PROPOSED FLOOD MITIGATION MEASURES FOR THE OSHAKATI/ONGWEDIVA AREA

DRAFT
ENVIRONMENTAL IMPACT REPORT

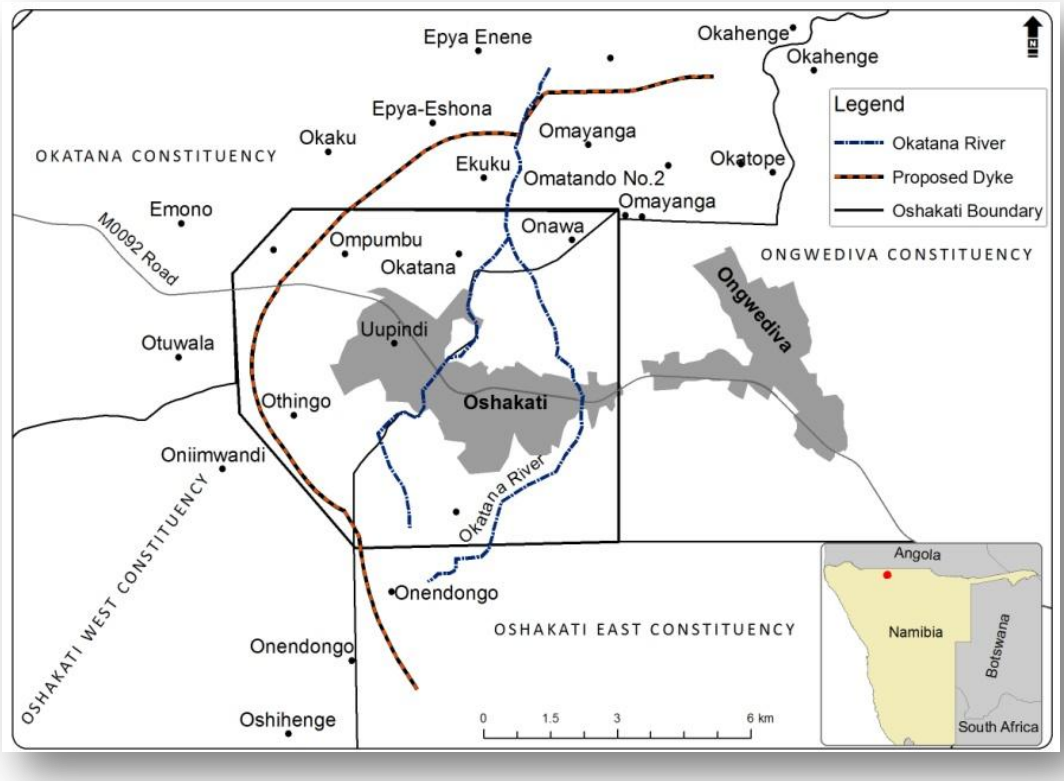
August 2012

PROJECT NAME	Draft Environmental Impact Report: Environmental Impact Assessment for the Proposed Mitigation Measures to be implemented for the Oshakati/Ongwediva area
STAGE OF REPORT	Draft to Client
CLIENT	Ministry of Regional and Government, Housing and Rural Development Oshakati Town Council Private Bag 5530 Oshakati Erf no. 0906, Sam Nujoma Road Tel: (065) 229500
LEAD CONSULTANT	Enviro Dynamics cc. Enquiries: Stephanie van Zyl Tel: (061) 223336 E-mail: stephanie@envirod.com
DATE OF RELEASE	August 2012
CONTRIBUTORS TO THE REPORT	Stephanie van Zyl, Eloise Carstens, Carla Saayman, and Sheldon Husselman. Summaries included of the specialist reports presented by Chris Muir, Ernst Simon, Shirley Bethune, Ben de Waal, and Arnold Bittner.

EXECUTIVE SUMMARY

Introduction

In March 2008, February 2009, and April 2011, heavy floods occurred in the Oshakati-Ongwediva area in northern Namibia (see map below)). The Oshakati-Ongwediva-Ondangwa area is regarded as one of the most important commercial, industrial and administrative nodes in Namibia. The urban area of Oshakati which is densely populated was heavily affected.



In order to find a permanent solution to the flooding problem in Oshakati, the Ministry of Regional and Local Government, Housing and Rural Development (MRLGHRD), in 2008, appointed the Buro of Architecture (BAR), a Belgium based consultant to compile a long term concept master plan for the town.

Besides various other proposals, the Concept Master Plan had two key components aimed at preventing future flooding of the town, namely:

- A dike (a structure similar to a dam wall) around the northern and western sections of Oshakati, diverting water to the south.

- Deepening of the Okatana River in Oshakati and lining of its banks with soil-crete or concrete where applicable.

Since these activities may not be undertaken without an Environmental Clearance Certificate (Government Notice No 29 of 2012), so as to ensure that on this project we do

> "*promote the sustainable management of the environment and the use of natural resources by establishing principles for decision making on matters affecting the environment (Environmental Management Act, 2007);*

and that its activities are assessed and appropriately controlled , since they may have significant effects on the environment.

The Ministry of Regional and Local Government and Housing and Rural Development therefore commissioned Enviro Dynamics cc to undertake the process of obtaining environmental clearance on their behalf.

The Legal Environment

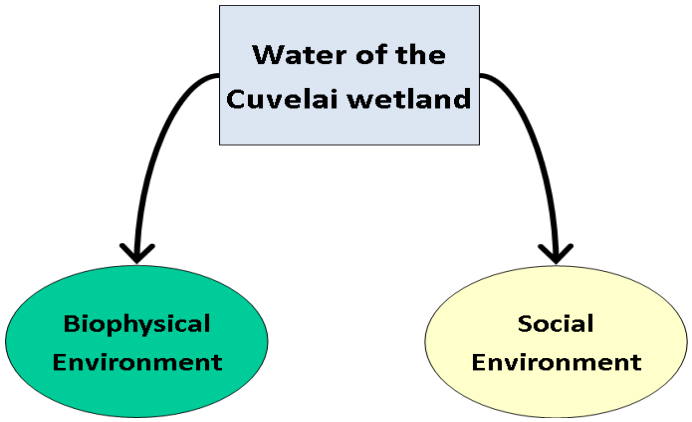
The legal and regulatory environmental which has a bearing on the decision-making process and implementation of this project is described in **Section 4** of this document. The main instruments of importance are the Environmental Management Act (2007) and its Regulations (January 2012) which gave effect to the Act, the Water Resources Management Act (2004), and the Ramsar Convention according to which the Cuvelai is an important feeder of water to the Etosha Pans, one of Namibia's Ramsar sites. These instruments require Government to think strategically about the best option for mitigating the flood problem in Oshakati and surrounds and to implement the most sustainable alternative.

Other instruments which require attention during the operations of the project are also listed in **Section 4**. They need to be incorporated into the Environmental Management Plan for the project.

The Receiving Environment

Since independence in 1991, Oshakati grew from a relative small and poorly developed town into a large urban settlement with modern buildings and services. The town is situated within the Cuvelai Delta which is characterised by shallow drainage channels called lishana with pockets or islands of higher lying land in between. The continued growth of the town meant that the pressure for suitable land in the town increased to a point where many people settled in lower lying areas on the edges of the higher lying land portions and sometimes even within the lishana. Since 2008, the Cuvelai delta experienced heavy rain and flooding which originates in the highlands of Angola and flows through the Cuvelai to the Etosha Pan. This led to substantial flooding of houses, homesteads and fields in Oshakati and its surrounds as well as throughout the Cuvelai delta.

Notwithstanding this pressure for available land, the Cuvelai wetland system provides a variety of renewable natural resources and vitally important ecological services. The collection and use of "free" wetland natural resources forms an important part of the livelihood of many people. In essence, both the social and ecological environments of the north-central parts of Namibia are sustained by the water of the Cuvelai wetland system (Figure below).



Importance of the water of the Cuvelai wetland in sustaining the biophysical and social environments.

The Cuvelai ecological, physical and social sensitivities are outlined in **Section 5** of this Environmental Impact Report. The resilience of these elements to withstand the changes proposed have been studied during the specialist studies.

Public Consultation

Consultation has been conducted in accordance with the Regulations of the Environmental Management Act (2007), during the scoping phase of the study. Consultation meetings were held in Windhoek (mainly with authorities and key stakeholders) and in Oshakati (authorities, key stakeholders and potentially affected community leadership).

The outcome of this process summarised in **Section 6**, but the details may be further studied in the separate Scoping Report.

Section 7 includes a list of all the issues raised, as well as a reference to where in this document they have been addressed.

Impact Assessment

For those issues that are relevant to this project and this EIA process, further specialist studies have now been conducted. This Environmental Impact Report contains a synthesis of the significant impacts identified (**Section 8**), while the specialist reports are annexed for further reference and details.

Conclusions and Recommendations

The following main areas of impacts have been gleaned from the detailed work during this study:

- Reduced flood risk, with additional space for future development, leading to local economic development. This will bring major positive change to the area.

- New flood areas to the West and North, with associated loss of livelihoods, assets, cultural sites and resettlement.

- Altered habitats, ecosystems and biodiversity resulting from altered water quality, flow, and direct habitat loss, both in Oshakati and downstream. This will influence the livelihoods of the local people who depend on the natural resources of the Cuvelai.

- Increased health and safety risks including the spread of Balharzia and Malaria associated with slow flowing water and, HIV/AIDS and other STDs during construction.

The main areas of mitigation to be implemented for these impacts are:

- The design and implementation of a resettlement and compensation action plan for the households to be affected by the backwaters of the dike.

- Altered design of the dike and Okatana River deepening and lining to embrace and resemble the *iishana* natural habitat, incorporating existing natural features such as islands and conservation worthy vegetation zones.

- The design of the sluice gate system to embrace and resemble the natural flow regime of the Cuvelai.

- Construction and excavation activities that are sensitive to the Cuvelai, keeping to natural contours, and rehabilitating altered terrain to resemble the original landscape as closely as possible.

- Close collaboration with the Ministry of Health and Social services in dealing with the spread of diseases Bilharziaand Malaria) and pandemics (HIV/AIDS and other STDs in a manner that would not compromise the integrity of the ecosystem.

- Ensure that the urban solid waste and sewage effluent is kept separate from the stormwater system in Oshakati. This will require the upgrading of the existing stormwater and solid waste management systems.

- Cooperation with the Ministry of Fisheries and Marine Resources to protect and sustain and perhaps supplement the fish resources of the project area.

- Otherwise the general and specific management and monitoring actions prescribed in the EMP need to be implemented for each stage of the project.

Final Analysis

- The project will affect a small part of the overall Cuvelai catchment and the waters flowing southwards towards Etosha.

- Therefore, if these requirements are adhered to, the project will generally hold a low risk to the people and the ecosystem of the Cuvelai and it is recommended that clearance be granted subject to these conditions.

- However, the flood challenge reaches much further than the current project area. Flood management of this nature duplicated regionally is expected to have severe implications, since the approach involves the implementation of reactionary measures. Therefore, the EIA Team brings to the attention of the decision makers the need for solving the flood challenge of the Cuvelai in a holistic and proactive manner, including attention to the following:

- Conduct a strategic study for the flood challenges of the Cuvelai, which aims at guiding development that would be in harmony with the natural processes of the ecosystem and providing sustainable long term solutions. The study will result in a development framework for future land use planning and flood management.

- Implement long term monitoring of the climatic and hydrological patterns of the entire Cuvelai, in collaboration with Angola.

The way forward

- This Draft Environmental Impact Report will be circulated to the stakeholders for comment, including a translated version of the executive summary.

- A feedback meeting will also be held for the community leadership in Oshakati.

- Comments will be incorporated and a comments and responses trail compiled. These will be submitted with the Final Environmental Impact Report to the Environmental Commissioner for clearance.

CONTENTS

LIST OF TABLES AND FIGURES

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

BAR	Buro of Architecture
BID	Background Information Document
CBD	Central Business District, Convention on Biological Diversity
CV	Curriculum Vitae
DEA	Directorate of Environmental Affairs
DRWS	Directorate of Rural Water Supply
DRFN	Desert Research Foundation of Namibia
DWAF	Directorate of Water Affairs and Forestry
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
EMP	Environmental Management Plan
GN	Government Notice
GRN	Government of the Republic of Namibia
I&AP	Interested and Affected Party
ISER	Institute for Social-Ecological Research
MASL	Metres above sea level
MAWF	Ministry of Agriculture, Water and Forestry
MET	Ministry of Environment and Tourism
MFMR	Ministry of Fisheries and Marine Resources
MHSS	Ministry of Health and Social Services
MME	Ministry of Mines and Energy

MOE	Ministry of Education
MRLGHRD	Ministry of Regional and Local Government and Housing and Rural Development
MWTC	Ministry of Works, Transport and Communication
NAMPOWER	Namibia Power Corporation
NAMWATER	Namibia Water Corporation
NCCI	Namibia Chamber of Commerce and Industry
NGO	Non Governmental Organisation
NORED	Northern Electricity Distribution
NPC	National Planning Commission
OC	Oshana Connections
PCDP	Public Consultation and Disclosure Plan
PDM	Probability Distributed Moisture
PPP	Public Participation Process
RON	Republic Of Namibia
SR	Scoping Report
SME	Small and Medium Enterprise
SEA	Social Environment Assessment
TOR	Terms Of Reference
UNAM	University of Namibia
VAT	Value Added Tax
WCE	Windhoek Consulting Engineers

GLOSSARY

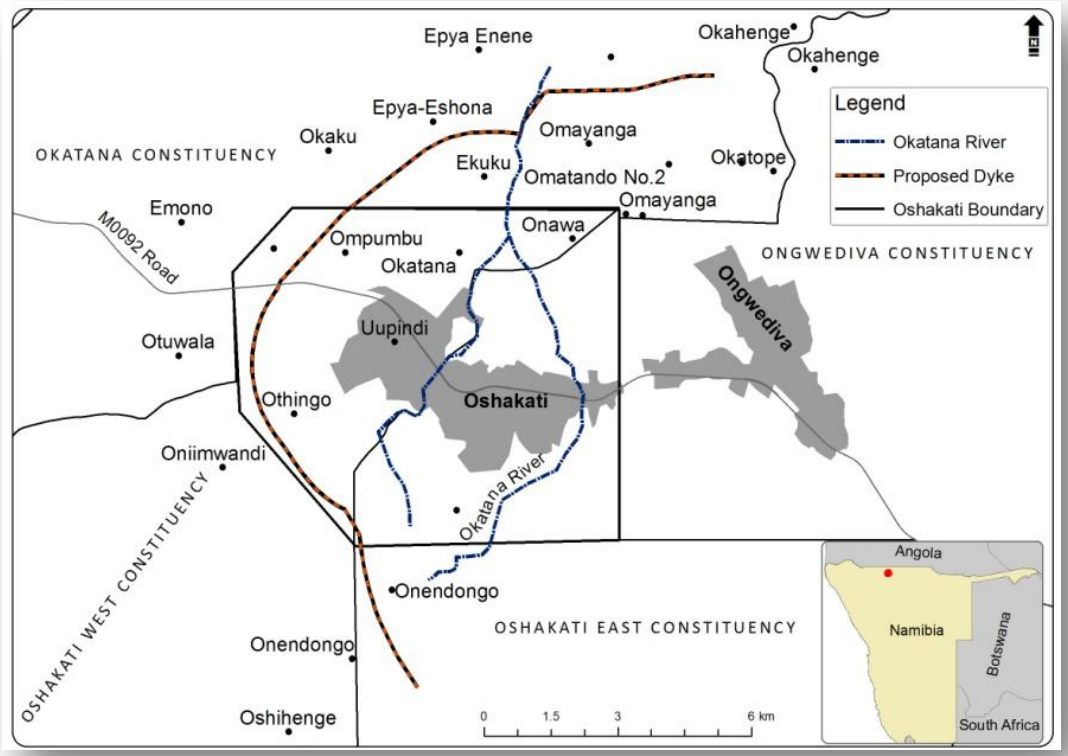
Crustaceans	Crustaceans form a very large group of arthropods, which includes such familiar animals as crabs, lobsters, crayfish, shrimp, krill and barnacles.
Cuvelai	The Cuvelai is a large drainage system which originates in Angola, its catchment falling between those of the Kunene River in the west and the Cubango/Okavango River in the east.
Dike	Dike is an earth wall, much like a dam wall which is designed to keep water in or out of a specific area is also a natural or artificial slope or wall to regulate water levels.
Endombe	Deeper water pools that hold water for longer periods. Several were artificially deepened about 50 years ago to improve water supply in the area. Ondombe – Singular of endombe
Endorheic	A closed drainage basin that retains water and allows no outflow to other external bodies of water.
Eutrophication	A natural or artificial addition of nutrients to bodies of water, also referring to the effects of the added nutrients, including algal blooms.
EIA	An assessment of the possible positive or negative impact that a proposed project may have on the environment, together consisting of the environmental, social and economic aspects.
Environmental Clearance Certificate	This Certificate obtained from the Ministry of Environment and Tourism (Directorate of Environmental Affairs) approving the EIA study and providing clearance to the proponent to initiate work.
Efundja	An irregular large flood event from higher up in the Cuvelai.
Geomorphological	The evolution and configuration of landforms.
Iishana	The local name for the system of interconnected drainage channels that flow through the central Owambo basin as part of the Cuvelai drainage basin (pl.: lishana).
Inter Alia	Amongst other things.
Omuramba	The local name for an ephemeral river or watercourse (pl.: omiramba)

Oshana	Local name for the system of interconnected drainage channels that flow through the central Owambo basin (Singular : Oshana, plural: lishana)
Paleo-Channel	A remnant of an inactive river or stream channel that has been either filled or buried by younger sediment.
Refugia	A local environment which provides a hieaway for fauna, often referring to fish.
Ramsar Convention	The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilization of wetlands.
Swamp	A type of wetland that is forested, and characterized by very slow-moving waters.
Sedges	Species of grassy plants in the family Cyperaceae. While sedges may be found growing in all kinds of situations, many are associated with wetlands, or with poor soils.
Sewage	Sewage is water-carried waste, in solution or suspension, that is intended to be removed from a community.
Scoping Report	A report, prepared to report on the Scoping Process of the Environmental Impact Assessment.
Stormwater	A permanent waterway/s designed to convey the stormwater runoff from an urban area.
Sluice Gate	Sluice refers to a movable gate allowing water to flow under it.
Tilapia	A type of fish that inhabits a variety of fresh water habitats, including shallow streams, ponds, rivers and lakes.
Veldkos	Means field food, refers to the native plants and animals of the veld.
Zooplankton	An organisms drifting in oceans, seas, and bodies of fresh water. It is a small organisms to be seen with naked eyes such as jellyfish

1 INTRODUCTION

1.1 BACKGROUND

In March 2008, February 2009, and April 2011, heavy floods occurred in the Oshakati-Ongwediva area in northern Namibia (**Figure 1**:). The Oshakati-Ongwediva-Ondangwa area is regarded as one of the most important commercial, industrial and administrative nodes in Namibia. The urban area of Oshakati which is densely populated was heavily affected.



igure 1: Locality map of proposed Oshakati Flood Mitigation Project.

In order to find a permanent solution to the flooding problem in Oshakati, the Ministry of Regional and Local Government, Housing and Rural Development (MRLGHRD), in 2008, appointed the Buro of Architecture (BAR), a Belgium based consultant to compile a long term concept master plan for the town.

Besides various other proposals, the Concept Master Plan had two key components aimed at preventing future flooding of the town, namely:

- A dike (a structure similar to a dam wall) around the northern and western sections of Oshakati, diverting water to the south (see **Figure 1**:).

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and that its activities are assessed and appropriately controlled since they may have significant effects on the environment.

The Ministry of Regional and Local Government and Housing and Rural Development therefore commissioned Enviro Dynamics cc. to undertake the environmental assessment process on their behalf.

1.2 THE EIA TEAM

The designated Environmental Assessment Practitioner (EAP) for this EIA process is Ms Stephanie van Zyl, in terms of Regulation 3 of the Environmental Management Act (2007), and her declaration for committing to the requirements of the Act for EAPs hereby follows.

DECLARATION

I hereby declare that I do:

(a) have knowledge of and experience in conducting assessments, including knowledge of the Act, these regulations and guidelines that have relevance to the proposed activity;

(b) perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;

(c) comply with the Act, these regulations, guidelines and other applicable laws.
I also declare that there is, to my knowledge, no information in my possession that reasonably has or may have the potential of influencing –

(i) any decision to be taken with respect to the application in terms of the Act and the regulations; or

(ii) the objectivity of this report, plan or document prepared in terms of the Act and these regulations.

The CV for Ms van Zyl is attached as ***Appendix A***.

The EIA Team for this Project is as follows.

COMPANY	LEAD SPECIALIST	RESPONSIBILITY
Enviro Dynamics	Stephanie van Zyl	EAP
Enviro Dynamics	Carla Saayman	Public Participation
WCE	Chris Muir	Hydrological impacts
LCE Consulting Namibia	Arnold Bittner	Geohydrological impacts
Urban Dynamics	Ernst Simon	Socio-economic impacts
Polytechnic of Namibia	Shirley Bethune	Ecological impacts
	Ben Van der Waal	Fish and fisheries impacts

2 TERMS OF REFERENCE

2.1 TERMS OF REFERENCE PROVIDED

The Terms of Reference issued for this assignment is attached as ***Appendix B.*** The document describes the original project description, which has changed since inception, as described in **Section 3** of this report.

As far as the Scope of Work is concerned, the following is provided in the TOR:

> *A socio-economic study must be conducted to address the implications of the temporary and permanent relocation of residents within the Townlands as necessitated by the new Concept Master Plan.*
>
> *An Environmental Impact Assessment must be conducted for the mediation measures indicated above.*
>
> *Both the study and the EIA must be conducted in strict accordance with all relevant current and anticipated legislation.*

2.2 LIMITATIONS

Following the TOR presented, a few adjustments were proposed in order to get the process in line with the requirements of the Environmental Management Act and its regulations. The proposal submitted reads as follows:

> *Our team regards this (i.e. the scope of works provided by the Client, quoted in 2) as a fragmented approach because the mediation measures may have substantial social impacts beyond the boundary of the Townlands while the concept master plan may also have substantial ecological impacts. In addition, the law requires that the concept master plan also be subject to environmental assessment. Omitting this would be unacceptable to the Ministry of Environment and Tourism.*
>
> *It is therefore proposed that, in the interest of the quality of the assessment and complying with the Environmental Management Act, (as required in the TOR) these components be combined into an Environmental and Social Impact Assessment (ESIA) and handled as one integrated assessment which will satisfy all requirements of the TOR.*

However, the Ministry has made it clear that the Concept Master Plan has already been approved by Cabinet and is therefore excluded from the Scope of Works of this EIA. It is only expected of the Consultant team to consider the impacts of the proposed Dike and Okatana River Channelling, and to propose mitigation measures to address the impacts.

Therefore, the following are missing steps to make the process complete in terms of the Environmental Management Act:

- The associated Concept Master Plan components have not yet been subjected to an environmental assessment.
- Alternatives to the proposed mitigation measures are therefore not available.

Since the appointment of the consultants, a third component was added to the project, namely a stormwater system for Oshakati. However, details of the system as not yet available and are therefore not included in this assessment. The stormwater system will need to integrate environmental considerations.

Limitations to the methodologies followed by the specialists, especially the hydrological modelling are mentioned in the various specialist reports.

2.3 METHODOLOGY AND WORK PLAN

The aims of the study are to:

Implement a robust Public Consultation and Disclosure Plan (PCDP) for the period of the environmental assessment, by ensuring that all stakeholders understand the implications of the project and are capacitated to make informed contributions.

Develop a thorough current and future "Without Project" baseline so that ecological and social factors are fully integrated into the design of the Project.

Work closely with the Client, the engineering and planning teams, contributing to the appraisal of alternatives and decisions on design and mitigation measures, so that measures can be integrated into the Project proposals of the earliest stage.

Provide strategic solutions that are sustainable, relevant locally and that are feasible and affordable for ecological and social management and monitoring during the different phases of project development, including guidance on management plans for environmental protection, resettlement and land acquisition, and capacity building in the local authority.

An overview of the work plan is provided in **Figure 2**: below.

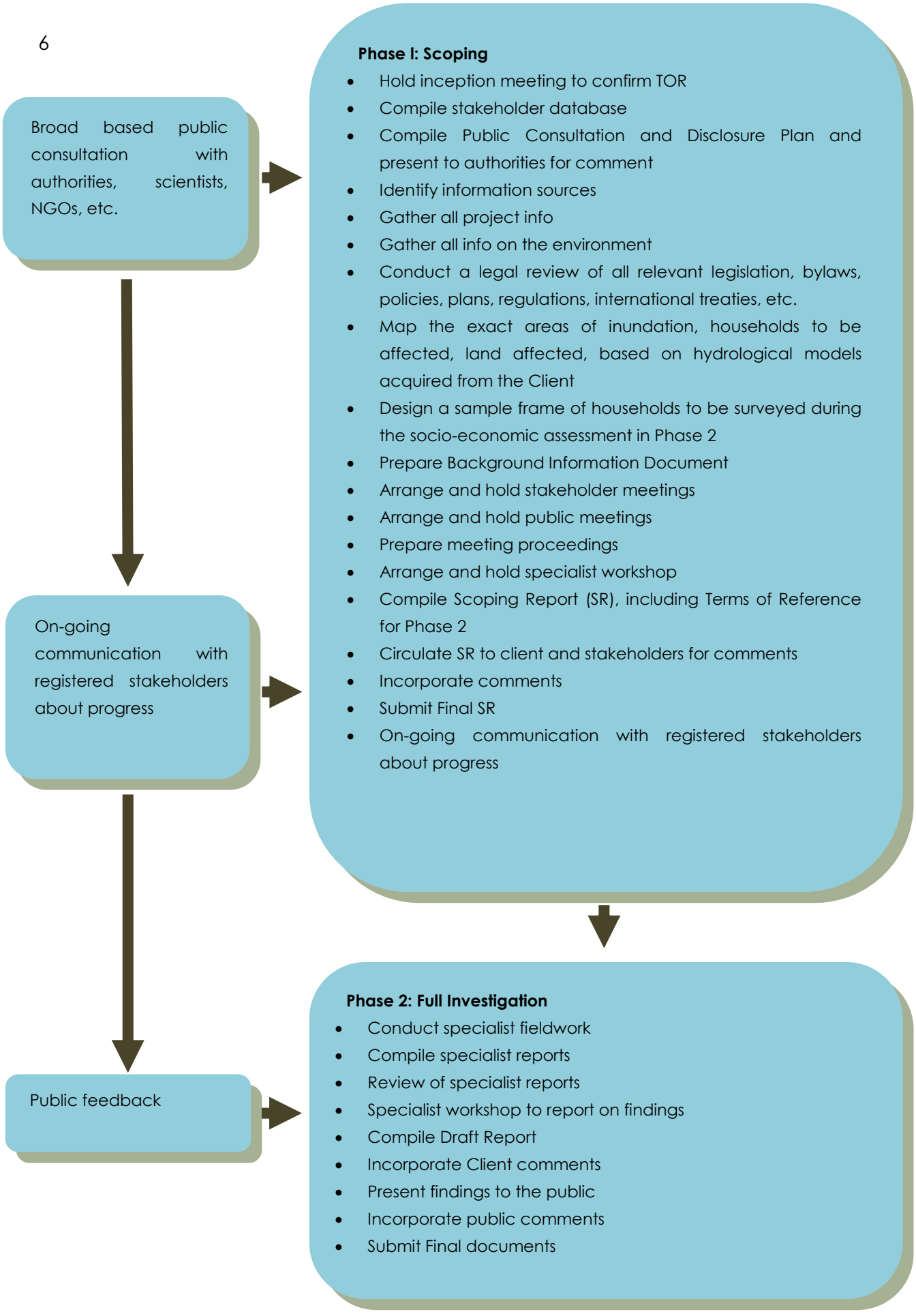

Figure 2: Work plan for the Environmental Assessment

3 PROJECT DESCRIPTION

3.1 RATIONALE

The Oshakati-Ongwediva-Ondangwa area is regarded as one of the most important commercial, industrial and administrative nodes in Namibia. The recent floods affected the lives of thousands of people residing in low lying areas.

The urban area of Oshakati, where a high density of people reside, was heavily influenced with access to schools, clinics and businesses affected and many households flooded to a point where the Government of Namibia and the Oshakati Town Council had to provide relief to the flood victims. Reportedly, about 3414 people (984 hh) were displaced in 2008, 2221 in 2009 (708 hh), 1402 in 2010 (377 hh), 2522 in 2011 (813 hh) and 506 so far in 2012 (155 hh). **Figure 3** provides an indication of the extent of the floods in the area.

Besides the direct effect the flooding has on residential areas, it also has a very negative influence on business at the town. Many businesses have to close during the flood period resulting in loss of income for both business owners and their employees. The floods also cause great damage to municipal infrastructure such as water supply, sanitation systems, roads and bridges.

The past informal settlement and development of the townlands as well as a lack of an effective local stormwater management system contributes significantly to the flood conditions.

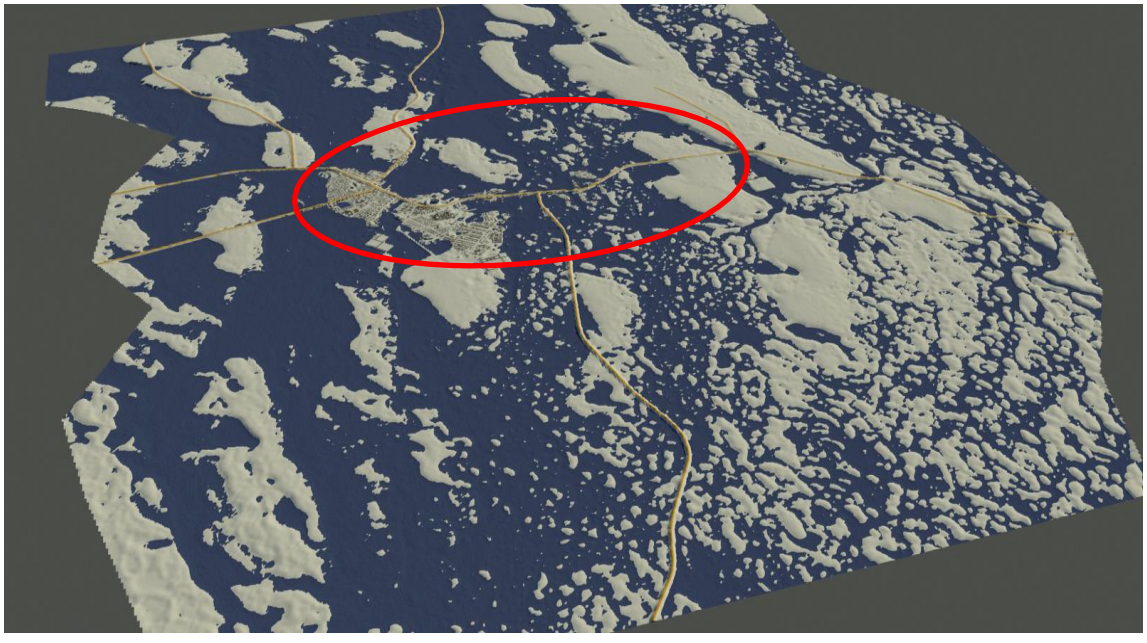

Figure 3: Current flood regime

Figure 4: The Proposed Oshakati Concept Master Plan.

In order to find a permanent solution to the flooding problem in Oshakati, the Ministry of Regional and Local Government, Housing and Rural Development (MRLGHRD), in 2008, appointed the Buro of Architecture (BAR), a Belgium based consultant to compile a long term concept master plan for the town (**Figure 4**).

Besides various other proposals, the Concept Master Plan had ***two key components aimed at preventing future flooding*** of the town.

Firstly, it is proposed that a dike be constructed from the Ongwediva high ground in a westward direction north of the current Town of Oshakati, turning south on the western side of the town (**Figure 5**).

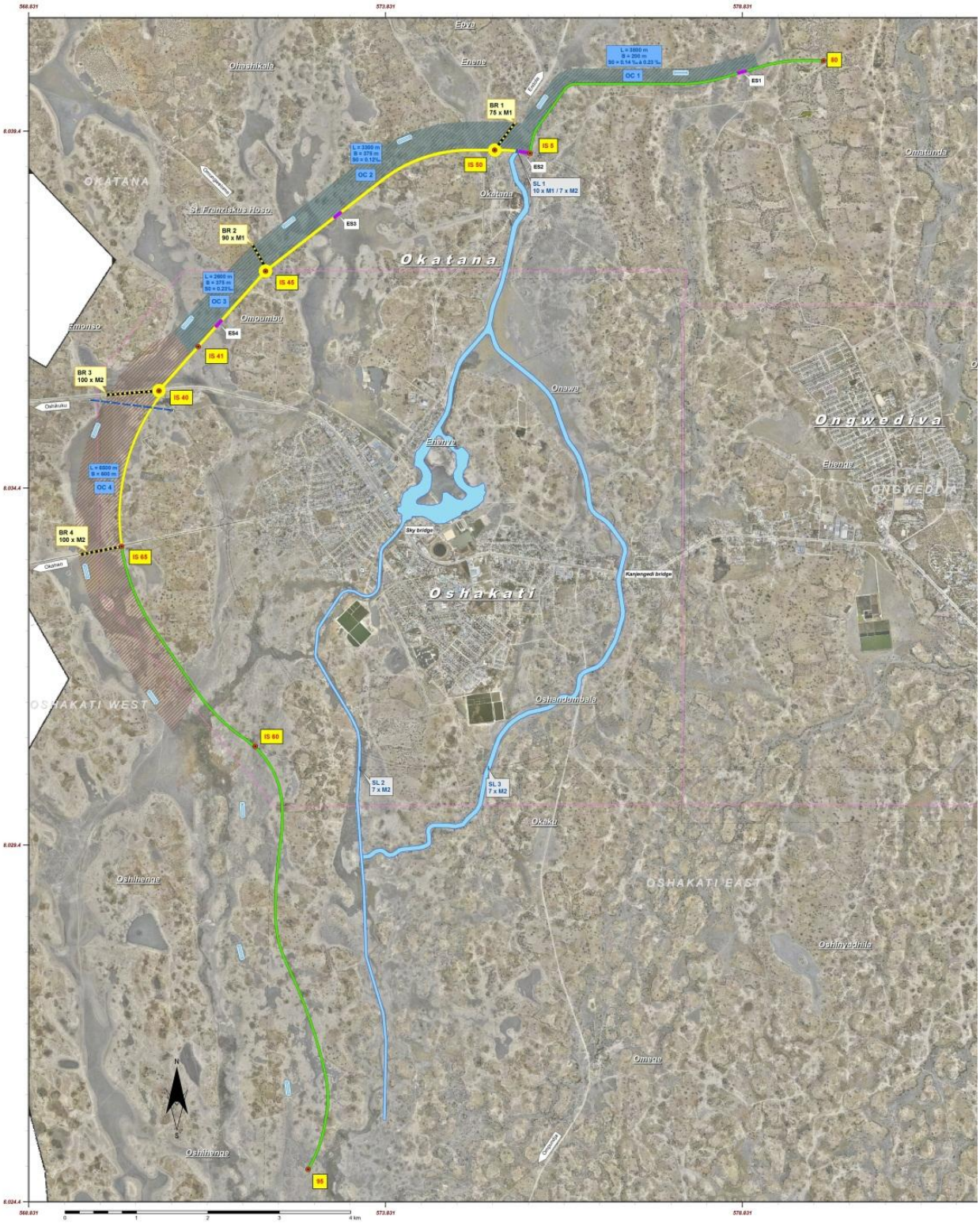

Figure 5: Overview of the proposed Oshakati flood protection measures.

This dike will be fitted with a series of sluice gates to let some water into Oshakati but enable water flow to be closed as soon as the water levels inside the town reach a certain level (**Figure 6**).

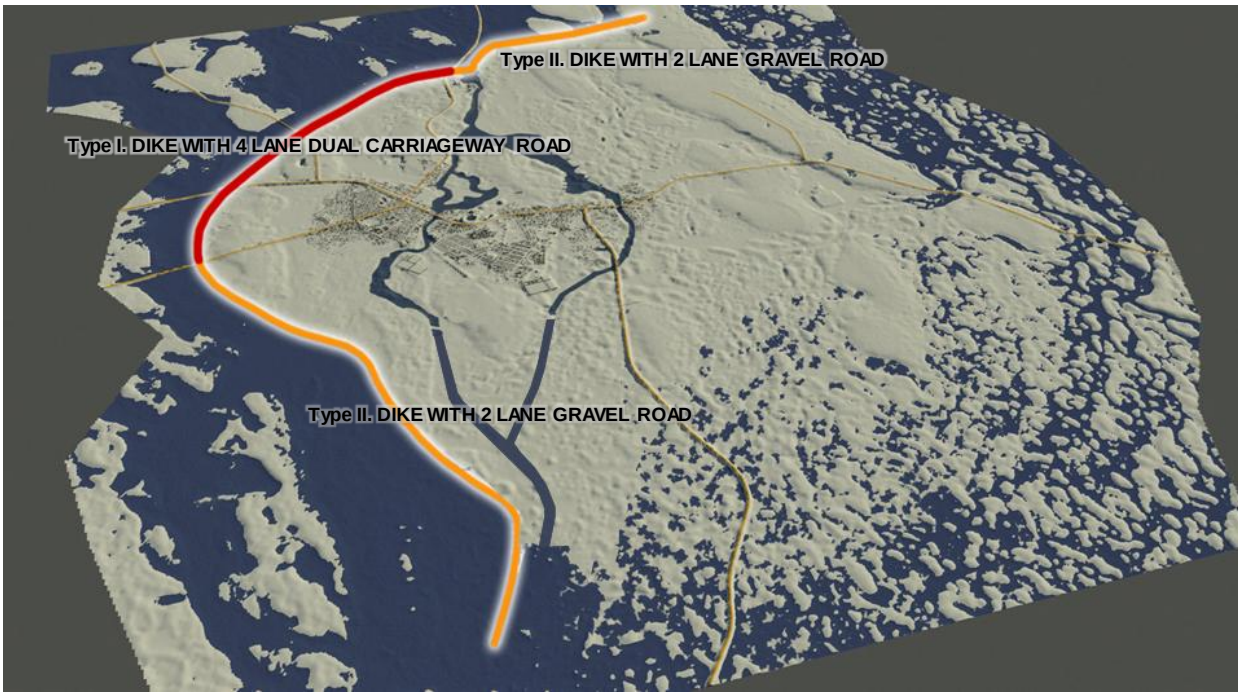

Figure 6: Expected flood patterns after the dike

The second component consists of the deepening and lining of the Okatana Channel in order to accommodate and manage the stormwater from the new stormwater system.

A third component is the development of a new internal stormwater system for the town of Oshakati. It was realised that due to the flat topography, even if the Cuvelai flow is kept out of town, local rainfall and runoff will still cause substantial flooding unless an effective stormwater system is installed.

3.2 THE PROPOSED DIKE

In essence, a dike is an earth wall, much like a dam wall which is designed to keep water in or out of a specific area.

The first step in the design is to develop a reliable flood model. The following components are considered in the hydrodynamic model:

- the dike
- the inner lishana
- the Oshana connections (the main streams)

- new bridges
- deepening of the Okatana river section in Oshakati

The model therefore has to evaluate the surface flood in the main Oshana streams as well a local storm water conditions (**Figure 7**). It is also important to ensure that the backwater will not flow back into Oshakati from the south during extreme flood conditions.

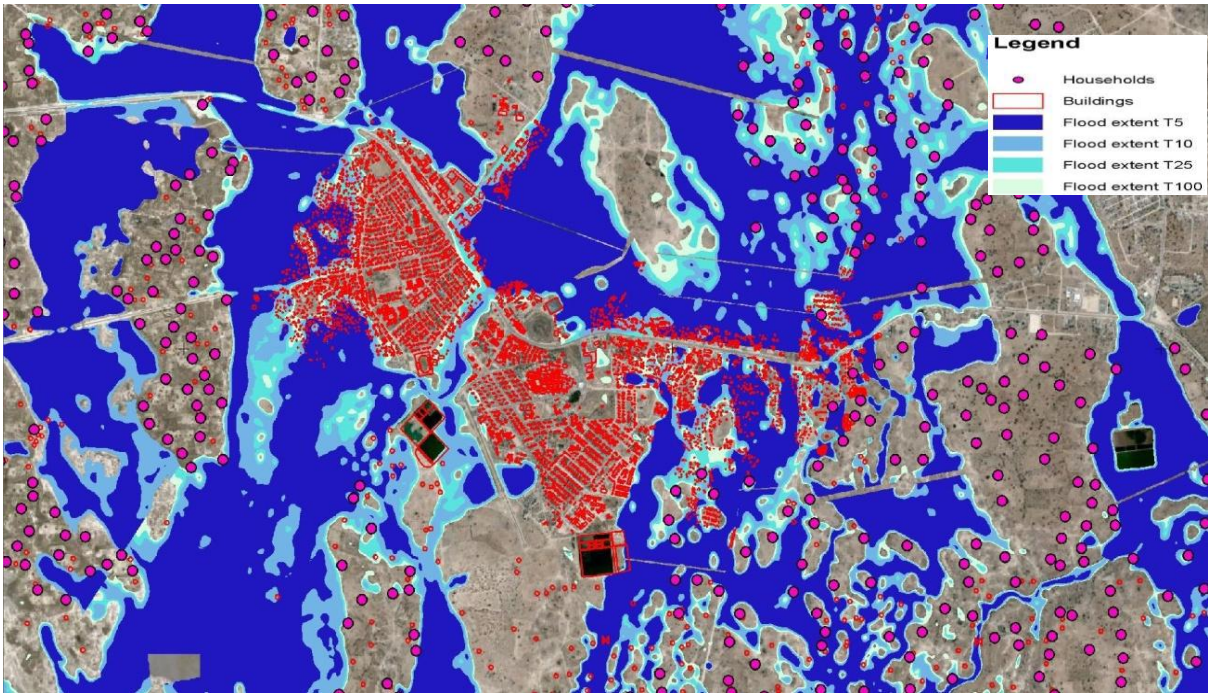

Figure 7: Flood model before the mitigation measures

The 200 year flood level has been determined using the hydrological and hydraulic model which has been developed with the support of the Department of Water Affairs and the EIA Team[1].

The proposed dike for Oshakati will be approximately 26km long and 44m wide (**Figure 5**). The crown height of the dike will be between 2.0-3.1m, relative to the existing oshana bed level.

This level corresponds to the maximum water level of the design flood (return period of 200 years).

A free board of at least 0.5m has been allowed for, considering the effect of wind waves and as extra safety. At three locations the dike height will correspond to the

[1] A separate document is available with further details of the hydraulic and hydrological models.

maximum water level of the design flood, thus not taking into account this free board. At these locations the dike will be protected to prevent erosion even when dike overtopping occurs.

The initial dike height will be higher to take into account future settlement of construction material. The southern extension of the dike past the townlands of Oshakati is necessary to avoid backwater flowing into the town from the south.

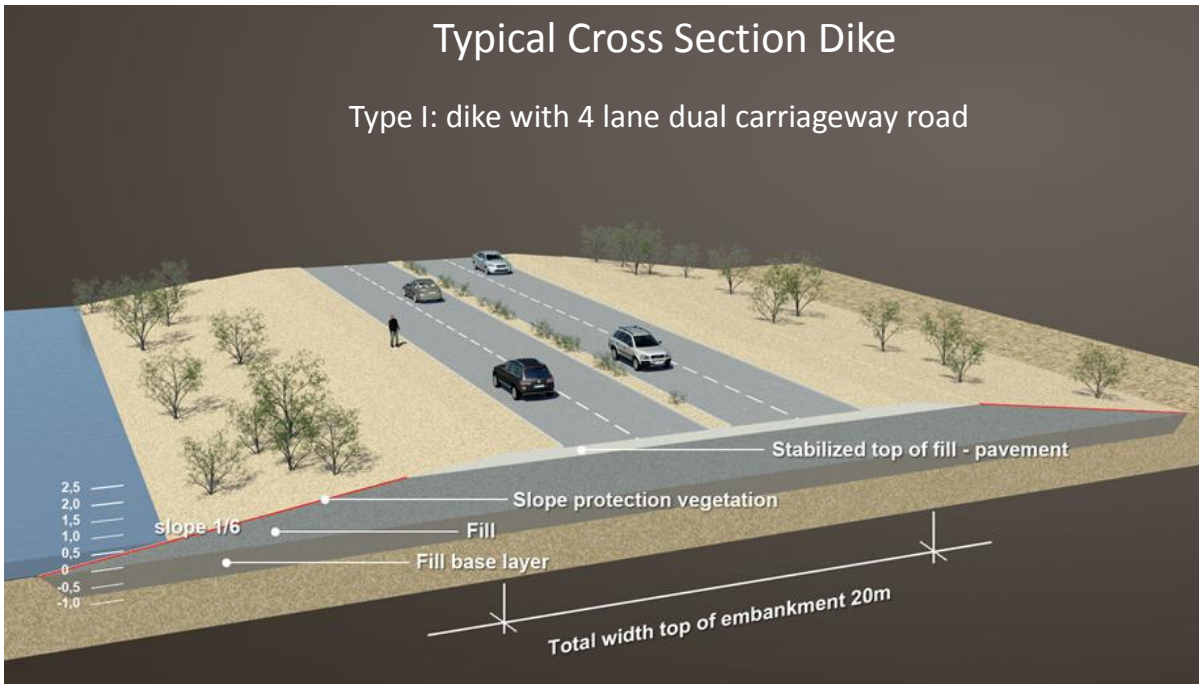

Figure 8: Section of the dike

The dikes will have a slope protection such as geo-cells filled with concrete at the water side to avoid erosion, the details of which will be designed according to the soil characteristics. At the land side a cemented gravel slope protection is foreseen. A drainage system is planned that will discharge ground water from the dike when the water level at the outside drops faster than the ground water level within the dike. The dike slopes will be flat enough so that animals can cross them and to avoid people not to fall in the water by accident (**Figure 8**).

All natural vegetation including large trees will be cleared from the footprint area of the dike to ensure a good foundation.

On top of the dike a dual carriage way (60m road reserve) will be constructed between the road to Endola (D3610) and the road to Okahao (C41) (red line in **Figure 5**) in order to divert traffic around the town. On the other parts of the dike a service road is foreseen (yellow line in **Figure 5**).

The ring road will have a limited access only at the intersections with the trunk roads entering Oshakati. These intersections will be designed as roundabouts with a large

radius to avoid the need for and maintenance of robot controlled intersections. The ring road is being considered in conjunction with the Roads Authority.

Provisions will have to be taken to prevent pedestrians and cyclists to use and cross the ring road. Therefore an acceptable alternative routing for these road users is essential.

Due to the construction of the dike around Oshakati, a part of the flow from the northern oshana has to be diverted around the town. This diverted flow will be directed west. Some obstacles prevent water of flowing fluently downstream. For this, three so-called 'Oshana Connections' (OCs) have to be excavated through the ridges currently separating the oshana.

It is proposed that a road would eventually be built on top of the dike and in some places; it could even accommodate a railway line (**Figure 5**).

In addition to the dike, it is also proposed that a 300m wide channel be made to the north and west of the dike. This channel will be deepened to allow water to flow in a westward direction.

To be able to control the flow of water into the town, sluice gates will be installed (**Figure 9**). These will be used to regulate the flow of water into the town. In times of high floods, these sluices will be closed (manually operated) to prevent too much water from entering the Okatana River system where it goes through town. An operating manual with alarm levels will be provided to the Town Council at the end of the works to serve as a guideline when to open and close the sluices.

Figure 9: Sluice gates

Since the widening of the Oshana Connections intersect with existing roads, new and wider bridges will be constructed. Both sluices and bridges are designed using the same type of precast concrete culvert modules, M1 and M2. M1 is 3.6 m wide and 1.2m high, while M2 is 3.6m wide and 1.8m high.

3.3 PROPOSED CHANGES TO THE OKATANA RIVER

The Okatana River will be retained, but modified to act as a focal point for storm water during wet times of the year (**Figure 10**). Low flows from north of the dike system will be allowed to enter the river, but high flows will be diverted through the use of the sluice gates. The river system will therefore act as the main stormwater collector for rainwater inside the dike area.

The system is ephemeral, thus it will not flow all the time. During the rainy season, fresh water would normally enter the system and then dry up again through the course of the dry season, only to be filled again during the rainy season. The discharge and the water level in the inner channels are controlled by manually operable sluices built into the dike system.

The initial concept was to have a wide water feature that runs through Oshakati which will enable water sport activities and other landscaping features such as a waterfront. However, this concept requires further development and design to address anticipated problems such as pollution, standing water creating mosquito breeding grounds and keeping the system full of water year round.

Since this feature is not yet designed in detail, it will not be covered by this EIA.

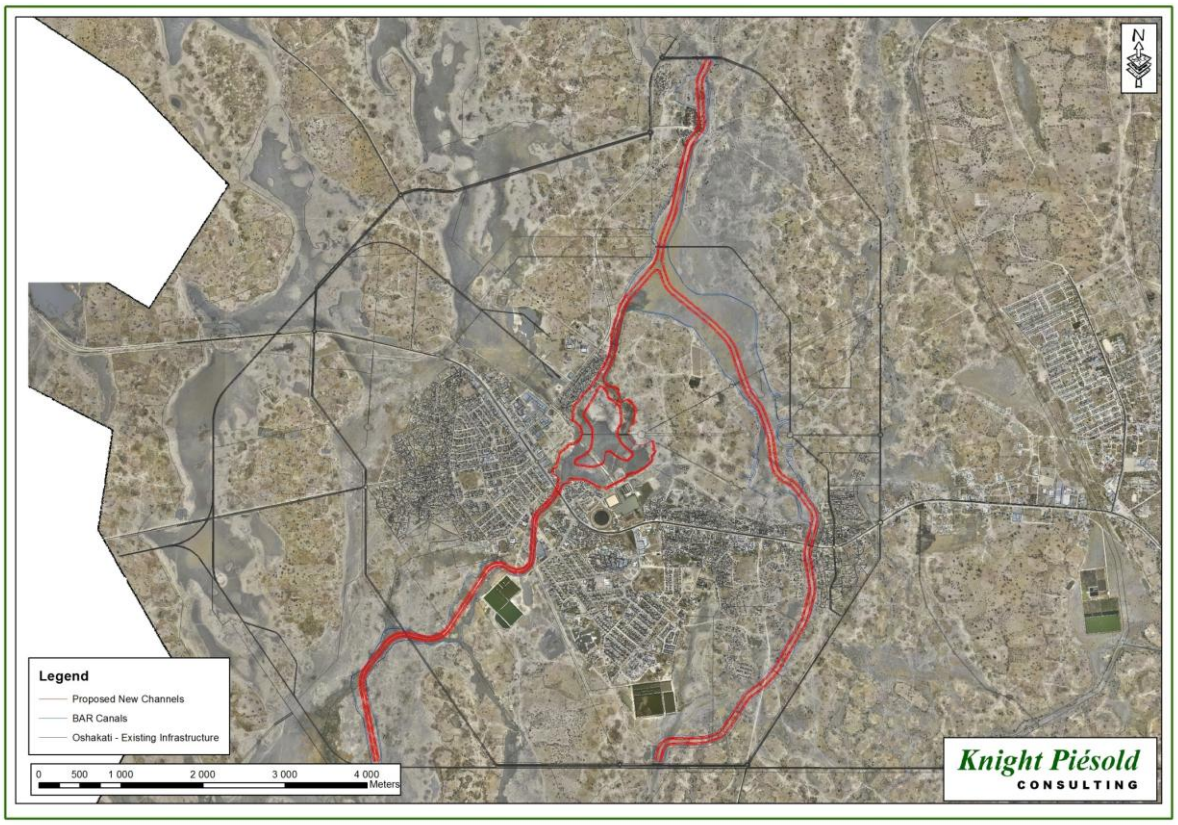

Figure 10: Proposed deepening and extensions of the Okatana River

The current plan is to deepen and line the edges of the Okatana River as it winds through Oshakati.

The current design has a width of 60m for the upper channel, and 40m for the two lower channels. The channel will follow the centreline of the existing riverbeds. The existing river crossings such as the Skye Bridge and the Ompundja road culverts will be replaced with bridge structures that accommodate the width of the channel.

The bottom of the river will be lined with 3, 200 mm thick, layers of compacted clay material. The banks will be lined with 2 layers of compacted clay material and a third layer soil-crete or concrete where applicable (**Figure 11**). The top and bottom of the bank will be protected by a concrete toe. The toe at the bottom will be used as a guide for future clearing of silt reintroduced into the system.

The embankments will be sloped at 1:4 to allow for safe access or exit of both animals and humans.

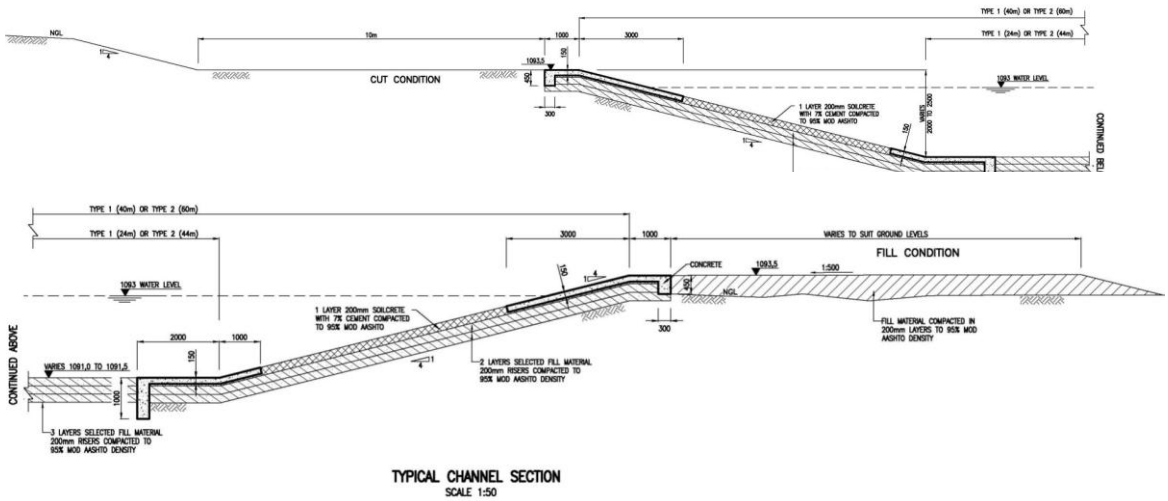

Figure 11: Typical channel sections under cut and fill conditions

The deepening will need to be to a level where it can act as the main stormwater collector for the internal stormwater drainage system. The capacity is designed to accommodate a flood return period of 50 years. In order to ensure adequate flow, the deepening will have to continue for a distance of about 10km to the south of the Oshakati Dike end.

The material that will be removed during the deepening of the channel will be used to fill flood prone areas in Oshakat to reclaim land for development (see **Figure 12**).

Deepening of the Okatana River System will also require the siphoning or removal and re-installation of municipal utility services that cross the river such as main water lines, main sewer lines, roads and bridges and electricity transmission and distribution lines. For the NamWater Canal, a siphon will need to be built underneath the river to ensure continued water supply.

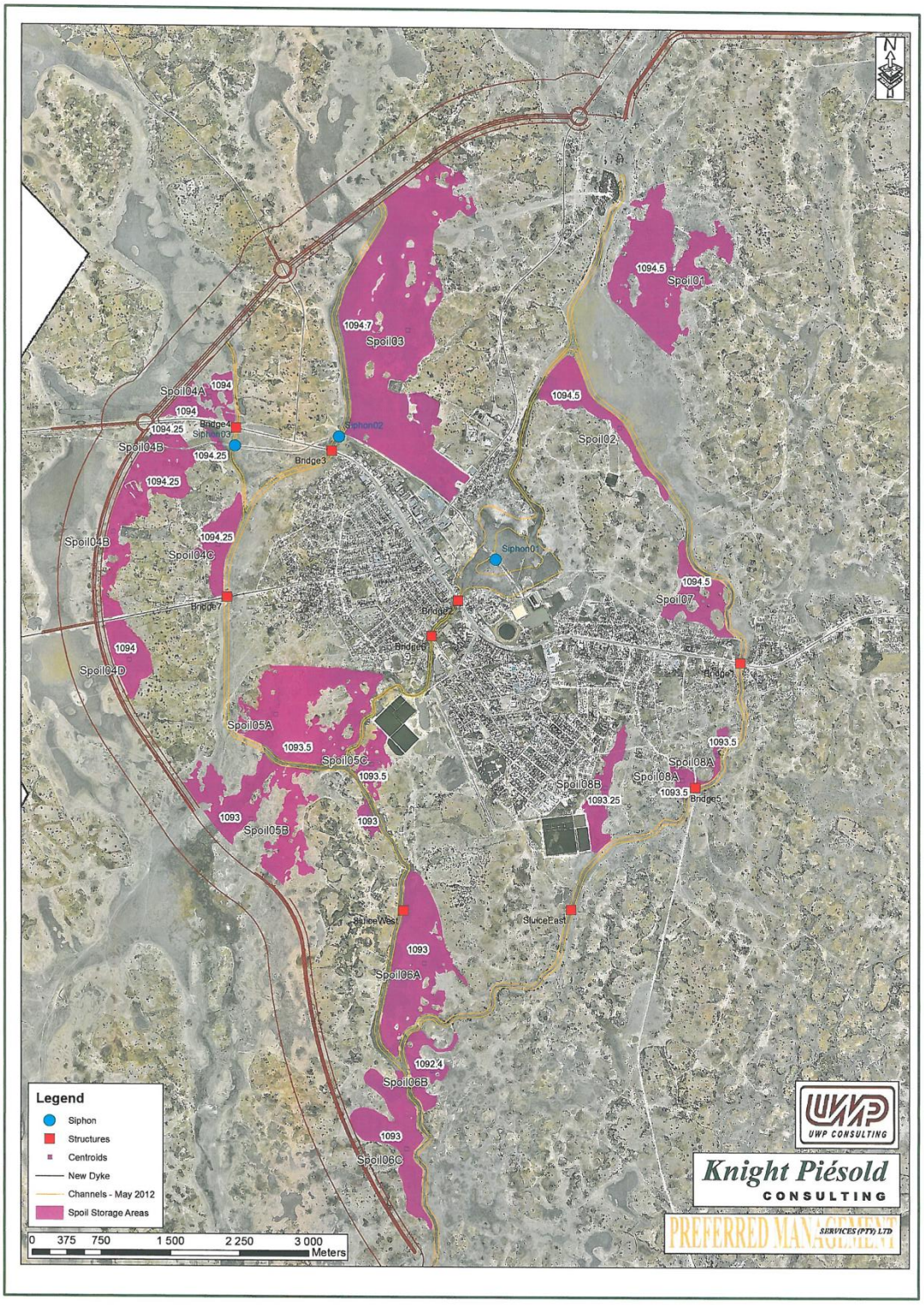

Figure 12: Areas to be filled with spoil material

3.4 INTERNAL STORMWATER

In order to address stormwater generated through rainfall inside the town, a conceptual stormwater design has been completed. The conceptual design will take both the current developed area of Oshakati as well as the area covered by the Concept Master Plan into account. Three drainage levels will be used namely rivers (which is the Okatana River system discussed above), major stormwater channels which will take stormwater from the minor drains into the river system and minor drains which collect stormwater from within the residential areas and streets and feed it into the major drainage channels.

In order to ensure adequate fall from the residential and business areas on the edges of town, the depth of the Okatana River system design will also be informed by the needs of the internal stormwater system.

3.5 PROJECT COSTS

A detailed bill of quantities and cost estimate has been prepared based on the design drawings.

In order to have the main purpose of the works (i.e. flood protection) realised as soon as possible and to spread the budget needs, the works are planned in phases.

The total amount of tasks is largely dependent on the method of construction and on the concept of certain parts of the works. The current cost estimate amounts to N$ 1,786,625,449.00 (exclusive VAT), for all the various components combined.

4 LEGAL AND REGULATORY REQUIREMENTS

The legal environment of this project can be divided into two central themes. The first is the statutes that have **strategic planning implications** for the project. This theme includes local and international statutes that has a bearing on this project and therefore need to be considered in the strategic planning phases of the project. The second theme relates to the statutes that have **project management implications** and consequently need to be considered in the implementation of the EMP. The statutes, according to these two themes, are listed below:

4.1 STRATEGIC PLANNING STATUTES

STATUTE	PROVISIONS	PROJECT IMPLICATIONS
NAMIBIAN LAWS		
The Constitution of the Republic of Namibia	Chapter 10 Article 91: The Ombudsman - Functions The functions of the Ombudsman shall be defined and prescribed by an Act of Parliament and shall include the following: The duty to investigate complaints concerning the over-utilization of living natural resources, the irrational exploitation of non-renewable resources, the degradation and destruction of ecosystems and failure to protect the beauty and character of Namibia; Chapter 11 Article 95: Promotion of the Welfare of the People. The State shall actively promote and maintain the welfare of the people by adopting policies that are aimed at maintaining ecosystems, essential ecological processes and the biological diversity of Namibia. It further promotes the sustainable utilization of living natural resources basis for the benefit of all Namibians, both present and future.	Aim towards achieving sustainable development by maintaining the ecological integrity of the ecosystems for the welfare of the Namibian people.
Environmental Management Act	Schedule of listed activities requiring an Environmental Clearance Certificate –	Follow the requirements of the Act to ensure sustainability of the

STATUTE	PROVISIONS	PROJECT IMPLICATIONS
(2007) and the Environmental Management Regulations (2012)	the following are applicable: • The establishment of land resettlement schemes. • Construction of canals and channels including the diversion of the normal flow of water in a riverbed. • Riverbed and water transfer schemes between water catchments and impoundments. • Construction of dams, reservoirs, levees and weirs. • Alteration of natural wetland systems. • Construction and other activities in water courses within flood lines. • Public roads; • Railways and harbours; • Prescribes the procedures to the followed for public participation. • Prescribes the procedures to be followed for authorisation of the project (i.e. Environmental clearance certificate) • Prescribes the contents of the Scoping Report and the Environmental Report.	project. Borrow pits should be constructed in such a way that they do not expose groundwater or pollute, block or deflect any surface water and its flow.
Water Act 54 of 1956 **Water Resources Management Act 24 of 2004**	The Water Resources Management Act is presently without regulations; therefore the Water Act is still in force. A permit application in terms of Sections 21(1) and 21(2) of the Water Act is required for the disposal of industrial or domestic waste water and effluent. Section 23 (1): Prohibits the pollution of underground and surface water bodies. Section 23 (2): Liability of clean up costs after closure/ abandonment of an activity. Protection against surface and underground water pollution. XIV Section 78 (1); Section 84 (1c)	Obligation not to pollute surface water bodies. The following permits are required in terms of the Water Act: • water abstraction permits; • domestic effluent discharge permits (site offices, construction camp); • industrial effluent discharge permits; • water use for dust suppression; and • water reticulation permits (pipelines). • No person may engage in any construction activity that may impound, block or otherwise impede the flow of water in a watercourse particular when it contributes to a flooding risk.

STATUTE	PROVISIONS	PROJECT IMPLICATIONS
		Although this Act has not commenced yet, the implications of the act remains applicable and should be abided by.
Public Health Act 36 of 1919	Provides for the prevention of pollution of public water supplies.	Potential pollution of the Cuvelai to be considered. A general obligation for the Contractor not to pollute the water bodies in the area.
RoN Revised Compensation Policy and Guidelines	Provides for compensation and resettlement of affected households so that they are not worse off post-project. Compensation rates and methodologies for negotiations are provided in this policy.	People to be compensated and resettled because of this project need to be treated in accordance with this policy.
INTERNATIONAL TREATIES		
Convention on Biological Diversity (CBD)	Namibia is obliged under international law to conserve its biodiversity.	Projects should refrain from causing any damage to the country's biodiversity.
United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa, 1994	Namibia is bound to prevent excessive land degradation that may threaten livelihoods.	This is a general requirement to be considered in all projects.
Ramsar Convention on Wetlands, 1971	Namibia is a signatory to this intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The Etosha Pan is one of the four Ramsar Sites in Namibia. The site and surrounding area play an important role in local hydrology.	Needs to be considered during the implementation of the project.

4.2 PROJECT MANAGEMENT STATUTES

STATUTE	PROVISIONS	PROJECT IMPLICATIONS
Atmospheric Pollution Prevention Ordinance 45 of 1965	• Part II - control of noxious or offensive gases, • Part III - atmospheric pollution by smoke, • Part IV - dust control, and • Part V - air pollution by fumes emitted by vehicles.	• Application for an Air Emissions permit.
Forest Act 12 of 2001	Provision for the protection of various plant species. No regulations promulgated yet. Section 22(1): It is unlawful for any person to "cut, destroy or remove: • any vegetation which is on a sand dune or drifting sand or on a gully unless the cutting, destruction or removal is done for the purpose of stabilizing the sand or gully; or • any living tree, bush or shrub growing within 100 metres from a river, stream or watercourse on land that is not part of a surveyed erf or a local authority area without a licence.	• Vegetation in water courses to be protected from damage. Intended removal of such vegetation would require a permit.
Hazardous Substances Ordinance 14 of 1974	Control of substances which may cause injury or ill-health or death of human beings because of their toxic, corrosive, irritant, strongly sensitising or flammable nature, and for the control of certain electronic products and radioactive material. Does not regulate the transport or dumping of hazardous substances. Regulations only relate to the declaration of certain substances as hazardous substances.	• The handling and storage of hazardous substances on the Project Site should be carefully controlled. • Disposal of hazardous substances needs to be carefully controlled.
Minerals (Prospecting and Mining) Act 33 of 1992	Provides for the reconnaissance, prospecting, mining, disposal and control of minerals in Namibia. Section 91 (f): EIA to accompany the mining licence application "indicating the extent of any pollution of the environment before any prospecting or mining operations are carried out and an estimate of the pollution likely to be	Large scale borrow material will be needed for the construction of the dike. These borrow pits need to be assessed in terms of the damage caused. Reclamation and rehabilitation of disturbed land to be addressed.

STATUTE	PROVISIONS	PROJECT IMPLICATIONS
	caused by the proposed activities. In case pollution is likely to be caused, an EMP is to be submitted to the Mining Commissioner indicating the proposed steps to minimise or prevent the pollution.	
National Heritage Act 27 of 2004	Part V Section 46; Section 48; Section 51 (3) Part VI; Section 55 Paragraphs 3 and 4.	Prohibits the removal, damage, alteration or excavation of heritage sites or remains. The Act also sets out the requirements for impact assessment and requires that any person who discovers an archaeological site should notify the National Heritage Council. Grave sites are of concern in the project area.
Nature Conservation Ordinance 4 of 1975	Prohibits *inter alia* the hunting of and protection of wild animals, and the protection of indigenous plants. Prohibits disturbance or destruction of the eggs of huntable game birds or protected birds without a permit. Requires a permit for picking (the definition of "picking" includes damage or destroy) protected plants without a permit.	Damage to protected plants need to be prohibited. In case there is an intention to remove protected species, then permits will be required.
Preservation of Trees and Forests Ordinance	Protection to tree species.	The Contractor will require a permit to remove any protected trees.
Soil Conservation Act 76 of 1969	Prevention and combating of soil erosion; conservation, improvement and manner of use of soil and vegetation, and protection of water sources. The Minister may direct owners or land occupiers in respect of *inter alia* water courses. No Regulations exist to this effect.	Removal of vegetation cover to be avoided and minimized at all costs. The mining area to be rehabilitated concurrently with operations where practical.
Petroleum (Exploration and Production) Act 2 of 1991	• Prevention of pollution of aquifers, rivers, streams, borehole, etc. • Inspections of proper health and safety requirements may be carried out. Requires precautions for proper rehabilitation.	• The Contractor to act diligently to avoid pollution of the riverbeds, and to ensure diligence in terms of health and safety of the workforce. • Proper rehabilitation to be carried out. Ensure proper handling of petroleum products and reporting of spills to MME.

STATUTE	PROVISIONS	PROJECT IMPLICATIONS
Petroleum Products and Energy Act 13 of 1990 **Regulations relating to the purchase, sale, supply, acquisition, usage, possession, disposal, storage, transportation, recovery and refinement of used mineral oil GN 112 of 1991** **Petroleum Product Regulations GN 155 of 2000**	1991 Regulations control the disposal, destruction, transport of oil. Petroleum Products Regulations 2000. Licence required for a petroleum products consumer installation and the Minister to take into consideration *inter alia* the protection of the environment and the suitability of the site. Licence required for storing >1000ℓ of petroleum. General duty to prevent social or environmental harm in storing, keeping, handling, conveying, using or disposing of any petroleum product. Provides conditions regarding petroleum spills and site abandonment. Annual reports required for storage tanks with a capacity of >2200 ℓ (above ground) and > 4560 ℓ (below ground). Inform the Ministry of "*major petroleum product spills*", i.e. > 200ℓ per spill and take all steps necessary in accordance with good industry to clean up the spill.	A permit is required for the storage of more than 1000ℓ of petroleum on the Project site. Obligations regarding petroleum products to be included in Contract Specifications. Reporting of any spills is required. Annual inspection of tanks is required.
Health and Safety Act 11 (2007)	The Health and Safety regulations GN 156/1997 (GG 1617) to this act prescribe conditions at the workplace, and inter alia deal with the following: • Welfare and facilities at work-places, including lighting, floor space, ventilation, sanitary and washing facilities, usage and storage of volatile flammable substances, fire precautions, etc.; • Appointment of a Safety Officer (Section 6); • Hazardous Substances including precautionary measures related to their transport, labelling, storage, and handling. Exposure limits, monitoring requirements, and record keeping are also detailed (Section 176-195); • Physical hazards including noise, vibration, ionizing radiation, non-ionizing radiation, thermal requirements, illumination, windows	The Contractors involved in this project will be responsible for adhering to these regulations, which need to be prescribed in their contracts. Because of various safety risks and the close proximity of communities to the construction sites, these requirements are crucial.

STATUTE	PROVISIONS	PROJECT IMPLICATIONS
	and ventilation; • Requirements for protective equipment (HSR s210-217); and First aid and emergency arrangements (HSR Section 228-242)	

The relevant legal requirements in this section have been carried over to the Environmental Management Plan to track and ensure compliance during the various phases of the project. The next section contains a summary of the salient physical, ecological and social sensitivities of the Cuvelai catchment and more closely in the Oshakati area.

5 THE RECEIVING ENVIRONMENT

5.1 INTRODUCTION

The Cuvelai-Etosha basin is located in the central northern part of Namibia and is comprised of the southern Angola delta in the north and the Etosha Pan in the south.

The Cuvelai catchment of 37 000 km^2 - 40 000 km^2, is a unique, endorheic wetland wedged between the Kunene River in the west and Okavango River in the east, ending in Etosha Pan, a vast dry salt lake of 4812 km^2 - 5000 km ^{2} within the Etosha National Park.

The *iishana* of the seasonal Cuvelai wetland system are made up of a network of shallow pans, or *iishana* and seasonally flowing interconnected channels or rivers, locally known as "omuramba". This wetland extends from southern Angola into north-central Namibia before terminating in the Etosha Pan.

The Etosha Pans complex was proclaimed an international Ramsar Site in 1995, one of the first four Ramsar sites in Namibia and the only inland Ramsar site. Although originally envisaged to include not only the Etosha Pan but also the 'Oponono' (Omadhiya) Pans and the *iishana* of the Cuvelai wetlands to the north, the northern boundary of the Ramsar site is the northern boundary of the Etosha National Park. The option has been reserved to, in future, extend the Ramsar site to cover the entire Cuvelai-Etosha wetland system.

Although it is characterized as a semi-arid region, the Cuvelai-Etosha basin is considered one of the wettest parts of Namibia. It receives between 350 mm and 450 mm of rain annually, which contributes, along with high floods, to the surface flow of the basin. As is the case with most of the entire Namibian landscape, the eastern portion of the Cuvelai-Etosha has much more consistent rainfalls, than the western section (Mendelsohn, et al 2009). Historically, communities develop where the water was most plentiful, and relied on shallow wells to retrieve water during dry periods.

It is important, though, to consider the climate of the entire Cuvelai catchment, since the waters from its upper reaches are a great part of the floods in the Oshakati area. Mendelsohn (2011) reminds us that the Cuvelai spans sub-tropical area in the north and semi-arid in the south **(Figure 13).** Rainfall in the northern-most catchment averages about 900 millimetres per year, just over double the average of 400 millimeters in the extreme south.

The highest rainfall averages are recorded in December, January and February, but the rainy season for the area is between October and April. The further south in the Basin, the more unpredictable rainfall is, and this is where the most extreme droughts occur. Moreover, the timing of rainfall within one summer may be so erratic that crops fail, even if the total amount of rain received is high.

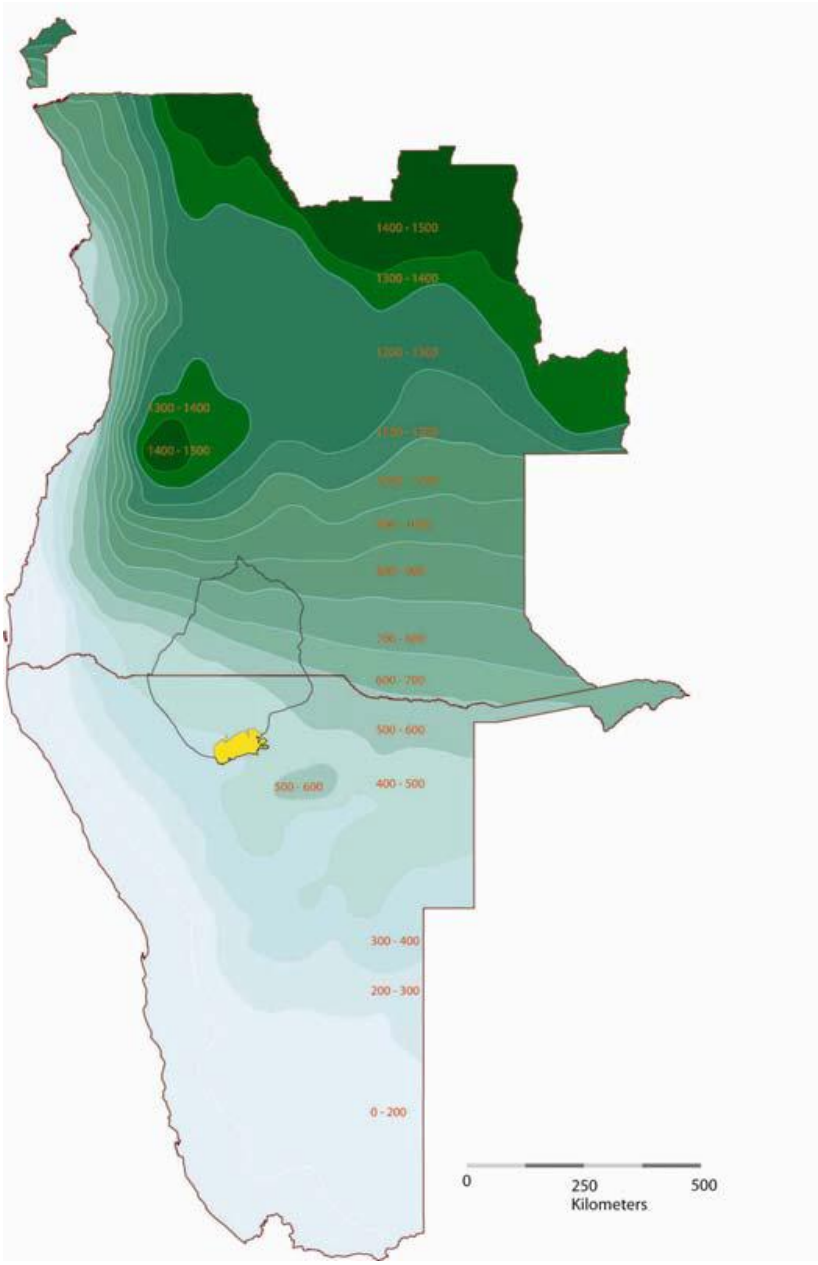

Figure 13: Average annual rainfall in the Cuvelai Basin and elsewhere in Angola and Namibia (Source: Mendelssohn, 2011).

Currently there are two major methods to retrieve non-surface water; an extensive network of NamWater and DRWS pipelines from the Kunene River and Angolan reservoirs, and boreholes that use solar, wind, and petrol energy to retrieve water from the aquifers deep underground (Amakali 2003).

Almost half of the Namibian population resides in the rural part of this basin, which is currently experiencing a relatively rapid population growth of about 2% per annum. This increase in population is the "biggest threat to achieving sustainable development in the area" (Amakali 2003). This population density provides a serious drain on the available water resources in the region. It has been remarked that "there is substantial evidence that the land is unable to support the current numbers of people" (Marsh & Seely, 1992).

5.2 WHY IS THE CUVELAI WETLAND IMPORTANT?

According to Kolberg, Griffen, & Simmons (1997) the significance of the Cuvelai drainage system lies in the fact that it forms a natural wetland that covers most of the north-central parts of Namibia. This system not only plays an important role in local hydrology, but also sustains one of the most biologically diverse areas in the country. Furthermore, the Cuvelai system supports around 45% of the population of Namibia, so both the social and ecological environments of the north-central parts of Namibia are sustained by the water of the Cuvelai wetland system (**Figure 14**:).

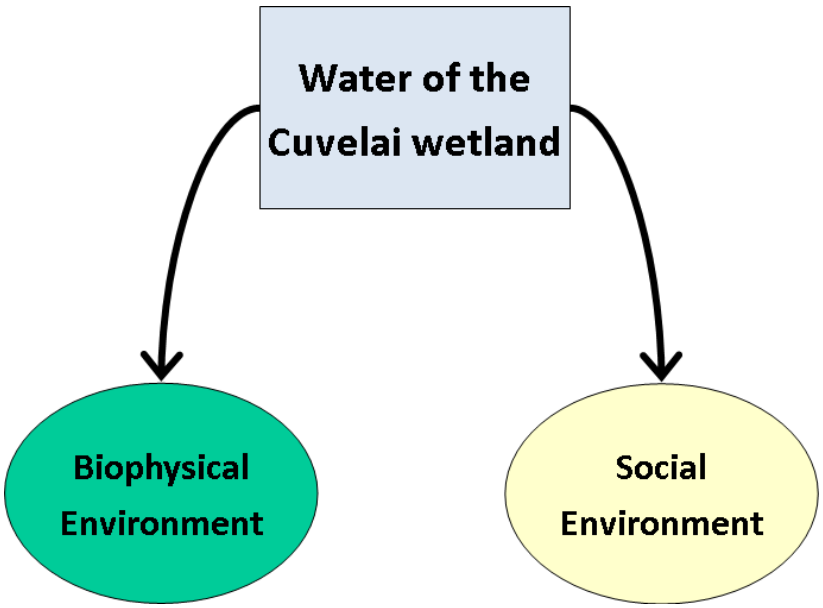

Figure 14: Importance of the water of the Cuvelai wetland in sustaining the biophysical and social environments.

Other than within the Etosha National Park, the Cuvelai system within Namibia is presently inhabited by 800 000 to one million people, many of whom live a largely subsistence life in the oshana region, supported by cash remittances, their livestock, what they can plant and natural products they can harvest such as fish, reeds, sedges, fruit and 'veldkos". The continued natural functioning of the Cuvelai wetland is thus important not only in ecological terms but also to a dense population of rural people who rely on these "free" wetland natural resources.

Further downstream the system is also of high ecological, economic and social value. The motivation in proclaiming the Etosha Pan as a Ramsar site, even though it is usually a dry pan, is because of the large numbers of wetland birds it can support when the shallow, wetland is inundated by rare floods and local rainfall. Then it serves as an important feeding area and breeding site for thousands of birds, supporting more than 1% of the world population of Great White Pelicans, Greater Flamingos, Caspian and Chestnut-banded Plovers (Bethune, Shaw, Roberts and Wetland Working Group of Namibia, 2007). Further, the Etosha Pan is important as one of only two breeding areas for the entire southern African population of Lesser and Greater flamingos. These features also benefit the country economically as they assist in attracting large numbers of tourists to the Etosha National Park.

5.3 THE CUVELAI WETLAND SYSTEM

The Cuvelai Delta is formed by the southwards drainage of the perennial Cuvelai River and its two main tributaries the Mui-Muu and Caundo rivers in central Angola, which due to the flatness of the Etosha Basin further south, forms a deltaic network of inter-connected streams with a width of some 70 km where it crosses the border into Namibia (Chivell *et al.*, 1991). By the time this network of Cuvelai streams reach Namibia they are no longer perennial, but rather seasonal, and even then the seasonal floods or *efundja* do not always extend into Namibia. Even without inflow from Angola, the ephemeral streams and pools called *iishana* in Namibia can be filled by local rain. Mean annual rainfall in the area varies from 300 mm/a in the southwest to 550mm/a in the northeast (Chivell *et al.* 1991).

Within Namibia the topography remains very flat, varying from 1 050 – 1 090 m asl, a gradient of only 1: 2 000, or 20cm/km over the catchment area within Namibia as a whole. According to Clarke (1998) it is even less, only 15cm/km in the area where most of the *iishana* occur. This flat terrain is an important feature in the shallow flooding of the area. The shallow pools, or *iishana*, and deeper pools, *endombe*, typically dry up each year, becoming increasingly saline and turbid. But while they hold water they are an important surface water source and source of fish to the large rural population. The dense population of the Cuvelai use the *oshana* water both for limited household use, small gardens and for livestock. The population is more

densely settled where water is available, which has caused severe overgrazing and trampling in areas close to water points (Clarke, 1998a, Marsh & Seely, 1991). Following the good rain and flood years of this decade, more and more people have moved into previously dry grazing areas, either with their livestock or to fish e.g. around the Omadhiya lakes, at least during the wet-season.

When the *efundja* is sufficiently large to reach into Namibia it brings with it fish that are essential to the livelihoods of people living alongside them. The first good rains or floods also trigger the emergence of aestivating African bullfrogs, *Pyxicephalus adspersus*, a seasonal protein source to the dense rural population in the area. With gross evaporation rates that vary from 1900 to 2000 mm/year i.e about 1.5 m a year, (Chivell *et al.* 1991) most of the *iishana* dry out by about June each year while the deeper *endombe* and gravel burrow pits may hold water longer, sometimes until the next rains, providing a refuge for the fish and aquatic invertebrate fauna of the system.

Within Namibia the Cuvelai Delta gradually narrows as the *iishana* converge cone-like towards a complex of shallow lakes known as the Omadhiya lake complex or commonly as the Lake Oponona area named after the best known of the lakes. As the system that will receive the possibly increased floodwaters diverted around Oshakati by the proposed dike as well as the stormwater draining out of the town via the Okatana river, it is worth looking at the system a little more closely. The information summarised here is from the specialist report by Bethune and Van del waal (2012, ***APPENDIX D***).

The Omadhiya lake complex includes 7 main inter-connected, shallow, ephemeral lakes or pans that usually dry out. All the water flowing through the Cuvelai system converges on these pans; from the west via the Etaka oshana water enters Lake Oponono ; from the north-west via *iishana* to the west of Ombalantu water enters Uupeke and Korola (24ha) lakes; from Ogongo and Oshikuku in the North water enters Uulidi (100ha), Omanetha (48 ha) and Inakuloyomodiya (83ha) lakes and from Oshakati and Ondangwa in the north-east floodwaters enter Onamagwena lake (507 ha), from where the water can flow east into Omanetha or south into Inakuloyomadiya (the grandmother of the lakes) or Oshituntu lake (100ha) from which the main outflow is the Ekuma River that flows into north-western Etosha. The lake sizes in brackets are low water sizes calculated from satellite images by Verlinden of the Northern Namibian Environmental Project after the 1995 *efundja*, cited by Van del waal (1999). He estimated that the total lake area inundated at low flood was 962 ha while at high flood it would be 7430 ha, showing the extreme natural variation of the *efundja*. Van del waal (1999) mentions three sources of input into the lakes: local rainfall (400 mm/a); local floods caused by rain upsteam in the oshana region; and *efundja* from Angola. Based on historical records, information from the Dept of Water Affairs and his own observations he calculated that the lakes are likely to receive

some water every two out of three years and that half of these could be from a large *efundja*, i.e. once in three years, but warns that inflows are extremely variable.

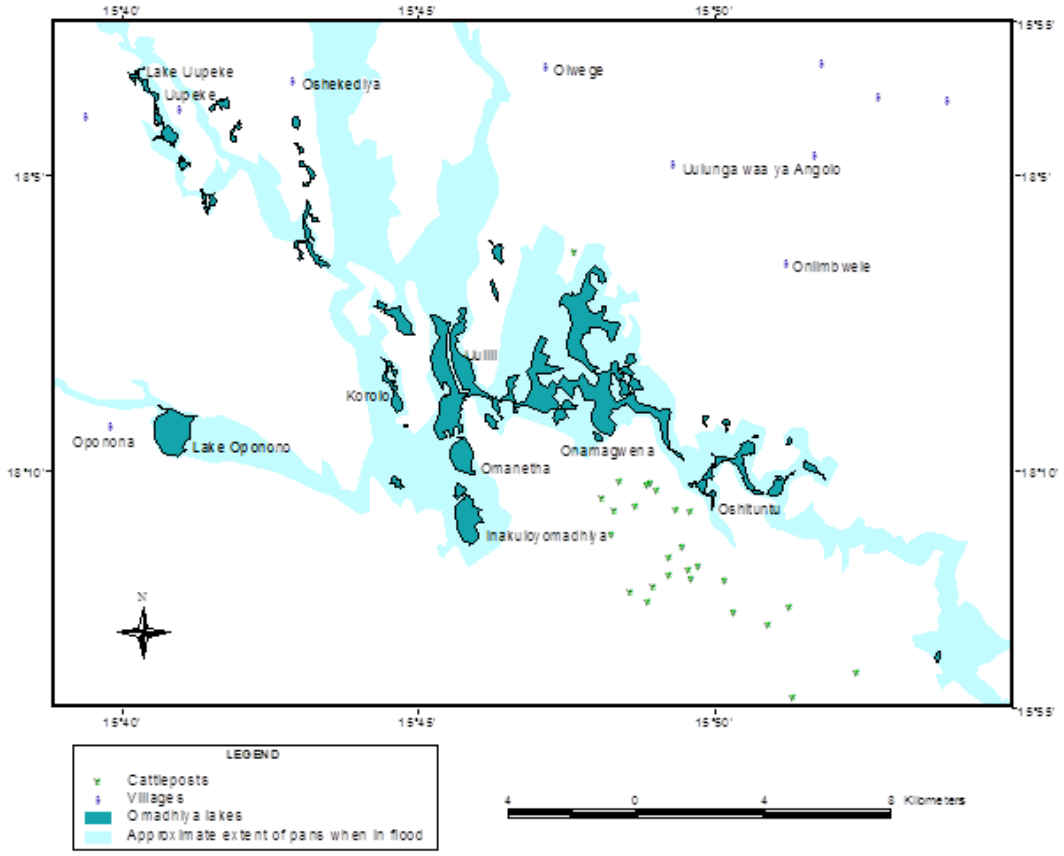

Figure 15: Map of the Omadhiya lake complex. Reproduced from van der Waal (2000)

Figure 15 is a map of the lakes of the Omadhiya complex, reproduced with permission.

The best defined of these channels is the Etaka canal from the west which some think may be an earlier link (paleo-channel) with the Kunene. Interestingly today, the Etaka canal, as the main outflow from below Olushanda Dam, which receives water from the Kunene River as part of the inter- basin water supply scheme to the area, is once again linking the Kunene and Cuvelai basins and like the canals system linking Kunene via the Etunda canal, the Olushandja – Ogongo canal and the Ogongo-Oshakati canal, it too is a likely conduit for Kunene species to enter the Cuvelai system.

From the Omadhiya lakes complex, in years of very large *efundja* water flows southwards via the Ekuma River in the west and several less defined southward flowing, ephemeral, such as the Oshigambe omuramba, finally ending in the Etosha Pan. The frequency of inflows into the Etosha Pan is very variable, calculations range from once in 4 years to reach the top, north western end of the pan to once in 7 to 10

years to fill the pan (Berry 1972, Simmonds 1996). Local rainfall on the 5 000 km^2 Etosha Pan also contributes water , which is again higher in the east, meaning that Fisher's Pan, close to Namatoni often has water without any inflow from the Cuvelai. The pan in Etosha is extremely saline, with a clay bottom and so supports very little vegetation. As expected when dry, the pan supports few animals, but is transformed into a rich wetland.

When inundated it is rich in aquatic invertebrates, wetland birds, African bullfrogs, as well as 5 – 14 hardy, salt tolerant fish species (Berry 1972, Curtis, Roberts, Griffin, Bethune, Hay, and Kolberg, 1998, Van del waal 1991).

5.4 WATER SUPPLY AND ITS EFFECTS ON THE CUVELAI SYSTEM

Bethune and Van del waal (2012, ***APPENDIX D***) provide details of the NamWater supply and its effect on the Cuvelai ecosystem, summarised here:

NamWater currently operates the inter-basin, bulk, water supply scheme that supplies water from Calueque Dam on the Kunene River in Angola, via the Etunda canal and a stabilising dam at Olushandja, through 100 km of lined canals to purification works at Ongongo and Oshakati where it is purified before being taken further via a network of almost 2 000 kilometres of pipes to towns that include Ondangwa, Oshikango, Eenhana, Okahau, Oshikuku, Okatana and Oshivelo. This inter-basin transfer of water has inadvertently introduced several Kunene River aquatic species that include some 7 documented snail species, including vectors of bilharzia and the Kunene mussel, *Caelatura kunenensis* (Curtis, 1996), several Kunene fish species (Van del waal, 1991) of which at least 10 have become established in *iishana* habitats. It is very likely that several aquatic plants, including the *Typha capensis* now forming dense stands near the Oshakati purification works. Burke (1995a, 1995b) found no alien invasive plant species in Olushandja but did conclude that the vegetation composition around the dam is more closely related to the Kunene River system than to the Cuvelai, suggesting transfer of seeds, plant fragments and even whole plants via the canal. Downstream in the canal plants like oxygen weed, *Lagarosiphon* and pondweed, *Potamogeton,* grow in the canal (observation: Bethune, 2012**)**.

In the 1950s and 1960s, a programme of deepening more than 100 pools was undertaken by the Department of Water Affairs, to improve water availability in dry months in remote areas. But given the flat terrain, these were mainly only 3 – 5 m deep, (deeper excavation was not possible due to contamination by saline water from the regional saline aquifer that underlies much of the area at depths of about 8 – 10m).

(Chivell, *et al.* 1991) found that in the years since these dams were excavated, their use for drinking water supply had diminished because: most of these excavated dams

have partly silted up; the pumps and the fences erected to keep out livestock had both long since disappeared; the high turbidity and fine colloids in the oshana water tended to clog the water purification filters and the availability of piped water provided a more direct source of potable water. These excavations do however still remain important for livestock watering and fishing and many support large fruit trees such as jackalberries, *Diospyros mespiliformis,* that have become established on the banks of these *endombe*. The hydrologists, (Chivell *et al.*1991) recognised their value to augment water supplies especially in remote areas, and recommended their rehabilitation also proposing new sites and designs for new excavation dams.

Attempts to secure water availability in remote areas are still ongoing, current initiatives include the Cuve Waters project, jointly run by the Institute for Social-Ecological Research in Hamburg and the Desert Research Foundation of Namibia (DRFN), that is investigating improving water security in the area through an integrated approach that involves a combination of rainwater harvesting, groundwater desalination, subsurface water storage of *oshana* floodwaters to avoid evaporative losses, and water reuse (Eisold & Benzing, 2010).

5.5 THE FLOODS OF THE CUVELAI

5.5.1 *The current flood situation*

The town of Oshakati was originally developed on higher lying areas between iishana. With the rapid urbanization that took place after 1990 development flowed over into the lower lying areas as well. These are the areas most affected by flooding.

The *iishana* in the Cuvelai Delta normally fill up from local rains but with little continuous flow. In good rainy seasons, floodwaters from the upper catchment in Angola reach Namibia, resulting in floods known as *efundja*. Under normal circumstances the local population welcomes the *efundja* because of the opportunity for fishing and because open water is available for stock drinking. However, with settlement is lower lying areas the local population experiences human safety risks, loss of property, loss of access to amenities during large flood events. Muir (2012, ***APPENDIX E***), concludes the following about these floods:

- They are mainly the results of local rainfall and rainfall just north of the border in the Cuvelai Delta.
- Efundja floods are mainly the result of a flood in the "main" Cuvelai River spreading out over the full width of the Cuvelai Delta north of the border.
- Floods in the Cuvelai Delta are often made worse by road embankments and other infrastructure which obstruct the flow of water in the iishana.

Flooding in Oshakati is caused by the flow from a few major iishana that flow from the north. Currently this flow goes through the centre of Oshakati and causes serious inundation of the low lying areas where a lot of informal settlement has occurred over the last number of years.

The rural areas are less affected by the floods as development has traditionally taken place on the higher lying ground next to the Iishana. However, recent floods have caused major problems with access where roads and other traditional access routes have been either breached or inundated.

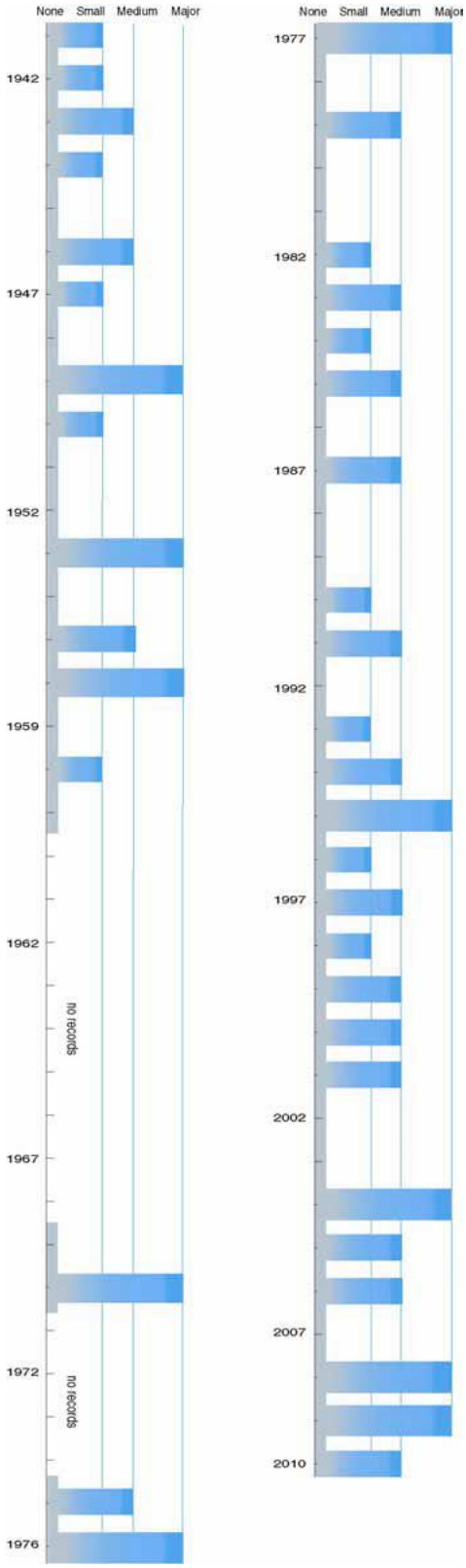

Figure 16: Flow records for the Cuvelai (Source: Mendelsohn, 2011)

5.5.2 *Hyrological data*

Although the Namibia MET office has rainfall records at a few stations in the Cuvelai, some of which stretch back to 1913, very little data is available on surface water flows in the catchment. There are 13 stations located south of the border which measure water levels, but no flow data are available.

No data is available for the major part of the catchment which lies north of the Namibia/Angola border.

Flows in the Cuvelai may change substantially from year to year. The graph in **Figure 16** shows the approximate extent or levels of flow and flooding from 1941 onwards. During this period spanning 69 years (which includes 13 years for which no information is available), exceptionally high flows (*efundjas*), occurred nine times: in 1950, 1954, 1957, 1971, 1977, 1995, 2004, 2008 and 2009. There were no or only negligible flows in 19 years.

Von Langenhoven (2011), however warns that "there is no systematic change towards higher or lower flows or towards higher variability, as climate change experts predict for the future". This statement is based on research of flow data for the Kunene, Zambezi and Kavango Rivers, for which long range and consistent data are available.

Floods are the combined result of rainfall and catchment response. The latter is subject to human interference, with for instance urbanization resulting in higher floods at local scale and deforestation and overgrazing would also contribute to higher floods. Satellite images show the distinction in vegetation density between the Angolan and Namibian parts of the Cuvelai catchment **(Figure 17).**

It has already been mentioned that roads and water carriers and other infrastructure crossing the channels without providing for free through flow, blocking and push the water higher upstream. An example is the main Oshakati-Ogongo-Outapi road and the parallel open water channel.

Von Langenhoven (2011) therefore concludes that "*the sudden occurrence of disastrous floods in the Cuvelai may be as the result of climate variability, the entering of a period with high rainfalls, also possible climate change, and human-modified runoff conditions. Other factors that influence the flood impact or the apparent flood impact are:*

> *The increased utilization of flood-prone areas because of population pressure.*
> *The development of infrastructure (roads) and services (schools, health enters) in especially rural areas.*
> *The much more intense access and wide dissemination by the media.*

Floods with similar magnitude would have caused far less damage 50 years ago and would also not have received the same publicity."

He contends, however, that future planning should be based on the prudent assumption that very high floods may appear any individual year.

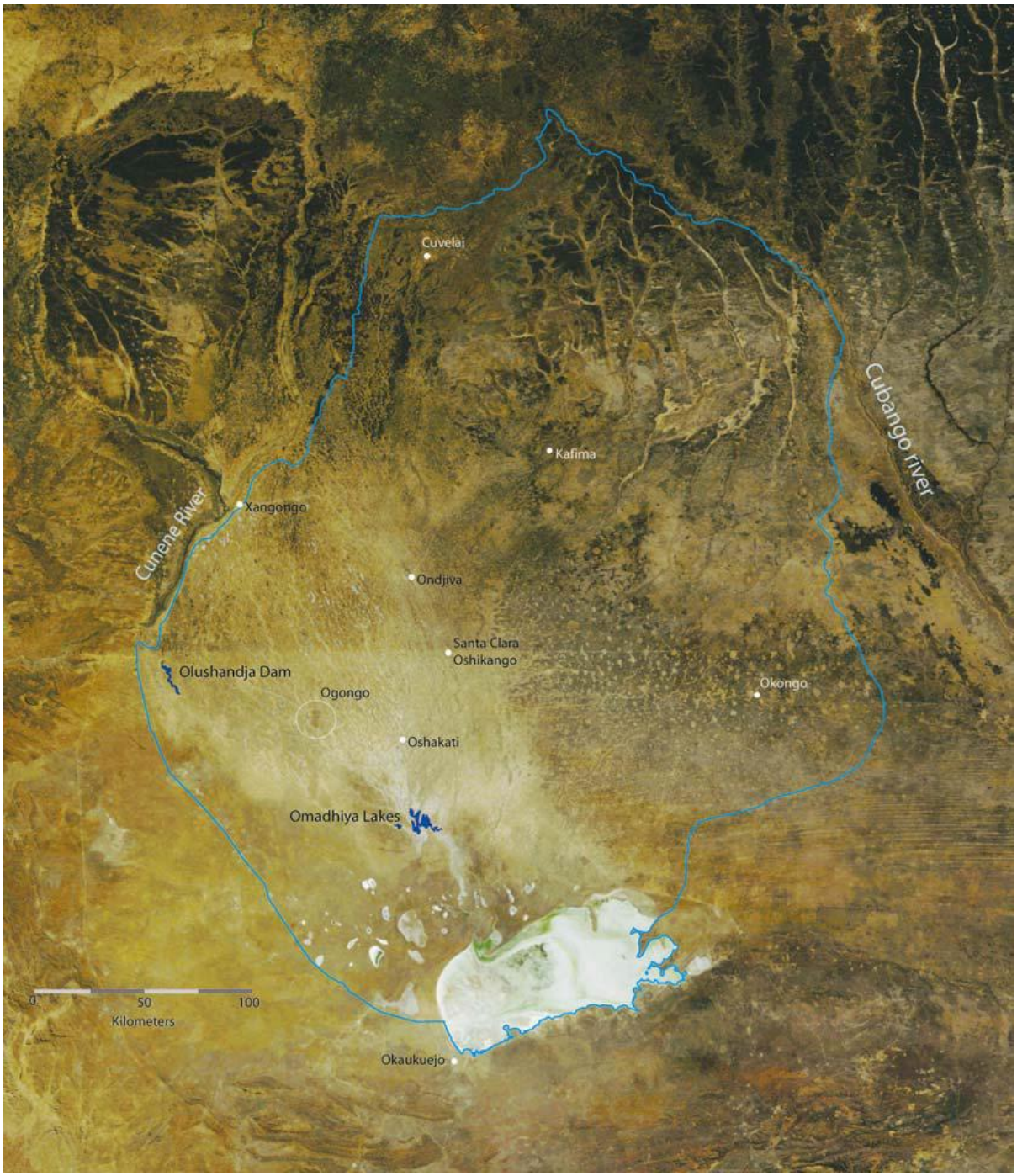

Figure 17: *The principal features of the Cuvelai Basin. The pale area south of the border caused by the loss of woodland, and the convergence of iishana into the Omadhiya Lakes and then into Etosha Pan. Olushandja Dam was built to store water from the Cunene River (Source: Mendelsohn, 2011).*

Table 1: Sensitivities and potential impacts related to hydrology

ENVIRONMENTAL FEATURE	SENSITIVITY	POTENTIAL IMPACT/ENHANCEMENT
Change in the effects of flow conditions upstream, in and downstream of the project area	Change in flow conditions may result in increased flooding of the new terrain in the area immediately upstream of the project. Currently flooded area.	Changes in flood conditions downstream, and upstream of the project area – rural areas outside of Oshakati flooded. Positive effect for the currently flooded area within Oshakati.
Transportation of sediments	Sediment transport along the bed of the channel is unknown. Material may be either deposited.	Sedimentation and changes in turbidity downstream
Water quality	Changes in the flow conditions upstream of the project area may lead to localized change in levels of contaminants and physical pollution deposition. Changes in the flow conditions in the transition area may lead to localised change in levels of contaminants . The upgrade of the Oshakati stormwater drainage may change in levels the accumulation of pollutants in the system as well as downstream of Oshakati in the transition area.	Changes to water quality within Oshakati and downstream of the project area.
Access from rural areas close to Oshakati into the town	Rural residents currently use numerous alternative, more informal routes into Oshakati.	During times of flood access will be negatively affected as the whole western side of Oshakati will only be accessed along major roads.

5.6 THE BIOPHYSICAL ENVIRONMENT

5.6.1 *Physical Components*

Water

Water may be considered a major wetland resource, but in ecological terms it is a major constituent of the wetland itself. It is inextricably intertwined with all levels of the

ecosystems it sustains and influences the surrounding area's environmental and socio-economic stability.

The determination of ecological water needs involves looking at the water needs of the environment so that sufficient water is retained in the wetland to maintain all the physical and ecological processes and wetland productivity. In order to achieve this, it is important to recognise the interconnected nature of a wetland system and its terrestrial surroundings.

Flood pulse is another important aspect of water that plays a role in sustaining biotic life, and maintaining interactions and productivity within the river-floodplain system (Junk *et al.*, 1989). Flood pulses are influenced by geomorphological and hydrological conditions, which determine the nature of the flood pulse.

Groundwater

SLR (2012 ***APPENDIX G***) provided the groundwater information for this study. The project area is underlain by unconsolidated to semi-consolidated sediments of the Kalahari Sequence. The sediments contain mainly saline groundwater as part of the regional shallow aquifer which was described as the Kalahari Oshana Aquifer, KOS **(see Figure 20).** The KOS is a shallow, 6 – 80 m deep, unconfined aquifer system, which comprises a relatively thick sequence of alluvial deposits of the Andoni Formation.

Groundwater bearing sand and sandstone layers are from a lacustrine and deltaic environment and have a good storage capacity. However, with seasonal and constantly shifting depositional environment, the resulting cross-bedding of sandstones and clay layers limits the hydrogeological properties. Clays have a lower yield than sandstones and sandy layers. Clay layers can therefore hamper the relatively easy flow of groundwater into the basin.

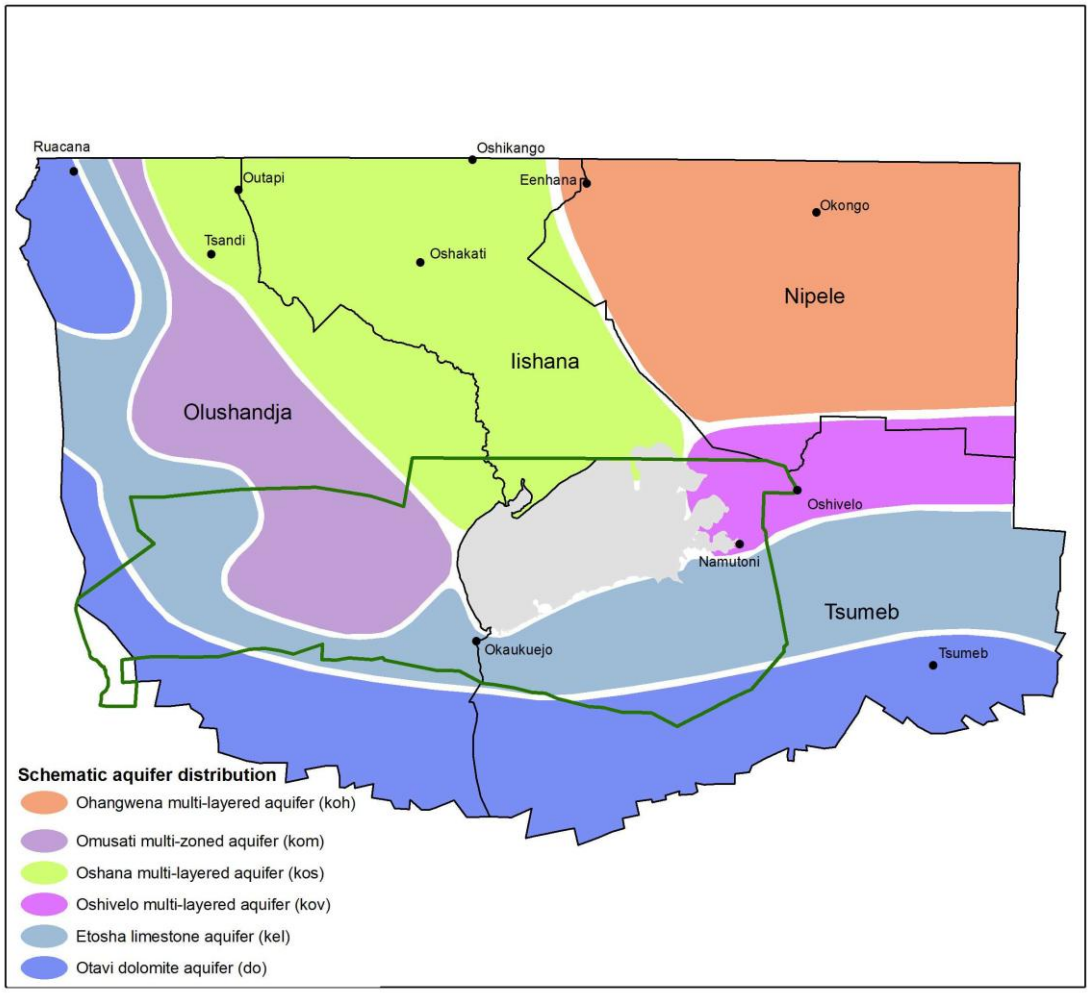

Figure 18: Regional aquifer distribution in the project area (Source: SLR, 2012).

The KOS aquifer is recharged mainly by regular flooding of the *efundja*. Groundwater flow is very slow in a south-easterly direction where the groundwater is discharged and subsequently evaporated in low elevation areas of the Etosha and Fisher's pans. The water table is rather shallow.

The Okatana River, a more prominent *oshana*, runs from north to south through Okatana village and holds water throughout the year. The surface water is believed to recharge the shallow Kalahari sediments, forming freshwater lenses on top of the regional saline aquifer. The fresh water lenses are, however, not continuous and mix with the saline water during the dry season.

Local rainfall can lead to localized runoff in the oshana system, which can also result in aquifer recharge. Lateral groundwater through-flow is believed to be limited due to the low gradient and low permeability of the Kalahari sediments. The water balance of the KOS is therefore mostly influenced by infiltration from runoff and rainfall (recharge) and evaporation (discharge).

The KOS aquifer is tapped by a series of hand-dug wells, which supplied the bulk of the water used by the population in the Oshana Region during the dry season prior to the construction of the pipeline network from the Kunene River. The water quality varies from brackish to saline with local freshwater lenses in the oshana channels. A small number of boreholes were drilled into the KOS and yields of up to 30 m_3/h are reported. The boreholes in the larger project area show yields between 1 m_3/h and 8 m_3/h.

Boreholes WW8281 and WW8137 were both drilled in or near Oshakati to depths of 61 m and 95 m (see borehole location map in ***APPENDIX E***). The original yields were relatively high (2-8m_3/h) and the water level was in both cases shallow (5-7 m below surface).

The old boreholes are most likely not existing anymore but the more recently drilled boreholes might still exist. The Geohydrology Division of NamWater in Windhoek was informed about the two boreholes and they are in the process of investigating. If they still exist it is recommended to use them as monitoring wells for regular groundwater level measurements and analysis of groundwater quality.

The salinity of the groundwater intersected was around TDS=30,000 mg/l, which is almost sea water quality. The salinity of the regional KOS aquifer is generally saline **(Figure 19).**

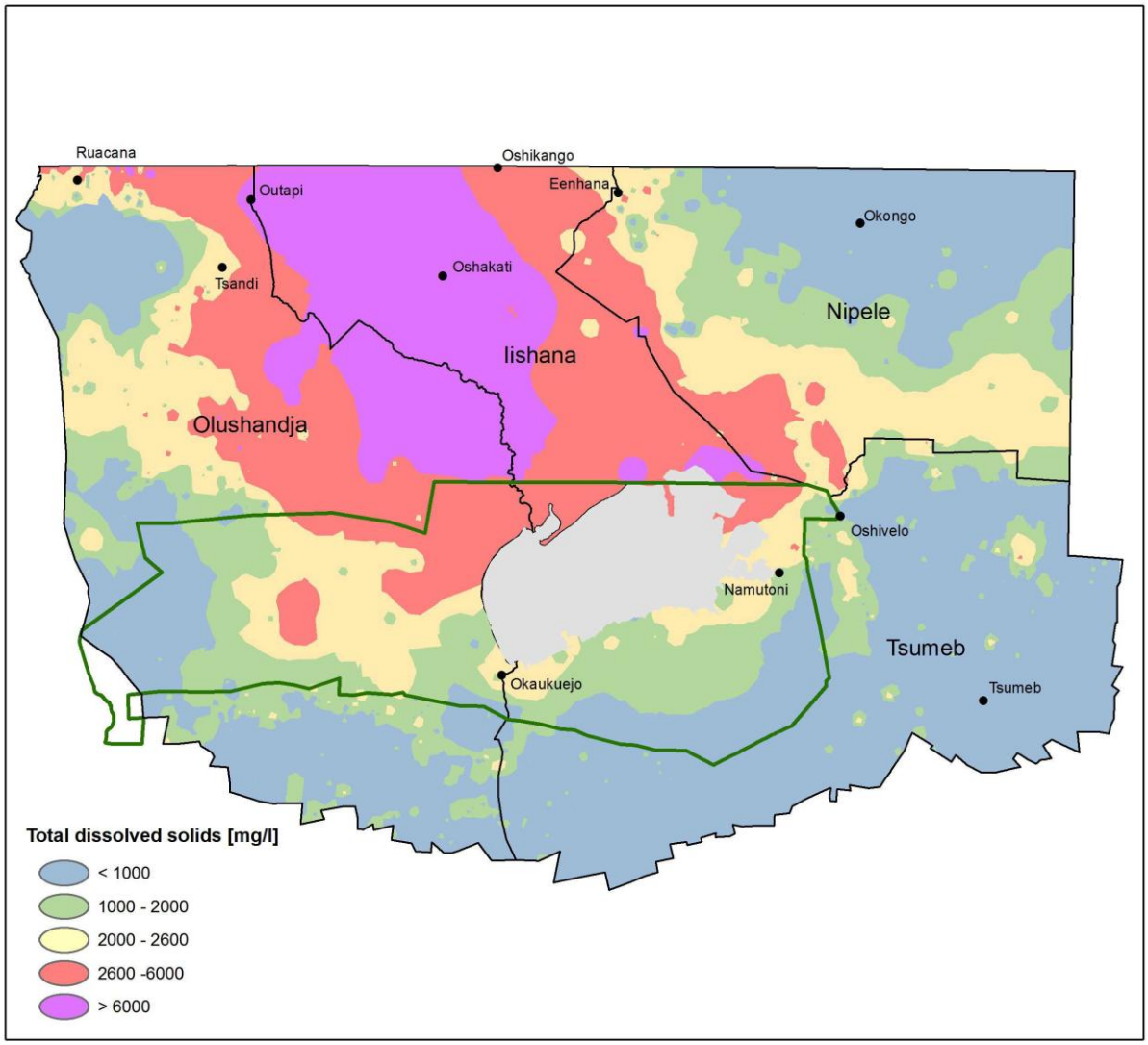

Figure 19: Groundwater salinity in the Etosha-cuvelai basin (colour grading according to Namibian drinking water classification: red=not suitable for human consumption; purple=not suitable for livestock) (Source: SLR, 2012).

Soils

Due to the flat topography of the north-central regions of Namibia, the floodwaters flowing from Angola to Namibia, spreads over a large area to recharge the groundwater, and as the water recedes, fertile soils are left behind that provide pastures for livestock in the dry season. Some of shallow depressions then form dry pans with a clayey and often saline base due to the accumulation of salts left behind each time the water evaporates.

Between the channels on higher ground are cambisol and calcisol soils that were formed as a reworked mix of alluvial and aeolian sediments (Mendelsohn, 2011). They are thus not too dense and clayey; neither are they too sandy, infertile and porous. Together with fresh water in shallow wells, it is these fertile soils that attracted people to settle and farm in the area since 500 to 600 years ago.

5.6.2 *Biological Components*

The natural resources the system freely provides to sustain the livelihoods of the people are (**Figure 20**):

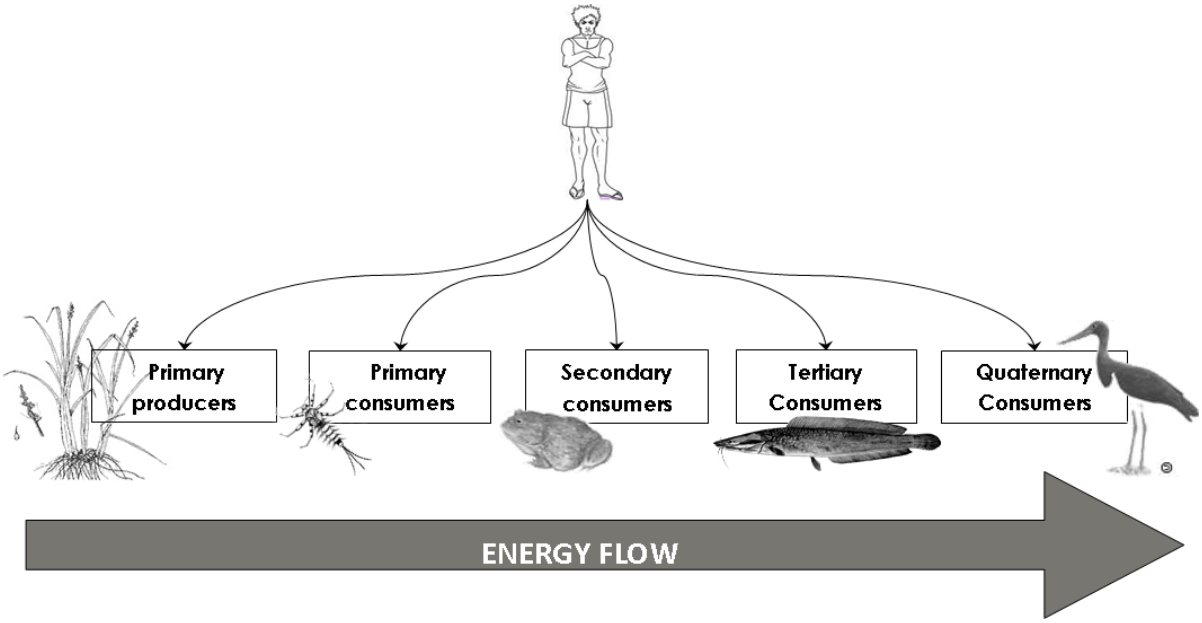

Figure 20: The natural resources of the Cuvelai sustain the livelihoods of the people.

5.6.2.1 *Vegetation*

The vegetation which grows in the Cuvelai supports the livelihoods of the local people. Reeds and sedges are used as building materials for household items such as baskets and fish traps. Grasses provide grazing for livestock and wildlife, while trees provide, shade and wood for fuel, tools, building materials and canoes. A large number of fruit trees are also associated with river systems and wetlands. Some plants are harvested for food and used as medicine for humans and livestock.

The distinct vegetation around the typical *oshana* as a gradually sloping terrace area of flooded grassland and is generally shallow and wider than the deeper *ondombe* that have steeper margins and no terrace section, but may support large fruit trees, such as jackalberries, *Diospyros mespeliformis, embe, Berchemia discolour* and *Ficus sycomorous* on the banks.

Clarke (1998a, cited in Bethune and Van del waal, 2012, ***APPENDIX D***) identified the following vegetation zones around the *oshana*/*ondombe*:

a) Woody species at the dry outer edges of the floodplain area that is usually dry, typical plants include *Acacia hebeclada* subspecies *tristis*, *Ziziphus mucronata*, (buffalo thorn), *Hyphaenae petersiana* (makalani palm) and *Combretum imberbe,* (leadwood) all trees that do not mind standing in water for short periods of time, found at the edges of floodplains.

b) Terrestrial/floodplain species in the area that is alternately flooded or dry, typical plants are sedges, grasses like Eragrostris trichophora and lilies e.g. Dipcadi crispum.

c) Shallow water / pool rooted aquatic plants can be emergent, submerged, or have floating leaves typical plants include Marsilea ferns, Aponogeton junceus (waterblommetjies), Uticularia, and a variety of sedges (Cyperaceae) and grasses that can grow in water like Diplachne amboesis.

d) Deep water pool species, also rooted e.g. Nymphaea nouchali waterlilies.

e) Saline pool and pan species, in areas where little grows due to high salinity, typically include salt tolerant grasses such as Sporobulos iocladus and Odyyssea paucinervis.

5.6.2.2 Fauna

Animals such as freshwater fish, frogs, reptiles, birds and many aquatic invertebrates are found in wetlands, while other wildlife and livestock congregate around wetland areas (**Table 2**). Iishana provide fish, frogs and other food resources when in flood and also recharge groundwater.

Larger animals

With the dense rural population, larger animals such as reptiles, birds and mammals are scarce and the area is considered as "depauperate" of wildlife. Only one of the reptiles occurring in the area, the Marsh terrapin, is truly aquatic. Clarke, (1998a) lists 65 reptile species known from the area, adapted from the list by Griffin (1991), but did not observe many during his two years of fieldwork.

Aquatic life

In a detailed study of the *iishana*, over two wet seasons, from 1996 to 1997, (Clarke (1998a), cited in Bethune, 2012, ***APPENDIX D***) found that early October rains of as little

as 20mm was enough to wet these pools and trigger hatching of crustacea such as *Triops,* a tadpole shrimp, and *Lovenula falcifera*, calanoid copepods that dominate the crustacea fauna. *Lovenula*, like the other ephemeral pool crustacean are specially adapted to survive in temporary waters, they can tolerate increasing temperature and water chemistry concentrations as the pools dry and even more importantly can complete their life-cycles within 3-4 weeks enabling them to lay drought resistant eggs before the pools dry out (Bethune, 1982). These pools typically dry up within a few weeks, and remain dry until the early January rains, which again triggered crustacea to hatch as well as then causing the first emergence of the aestivating bull frogs *Pyxicephalus adspersus*. Some 44 different species of crustacea occur in these pools, with *Lovenula falcifera*, a calanoid copepod, as the dominant species (Clarke 1998a, Clarke & Rayner 1999), (See list of crustacea and where they occur in Appendix 2 b of Bethune 2012, ***APPENDIX D***). Invertebrate species from the Cuvelai, based on museum records show that 60 crustacea including16 endemic species of ostracods are known from the Cuvelai/Etosha system (Curtis *et al.* 1998). Eleven snail species have been recorded (Curtis, 1991, Curtis *et al.* 1998).

The rains normally continue through January, February and March, keeping the pools filled and with time attracting insect invertebrates too (Clarke, 1998b). Some 72 species of aquatic insects including 4 endemic beetles have been recorded from the Cuvelai system (Curtis *et al.* 19980. Nakanwe (2009) confirms the species diversity of aquatic invertebrates and their ecological importance in the *iishana who* regularly surveyed some 10 *iishana* and *endombe* from December 2007 to May 2008.

With time the aquatic and marginal vegetation gradually establishes in and around the *iishana,* becoming densest and most diverse in March. Clarke (1998a, 1999) identified some 64 species of wetland dicotyledonous plants and 92 species of monocotyledons of which 39 species were grasses and 38 were sedges. (See Appendix 2 A, for a list of the plant species found, in Bethune 2012, ***APPENDIX D***).

Fifteen frog species are expected to occur in the Cuvelai system but other than museum collections no detailed studies have been done (Channing & Griffin, 1996, Clarke,1998a, Curtis *et al.* 1989, Griffin 1991). The most obvious and economically important amphibian is the African bullfrog, *Pyxicephalus adpersus*. Clarke (1989a) noted the first breeding bullfrogs appeared with the early rains, in the first week in January, and the first juvenile frogs a month later. He noted eggs after each heavy rainfall event. Large adult male frogs are a sought after traditional delicacy, particularly by older people.

The Cuvelai Basin is an important freshwater fish habitat in this eco-region, the subject of which is further covered in the section below.

The fish life of the ephemeral Cuvelai River and Oshana region is not well known, despite the fact that during good rain years (about one in three), local rainfall

together with the seasonal floods support a valuable intensive subsistence fishery when *iishana* fill with flood water and migrating fish from more permanent reaches higher up in Angola. Naturally, there are no permanent aquatic habitats in the Cuvelai system in Namibia. Depending on the intensity and duration of the floods and rainfall the water and fish can in some years (about 1 out of 3 years) reach the Omadhiya wetlands, and with a really good *efundja* (one in 4- 7 years) can continue via the Ekuma omaramba draining towards Etosha or even into Etosha itself. During recurring dry years, all these water bodies dry up completely and all fish succumb – no fish can survive the final salty mud or rock hard bottom once dry. The fish life in *iishana* and pans is thus temporary and relies on reseeding from either the more permanent reaches upstream in Angola or from fish remaining in more permanent man-made deep pools in *iishana*.

The fish species regularly found in isolated *iishana* and pools, is confined to three or four species. This is reflected in catches during the present investigation. During floods, a number of more sensitive species also migrate from the permanent rivers and pools in the north and populate the oshana region during the *efundja*. Two major *efundja* were studied, in 1976 and in 2008-2009, and the higher number of fish species collected then, is reflected in a Table 1 (see 2.2.3 in ***APPENDIX D***).

The conclusion is drawn that the *iishana* have a low diversity of pioneer fish species during low floods. In good flood years, or *efundja* as happened in 1976 and again in 2008 to 2010, the number of fish entering the *iishana* from the northern reaches higher up the river increases. Eventually, all fish die as waters dry out during dry cycles.

The Inter-basin Water Supply scheme bringing water from the Kunene River via a series of canals also has an effect on the fish biodiversity in the *iishana* as fish manage to escape from the canal and then enter *iishana*. Only 16 to 17 of the fish species are thought to be originally from the Cuvelai. By 1991, thirty-nine Kunene fish species that had previously not been regularly collected in the *iishana*, were found in the canal, Olushandja Dam and reservoirs associated with the canal at Ogongo and Oshakati (Van del waal 1991). Some Kunene fish species may now actually have established themselves in some more permanent pools in the Cuvelai particularly after several consecutive years of good rains and/or floods. This represents an alteration of the natural ecosystem by man inadvertently transferring species from one river basin into another where they did not occur, an example of human transformation.

The presented data demonstrate that two of the pioneer fish species, *B. paludinosus* and *O. andersonii*, have succeeded to breed in *oshana* environments recently, i.e. within the last two months. But almost all species were present as half-grown, immature fish that had migrated from higher up the river. The conclusion is reached that local breeding does take place on a limited scale, possibly aided by the many semi-permanent water structures around Oshakati.

It was noted that several of the deeper gravel, burrow pits had clear "No fishing" signs providing a safe place for fish to breed undisturbed. This local breeding must have a positive effect on the availability of fish in *iishana* during years of low rainfall and small floods when fish are not really caught in any large numbers. 2012 was a year of a small flood and no *efundja* took place. Yet the questionnaires reported that fish were harvested this year, we succeeded to collect fish at many sites and interviews stressed the importance of fish to the local communities.

The primarily subsistence fishery is aimed at catching fish migrating down the flood-filled *iishana* towards the end of the rainy season until the *iishana* pools dry up. According to available hydrological information a major *efundja* can be expected once in six years and no flow conditions once in three years (Mendelsohn & Weber, 2011). However, it must be remembered that the flows in this system are extremely variable. Fish are always present in the major floods but with smaller floods this varies, with the result that fish from Angola are probably present in floods about every third year. Nevertheless, fish form an important part of the diet of the population and to birds. Berry and van Vuuren (1973) estimated that Pelicans breeding on Etosha in 1972 consumed 1000 tons of fish and Van del waal (1991) calculated that 123 fishermen harvesting fish along the Ondangwa-Oshakati road on one day in 1975 caught 4.2 tons of fish. Fish are caught when available, but in the dry season and when the *iishana* do not flood and with an increasing cash-based economy, the availability of fish from the sea at both the market and in shops, marine fish are now also commonly eaten.

Fishing traditionally used to be controlled by local chiefs and kings setting a date for fishing as soon as fish size in the *efundja* had reached an acceptable size and most fish had migrated downstream. Clarke, (1998 a) noted that the first fish larvae start appearing in the *iishana* in mid-February and by March *Clarias* had grown to a sufficient size to be caught by local fishermen. Traditional traps, baskets and push baskets are now mostly replaced by effective funnel nets, gill nets and large seine nets, able to harvest large amounts of fish for both home consumption and offered for sale. This survey revealed that even though June is towards the end of the wet *efundja* season, markets in Oshakati and Ongwediva offered dried fish from *iishana* for sale.

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Figure 21: Barbus paludinosus caught in iishana alongside Okatana River June 2012. K. Roberts

That subsistence fishing is an important economic activity which serves as a welcome supplement to the diet of the rural population in the Cuvelai is clear. Surveys (this and previous studies reported on in Bethune, 2012, ***APPENDIX D***) indicate that although marine fish is also consumed widely, but that freshwater fish still seems to be preferred. It seems further the percentage of households who catch fish themselves is dropping gradually. However, this is also influenced by drier spells and the resulting unavailability of fish.

The only, but very prominent, uncertainty/limitation about artisanal fishing as an important economic activity in the area, is the varying availability of fish, depending on the size and frequency of the *efundja*. Without a major flood, there is no or little fish available. This uncertainty prevents the local subsistence fishery from being recognised as major sector in the local household economy.

Figure 22: Interviewing ladies at their fishing trap near Entembe (Photo: K. S. Roberts)

Birds

Regular wetland bird counts were been done on Olushandja Dam from 1995 to 1998 (Clarke 1989) giving a species richness of 48 species. See bird count lists in ***APPENDIX D*** 2 C. The more isolated Omadhiya pans complex is likely to be an important haven for wetland birds especially those that feed on fish. Berry, Stark & van Vuuren, (1973) estimated that pelicans breeding in Etosha in 1971 must have eaten at least 1000 tons of fish from these pans, the nearest source of fish. The feasibility of establishing a bird sanctuary in the "Oponono-Ekuma area, was investigated by the Ministry of Environment and Tourism (Kolberg, Griffin & Simmons, 1997, Hines 1998). Etosha Pan at the distant end of the Cuvelai is a Ramsar site, internationally recognised for its importance to birds.

Etosha Pan is one of only two breeding areas for the entire southern African population of Lesser and Greater flamingos. The only other site where they can breed is Sua Pan in Botswana which is equally unlikely to hold water. Given the extreme variability in both the timing and extent of flows in the Cuvelai system, conditions in Etosha are rarely conducive to breeding, In a 40 year period; investigated by Simmonds (1996) the pan only received some water in 17 of those years. Even then this was more often from local rainfall and then mainly in the eastern Fisher's pan section and not via *efundja* flowing through the Cuvelai. Although breeding was then attempted whenever the pan was flooded to a reasonable depth, flamingo breeding was only successful five times in that 40 year period. Too little water and the pan dried out again before the eggs could hatch or the fledglings could fly and so were vulnerable to predators such as Black backed jackals or in some cases, continued

rain bringing more floodwater caused nests, precariously perched on low islands just above the water to flood away. Like the rest of the Cuvelai in Namibia the Pan too is extremely flat and small changes in water level can have devastating impacts on the breeding success of the birds.

Last year, following the high floods in the Cuvelai an estimated 65 000 flamingos were attracted to Etosha Pan and bred successfully (Wilfred Versfeld, Researcher, Etosha Ecological Research Institute, September 2011).

Table 2: Significance for the biological components of the Cuvelai system.

BIOLOGICAL COMPONENT OF THE CUVELAI SYSTEM	NUMBER OF RECORDED SPECIES	SIGNIFICANCE
Plant species	Unknown	Wood is the main construction material in the north-central regions of Namibia. Deeper pools are often surrounded by larger trees bearing edible fruit, including birdplums, marulas and jackalberries.
Macro-invertebrate species* **Molluscs** **Crustaceans** **Invertebrates**	 11 species 60 species, 16 endemic 72 species, 4 endemic	Important source of food for fish and frogs.
Fish species*	49 species	Fish are heavily utilized by the local people with estimates of up to 4,000kg of fish caught in a 30km section in one day. The total harvest is unknown (Kolberg, Griffin, & Simmons, 1997). Total exploitation of fish stocks can be done every year without any harm to the system – replenished with every flood.
Frog species*	16 species	Sixteen out of the 52 amphibian species known or expected to occur in Namibia, are found in the Cuvelai-Etosha system. They include such species as the Large Bullfrog *Pyxicephalus adspersus* and the colourful Banded Rubber Frog *Phrynomantis bifasciatus*.

BIOLOGICAL COMPONENT OF THE CUVELAI SYSTEM	NUMBER OF RECORDED SPECIES	SIGNIFICANCE
Bird species	250 – 270 species of which more than 90 species are wetland species 42% of these are included in the Namibian Red Data Book 25 wetland species are known to breed in the Etosha	Breeding area Dependent on fish and frog species
Wildlife species		Mostly restricted to Etosha
*(Curtis, Roberts, Griffin, Bethune, Clinton, & Kolberg, 1998)		

5.6.3 *Ecological Services*

Biodiversity Support

Primary production in wetland systems enables the survival of diverse animal species. Linear riverine wetlands are ecological corridors enabling the movement of plant and animal species through harsh arid environments.

Water Quality Improvement

Oshana sustains life in the Cuvelai by replenishing aquifers and providing seasonal water sources. These seasonal water resources are however not reliable as most of it dries up to the end of the dry season. When this happen water quality deteriorates to become unfit for livestock and even the most hardy fish species. Aquatic plants recycle nutrients and hence keep their concentrations at levels conducive for healthy functioning. Water is filtered as it passes through the wetlands to underground aquifers.

Flood Abatement

The duration and amount of water in pans and oshana are unpredictable, with marked fluctuations in the diversity of biota associated with the system. During exceptional floods, water from the Oponono complex floods the Ekuma River and may reach the Etosha Pan. Water can also reach the Etosha Pan from the east via omiramba draining the north-eastern dunes and northern aspect of the Otavi highlands.

The ecological sensitivities associated with the Cuvelai system, are presented in **Table** 3 below:

Table 3: Environmental sensitivity and the potential impact

ENVIRONMENTAL FEATURE	SENSITIVITY	POTENTIAL IMPACT
Fauna and flora of the Cuvelai	The seasonal movement of fish and frog species and macro invertebrates (molluscs, crustaceans and aquatic insects) southwards is vital to maintaining the healthy functioning of the Cuvelai ecosystem and replenishment of fish stocks and frog populations.	• Infrastructure constructed in a predominantly east-west orientation interrupts the flow of water which flows from north to south. • Damage to the sensitive ecosystem during construction e.g. loss of vegetation
	Naturally occurring resources (e.g. fish, frogs, plants) important for sustaining livelihoods of the people.	Occurrence/abundance of resources may change in certain areas due to the altered flow. This could result in the unsustainable harvesting of frogs and fish in areas with low flow.
	Change in the flow dynamics of the Cuvelai during floods	• Impact on the biodiversity of fauna and flora lower down in the system due to the change in flow velocity, duration and time • Breeding grounds for disease bearing vectors such as mosquitos (vector for malaria) and *Bulinus globosus* (vector for bilharzia). • Impact of erosion • Distribution of pollution and litter from Oshakati to other areas not previously affected by the floods • Hydrological, nutrient and energy cycles of the oshana system may be altered.
	Opening up of large borrow pits to find suitable road construction material	Spoiling large volumes of material which is unsuitable for dike construction is not acceptable and must be re-used.

ENVIRONMENTAL FEATURE	SENSITIVITY	POTENTIAL IMPACT
	Deepening of the Okatana channel	Damage to the existing ecology of the channel
Etosha pan	Dependent on water from the northern parts of the Cuvelai One of only two mass breeding grounds for flamingos in Southern Africa	• Because Etosha is a Ramsar site, any project that could alter the system has international implications. • Impact on the sensitive habitats of the Etosha pans • Impact on breeding grounds of wetland birds

5.7 THE SOCIO-ECONOMIC ENVIRONMENT

5.7.1 *Introduction*

This section provides an overview of the full socio-economic profile contained in the Socio-economic Impact Assessment (Urban Dynamics, 2012, ***APPENDIX F***) for this study.

The proposed project area is located in the Oshana Region, one of the North-Central Regions of Namibia. The constituencies mainly affected by the proposed project are Okatana, Oshakati East and West and Ongwediva. This section of the report aims to provide baseline information for the Oshana Region as well as for these constituencies against which potential impacts can be assessed.

5.7.2 *Settlement Patterns*

The Oshana Region is the second most densely populated region (20.3 persons per km²), second only to the neighbouring Ohangwena Region (22.9 persons per km²). The population density had increased from 18.7 in 2001 to 20.3 persons per km² in 2011. Population concentration occurs around the urban centres of Oshakati, Ongwediva and Ondangwa in densities higher than 300 persons per km², as well as alongside major transport corridors.

The combined population of the Oshakati-Ongwediva-Ondangwa urban area, comprise a total population of 71 600 people, making it the second most populated urban area of Namibia, second only to the City of Windhoek (322 500 people). This area is also regarded as one of the main commercial, industrial and administrative nodes of Namibia.

In 2001, 77 % of the 155 874 people usually residing in the Oshana Region was born there. In-migration primarily occurred from the Ohangwena and Omusati Regions, while out-migration primarily occurred towards the Khomas and Oshikoto Region. The percentage of the rural population decreased from 74 % to 69 % and the urban population increased from 26 % to 31 % from 1991 to 2001. Rural to urban migration therefore appears to occur within Oshana Region towards the urban centres and outwards to other more urbanised regions.

5.7.3 *Demographic Profile*

The Oshana Region's population grew at a rate of 1.8 % per annum from 161 916 people in 2001 to 174 900 people by 2011. This increases of 12 984 people represents a growth rate of 0.8% per annum for the period 2001-2011, which is a significantly lower rate than the previous census period. Based on this growth rate, 190 000 people are projected to be in the Oshana Region by 2021. With respect to the affected constituencies, the population projections up to the year 2021 are shown in **Table 4**:

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Table 4: Total populations for Okatana, Oshakati East and West and Ongwediva constituencies for 2001 and 2011 projected up to 2021

Constituency	2001 Population	2011 Population	2021 Population Projection	% Growth (2001-2011)
Okatana	15,352	14,700	14,000	-0.5
Oshakati East	24,269	26,700	30,000	1
Oshakati West	19,862	20,200	20,500	0.2
Ongwediva	26,700	33,700	42,500	2.4

In 2001, the under 15 year age group of the Okatana constituency was 43 %, which is comparatively higher than Oshakati East (34 %) and West (32 %), Ongwediva (40 %), and as well as the Region (40 %). Oshakati East (59 %) and West (61 %) have a larger proportion of their population in the working age group than Ongwediva (53 %) and the Region (53 %), although Okatana (47 %) has a smaller proportion.

The population pyramids of the constituencies are characteristic of rural areas with a larger proportion of the population in the younger age group. Also, there are distinctly more women than men in the 20-30 year age groups. This is further indicative of young men of working age leaving the constituencies in search of employment opportunities in urban areas.

It should however be noted that the Regional fertility rate has decreased from 5.6 in 1991 to 3.8 in 2001. Also, the fertility rates of Okatana (3.7), Oshakati East (3.6) and West (3.5) and Ongwediva (3.5) are lower than the Regional average.

Table 5: Health indicators for Namibia and Oshana Region, 2000

Constituency	2001 Population	2011 Population	2021 Population Projection	% Growth (2001-2011)
Okatana	15,352	14,700	14,000	-0.5
Oshakati East	24,269	26,700	30,000	1
Oshakati West	19,862	20,200	20,500	0.2
Ongwediva	26,700	33,700	42,500	2.4

5.7.4 *Education and Health*

There are 21 secondary schools, 51 combined schools and 62 primary schools in the Oshana Region. The number of learners in the Region has decreased from 51 924 in 2005 to 51 326 in 2011. The number of schools also showed a decreased during 2008-2009 corresponding to the flood period, but again increased in 2010. The literacy rate for the constituencies are as follows: Okatana (89 %), Ongwediva (92 %), Oshakati East (92 %) and Oshakati West (94 %). Except for Okatana, the constituencies have higher literacy rates than the Region at 91 %.

With respect to health, there is a State Hospital located in Oshakati, with five health centres and eleven clinics found throughout the Region. As shown

Table **5**, the health indicators for the region is much better than the national averages, except for the prevalence rate amongst pregnant women. According to the 2008 HIV Sentinel Survey Report, the HIV prevalence rate of Oshakati shows a decrease from the highest recorded rate of 34% in 1998 to 22.4% in 2008, which are still amongst the highest prevalence rates in the country.

5.7.5 *Mean Household income*

In 2004, the Oshana Region had risen to become the region with the third highest mean annual household income of N$45 704, third only to the Erongo (N$53 408) and Khomas (N$ 91 028) Regions. By 2009, however, the Oshana Region dropped to fifth position with a mean annual household income of N$65 445, which is again below the national average of N$68 878. (GRN 2011).

5.7.6 *Poverty*

The incidence of poverty in the Oshana Region is the third lowest in the country. Based on the food consumption ratio, the Oshana Region showed improvement. In 2004, 6 % of households spent between 80-100 % of their income on food, and 25 % spent between 60-79 % of their income on food. By 2010, this decreased to 3 % of households spending between 80-100 % of their income on food, and 21 % spending between 60-79% of their income on food. This is however still above the national averages of 2% and 20%.

5.7.7 *Unemployment*

In 2001, the regional unemployment rate was relatively high at 40 % of the labour force, having doubled from 21% in 1991. The 2008 Labour Force Survey found that the unemployment rate (strict) showed a marginal decrease to 39% in 2008. The unemployment rate at consistency level is shown in Table 6.

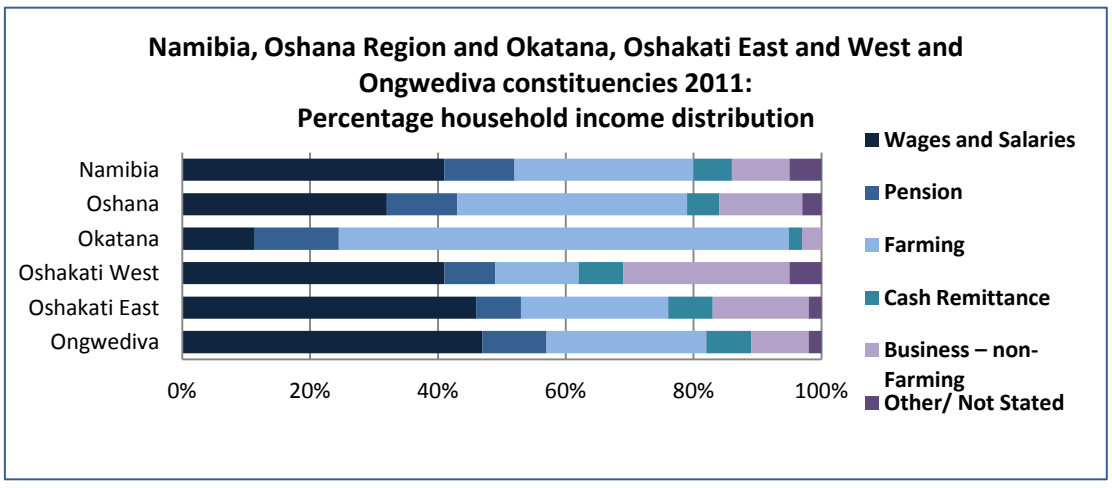
Table 6: Percentage of the Region and constituencies work force that are unemployed, 2001

Area	Oshana Region	Okatana	Oshakati East	Oshakati West	Ongwediva
Unemployment	40 %	30 %	34 %	40 %	35 %

5.7.8 *Sources of income*

The main sources of income for the Oshakati East and West and Ongwediva constituencies are wages and salaries, while the Okatana constituency heavily relies on farming. Table 7 shows the percentage of household by main sources of income for the Oshana Region and Constituencies in comparison to Namibia.

Table 7: Percentage of households by main sources of income for Namibia, Oshana region, and Okatana, Oshakati East and West and Ongwediva constituencies, 2001



5.7.9 *Socio-Economic Profile of the Affected Households*

The households most affected by the dike were classified into three distinct categories and a socio-economic survey was done which included all three of these categories. **Figure 23** shows the households marked in red **(impact zone one)** are the ones which will need to be relocated as a result of the dike and channel. The households marked in green **(impact zone two)** are the ones which were flooded in the 2011 floods and which would experience worse flooding under the same flood scenario with the dike in place. The households marked in blue **(impact zone three)** were not flooded during the 2011 floods, but will be flooded if the same flood occurs with the dike in place. The remaining contents of this section are devoted to the socio-economic profile of these three impact zones.

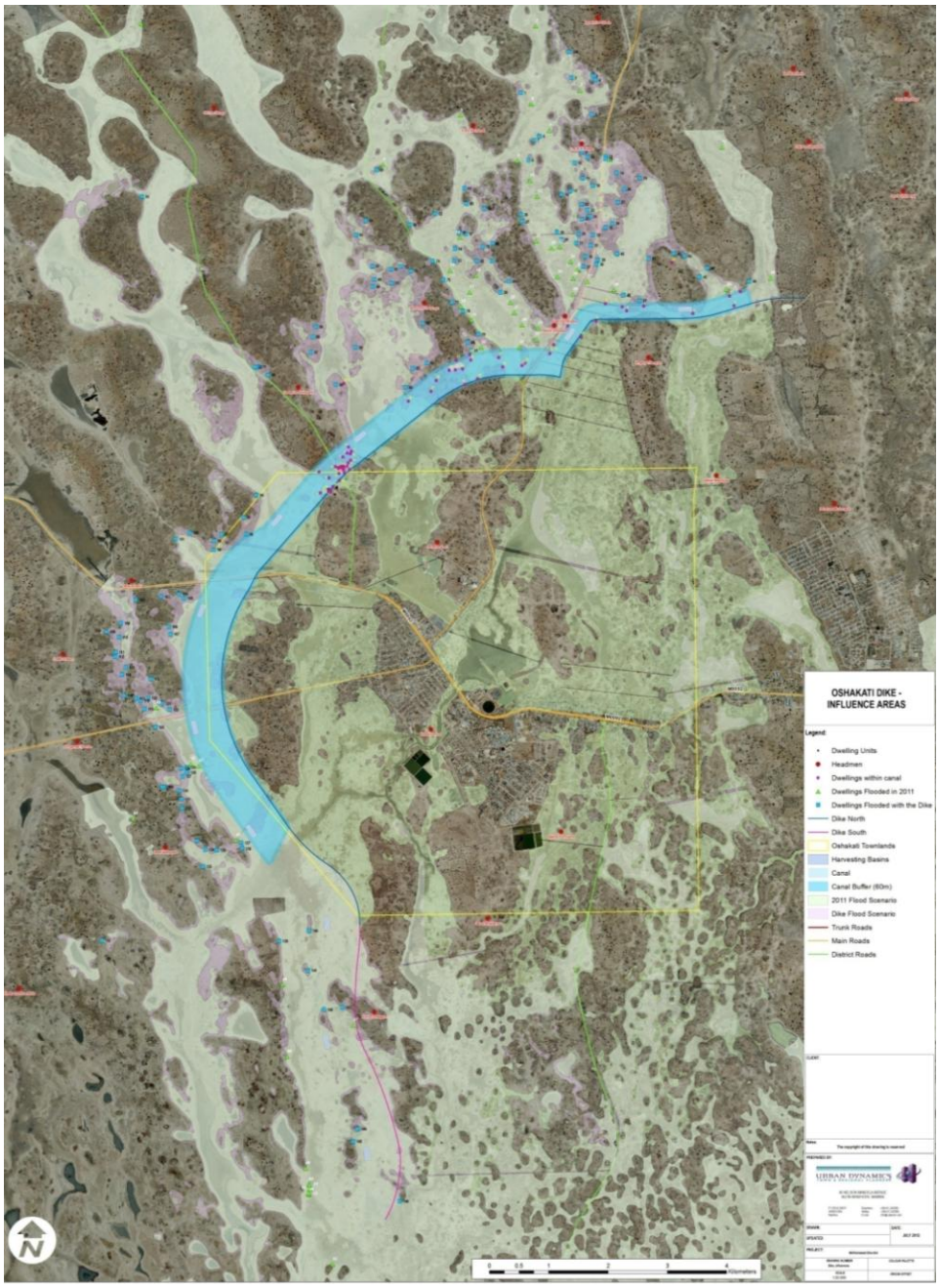


Figure 23: Map indicating the locality of the dike and the three impact zones

5.7.10 *Demographic Profile*

5.7.10.1 Household size and distribution

The households in impact zone one are generally located closer to the urban areas of Oshakati and Ongwediva while zone two households are slightly further away. Impact zone three households are more rural than the other two zones. The average household size ranges from 5.87 people in zone one to 7.25 people in zone three. The household size in the three zones increase with the distance from the main urban centres, which is in line with national trends where households in the rural areas are generally larger than those in the urban areas.

5.7.10.2 Employment and income

The actual means of livelihood and levels of income is an important variable in the directly affected areas of this project. People who are dependent on their livestock and fields as main source of livelihood are more vulnerable than those that hold other jobs and get an income from such positions.

The employment status of for the three zones are presented in **Figure 24**. In zones one and three, 23 % and 24 % of household members respectively, regarded themselves as employed. More people in impact zones one and two have their own businesses than in impact zone three, which supports the expectations for an area with more rural characteristics.

Figure 24: Employment Status

As for livestock farming, it is clear that the households in all impact zones have very little livestock. With a mean of mostly less than one animal per type per household, it can hardly be called livestock farming. Of those households that own livestock only 2 % in impact zone two and 1 % in impact zone three have between 21 and 30 cattle while not a single household was found with more than 30 cattle. This is a clear indication that the majority of people's livelihoods do not depend on livestock rearing and that very few of them have anything approximating a sustainable herd.

On the other hand, about 73 % of households in impact zone one, 80 % in zone two and 95 % in zone three indicated that they plant their crop fields on an annual basis. This indicates that fields are important and possibly in many cases it provides the household with the food they need to survive in addition to a cash income earned from wages. Also, it seems as if about 20 % of all households in all three zones do not

have any monthly income and it can be assumed that they live off their land only. Another 15 % live off pensions from one older person in the household only.

The majority of households in all three zones live on less than N$ 1000 per month, but there is a substantial group (between 20 % and 38 %) of households that own more than N$ 6000 per month which make them fairly well-off in comparison to the others.

5.7.11 *Key Socio-economic trends and issues of Importance for this Social Impact Assessment*

KEY SOCIO-ECONOMIC TRENDS IN THE OSHANA REGION AND THE IMPACT ZONES OF THE OSHAKATI FLOOD MITIGATION PROJECT.
• The region is densely populated, to such an extent that suitable higher lying land for crop production and grazing for livestock is becoming scarce.
• This contributes to high levels of urbanisation and growth of the main centres of Oshakati, Ongwediva and Ondangwa. Young people especially tend to look for a better life and opportunities in these urban areas.
• Mean household incomes in the region are increasing steadily. However, the rate of growth is lower than the national average.
• The rate of natural population growth is on the decrease with fertility rates declining from 5.6 in 1991 to 3.8 in 2001.
• The population age distribution indicates a typical pyramid for a developing nation with a high percentage of young people if compared to the pyramids of developed societies.
• Education and health facilities are well provided and compares favourably with national health and education indicators. However, the HIV infection rate in Oshakati is very high yet on the decrease
• Based on the food consumption ratio, about 3% of all households in the Region can be regarded as very poor while about 21% can be regarded as poor.
• Unemployment is high and on the increase. It rose from 21% in 1991 to 40% in 2001 and this trend is supported by a large young population completing school every year but being unable to find gainful employment.
• In the more rural areas on the outskirts of Oshakati where the negative social impact of the proposed project will be felt most, household sizes are still relatively big with many households surviving off their land only. However, between 20% and 38% of households in the three identified impact zones earn substantial incomes from employment in the urban settlements.
• It is interesting to note that few people regard themselves as farmers, yet about 30% - 40% of households have no cash income and live from their fields.
• More than 90% of all households own no livestock while those that own livestock seldom have a sustainable herd.
• Livelihoods in the area are clearly changing from a high level of dependence on their land to a situation where some members of a household earn a cash income elsewhere and this is then used to sustain the household. Also, pensions play a significant role in ensuring a little cash income to some of the most vulnerable households.
• The vast majority of households that must be resettled as a result of the proposed project have been living at their current place of residence for more than 10years or was born there.

6 PUBLIC CONSULTATION AND DISCLOSURE

6.1 INTRODUCTION

Public consultation forms an important component of an Environmental Impact Assessment (EIA). It has been defined by the Namibian Ministry of Environment and Tourism (MET) Environmental Assessment Regulations of the Environmental Management Act (2007), as a '*process in which potential interested and affected parties (I&APs) are given an opportunity to comment on, or raise issues relevant to, specific matters'*.

The Scoping Report includes the full details of the consultation process developed and implemented for this EIA process. This section provides an overview of what was done to ensure inclusive consultation with all levels of stakeholders.

6.2 THE STAKEHOLDERS

An interested and affected party can be defined as '(a) any person, group of persons or organization interested in or affected by an activity; and (b) any organ of state that may have jurisdiction over any aspect of the activity' (MET, 2010).

Key stakeholders have been identified at national, regional and local level. As for this project, local refers to the Oshakati community. A summary of these stakeholder groups are presented in **Table 8** below.

Members of the Public received the opportunity to register as stakeholders and were added to the stakeholder list as they came on board.

Table 8: Summary of Stakeholders

LEVEL	DESCRIPTION
NATIONAL	Ministry of Regional and Local Government and Housing and Rural Development (MRLGHRD) Ministry of Environment and Tourism (MET) Ministry of Agriculture, Water and Forestry (MAWF) Ministry of Health and Social Services (MHSS) Ministry of Works Transport and Communication (MWTC) Ministry of Education (MOE)
	Emergency Response Unit (Office of the Prime Minister) National Planning Commission NamWater NamPower NGOs Specialists
	Other Consultancies Media
REGIONAL	Ministry of Regional and Local Government and Housing and Rural Development Ministry of Environment and Tourism Ministry of Works Transport and Communication Ministry of Agriculture, Water and Forestry Ministry of Education
	Oshana Regional Council
	NORED NamPower Media
LOCAL	Oshakati Town Council Ongwediva Town Council
	Chamber of Commerce and Industry Premier Electric Telecom
	NGOs Specialists Other Consultancies Media

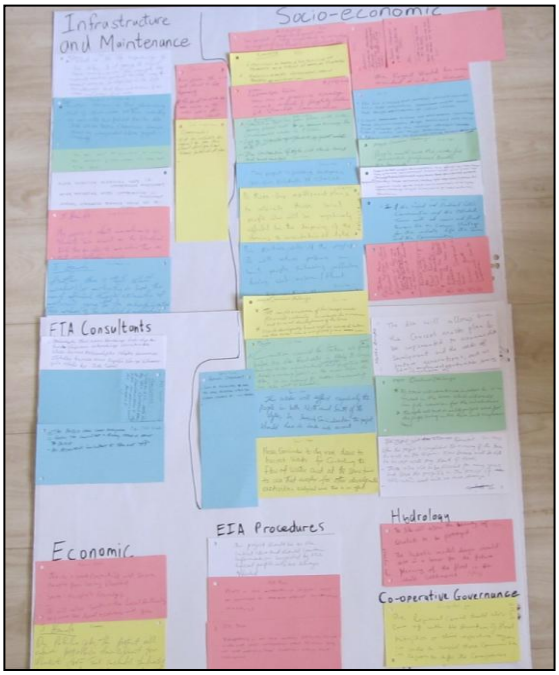


Figure 25: Cards used at the consultation meetings to ensure full participation.

6.3 MEETINGS HELD

A strategic level meeting was held in Windhoek at the outset of the EIA process. This was followed with more targeted stakeholder meetings in Windhoek and in Oshakati. Meetings were also held in the project area targeting the leadership of the local population and other interest groups. **Table 9** below provides a summary of the meetings held and their out outcomes. The detailed minutes of these meetings are contained in the Scoping Report.

Table 9: Summary of the Objectives and Methodology for Each Meeting, as well as main issues raised

OBJECTIVES	THE MEETINGS	MAIN ISSUES RAISED	METHODOLOGY
HIGH LEVEL STRATEGIC CONSULTATION			
• To consult with main stakeholders who are responsible for and concerned with the wellbeing of the Cuvelai System and its people and to consider where this projects fits into the "bigger picture".	• Windhoek: Held in November 2011. • Represented the MRLGHRD, Roads Authority, Water Affairs, NamWater, Oshakati Town Council, Water quality and hydrological specialists, the wetlands working group, etc.	• The Project is of critical importance. However, proper investigations are necessary for a sustainable solution. • Protection of flooded households and more space made available. In the medium term. • However, a strategic long-term planning approach is crucial for the sustainable development of the area and surrounds and to holistically solve the flooding vs. settlement dilemma in a responsible way. • Some elements of the project, including a stormwater master plan, cleaning of the channels through Oshakati, and the set up of gauging stations in the Cuvelai are urgent and do not hold significant risks. They should be implemented with immediate effect (significant progress has since been made with all these components). • Potential ecological effects may be very significant since they play a crucial role in the livelihoods of the Cuvelai inhabitants, which are maintained by natural ecological processes. These include potential change of groundwater and surface water resources, removal of the self-	• Key stakeholders identified and invited personally.

OBJECTIVES	THE MEETINGS	MAIN ISSUES RAISED	METHODOLOGY
		cleaning properties of the Cuvelai by lining and channelling it, impacts on fish communities, turning a seasonal system into a perennial one, which will change the entire bio-system, and the effects of these changes to the Etosha Pans, which is a declared Ramsar site. • The establishment of a permanent water body in Oshakati was questioned. It potentially has significant impacts, including, siltation, mosquito and other insect problems, spreading of waterborne diseases, algae growths and water contamination (it has subsequently been decided that the proposed water feature for Oshakati requires further engineering development and that it will not be covered in full detail in this EIA). • Potential negative social impacts include relocation of homesteads and other impacts on settlements due to the inundation by the backwater. • The proposed systems should be manageable from an operations and maintenance point of view keeping in mind current institutional constraints. The system needs to be appropriate for local social, institutional, ecological and physical conditions.	

OBJECTIVES	THE MEETINGS	MAIN ISSUES RAISED	METHODOLOGY
AUTHORITIES CONSULTATION			
• To consult with organs of state which have jurisdiction over the project areas. • To consider possible solutions to challenges faced.	• *Windhoek:* Held on 07 March 2012, attended by more than 40 people. Represented the MAWF, MET, MRLGHRD, DWAF, NPC, private consultants, City of Windhoek, Road Authority, and local businessmen. • *Oshakati:* Held on 08 March 2012, had 52 attendees. Represented the Oshakati Town Council, Oshana Regional Council, Traditional Authorities, MET, MWAF, MRLGHRD, hydrologist, private consultants and NamPol.	• Potential increased velocity of the water along the dike, • Impacts on villages downstream from the dike near Ompundja, • Crossing the dike and its water channel, • Potential harvesting of water, • Still standing water and associated health risks, • Locality of the dike, safety and linking up of the dike with existing roads. • Crossing of the Okatana River inside the town • Potential pollution.	• *Windhoek*: Authorities via fax and mail, a notice was placed in the newspapers to inform the Windhoek public. • *Oshakati:* The Oshana Regional Council assisted with invitations to the traditional authorities.
PUBLIC CONSULTATION			
• To create a platform whereby the concerns of individuals, groups or local communities could be conveyed and the parameters for the study in terms of issues to explore can be developed. • To facilitate transparency with the	• *Oshakati*: 09 March 2012 in Oshakati. • Represented the Namibia Chamber of Commerce and Industry (NCCI) and business community, Oshakati Town Council, Hydrology,	• Management of the sluice gates, • Changes in velocity of the water as it reaches Ompundja, • Spreading out of water at the end of the dike, • The linking of existing roads and villages to the dike, Access to Oshakati.	• Via e-mail and fax to the I&APs. • Announced in the various newspapers and over the radio with the help of the Oshakati Town Council, while

OBJECTIVES	THE MEETINGS	MAIN ISSUES RAISED	METHODOLOGY
public which aids in building good rapport, while identifying potential challenges brought about by the proposed project, along with possible solutions.	Traditional Authorities and students from UNAM.		• The Oshana Regional Council invited the traditional authorities and leadership as well as key business people. The NCCI also assisted by inviting their members.

igure 26: Photos of the Meetings Conducted

6.3.1 *Public Feedback*

Continuous public input and feedback is important as it also assists in transparency and building good relations. The following feedback mechanisms are included in this process:

- A two-week commentary period allowed I&APs the opportunity to submit any questions or comments on the BID as well as information presented at the meetings.
- The Draft Environmental Scoping Report which also includes a summary of the public participation process, the minutes and an Issues and Responses Trail, was made available on the Enviro Dynamics website for the perusal of all registered I&APs.
- Hard copies of the Draft Scoping Report were also placed at the Windhoek and Oshakati libraries. The Executive Summary of the Report was also translated into Oshiwambo and distributed via the Councillors to all concerned.
- All comments received during this round of consultation were collated into a Comments and Responses Trail which included statements of how the comments were considered and incorporated into the Final Environmental Scoping Report, which was submitted with the Final report to the DEA.

The feedback mechanism described above will again be followed for the distribution of the Draft Environmental Impact Report (i.e. this document).

6.3.2 *Issues Identified*

The key concerns and issues raised by the I&APs during the scoping process are summarized in **Table 10** below.

Table 10: Summary of Key Issues Identified

SUMMARY OF ISSUES	
Land use planning	• Dike will obstruct the westward expansion of Oshakati • Need for the designation and enforcement of restricted areas which are prone to flooding where no development should take place • Need for a SEA for the entire Cuvelai system • Concept Master Plan could formalise informal settlements • Need for region and nation-wide planning to deal with the flooding problem –other areas such as Caprivi are also subject to flooding

SUMMARY OF ISSUES	
	• Restrict the development of Oshakati and use the money for the development of other towns? This would be in keeping with Vision 2030, which seeks to develop towns other than those that are more established..
Water quality and Ecology	• Exposure of the hard salt/mud layer under the iishana could cause a change in water quality downstream during subsequent floods. • Hydrological, nutrient and energy cycles of the oshana system may be altered. • Distribution of pollution and litter from Oshakati to other areas not previously affected by the floods • Searching for material to use in the construction of the dike and the spoiling of large volumes of material which is unsuitable for dike construction could present ecological problem • Impact of increased velocities and volumes of water on sensitive ecosystems further south like Etosha (breeding grounds of wetland birds, unsustainable harvesting of frogs and fish in areas with low flow.). • Restriction of the normal flow of the watercourses could cause flooding in other areas. • Impact on flora and fauna (construction of the dike, deepening of Okatana channel), (e.g. deforestation, change in biodiversity due to change in flow velocity, duration and time - Loss of livelihood sources.) • Impact of siltation/turbidity downstream in a system where the water is already very turbid (erosion). • Impact of changes in water quality on fish production.
Hydrology	• Infrastructure constructed in a predominantly east-west orientation interrupts the flow of water which flows from north to south. • Consider early flood warning system with the use of satellite technology • Impact of the construction process during flooding • Increased seepage in Oshakati from the dike • Impact of the dike on the Calueque-Oshakati water scheme • Impact of the dike on the flow velocities of diverted/downstream water • Impacts of flood gate operations on Cuvelai system (duration and time of flow) • Removal of the salt/mud layer lining the iishana could have an impact on aquifer recharge, flows, etc. downstream. • Impact on the internal storm water drainage of Oshakati. • Integration of swamp/lake/canal/dike/stormwater systems • Risks associated with flash floods after heavy rainfall. • Consider the uncertainties and the associated risks of the hydrological model
EIA Process	• Consider alternatives to the construction of a dike/consider a simpler solution for flooding in the north-central regions that could be applied to other affected areas as well. • Consider the input from the local people • Consider the lessons learnt from similar projects (canalisation of rivers through towns) in other countries.

SUMMARY OF ISSUES	
	• Government should not take decisions without consulting the public – (referring to the Oshakati Concept Master Plan, which has already been approved by Cabinet). • The need for a feedback meeting. • Comments raised at meetings need to be translated into Oshiwambo for all to understand.
Socio-economic	• Impact of the project on residents to the north, west and further downstream (Ompundja) of the dike (relocation and compensation of locals - People will lose their homesteads and fields) • Employment of local people during the construction phase of this project (Reduction in unemployment and hence poverty) • Safety risks for people and animals associated with the deepening of the Okatana channel (i.e. people and animals falling into and drowning in the channel). • Increase in flooding in the area where the main discharge will again be accommodated in the normal unaltered oshana system. These households will be flooded as a result of the backwater effect and a mitigation regime will need to be put in place for them. • Impact of creating a precedent that settlements experiencing flooding can expect intervention from Government. • Improved protection of people's property and lives from flooding (Approximately 1000 households will now be flood free and will no longer be displaced annually as a result of the floods). • More space available for residential development (More land close to the centre of Oshakati available for development with resultant cost savings). • Increased, business, recreation and tourism opportunities • Access across the large body of water and a dike (traditional pathways, movement of livestock, children walking to school). • Capacity of headmen (residing outside Oshakati) in dealing with complaints and issues. • Consider damming the water for consumption by local residents (Lower water prices in the area, Water harvesting) • Effect of deforestation on locals especially the removal of fruit bearing trees. • Consider the potential of fish farming if water is dammed.
Economic/Financial/ Costing	• Frequency of flood events vs. justification of this project • Benefits of project for the Oshakati economy (development of multipurpose infrastructure, investments and improved capacity of local government) • Consider the cost associated with the relocation of people vs. the costs of the project.
Flood Infrastructure, Maintenance and Rehabilitation	• Institutional capacity to maintain and operate the flood mitigation structures • Consider siltation in the Maintenance Plan for the flood gates • Elevation of areas within Oshakati to avoid flooding caused by rainwater

SUMMARY OF ISSUES	
	accumulated in the town • Excavation of material from the river to the north of Oshakati to construct the dike. • EMP required for the rehabilitation of areas that will be excavated during construction. • Impact of the flood mitigation project on the time schedules of planned projects (e.g. road planned between Ongwediva and Oshakati, telecommunication projects) and projects currently in progress (e.g. the construction of the DR 3671 road) • Consider maintenance issues on the dike slopes. With domestic stock and foot borne human activity. • Costs and maintenance requirements of erosion control.
Health and Safety	• Health impacts associated with the spreading of diseases and malaria associated with the slow flow speed of water. • Pollution of standing and canalised water. • Improved sanitation due to the movement of previously standing (contaminated) water away from Oshakati
Environmental Consultants	• Issues and concerned raised must be objectively presented.
Co-operative governance	• Need for co-ordination between the various Regional Authorities in the affected regions so as to share solutions regarding flooding concerns • All relevant government institutions (like Roads Authority) need to be consulted and informed regarding the project.

7 IDENTIFICATION OF KEY IMPACTS

7.1 SCREENING OF ISSUES

In order to arrive at the final scope of the further investigations, all the baseline sensitivities, legal requirements as well as community concerns raised were collated. This list of issues was further screened to identify those for which further investigation is required, using a decision-making process explained in **Figure 27**.

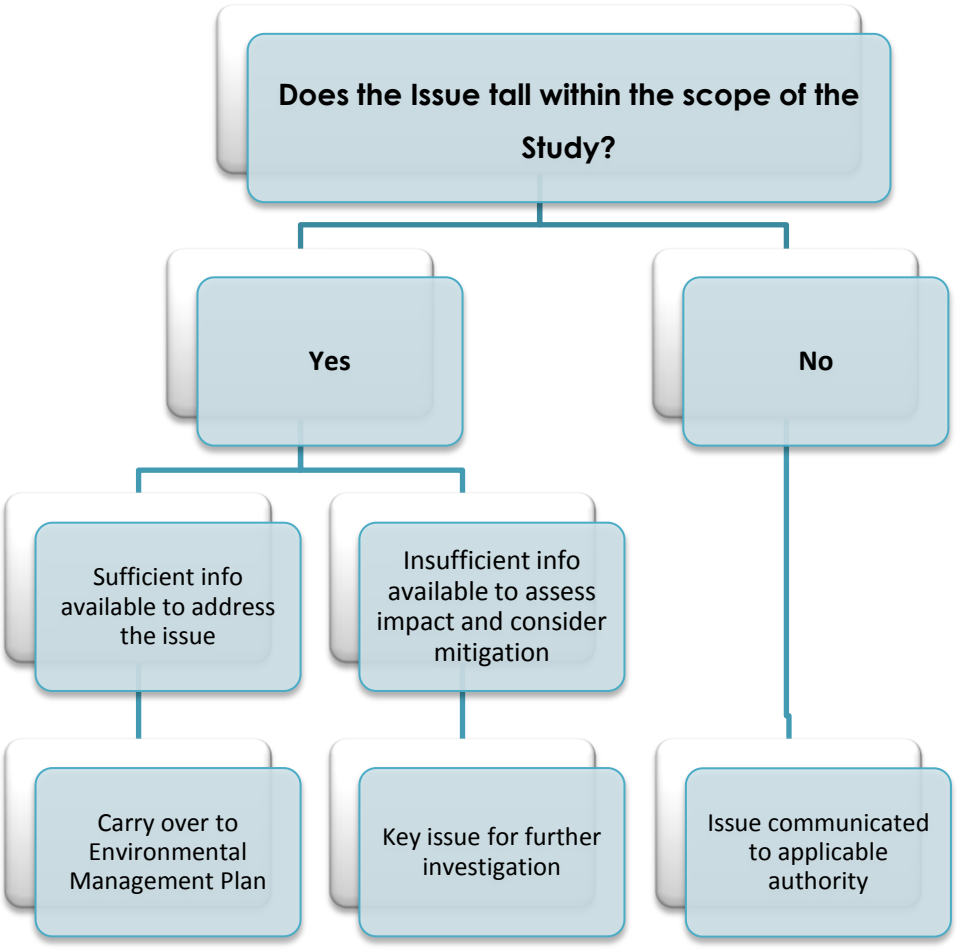


Figure 27: Screening process to determine key issues

All the potential impacts identified for this project are presented in **Table 11** with the above process applied. The highlighted rows represent potential significant impacts which required further investigation while the management of the remaining impacts will be addressed in the Environmental Management Plan.

The right column includes references to where further details on the subject may be found in this document.

Table 11: Potential impacts associated with this project.

IMPACT/ISSUE	DOES IT FALL UNDER THIS EIA? YES/NO	SUFFICIENT INFO YES/NO	MITIGATION AVAILABLE YES/NO	FURTHER WORK TO BE CONDUCTED
LAND USE PLANNING				
Dike will obstruct the westward expansion of Oshakati	No but part of MRLGHRD responsibility	Yes.	Not applicable.	Part of wider planning efforts for Oshakati.
Need for the designation and enforcement of restricted areas which are prone to flooding where no development should take place	No but part of MRLGHRD responsibility	Yes.	Not applicable.	Part of wider planning efforts for Oshakati. See **Section 9.**
Need for a SEA for the entire Cuvelai system	No but part of MRLGHRD responsibility	Yes.	Not applicable.	Part of wider planning efforts for the applicable regions. See **Section 9.**
Concept Master Plan could formalise informal settlements	No but part of MRLGHRD responsibility	Yes.	Yes.	Further guidelines to be established for the Master Plan.
Need for region and nation-wide planning to deal with the flooding problem –other areas such as Caprivi are also subject to flooding	No but part of MRLGHRD responsibility	Yes.	Not applicable.	Part of wider planning efforts for the applicable regions. **See Section 9.**
Restrict the development of Oshakati and use the money for the development of other towns? This would be in keeping with Vision 2030, which seeks to develop towns other than those that are more established.	No, for MRLGHRD to consider as part of wider planning.	Yes.	Not applicable.	Part of wider planning efforts.

Table 11: Potential impacts associated with this project.

IMPACT/ISSUE	DOES IT FALL UNDER THIS EIA? YES/NO	SUFFICIENT INFO YES/NO	MITIGATION AVAILABLE YES/NO	FURTHER WORK TO BE CONDUCTED
WATER QUALITY AND ECOLOGY				
Exposure of the hard salt/mud layer under the iishana could cause a change in water quality downstream during subsequent floods.	Yes.	No.	Uncertain.	See ***APPENDIX B***
• Hydrological, nutrient and energy cycles of the oshana system may be altered.	Yes.	No.	Uncertain.	**See 8.4.1**
• Distribution of pollution and litter from Oshakati to other areas not previously affected by the floods.	Yes.	No.	Uncertain.	**See 8.4.2**
Impact of removing material to be used for the construction of the dike.	Yes.	No.	Uncertain.	Further borrow pit investigation to be conducted, to include environmental considerations, See EMP, ***APPENDIX C***
Impact of changed flow, and increased velocities and volumes of water on sensitive ecosystems further south like Etosha (breeding grounds of wetland birds, unsustainable harvesting of frogs and fish in areas with low flow.).	Yes.	No.	Uncertain.	**See 8.4.3**

Table 11: Potential impacts associated with this project.

IMPACT/ISSUE	DOES IT FALL UNDER THIS EIA? YES/NO	SUFFICIENT INFO YES/NO	MITIGATION AVAILABLE YES/NO	FURTHER WORK TO BE CONDUCTED
Restriction of the normal flow of the watercourses could cause flooding in other areas.	Yes.	No.	Uncertain.	**See 8.3.3**
Impact on flora and fauna (construction of the dike, deepening of Okatana channel), (e.g. deforestation, change in biodiversity due to change in flow velocity, duration and time - Loss of livelihood sources.)	Yes.	No.	Uncertain.	**See 8.4.3-8.4.7**
Impact of siltation/turbidity downstream in a system where the water is already very turbid (erosion).	Yes.	No.	Uncertain.	See 8.4.3, **APPENDIX E**
Impact of changes in water quality on fish production.	Yes.	No.	Uncertain.	**See 8.4.4**
HYDROLOGY				
Roads constructed in a predominantly east-west orientation interrupts the flow of water which flows from north to south.	Yes.	Yes.	Yes.	Include in EMP that infrastructure must be wide enough not to obstruct flow. See **APPENDIX C**
Consider early flood warning system with the use of satelite technology	No.	No.	Not applicable.	Monitoring by Water Affairs.
Impact of the construction process during flooding	Yes.	Yes.	Yes.	Carry over to EMP(See **APPENDIX C**)

Table 11: Potential impacts associated with this project.

IMPACT/ISSUE	DOES IT FALL UNDER THIS EIA? YES/NO	SUFFICIENT INFO YES/NO	MITIGATION AVAILABLE YES/NO	FURTHER WORK TO BE CONDUCTED
Increased seepage in Oshakati from the dike .	Yes.	No.	Uncertain.	See groundwater study. **APPENDIX .E**
Impact of the dike on the Calueque-Oshakati water scheme	Yes.	Yes.	Yes.	EMP – design crossing infrastructure to accommodate this. **APPENDIX C...**
Impact of the dike on the flow velocities of diverted/downstream water	Yes.	No.	Uncertain.	**APPENDIX E...**
Impacts of flood gate operations on Cuvelai system (duration and time of flow)	Yes.	No.	Uncertain.	**See 8.4.6**
Impact on the internal storm water drainage of Oshakati. Risks associated with flash floods after heavy rainfall.	Yes.	No.	Yes.	Assumption – designs will accommodate internal stormwater drainage.
Integration of swamp/lake/canal/dike/stormwater systems	Yes.	Yes.	Yes.	Engineering team to integrate designs.
Consider the uncertainties and the associated risks of the hydrological model .	Yes.	No.	Uncertain.	See **APPENDIX E**
EIA PROCESS				
Consider alternatives to the construction of a dike/consider a	No. Recommendations to be made to consider	No.	Not applicable.	See Section 10. Otherwise TOR does not include

Table 11: Potential impacts associated with this project.

IMPACT/ISSUE	DOES IT FALL UNDER THIS EIA? YES/NO	SUFFICIENT INFO YES/NO	MITIGATION AVAILABLE YES/NO	FURTHER WORK TO BE CONDUCTED
simpler solution for flooding in the north-central regions that could be applied to other affected areas as well.	alternatives only.			consideration to alternatives.
Consider the input from the local people	Yes.	Not applicable.	Not applicable.	On-going consultation as part of the EIA.
Government should not take decisions without consulting the public – (referring to the Oshakati Concept Master Plan, which has already been approved by Cabinet).	No.	Not applicable.	Not applicable.	On-going consultation as part of the EIA. General note for government.
The need for a feedback meeting.	Yes.	Not applicable.	Not applicable.	Feedback meeting following the draft EIA.
Comments raised at meetings need to be translated into Oshiwambo for all to understand.	Yes.	Not applicable.	Not applicable.	Translation of executive summary.
SOCIO-ECONOMIC				
Impact of the project on residents to the north, west and further downstream (Ompundja) of the dike (relocation and compensation of locals - People will lose their homesteads and fields)	Yes.	No.	Uncertain.	**See 8.3.1-8.3.3**
Employment of local people during	Yes.	No.	Yes.	**See 8.3.4**

Table 11: Potential impacts associated with this project.

IMPACT/ISSUE	DOES IT FALL UNDER THIS EIA? YES/NO	SUFFICIENT INFO YES/NO	MITIGATION AVAILABLE YES/NO	FURTHER WORK TO BE CONDUCTED
the construction phase of this project (Reduction in unemployment and hence poverty)				
Safety risks for people and animals associated with the deepening of the Okatana channel (i.e. people and animals falling into and drowning in the channel).	Yes.	Yes	Yes	**See 8.3.5and 8.3.6**
Increase in flooding in the area where the main discharge will again be accommodated in the normal unaltered oshana system. These households will be flooded as a result of the backwater effect and a mitigation regime will need to be put in place for them.	Yes.	No.	Uncertain.	. **See 8.3.1-8.3.3**
Impact of creating a precedent that settlements experiencing flooding can expect intervention from Government.	No.	No.	Uncertain.	Government to consider.
Improved protection of people's property and lives from flooding (Approximately 1000 households will now be flood free and will no longer be displaced annually as a result of the floods).	Yes.	No.	Uncertain.	**See 8.3.7**

Table 11: Potential impacts associated with this project.

IMPACT/ISSUE	DOES IT FALL UNDER THIS EIA? YES/NO	SUFFICIENT INFO YES/NO	MITIGATION AVAILABLE YES/NO	FURTHER WORK TO BE CONDUCTED
More space available for residential development (More land close to the centre of Oshakati available for development with resultant cost savings).	Yes.	No.	Uncertain.	**See 8.3.8**
Increased, business, recreation and tourism opportunities	Yes.	No.	Uncertain.	**See 8.3.10**
Access across the large body of water and a dike (traditional pathways, movement of livestock, children walking to school).	Yes.	No.	Uncertain.	See **APPENDIX F**
Headman complaint that Oshakati town council does not consult with them concerning matters within Oshakati.	No.	No.	Not applicable.	None, for headman to take up directly.
Consider damming the water for consumption by local residents (Lower water prices in the area, Water harvesting)	No.	Uncertain.	Not applicable.	Engineering team to consider.
Effect of deforestation on locals especially the removal of fruit bearing trees.	Yes.	No.	Uncertain.	**See 8.4.7**
Consider the potential of fish farming if water is dammed.	No.	Not applicable.	Not applicable.	Government to consider. Ecology study to comment.

Table 11: Potential impacts associated with this project.

IMPACT/ISSUE	DOES IT FALL UNDER THIS EIA? YES/NO	SUFFICIENT INFO YES/NO	MITIGATION AVAILABLE YES/NO	FURTHER WORK TO BE CONDUCTED
ECONOMIC/FINANCIAL/COSTING				
Frequency of flood events vs. justification of this project	Yes.	Not applicable.	Not applicable.	Client to provide motivation for the project.
Benefits of project for the Oshakati economy (development of multipurpose infrastructure, investments and improved capacity of local government)	Yes.	No.	Uncertain.	**See 8.3.9.**
Consider the cost associated with the relocation of people vs. the costs of the project.	No.	No.	Info unavailable.	**See 8.3.1.** _compensation costs to be compared with the project costs.
FLOOD INFRASTRUCTURE, MAINTENANCE AND REHABILITATION				
Institutional capacity to maintain and operate the flood mitigation structures	Yes.	No.	Uncertain.	Consider institutional capacity and management recommendations in EMP. **APPENDIX C**
Consider siltation in the Maintenance Plan for the flood gates	Yes.	Uncertain.	Yes.	Carry over to EMP. Maintenance plan to be provided by engineers. **APPENDIX C**
Elevation of areas within Oshakati to avoid flooding caused by rainwater accumulated in the town	No.	Yes.	Yes.	Stormwater management plan

Table 11: Potential impacts associated with this project.

IMPACT/ISSUE	DOES IT FALL UNDER THIS EIA? YES/NO	SUFFICIENT INFO YES/NO	MITIGATION AVAILABLE YES/NO	FURTHER WORK TO BE CONDUCTED
Excavation of material from the river to the north of Oshakati to construct the dike.	Yes.	No.	Uncertain.	Engineering materials study to include environmental considerations.
EMP required for the rehabilitation of areas that will be excavated during construction.	Yes.	Yes.	Yes.	EMP, **APPENDIX C**
Impact of the flood mitigation project on the time schedules of planned projects (e.g. road planned between Ongwediva and Oshakati, telecommunication projects) and projects currently in progress (e.g. the construction of the DR 3671 road)	Yes.	No.	Yes.	Contact all relevant authorities for construction schedules. Include in EMP – **APPENDIX C**
Consider maintenance issues. With domestic stock and foot borne human activity.	Yes,	No.	Uncertain.	Maintenance Plan in EMP. **APPENDIX C**
Costs and maintenance requirements of erosion control.	Yes.	No.	Uncertain.	Consider in the EMP. **APPENDIX C**
HEALTH AND SAFETY				
Health impacts associated with the spreading of diseases, including balharzia and malaria associated with the slow flow speed of water.	Yes.	No.	Uncertain.	**See 8.4.8**
Pollution of standing and canalised	Yes.	No.	Uncertain.	**See 8.4.2**

Table 11: Potential impacts associated with this project.

IMPACT/ISSUE	DOES IT FALL UNDER THIS EIA? YES/NO	SUFFICIENT INFO YES/NO	MITIGATION AVAILABLE YES/NO	FURTHER WORK TO BE CONDUCTED
water.				
Improved sanitation due to the movement of previously standing (contaminated) water away from Oshakati	Yes.	No.	Uncertain.	**See 8.3.11and 8.4.2**
ENVIRONMENTAL CONSULTANTS				
Issues and concerns raised must be objectively presented.	Yes.	Yes.	n/a	Objective evaluation of positive and negative issues.
CO-OPERATIVE GOVERNANCE				
Need for co-ordination between the various Regional Authorities in the affected regions so as to share solutions regarding flooding concerns.	Yes.	N/a	n/a	See **Section 9**.
All relevant government institutions (like Roads Authority) need to be consulted and informed regarding the project.	Yes.	n/a	n/a	Consult authorities throughout the EIA. Government and engineers to do the same.

Subsequent to the Scoping phase, the relevant issues listed above were further investigated by the EIA Team. The right column indicates where in this document and in the appendices may details on each be found. The section to follow is a synopsis of the most significant impacts identified by the specialists on the team.

8 IMPACT ASSESSMENT

Each specialist was tasked to investigate the issues identified during coping. While some of the issues turned out to be of low significance, others are of greater concern. The section to follow concentrates on the potential impacts that are considered to be significant. Other impacts of low significance may be found in the specialist reports which are contained in the appendices of this main report. These lower significance impacts still need to be addressed by implementing the mitigation or enhancement measures where appropriate. Appropriate management actions to ensure mitigation is applied are contained in the Environmental Management Plan (***APPENDIX C***).

8.1 METHODOLOGY FOR IMPACT ASSESSMENT

The following methods were used by all specialists to determine the significance rating of impacts identified.

Description of impact

- Reviews the type of effect that a proposed activity will have on the environment;
- What will be affected; and
- How will it be affected.

Points 1 to 3 above were evaluated in the context of the following impact criteria:

- Extent;
- Duration;
- Probability; and
- Intensity / magnitude
- according to the criteria provided in **Table 12** below.

Table 12: Impact criteria for determination of significance

	DESCRIPTION				
EXTENT	Site specific At the facility constructed/ operated.	Local Limited to within a 15km radius	Regional (100km radius)	National Namibia	International Extending beyond Namibia's borders
DURATION	Very Short Term 3 days	Short term 3 days – 1 year	Medium term 1 - 5 years	Long term 5 – 20 years	Permanent > 20 years (life of mine)
INTENSITY/ MAGNITUDE	No lasting effect No environmental functions and process are affected	Minor effects The environment functions, but in a modified manner	Moderate effects Environmental functions and processes are altered to such extent that they temporarily cease	Serious effects Environmental functions and processes are altered to such extent that they permanently cease	

- **Status of the impact:** A description as to whether the impact is positive (a benefit), negative (a cost), or neutral.

- **Degree of confidence in predictions:** The degree of confidence in the predictions, based on the availability of information and specialist knowledge. This is assessed as high, medium or low.

Based on the above considerations, the specialist provides an overall evaluation of the significance of the potential impact, which is described as follows:

Table 13: Significance descriptions

	NONE	LOW	MEDIUM	HIGH
IMPACT SIGNIFICANCE	A concern or potential impact that, upon evaluation, is found to have no significant impact at all.	Any magnitude, impacts will be localised and temporary Accordingly the impact is not expected to require amendment to the project design.	Impacts of moderate magnitude locally to regionally in the short term. Accordingly the impact is expected to require modification of the project design or alternative mitigation.	Impacts of high magnitude locally and in the long term and/or regionally and beyond. Accordingly the impact could have a 'no go' implication for the project unless mitigation or re-design is practically achievable.

Furthermore,

- Impacts are described both before and after the proposed mitigation and management measures have been implemented;
- Where possible the impact evaluation takes into consideration the cumulative effects associated with this project. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts;
- Mitigation / management actions: Where negative impacts were identified, the specialists specifies practical mitigation measures (i.e. ways of avoiding or reducing negative impacts); and

Monitoring (forms part of mitigation): Specialists recommend monitoring requirements to assess the effectiveness of mitigation actions, indicating what actions are required, the timing and frequency thereof.

8.2 BASIS FOR THE ASSESSMENT

The entire project revolves around the diversion of water to avoid the developed area around Oshakati. Some land will therefore be laid dry, while other terrain may

experience the effect of backwaters. This will influence the socio-economic, as well as the bio-physical environment of the project.

The impact assessment was based on the hydrological and hydraulic models compiled by BAR. The EIA Team was involved in evaluating the reliability of these models. To this end the hydrological specialist on the EIA team is confident that the model is a sound basis for the impact assessment (see details in ***APPENDIX E***), and therefore concurs with its findings, in particular what is expected in terms of hydrological changes post-dike and post-river lining. The hydrological specialist report (***APPENDIX G)*** lists these changes, and they have been used as basis for determining the significant socio-economic and ecological changes, which are discussed in the sections following.

As an overall starting point, the impacts of this project should be considered in context of the larger Cuvelai system and its people. **Figure 28** highlights the relatively small portion this dike will influence in relation to the larger Cuvelai. This fact needs to be kept in mind when interpreting the impact assessment to follow.

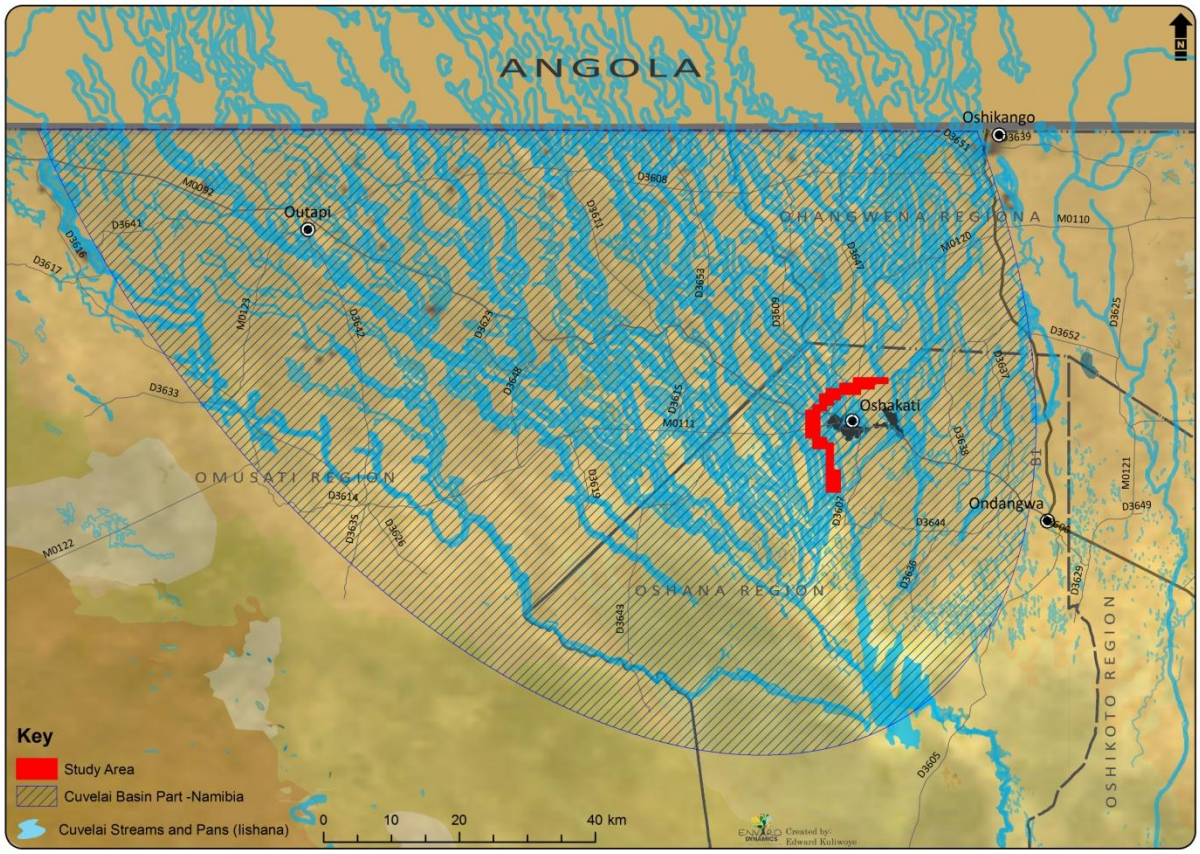


Figure 28: The locality of the Oshakati flood mitigation measures proposal in relation to the broader Namibian Cuvelai.

The socio-economic and bio-physical impacts below have been extracted and summarised from the specialist reports of Urban Dynamics (2012, ***APPENDIX F***.) and Bethune and Van del waal (2012, ***APPENDIX D)*** Only impacts which rated of medium or high significance are discussed in this section, while the less significant impacts may be consulted in the specialist reports. Applicable mitigation and enhancement measures have been included in the Environmental Management Plan (***APPENDIX C*** also for the impacts of low significance. It should be noted that hydrogeological impacts are discussed in the report by Bittner (2012), but are of low significance, so they are not discussed in this section, but may be referred to in ***APPENDIX G***

8.3 SOCIO-ECONOMIC IMPACTS

8.3.1 *Relocation/resettlement and Compensation of Households*

Discussion

Following the socio-economic survey and the asset inventory, it was found that **60** homesteads/houses/structures are in the way of the footprint of the dike and the channel and the associated works related to roads and bridges crossing the dike. The socio-economic profile of these households is presented in the previous section as impact zone 1. Of the 60 affected households, 33 are traditional homesteads with fields, 18 are improvised structures without fields and 9 are modern high-end houses. The key characteristics of these households are that they have very few livestock on average, that more than 90% of households have no livestock, that about 73% plant their crop fields on an annual basis, that only one percent of adults regard themselves as farmers, that about 34% of households have an income of N$ 500 per month or less, that 17% have no cash income, that 20% of households earn more than N$ 6000 per month, that about 21% of household members regard themselves as unemployed but seeking employment, and that 85% of all household members was either born at the current place of residence or have been residing there for more than 10 years.

It seems that the role of agriculture in people's livelihoods is decreasing if one considers the occupations and the sectors of employment and that the urban areas are drawing young people especially away from the rural areas.

By the time the dike system is in operation, the negative impact of relocation will remain and will be more severe for those who are dependent on the land and natural resources for their livelihoods than for those who have external or alternative sources of income.

The severity of the impact is assessed as high as opposed to very high because for some households it will simply mean relocation while for others it will mean a complete disruption of their lives as they knew it for many years. Over time the impact is likely to dissipate and its severity to decrease to moderate.

Mitigation / enhancement measures

From the socio-economic profile of the directly affected households it is very clear that they cannot be seen as a homogenous group. With the household conditions of each household known to the project proponent, it is recommended that the following mitigation measures be implemented:

- That each household be compensated fully and fairly in line with the Compensation Policy Guidelines for communal areas.

- That households who are not dependent on farming nor particularly vulnerable be paid the required compensation and then allowed to move to where it is most convenient for them, provided that it is acceptable to the responsible authorities.

Summary

Table 14: Summary– Relocation and Compensation

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• High	• Moderate
REVERSIBILITY	• Recoverable	• Recoverable
DURATION	• Medium	• Short
SPATIAL EXTENT	• Local	• Local
PROBABILITY	• Definite	• High
STATUS (+ OR -)	• Negative	• Negative
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• High	• Medium
MITIGATION ACCEPTABLE/PRACTICAL	• Yes – fair compensation to be paid to all households that are in the way of the dike, channel and ancillary works. System is in place.	• Yes – resettle those that make their living from subsistence agriculture to areas where they can continue to do so. Facilitate choice.
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• Low	• Low
CONFIDENCE LEVEL	• High	• High

8.3.2 *Loss of Livelihoods, especially for the Poor and Vulnerable*

Discussion

Although people will be compensated fairly, it will still cause a serious disruption in their lives and livelihoods, especially for those residing in homesteads and dependent on their crop fields for their livelihoods. Even if they receive substantial sums of compensation it does not ensure that they will spend it wisely to substitute their current livelihood sources with sustainable alternative sources.

Although households will be compensated, they will still need to find an alternative place to live and make a living. This would entail finding a new suitable place to settle, rebuilding their structures and fences and fostering new relationships in a new area. While the disruption will take place during construction it is likely to continue during the operation phase of the project. It is after the dust has settled, compensation has been paid and everybody continues with their lives, that the poor and vulnerable households will bear the brunt of their resettlement and rebuilding their lives.

Mitigation / enhancement measures

Special care needs to be taken to ensure that the poor and vulnerable households are cared for adequately. It is not enough to simply pay compensation and then leave them to their own devices. During fieldwork, it was observed that many households consist of old people, even physically challenged people and young children and they simply do not have the capacity to deal with such an upheaval. It is therefore proposed that the following mitigation measures be implemented to mitigate this impact:

- That each household be evaluated individually and that those that are found to be vulnerable and dependent on their fields be relocated to other areas where they can rebuild their lives and retain their livelihoods. For this to realise, it will be necessary for the traditional leadership to consider and allocate suitable areas to these households should they prefer to settle there.

- That some assistance in the form of transportation be provided to identified vulnerable households to relocate to a newly identified area or site.

- That traditional leaders be tasked to specifically monitor these households to ensure that they do not become worse-off than they were before the project.

- That a relocation action plan be prepared which will detail the methodology of resettlement, provide for special care of the poor and vulnerable and provide for grievances to be dealt with adequately and fairly.

Summary

Table 15: Summary – Loss of Livelihoods

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• High	• High
REVERSIBILITY	• Recoverable	• Recoverable
DURATION	• Medium	• Medium
SPATIAL EXTENT	• Local	• Local
PROBABILITY	• High	• High
STATUS (+ OR -)	• Negative	• Negative
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• High	• High
MITIGATION ACCEPTABLE/PRACTICAL	• Yes – dealing with households individually to ensure that the poor and vulnerable can retain their sources of livelihood, involvement of the traditional leaders to allocate land and monitor, provision of transport and a relocation action plan. .	
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• Low	• Low
CONFIDENCE LEVEL	• High	• High

8.3.3 *New and more severe Flooding of some households as a result of the Backwater effect of the Dike System*

The hydrological model was prepared on the basis of the 2011 floods in the area. It basically modelled what can be expected to happen should a similar intensity flood as in 2011 occur again and then modelled what could be expected with and without the dike in place. The findings of the model indicated that there will be a backwater effect, which is when the level of the water upstream from the dike will rise to a higher level under the same flood scenario as a result of the hydrological characteristics that can be expected from the flow of water into and around the dike wall and in the channel. The result of this is that 54 households that were flooded in 2011 will, if the same flood

occurs, now be even deeper under water than what was the case in 2011. In addition, the backwater effect will cause about 146 homesteads that were not flooded in 2011 to be flooded if the same flood occurs with the dike in place.

This impact may happen next year or only after another 50 years. Should this happen, people will most likely lose their crops, household assets and even structures in the process. However, it must be made clear that the hydrological model was based on assumptions about flood return periods, water volumes and velocities and hydrological properties which may not be entirely accurate. It is only a model which is imperfect without accurate time series data. To compensate for this the model is acknowledged to be on the conservative side and the backwater effect may not be as high as expected. It could also be that the actual areas likely to be flooded could be much less than anticipated.

The duration of the impact is short term and likely to occur only occasionally. It is not clear if so called climate change will have an impact on the frequency of flooding, nor what the impact will be.

Mitigation / enhancement measures

It is not proposed that these households be relocated, simply because of the uncertainty of the severity of flooding which may occur, the conservative assumptions used in the hydrological model and the fact that if such floods occur and the identified households are flooded, that it will be very short term and irregular. It is therefore proposed that:

- The Ministry of Agriculture erect the necessary monitoring stations along the main channels of the cuvelai delta to provide better information which can be used to re-calibrate the model, to make better predictions on the severity of flooding in future and to serve as an early warning system for the residents of the region and those that may be exposed to flooding as a result of the dike.

- The Oshana Regional Council and the Oshakati Town Council assess the flood risks and actual flooding regularly in order to plan a suitable response to come to the aid of flood victims should the predictions of the hydrological model be proven accurate.

Summary

Table 16: Summary – Backwater Flooding

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• n/a	• High
REVERSIBILITY	• n/a	• Irreversible
DURATION	• n/a	• Short Term
SPATIAL EXTENT	• n/a	• Local
PROBABILITY	• n/a	• Medium
STATUS (+ OR -)	• n/a	• Negative
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• n/a	• Medium
MITIGATION ACCEPTABLE/PRACTICAL	• n/a	• Yes – flood measurements stations, updating of hydrological model, early warning system and flood response system.,
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• n/a	• Low
CONFIDENCE LEVEL	• n/a	• medium

➢

8.3.4 *Creation of Local Employment Opportunities*

The Oshana Region has a 40% unemployment rate. Local employment creation is therefore one of the main concerns for the community and will be an extremely valuable contribution to the economy of the region as well as to the local economy. The construction of the dike will directly create significant numbers of both permanent and part time employment opportunities. However, there are concerns about the extent to which employment opportunities will be available for local people as opposed to people from outside the region who may move into the area and capture the jobs on offer. The actual significance of employment creation will depend on the extent of labour based or labour enhanced methods employed in the construction model. This can reduce unemployment and hence poverty.

The direct impact of local employment occurs only during construction. It is estimated that, should labour based or labour enhanced methods be used, about 5500 workers will be employed during the construction of the dike and the deepening of the Okatana Channel. If the construction is done conventionally, it is estimated that only about 550 workers will be needed for the project. During such employment, workers will acquire skills that could be employed elsewhere after construction. This will contribute to the employability of workers after the completion of the project.

Mitigation / enhancement measures

- It is recommended that labour based or labour enhanced methods be used in the construction of the dike and its ancillary works as well as the deepening of the Okatana Channel.

- In order to ensure that the benefit of employment creation will filter down to a local level it is necessary to include the obligation to recruit and use local workers first from Okatana, Oshakati East and West and Ongwediva to the maximum extent possible and practical.

- It is recommended that the successful contractor be obliged to only bring key staff from its head office, if outside the region, and to then set up an employment office and recruit local people for as high a proportion of the project scope as possible.

- Local political leaders and the ministry of labour should be involved in this process and partake in formulating the recruitment plan and conditions.

- It is further recommended that in respect of Namibian contractors they be required to recruit at least the unskilled and semi-skilled personnel required from within the project area.

Summary

Table 17: Summary of Impact Assessment – Employment Creation

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• High	• n/a
REVERSIBILITY	• Reversible	• n/a
DURATION	• Short Term	• n/a
SPATIAL EXTENT	• Local	• n/a
PROBABILITY	• Definite	• n/a
STATUS (+ OR -)	• Positive	• n/a
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• Medium	• n/a
MITIGATION ACCEPTABLE/PRACTICAL	• Yes – labour based/enhanced with local recruitment required	• n/a
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• High	• n/a
CONFIDENCE LEVEL	• High	• n/a

8.3.5 *Safety Risk to People and Livestock of Injury or Drowning*

There are safety risks for accidents associated with the deepening of the Okatana channel and the excavation of borrow pits i.e. people and animals falling into these and drown or be injured. The design of the dike slopes however significantly mitigate this risk and will be flat enough so that both people and animals can cross them safely. From previous studies it was also found that local people actually make use of the borrow pits for fishing.

Although there is an existing safety risk for people and animals from the annual *efundja*, the deepened channel north and west of the dike, and through Oshakati may increase the impact on human safety since it will be deeper and water velocity will be higher

than what people are used to. Borrow pits will need to be excavated for construction material which pose a safety risk to people and animals from falling in if the sides of the borrow pits are too steep.

There were reported cases of people drowning in *iishana* during the flood period, probably because no alternative means to cross were available. There will be bridges across the dike and channels so it is not known whether people will still choose to swim across. There is less certainty however regarding injury or drowning as a result of borrow pits. Confidence in these predictions is therefore considered to be **medium**.

Mitigation / enhancement measures

- Swimming in the dike and the channel must not be allowed or should be at one's own risk. Information boards to this effect must be erected at strategic points alongside the dike and channel.

- The walls of the borrow pits must be levelled afterwards and borrow pits rehabilitated where necessary so that people and livestock cannot fall in and get injured.

Summary

Table 18: Summary– Safety Risks of Injury/Drowning

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• n/a	• High
REVERSIBILITY	• n/a	• Recoverable
DURATION	• n/a	• Permanent
SPATIAL EXTENT	• n/a	• Local
PROBABILITY	• n/a	• Medium
STATUS (+ OR -)	• n/a	• Negative
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• n/a	• Medium
MITIGATION ACCEPTABLE/PRACTICAL	• n/a	• Yes – awareness raising and specifications of slopes, especially at the borrow pits.

	DURING CONSTRUCTION	DURING OPERATION
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• n/a	• Low
CONFIDENCE LEVEL	• n/a	• Medium

8.3.6 *Safety Risk to People and Livestock from Construction Machinery*

The movement and operation of large machinery presents a safety risk to local residents since the construction activities will occur in close proximity to homesteads as well as within the town of Oshakati. People, and children in particular, would become curious to see these machines in operation and this could result in serious accidents.

The severity would likely be **high** as local people will come into daily contact with large-scale construction activities and excavations.

Mitigation / enhancement measures

- It is necessary for safety procedures to be included in the Environmental Management Plan (EMP) in the form of guidelines on how to protect local people against injury and how to safeguard construction activities.
- Clear instructions must be given to contractor staff on how to be sensitive to and deal with people and children coming too close to dangerous construction activities.
- In addition, the traditional chief of the area must be called upon to inform residents to stay away from construction machinery and activities and to ensure that their children are kept away or at least remain at a safe distance.

Summary

Table 19: Summary – Safety Risk of Construction Machinery

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• High	• n/a
REVERSIBILITY	• Reversible	• n/a
DURATION	• Short Term	• n/a
SPATIAL EXTENT	• Site Specific	• n/a
PROBABILITY	• High	• n/a
STATUS (+ OR -)	• Negative	• n/a
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• Medium	• n/a
MITIGATION ACCEPTABLE/PRACTICAL	• Yes – EMP provisions to make sure that construction workers are constantly on guard to make sure that especially children stay away from dangerous areas and involvement of traditional leaders to control this from the side of the community.	• n/a
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• Low	• n/a
CONFIDENCE LEVEL	• High	• n/a

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8.3.7 *Flood Protection of the Oshakati / Ongwediva Urban Area*

Discussion

The main purpose of the construction of the dike is to prevent the flooding of houses which are currently located on lower-lying land in the town and relieve pressure from the local authority and the Government to look after a large number of displaced households. Also, it is to facilitate the gradual implementation of the Concept Master Plan.

Approximately 1000 households will be flood free and will no longer be displaced annually as a result of the floods.

Mitigation / enhancement measures

- A flood emergency and response plan must, as a precautionary measure, be prepared for the Oshakati and Ongwediva towns in the unlikely event of dike failure.
- Occasional inspection of the dike is required to ensure structural integrity and a maintenance plan must be prepared for the dike.
- Record must be taken of the frequency and strength of flooding of the *efundja* to form part of monitoring to determine whether future upgrading / expansion of the dike might be needed.

Summary

Table 20: Summary – Flood Protection

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• Very High	• n/a
REVERSIBILITY	• Irreversible	• n/a
DURATION	• Permanent	• n/a
SPATIAL EXTENT	• Local	• n/a
PROBABILITY	• Definite	• n/a
STATUS (+ OR -)	• Positive	• n/a

	DURING CONSTRUCTION	DURING OPERATION
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• High	• n/a
MITIGATION ACCEPTABLE/PRACTICAL	• Yes – ensure monitoring and emergency response plan to prevent dike failure and deal with it if it occurs.	• n/a
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• High	• n/a
CONFIDENCE LEVEL	• High	• n/a

8.3.8 *Reclamation of Land for Urban Development*

Discussion

More space will be reclaimed for urban development close to the centre of Oshakati with resultant cost savings. Where the current development is fairly spread out with only higher lying islands available for urban development, areas that are currently flooded will become available for development with opportunities for a more compact and cost effective urban form.

This will bring cost savings in terms of the provision of bulk services, the maintenance of services and the cost of land for various land uses. It will facilitate the gradual implementation of the Concept Master Plan. It is also likely to facilitate cost savings for individual people with reduced mean travelling distances.

Mitigation / enhancement measures

The impact is very positive and a mitigation measure in itself, and with a concept master plan in place to guide development no further enhancement measures is deemed necessary.

Summary

Table 21: Summary – Reclamation of Land

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• n/a	• Very High
REVERSIBILITY	• n/a	• Irreversible
DURATION	• n/a	• Permanent
SPATIAL EXTENT	• n/a	• Local
PROBABILITY	• n/a	• Definite
STATUS (+ OR -)	• n/a	• Positive
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• n/a	• High
MITIGATION ACCEPTABLE/PRACTICAL	• n/a	• No – not required
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• n/a	• High
CONFIDENCE LEVEL	• n/a	• High

8.3.9 *Benefits of Project for the Local Economy*

Summary

It is anticipated that the project will directly benefit the local economy and the community in a number of ways during construction. This will be primarily through access to employment opportunities and the creation of skills. The workers in turn will receive wages that will be circulated back into the local economy and support the network of small shops in the area and larger shops in town. The industrial and commercial sectors of Oshakati also stand to benefit by forming part of the supply chain of and in service provision to the contractor.

During operation the local economy will benefit significantly from protection against flooding as businesses that had to close during the flood period endured a substantial loss of income for both owners and employees.

Mitigation / enhancement measures

No further enhancement measures are required for this impact.

Summary

Table 22: Summary – Local Economy

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• High	• High
REVERSIBILITY	• Reversible	• Recoverable
DURATION	• Short	• Permanent
SPATIAL EXTENT	• Local	• Local
PROBABILITY	• High	• High
STATUS (+ OR -)	• Positive	• Positive
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• Medium	• Medium
MITIGATION ACCEPTABLE/PRACTICAL	• No – not required	• No – not required
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• Medium	• Medium
CONFIDENCE LEVEL	• High	• High

8.3.10 *Increased Business, Recreation and Tourism opportunities*

Discussion

Oshakati is primarily an overnight destination for visitors and business people and tourism opportunities are limited to accommodation establishments. It is possible that the dike and channel could form an important water feature of Oshakati although to a lesser extent as envisioned in the initial Oshakati Concept Master Plan. Some developments related to the dike and channels that could lead to an increase in tourism and business growth includes a waterfront development and landscaping of the channels to develop an esplanade with recreational facilities and amenities for the public. Water sport activities would also be possible to some extent during the *efundja* such as fishing or sailing.

Mitigation / enhancement measures

This part of the concept master plan needs further development and design for implementation.

Table 23: Summary – Increased business, tourism and recreation opportunities.

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• n/a	• High
REVERSIBILITY	• n/a	• Irreversible
DURATION	• n/a	• Permanent
SPATIAL EXTENT	• n/a	• Local
PROBABILITY	• n/a	• Low
STATUS (+ OR -)	• n/a	• Positive
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• n/a	• Medium
MITIGATION ACCEPTABLE/PRACTICAL	• n/a	• No – cannot be developed yet

	DURING CONSTRUCTION	DURING OPERATION
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• n/a	• Medium
CONFIDENCE LEVEL	• n/a	• High

8.3.11 *Improved Sanitation due to the movement of Previously Standing (contaminated) Water away from Oshakati*

Summary

Stagnant localised stormwater is a health risk and this will largely be eliminated by a good internal stormwater system. A stormwater system will reduce sewer seepage into the natural ground and surface water, something which is difficult to manage and maintain under the present flood scenario in the town.

Mitigation / enhancement measures

An effective maintenance plan for the stormwater system must be included in the EMP and provided to the Oshakati Town Council that has to prepare budgeting for its implementation. Maintenance is crucially needed to ensure that no blockage or siltation occurs which would otherwise again result in the accumulation of stagnant water or even the reversal of the impact to the extent that new areas could become flooded in the future.

Table 24: Summary – Improved Sanitation Conditions

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• n/a	• Very High
REVERSIBILITY	• n/a	• Irreversible
DURATION	• n/a	• Permanent
SPATIAL EXTENT	• n/a	• Local
PROBABILITY	• n/a	• High
STATUS (+ OR -)	• n/a	• Positive

	DURING CONSTRUCTION	DURING OPERATION
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• n/a	• High
MITIGATION ACCEPTABLE/PRACTICAL	• n/a	• No – not required
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• n/a	• High
CONFIDENCE LEVEL	• n/a	• High

8.3.12 *Destruction of Graves or Cultural Resources*

Graves represents a sensitive issue as it is places where people go to remember and commemorate the deceased. The Oshiwambo culture is more associated with activities rather than specific sites or artefacts therefore the likelihood of cultural sites being discovered that cannot be removed is unlikely. During the socio-economic survey however a grave site, which is in the way of the channel was found that will need to be relocated.

Mitigation / enhancement measures

- The graves that will be affected by construction of the dike have to be exhumed and reburied. This will require further consultation with the local community to obtain consent for exhumation and to identify a suitable site for reburial.

- A "chance find procedure" must be provided for in the EMP during construction in the event that graves (or the highly unlikely event of a cultural site) are discovered.

- This procedure must remain in place for some time after the dike is constructed should graves or cultural sites that had previously not been flood-prone be in danger of flooding as a result of the backwater effect. The exhumation of graves must be done in terms of Namibian legislation.

Summary

Table 25: Summary – Graves and Cultural Resources

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• Medium	• n/a
REVERSIBILITY	• Recoverable	• n/a
DURATION	• Immediate	• n/a
SPATIAL EXTENT	• Site Only	• n/a
PROBABILITY	• Definite	• n/a
STATUS (+ OR -)	• Negative	• n/a
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• Medium	• n/a
MITIGATION ACCEPTABLE/PRACTICAL	• Yes – Exhumation and re-burial and chance find procedure in EMP	• n/a
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• Low	• n/a
CONFIDENCE LEVEL	• High	• n/a

8.3.13 *Increase in the Spread of HIV/Aids and other STDs*

Discussion

The Oshana Region has one of the highest recorded HIV/AIDS rates in the country and sexual contact between the construction workers and the local population is bound to occur. Construction workers moving into the area from elsewhere could increase the spread of the HIV/AIDS pandemic. Largely linked to the presence of the construction workforce it is normally found that these workers come into an area and soon experience the need for social and sexual interaction. They generally receive above average incomes and can afford to pay for sexual favours which are normally sought from the local population. Research on the impacts of the Break the Chain Campaign

has shown that women tend to be attracted to such men and that, linked with the use of alcohol, it would result in sexual relationships with such men. If not mitigated, this could lead to an increase in the spread of HIV/AIDS and other sexually transmitted diseases. It could also lead to marital problems in the host communities when women get involved with the construction workers who splash money around in search of partners.

Mitigation / enhancement measures

- It must be a condition of the construction contract that HIV/AIDS awareness campaigns be undertaken amongst all construction staff. A suitably qualified person must design and implement the programme throughout the course of construction.

- In addition, it must also be made a condition of contract that as few as possible workers from outside be brought into the area. An adequate local recruitment drive to the satisfaction of the project proponent must be launched in Oshakati and only if the necessary skills cannot be found, should external recruitment be allowed. Monitoring and evaluation of this must form part of the EMP.

Summary

Table 26: Summary – Spread of HIV/AIDS and other STD's

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• Very High	• n/a
REVERSIBILITY	• Irreversible	• n/a
DURATION	• Permanent	• n/a
SPATIAL EXTENT	• Local	• n/a
PROBABILITY	• High	• n/a
STATUS (+ OR -)	• Negative	• n/a
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• High	• n/a
MITIGATION ACCEPTABLE/PRACTICAL	• Yes – HIV/AIDS awareness campaigns amongst workers and community, local	• n/a

	DURING CONSTRUCTION	DURING OPERATION
	recruitment and involvement of traditional leaders.	
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• Medium	• n/a
CONFIDENCE LEVEL	• High	• n/a

8.4 BIO-PHYSICAL IMPACTS

8.4.1 *Impacts on nutrient and energy cycles*

Discussion

Little work has been done on either nutrient or energy cycles in African floodplain wetlands and nothing on the Cuvelai system. Thus only broad impacts based on how wetlands function in general can be made. Wetland productivity depends on the plants and animals it can sustain and how nutrients and energy is cycled between them. Generally a healthy, undisturbed wetland will function better as it can support a diversity of organisms each with its own role in maintaining the ecosystem, e.g. algae and plants forming the basis of the food web with zooplankton i.e. the crustacean and plants in turn providing food to other aquatic creatures through several trophic levels up to the top predators who in the Cuvelai wetlands are fish-eating birds and man.

A second important function of wetland vegetation and filter-feeding invertebrates is that they maintain the water quality to maintain a healthy wetland with efficient nutrient and energy cycles. The new and secondary baseline studies for this EIA have proved that the Cuvelai iishana support a wide biodiversity. There are aquatic plants and animals at all trophic levels, sufficient to maintain healthy nutrient and energy cycles in this often very variable ecosystem.

However, disturbance of this by activities such as excavating the bottom or removing marginal sediment and vegetation and thus an important habitat or worse, by lining the *oshana* and preventing colonisation of the margins and bottom by naturally occurring plants and benthic fauna can seriously impair the natural functioning of this aquatic ecosystem by:

- reducing available food to organisms higher up in the food chain,
- reducing shelter to fish and
- reducing the self cleansing function of the wetland itself.

During construction there will be serious disturbance where the dike crosses or goes along existing *iishana,* the removal of sediment either for use as building material or to excavate the channel will impact on the bottom sediments and creatures that live or feed there. Productivity will be disrupted reducing food availability and sheltered breeding areas of fish lost. For example one of the tilapia species found in the system is *Oreochromis andersonii*, a fish that makes shallow " nests" in the mud. Lining the sides

of the dike with gravel will similarly affect that edge of the channel alongside it which for much of its distance will be flowing southwards within an existing oshana.

These impacts are expected to be of low significance, but that given the resilience of the system it will recover and the new channel will soon function as the original oshana did.

A serious impact would be the proposed lining of the Okatana River channel through the town. An impervious layer would seriously disrupt the natural functioning of the oshana, reducing the available substrate for aquatic plants and thus the habitat for the invertebrates and fish that live on and amongst the plants and would impair the self-cleansing ability of the system. If with time the new channel is allowed to build up sediment and colonisation by aquatic and marginal vegetation is allowed the system should be able to recover. Municipalities all over the developed world are spending fortunes "rehabilitating" rivers that flow through their cities by changing the rivers that were channelled some decades ago back to more natural systems by creating habitats to encourage plants to grow, putting in curves and even waterfalls and islands. Lets not make the same mistake.

Figure 29: Bulldozed channel in Oshakati, destroying the natural margins. K.S. Roberts

Mitigation

- Create a rough wall for the dike that will provide places where soil can collect again and plants can become re-established in the new channel.

- Changing the design of the Okatana River Deepening so that it allows for a natural functioning *oshana*

- Any excavation work should be done sensitively, to not interfere with the natural contours and living margins of the existing oshana. The photograph above **(**Figure 29**)** shows how not only the marginal zone has been entirely obliterated but the dumping of the soil removed has affected the terrace and banks too. How the excavation is done can be critical. The bulldozing procedure should be sensitive to the *iishana* and as far as possible follow the natural contours of the existing *iishana*. Any bulldozing of the oshana floor should not be perpendicular to the flow direction. Similarly the design and siting of any burrow pits will be crucial and if well placed can be beneficial offering much needed refugia where fish and other aquatic organisms can survive in deeper water through the drier periods. Borrow pits should be sited on the existing ridges and elsewhere interspersed with normal oshana floors and islands to maintain natural flow patterns.

- The construction phase work must be completed, leveled, compacted and covered in time with suitable sand or other less fine material before the next flood. If not, large scale deterioration of flood water with erosion can be expected, smothering vegetation downstream as well as preventing feeding and breeding of fish.

Summary

Table 27: Summary – impacts on nutrient and energy cycles

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• Low	• Moderate
REVERSIBILITY	• Reversible	• Irreversible
DURATION	• Medium Term	• Permanent
SPATIAL EXTENT	• Local	• Local
PROBABILITY	• Probable	• Probable
STATUS (+ OR -)	• Negative	• Negative
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• Low	• Medium
MITIGATION ACCEPTABLE/PRACTICAL	• Available and mitigation is practical.	• Change the design of the river deepening and the dike to a natural feature.

	DURING CONSTRUCTION	DURING OPERATION
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• Low	• Low
CONFIDENCE LEVEL	• Medium to Low	• Medium to Low

8.4.2 *Impacts of pollution and litter downstream*

Two rather different types of water pollution may arise:

Firstly from contaminated runoff that collects in the storm-water and so makes its way into the Okatana River which is expected to finally collect all the storm-water in the city once this system has been upgraded. In the older parts of the original town around the airfield and hospital there are still wide, shallow ditches alongside the sidewalks that were designed to collect and divert rain water through the town. Unfortunately with the rapid expansion of the town since Independence, large parts of the town particularly the rapidly growing informal settlement areas have no such provision. Rain water will simply collect whatever else has collected within the runoff area and so is very likely to become polluted with both biological waste as well as oil that has collected on the roads. This will enter the Okatana *oshana* and flow downstream.

Some organic eutrophication does little harm and may be good, adding nutrients (fertilizer) to the floodplains, this only becomes a problem at concentrations of nitrogen and phosphates high enough to promote nuisance algal growth. Such algal blooms and subsequent die off and decay of the algae can cause local anaerobic conditions that could cause fish kill. Of course any broken sewage pipes or flooding from the sewage treatment works will also spill into the storm-water as will runoff across dump sites, these can cause serious eutrophication and result in algal blooms as has happened in many African dams. Algal blooms are common in waterfront developments where canalisation has caused removed the natural fauna and flora responsible for the self cleansing processes of the wetland.

Mitigation

- It is necessary to insure that the sewage and solid waste collection systems in the town are up to standard and will not contribute to pollution.

- Crucial are the repositioning and upgrading of sewage treatment systems of Oshakati and all other towns where flooding of sewerage plants occurred during floods.

- Recycling of waste in the region should be implemented since no suitable site for waste disposal exists, nor is the geological structure suitable for dumping.

  Illegal waste dumping on the sides of the bridge on the road south of Oshakati was very evident and this must be stopped (Figure 30).

Figure 30: Bridge on the road south of Oshakati to Ompundja (K.S. Roberts)

- Not only have banks been bulldozed along the middle of an *oshana*, they also cut off the natural flow through the culvert and the bank was covered in litter and alien invasive plants like *Datura*.

- Introduce grids to block organic waste entering the storm-water drains.

- The Okatana channel should be kept as natural as possible to allow the re-establishment of plants and re-colonisation of the invertebrate fauna that help to keep the water clean.

- Waste dumping in and near the *oshana* must be prevented and the town dump site well cited and possibly lined to prevent contamination of either the surface or groundwater.

Summary

Table 28: Summary: impact on pollution and litter downstream.

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• Low	• Moderate
REVERSABILITY	• Reversible	• Irreversible
DURATION	• Medium Term	• Long term
SPATIAL EXTENT	• Local	• Local
PROBABILITY	• Probable	• Probable
STATUS (+ OR -)	• Negative	• Negative
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• Low	• Medium
MITIGATION ACCEPTABLE/PRACTICAL	• Available and mitigation is practical.	• Available and practical
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• Low	• Low
CONFIDENCE LEVEL	• Medium	• Medium

8.4.3 *Impacts of altered flows (velocities and volumes) on sensitive ecosystems downstream (Oshana receiving diverted water, Omadhiya lake complex, Ekuma River and Etosha Pan)*

Discussion

The main impacts foreseen have to do with increased velocities of flow due to larger volumes of *iishana* water accumulating in the diversion channel alongside the dike, this may also increase drainage from the *iishana* upstream that cause them to dry out sooner. The ecological impacts particularly on fish may extend to the receiving *oshana* south of Oshakati at Mpundja and might even have an effect on fisheries in Omadhiya lake complex but given that the *iishana* draining through and around Oshakati make up only a small proportion of the southward flow of the entire Cuvelai system, this impact is expected to be small and is not expected to extend to the Etosha Pan.

This was confirmed to the specialists in discussion with the Rural Water Supply hydrologist (Leonard Hango, personal communication, June 2012). A more detailed discussion of potential impacts related to fish is given below for completeness, and some recommendations to MFMR are given.

Oshana receiving diverted water (between Oshakati and Mpundja)

During low to normal flood years, flow will only increase slightly but during high flood years, the water volume will be increased tenfold, and the depth doubled. During large floods, fish migrating downstream will move faster than before, leading to a lower local colonisation. Young fish migrating upstream will be negatively affected by the increased flow. Small fish will be more preyed upon at any constriction in the canalised system.

Fishing will be improved in the landscaped/channelized oshana and at many new bridges constructed. This overharvesting is detrimental to the fish communities downstream that are reliant on migration from upstream.

Omadhiya lake complex, Ekuma River and Etosha Pan

The lakes are expected to receive more water as result of the faster drainage around Oshakati. It is of concern that further sediment deposition in the pans, possibly caused by increased flow velocities from the channel alongside the dike could threaten the viability of the pans. Increased sedimentation in pans may make them shallower, increasing the surface area of these shallow lakes and so evaporative losses. No mitigation seems possible, as the increased inflow and resultant sedimentation results from ongoing interference, not confined to the diversion channel but also by more general overgrazing, deforestation and trampling.

During large floods, the increased inflow and longer retention period will make breeding in the pans possible, which is a positive effect from the point of view of the fishery, but the long-term effect of accumulating sediments in pans can have a severe negative effect on fish and benthos.

If water stays longer than a year, and some protection is provided to fish in pans they can breed and provide young that can be distributed in the *oshana* system the next season.

Figure 31: Inakulayomadhiya lake – Grandmother lake of Omadhiya complex (K.S. Roberts)

The Ekuma River draining the Omadhiya Wetland to Etosha would also be subject to an increase in sediment load, having the same effects as mentioned above on inflow, fish and fisheries.

Better drainage to the Etosha Pan would possibly result in increased inflow, although the overall impact is diluted because of the total inflow to the system. It should be kept in mind that the Etosha Pan is an international Ramsar site, thereby increasing the significance of this impact. The increased fish migration that is expected during large floods will benefit fish-eating birds like pelicans. Ultimately all fish in Etosha succumb, either to high salinities or to inevitable drying out.

Effects on aquatic vegetation and aquatic invertebrates

Local scouring of *iishana* substrate will form new channels, remove aquatic and marginal vegetation and so remove the marginal vegetated habitat required by some invertebrates, reducing the number and biodiversity of invertebrates and decreasing overall productivity.

Faster drainage of upstream *iishana* will cause them to dry out sooner and so reduce the wet season and increase the dry season wetland habitats, again reducing overall productivity

Mitigation

- MFMR regulations need revision to enable control of fishing in certain years to curb overfishing. New, more applicable legislation may be required to protect fish at all culverts and bridges where large-scale interception of migrations with modern funnel nets takes place.

- MFMR should ensure implementation of existing fisheries legislation prohibiting use of any net 30m from any culvert or bridge.

- Keep floods and the *oshana* functioning as natural as possible, by operating sluices in a way that will allow small floods to continue through Oshakati town within the Okatana River. Avoid increasing flow velocity along the dike in channels that divert flow, rather let the water through the town as possible.

Summary

Table 29: Increased drainage of iishana towards the Omadhiya wetlands and Etosha

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• n/a	• Medorate
REVERSIBILITY	• n/a	• Irreversible
DURATION	• n/a	• Long Term
SPATIAL EXTENT	• n/a	• Local
PROBABILITY	• n/a	• High
STATUS (+ OR -)	• n/a	• Negative (positive effect on local fishing)
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• n/a	• Low to medium
MITIGATION ACCEPTABLE/PRACTICAL	• n/a	• Yes.
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• n/a	• Low
CONFIDENCE LEVEL	• n/a	• High

Table 30: Increased sediment transport

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• n/a	• Moderate
REVERSIBILITY	• n/a	• Irreversible
DURATION	• n/a	• Long Term
SPATIAL EXTENT	• n/a	• Regional, National
PROBABILITY	• n/a	• High
STATUS (+ OR -)	• n/a	• Negative
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• n/a	• Medium
MITIGATION ACCEPTABLE/PRACTICAL	• n/a	• Mitigation difficult – part of wider development trend. Keep flow rates below erosion rate levels.
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• n/a	• Low
CONFIDENCE LEVEL	• n/a	• High.

Table 31: Higher flow rate in channels during high floods

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• n/a	• Moderate
REVERSIBILITY	• n/a	• Reversible
DURATION	• n/a	• Long term
SPATIAL EXTENT	• n/a	• Regional, International – Ramsar Site
PROBABILITY	• n/a	• High
STATUS (+ OR -)	• n/a	• Negative

	DURING CONSTRUCTION	DURING OPERATION
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• n/a	• Medium
MITIGATION ACCEPTABLE/PRACTICAL	• n/a	• Yes, reduce flow volumes and velocities by letting water flow as naturally as possible through the sluice gates.
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• n/a	• Low
CONFIDENCE LEVEL	• n/a	• High

8.4.4 *Impacts on fish and wetland diversity and on livelihoods dependent on fish*

The dike will confine the larger floods to a 300m channel alongside it, preventing the natural spreading out of this water across a large area of floodplain and so reduce the surface area an area of flooded vegetation available for fish considerably, both directly and by preventing flooding of large areas behind the dike inside Oshakati town. With a projected expected fish biomass of 30kg per ha, 3000 kg fish production and growth is lost for every km^2 of *oshana* surface area that cannot be compensated for in any way.

During high flood , *efundja* the fish diversity in *iishana* is mainly dependent on what fish species have migrated down the Cuvelai from Angola.

During low floods, especially after a long dry period, there is very little fish life in the few open water ponds remaining in the *oshana* system – all fish have died or been caught out by local people.

Permanent waters acting as refugia play a very important role to maintain fish species presence during the recurring dry periods.

Against this background the impact of the dike and associated channels have very little direct impact on fish diversity or the fishery except for those aspects discussed elsewhere.

If the dike and channels are to have a positive impact on the livelihood of the local communities, it has to do with fishery management and specifically with protection of fish life in more permanent water bodies to act as inoculate for new populations

breeding and distributing in the *iishana* once inundated. This project may convince policy makers that it is worthwhile to invest in education and law enforcement to identify refugia in the whole *oshana* region where fish are protected during dry season to be left so that they are available to repopulate the *oshana* system in the next rainy year.

The 'no fishing" signs erected at several of the deeper burrow pits such as the one at the bridge on the Okatana road show that authorities are aware of this and are restricting fishing in these refugia.

Proof of successful breeding of fishes in Namibian reaches of the Cuvelai System, *oshana* region has been obtained earlier (Van del waal 1991, 2000) and was again evident in the juvenile fish collected now.

The increase in available fish habitat by creating more refugia for fish and if water also remain longer, with a deepened channel, fish production may increase, partly offsetting the reduction in area caused by cutting off of *iishana* inside the dike.

Mitigation

Sensitive construction and operation of the flood diversion scheme can largely mitigate any impacts and the creation of borrow pits that can serve as refugia for fish and other aquatic life can be positive as the deeper water will allow their survival in the dry periods providing refugia from where the *iishana* can again be colonised the next season.

Table 32: Impacts on fish and wetland diversity and on livelihoods dependent on fish

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• n/a	• Moderate
REVERSIBILITY	• n/a	• Reversible
DURATION	• n/a	• Long term
SPATIAL EXTENT	• n/a	• Local
PROBABILITY	• n/a	• High
STATUS (+ OR -)	• n/a	• Positive (negative – loss of fish biomass)
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• n/a	• Medium

	DURING CONSTRUCTION	DURING OPERATION
MITIGATION ACCEPTABLE/PRACTICAL	• n/a	• Borrow pits should be placed sensitively to act as refugia during dry seasons. Fisheries enforcement to avoid overfishing.
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• n/a	• Medium (low for negative)
CONFIDENCE LEVEL	• n/a	• High, if mitigation is applied.

8.4.5 *Impacts of changes in water quality (turbidity, salinity, nutrient concentrations) on iishana habitats and fish and fisheries*

Discussion

In all cases where oshana bottoms are disturbed by deepening existing channels, serious negative effects on water quality can be expected over the short-term, such as one summer season, as loosened silt takes very long to settle out. Fish species of the *iishana* are not sensitive to slight changes and deterioration of water quality and experience serious increases in salinity as the deeper *iishana* and pans of the Omadhiya lake complex dry out. The salts are concentrated as the water evaporates, with ever increasing salinities the fish will eventually all die off. But this is no excuse to hasten the process by careless construction practises or bad timing.

The dike and channel will have a short-term, one season, negative effect during construction on water quality and turbidity which will affect fish life by decreasing available food organisms, which will lead to overall loss of condition and so to lower spawning success rates and overall productivity of the system. Over the longer term, rehabilitation of the dike and channel will alleviate these negative impacts. Some erosion and ongoing leaching of salts from disturbed sediments, e.g. sediment taken from the oshana bottom and used to build walls/ flood protection banks can however cause water quality deterioration over a longer term, i.e. 10 years. (Refer to photograph in **Figure 32**).

Figure 32: Bulldozed wall within oshana on outskirts of Oshakati to protect shacks (K.S. Roberts)

Disturbance of oshana bottom substrate may have a short-term to medium-term negative effect on water quality, aquatic and fish life. Over the longer-term, stabilization and smothering of the bottom by newly transported sediments and the establishment of aquatic vegetation will alleviate this impact. The hardened surfaces of the channel will however prevent any submerged aquatic plant growth or contact with the hyporheos. The impact will be permanent if accumulated sediment is continuously removed to "clean' the lined channel.

Mitigation

- Mitigation measures for avoiding water quality deterioration and rehabilitation after construction are presented under 8.4.1.

Summary

Table 33: Changes in water quality (turbidity, salinity, nutrient concentrations) affecting iishana habitats and fish and fisheries.

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• Moderate	• Moderate
REVERSIBILITY	• Reversible	• Reversible
DURATION	• Short Term	• Long term
SPATIAL EXTENT	• Local	• Regional
PROBABILITY	• High	• High

	DURING CONSTRUCTION	DURING OPERATION
STATUS (+ OR -)	• Negative	• Negative
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• Medium	• High
MITIGATION ACCEPTABLE/PRACTICAL	• Yes. Cover exposed areas with sand.	• Cover exposed surfaces with sand.
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• Low	• Low
CONFIDENCE LEVEL	• High	• High

8.4.6 *Impacts of floodgate operation (duration and timing of flows) on iishana and fish*

Discussion

These impacts are mainly to do with allowing free migration of fish and aquatic invertebrates occurring in this network of inter-connected *iishana* through the system, also through the Okatana *oshana* to reach other *iishana* and the pans downstream. Clarke (1998a) who studied *iishana* that extended across such barriers found little evidence of such impacts from which it could be assumed that enough fish were able to move downstream, however his study was nearly 15 years ago and there has been an increase both in the number of people living and fishing in the area as well as in the availability of mosquito nets which are often found completely covering culverts and even siphons entrances. Essentially this is an issue that needs to be addressed by MFMR regulations and their enforcement.

Fish migrations down the Cuvelai and its associated *iishana* ending in the channel in front of the dike will all be deflected along the featureless banks of the channel next to the dike. An increase in predation of smaller fish by catfish and piscivorous birds can be expected. When floodgates are open and some of this dammed up water moves down the channelized Okatana River, fish will move through and are then extra vulnerable to injury and predation by birds and predatory fish.

Of greater concern is the increased opportunity for fishing by local people using modern day effective fishing gear. The use of long fish funnels and dikes and nets at

culverts and bridges is prohibited in the fisheries legislation but little specific law enforcement is taking place to enforce these fishery regulations in the *oshana* region, the argument being that as result of the temporary or ephemeral nature of the fish habitat, all fish will anyway succumb and so are free to be harvested.

Mitigation

- For long-term benefit of the fisheries as natural resource, a *laissez faire* approach is not conducive. Neither is it according to the traditional natural resource management of fish resources in the area where limits were set by traditional chiefs on appropriate fishing times and gear types (Van del waal, 2000). If the optimal benefit of these artisanal fish resources for local communities is a goal of the MFMR, all bridges and culverts and sluices should be no-fishing zones allowing free passage for migrating fish.

- The sluice gates should be operated so as to reflect the natural qualities of the current system.

Table 34: Impacts of floodgate operations (duration and timing of flows) on iishana and fish

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• n/a	• Moderate
REVERSIBILITY	• n/a	• Reversible
DURATION	• n/a	• Long term
SPATIAL EXTENT	• n/a	• Local
PROBABILITY	• n/a	• High
STATUS (+ OR -)	• n/a	• Negative
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• n/a	• Medium
MITIGATION ACCEPTABLE/PRACTICAL	• n/a	• Regulate fishing, control sluices.
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• n/a	• Low
CONFIDENCE LEVEL	• n/a	• High

8.4.7 *Impacts of removal of vegetation, (including large fruit trees) and lining of Okatana River on the iishana habitats, fish and fishing.*

Figure 33: Figure 34: Makalani Palms, Hyphaene petersiana, alongside Cuvelai oshana (K.S. Roberts)

Important features of the Cuvelai vegetation are the larger riverine trees found on the banks of the larger *endombe* and on the ridges or higher ground alongside the *iishana*. The groundwater recharged by these wetlands support large fruit trees such as jackalberries, *Diospyros mespiliformis, Berchemia discolor* or *embe,* the makalani fan palm, *Hyphaene petersiana* **(Figure 34)**, sycamore fig trees, *Ficus sycomorus*, leadwoods, *Combretum imberbe* as well as some typical riverbank trees like the ana tree, *Faidherbia albida,* woodland waterberries, *Syzigium guineense*, and acacia species with nutritious pods, important for fodder, like *Acacia nilotica, A. arenaria* and *A. hebeclada*. All these trees are well established and of value both for their fruit to man, his livestock, and birds, provide shade and serve to stabilise the banks and margins of the wetlands against erosion. The fact that in many places these trees have been left when others like the mopane were removed to clear crop land testifies to their value as a natural resource of the wetland.

Although only one study on the ethnobotany of the Cuvelai (Rodin, 1985) it is well known that wild fruits as well as other wetland vegetation is extensively used and collected to sell. This includes reeds and sedges as building material, to make fishing gear and baskets and in the case of the corms of some Cyperaceae species as food. The *iishana* also support large semi-aquatic grasslands in the wet season that provide good grazing in the dry times.

The 2001 Forestry Act specifically makes it illegal to remove or damage any plant that grows within 100m of a watercourse, the *iishana* of the Cuvelai are very wide, braided watercourses.

All along the proposed dike route, several large trees, particularly important fruit trees were noted, in fact each is visible in the large scale aerial photographs used.

The deepening of the channel may be advantageous in terms of keeping water for longer but if the intention and design aim to be able to drain Oshakati completely, or requires regular removal of accumulated sediment and vegetation this positive impact may be lost.

Little vegetation is expected to regrow on the sides of the dike or in the channel next to it. This has negative effects on all aquatic life including the fish, causing loss of habitat and shelter or cover to fish and the aquatic invertebrates that are their food source, and can increase water temperatures due to the shallow waters being more exposed to the sun.

Mitigation

- Avoid any unnecessary removal of these trees.
- Ensure sensitive alignment of the dike to follow the natural contours of the *iishana* along which it passes. Trees that are on slightly higher ground can so be prevented.
- Where this is not possible saplings should be replanted on the bank opposite the dike to replace any trees lost.
- Identify important vegetation zones by creating or leaving some higher lying islands within the deepened channel allowing the flow to naturally braid around it or even by creating some long islands as well as some quieter water areas. The focus should be to keep the channel natural.
- Mimimize any disturbance to the marginal and terrace vegetation alongside the town *oshana,* or once constructed the channel should be re-habilitated to encourage regrowth of vegetation in and alongside it. Care must be taken not

to remove any large trees or to dump sand near them which was shown to kill jackalberry trees at the Fishery institute in Ongwediva

- To maximise the potential fishing the system within the town, vegetated habitats needed by the fish for shelter, feeding and breeding should be retained or re-created and at least the small floods should be allowed through the town each year with sufficient capacity of shallow sections in the Okatana river channel to absorb these floodwaters. Thus design of the route within the town should move away from the idea of a canalized ditch confined to its banks that will move water away as quickly as possible, to a more natural braided system flowing around islands and at times allowed flood shallow areas adjacent to the main course.

Summary

Table 35: Impact of removal of vegetation, (including large fruit trees), and lining of Okatana River on iishana habitat,fish and fishing

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• High	• n/a
REVERSIBILITY	• Irreversible	• n/a
DURATION	• Permanent	• n/a
SPATIAL EXTENT	• Local	• n/a
PROBABILITY	• HIgh	• n/a
STATUS (+ OR -)	• Negative	• n/a
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• High	• n/a
MITIGATION ACCEPTABLE/PRACTICAL	• Yes. Take care to retain vegetation, replant saplings, and conserve vegetation cones in channel.	• n/a
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• Low	• n/a
CONFIDENCE LEVEL	• High	• n/a

8.4.8 *Spread of bilharzia and malaria associated with slow flowing water*

Discussion

As mentioned earlier in this report, bilharzia and the snails that serve as vectors to this parasite were unknown in the Cuvelai prior to 1990 (Curtis, 1990, 1991). Since then with the introduction of Kunene river water via the interbasin water supply scheme operated by NamWater, both host snails have been found on vegetation, mainly living on floating leaves of *Lugwigia stolonifera* in the northern section of Olushandja Dam (Curtis, 1995a, 1995b, Clarke, 1997, 1998b) but not anywhere else in the system at that time. Yet, cases of bilharzia were increasing at Ombalantu hospital each year even though many of the patients had never been to Olushandja Dam suggesting that the ceracia (the free-swimming life-stage that infects people in the water) had managed to survive in the canal downstream.

Malaria is endemic (in the medical sense) in the Cuvelai, as drying *iishana* pools provide foci for the insect carriers, *Anopheles* mosquitoes to breed. They too prefer standing water.

Mitigation

- Bilharzia snails live in well vegetated, quiet waters. Such conditions could exist on the quiet margins of *iishana* systems and in pools isolated as waters begin to dry out. At places where such conditions are likely, create vegetation-free access points for people using resources from the wetland.

- It does not make any sense to eliminate mosquito/bilharzia-prone habitats from the *iishana* system as they also support many beneficial creatures. Several fish species are known to eat mosquito and provided they occur naturally within the Cuvelai system could be introduced into for example the pools created within burrow pits. Otherwise the precautions advocated by the Ministry of Health should be followed and care taken in the application of DDT that this bioaccumulative poison that targets all insects including beneficial ones, be done in a way that will not contaminate *iishana*.

- Awareness that mosquito nets are for sleeping under and not for fishing needs to be done.

- The snail surveys of 1991 and 1997 need to be repeated and become part of a regular, annual, ecological monitoring programme of the water supply scheme and any *iishana* inadvertently linked to it, including the new diversion channel alongside the dike, the Okatana *oshana* in Oshakati, the receiving *iishana*. (not the Omadhiya lakes as suitable vegetation is unlikely to occur) The best time to monitor would be towards the end of the wet season when

isolated pools remain. The hospital records should be regularly checked Should vector snails be found, recommendations Olushandja should be applied e.g. having vegetation-free access points for people to use.

Summary

Table 36: Spread of bilharzia and malaria associated with slow flowing water

	DURING CONSTRUCTION	DURING OPERATION
SEVERITY/MAGNITUDE	• n/a	• Low
REVERSIBILITY	• n/a	• Reversible
DURATION	• n/a	• Long term
SPATIAL EXTENT	• n/a	• Local
PROBABILITY	• n/a	• High
STATUS (+ OR -)	• n/a	• Negative
SIGNIFICANCE (NO MITIGATION/ENHANCEMENT)	• n/a	• Medium
MITIGATION ACCEPTABLE/PRACTICAL	• n/a	• Yes. Measures from Ministry of Health and Social Services, with other suggestions. Further monitoring.
SIGNIFICANCE (WITH MITIGATION/ENHANCEMENT)	• n/a	• Low
CONFIDENCE LEVEL	• n/a	• Medium

9 CONCLUSIONS AND RECOMMENDATIONS

Summary of impacts

Table 37: Summary of impacts below provides a summary of those impacts which are considered of medium or high significance if nothing is done to lessen their effect.

Table 37: Summary of impacts

IMPACT	SIGNIFICANCE RATING	KEY MITIGATION
POSITIVE IMPACTS		
Flood Protection of the Oshakati/Ongwediva urban area and reclamation of land for urban development.	High	Flood emergence/response plan Monitor flooding, early warning system Labour enhancement construction methods, locals first policy
Creation of local employment opportunities during construction	Medium, high with enhancement	
Benefits of project for the local economy, including increased business, recreation and tourism opportunities.	Medium	
NEGATIVE IMPACTS		
Relocation/resettlement and compensation of households.	Medium, low with mitigation	Resettlement and Compensation Action Plan
Loss of livelihoods, especially for the poor and vulnerable high to low.	High, low with mitigation	
New and more severe flooding of some households as a result of the backwater effect of the dike system.	Medium, low with mitigation	
Safety risk to people and livestock during construction activities and operations.	Medium, low with mitigation	Safety measures included in design and by contractors, awareness campaigns
Improved sanitation due to the movement of previously standing contaminated water away from Oshakati, but simultaneous negative impact of pollution and litter on the ecosystem downstream.	High positive inside the urban area, medium negative impact on the ecosystem, low with mitigation.	Improve sewerage system, improved waste management, maintenance system for stormwater management system.

IMPACT	SIGNIFICANCE RATING	KEY MITIGATION
Destruction of graves or cultural resources.	Medium, can be mitigated to low.	Chance-find procedure, gravesites affected to be exhumed, re-buried.
Increase in the Spread of HIV/Aids and other stds.	High, with mitigation, medium	HIV/AIDS awareness during construction, avoid interaction of the workforce with the population.
Spread of bilharzia and malaria associated with slow flowing water.	Medium, with mitigation, low	Repeat snail survey, work with the Ministry of Health and Social Services campaigns.
Impacts on nutrient and energy cycles and consequent impacts on the wetland system (including impacts on fish, wetland diversity and livelihoods dependent on fish).	Medium, with mitigation, low	Rough wall design for the dike, river designed to function as natural oshana, sensitive excavation work, rehabilitation, sensitive siting and design of borrow pits.
Impacts of altered flows (velocities and volumes) on sensitive ecosystems downstream (Oshana receiving diverted water, Omadhiya lake complex, Ekuma River and Etosha Pan).	High, with mitigation, low to medium	Revise MFMR regulations, implement no-fishing zone around culverts and bridges, operate sluice gates as close to natural floods as possible.
Impacts of changes in water quality (turbidity, salinity, nutrient concentrations) on iishana habitats and fish and fisheries.	High, with mitigation, low	Concurrent rehabilitation with construction, waste management, etc.
Impacts of floodgate operation (duration and timing of flows) on iishana and fish.	Medium, low with mitigation	Operate sluice as close to natural system as possible.
Impacts of removal of vegetation, (including large fruit trees) and lining of Okatana River on the iishana habitats, fish and fishing.	High, with mitigation, low	Design the features to incorporate natural vegetation, re-vegetation, rehabilitation.

Main areas of impact and mitigation

From the above table, the following main areas of impacts can be gleaned:

- Reduced flood risk, with additional space for future development, leading to local economic development. This will bring major positive change to the area.

- New flood areas to the West and North, with associated loss of livelihoods, assets, cultural sites and resettlement.

- Altered habitats, ecosystems and biodiversity resulting from altered water quality, flow, and direct habitat loss, both in Oshakati and downstream. This will influence the livelihoods of the local people who depend on the natural resources of the Cuvelai.

- Increased health and safety risks including the spread of Bilharzia and Malaria associated with slow flowing water and, HIV/AIDS and other STDs during construction.

The main areas of mitigation to be implemented for these areas of impact are:

- The design and implementation of a resettlement and compensation action plan for the households to be affected by the backwaters of the dike.

- Altered design of the dike and Okatana River deepening and lining to embrace and resemble the *iishana* natural habitat, incorporating existing natural features such as islands and conservation worthy vegetation zones.

- The design of the sluice gate system to embrace and resemble the natural flow regime of the Cuvelai.

- Construction and excavation activities that are sensitive to the Cuvelai, keeping to natural contours, and rehabilitating altered terrain to resemble the original landscape as closely as possible.

- Close collaboration with the Ministry of Health and Social services in dealing with the spread of diseases Bilharzias and Malaria) and pandemics (HIV/AIDS and other STDs in a manner that would not compromise the integrity of the ecosystem.

- Ensure that the urban solid waste and sewage effluent is kept separate from the stormwater system in Oshakati. This will require the upgrading of the existing stormwater and solid waste management systems.

- Cooperation with the Ministry of Fisheries and Marine Resources to protect and sustain and perhaps supplement the fish resources of the project area.

- Otherwise the general and specific management and monitoring actions prescribed in the EMP need to be implemented for each stage of the project.

Final Analysis

- The project will affect a small part of the overall Cuvelai catchment and the waters flowing southwards towards Etosha.

- Therefore, if these requirements are adhered to, the project will generally hold a low risk to the people and the ecosystem of the Cuvelai and it is recommended that clearance be granted subject to these conditions.

- However, the flood challenge reaches much further than the current project area. Flood management of this nature duplicated regionally is expected to have severe implications, since the approach involves the implementation of reactionary measures. Therefore, the EIA Team brings to the attention of the decision makers the need for solving the flood challenge of the Cuvelai in a holistic and proactive manner, including attention to the following:

- Conduct a strategic study for the flood challenges of the Cuvelai, which aims at guiding development that would be in harmony with the natural processes of the ecosystem and providing sustainable long term solutions. The study will result in a development framework for future land use planning and flood management.

- Implement long term monitoring of the climatic and hydrological patterns of the entire Cuvelai, in collaboration with Angola.

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Personal Communications

Leonard Hango, June 2012

Wilfred Versfeld, Researcher, Etosha Ecological Research Institute, September 2011.