

## BACKGROUND INFORMATION

### Strategic session in preparation for the Oshakati Flood Mitigation project EIA

#### THE PURPOSE OF THIS DOCUMENT IS TO:

- provide a brief background to the proposed development; and
- to prepare delegates for the strategic dialogue on the 2<sup>nd</sup> of November 2011.

#### SOURCES USED FOR THIS DOCUMENT:

This document has been compiled by directly quoting or summarising selected sections from the following documents:

- Ministry of Regional and Local Government, Housing and Rural Development. 2009 **Investigation of technical and financial feasibility of flood mitigation measures in the Oshakati-Ongwediva Area.** Windhoek, Namibia.
- **Presentation by BAR on flood mitigation measures.** Presented on 07 October 2011 at Oshakati Stakeholders Meeting on the design of the dyke around Oshakati and the Deepening of the Okatana River.
- **Presentation by Knight Piésold on flood mitigation measures.** Presented on 07 October 2011 at Oshakati Stakeholders Meeting on the design of the dyke around Oshakati and the Deepening of the Okatana River.
- A Lux and C Janowicz. 2009. **Water use options for regional development. Potentials of new water technologies in Central Northern Namibia** CuveWaters Papers, No. 6. Institute for Social-Ecological Research (ISOE), Hamburger Allee 45, 60486 Frankfurt/Main, Germany.

## 1. INTRODUCTION

Since 2008 the northern areas of Namibia have been subjected to significant floods. The Town of Oshakati was particularly badly affected. In response to this challenge the Ministry of Regional and Local Government, Housing and Rural Development lodged an initiative to address the flooding of Oshakati with protection measures extended to include Ongwediva and Okatana.

The project involves the following components:

Bureau of Architecture (BAR) Namibia have been appointed to provide a concept master plan for the future development of Oshakati.

This plan includes the delineation of various dykes, channels and retention ponds as well as a water channelling system through the centre of Oshakati. Besides the master plan, BAR is currently designing the dyke system around the town.

Preferred Management Services (PMS), in association with UWP Consulting and Knight Piésold Consulting Engineers, performed a feasibility study to

- assess the anticipated flood levels,
- to assimilate the flood measures proposed by the master plan,
- to formulate them into a cohesive engineering strategy for flood mitigation including aspects such as bridge widening, extension, etc and
- to implement these measures through design and contract supervision.

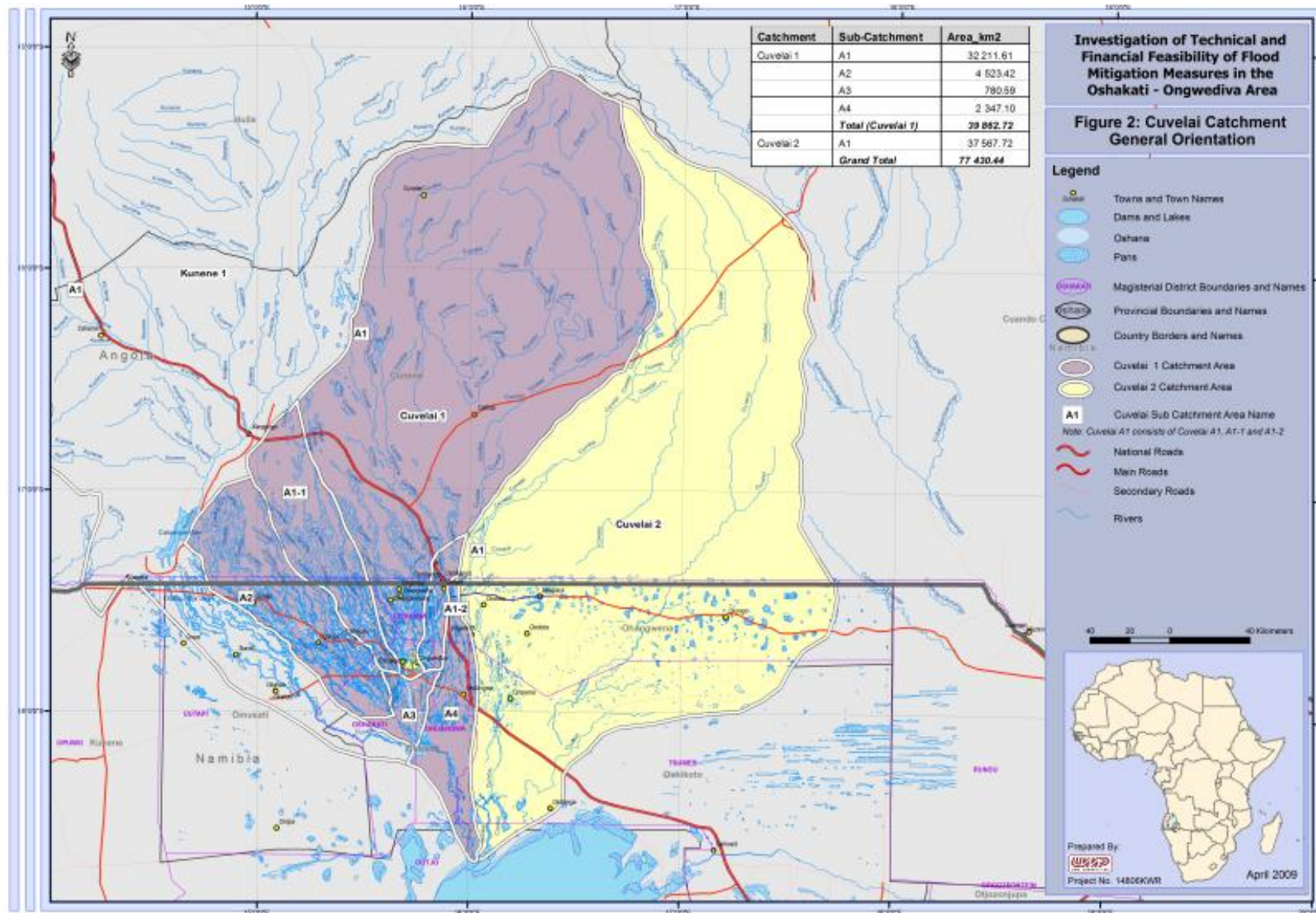
Knight Piésold is currently busy designing the deepening of the Okatana River System which runs through Oshakati and the design and construction supervision for the replacement of the Okanjengedhi bridge.

**The above changes could have a significant impact on the Cuvelai basin and the ecological and social well-being of the area.**

The Ministry therefore appointed Enviro Dynamics to conduct an Environmental Impact Assessment of the proposed flood mitigation measures for Oshakati and surrounds.

## 2. AREA DESCRIPTION AND CONTEXT

- Cuvelai Catchment
- 45,000km<sup>2</sup> catchment
- 2008, 2009 and 2011 flooding severely affected Oshakati and surrounds



**Figure 1: General description of the wider affected area in the Cuvelai Basin**

During the **Integrated Water Resources Management in the Namibian Part of the Cuvelai Basin** consultations, issues relevant for the establishment of basin wide management, identified by local stakeholders, were recorded.

The main issues identified were:

- 1) *Keeping water in the basin* by harvesting it before it disappears into the Etosha Pan, and prioritise the use for human consumption and agricultural development.
- 2) *Ensuring that Angola opens up the dams so that water can flow towards Namibia.* According to some stakeholders water does not flow as freely from Angola as it used to. Some people claim that the rivers have been blocked upstream on the Angolan side.
- 3) *The high salinity of groundwater in the central parts of the basin, which prevents infrastructural development.* It was suggested to establish a desalination plant to improve the water quality, or at least make it drinkable for livestock, in areas where groundwater is brackish.
- 4) *Deepening the Etaka canal.* Many stakeholders believe that the Etaka canal can be deepened so that water from Olushandja dam can be diverted into the channel to flow to the downstream users, or another artificial channel
- 5) Water pollution and water sharing was stated to be a problem especially in the southern part of the basin. It is not clear what water sharing the stakeholders referred to, but it is likely that it has to do with the increased number of people moving towards the southern parts of the Cuvelai basin in search for grazing, which has led to more people and livestock making use of the water provided by pipelines there.

## 2.1. Typical flood mitigation interventions described in the Oshakati flood mitigation feasibility study

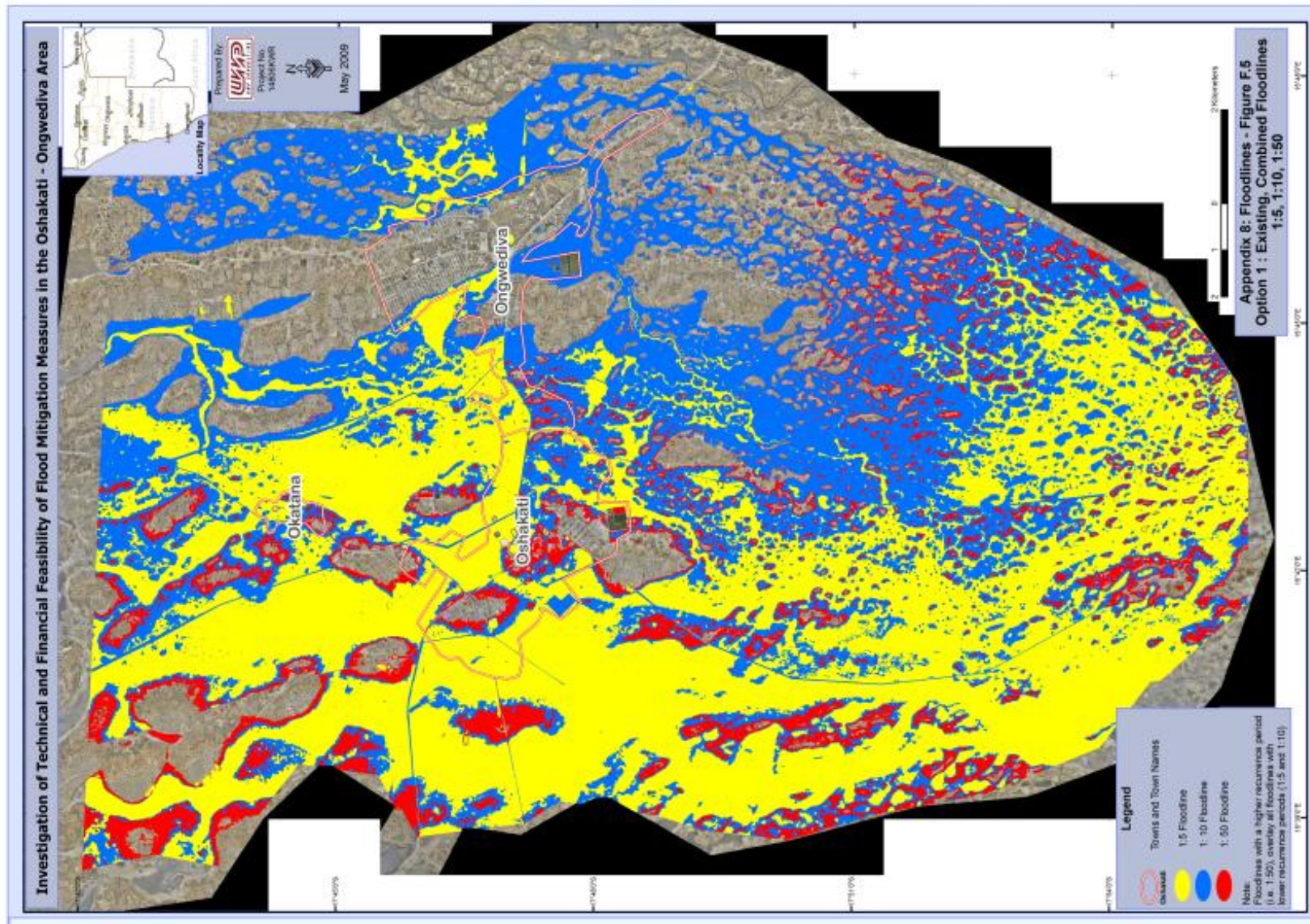
“Owing to the specific characteristics of the study area (large catchment, flat topography, and poorly defined water courses) the availability of feasible flood mitigation measures is very limited. The following paragraphs contain comments on typical flood mitigation interventions and their applicability to the project area.

- *Construction of a flood attenuation storage dam upstream of the area to be protected. This option is not available for this area. A storage reservoir with a capacity of about 300 million m<sup>3</sup> (similar to the size of the Hardap Dam) would be required to attenuate the peak flows from recurrence periods of 1:50 years to 1:10 years (estimated time of concentration 100 hr at flood peak of 3 500 m<sup>3</sup>/s). There are no suitable sites for the development of such a large dam, and the costs would anyway be prohibitively high.*
- *The local authorities would typically allow new developments only outside of the 1:50 flood lines. In this case this is practically impossible since the available space for safe*

development has already been occupied. Serious consideration should be given to the option of extending and even relocating the town to an alternative location.

- *Formally channelizing (widening and lining of streams), upgrading of road crossings, together with the upgrading (formalising) the internal stormwater drainage system. This measure should be implemented in conjunction with other measures. Because of the flat topography this measure will not be sufficient to mitigate floods with high recurrence periods (see the sections 4.3.2 and 4.5).*
- *Regular maintenance of streams, removal of sediment and cleaning of vegetation from streams and banks. Not sufficient as a standalone intervention, but should be implemented in conjunction with other measures.*
- *Construction of dykes and channels to divert high flood flows away from the protected area. This appears to be the only technically viable intervention applicable to the study area, which will result in a sustainable long term solution. This intervention has been evaluated from technical point of view and is discussed in more detail in the following sections."*



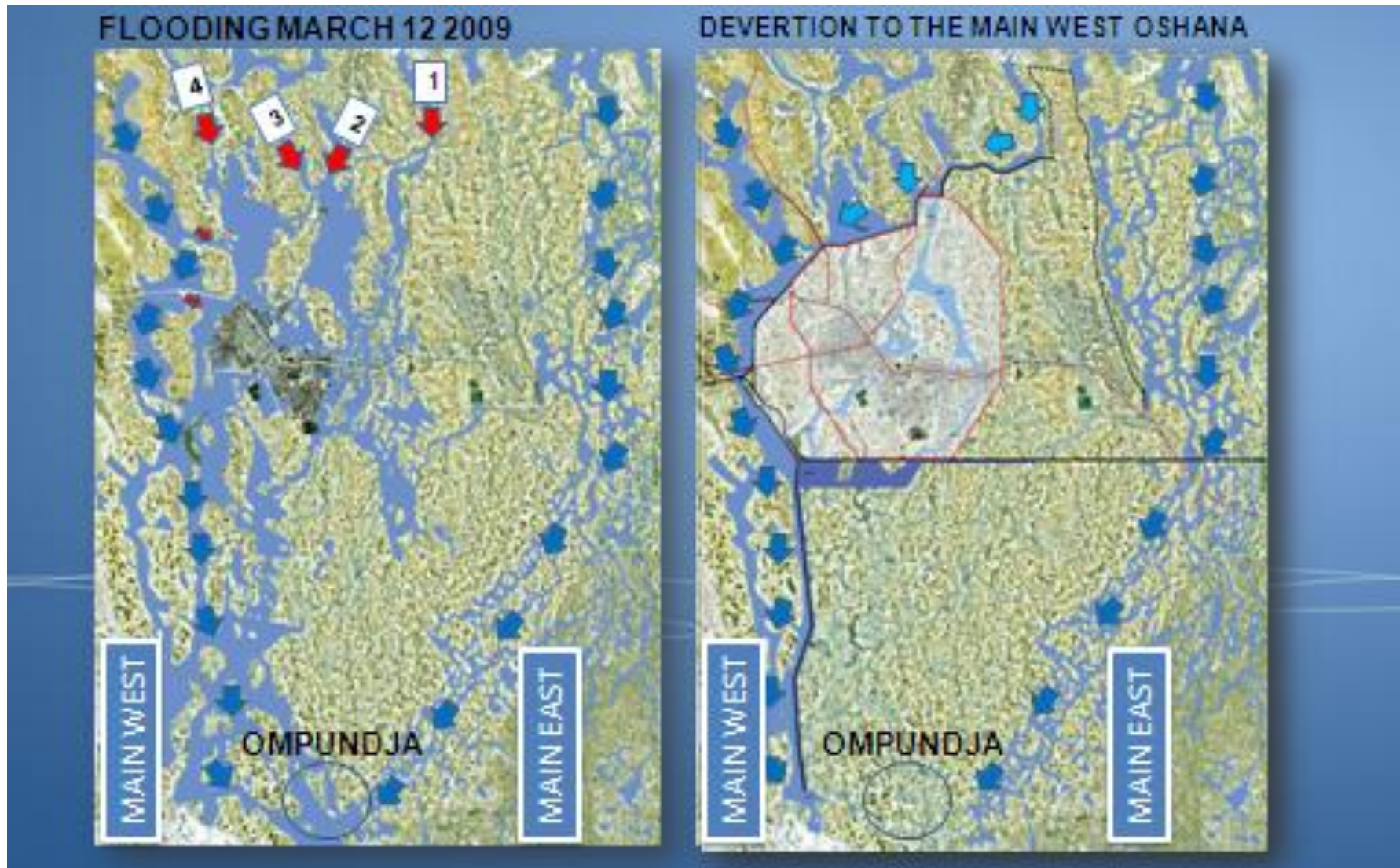


**Figure 2: Description of flood lines in the Oshakati area**









**Figure 4: Comparison of pre- and post- mitigation flooding**

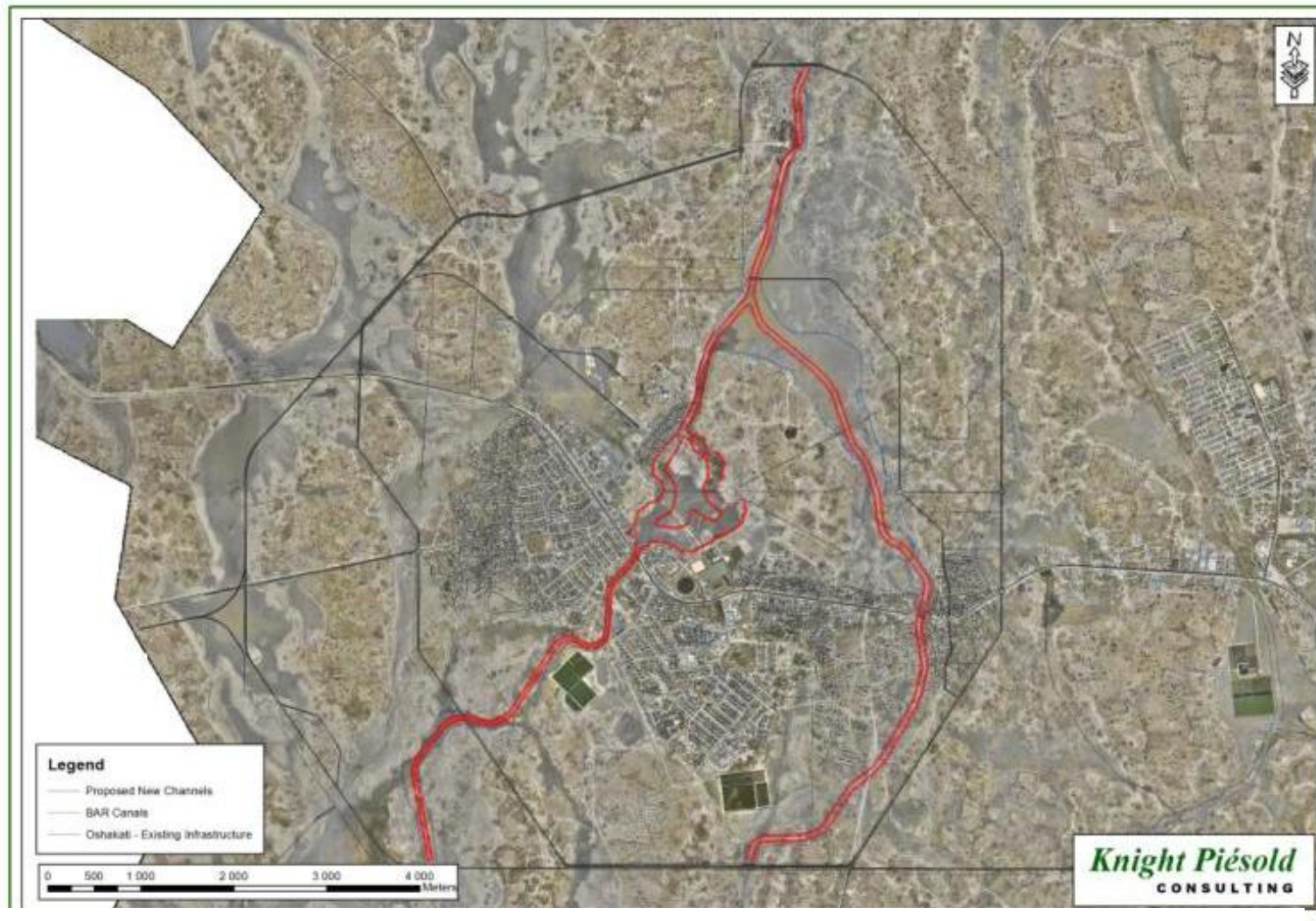
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### 3. INFRASTRUCTURE – RIVER DEEPENING & DYKE

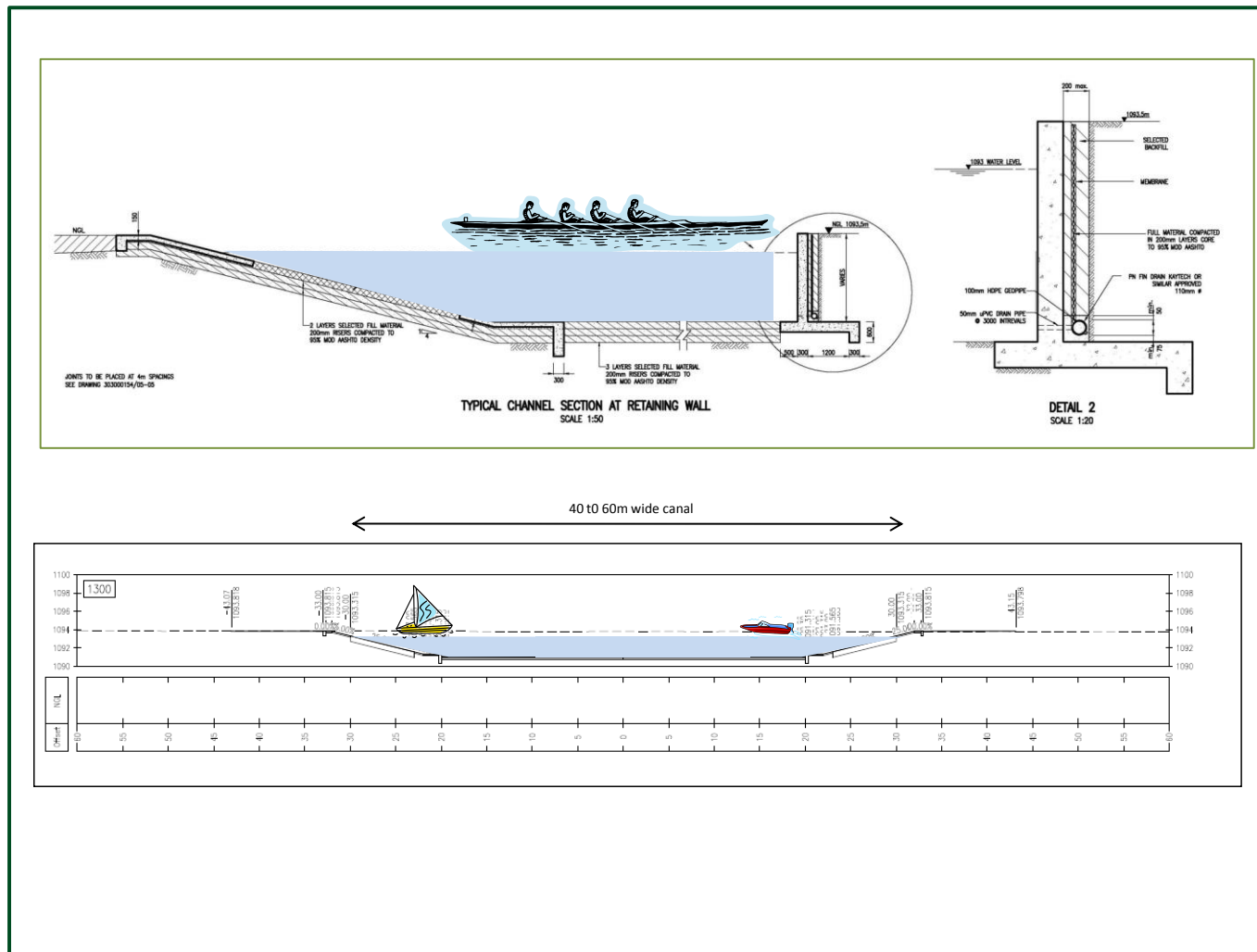


**Figure 5: General description of the deepening of the Okatana River in Oshakati**

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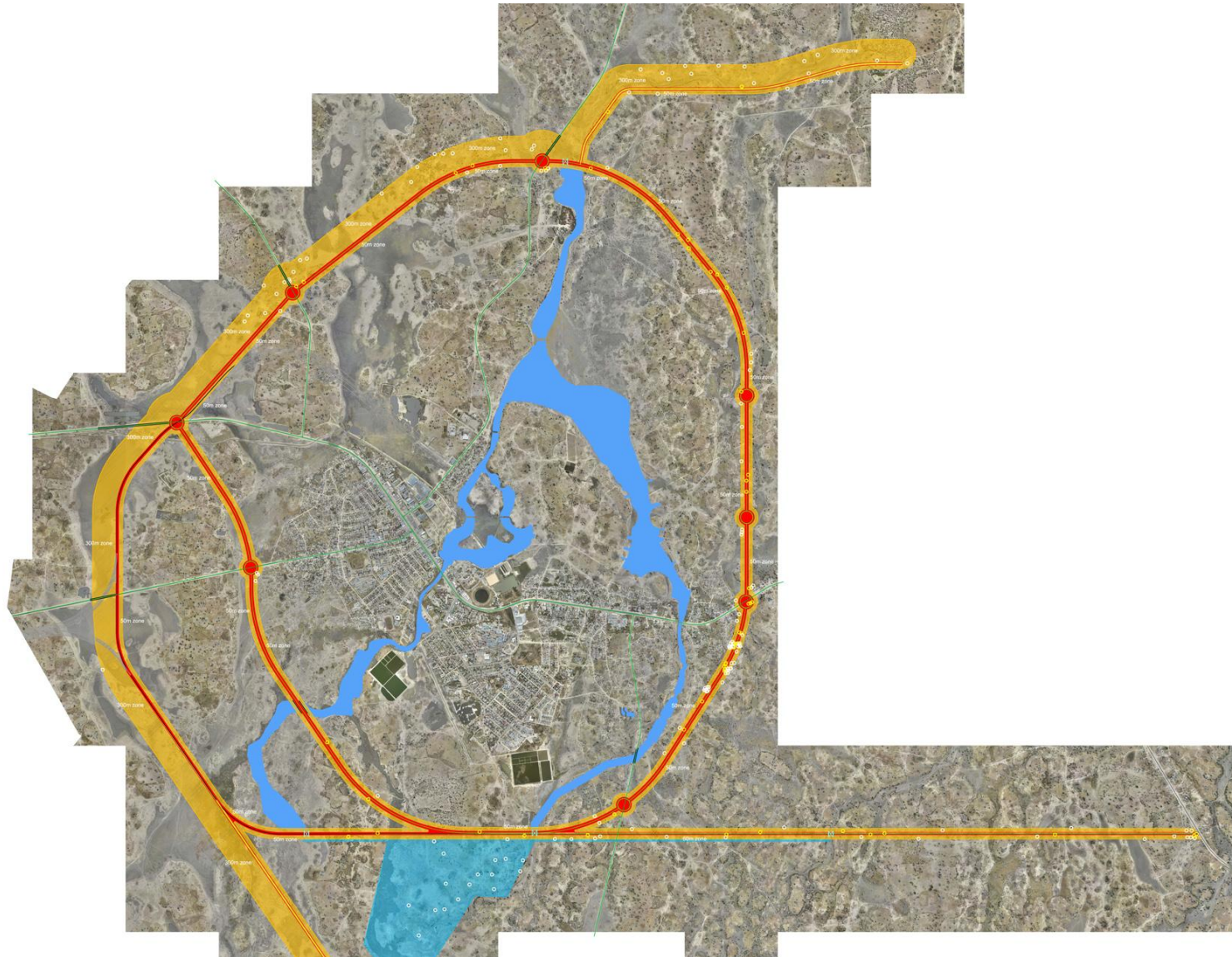
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**Figure 6: General details of the deepening of the Okatana River in Oshakati**





**Figure 7: General layout of dyke around Oshakati**

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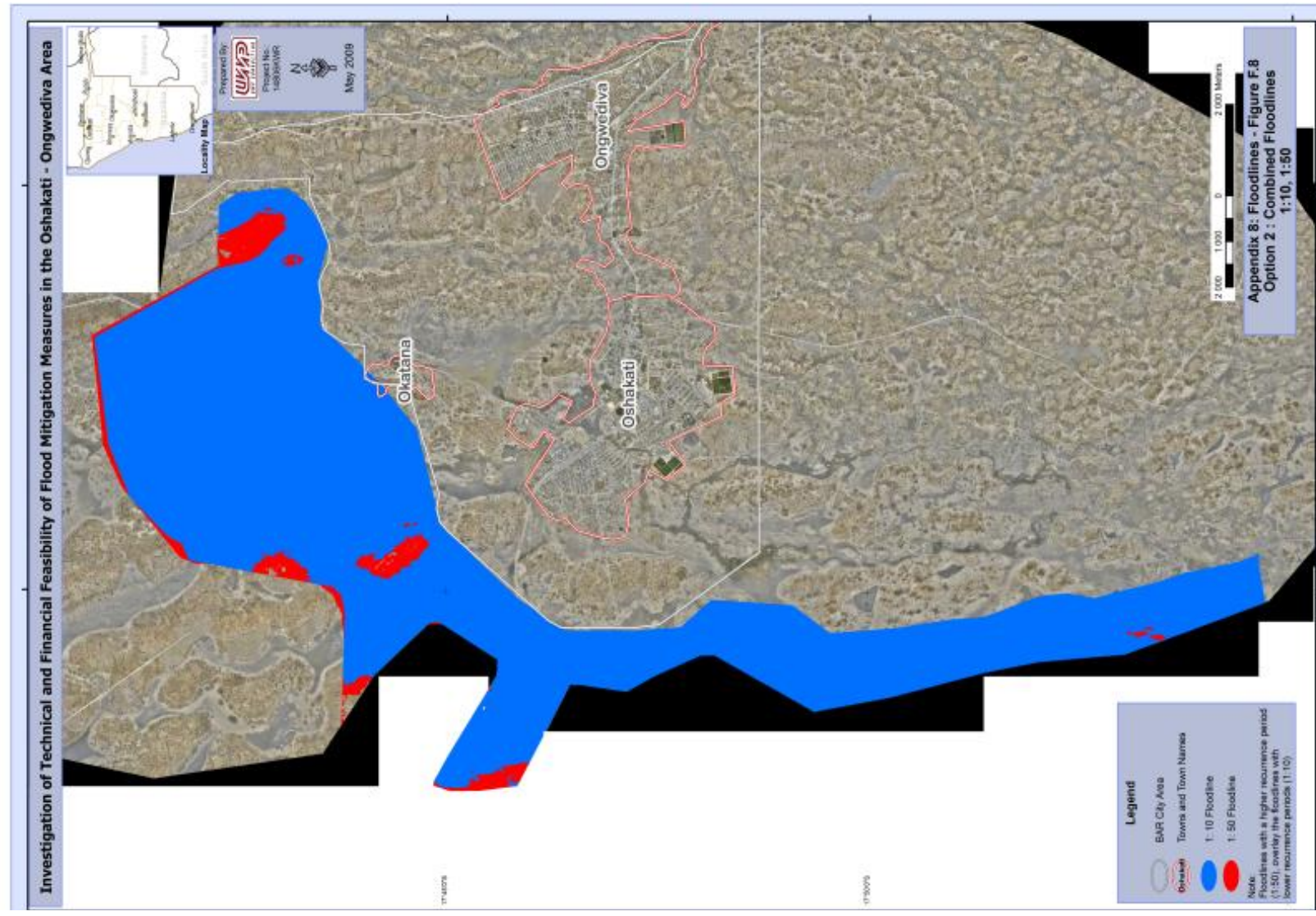
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**Figure 7: General detail of dyke around Oshakati**



**Figure 8: General description of the flood diversion due to the dyke**

### 3.1. Composition and size of the mitigation infrastructure of Oshakati flood mitigation feasibility study

"The proposed flood mitigation infrastructure will consist of the following elements, the approximate position of which are shown in **Appendix 9, Drawing A**. Drawings 1 to 6, Appendix 9, provide typical details for the main components of the scheme.

- **The dyke**, as described in Section 4.2 has a typical cross section as shown on Drawing 01. Three options for the dyke have been considered:
  - **Option D1:** position as proposed by BAR, including a road over the dyke (the dyke section has been specified to include the necessary road layer works), 11m top width, 31,390m long. Average height varies between 2.65m and 3.66m depending on the flood recurrence period, which includes a 300mm high free board.
  - **Option D2:** position as proposed by BAR, but excluding provision for a road (this reduces the top width of the dyke, and allows for less complex and expensive construction of the dyke), 3m top width, 31,390m long. A road can be constructed later adjacent to, or over the dyke. Average height varies between 2.65m and 3.66m depending on the flood recurrence period, which includes a 300mm free board.
  - **Option D3:** the proposed layout of the dyke has been amended to minimise the dyke height. The revised position of the dyke is shown as position A1 on Figure 9A. Similarly to Option D2 the top width of the dyke is 3m and no provision for a road has been made. Average depth varies between 1.84m and 2.88m depending on the flood recurrence period.
- **Upgrading of existing roads at the dyke crossings:** Provision for upgrading of 1.5km of each existing road, which crosses the dyke has been made (Roads C41, C45, C46 and D3609). This is necessary in order to re-align the vertical and horizontal alignments, as well as to make provision for the construction of bridges. A typical road section in fill is illustrated in Drawing 03, Appendix 9.
- **New bridges** at each road crossing with the dyke (roads C41, C45, C46 and D3609) have to be constructed. Since the flow from the entire catchment has been diverted around the dyke, the new bridges will be substantially larger than the existing ones. A typical culvert bridge detail is shown on Drawing 02, Appendix 9. The selection of bridge type (pillar or culvert) will be finalised during the design stage.
- **New light bridges.** Provision for 3 pedestrian, wagon and animal crossings of the modified stream has been made. These will be low level crossings, which will allow



convenient passage during low flow conditions, but will be inaccessible during flood conditions.

- **Hydraulically controlled radial flow gates:** Provision has been made for the installation of water level control gates at streams S2, S3 and S4. These gates will control the downstream water level and the flow rates in the streams flowing into Oshakati. They will allow water to pass during normal flow conditions, but will restrict and divert excess flows during flood conditions. The gates are automatic and work on hydraulic principles. A typical detail for the proposed gates is shown on Drawing 04, Appendix 9. Manually operated sluice gates could be considered as an alternative. The control philosophy and gate types will be optimised during the design stage.
- **Relocation of canal:** The existing Calueque – Oshakati canal will be affected by the proposed stream modifications. Provision has been made to construct a 2.5km long, 1.8m ND inverted siphon to accommodate the flow in the canal. The actual length and size of the siphon will depend on the flood lines, available elevation head and topography to the west of Oshakati. Additional survey data is required to finalise the sizing.

### 3.2. Summary and conclusions of the Oshakati flood mitigation feasibility study

The catchment area draining into the town of Oshakati is very large, with an estimated size of approximately 28,000km<sup>2</sup>. It forms part of the Cuvelai River Catchment, which is located predominantly in Angola. The area is very flat. The flow pattern is typically overland, with very poorly defined streams and significant cross flows between oshanas. Flow patterns vary in time depending on flow depth and sediment deposits.

The mean annual precipitation (MAP) in the catchment ranges from 500 mm in the south to approximately 1,000mm in the north. The streams in the catchment are non-perennial.

The peak flood flows draining from the catchment are high, estimated to vary between 1,700m<sup>3</sup>/s and 4,700m<sup>3</sup>/s for flood recurrence periods of 1:10 and 1:100 years respectively.

Similarly, the area around Oshakati and Okatana is characterised by very flat topography with numerous interconnecting oshanas and pans. During the dry season the flows are confined within the streams, but during flood conditions shallow overland flows prevail. These towns experienced moderate (flow velocities lower than 2.0m/s and flood water depth below 1.2m, see hazard rating in Figure F.7, Appendix 8) flooding hazard in 2008 and again in 2009, which is considered to be of low recurrence period, probably in the order of 1:5 years, with associated flow rates lower than 500m<sup>3</sup>/s.

The hydrological and hydraulic modelling revealed that there is a high probability of more severe and even devastating flood impact in the towns of Oshakati and Okatana. These

towns will be severely affected when floods with recurrence periods exceeding 1:20 occur, which can be any time from now. Urgent action is therefore required. The towns have been established in the middle of a flood plain, which is not suitable for major town developments.

The town of Ongwediva is established in a safe location. It will not be affected by floods even at recurrence periods of 1:100 years.

At present the town of Oshakati does not have any formal internal stormwater drainage infrastructure. The absence of such infrastructure, combined with the very flat topography could result in local flooding even at low recurrence periods.

A draft urban master plan for the town of Oshakati has been prepared by another consultant. This plan makes provision for considerable modifications to the existing natural drainage system in and around the town.

Various flood mitigation interventions were considered and it was concluded that the only technically viable long term flood mitigation intervention would be to protect the area by constructing a dyke (approximately 3.0m high and 31km long). The project would also involve the upgrading and re-alignment of existing roads, construction of new major bridges and pedestrian crossings, flow control gates, relocation of existing canal, etc.

The estimated cost of the required construction works amounts to N\$627 million (protection for flood recurrence period of 1:50 years) or N\$678 million (protection for flood recurrence period of 1:100 years).

### **3.3. Limitations**

The absence of the following data may have affected the level of confidence in, and the accuracy of the results of this investigation. A rather conservative approach has been applied where data was insufficient, so that safety of the towns is not compromised.

- Owing to the very flat topography, prevailing overland flow conditions and interconnected oshanas, and the absence of any topographical information for the majority of the catchment located in Angola, it was difficult to estimate accurately the size of the catchment area.
- No reliable rainfall data for Angola was available, which could have affected the accuracy of the peak flood flow estimates.
- Owing to the absence of any stream flow records for the catchment, the estimated flood peak flows could not be verified and the hydraulic models could not be calibrated against observed flow data.

- The available topographic information (DTM) for the project area did not extend sufficiently to the west. This could have resulted in inaccuracies in the estimated flood levels.

### 3.4. Recommendations and way forward

The following recommendations are offered:

- The client should construct and equip appropriately calibrated flow gauging stations at key locations in the area and should record both primary (water levels) and secondary (flow rates) data.
- A surveyor should be appointed to extend the topographical surveys to the west of the area covered by the previous surveys. The extension should cover a strip with a width of at least 6km (preferably 10km).
- A consultant should urgently be appointed to undertake a detailed stormwater master plan for the town of Oshakati, since that will affect the requirements for modifications to streams within and downstream of the town.
- It is recommended that the proposed urban master plan for Oshakati is carefully evaluated from engineering, economic and ecological perspective before implementation. The following key issues should be addressed:
  - In view of its inappropriate location of the town (from stormwater management perspective), a careful consideration should be given to the future expansion of the town at an alternative location, for instance, on the plateau adjacent to Ongwediva. This could result in very significant cost savings.
  - The feasibility of the proposed deviation of stream S2 and the associated redundancy of major bridges (B2, B3 and B8) should be assessed.
  - The feasibility of developing a “water front” space in an area with non-perennial streams should be assessed.
  - The impact on the internal stormwater drainage should be evaluated. The proposed stormwater and urban master plans should be aligned and considered conjunctively.
- A consultant should be appointed to undertake an environmental impact assessment (ecological and social) for the interventions proposed by the urban and stormwater master plans, as well as the mitigation measures proposed in this report.
- Once the key issues outlined above have been resolved, the client should proceed with the design and implementation of the selected and acceptable stormwater mitigation interventions.



- It is recommended that option D2 (as specified in Section 4.4) should be implemented immediately. The estimated capital cost for implementing this option would amount to N\$627 million (protection against flood recurrence period of 1:50 years) or N\$678 million (protection against flood recurrence period of 1:100 years)."

#### 4. STRATEGIC CONSULTATION

The purpose of this strategic session is to

- To consult key authorities and stakeholders about the project so that their key concerns may be heard and incorporated;
- To assist Government in identifying all relevant options for decision-making purposes;
- To identify strategic considerations that need to be addressed during the decision-making process of the project; and
- To fine tune the direction and the key issues to be considered in the remainder of the EIA process.

You are hereby encouraged to submit your comments/inputs/concerns in one or more of the following ways:

**E-mail or fax your comments to:**

Ms Stephanie van Zyl | Mr Norman van Zyl

Enviro Dynamics cc

Tel: (061) 223 336 | Fax: (061) 307 437 | E-mail: [info@envirod.com](mailto:info@envirod.com)

Comments should reach Enviro Dynamics no later than **Wednesday, 10 November 2011**.