REPORT NUMBER: P RSA 000/A00/18413

Department:
Water and Sanitation

Chief Directorate: Integrated Water Resource Planning
Directorate: Options Analysis

MOKOLO AND CROCODILE RIVER (WEST) WATER AUGMENTATION PROJECT (MCWAP)

POST FEASIBILITY BRIDGING STUDY

MCWAP 2A: REVIEW REPORT

August 2015

STRUCTURE OF THE TECHNICAL ASSESSMENT STUDY REPORTS

(The reports of the Environmental Impact Assessment process undertaken in parallel, are not shown below)

FEASIBILITY BRIDGING STAGE

Post Feasibility Bridging Study;
MCWAP-2A: Review Report
P RSA 000/A00/18413

FEASIBILITY STAGE

Main Report
MCWAP Feasibility Study
Technical Module Summary
P RSA A000/00/8109

- Supporting Report 8A
  Geotechnical Investigation Phase 1
  P RSA A000/00/8409
- Supporting Report 8B
  Geotechnical Investigation Phase 2
  P RSA A000/00/8709
- Supporting Report 9
  Topographical Surveys
  P RSA A000/00/8509
- Supporting Report 10
  Requirements for the Sustainable Delivery of Water
  P RSA A000/00/8609
- Supporting Report 11
  Phase 1 Feasibility Stage
  P RSA A000/00/8209
- Supporting Report 12
  Phase 2 Feasibility Stage
  P RSA A000/00/8309

PRE-FEASIBILITY STAGE

Main Report
MCWAP Feasibility Study
Technical Module Summary
P RSA A000/00/8109

- Supporting Report 5
  Mokolo River Development Options
  P RSA A000/00/9209
- Supporting Report 6
  Crocodile River Transfer Scheme Options
  P RSA A000/00/9309
- Supporting Report 7
  Social and Environmental Screening
  P RSA A000/00/9409
- Supporting Report 1
  Water Requirements
  P RSA A000/00/8809
- Supporting Report 2
  Water Resources
  P RSA A000/00/8909
- Supporting Report 3
  Guidelines for Preliminary Costing and Economic Evaluation of Development Options
  P RSA A000/00/9009
- Supporting Report 4
  Dam, Weir and River Engineering
  P RSA A000/00/9109

INCEPTION STAGE

Inception Report

P RSA A000/00/9609

LIST OF TECHNICAL ASSESSMENT REPORTS

(The reports of the Environmental Impact Assessment process undertaken in parallel, are not shown below)

REPORT NO	DESCRIPTION	REPORT NAME
POST FEASIBILITY BRIDGING STAGE		
P RSA 000/A00/18413	**Review Report**	**POST FEASIBILITY BRIDGING STUDY MCWAP 2A: REVIEW REPORT**
FEASIBILITY STAGE		
P RSA A000/00/8109	Main Report	MCWAP FEASIBILITY STUDY TECHNICAL MODULE SUMMARY REPORT
P RSA A000/00/8409	Supporting Report 8A	GEOTECHNICAL INVESTIGATIONS PHASE 1
P RSA A000/00/8709	Supporting Report 8B	GEOTECHNICAL INVESTIGATIONS PHASE 2
P RSA A000/00/8509	Supporting Report 9	TOPOGRAPHICAL SURVEY
P RSA A000/00/8609	Supporting Report 10	REQUIREMENTS FOR THE SUSTAINABLE DELIVERY OF WATER
P RSA A000/00/8209	Supporting Report 11	PHASE 1 FEASIBILITY STAGE
P RSA A000/00/8309	Supporting Report 12	PHASE 2 FEASIBILITY STAGE
PRE-FEASIBILITY STAGE		
P RSA A000/00/8809	Supporting Report 1	WATER REQUIREMENTS
P RSA A000/00/8909	Supporting Report 2	WATER RESOURCES
P RSA A000/00/9009	Supporting Report 3	GUIDELINES FOR PRELIMINARY SIZING, COSTING AND ECONOMIC EVALUATION OF DEVELOPMENT OPTIONS
P RSA A000/00/9109	Supporting Report 4	DAM, ABSTRACTION WEIRS AND RIVER WORKS
P RSA A000/00/9209	Supporting Report 5	MOKOLO RIVER DEVELOPMENT OPTIONS
P RSA A000/00/9309	Supporting Report 6	WATER TRANSFER SCHEME OPTIONS
P RSA A000/00/9409	Supporting Report 7	SOCIAL AND ENVIRONMENTAL SCREENING
INCEPTION STAGE		
P RSA A000/00/9609	Inception	INCEPTION REPORT

REFERENCE

This report is to be referred to in bibliographies as:

Department: Water and Sanitation, South Africa, 2013. Mokolo and Crocodile River (West) Water Augmentation Project (MCWAP), Post Feasibility Bridging Study: Phase 2A - Review Report. Prepared by Mokolo Crocodile Consultants Joint Venture (TCTA PSP).

DWS Report No. P RSA 000/A00/18413

Project Name:	*MOKOLO AND CROCODILE RIVER (WEST) WATER AUGMENTATION PROJECT; POST FEASIBILITY BRIDGING STUDY*
Title:	*MCWAP 2A - REVIEW REPORT*
Authors:	*Paul le Roux & Dawid van Coller*
DWSF Report No:	*P RSA 000/A00/18413*
Status of Report:	*Final*
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Preface

The Mokolo and Crocodile River Water Augmentation Project (MCWAP) has been approved as a Government Waterwork. It is a key project to unlock the mineral wealth in the Waterberg as envisaged in the Strategic Integrated Project 1 (SIP1) by the Presidential Infrastructure Coordinating Commission (PICC).

There are a number of planned and anticipated consequential developments in the Lephalale area associated with the rich coal reserves in the Waterberg coal field for which additional water will be required. These developments include inter alia further coal fired power stations by Eskom and others, the associated coal mining and industrial activities, coal mining for Eskom in Mpumalanga, coal mining for export and the associated residential development.

The development of new power stations is of high strategic importance with tight timeframes. The first of the generation units at Medupi (Unit 6) was commissioned in 2015. Coal supply to Eskom in Mpumalanga was due to commence in 2017 and rail capacity for coal export is expected to be available from 2020.

The Mokolo (Mogol) River catchment is part of the Limpopo Water Management Area (WMA). The Mokolo River originates close to Modimolle (Nylstroom) and then drains to the north into the Limpopo River. The Mokolo Dam (formerly known as the Hans Strijdom Dam) is the largest dam in the catchment. The dam was constructed in the late 1970s and completed in July 1980, to supply water to Matimba Power Station, Grootegeluk Mine, Lephalale (Ellisras) Municipality and for irrigation downstream of the dam.

The Department Water and Sanitation commissioned the Mokolo and Crocodile River (West) Water Augmentation Project (MCWAP) to analyse the options for augmenting water supply. The Technical Module of this study was completed in 2010 by Africon in association with Kwezi V3, Vela VKE and specialists. The focus of the Technical Module was to investigate the feasibility of options to:

- Augment the supply from Mokolo Dam (Phase 1 (MCWAP-1)) to supply in the growing water use requirement for the interim period until a transfer pipeline from the Crocodile River (West) can be implemented, and over the long term to optimally utilise the full yield from Mokolo Dam; and
- Transfer water from the Crocodile River (West) to the Steenbokpan and Lephalale areas (Phase 2 (MCWAP-2)).

Refer to the map below indicating the study area.

The Trans Caledon Tunnel Authority (TCTA) was subsequently instructed by the then Minister of Water and Environmental Affairs to implement MCWAP. A directive was issued on 19 May 2010. However, due to significant changes occurring in the energy planning environment and their related water demand figures compared to the demand scenarios considered during the 2010 feasibility study, the implementation of MCWAP-2 was placed on hold. This was informed by the Department of Energy's Integrated Resource Plan (IRP 2010) published in March 2011 (updated in November 2013) which redefined the country's future electric power supply energy mix and also Sasol's decision to cancel their plans for developing a coal to liquid fuel facility called Project Mafutha.

In order to address the impact of the reduced water demand from the revised energy planning process, DWS initiated a bridging study to review and update the feasibility study findings on water requirements and the transfer capacity for MCWAP-2. The important development principles that have been formulated in the feasibility study reports, remains relevant. These documents outline the design, construction and operation approach for the MCWAP. This bridging study has a limited scope only aimed at redefining the capacity required for MCWAP-2A and an indicative implementation timeframe.

This report (MCWAP-2 Review Report) covers the following:

- **Updated water demand projections;**
- **Review of latest integrated system yield analysis;**
- **Review of water transfer system capacity including options analysis; and**
- **Updated Life Cycle Costs Analysis.**

The planning horizon of the initial water requirement investigation in this bridging study was 2050. The phased development option analysis favoured a phase 2A capacity of 80 million m^3/a followed by a future parallel phase 2B capacity of 30 million m^3/a. Post the essential completion of the bridging study report in December 2013, it became clear during the initial water supply agreement discussions that the users' potential commitment was limited to a transfer scheme with a capacity of 100 million m^3/a. This was based on a planning horizon of 2040 plus long term commitment beyond 2040 confirmed at that stage. National Treasury facilitated discussions involving officials of TCTA, DWS, DOE, National Treasury, DMR, NERSA and DPE on how the off take should be funded. There were concerns about uncertainties of the integrated energy resource plan beyond 2035. The effective planning horizon then moved to 2035 which limited the phase 2A capacity to 75 million m^3/a. This specifically excludes provision for Coal 4 power station which had been scheduled in the development scenarios for commissioning after 2035.

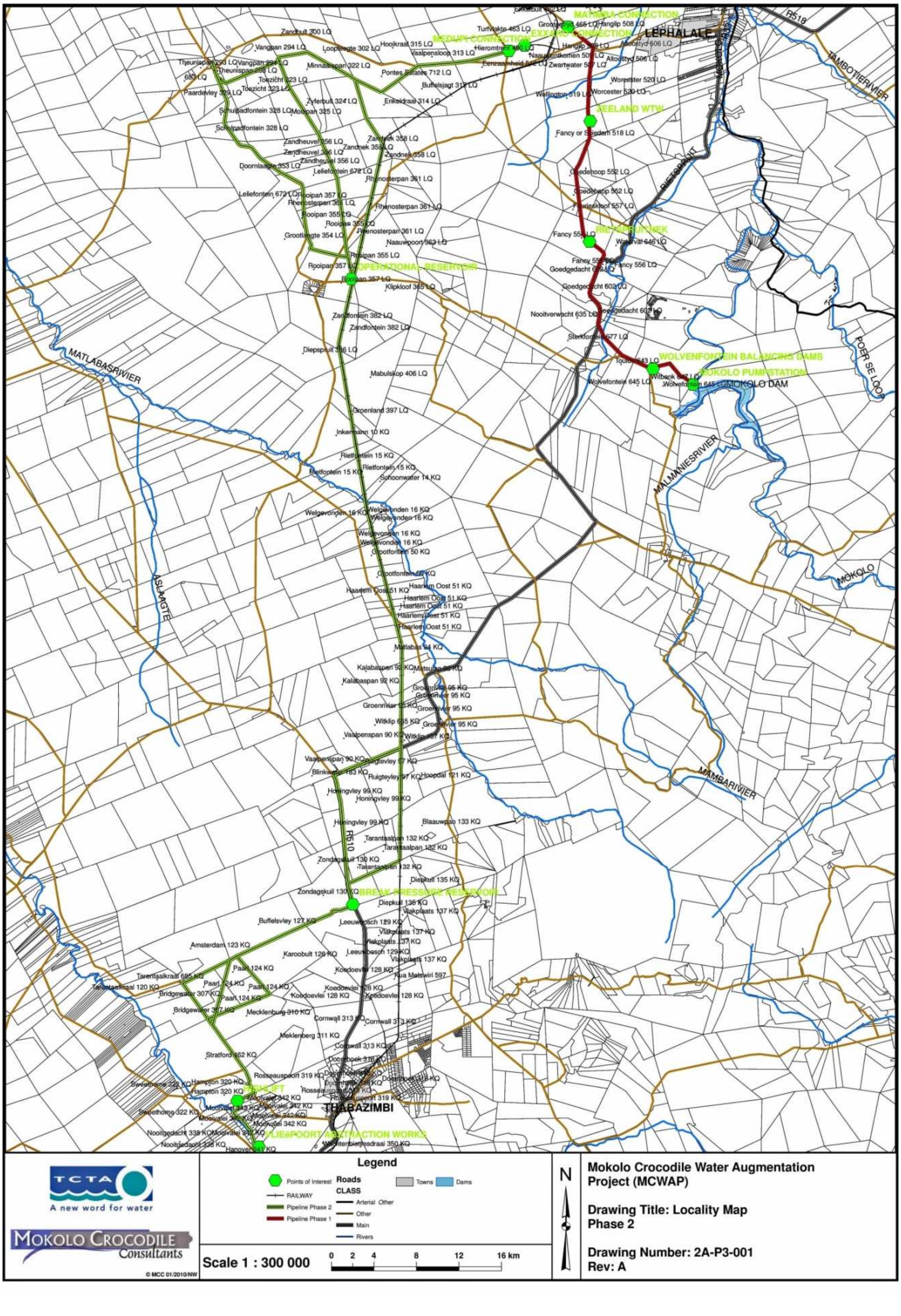
The executive summary and final recommendations in this report were adjusted to:

a) Align it with the strategic position that National Treasury and other key authorities supported and reflect the impact;
b) Record the process of recommending the transfer capacity of MCWAP 2A; and
c) Provide the implementation process with the latest indicative development time frames.

The dynamic and challenging project implementation environment is reflected by the following:

a) Water and energy long term planning horizons are not aligned and this creates project implementation funding challenges (20 year planning horizon is insufficient for a 20 year funding commitment);
b) The changed energy planning process is causing an estimated delay of more than three years to the original targeted MCWAP-2A water delivery date;
c) The projected MCWAP water demand will change with time. The rapid growth rate expected initially is probably going to be spread over a longer period; and
d) The uncertain environment will probably impact negatively on the project implementation cost and the funding of the project.

A key success factor in the implementation of MCWAP is the ability to adapt in a dynamic and uncertain environment. It will challenge the leadership of the PICC and SIP 1 to facilitate an integrated implementation environment. Despite the reality of the major challenges listed above, DWS remains committed and focused on achieving the national strategic objective to unlock the Northern Mineral Belt with Waterberg coalfield as the Catalyst.



MOKOLO AND CROCODILE RIVER (WEST) WATER AUGMENTATION PROJECT

POST FEASIBILITY BRIDGING STUDY:

MCWAP-2A: REVIEW REPORT

EXECUTIVE SUMMARY

1. Study Background

When DWS concluded the feasibility study for the MCWAP in September 2010, a phased implementation approach for the complete project was defined to increase the supply as the future water requirements grow due to the envisaged developments of the Waterberg coal fields. The feasibility study was analysed on the basis of two additional large power stations besides Matimba and Medupi, provision for Independent Power Producers with capacity equivalent to one large power station, coal supply to these power stations, coal production to supply other markets, Sasol's Mafutha 1, Coal to Liquid fuel (CTL) project, and associated urban development (referred to as Scenario 9 in the feasibility study reports). It was anticipated that all these developments would be operational by 2030. The Executive Summary of the MCWAP Feasibility Study: Technical Module: Main Report (P RSA A000/00/8109) should be read in conjunction as it outlines the feasibility study approach, findings and recommendations.

However, due to the Department of Energy's Integrated Resource Plan (IRP 2010) published in 2011 (subsequently updated in November 2013) that redefined the country's future energy mix, and also Sasol's decision to cancel their plans for developing Mafutha, the envisaged future water demands were significantly reduced and delayed compared to the demand scenarios considered during the 2010 DWS feasibility study. The indication at the time was that the combined MCWAP average annual demand could potentially be reduced by 44% from 197 million m^3/a to 110 million m^3/a.

DWS consequently requested the Trans Caledon Tunnel Authority (TCTA) to review the water demands for the MCWAP. This is the study being reported on. This bridging study involves an assessment of the current and future water demands of the key rural, urban and industrial development areas in the Lephalale area and a review of the required transfer capacity of MCWAP-2A. The assessment is based on data gathered from all known planned and anticipated developments associated with the rich coal reserves in the Waterberg coal field, for which additional water will be required.

The basic approach to review the current and future water requirements and to assess the impact on the bulk water infrastructure planning included the following:

- *Identification and consultation of stakeholders within all sectors of water use, particularly urban, rural, power generation and mining water supply was accorded specific consideration. Separate supporting tasks have investigated the Reserve, irrigation and* *groundwater requirements, which have not been included in this study, as those are not relevant to the transfer infrastructure sizing;*

- *The above consultations facilitated an information and data collection process;*
- *The review and assessment of the reliability of the sources and the accuracy of the data;*
- *The presentation of various projected integrated water requirements as scenarios;*
- *The review of the assurance of supply;*
- *The presentation of the required capacities of the planned water transfer infrastructure as options; and*
- *Recommendations taking risk into account.*

2. Update of Water Requirement Projections

Based on survey questionnaires and follow up discussions with potential users, various water requirement scenarios were constructed. Table A indicates the water requirement scenarios that were considered during the bridging study. The feasibility water requirement Scenario 9 was adjusted using this water requirement survey process.

Table A: Water Requirement Scenarios

Water Requirement Scenario	Description
A	Full development of all projects starting 2019. (Matimba stop 2040)
B1	Same as A except that rural water was removed
B2	Same as B1 except that the iron ore mine was removed
C1	Same as B1 except that Matimba continues till 2050
C2	Same as C1 except that the iron ore mine was removed
C3	Same as C2 except that CFP- 4 and its mines were removed
C4	Same as C2 with minor adjustments done following users review
C5	Same as C4 except that CFP- 4 was started 10 years earlier (2026)
C6	Same as C4 except that CFP- 4 was delayed by 10 years (2046)
D1	Same as C4 but full development of projects delayed to 2022 and Mpumalanga coal exports delayed to 2025

The number of and variations in the water requirement scenarios reflects a highly dynamic planning environment. The fundamental drivers determining the scope of potential development changed in 2010 as indicated above. After this the scope of potential development was also impacted by the alignment of planning horizons. The impact of this alignment is best described by the water requirement scenarios prior and post December 2013. Water requirement Scenario C4 provides a realistic perspective prior to December 2013 and Scenario D1 provides the perspective beyond the scope timeline adjustment.

DWS applies a 45-year life cycle planning and design approach. Based on this the planning horizon of the MCWAP Feasibility is 2050. The power generation sector's planning horizon is only up to 2030 as reflected in the updated IRP 2010. This bridging study consulted with Eskom *regarding planned power generation beyond 2030. With time it became clear that the industry was not really in a position to commit to development beyond 2040. The uncertainty regarding the development of CFP-4 makes it even more risky to plan beyond 2035.*

For the purpose of concluding the bridging study in this uncertain development environment, the water requirements as reflected in Scenarios C4 and D1 best reflects the potential based on the integration of all available information.

The total MCWAP water demand associated with the full development up to 2050 is represented as Scenario C4 and shown in Figure A and Table B below. This reflects the planning situation until December 2013.

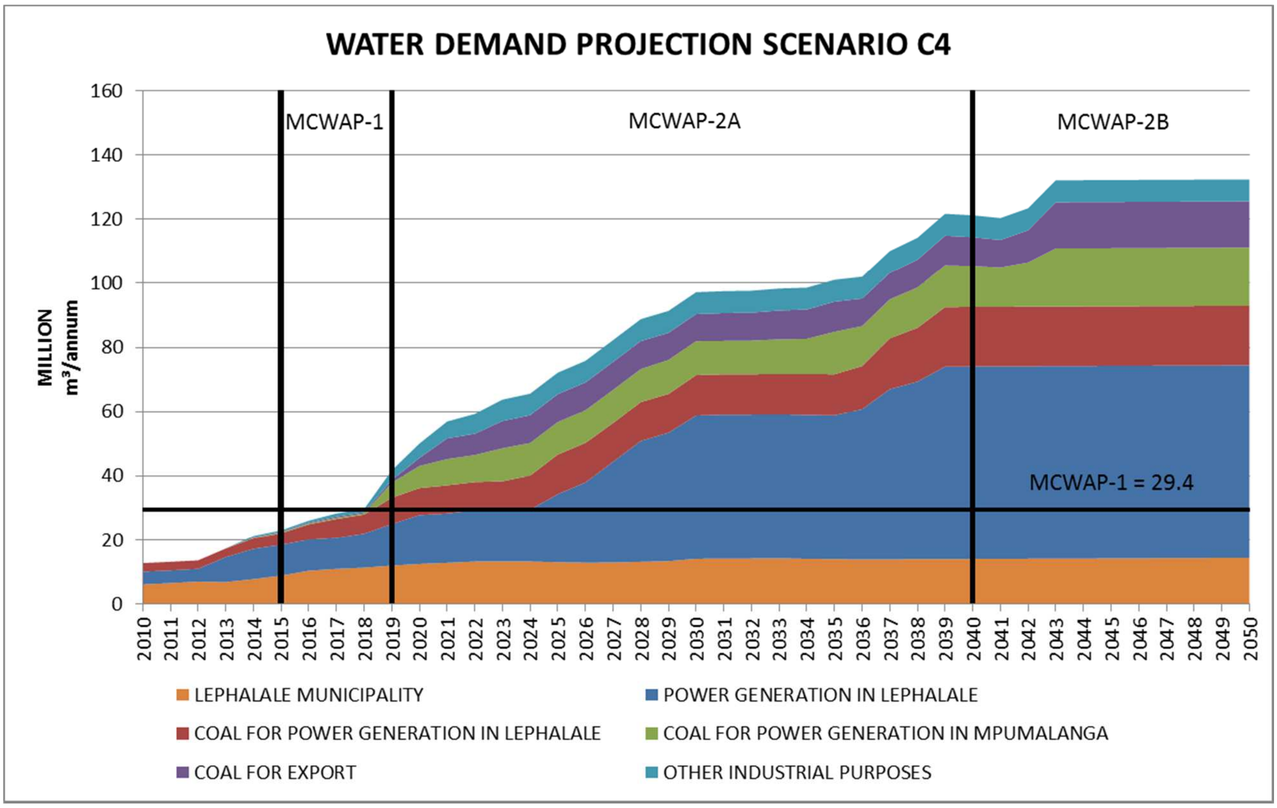


Figure A: Water Requirement Curve Sector Breakdown

Table B: Combined Total water requirement projection for Scenario C4 (million m^3/a)

USER	2020	2025	2030	2035	2040	2045	2050
Strategic Industries: Power generation in Waterberg Coal Fields:							
Power stations:	*15,30*	*21,29*	*44,75*	*44,92*	*60,05*	*60,05*	*60,05*
Strategic Industries: Mining for power generation:							
Support power generation in the Waterberg Coal Fields:							
Total	*8,44*	*12,35*	*12,54*	*12,74*	*18,54*	*18,54*	*18,54*
Support power generation in Mpumalanga:							
Total	*6,88*	*10,12*	*10,58*	*13,23*	*12,83*	*18,23*	*18,23*

USER	2020	2025	2030	2035	2040	2045	2050
Industrial / Mining for other purposes:							
Production for coal export:							
Total	*2,53*	*8,67*	*8,43*	*9,39*	*8,99*	*14,39*	*14,39*
Other industrial purposes:							
Total	*4,46*	*6,70*	*6,83*	*6,83*	*6,83*	*6,83*	*6,83*
Urban use by Lephalale Municipality:							
Municipality	*12,47*	*13,02*	*14,08*	*13,97*	*14,02*	*14,20*	*14,39*
Incidental Users:							
Total	*0,40*	*0,40*	*0,40*	*0,40*	*0,40*	*0,40*	*0,40*
Total Demand	***50,48***	***72,55***	***97,61***	***101,48***	***121,66***	***132,64***	***132,83***
MCWAP 1	***29.40***	***29.40***	***29.40***	***29.40***	***29.40***	***29.40***	***29.40***
MCWAP 2	***21.08***	***43.15***	***68.21***	***72.08***	***92.26***	***103.24***	***103,43***

After December 2013 the water requirement Scenario C4 was further adjusted to reflect the reduced growth rate and delayed projects start-up.

The revised total MCWAP water demand associated with the full development up to 2050 is represented as Scenario D1 and shown in Figure B and Table C below. This reflects the updated planning situation up to August 2015. The purpose of this updated water demand projection is to facilitate the project implementation planning.

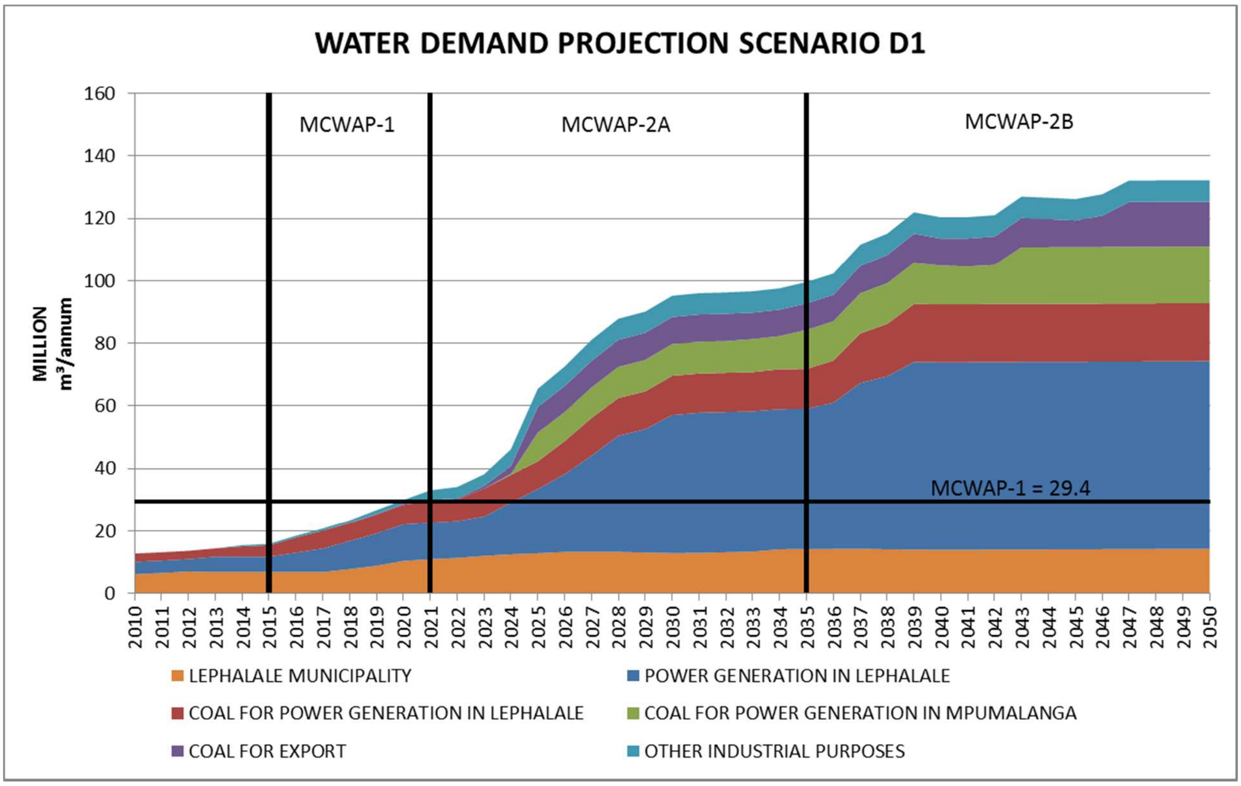


Figure B: Water Requirement Curve Sector Breakdown

Table C: Combined Total water requirement projection for Scenario D1 (million m³/a)

USER	2020	2025	2030	2035	2040	2045	2050
Strategic Industries: Power generation in Waterberg Coal Fields:							
Power stations:	*11,72*	*20,64*	*44,22*	*44,92*	*60,05*	*60,05*	*60,05*
Strategic Industries: Mining for power generation:							
Support power generation in the Waterberg Coal Fields:							
Total	*6,38*	*8,87*	*12,54*	*12,74*	*18,54*	*18,54*	*18,54*
Support power generation in Mpumalanga:							
Total	*0,00*	*9,17*	*10,12*	*12,48*	*12,43*	*18,23*	*18,23*
Industrial / Mining for other purposes:							
Production for coal export:							
Total	*0,29*	*8,20*	*8,67*	*8,48*	*8,69*	*8,54*	*14,39*
Other industrial purposes:							
Total	*1,18*	*5,78*	*6,78*	*6,83*	*6,83*	*6,83*	*6,83*
Urban use by Lephalale Municipality:							
Municipality	*10,35*	*12,81*	*12,88*	*14,15*	*13,88*	*14,05*	*14,24*
Incidental Users:							
Total	*0,40*	*0,40*	*0,40*	*0,40*	*0,40*	*0,40*	*0,40*
Total Demand	***30,32***	***65,87***	***95,59***	***100,00***	***120,82***	***126.64***	***132,68***
MCWAP 1	***29,40***	***29,40***	***29,40***	***29,40***	***29,40***	***29,40***	***29,40***
MCWAP 2	***0,92***	***36,47***	***66,19***	***70,60***	***91,42***	***97,24***	***103,28***

3. Review of Latest Integrated River System Yield Analysis (Assurance of Supply)

The maximum water supply allocation from the Mokolo River has been made based on a differentiated assurance of supply from the existing river system. The total water allocation from MCWAP-1 is 29,4 million m³/a. The initial indication was that the related water demand would exceed the allocation from the available Mokolo River system yield by 2019 by which time MCWAP-2A should have been operational. Taking into account the reduced rate of development and project delays, it is currently projected that water demand would probably exceed the allocation from the available Mokolo River system yield by 2021. This is a fundamental driver for the implementation and water delivery of MCWAP-2A.

The water resources study entitled "Development of a Reconciliation Strategy for the Crocodile West Water Supply System" (CRSS) which was completed in 2009, assessed the availability of surplus water at the proposed MCWAP-2 abstraction works at Vlieëpoort, after the water needs within the Crocodile River catchment have been accounted for. This is being reviewed on an ongoing basis by the DWS in cooperation with institutions in the water sector that are represented on the Strategy Steering Committee (SSC) by national and provincial government departments, municipalities, water service providers, industry, agriculture as well as Non-Governmental Organisations.

After the completion of the MCWAP-2 Feasibility Report, the availability of surplus water in the Crocodile River (West) System has been reviewed twice. It is thus concluded from Figure C below that there is sufficient surplus water available, after the water needs within the Crocodile River catchment have been accounted for, to supply the full development potential in the Lephalale area inclusive of a potential fourth coal fired power station.

For the purpose of this bridging study, the surplus water supply risk is deemed to be manageable. It remains imperative that the proposed Crocodile River (West) river management system be successfully implemented 18 months before the targeted water delivery date for MCWAP-2A to assist with the surplus water conveyance management process. Securing of access to the future growing surplus water source remains the responsibility of DWS.

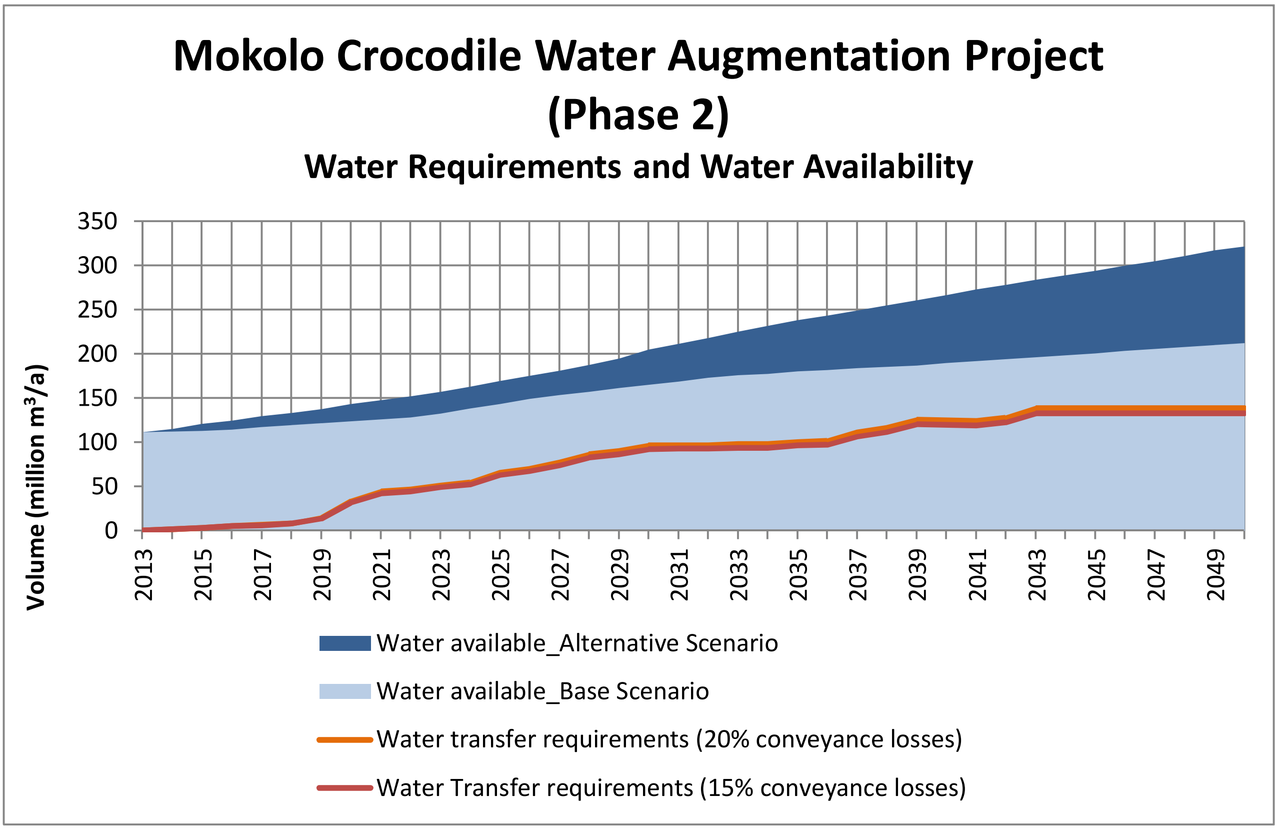


Figure C: MCWAP-2 Water Transfer Requirements vs Surplus Water Available

4. Review of Water Transfer Scheme Capacity including Options Analysis

In light of the available water requirement projections up to December 2013, the revised IRP 2010 and potential commitment by users, it became clear that the required MCWAP-2A transfer capacity is expected to vary between 50 million m³/a and 100 million m³/a. However, during the early stages of the bridging study, water transfer options for MCWAP-2A were investigated varying from 50 million m³/a to 110 million m³/a in 5 million m³/a increments. The purpose of this was to exhibit the sensitivity of the relative construction and life cycle costs to variation of the MCWAP-2 transfer system capacity.

The following bulk water infrastructure options were initially investigated for MCWAP-2A:

- *Option V: Construct only 80 million m³/a capacity and re-assess the requirements in future;*
- *Option W: Construct only 95 million m³/a capacity and re-assess the requirements in future;*
- *Option X: Construct full 110 million m³/a capacity from the start (2019);*
- *Option Y: Construct 80 million m³/a capacity in 2019 supplemented by 30 million m³/a in 2036; and*
- *Option Z: Construct 80 million m³/a capacity in 2019 supplemented by 80 million m³/a in 2036.*

*After the development of the initial 5 options further refinement of the water requirement projections indicated that the preferred MCWAP-2A capacity is 100 million m^3/a. Option X** was introduced targeting a MCWAP-2A capacity of 100 million m^3/a. The probability of having to do further future phased capacity development is regarded to be small.*

The option analysis further investigated the impact of:

- *Applying the principle of economy of scale; and*
- *Applying a phased approach due to development and operational risk constraints.*

*After December 2013 and the alignment of the planning horizons Option Y** was then developed to check the relative additional cost of the phased approach compared to Option X**. The probability of having to do further future phased capacity development is higher.*

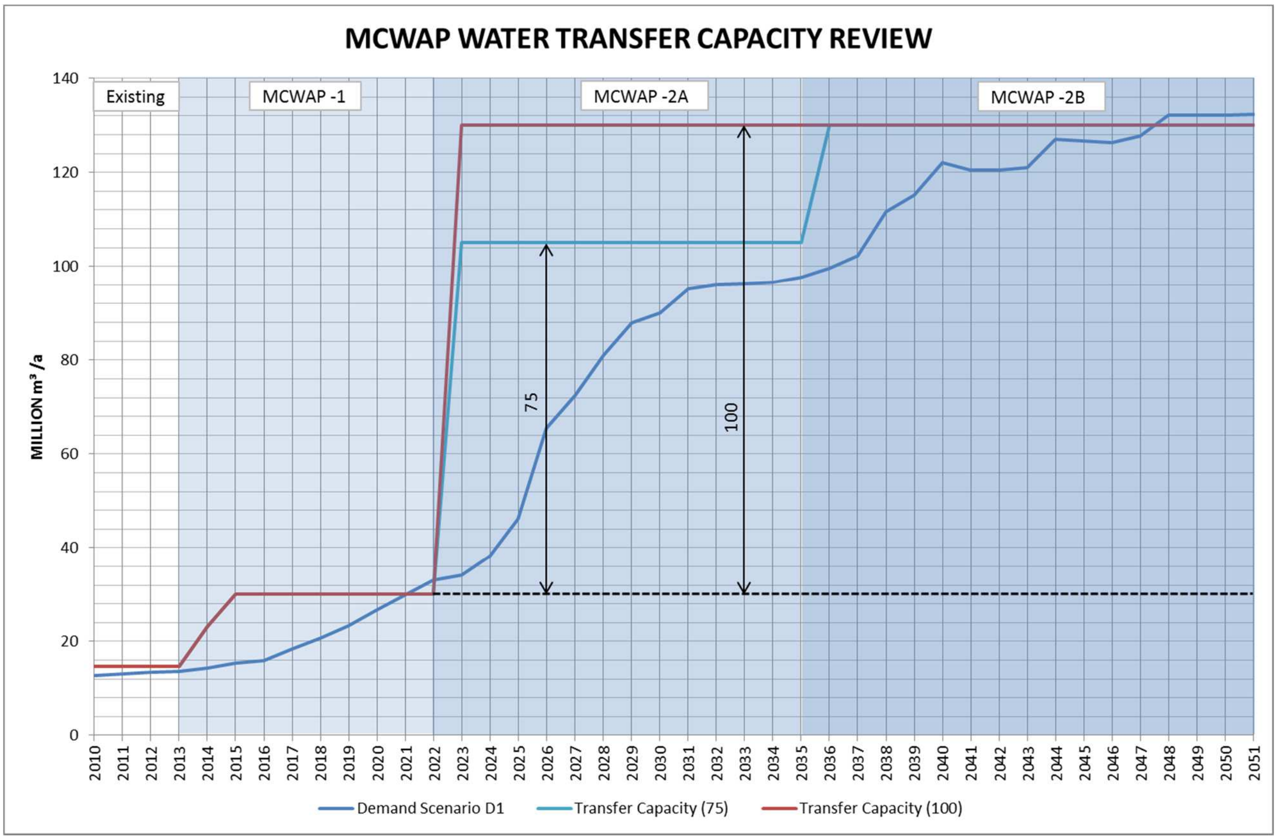


Figure D: MCWAP-2 Water Demand vs Transfer System Capacity

*Figure D above indicated the potential phased development of the system capacity. Option Y** was introduced targeting an initial MCWAP-2A capacity of 75 million m^3/a (nominal).*

*Option V** was also introduced indicating the situation if CFP-4 and its associated mines are not developed.*

5. Updated Life Cycle Cost Analysis

The construction cost estimates have a base date of April 2012 and were based on the planning costing model used for the MCWAP feasibility study.

A summary of the construction cost estimates for each of the Options are summarised in Table D below. The comparison was made relative to Option X, the long term fully developed scenario up to 2050.

Table D: Estimated Construction Cost Comparison

Option	System Capacity million m^3/a	Construction cost R million	% Difference to Option X	Coal 4 start first unit
V**	75	6 014	-11%	
V	80	6 140	-9%	
W	95	6 496	-4%	
X**	100	6 591	-3%	
X	110	6 779	0%	2036
Y	80+30	8 931	+32%	2036
Y**	75+25	8 639	+27%	2036
Z	80+80	10 446	+54%	2036

The present value (PV) of the estimated life cycle cost of the phased options was used to compare the phased approaches for the economy of scale singly system development approach. Discount rates of 4, 6 and 8% per annum were applied and a design life of 45 years was assumed. The life cycle costs include the construction costs, operational costs, maintenance costs and energy costs. It is expected that given the slow rate of recovery and the international economy, the average discount rate would be varying between 4% and 6% for the largest part of the 45-year design life. ***Please note that the Options are not directly comparable due to the system capacity differences****.*

*Options X**, Y** and V** are regarded to present the more realistic perspectives. The life cycle costs are summarised in Table E.*

Table E: Post 2013: Present Value Life Cycle Cost Comparison

Option	System Capacity Million m^3/a	PV Life Cycle Cost (4%) R million	% Difference to Option X**	PV Life Cycle Cost (6%) R million	% Difference to Option X**	PV Life Cycle Cost (8%) R million	% Difference to Option X**
V**	75	5 609	-6%	4 723	-6%	4 045	-6%
X**	100	5 968	N/A	5 011	N/A	4 284	N/A
Y**	75+25	6 902	16%	5 572	11%	4 611	8%

*After December 2013 the above option analysis that the phased implementation of MCWAP-2A (Option Y** and Option X**) can be expected to up to 18% more expensive (in terms of present value life cycle cost and URV). The revised URV's for the three most relevant options are summarised in Table F below.*

Table F: Revised Option URV Comparison

Option	URV (4%) over 45 years R/m^3	% Difference to Option X**	URV (6%) over 45 years R/m^3	% Difference to Option X**	URV (8%) over 45 years R/m^3	% Difference to Option X**
V**	7.03	9%	9.57	8%	12.76	7%
X**	6.44	N/A	8.85	N/A	11.90	N/A
Y**	7.57	18%	10.09	14%	13.25	11%

6. Conclusion

6.1. Integrated Planning Environment

When Sasol decided in 2010 not to proceed with the Mafutha Project the water requirement from MCWAP-2 reduced significantly. Parallel to this the planning uncertainties in the power generation sector and delays in the commissioning of the Medupi power station created a very complex water requirement planning environment. The bulk water planning requires the integration of the very dynamic and also largely confidential planning processes of power generation and associated coal mining. The review of the water requirements in this highly dynamic environment required that water requirement projections had to be adjusted continuously during the review process. For this reason the report reflects various stages of the extremely dynamic process.

6.2. Initial Conclusions before December 2013

Although the projected MCWAP water demand is reduced significantly from the initial feasibility study, the anticipated growth remains exceptionally steep between 2019 and 2031. This coincides with the Flue Gas Desulphurisation (FGD) retrofitting at Medupi and Matimba, the development of a third coal fired power station and associated mines and infrastructure, as well as coal supplies to existing power stations in Mpumalanga. The water demand to which users can potentially *commit financially does not general extend beyond 2040. The exception was Eskom's undertaking to commit to procure water for coal production for use in Mpumalanga.*

It was concluded that the total required system transfer capacity for MCWAP-2 until 2040 is hence likely in the range of 80 to 100 million m³/a. Should no decision be made to provide capacity in MCWAP-2 for CFP-4, the MCWAP-2 capacity was proposed to be 80 million m³/a. Should provision be made for CFP-4 for commissioning by 2036, the MCWAP-2A capacity was proposed to be 100 million m³/a. Until December 2013 it was concluded that Option X in this report was the most economical solution based on economy of scale considerations.

6.3. Conclusions post December 2013

*Following the refinement of the water requirement Scenario C4 to Scenario D1 and the refinement of Bulk Water Infrastructure Options V, X and Y to V**, X** and Y** respectively, it set the scene to use phased development to mitigate the uncertainty associated with the possible long-term development of CFP-4 or not. From this process it is concluded that:*

*a) Implementation Option X** (100 million m³/a) is the most cost efficient long-term solution. Option Y** (75+25 million m³/a) is 31% more expensive from a construction cost point of view;*

*b) The phased implementation of MCWAP-2A (Option Y** vs Option X**) can be expected to be between 18% and 11% more expensive (in terms of URV based on discount rates of 4% and 8% respectively);*

*c) Based on the present value analysis the implementation Option X** (100 million m³/a) is 6% more expensive than Option V** (75 million m³/a), but it effectively offers a saving of between 8% and 16% in the long term;*

d) Based on the fact that the user water requirement projection input was obtained in 2012, the planning time frames are already out dated and the accuracy of the location and water demand assumptions are losing relevance;

*e) The misalignment of the planning horizons (2030 for electricity vs 2050 for water) impacted significantly on the planning process. The Department of Energy and National Treasury are only willing to support the integrated planning process up to 2035. It effectively includes allowance for the development of CFP3 but excludes any allowance for the development of CFP 4 and the associated mining activities. The refined review process after December 2013 reflects the impact of this situation. Exclusion or postponement of CFP4 favours Option Y** (75 + 25 million m³/a). It also holds the benefit that a decision on the timing and size of the future sub-phase can be postponed until there is more certainty about developments in the long term;*

f) Based on the latest adjusted water demand projection (Scenario D1), the MCWAP-2A is required to deliver water by December 2021; and

g) Based on the recommendation in the Feasibility Study that the Crocodile River (West) river management system must be operational 18 months before the MCWAP-2A water delivery date, the river management system needs to be operational by June 2019.

6.4. General Conclusions

The following general conclusions are relevant:

- *The relevant rural communities can potentially be more economically supplied from local ground water sources until 2030. The MCWAP-2A water tariff is regarded to be significantly more expensive compared to other potential sources. Furthermore, water will be available only much later from MCWAP-2;*
- *The urban water demand is growing faster than expected. Demand management measures should be implemented as soon as possible as part of the raw water supply agreement with the Lephalale Municipality;*
- *The latest Crocodile River (West) reconciliation report indicates that there is sufficient surplus water available to supply in the projected water requirement as presented in the latest Scenario D1; and*
- *It is required that the river system analysis model for the Mokolo River and the Crocodile River (West) be integrated to assess the water availability annually.*

7. Recommendations

In order to manage the risks associated with commercial users not being in a position to commit at the time that implementation should commence, the following approach is recommended:

a) *The most economical solution is offered by Option X**. From an economy of scale and cost-efficient implementation point of view it is recommended that the civil structures be based on a water requirement of 100 million m³/a. The mechanical and electrical components can be phased in as required. Table G below reflects the recommended design capacities of the MCWAP 2A infrastructure components for Option X**.*

b) *Should funding not be secured for water infrastructure required beyond 2035, a phased transfer capacity development approach can be followed (Option Y**). The minimum design capacity for a MCWAP-2A should then be 75 million m³/a. The design capacity for the civil works should be reviewed for potential future extension. Table H reflects the recommended design capacities of the MCWAP-2A infrastructure components for Option Y**.*

Table G: Transfer System Component Phased Design Capacities (Option X**)

Component	Current Design Horizon	Design Capacity Million m^3/a
Abstraction Weir	2B+	125
Low lift PS (Civil works)	2B+	125
Low lift PS (M&E works)	2A and Provision for 2B	75
Low lift rising main (2 Pipes)	2A + Space for 2B	100
De-silting works	2A + Space for 2B	100
Balancing dams	2A + Space for 2B	100
High Lift PS(Civil Works)	2A + Space for 2B	100+
High Lift PS(M&E Works)	2A and Provision for 2B	75

Component	*Current Design Horizon*	*Design Capacity Million m^3/a*
High lift rising main	*2A + Space for 2B*	*100*
Reservoirs	*2A + Space for 2B*	*100*
Gravity main to Steenbokpan	*2A + Space for 2B*	*100*
Gravity main to Medupi	*2A + Space for 2B*	*75*

2B+ means beyond MCWAP-2B

Table H: Transfer System Component Phased Design Capacities (Option Y**)

Component	*Current Design Horizon*	*Design Capacity Million m^3/a*
Abstraction Weir	*2B+*	*125*
Low lift PS (Civil works)	*2B+*	*125*
Low lift PS (M&E works)	*2A and Provision for 2B*	*75*
Low lift rising main (2 Pipes)	*2A + Space for 2B*	*75*
De-silting works	*2A + Space for 2B*	*75*
Balancing dams	*2A + Space for 2B*	*75*
High Lift PS (Civil Works)	*2A+ Space for 2B*	*100+*
High Lift PS (M&E Works)	*2A and Provision for 2B*	*75*
High lift rising main	*2A + Space for 2B*	*75*
Reservoirs	*2A + Space for 2B*	*75*
Gravity main to Steenbokpan	*2A + Space for 2B*	*75*
Gravity main to Medupi	*2A + Space for 2B*	*50*

2B+ means beyond MCWAP-2B

It is further recommended that:

- *MCWAP-2A be implemented to target water delivery by end of 2021;*
- *The river management system for the Crocodile River (West) be implemented in time to be operational by June 2019 (i.e. 18 months prior to the transfer scheme water delivery date); and*
- *DWS in due course develop an integrated river system analysis model for the Mokolo River and the Crocodile River (West) systems to simulate the assurance of supply on an annual basis, for consideration by the System Operating Forum on the need for possible curtailments during drought situations.*

MOKOLO AND CROCODILE (WEST) WATER AUGMENTATION PROJECT

POST FEASIBILITY BRIDGING STUDY: REVIEW REPORT POST FEASIBILITY BRIDGING STUDY

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LIST OF ABBREVIATIONS

DMR	Department of Mineral Resources
DOE	Department of Energy
DPE	Department of Public Enterprises
DWS	Department Water and Sanitation
O&M	Operation and Maintenance
CD	Compact Disc
CFP	Coal Fired Power Station
CPI	Consumer Price Index
CRSS	Crocodile River (West) Water Supply System
CTL	Coal to Liquid
FBC	Fluidised Bed Combustion
FGD	Flue Gas Desulphurisation
IDP	Integrated Development Plan
IPP	Independent Power Producers
IRP	Integrated Resource Plan
MCWAP	Mokolo Crocodile (West) Water Augmentation Project
M&E	Mechanical and Electrical
NERSA	National Energy Regulator of South Africa
NPV	Net Present Value
PICC	Presidential Infrastructure Coordinating Commission
PV	Present Value
SIP1	Strategic Integrated Project 1
SOF	System Operating Forum
SSC	Strategy Steering Committee
TCTA	Trans-Caledon Tunnel Authority
URV	Unit Reference Value
VAT	Value Added Tax
WWTW	Waste Water Treatment Works
WTW	Water Treatment Works

1 INTRODUCTION AND BACKGROUND

1.1 Background

The Mokolo and Crocodile River Water Augmentation Project (MCWAP) has been approved as a Government Waterwork. It is a key project to unlock the mineral wealth in the Waterberg as envisaged in the Strategic Integrated Project 1 (SIP1) by the Presidential Infrastructure Coordinating Commission (PICC).

SIP1 indicates that the urban development in the Waterberg will be the first major post-apartheid new urban centre and will be a "green" development project. The MCWAP forms part of the proactive activity of the Department Water & Sanitation (DWS) to ensure the future availability of water to strategic industrial and urban developments in the Lephalale area.

The Department of Water & Sanitation (DWS) initiated a feasibility study in 2008 "Mokolo and Crocodile River (West) Water Augmentation Project (MCWAP) Feasibility Study". The feasibility study was commissioned to determine the optimum solution to the timely supply of the required quantities of water to the various proposed developments in the Lephalale area. The reports were completed in September 2010 based on the best available industrial development information at the time. Refer to Appendix A for the executive summary of the Main Report of the feasibility study.

The focus of the Technical Module was to investigate the feasibility of options to:

- Augment the supply from Mokolo Dam (Phase 1 (MCWAP-1)) to supply in the growing water use requirement for the interim period until a transfer pipeline from the Crocodile River (West) can be implemented, and over the long term to optimally utilise the full yield from Mokolo Dam; and
- Transfer water from the Crocodile River (West) to the Steenbokpan and Lephalale areas (Phase 2 (MCWAP-2)).

The MCWAP was sized at the time to transfer the water requirements to the following end users:

- **Eskom:** Matimba Fluidised Bed Combustion (FBC), Medupi plus four (4) additional coal fired power stations (the Flue Gas Desulphurisation (FGD) retrofit for Medupi was scheduled for the first major planned maintenance shutdown for each of the units);
- **Independent Power Producers (IPP's):** Equivalent of one (1) Eskom power station (starting in July 2010);
- **Exxaro:** Matimba coal supply, as well as implementation of projects A to K (new coal mines);
- **Coal mining:** Allowance for four (4) additional coal mines each supplying a power station;
- **Sasol:** Mafutha one (1) Coal to Liquid Fuel (CTL) plant and associated coal mine (starting in July 2011); and
- **Lephalale and Steenbokpan:** Estimate based on projected growth in households for construction and permanent workforce associated with the above level of industrial development.

This was known at the time as water demand Scenario 9. The total MCWAP water demand was estimated to be 194,1 million m³/a in 2025 and 197,2 million m³/a in 2030, growing from the supply capacity of 14,5 million m³/a from Mokolo Dam, at the time. All infrastructure, apart from the abstraction works, was sized for the 2025 requirement, but taking into account the growth associated with projects not fully commissioned by 2025. Further projects after 2025 would have required expansion of the Phase 2A infrastructure. The Scenario 9 water requirements were projected up to 2030 and the system capacity was also based on the 2030 requirement. The abstraction works was sized for the planned ultimate water requirement in 2050.

Due to the Department of Energy's Integrated Resource Plan (IRP 2010) published in 2011 which redefined the country's future energy mix, and also Sasol's decision to cancel their plans for developing Mafutha, it became clear that the future water demands would significantly reduce, compared to the demand scenarios considered during the 2010 DWS feasibility study. Implementation of MCWAP-2 was therefore put on hold in order to review the transfer capacity.

The maximum water allocations from the Mokolo River have been based on a water resource assessment applying differentiated assurance of supply for different user sectors. Table 1 summarises the allocated water from Mokolo Dam.

Table 1: Annual Average Demands per User (Differentiated Assurance of Supply)

USER	EST. DEMAND	ALLOCABLE WATER
	million m^3 per annum	
Exxaro	7,6	7,6
Eskom (Matimba and Medupi)	17,6	14,5
Lephalale (including Marapong)	7,2	7,2
Incidental users	0,1	0,1
SUBTOTAL SUPPLIED FROM MOKOLO DAM	32,5	29,4
Irrigation downstream of Mokolo Dam	10,4	10,4
Provision for the Mokolo Reserve	4,0	4,0
TOTAL	**46,9**	**43,8**

Table 1 indicates a shortfall in the supply from Mokolo Dam of 3,1 million m³/a which is to be made up in the interim from groundwater and recycled return water sources until MCWAP-2 would be operational. This allocation is based on a provisional allowance for the Reserve. The preliminary determination of the reserve in the Mokolo River found that the irrigation water releases will sufficiently provide in the ecological water needs downstream of Mokolo Dam.

Further industrial development would have to be delayed until the commissioning of MCWAP-2A.

The Matimba power station, the Lephalale water treatment works and some processes at Exxaro have been designed to operate on the good water quality of the Mokolo River. They are not able to treat the nutrient rich water of the Crocodile River (West). Should the demand from any of these processes increase, a redistribution of the allocation from the Mokolo River system would be required.

Subsequent to the completion of the feasibility report in September 2010, the following significant changes occurred to the planned industrial development in the area:

a) The municipality has extended the capacity of the Zeeland water treatment works (WTW) to 40 Mℓ/day which is equivalent to 14,6 million m³/a. This exceeds the current allocation from the Mokolo River system of 7,2 million m³/annum.
b) The Marapong area is supplied by Eskom from their potable water treatment works at Matimba. Approximately 1,3 million m³/a will have to be supplied additional from the Zeeland WTW when the municipality takes responsibility for Marapong water supply as agreed between the municipality and Eskom.
c) The latest urban water demand projection is well above the current allocation.
d) FGD retrofitting is required at Matimba which would increase the requirement from 7,6 million m³/a to 11,2 million m³/a. The projected requirement from Medupi power station is 15,4 million m³/a. The combined projected water requirement for the two power stations is thus 26,6 million m³/a which exceeds the current allocation of 14,5 million m³/a to Eskom from the Mokolo River system.
e) Sasol subsequently indicated that the Mafutha Project has been terminated and that the projected water demand from this key user (37 million m³/a) will no longer materialise.
f) Eskom decided to source coal from the Waterberg Coal field as feedstock to some of their power stations in Mpumalanga where the coal reserves become depleted.

DWS consequently requested TCTA to review the water demands for the MCWAP. This is the study being reported on. The study involves an assessment of the current and future water requirements of the rural, urban and industrial developments in the Lephalale area and the review of the transfer capacity of MCWAP-2A. The assessment is based on data gathered from all known planned and anticipated developments associated with the rich coal reserves in the Waterberg coal field, for which additional water will be required.

The maximum water supply allocation from the Mokolo River has been made based on a differentiated assurance of supply from the existing river system. The total water allocation from MCWAP-1 is 29,4 million m³/a. The indication was that the related water requirement would exceed the available Mokolo River system allocation by 2018 by which time MCWAP-2A should be operational.

1.2 Purpose of the MCWAP

MCWAP is a key project to unlock the mineral wealth in the Waterberg. The intention of the project is to supply water in sufficient quantities and most economically for the anticipated development in the Lephalale/Steenbokpan area.

MCWAP is implemented in two development phases to supply water from two sources (available yield in Mokolo Dam and surplus return flows in the Crocodile River (West)). The allocation of water from MCWAP will take in account the fact that the processes at Matimba power station and the Zeeland WTW were historically designed for the raw water quality from Mokolo Dam. The objective remains to optimally utilise the available yield from the Mokolo system for these processes prior to supplementing supply from the Crocodile River (West).

1.3 Purpose and Context of this Report

The objective of the study is to determine the current and future water requirements for all sectors of water use, particularly power generation, mining (and the projected growth in mining), irrigation, urban and rural water supply in the Lephalale area as well as review of the required transfer capacity of MCWAP-2A. Consideration was also given to major return flows, as these form significant contributions to the water resources of the area.

DWS' specific interest is the review of the water requirement of MCWAP-2A associated with the anticipated infrastructure developments in the area as well as the associated municipal raw water requirement and also the review of the transfer capacity of MCWAP-2A.

1.4 Study Area

The MCWAP Study Area comprises the area between the Crocodile River (West) in the South and the Lephalale/Steenbokpan demand area in the North. The Crocodile River reaches downstream of Roodekopjes Dam and the Mokolo Dam form part of the broader study area. The project will be using water from the shared international Limpopo watercourse. Figure 1 below indicates the geographical location and towns in the vicinity of the project.

The Lephalale area falls in the Mokolo River catchment where large new power stations and coal mines are proposed, with some already under construction. The local water resources are insufficient for these large developments and hence water required for these developments needs to be augmented from or via the Crocodile River (West) catchment.

From the confluence of the Crocodile and Marico rivers, the river is known as the Limpopo River which forms the western border of South Africa with Botswana and then with Zimbabwe, before flowing into Mozambique where it discharges into the Indian Ocean. The Limpopo River basin thus is an international basin shared by South Africa, Botswana, Zimbabwe and Mozambique.

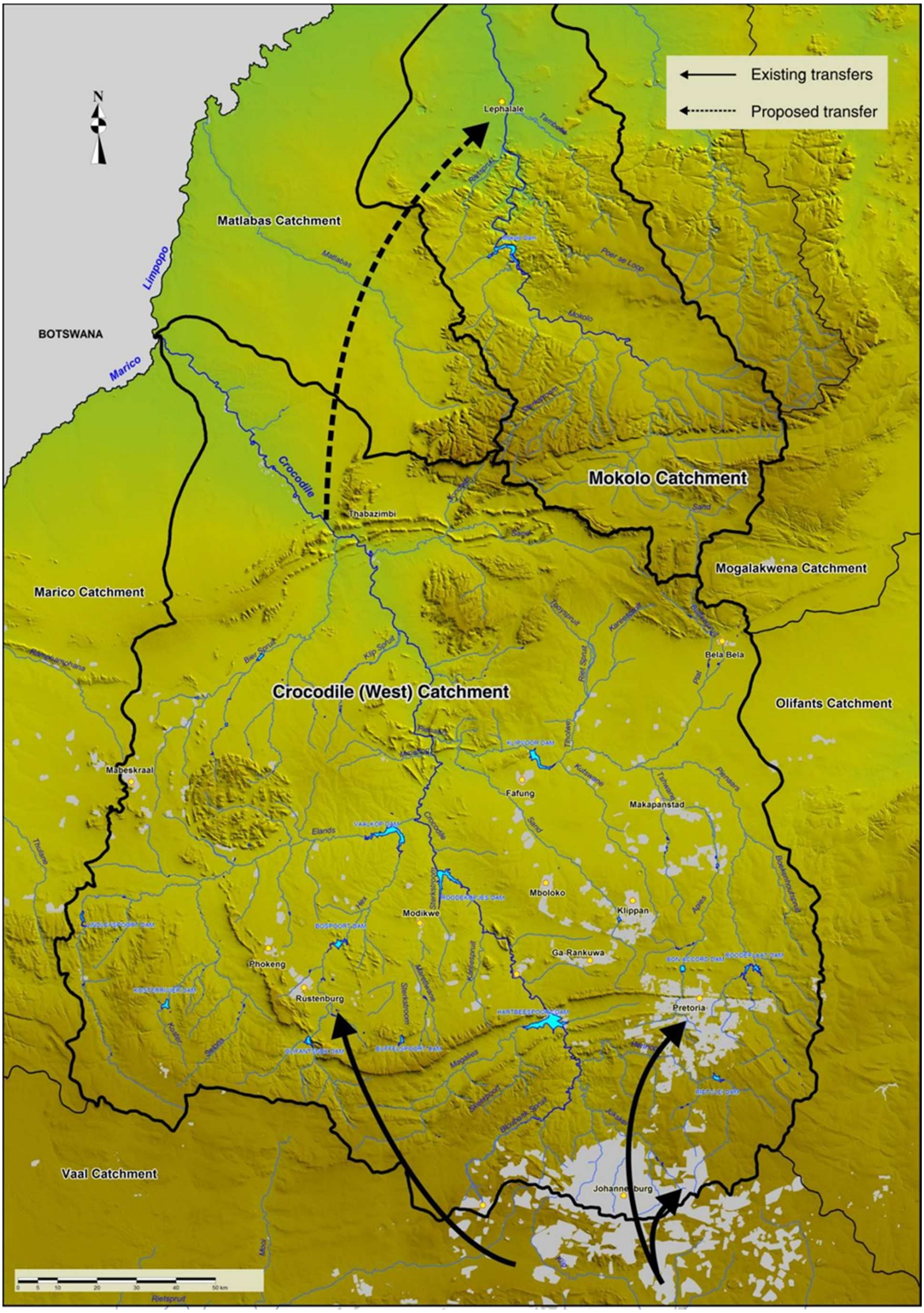

Figure 1: Map of the Study Area

2 METHODOLOGY

The basic approach to review the current and future water requirements and to assess the impact on the bulk water infrastructure planning included the following:

- Identification and consultation of stakeholders within all sectors of water use, particularly urban, rural, power generation and mining water supply was accorded specific consideration. Separate supporting tasks have investigated the Reserve, irrigation and groundwater requirements, which have not been included in this study, as those are not relevant to the transfer infrastructure sizing;
- The above consultations facilitated an information and data collection process;
- The review and assessment of the reliability of the sources and the accuracy of the data;
- The presentation of various projected integrated water requirements as scenarios;
- The review of the assurance of supply;
- The presentation of the required capacities of the planned water transfer infrastructure as options; and
- Recommendations taking risk into account.

The framework of this report is aligned with the above methodology.

3 DATA COLLECTIONS

3.1 Municipal Stakeholder

Municipal water requirements were assessed based on water services planning. In the case of urban water requirements, it was assumed that the main driver was population growth following on industrial and mining developments. The methodology to derive the current and future urban water requirements in this study was based on the Lephalale Integrated Development Plan (IDP) study (as published in the Lephalale Integrated Project Scoping- Scenario Report).

Formal discussions were held with the study team of the Lephalale IDP to discuss the approach followed, to extend the approach to the current study and to compare results. This was the case with population projections as well as the growth in water requirements and to take due cognisance of the assumptions used in the consideration of the various scenarios.

The Lephalale Integrated Scoping Report took into account the number of erven needed to accommodate the people directly employed by the new developments and the associated services that follow the industrial services. This indicated that Lephalale town will be fully developed and utilised by 2030. Based on these findings the population growth was projected until 2050. High and low population growth projections were developed and used to provide a planning envelope. Per-capita water requirements in accordance with standard procedures were applied on the high and low population growth projections.

The Lephalale IDP included the following three focus areas/nodes:

- Node 1: Central urban area;
- Node 2: North eastern rural area; and
- Node 3: Western Steenbokpan area.

3.2 Industrial Stakeholders

TCTA established a MCWAP-2 stakeholder forum as part of the initial implementation mandate. The study team consulted with the industrial stakeholders and collected the historical, current and planned future water requirement information.

Questionnaires were compiled to facilitate the water requirement projection process from 2010 to 2050. Mines and power generation industries in the area were specifically targeted. The questionnaires were distributed by DWS at the start of September 2012 to Eskom, eight coal mine groups, a solar power generation group, as well as a small Ferro mine group.

The initial response was not satisfactory and separate formal discussion meetings were therefore held with the relevant mines and industries to facilitate the data collection process. Where explicit estimates of future water requirements were available, these were used. Where planning information was not available, assumptions were agreed with the stakeholders.

3.3 Data Collection Process

A questionnaire was formulated to address the industrial data requirements and was accompanied by a letter from DWS providing the background information on the study and requesting the cooperation of the stakeholder to provide the requested information. The aim of the questionnaire was to avoid the need for different team members to engage with the stakeholders separately, in order to minimise the number of meetings.

The content of the questionnaire requested each user to provide the following information:

- Projects and location of projects;
- Differentiated water use:
  - a) Water for power generation;
  - b) Water for coal mining for power generation in the Waterberg area;
  - c) Water for coal mining for power generation in Mpumalanga;
  - d) Water for export of coal; and
  - e) Water use for coal for other purposes (e.g. metallurgic etc.);
- Number of associated jobs created per project;
- Commissioning dates of current anticipated projects; and
- High and low water demand scenarios.

Refer to Appendix C for the template of the questionnaire and a CD with the confidential content of completed questionnaires. Due to the confidential nature of the data, the CD cannot be publicly distributed.

Urban and rural population projections were derived from the Lephalale IDP study (as published in the Lephalale Integrated Project Scoping- Scenario Report) and the associated water requirements were established using a land-use model developed by Aurecon. The land-use model was used to quantify the total estimated urban and rural water requirements.

The work undertaken included a substantial data collection and verification component. Calls were made to municipalities, and important industrial users, particularly mines and power generation.

3.4 Data Sources and Data Assessment

The results of this extensive data gathering exercise proved to be only partly useable. Obtaining data from mining operations and power generation industries were difficult in an uncertain and highly competitive environment. The planning horizon up to 2050 also proved challenging. Estimation and considered judgement had to be applied in assessing the data obtained.

A data reliability assessment of the coal balance for power generation was conducted to ensure that no duplication of potential coal providers occurs. The results indicated the following:

- Projected long-term coal requirement = 108,55 million t/a;
- Planned coal production stated in questionnaires = 90,75 million t/a; and
- Long term shortfall in coal production = 17,80 million t/a.

The long-term shortfall is associated essentially with the future possible coal fired power station 4. At this stage there seems to be an interest from the identified eight mines to support mine development up to coal fired power station 3. Allowance was made for “Mine X” to cover the water requirements from this future anticipated short-fall in coal production.

In addition to this a check regarding coal for export indicated that four relatively large mines specified export plans of 25,85 million t/a.

Parallel to this, an assessment of the water requirements for other industries was also conducted, which indicated a water requirement of 1,90 million m^3/a required by an iron ore plant (for beneficiation) as well as a water requirement of 0,55 million m^3/a for potential solar power generation.

Further to the data that was obtained and interpreted, commissioning dates received from the stakeholders indicated early start dates which are not aligned with the current regional bulk water program.

At that stage the mine groups had been notified that water from MCWAP-2 would only be available after end 2018, and that they would have to make their own arrangements for water in the interim, if needed.

Due to the early commissioning dates, the population growth following on industrial growth indicates an earlier steep growth of the total future projected population in the Lephalale area. Clarity with respect to the anticipated starting and commissioning dates had to be established individually with each stakeholder.

4 ASSESSMENT OF THE MUNICIPAL WATER REQUIREMENTS

4.1 General

Urban and rural population projections for the Lephalale area were derived from the Lephalale IDP study. The IDP study team had formulated development scenarios for the Lephalale area that are most likely to unfold in various stages over the next twenty years. Current trends were projected and company releases were used to indicate where trend breaks could occur.

The methodology undertaken was to update the corresponding population figures taking into account the identified new potential industrial/mining developments. Information on future urban and rural primary water requirements was derived based on population projections.

4.2 Urban Population Growth

From an assessment of historical population figures, employment levels and the occupation of stands, it is assumed that there were approximately 6 400 permanent households in Lephalale town in 2010. This is consistent with the count that was done from aerial photographs by DWS in December 2009, which recorded 26 000 persons in the area assuming an average household size of 4,06 persons.

Table 2 reflects all the identified new developments and the associated jobs created, that are factored into the population projections for Lephalale town. It is assumed that all the recruited staff will be new residents and will reside in the area.

Table 2: Total Urban Population Growth Figures

Projects	2010	2015	2020	2025	2030	2035	2040	2045	2050
Current Households	6 400								
AAC			968	968	968	968	968	968	968
Exxaro		3 492	5 820	5 820	5 820	5 820	5 820	5 820	5 820
Sasol Mining			583	583	583	583	583	583	583
Sekoko		560	1 400	1 400	1 400	1 400	1 400	1 400	1 400
Umbono		285	713	713	713	713	713	713	713
Resgen		500	2 000	2 000	2 000	2 000	2 000	2 000	2 000
Ferrum Crescent		100	690	690	690	690	690	690	690
Jindel Coal		100	680	680	680	680	680	680	680
Temo Coal		100	500	500	500	500	500	500	500
T-Solar			100	100	100	100	100	100	100
Medupi		500	800	800	800	800	800	800	800
Coal 3		20	300	500	500	500	500	500	500
Coal 4					20	400	500	500	500
IPP Exxaro		300	1 200	1 200	1 200	1 200	1 200	1 200	1 200
IPP AAC			513	513	513	513	513	513	513
IPP Resgen		25	100	100	100	100	100	100	100
“Mine x”					1 000	1 000	1 000	1 000	1 000
Subtotal direct new jobs/year	0	5 982	16 367	16 567	17 587	17 967	18 067	18 067	18 067
Secondary (indirect)/jobs	0	3 589	9 820	9 940	10 552	10 780	10 840	10 840	10 840
Total new jobs/year	0	9 572	26 187	26 507	28 139	28 747	28 907	28 907	28 907
New Permanent households/year	0	8 423	23 045	23 326	24 762	25 298	25 438	25 438	25 438
2010 Households + 1% Growth	6 400	6 726	7 070	7 430	7 809	8 208	8 626	9 066	9 529
Total Households	6 400	15 149	30 114	30 757	32 572	33 505	34 065	34 505	34 967
Population (4no./household)	25 600	60 598	120 457	123 026	130 287	134 020	136 258	138 018	139 868

The total direct new employment from 2012 to 2050, assuming all projects referred to are approved, is estimated to be 18 067 persons. An employment multiplier was added to this figure to cater for the commercial and community services that the new households will require. In Lephalale town the sum of the mining and power generation jobs represents 60% of total jobs, according to the census of 2001. This ratio was retained in order to derive the additional secondary jobs that will be created in support of the new primary jobs.

According to the 2001 census, there were 14% more employees than households in the Lephalale urban node, which implies a household to employment ratio of 0,88. The sum of new direct jobs was converted by this factor to arrive at an estimated number of households for the town. A natural growth of approximately 1% per year was also assumed. The number of households in the Lephalale area is therefore projected to grow from 6 400 in 2010 to more than 30 100 in 2020, escalating to almost 32 570 in 2030 and to 34 970 in 2050.

Urban population projections for the Lephalale area were determined for high, low and base growth scenarios. High and low variants of the population projections were developed in order to provide a planning envelope:

- The high growth scenario indicates the population growth based on the current and long-term industrial activity in the area. This includes coal fired power station 3, coal fired power station 4, the IPPs and coal for power generation in Mpumalanga;
- The medium growth scenario indicates the population growth based on the current and down-scaled long-term industrial activity in the area. This includes coal fired power station 3 or the IPPs and coal for power generation in Mpumalanga; and
- The low growth scenario indicates the population growth based on the current industrial activity in the Lephalale area. This includes Matimba, Medupi, and coal for power generation in Mpumalanga.

The total urban population projections for the study area for the above scenarios are indicated in Figure 2. It should be noted that the population projections exclude the number of projected construction workers. However, the water needed to house the construction workers have been provided for as the 2010 statistics already includes for the Medupi construction activities.

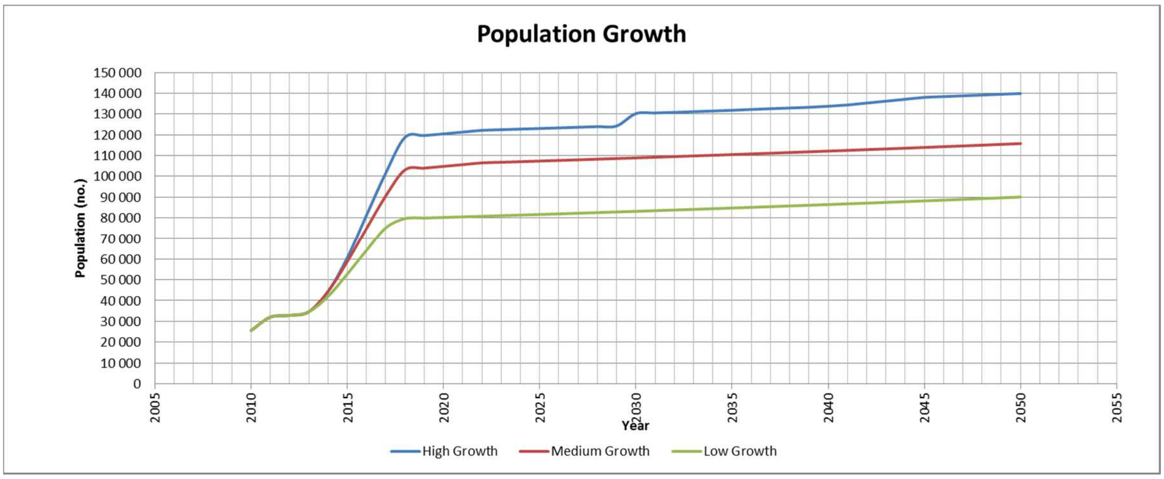

Figure 2: Population Growth Scenarios

From the high growth curve, there is a stepped increase in population after 2030 due to coal fired power station 4, scheduled for commissioning in 2036. Such potential growth after 2030 will require updated town planning to accommodate the population growth.

4.3 Rural Population Growth

4.3.1 Low Growth Approach

Several rural settlements are situated approximately 40 to 70 km to the north-east of the Lephalale urban node. This vast municipal space is rural in nature with a dispersed economic base comprising of subsistence agriculture and the small human settlements that are scattered, mostly in the eastern part. The economic base is inadequate to provide in the employment needs of the 57 000 people who reside in rural villages.

It was estimated by the Lephalale IDP study that an unemployment rate of 40% and a labour force participation rate of 40% (similar to that of Limpopo Province) are relevant to this area. Based on an estimation that 56% of the population are of working age (also similar to Limpopo Province), it could be interpreted that approximately 5 000 persons are currently unemployed in the rural settlements of Lephalale. Another 4 000 who are currently employed on commercial farms would be willing to work in the Lephalale urban node if better jobs were available.

The low growth estimate is based on the assumption that 10% of the jobs in the Lephalale urban node will be filled by persons from rural villages within Lephalale Municipality and that half of these persons (mostly young people without families) will move to the Lephalale urban node and that the other half will commute on a daily basis. Young persons and young families who move away are in the prime pro-creation phases of their lives. The population growth rate among the people who stay behind is therefore likely to drop.

The IDP study assumed that if 300 newly employed persons leave the rural villages each year for the next ten years, half of them single and the other half with their families (assumed as young families with 3 members on average), the local residents would reduce by 600 people each year. If the population growth rate then drops from 0,8% per year to 0,7% per year, it is likely that the total population in the rural villages could decline from the current 57 000 to 54 000. Household numbers could drop from almost 13 600 at present to 12 740 in 2030.

The scenario can continue for another ten years, provided that the labour force participation rate improves from the current low level of 40% to 60%. This is possible in view of the higher disposable income conditions that are then likely to prevail in the rural villages. However, the population growth rate could fall significantly during this time. The scenario assumes 0,8% natural growth from 2010 to 2019 and 0,7% growth from then onwards.

Population projections (taking into account the above study) are reflected in Table 3.

Table 3: Total Rural Population Growth Figures (Low)

Year	Rural Villages			
	Population	Households	Out-migration[1]	Natural Growth (Population)
2010	57 106	13 597	600	457
2015	56 379	13 423	600	451
2020	55 622	13 243	600	445
2025	54 611	13 003	600	382
2030	53 507	12 740	600	375
2035	52 372	12 470	600	371
2040	51 212	12 194	600	366
2045	50 027	11 911	600	361
2050	48 817	11 623	600	356

[1]This figure is based on the assumption that 300 persons from rural settlements will move to the urban node for employment every year, half of them single and the other half with their families

4.3.2 High Growth Approach

Senior officials of the Lephalale Municipality were of the opinion that the above rural population projections were too low and a high population growth scenario was constructed.

The methodology was based on the national statistics of Lephalale of 8% growth rate from 1996 to 2001 and 35% from 2001 to 2011. A growth rate of 3,5% per annum was applied up to 2030 and thereafter 1,6% per annum growth. This assumption was applied based on the level of industrial activity expected in Lephalale up to 2027 and reducing thereafter.

Population projections, taking into account the above assumptions, are reflected in Table 4.

Table 4: Total Rural Population Growth Figures (High)

Year	Rural Villages		
	Population	Households	Natural Growth (Population)
2010	57 106	13 597	1 999
2015	67 824	16 149	2 374
2020	80 554	19 180	2 819
2025	95 672	22 780	3 349
2030	105 512	25 123	1 688
2035	114 228	27 198	1 828
2040	123 663	29 444	1 979
2045	133 878	31 876	2 142
2050	144 936	34 509	2 319

4.4 Urban Water Requirements

As part of the Lephalale Integrated Project Scoping Study (LGDP02/2010), a land use model of the urban node was developed by Aurecon. This was used to quantify the total net urban water requirements in the area. The model provided the opportunity to build on the extensive work that had gone into the development of the model.

The Lephalale central urban node was divided into four zones, namely; Altoostyd & Hanglip & Ext 89, Onverwacht including new extensions, Ledibeng & Schaapplaats, Ellisras and Marapong. A general summary of the Lephalale urban node is indicated in Appendix B of the Lephalale nodal development plan.

The high population growth scenario shown in Figure 2 was used as a basis for modelling the water requirements as this is the situation that is aligned with the assumed industrial development. Urban populations were assigned to the different zones and different water requirement categories in the model (as used in the Lephalale IDP study) and given in Table 5 below. These unit consumption figures are in accordance with the Guidelines for Human Settlement Planning and Design (Red Book).

Table 5: Land Use Categories used in Urban Water Requirements Model

Category Number	Category Description	Default Water Requirement	
1	Residential 1	850	ℓ/erf/day
2	Residential 2	750	ℓ/dwelling/day
3	Residential 3	750	ℓ/dwelling/day
4	Residential 4	600	ℓ/dwelling/day
5	Educational (Number)	20	ℓ/pupil/d
6	Health & Welfare/Institutional (m²)	500	ℓ/100m²/d
7	Government/Municipal (m²)	400	ℓ/100m²/d

Category Number	Category Description	Default Water Requirement
8	Open Space (m²)	15 kℓ/ha/d
9	Business (m²)	600 ℓ/100m²/d
10	Industry (m²)	800 ℓ/100m²/d

Provision was made for water to house the construction employees. Due to most of the water users not specifying the number of construction employees as requested in the questionnaire, the number of construction workers was based on a judgment of the size and type of each proposed industrial/mining development. The construction water requirements were based on a per capita consumption of 100 ℓ/capita/day.

The graph in Figure 3 below indicates the projected urban and construction domestic demand. It is evident that there is a significant increase in demand from the central urban node 1. After 2030 additional development is projected due to Coal Fired Power Station 4. The potential growth after 2030 will therefore require updated town planning regarding the water demand in Lephalale (potential future expansion to node 2).

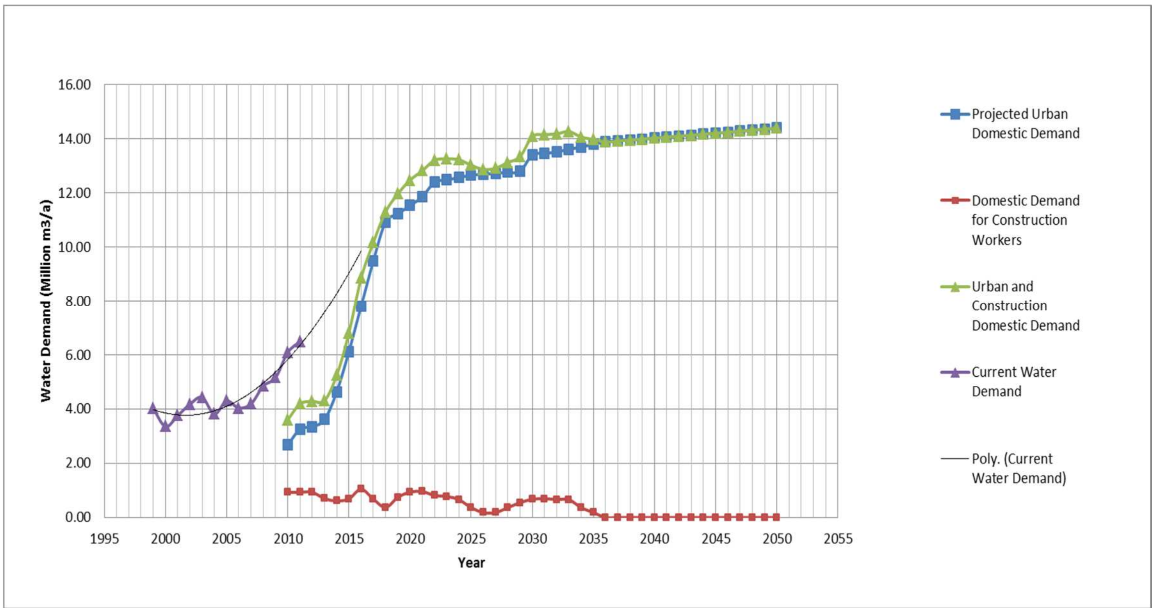

Figure 3: Actual and Projected Urban Water Requirement

The current water demand section of the curve indicates the actual water demand of Lephalale town from 1999 to 2011. These figures were obtained from Exxaro whom operated the supply pipeline from Mokolo Dam for the past 30 years. This demand includes the construction domestic water requirements as well. The significant difference in demand between the current and projected water demand highlights the need to implement water demand management strategies, as this can provide a significant reduction in the water demands in the area if the measures are implemented properly and maintained indefinitely.

If water demand management strategies are implemented effectively and the current water demand is reduced by 35% to align with the projected demand, this would reduce the cost of water by approximately R 11,5 million, assuming a raw water tariff of R 5/m³.

The Lephalale Municipality has an allocation of 7.2 million m³/annum in the current MCWAP-1 water supply agreement. Figure 4 below indicates a more recent raw water balance trend in the residential or urban demand. It is anticipated that this user will first exceed the allocation from the Mokolo system and is uncomfortably close to this situation. The need to reallocate bulk water from the combined MCWAP system in the near future is regarded as one of the drivers to implement MCWAP-2A.

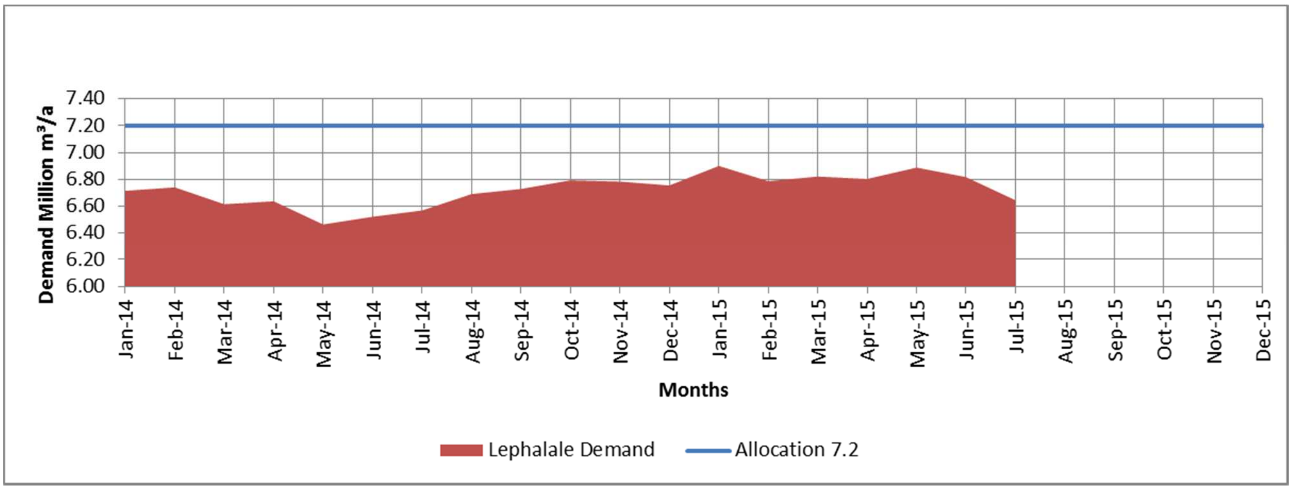

Figure 4: Actual Urban Water Requirement Trend

4.5 Rural Water Requirements

Primary water requirements in rural areas were based on the assumption of a fixed per capita consumption, initially 50 ℓ/c/day. However, it became apparent that this was not acceptable to the Municipality, and a stepped increase per capita approach was taken to rural water requirements as reflected in Table 6.

Table 6: Rural per Capita Requirements

Year	2001	2005	2010	2015	2020	2025	2030
ℓ/c/day	40	40	60	60	80	80	100

The increase in per capita rural water requirements to 2010 is in line with the policy of DWS to progressively increase the minimum level of water supplied to at least 50 ℓ/capita/day, clear the sanitation backlog and eradicate the bucket system.

As the study area includes several larger towns it was considered reasonable to set the requirement somewhat higher than the national target. A per capita consumption growing to 100 ℓ/capita/day as shown in Table 6 was used to quantify the total net rural water requirements in the area.

The total rural water requirement for the high and low population growth is indicated in Figure 5.

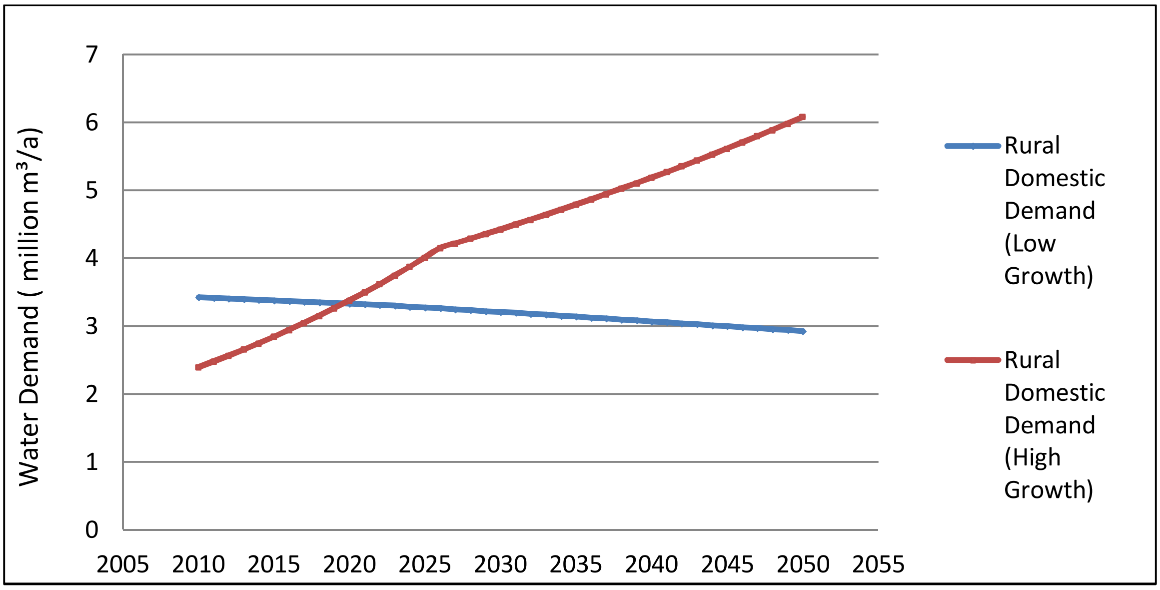

Figure 5: Rural Domestic Demand

Based largely on general assumptions with respect to the rural population trends, the water demand projections from these rural areas are at best an estimate with a low level of confidence. The water requirement from these areas is expected to vary in the range between 3 and 4.5 million m^3/annum by 2030. The DWS's All Towns Reconciliation Strategy for Lephalale Local Municipality recommended that such level of water requirements should be supplied from local groundwater resources.

5 IRRIGATION WATER REQUIREMENTS

Irrigation water requirements were previously determined from actual irrigation areas as determined from satellite images linked to crop types. A study to validate and verify the existing lawful irrigation areas and linked irrigation water use for licensing purposes is currently being executed for DWS.

For the purposes of this water requirement review, the irrigation areas as well as the irrigation water requirements are assumed to remain unchanged. The irrigation water allocation from Mokolo dam is 10,4 million m^3/annum.

The review of the irrigation water requirement from the Crocodile (West) River does not form part of this bridging study. There is no irrigation water requirement forming part of the Mokolo Crocodile Water Augmentation Scheme. The impact of the projected water requirements from the Mokolo Crocodile Water Augmentation Scheme was reviewed as part of the water reconciliation strategy reporting process of DWS. Refer to PWMA03/A31/00/6615/2 Crocodile (West) River Reconciliation Strategy 2015 (Continuation of Phase 2).

The above reconciliation strategy report indicates that no growth in irrigation water requirements from the Crocodile (West) River was considered.

6 INDUSTRIAL WATER REQUIREMENTS

The industrial water requirements are summarised for each of the following sub-sectors:

- Power generation in the Waterberg area;
- Coal production for power generation in the Waterberg area;
- Coal production for power generation in Mpumalanga;
- Coal production for export; and
- Other industrial/mining development.

6.1 Power Generation in the Waterberg Area

The key drivers in this area are the two existing power stations (Matimba and Medupi), Eskom's 3rd future coal fired power station and a potential 4th coal fired power station, two Independent Power Producers (IPPs) and one private initiative. 40 million tons of coal per annum is also envisaged to be supplied from the Lephalale area to the Mpumalanga energy sector, to replace shortfall of coal production in that area.

The existing and future water requirements for power generation in the Waterberg area are indicated in Table 7 below.

Table 7: Existing and Future Water Requirements for Power Generation

PURPOSE OF THE POWER GENERATION PROJECT	POWER GENERATION PROJECT	POWER GENERATION CAPACITY	LONG TERM AVERAGE WATER REQUIREMENT
		MW	million m³/a
Eskom Grid	Matimba 3 600MW	6 x 600 units	3,60
	Matimba 3 600MW (With FGD)	6 x 600 units	11,20
	Medupi 4 800MW	6 x 800 units	15,40
	CFP 3 "Next Coal"	6 x 800 units	15,50
	CFP 4 "Future Coal"	6 x 800 units	15,50
Private to National Grid	IPP Exxaro	3 x 600 units	1,95
	IPP AAC	2 x 600 units	0,50
Private for Own Use	IPP Resgen[1]	45	0,61
SUB-TOTAL			**60.66**

[1] Resgen indicated that if the CFP 4 “Future Coal” project were to go ahead, they would not implement their IPP project

The time frames associated with the developments indicated in Table 7 are included in the water demand scenario modelling in Appendix D.

6.2 Coal Production for Power Generation in the Waterberg Area

Three mining groups indicated that they intend to produce coal for power generation in the Waterberg area as indicated in Table 8. In order to avoid a breach of the confidentiality with respect to the sharing of their planned water requirements, the mines are not identified but referred to as Mine 1, Mine 2, etc.

Table 8: Water Requirements for Coal for Power Generation in Waterberg

User	Maximum Coal Production (million t/a)	Maximum Water Requirement (million m³/a)
Mine 1 Stage 1	37,00	3,69
Mine 1 Stage 2		2,43
Mine 1 Stage 3		0,42
Mine 2 Stage 1	14,40	0,27
Mine 2 Stage 2		1,79
Mine 3	8,00	3,48
Future Mine X	9,15	6,46
Total	68,55	18,54

The total coal production forecasts from the three mine groups indicated that there would be a shortfall in coal production to sustain power generation in the Waterberg area. For this reason, an allowance for a so-called Future Mine X was made to ensure that water will be available for any mines that may develop in future to provide for this shortfall (refer to 3.4 of this report).

6.3 Coal Production for Power Generation in Mpumalanga

At the end of 2012 Eskom put out an Expression of Interest for the supply of coal to Mpumalanga from the Waterberg area to supplement coal supplies in the Mpumalanga area. Five mining groups indicated that they intend to produce coal for power generation in the Mpumalanga area as indicated in Table 9. The final actual water requirement will only materialise from awarded coal contracts.

Table 9: Water Requirements for Coal for Power Generation in Mpumalanga

User	Maximum Coal Production (million t/a)	Maximum Water Requirement (million m³/a)
Mine 1 Stage 1	8,00	0,35
Mine 1 Stage 2		1,45
Mine 1 Stage 3		0,42
Mine 2	2,80	7,00
Mine 3	10,00	3.43
Mine 4	5,80	1,76
Mine 5	4,75	1,77
Future Mine X	8,65	2.04
Total	**40,00**	**18.23**

The total coal production forecasts from the five mine groups indicated that there would be a shortfall in coal production to sustain power generation in the Mpumalanga area. For this reason, an allowance for a so-called Future Mine X was made to ensure that water will be available for any mines that may develop in future to provide for this shortfall (refer to 3.4 of this report).

The projected water requirement per ton of coal produced varies between the different mining operations. The detail of the selected beneficiation processes is confidential and relates to the variation in the quality of coal mined from different locations.

6.4 Coal Production for Export

Six mining groups indicated that they intend to produce coal for export as indicated in Table 10:

Table 10: Water Requirements for Coal Export

User	Coal Production (million t/a)	Estimated Water Requirement (million m³/a)
Mine 1	5 - 9,80	1,59
Mine 2	Unconfirmed	7,00 long term
Mine 3	1 - 3,30	0,27
Mine 4	4,75	1,77
Mine 5 Stage 1	4,00	0,35
Mine 5 Stage 2		0,49
Mine 5 Stage 3		0,43
Mine 6	7.8	2,50
Total		**14,39**

The projected water requirement per ton of export grade coal produced varies between the different mining activities. The detail of the selected beneficiation processes is confidential and relates to the variation in the quality of coal mined from different locations.

6.5 Other Industrial/Mining Development

Several other groups were identified who indicated that they would require water for purposes such as iron ore mining, solar power plants and coal production for other industrial uses as indicated in Table 11.

Table 11: Water Requirements for Other Industrial/Mining Development

User	Coal Production (million t/a)	Maximum Water Requirement (million m³/a)
Mine 1 Stage 1	Unconfirmed	0,71
Mine 1 Stage 2		0,49
Mine 1 Stage 3		2,98
Mine 2	1,70	0,94
Mine 3[1]	N/A	1,90
Mine 4	Unconfirmed	1,17
Company 5	N/A	0,55
Total		**8,73**

[1] Mine 3 indicated during April 2013 that they no longer require water from the MCWAP scheme

Table 12 below indicates the total water requirement from the mining sector.

Table 12: Mining Sector Maximum Water Requirement

Mining Markets	Maximum Water Requirement (million m³/a)
Coal mining for power generation in the Waterberg Area	18.54
Coal mining for power generation in Mpumalanga	18.23
Coal mining for export	14.39
Various other smaller markets	8.73
Total	**59.89**

7 TOTAL WATER REQUIREMENTS

7.1 Scenario Development

Based on the questionnaires and follow up discussions with potential end users, various demand scenarios were constructed. As additional information or options were considered, the water requirement scenarios were adjusted or revised accordingly.

Table 13 indicates the water requirement scenarios that were considered during the bridging study. The feasibility water requirement Scenario 9 was adjusted using the water requirement survey process.

Table 13: Water Requirement Scenarios

Water Requirement Scenario	Description
A	Full development of all projects starting 2019. Matimba stop 2040
B1	Same as A except that rural water was removed
B2	Same as B1 except that the iron ore mine was removed
C1	Same as B1 except that Matimba continues till 2050
C2	Same as C1 except that the iron ore mine was removed
C3	Same as C2 except that CFP- 4 and its mines were removed
C4	Same as C2 with minor adjustments done following users review
C5	Same as C4 except that CFP- 4 was started 10 years earlier (2026)
C6	Same as C4 except that CFP- 4 was delayed by 10 years (2046)
D1	Same as C4 but full development of projects delayed to 2022 and Mpumalanga coal exports delayed to 2025

The following sub sections demonstrate the development of the water requirement scenarios:

7.1.1 Scenario A

Commissioning dates received from the stakeholders indicated early start dates which are not aligned with the regional bulk water planning programme. As a result, the mine groups were notified in 2012 that water may only be available from end 2018, due to MCWAP-2 commissioning only after end 2018. At the time of the initial report the water requirements for these stakeholders were adjusted to only start after 2018. This adjustment was further substantiated by the lack of freight rail capacity for the export of coal from the area. At the time of the initial report, Transnet indicated the intention to upgrade the rail capacity by 2018.

In this scenario it was assumed that the Matimba power station would be de-commissioned in 2040 in line with a 50 year design life. The maximum rural water demand was included in this scenario.

Water Requirement Scenario A is depicted in Figure 6 below.

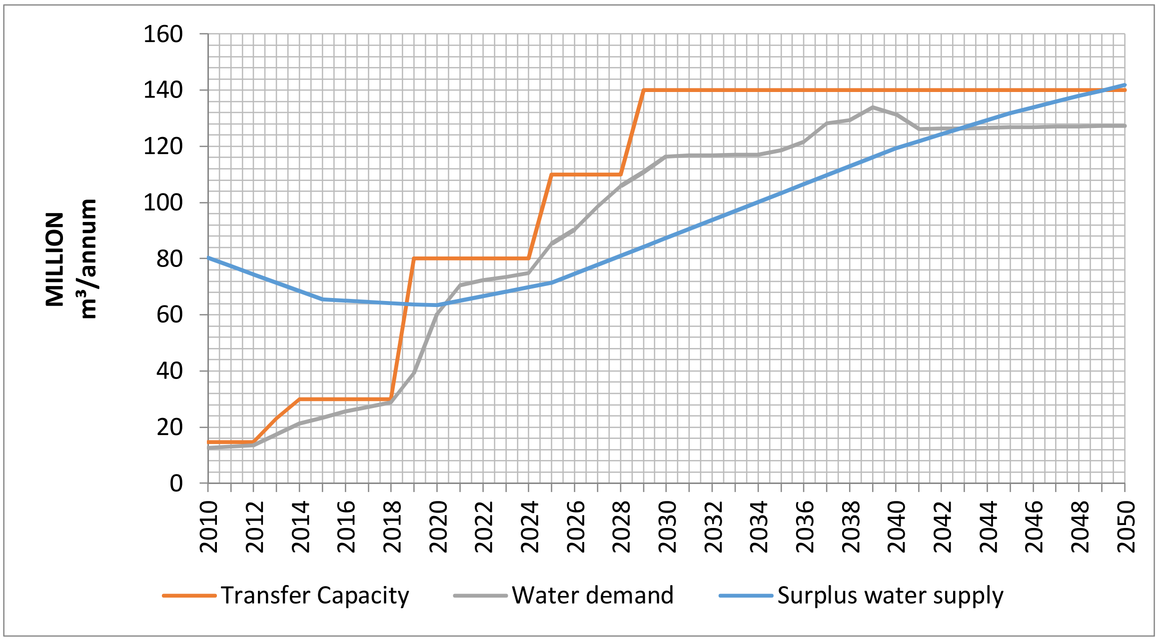

Figure 6: Water Requirement Scenario A

It should be noted that the above graph indicates that the demand exceeds the surplus water supply between 2020 and 2040. Subsequent to the initial water demand analysis the available surplus water supply was adjusted upward in the Crocodile River (West) Reconciliation Strategy indicating no predicted shortfalls.

7.1.2 Scenario B1

This scenario is essentially the same as Scenario A, but the rural demand component was removed. Provision for the rural water demand component was not taken into consideration in this scenario, due to preference for more economical water supply from local ground water sources.

Water Requirement Scenario B1 is depicted in Figure 7.

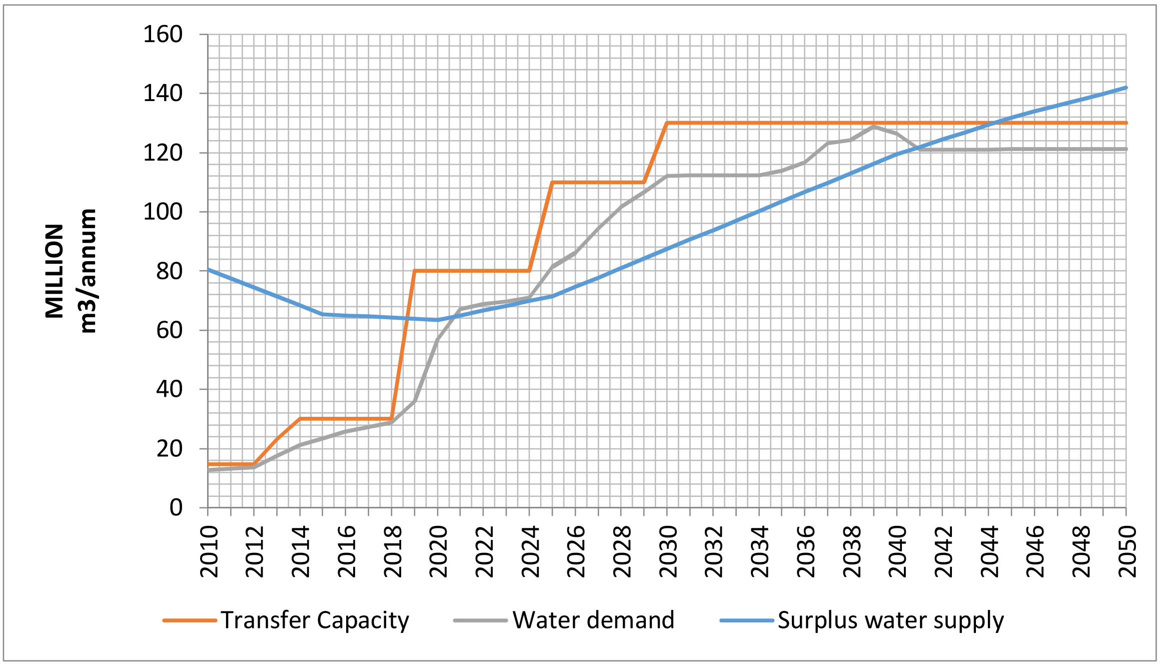

Figure 7: Water Requirement Scenario B1

7.1.3 Scenario B2

This scenario is essentially the same as Scenario B1, but the water requirement for the iron ore mine removed. The mine indicated that they would no longer need water from the MCWAP-2 Scheme. They will apply for a license to abstract water directly from the Crocodile River (West) in Thabazimbi.

Water Requirement Scenario B2 is depicted in Figure 8 below.

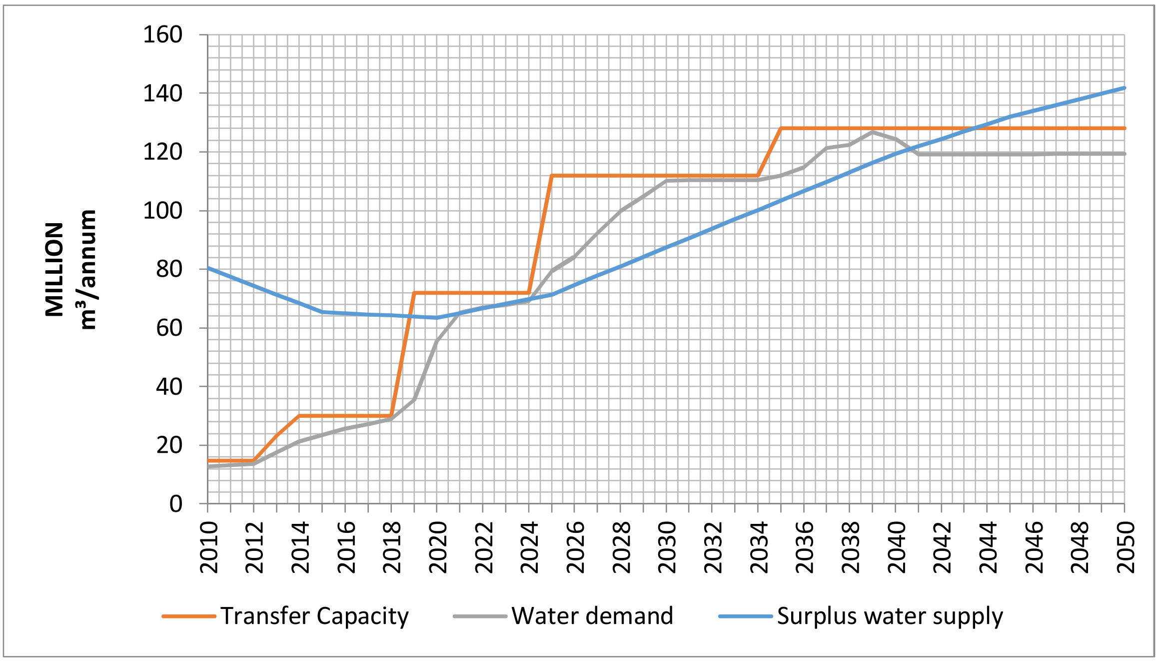

Figure 8: Water Requirement Scenario B2

7.1.4 Scenario C1

This scenario is essentially the same as Scenario B1, but it was assumed that the Matimba power station would continue to operate until the end of the period under consideration (2050). Eskom indicated that it was expected that their Mega power stations will operate well beyond their design lives (60 years plus).

Water Requirement Scenario C1 is depicted in Figure 9 below.

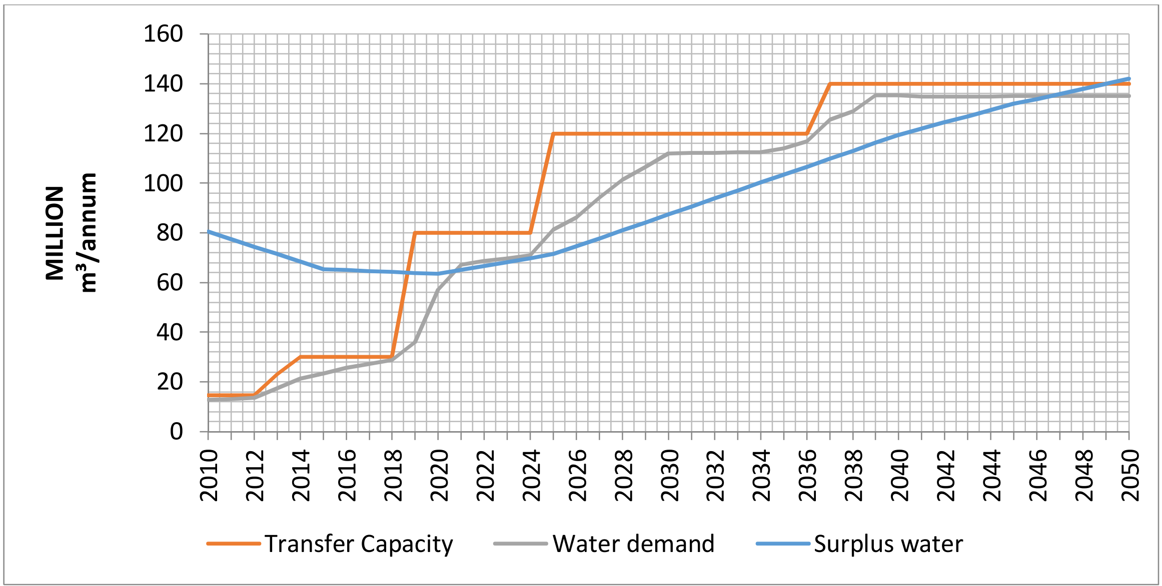

Figure 9: Water Requirement Scenario C1

7.1.5 Scenario C2

This scenario is essentially the same as Scenario C1, but the water requirement for the iron ore mine was removed.

Water Requirement Scenario C2 is depicted in Figure 10 below.

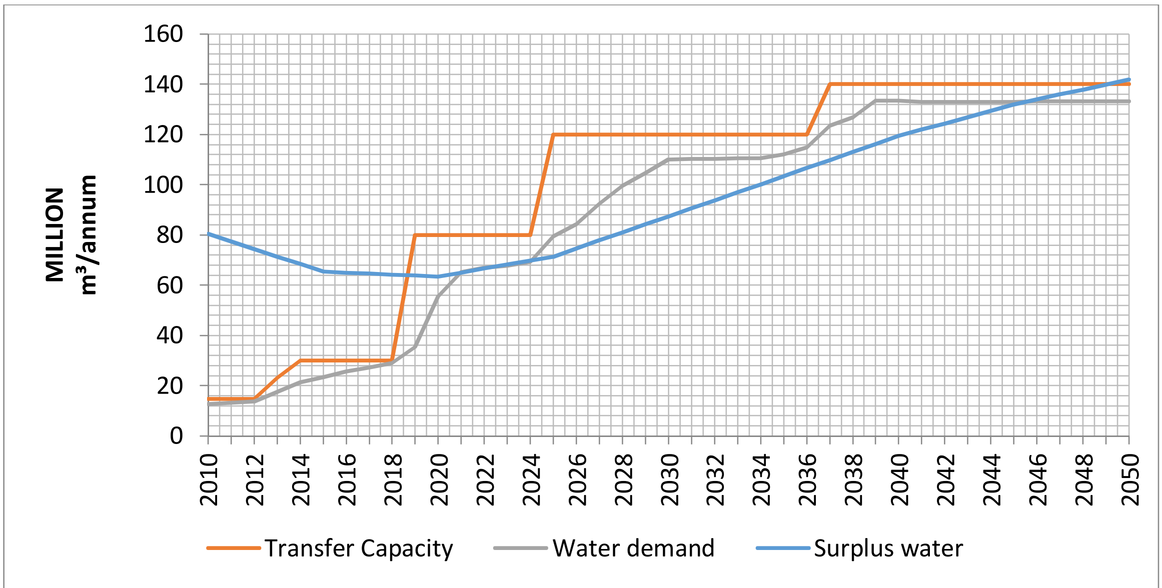

Figure 10: Water Requirement Scenario C2

7.1.6 Scenario C3

This scenario is essentially the same as Scenario C2, but the water requirement for the 4th coal fired power station was removed.

Water Requirement Scenario C3 is depicted in Figure 11 below.

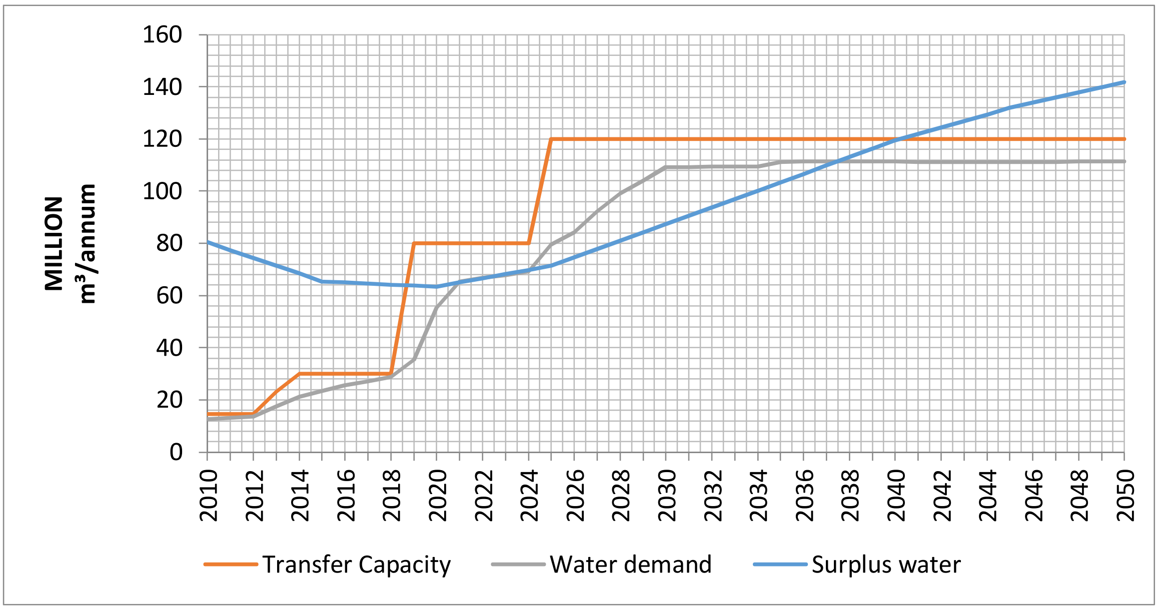

Figure 11: Water Requirement Scenario C3

7.1.7 Scenario C4

This scenario is essentially the same as Scenario C2, but the water requirements for several users were updated with their latest information provided during a round of one-on-one user meetings on 2/3 April 2013.

Water Requirement Scenario C4 is depicted in Figure 12 below.

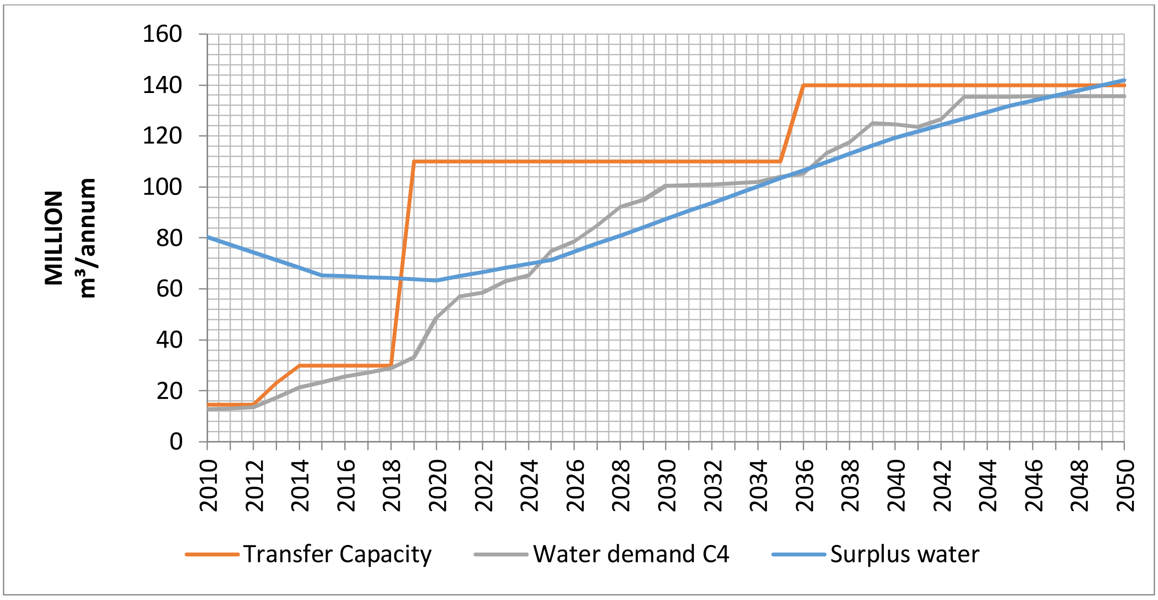

Figure 12: Water Requirement Scenario C4

The total MCWAP water demand associated with the full development up to 2050 is represented as Scenario C4 and shown in Figure 13. This reflects the planning situation up to December 2013.

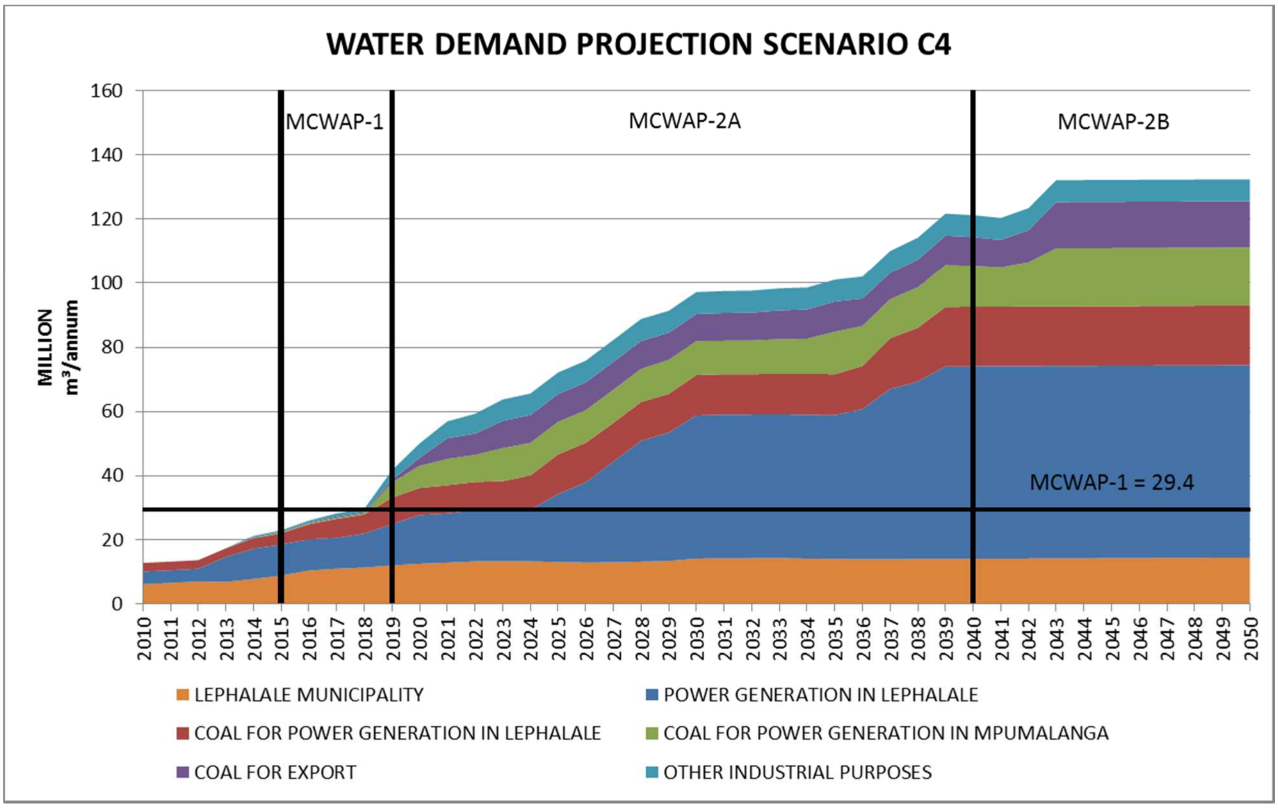

Figure 13: Water Requirement Curve Sector Breakdown

Table 14: Combined Total water requirement projection for Scenario C4 (million m³/a)

USER	2020	2025	2030	2035	2040	2045	2050
Strategic Industries: Power generation in Waterberg Coal Fields:							
Power stations:	15,30	21,29	44,75	44,92	60,05	60,05	60,05
Strategic Industries: Mining for power generation:							
Support power generation in the Waterberg Coal Fields:							
Total	8,44	12,35	12,54	12,74	18,54	18,54	18,54
Support power generation in Mpumalanga:							
Total	6,88	10,12	10,58	13,23	12,83	18,23	18,23
Industrial / Mining for other purposes:							
Production for coal export:							
Total	2,53	8,67	8,43	9,39	8,99	14,39	14,39
Other industrial purposes:							
Total	4,46	6,70	6,83	6,83	6,83	6,83	6,83

USER	2020	2025	2030	2035	2040	2045	2050
Urban use by Lephalale Municipality:							
Municipality	12,47	13,02	14,08	13,97	14,02	14,20	14,39
Incidental Users:							
Total	0,40	0,40	0,40	0,40	0,40	0,40	0,40
Total Demand	50,48	72,55	97,61	101,48	121,66	132,64	132,83
MCWAP 1	29.40	29.40	29.40	29.40	29.40	29.40	29.40
MCWAP 2	21.08	43.15	68.21	72.08	92.26	103.24	103.43

7.1.8 Scenario C5

This scenario is essentially the same as Scenario C4, but the water requirement for the 4th coal fired power station was moved 10 years earlier.

Water requirement Scenario C5 is depicted in Figure 14 below.

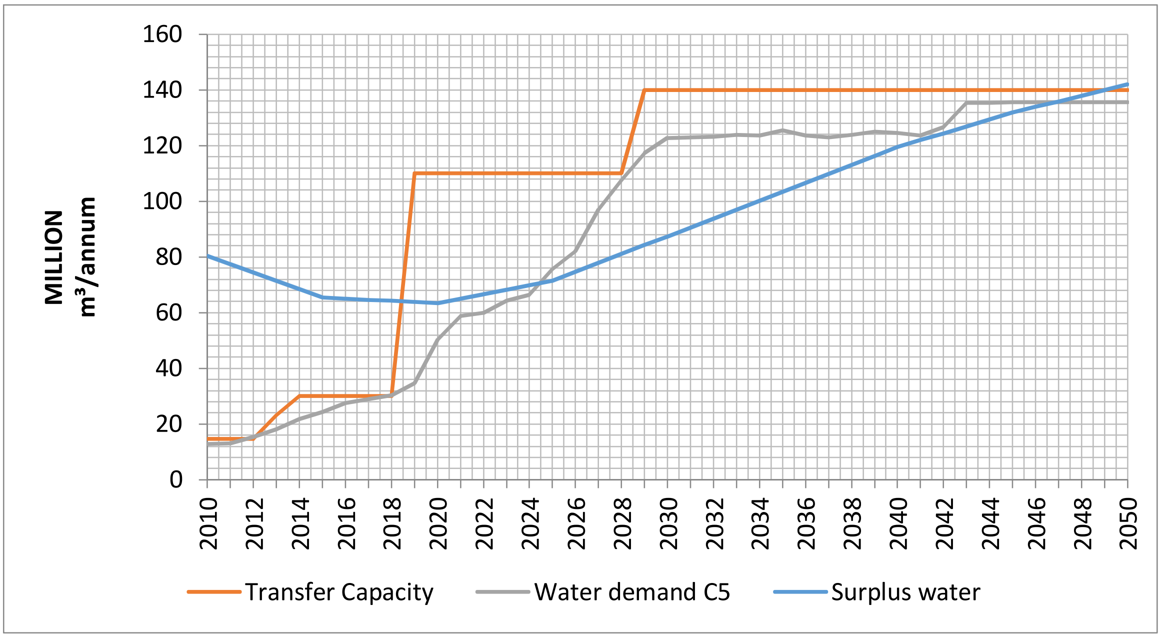

Figure 14: Water Requirement Scenario C5

7.1.9 Scenario C6

This scenario is essentially the same as Scenario C4, but the water requirement for the 4th coal fired power station was moved 10 years later.

Water Requirement Scenario C6 is depicted in Figure 15.

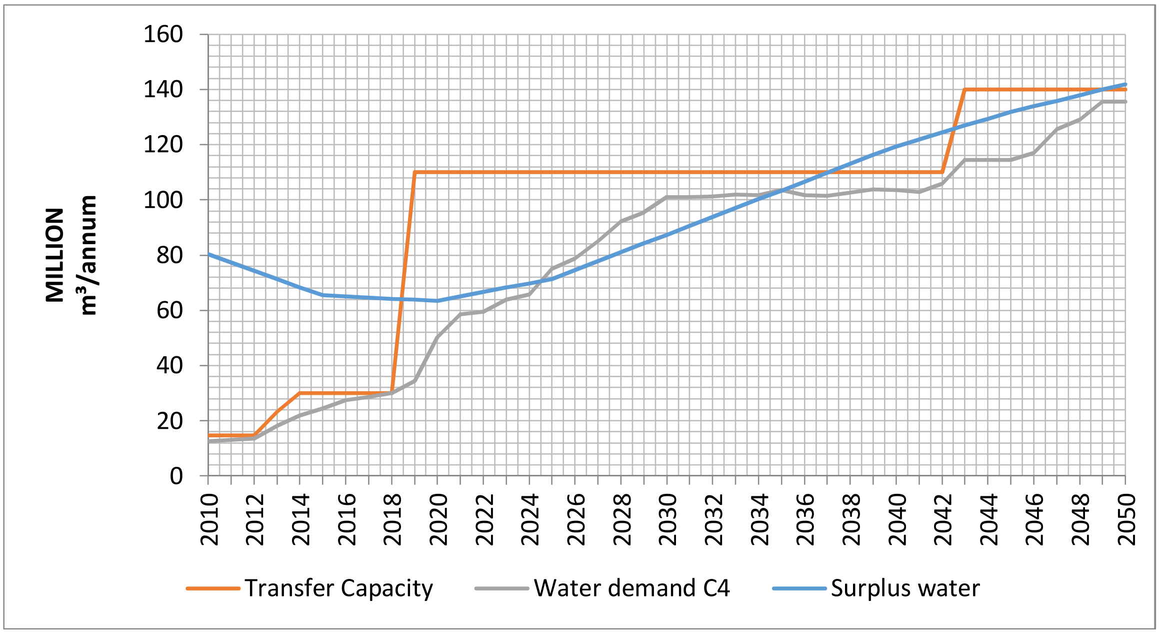

Figure 15: Water Requirement Scenario C6

7.1.10 Scenario D1

This scenario is essentially the same as Scenario C4, but the water requirement made provision for the following delayed starting dates:

- • Coal for export only commence in 2022;
- • Coal for Mpumalanga only commence in 2025; and
- • Medupi FGD only commence in 2024.

The revised total MCWAP water requirement associated with the full development up to 2050 is represented as Scenario D1 and shown in Figure 16.

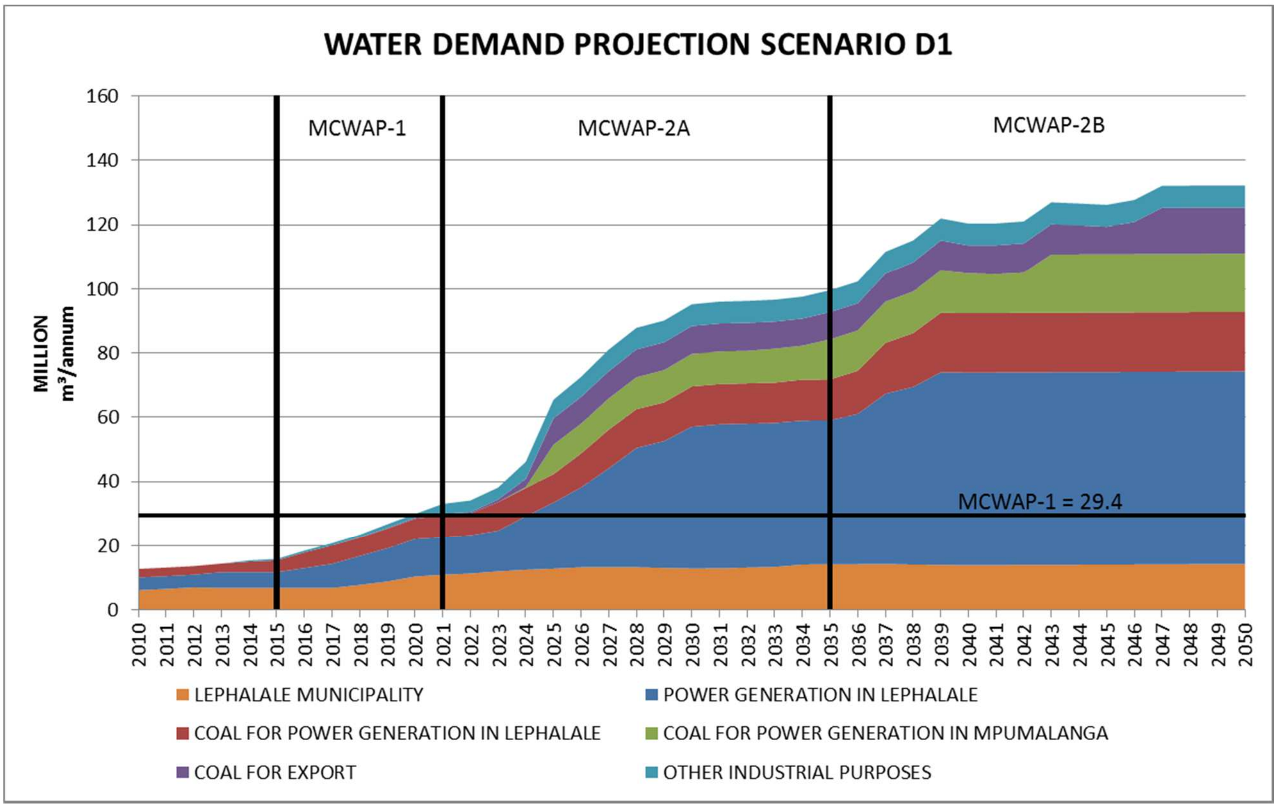

Figure 16: Water Requirement Curve Sector Breakdown

Table 15 below shows the sector breakdown of the total water demand associated with the full development up to 2050 as represented by Scenario D1.

Table 15: Combined Total water requirement projection for Scenario D1 (million m^3/a)

USER	2020	2025	2030	2035	2040	2045	2050
Strategic Industries: Power generation in Waterberg Coal Fields:							
Power stations:	11,72	20,64	44,22	44,92	60,05	60,05	60,05
Strategic Industries: Mining for power generation*:*							
Support power generation in the Waterberg Coal Fields:							
Total	6,38	8,87	12,54	12,74	18,54	18,54	18,54
Support power generation in Mpumalanga:							
Total	0,00	9,17	10,12	12,48	12,43	18,23	18,23
Industrial / Mining for other purposes:							
Production for coal export:							
Total	0,29	8,20	8,67	8,48	8,69	8,54	14,39
Other industrial purposes:							
Total	1,18	5,78	6,78	6,83	6,83	6,83	6,83

USER	2020	2025	2030	2035	2040	2045	2050
Urban use by Lephalale Municipality:							
Municipality	10,35	12,81	12,88	14,15	13,88	14,05	14,24
Incidental Users:							
Total	0,40	0,40	0,40	0,40	0,40	0,40	0,40
Total Demand	30,32	65,87	95,59	100,00	120,82	126,64	132,68
MCWAP 1	29,40	29,40	29,40	29,40	29,40	29,40	29,40
MCWAP 2	0,92	36,47	66,19	70,60	91,42	97,24	103,28

7.2 Recommended Scenario for Further Project Development

Water requirement Scenario D1 is deemed most realistic taking into account the historic delayed implementation of the infrastructure required to open up development of the Waterberg mineral belt.

It is recommended that further development of the MCWAP project be based on this scenario. Detailed tables for this scenario are included in Appendix D.

The biggest uncertainty remaining within this scenario is whether or not the 4th coal fired power station will be developed as well the timing thereof. These uncertainties can be accommodated within the potential phasing of the MCWAP-2 project as demonstrated in the subsequent sections of this report.

8 ASSURANCE OF WATER SUPPLY

The water resources study entitled "Development of a Reconciliation Strategy for the Crocodile West Water Supply System" (CRSS) was completed in 2009. The ongoing review of the Crocodile River (West) Water Supply System Reconciliation Strategy that was developed in 2009 is being undertaken by the DWS in cooperation with institutions in the water sector that are represented on the Strategy Steering Committee (SSC) by national and provincial government departments, municipalities, water service providers, industry, agriculture as well as Non-Governmental Organisations.

Subsequent to the completion of the MCWAP-2 Feasibility Report, the availability of surplus water in the Crocodile River (West) System has been reviewed twice. On 25 July 2012 feedback was given on the status of various activities to SSC members and a revised CRSS was presented and subsequently approved by DWS. This indicated that some shortfalls in available surplus water may occur. However, the latest 2013 review of available surplus water, based on a partially updated demand projection, indicates that no shortfalls are expected up to 2050. The main reason for the changed position is that the growth in return of surplus water, originally supplied from the Vaal River system, was previously under estimated. It is thus concluded from the Figure 17 below that there is sufficient surplus water available, after the water needs within the Crocodile River catchment have been accounted for, to supply the full development potential in the Lephalale area inclusive of a potential fourth coal fire power station. The lower growth rate in available surplus water of the base scenario reflects the likely Gauteng growth scenario. It is also anticipated that the City of Tshwane will also recycle more return flow especially in the Pienaars river catchment. DWS needs to carefully manage the future availability of the targeted return flow in an environment where water shortages may be a future reality.

Refer to PWMA03/A31/00/6615/2 Crocodile (West) River Reconciliation Strategy 2015 (Continuation of Phase 2).

For the purpose of this bridging study, the surplus water supply risk appears to be manageable. It remains imperative that the proposed Crocodile West river management system be successfully implemented to assist with the surplus water conveyance management process. Monitoring of availability and mitigating possible shortfalls to the future growing surplus water source remains the responsibility of DWS. The development of MCWAP 3 or MCWAP 4 in future remains available as mitigation options.

The Users have provided their long-term demand projections from the MCWAP, which are material to the planning and execution of the MCWAP-2. As the river system analysis models for the Mokolo and Crocodile River systems are still separate, the yield simulations were manually integrated to assess the long term yield for the integrated system, applying the agreed differentiated levels of assurance of supply for different user sectors. The Users will notwithstanding the initial demand projections, annually provide and inform DWS of their annual forecast of water use requirements. DWS will in due course develop an integrated river system analysis model for the Mokolo River and the Crocodile River (West) systems to simulate the assurance of supply on an annual basis, and for consideration by the System Operating Forum on the need for possible curtailments during drought situations.

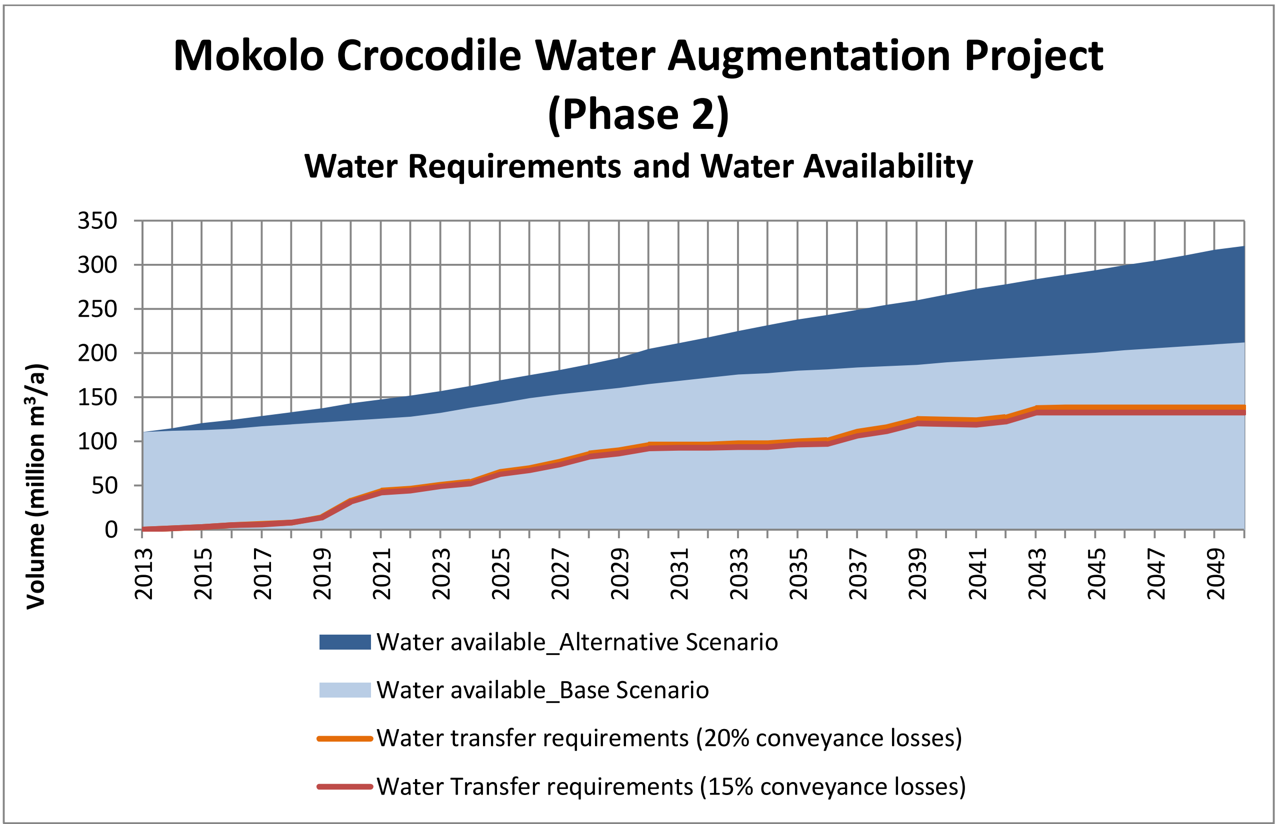

Figure 17: MCWAP-2 Water Transfer Requirements vs Surplus Water Available

The Crocodile River (West) Annual Operating Analyses Study being undertaken by DWS is deemed critical for its engagement with water users through the System Operating Forum to determine the quantities of water available over the short-term, especially when water resource systems are experiencing a drought. The DWS is also winding up the classification of water resources in the Crocodile and neighbouring catchments, which will result in the setting of classes of the water resources and associated ecological water requirements.

Water quality in the Crocodile River (West) is an increasingly important challenge in the catchment and the Strategy Steering Committee (SSC) recommended that the DWS should undertake a water quality assessment study guided by a proposed Steering Committee to evaluate and ensure fitness of water for use. TCTA already prepared a Crocodile River (West) water quality baseline report in compliance with the EIA requirements for the implementation of MCWAP-2A.

The MCWAP is funded off-budget based on the principle that the Users pay. The Users require the assurance that the surplus water will be available as per the projected demand. This specifically emphasises the need of the Users for an integrated water supply planning system, contemplated in terms of the NWRS, devised by the Minister in terms of Sections 5, 6 and 7 of the NW Act, for the compilation and maintenance of total demand scenarios of all water users from the MCWAP.

9 INFRASTRUCTURE IMPLEMENTATION OPTIONS

9.1 Options and Configurations Considered

The MCWAP-2 is a very large scale infrastructure development and the investment needs to be optimised by constructing optimally sized components that will deal with the growing water requirements in the Waterberg Coalfields over the next 20-30 years, a typical period for which bulk water projects are planned for in the RSA. For the purpose of this study the water requirement scenarios covers a planning horizon of up to 2050.

As indicated previously, the use of the off-budget project funding model depends on users that are in a position to commit to the procurement of water at the agreed rates for a period of at least 20 years. For this reason all users with large potential developments planned are regarded to be relevant.

When this bridging study commenced the estimated long term (2050) MCWAP water requirement from a fully developed area was estimated 135 million m^3/a. Refer to water demand Scenarios C1 in this regard. Based on water requirement Scenario C1 the total potential projected water requirement in 2050 is 135,15 million m^3/a. Taking into account the capacity of MCWAP-1, the transfer capacity required for MCWAP-2 in 2050 is 105,75 million m^3/a (135,15 – 29,4 million m^3/a).

Based on water requirement Scenario C1 the total potential projected water requirement in 2040 is virtually the same due to the assumed rapid development in the area. The conservative indicative required capacity of MCWAP-2 was then expected to be 110 million m^3/a.

The planning horizon of the Department of Energy was only up to 2030 at the time of this report (refer to IRP 2010). Although Eskom was consulted regarding the planning for future power generation and the related coal demand, the Department of Energy was not in a position to verify specific energy planning for this region beyond 2035. To better align the global planning processes, the planning of the implementation of MCWAP-2 bulk water infrastructure focus on the water requirements up to 2040. This started the idea to follow a phased implementation approach for MCWAP-2.

Up to December 2013 the planning process also looked at the event that CFP 4 may not be developed or be delayed. In this event the adjusted MCWAP projected water demand in 2040 is 105,56 million m^3/a. This is inclusive of Eskom still requiring the 5,4 million m^3/a beyond 2040 to produce coal for power generation in Mpumalanga. Assuming that 29,4 million m^3/a will be supplied from the Mokolo River system (MCWAP-1), the balance that needs to be supplied from the Crocodile River (West) system (MCWAP-2A) under this scenario is 76,16 million m^3/a. For this water requirement scenario, the MCWAP-2A transfer capacity was assumed to be 80 million m^3/a.

At the time the full development scenario was still deemed to be 110 million m^3/a.

During the early stages of the bridging study, water transfer options for MCWAP-2 were investigated varying from 50 million m^3/a to 110 million m^3/a in 5 million m^3/a increments. The purpose of this was to exhibit the sensitivity of the relative construction and life cycle costs to variation of the MCWAP-2 transfer system capacity.

The option analysis further investigated the impact of:

- Applying the principle of economy of scale; and
- Applying a phased approach due to development and operational risk constraints.

Five MCWAP-2 implementation options were initially investigated:

- Option V: Construct only 80 million m³/a capacity and re-assess the requirements in future;
- Option W: Construct only 95 million m³/a capacity and re-assess the requirements in future;
- Option X: Construct full 110 million m³/a capacity from the start (2019);
- Option Y: Construct 80 million m³/a capacity in 2019 supplemented by 30 million m³/a in 2036; and
- Option Z: Construct 80 million m³/a capacity in 2019 supplemented by 80 million m³/a in 2036.

In light of the slightly reduced water requirement projections up to December 2013, the revised IRP 2010 and potential commitment by users, the required MCWAP-2 transfer capacity is expected to vary between 50 million m³/a and 100 million m³/a.

Option Z addresses the introduction of some operational redundancy to facilitate future pipeline rehabilitation. A sensitivity analysis was also done on Options Y and Z to assess the impact if the 4th coal fired power station were to be developed 10 years earlier or 10 years later than the 2036 currently anticipated. The Options are not directly comparable due to the varying capacities. Only Options X and Y are comparable in this regard. Option W with a capacity of 95 million m^3/a, was investigated to reflect the situation where there is commitment for CFP 4 but not for the long-term export coal mine development beyond 2040.

The transfer system needs to be designed with sufficient redundancy to provide 95% availability. The design will also be checked for the ability to provide Medupi only from MCWAP-2 for extreme operating conditions. The transfer system design was optimised for the committed 2040 demand with limited provision for future expansion (MCWAP-2B). It is further recommended that the abstraction weir component be sized for the very long term water demand potential indicated by Scenario 9 during the feasibility stage namely 197,2 million m^3/a (say 200 million m^3/a), as it is not regarded practical to phase develop such a relative low structure, also considering the poor foundation conditions.

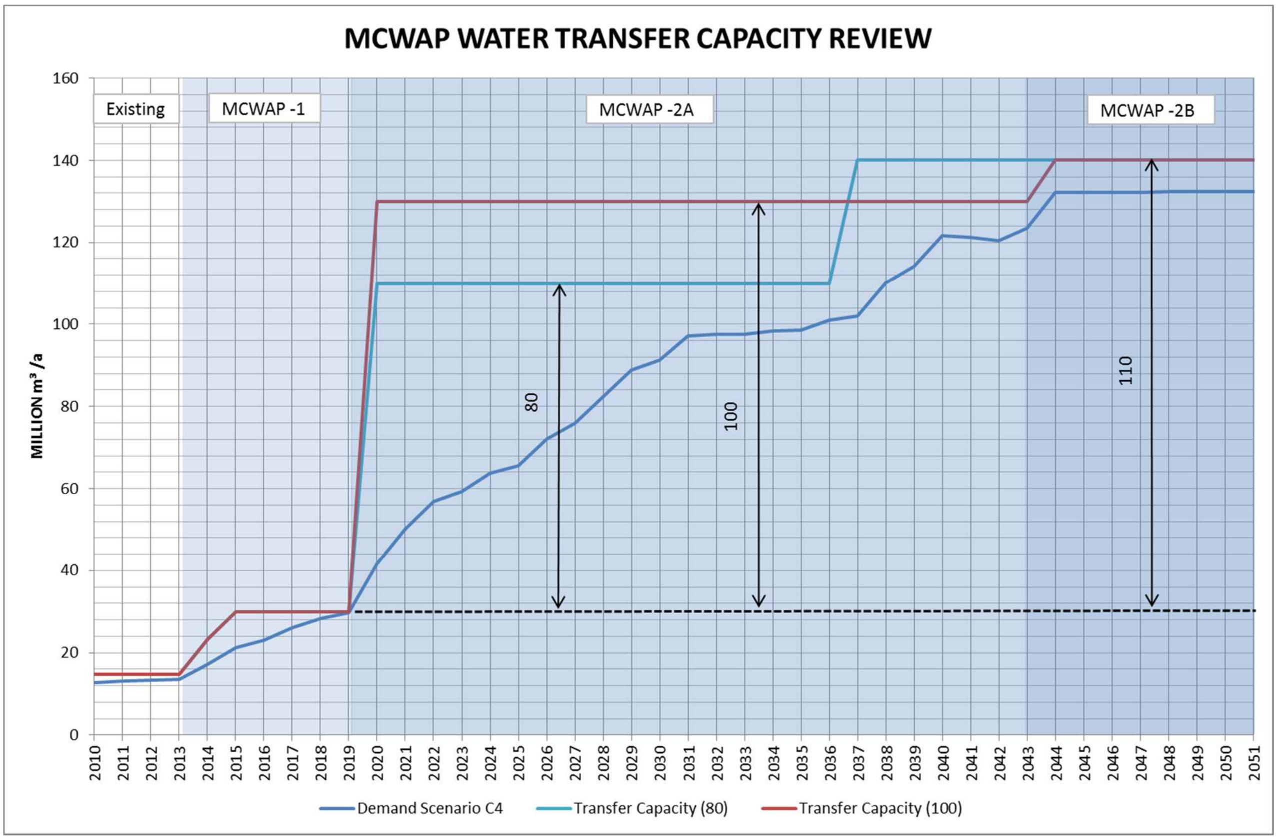

Figure 18: MCWAP-2 Water Requirement vs Transfer System Capacity

Figure 18 above indicates the potential phased development options of the system capacity.

Subsequent to the development of the 5 options described above further refinement of the water requirement projections indicated that the preferred MCWAP-2A capacity is 100 million m^3/a. Option X** was introduced targeting a MCWAP-2A capacity of 100 million m^3/a. The probability of having to do further future phased capacity development is small.

Subsequent to December 2013 and the commitment by National Treasury the Option Y** was then developed to check the relative additional cost of the phased approach compared to Option X**. The probability of having to do further future phased capacity development is higher.

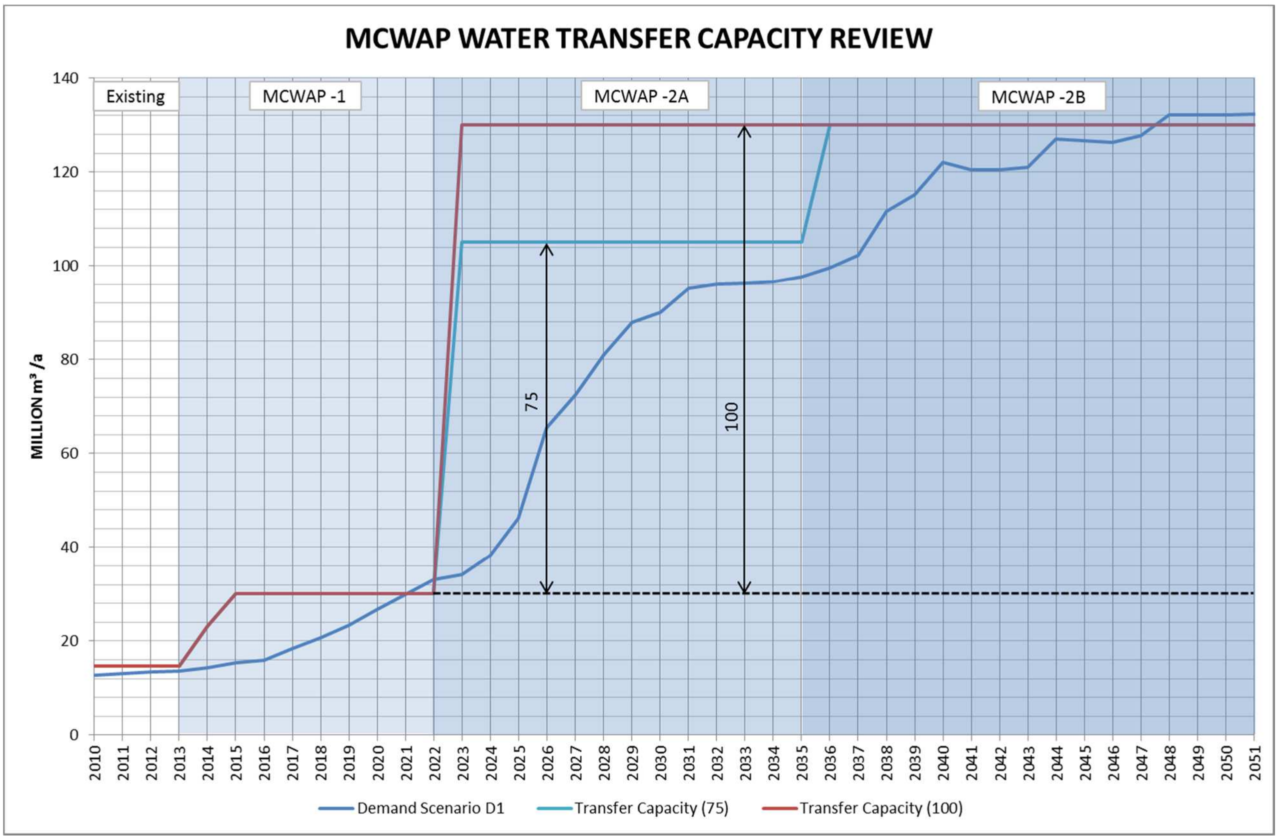

Figure 19: MCWAP-2 Water Requirement vs Transfer System Capacity

Figure 19 above indicates the alternative phased development option of the system capacity post 2013. Option Y** was introduced targeting a MCWAP-2A capacity of 75 million m^3/a with additional capacity (25 million m^3/a) provided after 2035.

Option V** was also introduced indicating the situation if CF-4 and its associated mines are not developed, assessing a MCWAP-2A capacity of 75 million m^3/a.

9.2 Construction Cost

The construction cost estimates have a base date of April 2012 and were based on the costing model used for the MCWAP feasibility study. These cost estimates should only be used for sensitivity analyses and comparative purposes. The final total MCWAP-2 development cost estimate will be determined by the TCTA inclusive of the financing cost and administrative processes. The water tariff will be determined using the TCTA total estimated construction, operation and maintenance and financing cost.

A summary of the construction cost estimates for each of the Options are summarised in Table 16. The comparison was made relative to Option X, the long term fully developed scenario up to 2050.

Table 16: Options Construction Cost Comparison

Option	System Capacity million m³/a	Construction cost R million	% Difference to Option X	Coal 4 start first unit
V**	75	6 014	-11%	
V	80	6 140	-9%	
W	95	6 496	-4%	
X**	100	6 591	-3%	
X	110	6 779	0%	2036
Y	80+30	8 931	+32%	2036
Y**	75+25	8 639	+27%	2036
Z	80+80	10 446	+54%	2036

9.3 A Life Cycle Cost

The present value of the estimated life cycle cost of the phased options was used to compare the phased approaches to the single system. Discount rates of 4%, 6% and 8% per annum were applied and a design life of 45 years was assumed. The life cycle costs include the construction costs, operational costs, maintenance costs and energy costs.

Table 17 below shows an estimated construction cost and life cycle cost (45 years) for different MCWAP-2 transfer capacities. These cost estimates are to be utilised for relative comparison and sensitivity analysis purposes only. The final total MCWAP-2 development cost estimate will be determined by the TCTA inclusive of the financing cost and administrative processes. The water tariff will be determined using the TCTA total estimated construction, operation and maintenance and financing cost.

Table 17: MCWAP-2: Construction Cost and Life Cycle Cost Comparison

Relative Cost Comparison in terms of April 2012 Rand				
Transfer Capacity	**Construction Cost**	**PV Lifecycle cost (4%)**	**PV Lifecycle cost (6%)**	**PV Lifecycle cost (8%)**
Million m³/a	**R**	**R**	**R**	**R**
50	5 380 283 254	5 345 475 450	4 696 679 534	4 189 444 804
55	5 506 929 535	5 497 921 970	4 822 849 802	4 297 335 303
60	5 633 575 817	5 650 368 491	4 949 020 070	4 405 225 803
65	5 760 222 098	5 802 815 011	5 075 190 338	4 513 116 302
70	5 886 868 380	5 955 261 532	5 201 360 605	4 621 006 802
75	6 013 514 662	6 107 708 052	5 327 530 873	4 728 897 302
80	6 140 160 943	6 260 154 572	5 453 701 141	4 836 787 801
85	6 258 782 271	6 367 248 257	5 548 200 913	4 921 589 844
90	6 377 403 600	6 474 341 941	5 642 700 686	5 006 391 886
95	6 496 024 928	6 581 435 625	5 737 200 459	5 091 193 928

Relative Cost Comparison in terms of April 2012 Rand				
Transfer Capacity	**Construction Cost**	**PV Lifecycle cost (4%)**	**PV Lifecycle cost (6%)**	**PV Lifecycle cost (8%)**
Million m³/a	**R**	**R**	**R**	**R**
100	6 590 456 583	6 681 587 158	5 822 093 943	5 165 299 817
105	6 684 888 239	6 781 738 690	5 906 987 427	5 239 405 707
110	6 779 319 894	6 881 890 223	5 991 880 911	5 313 511 596

* Note : The values in the table not indicated in bold are interpolated values

It is worth noting that the estimated construction cost of a scheme with a 100 million m^3/a transfer capacity is only 7,3% more than a scheme with an 80 million m^3/a transfer capacity which is less than the accuracy level required for feasibility stage cost estimation. It is concluded that with the flat shape of the capacity vs cost curve, the selection of the capacity is less sensitive to the final construction cost estimation.

The present value (PV) of the estimated life cycle cost of the phased options was used to compare the phased approaches to the economy of scale single system development approach.

It is expected that given the slow rate of recovery of the international economy, the average discount rate would be varying between 4% and 6% for the largest part of the 45 year design life. Please note that the Options are not directly comparable due to the system capacity differences. The results are summarised in Tables 18 and 19 below.

Table 18: Options Present Value Life Cycle Cost Comparison

Option	System Capacity Million m^3/a	PV Life Cycle Cost (4%) R million	% Difference to Option X	PV Life Cycle Cost (6%) R million	% Difference to Option X	PV Life Cycle Cost (8%) R million	% Difference to Option X
V	80	6 260	-9%	5 454	-9%	4 837	-9%
W	95	6 581	-4%	5 737	-4%	5 091	-4%
X**	100	6 682	-3%	5 822	-3%	5 165	-3%
X	110	6 882	0%	5 992	0%	5 314	0%
Y	80+30	7 672	+11%	6 378	+6%	5 451	+3%
Z	80+80	8 390	+22%	6 853	+14%	5 769	+9%

Table 19: Post 2013 Options Present Value Life Cycle Cost Comparison

Option	System Capacity Million m^3/a	PV Life Cycle Cost (4%) R million	% Difference to Option X**	PV Life Cycle Cost (6%) R million	% Difference to Option X**	PV Life Cycle Cost (8%) R million	% Difference to Option X**
V**	75	5 609	-6%	4 723	-6%	4 045	-6%
X**	100	5 968	0%	5 011	0%	4 284	0%
Y**	75+25	6 902	16%	5 572	11%	4 611	8%

9.4 Unit Reference Value (URV)

The unit reference value (URV) of water is defined as the value attached to the net water requirement supplied to the consumers so that the discounted present value of the water is equal to the discounted present value of the cost. It should not be interpreted as or confused with a water tariff.

The URV of water has been determined for discount rates of 4%, 6% and 8% and is based on the net water transferred to the demand centres for a 45-year period. The URVs for the various options are summarised in Table 20. These figures are based on April 2012 prices. All discounting was done to 2012 over a period of 45 years.

Table 20: Option URV Comparison

Option	URV (4%) over 45 years R/m^3	% Difference to Option X	URV (6%) over 45 years R/m^3	% Difference to Option X	URV (8%) over 45 years R/m^3	% Difference to Option X
V	6,80	+4%	9,33	+1%	12,50	-1%
W	6,61	+1%	9,19	0%	12,48	-1%
X**	6.67	+2%	8.93	-3%	11.78	-7%
X	6,57	0%	9.22	0%	12.62	+0%
Y	7,32	+11%	9.82	+6%	12.95	+3%
Z	8,01	+22%	10.55	+14%	13.70	+9%

Up to December 2013 the above option analysis indicated that the phased implementation of MCWAP-2A (Option Y vs Option X) can be expected to be up to 11% more expensive (in terms of present value life cycle cost and URV).

Subsequent to December 2013 the above option analysis indicates that the phased implementation of MCWAP-2A (Option Y** vs Option X**) can be expected to be up to 18% more expensive (in terms of present value life cycle cost and URV). The revised URV's for three remaining options are summarised in Table 21 below.

Table 21: Revised Option URV Comparison

Option	URV (4%) over 45 years R/m³	% Difference to Option X**	URV (6%) over 45 years R/m³	% Difference to Option X**	URV (8%) over 45 years R/m³	% Difference to Option X**
V**	7.03	9%	9.57	8%	12.76	7%
X**	6.44	0%	8.85	0%	11.90	0%
Y**	7.57	18%	10.09	14%	13.25	11%

There is a higher degree of uncertainty associated with the development of CFP-4 and its associated mine infrastructure. The additional estimated life cycle cost of a phased development (Option Y) is significant, especially if CFP-4 is developed early or at the currently anticipated commissioning date of 2036. However, should CFP-4 be required to commence with power supply beyond 2040, the estimated additional life cycle cost of a phased development would be marginal.

9.5 Cost Analysis

It is concluded that the phased implementation of MCWAP-2 (Option Y vs Option X) may be up to 11% more expensive (in terms of present value life cycle cost and URV) if CFP-4 is commissioned in 2036. However, should CFP-4 be developed 10 years earlier, the phased development may be up to 22% more expensive compared to the single phase development. Should CFP-4 be developed 10 years later than 2036, the phased development may be only 4% more expensive compared to the single phase development.

There is still a high degree of uncertainty associated with the development of CFP-4 and its associated mine infrastructure. The additional estimated life cycle cost of a phased development is significant, especially if CFP-4 is developed early or at the currently anticipated commissioning date of 2036. However, should CFP-4 be required to commence with power supply much later (2046), the estimated additional life cycle cost of a phased development would be less significant. A decision on the phasing of MCWAP-2 is thus dependent on discounting the risks with respect to CFP-4.

Table 22 indicates the sensitivity with regard to the pipe size selection for the various planned pipeline trajectories. The hydraulic models for each of the scenarios are included in Appendix E.

Table 22: Comparative Pipe Sizes

Pipeline Trajectory	**Length (km)**	**75 Million m³/a**	**80 Million m³/a**	**95 Million m³/a**	**100 Million m³/a**	**110 Million m³/a**	**75+25 Million m³/a**	**80 + 30 Million m³/a**	**80 + 80 Million m³/a**
		Diameter (mm)	**Diameter (mm)**	**Diameter (mm)**	**Diameter (mm)**	**Diameter (mm)**	**Diameter (mm)**	**Diameter (mm)**	**Diameter (mm)**
		Option V*	**Option V**	**Option W**	**Option X***	**Option X**	**Option Y***	**Option Y**	**Option Z**
Pipelines between High lift Pump Station and Steenbokpan									
Rising Main PS to BPR	29,0	1300	1 300	1 500	1500	1 600	1 300 & 800	1 300 & 800	1 300 & 1 300
Gravity Main 1 BPR to OR	63,6	1700	1 700	1 800	1900	1 900	1 700 & 1 100	1 700 & 1 200	1 700 & 1 700
Gravity Main 2 OR to CP	9,2	2200	2 200	2 300	2400	2 400	2 200 & 1 500	2 200 & 1 600	2 200 & 2 200
Gravity Main 3 CP to OT1	8,7	1500	1 500	1 600	1600	1 600	1 500 & 900	1 500 & 1 000	1 500 & 1 500
Gravity Main 4 OT1 to OT2	8,3	1500	1 500	1 600	1600	1 600	1 500 & 900	1 500 & 1 000	1 500 & 1 500
Total Length	**118,8**								
Pipelines between Steenbokpan and Medupi Power Station									
Gravity Main 5 OT2 to HP	18,2	1400	1 400	1 500	1500	1 600	1 400 & 800	1 400 & 800	1 400 & 1 400
Gravity Main 6 HP to OT3	3,7	1000	1 000	1 100	1100	1 100	1 000 & 600	1 000 & 600	1 000 & 1 000
Gravity Main 7 OT3 to OT4	10,9	1000	1 000	1 100	1100	1 100	1 000 & 600	1 000 & 600	1 000 & 1 000
Total Length	**32,8**								

From the above comparison it can be concluded that the decision about the final design capacity of the MCWAP-2 transfer system may be driven by the management of risks. The required pipe sizes for the various options vary by only one or two standard pipe sizes. Initially the single 110 million m^3/a appeared to be the most economical option, but there is a risk that it may be too large. This risk can only be finally quantified once the decision on the likelihood of the 4^{th} coal fired power station is made. However, this decision will not be made within the available time frame to implement MCWAP-2.

From a risk management perspective, it may be prudent to phase the MCWAP-2 design capacity. The present value of the comparative estimated life cycle cost for Option Y is more expensive than Option X, but it offers the flexibility to adjust the future capacity supplementation phase to be better aligned with the strategic power generation decisions to be made at that time. It also offers the opportunity not to overspend, should CFP-4 not be developed. Should it be necessary to develop CFP-4 earlier, this phased decision will be at a premium. However, this premium may still be less expensive compared to other power generation options that forms part of the national integrated resource plan for electricity (IRP).

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

10.1.1 General

When Sasol decided in 2010 not to proceed with the Mafutha Project the water requirement from MCWAP-2 reduced significantly. Parallel to this the planning uncertainties in the power generation sector and delays in the commissioning of the Medupi power station created a very complex water requirement planning environment. The bulk water planning process requires the integration of the very dynamic and also largely confidential planning processes of power generation and associated coal mining. The review of the water requirements in this highly dynamic environment required that water requirement projections had to be adjusted continuously during the review process. For this reason the report reflects stages of the extremely dynamic process.

December 2013 was selected to reflect the impact of the misalignment of the external planning horizons. The water requirement scenarios and bulk water infrastructure options identified prior to December 2013 had to be adjusted for on-going potential reduced water requirements after 2013. This report concluded in 2015 that the determination of the final MCWAP-2 water requirement is still largely dependent on the final extent of power generation that is planned in the Waterberg coal field area.

10.1.2 Pre December 2013

Although the projected MCWAP water demand is reduced significantly from the initial feasibility study, the anticipated growth was still exceptionally steep between 2019 and 2031. This coincides with the Flue Gas Desulphurisation retrofitting at Medupi and Matimba, the development of a third coal fired power station and associated mines and infrastructure, as well as coal supplies to existing power stations in Mpumalanga. The water demand to which users can potentially commit financially does not generally extend beyond 2040. The exception was Eskom's undertaking to commit to procure water for coal production for Mpumalanga.

It was concluded that the total required system transfer capacity for MCWAP-2 up to 2040 is hence likely in the range 80 to 100 million m³/a. Should no decision be made to provide capacity in MCWAP-2 for CFP-4, the MCWAP-2 capacity was proposed to be 80 million m³/a. Should provision be made for CFP-4 for commissioning by 2036, the MCWAP-2A capacity was proposed to be 100 million m³/a. Up to December 2013 it was concluded that Option X in this report is the most economical solution based on economy of scale considerations.

10.1.3 Post December 2013

Following the refinement of the water requirement Scenario C4 to Scenario D1 and the refinement of Bulk Water Infrastructure Options V, X and Y to V**, X** and Y** respectively, it set the scene to use phased development to mitigate the uncertainty associated with the possible long-term development of CFP-4 or not. From this process it is concluded that:

a) Implementation Option X** (100 million m^3/a) is the most cost efficient long-term solution. The current user committed Option Y** (75+25 million m^3/a) is 31% more expensive from a construction cost point of view;

b) The phased implementation of MCWAP-2A (Option Y** vs Option X**) can be expected to be between 18% and 11% more expensive in terms of URV based on discount rates of 4% and 8% respectively;

c) Based on the present value analysis the implementation Option X** (100 million m^3/a) is 6% more expensive than Option V** (75 million m^3/a), but it effectively offers a saving of between 8% and 16% in the long term;

d) Based on the fact that the user water requirement projection input was obtained in 2012, the planning time frames are already outdated and the accuracy of the location and water demand assumptions are losing relevance;

e) The misalignment of the planning horizons (2030 for electricity vs 2050 for water) impacted significantly on the planning process. The Department of Energy and National Treasury is only willing to support the integrated planning process up to 2035. It effectively includes allowance for the development of CFP3 but excludes any allowance for the development of CFP 4 and the associated mining activities. The refined review process subsequent to December 2013 reflects the impact of this situation. Exclusion or postponement of CFP4 favours Option Y** (75 + 25 million m^3/a). It also holds the benefit that a decision on the timing and size of the future sub-phase can be postponed until there is more certainty about developments in the long term;

f) Based on the latest adjusted water demand projection (Scenario D1), the MCWAP 2A is required to deliver water by December 2021; and

g) Based on the recommendation in the Feasibility Study that the Crocodile River (West) river management system must be operational 18 months before the MCWAP 2A water delivery date, the river management system needs to be operational by June 2019.

The following general conclusions are relevant:

- The relevant rural communities can potentially be more economically supplied from local ground water sources until 2030. The MCWAP 2A water tariff is regarded to be significantly more expensive compared to other potential sources. Furthermore, water will be available only much later from MCWAP-2;
- The urban water demand is growing faster than expected. Demand management measures should be implemented as soon as possible as part of the raw water supply agreement with the Lephalale Municipality;
- The latest Crocodile River (West) reconciliation report indicates that there is sufficient surplus water available to supply in the projected water requirement as presented in the latest Scenario D1; and
- It is required that the river system analysis model for the Mokolo River and the Crocodile River (West) be integrated to assess the water availability annually.

10.2 Recommendations

In order to manage the risks associated with commercial users not being in a position to commit at the time that implementation should commence, the following approach is recommended:

a) The most economical solution is offered by Option X**. From an economy of scale and cost efficient implementation point of view it is recommended that the civil structures be based on a water requirement of 100 million m³/a. The mechanical and electrical components can be phased in as required. Table 23 below reflects the recommended design capacities of the MCWAP-2A infrastructure components for Option X**.

b) Should funding not be secured for water infrastructure required beyond 2035, a phased transfer capacity development approach can be followed (Option Y**). The minimum design capacity for a MCWAP-2A should then be 75 million m³/a. The design capacity for the civil works should be reviewed for potential future extension. Table 24 below reflects the recommended design capacities of the MCWAP 2A infrastructure components for Option Y**.

Table 23: Transfer System Component Phased Design Capacities (Option X)**

Component	Current Design Horizon	Design Capacity Million m^3/a
Abstraction Weir	2B+	125
Low lift PS (Civil works)	2B+	125
Low lift PS (M&E works)	2A and Provision for 2B	75
Low lift rising main (2 Pipes)	2A + Space for 2B	100
De-silting works	2A + Space for 2B	100
Balancing dams	2A + Space for 2B	100
High Lift PS (Civil Works)	2A+ Space for 2B	100+
High Lift PS (M&E Works)	2A and Provision for 2B	75
High lift rising main	2A + Space for 2B	100
Reservoirs	2A + Space for 2B	100
Gravity main to Steenbokpan	2A + Space for 2B	100
Gravity main to Medupi	2A + Space for 2B	75

2B+ means beyond MCWAP-2B

Table 24: Transfer System Component Phased Design Capacities (Option Y)**

Component	Current Design Horizon	Design Capacity Million m^3/a
Abstraction Weir	2B+	125
Low lift PS (Civil works)	2B+	125
Low lift PS (M&E works)	2A and Provision for 2B	75

Component	Current Design Horizon	Design Capacity Million m^3/a
Low lift rising main (2 Pipes)	2A + Space for 2B	75
De-silting works	2A + Space for 2B	75
Balancing dams	2A + Space for 2B	75
High Lift PS (Civil Works)	2A+ Space for 2B	100+
High Lift PS (M&E Works)	2A and Provision for 2B	75
High lift rising main	2A + Space for 2B	75
Reservoirs	2A + Space for 2B	75
Gravity main to Steenbokpan	2A + Space for 2B	75
Gravity main to Medupi	2A + Space for 2B	50

2B+ means beyond MCWAP-2B

It is further recommended that:

- MCWAP 2A be implemented to target water delivery by end of 2021;
- The river management system for the Crocodile River (West) be implemented in time to be operational by June 2019 (18 months prior to the transfer scheme water delivery date); and
- DWS in due course develop an integrated river system analysis model for the Mokolo River and the Crocodile River (West) systems to simulate the assurance of supply on an annual basis, for consideration by the System Operating Forum on the need for possible curtailments during drought situation.