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REPUBLIC OF SOUTH AFRICA
Directorate: National Water Resource Planning

Vaal River System: Large Bulk Water Supply Reconciliation Strategy

EXECUTIVE SUMMARY





MARCH 2009

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DEPARTMENT OF WATER AFFAIRS AND FORESTRY

DIRECTORATE: NATIONAL WATER RESOURCE PLANNING

VAAL RIVER SYSTEM: LARGE BULK WATER SUPPLY RECONCILIATION STRATEGY

Executive Summary

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VAAL RIVER SYSTEM: LARGE BULK WATER SUPPLY RECONCILIATION STRATEGY

LIST OF REPORTS

Report No:	Title
P RSA C000/00/4406/01	Urban Water Requirements and Return Flows
P RSA C000/00/4406/02	Potential Savings through WC/WDM in the Upper and Middle Vaal Water Management Areas
P RSA C000/00/4406/03	Re-use Options
P RSA C000/00/4406/04	Irrigation Water Use and Return Flows
P RSA C000/00/4406/05	Water Resource Analysis
P RSA C000/00/4406/06	Groundwater Assessment
P RSA C000/00/4406/07	First Stage Reconciliation Strategy
P RSA C000/00/4406/08	Second Stage Reconciliation Strategy
P RSA C000/00/4406/09	Executive Summary

Above list of reports effective as at March 2009.

VAAL RIVER SYSTEM: LARGE BULK WATER SUPPLY RECONCILIATION STRATEGY

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Consultants: DMM / Golder Associates Africa / SRK / WRP and Zitholele

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WATER RECONCILIATION STRATEGY FOR THE VAAL RIVER SYSTEM

Executive Summary

TABLE OF CONTENTS

1 PURPOSE OF THE DOCUMENT

The purpose of the Executive Summary is to provide an abridged description of the Water Supply Reconciliation Strategy that was developed during the Vaal River System: Large Bulk Water Supply Reconciliation Strategy Study. An overview of the strategy is presented along with the recommendations that are required to ensure sufficient water is made available for the growing water requirements of the users dependant on the system.

2 INTRODUCTION

The supply area of the Vaal River System stretches far beyond the catchment boundaries of the Vaal River and includes most of Gauteng, Eskom's power-stations and Sasol's petro-chemical plants on the Mpumalanga Highveld, the North-West and Free State goldfields, iron and manganese mines in the Northern Cape, Kimberley, several small towns along the main course of the river, as well as the Vaalharts Irrigation Scheme. It will soon be extended to also supply water to the developments on the Waterberg coal-fields near the town of Lephalale in the Mokolo catchment.

Over decades the water resources of the Vaal River System were augmented to match the growing water requirements and major inter-basin transfer schemes were developed to convey water into the system from the high rainfall regions of the upper Thukela and Usutu rivers as well as from the headwaters of the Orange River in the highlands of the Kingdom of Lesotho. **Figure A-1** in **Appendix A** shows a geographical map of how the Vaal River System is integrated with other rivers and depicts the area of concern for this document. The water resource components of the Integrated Vaal River System are highly inter-dependant due to the cascading orientation of the three Vaal River Water Management Areas as well as the links that exist as a result of the transfer schemes (indicated by the arrows on **Figure A-1**).

The Department of Water Affairs and Forestry is conducting a number of studies of the large metropolitan areas of which the *Large Bulk Water Supply Reconciliation Strategy for the Vaal River System* and the *Crocodile (West) River Reconciliation Strategy* studies serve to inform this document. These are comprehensive planning studies with the objective to determine a strategy that will ensure that enough water will be available when it is required in future. Scenarios of future demands are developed and the measures that would have to be implemented to meet those future needs are identified and investigated. Climate change and its possible impacts on water resource availability were also considered. From the limited information available with the associated low level of confidence, it was decided that the impact of climate change on the overall Vaal River System is not substantial enough for it to be incorporated into the strategy.

3 SCENARIO PLANNING

The strategy development methodology followed a Scenario Planning process where future water requirement scenarios provide the target water needs which have to be met by a combination of intervention measures. In this process alternative future water requirement projections (scenarios) are compiled and compared to different combinations of intervention measures with the aim to find

flexible solutions.

The starting point of compiling water requirement scenarios (for the water uses depending on the Vaal River System) was the development of alternative (high, base and low) scenarios of possible future population. These were in turn applied as the main driver for the water requirement and return flow scenarios of the urban centres. The High population scenario represents the situation where in-migration to Gauteng occurs at a steady rate due to strong economy growth, effective service delivery and successful interventions for HIV/AIDS are implemented. For the Base Scenario it is assumed the recent and current trends are extended into the future, where the Low Scenario assumes sluggish economic growth, experiencing constraints in service delivery and lower population growth due to the effect of HIV/AIDS. (The projected water balance for the High Scenario is discussed further in **Section 6**)

In addition to the direct water needs of increased urbanisation in the Gauteng Province, water is also required for the provision of energy to feed the expanding economy, not just of Gauteng but also of the Southern African region. Over the short term the bulk of the region's growth in electricity needs will be provided from the thermal power stations that are located on the Eastern Highveld Coal Fields and the associated increased water requirements will be supplied from the Integrated Vaal River System. Furthermore liquid fuel produced by Sasol at their coal-to-liquid plants near Secunda and Sasolburg also requires substantial volumes of water which is expected to increase over time.

Plans to provide in the medium to long term energy needs of the region are by means of large scale developments by Eskom, Sasol and related mining in the Lephalale area located in the Mokolo River catchment. The local water resources from the Mokolo River are insufficient to meet the requirements for such developments, and additional water transfers will be necessary from the Crocodile (West) River and Vaal River systems (indicated as proposed transfer scheme arrows on **Figure A-1**).

Irrigation water requirement makes up about 37% of the total water use supplied from the Vaal River System and detail validation studies carried out for DWAF indicated that as much as 174 million m^3/annum could be unlawful. The bulk of this unlawful water abstraction is located in the river reach upstream of Vaal Dam and downstream of the outflow where the water from the Lesotho Highlands Water Project is discharge into the Ash River from the tunnels. This volume of unlawful abstraction effectively implies that a large proportion of the additional water available from Mohale Dam (part of the Lesotho Highlands Water Project) does not reach the intended users supplied from Vaal Dam.

This unlawful water use must be eradicated as a national priority to reduce the risk of water shortages and to prevent a crisis in the economic hub of the country. The Department has already initiated a process where all legal and compliance enforcement measures are being investigated and preparations made for an enforcement campaign.

Combining the water needs of all the users, scenarios of future requirements were developed. The "high" scenario was used in the planning to ensure that measures are in place to deal with that. The other scenarios were applied mainly to check the impact on the timing of the measures, as well as to ensure that the recommendations are stable and provide a flexible solution.

4 WATER CONSERVATION AND WATER DEMAND MANAGEMENT

Integrated with the *Large Bulk Water Supply Reconciliation Strategy Studies,* the Department also conducted an investigation to determine the potential savings that could be achieved through Water Conservation and Water Demand Management measures in the urban area. The findings from the study indicated that about 15% savings in urban water use is possible through implementing loss management measures such as pressure management, retrofitting and removal of wasteful devices, leak detection and repair, etc. In addition, it was found that measures to improve the efficiency of urban water use can reduce the water requirements by a further 15% (total saving of 30% for all Water Conservation and Water Demand Management measures).

Some of the proposed WC/WDM measures reduce return flows and the net effect of the savings in water supply and the associated reduction in return flows must be taken into account.

The influence of WC/WDM measures that are implemented in the industrial, mining and power generation sectors are factored into the water demand projections of these sectors. The existing projects that have been implemented to improve irrigation efficiency will result in savings, which for the purpose of this study were assumed to be used to address Water Allocation Reform in this sector.

5 MEASURES TO INCREASE THE WATER RESOURCE

Previous investigations by the Department identified that there are two alternative infrastructure options available to serve as the next augmentation scheme for the Vaal River System. They are a further phase of the Lesotho Highlands Water Project (LHWP) and the Thukela Water Project (TWP).

Detailed feasibility studies have been completed for both options and the Department has commissioned the *Vaal Augmentation Comparison Study* to determine, on technical grounds, which of the two options should be selected as the next scheme to augment the Vaal River System.

The outcome of the above-mentioned study led to the decisions by the Minister of the Department of Water Affairs and Forestry and ratified by Cabinet (in December 2008), to proceed with the negotiations with the Government of Lesotho for the implementation of Phase 2 of the Lesotho Highlands Water Project.

6 RECONCILIATION SCENARIOS

Reconciliation Scenarios were defined to determine how a sequence of interventions can be scheduled (phased) to satisfy the water requirements of the supply area up to the year 2040. Different scenarios, each consisting of alternative groupings of measures, were formulated to investigate the constraints and opportunities of a range of possible solutions.

Several scenarios were evaluated during the cause of the study which led to the identification of

actions necessary for sustainable water supply. In order to motivate the water management recommendations the following Reconciliation Scenarios are presented:

Reconciliation Scenario A *is defined as follows:*

- The high water requirement scenario occurs and no further water loss reduction measures are implemented. No reduction in water use due to WC/WDM is assumed in this scenario.

- The increasing trend in the irrigation water use that was observed since 1998 (most of this increase is considered to be unlawful) continues until the total registered irrigation water use volume is reached in the year 2016. This scenario represents the case in the unlikely event the curbing of the unlawful water use is not successful and demonstrates the importance of water use compliance enforcement.

- Implement both Phase 2 of the Lesotho Highlands Water Project (LHWP) and the Thukela Water Project (TWP). The TWP consists of Jana Dam and Mielietuin Dam (in the Bushmans River, a tributary of the Thukela River) and the LHWP Phase 2 option consists of Polihali Dam, both with appropriate conveyance infrastructure.

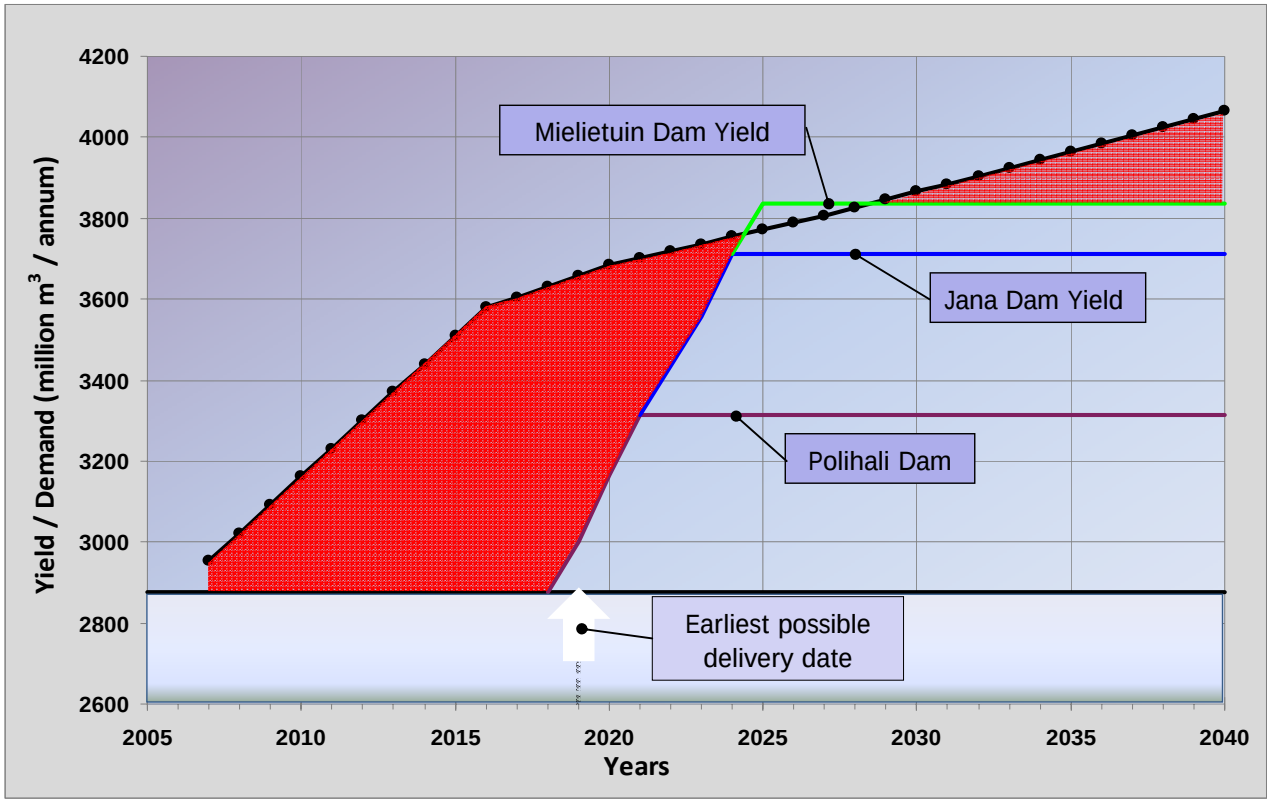

Figure 1: Water balance for Reconciliation Scenario A

Observations from ***Figure 1*** *indicate the following findings:*

- Significant shortages (indicted by the shaded red areas) in supply will occur in the period prior to the date when the augmentation schemes can deliver water, by the year 2019. This is an unacceptable situation which will result in major water supply problems causing significant economic impairments to primary (domestic) and strategic water users.

- The high water requirements of this scenario show that both Phase 2 of the LHWP and the TWP will only supply the system until the year 2029, after which shortages will again occur.

***Reconciliation Scenario B** is defined as follows:*

- This scenario represents the situation where the unlawful irrigation water use is eradicated by 2011 and no further increases in water use occur in that sector.

- The high water requirement scenario is assumed and no further water loss reduction measures are implemented – the same assumption as for **Reconciliation Scenario A**.

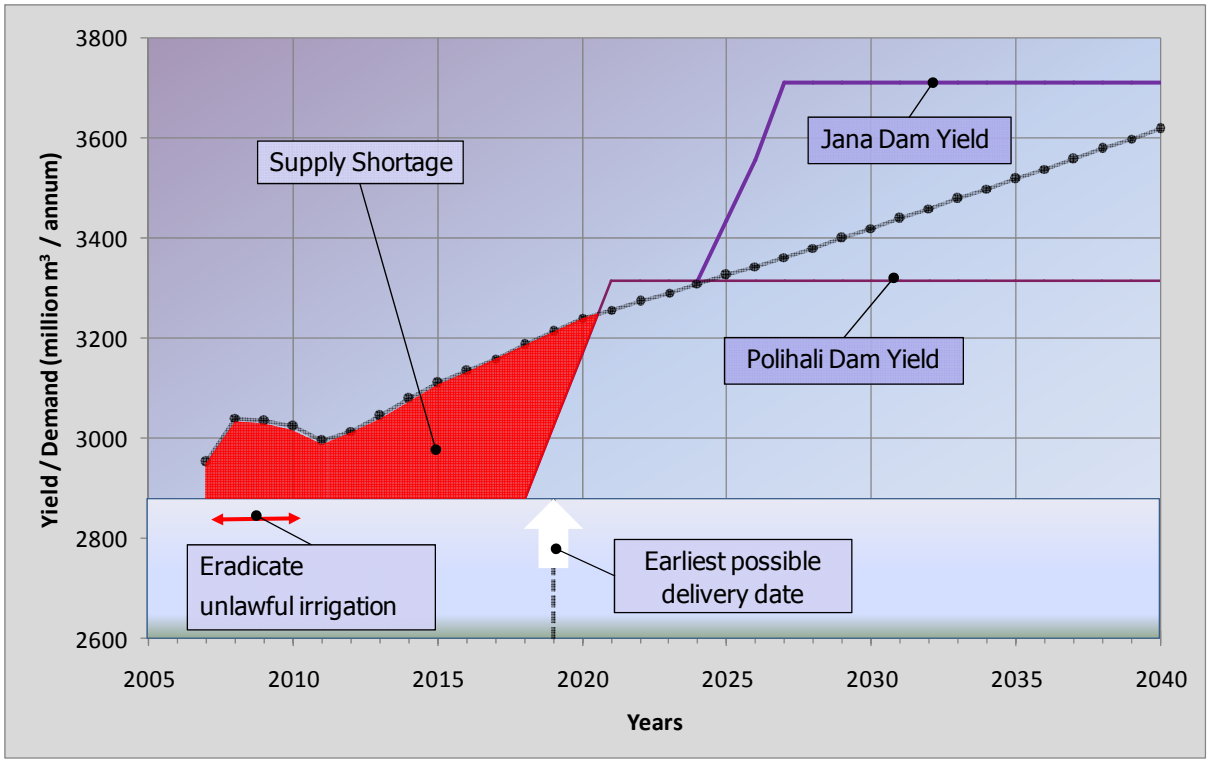

Figure 2: Reconciliation Scenario B, removal of unlawful irrigation and excluding further WC/WDM

*Observations from **Figure 2** indicate the following findings:*

- Compared to **Figure 1**, the shortages are significantly reduced and it is possible to reconcile the water requirements with the deployed resource of Polihali and Jana dams until after the year 2040.

- The water balance situation prior to the date when Polihali Dam can deliver water, however, remains a problem and unacceptable high risks of water curtailments will be experienced during that time. Further interventions are therefore needed to overcome the shortages over the next ten years.

***Reconciliation Scenario C** is defined as follows:*

- Eradicate the unlawful irrigation water use and maintain irrigation at these levels – same as for **Reconciliation Scenario B**.

- Implement Water Conservation and Water Demand Management measures to reduce losses (15% saving scenario) by decreasing the water requirements of the high scenarios.

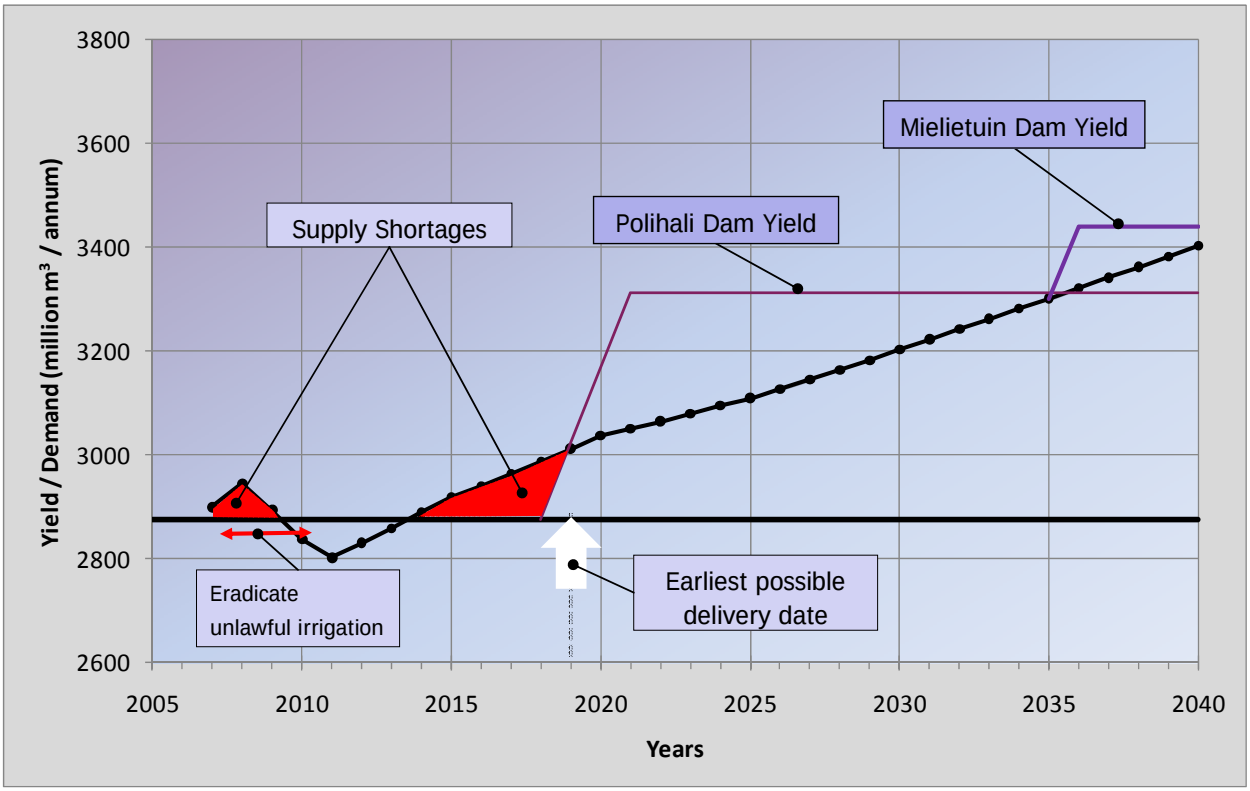

Figure 3: Reconciliation Scenario C, unlawful irrigation removed and 15% savings through WC/WDM

*Observations from **Figure 3** indicate the following findings:*

- The implementation of WC/WDM measures (15% saving scenario) improves the supply situation significantly over the first ten years (compared to **Figure 1**), however, shortages will be experienced from 2014 until Polihali Dam can deliver water in 2019. It will be indicated in **Section 7** how the re-use of treated effluent can be utilised to supply these shortages.

- In this scenario only the smaller Mielietuin Dam options of the TWP is required after Polihali Dam to achieve a positive water balance until 2040.

7 PERSPECTIVE ON WATER QUALITY MANAGEMENT

7.1 SITUATION ASSESSMENT

A water quality situation assessment of the Vaal River System was carried out as part of the Integrated Water Quality Management Plan development. During this process the following was undertaken :-

- The available water quality data was collected and analysed for the Vaal River main stem and the major tributaries.
- An initial set of Resource Water Quality Objectives were set up for the Vaal main stem and the major tributaries.

- The current water quality data was analysed and compared to the Resource Water Quality Objectives to identify water quality variables of concern.

This process identified that salinity (as represented by Total Dissolved Solids), eutrophication and microbiological water quality as the major water quality issues that need to be addressed by the strategy.

The salinity in the Grootdraai Dam and Vaal Dam catchments is currently adequate and meets the water user requirements. However, the water quality in both these dams is influenced by the water quality of the transfers from Lesotho, Thukela, Zaaihoek and the Usutu transfer schemes. Currently, this transfer water is of a good quality and assists in maintaining the current water quality in these dams. However, the water quality in Grootdraai Dam is under threat from mining, in particular decants from closed mines in the catchment. The salinity deteriorates significantly from the Vaal Barrage to Bloemhof Dam due to the urbanisation of the catchment, return flows from wastewater treatment works, industrial discharges and mine dewatering discharges. The current status does not meet the Resource Water Quality Objectives set for this reach of river.

The water quality assessment showed that Vaal Dam, Vaal Barrage and Bloemhof Dam are eutrophic to hypertrophic. The average phosphorus concentrations exceed the proposed Resource Water Quality Objectives significantly. The eutrophic conditions in the middle reaches of the Vaal River have impacted on the performance of the water treatment plants of Midvaal and Sedibeng Water. Additional treatment processes to deal with the colour and odour associated with the eutrophic waters has had to be installed. The major source of the nutrients is the wastewater treatment works effluent discharges and the management and maintenance of the sewerage systems. A number of wastewater treatment works are not performing according to specifications.

The available microbiological database does not support an extensive assessment of the entire Vaal River System. The database does however identify “hot spots” located in the tributaries close to wastewater treatment works discharges. The microbiological water quality in the main stem of the Vaal River, however, in general meets the full contact recreation water quality requirement for E-Coli.

7.2 STRATEGIC MEASURES – WATER QUALITY MANAGEMENT

Management strategies were developed to address salinity, eutrophication and microbiological quality.

The salinity management strategies recommended:-

- Ongoing dilution with releases from Vaal Dam to maintain the TDS concentration in the outflow from the Vaal Barrage at 600 mg/l in the short term.
- Desalination of all the major saline mine water and WWTW discharges to potable standard for re-use in the Rand Water distribution system in the medium and long term.

The nutrient management options recommended are:-

- Flow manipulation in the middle reaches of the Vaal River to break down stratification and reduce residence time to limit the algal bloom development.

- Phosphorus reduction programs through more stringent phosphorus discharge standards. The reductions could not be easily assessed as the nutrient and eutrophication models available are not as well developed and applied as the salinity models and need further work.

The microbiological management scenarios recommended were to audit the wastewater treatment works and sewerage systems in terms of current performance and future planning.

7.3 UTILISATION OF TREATED EFFLUENT AND OTHER DISCHARGES

A particular important, albeit indirect, inter-basin transfer out of the Vaal River System is where treated potable water is conveyed through the pipelines of Rand Water from the Vaal River System across the catchment and continental divide to the northern urban areas of Gauteng that are situated in the upper part of the Crocodile (West) and Marico Water Management Areas . A large portion of this transferred water is discharged into the Crocodile River System as treated effluent. The volumes of treated effluent are expected to increase in future and a substantial portion of this water is earmarked for supply to the expansion programmes of Eskom and possible further Coal to Liquid plants planned for at the coal fields in the Lephalale area.

In addition there are mine dewatering discharges entering the Vaal River System which contains high salinity concentrations and adds to the need for the dilution operating rule.

Sophisticated risk analysis of the Integrated Vaal River System carried out as part of the study to developed the *Integrated Water Quality Management Plan* showed that there will be excess water available in the system downstream of the Vaal Barrage (a flow regulating storage structure located downstream of Vaal Dam) by the year 2015. This excess is a result of increases in treated effluent from the urban areas as well as the implementation of the 600mg/l dilution rule that is currently in operation and is being recommended to continue for the short term.

It should be noted that the *Crocodile (West) River Reconciliation Strategy* indicated that raw water transfers into that system (in addition to the potable supply from Rand Water) would be necessary to provide sufficient water for the proposed electrical power generation and possible Coal to Liquid industries envisaged at the coal fields near the town of Lephalale. The only source for the water is the Vaal River System and a scheme to pump water from selected sewage works (currently discharging to the Vaal) into the Crocodile catchment has been investigated at reconnaissance level of detail.

The remainder of this excess water should be treated further and supplied to users in the Gauteng area.

Given the various options and associated implication (costs of treatment as well as environmental considerations) of utilising the excess, a feasibility study will be commissioned to evaluate all alternative options and to compare the advantages and disadvantages of the various alternatives with the aim of finding the optimum use of the excess water.

8 STAKEHOLDER ENGAGEMENT PROCESS DURING THE STUDY

During the course of the study several Stakeholder Participation meetings were held for different purposes as presented in **Table B1** in **Appendix B**. A Study Steering Committee was established to guide the development of the Reconciliation Strategy, representing the following sectors, industrial, agricultural, environmental, water service providers and local government.

9 PERSPECTIVE ON RECONCILIATION

The size of the Vaal River System, the various inter-basin transfers coupled with the extensive bulk water distribution infrastructure and the geographical location of the water users in relation to the position of the water resource components provides for a complex mix of variables that influences both the demand and availability.

Ensuring that sufficient water is available to supply the future water requirements in the supply area of the Vaal River System requires a five pillar strategy consisting of the following main components:

- The eradication of the unlawful water use is an essential strategy that has to be implemented in order to rectify the current deficit (negative water balance) in the Vaal River System. The legal actions and procedures that will be implemented should be designed to achieve legal precedence to protect the entitlements of lawful water users and assist in compliance monitoring and water use regulation in future.
- The continuation of current and the initiation of further Water Conservation and Water Demand Management measures are essential to maintain a positive water balance in the Vaal River System over the next ten years. The potential savings that can be achieved through the reduction of water wastage will ensure the risk of drought curtailments are reduced until such time as Phase 2 of the LHWP can deliver water.
- The results from simulation analysis show that the re-use of mine water effluent in combination with other interventions could have a significant benefit by solving the shortage between the year 2014 and 2019 and postponing the need for further augmentation after the implementation of Phase 2 of the Lesotho Highlands Water Project. Given the various options and associated implication (costs of treatment as well as environmental considerations) of implementing options of re-using effluent, it is recommended that a feasibility study be commissioned to evaluate all alternative options to compare the advantages and disadvantages with the aim of finding an optimum solution.
- The Minister of the Department of Water Affairs and Forestry and Cabinet made the decision in December 2008 that the Department should proceed to negotiate with the Government of Lesotho for the implementation of the Phase 2 of the Lesotho Highlands Water Project.
- It is proposed that a Strategy Steering Committee (SSC) be established to take the strategy further. Broadly, the function of the committee will be to monitor the implementation of the recommendations of the strategy and to see that these are strictly adhered to. It must also be able to adjust the strategy if required, report back to DWAF, Provinces and Local Authorities and provide feedback to stakeholders and the public. To do this it must continuously monitor the water balance situation of the Vaal River System and advise the responsible institutions on whether or not the objectives of the strategies are being achieved.

10 SUMMARY OF RECOMMENDED ACTIONS AND RESPONSIBILITIES

- Apply all the necessary resources to eradicate the unlawful water use as a national priority by 2011.

  Action: DWAF

- Implement Water Conservation and Water Demand Management measures to reduce losses and reduce the urban demand by at least 15% by 2014.

  Action: All Metropolitan Municipalities supported by DWAF

- Undertake a feasibility study into the use of the excess water, with as first priority the water pumped from the gold mines.

  Action: DWAF

- Implement the next infrastructure option (Phase 2 of LHWP)

  Action: DWAF

- Constitute the Strategy Steering Committee.

  Action: DWAF

Appendix A

Figures

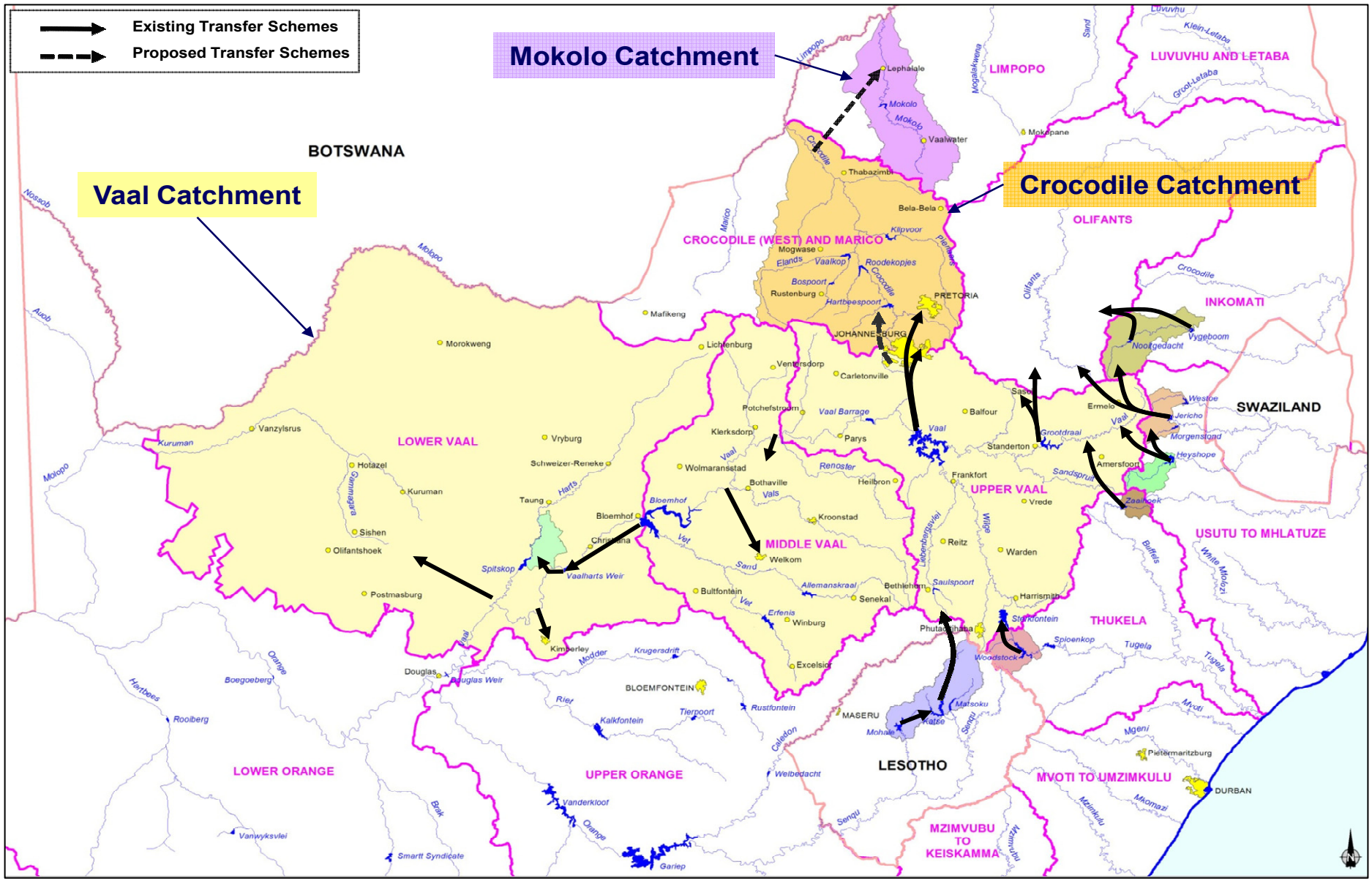

Figure A-1: Map of the Integrated Vaal River System

Appendix B

Stakeholder Participation Events

Table B-1. Stakeholder Participation meeting details

MEETING DESCRIPTION	DATE	VENUE	COMMENTS	TOTAL NUMBER OF STAKEHOLDERS ATTENDED EACH MEETING
Vaal River Studies: Pre-consultation with key stakeholder	29 July 2005	Emerald Casino and Conference Centre, Vanderbijlpark	Stakeholders sanctioned study processes	**47** stakeholders attended the workshop
Stakeholder/Public Meeting	11 November 2005	Moqhaka Local Municipality (reception hall) Kroonstad	Nomination of PSC members	**41** stakeholders attended the workshop for the nominations of PSC members
IWQMP for the Vaal River System: 1st Project Steering Committee	28 March 2006	Golder Associates offices, Midrand	PSC	**22** members of the Steering committee attended the meeting
Large Bulk Water Supply Reconciliation Strategy Study: 1st Project Steering Committee	29 March 2006	Gauteng Regional Office, Pretoria	PSC	**42** members of the Steering committee attended the meeting
IWQMP for the Vaal River System: 2nd Project Steering Committee	10 November 2006	Gauteng Regional Office, Pretoria	PSC	**23** members of the Steering committee attended the meeting
Large Bulk Water Supply Reconciliation Strategy Study: 2nd Project Steering Committee	17 November 2006	Gauteng Regional Office, Pretoria	PSC	**26** members of the Steering committee attended the meeting
IWQMP for the Vaal River System: 3rd Project Steering Committee	12 November 2007	Gauteng Regional Office, Pretoria	PSC	**30** members of the Steering committee attended the meeting
Large Bulk Water Supply Reconciliation Strategy Study: 3rd Project Steering Committee	19 November 2007	Gauteng Regional Office, Pretoria	PSC	**30** members of the Steering committee attended the meeting
Large Bulk Water Supply Reconciliation Strategy Study: 4th (final) Project Steering Committee	3 September 2008	Gauteng Regional Office, Pretoria	PSC	**42** members of the Steering committee attended the meeting

MEETING DESCRIPTION	DATE	VENUE	COMMENTS	TOTAL NUMBER OF STAKEHOLDERS ATTENDED EACH MEETING
IWQMP for the Vaal River System: 4th (final) Project Steering Committee	4 September 2008	Gauteng Regional Office, Pretoria	PSC	**28** members of the Steering committee attended the meeting
Stakeholder Information Meeting	9 September 2008	Stone Haven-on-Vaal, Vanderbijlpark	To present to stakeholders the proposed integrated water management strategy for the Vaal River System	**47** stakeholders attended the workshop
Stakeholder Information Meeting	18 September 2008	Flamingo Casino and Conference Centre, Kimberley	To present to stakeholders the proposed integrated water management strategy for the Vaal River System	**25** stakeholders attended the workshop