



**water & forestry**

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Water Affairs and Forestry  
**REPUBLIC OF SOUTH AFRICA**

P WMA 03/A31/00/6110/4

# Support to the Implementation and Maintenance of the Reconciliation Strategy of the Crocodile West Water Supply System

## CROCODILE WEST RIVER RECONCILIATION STRATEGY 2012

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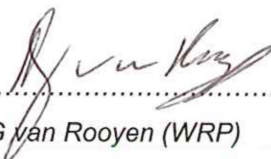
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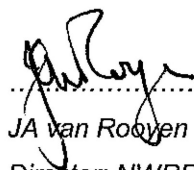
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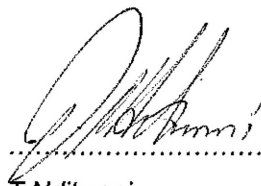
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## List of study reports and other relevant documents

### This Study

REPORT NAME	REPORT NR
Inception Report	P WMA 03/A31/00/6110/1
Water Quality Modelling	P WMA 03/A31/00/6110/2
Water Resources Planning Model Analyses	P WMA 03/A31/00/6110/3
<b>Crocodile West River Reconciliation Strategy 2012</b>	<b>P WMA 03/A31/00/6110/4</b>

### Other Relevant Documents

Document Name	Report Number	Study
Crocodile (West) River Reconciliation Strategy: Version 1	P WMA 03/000/00/3608	The Development of a Reconciliation Strategy for the Crocodile West Water Supply System

# SUPPORT TO THE IMPLEMENTATION AND MAINTENANCE OF THE RECONCILIATION STRATEGY OF THE CROCODILE WEST WATER SUPPLY SYSTEM

## CROCODILE WEST RIVER RECONCILIATION STRATEGY 2012

### **The Crocodile West Reconciliation Strategy 2012 in a Nutshell**

*The abridged revised 2012 Reconciliation Strategy for the Crocodile West River System entails the following:*

- i. The Rand Water service area in the Crocodile West River catchment will in future continue to be supplied from the Vaal River System and additional re-use will be considered only when surplus becomes available.*
- ii. The areas north of the Magaliesberg outside the Rand Water supply area will receive increased treated effluent from the metropolitan areas as a future source of water.*
- iii. In the Waterberg area (north of Crocodile West catchment) the optimal utilisation of local resources will continue and surplus water in the Crocodile West River System will be transferred to the Lephalale area.*
- iv. Intervention to supply short-duration shortfall will be evaluated by investigating demand side management and/or potential augmentation by transferring treated wastewater from the Vaal River System to the Crocodile West River System*
- v. Available groundwater resources should be utilised in all areas and opportunities for conjunctive surface / groundwater utilisation should be explored.*

*The rollout of the strategy will rely on the following recommended activities:*

- i. Mining sector to provide annual updates of water requirement projections.*
- ii. Continuous coordination of planning between bulk water service providers.*
- iii. Annual monitoring of water requirements and return flows and review water balance – consider revising long term projections.*
- iv. Undertake Annual Operating Analyses and engage water users through System Operating Forum.*
- v. Complete validation and verification of existing lawful use and review water balance.*

# **SUPPORT TO THE IMPLEMENTATION AND MAINTENANCE OF THE RECONCILIATION STRATEGY OF THE CROCODILE WEST WATER SUPPLY SYSTEM**

## **CROCODILE WEST RIVER RECONCILIATION STRATEGY 2012**

### ***EXECUTIVE SUMMARY***

#### ***Background***

*The catchment area of the Crocodile West River is one of the most developed in the country. It is characterized 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 more specific management strategies are of paramount importance.*

*The water resources that naturally occur in the catchment have already been fully developed and most of the tributaries as well as the main stem of the Crocodile River are highly regulated. Much of the water supplied to the metropolitan areas and some mining developments is transferred from the Vaal River system via Rand Water. This in turn results in large quantities of effluent from the urban and industrial users, most of which is 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. The effluent return flows constitute a large portion of the water availability in the catchment and are an important resource.*

#### ***Water balance***

*The water balance in the Crocodile West River system was assessed by undertaking sophisticated risk analyses, including salinity modelling. Projected water balances were compiled for the planning period until the year 2040. It was found that the system has surplus water originating from growing treated wastewater generated in the urban areas of Northern Gauteng.*

*This water balance makes provision for the growing water needs of the mining sector (mainly around Rustenburg and north of the Magaliesberg and the Pilanesberg), the sprawling urban developments of Tshwane's northern areas, Madibeng as well as the areas served by the expansion plans of Magalies Water, primarily outside of the Rand Water supply area. The water requirements of the agricultural sector were also taken into consideration. Special attention was given to ensure that the assurance of water supply to irrigators, such as the Crocodile West Irrigation Board and the Makoppa area, was maintained.*

*The water balance scenarios made provision that the source of water for the Rand Water supply area remains to be the Vaal River system, effectively representing an increasing inter-basin transfer taking place through the bulk supply pipelines of Rand Water.*

*The possible utilisation of the projected surplus water in the Crocodile West River system could be for transfer to the Lephalale area or for reuse schemes within the catchment that will reduce the transfer from the Vaal River system, such as the proposed Tshwane Potable Water Augmentation Program. Due to the priority placed by Government on the Strategically Important Projects (SIPs) which includes the Lephalale mineral belt, it was prudent to formulate the Strategy so that priority can be given to the future water needs of the Lephalale area in support of the national development imperatives.*

*The resulting water balance for the Crocodile West River system, including the transfers to the Lephalale area, indicated that shortages could occur over the medium-term planning period. These shortages, however, are relatively small in volume and only temporary as the return flows in the Crocodile West River continue to grow. These shortfalls will require further interventions that could be in the form of infrastructure developments (further transfers from the Vaal River system) or water demand management measures.*

### **Reconciliation Strategy**

*The objective of the Water Resource Reconciliation and Management Strategy is “to ensure the sufficient and reliable supply of water of appropriate quality to all existing and future users together with the best utilisation of resources in the catchment, at the lowest cost and in an environmentally sustainable manner”. The Strategy is targeted at water related issues and addresses options, interventions and actions towards achieving the above. It is cognisant of the possible development scenarios and of the impacts and risks/uncertainties associated with the various options.*

*The Strategy is not intended to be a singular master plan with fixed sequencing and time scales, but should be both flexible and robust under changing conditions.*

*The Strategy comprises:*

- (1) Certain general items and ongoing activities that need to be attended to as primary functions in support of the implementation of other components of the Strategy; and*
- (2) Specific strategies, other than the above, for addressing of other key issues.*

### **General items and ongoing activities**

*Certain elements of the Strategy are common to all scenarios and are of general application towards improved water resource management. These include:*

- The validation and verification of water use licenses, and confirmation of actual abstraction and use. This has already been embarked upon and should receive high priority, with particular focus on irrigation water.*

- *Regular review as well as constant monitoring and enforcement of water use licenses. Without proper enforcement much of the water resource management strategies will be futile. These activities appear to have been neglected in recent years.*
- *The allocation and management of water resources to meet user water quality objectives.*
- *Management of the water resources in the Crocodile River catchment in order to minimise both the excess discharges to the Limpopo River as well as the overall transfers from the Vaal River system.*

### **Specific reconciliation strategies**

*The revised 2012 Reconciliation Strategy for the Crocodile West River system entails the following:*

- *The Rand Water service area in the Crocodile West River catchment will in future continue to be supplied from the Vaal River system and additional re-use within the catchment will be considered only when surplus becomes available.*
- *The areas north of the Magaliesberg outside the Rand Water supply area will receive increased treated effluent from the metropolitan areas as a future source of water.*
- *In the Waterberg area (north of the Crocodile West River catchment) the optimal utilisation of local resources will continue and surplus water in the Crocodile West River system will be transferred to the Lephalale area.*
- *Interventions to supply the projected future temporary shortfall will be evaluated by investigating demand side management and/or potential augmentation by transferring treated wastewater from the Vaal River system to the Crocodile West River system. Available groundwater resources should be utilised in all areas and opportunities for conjunctive surface / groundwater utilisation should be explored.*
- *Mining sector should provide annual updates of historic water use and future water requirement projections.*
- *Continuous coordination of planning between bulk water service providers.*
- *Annual monitoring of actual water requirements and return flows and review of the water balance – consider revising long-term projections.*
- *Undertake Annual Operating Analyses and engage water users through the Crocodile West River System Operating Forum.*
- *Complete validation and verification of existing lawful use and review the water balance.*

# SUPPORT TO THE IMPLEMENTATION AND MAINTENANCE OF THE RECONCILIATION STRATEGY OF THE CROCODILE WEST WATER SUPPLY SYSTEM

## CROCODILE WEST RIVER RECONCILIATION STRATEGY 2012

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### **List of Acronyms and Abbreviations**

DWA	Department of Water Affairs
EWR	Ecological Water Requirements
LM	Local Municipality
MM	Metro Municipality
RWQO	Resource Water Quality Objective
SIP	Strategically Import Project
SSC	Strategy Steering Committee
WC/WDM	Water conservation and water demand management
WQT	Water Quality Model
WRPM	Water Resources Planning Model

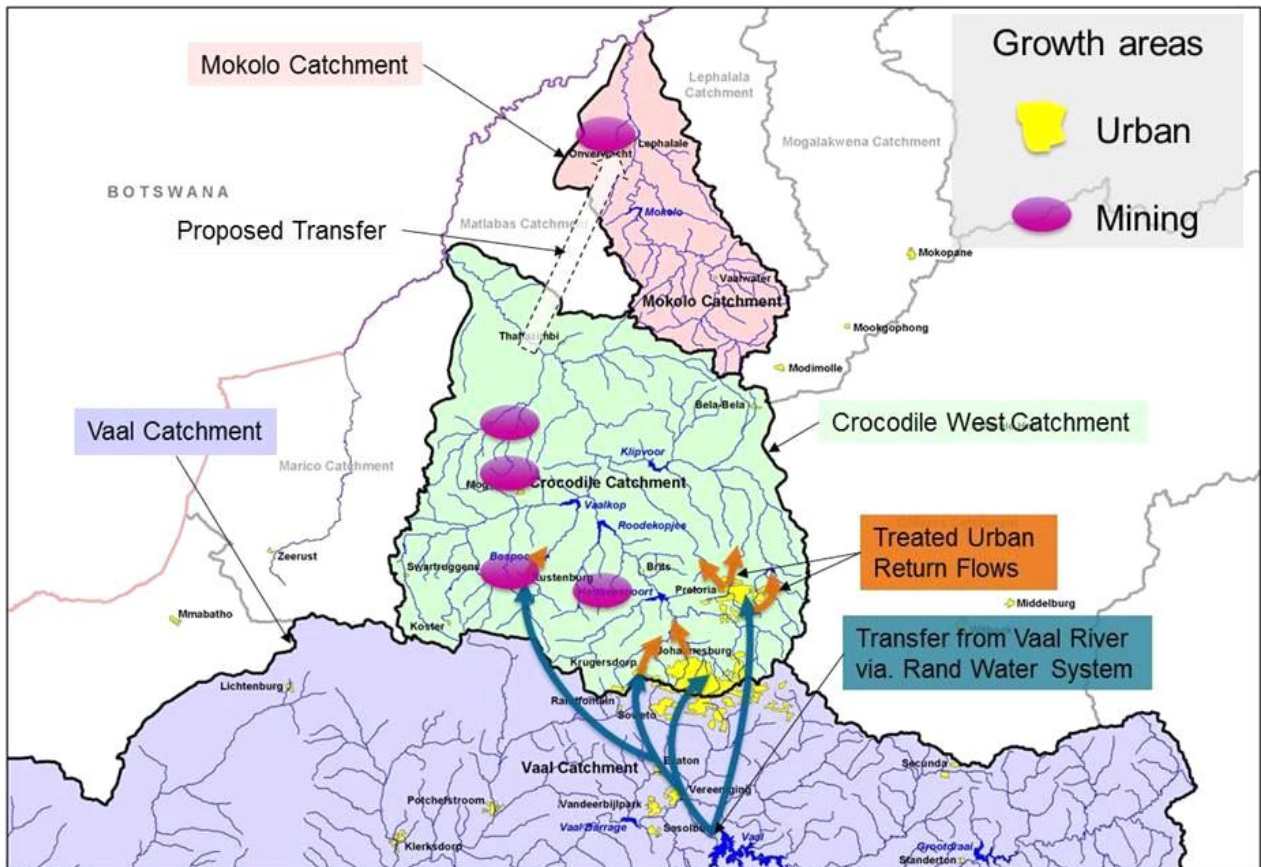


# 1. INTRODUCTION

## 1.1 DESCRIPTION OF STUDY AREA

The study area covers the Crocodile West River catchment, which forms the major part of the Crocodile West and Marico Water Management Area (WMA), but excludes the Marico River catchment. It extends northwards from the Witwatersrand catchment divide in central Johannesburg (where the Crocodile River originates), to the confluence of the Crocodile and Marico rivers. The catchment area includes part of the Gauteng, North West and Limpopo Provinces.

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 total catchment area is about 29 000 km<sup>2</sup>. A locality map is included as **Figure 1-1**. A larger copy is included in **Appendix A**.



**Figure 2-1: Locality Map: Crocodile West River catchment and proposed transfer to the Lephallale area**

The catchment area of the Crocodile West River is one of the most developed in the country, and strategically an important catchment. Further to this the overarching planning of Government through the Strategically Important Projects (SIPs) links the

Crocodile West River catchment with the Mokolo River catchment through the likely future transfer of water to support the developments in the mineral rich Lephalale area.

## 1.2 BACKGROUND AND PURPOSE OF THE STRATEGY

The Reconciliation Strategy for the Crocodile West Water Supply System was developed and published in 2008 by the Department of Water Affairs (DWA) to ensure sufficient water can be made available to supply the current and future water requirements of the urban, industrial, mining and irrigations users in the system. The Strategy primarily focused on the quantitative reconciliation of the water requirements with the available resources and also considered water quality where it impacts on the water balance.

DWA recognised that the successful implementation of the Strategy requires continuous monitoring, review and revision to ensure its relevance in a changing environment where both short-term economic swings and evolving long-term development planning has to be accommodated. The Strategy also aims at promoting co-operation among water institutions through the Strategy Steering Committee (SSC) who drives the Strategy, with the DWA taking the lead. Through the Strategy water resources development planning and management are also conducted in a coordinated manner.

This study, *Support to the Implementation and Maintenance of the Reconciliation Strategy of the Crocodile West Water Supply System*, provides continuation of the administrative, technical and organisational support for DWA and the collaborating institutions represented on the SSC.

The objective of the Water Resource Reconciliation and Management Strategy is “*to ensure the sufficient and reliable supply of water of appropriate quality to all existing and future users together with the best utilisation of resources in the catchment, at the lowest cost and in an environmentally sustainable manner*” (DWA, 2010). The Strategy is targeted at water-related issues and recommends options, interventions and actions towards achieving the above. It is cognisant of possible future socio-economic developments and aims to integrate water related planning initiatives of all institutions by formulating coherent scenarios of elements affecting the projected water balance for the planning period up to the year 2040.

The Strategy is intended to be both flexible and robust under changing conditions.

### 1.2.1 Crocodile West Reconciliation Strategy: Version 1

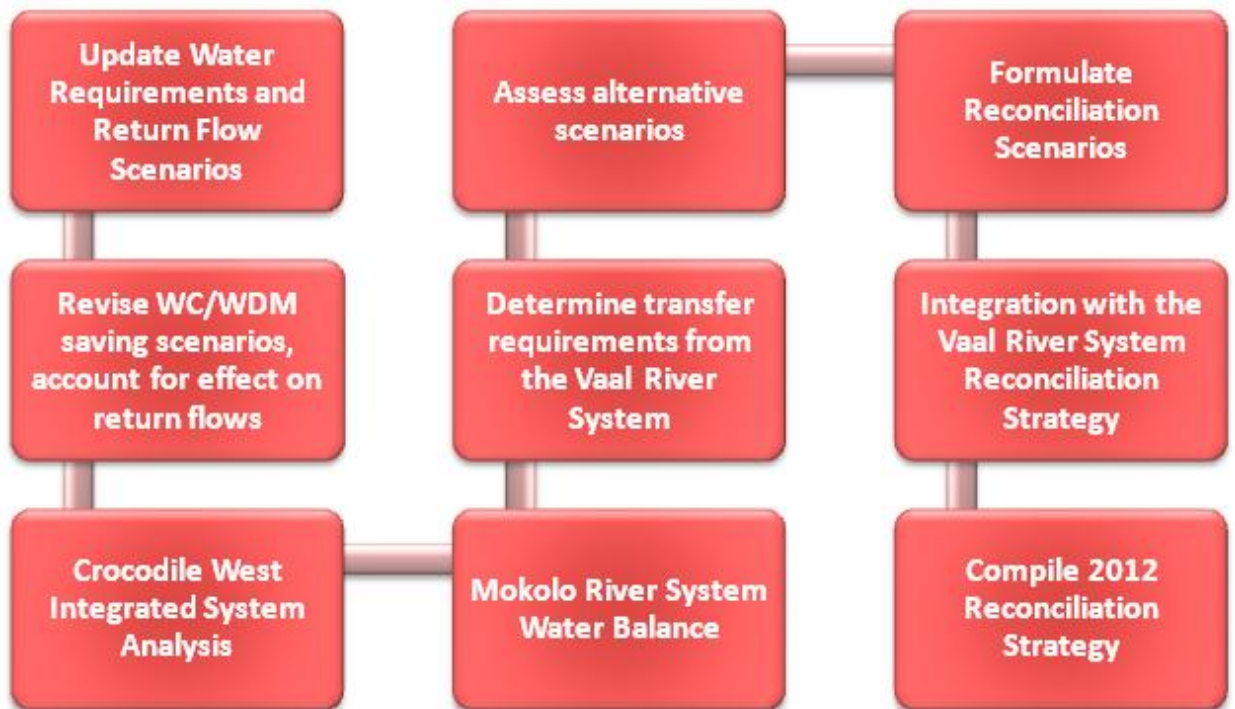
The 2008 Crocodile West Reconciliation Strategy summarised the background information from the *Crocodile West Modelling Study* and other supporting documentation, leading to the formulation of a Strategy for reconciling the requirements for water in the Crocodile West River catchment with the availability thereof. Version 1 (2008) of the Crocodile West River Reconciliation Strategy is summarised in **Appendix A**.

Water balances were determined for the period 2005 to 2030 at 5-year intervals to facilitate the development of a robust strategy that would be stable over time. These were done for eleven representative sub-areas.

### 1.2.2 Strategy revision procedure

This 2012 revision of the Crocodile West River Reconciliation Strategy updates and refines the 2008 Strategy based on new information and continued stakeholder involvement. This was achieved through the Strategy Steering Committee (SSC) who met twice a year, and reviewed the Strategy based on the updated information, including revised water balances. The revised water balances and the configuration of the Water Resources Planning Model (WRPM) are covered in more detail in the *Water Resources Planning Model Analyses Report (DWA, 2012b)*. To assist the Strategy in being more comprehensive, a water quality model (salinity) was configured to allow the impacts of development and management scenarios to be assessed. The Water Quality Model (WQT) configuration and calibration is discussed in more detail in the WQT Report (DWA, 2012a).

The process of revising and updating the Strategy is summarised in **Figure 2-**



**Figure 2-2: Process for revising and updating the Reconciliation Strategy**

### 1.3 PURPOSE OF THIS REPORT

The purpose of this report is to summarise the information included in the other supporting technical reports, and to present this revised Reconciliation Strategy 2012 for the Crocodile West River catchment.

## 2. WATER REQUIREMENTS

### 2.1 WATER REQUIREMENTS WITHIN THE CROCODILE WEST RIVER CATCHMENT

Water requirements, water availability and the water balance was calculated using the WRPM and have been covered in detail in the *Water Resources Planning Model Analyses Report (DWA, 2012b)*. As such water requirements, water availability and the associated water balance will only be summarised in Section 2, Section 3 and Section 4 respectively.

Domestic, irrigation, mining, power generation and industrial water requirements are summarised per water user sector up until 2040 for the preferred planning scenario (high population growth) in **Table 2.1**. Domestic water requirements include medium efficiency (15% savings) water conservation and water demand management (WC/WDM). Irrigation water requirements for the large irrigation boards and Government Water Schemes are shown. Some additional diffuse (smaller scale individual farms) irrigation exists in the catchment which has not been included in **Table 2.1**, but has been taken account in the water balance. Mining water requirements included in **Table 2.1** are those supplied by surface water within the catchment. Some additional mining in the catchment exists that receives water directly from Rand Water or ground water and does not directly impact the water balance of the Crocodile West River catchment.

**Table 2.1: Water requirements per sector for the Crocodile West River catchment**

Water use sector	Water requirements (million m <sup>3</sup> /a)						
	2010	2015	2020	2025	2030	2035	2040
Domestic	674	694	766	820	885	927	970
Irrigation	268	268	268	268	268	268	268
Mining, power and industry	93	116	131	133	134	134	133
<b>Total</b>	<b>1 035</b>	<b>1 078</b>	<b>1 165</b>	<b>1 221</b>	<b>1 287</b>	<b>1 328</b>	<b>1 371</b>

## 2.2 INTER-BASIN TRANSFERS

### 2.2.1 Transfers to the north to Modimolle and Mookgopong

The existing pipeline to Bela-Bela may be extended to supply water to meet the growing domestic water requirements in Modimolle and Mookgopong. The possible source of water is either Roodeplaat Dam or Klipvoor Dam on the Pienaars River. The volumes required are 8.5 million m<sup>3</sup>/a by 2040 and have been included as a future transfer in the water balance assessment of the Crocodile West River catchment.

### 2.2.2 Transfer to Lephalale

The first of 17 Strategic Integrated Projects (SIPs) aims to unlock the enormous mineral belt in the Steelpoort, Mpumalanga, and the Waterberg areas west of Lephalale. In addition, SIP 1 also makes provision for the transportation of coal by rail from the Waterberg area to the power stations located in the Highveld of Mpumalanga. The

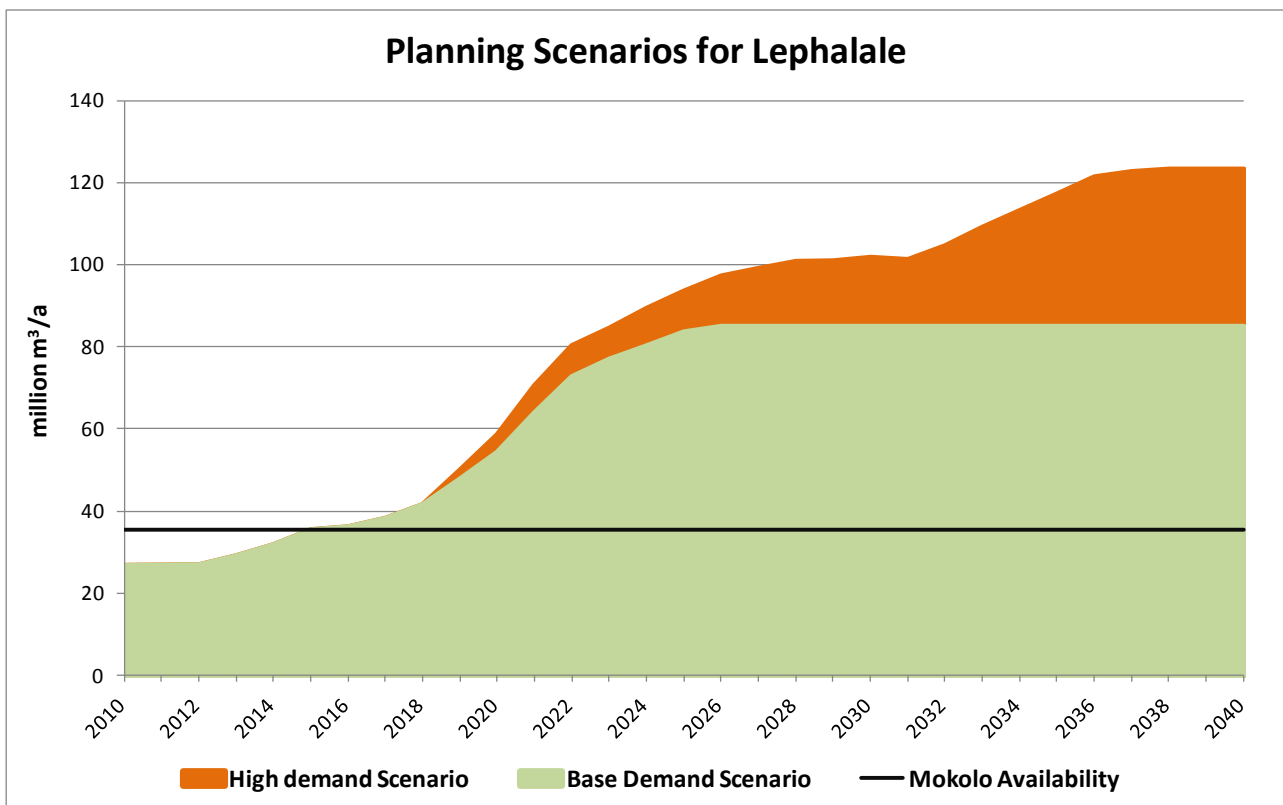
increased water requirements for these developments will exceed the available water resources in Lephalale (Mokolo River system) and further augmentation, by transferring water from the Crocodile West River system, will be necessary.

The proposed transfer of water from the Crocodile River to Lephalale is thus of high strategic importance and would constitute Phase 2 of the Mokolo-Crocodile Water Augmentation Project (MCWAP-2). Detail planning and optimisation of MCWAP-2 must still be completed and **Figure 2-1** shows the conceptual layout of the proposed transfer scheme as well as other important water resource features of the Crocodile West River system.

The annual water balance of the Mokolo River system is shown in **Figure 2-1** for two water requirement planning scenarios for the Lephalale Area. The scenarios include the following developments:

- Lephalale Base Demand Scenario 2012: Three coal-fired power stations plus two phases of coal export to existing power stations in Mpumalanga.
- Lephalale High Demand Scenario 2012: Four coal-fired power stations plus four phases of coal export to existing power stations in Mpumalanga.

The long-term required transfer volumes are 45 and 80 million m<sup>3</sup>/a for the Base and High demand scenarios respectively.



**Figure 2-1: Lephalale 2012 High and Base Demand scenarios**



### **2.3 ECOLOGICAL WATER REQUIREMENTS (RESERVE)**

Due to the highly altered flow regime in the Crocodile River catchment where the volumes of return flows are well in excess of the natural runoff for the main stem of the river and most of the main tributaries, provision for the Reserve has little impact on the yield from reservoirs and the availability of water.

A negative impact of the high proportion of return flows and the regulation of flow by control structures is that the natural variability of stream flow is smoothed out, also with resultant unnaturally high winter flows.

A comprehensive Reserve determination has been conducted for the catchment. Further to this, the continuation of the Strategy will integrate with the current classification study for the purpose of coherent scenario formulation and planning.

### 3. WATER AVAILABILITY

The water availability has been determined from different sources and sectors which are discussed and summarised below.

#### 3.1 LOCAL WATER RESOURCES

Local water resources include surface water and groundwater naturally occurring in the catchment. Effluent return flows constitute a significant portion of the available surface water resource.

##### 3.1.1 Surface water

Water availability from surface water is reported in the WRYM Analyses Report of the *Crocodile West Modelling Study*. However, the availability of surface water resources was better accounted for in the Water Resources Planning Model (WRPM) where the assurance supply criteria of the users are taken directly into account.

##### 3.1.2 Groundwater

A separate report on groundwater assessment was compiled as part of the *Crocodile West Modelling Study (DWAF, 2007)*. Water availability from groundwater was determined on a quaternary basis. These figures were accepted as best available and have not been updated since.

#### 3.2 INTER-BASIN TRANSFERS IN

Transfers of water into the catchment from the Vaal by Rand Water, supplies a majority of the domestic water requirements in the larger Metros in the Southern Part of the catchment. The current and projected transfers into the Crocodile West River catchment from the Vaal River system by Rand Water for domestic supply are shown in **Table 3.1**.

**Table 3.1: Projected water future transfer volumes into the Crocodile West River catchment from the Vaal by Rand Water for domestic water supply**

	Projected transfers into the Crocodile River catchment (million m <sup>3</sup> /a)						
	2010	2015	2020	2025	2030	2035	2040
Rand Water supply	523	524	577	624	686	725	765

#### 4. WATER CONSERVATION AND DEMAND MANAGEMENT

Water use can be classified in to two main components:

- (i) water that is used consumptively; and
- (ii) non-consumptive water use, which is the component giving rise to return flows.

Most return flows originate from urban areas where, for the Crocodile River catchment, more than 50% of the urban water requirements are discharged as effluent and returned to the rivers for possible re-use.

Savings on consumptive use would reduce the requirements for water, without impacting on the volume of return flows. It would, however, change the proportion of water requirements that ends up as return flows. Such savings would include the reduction of leakage (throughout the whole water distribution system), more efficient garden irrigation, etc.

Savings with respect to non-consumptive uses of water would influence both the requirements for water and the resultant return flows. Examples of non-consumptive use include most in-house uses of water, office buildings as well as certain components of industrial processes.

Water conservation and water demand management (WC/WDM) in the Crocodile River catchment can reduce the water transfers from the Vaal River system and, depending on the measures implemented, may also reduce the volume of return flows available for re-use.

High and medium efficiency WC/WDM scenarios for urban water users, similar as those determined for the Vaal River Reconciliation Strategy were considered. The medium WC/WDM scenario with 15% savings was chosen for the preferred planning scenario and appears to be in line with actual savings achieved by the most successful municipalities to date. The 15% savings (reduction) were included to be achieved within five years starting in 2010. This saving was then maintained from 2015 onwards.

Additional information was obtained on from two reports prepared by the *Development Of A Comprehensive Water Conservation And Water Demand Management Strategy And Business Plan And Pilot Implementation For The Crocodile West Marico Water Management Area: Water Use Sectors (DWA, 2010)*. These two reports are titled *Situation Assessment and Strategy for Implementing WC/WDM For the Domestic Sector in Ngaka Modiri Molema District Municipality (DWA 2010a)*, and *Situation Assessment and Strategy for Implementing WC/WDM for the Domestic Sector in Bojanala District Municipality (DWA 2010b)*

## 5. **WATER QUALITY**

Water quality in the catchment is a significant issue due to the large volumes of return flows and associated Nutrients. Other activities such as mining and irrigation also impact on water quality.

The DWA is monitoring water quality in the catchment and setting preliminary Resource Water Quality Objectives (RWQO's). To accompany this effort a water quality model (WQT) model has been configured and calibrated to simulate salts in the catchment. The salinity modelling capabilities have been added to the WRPM to allow for the assessment of salt build up for different development scenarios. This will continue to be a valuable tool in the maintenance of the Strategy, and in particular to assess the impact of further re-use of treated effluent return flows.

## **6. DEVELOPMENT SCENARIOS**

### **6.1 BASE SCENARIO**

It is anticipated that the current development trends will continue for the foreseeable future. Strong growth in the urban/industrial sectors is expected to continue in and around the existing metropolitan areas located in the upper parts of the catchment (and contributing to return flows downstream). New mining developments will mainly be in the middle and lower parts of the catchment, whilst a strong need also exists for the abstraction of water in the lower parts of the Crocodile River for transfer to new proposed developments in the Lephalale area which is located in the Mokolo River catchment.

The primary elements that would impact on the growth in water requirements are concisely summarised below. The base scenario adopts the population growth and medium efficiency WC/WDM savings. These water requirements are presented in **Section 2** of this report.

### **6.2 ALTERNATIVE SCENARIOS**

#### **6.2.1 Magalies Water demand scenario**

During discussions with officials of Magalies Water it became apparent that alternative growth to the Base Scenario is expected by Magalies Water for a few specific areas in the catchment. This was predominantly in the area around Roodeplaas Dam which, although now part of the City of Tshwane Metro, was previously part of the Nokeng Tsa Tsaemane LM. The alternative scenario with much higher growth suggested by Magalies Water was based on the Nokeng Tsa Tsaemane LM Water Services Development Plan. This scenario was analysed using the WRPM to assess the impacts of this alternative water requirement growth scenario.

#### **6.2.2 Tshwane re-use scenario**

The City of Tshwane Metro has planned their Water Augmentation Program which entails significant in-direct re-use of return flows, and this is coupled with a reduction in the water requirements from the Vaal River system in some areas (City of Tshwane, 2011). The majority of the interventions are planned from 2017 onwards. This would impact the water balance, and as such was included as an alternative water use scenario and analysed with the WRPM.

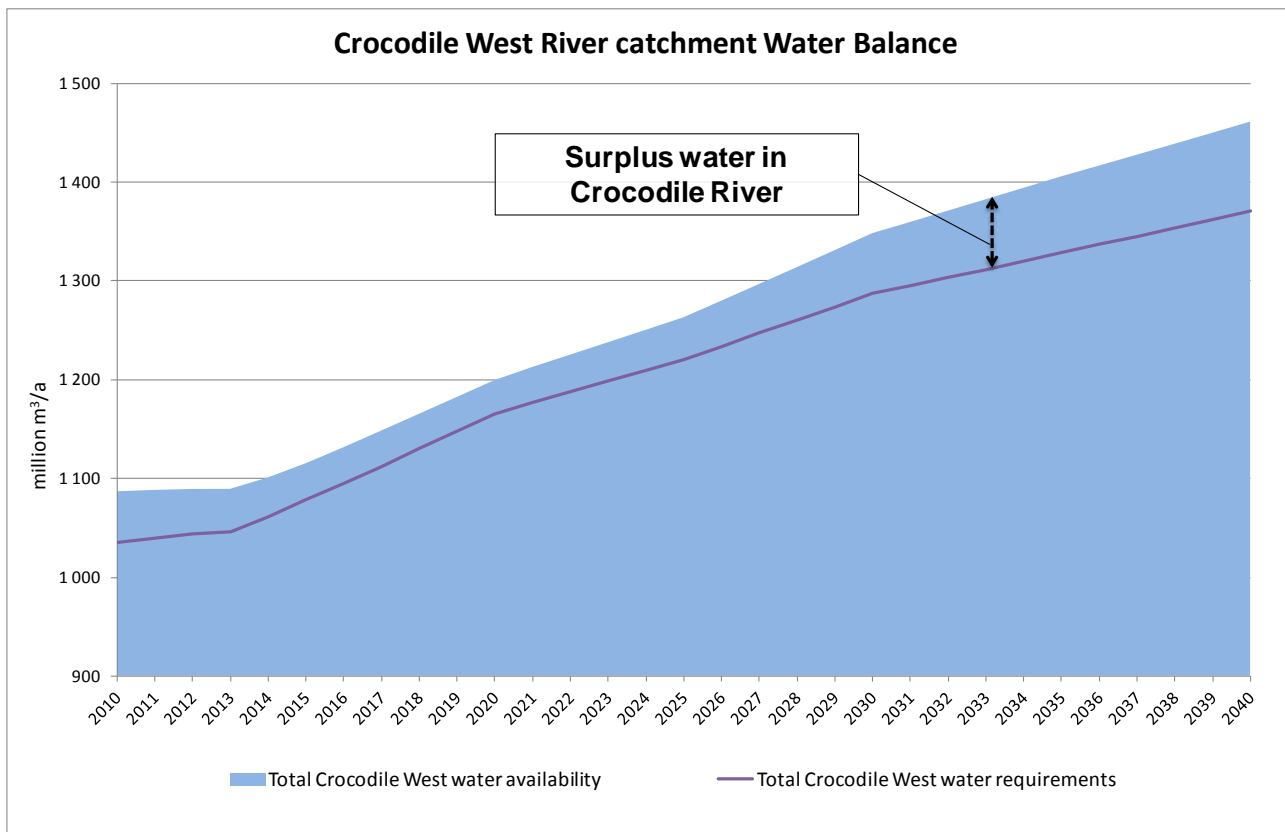
## 7. WATER BALANCES

The water balances were calculated using the WRPM and the process and methodology is described in detail in the *Water Resources Planning Model Analyses Report (DWA 2013)*. The water balance was calculated taking into account the future growth in water requirements and return flows of the Base Scenario (2012 preferred planning scenario), as well as for some additional development scenarios.

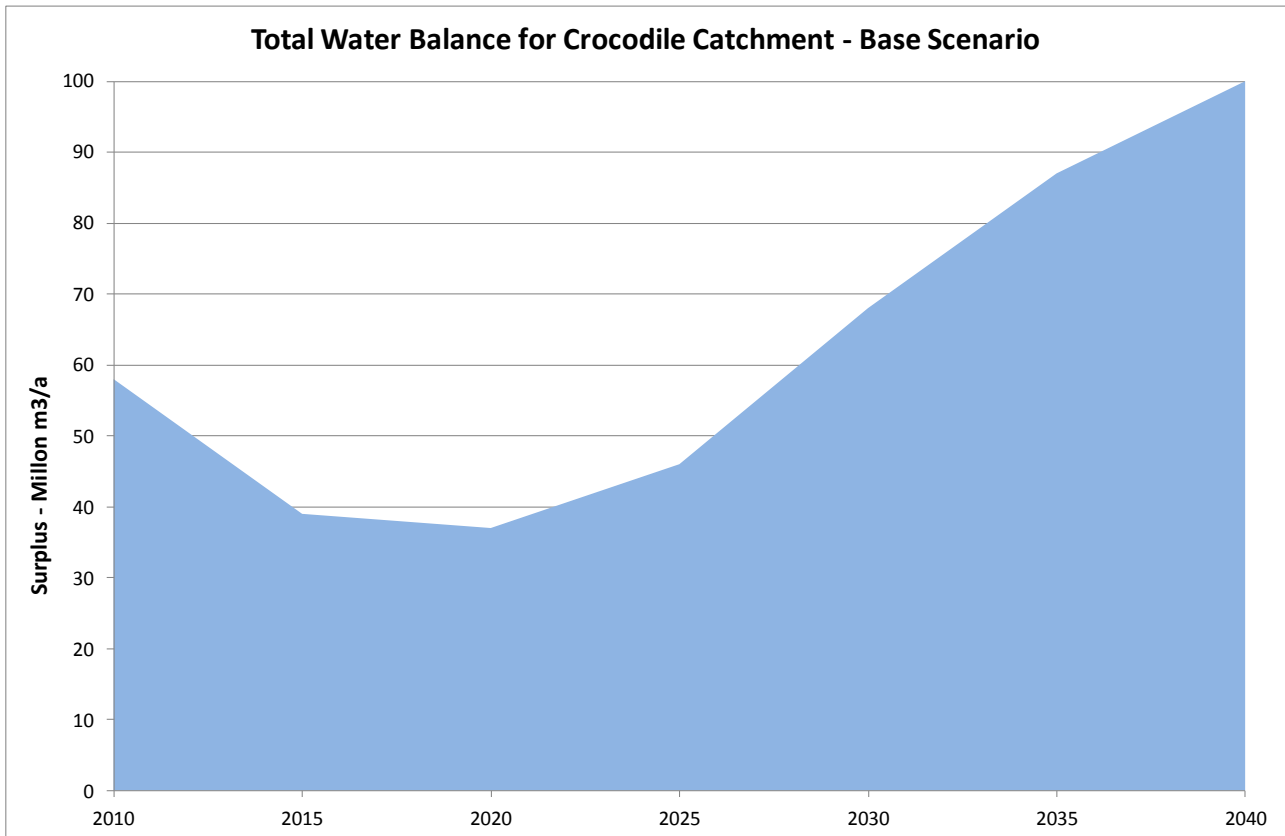
### 7.1 WATER BALANCES FOR THE CROCODILE RIVER CATCHMENT SCENARIOS

#### 7.1.1 Base Scenario

The water balance for the total Crocodile River catchment for the Base Scenario is summarised in **Figure 7-1**. As can be seen there is a surplus in the catchment due mostly to the growing effluent return flows from the large urban areas. The surplus on its own is shown in **Figure 7-2**.



**Figure 7-1: Water balance for the Crocodile West River catchment**



**Figure 7-2: Surplus projected for the base scenario of the Crocodile West River catchment**

### 7.1.2 Alternative scenarios

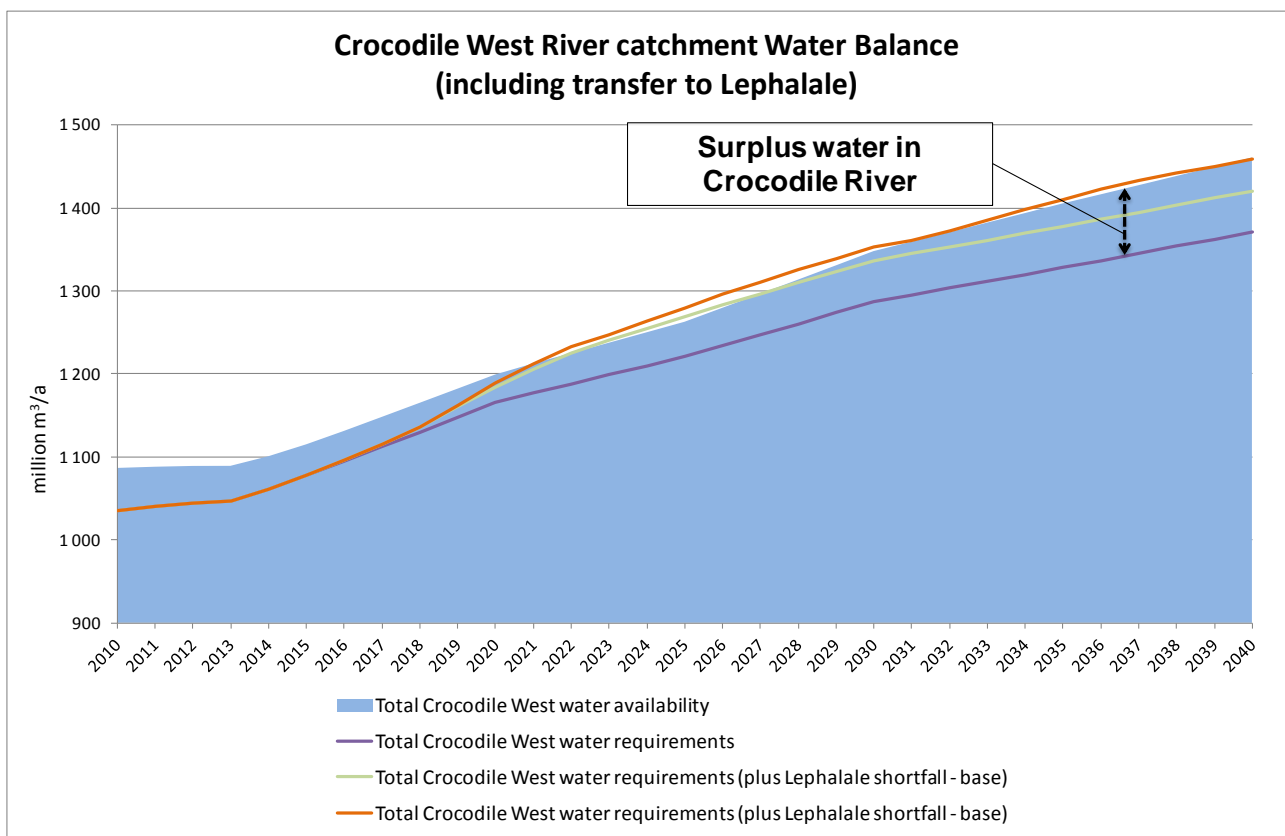
The water balances of the Magalies Water and Tshwane Re-use scenarios are covered in more detail in the *Water Resources Planning Model Analyses Report (DWA, 2012b)*. In summary both alternative scenarios have a significant reduction impact on the catchment water balance. In a workshop discussion the following was noted:

- The water requirements of the area around Roodeplaat Dam that differ in the Magalies Water Scenario now fall under the City of Tshwane’s jurisdiction. The water requirement growth rates adopted from the old Nokeng Tsa Tsaemane LM Water Services Development Plan are thus outdated and needs to be reviewed once the City of Tshwane revises it’s planning. This scenario highlighted the need to review water requirement growth projections, particularly for Tshwane, and that if very high growth in the Roodeplaat Dam surrounding area realises then the surplus in the Apies-Pienaars sub-catchment will be impacted.
- The Tshwane Re-use Scenario highlighted how the potable water augmentation planned by the City of Tshwane will use the surplus in the catchment, particularly for the period between 2017 and 2025 when the catchment would experience a short-term deficit. The timing of this program will need to be reviewed as shown by the water balance including the water transfer to the Lephale area, as discussed in **Section 7.2**.

## 7.2 WATER BALANCES FOR THE CROCODILE-MOKOLO SYSTEM

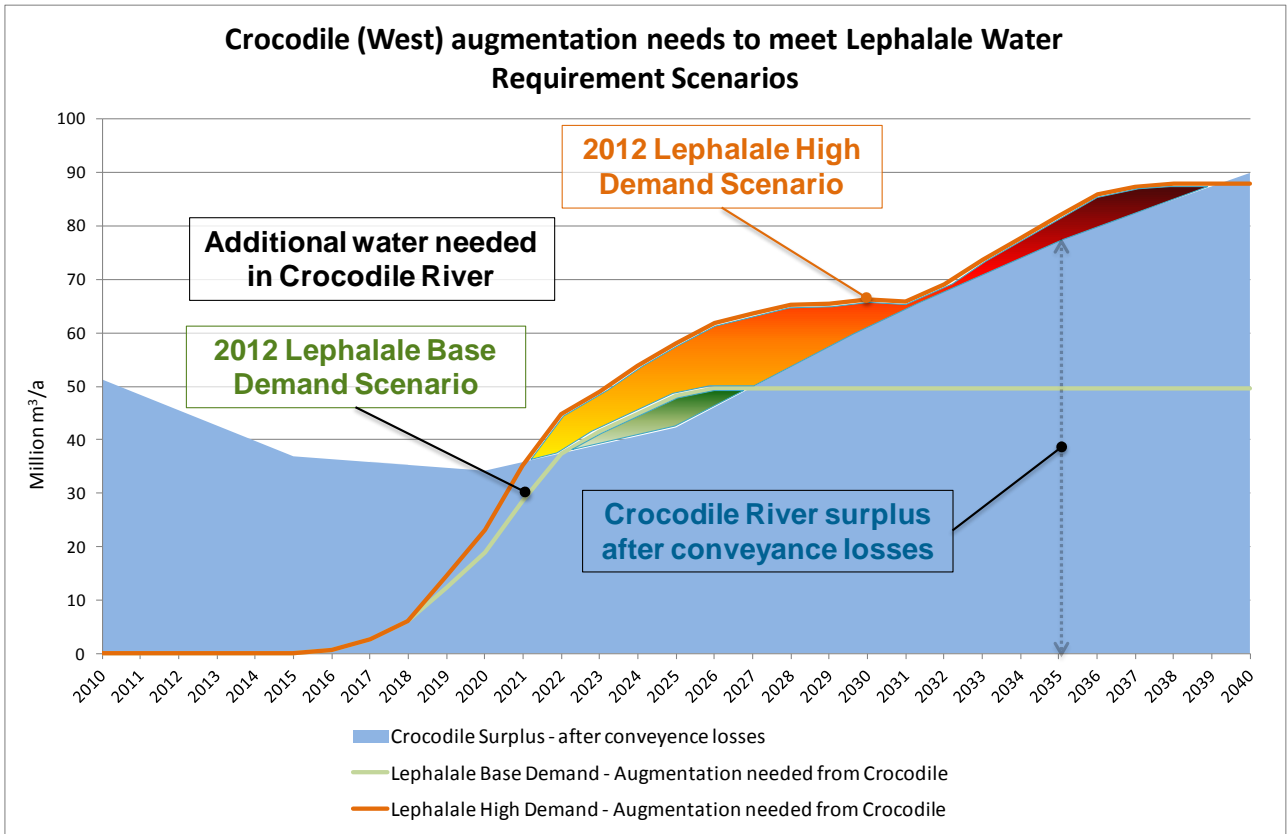
The surplus water in the Crocodile River catchment for the Base Scenario was compared to the water transfer needs to the Lephalale area as presented in **Section 2.2.2**. A conveyance loss of 10% was assumed for the river stretch between the upstream dams in the Crocodile West River catchment where the surplus is located, and the abstraction point of the transfer at Vlieëpoort (near Thabazimbi) in the Lower Crocodile sub-catchment.

The total water balance for the Crocodile West River catchment, taking into account water transfer requirements to Lephalale, is shown in **Figure 7-3**. Zooming into the top part of the water balance graph, the extent to which the surplus in the Crocodile River can meet the transfer requirements to the Lephalale area is shown in **Figure 7-4**, for both the High and Base demand scenarios of Lephalale. The shortfall of surplus in the Crocodile River catchment to meet the transfer requirements to the Lephalale area is shown in **Figure 7-5**. As can be seen the shortfall in surplus is small and also temporary. As return flows continue to grow in the Crocodile West River catchment in future the surplus is projected to again exceed the transfer requirements.

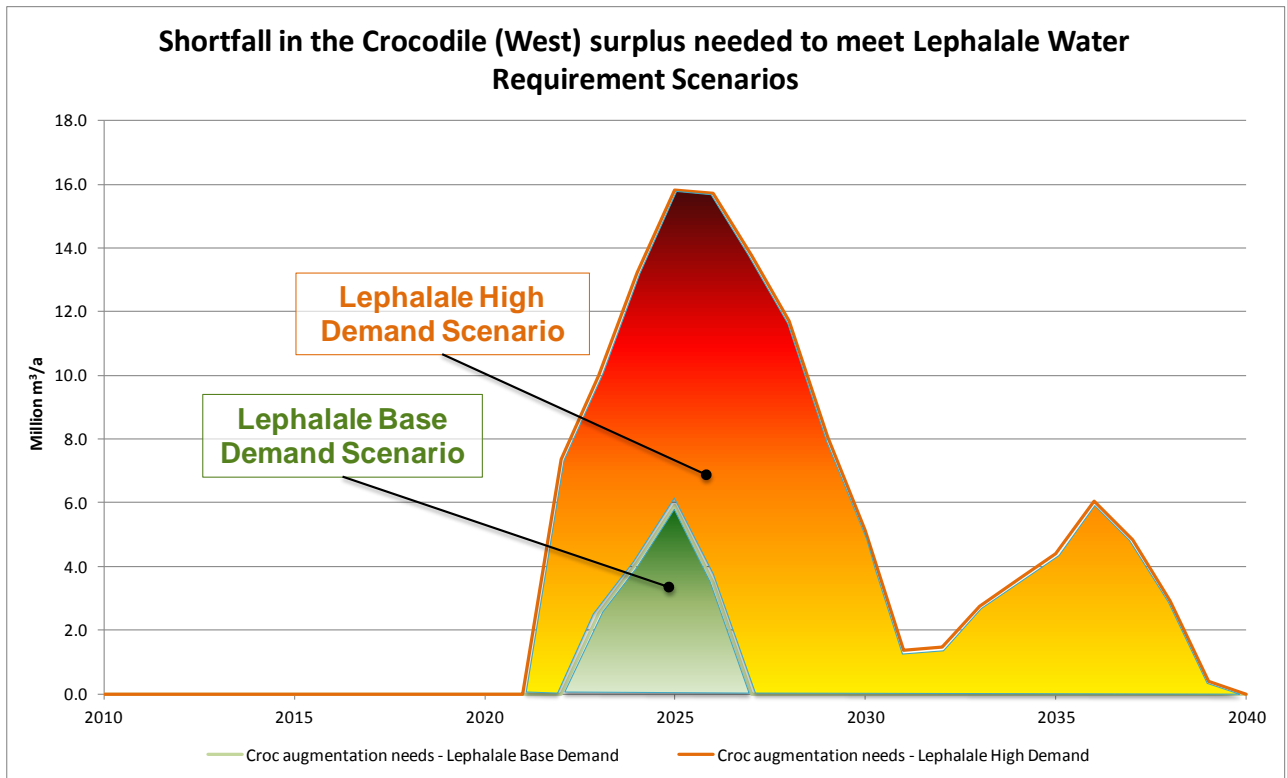


**Figure 7-3: Water balance of the Crocodile West River catchment taking into account water transfers to the Lephalale area**





**Figure 7-4: Comparison of surplus water in the Crocodile West River catchment, and the water transfer needs to Lephale to augment water supply of anticipated power generation and mining developments**



**Figure 7-5: Additional water needed in the Crocodile West River catchment to meet transfer needs to the Lephale area**

## 8. CORE OBSERVATIONS AND RECONCILIATION PERSPECTIVE

The water balance results presented in the previous section give rise to the following perspectives relating to the reconciliation of the water requirements with available water resource in the Crocodile West River system:

- It is possible to maintain the reliability of supply to all current and future water users within the Crocodile West River system up to 2040.
- The projected surplus water in the Crocodile West River system can mostly supply the augmentation needs of the Lephalale area (proposed MCWAP-2 transfer scheme):
  - For the 2012 Lephalale Base demand scenario, intervention is required in the Crocodile River to address the shortages between 2022 and 2027, which reach a peak shortage of 6 million m<sup>3</sup>/a in 2025 (see **Figure 7-5**).
  - For the 2012 Lephalale High demand scenario a longer period of intervention is needed, from 2021 to 2040, when the surplus is fully utilised. The peak shortage of 16 million m<sup>3</sup>/a also occurs in 2025 for this scenario.

## 9. KEY FACTORS INFLUENCING THE WATER BALANCE

Long-term planning in general, and water requirements scenario in particular, are inherently uncertain, which make it essential to identify and monitor those key variables that could influence the projected water balances.

In the Crocodile West River system and its linked systems, the following factors will influence the water balances and ultimately the Reconciliation Strategy:

- Urban water requirements and return flow growth.
- Growth in water requirements of mining and related industries (platinum and coal). The rate of mining development is highly influenced by global economic outlook and commodity prices. In this regard liaison and information sharing with the *Consolidation of Feasibility studies in the Bojanala Platinum DM Study* were taking place to ensure the alignment of development scenarios.
- Power generation and related developments on the Waterberg coal fields in the Lephale area.
- Success of water conservation and water demand management measures, both in terms of the volumes of water abstracted and the return flows (treated wastewater).
- Classification of water resources and ecological monitoring.
- Dynamic institutional arrangements, such as the extension of Tshwane's jurisdiction of responsibility, now including areas such as Nokeng Tsa Taemane and Kungwini Local Municipalities. Tshwane also requested Magalies Water to take over the water supply to Moretele. The proposal of Magalies Water is to supply water from their Klipdrift water treatment plant (WTP) as well as a new proposed WTP at Klipvoor Dam.
- Assumptions of how the return flows will reduce due to the implementation of water conservation and water demand management. The City of Tshwane expressed concern and requested a review of the assumptions made. This should be done for the greater Gauteng as it will also influence the Vaal Reconciliation strategy.
- Water quality assessment guided by a proposed Steering Committee to evaluate and ensure fitness for use.

## 10. RECONCILIATION AND MANAGEMENT STRATEGY

The objective of the Water Resource Reconciliation and Management Strategy is “to ensure the sufficient and reliable supply of water of appropriate quality to all existing and future users together with the best utilisation of resources in the catchment, at the lowest cost and in an environmentally sustainable manner”. The Strategy is targeted at water related issues and addresses options, interventions and actions towards achieving the above. It is cognisant of the possible future development scenarios and of the impacts and risks/uncertainties associated with the various options.

The Strategy is not intended to be a singular master plan with fixed sequencing and time scales, but should be both flexible and robust under changing conditions.

The Strategy comprises:

- (1) certain general items and ongoing activities that need to be attended to as primary functions in support of the implementation of other components of the Strategy; and
- (2) specific strategies, other than the above, for addressing of other key issues.

These are covered in the sections that follow.

### 10.1 GENERAL ITEMS AND ONGING ACTIVITIES

Certain elements of the Strategy are common to all scenarios and are of general application towards improved water resource management. These include:

- The validation and verification of water use licenses, and confirmation of actual abstraction and use. This has already been embarked upon in a separate study and should receive high priority, with particular focus on irrigation water.
- Regular review as well as constant monitoring and enforcement of water use licenses. Without proper enforcement much of the water resource management strategies will be futile. These activities appear to have been neglected in recent years.
- Setting of assurance of supply requirements for different categories of water users, reflection of such in the water use licenses, and management of the water resources accordingly to ensure that the optimal utilisation is achieved.
- The allocation and management of water resources to meet user quality objectives.
- Management of the water resources in the Crocodile River catchment in order to minimise excess discharges to the Limpopo River as well as to minimise the overall transfers from the Vaal River system.

## 10.2 SPECIFIC RECONCILIATION STRATEGIES

The abridged revised 2012 Reconciliation Strategy for the Crocodile West River system entails the following:

- The Rand Water service area in the Crocodile West River catchment will in future continue to be supplied from the Vaal River system and additional re-use will be considered only when surplus becomes available.
- The areas north of the Magaliesberg outside the Rand Water supply area will receive increased treated effluent from the metropolitan areas as a future source of water.
- In the Waterberg area (north of the Crocodile River catchment) the optimal utilisation of local resources will continue and surplus water in the catchment will be transferred to the Lephalale area.
- Interventions to supply the temporary shortfall of future supply will be evaluated by investigating demand side management and/or potential augmentation by transferring treated wastewater from the Vaal River system to the Crocodile West River system. Some of these interventions may include:
  - Monitoring, review and enforcement of water use licenses.
  - Improved water resources management, with negotiated assurance of supply requirements.
  - Management and allocation of water resources in order to meet user quality requirements.
  - Trading (re-allocation) of irrigation water.
  - Development of groundwater (localised small potential).
  - Removal of alien vegetation; and
  - Increase transfers from the Vaal River system.
- Available groundwater resources should be utilised in all areas and opportunities for conjunctive surface/groundwater utilisation should be explored

## 11. CURRENT WATER RESOURCE MANAGEMENT ACTIVITIES

### 11.1 DEVELOPMENT AND APPLICATION OF SYSTEM OPERATING RULES

The objective of this current (2013) DWA study is to develop and implement operating rules (provide annual operating decision support) for the Crocodile West River system.

A System Operating Forum (SOF) has been established and consists of organisations representing users who have a direct interest in the operation of the dams, abstraction works and conveyance infrastructure in the System.

Risk-based simulation analyses will be undertaken to evaluate alternative operating scenarios and annual water allocations that will be motivated and presented to the SOF for consideration and approval. The focus of the analysis will be on the main reservoirs in the system, which includes Hartbeespoort, Roodekopjes, Roodeplaat, Klipvoor, Vaalkop, Buffelspoort, Rietvlei, Bospoort, Koster, Lindleyspoort and Olifantsnek dams.

### 11.2 VALIDATION AND VERIFICATION OF WATER USE

A DWA study on the validation and verification of lawful water use has recently commenced in the Crocodile West River system. This process aims to identify water users who have:

- Registered their water use entitlements correctly (correct registration).
- Registered water uses they are not entitled to (over-registration or unlawful use).
- Omitted to register water use they are entitled to (under-registration or terminated use).
- Failed to register water use.

**Verification** is a process to check the volume of water registered by existing users and its lawfulness under previous legislation, so as to certify the extent of existing lawful use.

**Validation** is the process through which the DWA compares the volume of water use registered against how much water was actually used, and how much is currently being used.

### 11.3 WATER USE CLASSIFICATION OF SIGNIFICANT WATER RESOURCES IN THE MOKOLO-MATLABAS CATCHMENTS AND THE CROCODILE WEST AND MARICO WATER MANAGEMENT AREA

This DWA project has recently been initiated and aims at setting the ecological classes for the rivers in the study area. This is a formalisation of the Reserve and will be conducted in a number of steps that take into account both the ecological and socio-economic values of the water resources when setting the classes.

#### **11.4 WATER CONSERVATION / WATER DEMAND MANAGEMENT INITIATIVES OF MUNICIPALITIES IN THE AREA**

Municipalities are encouraged to attend the Crocodile West Strategy Steering Committee meetings and share water conservation and water demand management (WC/WDM) initiatives and also to hear how others are dealing with similar problems at local authority level.

Sufficient funding for WC/WDM remains to be a limiting factor in achieving the potential savings in water use. Problems facing some of the smaller towns include the absence of bulk meters to measure how much water is actually abstracted and supplied.

Magalies Water has been appointed by the DWA to assist with WC/WDM support to all Water Services Authorities in the study area. There are serious gaps in terms of municipalities reporting on WC/WDM initiatives and this project should improve the data available on WC/WDM. All available reports have been collected from the municipalities that are serving as the baseline for this project. Meetings will be held with the municipalities to find out more about the WC/WDM challenges they are facing. One of the main aims of this project is to prepare a WC/WDM plan for the North West region.

## **12. STATUS OF INFRASTRUCTURE PLANNING**

### **12.1 THE MOKOLO-CROCODILE WATER AUGMENTATION PROJECT**

The Mokolo-Crocodile Water Augmentation Project (MCWAP) will provide water to the power stations and other future developments in the Lephalale area.

Phase 1 of MCWAP (a pipeline parallel to the existing pipeline from Mokolo Dam to users) is currently under construction. Environmental authorisation was granted in December 2010, a contractor appointed in September 2011 and the project should be completed by December 2013.

Phase 2 of MCWAP (a water transfer scheme from the Crocodile River near Thabazimbi to the Lephalale area) should proceed to ensure that the power stations have access to water from more than one source. However, this phase and the other phases will only be initiated when required.

The Medupi power station will be commissioned one unit at a time, starting from 2013 up to 2019 when all six units will be operational. Each unit will require 1 million m<sup>3</sup>/a water. There is enough time to get all the resources in place until 2019, when 6 million m<sup>3</sup>/a water will be required.

### **12.2 MAGALIES WATER – BULK WATER EXPANSION PLANS**

The latest status on the expansion plans of Magalies Water is that there are significant additional requirements for bulk water supply in the area from mining, industry and housing developments and billions of rand are being spent on infrastructure development.

Magalies Water will be concentrating on the following activities in the near future:

- Support WC/WDM interventions at municipal level.
- Ensure economical bulk water supply to all.
- The planned Pilanesberg Water Scheme and the proposed Klipvoor Bulk Water Supply Scheme.
- Eradication of both bulk and retail backlogs.
- Providing co-operation on water and sanitation provision in its area of operation.
- Efficient use of existing bulk infrastructure.



### 13. **RECOMMENDATIONS**

The following recommendations were listed as actions for analyses and discussion at Strategy Steering Committee meetings:

- The mining sector should provide annual updates of water requirement and return flow projections.
- Continuous coordination of planning between bulk water service providers.
- Phase 2 of the Mokolo-Crocodile River Water Augmentation Project must be planned and optimised for further augmentation to transfer surplus water to the Lephalale area as mentioned in the Budget Vote speech of the Minister of Water and Environmental Affairs.
- Water tariffs in the Crocodile West River catchment are low in comparison to some other parts of the country, which is partly attributable to the high proportion of return flows that may not properly be accounted for. The tariff structure need to be investigated and consideration should be given to bringing it in line with water tariffs in the Vaal River area. This has been included as one of the tasks to be addresses in a follow-up (Phase 2) of this study.
- Continued discussions must be held with the City of Tshwane to improve on projected water requirement and return flow information.
- Annual monitoring of water requirements and return flows as well as the review of the water balance – consider revising long-term projections.
- The DWA should undertake a water quality assessment study guided by a proposed Steering Committee to evaluate and ensure fitness of water for use.
- Continue to undertake annual operating analyses and engage water users through the System Operating Forum.
- Complete validation and verification of existing lawful use and review the water balance after completion.
- The continuation of monitoring and reporting through Strategy Steering Committee meetings.
- All municipalities must make a conserved effort to improve their WC/WDM strategies to reach the targeted 15% saving of water. The City of Tshwane is currently the only municipality in the study area achieving this milestone. Sufficient funding to municipalities for WC/WDM remains the main obstacle in achieving the potential savings in water use.
- More information on this study can be found at the following link: <http://www.dwa.gov.za/Projects/crocodilemaintenance/default.aspx>

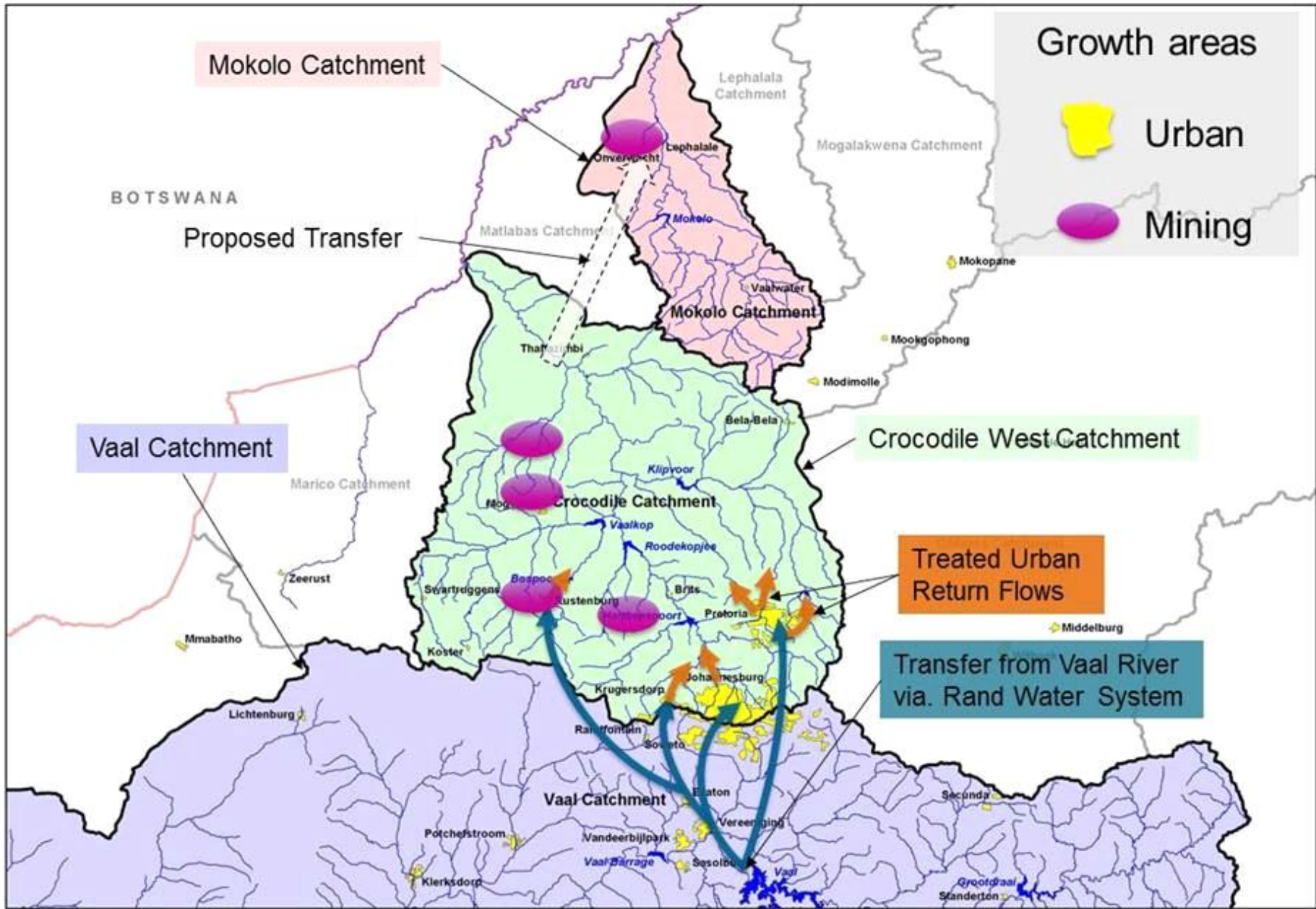
## 14. REFERENCES

1. Department of Water Affairs and Forestry (South Africa). 2008. **Water requirement and availability scenarios for the Lephale Area**. DWAF Report Number P WMA 03/000/00/4107. Report by BKS.
2. Department of Water Affairs and Forestry (South Africa). 2008. **Groundwater Assessment**. DWAF Report Number P WMA 03/000/00/2507. Report by AGES.
3. Department of Water Affairs and Forestry (South Africa). 2008. **Crocodile (West) River Catchment: Hydrological Assessment**. DWAF Report Number P WMA 03/000/00/2307. Report by BKS and Arcus Gibb.
4. Department of Water Affairs and Forestry (South Africa). 2008. **Agricultural Assessment**. DWAF Report Number P WMA 03/000/00/2207. Report by Schoeman en Vennote.
5. Department of Water Affairs and Forestry (South Africa). 2007. **Vaal River System: Large Bulk Water Supply Reconciliation Strategies: Current and Future Urban Water Requirements and Return-Flows**. DWAF Report No. P RSA C000/00/4405/01. Report by DMM Development Consultants, Golder Associates Africa, SRK, WRP Consulting Engineers and Zitholele Consulting.
6. Department of Water Affairs and Forestry (South Africa). 2004. **Crocodile (West) River Return Flow Analysis Study**. DWAF Report Number P WMA 03/000/00/0504. Report by WRP Consulting Engineers.
7. Department of Water Affairs and Forestry, Anglo Platinum and Lonmin Platinum. 2008. **Pre-feasibility study for the supply of industrial grade water between Hartbeespoort Dam and Lephale**. Draft Report by Bigen Africa and BKS.
8. Department of Water Affairs 2010a. **Situation Assessment and Strategy for Implementing WC/WDM for the Domestic Sector in Bojanala District Municipality**. Part of the Development of a Comprehensive Water Conservation and Water Demand Management Strategy and Business Plan and Pilot Implementation for the Crocodile (West) Marico Water Management Area: Water Use Sectors. DWA contract WP9940

9. Department of Water Affairs 2010b. **Situation Assessment and Strategy for Implementing WC/WDM for the Domestic Sector in Bojanala District Municipality.** Part of the Development of a Comprehensive Water Conservation and Water Demand Management Strategy and Business Plan and Pilot Implementation for the Crocodile (West) Marico Water Management Area: Water Use Sectors. DWA contract WP9940.
10. City of Tshwane, 2011. Presentation on the **Proposed Potable Water Augmentation Program.** Presented by F.I. Sherrif, Executive Director of Water & Sanitation.
11. Department of Water Affairs (South Africa). 2013. **Water Resources Planning Model Analyses Report.** Support to the Implementation and Maintenance of the Reconciliation Strategy of the Crocodile West Water Supply System Study. DWA Report Number P WMA 03/A31/00/6110/4. Report by BKS and WRP Consulting Engineers.

## ***Appendix A***

*Locality Map: Crocodile West River  
catchment and proposed transfer  
to the Lephale area*



## ***Appendix B***

### ***Executive Summary of the Reconciliation Strategy Version 1 (2008)***

## **Reconciliation and Management Strategy**

*Potential options to reconcile the requirements for water with the availability thereof are covered in Chapter 9 of the report. Water quantity as well as water quality are taken into account, with due cognisance also to geographic location. These options form the core elements from which Version 1 of the Strategy was distilled.*

*The Strategy is not intended to be a singular master plan with fixed sequencing and time scales, but should cater for a spectrum of plausible future scenarios, and also be both flexible and robust under changing conditions.*

*The Strategy as formulated comprises:*

- (1) certain general items and ongoing activities that need to be attended to as primary functions in support of the implementation of other components of the Strategy;*
- (2) strategies of general nature, directed at key issues or components, and*
- (3) specific strategies, other than the above, for addressing of other key issues.*

*The general items and ongoing activities include:*

- The validation and verification of water use licenses.*
- Regular review as well as constant monitoring and enforcement of water use licenses.*
- Setting of assurance of supply requirements for different categories of water users.*
- The allocation and management of water resources to meet user quality objectives.*
- Management of the water resources in the Crocodile River catchment in order to minimise excess discharges to the Limpopo River as well as to minimise the overall transfers from the Vaal River system.*

*The general strategies provide broad directives for dealing with the following items or issues:*

- Increased water requirements*
- Water conservation and demand management*
- Direct recycling of effluent*
- Indirect re-use of effluent*
- Groundwater*
- Water quality*
- Implementation of the Reserve*
- Alien vegetation*

Specific strategies are proposed with respect to the following:

- **Regulation of return flows:** *The efficient control and re-use of return flows is of primary importance with respect to the proper management of water resources in the Crocodile River catchment. To facilitate this, it is proposed that a new regulation dam be investigated on the main stem of the Crocodile River at a location downstream of the confluence of the Moretele River, which is the last main tributary that contributes return flows.*
- **Re-use of effluent below Hartbeespoort Dam:** *Most of the effluent return flows in the Crocodile catchment are discharged to the river system upstream of Hartbeespoort Dam, with the resultant surplus availability of water at that point. Most of the mining developments north of the Magaliesberg can best be supplied with water from the Hartbeespoort Dam. This will lessen the need for use of higher quality potable water from Rand Water, which could better be allocated to urban use.*
- **Water supply to Madibeng and Rustenburg municipalities:** *Potable water supply to these areas should best be from Rand Water and Magalies Water. The number of small wastewater treatment plants should be rationalised, and the option be investigated of routing effluent to downstream of Hartbeespoort Dam.*
- **Water for transfer to the Lephale area:** *The abstraction of water from the Crocodile River for the augmentation of resources in the Lephale area could (probably best) be made at or downstream of the proposed new balancing dam. However, sufficient water (from return flows) will not be available in the Crocodile River to meet all the needs with respect to the water requirement scenarios for the Lephale area.*

*For the higher water use scenarios in the Lephale area, additional water will have to be transferred from the Vaal River system. Several options need to be investigated in this respect.*

*Other smaller scale as well as interim options to augment the resources include:*

- *The raising of the Mokolo Dam;*
- *Freeing up of water through improvements to irrigation distribution systems in the Crocodile River catchment;*
- *Re-allocation (purchase) of water from irrigation in the Crocodile and/or Mokolo River catchments; and*
- *Interim use (purchase) of irrigation water in the Crocodile and/or Mokolo River catchments.*