Department of Water & Sanitation

Report Number 5

Edition 1

REPORT

Integrated Water Quality Management Plan for the Olifants River System

Reconciliation and Foresight Report

Edition 1

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DEPARTMENT OF WATER AND SANITATION

Water Resource Planning Systems Series

Development of an Integrated Water Quality Management Plan for the Olifants River System

Reconciliation and Foresight Report

Study Report No. 5

P WMA 04/B50/00/8916/6

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14.0	P WMA 04/B50/00/8916/15	Implementation Plan Report
15.0	P WMA 04/B50/00/8916/16	Study Close-out Report

APPROVAL

Title: Development of an Integrated Water Quality Management Plan for the Olifants River System: **Reconciliation and Foresight Report**

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EXECUTIVE SUMMARY

The Department of Water and Sanitation (DWS) from a planning perspective has identified the need to develop an overarching Integrated Water Quality Management Plan (IWQMP) for the Olifants WMA in order to manage the water resources and needs to take cognisance of, and align to a number of studies and initiatives that have been completed to date, and needs to establish clear goals relating to the quality of the relevant water resource in order to facilitate a balance between protection and use of water resources.

The main objective of the study is to develop management measures to maintain and improve the water quality in the Olifants WMA in a holistic and sustainable manner so as to ensure sustainable provision of water to local and international users. The management measures will be of an overarching nature and will deal with the broader Olifants WMA while taking the strategies and plans developed at the sub-catchment level into account.

The following aspects of the study have already been undertaken:

- Inception Report (Report No: P WMA 04/B50/00/8916/1);
- Water Quality Status Assessment and International Obligations With Respect To Water Quality Report: (Report No: P WMA 04/B50/00/8916/3); and
- Water Quality Planning Limits Report: (Report No: P WMA 04/B50/00/8916/4).

The following components are now underway:

- Scenario Analysis Report;
- Reconciliation and Foresight Report;
- Management Options Report;
- Integrated Water Quality Management Plans for each Sub-catchment:
    - IWQMP for the Upper Olifants sub-catchment;
    - IWQMP for the Middle Olifants sub-catchment;
    - IWQMP for the Lower Olifants sub-catchment;
    - IWQMP for the Steelpoort sub-catchment; and
    - IWQMP for the Letaba and Shingwedzi sub-catchments,
- Monitoring Programmes Report;
- Overarching IWQMP for the Olifants River System; and
- Implementation Plan Report.

The key to the successful management of the water quality in the Olifants River System is the formulation of management measures that will integrate all the relevant aspects that have a bearing on the water resources. In this respect an assessment of the physical, economic, social, institutional, statutory and ecological aspects in the system was undertaken to understand the current situation and therefore be in a position to assess existing management options and proposed new options that will be able to handle the existing as well as anticipated future challenges (DWS Report number: P WMA 04/B50/00/8916/3).

Furthermore it is expected that the growing economy, in the Olifants System, will intensify the pressures on the water quality of the resource and it is therefore necessary to find innovative measures that offer economical and sustainable management solutions.

The Reconciliation Strategies developed for the Olifants and Letaba sub-catchments are described in the following documents:

- Department of Water Affairs (2014) *Development of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System*: Final Reconciliation Strategy. Report No. P WMA 02/B810/00/1412/15
- Department of Water and Sanitation (2015) *Olifants River Water Supply System Reconciliation Strategy.* Report No. P WMA 04/B50/00/8715; and

These studies, informed by several sub-strategies, make a number of recommendations that need to be implemented to ensure that there is adequate water to supply the various sectors. The recommendations do not however consider the implications to water quality. The objective of the reconciliation and foresight task is therefore to assess the implications of the implementation of the reconciliation recommendations on the water quality of the system.

Summary of main contributors to salinity and nutrient loads to the system

In respect of salinity, the biggest load is associated with the main stem Olifants River, calculated at the Wolwerkrans weir to be in the order of 80 000 T/a, which receives salinity contributions from MU3 (Koringspruit) and MU5 (Klippoortjiespruit) and the lower portions of MU2 (Rietspruit), MU7 (Steenkoolspruit) and MU8 (main Olifants below the confluence with the Viskuile): about a 30 kilometre radius from the Wolwekrans weir.

Further large contributions emanate from the Klein Olifants: MU14 (an estimated 29 000 T/a) measured on the Klein Olifants, however the major contributions do not emanate in MU14 but are upstream from MU11 (Rietkuilspruit), MU12 (Bosmanspruit) and MU13 (Woestalleenspruit).

In the Lower Olifants sub-catchment the Ga-Selati (measured at Loole weir) contributes and estimated 4 600 T/a.

In respect of nutrients, the major contributors are the discharges from the WWTW, run-off from urban/ semi-urban areas and return flows and run-off from irrigated areas. As indicated in the situation assessment there are no Green Drop certified WWTWs in the Olifants WMA and increased ortho-phosphate concentrations can be linked to WWTWs and urban or semi-urban areas where storm water management is poor. While limited microbiological monitoring is undertaken, these points would also be associated with increased faecal coliform counts. The oxidation pond systems are also linked to groundwater contamination and overflows that would also contribute to increased nutrients and microbiological contamination to the system.

Impacts from intensive irrigation were noted in the Upper Middle Olifants, particularly along the Moses in MU35 and Elands Rivers in MU36, as well as in the Lower Olifants, MU47 (Ohrigstadt River) and MU50 (Blyde River and Rietspruit). While it is not currently very prominent there is also the potential for nutrient enrichment due to irrigation in the upper parts of the Letaba (MU69).

The results of the study to date have indicated that there is very little assimilative capacity in the whole of the Olifants River, both for salinity and nutrients. In the Upper Olifants, those areas where there may be some assimilative capacity, such as in the Wilge River sub-catchments, are however already showing increased trends and will not be able to comply with the legislated classification of a Class II River. The same holds true for the Middle and Lower Olifants and Steelpoort. In addition, those areas where acceptable or good water quality is noted, such as in the upper portion of the Letaba sub-catchments and the Blyde River, are mainly within Nature Reserves, Biosphere Reserves or National Parks, designated as such under the Protected Areas Act (Act 57 of 2003).

It is noted that when developing the Reconciliation Strategy for a catchment, a water quality assessment is undertaken, however the recommendations made do not necessarily consider the impacts on water quality. Even for Reserve determinations, while water quality is considered it is currently not integrally linked to the quantity component. This report has therefore tried to put into perspective the positive or negative changes that may occur as the recommendations are implemented and water of different chemical and biological quality is either kept out of the system or added to the system. The following aspects relating to the recommendations made in both the Olifants and Luvuvhu/ Letaba Reconciliation strategies have been considered:

- *Implement WC/ WDM* in the irrigation, urban and mining sectors: often considered as the savings that can be found in respect of decreasing unaccounted for water. This is specifically the case when undertaking the reconciliation strategies for the catchments. However there are several components that contribute to WC/ WDM (water resource management, distribution management, consumer demand management and return flow management) that may have direct impacts on water quality;
- *Eliminate Unlawful Use*: The implementation of assessing whether a water use is unlawful would apply to water quality in respect of designs, operation and maintenance of facilities that may have an impact on water quality of a system in respect of both point and non-point sources of pollution, as well as impacts from the over-abstraction from systems;
- *Development of Groundwater Resources*: unlikely to have much of an impact of the water quality of the Olifants system, however would need to be considered in respect of the use for which the water is intended and the water quality required for that use.
- *Removal of invasive alien plants:* Invasive alien vegetation can result in several impacts to river systems, often associated with ecological, economic, management and land use opportunity costs. In respect of water quality the method of alien removal is important, for example**,** when using chemical control, care must be taken to avoid the herbicide causing additional pollution to the downstream water or sediments. Herbicides may contaminate sites used for drinking water, washing or fishing and may affect general river ecosystem health;

- *Treatment of mine water:* mine water treatment has to some extent been quite successful in the Upper Olifants sub-catchments by removing large volumes of contaminated water from entering the rivers, and only discharging water of acceptable quality for the requirements of the Reserve, or having a dilution effect where larger volumes are discharged after treatment;
- *Municipal effluent re-use:* Municipal effluent re-use could, in some cases be beneficial to the river system due to the poor quality effluent being removed from the system, however good quality treated effluent should be returned to the system if required by the Reserve;

Supporting Infrastructure Development and Operational Projects:

- Olifants River Water Resources Development Project;
- Determination, review and implementation of the Reserve in the Olifants/ Letaba System which his has now been completed; and
- Integrated Olifants River Supply System Operating rules.

These aspects and the specific concerns noted in the sub-catchments support the scenarios proposed in the Scenario Analysis Report (P WMA 04/B50/00/8916/5):

- Reduced load due to seepages from the mine, industrial and power station waste storage facilities and mining operations in the Upper Olifants sub-catchment, some load from the Steelpoort sub-catchments and the Ga-Selati in the lower Olifants sub-catchments;
- Reduced load from excess mine water on the mining operations threatening to decant or starting to flood the coal reserves in the Upper Olifants sub-catchment;
- Reduced load from irrigation return flows in the Upper and Middle Olifants;
- Reduction of nutrient load from domestic WWTW that discharge to the water resources, by considering a reduction of the orthophosphate concentration to 1 mgP/l;
- Reduction of nutrient and sediment load from agricultural areas and areas where changing land uses may be occurring;
- Reduction of nutrient and sediment load from run-off from urban/ densely populated areas; and
- Improved reuse of effluent from domestic wastewater treatment works not designed to meet the general discharge limits.

This will now be taken forward into the management options report that will give further details on what should be implemented to achieve short and longer term improvements in the system.

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AIP	Alien Invasive Plants
AMD	Acid Mine Drainage
BWPCP	Brugspruit Water Pollution Control Plant
CAIA	Chemical Allied Industry Association
COGTA	Co-operative Governance and Traditional Affairs
CMF	Catchment Management Forum
CSIR	Scientific and Industrial Research
DMR	Department of Mineral Resources
DoA	Department of Agriculture
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EDC	Endocrine Disrupting Compound
EFR	Ecological Flow Requirements
EWR	Ecological Water Requirements
EWRP	eMalahleni Water Reclamation Plant
FGM	Focus Group Meeting
GDS	Green Drop System
GIS	Geographical Information System
GLOBALG.A.P.	Global Good Agricultural Practice
GWP	Global Water Partnership
IWRM	Integrated Water Resources Management
IWQM	Integrated Water Quality Management
IWQMP	Integrated Water Quality Management Plan
IWUL	Integrated Water Use Licence
IWULA	Integrated Water Use Licence Application

IWWMP	Integrated Water and Waste Management Plan
KNP	Kruger National Park
LNW	Lepelle Northern Water
LOROC	Lower Olifants River Operations Committee
MSS	Municipal Support Strategy
MU	Management Unit
MUTT	Management Unit Task Team
MWCB	Mine Water Co-ordinating Body
MWRP	Mine Water Reclamation Plants
NIP	National Implementation Plan
NMMP	National Microbial Monitoring Programme
NWA	National Water Act
NWRS	National Water Resource Strategy
ORS	Olifants River System
OWRP	Otimum Water Reclamation PLant
PAA	Protected Areas Act
PAC	Project Administrative Committee
PGM	Platinum Group Metals
PMC	Project Management Committee
POP	Persistent Organic Pollutant
PSC	Project Steering Committee
PSP	Professional Service Provider
PPECB	Perishable Products Export Control Board
RDM	Resource Directed Measures
R/O	Regional Office
RQOs	Resource Quality Objectives
RWQOs	Resource Water Quality Objectives
SA	South Africa

SALGA	South African Local Government Association
SANS	South African National Standards
SAWQG	South African Water Quality Guidelines
TDS	Total Dissolved Salts
TOR	Terms of Reference
UFS	University of the Free State
WC/ WDM	Water Conservation/ Water Demand Management
WITS	University of the Witwatersrand
WMA	Water Management Area
WMS	Water Management System
WQM	Water Quality Management
WQP	Water Quality Planning
WQPL	Water Quality Planning Limits
WRC	Water Research Commission
WRP	Water Reclamation Plant
WRPM	Water Resource Planning Model
WWTW	Wastewater Treatment Works

1. INTRODUCTION

1.1 Background

The Olifants River System which comprises the Upper, Middle and Lower Olifants River sub-catchments, as well as the Steelpoort, Letaba and Shingwedzi sub-catchments, is a highly utilised and regulated catchment and like many other Water Management Areas (WMA) in South Africa, its water resources are critically stressed in respect of bothy water quantity and quality. This is due to an accelerated rate of development and the scarcity of water resources. There is therefore an urgency to ensure that water resources in the Olifants River System are able to sustain their level of uses and be maintained at their desired states.

Formal economic activity in the system is highly diverse and is characterised by commercial and subsistence agriculture (both irrigated and rain fed), diverse mining activities, manufacturing, commerce and tourism. Large coal deposits are found in the eMalahleni and Middelburg areas (Upper Olifants) and large platinum group metal (PGM) deposits are found in the Steelpoort, and copper in the Phalaborwa areas. The catchment is home to several large thermal power stations, which provide energy to large portions of the country. Extensive agriculture can be found in the Loskop Dam area, the lower catchment near the confluence of the Blyde and Olifants Rivers as well as in the Steelpoort Valley, the upper Selati catchment and the upper catchments of the Groot Letaba. A large informal economy exists in the Middle Olifants, Middle Letaba and Shingwedzi, with many resource-poor farmers dependent upon ecosystem services. The WMA has many important tourist destinations, including the Blyde River Canyon and the Kruger National Park. Land use in the Olifants River System is diverse and consists of irrigated and dryland cultivation, improved and unimproved grazing, mining, industry, forestry and urban and rural settlements.

The Department of Water and Sanitation (DWS) from a planning perspective has identified the need to develop an overarching Integrated Water Quality Management Plan (IWQMP) for the Olifants WMA in order to manage the water resources and needs to take cognisance of, and align to a number of studies and initiatives that have been completed to date, and needs to establish clear goals relating to the quality of the relevant water resource in order to facilitate a balance between protection and use of water resources.

The main objective of the study is to develop management measures to maintain and improve the water quality in the Olifants WMA for the different user types in a holistic and sustainable manner to ensure sustainable provision of water to local and international users. The management measures will be of an overarching nature and will deal with the broader Olifants WMA while taking the strategies and plans developed at the sub-catchment level into account.

The following aspects of the study have already been undertaken:

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  - IWQMP for the Lower Olifants sub-catchment;
  - IWQMP for the Steelpoort sub-catchment; and
  - IWQMP for the Letaba and Shingwedzi sub-catchments,
- Monitoring Programmes Report;
- Overarching IWQMP for the Olifants River System; and
- Implementation Plan Report.

1.2 Study Area

The spatial extent of the Olifants River System comprises tertiary drainage regions B11, B12, B20, B31, B32, B41, B42, B52, B52, B60, B71, B72 and B73 in the Olifants River catchment, B81, B82 and B83 in the Letaba catchment and B90 in the Shingwedzi catchment. The study area has been sub-divided into the following sub-catchments (Figure 1):

- Upper Olifants;
- Middle Olifants;
- Steelpoort;
- Lower Olifants; and
- Letaba and Shingwedzi.

The Olifants River flows northwards through Witbank Dam down to Loskop Dam. The confluences of the Klein Olifants, Spookspruit, Klipspruit and Wilge Rivers with the Olifants River are between the Witbank and Loskop dams. From Loskop Dam the Olifants River flows some 80 km to Flag Boshielo Dam. The Moses and Elands Rivers join the Olifants River downstream of Loskop Dam from the west while the Bloed River joins from the east. The Steelpoort River confluences with the Olifants about 50 kilometres before the confluence of the Olifants and Blyde rivers after which it confluences with the Ga-Selati on the border of the Kruger National Park (KNP). The Letaba River joins the Olifants River upstream of the border into Mozambique in the KNP, after which it flows into the Massingir Dam about six (6) kilometres from the border, before it joins the Limpopo River which eventually discharges into the Indian Ocean. The Shingwidzi River flows south east through the KNP becoming the Rio Shingwidzi in Mozambique where it confluences with the Rio Elefantes downstream of the Massingir Dam.

This study focusses on the South African sector of the Olifants River system and does not deal with the Mozambique sector, however the improvement in the South Africa portion of the Olifants River system, will ultimately have a positive impact on the Massingir Dam and the lowest reaches of the Rio Elephantes which is controlled by inflows from upstream (South Africa).

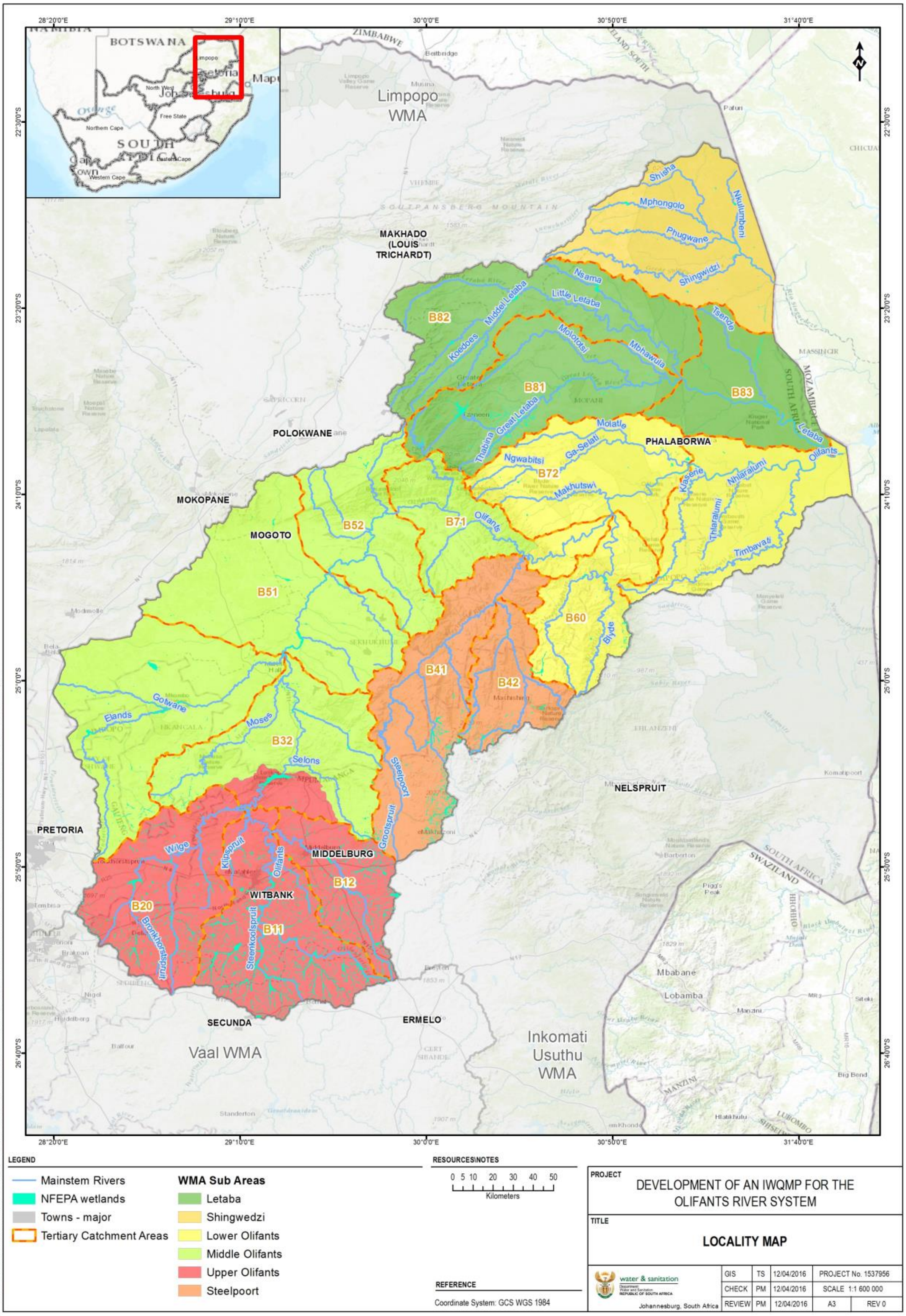


Figure 1: Study Area

1.3 Objective of the Reconciliation and Foresight task

The objectives of this report was to, based on the situation assessment and water quality planning limits components of this project, as well as the modelling results, assess whether there is any assimilative capacity in the various sub-catchments (short and longer term).

The Reconciliation Strategies developed for the Olifants and Letaba sub-catchments are described in the following documents:

- Department of Water Affairs (2014) *Development of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System*: Final Reconciliation Strategy. Report No. P WMA 02/B810/00/1412/15
- Department of Water and Sanitation (2015) *Olifants River Water Supply System Reconciliation Strategy.* Report No. P WMA 04/B50/00/8715; and

These studies, informed by several sub-strategies, make a number of recommendations that need to be implemented to ensure that there is adequate water to supply the various sectors. The recommendations do not however consider the implications to water quality. The objective of the reconciliation and foresight task is therefore to assess the implications of the implementation of the reconciliation recommendations on the water quality.

2. STATUS ASSESSMENT OF THE WATER QUALITY OF THE OLIFANTS WMA

In order to determine water quality planning limits (WQPLs) a status assessment of the water quality, against the various user sector requirements, based on the South African Water Quality Guidelines (DWAF, 1996), was undertaken during the initial stages of the project. This was done to get an understanding of the water quality in the different management units and to give weight to the WQPLs subsequently set. The results are detailed in the following reports:

- Water Quality Status Assessment and International Obligations with respect to Water Quality Report, Report No. P WMA 04/B50/00/8916/3; and
- Water Quality Planning Limits Report, Report No. P WMA 04/B50/00/8916/4.

In addition the outcomes of the Reserve determination and the classification and Resource Quality Objectives (RQO) were considered when setting the WQPLs.

A compliance assessment indicated the following areas of concern with respect to non-compliance in relation to salinity and nutrient enrichment (based on ortho-phosphate concentrations).

Salinity

Figure 2 illustrates those areas in the WMA where salinity will need to be removed. This is predominantly related to sulphate, however, chlorides in MU36 and lower end of MU35 and MU38 show some elevated trends so will need to be monitored.

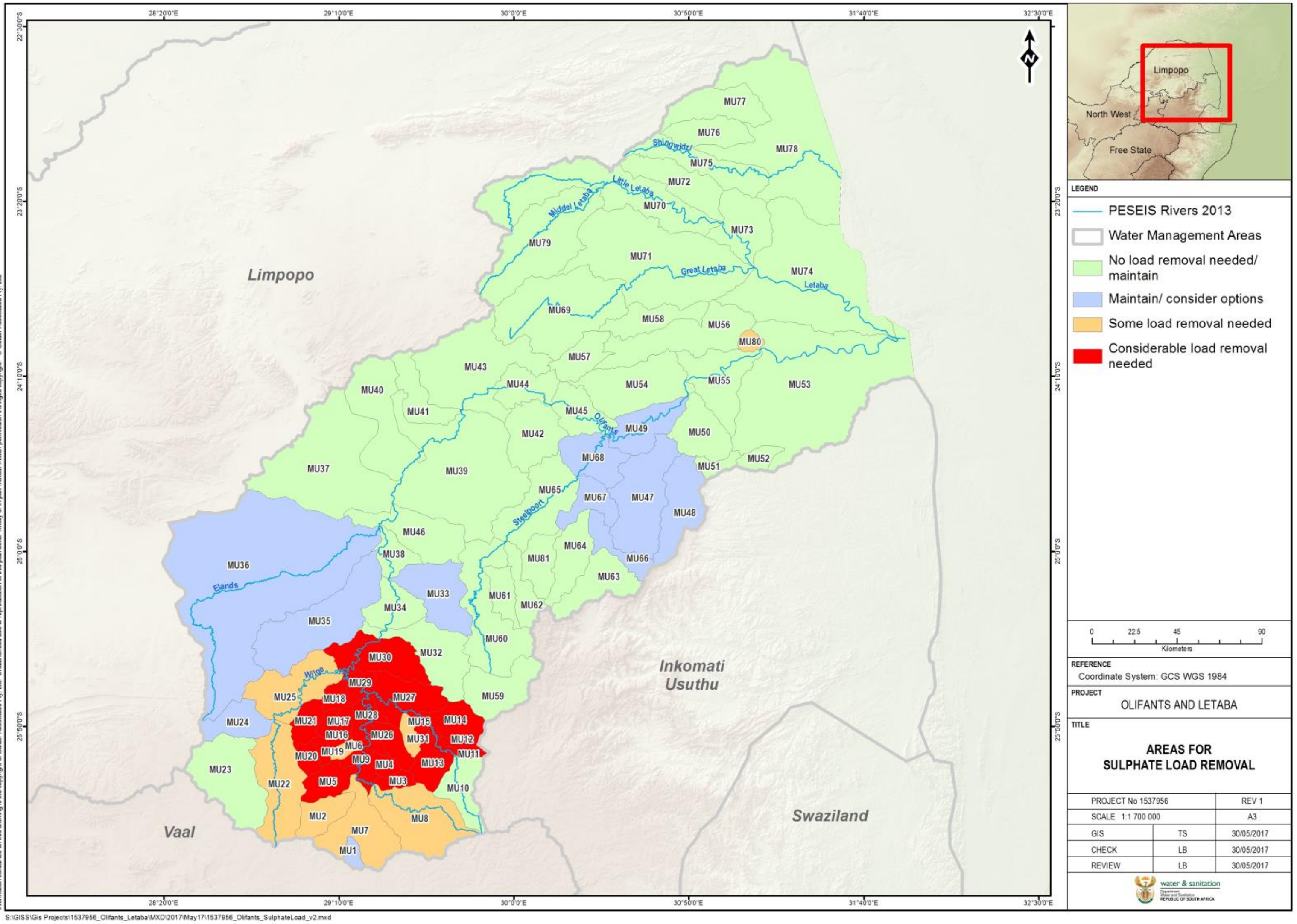


Figure 2: Areas where salinity load will need to be removed

Table 1: Management Units with salinity load concerns

MU	Description	Average Loads (tonnes/annum)(T/a)
8	Olifants River at Middelkraal (B1H18)	3 424
26	Spookspruit @ Elandspruit (B1H2)	11 184
9	Olifants River@ Wolvekrans (B1H5)	80 399
2	Canal from Riet Spruit Dam @ Roodepoort	2 661
22	Wilge River @ Onverwacht (B2H14)	1 673
24	Bronkhorstspruit @ Bronkhorstspruit (B2H3)	1 006
14	Klein Olifants @ Rondebosch (B1H12)	28 925
6	Noupoortspruit @ Naauwpoort (B1H19)	2 288
16,17,18	Klipspruit@Zaaihoek (B1H4)	16 251
25	Wilge River @ Waterval (B2H15)	6 092
7	Steenkool Spruit @ Middeldrift (B1H21)	7 574
15	Town Pipeline @ Rondebosch	21 886
5	Saaiwater Spruit @ Klipplaat	15 524
28	Witbank Municipal Area	47 076
4	Witbank Dam on Olifants River	8 793
19, 21, 20	Waschbank downstream Kromdraai Mine on Kromdraaispruit	14 682
30	Olifants River @ Loskop Nat.Res	64 481
81	Ga-Selati River at Loole (B7H19)	4 684

Figure 3 illustrates in more detail that the following management units have concerns around salinity, mostly related to elevated sulphate in the Upper Olifants, with Management Units 9, 30, 28, 11, 12, 13, 14, 15, 16, 17, 18, 5, 19, 21, 20 and 26 recording loads of >10 000 t/annum.

The biggest load is associated with the main stem Olifants River, calculated at the Wolwerkrans weir to be in the order of 80 000 T/a, which receives salinity contributions from MU3 (Koringspruit) and MU5 (Klippoortjiespruit) and the lower portions of MU2 (Rietspruit), MU7 (Steenkoolspruit) and MU8 (main Olifants below the confluence with the Viskuile): about a 30 kilometre radius from the Wolwekrans weir.

Further large contributions emanate from the Klein Olifants: MU14 (an estimated 29 000 T/a) measured on the Klein Olifants, however the major contributions do not emanate in MU14 but are upstream from MU11 (Rietkuilspruit), MU12 (Bosmanspruit) and MU13 (Woestalleenspruit).

In the Lower Olifants sub-catchment the Ga-Selati (measured at Loole weir) contributes and estimated 4 600 T/a.

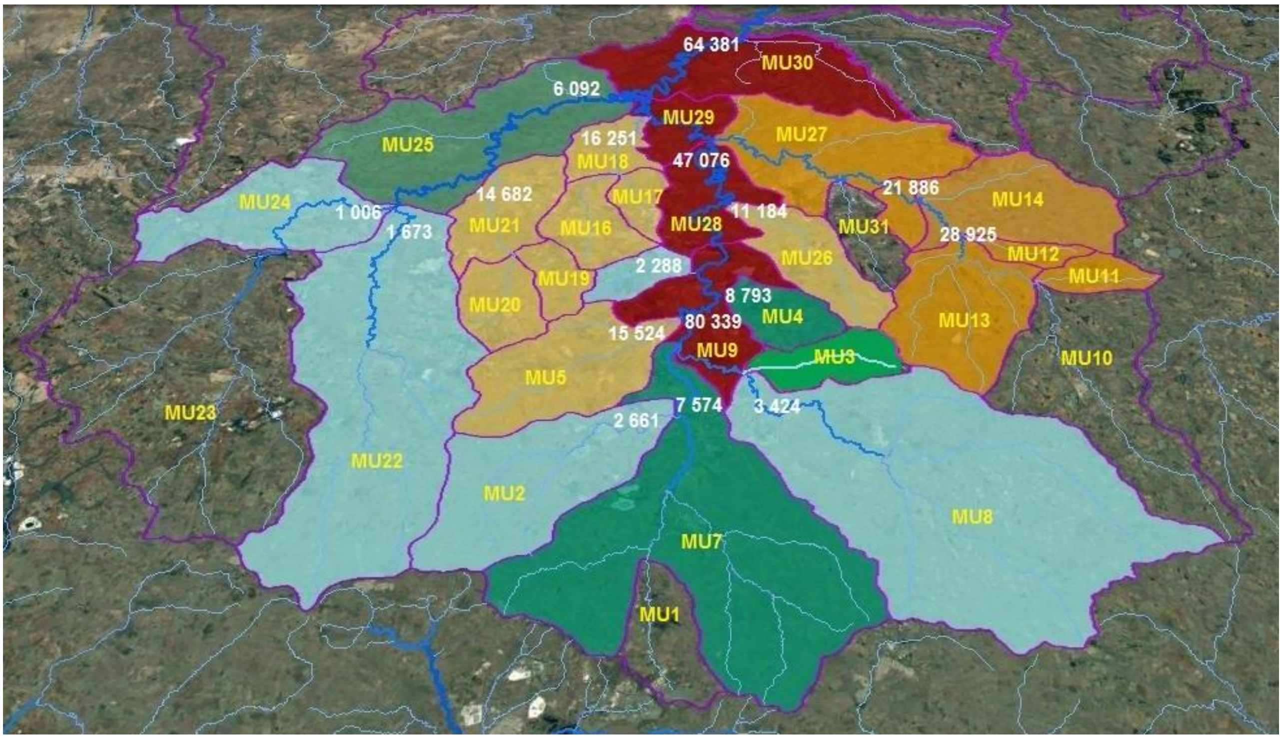


Figure 3: Management Units where salinity load is a concern in the Upper Olifants

The mines located in these Management Units include those set out in Table 2.

Table 2: Mines contributing to Management Units with highest salinity contributions

MU	Mines contributing to the salinity load
8	Ilanga Colliery; Halfgewonnen Colliery; Sudor Coal Mine; De Wittekrans; Forzando Coal Mines (PTY) Ltd; Kranspoort (defunct)
26	Middleburg Mine; Goedehoop North
9	Kleinkopje Colliery; Douglas Colliery; New Clydesdale Colliery; Duvha Power Station dams;
3	Blinkpan; Komati Power Station;
2	Matla Colliery; South Witbank Colliery; Kriel Colliery
22	Leeuwfontein/ Lakeside Colliery; Side Minerals; Bankfontein Colliery; Kendal Power Station; Kusile Power Station; New Largo;
11, 12 , 13 (14)	No mines in 14 – impacts from MUs 11, 12 and 13: Arnot Colliery; Optimum Colliery; Woestalleen Mine; Coastal Coal; Kopermyn; Mafube – Wildfontein and Springboklaagte; Zonnebloem; and Vuna; Hendrina Power Station
6	Greenside Colliery
16,17,18	Landau Colliery (Kromdraai); Bulpan; defunct mines; Vanchem; Highveld Steel
25	No mines – impacts from mines in MUs 19, 20, and 21
7	Phoenix Colliery; Rietspruit Mine; Tavistock Colliery; Polmaise Colliery; Dorstfontein Coal Mines; Isibonelo
15	No mines - impacts from mines in MUs 11, 12 and 13
5	Boschmans Colliery; Waterpan Colliery; Witcons Colliery; Khutala Colliery; Goedgevonden Colliery; South Witbank Colliery; Rietspruit Mine; Oogiesfontein; Zibulo; Mbali Coal;
28	No mines – impacts from MU26 (Spookspruit) and MU9
4	Eikeboom; Duvha Power Station

MU	Mines contributing to the salinity load
19, 21, 20	Leeuwfontein Colliery; Elandsfontein; Zibulo Opencast; Klipsruit; New Largo; Balmoral Colliery;
30	No mines – all upstream impacts from Witbank and Middelburg Dams and MU MU26 (Spookspruit), MU16 (Klipspruit) and MU17 (Blesbokpruit).
81	Phalaborwa Mining Company; Foskor;

Nutrient enrichment

In respect of nutrients, the major contributors are the discharges from the WWTW, run-off from urban/ semi-urban areas and return flows and run-off from irrigated areas.

Figure 4 illustrates the various WWTW types. Those shown as activated sludge and biofilters are likely to have some discharge which may be direct discharge after treatment or possibly irrigation of treated effluent. As indicated in the situation assessment there are no Green Drop certified WWTWs in the Olifants WMA and increased ortho-phosphate concentrations can be linked to WWTWs and urban or semi-urban areas where storm water management is poor. While limited microbiological monitoring is undertaken, these points would also be associated with increased faecal coliform counts. The oxidation pond systems are also linked to groundwater contamination and overflows that would also contribute to increased nutrients and microbiological contamination to the system.

Impacts from intensive irrigation were noted in the Upper Middle Olifants, particularly along the Moses (MU35) and Elands Rivers in MU36, as well as in the Lower Olifants, MU47 (Ohrigstadt River) and MU50 (Blyde River and Rietspruit). While it is not currently very prominent there is also the potential for nutrient enrichment due to irrigation in the upper parts of the Letaba (MU69) (Figure 5).

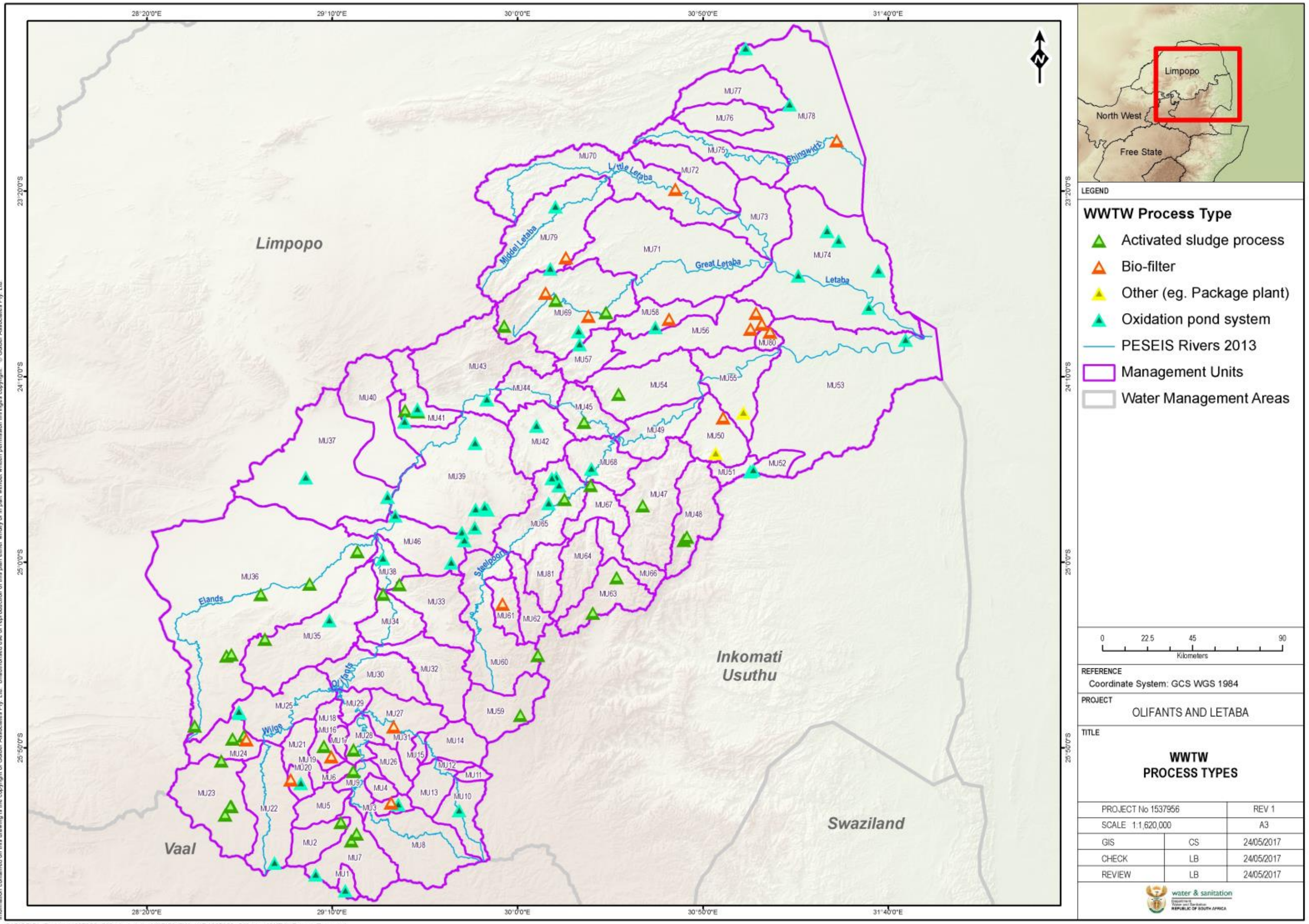


Figure 4: WWTW Types

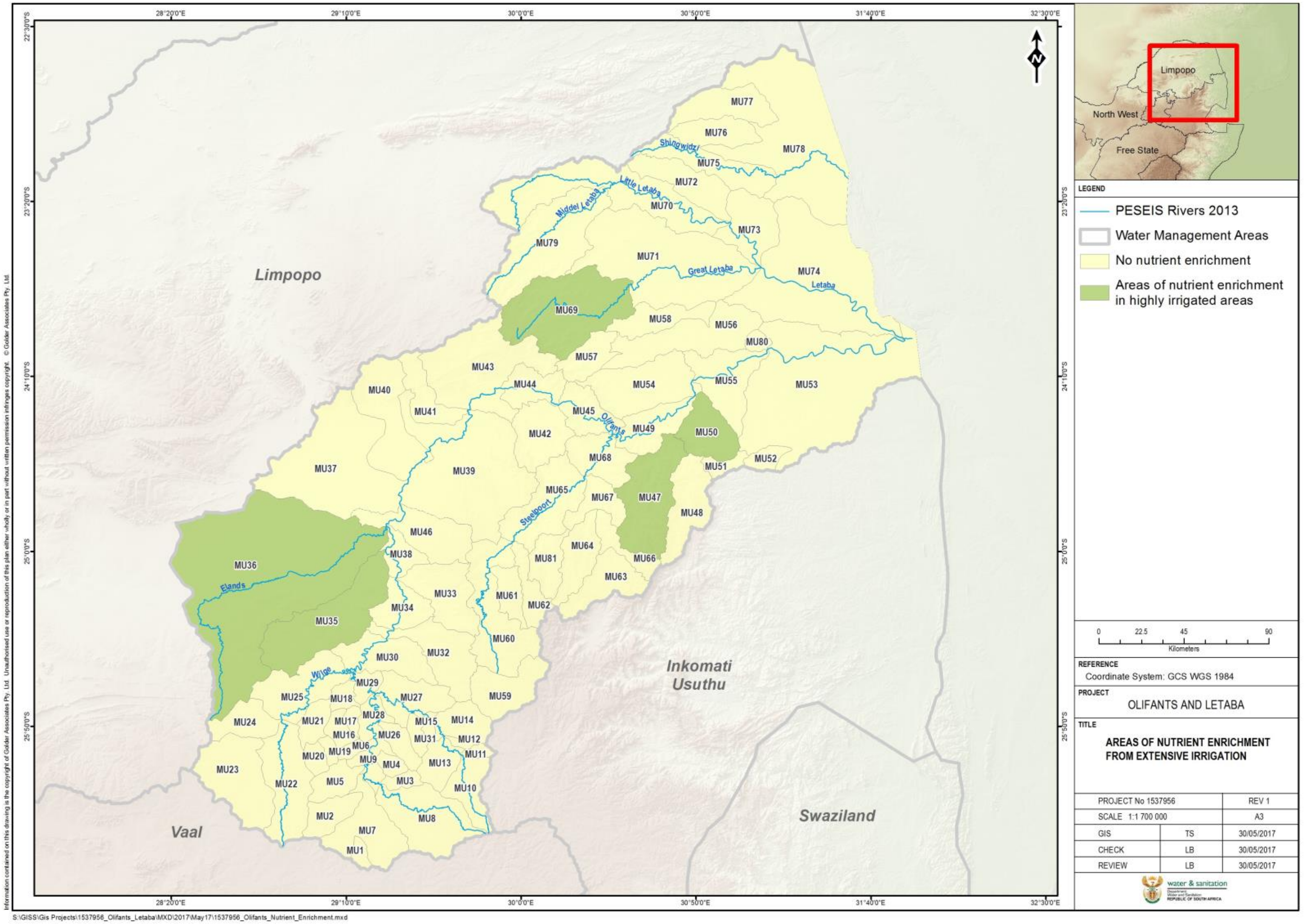


Figure 5: Areas of nutrient enrichment from irrigation activities

3 ASSIMILATIVE CAPACITY

Assimilative capacity of a natural body of water is the capacity to receive water containing waste without harmful effects to the fitness for use of the water body. The Water Quality Planning Limits (WQPL), based on the South African Water Quality Guidelines for various sectors, and described in the Water Quality Planning Limits Report: (Report No: P WMA 04/B50/00/8916/4), are a benchmark for the point at which a chemical, physical or microbiological parameter in the water could be considered unacceptable for a particular water user. Based on the flow and chemical concentration a specific point, the load can then be calculated and a comparison made against the load based on the WQPL, and the assimilative capacity of that stretch of river determined.

It has been clearly shown that in respect of salinity and nutrients, there is limited assimilative capacity in the whole of the Olifants WMA.

3.1 Assimilative capacity in the Upper Olifants

In the upper catchments of the Upper Olifants, the pH is for the most part in the acceptable range of 6.5 to 8.4.

The number of mines and the mining operations have grown significantly in the last 15 to 20 years, resulting in growth increases in excess mine water that needs to be managed. In most cases the fitness for use has been severely compromised as indicated by the loads determined for TDS (Table 8) versus the load if the proposed WQPL was being achieved. The river systems do not have any assimilative capacity for further salinity pollutant loads. In addition, the water reconciliation and dam system operation and effects of the prolonged drought are such that there is no water available in the dams to provide dilution water to maintain the salinity in the downstream rivers at a suitable level. The end result is that to prevent further deterioration no further diffuse or point source loads can be accepted in the river systems. In fact in the Koringspruit, Boesmanskransspruit, Tweefonteinspruit, Noupoortspruit, Woestalleenspruit, Spookspruit and the Klipspruit, salinity load will have to be removed from the system to achieve the WQPLs determined for the specific Management Units and the downstream dams.

Except for the upper parts of the Wilge River, there is no assimilative capacity in the Upper Olifants sub-catchment. The Wilge River catchment is mostly in compliance except for MU 25 (Grootspruit), and the Saalboomspruit (MUs 20 and 21) which shows increased salinity levels. As this system has been classified as a Class II river, it is important that any increased salinity trends are reversed.

However the situation assessment has shown that the trends in the Wilge River are already showing an increase, which means that to comply with the legislated classification of a Class II river this increase will need to be halted. In addition the Loskop Dam Nature Reserve is a designated Nature Reserve under the Protected Areas Act (Act 57 of 2003) (PAA), which states that “No person may, at any time or in any manner including by the use of detergents, pollute any water in a river, spring, pan, well, borehole, groundwater, dam, reservoir or lake in a special nature reserve, national park or world heritage site".

NOTE: Just because it may appear that there is assimilative capacity because the 95 or 50 percentile is lower than the WQPL, this does not mean that it should be utilised. In the Upper Olifants sub-catchment the only areas where assimilative capacity is available are in those areas which have been classified at a higher level and those areas in the upper reaches of the Trichardspruit in MU1, Olifants/ Joubertvleispruit/ Viskuile in MU 8, and the Wilge catchment management units - this should not be compromised.

The only opportunity would be for the implementation of the controlled release scheme where the load to the system at various points would need to be continuously calculated to assess whether there would be an opportunity for release of some salinity load.

In respect of nutrients, due to the discharge from the WWTW, there is no assimilative capacity in any of the rivers.

Table 3: Assimilative capacity for TDS in the Upper Olifants MUs

MU	Main river/ tributary	WQ MP/WEIR	TDS (mg/L) 95%	Load (kg/d)	WQPL	Load (kg/d)	Assim-ilative capacity
1	Trichardspruit	90420	241	17452	240	17418	N
2	Rietspruit	1000003173	1606	97950	500	30672	N
3	Koringspruit	90418	2195	142205	500	32400	N
4	Olifants	88607	532	30273	500	28512	N
5	Klippoortjiespruit.	189430	2390	115258	500	24192	N
6	Noupoortspruit	188537	463	26369	500	28512	Y
7	Steenkoolspruit/ Dwars in-die-Weg Spruit	90415	624	36853	450	26438	N
8	Olifants/ Joubertvleispruit/ Viskuile	188596	212	34557	400	65318	Y
9	Olfants	188536	910	58944	500	32400	N
10	Klein Olifants	188596	542	21206	260	10109	N
11	Rietkuilspruit	188397	665	43897	260	17073	N
12	Bosmanspruit	90421	886	58463	260	17073	N
13	Woestalleenspruit	nd	nd	nd	260	17073	nd
14	Klein Olifants	88506	1820	108602	400	23846	N
15	Goeiehoopspruit/ Klein Olifants	188390	148	8813	200	11923	Y
16	Brugspruit	188539	393	24956	500	31968	Y
17	Blesbokspruit	90430	1320	83878	500	31968	N
18	Klipspruit	90408	1008	64043	500	31968	N
19	Saalboomspruit/ (Saalklapspruit)	189465	414	29381	260	18420	N
20	Saalboomspruit/ (Saalklapspruit)	188545	566	40207	260	18420	N
21	Saalboomspruit/ (Saalklapspruit)	88821	252	17889	260	18420	Y
22	Wilge River	189470	504	30789	260	15949	N
23	Bronkhorstspruit	90438	200	14027	260	18196	Y
24	Honde River	90433	261	16281	260	16174	N

MU	Main river/ tributary	WQ MP/WEIR	TDS (mg/L) 95%	Load (kg/d)	WQPL	Load (kg/d)	Assim-ilative capacity
25	Grootspruit/ Wilge River	90442	325	22773	350	24494	Y
26	Spookspruit	90407	1636	64380	500	19872	N
27	Keeromspruit	nd	nd	nd	240	14308	
28	Olfants River	188530	635	26021	400	16243	N
29	Klip/ Olifants	nd	nd	nd	350	13608	nd
30	Olifants; Kranspoortspruit	nd	nd	nd	350	13608	nd
31	Vaalbankspruit	90420	162	9637	260	15500	Y

*nd: no data available in the MUs

3.2 Assimilative capacity in the Middle Olifants

In the Middle Olifants, the pH is for the most part in the acceptable range of 6.5 to 8.4, with non-compliances being on the upper limits.

There are concerns around several of the management units that are considerably higher in salts than allowed for in the RQOs. These include the two management units (MU 34 and 38) immediately downstream of Loskop Dam as well as MU 36 (Elands River) where it appears that there are considerable impacts from irrigated lands and limited mining in the Marble Hall area (Table 9). Downstream of this area in the rest of the Middle Olifants sub-catchment there is very limited data and additional monitoring points may be required.

Therefore while the salinity decreases dramatically, there are still some increasing trends that need to be halted, coming from Loskop Dam as well as the Moses and Elands tributaries. In addition, an important consideration is that the downstream irrigators need to comply with strict chemical, physical and microbiological water quality for export requirements. Higher salinity would also imply that subsistence farmers irrigating from the river would have poorer yields. The impact of using any remaining assimilative capacity could therefore have serious economic implications for the area. The Flag Boshielo Dam is bounded by the Schuinsdraai Nature Reserve declared in March 1993 and designated as such under the PAA. The TDS and chloride at this point are elevated above the proposed WQPL.

Table 4: Assimilative capacity for TDS in the Middle Olifants MUs

MU	Main river/ tributary	TDS (mg/L) 95%	Load (kg/d)	WQPL	Load (kg/d)	Assimilative capacity
32	Olifants d/s Loskop Dam)/ Klipspruit/ Selons	167	16523	260	25609	Y
33	Bloed River	nd	nd	180	7465	nd
34	Olifants River	619	16290	260	6739	N
35	Moses River	117	11353	240	16174	Y
36	Elands River	738	152494	500	18144	N
37	Grass Valley River	nd	nd	355	2760	nd

38	Olifants	427	4144	500	4752	N
39	Olifants	1188	54987	355	4601	N
40	Doring/ Nkumpi	nd	nd	355	3987	nd
41	Chunies River	nd	nd	355	3067	nd
42	Motse	820	23977	355	10428	N
43	Olifants/ Monametsi	1410	158927	260	2920	N
44	Olifants	491	80630	260	2471	N
45	Olifants	nd	0	260	25609	

In respect of nutrients, due to the discharge from the WWTW and considerable upstream irrigation, there is no assimilative capacity in any of the rivers. It must be noted that nutrient data assessed does not appear to be very reliable.

3.3 Assimilative capacity in the Steelpoort

There are a number of areas that have been designated Protected Areas under PAA, specifically in the areas of the of the upper Steelpoort sub-catchment, including the Dorps and Blyde Rivers. This area supplies good quality water to the Olifants and development in respect of mines and industries in the Steelpoort should be managed to maintain the current chemical and physical water quality and the Blyde River area should not be developed as the major portion falls with a Nature Reserve and the Kruger to Canyons Biosphere Reserve.

Table 5: Assimilative capacity for TDS in the Steelpoort

MU	Main River/ tributary	TDS (mg/L) 95%	Load (kg/d)	WQPL	Load (kg/d)	Assimilative capacity
59	Grootspruit	146	17053	260	30551	Y
60	Steelpoort	258	29241	260	29428	Y
61	Masala	444	18401	260	10783	N
62	Klip	92	4565	260	13029	Y
63	Dorps	139	13723	120	11820	N
64	Waterval	149	11787	160	12718	Y
65	Steelpoort	457	8394	400	7258	N
66	Spekboom	156	2299	160	2350	Y
67	Spekboom	nd	nd	160	3456	Y
68	Steelpoort	981	40433	290	12027	N
81	Dwars	505	35198	400	27994	N

*nd: no data available for that MU

In respect of nutrients the Ohrigstadt and Rietspruit Rivers do not have assimilative capacity. Any assimilative capacity in the Blyde River should not be exploited.

3.4 Assimilative capacity in the Lower Olifants

The Lower Olifants sub-catchment falls in the Kruger to Canyons Biosphere Reserve and the Kruger National Park, and essentially bears the brunt of the upstream impacts in the Olifants, and impacts from the Phalaborwa industries and mines in the Ga-Selati River. Any available assimilative capacity in the upstream regions of the Ga-Selati should not be exploited as this would put further burdens on the already impacted downstream regions. This relates to both salinity and nutrients.

Table 6: Assimilative capacity for TDS in the Lower Olifants

MU	Main River/ tributary	TDS (mg/L) 95%	Load (kg/d)	WQPL	Load (kg/d)	Assimilative capacity
47	Ohrigstadt	106	4059	180	6843	Y
48	Blyde River	110	29046	180	47745	Y
49	Olifants	464	11253	370	8951	N
50	Blyde River	162	14225	180	15708	Y
51	Klaserie	62	5215	80	6774	Y
52	Timbavati	nd	nd	80	2350	nd
53	Timbavati	nd	nd	400	10368	nd
54	Makhutswi	301	3747	260	3145	N
55	Olifants to Phalaborwa barrage	433	7706	350	6350	N
56	Ngwabitsi	168	5902	500	17712	Y
57	Ga-Selati	71	4658	120	7880	Y
58	Molatle	nd	nd	120	3732	nd
80	Ga-Selati	1498	36570	500	12096	N

*nd: no data available for that MU

3.5 Assimilative capacity in the Letaba

The upper portions of the Letaba sub-catchment are located within the Kruger to Canyons Biosphere Reserve and several smaller protected areas (Wolkeberg Wilderness Area and the Nature Reserve: Co-operation and Development), and releases of very good chemical and physical quality water downstream of Tzaneen Dam are noted. However downstream of this area, large urban settlements (and to a much lesser extent irrigation) impact considerably on any available assimilative capacity in respect of TDS and nutrients.

Salinity is not a concern in this area and because of the protected areas and the positive impacts on the downstream water quality, should be maintained.

Table 7: Compliance of present data vs WQPL for TDS and orthophosphate in the Letaba MU

MU	Main River/ tributary	95% TDS	Load (kg/d)	WQPL	Load (kg/d)	Assimilative capacity
69	Groot Letaba	165	9132	180	6636	N
70	Klein Letaba	865	32775	260	9884	N
71	Groot Letaba	586	87226	500	74304	N
72	Nsama	258	10666	260	10783	Y
73	Klein Letaba	447	22717	500	25488	Y
74	Groot Letaba	477	23484	500	14774	N
79	Middle Letaba	329	14837	260	10109	N

3.6 Assimilative capacity in the Shingwedzi

The Shingwedzi sub-catchment has non-perennial rivers, so assimilative capacity is not relevant.

4 RECONCILIATION STRATEGY FOR THE OLIFANTS WMA

4.1 The Olifants Reconciliation Strategy

The Department of Water and Sanitation (DWS) completed a project for the "Development of a Reconciliation Strategy for the Olifants River System" in 2012 (DWA, 2012). The project recommended the most cost effective interventions to reconcile the growing water requirements and possible supply augmentation options based on an assessment that included:

- Water requirements,
- Water use efficiency options,
- Schemes to provide supplementary water,
- Implementation of the reserve,
- Groundwater utilisation,
- Decision making,
- Funding, and
- Stakeholder commitment.

To support the implementation of the Olifants River Reconciliation Strategy, the DWS commissioned the *Continuation of the Olifants River Water Supply System Water Reconciliation Strategy – Phase 1* Study.

The main purpose of updating the Reconciliation Strategy was to ensure that the Strategy remains relevant, technically sound, socially acceptable and sustainable.

In 2015, the 2012 Strategy was reassessed by formulating a *full balance* scenario to meet high water requirement growth scenarios and individual dam balances were developed to assess the individual water balance situation and required interventions. The Water Resources Planning Model (WRPM) was configured with updated information to assess the risks associated with the "Full balance" scenario for each of the individual dam balances. The main changes made included:

- The inclusion of the latest Ecological Water Requirements (EWRs) from the Reserve;
- The water requirement projections and future infrastructure changes relating to the Flag Boshielo and De Hoop dam areas were carefully configured;
- The existing operating rule of the Loskop Irrigation Board was included; and
- The updating of selected mine modules.

The Olifants River Water Resources Development Project (ORWRDP)

The purpose of the Olifants River Water Resources Development Project (ORWRDP) is to supply the needs for water for both domestic and mining in the middle part of the Olifants River catchment, as well as considering the adjacent Mogalakwena and Polokwane Municipal areas. The ORWRDP project will facilitate improving social conditions in the area as well as enabling much needed economic development. With mining as the main economic stimulant and major user of water, the opportunity arises to share in the economies of scale to also enable the improved supply of water to urban and rural domestic users, in particular to impoverished communities in the area (DWS 2015b). The ORWRDP comprises two main phases, illustrated in (Figure 7):

- *Phase 1* involved the raising of the Flag Boshielo Dam on the Olifants River by 5 m (ORWRDP-1); and
- *Phase 2* involves the development of additional water resource infrastructure (the De Hoop Dam on the Steelpoort River and bulk raw water distribution infrastructure) in the Middle Olifants sub-catchment (ORWRDP-2). Phase 2 includes nine sub-phases namely:
    - Phase 2A: De Hoop Dam;
    - Phase 2B: Bulk distribution system from Flag Boshielo to Mokopane.
- Phase 2C: Bulk distribution system from De Hoop to Steelpoort (which is under construction) including:
        - Jane Furse off-take;
        - Spitskop pump station link to supply water in the Dwars River Valley;
        - Steelpoort pump station; and

- Flow reversal in section of Lebalelo Scheme from Steelpoort town to Groothoek balancing dam and Mooihoek Water Treatment Work (2D(H)).

- Phase 2D: Bulk distribution system from Steelpoort to Groothoek including:
  - Parallel pipelines;
  - Groothoek balancing dam;
  - Mooihoek WTW Link;
- Flow reversal in section of Lebalelo Scheme from Groothoek balancing dam to the Havercroft Junction (2E(H)); and
- Phase 2E: Possible parallel pipeline Groothoek balancing dam to Havercroft junction; and
- Phase 2F: Possible pipeline to Olifantspoort WTW.

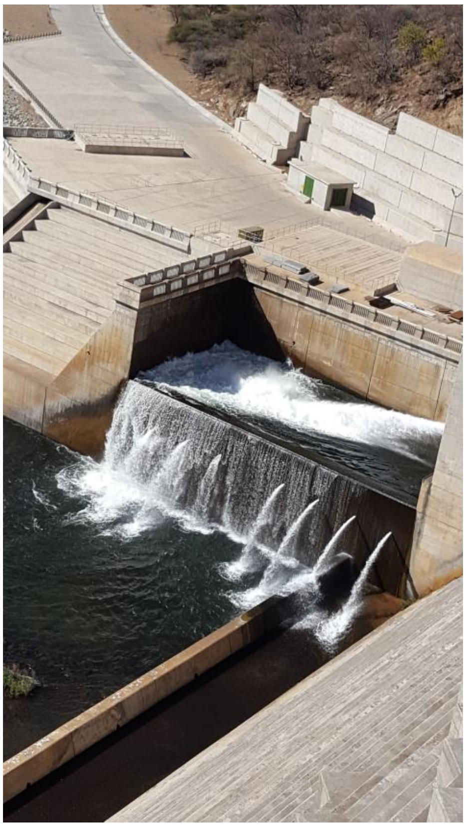


Figure 6: Outflow from De Hoop Dam

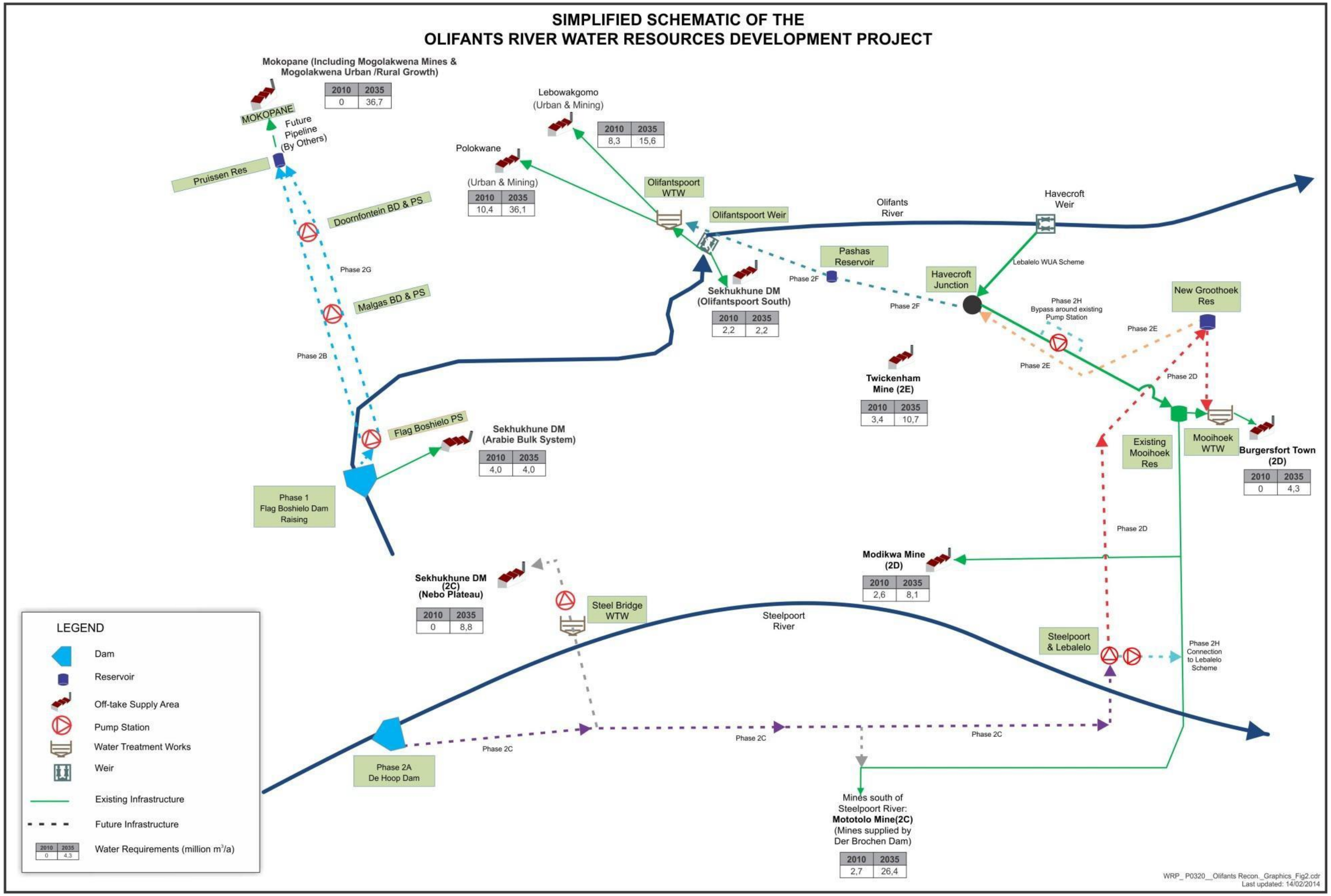


Figure 7: ORWRDP simplified schematic (DWS, 2015)

4.2 The Letaba Reconciliation Strategy

Letaba sub-catchments

The surface water resources in the Letaba sub-catchment are inadequate to meet the needs of eth water users all of the time. The resources are extensively developed with several small to major dams that have been constructed to meet domestic (urban and rural), irrigation and industrial needs. All the dams: Dap Naudé, Ebenezer, Magoebaskloof, Vergelegen, Hans Merensky, Tzaneen, Thabina, Middle Letaba, Thapani, form part of the inter-linked Letaba Regional Water Supply Scheme. The Modjadji Scheme is not included – it utilises water from the Molototsi River, is located adjacent to the Groot Letaba Scheme, however operates on its own.

Irrigation is the largest water users in the sector (70%) followed by domestic (17%) and commercial forestry (12%). Alien invasives make up 2% of the water requirements. A wide range of crops are irrigated from:

- Formal canal and run-of-river Government Water Schemes (GWS);
- Farm dams;
- Run-of-river; and
- Groundwater resources.

Shingwedzi sub-catchments

There are no dams within the Shingwedzi sub-catchments area due the limited water resources and suitable dam sites. The sub-catchment is situated almost entirely in the KNP. No sustainable yield is derived from surface water flow in this sub-catchment and water use from run-off is negligible.

4.3 Water balance perspectives

In summary, the following observations can be made from the final June 2015 Scenario water balances:

In respect of the Ecological Water Requirements (EWR) set to meet the Reserve, the implementation of EWR releases downstream of Loskop and Flag Boshielo dams will have to be made gradually to maintain the assurance of supply at acceptable levels. The EWR releases from Loskop Dam will have to occur in unison with the implementation of intervention measures such as WC/ WDM, re-allocation of water and/or accepting a reduced assurance of supply (higher risk or drought restrictions). The June 2015 scenario made provision for the full EWR release to be implemented by 2025. The EWR downstream of De Hoop Dam should be implemented in full once the dam has been commissioned.

Interventions proposed in the Olifants River System include:

- WC/ WDM (Irrigation, Urban and Mining Sectors):

- Eliminate Unlawful Use;
- Development of Groundwater Resources;
- Removal of Invasive Alien Plants;
- Treatment of mine water;
- Municipal effluent re-use

Supporting Infrastructure Development and Operational Projects:

- Olifants River Water Resources Development Project;
- Determination, review and implementation of the Reserve in the Olifants/ Letaba System which his has now been completed; and
- Integrated Olifants River Supply System Operating rules.

5 IMPLICATIONS OF RECONCILIATION RECOMMENDATIONS FOR WATER QUALITY

When developing the Reconciliation Strategy for a catchment, a water quality assessment is undertaken, however the recommendations made do not necessarily consider the impacts on water quality. Even for Reserve determinations, while water quality is considered it is currently not integrally linked to the quantity component. The sections to follow therefore try to put into perspective the positive or negative changes that may occur as the recommendations are implemented and water of different chemical and biological quality is either kept out of the system or added to the system.

5.1 Water Conservation and Water Demand Management

WC/ WDM is often considered as the savings that can be found in respect of decreasing unaccounted for water. This is specifically the case when undertaking the reconciliation strategies for the catchments. However there are several components that contribute to WC/ WDM.

Figure 8 illustrates the various components and those that may have direct impacts on water quality, with some examples given.

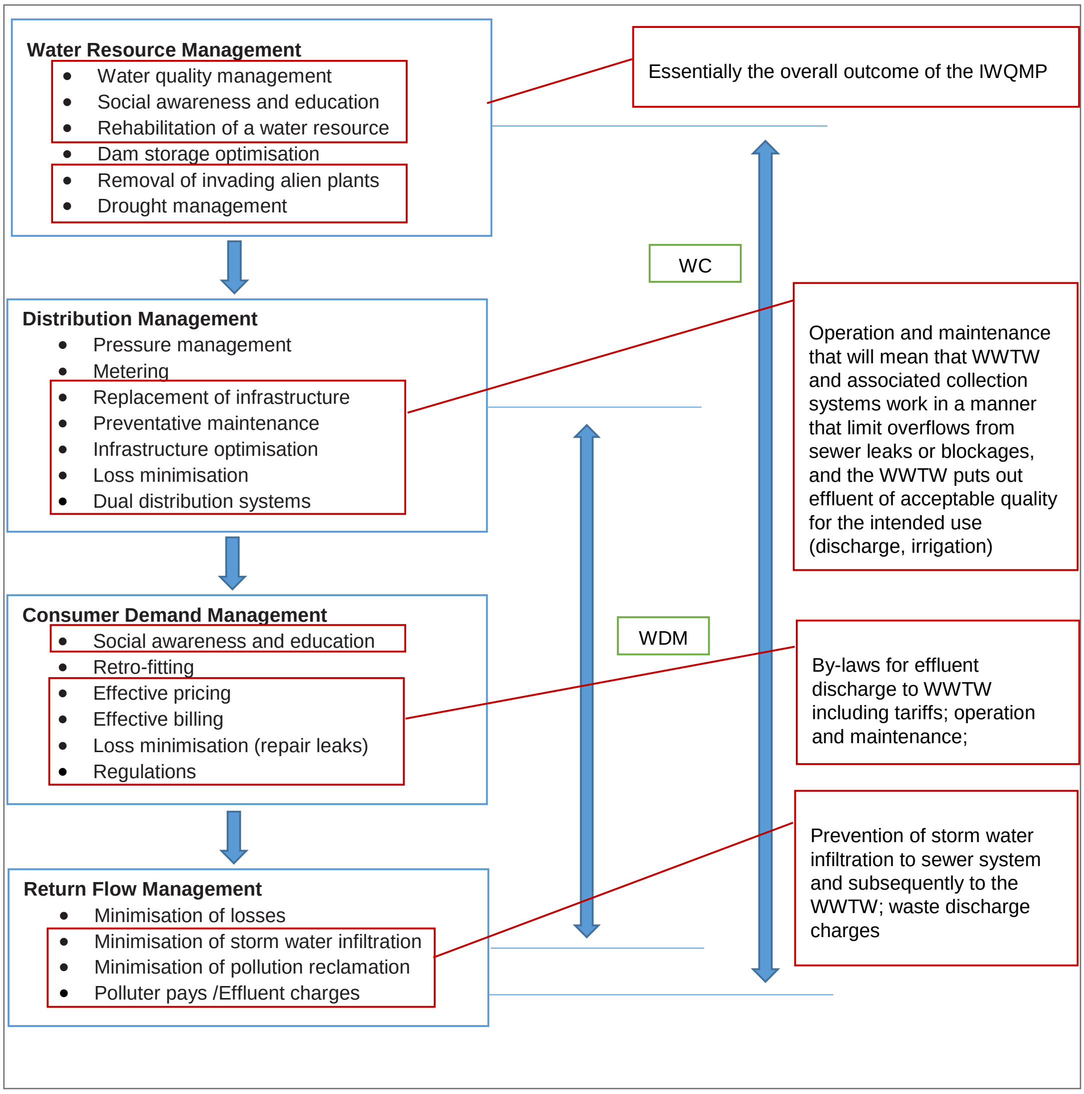


Figure 8: WC/ WDM and water quality

Implementation of all the components of WC/ WDM would therefore be of great benefit for improving water quality, not only because of increased water in the system, but also because of effective operation and maintenance plans in the various sectors, as WC/ WDM is not only limited to local government.

5.2 Eliminate unlawful use

Water use may be either consumptive or non-consumptive (quality and quantity) as described in Section 21 of the National Water Act (Act 36 of 1998) and includes:

a) Taking water from a water resource;

b) Storing water;

c) Impeding or diverting the flow of water in a watercourse;

d) Engaging in a stream flow reduction activity contemplated in section 36;

e) Engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);

f) Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;

g) Disposing of waste in a manner which may detrimentally impact on a water resource;

h) Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;

i) Altering the bed, banks, course or characteristics of a watercourse;

j) Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and

k) Using water for recreational purposes.

The implementation of assessing whether a water use is unlawful would apply to water quality in respect of designs, operation and maintenance of facilities that may have an impact on water quality of a system in respect of both point and non-point sources of pollution, as well as impacts from the over-abstraction from systems.

5.3 Development of groundwater resources

The development of groundwater resources is unlikely to have much of an impact of the water quality of the Olifants system, however would need to be considered in respect of the use for which the water is intended and the water quality required for that use.

5.4 Removal of invasive alien plants

Invasive alien vegetation can result in several impacts to river systems, often associated with ecological, economic, management and land use opportunity costs:

- Decreased stream flow;
- Promoting seasonal rather than perennial rivers;
- Increasing sediment supply to rivers;
- Increasing channel and bed erosion in high flows;
- Altering channel shape through;
- Reducing plant and animal biodiversity by altering habitat type;
- Changing soil and water chemistry including nutrient availability;
- Promoting invasion by alien animals (e.g. alien fish species) by changing habitat; and
- Increasing instream shading, creating cooler water and increasing shelter for alien (or indigenous) fauna.

In respect of water quality the method of alien removal is important, for example, when using chemical control, care must be taken to avoid the herbicide causing additional pollution to the downstream water or sediments. Herbicides may contaminate sites used for drinking water, washing or fishing and may affect general river ecosystem health.

Manual removal using mechanical tools may also lead to pollution of water with oils. When undertaking physical clearing, the prevention of erosion is important.

Increased volumes of water could also assist with reducing the contaminant loads.

5.5 Treatment of mine water

In respect water quality management mine water treatment has to some extent been quite successful in the Upper Olifants sub-catchments by removing large volumes of contaminated water from entering the rivers, and only discharging water of acceptable quality for the requirements of the Reserve, or having a dilution effect where larger volumes are discharged after treatment.

5.6 Municipal effluent re-use

Municipal effluent re-use could, in some cases be beneficial to the river system due to the poor quality effluent being removed from the system, thereby reducing the nutrient load entering the rivers and dams.

However good quality treated effluent should be returned to the system if required by the Reserve and downstream users.

In respect of water quantity, the reconciliation strategies note that reuse of treated effluent is required for Steve Tshwete and eMalahleni local municipalities while Polokwane, Mokopane and Lebowakgomo need to continue and expand their reuse activities.

6 WATER BALANCE SCENARIO IMPLICATIONS FOR WATER QUALITY PER SUB-CATCHMENT

The sections to follow describe the water balances for the major dams in each of the sub-catchment areas and the implications for water quality if the recommendations are implemented.

6.1 Upper Olifants sub-catchment

The three main systems in the Upper Olifants comprise the Middleburg, Witbank and the Loskop Dams.

6.1.1 Middelburg Dam on the Klein Olifants

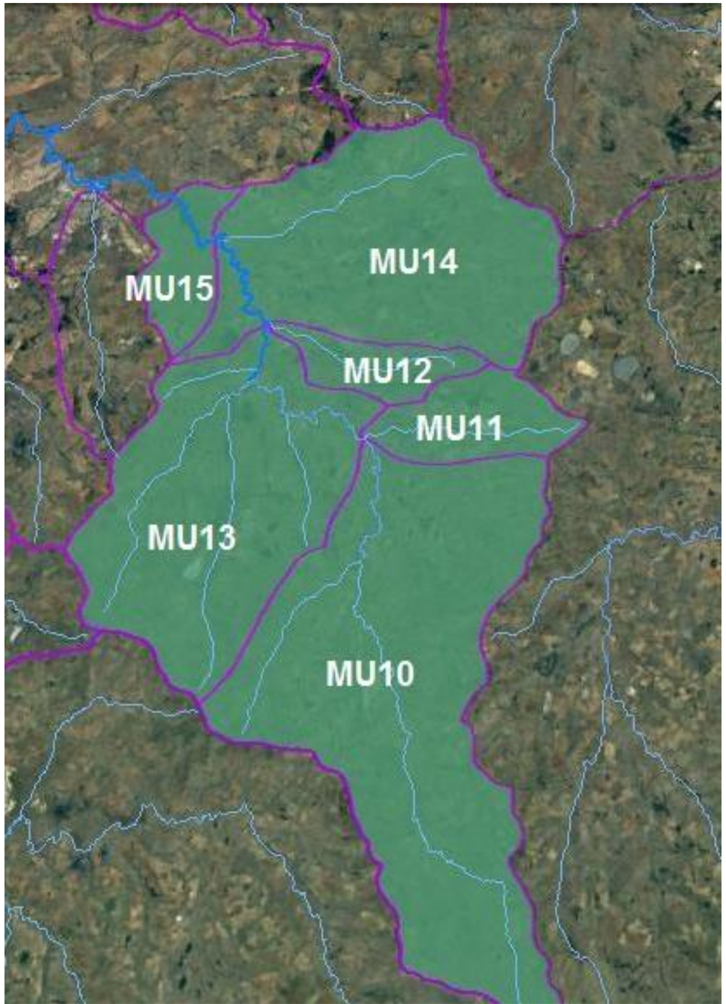


Figure 10: MUs contributing to the Middelburg Dam

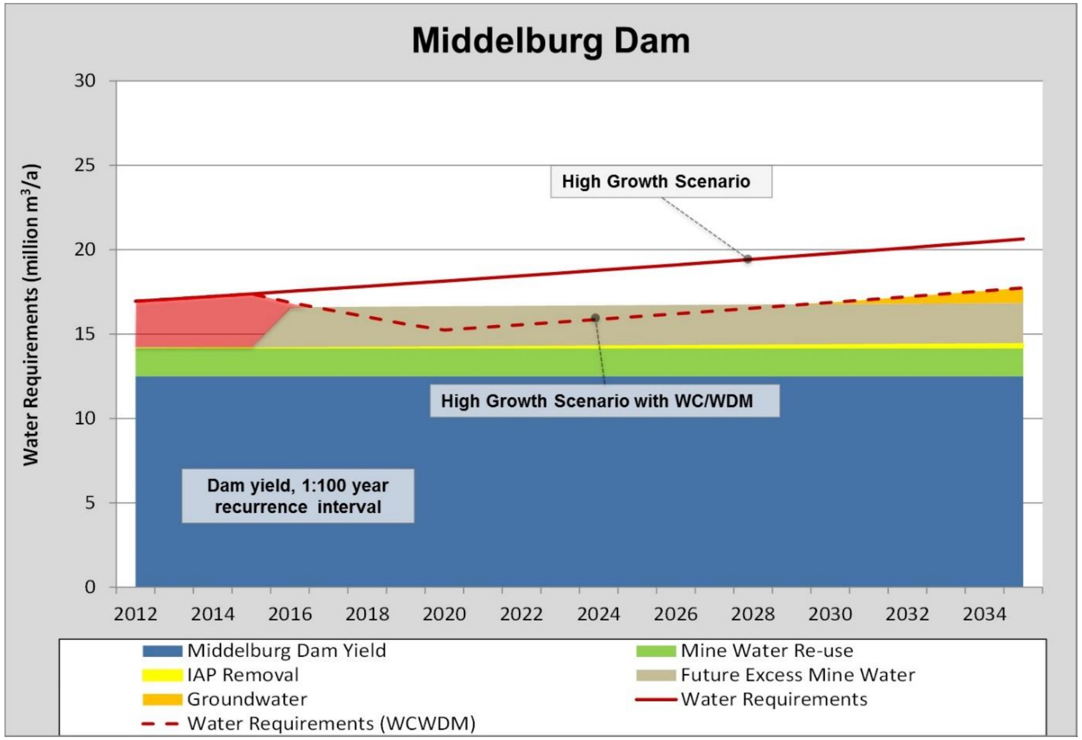


Figure 9: Water balance for Middelburg Dam

Middelburg Dam can supply the high growth water requirements throughout the projection period (Figure 9), provided that the following interventions are implemented:

- Continuous re-use of mine water from the Optimum Coal reclamation works;
- Full implementation of Water Conservation/ Water Demand Management (WC/WDM);

- Invasive alien plan (AIP) removal in the Middelburg Dam Catchment;
- Future excess mine water re-use; and
- Small contribution from groundwater required from 2030 onwards.

Implications for water quality

The current water quality shows non-compliance against TDS, sulphates and ortho-phosphate in all the MUs contributing to the Middelburg Dam. The biggest salinity load is however from MUs 11, 12 and 13.

Table 8: Implications for water quality in the Middleburg Dam MUs of the Upper Olifants sub-catchment

Recommended interventions (DWS, 2015)	Implications for water quality
Continuous re-use of mine water from the Optimum Coal reclamation plant (OWRP)	Optimum WRP (located in MU13) is treating water to potable standard to supply to the town of Hendrina. Some of the water is released to water resources in respect of meeting the Reserve and Hendrina not requiring all the water. However, the better quality water does not appear to be improving the system much, or even reaching the Middleburg Dam as would have been expected.
Full implementation of Water Conservation/ Water Demand Management (WC/ WDM)	This scenario should mean that there is more water in the system if municipalities are abstracting less, so the load should be decreased as more water becomes available. In addition WC/ WDM also includes the impacts of sewer overflows, WWTW operation and maintenance measures so should have a positive impact on nutrient loads.
Invasive alien plan (AIP) removal in the Middelburg Dam Catchment	The volume of water expected to be gained from AIP clearing is not expected to have a large impact on the decrease in salinity and nutrient loads, especially in the short term. Depending on the type of method used, alien clearing may in fact lead to pollution of water resources by herbicides and oils.
Future excess mine water re-use	Excess mine water re-use could mean that water is treated and released to Middelburg Dam, which should then have a beneficial impact on the water quality, however if it is treated and reused directly by a town, releasing only that volume required for meeting the EFR, there would be less water is the system thereby potentially increasing the salinity and nutrient loads.
Small contribution from groundwater required from 2030 onwards	Will not have an impact on surface water quality. In respect of groundwater use, the quality would need to be assessed prior to domestic use.

6.1.2 Witbank Dam on the Olifants

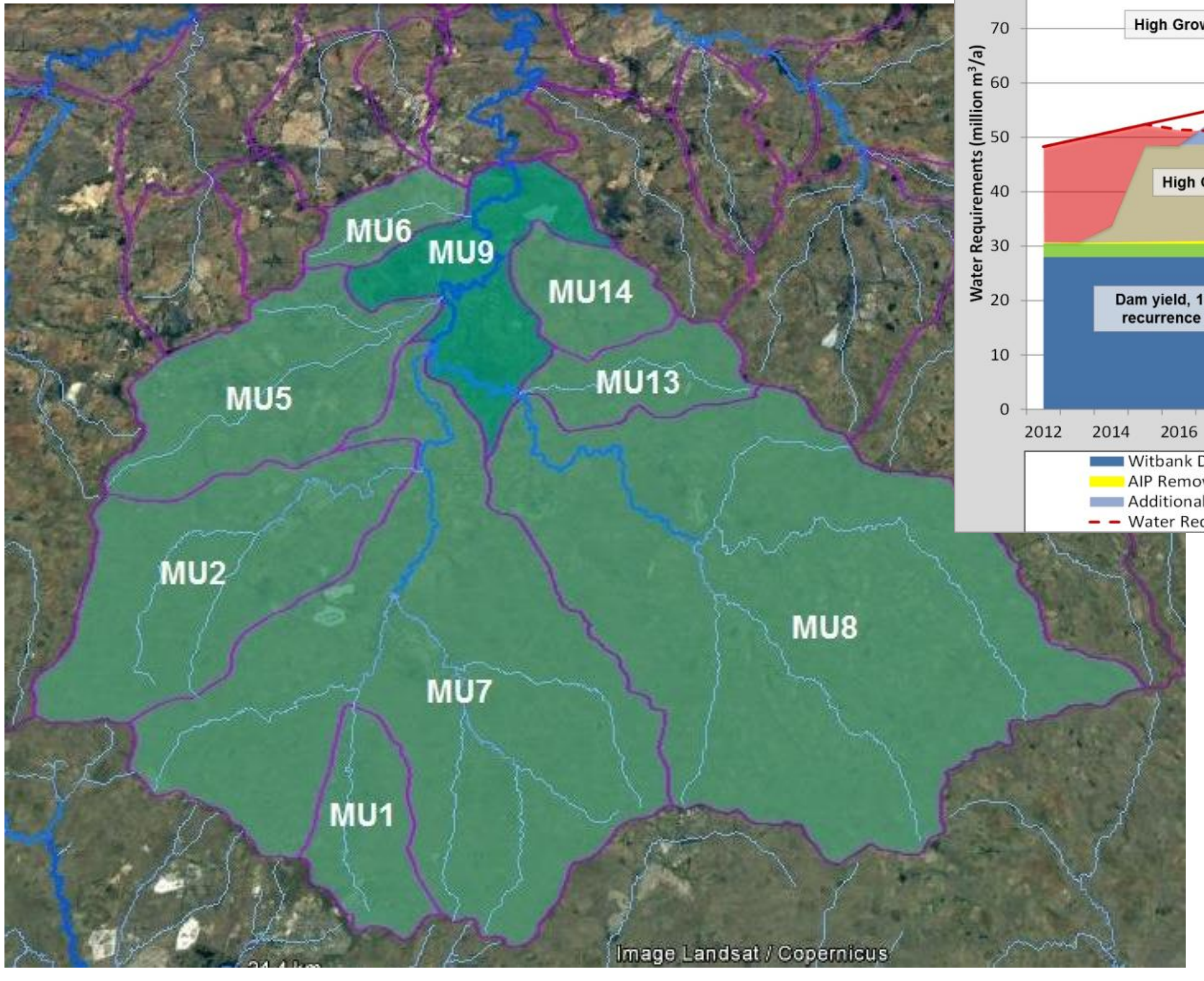


Figure 12: MUs contributing to the Witbank Dam

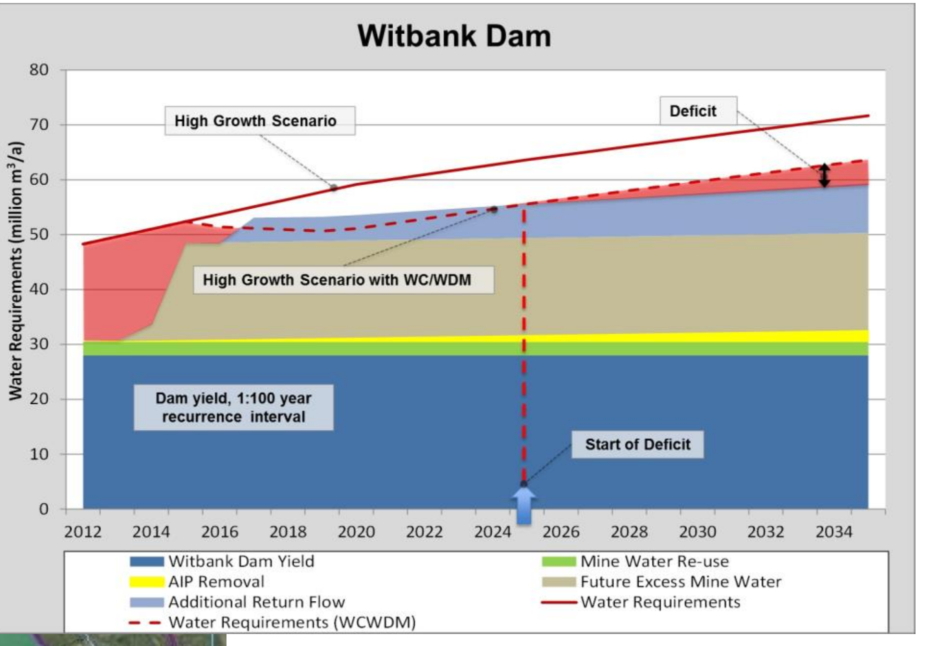


Figure 11: Witbank Dam water balance (DWS, 2015)

The projected water balance for Witbank Dam (Figure 11) illustrates that the projected water requirements exceed the currently available resources throughout the projection period. The high growth water requirements can only be met up to 2025, after which additional augmentation is required, if the following interventions are implemented:

- Continuous re-use of mine water from the Anglo Coal reclamation works
- Full implementation of WC/ WDM
- AIP removal in the Witbank Dam Catchment
- Re-use of treated urban/municipal wastewater
- Further excess mine water re-use

Potential options that could be considered to defer the indicated deficit are the transfer of water from Grootdraai Dam (Vaal River System), applying an integrated operation rule where transfers are only implemented during drought periods and/or the reallocation of water use entitlements of users abstracting water from the river system upstream of Witbank Dam. These alternatives require further investigation before they are incorporated as Strategy Interventions and after monitoring confirms that the actual water use is following the high growth projection trend.

Implications for water quality

The current water quality shows non-compliance against TDS, sulphates and ortho-phosphate in all the MUs contributing to the Witbank Dam. Only the very upper portions of MU 1, MU 7 and MU 8 are still in an acceptable quality.

Table 9: Implications for water quality in the Witbank Dam MUs of the Upper Olifants sub-catchment

Recommended interventions (DWS, 2015)	Implications for water quality
Continuous re-use of mine water from the eMalahleni Water Reclamation Plant (EWRP)	The EWRP located in MU 6 is treating water to potable standard to supply to the eMalahleni Local Municipality. Some of the water is released to water resources in respect of meeting the Reserve. This water is discharged to the Noupoortspruit which then flows through an urban area with discharge from a WWTW, so nutrient enrichment and microbiological contamination negate the potential positive impact.
Full implementation of Water Conservation/ Water Demand Management (WC/ WDM)	This scenario should mean that there is more water in the system if municipalities are abstracting less, so the load should be decreased as more water becomes available. In addition WC/ WDM also includes the impacts of sewer overflows, WWTW operation and maintenance measures so should have a positive impact on nutrient loads.
Invasive alien plan (AIP) removal in the Witbank Dam Catchment	The volume of water expected to be gained from AIP clearing is not expected to have a large impact on the decrease in salinity and nutrient loads, especially in the short term. Depending on the type of method used, alien clearing may in fact lead to pollution of water resources by herbicides and oils.
Further excess mine water re-use	Excess mine water re-use could mean that water is treated and released to Witbank Dam, which should then have a

Recommended interventions (DWS, 2015)	Implications for water quality
	beneficial impact on the water quality, however if it is treated and reused directly by a town or on a mine or power station, releasing only that volume required for meeting the EFR, there would be limited benefit
Re-use of treated urban/ municipal wastewater	Municipal effluent re-use could, in some cases be beneficial to the river system due to the poor quality effluent being removed from the system, thereby reducing the nutrient load entering the rivers and dams.

6.1.3 Loskop Dam incremental catchments

Figure 13 shows the water balance for the Loskop Dam if the EWRs are met in 2017. This scenario indicates that there will be deficits in the water balance with the following interventions included:

- Full implementation of WC/WDM
- AIP removal in the Loskop Dam Catchment
- Small contribution from groundwater development

The lower assurance yield (1:20 year recurrence interval) is also illustrated as more than 95% of the water use supports the irrigation sector. The deficit reduces over time through the implementation of WC/ WDM measures. However, to prevent negative socio-economic implications it is proposed that the EWR releases be gradually implemented as illustrated in

Figure 14 to maintain a positive water balance until 2025. The deficit after 2025 can be managed by water users accepting a lower assurance of supply or reallocation of water use entitlements.

Figure 13: Loskop Dam balance with EWRs met in 2017 (DWS, 2015)

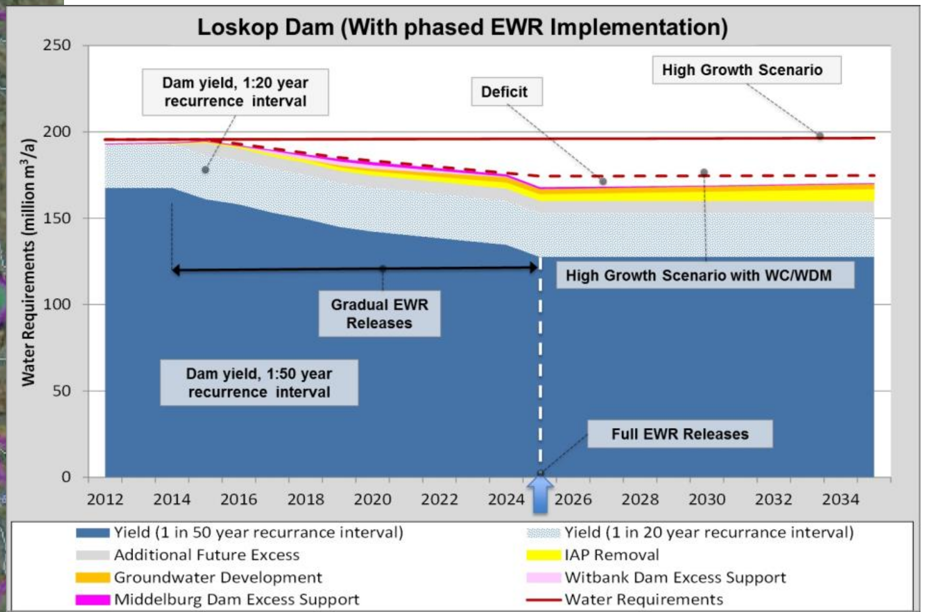


Figure 14: Loskop Water balance with phased EWR implementation (DWS, 2015)

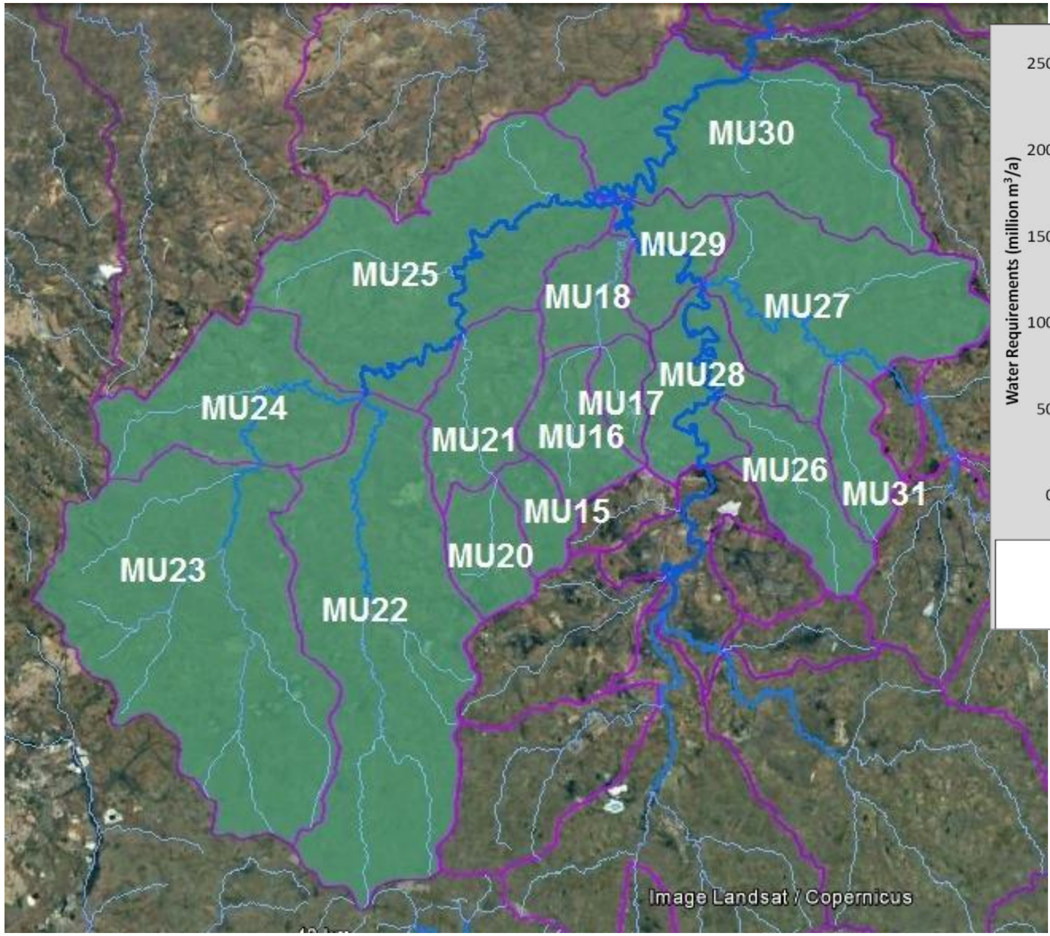


Figure 15: Management Units contributing to the Loskop Dam (including Wilge sub-catchments)

Implications for water quality

When compared against the proposed WQPLs, the current water quality in the MUs shows compliance for sulphate in the Wilge sub-catchments, however non-compliance for TDS and ortho-phosphate. MUs 20 and 21 (Saalboomspruit) however show considerable non-compliance. MU 26 (Spookspruit) and MUs 15, 16 and 17 (Klipspruit and Brugspruit) show considerable non-compliance for sulphate, TDS and orthophosphate.

Table 10: Implications for water quality in the Loskop Dam MUs of the Upper Olifants sub-catchment

Recommended interventions (DWS, 2015)	Implications for water quality
Full implementation of WC/ WDM	This scenario should mean that there is more water in the system if municipalities and the downstream irrigation users are abstracting less, so the load should be decreased as more water becomes available. In addition WC/ WDM also includes the impacts of sewer overflows, WWTW operation and maintenance measures so should have a positive impact on nutrient loads, specifically around the town of Bronkhorstspruit.
AIP removal in the Loskop Dam Catchment	The volume of water expected to be gained from AIP clearing is not expected to have a large impact on the decrease in salinity and nutrient loads, especially in the short term. Depending on the type of method used, alien clearing may in fact lead to pollution of water resources by herbicides and oils.
Small contribution from groundwater development	Not applicable to the surface water component. However in terms of groundwater use the water use sector that will be using the water needs to be considered and relevant treatment option included.

6.2 Middle Olifants sub-catchment

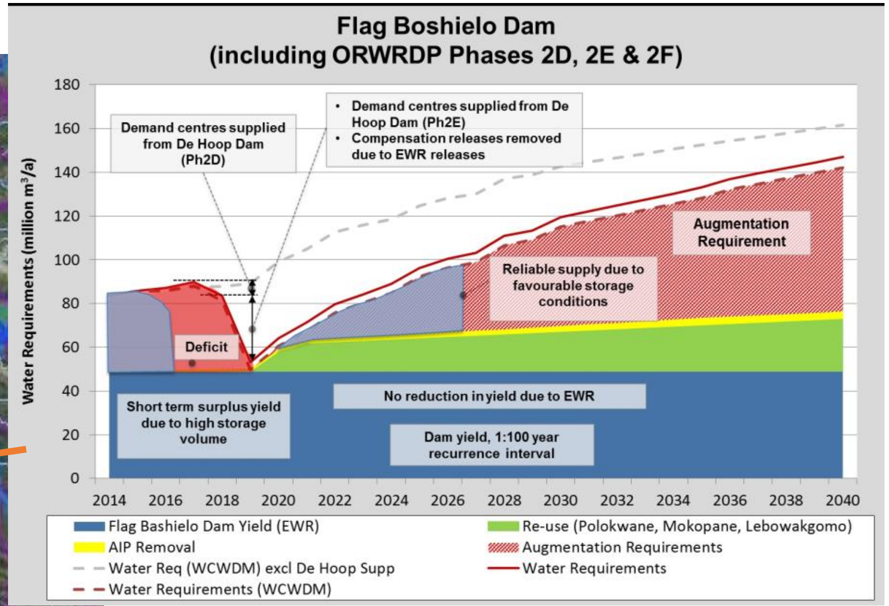


Figure 16: Water balance for Flag Boshielo Dam

The projected water balance of Flag Boshielo Dam (Figure 16), indicates that over the short term there will be deficits until the ORWRDP phases are implemented. This deficit can be mitigated since the actual current irrigation use from the dam is less than the total allocations, which has been included.

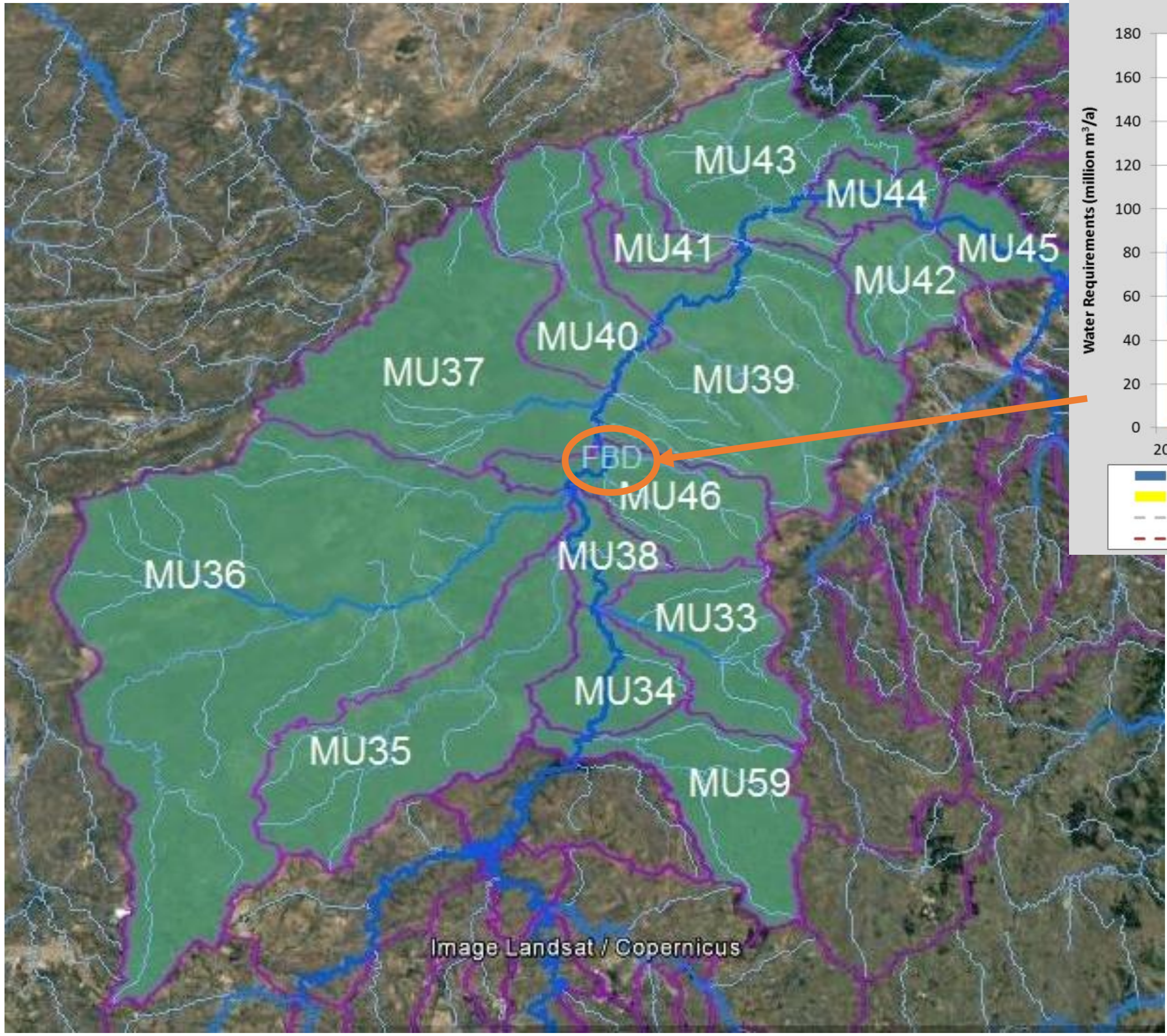


Figure 17: Management Units contributing to Flag Boshielo Dam (and downstream)

Figure 16 illustrates that due to the favourable current storage conditions and through the implementation of the following interventions, augmentation will be needed from 2026 onwards:

- Full implementation of WC/ WDM;
- AIP removal in the Flag Boshielo Dam Catchment; and
- Re-use of urban/ municipal wastewater (Polokwane, Mokopane and Lebowakgomo).

Implications for water quality

The biggest concerns in the Middle Olifants, both up and downstream of Flag Boshielo Dam are due to nutrients from the wastewater treatment works and domestic related non-point source pollution. Chlorides in MU35, and to a lesser extent MU36, contribute to the salinity in the upper portions of the Middle Olifants.

Table 11: Implications for water quality in the Flag Boshielo Dam MUs of the Middle Olifants sub-catchment

Recommended interventions (DWS, 2015)	Implications for water quality
Full implementation of WC/ WDM	This scenario should mean that there is more water in the system if municipalities and the downstream irrigation users are abstracting less, so the load should be decreased as more water becomes available. In addition WC/ WDM also includes the impacts of sewer overflows, WWTW operation and maintenance measures so should have a positive impact on nutrient loads, specifically around the town of Groblersdal, Marble Hall and Lebowakgomo.
AIP removal in the Flag Boshielo Dam Catchment	The volume of water expected to be gained from AIP clearing is not expected to have a large impact on the decrease in salinity and nutrient loads, especially in the short term. Depending on the type of method used, alien clearing may in fact lead to pollution of water resources by herbicides and oils.
Re-use of urban/ municipal wastewater (Polokwane, Mokopane and Lebowakgomo)	Municipal effluent re-use could, in some cases be beneficial to the river system due to the poor quality effluent being removed from the system, thereby reducing the nutrient load entering the rivers and dams.

6.3 Steelpoort sub-catchment

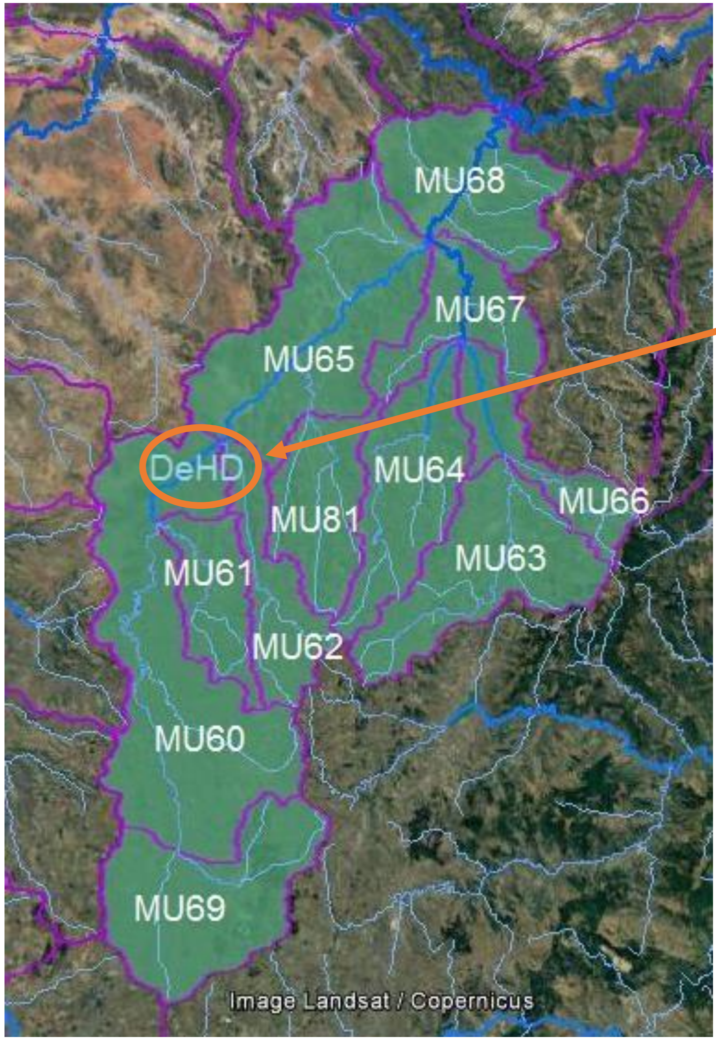


Figure 19: MUs up and downstream of De Hoop Dam

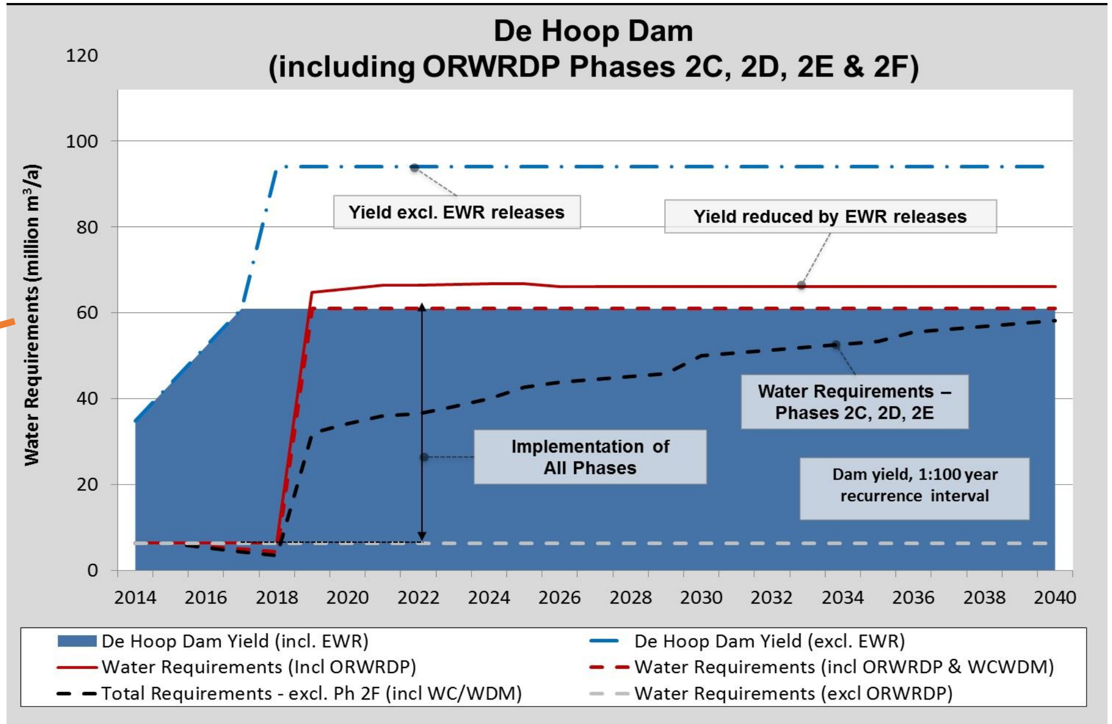


Figure 18: Water balance for De Hoop Dam

De Hoop Dam's 1:100 year assured yield, after allowances for in catchment downstream users and EWR requirements can be utilised by implementing all the ORWRDP phases (conveyance infrastructure) and indirectly augmenting Flag Boshielo Dam sub-system over the medium term. Figure 18 shows that all the ORWRDP Phases 2C, 2D, 2E and 2F are required to fully utilise De Hoop and reduce the water requirements imposed on Flag Boshielo Dam.

6.4 Lower Olifants sub-catchment

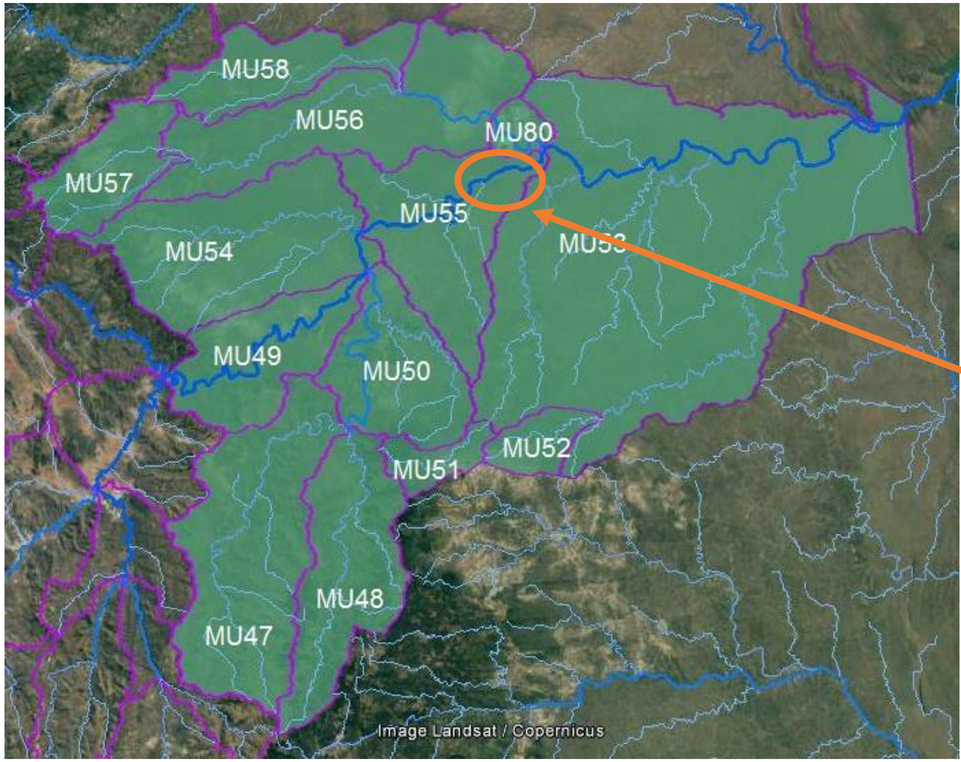


Figure 20: MUs in the Lower Olifants contributing to the Phalaborwa Barrage

There has been a substantial reduction in the projected water requirement due to reduced mining activity as well as substantial savings in water use through various water saving initiatives implement by Phalaborwa Mining in recent years.

The projected water balance for the Phalaborwa Barrage indicates that the high growth requirements for the Barrage can be met for the entire planning horizon.

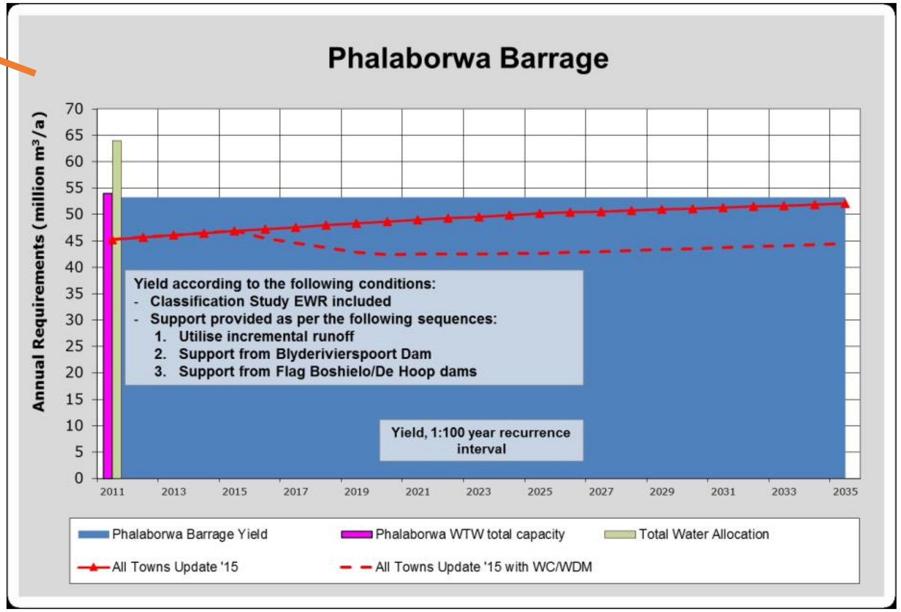


Figure 21: Water balance for the Phalaborwa Barrage

For both Flag Boshielo and the Phalaborwa Barrage, there are no recommendations made for water augmentation. However, even though there is adequate water for the area without having to augment, the aspects of WC/ WDM as described in Section 4.1 must be implemented in these areas as well.

6.5 Letaba sub-catchment

6.5.1 Groot Letaba River System

The reconciliation strategy identified several intervention options for the Groot Letaba Main system, however even with these in place the Groot Letaba Main system will be unable to supply the full irrigation allocation at a reasonable assured yield.

The Groot Letaba Main system water balance contains the following elements (Figure 23).

- Total yield (high and low assurance) reflecting an average supply of about 60% to the irrigators;
- Implementation of WC/ WDM in the urban sector (dashed red line);
- Raising of Tzaneen Dam: main purpose to improve the assurance of supply;
- Nwamitwa Dam implementation (yellow area): water supplied to the areas currently receiving water from Thabina and Thapane dams;
- Ebenezer Dam is used to support users receiving water from Tzaneen Dam when Tzaneen Dam reaches low storage levels;
- The excess water in Ebenezer Dam is made available to support users receiving water from Tzaneen Dam;
- Water from existing and additional groundwater resources for target areas as yield; and
- Low flow EWRs implemented.

It is therefore important that the irrigation users continue with the restriction rule, which will require some adjustments when the raising of Tzaneen Dam is completed and again when Nwamitwa Dam starts to deliver water – while the water balance includes a date of 2020 when it is expected to deliver, it is however not clear when these projects will commence.

The water balance illustrated in Figure 23 includes the assumption that the current assurance of supply to the irrigators will be maintained over the planning period. Most of the smaller sub-systems (Thapane and Thabina from 2020) that support part of the rural domestic requirements in or close to the Groot Letaba Main system supply area also require future augmentation. Deficits in the Modjadji sub-system are expected from 2017 onwards. The Groot Letaba Main system with all intervention options included can only remain in balance until 2030. It was therefore decided to rather impose the deficits in the Modjadji sub-system on the Middle Letaba sub-system and not on the Groot Letaba.

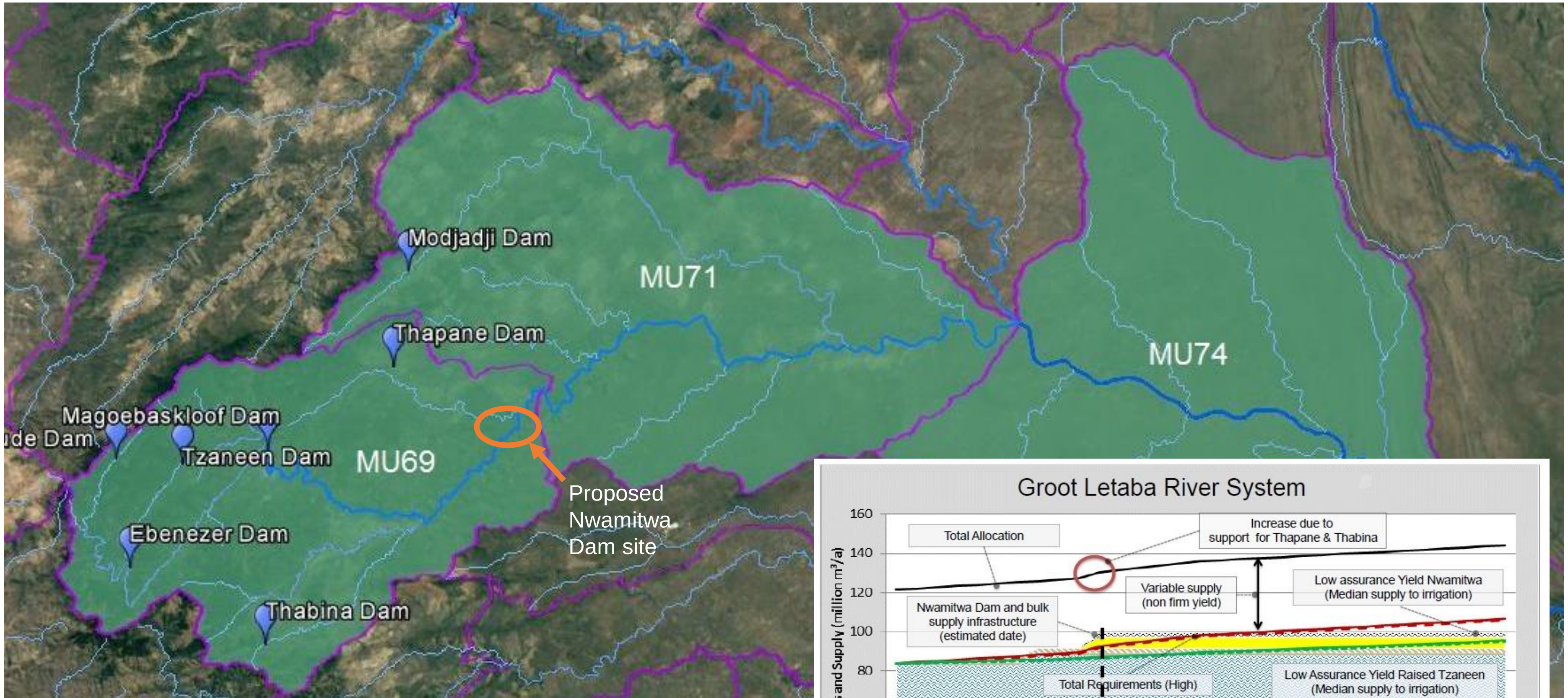


Figure 22: Groot Letaba Management Units contributing to the WB

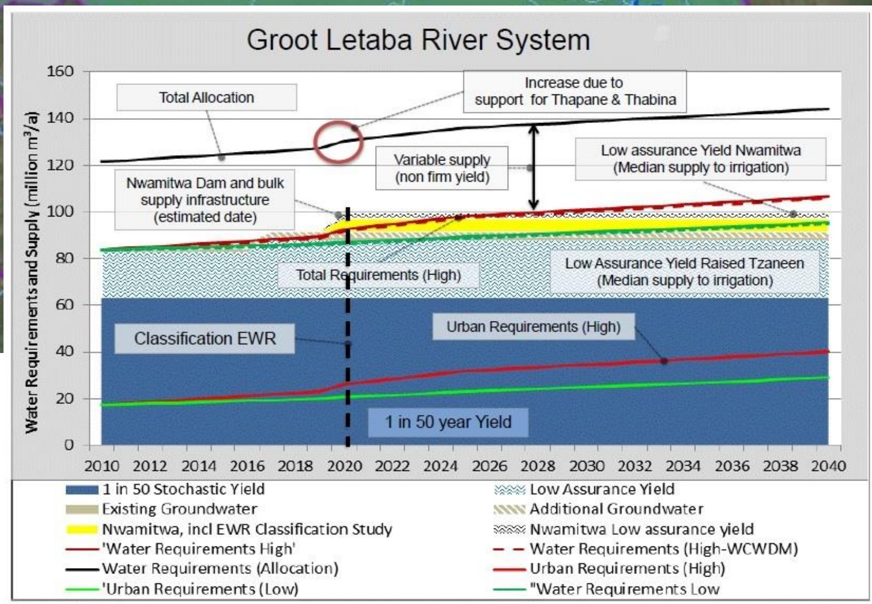
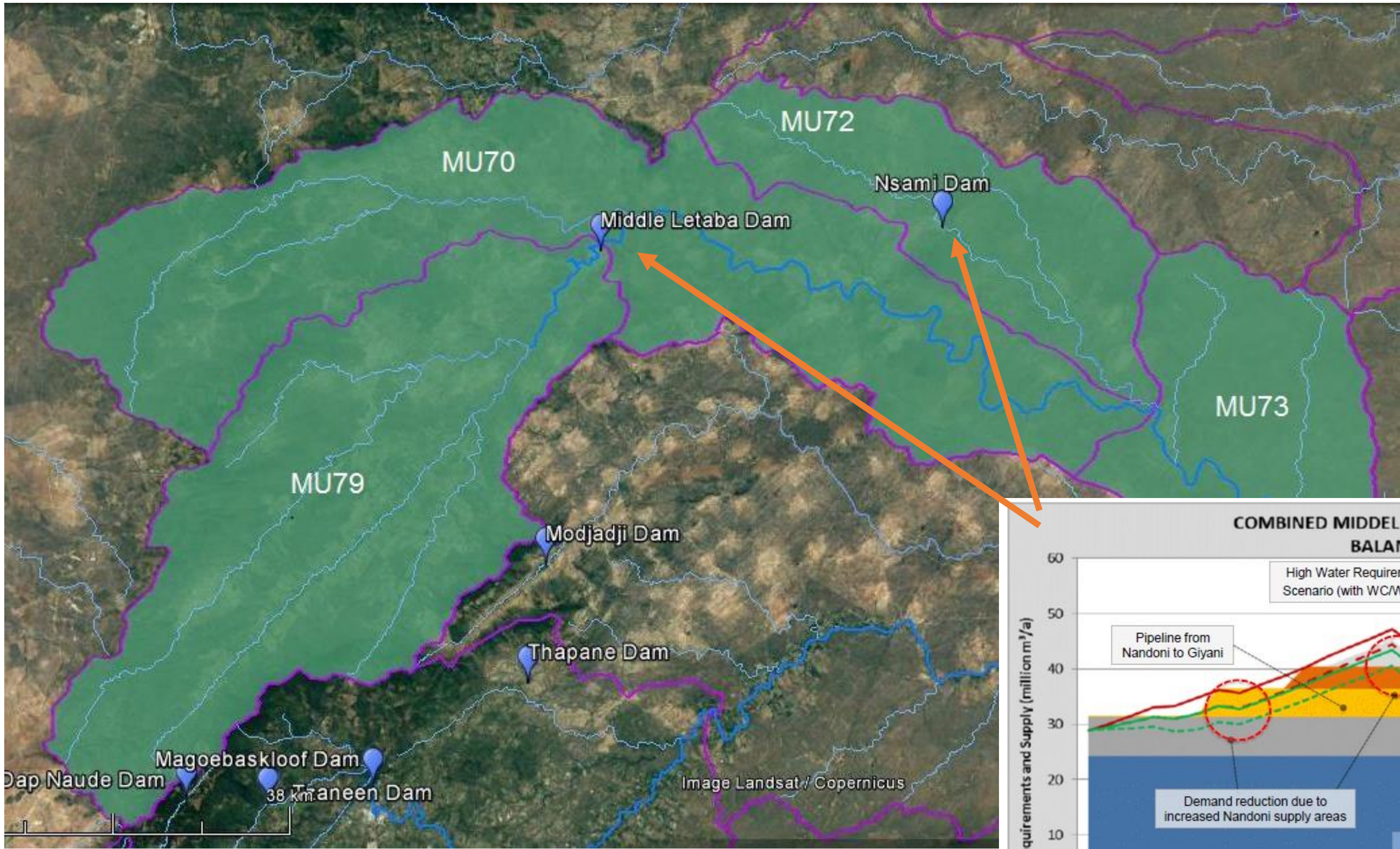


Figure 23: Groot Letaba River system WB

6.5.2 Middle Letaba River System

The Middle Letaba/ Nsami System water balance (Figure 25) contains the following elements:

- Yield of both dams as well as the existing groundwater resources;
- Implementation of Water Conservation and Demand Management in the urban sector (dashed red line);
- Transfer from Nandoni Dam in the Luvuvhu catchment (Limpopo WMA), indicated by the orange augmentation option;
- Some of the current Middle Letaba supply areas should be receiving water from Nandoni Dam, and further supplies in about 2024, reducing the load on Middle Letaba Dam as indicated by the drop in demands shown by the red and green demand projection lines;
- Replacement of the canal transferring water from Middle Letaba Dam to the water treatment works at Nsami Dam with a pipeline option (the brown intervention option); and
- Developing additional groundwater resources from 2022.



The Middle Letaba/ Nsami system is already in deficit from 2012 onwards, even when taking into account that the total demand imposed on the system is reduced from certain years onwards, when portions of the water service schemes currently supplied Middle Letaba Dam, start to receive support from Nandoni Dam.

Figure 24: Middle Letaba Management Units contributing to WB

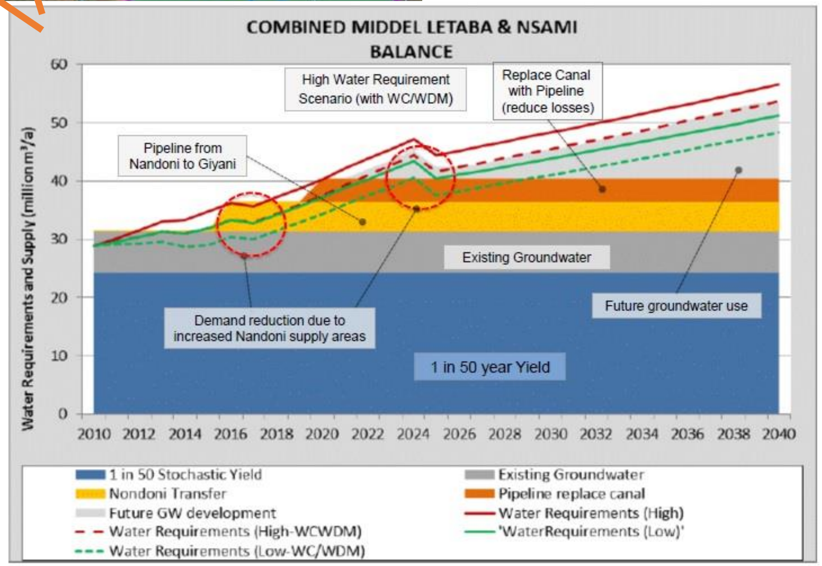


Figure 25: Middle Letaba/ Nsami WB

Implications for water quality

The biggest water quality concerns in the Letaba are from wastewater treatment works discharge and agricultural run-off, both of which exacerbate nutrient enrichment.

Table 12: Implications for water quality in the Letaba MUs

Recommended interventions (DWS, 2015)	Implications for water quality
Implementation of WC/ WDM	This scenario should mean that there is more water in the system if municipalities and the downstream irrigation users are abstracting less, so the load should be decreased as more water becomes available. In addition WC/ WDM also includes the impacts of sewer overflows, WWTW operation and maintenance measures so should have a positive impact on nutrient loads, especially in the Tzaneen and Giyani areas.
Re-use of urban/ municipal wastewater	Municipal effluent re-use could, in some cases be beneficial to the river system due to the poor quality effluent being removed from the system, thereby reducing the nutrient load entering the rivers and dams. The WWTW are however small and this would only be feasible in the Tzaneen and Giyani areas.
Raising of Tzaneen Dam	Should not have a major impact on water quality, except that it may contribute to lower flows downstream
Nwamitwa Dam implementation	Should not have a major impact on water quality in the short to medium term, however the proposed dam site is located on the Nwanedzi and Groot Letaba rivers, both of which flow through urban/ sprawling settlement areas as well as agricultural lands, and the dam may become a sink for nutrients.
Groundwater use	Not applicable to the surface water component. However in terms of groundwater use the water use sector that will be using the water needs to be considered and relevant treatment option included.
Low flow EWRs implemented	Is not too different from the current scenario so should not have a major impact on water quality.
Water from Nandoni Dam	This would mean that the load on Middle Letaba Dam is reduced so that more water will be available to be released downstream, which should be good for downstream water quality as the water quality in the Middle Letaba Dam is good, with the exception of marginally elevated ortho-phosphate levels.
Replacement of the canal from Middle Letaba Dam to the WTW at Nsami Dam with a pipeline	This should reduce the water losses in the canals thereby providing increased water for downstream releases.

6.6 Shingwedzi sub-catchment

The majority of the Shingwedzi sub-catchment falls within the KNP. Outside the KNP land use is mainly subsistence agriculture and villages. The reconciliation strategy indicates that surface water use is negligible due to the non-perennial nature of the streams. In general the water quality of the Shingwidzi River and tributaries has remained very good when water is available to be sampled, however shows contamination from the domestic WWTW, as well as general urban pollution from the larger villages, and is unlikely to change, except for improvements if these issued are addressed.

7 RECOMMENDATIONS AND CONCLUSIONS

In respect of salinity, the biggest load is associated with the main stem Olifants River, calculated at the Wolwerkrans weir to be in the order of 80 000 T/a, which receives salinity contributions from MU3 (Koringspruit) and MU5 (Klippoortjiespruit) and the lower portions of MU2 (Rietspruit), MU7 (Steenkoolspruit) and MU8 (main Olifants below the confluence with the Viskuile): about a 30 kilometre radius from the Wolwekrans weir.

Further large contributions emanate from the Klein Olifants: MU14 (an estimated 29 000 T/a) measured on the Klein Olifants, however the major contributions do not emanate in MU14 but are upstream from MU11 (Rietkuilspruit), MU12 (Bosmanspruit) and MU13 (Woestalleenspruit).

In the Lower Olifants sub-catchment the Ga-Selati (measured at Loole weir) contributes and estimated 4 600 T/a.

In respect of nutrients, the major contributors are the discharges from the WWTW, run-off from urban/ semi-urban areas and return flows and run-off from irrigated areas. As indicated in the situation assessment there are no Green Drop certified WWTWs in the Olifants WMA and increased ortho-phosphate concentrations can be linked to WWTWs and urban or semi-urban areas where storm water management is poor. While limited microbiological monitoring is undertaken, these points would also be associated with increased faecal coliform counts. The oxidation pond systems are also linked to groundwater contamination and overflows that would also contribute to increased nutrients and microbiological contamination to the system.

Impacts from intensive irrigation were noted in the Upper Middle Olifants, particularly along the Moses in MU35 and Elands Rivers in MU36, as well as in the Lower Olifants, MU47 (Ohrigstadt River) and MU50 (Blyde River and Rietspruit). While it is not currently very prominent there is also the potential for nutrient enrichment due to irrigation in the upper parts of the Letaba (MU69).

The results of the study to date, have therefore indicated that there is very little assimilative capacity in the whole of the Olifants River, both for salinity and nutrients. In the Upper Olifants, those areas where there may be some assimilative capacity, such as in the Wilge River sub-catchments, are however already showing increased trends and will not be able to comply with the legislated classification of a Class II River. The same holds true for the Middle and Lower Olifants and Steelpoort. In addition, those areas where acceptable or good water quality is noted, such as in the upper portion of the Letaba sub-catchments and the Blyde River, are mainly within Nature Reserves, Biosphere Reserves or National Parks, designated as such under the Protected Areas Act (Act 57 of 2003).

It is noted that when developing the Reconciliation Strategy for a catchment, a water quality assessment is undertaken, however the recommendations made do not necessarily consider the impacts on water quality. Even for Reserve determinations, while water quality is considered it is currently not integrally linked to the quantity component. This report has therefore tried to put into perspective the positive or negative changes that may occur as the recommendations are implemented and water of different chemical and biological quality is either kept out of the system or added to the system. The following aspects relating to the recommendations made in both the Olifants and Luvuvhu/ Letaba Reconciliation strategies were considered:

- *Implement WC/ WDM* in the irrigation, urban and mining sectors: often considered as the savings that can be found in respect of decreasing unaccounted for water. This is specifically the case when undertaking the reconciliation strategies for the catchments. However there are several components that contribute to WC/ WDM (water resource management, distribution management, consumer demand management and return flow management) that may have direct impacts on water quality;
- *Eliminate Unlawful Use*: The implementation of assessing whether a water use is unlawful would apply to water quality in respect of designs, operation and maintenance of facilities that may have an impact on water quality of a system in respect of both point and non-point sources of pollution, as well as impacts from the over-abstraction from systems;
- *Development of Groundwater Resources*: unlikely to have much of an impact of the water quality of the Olifants system, however would need to be considered in respect of the use for which the water is intended and the water quality required for that use.
- *Removal of invasive alien plants:* Invasive alien vegetation can result in several impacts to river systems, often associated with ecological, economic, management and land use opportunity costs. In respect of water quality the method of alien removal is important, for example**,** when using chemical control, care must be taken to avoid the herbicide causing additional pollution to the downstream water or sediments. Herbicides may contaminate sites

used for drinking water, washing or fishing and may affect general river ecosystem health;

- *Treatment of mine water:* mine water treatment has to some extent been quite successful in the Upper Olifants sub-catchments by removing large volumes of contaminated water from entering the rivers, and only discharging water of acceptable quality for the requirements of the Reserve, or having a dilution effect where larger volumes are discharged after treatment;
- *Municipal effluent re-use:* Municipal effluent re-use could, in some cases be beneficial to the river system due to the poor quality effluent being removed from the system, however good quality treated effluent should be returned to the system if required by the Reserve;

Supporting Infrastructure Development and Operational Projects:

- Olifants River Water Resources Development Project;
- Determination, review and implementation of the Reserve in the Olifants/ Letaba System which his has now been completed; and
- Integrated Olifants River Supply System Operating rules.

These aspects and the specific concerns noted in the sub-catchments support the scenarios proposed in the Scenario Analysis Report (P WMA 04/B50/00/8916/5):

- Reduced load due to seepages from the mine, industrial and power station waste storage facilities and mining operations in the Upper Olifants sub-catchment, some load from the Steelpoort sub-catchments and the Ga-Selati in the lower Olifants sub-catchments;
- Reduced load from excess mine water on the mining operations threatening to decant or starting to flood the coal reserves in the Upper Olifants sub-catchment;
- Reduced load from irrigation return flows in the Upper and Middle Olifants;
- Reduction of nutrient load from domestic WWTW that discharge to the water resources, by considering a reduction of the orthophosphate concentration to 1 mgP/l;
- Reduction of nutrient and sediment load from agricultural areas and areas where changing land uses may be occurring;
- Reduction of nutrient and sediment load from run-off from urban/ densely populated areas; and
- Improved reuse of effluent from domestic wastewater treatment works not designed to meet the general discharge limits.

This will now be taken forward into the management options report that will give further details on what should be implemented to achieve short and longer term improvements in the system.

8 REFERENCES

Department of Water Affairs (2014) *Development of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System*: Final Reconciliation Strategy. Report No. P WMA 02/B810/00/1412/15

Department of Water and Sanitation (2015) *Olifants River Water Supply System Reconciliation Strategy.* Report No. P WMA 04/B50/00/8715

APPENDIX A:

PROJECT STEERING COMMITTEE MEMBERS

Title	Surname	First Name	Organisation
Mr	Atwaru	Yakeen	Department of Water and Sanitation
Mr	Bierman	Bertus	Joint Water Forum/ Lebalelo WUA
Dr	Burgess	Jo	Water Research Commission
Dr	Cogho	Vic	Glencore
Mr	Dabrowski	James	Private Consultant
Mr	De Witt	Pieter	Dept. of Agriculture, Forestry and Fisheries
Dr	Driver	Mandy	SANBI
Ms	Fakude	Barbara	DWS
Mr	Gouws	Marthinus NJ	Depart. Of Agriculture, Rural Development and Land Administration
Mr	Govender	Bashan	Dept. of Water and Sanitation
Mr	Govender	Nandha	Strategic Water Partnership Network
Mr	Grobler	Geert	Dept. of Water and Sanitation
Dr	Gyedu-Ababio	Thomas	IUCMA
Mr	Harris	James	Olifants River Forum
Mr	Hugo	Retief	AWARD
Mr	Jezewski	Witek	Dept. of Water and Sanitation
Mr	Keet	Marius	Dept. of Water and Sanitation: Gauteng
Mrs	Kobe	Lucy	Dept. of Water and Sanitation
Mr	Kruger	Dirko	Agri-SA
Ms	Kubashni	Mari	Shanduka Coal
Mr	Le Roux	Roelf	Magalies Water
Mr	Leballo	Labane	Lepelle Water
Mr	Lee	Clinton	South 32
Mr	Linstrom	Charles	Exxaro
Mr	Liphadzi	Stanley	Water Research Commission
Mr	Llanley	Simpson	DST
Mr	Mabada	Hangwani	Dept. of Water and Sanitation: Limpopo
Mr	Mabalane	Reginald	Chamber of Mines
Mr	Mabogo	Rudzani	Dept. of Mineral Resources
Mrs	Mabuda	Mpho	Dept. of Water and Sanitation
Mr	Mabuda	Livhuwani	Dept. of Water and Sanitation
Mr	Macevele	Stanford	Dept. of Water and Sanitation: Mpumalanga
Mr	Machete	Norman	Limpopo Provincial Administration
Mr	Madubane	Max	Dept. of Mineral Resources
Mr	Maduka	Mashudu	Dept. of Mineral Resources
Mr	Malinga	Neo	Dept. of Water and Sanitation
Mr	Mannya	KCM	Dept. of Agriculture, Forestry and Fisheries
Mr	Masenya	Reuben	Dept. of Mineral Resources
Ms	Maswuma	Z	Dept. of Water and Sanitation
Mr	Mathebe	Rodney	Dept. of Water and Sanitation
Ms	Mathekga	Jacqueline	Dept. of Mineral Resources
Ms	Mathey	Shirley	Dept. of Mineral Resources
Ms	Matlala	Lebogang	Dept. of Water and Sanitation
Mr	Matodzi	Bethuel	Dept. of Mineral Resources
Mr	Mboweni	Manias Bukuta	Department of Agriculture, Rural Development and Land Administration
Mr	Meintjies	Louis	National Water Forum TAU SA
Mr	Mntambo	Fanyana	Dept. of Water and Sanitation: Mpumalanga
Mr	Modipane	B J	House of Traditional Leadership
	Modjadji	N	Lepelle Water
Dr	Molwantwa	Jennifer	IUCMA

Mr	Mongwe	Victor	Dept. of Economic Development, Environment and Tourism
Mr	Moraka	William	SALGA – National
Mr	Morokane	Molefe	Dept. of Mineral Resources
Mr	Mortimer	M	Dept. of Agriculture, Fisheries and Forestry
Mr	Mosefowa	Kganetsi W	Dept. of Water and Sanitation
Ms	Mosoa	Moleboheng	Dept. of Water and Sanitation
Mr	Mphaka	Matlhodi	SANBI
Mr	Mthembu	Dumisani	Dept. of Environmental Affairs
Ms	Mudau	S	Chamber of Mines
Ms	Muhlbauer	Ritva	Anglo
Ms	Muir	Anet	Dept. of Water and Sanitation
Mr	Mulaudzi	M	Dept. of Water and Sanitation
Mr	Musekene	Lucky	Dept. of Water and Sanitation
Dr	Mwaka	Beason	Dept. of Water and Sanitation
Mr	Nditwani	Tendani	Dept. of Water and Sanitation
Ms	Nefale	Avhashoni	Dept. of Water and Sanitation
Mr	Nethononda	B	Dept. of Environmental Affairs
Mr	Nethwadzi	Phumudzo	Dept. Mineral Resources
Mr	Nico	Dooge	Glencore
Mr	Nokeri	Norman	Lepelle Water
Mr	Oberholzer	Michael	Dept. of Mineral Resources
Ms	Olivier	Dorothy	Dept. of Mineral Resources
Mr	Opperman	Nic	Agri-SA
Mr	Parrott	Brenton JS	Delmas WUA: Representing irrigators in the Upper Olifants Area
Mr	Phalandwa	Musa	Eskom
Mr	Po	Jan	Dept. of Agriculture, Fisheries and Forestry
Mr	Potgieter	Jan	National Dept. of Agriculture
Ms	Ralekoa	Wendy	DWS
Mr	Ramatsekia	Rudzani	Dept. Mineral Resources
Ms	Rammalo	Albertina	MDW
Mr	Ramovha	Matshilele	Dept. Mineral Resources
Mr	Ramphisa	Philip	Platreef Mine
Mr	Raphalalani	Israel	Dept. of Water and Sanitation
Mr	Riddel	Eddie	SANPARKS – KNP
Mr	Roman	Henry	DST
Mr	Rossouw	Ossie	Lebalelo WUA
Mr	Schmahl	Carel	Lepelle Water
Mr	Selepe	Marcus	IUCMA
Mrs	Shai	Caroline	Dept. of Water and Sanitation
Dr	Sharon	Pollard	Award
Ms	Shaw	Vicki	Mine Water Coordinating Body (MWCB)
Ms	Sigwaza	Thoko	Dept. of Water and Sanitation
Ms	Sinthumule	Ethel	Dept. of Mineral Resources
Ms	Sithole	Nelisiwe	Mpumalanga Provincial Department of Agriculture
Ms	Skosana	M	Dept. of Water and Sanitation
Mr	Stephinah	Mudau	Chamber of Mines
Mr	Surendra	Anesh	Eskom
Mr	Surmon	Mark	Palabora Mining Company
Mr	Tloubatla	L	Dept. of Water and Sanitation
Mr	Tshivhandekano	Aubrey	Dept. of Mineral Resources
Mr	Tshukudu	Rabeng	Mpumalanga Provincial Government

Ms	Ugwu	Phindile	DMR
Mr	Van Aswegen	Johann	Dept. of Water and Sanitation
Mr	Van Den Berg	Ockie	Dept. of Water and Sanitation
Mr	Van der Merwe	Alwyn	Eskom
Mr	Van Niekerk	Peter	Dept. of Water and Sanitation
Mr	Van Rooyen	Marius	Mpumalanga Provincial Department of Agriculture
Mr	Van Stryp	Johan	Loskop Irrigation Board: representing irrigators in the Middle Olifants Area
Mr	Van Vuuren	Jurie	Lower Blyde WUA: representing irrigators in the Lower Olifants Area
Mr	Venter	Jacques	SANPARKS – KNP
Mr	Viljoen	Pieter	Dept. of Water and Sanitation
Ms	Willard	Candice	DST
Ms	Zokufa	T	Dept. of Water and Sanitation

APPENDIX B:

BROADER STAKEHOLDERS WHO CONTRIBUTED TO THE PROJECT

Name	Organisation
Adivhaho Rambuda	DWS, Bronkhorstpruit
Adolph Maredi	DWS
Alistair Collier	Olifants Joint Water Forum
Alta van Dyk	Lonmin Akanani
André Venter	Letaba Water User Association
Aneshia Sohan	Sasol
Angelika Möhr	SRK
Anna-Manth	OFF (MCCI)
Ansia de Jager	JWF
Avhafuni Ratombo	DWS, Bronkhorstspruit
Avril Owens	SRK
Ayanda Mtatwa	DWS: MWM
Betty Marhaneleh	LDARD: Mopani
Betty Nguni	DWS
Bongani Mtzweni	Samancor
Brenda Lundie	Sasol Satellite Operations
Cara	Kungwini Wise
Carina Koelman	DARDLEA
Caroline Shai	DWS, Compliance
Cecilia Mkhatshwa	City of Tshwane
Celiwe Ntuli	DWS
Charles Linström	Exxaro
Charlotte Khoza	Lepelle Northern Water
Christo Louw	DWS
Craig Zinn	Mpumamanzi Group
Danny Talhami	Clover Hill Club Share block
David Paila	Glencore Lion
Dayton Tangwi	DWS
Decia Matumba	SALGA
Derrick Netshitungulu	Nkwe Platinum
Dr James Meyer	Topigs SA
Eben Ferreira	Keaton Energy Mining Vanggatfontein Colliery Delmas
Eddie Ridell	KNP
Edwin Mamega	DAFF
Elmien Webb	Glencore
Emile Corradie	Bosveld Phosphate
Faith Mugivhi	ASA Metals/ Dilokong Chrome Mine
Farah Adams	Golder Associates Africa
Gavin Tennant	Agri-Letaba
Geert Grobler	DWS
Gloria Moloto	DWS, Bronkhorstspruit
Gloria Sambo	Agriculture

Heather Booysen	Samancor
Hugo Retief	AWARD
Imani Munyai	Wescoal Mining
Jakes Louw	Joint Water Forum
James Ndou	Modikwa Platinum Mine
Jan de Klerk	Sasol
Jaques Venter	SANparks
Jerry Penyene	AFASA
Johan van Stryp	Loskop Water Forum
Johanes Mathungene	LEPELLE/ farmer
Johannes Senyane	Two Rivers Platinum Mine
John Gearg	Wescoal/JKC
Joseph Phasha	DWS, Compliance
Kamo Meso	DWS
Karabo Motene	Glencore Mototolo Platinum Mine
Kerry Beamish	Rand Carbide
Kgaowelo Moshokwa	Anglo American Coal- Goedehoop Colliery
L.D Mutshaine	DWS: MWM
Leah Muoetha	Lepelle Northern Water
Lebo Mosoa	DWS
Lebohang Sebola	Lepelle Northern Water
Lee Boyd	Golder Associates Africa
Lee-Ann Ryan-Beeming	Glencore Eastern Chrome Mines
Lerato Maesela	LEDET
Linda Desmet	Palabora Mining Company
Love Shabane	DAFF
Lucas Masango	Private
Lulu Moya	Greater Giyani Municipality
M.S Makuwa	LEDET
Mahlakoane Foletji	DAFF: LUSM
Marcia Mofokeng	DWS: Letaba CMF
Marie Helm	DA Councillor, Mopani District Municipality
Martha Mokonyane	Mbuyelo Group (Pty)Ltd (Vlakvarkfontein and Rirhandzu Collieries)
Mashweu Matsiela	Industrial Development Corporation
Mathabo Kgosana	DWS, Planning and technical support
Michelle Proenca	GS Schoonbee Estates
Mologadi Mpahlele	Mbuyelo Group (Pty)Ltd (Vlakvarkfontein and Rirhandzu Collieries)
Moses Sithole	SBBC
Movwape Ntchabeleng	DAFF
Mpho Makgatha	Steve Tshwete Local Municipality
Musa Lubambo	DWS, Bronkhorstspruit
Ndwamato Ramabulama	DAFF
Nico Dooge	Glencore

Nnzumbeni Tshikalange	DWS
Nomathemba Mazwi	Resource Protection and Waste
Nonceba Noqayi	DWS, Mbombela
Nonki Lodi	AFASA
P.K Dzambuken	DWS: Tzaneen
Palo Kgasago	DAFF
Percy Ratombo	DWS
Phillemon Mphahlele	Municipal Health Services
Phuti Mabotha	LEDET
Pieter Pretorius	Loskop Irrigation Board
Pieter Viljoen	DWS
Portia Munyai	DWS
Pumale Nkuna	DWS:Mpumda
Raisibe Morudu	Thembisile Hani LM
Ramasenya Meso	DWS
Reginah Kganyago	DWS
Resenga Shibambo	DWS, Enforcement
Reynie Reyneke	EXXARO
Robert Davel	Mpumalanga Agriculture (provincial affiliate Agri SA)
Sabelo Mamba	Small Enterprise Finance Agency
Sakhi Mamashole	FOSKOR
Sakhile Mndaweni	DWS, National Office
Salome Sathekge	Polokwane Municipality
Siboniso Mkhaliphi	DWS
Simon Moewg	NEPRO
Solomon Tshikovhele	DWS: HO
Stanford Macevele	DWS: MP
Stephan Kitching	Wescoal Processing
Steven Friswell	Clover Hill Club Share block
Tanya Botha	Evraz Highveld
Tendani Nditwani	DWS: NWRP
Thabiso Mpahlele	Lepelle Northern Water
Thia Oberholzer	Evraz Highveld
Thomas Napo	LDARD
Timothy Marobane	Steelpoort Business Bridge Chamber
Tintswalo Ndleve	DEA (NRM)
Tony Bowers	Mpumamanzi Group cc
Tshepo Magongwoto	LEDET
Tshidi Mamotja	Department Environmental Affairs
Vinesh Dilsook	Anglo American Platinum
Wilna Wepener	Lonmin Akanani
Zama Ramokgadi	Tubatse Chrome
Zonke Miya	Mpumamanzi Group cc