ENVIRONMENTAL IMPACT ASSESSMENT

Second Draft Environmental Impact Assessment Report for the Proposed Construction, Operation and Decommissioning of a Seawater Reverse Osmosis Plant and Associated Infrastructure in Tongaat, Kwazulu-Natal

SECOND DRAFT EIA REPORT

APPENDIX H:

Additional Information

APPENDIX H.1

MEETING WITH LANDOWNERS

UMGENI DESALALINATION PLANT DETAILED FEASIBILITY STUDY – TONGAAT SITE

Meeting with Landowners **05 June 2012**

Kevin Meier (KM) introduced UW and described the requirements for undertaking the desalination project going into detail the requirement for water and the options that are available including eMkomazi and Reuse. The site selection process was described and the reasons for identifying the site were made clear. It was also described how the Mdloti Site was originally considered optimal but after the due diligence exercise it was shown to be less than ideal. KM mentioned that a site covering the residents land could be feasible and that the project would be taken to a DFS if the residents were not strongly opposed to the project even though the outcome might mean a sub division of their property or the purchase of the entire property.

It was clearly stated that this was a detailed feasibility study and that the project might not ever go ahead. The infrastructure components were discussed in detail.

QUESTIONS AND CONCERNS:

1. How many hectares of land would be needed for the proposed project?
   7.5 to 10 ha

2. When is the project (Geo Tech study) likely to start?
   Within the next 3 months but landowners will be contacted before the study is undertaken. Water Quality monitoring would begin on the 07th June 2012 with the installation of a buoy with monitoring equipment. A bathymetry survey of the cost would also be undertaken soon.

3. Time frame of the project, i.e. feasibility study, design and implementation.
   If the project went to construction then the implementation date would probably be around 6 to 8 years

4. Land owners concerned about the value of the properties for future selling once the plant has been built.
   This concern is understood and the landowners will have to bring this up at the EIA. UW will respond to all concerns as part of the EIA and will put forward any required mitigation measures.

5. Impact of the noise during the construction and also after construction

There will be noise from large plant during construction. The entire construction process will last approximately 2 years. The design of the Desalination works will take noise of operation into consideration and the buildings will be designed to dampen out noise.

6. How will they be compensated as these are commercial gardens and they earn revenue?
   Landowners will be compensated based on a fair market value determined by an independent property evaluator. If the upper section of the land became un-usable because of the plant being constructed at the water source for the property then this would have to be assessed. It may then be necessary to make additional compensation or to buy the entire property and not just the section affected by the plant.

7. Should a permanent structure be built, will Umgeni Water be prepared to buy the land and also surrounding houses as they are sceptic of losing value to their houses.
   UW would definitely buy up the land on which the plant is positioned. If adjacent properties would be seriously affected then UW could purchase these properties or compensate or mitigate in some other way.

8. Will the municipality evaluate the land or an independent evaluator would be appointed?
   An independent evaluator would be used to value land.

9. Concern that the land was subdivided many generations ago and some of the land owners may not be living in the area.
   UW would have to trace the land owners. Residents mentioned that they are the new generation and that they are not held to the land by tradition etc. They would certainly consider selling if necessary and as long as the value offered was fair.

10. Concerned about the spring water in the area, is Umgeni Water going to create ponds for them in future?
    It may be possible to catch the spring water and pump it away from the plant to other areas although this could only be determined during the design phase of the project.

11. Would the public participation be conducted?
    A full EIA and public participation exercise would be undertaken.

12. Land owners are in support of the study but concerned with the reaction of the public suppose it is negative, what would then happen?
    Any negative reaction would have to be assessed on its merits and decisions to mitigate or other made at that stage. This would all become clear during the EIA.

CONTACT DETAILS

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MEETING WITH LAND OWNERS : PROPOSED FEASIBILITY STUDY FOR DESALLINATION PLANT
VENUE : SEABELLE RESTAURANT UMDLOTI: 18H00 : 05 JUNE 2012
ATTENDANCE REGISTER

NAME & SURNAME	PORTFOLIO	TELEPHONE NUMBER	SIGNATURE
1. I NAIDOO	PROPERTY OWNER	0796926044	[illegible] .naidoo.sandy@ymail.com
2. M. Abdulla	" "	0723785396	[illegible]
3. M. GOVENDER	" "	~~[illegible]~~ 0716790591	M. Govender
4. Haroshen Govender	Property representative	0735138889	[illegible]
5. R. ABDULLA	PROPERTY REPRESENTATIVE	0835092838	[illegible]
6. A. D. JEEAWON	" OWNER	082-2643510	[illegible]
7. A. Govender	Property Owner	0828770965	[illegible]
8. S. GOVENDER	PROPERTY OWNER	0828157269	[illegible]
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APPENDIX H.2

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KWAZULU-NATAL EAST COAST DESALINATION PLANTS

DETAILED FEASIBILITY STUDY

Report Number: 601.3.2/R02/2015

Final

Prepared for:

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Approval			
Author signature		Approver signature	
Name	Graham English	Name	
Title	Associate	Title	

UMGENI WATER **June 2015**

KWAZULU-NATAL EAST COAST DESALINATION DETAILED FEASIBILITY STUDY

DUE DILIGENCE ASSESSMENT REPORT

Umgeni Water Report No: 601.3.2/R02/2015

Prepared by Aurecon

....

M Killick *PrEng*

Approved for Umgeni Water Planning Services by:

....

K Meier *PrEng*

Manager: Planning Services

This report is to be referred in bibliographies as:

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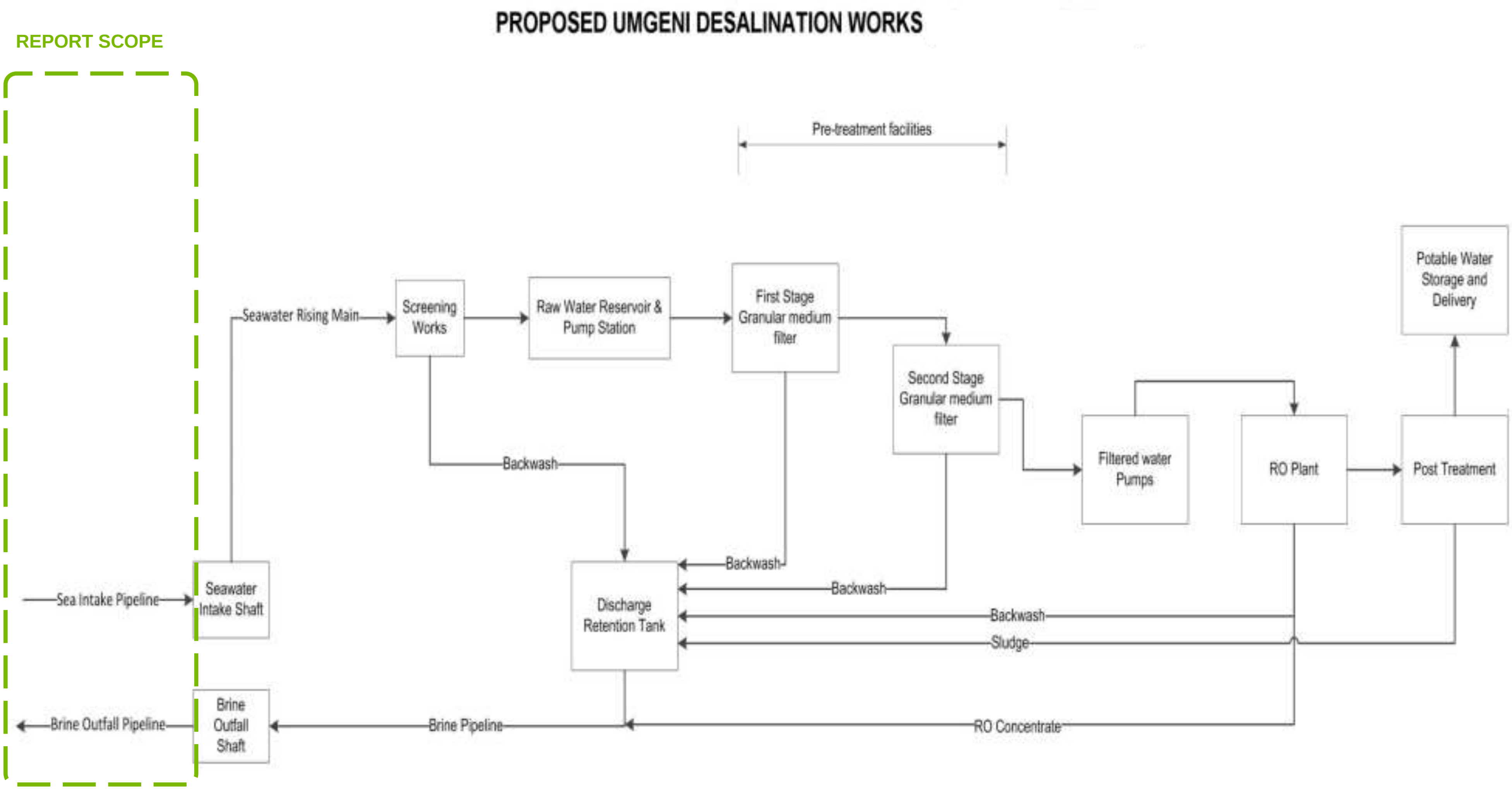
SCOPE OF THIS REPORT



CONTENTS

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APPENDICES

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LIST OF ABBREVIATIONS

CIP	Clean in Place
dia	diameter
DM	District Municipality
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
GRP	Glass-fibre Reinforced Pipes
HDPE	High Density Polyethylene
kPa	Kilopascal
KZN	KwaZulu-Natal
LM	Local Municipality
LTBWSS	Lower Thukela Bulk Water Supply Scheme
MSL	Mean Sea Level
Mℓ/d	Mega litres per day
Mm^3/a	Million cubic metres per annum
m^3/s	Cubic metres per second
NPV	Net Present Value
RO	Reverse Osmosis
SANS	South African National Standards
SCA	South Coast Augmentation
TBM	Tunnel Boring Machine
UW	Umgeni Water
WTW	Water Treatment Works
WWTW	Waste Water Treatment Works

1 INTRODUCTION

1.1 Project Background

The water requirements of the Kwazulu-Natal Coastal Metropolitan areas in the vicinity of Durban are growing rapidly. Approximately 92% (1072 Mλ/d) of the water provided by Umgeni Water (UW) to the six water services authorities it supplies is sourced from the Umgeni system. This system consists of an extensive network of pipelines, aqueducts, water treatment works and reservoirs, supplied from the Midmar, Albert Falls, Nagle and Inanda Dams in the Mgeni System, as well as from Hazelmere Dam on the Mdloti River. The Mooi-Mgeni transfer scheme supplements the supply to water in the upper Mgeni River (Midmar Dam).

The Reconciliation Strategy Study for the Kwazulu-Natal Metropolitan Coastal Areas indicates that even with further augmentation of the Mgeni System (including the implementation of Spring Grove Dam that is under construction) by an additional 137Mλ/day (50 million m^3/a), the supply of water in future will not be of an adequate assurance of supply. Phase 1 of the proposed Mkomazi Water Project is planned to secure an additional 326 Mλ/d (119 million m^3/a). This involves the potential development of Smithfield Dam located along the central reaches of the Mkomazi River, with a storage capacity of 137 million m^3 (137 000 Mλ).

UW has recognized the possibility of implementing desalination at a large scale as an alternative to the Mkomazi Water Project, and as a scheme which could be implemented fairly quickly, with opportunity for phasing of its implementation.

A pre-feasibility study undertaken by UW in 2010/11 (described in more detail in **Section 2** of this report) identified two potential sites along the KwaZulu-Natal coastline where the implementation of desalination at scale could be considered.

In December 2011 UW appointed Aurecon to undertake detailed feasibility studies of the two potential desalination plant sites, one at the Lovu River estuary, approximately 30km south of Durban and one at the Mdloti River Estuary, 30km north of Durban. Both potential schemes are to be investigated, each for possible potable water augmentation of the Mgeni System by 150 Mλ/d.

Figure 1-1 shows the location and extent of the proposed Mkomazi Water Project, of which Smithfield Dam would comprise Phase 1.

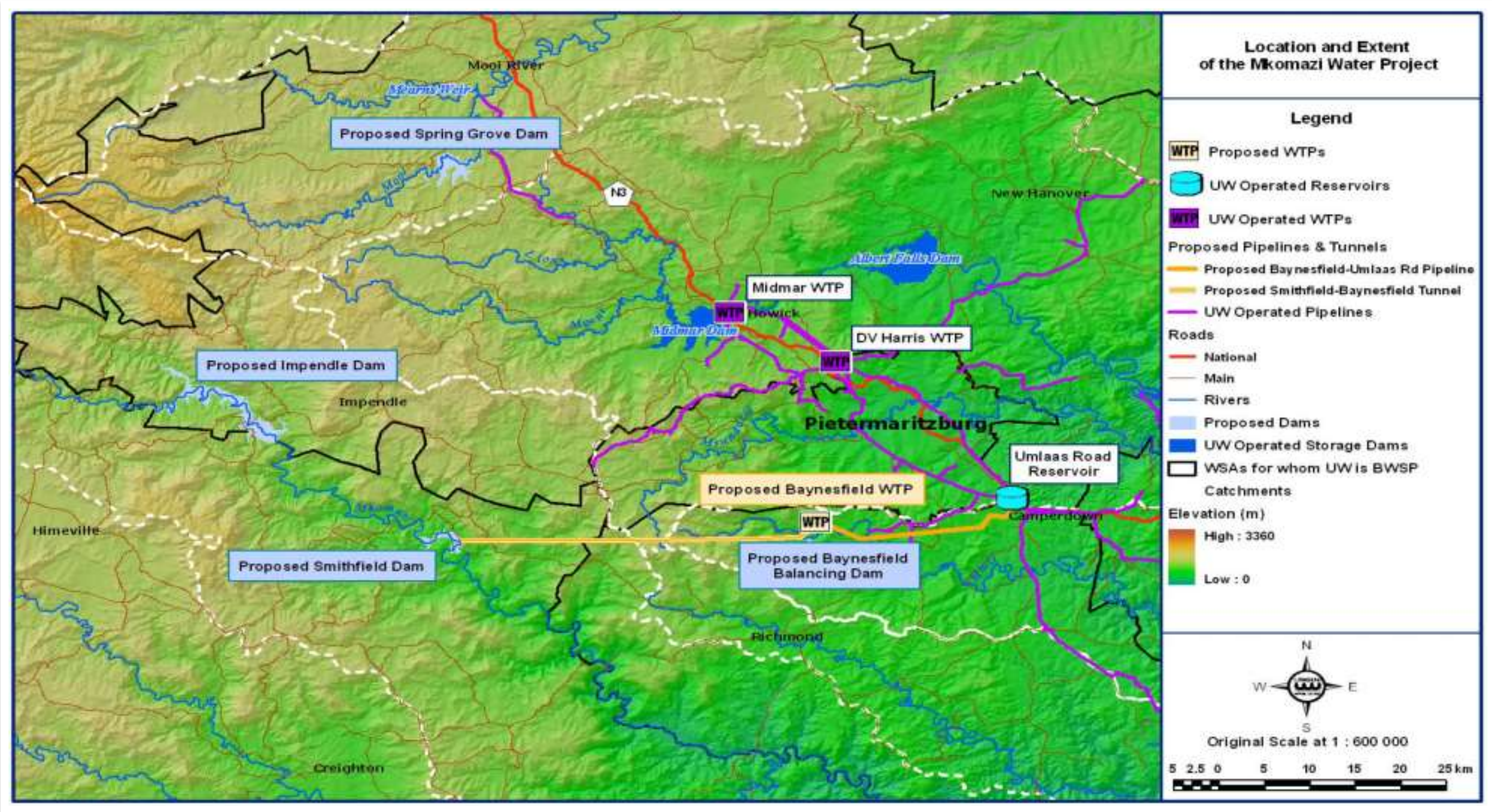


Figure 1-1 Location and Extent of the Mkomazi Water Project

1.2 Project Scope

The purpose of this project is to undertake a detailed feasibility study and preliminary design of all infrastructure required for potential desalination plants at both of the proposed sites, considering the optimum configuration, sizing, phasing, costing and design criteria. Each of the two proposed schemes will comprise the following main infrastructure components:

- A sea water intake and sea water pipeline
- A sea water pump station and rising main (pipeline, tunnel or both)
- A reverse osmosis desalination treatment plant of about 150Ml/d (product water)
- A brine return pipeline with possible energy recovery applications
- A brine diffuser system
- Freshwater (potable) pipelines to connect into existing bulk water infrastructure and high-lift pump stations
- High lift pump stations
- Power supply infrastructure

The study is being conducted in two phases, namely:

- Phase 1 – Due Diligence (this report)
- Phase 2 – Detailed Feasibility Study

The objective of the Due Diligence Phase is to assess the previously prioritised sites identified by UW and to report on their suitability (including alternative options) and viability for further investigation to feasibility level during Phase 2.

1.3 Study Area

The study area involves the Lovu (south) estuarine site, the Mdloti (north) estuarine site and an alternative (non-estuarine) northern site in close proximity to Mdloti, in the vicinity of Desainager near Tongaat. The introduction of this alternative non-estuarine site is described in **Section 6** of this report. Potable water users to be supplied from the two potential desalination plants include:

- Users reliant on the South Coast Augmentation (SCA) and South Coast pipeline, from the southern Lovu site.
- Users reliant on the planned Hazelmere bifurcation pipeline and/or the existing Waterloo reservoir, from the northern sites, either Mdloti or Tongaat.

The physical integration of these potential schemes into the existing system, taking cognisance of the ability to utilize the water is a key component of this study and is addressed in **Sections 4, 5 and 6** of this report.

Figure 1-2, Figure 1-3 and **Figure 1-4** show the general locality maps of the two estuarine areas, Lovu and Mdloti. The Tongaat site location, near Desainager can be seen on **Figure 1-4.**

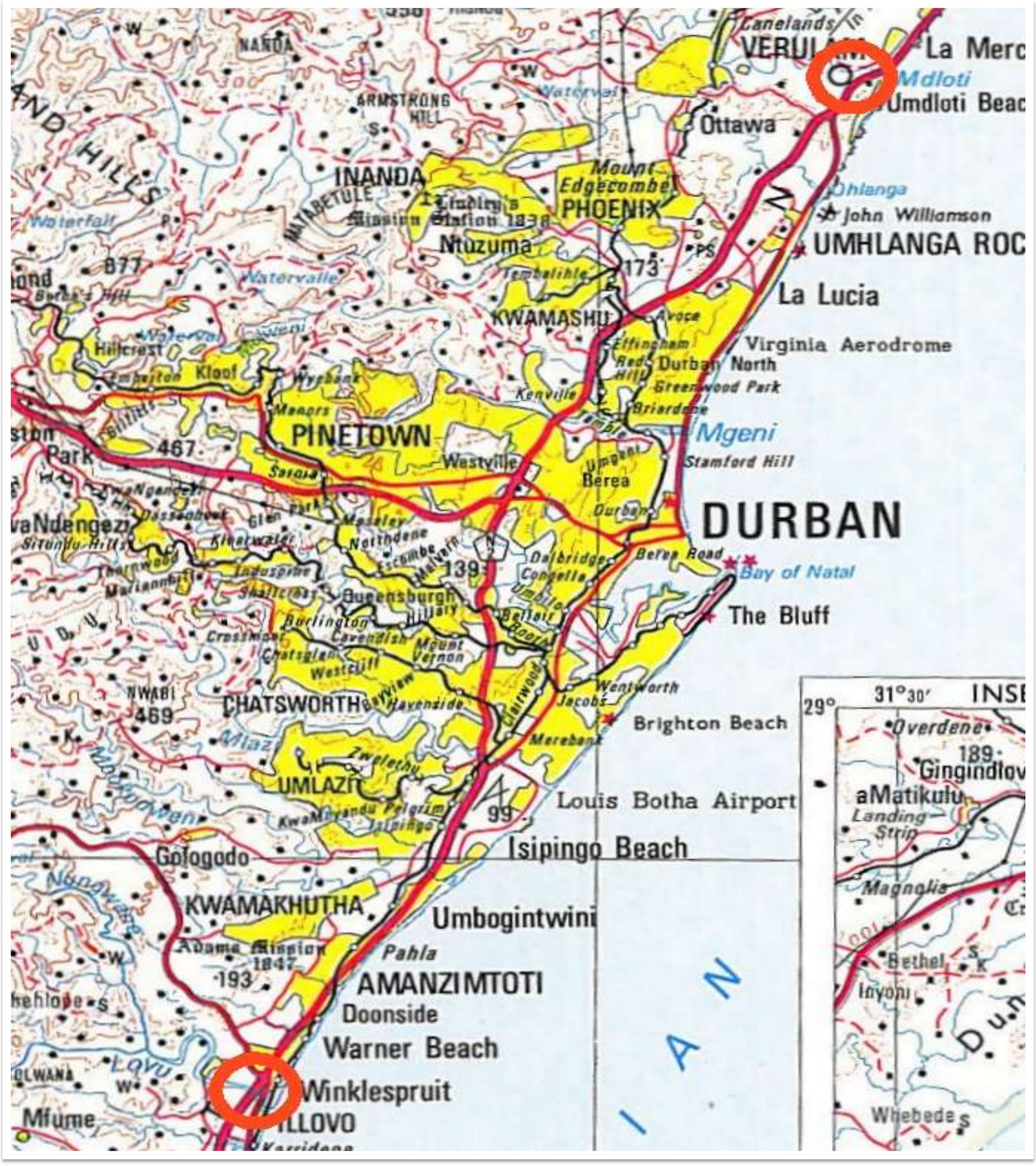


Figure 1-2: **Locality map of the two study areas**

Figure 1-3 Location of the Lovu Site

Figure 1-4 Location of the Mdloti and Tongaat Sites

Table 1-1 below provides the co-ordinates of the beaches in the proximity of each of the three sites.

Table 1-1 Co-ordinates of the beach at each of the three sites

SITE	LAT (D:M:S)	LONG (D:M:S)
Lovu Estuary Mouth	30º 06’ 46”	30º 51’ 14”
Mdloti Estuary Mouth	29º 39’ 02”	31º 07’ 44”
Tongaat Beach	29º 37’ 30”	31º 08’ 52”

2 OVERVIEW OF PREVIOUS DESALINATION INVESTIGATIONS

During 2010/2011 UW investigated eleven potential sites at which the possible implementation of desalination could be considered. **Figure 2-1** shows the approximate location of these sites in relation to one another and to the existing bulk water pipelines owned by UW and by eThekwini Municipality.

The report dated May 2011 and entitled "*East Coast Desalination Plant, Potential Sites Identification and Assessment"*, made use of GIS based information to evaluate the 11 sites and to arrive at recommended options that warranted further investigation. The **UW criteria** used to evaluate each site and to compare them were as follows:

- Plant elevation above sea-level – limited to 30m maximum.
- Plant distance from the sea – 3000m from coastline set as the limit.
- Distance from the shore to the sea intake – at most sites, 20m depth is reached within 1000m.
- Sea bed geology – no criteria could be set as detailed bathymetric survey would be required.
- Existing land-use – no development of desalination plants in or adjacent to extensively built-up urban areas.
- Position of Existing Bulk Water Infrastructure – one of the most important criteria considered. Conveyance capacity of existing infrastructure into the current system via eThekwini's or UW's bulk pipelines was considered.
- Position of Electrical Infrastructure – the existing bulk electricity supply lines were considered but spare capacity within them would need to be confirmed.
- Terrestrial Environmental Sensitivity – Ezemvelo KZN Wildlife's Index of Environmental Irreplaceability was taken into account.
- Estuaries – no permanent infrastructure footprints or permanent disturbance below the 5m contour within the estuarine environment.
- Environmental considerations in the ocean – the Ezemvelo KZN Wildlife's proposed Marine Biodiversity Protection Areas are to be avoided.
- Source Water Quality – Turbidity and Chlorophyll variability was considered as well as the location of existing marine outfalls that would impact on water quality.
- Product Water Quality Integration – product water quality and disinfection practices in the existing distribution system were evaluated for compatibility with the desalinated water.
- Sea Surface Temperature – increased water temperature is favourable due to reduced viscosity and more effective RO membrane performance resulting.

Other considerations also taken into account:

- Site Location Issues – the flooding potential, wave height and beach erosion of the intake pump station site and the desalination plant site were evaluated in order to assess the potential natural hazards that will need to be mitigated by appropriate design measures.
- Factors of anthropogenic nature such as wastewater and storm water discharges within 2 km of the intake location were identified and evaluated for potential impact on source water quality. Turbidity, temperature, chlorophyll and salinity profiles will be developed to identify the optimum location and depth of the plant intake.
- Underwater currents in the vicinity of the intakes – location, direction and velocity of underwater currents in the vicinity of the potential plant intake sites were studied to determine suitable position to avoid the conveyance and recirculation of concentrate (brine) discharge into the intake system.

The outcomes of the above assessment were that for potential desalination on the KZN north coast, the Mdloti and Tongaat sites appeared favourable. In the south, the Lovu site appeared favourable. At the time of the report, the option of tunnelling for the sea intake and brine outfalls had not been considered. The Tongaat site was viewed as less favourable than the Mdloti site and on that basis, UW called for tenders from service providers to undertake feasibility studies for the Mdloti and Lovu sites only.

Figure 2-1 The Eleven Sites Assessed by Umgeni Water

3 DUE DILIGENCE CONSIDERATIONS

3.1 Site Visits

The Lovu and Mdloti sites were visited on 6 and 7 February 2012 (see **Figure 3-1** and **Figure 3-2**) at which representatives from UW, DWA, eThekwini Municipality and the Study Team were present, including the following specialists:

- Water Quality Monitoring
- Geotechnical
- Desalination Infrastructure
- Pipelines and Pump stations
- Marine Biology
- Marine and Coastal Structures

Figure 3-1 Lovu Site Visit

Figure 3-2 Mdloti Site Visit

Shortly after these initial site visits it became apparent that the potential estuarine impacts, particularly at Mdloti (described in **Section 5.8**) warranted the further investigation of a possible alternative option for a northern site. The sites initially identified by UW were again considered and the non-estuarine Tongaat site near Daisenager was considered to be the next best alternative for the northern area, warranting closer investigation as part of an extended due diligence phase. Furthermore, it was also recognized that the following additional specialist screening investigations (not part of the original proposal) were necessary, at all 3 sites in order to support a comparable and defendable evaluation:

- Botanical Impact Screening Assessment
- Social Impact Screening Assessment
- Estuarine Impact Screening Assessment

Consequently on 2 April 2012, the Study Technical Leader accompanied the additional Botanical, Social and Estuaries specialists on a visit to the Tongaat site (see **Figure 3-3**) and revisited the Lovu and Mdloti sites to ensure that all 3 potential locations were equitably assessed. A separate visit to Tongaat was undertaken by the Geotechnical specialist in early May 2012 to identify the likely geological and geotechnical considerations.

Figure 3-3 Tongaat Site Visit

The general findings of each of the three site visits are enclosed in Appendices A (Mdloti and Lovu) and B (Tongaat). The individual specialist reports and site related technical notes covering the following aspects are provided in Appendices as follows:

- Geotechnical Inspections and Comments - **Appendix C**
- Marine Biological Screening Assessment - **Appendix D**
- Botanical Screening Assessment - **Appendix E**
- Social Screening Assessment - **Appendix F**
- Notes on experience gained at Adelaide Desalination Plant - **Appendix G**
- Notes on potential energy recovery from brine return flow - **Appendix H**
- Notes on Alternative tunnelling possibilities - **Appendix I**
- Notes on Sizing and Integration of the Lovu Desalination Plant - **Appendix J**
- Details of Indicative Cost Estimates for Desalination Implementation - **Appendix K**
- A1 Layouts of the Three Desalination Sites - **Appendix L**

A summary of the key findings and recommendations contained in each of the above documents is included under the subsequent chapters herein.

3.2 Elevation as a Criterion

During the site investigations at Mdloti, it was recognized that if potential desalination sites at elevations higher than the 30m criterion (used by UW in their initial assessments) were considered, additional potential locations may be feasible. The Adelaide desalination plant in Australia is located at an elevation of 60m, which results in an effective surplus head of some 47m. This surplus head in the brine return flow is utilized to generate electricity through energy recovery equipment. A preliminary economic analysis at Mdloti was undertaken to determine whether the value of energy that could be recovered from the brine would be sufficient to offset the higher sea water pumping costs, plus the additional capital costs of turbines and associated infrastructure. The details of this analysis are presented in **Appendix H**. Elevated sites (35 and 55m) at Mdloti were considered and compared to a potential site at 10m elevation.

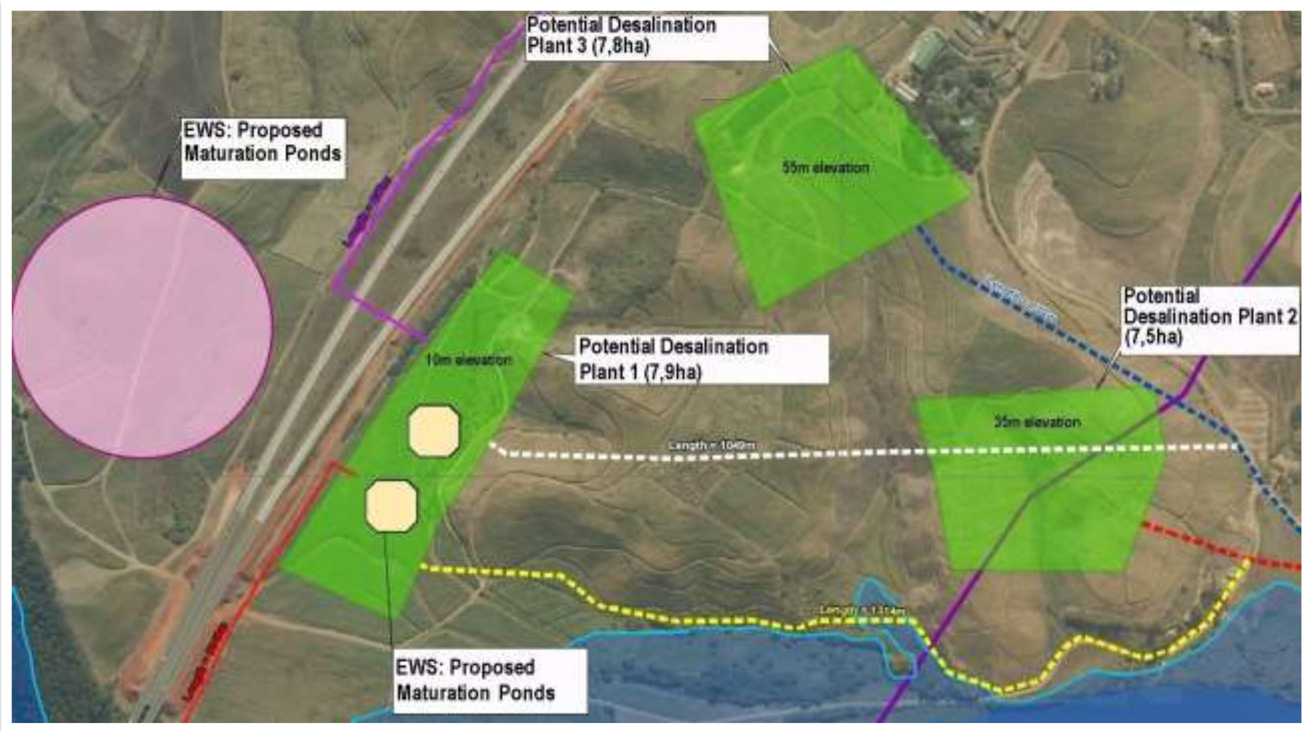


Figure 3-4 Mdloti Sites with Elevated Options

The following factors were taken into account when comparing the marginal cost impacts associated with considering the elevated sites:

- Elevation marginal costs up to 55m
- The future price of electricity
- The economics of sea water intake and brine return pipelines
- The opportunity for energy recovery (power generation) and additional equipment needed for power generation
- The reduced fresh water pumping conveyance costs associated with the desalination plant being at a higher elevation.

In summary, it was found that with energy recovery at Mdloti, and after making allowance for the cost of a 150 Mλ/d desalination plant and its electricity requirements, the Unit Reference Value (URV) of the scheme located at 55m elevation (R7,43/m^3) is less than 3% more than a scheme at 10m elevation (R7,22/m^3 - refer to **Appendix H** for details). Therefore the recommendation is that the siting of the desalination plant should not be limited to elevations below 30m as was originally used as a criterion by UW in their initial investigations. **Figure 3-5** shows the location of one of the three desalination plant sites assessed at Mdloti, namely the Plant 2 site shown in **Figure 3-4** which is situated at an elevation of about 35m.

Figure 3-5 View from 35m elevation site to Mdloti beach

3.3 Marine Environmental Considerations

3.3.1 Marine Biodiversity Focus Areas

In January 2012, Ezemvelo KZN Wildlife published a report identifying targeted additional areas for marine biodiversity in Kwazulu-Natal. This forms part of the KZN Marine Systematic Conservation Plan which aims to provide a framework for assessment of biodiversity areas and spatially identifying priorities for marine conservation efforts.

Figure 3-6 shows the location of the closest biodiversity area to the proposed Lovu desalination site. This biodiversity area includes the Aliwal Shoal. The brine discharge from the potential desalination scheme would, however, be some 10km north of the biodiversity area boundary. No significant impact on the focus area is anticipated. However, the EIA would need to obtain specialist input to assess the hydrodynamic modelling of the desalination plant discharge in terms of dilution, taking the current effects into account.

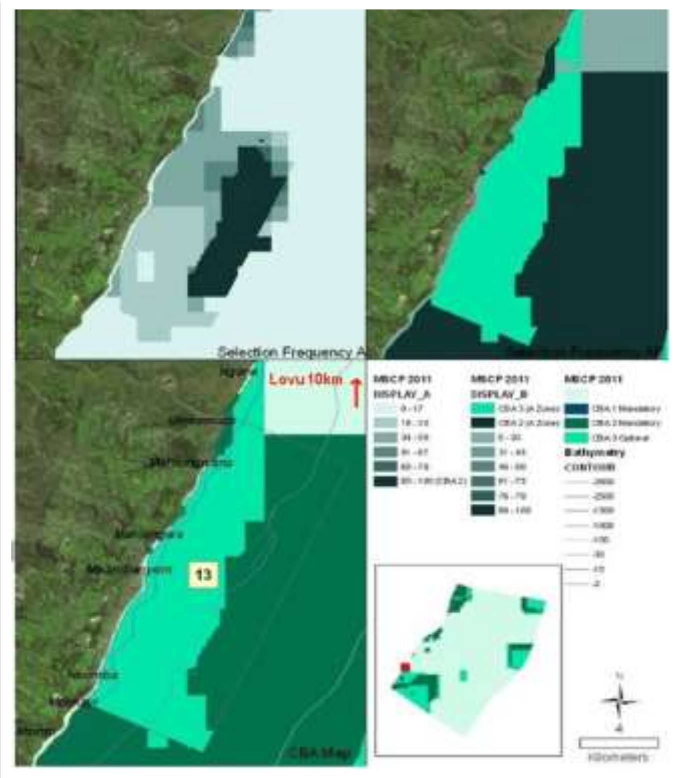


Figure 3-6 Marine biodiversity area (Aliwal Shoal)

Figure 3-7 shows that the closest biodiversity area to the Mdloti site is about 6 to 7 km away. Strong currents would aid dispersion and dilution of the brine. The EIA would need to assess the impacts on offshore biozones and pelagic fish species as well as the impacts of the inlet and outfall infrastructure construction.

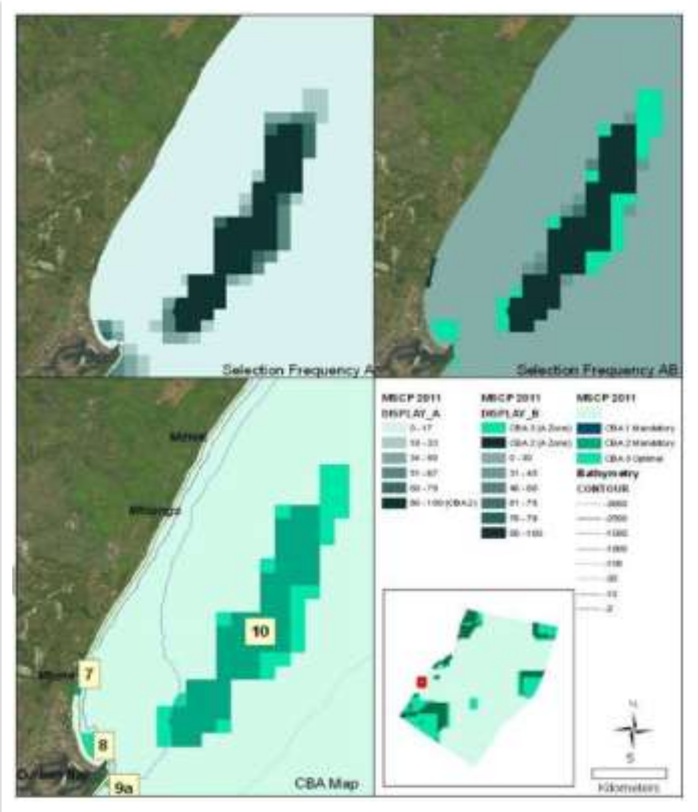


Figure 3-7 Marine biodiversity area (Mdloti)

3.3.2 Anticipated Marine Environmental Impacts

The potential impacts associated with the construction of the feed-water intake and brine discharge structures in the marine environment are related to:

- Onshore construction (human activity, air, noise and vibration pollution, dust, blasting and pile driving, disturbance of coastal flora and fauna and other users of the coastal environment);
- Construction and installation of offshore pipeline intakes, inlet structure and discharge dilution diffuser systems (construction site, pipe lay-down areas, and trenching in the marine environment, vehicular traffic on the beach and consequent disturbance of intertidal and subtidal biota).

The RO Plants including the pump stations would be constructed a set-back distance from the existing estuary and shorelines, respectively. Consequently, issues associated with the location of the plants and pump stations, and the associated pipelines leading to and from these constructions are not dealt with here. Infrastructure extending into the sea will potentially impact on intertidal and shallow subtidal biota during the construction phase in the following ways:

- Temporary loss of benthic habitat and associated communities due to preparation of the seabed for buried pipeline laying and associated activities (e.g. jetties);
- Possible temporary short-term impacts on habitat health due to turbidity generated during construction;
- Temporary disturbance of marine biota, particularly marine mammals and turtles, due to construction activities (blasting and pile driving, jetty construction);
- Interruption of longshore sediment movement by sheet piling and jetty structure resulting in increased erosion and/or accretion around the construction site; and

- Possible impacts to marine water quality and sediments through hydrocarbon pollution by marine construction infrastructure and plant, which could in turn lead to impacts upon marine flora, fauna and habitat.

The Lovu, Mdloti and Tongaat site beaches are shown in **Figure 3-8, Figure 3-9** and **Figure 3-10** respectively.

Figure 3-8 Lovu Beach

Figure 3-9 Mdloti Beach

Figure 3-10 Tongaat Beach

The key issues related to the presence of pipeline infrastructure and brine discharges into the marine environment during plant operation are:

- Altered flows at the intake and discharge resulting in ecological impacts (e.g. entrainment and impingement on biota at the intake, flow distortion/changes at the discharge, and effects on natural sediment dynamics);
- The pipelines and intake and discharge do not have an impact on the sediment dynamics, other than a short term temporary impact during construction;
- Potential for habitat health impacts/losses resulting from elevated salinity in the vicinity of the brine discharge for a radius of about 50m around each diffuser.
- Biocidal action of any residual chlorine in the effluent. It should be noted that chlorine is typically not discharged with the concentrate. It is removed by sodium bisulfite and as such is unlikely to be discharged.
- The effects of co-discharged constituents in the waste-water. As different chemicals are suited for different types of membranes, exact specifications for some of the additives (e.g. the antiscalant and membrane clean in place (CIP) chemicals) will only be known once the RO plant operator has been appointed, the membrane type decided on and source water quality is well characterized. Manufacturers of RO membranes will provide relevant information in product manuals and are likely to offer consultation with regard to pre-treatment and CIP chemicals.
- The removal of particulate matter from the water column where it is a significant food source, as well as changes in phytoplankton production due to changes in nutrients, reduction in light, water column structure and mixing processes; and

- Direct changes in dissolved oxygen content due to the difference between the ambient dissolved oxygen (DO) concentrations and those in the discharged effluent, and indirect changes in dissolved oxygen content of the water column and sediments due to changes in phytoplankton production as a result of nutrient input. It should be noted that typically RO desalination plants only increase the DO concentration in the plant discharge as a result of source water aeration during backwash. RO membranes do not remove (reject) gases, including dissolved oxygen. DO of the plant discharge could only be impacted when the feed water is treated with sodium bisulfite to remove residual chlorine. Since sodium bisulfite is reducing chemical, if overdozed it will not only consume residual chlorine in the source water but also consume some of the oxygen contained in the source water.

3.3.3 General Oceanographic Features of the Local Coastline

The general marine and oceanographic features of this area are influenced by the South-westerly flowing Agulhas current which flows generally along the Kwa-Zulu Natal coast and at velocities of between 1-2 m/s. The core of the Agulhas current is typically located just offshore from the continental shelf in water depths of 100 m (see **Figure 3-11**).

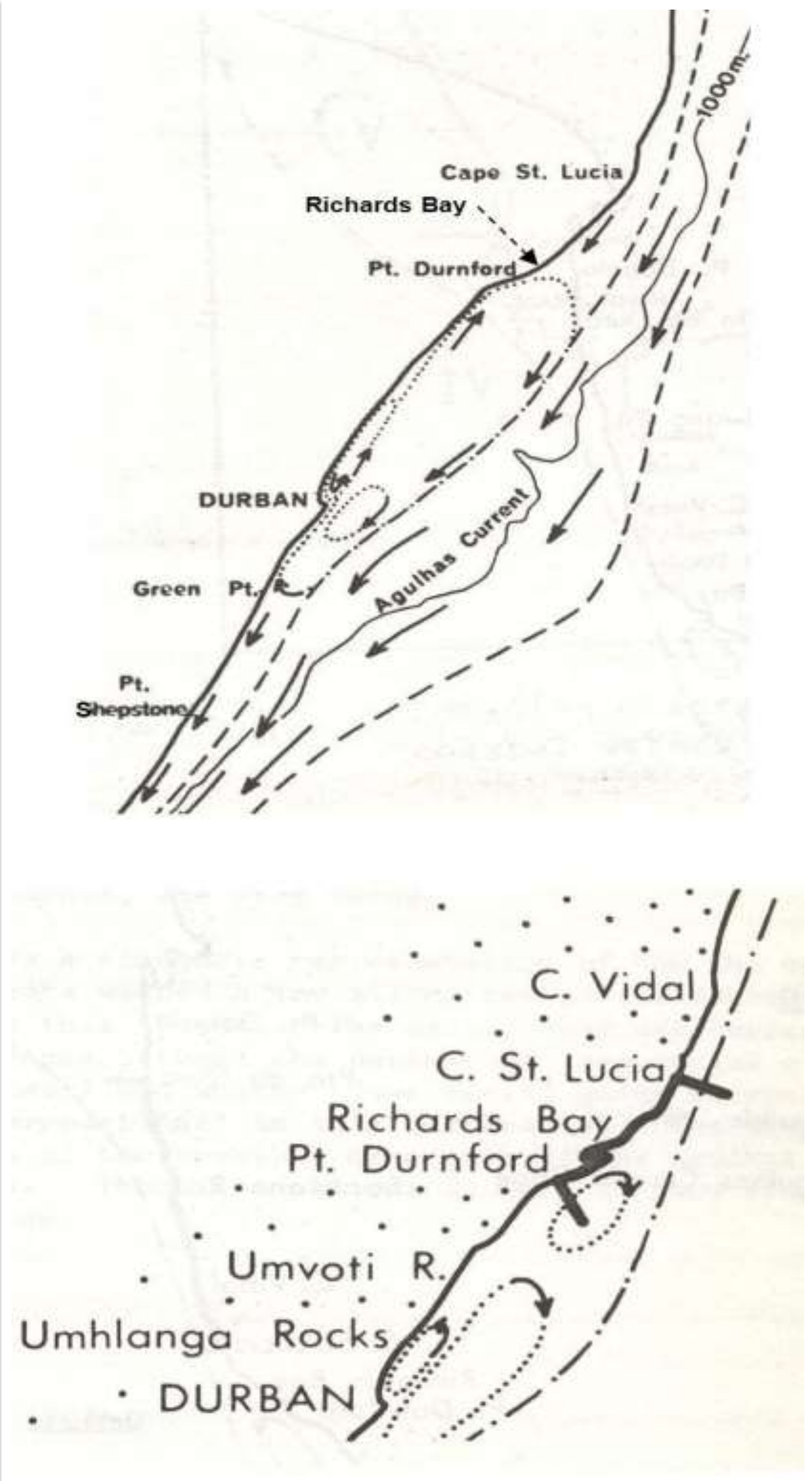
Gyres/eddies are typically formed in the shallower waters, between Richards Bay and south of Durban, and where the coastline and the mean path of the Agulhas current diverge, often resulting in counter directional along-shore flow (opposite to that of the Agulhas current).

At the proposed intake and discharge sites, the intakes will be located between 550 and 800m offshore and will therefore negate the potential negative impacts of these currents on the water quality. The brine diffusers would be at a distance of between 400 and 600m offshore and downstream of the intake structures such that the underwater currents convey the discharge away from the intake structure. The currents at these locations are anticipated to be flowing at velocities of between 0,2 and 0,3 m/s, and with a maximum of about 0,6 m/s. It should be noted that such current velocities are typically adequate to install wedgewire screens instead of conventional intake structures and this will be further investigated in Phase 2. The nearshore currents are alongshore (both South-westerly and North-easterly) for about 70 % of the time, with about 15 % onshore currents and 15 % offshore currents

Pipelines crossing the surf zone are normally buried to protect the pipeline from large forces induced by breaking waves, to limit the degradation of the pipeline material, to prevent vandalism and for aesthetic reasons. Natural seasonal variations in the beach and seabed level affect the burial depth of the pipeline through the surf zone. In order to determine the burial depth, it is necessary to know the vertical profile variations along the pipeline route. Based on measurements of beach and nearshore profiles, most of the significant profile changes occur at water depths up to 9 m, with virtually no changes beyond 12 to 15 m. The maximum profile variations range from 3 to 4,2 m. This means that the maximum burial depth for the pipeline within the beach area should then also be some 3 to 4 m.

It is anticipated that the trenching requirements for the invert of the pump station sumps is likely to be at -5 to -6 MSL and is based on the requirement that the sump at the pump station shall be deep enough to allow for gravitational inflow of the seawater into the sump.

The site visit and subsequent reviews indicate that no significant beach erosion occurs in the vicinity of the intake sites. The sites are exposed to a reasonable high wave action and potential flooding.



TYPICAL CURRENT PATTERNS ALONG THE KWAZULU-NATAL COAST (HARRIS, 1978)

Figure 3-11 General oceanographic Features

3.3.4 Location of Existing Marine Outfalls

Figure 3-12 shows the relative locations of existing marine outfalls in the region and **Figure 3-13** provides a summary of the discharge volumes.

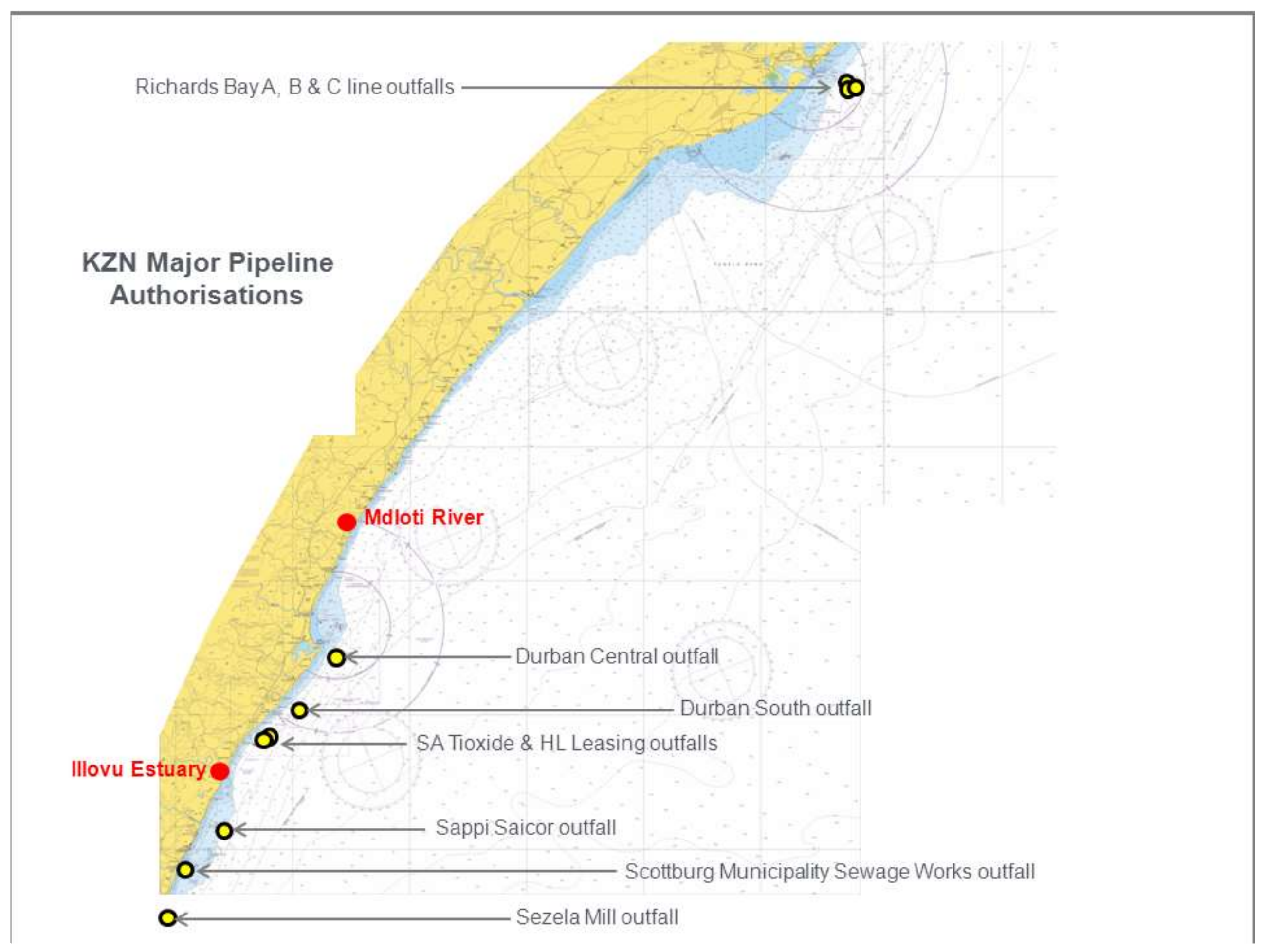


Figure 3-12 Location of Marine Outfalls

It should be noted that these existing waste discharge outfalls located in the vicinity of the desalination plant intakes are typically substantially longer (up to 6,5km) than those proposed for brine disposal and are discharging significantly more aggressive effluent waste than the brine that would be discharged from the proposed desalination sites (at distances of up to 600m). Such outfalls are designed to take advantage of the mixing provided of the currents that naturally occur at this distance. The natural currents would carry the waste discharges away from the desalination plant intake and prevent impacts on desalination plant water quality. The sewage and industrial effluent discharged through these outfalls requires significantly higher dilutions in order to render these environmentally harmless, which in turn can be achieved only with longer pipelines discharging in deeper water. All other existing outfalls are sufficiently far removed from the proposed desalination seawater intake locations, so that no cross contamination of the intake water will be possible.

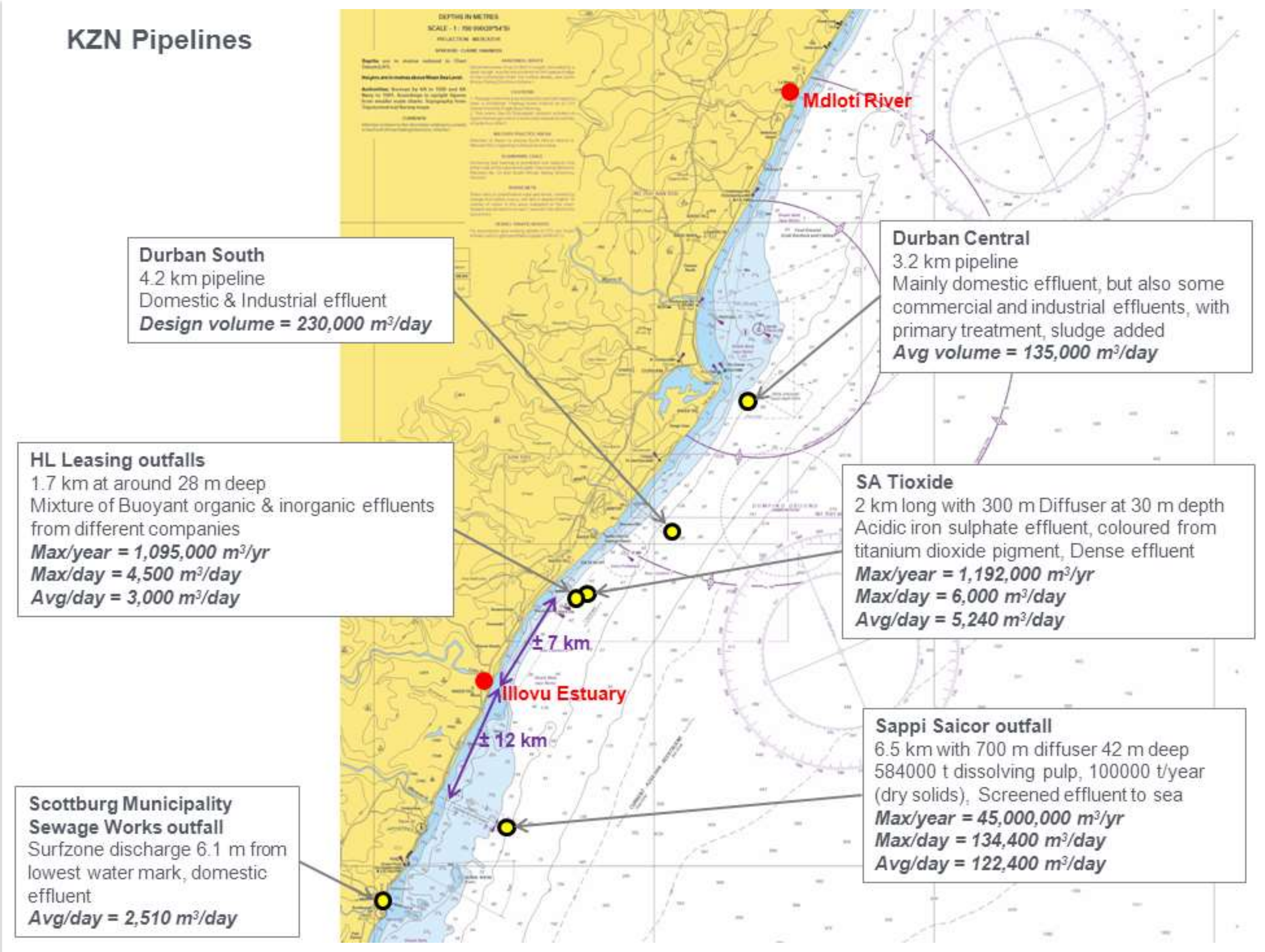


Figure 3-13 Discharge Details

3.3.5 Typical Sea Water Intake and Brine Discharge Infrastructure

The targeted water depth for the location of the sea water intakes would be at about 15m. This would be dependent on the water quality characteristics which will be determined during the sea water monitoring program to be undertaken in Phase 2 of this study. The methodology and parameter selection for the water quality monitoring have been compiled in a water quality monitoring program report which will be finalised in July 2012.

The offshore lengths of the intake pipelines would be between 550m and 800m, to achieve a depth of about 15m. The intake would consist of coarse screens at mid-water depth with an inflow velocity of about 0,15m/s. The intake at mid-depth will ensure that both the ingress of marine sediment as well as the ingress of any floating matter will be avoided as much as possible. The low intake velocity must ensure that the ingress of fish and other marine organisms is minimized. The brine discharge would be at depths of about 8-10m, with the pipelines being about 300m shorter than those of the intake pipelines. This would be necessary in order to ensure adequate dilution and to avoid short-circuiting of higher salinity concentrations at the intake system. **Figure 3-14** shows a typical intake arrangement in schematic format.

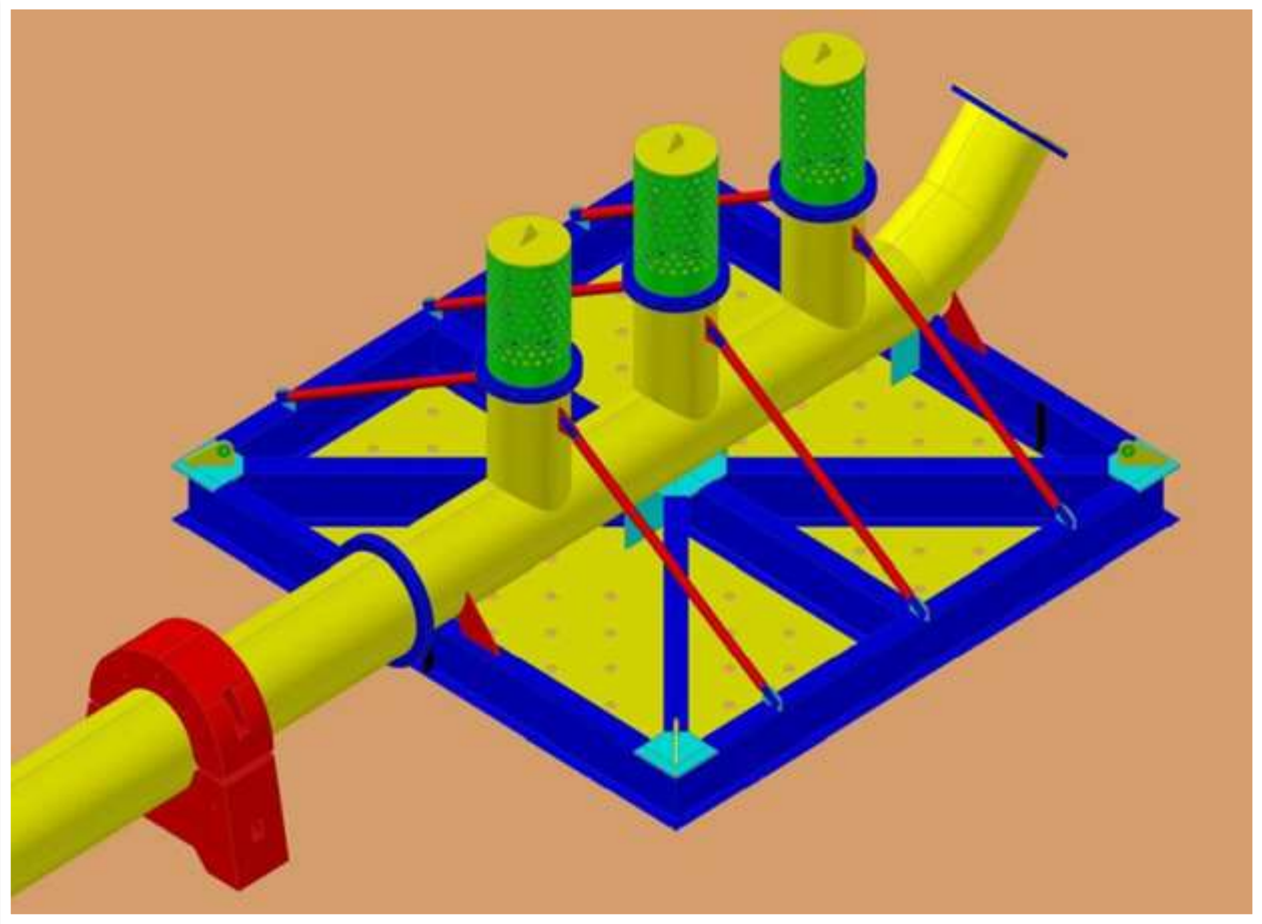


Figure 3-14 Typical Intake Arrangement

At this stage it is anticipated that the intake pipeline would be of a diameter of about 2,2m, or alternatively two smaller parallel intakes of 1,5m diameter each. The brine return pipeline would be of about 1,5m diameter. The pipe material is likely to be HDPE, GRP or steel, depending on the selected method of installation at each site. The conventional approach to installation would be a buried pipeline through the surf zone, and thereafter laid (and adequately anchored) directly onto the sea bed. At both the Tongaat and Mdloti sites, rock outcrops on the beach and within the surf zone are evident. In such cases offshore rock removal (via blasting or other methods) is likely to be necessary. The pipeline burial would require the construction of a temporary jetty. Tunnelling is an alternative, either for partial distance or throughout, i.e. from the desalination plant right the way through to the off-shore intake.

3.3.6 Wave and Tide Survey

At this due diligence stage effort has not been expended on wave and tide survey. The waves in this study area are typically very similar throughout the stretch. However, during Phase 2 (Feasibility Study) significant attention will be required in considering the both wave and current forces in the design of the intake structures and for the pipeline stability. This will be done using the design standards (Det Norske Veritas), which are normally used for this purpose. They are based on 1 in 100 year recurrence intervals for waves.

3.3.7 Geotechnical

The original ToR allowed for a degree of geotechnical investigation during the Due Diligence Phase (limited DCP tests and core drilling). However, once the study commenced, agreement was reached with UW that the investment in core drilling and DCP testing would best be made during Phase 2 (Feasibility Study), once the preferred desalination sites have been identified, and once pipeline / tunnel alignment options have been refined. Local geotechnical knowledge within the Study Team and use of existing geotechnical information from local bridge and syphon designs were considered more than adequate for due diligence assessment. At the commencement of Phase 2, an approach to the detailed geotechnical investigations will be developed and proposed to UW.

3.3.8 Mini-tunnelling

Mini-tunnelling is currently being undertaken in the Durban Point area. In May 2012, the study team and UW visited the site to obtain an understanding of the tunnelling operation and its method. It was mentioned by the contractor that the Tunnel Boring Machine (TBM) being used can be conducted through a range of material, from concrete to hard rock to sedimentary material but could not be used through steel or wood. **Figure 3-15** shows a schematic of the mini-tunnelling approach.

Figure 3-15 Mini-Tunnelling Approach

Two pits or more are required, a starting or launching pit and one or more receiving pits (depending on the length to be tunnelled). A platform and jacking station drives the TBM forward while the cutting head rotates and cut material is removed via a pumped slurry. The slurry is settled in receiving tanks, and the water returned to the cutting head for re-use. The settled solids are removed. Once the TBM has advanced about 2,5m, a concrete (HDPE lined) pipe section (see **Figure 3-16**) is placed behind the TBM and jacked forward. This process continues incrementally as the drilling progresses and the pipe is jacked forward into the bored tunnel. Once the receiving pit is reached, the TBM can either be lifted out of a constructed shaft or caisson, or alternatively is not recovered.

Figure 3-16 Typical Pipe Segments for Jacking at Durban Port Mini-Tunnelling

At the Durban Port, tunnelling progress of 19mm per minute is anticipated which if achieved would take 9 days to complete 220m. This is a 1,5m diameter TBM bored tunnel with a 1.2m diameter pipe. A thin bentonite slurry is being used to lubricate the space between the pipe outer wall and the drilled hole. The TBM can be steered through large radius bends only (1000m in this case). Each jacked segment of pipe is separated by a 4cm thick timber ring to distribute pressure and prevent possible cracking. The pipe sections are coupled by means of steel bands and rubber rings are used to ensure water tight connections.

Significant advantage could be created through the use of two separate seawater intake tunnels. Maintenance of one could be undertaken whilst still operating the other. Also the positions of the two intakes need not be at the exactly same location, also adding flexibility to the intake positions relative to the positions of the brine diffusers. Under conventional pipeline construction, parallel pipelines are essential as they would all be laid from the same temporary jetty.

Other tunnelling possibilities (over and above mini-tunnelling) will be considered in Phase 2 as well as comparative costs estimates.

3.3.9 Power Supply Considerations

The extent of energy required for schemes of this size would have to be sourced from Eskom's national grid as there are no current local independent power producers (IPP's) such as sugar mills, wind farms or solar option's that could supply the amount energy required. During Phase 2, attention will be paid to identifying any prospective IPP's that may have intention of establishing within the region. The total energy demand for a 150 Ml/d reverse osmosis desalination plant would be in the order of 25 MW (about 4kWh/m^3 of fresh water produced). Eskom's planning section has indicated that there are adequate reserves on the national grid to accommodate two RO desalination plants, requiring around 50 MW in total.

A possible scenario is that UW would enter into a service level agreement with each of the local area supplier's for power supply as both sites identified fall with in different municipal areas.

The conventional approach would be that Eskom would build the required electrical infrastructure (HV Lines and Substations) but that could have unattractive time implications as well as the likelihood that all costs for building the required services will be passed onto the client. To accelerate the process and possibly lower the cost, a self-build option could be considered but the implementation would need to be according to Eskom specifications.

3.3.10 Anticipated Terrestrial Environmental Impacts

The project team has investigated the three potential desalination plant locations (Lovu, Mdloti and Tongaat) during the site visits to determine whether these sites have specific features that may result in significant environmental impacts during project construction and operation phases. The initial review of the sites for the intake pump station and the RO system indicates that there are no endangered species leaving on these sites and the sites are free from surface contamination and debris.

3.3.11 Site Specific Overviews

In the Chapters which follow, a more site-specific overview of each of the three potential desalination sites is provided, culminating in recommendations and conclusions towards Phase 2 (Feasibility Study) of this project.

4 THE LOVU SITE : SITE-SPECIFIC CONSIDERATIONS

The following aspects that are site-specific to the Lovu site are summarised in this chapter:

- Intake and Outfall Considerations
- Sea Water Pump station Location
- Pipeline Routes and Potential Desalination Sites
- Integration Opportunities (into existing infrastructure)
- Flood Risk Assessment
- Geotechnical Considerations
- Botanical Considerations
- Estuarine Considerations
- Social Considerations

Appendix L contains an A1 plot of the overall Lovu scheme showing the infrastructure locations, footprint areas and proposed alignments.

4.1 Intake and Outfall Considerations

During Phase 2 of this study, a detailed marine and hydrographical survey will be undertaken at the sites selected for further investigation to feasibility level. In the interim, use has been made of available Admiralty Charts to gain an indication of the approximate ocean water depth profiles in the vicinity of the sites. **Figure** 4-1 shows that at a distance of about 1km offshore (from the Lovu site), water depths in the order of 20m can be achieved.

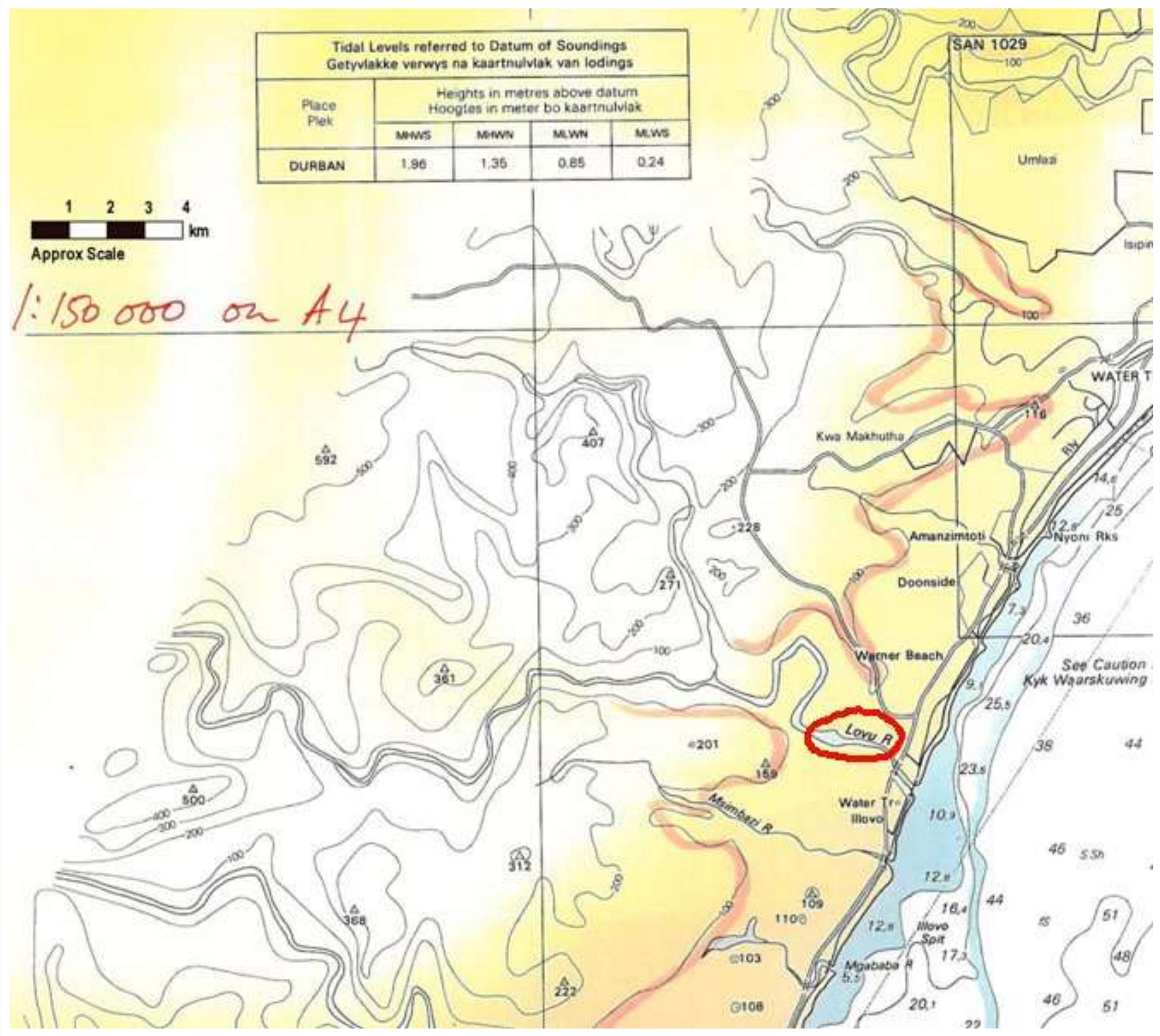


Figure 4-1 **Admiralty Chart for Lovu Site**

Figure 4-2 shows the anticipated alignment of the Lovu intake structure, intake pipeline and proposed raw water pump station location which was amended to a site at the corner of the existing roads so as to minimise botanical impacts. The approximate length of the pipeline to reach a water depth of about 15m is estimated to be about 800m. The brine diffuser would be located in about 8-10m water depth at around 300m from the intake (i.e. at 500m offshore). There are no visible rock outcrops on the beach in the immediate vicinity of the proposed beach crossing, however, there are rock outcrops north and south of the site. The pump station would be located in a disturbed dune area, in close proximity to the beach (see **Figure 4-3**).

The beach itself might pose some challenges as there is limited workspace for conventional pipe laying methods. It is anticipated that the pump station sump invert would be at a depth of about -6 MSL.

Figure 4-2 Lovu Intake and Pump station Locations

Figure 4-3 Lovu Pump station Site at corner existing roads

4.2 Pipeline Routes and Potential Desalination Plant Sites

Figure 4-4 shows the location of the only feasible desalination plant site at Lovu, as well as the potential pipeline alignments from the sea water pump station to that site. Whilst other sites for the desalination plant were considered, one of these fell within the 5m contour (shown in **blue shaded** are), a criteria that cannot be accepted from an estuarine perspective), and would be adversely exposed to flooding. Another potential elevated site that was considered would have unacceptable social impacts within a very densely developed, upmarket urban area. The elevated site has not been further considered in this due diligence task as it would entail a more difficult crossing of the estuary and is remote from existing infrastructure shown on the layout drawing enclosed in **Appendix L**.

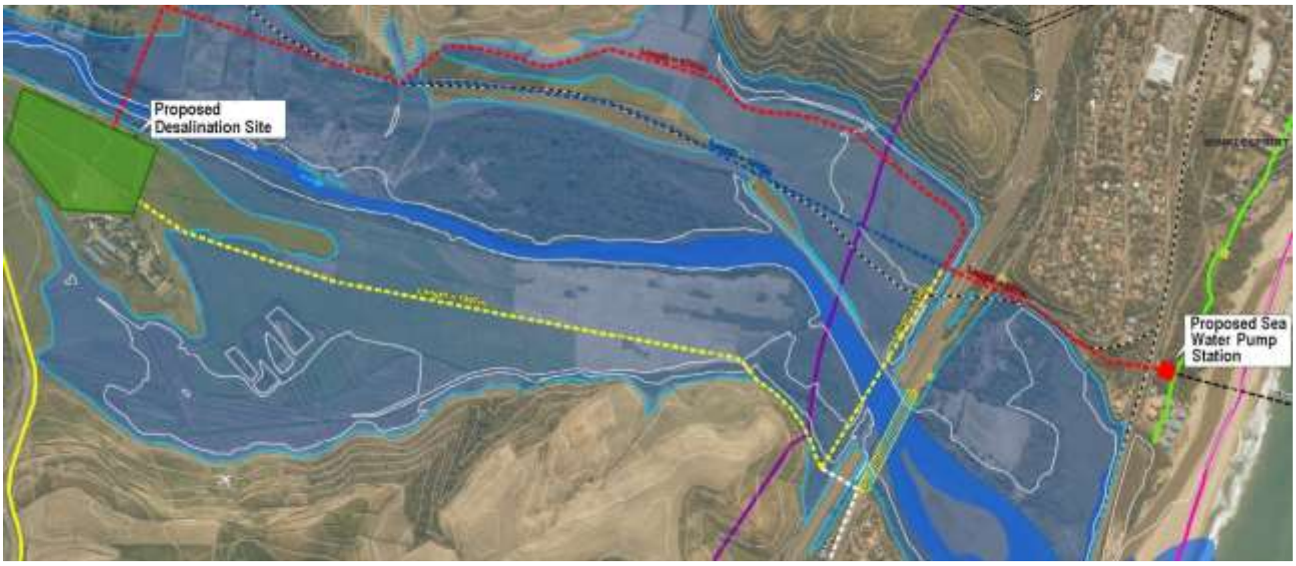


Figure 4-4 The Lovu Desalination Site and Pipeline Alignments

The site visit notes (**Appendix A**) provide details of the possible pipeline alignments. In summary, the proposed sea water and brine pipelines would require jacking from the pump station, under the local access road through the local caravan park and would then align with the unused railway line servitude towards the N2. Jacking under the R102 and N2 would be required, where after the pipelines would again align approximately with the servitude of the discontinued railway line (the Blue Route). Alternatively, the red route offers a slightly longer alignment but with reduced risk of flood damage. However, it is entirely below the 5m contour and as such more substantial environmental consideration of this route would be required during the EIA. A pipe bridge would be necessary over the Lovu River for both options and this could be constructed without draining of the estuary.

Both alternatives would require extensive de-watering arrangements for laying of pipelines. **Figure 4-5** shows the existing road which is closely aligned with the servitude of the discontinued railway line.

Figure 4-5 Proposed pipeline route along existing farm road through cane fields on northern bank

4.3 Integration Opportunities

The recently constructed 800mm dia. South Coast Pipeline from Amanzimtoti WTW (in the north) to Quarry Reservoir (in the South) passes immediately to the west of the proposed desalination site at Lovu. This pipeline is boosted by the Umnini pump station and distributes water from the Amanzimtoti WTW and also from the Wiggins WTW (which delivers water to the Amanzimtoti WTW) via the South Coast Augmentation (SCA) pipeline. In order to fully utilize 150 Mλ/d of potable water from the Lovu desalination plant, it would be necessary to enable reverse flow in the northern section of the South Coast Pipeline and probably also in the SCA pipeline from Wiggins. A continuous demand of 150Mλ/d may only arise in the long-term future and other possible interventions such as the Mkomazi Water Supply Scheme (Phase 1 – Smithfield Dam) would need to be compared as alternative options. During Phase 2, a closer assessment of integration of the desalinated water into the existing distribution system will be considered, both from a water requirement projection perspective as well as to match the plant product water quality with the existing water quality in the distribution system.

4.4 Flood Risk Assessment

4.4.1 Floodlines

Figure 4-6 shows the 1:100 year floodline for the Lovu River and confirms that the desalination site at about 10m above sea-level lies just over 3m above the 100 year floodline, which is at about 6,7m near that location.

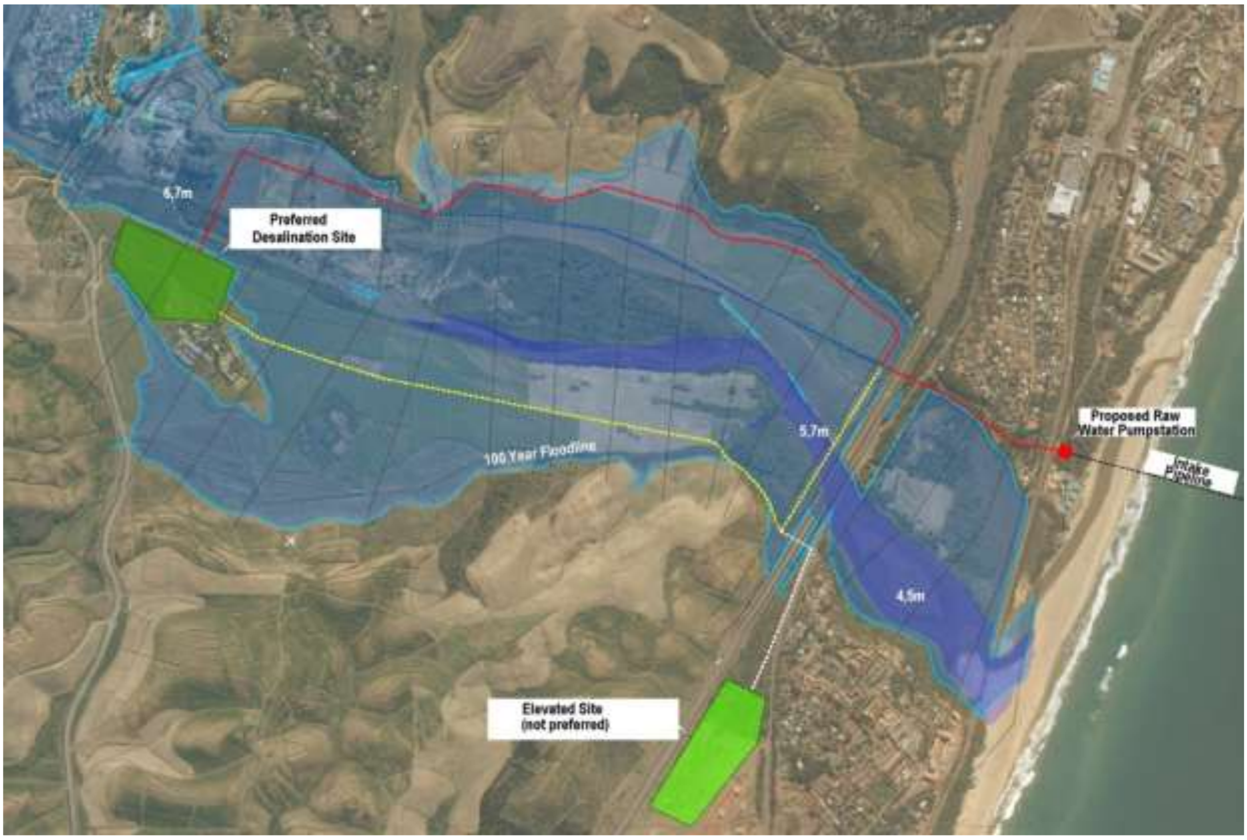


Figure 4-6 1:100 Year Floodline at Lovu

It is of interest to note that during the September 1987 floods in Kwazulu-Natal, the flood peak was estimated at 1800 m^3/s which is almost equivalent to the 1:100 year return period flood of 1824 m^3/s. The estimated 1:50 year and 1:20 year return period floods are 1361 and 930 m^3/s respectively. **Figure 4-7** shows the resulting effects of the September 1987 floods at the Lovu Estuary.

Figure 4-7 The 1987 floods at the Lovu Estuary

The University of Cape Town has offered to assist the Study Team in obtaining historical satellite imagery to correspond with a range of smaller flood events so as to develop a visual understanding of the extent of the sediment plume into the sea in relation to the proposed location of the sea water intake structure. On account of the delayed availability of such imagery at a suitably fine resolution, this visual analysis will be undertaken during the feasibility study. Should there be a need to site the intakes at a greater distance offshore on account of the sediment plume information on sea bed profile to a distance of 2km offshore would be available. Initial indications are that this would not be necessary and that during severe flood events, the desalination plant could be "switched off" for a period of time, and use made of conventional surface water sources as the dams should be relatively full.

4.5 Geotechnical considerations

A first-order geotechnical assessment based on the site visits, on visual interpretation and on local knowledge has been prepared for the Lovu site and is enclosed in **Appendix C**. In summary, the situation is likely to be as follows:

4.5.1 Lovu Pump station Site

The sand dune is likely to consist of at least 10m of unconsolidated, collapsible dune sand. Collapse settlement will occur with abnormal increases in moisture content under load. Excavatability can be classified as soft and trenches or embankments created during earthworks will require permanent or temporary lateral support. Grout injected flight auger piled foundations are expected to be required in the loose collapsible dune sands.

4.5.2 Lovu Desalination Plant Site

The shale (sedimentary) bedrock is expected to be ripable but Dolerite intrusions of variable weathering might be exposed during earthworks. Seasonal seepage may occur although the cane farm land is well drained and seepage within the shallow sediments is less likely. Bearing capacity of the sedimentary bedrock is expected to be between 150 and 350 kPa. No signs of slope instability were noticed during the site visit.

4.5.3 Pipe Jacking

Use of the abandoned rail tunnels may be an alternative to pipe jacking under the N2, if suitably wide and high enough to accommodate the two (and possibly) three pipes that would need to be routed through them as well as space for construction purposes. The permanent shallow water table might cause some challenges to pipe jacking in the immediate area.

4.5.4 Fill to Desalination Plant Site

Fill with drainage may be required at the proposed site. Slope may be an issue and advanced engineering solutions might be required. Competent materials are likely to be recovered when cutting down the area to a level platform. Deep founding solutions may be required through the fill body into in-situ materials.

4.5.5 Pipeline route

The pipeline route along the Northern bank of the estuary would encounter sedimentary deposits and a high water table. Deep piled foundations would be required for the pipe bridge.

4.6 Estuarine Considerations

Portions of the proposed route for the seawater and brine pipelines would be situated below the 5m contour which eThekweni has determined to be the boundary of the estuary (as indicated by the blue shaded area shown previously on **Figure 4-4)**. These portions of the route either traverse degraded coastal forest or canelands which may be rehabilitated to estuarine vegetation in the future. This should be addressed by the EIA with appropriate mitigation measures.

4.7 Botanical and Wildlife Considerations

Appendix E contains the botanical assessment in relation to the Lovu site. These are shown on **Figure 4-8.** Some impact can be anticipated on degraded coastal forest in the vicinity of the pump station and between the south coast railway line and the N2. Initial site review indicates that the Lovu site is clear of existing visible contamination, debris and structures. No endangered species or other wildlife (i.e., nesting birds and turtles) were found on the site during the project team site visit.

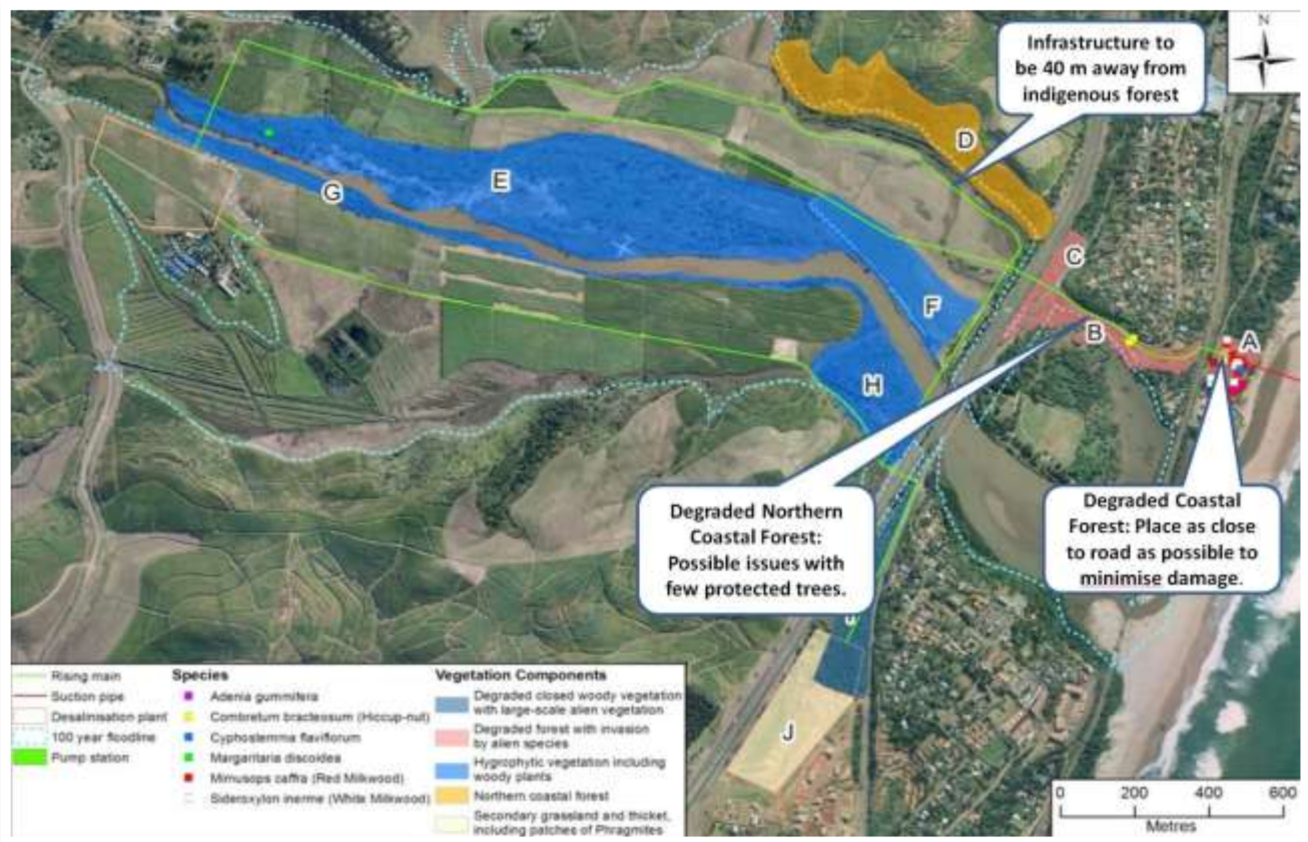


Figure 4-8 Botanical considerations

4.8 Social Considerations

A broad level social screening and site visit was undertaken to each of the three sites. **Appendix F** contains the report on that assessment. This is summarised in **Figure 4-9**.

Site	Neighbours	Distance from nearest (m)	Likely issues and potential impact					Flag
			Public safety and Risk	Economic activity	Noise and vibration	Visual amenity	Recreation	
Lovu	Access road	0	C: High O: Medium	Not applicable	C: Medium O: Low	C: High O: Medium	Not applicable	Amber
	Children's Home	20	C: High O: Low	C: Medium O: Low	C: Medium O: Low	C: Medium O: Medium	C: Medium O: Low	
	Sugar estate office	110	C: High O: Medium	Not applicable	C: Medium O: Low	C: High O: Medium	Not applicable	
	Light industrial	170	C: Negligible O:Negligible	C: Negligible O:Negligible	C: Negligible O:Negligible	C: Negligible O:Negligible	Not applicable	
	Gated apartment blocks opposite proposed Raw Water Pump Station	100	C: High O: Medium	C: High O: Medium	C: High O: Medium	C: Low O: Low	Not applicable	
	Campsite and Caravan Park near proposed Raw Water Pump Station	50	C: High O: Medium	C: High O: Medium	C: High O: Medium	C: Low O: Low	C: Negligible O: Negligible	

Flags Red = Social issues are strongly negative – do not proceed
Amber =Social issues require further investigation and negotiation – proceed with great caution
Green = Social issues do not appear to be a constraint.

Figure 4-9 Social Impact Summary

No red flags were identified in terms of social impacts at Lovu, although the preferred site will impact on the existing children's home, and mitigation would be required. Other social impacts would be at the coast, where the up-market apartment blocks are located in close proximity to the proposed pump station. The caravan park would also be impacted by the pipelines.

4.9 Lovu Summary

In summary, the following key aspects relate to the potential implementation of desalination at the Lovu site:

- The intake pipeline would be at a distance of about 800m offshore at a depth of about 15m.
- The brine diffusers would be at a depth of about 8-10m, some 500m offshore.
- The pump station would be located in a disturbed dune site close to the beach.
- Scheme integration is feasible, subject to actual future water requirements that could be met from this site.
- The desalination site would be at an elevation of about 10m, 3m above the 1:100 year floodline.
- Geotechnical challenges can be overcome.
- There is a limited botanical disturbance concern.
- Infrastructure footprints are to be targeted for above the 5m estuarine boundary, however, part of the pipeline route would be below this level.
- There is no estuarine red-flag associated with the scheme but specific design requirements will be necessary.
- There will be some social impact, notably at the existing children's home, caravan park, sugar estate and the beach apartments. These are not considered to be red-flags.

5 THE MDLOTI SITE : SITE SPECIFIC CONSIDERATIONS

The following aspects that are site-specific to the Mdloti site are summarised in this chapter:

- Intake and Outfall Considerations.
- Sea Water Pump station Location.
- Pipeline Routes and Potential Desalination Sites.
- Integration Opportunities (into existing infrastructure).
- Flood Risk Assessment.
- Geotechnical Considerations.
- Botanical Considerations.
- Estuarine Considerations.
- Social Considerations.

Appendix L contains an A1 plot of the overall proposed scheme at Mdloti showing the infrastructure locations, footprint areas and proposed alignments.

5.1 Intake and Outfall Considerations

In the absence of a bathymetric survey being available in Phase 1, use has been made of available information from admiralty charts to estimate the likely offshore pipeline lengths and water depths, as shown in **Figure 5-1**. This indicates that a depth of 20m can be achieved within 1km offshore of the Mdloti beach.

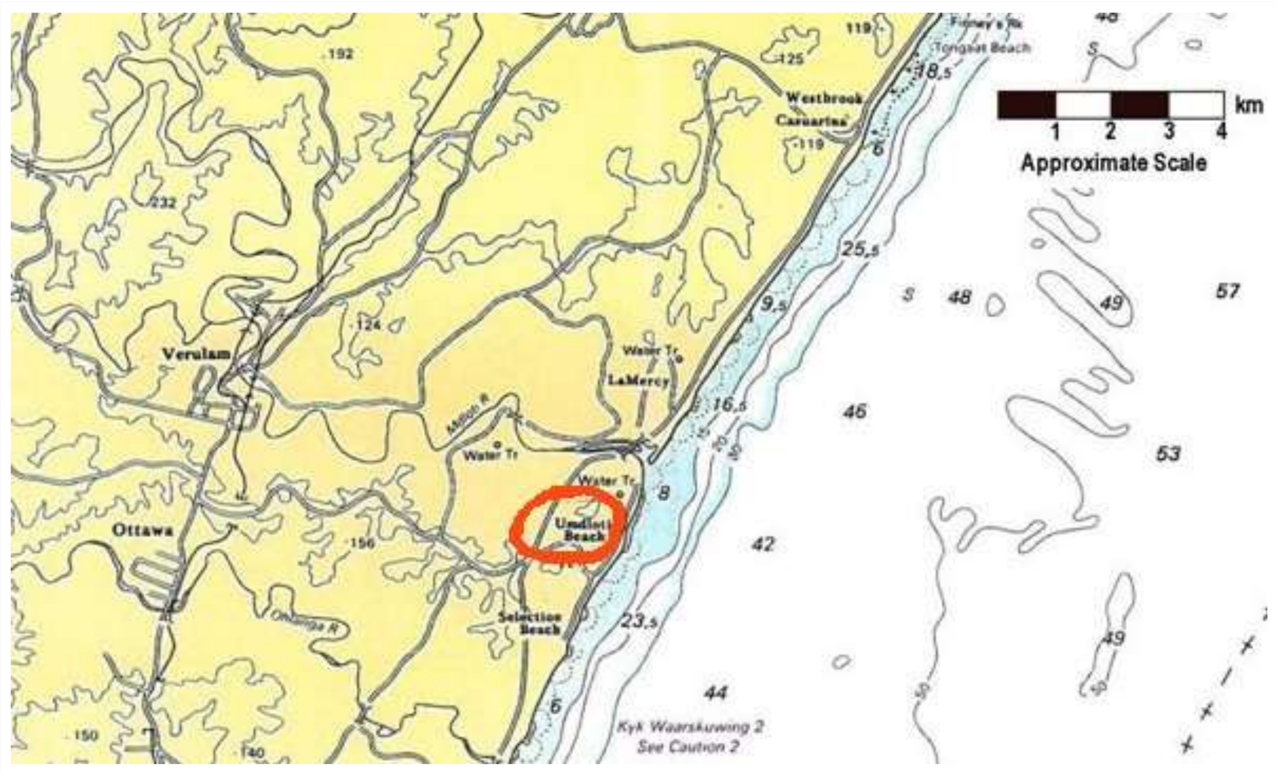


Figure 5-1 Admiralty Chart for Mdloti site

Figure 5-2 shows the anticipated alignment of the Mdloti intake structure, intake pipeline and proposed raw water pump station location. The approximate length of intake pipeline to reach a depth of about 15m would be between 500 and 600m. The brine diffuser would be located at a depth of about 8-10m and this would be at about 400m offshore.

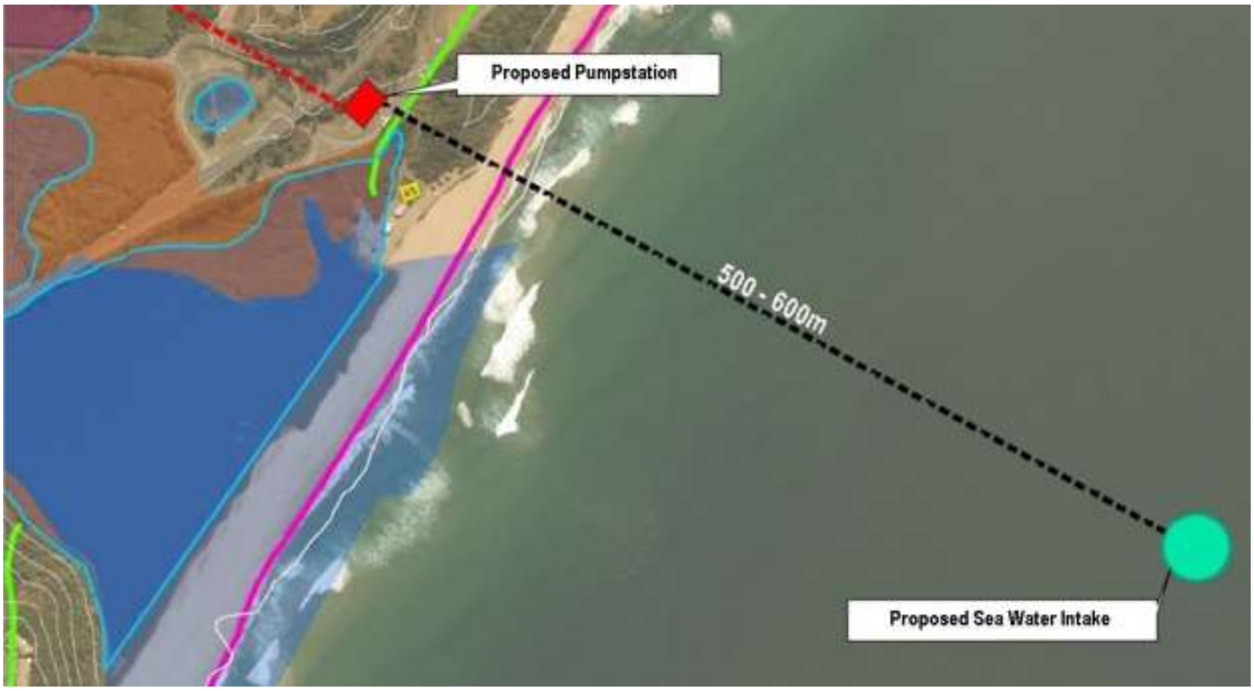


Figure 5-2 Mdloti Intake and Pump station Locations

Figure 5-3 shows the evidence of rocky outcrops within the shallow surf zone indicating that hard rock excavation (blasting) would be required, for the pump station excavation and pipeline through the surf zone (unless tunnelling were to be considered as an option).

Figure 5-3 Evidence of Rock Outcrops at Mdloti Beach

The beach width at Mdloti is very limited and is relatively steep, presenting challenges if conventional pipe laying methods (land-based) were to be considered. It is estimated that the invert of the pump station would be at about -6 MSL, and excavation through rock is therefore likely to be required. **Figure 5-4** shows the proposed location for the pump station at Mdloti, which would be in the existing beach car park, inland from the coastal dunes and outside of the Barringtonia Racemosa, fresh water swamp area.

Figure 5-4 Mdloti Pump station site in existing car park

5.2 Pipeline Routes and Potential Desalination Plant Sites

Figure 5-5 shows the location of the three potential desalination plant sites at Mdloti which appear favourable for further investigation. The alternative pipeline alignments between the sea water pump station and desalination plant sites are also shown. As was described in **Section 3.2**, elevation has been proven to not necessarily be a limiting factor at Mdloti. As such two sites (No's 2 and 3) at elevation (one at 35m and one at 55m) have been identified. Site 1 is at a low elevation and lies within a water course which drains the local catchment area of the N2. Furthermore, the proposed maturation ponds associated with eThekwini's planned Waste Water Treatment Works (WWTW) are also intended to be located here. Although Site 2 is 20m lower, land acquisition and visual impact may prohibit its development and it is therefore likely that Site 3 (at 55m elevation), may prove preferable. It would, however, impact on the existing farm located to the north of Site 3.

The potential pipeline alignments to each site are all located on the northern side of the estuary and the red, blue and white alignment options appear more favourable than the yellow, as a result of their increased distance from, and reduced impact on the 5m contour (estuarine environment). The common alignment section from the pump station to beyond the residential properties (red route) will require rehabilitation of the wetland area and expropriation of certain properties, posing significant challenges for design and construction.

The common alignment (red route) is likely to involve pipe jacking from the pump station in the car park, under the coastal forest and dunes to provide a route for the seawater intake and brine outfall pipelines. From the pump station, jacking would also be required in an in-land direction under the M4 motorway, where after the local wetland area containing phragmites reeds would be crossed by means of a berm. Rehabilitation of this wetland area would be required after construction (unless tunnelling were to be considered as an alternative.

As a result of challenges associated with the estuarine environment (including the freshwater mangroves – Barringtonia Racemosa) as well as the likely occurrence of rock near to the Mdloti beach, the possibility of implementing tunnelling warrants further consideration. This could either be considered over a partial distance (see **Figure 5-6**), or full length tunnelling (see **Figure 5-7**) from the desalination site to the sea water pump station and then on to the intake structure. The approach to small diameter tunnelling is described previously in **Section 3.3.8**. During Phase 2 of this study, cost estimates of tunnelling and potential alignments would be determined in order to assess the possible approaches that could be implemented in this regard.

The Mdloti site visit notes (see **Annexure A**) provide a more detailed description of the potential alignments considered.

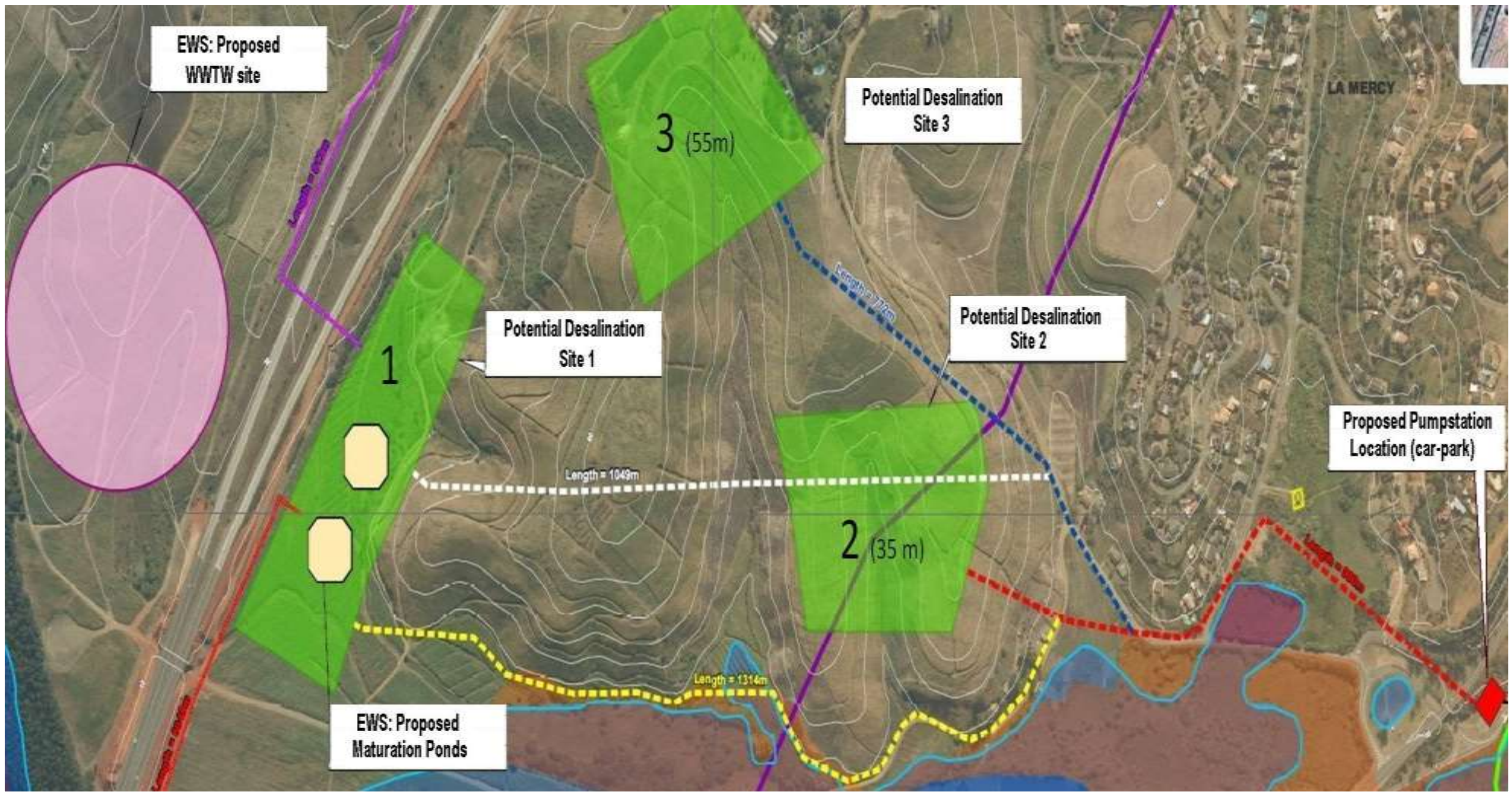


Figure 5-5 The Mdloti Desalination Sites and Potential Pipeline Alignments

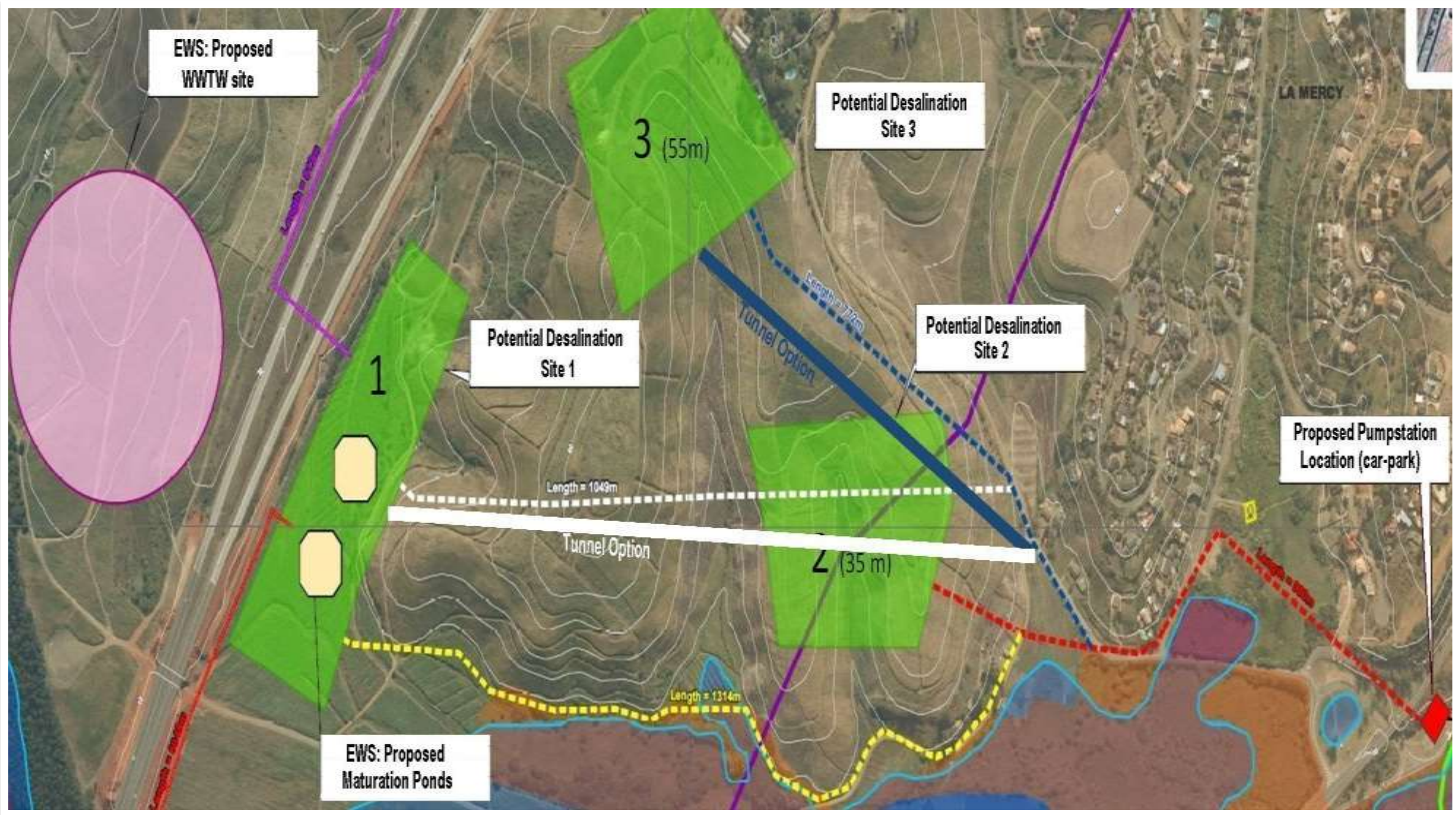


Figure 5-6 Possible Options for Partial Terrestrial Tunnelling

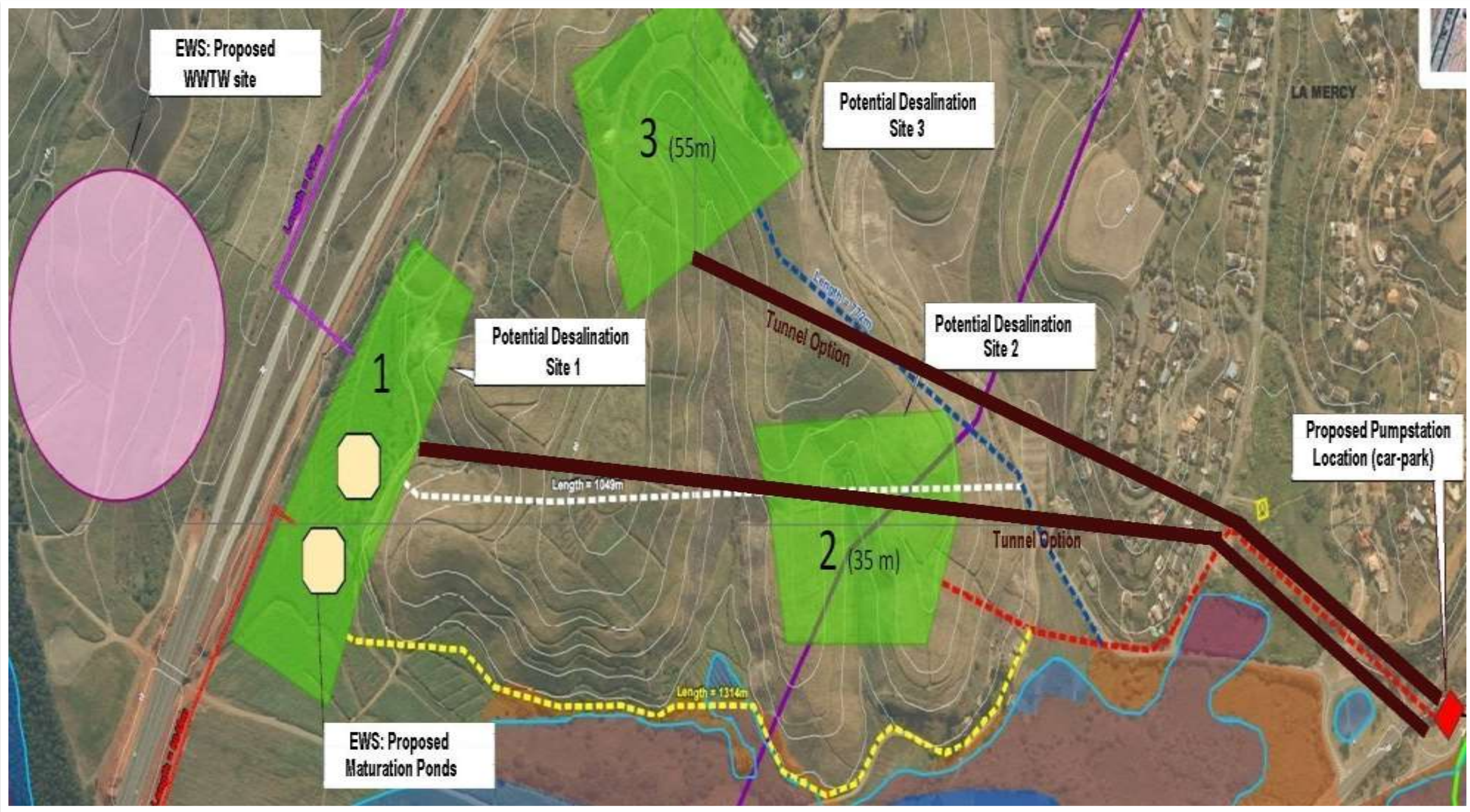


Figure 5-7 Possible Options for Full Length Terrestrial Tunnelling

5.3 Other Planning Initiatives at Mdloti

The proposed implementation of a new WWTW and rising main by eThekwini Municipality clashes with the possible use of Site 1 for a desalination plant. It is important to note (see **Figure 5-8**) that the preferred alignment of the sewer rising main being considered by eThekwini Municipality corresponds exactly with the proposed (and preferred) sea water and brine pipeline alignments for the desalination plant.

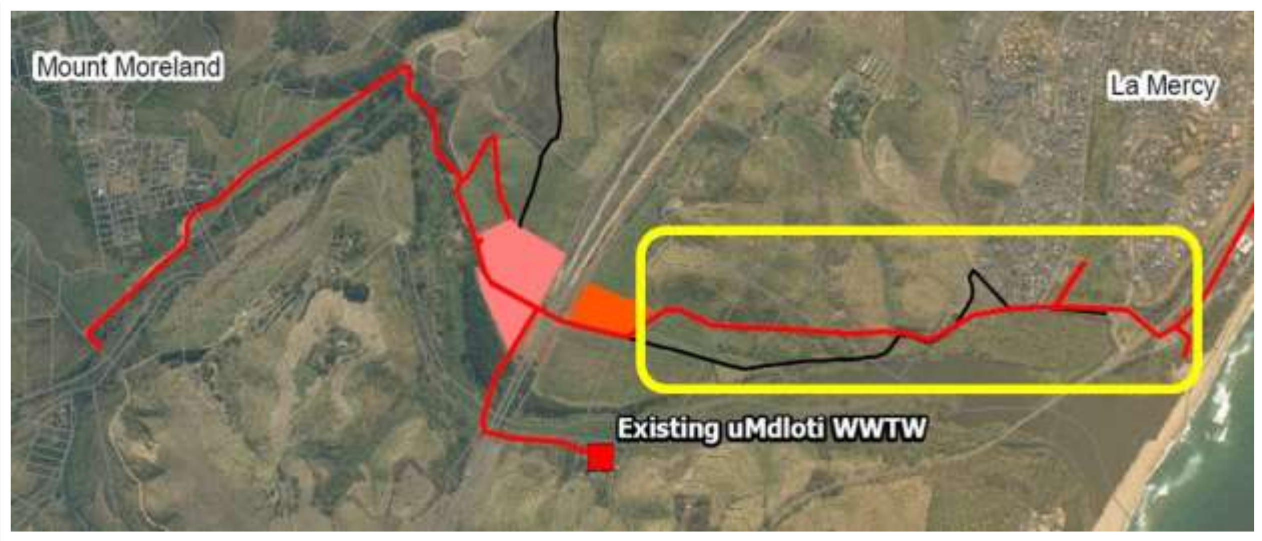


Figure 5-8 Proposed eThekwini Rising Main Alignment to WWTW

5.4 Integration Opportunities

There are two options to enable integration of the 150Mλ/d of product water from a desalination plant at Mdloti into the existing and proposed bulk water distribution infrastructure. The first option would involve connecting into the planned 700mm dia. Hazelmere Bifurcation pipeline which may offer the opportunity for wider distribution into the Hazelmere system (including facilitation of reversed flow in the planned bifurcation pipeline). Alternatively, integration could also be possible via the existing Waterloo Reservoir from where distribution via various pipelines is possible. Water could also be delivered from Waterloo into the northern aqueduct in which the provision for flow reversal could serve upstream users.

A continuous demand of 150Mλ/d may only arise in the long-term future and other possible interventions such as the Mkomazi Water Supply Scheme (Phase 1 – Smithfield Dam) would need to be compared as alternative options to desalination.

During Phase 2, for each of the two options selected for feasibility study, a closer assessment of integration of the desalinated water into the existing distribution system will be considered. This will be necessary both from a quantitative perspective (projected future water demands) and from a quality perspective so as to match the plant product water quality with the existing water quality in the distribution system.

Figure 5-9 shows the bulk distribution pipeline integration opportunities from Mdloti.

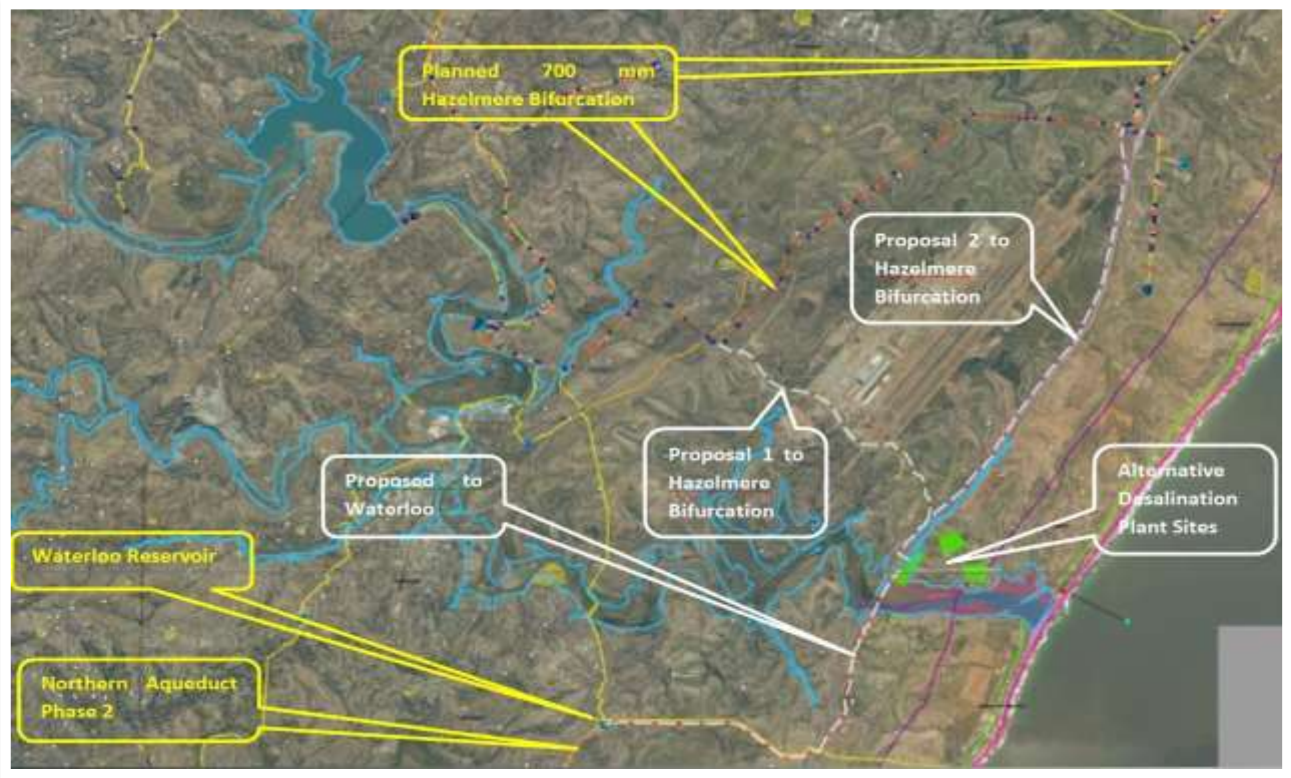


Figure 5-9 Scheme Integration Opportunities from Mdloti

5.5 Flood Risk Assessment

Figure 5-10 shows the 1:100 year floodline for the Mdloti River and confirms that the two elevated desalination sites would be well above the floodline but that Site 1 would be impacted. The 1 in 100 year flood levels at the M4 and N2 bridge crossings are indicated as 7,7m and 8,9m respectively.

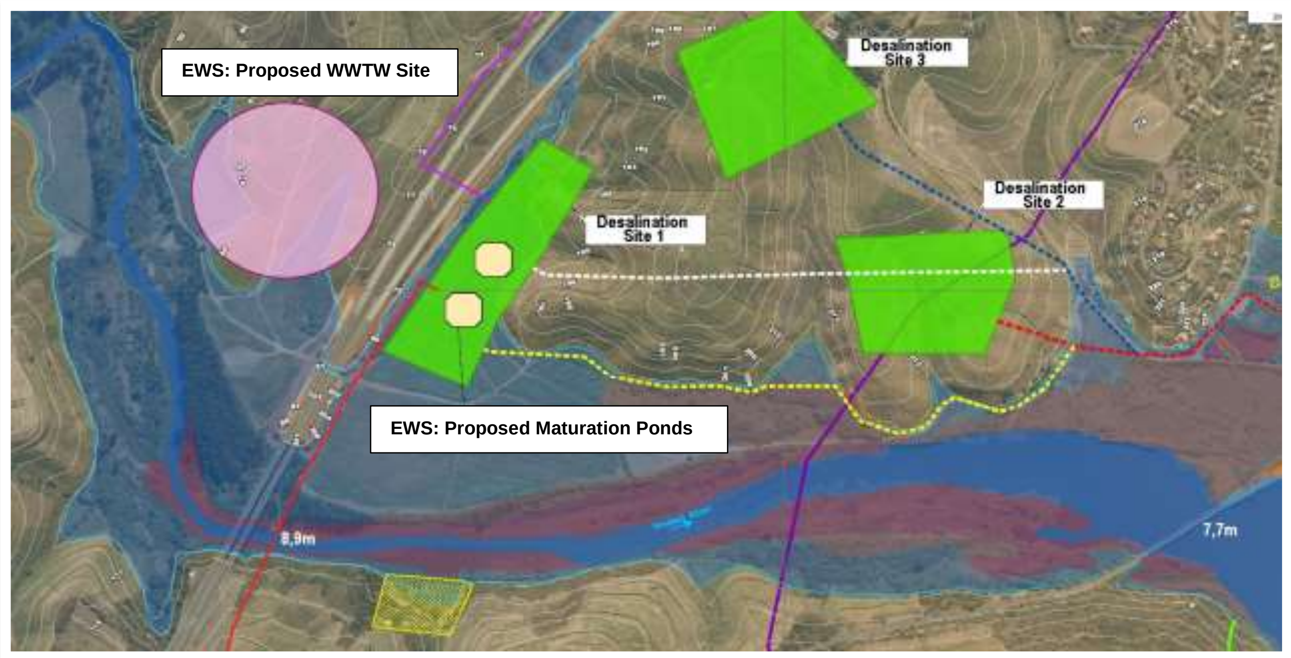


Figure 5-10 1:100 Year Floodline at Mdloti

It is of interest to note that during the September 1987 floods in Kwazulu-Natal, the flood peak was estimated to have been 2130 m^3/s which is in excess of the 1:100 year return period flood of 1571 m^3/s. The estimated 1:50 year and 1:20 year return period floods are 1218 m^3/s and 798 m^3/s, respectively. **Figure 5-11** provides an indication of the resulting effect of the September 1987 floods at the Mdloti Estuary.

Figure 5-11 The 1987 Floods at the Mdloti Estuary

Refer to **Section 4.4** which explains the intended approach to assessing the possible impact of the freshwater plume on water quality during varying degrees of historical flood events.

5.6 Geotechnical Considerations

Based on the site visits, on visual interpretation and on local knowledge, a first-order geotechnical assessment has been prepared for the Mdloti site and is enclosed in **Appendix C**. In summary, the anticipated geotechnical considerations are as follows:

Mdloti Pump station Site

Regardless of the site chosen for the desalination plant, a pump station would be required. The site proposed for the pump station is situated in the existing car park near the end of the M4 off ramp north ward bound leading onto South Beach Road, and approximately 100m from the coast line. The shallow sandstone sequence of the Vryheid Formation bedrock which is exposed might not be ripable in open excavation. Pneumatic tools or blasting might be required locally. Shallow founding into competent bedrock using column based foundations or strip footings are regarded as feasible founding options. The bearing capacity of the sandstone bedrock is expected to range between 200kPa and 400kPa depending on the nature of the weathered bedrock locally.

Mdloti Desalination Plant Site

For Site 1, additional competent materials would have to be imported to create a platform for construction. Such a fill platform would require advanced drainage solutions also taking into account the drainage requirements of the adjacent N2 freeway. For Sites 2 and 3 it is expected that competent materials would be available from cutting the surrounding spurs to create the level platform. The fill would have to be engineered accordingly and benched into competent in-situ material. Advanced engineering solutions such as rock anchoring or rock toes might be required, if the dip direction of bedding planes and tectonic planes dip adversely south to south east. Drainage solutions are likely to be required to be incorporated into the fill development.

Pipe Jacking

Pipe jacking to the east through bedrock and possibly also recent dune sands to the coast is considered feasible provided that the water table and material instability of the loose dune and beach sands would have to be taken into consideration. Pipe jacking from the pump station towards the proposed desalination plant sites through the shallow sandstone might be challenging. Alternatively, jacking through the fill embankment slightly south or initially the pipes in a culvert under the embankment at Sea Pride Circle might be more suitable.

Tunnelling

Tunnelling would be possible with adequate support and drainage over the full length of any tunnel for these sedimentary materials. This would need to account for dip directions of bedding planes and tectonic planes, the possibility of clay lenses within the less weathered bedrock and the possibility of dolerite intrusions ranging from completely weathered to unwethered bedrock. These may cause some instability during the process of tunnelling and detailed geotechnical assessments would have to be carried out as unfavourable conditions might occur during the tunnel works. Furthermore, it is known that ground water occurs at the contact of intrusive dolerite bodies and the sedimentary rock.

5.7 Botanical Considerations

Appendix E contains the botanical assessment in relation to the Mdloti site. The findings are summarized in **Figure 5-12**.

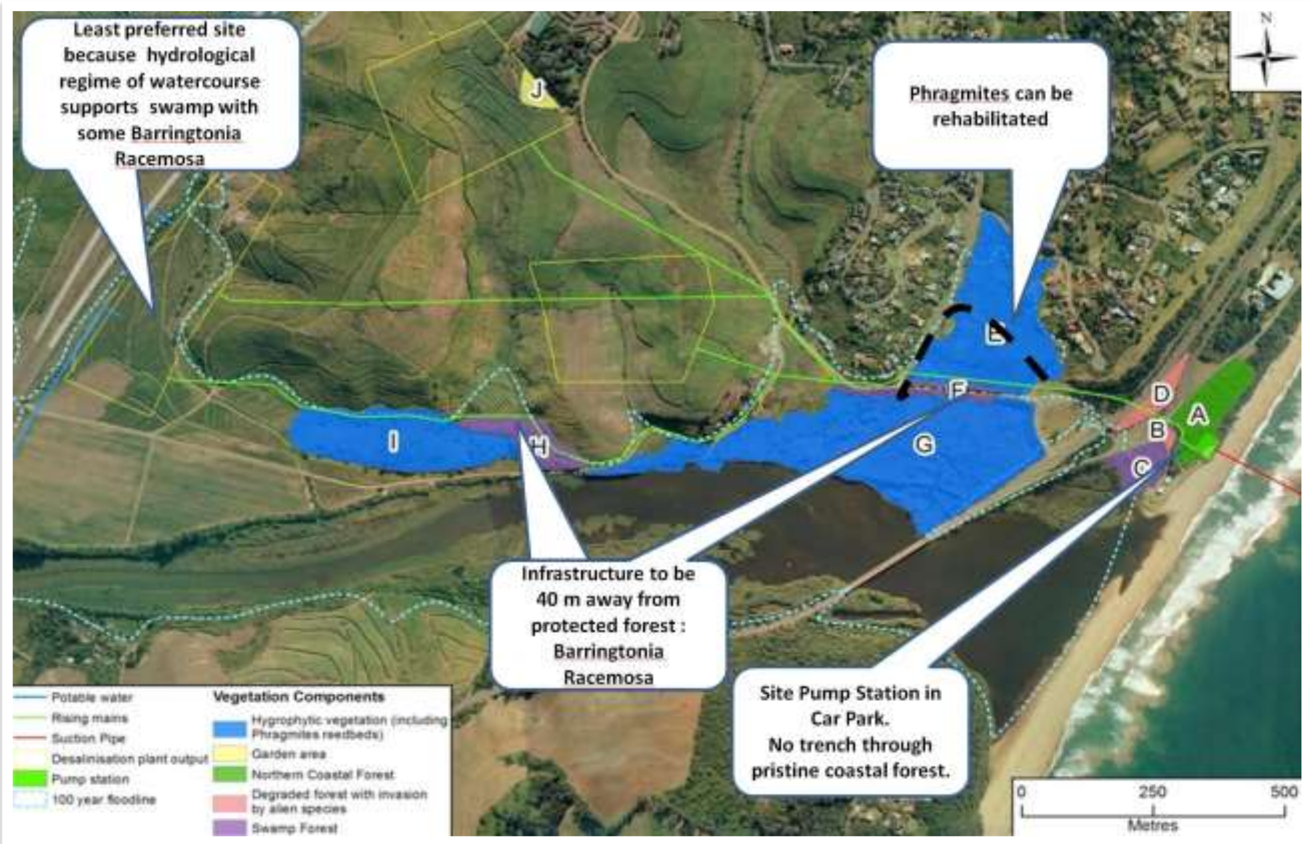


Figure 5-12 Mdloti Botanical Considerations

In summary, the botanical assessment strongly suggests that the pump station location in the car park is preferred on account of the need to preserve the near pristine coastal dune forest. Pipe jacking or tunnelling would be preferred as this would allow for potential impacts to all areas of vegetative sensitivity to be minimized.

5.8 Estuarine Considerations

The portion of the pipeline route which would cross the first (mainly phragmites) wetland would be below the eThekwini 5m contour which delineates the estuary. The impact on the estuary and wetland could be minimised by rehabilitation and suitable mitigation measures. As mentioned in **Section 5.2**, one of the advantages of alternative sites 2 and 3 is that the remainder of the pipeline routes would be remote from the estuary.

5.9 Social Considerations

A broad level social screening and site visit was undertaken to each of the potential 3 sites at Mdloti. **Appendix F** contains the report on that assessment. This is summarised in **Figure 5-13** below.

Site	Neighbours	Distance from nearest (m)	Likely issues and potential impact					Flag
			Public safety and Risk	Economic activity	Noise and vibration	Visual amenity	Recreation	
Mdloti 1	National road (N2)	10	C: Negligible O: Negligible	Not applicable	C: Negligible O: Negligible	C: Negligible O: Negligible	Not applicable	Green
Mdloti 2	Dwellings	180	C: Medium O: Low	Not applicable	C: Medium O: Low	C: Low O: Low	C: Low O: Low	Green
	Angling club	170	C: Medium O: Low	C: Negligible O: Negligible	C: Low O: Low	C: Low O: Low	C: Low O: Low	
	Local road (Sugar Cane Rd)	180	C: High O: Medium	Not applicable	C: Medium O: Low	C: High O: Medium	Not applicable	
Mdloti 3	Farm house	40	C: Medium O: Low	C: Low O: Medium	C: High O: Medium	C: Medium O: Medium	C: Low O: Low	Amber
	Egg production plant	120	C: Medium O: Low	C: Low O: Medium	C: Low O: Medium	C: Negligible O: Negligible	Not applicable	
	Dwellings	350	C: Low O: Low	C: Low O: Low	C: Low O: Low	C: Negligible O: Negligible	Not applicable	

Flags Red = Social issues are strongly negative – do not proceed
Amber = Social issues require further investigation and negotiation – proceed with great caution
Green = Social issues do not appear to be a constraint.

Figure 5-13 Social Impact Summary

No social red flags were identified at the Mdloti sites although there would be some impact at Site 3 on the farm house, egg production plant and dwellings of the proposed desalination plant site where expropriation may be necessary.

5.10 Mdloti Summary

In summary, the following key aspects relate to the potential implementation of desalination at the Mdloti site:

- The intake pipeline would extend about 500-600m offshore to a depth of about 15m.
- The brine diffusers would be at a depth of between 8-10m, some 400m offshore.
- The pump station would be located in the existing car park, adjacent to the fresh water mangrove (Barringtonia Racemosa) swamp.

- Scheme integration would be feasible, subject to actual future water requirements that could be met from this site.
- The preferred desalination site option (Site 3) would be at an elevation of about 55m with energy recovery implemented.
- The low level desalination site (option 1) is least preferred due to its relatively bigger estuarine impact, its drainage related challenges and the fact that it clashes with the proposed eThekwini Municipal WWTW planning.
- Geotechnical challenges could be overcome.
- There would be limited botanical disturbance concern.
- There would also be limited estuarine disturbance during the construction of the seawater and brine pipelines, of a mainly phragmites wetland.
- Infrastructure footprints to be targeted for above the 5m estuarine boundary cut-off.
- Tunnelling would significantly reduce the impact on the estuary (below the 5m contour) and on areas of botanical importance.
- There would be some social impacts, but these are not considered to be red-flags.

6 THE TONGAAT SITE : SITE SPECIFIC CONSIDERATIONS

The Tongaat site has been identified as a possible alternative to the Mdloti site for the supply of water to the northern areas. It is a non-estuarine site, has no large-scale flood risk, is at a relatively low elevation (22m) and is located in very close proximity to the coast. The site is located about 3km north of the Mdloti River estuary.

Appendix B contains an A1 layout of the overall proposed scheme footprint at Tongaat.

6.1 Intake and Outfall Considerations

Figure 5-1 (Mdloti) shows the admiralty chart corresponding to this area from which it can be seen that a water depth of up to 20m can be achieved within a distance of 1km offshore. **Figure 6-1** shows the anticipated alignment of the Tongaat intake structure, intake pipeline and four potential sea water pump station locations (Options 1, 2, 3 and 4). The intake pipeline would be about 500-600m long, with the intake at a depth of about 15m. The brine return pipeline would be at about 400m offshore at a depth of approximately 8-10m.

Figure 6-1 Tongaat Intake and Pump station Locations

Figure 6-2 shows evidence of rocky outcrops at Tongaat Beach and in the surf zone, indicating that hard rock excavation for the pump station and the pipelines through the surf zone would be required. Tunnelling would certainly be an option to consider at this site as this would also facilitate crossing under the M4, the local coastal road and the dune forest.

Figure 6-2 Evidence of Rock Outcrops at Tongaat Beach

The beach width at Tongaat is also limited in terms of workspace for conventional pipe laying methods (land-based). It is estimated that the invert to the pump station sump would be at about -6 MSL and as such excavation through hard rock material is highly likely. The options for a pump station include sites on both sides of the local coastal road although at this stage the preferred site (Option 1) would be within the proposed footprint area of the desalination site itself.

6.2 Pipelines and Potential Desalination Site

As shown on **Figure 6-1** there is only one possible site large enough to accommodate a desalination plant footprint (7ha). Fairly significant earthworks (cut and fill) would be required to create a level platform at an elevation of about 22 MSL. The seawater and brine pipelines would best be accommodated by means of tunnelling (for the reasons described previously) as these would also have least impact on the properties along the coastal strip and on the dune vegetation.

6.3 Integration Opportunities

The integration of a potential 150 Mλ/d desalination plant at the Tongaat site would consist of two options. The pipeline could lead to the Hazelmere Bifurcation pipeline, to deliver water to the north and to the south by reversing the flow in the bifurcation pipeline. Alternatively the pipeline to the Hazelmere Bifurcation pipeline could follow a southern route to the south of King Shaka Airport, through the Dube Trade port area, pending any possible restrictions through that zone. The first portion of the pipeline route to the Waterloo Reservoir would follow the southern route to the Hazelmere Bifurcation pipeline, as described above, but would continue southwards, cross the Mdloti River to the east of the N2 bridges, which would probably necessitate the construction of a pipe bridge on account of the likely depth to sound founding material.

A continuous demand of 150 Mλ/d may only materialize in the long-term and cognisance of other augmentation options, such as the Mkomazi Water Supply Scheme (Phase 1 – Smithfield Dam) would need to be compared as an alternative to desalination. **Figure 6-3** summarises the possible integration opportunities from Tongaat. Integration based on quantity (water requirement projections) and water quality will be further considered in Phase 2.

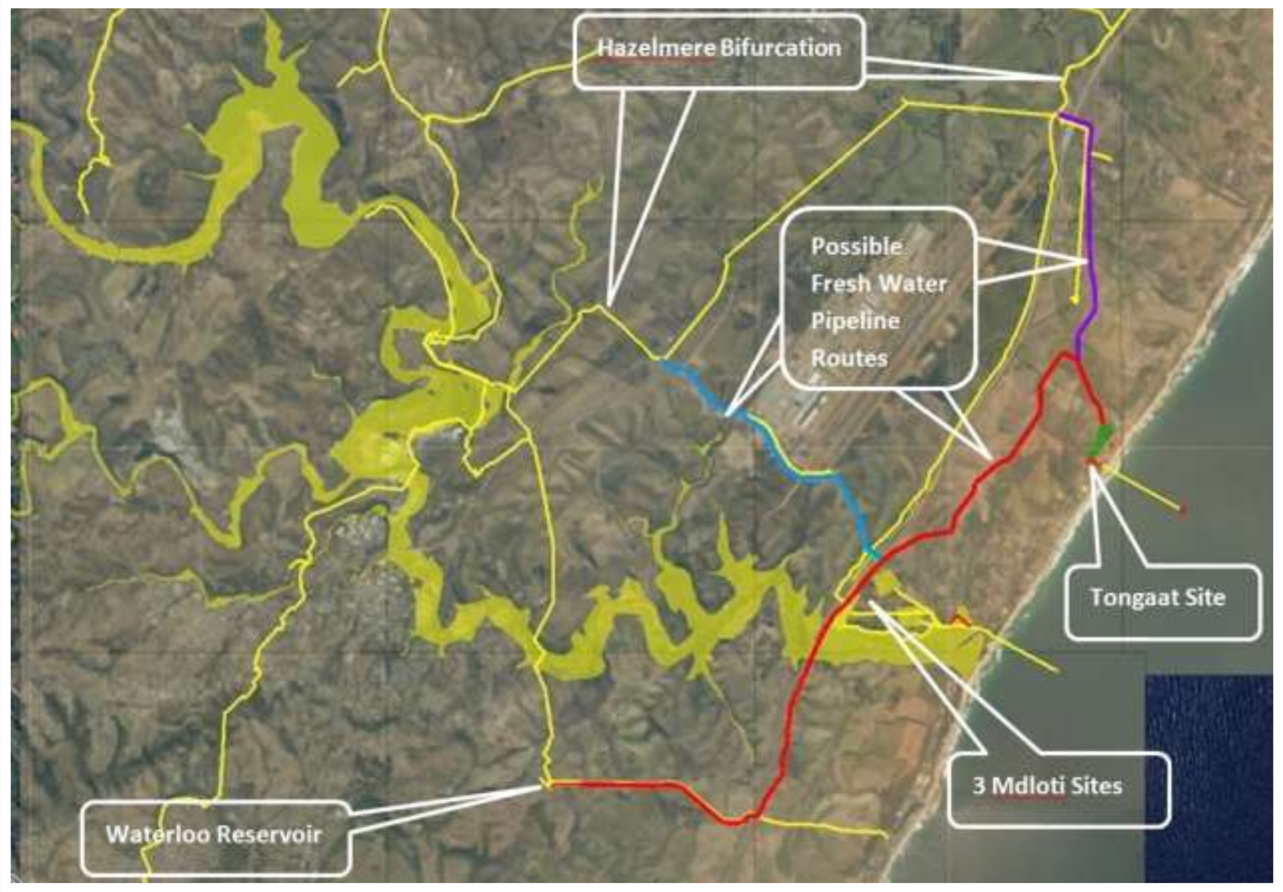


Figure 6-3 Scheme Integration Opportunities from Tongaat

6.4 Flood Risk Assessment

Local drainage considerations would need to be taken into account but this site does not lie on a major water course and as such large-scale flooding is not a risk. As described in **Section 4.4**, the potential plume impact on water quality at the intake would need to be considered in view of the relatively close proximity (3km) to the Mdloti River Estuary in the south and to the Tongati River Estuary (6,5km) to the north.

6.5 Geotechnical Considerations

Based on the site visits, on visual inspection/interpretation and on local knowledge, a first order geotechnical assessment has been prepared for the Tongaat site and is enclosed in **Appendix C**. In summary, the anticipated geotechnical considerations are as follows:

Tongaat Pump station Sites

The upper recent Dune Sands, Cenozoic sediments and residual sandy clays and clayey sands as well as the upper completely to highly weathered Permian bedrock materials are expected to comply to "soft excavation" according to SABS 1200D standards. Deep founding solutions are likely to be required taken through the fill body. Light weight structures may be founded onto the fill body, provided the proposed fill has been engineered accordingly. The proposed pump station sites are likely to require hard rock excavation, taking into account the visible rock outcrops on the Tongaat beach and the fact that the pump station sump is likely to be at about -6MSL.

Tongaat Desalination Site

A building platform would be required to accommodate the various proposed structures of the desalination plant itself. This would entail considerable cut and fill operations in which cutting of the existing hill tops would be required. The permanent saturation of the underlying soils fed by the adjacent hills would require extensive drainage both under, and within a proposed fill body. The cut and fill stability would require detailed geotechnical investigation and stability analysis relative to filling on top of wet /soft clays.

Pipe Jacking

Regardless of the placement of the proposed pump station, pipe jacking or tunnelling would be required under all three roads, namely South Beach Road, the M4 and South Dune Road. Pipe jacking is in general considered feasible, however, other considerations would have to be taken into account including the presence and depth of the water table, the possibility of the presence of the Basal Berea Boulder beds, the likeliness of loose unstable sands, and the nature of the fill materials, where the roads are situated on engineered fill materials.

Tunnelling

Tunnelling would appear to be the preferred means of providing for the intake and outlet pipeline routes due to the visible presence of rock at the beach and in the surf zone.

6.6 Botanical Considerations

Appendix E contains the botanical assessment in relation to the Tongaat site. The findings are summarized in **Figure 6-4**.

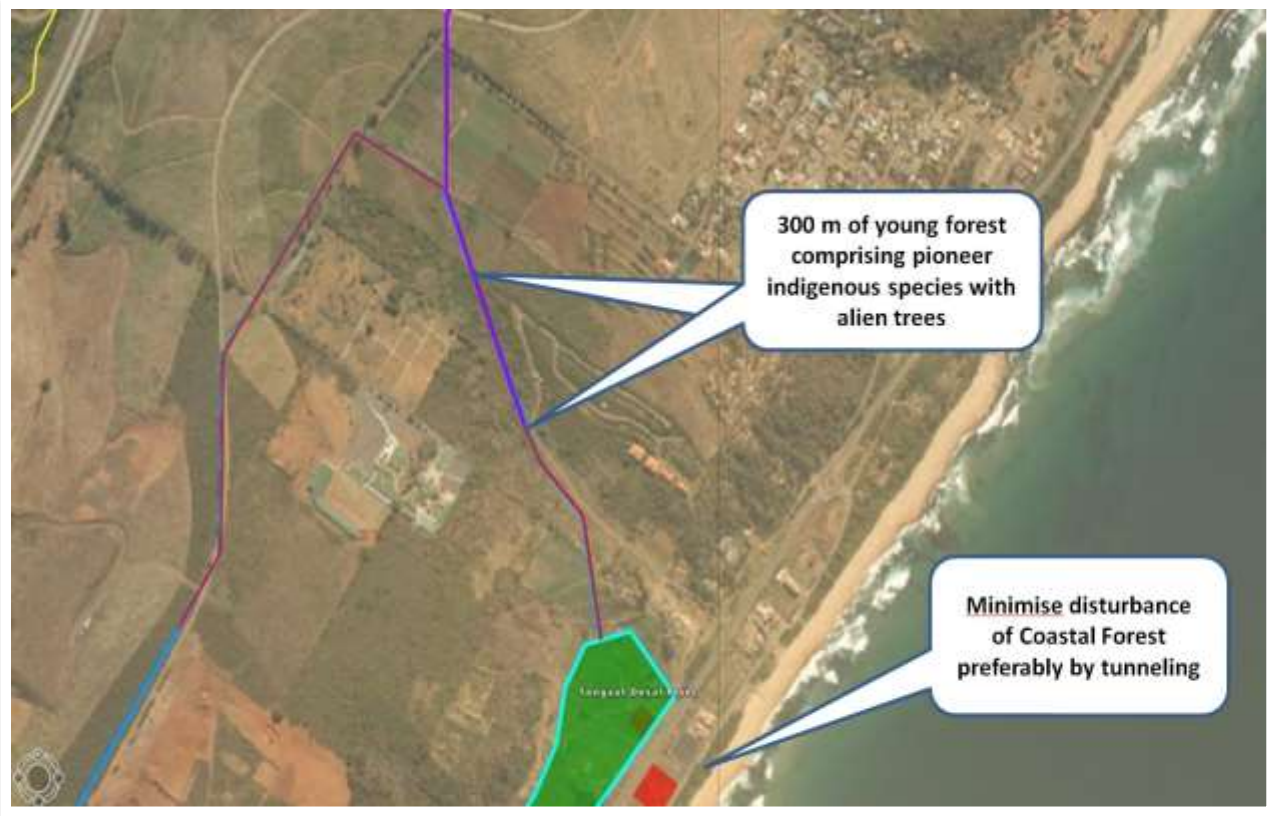


Figure 6-4 Tongaat Botanical Considerations

In summary, the botanical assessment has reported that tunnelling under the coastal forest would be preferable to conventional pipe laying. There would be impacts on the young forest to the north of the site where the option of a delivery pipeline via the Dube Trade Port and Hazelmere bifurcation is proposed. Comment on the impact on the young forest was also obtained from eThekwini Municipality (Richard Boon) in which he indicated that this impact could be mitigated through design and rehabilitation measures.

6.7 Tongaat Social Consideration

A broad level social screening and site visit was undertaken to the Tongaat site to assess the social impact on land owners and on the existing market gardeners. **Appendix F** contains the Social Report, a summary of which is shown in **Figure 6-5** below.

Site	Neighbours	Distance from nearest (m)	Likely issues and potential impact					Flag
			Public safety and Risk	Economic activity	Noise and vibration	Visual amenity	Recreation	
Tongaat	Small scale market gardening	0	C: Medium O: Low	High and permanent	Not applicable	Not applicable	Not applicable	Amber
	Dwellings	30	C: Medium O: Low	C: High O: Medium	C: High O: Medium	C: High O: Medium	C: High O: Medium	
	Major road (M4)	30	C: Medium O: Low	Not applicable	C: High O: Low	C: High O: Low	Nil	
	Local road (South Dune Rd)	1	C: High O: Medium	Not applicable	C: Medium O: Low	C: High O: Medium	Not applicable	
	Apartment buildings	200	C: Medium O: Low	Nil	C: Medium O: Low	C: Medium O: Low	C: Medium O: Low	
	Hotel	60	C: Medium O: Low	C: Medium O: Low	C: Medium O: Low	C: Low O: Low	C: Low O: Low	
	Commercial enterprise	50	C: Medium O: Low	Nil	C: Medium O: Low	C: Low O: Low	C: Low O: Low	

Flags Red = Social issues are strongly negative – do not proceed
Amber = Social issues require further investigation and negotiation – proceed with great caution
Green = Social issues do not appear to be a constraint.

Figure 6-5 Social Impact Survey

Although not considered a "show-stopper" at this stage, a cautionary approach has been adopted to the Tongaat site from a social perspective. Major disruption and upheaval is likely, both in terms of the coastal strip landowners and the market gardeners. The latter have (in certain cases) been established for up to three generations and suitably acceptable alternative land and water supply to compensate for what they currently enjoy would need to be identified.

On 5 June 2012 UW undertook an informal public meeting with the Tongaat land owners. The concepts around the desalination feasibility study were explained and questions relating to noise (during and after construction), environmental issues, time frames and financial compensation were discussed. The land-owners of the land leased to the market gardeners did not show any strong objection and appeared interested in the possible opportunity to sell the properties for fair compensation. As such, the potential implementation of desalination at the Tongaat site appears initially acceptable from a social perspective, subject to fair negotiation and compensation.

6.8 Tongaat Summary

In summary, the following key aspects relate to the potential implementation of desalination at the Tongaat site:

- The intake pipeline would be at about 500-600m offshore with the intake at a depth of about 15m.
- The brine diffusers would be at a depth of between 8-10m and about 400m offshore.
- The potential pump station locations could be sited on either side of the coastal road, however, the proposed site on the northern side would have significant advantages.
- Scheme integration is feasible subject to actual future water requirements that could be met from this site.
- The desalination site would be very close to the coast at an elevation of about 22m and would not be exposed to any significant flood risk.
- Geotechnical challenges (notably a high water table) could be overcome.
- There is some botanical concern in relation to the coastal forest and young indigenous forest areas but mitigation would be possible.
- There would be a significant social impact, and a cautionary approach is advised but initial indications suggest that this need not preclude the Tongaat site from investigation to feasibility level.

7 INDICATIVE COST ESTIMATES

First order cost estimates have been prepared for the Lovu, Mdloti and Tongaat sites for comparative purposes. Although not a requirement of the original ToR for this Due Diligence phase, they are provided as an indicative estimate of the capital and operating costs.

Detailed cost estimates for the potential schemes, including costs associated with tunnelling will be undertaken during Phase 2 (Feasibility Study). The unit reference values (URVs) for each option at the three sites (Lovu, Mdloti and Tongaat) have been determined and are shown in **Table 7-1** below. The detailed cost calculations are enclosed in **Appendix K**.

Table 7-1 Indicative First Order Capital and Electricity Estimates and Unit Reference Values for 6% Discount Rate and Electricity Cost of R1,00/kWh

CAPITAL COSTS: Site Specific					
SITE Elevation m	LOVU 10	MDLOTI 1 10	MDLOTI 2 35	MDLOTI 3 55	TONGAAT 22
			Rand (Million)		
Seawater Pipeline and Pumps	R 73	R 58	R 60	R 90	R 24
Brine Pipeline and Turbine	R 20	R 16	R 29	R 48	R 9
Clear Water Pipelines and Pumps	R 68	R 103	R 115	R 100	R 128
TOTAL: Pipelines and Pumps	R 162	R 177	R 204	R 238	R 161
TOTAL: Earthworks	R 3	R 36	R 20	R 19	R 14
TOTAL CAPITAL: Site Specific	R 164	R 213	R 224	R 257	R 175
ELECTRICITY COSTS: Site Specific (R1/kWh for 30 years @6% pa)					
SITE Elevation m	LOVU 10	MDLOTI 1 10	MDLOTI 2 35	MDLOTI 3 55	TONGAAT 22
			Rand (Million)		
Seawater Pumps	R 70	R 69	R 230	R 361	R 144
Brine Turbine	R 0	R 0	-R 87	-R 158	-R 43
Clear Water Pumps to Hazelmere Bifurcation	R 250	R 285	R 251	R 212	R 267
Clear Water Pumps to Waterloo	R 265	R 294	R 275	R 235	R 277
TOTAL ELECTRICITY: Pumps and Turbine	R 586	R 649	R 668	R 651	R 644
SITE SPECIFIC COSTS: Beach Works and Offshore					
SITE Elevation m	LOVU 10	MDLOTI 1 10	MDLOTI 2 35	MDLOTI 3 55	TONGAAT 22
			Rand (Million)		
TOTAL COSTS: Beach and Offshore	180	180	180	180	180
SITE SPECIFIC LAND:					
SITE Elevation m	LOVU 10	MDLOTI 1 10	MDLOTI 2 35	MDLOTI 3 55	TONGAAT 22
			Rand (Million)		
Capital Cost	R 164	R 213	R 224	R 257	R 175
Electricity Cost	R 586	R 649	R 668	R 651	R 644
TOTAL COSTS: Site Specific	R 750	R 862	R 892	R 908	R 819
DESALINATION:					
SITE Elevation m	LOVU 10	MDLOTI 1 10	MDLOTI 2 35	MDLOTI 3 55	TONGAAT 22
			Rand (Million)		
Capital Cost	R 1,500	R 1,500	R 1,500	R 1,500	R 1,500
Electricity Cost	R 3,015	R 3,015	R 3,015	R 3,015	R 3,015
TOTAL COSTS: Desalination	R 4,515	R 4,515	R 4,515	R 4,515	R 4,515
SITE SPECIFIC PLUS DESALINATION:					
SITE Elevation m	LOVU 10	MDLOTI 1 10	MDLOTI 2 35	MDLOTI 3 55	TONGAAT 22
			Rand (Million)		
TOTAL COSTS	R 5,444	R 5,556	R 5,587	R 5,602	R 5,514
UNIT REFERENCE VALUES:					
RAND/m^3	R 7.22	R 7.37	R 7.41	R 7.43	R 7.31

Based on this cost comparison, the Lovu and Tongaat sites appear to be the slightly more favourable options for further study.

8 DUE DILIGENCE RECOMMENDATIONS

Based on the findings presented in this report and on the supporting information in the Appendices, the recommendation is that the following two sites be investigated in the Phase 2 feasibility study:

- Lovu (southern supply area)
- Tongaat (northern supply area)

It is further concluded that micro-tunnelling offers significant opportunity in terms of mitigating environmental and social concerns relating to the conveyance infrastructure. This should be investigated in Phase 2 and comparative costs developed for the tunnelling options. Extensive geotechnical investigations will be required in Phase 2 to guide and support the preliminary design of the required infrastructure.

The Mdloti site should remain "on the table" as an option which could be re-considered if the social impact at the Tongaat site proves to become a "show-stopper" during the EIA process.