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Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA

THE DEVELOPMENT OF A RECONCILIATION STRATEGY FOR THE CROCODILE WEST WATER SUPPLY SYSTEM

Executive Summary

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LIST OF STUDY REPORTS

THE DEVELOPMENT OF A RECONCILIATION STRATEGY FOR THE CROCODILE (WEST) WATER SUPPLY SYSTEM:	REPORT NUMBER	
	DWAf	BKS
Inception Report	P WMA 03/000/00/3307	H4125-01
Summary of Previous and Current Studies	P WMA 03/000/00/3408	H4125-02
Current and Future Water Requirements and Return Flows and Urban Water Conservation and Demand Management	P WMA 03/000/00/3508	H4125-05
Water Resource Reconciliation Strategy: Version 1	P WMA 03/000/00/3608	H4125-06
WRPM Analyses	P WMA 03/000/00/3708	H4125-07
Executive Summary	P WMA 03/000/00/3908	H4125-09
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THE DEVELOPMENT OF A RECONCILIATION STRATEGY FOR THE CROCODILE WEST WATER SUPPLY SYSTEM

EXECUTIVE SUMMARY

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1. PURPOSE

The purpose of this document is to set out the strategies that must be implemented to ensure that enough water would be available to meet the growing water requirements in the Crocodile West water supply area.

2. INTRODUCTION

2.1 GENERAL OVERVIEW

The Crocodile West River is the largest and most important river in the Crocodile West and Marico WMA. The catchment extends northwards from the Witwatersrand catchment divide in central Johannesburg (where the Crocodile River originates) to the confluence of the Crocodile and Marico rivers. It is characterised by the sprawling urban and industrial areas of northern Johannesburg and Pretoria, extensive irrigation downstream of Hartbeespoort Dam and large mining developments north of the Magaliesberg. As a result, the Crocodile River is one of the rivers in the country that has been most influenced by human activities, and where specific water management strategies are of paramount importance.

The Water Reconciliation Strategy for the Crocodile West water supply system forms part of the proactive activity of the Department of Water Affairs and Forestry (DWAF) to ensure the future availability of water to key metropolitan and development areas in the country. The strategy is primarily focussed on the quantitative reconciliation of the requirements for and availability of water, with due consideration of water quality where it impacts on the reconciliation. These goals to ensure the sufficient and reliable supply of water of appropriate quality to users should be achieved within the framework of the best utilisation of water resources, at the lowest cost and in an environmentally sustainable manner.

Scenarios of future water requirements and water availability, with resultant water balances, were developed to provide the basis for devising the Strategy. The Strategy caters for existing as well as future needs and is targeted to be sufficiently comprehensive and pliant to enable quick response to changing circumstances. Although a chronology of events and time scales are considered, the Strategy should not be viewed as a rigid singular plan with fixed sequencing and time scales. Rather, it is intended to be both flexible and robust under changing conditions, and will be adjusted regularly as time goes on.

The study was executed in close collaboration with the main water use sectors in the study area; which also facilitated the development of the strategy in a transparent, open and consultative way that properly conforms to the embracing of cooperative governance.

This report gives a short summary of the study and the strategy. It is also available on the DWAF website.

2.2 STUDY AREA

The study area includes the whole of the Crocodile West River catchment as shown in **Figure 1**. The Mokolo River catchment, where water supplies to the large mining, power generation and petrochemical developments in the Lephalale area need to be augmented from or via the Crocodile River catchment, is also included.

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

The study area extends over parts of the Gauteng, North West and Limpopo provinces and includes the largest population concentration in the country. The Crocodile Marico WMA is the WMA with the largest contribution to the national economy at about 25% of the national GDP, over 95% of which is generated in the Crocodile River catchment. On a provincial basis roughly 70% of the GDP of the Gauteng Province, about 80% of the GDP of North West Province, and in the order of 20% with respect to Limpopo Province, is generated in the study area. A very strong growth in the requirements for water is experienced because of economic growth in all three provinces as well as the influx of people from rural areas, mainly to Gauteng.

The study area can be classified under three geographic areas of broadly similar characteristics.

- (i) ***Gauteng North, which is mainly the part of the catchment south of the Magaliesberg:*** This area is characterized by extensive urban and industrial developments, which are concentrated in and around the large metropolitan areas of northern Johannesburg and Midrand, as well as Tshwane and environs. Much of the water to this area is supplied via the Rand Water system from the Vaal River.
- (ii) ***The Crocodile River catchment north of the Magaliesberg:*** Economic activity in this area mainly relates to platinum mining and irrigation. Most of the water is supplied from the resources of the Crocodile River together with return flows from urban areas upstream.
- (iii) ***The Lephalale area:*** This area falls in the neighbouring Mokolo River catchment where large new power stations, petrochemical industries and coal mines are planned, with some already under construction. The local water resources are insufficient for these developments.

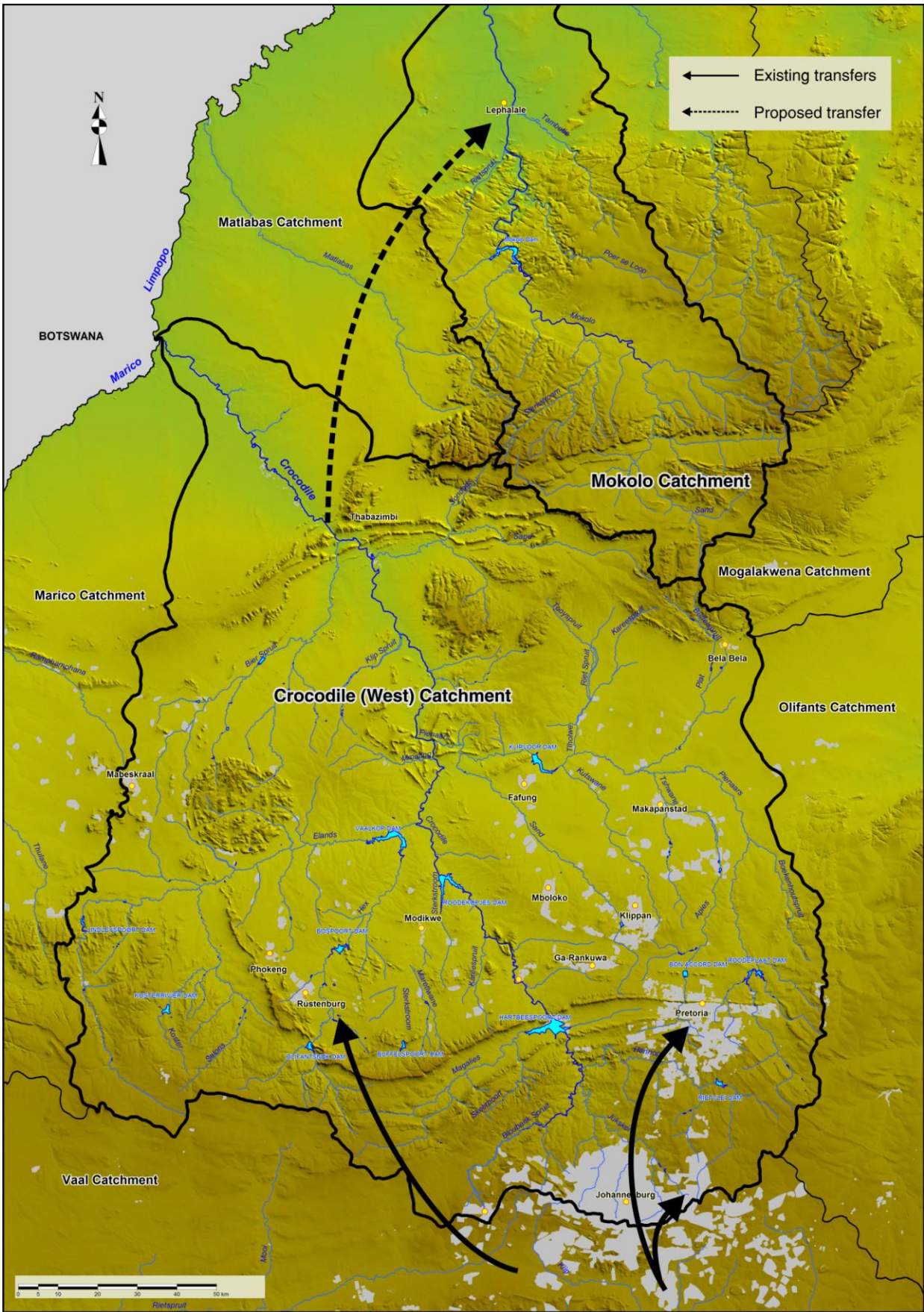


Figure 1: Map of the study area

2.3 LINKAGE TO THE VAAL RIVER SYSTEM

Most of the water used in the Crocodile River catchment is supplied from the Vaal River system via Rand Water, as discussed in more detail in the sections that follow. The Reconciliation Strategy for the Crocodile West Water Supply Area has therefore been carefully synchronized with that of the Vaal River system. Amongst others, the same demographic information, a common basis for estimating future water requirements and return flows, and the same scenarios with respect to water conservation and water demand management, were used.

3. SUPPORTING STUDIES

Detailed studies of the current and future water requirements, return flows, water resources and the relevant infrastructure were performed as background to the formulation of scenarios that informed the development of the strategy.

3.1 WATER REQUIREMENTS

Estimates were made of current and future water requirements for the following sectors:

- Urban, which comprise (i) domestic or household use of water and (ii) commercial, industrial and public use of water.
- Rural water requirements, which include domestic and stock watering.
- Irrigation requirements for commercial agriculture.
- Mining water requirements.
- Power generation in the Crocodile River catchment.
- Transfer of water to neighbouring areas. This mainly relates to the Lephalale area, for which different development scenarios were also considered, mainly driven by the energy sector.

In total the water requirements of all the users within the Crocodile River catchment are expected to grow from about 1 100 million m³/a in 2005 to between 1 300 and 1 500 million m³/a in 2030. Between 40% and 55% of this is/will be supplied via the Rand Water system (depending on the scenario). In addition, about 185 million m³/a will have to be supplied to the Lephalale area from or via the Crocodile River catchment by that time.

With respect to Water conservation and demand management (WCDM), the focus was on the urban water users, which already in 2005 represented more than 50 % of the water use in the catchment. This focus on the urban sector is in accordance with the current policy of the DWAF that savings in water by the irrigation sector will mainly be used to expand irrigation, especially aimed at redressing inequities of the past. Future updates of the Strategy may require that this approach be revisited.

Based on detailed assessments made on various supply zones in municipal areas, the potential savings coupled with a range of WCDM measures were determined.

Four scenarios were developed with respect to the future water requirements in the Crocodile catchment, on which development scenarios for the Lephalale area were later super imposed:

- High population growth, medium efficiency water demand management;
- Base population growth, medium efficiency water demand management;
- Low population growth, medium efficiency water demand management; and
- High population growth, high efficiency water demand management.

3.2 WATER RESOURCES

The following main components were considered with respect to the availability of water:

- Local water resources, which refer to the resources that naturally occur in the catchment, comprise (i) surface water and (ii) groundwater.

Most of the **surface water** (streamflow) originates in the southern and higher rainfall part of the Crocodile River catchment that roughly corresponds to the Gauteng North area. Large paved areas, due to the extensive urbanisation in this part of the catchment, also contribute to increases in runoff.

Large **groundwater** yields are abstracted from dolomitic aquifers mainly in the southern part of the catchment, whilst sandy aquifers occur along the lower reaches of the main Crocodile River. However, the bulk of the study area is underlain by low-yielding fractured rock formations.

- Large scale transfers of water from the Vaal River system, to supply mainly urban and mining users in the Crocodile River catchment, are necessitated by the insufficiency of the local water resources in the catchment. These transfer amounted to 555 million m³/a in 2005, which was roughly equal to the total urban water requirements.
- Return flows from urban areas, largely as a result of the water transferred from the Vaal River system, constitute a large and growing source of water for re-use. Already in 2005, the volume of return flow was more than double the yield from surface water resources.

3.3 WATER TARIFFS

Water tariffs in the Crocodile River catchment are low in comparison to some other parts of the country, in particular the Vaal River area. Given the large quantities of water in the Crocodile River catchment that result from transfers from the Vaal River system, it is important that the tariff structure for water in the Crocodile River catchment be brought in line with that in the Vaal River catchment.

4. STRATEGIC PERSPECTIVE ON WATER RESOURCES

The water resources that naturally occur in the Crocodile River catchment have already been fully developed and most of the tributaries as well as the main stem of the river are highly regulated. Several large dams were built in the past and very few, if any, sites for further regulation remain. Because of the extensive developments and level of human activity in the catchment, however, water use in the catchment by far exceeds the water available from the local sources – already by a factor of more than fourfold. Most of the water used in the catchment, if therefore supplied from the Vaal River system via Rand Water, mainly to serve the metropolitan areas and some mining developments. This in turn results in large quantities of return flows from the urban and industrial users, most of which is effluent discharged to the river system after treatment, for re-use downstream. In many of the streams and impoundments, water quality is severely compromised by the proportionate large return flows.

Given the above background and the knowledge from the supporting studies, various scenarios of future developments and possible reconciliation options were developed, as background for the formulation of the Strategy. Underlying the scenarios is also the pragmatic acceptance that the existing water users that are currently supplied by Rand Water will in future still be supplied with water from Rand Water. This acceptance is informed by the results from the scenario analyses which showed that all the return flows (and more) are required for users downstream of the area that is supplied by Rand Water. Also see paragraph 5.1.

Local water resources (including return flows) will be used to supply the growing water requirements in those areas not supplied by Rand Water. With these assumptions the water transfers from the Vaal River system via Rand Water to the Crocodile River catchment are expected to increase from 500 million m³/a in 2005 to as much as 800 million m³/a in 2030. This was provided for in the strategy for the Vaal River system. The total projected water requirements from the Rand Water system for the high population, medium water demand management scenario is given in **Table 1**.

Table 1: Water requirements via the Rand Water system for the high population, medium water demand management scenario

Year	2005	2010	2015	2020	2025	2030
Volume required (million m ³ /a)	554	558	624	691	741	805

Figure 2 illustrates the reconciliation of total water requirements and water availability for a high water use scenario in the Crocodile River catchment. Without demand management possible small deficits could be experienced in the Crocodile catchment. It is, however, evident that sufficient water is expected to be available for meeting all the requirements for water in the Crocodile catchment into the foreseeable future if medium demand management (reduction in wastage over 5 years with no efficiency

improvement, equivalent to about a 10% reduction in urban water requirement) is implemented. No specific or urgent actions are therefore required in order to meet the growing water requirements in this catchment, whilst the surplus available would serve to augment the supplies to the Lephalale area.

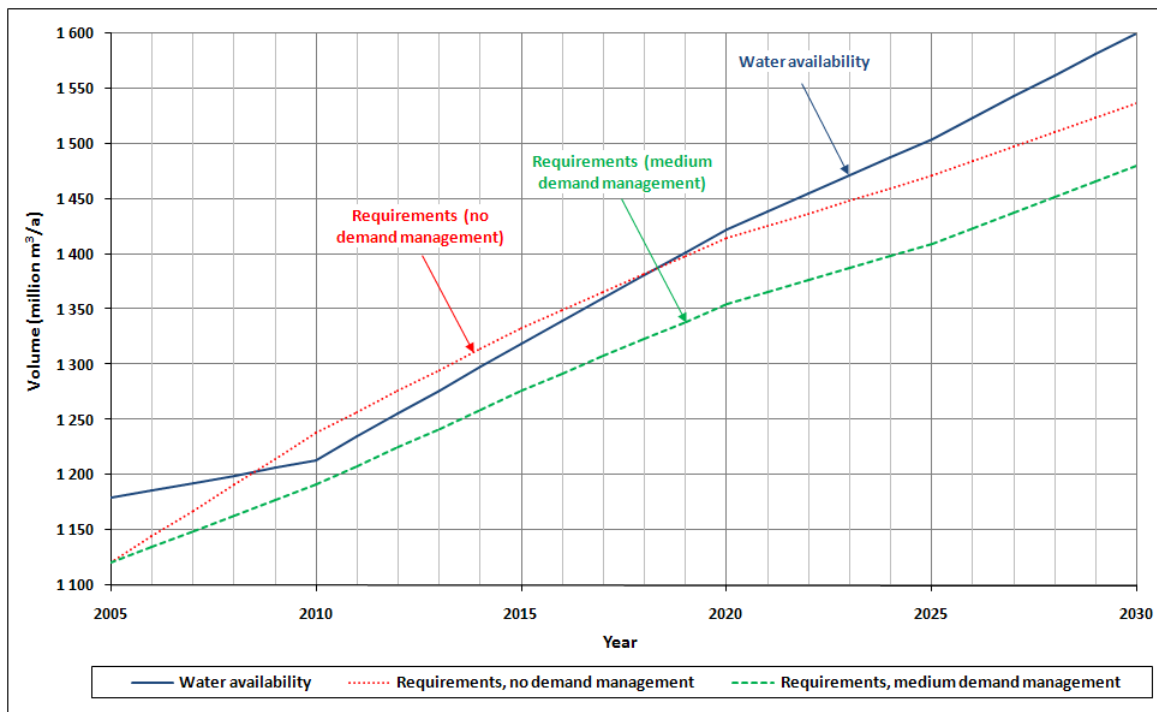


Figure 2: Water balance for the Crocodile River catchment: High population, medium water demand management scenario

Various scenarios were also considered for the Lephalale area and the water balance for the high scenario, which is currently being used for the planning of the transfer pipeline from the Crocodile catchment to the Lephalale area, is shown on **Figure 3**. This scenario provides for five Eskom power stations, a Coal to Liquid Fuel plant, the water requirements of the coal mines and associated secondary and tertiary developments, as well as growth in domestic requirements in the Lephalale area. Evidently the combined Mokolo Dam yield plus the Crocodile River surplus is not sufficient to supply the growing water requirements in the Lephalale area. Additional augmentation from the Vaal River system will therefore be required.

The **Stability of the Strategy** has been tested against a wide spectrum of possible future scenarios and was found to be stable under all conditions. The main variable being the quantity of effluent that needs to be transferred from the Vaal River system to augment the transfers from the Crocodile River catchment to the Lephalale area.

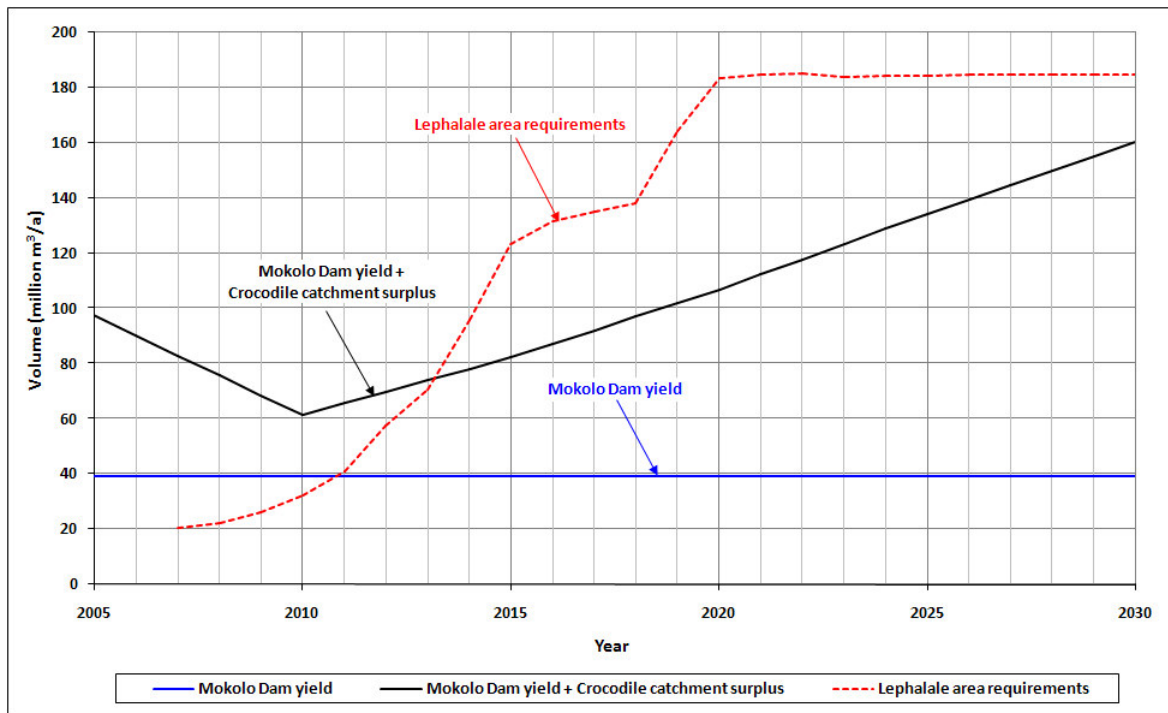


Figure 3: Water balance for the Lephale area: High population, medium water demand management scenario in the Crocodile River catchment, high water requirements in the Lephale area

It should also be noted that due to the high degree of development and regulation of the water resources in the catchment, together with the large quantities of return flows to many tributaries and eventually to the main stem of the river, the natural flow regime of streams in the catchment has been highly altered and generally exceeds the ecological flow requirements. This will also limit the extent to which natural variability can be reinstated through the implementation of the Reserve.

5. STRATEGIES FOR THE CROCODILE RIVER CATCHMENT AND THE LEPHALALE AREA

Broad strategies pertaining to the three main geographic areas, followed by more detailed strategies for specific components and geographic areas, are described in the subsequent sections.

5.1 BROAD STRATEGIC APPROACH

(i) *Gauteng North / catchment south of the Magaliesberg*

Water for urban and industrial use in this area should continue to predominantly be supplied from the Vaal River system via Rand Water. Water for irrigation and rural users should be supplied from local sources.

(ii) Crocodile catchment north of the Magaliesburg

The bulk of the water available in this area consists of a combination of local surface resources and return flows. All the projections show that sufficient water should be available from these sources to meet the demands in the catchment (irrigation, urban, mining). Some rural users should continue to be supplied from groundwater.

No further allocations will be made to irrigation. Water that may become available through increased efficiency of irrigation water use should be applied to redress inequities by increasing irrigation production.

(iii) Lephalale area

Only a small portion of the water requirements in this rapidly developing area can be supplied from the Mokolo Dam. Large quantities of water therefore need to be transferred to the area to augment the local resources. These transfers can partly be sourced from the Crocodile River catchment by using the surpluses available in the catchment, together with further augmentation from the Vaal River system.

5.2 COMPONENT AND SPECIFIC STRATEGIES

5.2.1 Water conservation and demand management

Water is a scarce resource in South Africa and is particularly limited in the inland parts of the country. Studies in the Vaal River supply area showed large potential for reducing the water demand in various ways, which also apply to the Crocodile West water supply area.

The primary focus in the urban/industrial sector should be on the minimisation of leaks, which is where most of the losses occur. Thereafter the focus should be on the reduction on consumptive use. The reduction of non-consumptive uses does not directly contribute to water savings, but impacts on infrastructure sizing and effluent concentrations.

DWAF should engage with municipalities to overcome their constraints and possibly provide resources to implement WC/WDM measures in their supply areas. WC/WDM is a primary measure to mitigate the shortage over the short term and therefore should be a priority action of the municipalities. Interventions by the department will probably have to be accompanied by funding through the proposed Funding Facilitation Unit (FFU). The FFU is a mechanism being developed by DWAF to technically and financially assist local government with implementation of WC/WDM.

5.2.2 Groundwater development

Specific focus and management interventions through compulsory licensing are required where over-abstraction occurs, such as at Maloney's Eye. An active and reliable data base on groundwater use and aquifer performance should be developed for the identification of potential problem areas. Pumping from induced recharge from rivers should also be investigated and controlled.

Further groundwater development in unstressed aquifers for small scale town and community water supply should be pro-actively promoted. Groundwater development for mining purposes may also be possible, subject to the proven sustainability thereof. Appropriate preventative or remedial measures need to be taken where the dewatering of mines could impact on existing users.

5.2.3 Water quality

Water quality in the Crocodile River catchment is severely compromised as a result of the sprawling urban developments and large volumes of return flows. Priority should first be given to the proper enforcement of effluent standards at all times.

Water quality objectives should be established for all major streams and impoundments, and management options be investigated towards achieving these. Possible interventions could include a tightening of effluent standards, rerouting of return flows to solve local problems, etc. The current initiatives with respect to improving the quality of water in the Hartbeespoort Dam should be supported (see **Figure 4**).

Inadequate sanitation, as often occur in peri-urban and informal areas, is the cause of both surface water and groundwater pollution. The initiatives by the national and local governments towards improving sanitation infrastructure should be supported and prioritised.

5.2.4 Protection and control of return flows

Of primary importance with respect to the management of water resources in the Crocodile River catchment, is the efficient control and re-use of return flows. Return flows to the Crocodile River are dispersed over a wide geographic area. Similarly with respect to new urban and industrial developments that will contribute to return flows in future, and where the locations of these are determined by many factors other than the point of return flow. This situation is partly compensated for by the fact that the return flows and new developments are mainly concentrated in the upper (southern) parts of the catchment, whilst the greatest potential for re-use of the return flows occurs in the middle and downstream parts of the catchment (below Hartbeespoort Dam and towards Thabazimbi).



Figure 4: Hartbeespoort Dam

5.2.5 Protection and control of return flows

Of primary importance with respect to the management of water resources in the Crocodile River catchment, is the efficient control and re-use of return flows. Return flows to the Crocodile River are dispersed over a wide geographic area. Similarly with respect to new urban and industrial developments that will contribute to return flows in future, and where the locations of these are determined by many factors other than the point of return flow. This situation is partly compensated for by the fact that the return flows and new developments are mainly concentrated in the upper (southern) parts of the catchment, whilst the greatest potential for re-use of the return flows occurs in the middle and downstream parts of the catchment (below Hartbeespoort Dam and towards Thabazimbi).

It is of compelling importance to ensure that the correct quantities of water that are intended to be abstracted for transfer to the Lephalale area reach the abstraction point. This should include the effective prevention of illegal abstractions from the constantly flowing stream, whilst the building of a possible small reregulation dam is also being considered as part of a feasibility study (*Crocodile Mokolo Water Augmentation Project*).

5.2.6 Water supply to Madibeng and Rustenburg

a) *Madibeng area*

Madibeng currently abstracts raw water from the Crocodile River for own treatment and distribution, whilst water is also abstracted at different locations from the Hartbeespoort Dam for treatment and distribution to communities along the shores. Given the number of small treatment plants, it is difficult for these to be cost efficiently operated at the level of sophistication necessary to consistently produce the high quality potable water from a poor and variable quality source. The abstraction of water from the same source to which effluent from the relevant communities are discharged, is also not an ideal situation.

It is advisable that the treatment plants for Madibeng town and the communities around the dam be rationalized and also be of higher sophistication. As an alternative, these users may best be served with potable water directly from the Rand Water system. The feasibility of routing effluent discharges from the communities near the dam to a location downstream of the dam should also be investigated.

b) *Rustenburg*

The water supplies to Rustenburg could be augmented from Magalies Water with water from the Crocodile catchment, or from Rand Water. The provision of water to the mines in the Rustenburg area with water from Hartbeespoort Dam would free up some potable water currently used by the mines, for urban use in Rustenburg. The sufficiency of the existing pipeline capacity from Rand Water would thereby be extended by a number of years, thereafter expansion of the pipe network may again be required.

5.2.7 Water supply to the Lephalale area

Water for transfer to Lephalale could be abstracted from the main stem of the lower Crocodile River. DWAF already commissioned a feasibility study (*Crocodile Mokolo Water Augmentation Project*) to investigate the best options for the transfer of water from the Crocodile River to supplement the water supply to the Lephalale area.

However, sufficient water will not be available in the Crocodile River to meet all the needs with respect to the water requirement scenarios for the Lephalale area and additional resources will be needed to meet the requirements for essentially all cases. Several options were considered, with the common outcome that additional water would need to be transferred from the Vaal River system. The diversion of effluent from waste water treatment plants in the Vaal River catchment but close to the divide with the Crocodile catchment, to the Crocodile River, appears to be the best option.

As a further option that would reduce the need for the water from the Vaal River system, irrigation water could be re-allocated (through purchase) to the developments in Lephalale. Such irrigation areas could be located either in the Crocodile River catchment or in the Mokolo River catchment.

All of the infrastructure options will require substantial time to be implemented (investigations, approvals, design, construction) and it is most unlikely that the growth in water requirements in the Lephalale area as currently projected can be met from such measures alone. As a short term solution, irrigation water may also be acquired for an interim period only, whilst the permanent/long term measures are being implemented. Water from the Mokolo catchment would obviously offer the shortest time scales.

5.2.8 Water supply to Mookgophong and Modimolle Local Municipalities

DWAF is currently conducting a feasibility study to assess future water requirements as well as the best supply option for this area. The preliminary findings indicate that the water transfer could be either from the existing Magalies Water pipeline from Klipdrift treatment works, or from a proposed new treatment works and pipeline from the Klipvoor dam. This was provided for in the Strategy.

6. STRATEGY STEERING COMMITTEE

From the above discussions it is clear that co-operation of the intuitions responsible for the entire water supply chain is essential and vital to achieve the intended objectives.

Creating an environment where partnerships can be formed to take specific actions as recommended, should be encouraged.

Therefore, it is recommended that a Strategy Steering Committee (SSC) be established, which will have the following main functions and objectives:

- To ensure implementation of the recommendations of the Reconciliation Strategy.
- To ensure the monitoring of key variables.
- To regularly review and update the Strategy to ensure that it remains relevant.
- To ensure that the Strategy and its recommendations are appropriately communicated.

The successful development and implementation of such water reconciliation strategies requires the main stakeholders in the study area to be actively involved, using the existing forums. Partnerships have been established with these stakeholders, and it is envisaged that representation on the SCC should include Other Government Departments, Municipalities, Water Boards, Eskom and Mining Houses. These organisations were consulted with regard to information sourcing for the various study tasks and are also involved in the transparent process of developing the strategies.

High level management and political support will be required to ensure that the recommendations are implemented.

7. SUMMARY OF RECOMMENDATIONS

7.1 CROCODILE-LEPHALALE TRANSFERS

Complete the feasibility study currently in progress and continue with implementation arrangements to supplement the water supply to the Lephhalale area as a priority. This includes identification of the best option for augmenting the Crocodile River system (and thus the Lephhalale area) from the Vaal River system as well as considering the feasibility of a possible re-regulation dam on the main stem of the Crocodile River.

Action: DWAF: Directorate Options Analysis

Timing: Immediate

7.2 LEASING/RE-ALLOCATION OF IRRIGATION WATER

Investigate the possible leasing of water from irrigation farmers as an interim measure whilst the transfer schemes are being constructed. Also the possible long term re-allocation or irrigation water to the developments in the Lephhalale area. Such irrigation could be located in the Mokolo and/or Crocodile catchment, and could impact on the sizing of the transfer schemes.

Action: Eskom, Sasol, Mines under auspices of DWAF: Directorate Water Allocation, Directorate Legal Services

Timing: Immediate

7.3 PRICING OF WATER

Water tariffs in the Crocodile West Water Supply Area (and the Lephhalale area) need to be brought in line with water tariffs in the Vaal River system supply area. Account should specifically be taken of the large quantities of effluent in the Crocodile catchment resulting from the use of water from the Vaal River system.

Action: DWAF: Directorate Water Resource Finance and Pricing

Timing: Immediate

7.4 WATER CONSERVATION AND DEMAND MANAGEMENT

A detailed action plan must be developed urgently to implement further WC/WDM measures. Support should be provided through the FFU. Also to establish a forum where information on projects and measures to save water, are discussed and experiences are exchanged.

Action: Municipalities, under auspices of Strategy Steering Committee and DWAF: Directorate Water Use Efficiency

Timing: Immediate. A 15% saving should be achieved by 2015.

7.5 ABSTRACTION CONTROL

Implement measures to ensure that all abstractions of water comply with the licensing provisions.

Action: DWAF: Regional Office

Timing: Immediate

7.6 WATER QUALITY

Set Resource Quality Objectives and ensure that effluent standards are enforced at all times.

Action: DWAF: Regional Office

Timing: Immediate

7.7 GROUNDWATER USE

Implement control measures to curb the over exploitation of groundwater in critical areas (e.g. Maloney's Eye).

Action: DWAF: Regional Office

Timing: Immediate

7.8 STRATEGY STEERING COMMITTEE

Constitute a Strategy Steering Committee as soon as the Reconciliation Strategy has been finalized.

Action: DWAF: Directorate National Water Resource Planning

Timing: End 2009

8. REFERENCES

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