

Scoring of these criteria then places the wetland in a Wetland Importance Class (A-D) (see Table 8-A1).

Table 8-A1
Wetland Importance Class integrating Ecological Importance and Sensitivity, and functional and socio-cultural importance modifiers.

Importance class (one or more attributes may apply)	Range of Median	Wetland Importance Class
Very high Representative of wetlands that: • support key populations of rare or endangered species; • have a high level of habitat and species richness; • have a high degree of taxonomic uniqueness and/or intolerant taxa; • provide unique habitat (e.g. salt marsh or ephemeral pan; physiognomic features, spawning or nursery environments); • is a crucial avifaunal migratory node (e.g. RAMSAR wetlands); • may provide hydraulic buffering and sediment retention for large to major rivers that originate largely outside of urban conurbations; • have groundwater recharge/discharge comprising a major component of the hydrological regime of the wetland; • are highly sensitive to changes in hydrology, patterns of inundation, discharge rates, water quality and/or disturbance; and • are of extreme importance for conservation, research or education.	>3 <=4	A
High Representative of wetlands that: • support populations of rare or endangered species, or fragments of such populations that are present in other similar and geographically-adjacent wetlands; • contain areas of habitat and species richness; • contain elements of taxonomic uniqueness and/or intolerant taxa; • contain habitat suitable for specific species (e.g. physiognomic features); • provide unique habitat (e.g. salt marsh or ephemeral pan; spawning or nursery environments, heronries); • may provide hydraulic buffering and sediment retention for rivers that originate largely outside of urban conurbations, or within residential fringes of urban areas; • have groundwater recharge/discharge comprising a component of the hydrological regime of the wetland; • may be sensitive to changes in hydrology, patterns of inundation, discharge rates, water quality and/or human disturbance; and • are important for conservation, research, education or eco-tourism.	> 2 <= 3	B
Moderate Representative of wetlands that: • contain small areas of habitat and species richness; • provide limited elements of habitat that has become fragmented by development (e.g. salt marsh, ephemeral pan; roosting sites and heronries);	>1 <= 2	C

Importance class (one or more attributes may apply)	Range of Median	Wetland Importance Class
• provide hydraulic buffering for rivers that originate in urban areas; • are moderately sensitive to changes in hydrology, patterns of inundation, discharge rates and/or human disturbance; • perform a moderate degree of water quality enhancement, but are insensitive to sustained eutrophication and/or pollution; and • are of importance for active and passive recreational activities.		
Low/marginal Representative of wetlands that: • contain large areas of coarse (reeds) wetland vegetation with minimal floral and faunal diversity; • have a high urban watershed:wetland area ratio; • are important for active and passive recreation; • provide moderate to high levels of hydraulic buffering; • may be eutrophic and generally insensitive to further nutrient loading; • are generally insensitive to changes in hydrology, patterns of inundation, discharge rates and/or human disturbance; • have regulated water; and • contain large quantities of accumulated organic and inorganic sediments.	>0 <= 1	D

8.10.1.3 Assessment of wetland condition

Wetland condition was assessed using the desk-top Present Ecological State (PES) methodology, adapted from DWAF (1999). The methodology is based on a comparison of current attributes of the wetland, which are scored against those of a desired baseline or reference condition, resulting in the assignment of a wetland to one of six PES categories, as defined in DWAF (1999) and described in Table 8-A2. The methodology is applicable to natural wetlands only.

Table 8- A2
Interpretation of PES score, using the DWAF (1999) methodology.

PES Score	Wetland Description	PES Category	Comment
> 4	Unmodified or approximates natural condition	A	Acceptable Condition
> 3 <=4	Largely natural with few modifications, minor loss of habitat	B	
> 2 <=3	Moderately modified with some loss of habitat	C	
= 2	Largely modified with loss of habitat and wetland functions	D	
> 0 < 2	Seriously modified with extensive loss of habitat and wetland function.	E	Unacceptable Condition
0	Critically modified. Losses of habitat and function are almost total, and the wetland has been modified completely.	F	