APPENDIX A

EXECUTIVE SUMMARY OF THE MOKOLO AND CROCODILE (WEST) WATER AUGMENTATION PROJECT FEASIBILITY STUDY MAIN REPORT

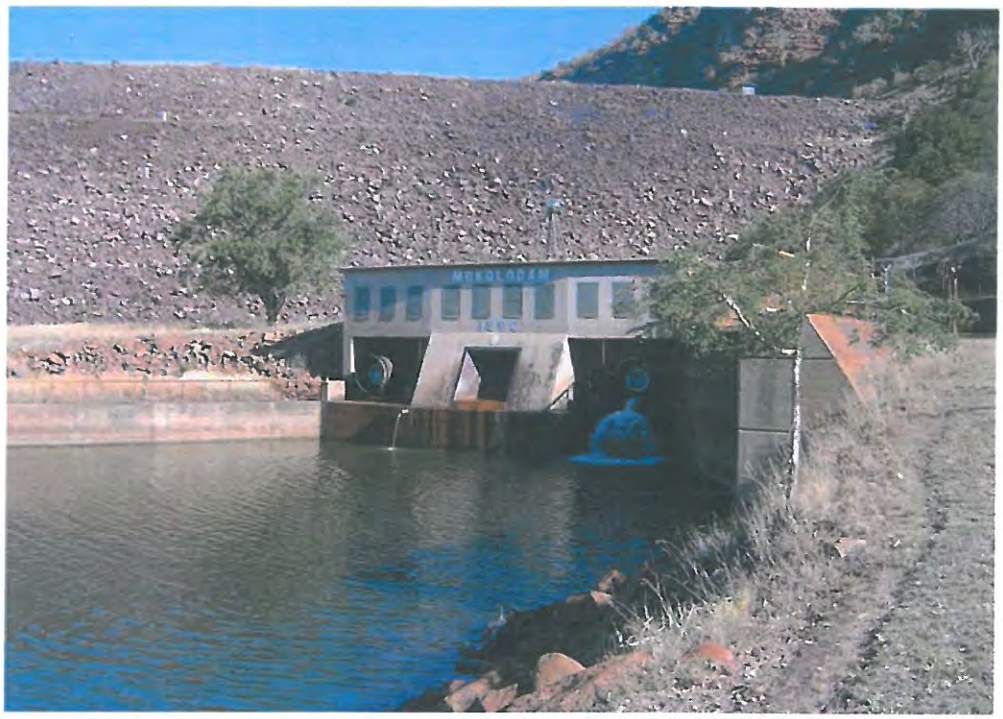
REPORT NUMBER: P RSA A000/00/8109

Department of Water Affairs

Chief Directorate: Integrated Water Resource Planning

Directorate: Options Analysis

MOKOLO AND CROCODILE (WEST) WATER AUGMENTATION PROJECT (MCWAP) FEASIBILITY STUDY: TECHNICAL MODULE



FEASIBILITY STUDY TECHNICAL MODULE SUMMARY REPORT

MAIN REPORT

Lead Consultant: Africon

In association with: KV3, VELAVKE

MOKOLO AND CROCODILE RIVER (WEST) WATER AUGMENTATION PROJECT FEASIBILITY STUDY: FEASIBILITY STAGE: MAIN REPORT

EXECUTIVE SUMMARY

BACKGROUND

Lephalale is a relatively small Local Municipality in terms of population and is situated in the south-western part of the Waterberg District Municipality in Limpopo Province.

A very important and relevant feature of Lephalale is the huge coal reserves found in the municipal area, estimated by some sources at 53% of the total reserves of the country. The Grootegeluk Coal Mine is the largest open cast coal mine in the country with the largest coal beneficiation activities in the world, and serves the Matimba Power Station, as well as other domestic and export coal needs. The new Medupi Power Station with a total capacity of approximately 4 800 MW has been approved and construction started in late 2007. At the same time, the Grootegeluk Mine is continuously expanding, while Anglo Coal is implementing a pilot project to establish the feasibility of exploiting Coal Bed Methane extraction. Sasol is presently investigating development of a Coal-to-Liquid fuel plant, and Lephalale is one of the two areas where the development may be located. This, and other potential developments, requires the provision of additional bulk water services for the industrial, mining, domestic and social needs arising directly and indirectly in the area as a result of the industrial development.

WATER RESOURCES

Groundwater *- Three groundwater orientated studies have been initiated in the Lephalale area. The results indicated that the sustainable yield from the boreholes drilled is estimated at 1.7 Million m^3/annum.*

It is further estimated that for a short-term two-year use 7.19 Million m^3/annum can be abstracted, but will need to be followed by a period of recovery.

Mokolo Dam *- Mokolo Dam is located on the Mokolo River approximately 45 km south-east of Lephalale (formerly Ellisras) in the Limpopo Province. The Mokolo River is a major tributary of the Limpopo River and has a total catchment area of over 8 380 km^2 with a total natural mean annual runoff (MAR) of almost 300 Million m^3. The catchment stretches from the Waterberg Mountains through the upper reaches of the Sand River.*

The Mokolo Dam has a long-term (1:200 year recurrence interval (RI)) yield of 39.1 Million m^3/annum of which 10.4 million m^3/annum is allocated for irrigation. The remaining 28.7 Million m^3/annum is available to supply water to other water users. The

results of a yield analysis conducted for Mokolo dam, which is based on the scenario with the most reliable representation of the current-day situation, are summarised below.

Mokolo Dam Yield Analysis Results

Historic Firm Yield		Yield (Million m^3/a), at indicated Recurrence Interval			
(Million m^3/a)	Recurrence Interval (years)	1:200	1:100	1:50	1:20
38.7	1:224	39.1	44.6	50.7	66.8

The 1:200 year firm yield available from the Mokolo Dam under current day conditions of land and water use is 39.1 Million m^3/annum, and was accepted for further planning purposes.

Crocodile River (West) - *The Crocodile River (West) catchment extends northwards from the continental divide in central Johannesburg (where the Crocodile River (West) originates), to the confluence of the Crocodile (West) and Marico Rivers. The catchment area includes part of the Gauteng, North West and Limpopo Provinces. From the confluence of the Crocodile River (West) and Marico River, the river is known as the Limpopo River, which forms the northern border of South Africa with Botswana and then with Zimbabwe, before flowing into Mozambique where it discharges into the Indian Ocean. The total gross catchment area of the Crocodile River (West) is approximately 29 000 km^2.*

PROJECT SCOPE

The intention of the project is to supply water in sufficient quantities and most economically for the anticipated development in the Lephalale/Steenbokpan area. The main components of the MCWAP are:

- *Mokolo Dam, located approximately 45 km south-east of Lephalale on the Mokolo River.*
- *The existing water conveyance system from the Mokolo Dam, consisting of a pump station located at the dam, a rising main, balancing reservoir and gravity main up to the terminal point close the Matimba Power Station; collectively referred to as the Exxaro pipeline.*
- *The envisaged new water conveyance scheme from Mokolo Dam that will increase the capacity of the existing system.*
- *A new water transfer scheme from the Crocodile River (West) to the demand area at Steenbokpan, consisting of an abstraction weir at Vlieëpoort, High-lift pump station and balancing dams, rising main, gravity main and terminating in reservoirs at each of the water users.*
- *The two systems will be interconnected by a reversible west-to-east delivery system with tee-off points onto which the users will connect.*

- *The system will be operated as an integrated whole with pressure and flow control at the user terminal reservoirs to ensure operational efficiency and adequate reliability of supply.*
- *Possible future augmentation from the Klip River in the Vaal River Catchment into the Crocodile River (West) catchment, depending on the future (currently unknown) water requirements.*

The objective of this Feasibility Study is to determine the optimum solution for the timely supply of the required quantities of water to the various proposed developments in the Lephalale area.

Projected Water Requirements

The current major water users in the study area can be grouped as follows:

- *Urban domestic users: Lephalale/Onverwacht/Marapong/Thabo Mbeki;*
- *Scattered domestic users: 38 Villages north of the Lephalale River;*
- *Industrial users: Grootegeluk Mine (Exxaro) and Matimba Power Station (Eskom);*
- *Irrigation users: Mainly along the Mokolo-, Lephalale- and Limpopo Rivers; and*
- *Rural areas: Farm dwellers.*

The possible additional future water users can be grouped as follows:

- *Urban domestic users: Increase in population in existing towns;*
- *Scattered domestic users: Increase in population in existing villages; and*
- *Industrial users: Eskom's Medupi and additional coal fired power stations, Independent Power Producers (IPPs), Exxaro and other new coal mines, Sasol's Mafutha Plant.*

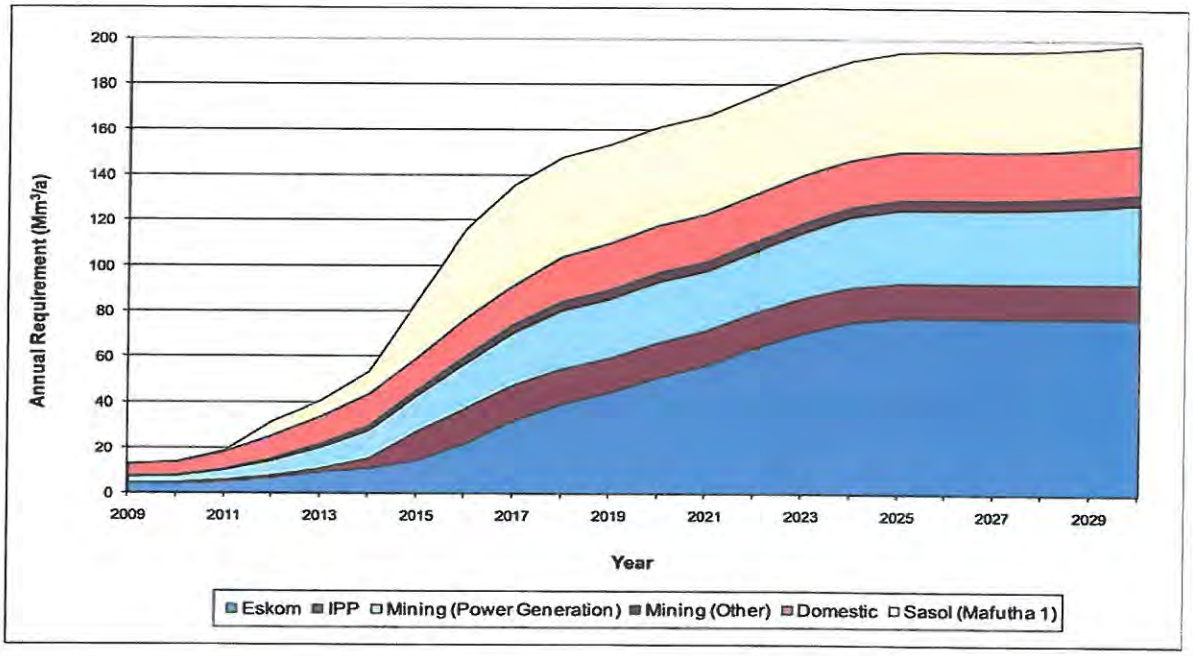
In February 2009, updated water requirements were released and a water requirements scenario (Scenario 9) was used for the Feasibility stage investigation. Scenario 9 incorporates the following water requirements:

- ***Eskom:** Matimba, Medupi plus four additional coal fired power stations (with flue gas desulphurisation (FGD) retrofit for Medupi scheduled for implementation with the first major maintenance shutdown).*
- ***Independent Power Producers (IPPs):** Equivalent of one (1) Eskom power station (starting in July 2010).*
- ***Exxaro:** Matimba coal supply, as well as implementation of projects A to K (expansion of existing and development of a new coal mine).*
- ***Additional coal mining:** Allowance for four (4) additional coal mines each supplying a power station.*
- ***Sasol:** Mafutha 1 Coal-to-Liquid fuel (CTL) plant and associated coal mine (starting in July 2011).*

- ***Lephalale and Steenbokpan:*** *Estimate based on projected growth in households for construction and permanent workforce.*

Scenario 9: Water Requirement Projection per Major User Group

	Annual Water Requirement (Million m³/a)									
Year	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2020**	**2025**	**2030**
Eskom	4.3	4.3	4.9	6.8	9.3	10.9	14.3	50.9	77.6	77.6
IPP's	0.0	0.4	0.9	0.9	1.5	4.4	13.2	15.6	15.6	15.6
Coal Mining	0.0	0.0	1.1	2.7	4.4	5.3	6.8	14.1	20.0	20.0
Exxaro Projects	3.0	3.2	3.7	4.7	6.6	9.2	10.8	16.9	16.2	19.2
Sasol (Mafutha 1)	0.0	0.0	0.4	6.1	6.6	9.9	25.2	43.5	43.5	44.0
Municipality	5.6	5.9	7.7	10.4	12.0	13.6	14.5	20.4	21.2	21.6
Total	**12.9**	**13.8**	**18.7**	**31.7**	**40.4**	**53.4**	**84.8**	**161.4**	**194.1**	**198.0**
Irrigation	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
Total + Irrigation	**23.3**	**24.2**	**29.1**	**42.1**	**50.8**	**63.8**	**95.2**	**171.8**	**204.5**	**208.4**



Scenario 9: Water Requirement Projection per Major User Group (excluding Irrigation)

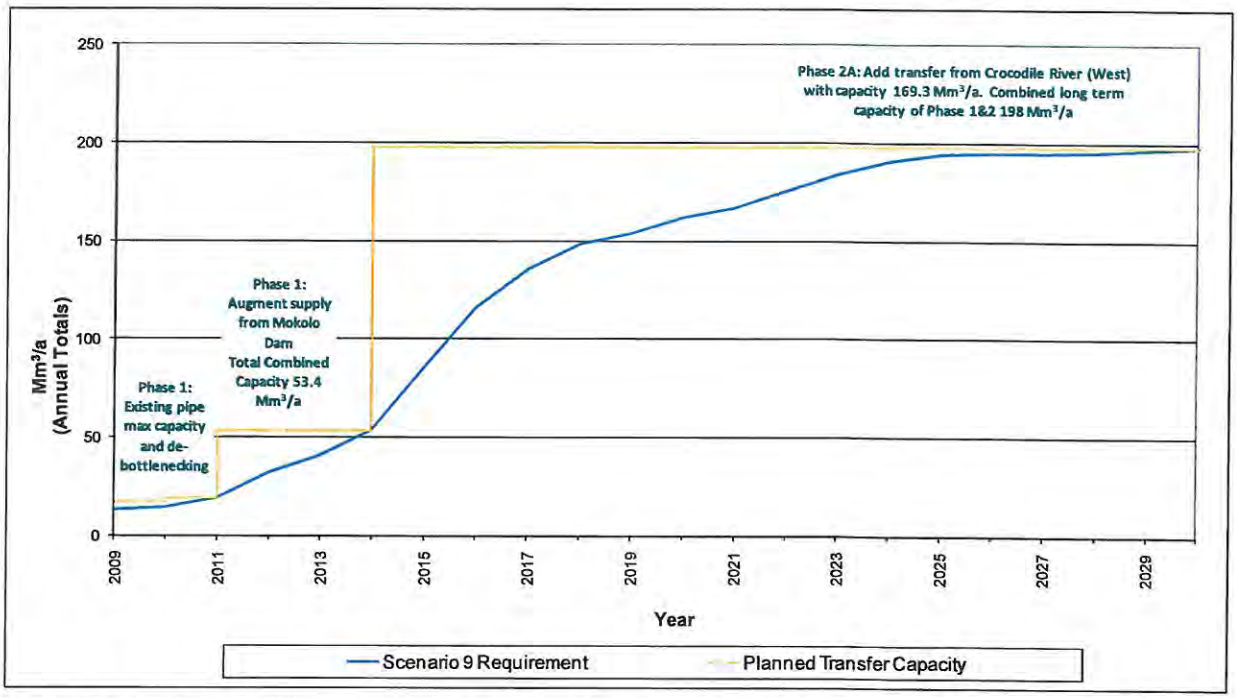
The water requirement scenarios were substantially updated (Scenarios 10a to 10d and 11) to accommodate changes in the implementation planning of the large users. The Feasibility Study was, however, concluded based on Scenario 9 to be in line with the original requirement of DWA. The impact of the changed scenarios were assessed and discussed jointly between the large users and the project team and it was agreed that the eventual design will be based on the final requirement.

Phases Identified

During the Pre-Feasibility Planning phase, it became apparent that a phased development approach is preferred due to the high cost of the development and uncertainty with regards to growth in the water requirements. The following development phases were subsequently defined:

- ***Phase 1*** *– Augment the supply of water from Mokolo Dam to meet the growing needs in Lephalale area.*
- ***Phase 2A*** *– Transfer water from the Crocodile River (West) to the larger Steenbokpan / Lephalale area to further augment the water supplies.*
- ***Phase 2B*** *– A future phase for increased supply from the Crocodile River (West) to the larger Steenbokpan / Lephalale area.*
- ***Phase 3*** *– River conveyance and river management.*
- ***Phase 4*** *– Transfer water from the Klip River to the Crocodile River (West) depending on the eventual water requirement, effluent flows and size of Phase 2B.*

Phases 2B, 3 and 4 are not reported in this study. The options developed, evaluated and reported on in this document only related to Phases 1 and 2A.



Mokolo and Crocodile River (West) Water Augmentation Project Combined Net Water Requirement and Planned Total Project Transfer Capacity and Implementation Phases

Aspects of Reliability and Redundancy

The strategic importance of the users that will account for the bulk of the water consumption requires that the risk of failure in the supply of water be kept to a minimum. Sufficient reliability and redundancy must therefore be provided in the combined Mokolo and Crocodile River (West) Water Augmentation Project.

It is not feasible or possible to provide absolute reliability, i.e. no risk of an interruption in the delivery of water from a scheme.

In this regard, the schemes shall be sized for 95% reliability, implying that water shall continue to be supplied without interruption even if the scheme is inoperative for up to

18 days of any one year, and the scheme capacity adjusted to allow the full annual requirements to be supplied in 347 days. Eighteen days storage capacity will be designed into the system to ensure that strategic customers will not be exposed to an unduly high risk of supply failure. The storage facilities must be provided by the end users and are therefore excluded from the project cost estimate.

Mokolo Dam Scheme

The following aspects were considered in defining the pipeline routes:

- *Abstraction and water supply locations;*
- *Existing roads, as well as boundaries between land owners along the routes;*
- *Historical and planned future mining activities in the area, both sub-surface and open cast;*
- *Site constraints, potential river/stream crossings, road and railway crossings;*
- *Geotechnical overview;*
- *Environmental impacts; and*
- *Social impacts.*

The water from the Mokolo Dam is of a much better quality than that from the Crocodile River (West). It was therefore necessary to design and operate the MCWAP system in such a way that the water from the two sources does not mix during normal operation.

The following two most viable options of transferring water from the Mokolo Dam to the end users during Phase 1 have been identified and investigated:

- *Construct a weir, abstraction works and a High-lift pump station downstream of Mokolo Dam, as well as a pipeline to deliver water to Zeeland, Matimba and Medupi Power Stations, as well as Steenbokpan; and*
- *Construct a pump station and new pipeline from Mokolo Dam to Zeeland, Matimba and Medupi Power Stations, as well as Steenbokpan.*

The Mokolo Dam pipeline option would follow a route parallel to that of the existing pipeline except for the section from Mokolo Dam to the Wolwenfontein Reservoir where the pipeline will follow the existing access road.

Crocodile River (West) Transfer Scheme

The same aspects that were considered for the Mokolo Dam Scheme were evaluated for the Crocodile River (West) Transfer Scheme. This scheme was also sized to allow for a downtime period of up to 18 days continuous per year.

The following infrastructure components were considered during the Pre-Feasibility assessment of the scheme:

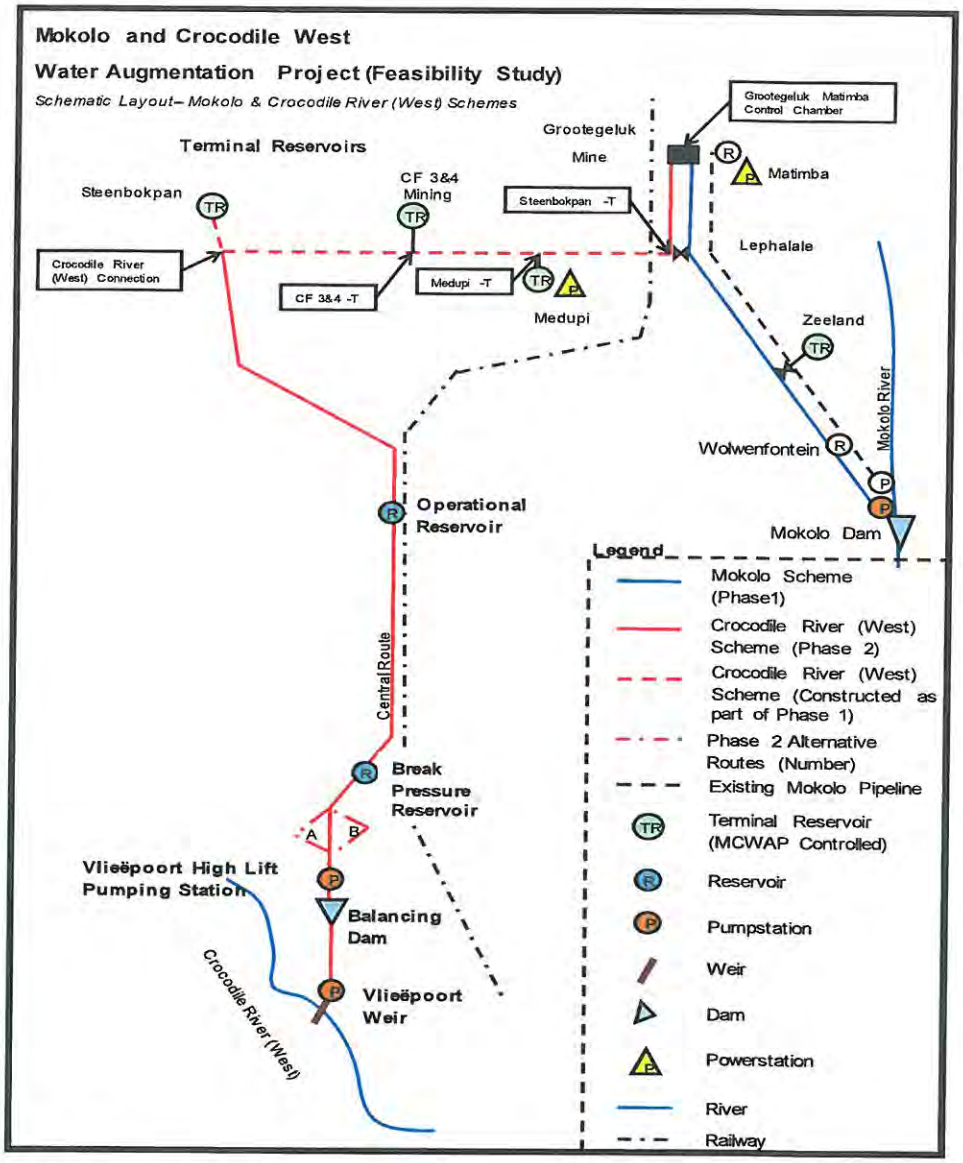
- *Abstraction Weir. Five sites along the Crocodile River (West) were investigated for appropriateness. Two sites along the Crocodile River (West) (Boschkop and Vlieëpoort) were selected and taken to Pre-Feasibility Study level. Components associated with the abstraction weirs included:*
  - *Abstraction Pump Stations;*
  - *Desilting Structures; and*
  - *Balancing Storage.*
- *High-lift pump stations.*
- *Conveyance options. The following conveyance options and alternatives were considered as part of the pre-feasibility investigation:*
  - *River conveyance;*
  - *Canal conveyance; and*
  - *Pipeline conveyance.*
- *A combination of reliability storage and balancing storage options were investigated.*

Options Selected

Based on these findings, the following was recommended for further consideration during the Feasibility stage of the project:

- ***Phase 1** – Mokolo Dam Scheme: Preferred option is a pipeline from Mokolo Dam to Lephalale and further to Steenbokpan.*
- ***Phase 2** – Abstraction at Vlieëpoort with a rising main along the Central Route to the position of the Operational Reservoir separating the rising main and gravity main portions of the Crocodile River (West) Transfer Scheme and providing short-term operational balancing storage. From here the water will be gravity fed into on-site Terminal Reservoirs (capacity 18 days + user balancing and emergency storage requirements) at each of the users.*
- ***Phase 3** (Not addressed in this report) – Requirements for the Sustainable Delivery of Water for the stretch of the river impacted by the project. Refer to report P RSA A000/00/8609. Defined as a possible pipeline from Boschkop to Vlieëpoort. This system works was included in the Phase 2 work.*

The preferred options for Phase 1 and Phase 2 are illustrated in the figure below.



Schematic Layout

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

The construction of major civil works and pipelines are listed activities in terms of the National Environmental Management Act 1998 (Act 107 of 1998), which may not commence without environmental authorisation from the competent authority. An environmental screening was conducted under the Feasibility Study to identify the potential environmental impacts of the project. These were reported and subsequently expanded upon in a full Environmental Impact Assessment conducted under a separate assignment of the Department of Water Affairs.

The study further assessed and quantified the most significant socio-economic impacts of the proposed project. The cost of mitigating the environmental and social impacts were determined and considered in the evaluation of alternatives.

OPERATION AND MAINTENANCE

The control and operation of all sites forming part of the MCWAP will be monitored and managed by means of a System Control and Data Acquisition (SCADA) system from a central control room manned on a 24 hour/day basis. The monitoring system must provide adequate planning, operational and costing reports to effectively manage, operate and maintain the system.

The maintenance philosophy must address mechanical, electrical and civil engineering aspects, categorised as follows:

- *Routine planned maintenance;*
- *Major Breakdown repairs; and*
- *Minor breakdown repairs.*

IMPLEMENTATION PROGRAMMES

The key project dates at the time of preparing the report (November 2009) are summarised below.

Project Key Dates

Item No.	DESCRIPTION	Anticipated Programme
1.	Topographical Survey	28 Sep 2009
2.	Detail Geotechnical Investigations P1	14 Aug 2009
3.	Detail Geotechnical Investigations P2A	7 Jun 2010
4.	Environmental Module	13 Sep 2010
5.	User Water Supply Agreements P1	09 Dec 2009
6.	User Supply Agreements P2A	12 June 2011
7.	Procure Engineering Services	31 July 2009
7.	Land Acquisition Phase 1	6 Dec 2010
8.	Land Acquisition Phase 2A	28 Jun 2011
9.	Award Contracts Phase 1	6 Dec 2010
10.	Award Contracts Phase 2A	9 Aug 2011
11.	Water Delivery Phase 1	3 Dec 2012
12.	Water Delivery Phase 2A	12 Aug 2015

MCWAP COST ESTIMATES

The cost estimates included the following:

- *Capital costs;*

- *Energy costs;*
- *Operation and maintenance costs;*
- *Raw water costs; and*
- *Other costs; including environmental, social, land acquisition, engineering design and implementation, etc.*

The costs listed above are summarised in the two tables below. The first table includes all the capital costs, and the second table includes all the operation and maintenance costs.

Mokolo and Crocodile River (West) Water Augmentation Project Capital Cost Estimate

	Component	***Total (R)***
	Mokolo Dam Scheme – Phase 1	
1.1	*Pump Station (Civil, Mechanical and Electrical Work)*	*135 575 000*
1.2	*Rising Main*	*86 540 000*
1.3	*Gravity Mains*	*1 232 642 000*
1.4	*Eskom Electricity to Site*	*76 430 000*
1.5	*Compensation*	*2 170 000*
1.6	*Environmental and Socio-economic*	*1 000 000*
	Sub Total	***1 534 357 000***
	Crocodile River (West) Transfer Scheme - Phase 2	
2.1	*Abstraction Weir, Low-Lift Pump Station, De-silting Works and Balancing Dam*	*898 687 000*
2.2	*High-lift pump station*	*350 544 000*
2.3	*Rising Main*	*1 263 545 000*
2.4	*Gravity Mains*	*4 932 732 000*
2.5	*Operational and Break Pressure Reservoir*	*118 964 000*
2.6	*Eskom electricity to Vlieëpoort site*	*156 564 000*
	Sub Total	***7 721 036 000***
	TOTAL COMBINED CAPITAL COST – MOKOLO AND CROCODILE RIVER (WEST) WATER AUGMENTATION PROJECT (Phases 1 and 2A)	***9 255 393 000***

Mokolo and Crocodile River (West) Water Augmentation Project Annual Operation and Maintenance Costs

	Component	Total (R)/a
	Mokolo Dam Scheme – Phase 1	
	New Phase 1 Works	
1.1	*Pump Station (Civil, Mechanical and Electrical)*	*16 734 000*
1.2	*Rising Main*	*376 000*
1.3	*Gravity Mains*	*5 359 000*
	Existing Exxaro Works	*394 000*
3.1	*Raw Water Costs*	*58 571 000*
	Sub Total	***81 434 000***
	Crocodile River (West) Scheme - Phase 2	
4.1	*Abstraction Weir, Low-Lift Pump Station, De-silting Works and Balancing Dam*	*20 366 000*
4.2	*High-lift pump station*	*81 750 000*
4.3	*Rising Main*	*3 018 000*
4.4	*Gravity Mains*	*11 848 000*
4.5	*Operational and Break pressure Reservoirs*	*308 000*
4.6	*Raw water costs*	*1 142 408 000*
	Sub Total	***1 239 332 000***
5	***Annual River Management Cost***	*4 500 000*
	TOTAL COMBINED ANNUAL O&M COST (2030) – MOKOLO AND CROCODILE RIVER (WEST) WATER AUGMENTATION PROJECT	***1 345 632 000***

Unit Reference Values

The Unit Reference Value (URV) of water has been determined for a discount rate of 6%, 8% and 10% and is based on the net water transferred to the demand centres for a 45-year period. The Unit Reference Values for the Mokolo and Crocodile River (West) Water Augmentation Project are summarised below. These figures exclude VAT, and are based on April 2008 prices. All discounting was done to 2008 and over a period of 45 years after completion of construction of Phase 2A. Residual values at the end of the period were excluded from the analyses.

Unit Reference Values

Discount Rate	*Discounted Present Value of Net Water @ R1/m³ (R)*	*Discounted Present Value (R)*	*Unit Reference Value (R/m³)*
6%	*2 020 000 000*	*20 462 103 000*	*10.14*
8%	*1 410 000 000*	*15 950 388 000*	*11.35*
10%	*1 020 000 000*	*13 029 165 000*	*12.72*

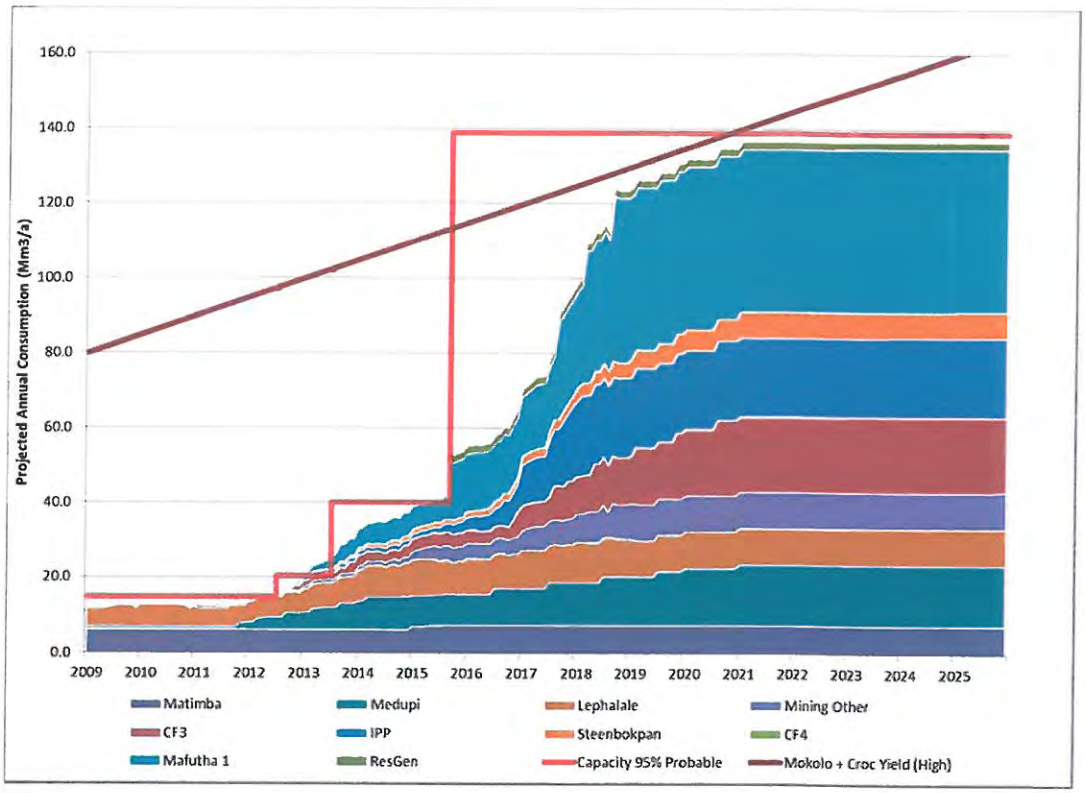
Summary of Discounted Present Values

Discount Rate	*Capital (R)*	*O&M (R)*	*Total (R/m³)*
6%	*7 726 136 000*	*12 733 903 000*	*20 460 039 000*
8%	*7 265 744 000*	*8 682 042 000*	*15 947 786 000*
10%	*6 844 128 000*	*6 181 959 000*	*13 026 087 000*

Changes under Development

Water Requirements for the projects were continually updated during the Feasibility Investigation period to accommodate changes in the planning of the large users. The Project Team decided late in 2009 to correct the requirements to Scenario 9 for the purpose of finalising the feasibility sizing, costing and reporting.

The Project Team, however, continued to assist in the preparation and evaluation of revised water requirement projects, as well as the interpretation of implementation constraints and costing. As such, Scenario 10 was developed and analysed to support the large users at the time in selecting the appropriate scheme capacity and with preparation of their board submissions. Scenario 11 was a further development that considered even further changes. The principles of sizing and costing the infrastructure options for the different scenarios were, however, kept constant throughout. The figure below illustrates the effect of the changed water requirements, i.e. combined scheme capacity reduced to 140 Mm³/a and Phase 2 implementation deferred to 2015.



Scenario 11 Water Requirement – Revised Estimate November 2009