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Integrated Water Quality Management Plan for the Olifants River System

Water Quality Status Assessment and International Obligations with respect to Water Quality Report

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APPROVAL

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EXECUTIVE SUMMARY

The quality of any body of surface water or groundwater is a function of both natural and human influences. If there were no human influences water quality would be determined by the weathering of bedrock minerals, by the atmospheric processes of evapotranspiration and the deposition of dust and salt by wind, as well as by natural leaching of organic matter and nutrients from soil, hydrological factors that lead to run-off and by biological processes within the aquatic environment that can alter the physical and chemical composition of water.

The water quality of a particular body of water is determined by measuring the physical, chemical, aesthetic and biological characteristics of the water and typically, the fitness for use of the water is determined by comparing these characteristics against water quality guidelines or standards for a particular water use. In South Africa, the South African Water Quality Guidelines series (DWAF, 1996) is essentially a series of documents that was developed based on different user specifications (including use by the following sectors: domestic, industrial, livestock watering, irrigation and aquatic ecosystems) and were based on scientifically assessed acceptable levels of toxicity to either humans or aquatic organisms.

Declining water quality has become a global issue of concern as human populations grow, industrial and agricultural activities expand, and climate change threatens to cause major alterations to the hydrological cycle.

The Olifants River system faces a number of water quality challenges impacting on both surface water and groundwater including salinisation, sedimentation, nutrient enrichment and microbial and agrochemical pollution, all at different scales within the sub-catchments of the WMA.

Over the years significant catchment development, including industrial growth and power stations, widespread mining activities, especially in the upper catchments, irrigation and formal and informal urbanisation has impacted on the surface water and groundwater resources of the Olifants River System.

This situation assessment report has been divided into four main parts:

Part One: Context and Background

This section provides the background and context to the situation assessment task and the framework for the IWQMP study. It includes a discussion on integrated water resources management in the South Africa context and how this study needs to align with and complement the results of the Reserve, classification and Resource Quality Objectives projects that have been undertaken in the WMA and the importance of incorporating the results, and in particular the final Implementation Plan, of this study into the Catchment Management Strategy that will be developed.

In addition a chapter on International Obligations with respect to water quality management has been included. Key to this project is the alignment with the policies and strategies being

developed by the DWS, Directorate: Water Resource Planning Systems under the project: Development of an Integrated Water Quality Management Strategy for South Africa.

Part Two: Catchment description

This section describes the catchment area in terms of physical attributes, water resource systems, description of the current land use activities and developmental attributes.

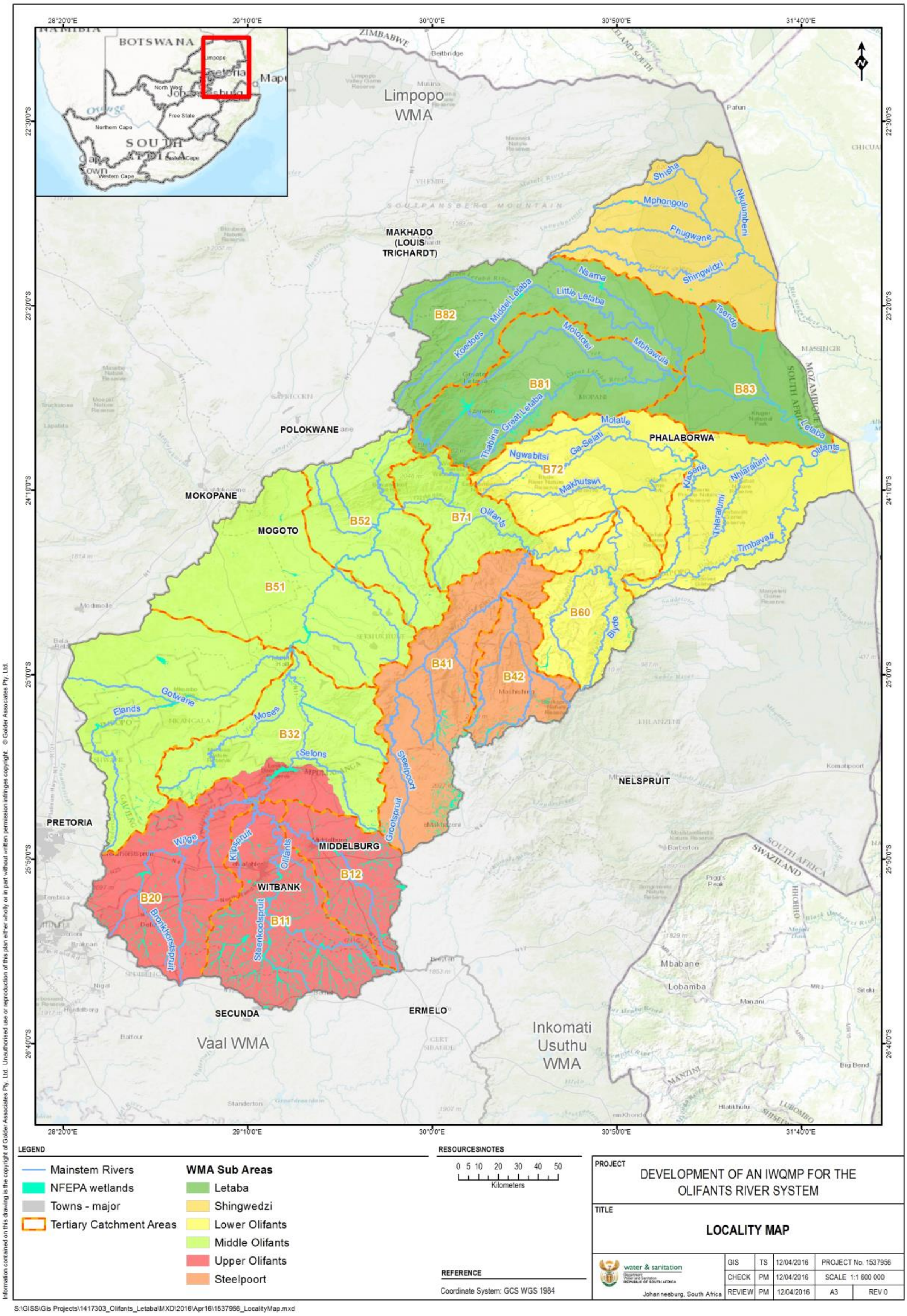
The spatial extent of the study area is the Olifants Water Management Area, also referred to as the Olifants River System that includes the Olifants River catchment (tertiary drainage regions B11, B12, B20, B31, B32, B41, B42, 52, B52, B60, B71, B72 and B73); Letaba River catchment (tertiary drainage regions B81, B82 and B83); and Shingwedzi River catchment: tertiary drainage region B90.

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) kilomteres 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).

The study area has been sub-divided into the following sub-catchments:

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



Study Area showing sub-catchments

Part Three: *Water Quality Status*

The section provides an assessment of the current water quality trends in the Olifants River System with respect to salinity, eutrophication, metals and microbial pollution; the review and setting of Water Quality Planning Limits (previously referred to as Resource Water Quality Objectives; and summarises the gaps that exist in terms of for example, numbers of monitoring points, location of monitoring points and current variables being monitored, especially in respect of agrochemicals. The 4 levels of monitoring that have been considered are:

Level 1: water quality and/ or quantity monitoring points on the main stem Olifants River.

Level 2: water quality and/ or quantity monitoring points at the lowest point on the main tributaries.

Level 3: upstream water quality and/ or quantity monitoring points on minor tributaries.

Level 4: water quality and/ or quantity monitoring points at point sources.

Part Four: Discussion and Conclusions

This sections provides discussion of the findings of the assessment, formulation and prioritisation of key water quality concerns, gaps and priorities for which management plans will need to be detailed.

A spectrum of issues in the Olifants River System have been identified including salinisation, nutrient enrichment, metal contamination and concerns around emerging contaminants.

The greatest impact is seen in the Upper Olifants catchment from mines and urbanisation which impacts considerably on downstream users. Impacts from agriculture and poor functioning municipal wastewater treatment works are the main pollution sources in the other sub-catchments, except for the mines in the Phalaborwa area that have a major impact on the lower reaches once the Olifants River enters the Kruger National Park.

In summary the following areas have been identified as priorities to be taken forward as part of the development of IWQMP, and particularly in the development of the implementation plan:

- Data collection, handling and management;
- Lack of WQPLs;
- Impacts of the mining activities and mine closure;
- Management of wastewater treatment works discharges;
- Urbanisation;
- Irrigation Schemes;
- Waste Discharge charges;
- Research needs;

- Monitoring; and
- Integrated management.

The next steps in the project

The next step in the project involves the definition, development, integration and balancing of water quality planning limits (WQPLs) that will maintain or improve the systems water quality, using as a point of departure the existing WQPLs (previously known as Resource Water Quality Objectives (RWQOs)) and RQOs. The second component will be to establish how the system complies with the WQPLs, which will be determined through analysis of available data and undertaking modelling of possible future scenarios. The analysis will show where non-compliance occurs and indicates areas with available assimilative capacity. This task will identify areas where particular attention will have to be given to the development of options in the management option analysis.

Key to the development of the plan is an understanding of the sources of pollution. This is best done through modelling. The WQT salinity model has been calibrated for sulphate and total dissolved solids (TDS) down to the Flag Boshielo Dam. The WQT calibration has been included in the Water Resources Planning Model (WRPM). This modelling system will be extended to cover the entire catchment and will be updated to include the latest mine, industrial and power station information and catchment data. The mine information has been updated for the reconciliation plan and will be extended to include the water quality components. The understanding of the sources of salt load gained during the waste discharge charge project will be included in the modelling. A nutrient balance will be developed for key areas of the study area. Key is the Loskop Dam catchment and the lower Olifants River passing through the Kruger National Park. In these areas nutrients have been identified as issues requiring management. The nutrient balance will be based on the available instream water quality information, point source and typical unit load runoff factors for urban and agricultural areas. In this way the major sources of nutrient loads will be identified and the nutrient balance model can be used to assess the effectiveness of the management options identified to achieve the WQPL. The concerns around assimilative capacity as well as the need for other water quality variables will be assessed.

The third step will involve identifying and developing proposed management measures and options that will improve the non-compliance cases and deteriorating trends and utilise the available assimilative capacity to the benefit of the water users and ensure the sustainability of the system.

It may be that existing management options are the right ones to follow, however that implementation and enforcement have not been done effectively. An overview of the current management options being applied as well as an assessment of their effectiveness and possible reason(s) for failure (including institutional arrangements) will be undertaken, after which the management options (existing or new) will be considered and will include options that could address the reasons for failure.

The key to the successful management of the water quality in the Olifants River System is the formulation of management measures that integrates all the relevant aspects that have a bearing on the water resources. This requires assessments of the physical, economic, social, institutional, statutory and ecological aspects in the system in order to understand the current situation and be in a position to find strategies (management options) that will be able to handle the existing as well as anticipated future challenges. Furthermore it is expected that the growing economy, in the Olifants River System, will intensify the pressures on the water quality of the resource and it is therefore necessary to find innovative measures that offers economical and sustainable management solutions.

The study team, in consultation with relevant stakeholders, will identify and screen possible management measures with the aim to find the most feasible options for implementation.

Once the feasible management options are identified and described, related monitoring requirements will be identified and described. A gap analysis will then be undertaken by comparing the needs with the existing monitoring network.

Sub-catchment IWQMPs will be developed for the six sub-catchments to address the localised WQ issues and achieve the WQPLs that have been set. These sub-catchment plans will address the thematic strategies that need to be developed and will be informed by the water resource management activities and initiatives already in place within a catchment area. The IWQMPs will take account of influences of cascading effects, neighbouring catchment dynamics and international requirements; and will be aligned to the overarching system IWQMP.

The Integrated Water Quality Management Plan is the main report from the study that will bring together all the information from the above tasks, into one document summarising the priority system WQ issues, presenting the recommended WQPLs, describing and motivating the recommended management options and implementation strategies and, finally, presenting the implementation and monitoring programme. An implementation programme will clearly indicate the short, medium and long term management activities that are required for implementation.

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LIST OF ACRONYMS

AMD	Acid Mine Drainage
COGTA	Co-operative Governance and Traditional Affairs
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
CSIR	Council for Scientific and Industrial Research
DMR	Department of Mineral Resources
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
GWP	Global Water Partnership
IWRM	Integrated Water Resources Management
IWQM	Integrated Water Quality Management
IWQMP	Integrated Water Quality Management Plan
IWULA	Integrated Water Use Licence Application
KNP	Kruger National Park
NWA	National Water Act
NWRS	National Water Resource Strategy
ORS	Olifants River System
PAC	Project Administrative Committee
PMC	Project Management Committee
PSC	Project Steering Committee
PSP	Professional Service Provider
RDM	Resource Directed Measures
RQOs	Resource Quality Objectives
RWQOs	Resource Water Quality Objectives
SA	South Africa

SALGA	South African Local Government Association
SAWQG	South African Water Quality Guidelines
TDS	Total Dissolved Salts
TOR	Terms of Reference
TWQR	Target Water Quality Range
WET	Whole Effluent Toxicity
WDCS	Waste Discharge Charge System
WHO	World Health Organisation
WMA	Water Management Area
WMI	Water Management Institution (relating in this report to the CMA)
WMS	Water Management System
WQM	Water Quality Management
WQP	Water Quality Planning
WQPL	Water Quality Planning Limit
WRPM	Water Resource Planning Model

PART 1: CONTEXT AND BACKGROUND TO THE STUDY

1. INTRODUCTION

South Africa as a water-constrained economy and several indicators distinguish it as one of the driest countries in the world with above average water consumption. However, many South Africans are not aware of the scarcity of water in the country and that if water is not well managed there will not be adequate supplies to meet all the demands (DWA, 2013).

The National Water Resource Strategy: *Water for an equitable and Sustainable Future*, June 2013, Second Edition, states that an adequate water supply of suitable quantity and quality makes a major contribution to economic and social development. In order to achieve this however, healthy water ecosystems are imperative to sustain the water resource, which, in turn, provide the goods and services on which communities depend (DWA, 2013). This indivisibility of water is a cornerstone of the National Water Policy, to the extent that water ecosystems are not seen as users of water in competition with other users, but as the base from which the resource is derived, without which, growth and development cannot be sustainable (DWA, 2013).

Chapter 3 of the The National Water Act (Act 36 of 1998) (NWA), prescribes the protection of the water resources through resource directed measures (RDM) and the classification of water resources. Together, these measures are intended to ensure the protection of the water resource as well as including measures for pollution prevention, remedying the effects of pollution while balancing with the need to use water as a factor of production to enable socio-economic growth and development.

However, even with this legislation in place, there has been a demonstrable deterioration in water quality across water resources. Water resources are facing ever increasing pressures from climate change, population growth, over utilization, poor land-use practices and subsequent pollution.

South Africans need to value water far more and use it more efficiently. This means that they need to recognise water as a valuable resource and invest in technologies and communications that will improve the way in which water is used and managed (DWA, 2013).

1.1 STRUCTURE OF THE REPORT

This report has been divided into four main parts:

- ***Part One***: Context and Background to the Study provides background to the study and the context of the task and the framework for the IWQMP study;

- ***Part Two***: Description of the Catchment Area deals with the characterisation of the study area, physical attributes, water resource systems, description of the current land use activities and development;
- ***Part Three***: Water Quality Status provides an assessment of the current water quality status of the Olifants River System; and
- ***Part Four***: Discussion and Conclusions provides discussion of the findings of the assessment, formulation and prioritisation of key water quality concerns, gaps and priorities for which management plans will need to be detailed.

1.2 GENERAL BACKGROUND

The Olifants River System (ORS) or the Olifants Water Management Area (WMA), comprising the Olifants, Letaba and Shingwedzi catchments, falls into the above water-constrained economy, being a highly utilised and regulated catchment. Its' water resources are becoming more stressed both from a water quantity and water quality point of view.

In this respect there is an urgency to ensure that water resources in the WMA are able to sustain their level of uses and be maintained at their desired states. The Department of Water and Sanitation (DWS) from a planning perspective has therefore identified the need to develop an overarching Integrated Water Quality Management Plan (IWQMP) for the Olifants WMA in order to manage the water resources across the WMA. The plan needs to take cognisance 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.

1.3 INTEGRATED WATER QUALITY MANAGEMENT PLAN STUDY DESCRIPTION

The main objective of the IWQMP study is to ultimately develop management measures to maintain and improve the water quality in the water resources of the Olifants WMA (as per the NWRS2) in a holistic and sustainable manner to ensure sustainable provision of water of an acceptable quality to local and international users.

The management measures will be of an overarching nature and will deal with the broader Olifants WMA while taking strategies and plans developed at sub-catchment level into account. The IWQMP will detail feasible management options for implementation in the short term (next 5 years), assess the medium term strategies (10 years) at the pre-feasibility level and longer term strategies at the reconnaissance level.

A further important deliverable from the study will be a set of integrated Water Quality Planning Limits (WQPLs) for the Olifants WMA and the individual sub-catchments that will include development of WQPLs, adjustments to the existing WQPLs and alignment to Resource Quality Objectives (RQOs).

The following key aspects will be undertaken as part of the study:

- Catchment assessment (this report);
- Development of Water Quality Planning Limits;
- Evaluation of Management Options;
- Sub-catchments integrated water quality management plans;
- Assessment and development of a Water Quality Monitoring Programme;
- Compilation of an overall IWQMP including the sub-catchment strategies; and
- A practical and detailed implementation plan.

The following aspects will also be fundamental to the study and will inform and support the IWQMP development during the study execution phase:

- Legal considerations that inform the IWQMP and its implementation (sub-catchment and overarching);
- External Drivers, Considerations and Influences to water quality and WQM: In the development of the IWQMP for the Olifants River System, the multi-dimensional facets to water quality and WQM, such as international and transboundary obligations, water quantity aspects, water resource planning priorities, resource directed measures (Classification, RQOs and the Reserve), ecosystems, water services related aspects, waste management, water resource economics and integrated water resources management, will be incorporated and considered;
- Integration of stakeholder issues and technical aspects; and
- Integration/ alignment with other processes/ initiatives.

1.4 SPATIAL EXTENT OF THE STUDY

The spatial extent of the study area is the Olifants Water Management Area, also referred to as the Olifants River System (Figure 1) and includes:

- Olifants River catchment: tertiary drainage regions B11, B12, B20, B31, B32, B41, B42, 52, B52, B60, B71, B72 and B73;
- Letaba River catchment: tertiary drainage regions B81, B82 and B83; and
- Shingwedzi River catchment: tertiary drainage region B90.

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) kilomteres 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).

The study area has been sub-divided into the following sub-catchments (Figure 2), details of which are discussed in Section 4 of this report:

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

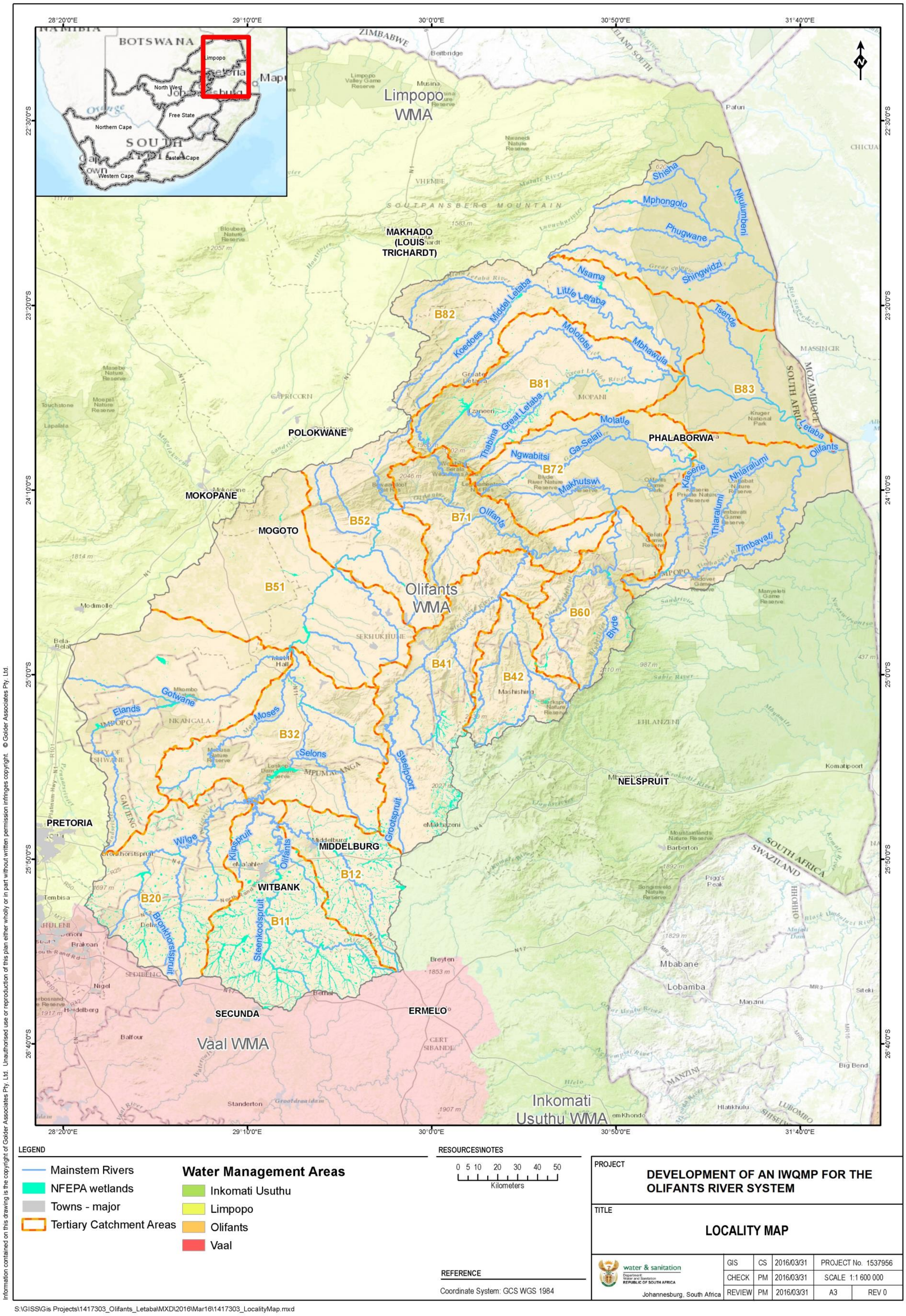

Figure 1: The study area: Olifants Water Management Area

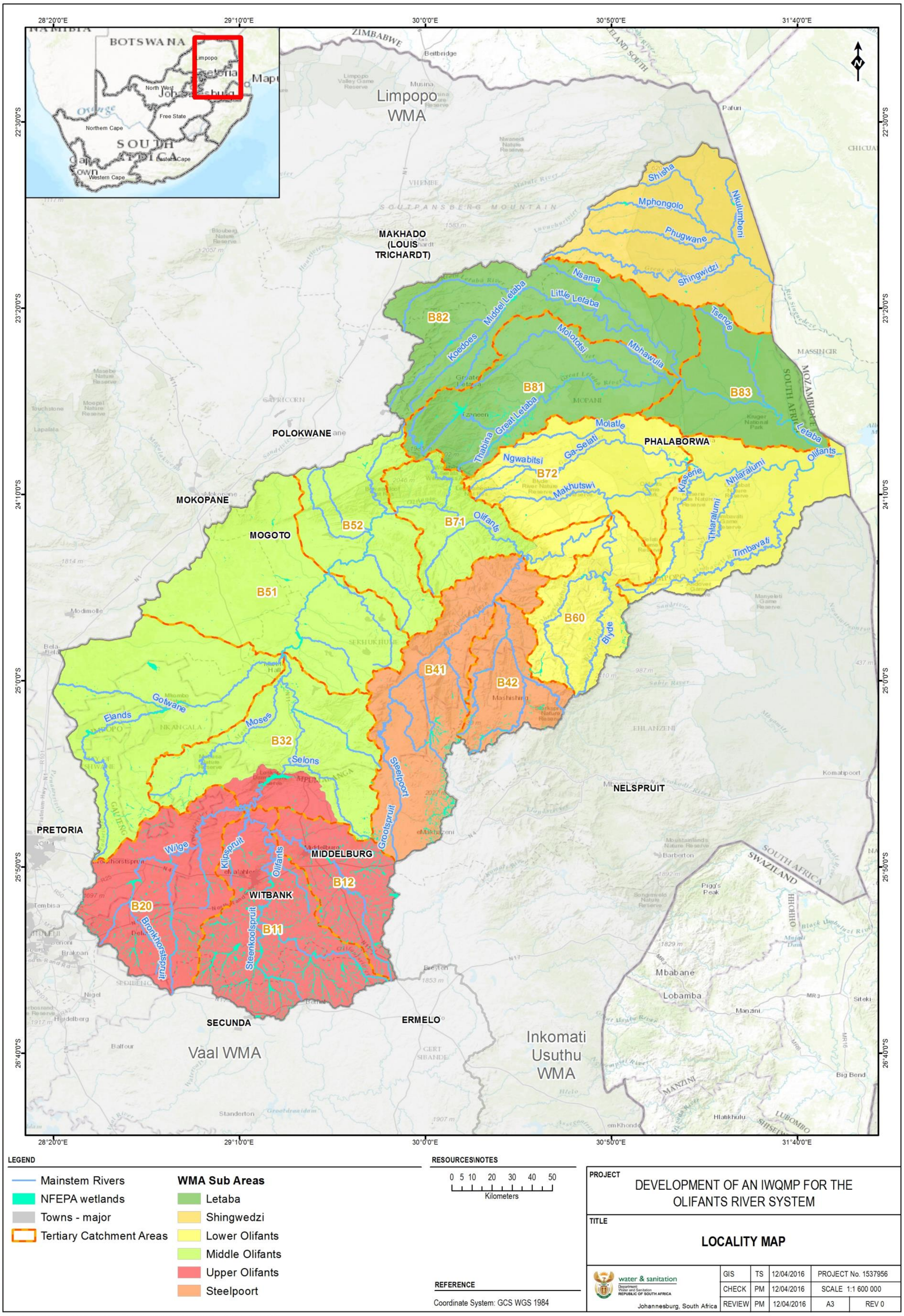

Figure 2: Sub-catchments in the study area

1.5 OBJECTIVES OF THE STATUS ASSESSMENT TASK

The purpose of this status assessment task is not to provide a state of the environment report but rather to determine the issues, gaps and priorities resulting from the environment/ development interaction in order to set a context for informed decision-making.

1.6 APPROACH ADOPTED

The approach adopted for this study is based on identifying the stakeholders' needs with respect to use of the water resource over and above these requirements. This will be attained by following an iterative and incremental process that answers four generic questions:

a. What are the goals for water quality management?

Establish *water quality planning limits (WQPL)* for use of the resource to meet the requirements of the users to use and to dispose of water containing waste, based on the fitness for use required for the particular use.

b. How must the loads to the water resource change to achieve the goals?

Determine *source management objectives* to meet these needs.

c. How will this be managed across the WMA?

Formulate a WMA-wide *water quality management framework-plan* that indicates the management priorities, requirements, CMS linkages, sectoral responsibilities and programme to achieve these objectives.

d. How, where, by whom and when will this be implemented?

Develop individual *water quality management implementation plans*, which may be source-, issue- or sector-specific, or even, multi-sectoral, to give effect to the water quality management framework-plan.

Data assessment

In respect of this water quality status assessment, the first step would be a high level analysis of the available information on the water quality and quantity situation in the Olifants River System. This will create a clear picture of the current situation regarding the salt and nutrient loads to the system and in doing so identify the water quality and quantity gaps as well as hot spots that will have an impact on the overarching management of the system.

Based on the gaps identified, once off field surveys will be undertaken to obtain water quality data. Both DWS and external sources of data, where available, will be used. Data requirements for the modelling tasks will be identified at this stage.

The catchment processes/ linkages between the changes in water quality, as related to specific drivers, will be explored and explained (including the linkages between the changes in water quality, changes in surface flow, ground water quality, surrounding geology, riparian and wetland habitat.

The reasons for the inconsistent capture of data on the Departments' Water Management System (WMS) will also be assessed as part of this phase

Key water quality concerns

The key water quality issues will be identified and prioritised. The key water quality management (WQM) issues will be categorised in terms of those that are of an overarching nature and affect the overall Olifants River System and issues that are localised and would be addressed in the sub-catchment catchment management plans. The identification of the water quality issues and their prioritisation will direct the formation of management options and assist in identifying options that could address more than one issue at the same time.

Assessment of existing management options

An overview of the current management options being applied as well as an assessment of their effectiveness and possible reason(s) for failure (root cause analysis) will be undertaken as part of the situation assessment and identify new approaches to achieve the intended objectives.

This will include an overview of the current institutional framework in place, covering both internal (DWS) and external organisations. This assessment will address mandates and functions and will indicate as far as possible where overlap or uncertainty exists.

The process will take account of international water agreements.

1.7 STAKEHOLDER ENGAGEMENT

The development of an IWQMP for the Olifants River System will require dedicated and ongoing communication with the broader public and, ongoing, targeted communication with identified directly affected stakeholders, influencers, decision-makers and thought leaders in the study area. The project has a number of components and currently, some stakeholders are involved in some of the components resulting in a lack of a holistic understanding of the project in its entirety and its strategic importance.

The Communication Action Plan is intended as an internal, living document that will be updated during the course of the project. Given the context of communication, this plan seeks to:

- Inform the broader public of the project and its connection to concurrent project-related aspects;
- Engage key stakeholders; and
- Through sound relationships with key stakeholders and satisfactory process communication, build trust and create understanding, as well as collaboration to ensure that the work towards the development of a pragmatic and implementable IWQMP.

A high-level view of current views and perceptions held by some key stakeholder groups are presented, namely local government, agriculture, mining and conservation and will need to be further unpacked during the course of the project.

Communication will comprise focussed engagement with key stakeholder groups and consultation with the broader body of stakeholders. Methods of communication will include keeping stakeholders informed by means of quarterly newsletters, collecting inputs by means of convening focus group meetings with key stakeholder groups, workshops with technical experts and public meetings as well as, presentations to forum meetings. One of the key deliverables will be a consultation report to present the stakeholder engagement process followed including a high-level evaluation of the consultation process.

The study team, DWS and key stakeholder committees' roles and responsibilities provide clear guidance in terms of project expectations.

Current experience and understanding of the context within which stakeholder engagement will take place, indicate that there is a need for consistent and well-coordinated, meaningful communication with key stakeholders and the broader public. People seem to have different versions of messages and lack understanding of the overall, strategic drivers for project implementation as well as the consequences should the project not be implemented against the set timeframes. Confusion seems to create collective misperceptions and feed negative expectations, all of which need to be managed through carefully structured conversation with the right stakeholders by the right project team members.

1.8 FUTURE TASKS

The next step in the project involves the definition, development, integration and balancing of water quality planning limits (WQPLs) that will maintain or improve the systems water quality, using as a point of departure the existing WQPLs (previously known as Resource Water Quality Objectives (RWQOs)) and RQOs. The second component will be to establish how the system complies with the WQPLs, which will be determined through analysis of available data and undertaking modelling of possible future scenarios. The analysis will show where non-compliance occurs and indicates areas with available assimilative capacity. This task will identify areas where particular attention will have to be given to the development of options in the management option analysis.

Key to the development of the plan is an understanding of the sources of pollution. This is best done through modelling. The WQT salinity model has been calibrated for sulphate and total dissolved solids (TDS) down to the Flag Boshielo Dam. The WQT calibration has been included in the Water Resources Planning Model (WRPM). This modelling system will be extended to cover the entire catchment and will be updated to include the latest mine, industrial and power station information and catchment data. The mine information has been updated for the reconciliation plan and will be extended to include the water quality components. The understanding of the sources of salt load gained during the waste discharge charge project will be included in the modelling. A nutrient balance will be developed for key areas of the study area. Key is the Loskop Dam catchment and the lower Olifants River passing through the Kruger National Park. In these areas nutrients have been identified as issues requiring management. The nutrient balance will be based on the available instream water quality information, point source and typical unit load runoff factors for urban and agricultural areas. In this way the major sources of nutrient loads will be identified and the nutrient balance model can be used to assess the effectiveness of the management options identified to achieve the WQPL. The concerns around assimilative capacity as well as the need for other water quality variables will be assessed.

The third step will involve identifying and developing proposed management measures and options that will improve the non-compliance cases and deteriorating trends and utilise the available assimilative capacity to the benefit of the water users and ensure the sustainability of the system.

It may be that existing management options are the right ones to follow, however that implementation and enforcement have not been done effectively. An overview of the current management options being applied as well as an assessment of their effectiveness and possible reason(s) for failure (including institutional arrangements) will be undertaken, after which the management options (existing or new) will be considered and will include options that could address the reasons for failure.

The key to the successful management of the water quality in the Olifants River System is the formulation of management measures that integrates all the relevant aspects that have a bearing on the water resources. This requires assessments of the physical, economic, social, institutional, statutory and ecological aspects in the system in order to understand the current situation and be in a position to find strategies (management options) that will be able to handle the existing as well as anticipated future challenges. 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 offers economical and sustainable management solutions.

The study team, in consultation with relevant stakeholders, will identify and screen possible management measures with the aim to find the most feasible options for implementation.

Once the feasible management options are identified and described, related monitoring requirements will be identified and described. A gap analysis will then be undertaken by comparing the needs with the existing monitoring network.

Sub-catchment IWQMPs will be developed for the six sub-catchments to address the localised WQ issues and achieve the WQPLs that have been set. These sub-catchment plans will address the thematic strategies that need to be developed and will be informed by the water resource management activities and initiatives already in place within a catchment area. The IWQMPs will take account of influences of cascading effects, neighbouring catchment dynamics and international requirements; and will be aligned to the overarching system IWQMP.

The Integrated Water Quality Management Plan is the main report from the study that will bring together all the information from the above tasks, into one document summarising the priority system WQ issues, presenting the recommended WQPLs, describing and motivating the recommended management options and implementation strategies and, finally, presenting the implementation and monitoring programme. An implementation programme will clearly indicate the short, medium and long term management activities that are required for implementation.

2. INTEGRATED WATER RESOURCES MANAGEMENT IN SOUTH AFRICA

An important milestones in the revision of the Water Law in South Africa was the publication of the ‘White Paper on a National Water Policy for South Africa’ which set out overarching policy principles regarding water resource management in South Africa. These were later taken up into the National Water Act (Act No. 36 of 1998) (NWA) where the need for the integrated management of all aspects of water resources is recognised and, where appropriate, the delegation of management functions to a regional or catchment level would enable broader stakeholders to participate in water resources management.

2.1 INTEGRATED WATER RESOURCES MANAGEMENT IN A CATCHMENT CONTEXT

The Global Water Partnership (GWP) defines IWRM as a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems

IWRM is therefore a cross-sectoral policy approach, designed to replace the traditional, fragmented sectoral approach to water resources and management that has often led to poor services and unsustainable water resources use. IWRM is based on the understanding that water resources are an integral component of the ecosystem, are a natural resource as well as a social and economic good.

IWRM therefore aims to strike a balance between the use of water resources for livelihoods and the conservation and protection of these resources to sustain their functions for future generations. In this respect IWRM is aimed at promoting the guiding principles of the NWA which include the sustainable and equitable use of water resources for the *optimum social and economic benefit* for the country.

As the water resource cannot be considered separately from the people who use it, a transparent and a participative approach to water resource management is extremely important.

2.1.1 Dimensions of IWRM

Water resource management at the catchment or regional level occurs within a highly integrated environment, where water quality, quantity and the aquatic ecosystem are all interlinked and interdependent. This integration is achieved at a national level by the National Water Resource Strategy (NWRS), and by Catchment Management Strategies (CMS) at a catchment or water management area (WMA) level. These strategies link together the management elements required by the water quality, water quantity and aquatic ecosystem components of the water resource into a coherent approach that aims to secure the beneficial, equitable and sustainable use of the water resource.

The fresh water resource in itself is a complex system comprising both e water quality and quantity of groundwater and surface water (rivers, springs, dams and wetlands); and considering the impacts of rainfall, runoff from the land, infiltration into the ground and evaporation from the surface back to the atmosphere. Each of these components must be managed with regard to its inter-relationships with the others.

In addition to the above elements, human activities such as land use for agriculture, mining and industry; waste disposal and air pollution can have major impacts on the quality of water, while the abstraction and storage of water and the discharge of waste into water resources can impact on the quality and quantity of the water resource. These interactions must also be addressed in the management of water resources.

Water must also be managed with a good understanding of its importance for social and economic development.

2.1.2 Framework for IWRM in South Africa

IWRM in South Africa is seen to be achieved through:

- The statutory framework provided by the NWA;
- The National Water Resource Strategy; and
- The Catchment Management Strategies (CMS) which according to the NWA, Chapter 2, Part 2 (Section 9) must:

a) *take into account the class of water resources and resource quality objectives contemplated in Chapter 3, the requirements of the Reserve and, where applicable, international obligations;*

b) *not be in conflict with the NWRS;*

c) *set out the strategies, objectives, plans, guidelines and procedures of the CMA for the protection, use, development, conservation, management and control of water resources within its WMA;*

d) *take into account the geology, demography, land use, climate, vegetation and waterworks within its WMA;*

e) *contain water allocation plans which are subject to S 23, and which must set out principles for allocating water, taking into account the factors mentioned in S 27(1);*

f) *take account of any relevant national or regional plans prepared in terms of any other law, including any development plan adopted in terms of the Water Services Act, 1997 (Act No. 108 of 1997);*

g) *enable the public to participate in managing the water resources within its water management area;*

h) *take into account the needs and expectations of existing and potential water users; and*

i) *set out the institutions to be established.*

The development of a CMS is therefore aligned with IWRM in that the approach considers not only the water resource but takes into consideration the broader aspects of land use, climate, vegetation and water uses as defined by Section 21 of the NWA, as well as the various institutions that may be responsible for managing these aspects. In other words the CMS is aimed at a sustainable balance between utilisation and protection of *all* natural resources in a catchment.

2.1.3 The National Water Resources Strategy

The purpose of the second edition of the National Water Resource Strategy (NWRS) is to ensure that national water resources are managed towards achieving South

Africa's growth, development and socio-economic priorities in an equitable and sustainable manner over the next five to 10 years (NWRS, June 2013, Second Edition).

The NWRS is the legal instrument for implementing or operationalising the NWA. It is thus binding on all authorities and institutions implementing the Act and is the primary mechanism to manage water across all sectors towards achieving national government's development objectives.

While there is a legislative requirement under the NWA to develop a NWRS, there is also a need to respond to new strategic drivers, challenges and priorities. The second edition of the Strategy (NWRS2) outlines the key challenges, constraints and opportunities in water resource management and proposes new approaches to be adopted in ensuring effective challenges, constraints and opportunities.

2.1.4 The Catchment Management Strategy

In South Africa, a vital component of IWRM is the progressive devolution of responsibility and authority over water resources to Catchment Management Agencies (CMAs) as described in Chapter 6 of the NWA. The scale of operation for the CMAs is that of Water Management Areas (WMAs). In terms of the National Water Resource Strategy (NWRS2), nine (9) WMAs (as opposed to the 19 WMAs in NWRS1 in 2004) have been delineated in South Africa (Figure 3). The change from 19 to nine WMAs was made based on an assessment undertaken on the viability of the envisaged 19 CMAs in respect of the availability and allocation of funding, capacity, skills and expertise for the water institutions. The nine CMAs are in various stages of establishment. The management of water resources is to be detailed in Catchment Management Strategies (CMS) that must be developed for each of the 9 WMAs.

As described in Section 2.1.2 a CMS is the framework for water resource management in a WMA and provides a clear approach and intent for managing water resources in the WMA. The CMS should be viewed as both a process and framework for management, which binds the Department and the CMA as well as the water users, stakeholders and their representative structures. The CMS can therefore be considered a business plan for IWRM in the WMA, which focuses on priority water resource management issues, and details specific activities, resources, responsibilities, timeframes and institutions required to address these priorities in an efficient and sustainable manner.

The NWRS provides a framework within which all CMSs will be prepared and implemented in a manner that is consistent throughout the country. In particular, in terms of section 9(b) of the NWA a CMS must not be in conflict with the NWRS. It is anticipated that insights and information gathered as part of the CMS development will inform the review of the NWRS (DWA, 2013)

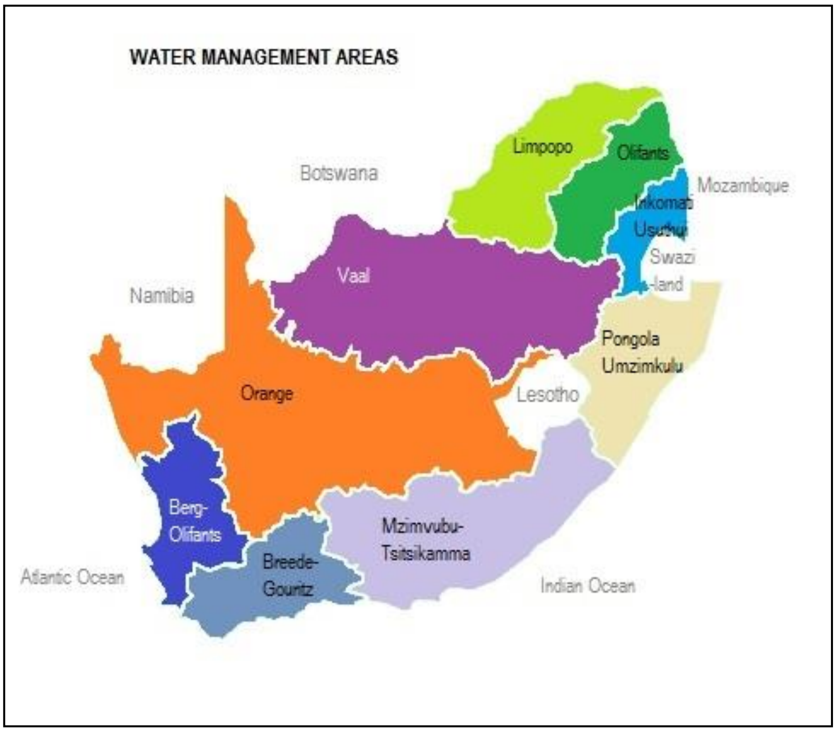

Figure 3: Water Management Areas in South Africa

2.1.5 Reconciliation Strategies

Reconciliation Strategies are developed by the Department, the overall objective of which is to meet legitimate current and future water requirements in the specific catchment being studied and its links to adjacent catchments. The sub-objectives of the development of a reconciliation strategy include the development of a water reconciliation strategy for the catchments' Water Supply System; and the implementation and maintenance of the water reconciliation strategy.

The reconciliation strategy is developed in order to:

- Address growing water demands as well as serious water quality problems experienced in the catchment that would affect water availability;
- Identify water resource management and development options;
- Provide reconciliation interventions – both structural and administrative/regulatory; and
- Facilitate communication and strengthen the partnership between DWS and key stakeholders.

2.2 THE CATCHMENT MANAGEMENT PROCESS

Catchment management requires a flexible approach in which different tasks/ activities need to be undertaken at different intervals (Figure 4). The catchment management process can in general include the following stages however these stages should not be confined to a given time period and are characterised as being ongoing, iterative and adaptive (WRC, 1998).

- *Initiation*: of the process, triggered by one or more water-environment related issues;
- *Assessment (Situation analysis)*: to gain understanding of the social, economic, technical and institutional environments governing the water-related issues;
- *Planning:* for catchment management in the area, which would result in a CMS. (based on the assessment reach consensus on institutional needs, water and land use management strategies, resource directed measures, social and economic concerns and considerations; responsibilities and actions, etc. which would lead to a vision for the catchment);
- *Implementation*: of the actions and procedures of the strategies specified in the CMS;
- *Administration*: of the catchment by the institutional structures in place in terms of managing and supporting the implementation measures instituted and maintaining stakeholder support.
- *Monitoring*: and processing of data and information collected in the catchment; and
- *Auditing*: of catchment management by periodically reassessing, re-planning, revising objectives and strategies, based on performance indicators, which would lead to regular review of the strategy.

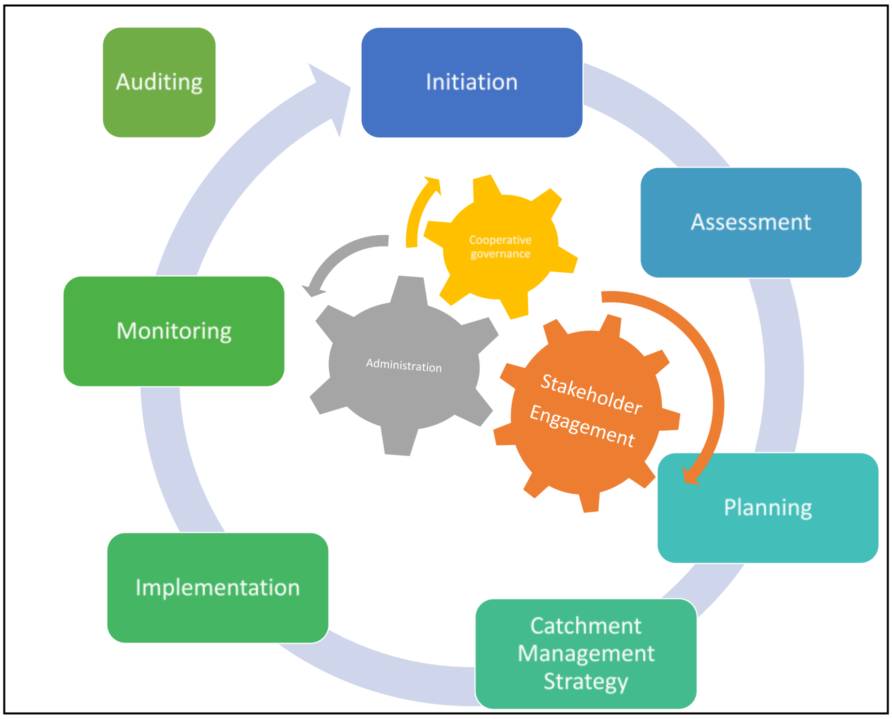

Figure 4: Catchment Management Process

Stakeholder engagement in catchment management are not clearly identified as stages of the process, as these form the backbone of all stages in the process. This is critical to the sustainability of catchment management as these components ensure the buy-in and ownership by the stakeholders.

3. DEVELOPMENT OF AN INTEGRATED WATER QUALITY MANAGEMENT STRATEGY (IWQMS)

The DWS, Directorate: Water Resource Planning Systems, is currently developing a strategy for integrated water quality management in South Africa. The outcomes of this project, while still in the development phase, will guide the development of the IWQMP for the Olifants River System.

In developing the IWQMS policy for South Africa, the project team has to date drafted a series of papers examining the current situation and international experiences. The papers are focused on a situation assessment of water quality and water quality management challenges in South Africa (DWS, 2016)*;* institutional arrangements for WQM in South Africa (DWS, 2015b); a review of water quality management instruments for South Africa (DWS, 2015c); South African policy and strategy for water quality management (DWS, 2015d); and lessons from international experiences on dealing with WQM (DWS, 2015d).

Key to the IWQMS project, water quality issues were graphically mapped on a continuum of severity of impacts against the level of knowledge and understanding. Based on the current knowledge and understanding and the potential impacts associated, five water quality issues were prioritised for water quality management: eutrophication, salinisation, sedimentation, acidification and urban pollution.

In addition, six "mega-trends" which, based on stakeholder engagement, knowledge experts in the field and ongoing research, have been identified and can be expected to unfold in South Africa during the next few decades. These may lead to new or accelerated water quality impacts in many locations across the country. These trends are: climate change; hydraulic fracturing; renewable energy; water-energy-food security nexus; growth of inadequately serviced densely populated settlements; and water re-use.

Economic Impact of Water Quality Challenges

The IWQMS project has also considered the economic impacts of water quality challenges. The need for this has stemmed from the fact that water pollution has direct, but insufficiently recognised, impacts on economic growth, job creation and the cost of doing business. The most obvious of these are impacts on livelihoods and productive sectors of the economy such as agriculture, tourism and industrial sectors. However, economic costs also originate from impacts of water pollution on a range of other areas including human health, ecosystems health, infrastructure, aesthetics and municipal services. The project discusses the economic costs related to each of the following areas:

- **Economic impacts related to livelihoods and productive sectors**: Productive sectors are directly affected through, for example, reduction in crop yields, loss of tourism, and increased requirements for pre-treatment of water.
- **Economic impacts related to municipal services**: Costs associated with treating affected water for potable/industrial use.
- **Economic impacts related to health of people**: Costs to the public and private health system from diseases related to polluted water.
- **Economic impacts related to ecology**: Costs related to change in ecology thus impacting on ecological services, as well as costs related to rehabilitation of polluted water.
- **Economic impacts related to infrastructure**: Costs related to corrosion of equipment and conveyance systems; costs related to clearing of waterways and drainage systems; costs related to storage capacity of impoundments. These costs accrue to both the private and public sectors.
- **Economic impacts related to aesthetics**: Costs related, for instance, to the depreciation of economic value of properties.

Another key aspect being considered in the IWQMS project is the reasons for why water quality management is failing, even though South Africa has excellent legislation. Several aspects have been highlighted that are contributing factors:

- Limited technical skills in government;
- Fragmented policies and implementation;
- Inadequate measures to counter adverse agricultural and silvicultural practices;
- Challenges in municipalities;
- Inadequate monitoring and assessment;
- Ineffective enforcement;
- Delay in the development of Catchment Management Strategies; and
- Limited financing for WQM initiatives.

The proposed policy for integrated water quality management is being developed under four headings which capture the key challenges and areas of focus required to address the current challenges. A summary of the policy principles being developed to inform the strategy under each of the four main challenges are set out in Table 1.

Table 1: Challenges and related policy principles

Key challenge	Policy principle	Notes
Water quality is a developmental issue	***Water quality is a development issue***	In addressing the management of water quality, the economic, social and environmental impacts of deteriorating water quality must be considered.
	Government-wide water quality management	It is the Constitutional duty of all spheres of government to protect the quality of water in our water resources
	Subsidiarity and accountability	Water quality should be managed at the lowest appropriate level and the institutions responsible for managing water quality must be held accountable
	Partnerships	In order to manage water quality effectively, partnerships should be developed between government, the private sector and civil society
Integrated water quality regulation and management	***Transboundary Water Quality Management***	Water pollution is a transboundary water management problem and must be managed within the SADC Protocol of Shared Watercourses
	An integrated	An integrated resource, remediation and

Key challenge	Policy principle	Notes
	approach	source directed approach which manages the water resources system as a whole at catchment or sub-catchment scale will be adopted
	Differentiated, risk-based approach	A differentiated risk-based approach to regulation should be adopted based on the magnitude of potential impacts
	Hierarchy of approaches	Water pollution management should follow the hierarchy of prevention, minimization and re-use, including adopting the precautionary approach
	Green/ ecological infrastructure and restoration and rehabilitation	Rehabilitation and restoration of catchments should be pursued, including the use of green /ecological infrastructure
Financing integrated water quality management	***Partnerships***	In order to manage water quality effectively, partnerships should be developed between government, the private sector and civil society
	Broadened funding mechanisms	The mechanisms for funding water quality management should be broadened (that is, outside of DWS), given that water quality is impacted on by, and impacts on, many different sectors, and recognising the developmental impact of declining water quality
	Polluter pays	The costs of remedying pollution, degradation of resource quality and consequent adverse health effects, and of preventing, minimising or controlling pollution is the responsibility of the polluter
	Regulatory Framework and Administrative Penalties	The Department of Water and Sanitation will set up a regulatory framework for water pollution offences, including a system of tough administrative penalties
Knowledge and information management	***Collection, use and protection of data***	Data on water quality must be standardised, collected, managed, protected and used as a strategic asset for monitoring, management and research purposes, in an integrated, national monitoring framework
	Publicly available information	Information and data on water quality and waste discharges must be available in the

Key challenge	Policy principle	Notes
		public domain

4. WATER RESOURCE MANAGEMENT STUDIES IN THE OLIFANTS RIVER SYSTEM

In terms of the NWA and in line with the Department's obligation to ensure that the country's water resources are fit for use on an equitable and sustainable basis, it has adopted the approach of the progressive development and implementation of CMSs, as described in Section 2, to fulfil this mandate. Each CMA is responsible for the progressive development of a CMS for its respective WMA that is developed in consultation with stakeholders within the area.

The Olifants WMA is a region where the CMA has not yet been established, however a WMI is in place. With support from the Mpumalanga and Limpopo Regional and National DWS Offices, the Olifants WMI will continue manage the water resources in the WMA.

In terms of meeting the NWA obligations the Department has initiated the development of management strategies for the various WMAs within South Africa in an attempt to provide the framework and constraints within which the water resources will be managed into the foreseeable future. These various strategies and plans have arisen out of the ISP development process which has identified the relevant water resource management issues and concerns in each of the WMAs.

There are a number of water resource studies and data that have been and are being undertaken in the Olifants WMA that will support the development of the IWQMP and ultimately the CMS. These include:

- The Reconciliation Strategy for the Olifants catchment where the existing Water Resources Yield/ Planning Model (WRYM/ WRPM) will be used to undertake the operational scenario analysis for the quantity component taking into account the water quality component in the form of the WQT model;
- The latest available hydrology from the reconciliation plan studies will be used without any re-calibration or simulation. The simulated present day flows and scenario flows from the WRYM/ WRPM will be used for the water quality assessment. se
- The existing DWS water quality database; *i.e*. DWS Water Management System will be used as the primary source of water quality data. However, wherever available, other external sources of water quality data will be used. Once off water quality samples will be taken at various sites where data is lacking at the identified priority sites.
- Groundwater

  - Baseline groundwater data is available from the National Groundwater Archive (NGA), time series related data (water levels and quality) is available from Hydstra and the Water System Management platform and time series groundwater quality from the CHART system;
  - Several DWS reports of the groundwater potential and availability (for example, the Northern Springbok Flats, the Wolkberg Dolomites, and the Gabbro-Norite Complexes) are available for reference;
  - Recent studies of the area, focussing on implementation of groundwater management protocols (e.g. monitoring programmes) are available for the northern parts of the Olifants/ Letaba System.
- Data sources to be used will include the following:
  - Existing information from preliminary Reserve Studies and Water Resource Classification and RQOs determination information for the Olifants and Letaba Catchments;
  - Relevant scientific papers on the Shingwedzi catchment area;
  - The Water Resource Planning Model (WRPM) and the Water Resources Yield Model (WRYM) for the Olifants and Letaba systems (DWS, Directorate National Water Resource Planning)
  - Water demand and requirement projections from parallel studies (Reconciliation plan studies, Directorate National Water Resource Planning);
  - Groundwater data will be collated from the 2014 WARMS dataset, groundwater monitoring data (especially the updated Kruger National Park's programme) and recent groundwater investigations (reports on significant aquifer systems in the Olifants/ Letaba System). Data and information collated during two previous Reserve related studies in the former Olifants and Letaba/ Luvuvhu WMA will be used as baseline criteria (WSM, 2006 and SRK, 2009).
  - Letaba Catchment Reserve Determination Study, Wetland Scoping Report Final February 2006.
  - Wetland inventory and classification. In: Ecological and economic evaluation of wetlands in the upper Olifants River catchment Water Research Commission Report No. 1162/1/02.
  - Supporting better decision-making around coal mining in the Mpumalanga Highveld through the development of mapping tools and refinement of spatial data on wetlands. Water Research Commission Report No TT 614/14, 2015.
  - Bio-monitoring data sources including the River Health Monitoring Programme data; Kruger National Park monitoring data and the River Ecosystem Monitoring Program (REMP) data (Mpumalanga Nature Conservation)
  - Technical Report for the National Freshwater Ecosystem Priority Areas Project. Water Research Commission (WRC) Report No. 1801/1/11, 2011

- CSIR, Natural Resources and the Environment. Risk Assessment of Pollution in Surface Waters of the Upper Olifants River System: Implications for Aquatic Ecosystem Health and the Health of Human Users of Water. Report to the Olifants River Forum. March 2011. CSIR/NRE/WR/IR/2011/0041/B
- MOSA, October 2014. Draft document entitled: Planning and Decision Support Tools for Integrated Water Resources Management

For parallel studies, ongoing liaison will be maintained with other study teams to ensure transfer of information, data and reports occurs. This is especially important for the Water Quality Management Strategy study being undertaken by Pegasys on behalf of DWS and interim results from the Waste Discharge Charge System project, as well as projects being undertaken by other organisations such as The Association for Water and Rural Development (AWARD) and the Water Research Commission (WRC).

4.1 RECONCILIATION STUDIES

4.1.1 Olifants Reconciliation Strategy

The Olifants Reconciliation Strategy Study was completed in 2012. The study recommended the most cost effective interventions to reconcile the growing water requirements and possible supply augmentation options. Once the Strategy was developed, it needed to be implemented to ensure sustainable water use in the water supply system. 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.

4.1.2 Letaba Reconciliation Strategy

The Letaba Reconciliation Strategy (including the Luvuvhu, Shingwedzi and Mutale catchments) was completed in September 2014. The Reconciliation Strategy incorporated approved water resource development projects such as the Groot Letaba Water Development Project (GLeWaP), which is a key initiative by the DWA to support the social and economic development strategy for the Limpopo Province.

4.2 OLIFANTS RIVER WATER RESOURCES DEVELOPMENT PLAN

The purpose of the ongoing Olifants River Water Resources Development Project (ORWRDP) is to supply the needs for water (both domestic and mining) in the middle part of the Olifants River catchment, and the adjacent Mogalakwena and Polokwane Municipal areas. The 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:

- *Phase 1* involves the raising of the Flag Boshielo Dam on the Olifants River by 5 m (ORWRDP-1) which was completed in 2005; 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 catchment (ORWRDP-2).

The project faces a number of challenges as a result of changing water requirements and difficulty to reconcile these new water requirements with the available water resources. A substantial portion of the mining water requirements have also shifted from the Sekhukhune District Municipality (DM) area to the Mogalakwena Local Municipality (LM) area since the start of the project. The configuration of the project infrastructure required changes and augmentation to water resources which needed to be investigated. It was therefore decided to do a technical review of the planning and design work done so far and where necessary recommend changes in a Technical Review Report that would be used to inform the due diligence process embarked upon by the National Treasury (NT) to consider issuing an explicit guarantee by government or fiscal funding. The current RID report will also be revised to accommodate the changes.

To date, the ORWRDP has linked closely with the Olifants Reconciliation Strategy update and all information used has been consistent between the two studies. The infrastructure capacities as determined by the ORWRDP have been included into the WRPM for various scenarios analysed.

4.3 RESOURCE DIRECTED MEASURES

Studies for the determination of the Reserve, Management Classes and the Resource Quality Objectives (RQO) have all been undertaken. The initial Reserve however was undertaken in 2001 and is currently being revised. A summary of the results for each of the studies is included in the sections to follow.

Appendix A includes a summary of the various river stretches and EWR sites, and an attempt has been made to score the water quality issues (from the desktop PES/EI/ES study) from 0 – 5, where 4 and 5 are serious and critical respectively.

4.3.1 Reserve determinations

The preliminary Reserve determination for the Olifants system was undertaken in 2001, nine years prior to the water resource classification, and for the Letaba system in 2006. A review of the Reserve is therefore required to ensure that it is in accordance with the water resource classes (determined in 2011) and is applicable to the current system needs and demands.

The Chief Directorate: Water Ecosystems therefore initiated the study ‘Determination, Review and Implementation of the Reserve in the ORS, in 2015.

The purpose of the study is to determine, review and implement the Reserve in the ORS; with the aim of specifically addressing ecological gaps and reviewing and updating the preliminary Reserves that were determined.

The proposed management classes and Resource Quality Objectives (RQOs) have been published for public comment by Government Notice (Government Gazette No 37999, 19 September 2014, GN 819 of 2014) and once approved by the Minister of Water and Sanitation, will be gazetted and thereafter implemented. This Reserve study will focus on:

- Addressing ecological gaps at identified priority sites that have not been addressed by preliminary Reserve determination studies but require a degree of ecological protection afforded by a Reserve;
- Addressing the ecological gaps at identified priority Ecological Water Requirement (EWR) sites that require an update of existing information;
- Protection requirements, water quality measures and ecological specifications of identified priority wetlands within the system;
- Updating the water quality component of the Reserve at the EWR sites and setting ecological specifications. In addition at strategic sub-catchments ecological water quality requirements will be specified to ensure that the water quality ecospecs at the EWR sites through the system can be achieved;
- Identify the priority groundwater resources and systems and define appropriate protection requirements;
- Assessing the operational scenarios as part of the implementation component to determine the EWRs and basic human needs (BHN) that are required and that can be met;
- Taking cognisance of the reconciliation study that was recently being completed by the Department and is currently being implemented for the ORS system, especially during the formulation of a management/ implementation plan for the Reserve; and
- Formulation of a water resource management plan as the final study output that will serve to guide the Department in operationalising Resource Directed Measures (RDM) in the ORS, thereby moving towards improving the state of the water resources within this system.

The outcomes of the Reserve are therefore closely linked to the IWQMP for the ORS and collaboration with the Reserve Team is important and will take place.

4.3.2 Classification

Olifants classification

The classification of the significant water resources in the Olifants Water Management Area (WMA) was undertaken in 2010 in accordance with the Water Resource Classification System (WRCS).

Classification of water resources aims to ensure that a balance is reached between the need to protect and sustain water resources on one hand and the need to develop and use them on the other. The ultimate goal of the classification process is the implementation of the WRCS which has as its final product the selection of one of three Management Classes (MCs) for the 13 Integrated Units of Analysis (IUAs) that were identified in the Olifants WMA.

The purpose of the MC is to establish clear goals relating to the quantity and quality of the relevant water resource, and conversely, the degree to which it can be utilised by considering the economic, social and ecological goals from an integrated water resource management perspective.

The WRCS places the following principles at the forefront of implementation:

(1) Maximising economic returns from the use of water resources;

(2) Allocating and distributing the costs and benefits of utilising the water resource fairly; and

(3) Promoting the sustainable use of water resources to meet social and economic goals without detrimentally impacting on the ecological integrity of the water resource.

The proposed MCs for each of the Integrated Units of Analysis are shown in

Figure **5**.

Letaba classification

Classification of significant water resources and the determination of Resource Quality Objectives for the Letaba sub-catchment was undertaken in 2013 and gazetted for comment in Government Gazette No 39614, 22 January 2016 (GN 54).

The proposed MCs for each of the Integrated Units of Analysis are shown in

Figure **5**.

Shingwedzi classification

The Shingwedzi catchment (B90) has not been classified and a preliminary Reserve determination has not yet been undertaken for the water resources in this catchment. A preliminary Reserve and ecological specifications for identified sites will be determined as part of the Olifants/ Letaba Reserve update study currently being undertaken by the DWS.

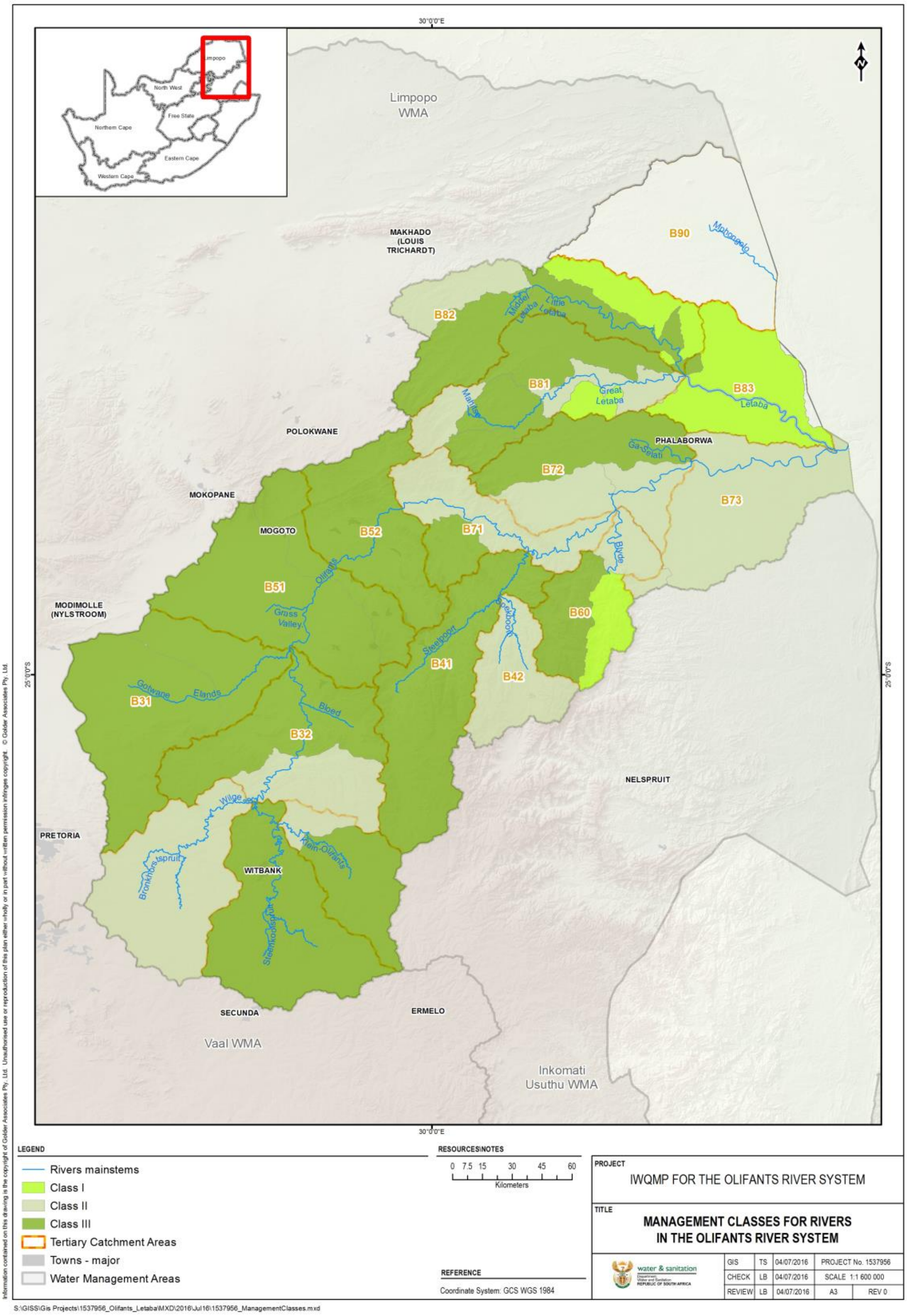

Figure 5: Management Classes for the Olifants River System

4.3.3 Resource Quality Objectives

Olifants River catchment

The Resource Quality Objectives (RQOs) determination procedures for the 'old' Olifants Water Management Area (WMA) involved the application of the seven step framework established by the then Department of Water Affairs in 2011. The area excluded the Letaba and Shingwedzi catchments.

The procedural steps established for this case study to determine RQOs for rivers, groundwater, dams and wetland resources in the WMA included:

- Delineating the Integrated Units of Analyses (IUAs) and Resource Units (RUs);
- Establishing a vision for the catchment and key elements for the IUAs;
- Prioritising and selecting RUs and ecosystems for RQO determination;
- Prioritising sub-components for RQO determination, selecting indicators for monitoring and proposing the direction of change;
- Developing draft RQOs and NLs;
- Agreeing on Resource Units, RQOs and Numerical Limits with stakeholders; and
- Finalising and Gazetting the RQOs.

The components and sub-components for which RQOs and NLs were provided include:

- Quality components including low and high flow sub-components;
- Quantity components including nutrients, salts, system variables, toxicants and pathogen subcomponents;
- Habitat components including instream and riparian habitat sub-components; and
- Biota components including fish, plants, mammals, birds, amphibians and reptiles, periphyton, invertebrates and diatom sub-components.

Through this step a total of 494 RQOs were determined for the Olifants WMA:

- A total of 212 RQOs were determined for river resources;
- A total of 80 RQOs were determined for wetlands resources;
- A total of 69 RQOs were determined for dam resources; and
- A total of 133 RQOs were determined for groundwater resources.

A summary of the water quality related RQOs is included in Table 2, Table 3 and Table 4 and where the limits included refer to the upper boundary except for pH where both lower and upper boundaries are included. The points are illustrated in Figure 6.

Table 2: Water Quality RQOs for catchments in the Upper Olifants sub-catchment

Variable	Units	Olifants B11 G; B11J (upper portion)	Olifants B11J	Olifants B11L	Klip-spruit B11K/L	Wilge B20J	Klein Olifants B12E
Chloride (Cl)	mg/L						
TDS	mg/L						
EC	mS/m	111		55	111		85
SO_4	mg/L	500		80	500	200	200
pH	units						
Phosphate	mg/L P	0.125	0.125	0.015	0.125		
Nitrate-Nitrite	mg/L N	4	4	0.7			
TIN	mg/L						
Ammonia	mg/L N	0.1	0.1				
Chl-*a* phytoplankton	µg/l						
Akalinity	mg/L ($CaCO_3$)	60			60		
Turbidity	NTU	10					
Dissolved oxygen	mg/L	6.5			6.5		
Temperature					≤abs (dev from ambient) 4.0		
Suspended Solids	mg/L						
F	mg/L	3			3	2.5	
Al	mg/L	0.15			0.15	0.105	
As	mg/L	0.13			0.13	0.095	
Cd(hard)	ug/l	5			5	3	
Cr (VI)	ug/l	200			200	121	
Cu hard	ug/l	8			8	6	
Hg	ug/l	1.7			1.7	0.97	
Mn	mg/L	1.3			1.3	0.99	
Pb hard	ug/l	13			13	9.5	
Se	mg/L	0.03			0.03	0.022	
Zn	ug/l	36			36	25.2	
Chlorine	ug/l	5.0 free Cl			5.0 free Cl	3.1 free Cl	
Endosulfan	ug/l	0.2			0.2	0.13	
Atrazine	ug/l	100			100	78.5	
Pathogens	counts/ 100ml *E. coli*					130	

Table 3: Water quality RQOs set for the Middle and Lower Olifants and Steelpoort sub-catchments

Variable	**Units**	**Elands (outlet of quat, confluence with Olifants) 31J**	**Olifants B32C Bottom of quat, outlet)**	**Olifants 32H (outlet of quat). Included Moses and Mametse (32G and 32H)**	**Steelpoort confluence with Olifants B41K**	**Spekboom B42H**	**Ohrigstad and tributaries (B60E, B60F, B60H)**	**Ga-Selati (B72K) outlet and EWR site 14b**	**Olifants EWR site13 B72D**
Chloride (Cl)	mg/L								
TDS	mg/L								
EC	mS/m		111					111	
SO4	mg/L		500					500	
pH	units								
Phosphate	mg/L P				0.125		0.125		
Nitrate-Nitrite	mg/L N						4		
TIN	mg/L								
Ammonia	mg/L N								
Chl-*a* phytoplankton	ug/l								
Akalinity	mg/L ($CaCO_3$)		60					60	
Turbidity	NTU							10	
Dissolved oxygen	mg/L		6.5					6.5	
Temperature			≤abs (dev from ambient) 4.0					≤abs (dev from ambient) 4.0	
Suspended Solids	mg/L							50	25
F	mg/L		3		2	3		2.5	
Al	mg/L		0.15		0.063	0.15		0.105	
As	mg/L		0.13		0.058	0.13		0.095	
Cd (hard)	ug/l		5		1.6	5		3	
Cr (VI)	ug/l		200		68	200		121	
Cu hard	ug/l		8		4.9	8		6	

Variable	**Units**	**Elands (outlet of quat, confluence with Olifants) 31J**	**Olifants B32C Bottom of quat, outlet)**	**Olifants 32H (outlet of quat). Included Moses and Mametse (32G and 32H)**	**Steelpoort confluence with Olifants B41K**	**Spekboom B42H**	**Ohrigstad and tributaries (B60E, B60F, B60H)**	**Ga-Selati (B72K) outlet and EWR site 14b**	**Olifants EWR site13 B72D**
Hg	ug/l		1.7		0.53	1.7		0.97	
Mn	mg/L		1.3		0.68	1.3		0.99	
Pb (hard)	ug/l		13		5.8	13		9.5	
Se	mg/L		0.03		0.013	0.03		0.022	
Zn	ug/l		36		14.4	36		25.2	
Chlorine	ug/l		5 free Cl		1.8 free Cl	5 free Cl		3.1 free Cl	
Endosulfan	ug/l		0.2		0.08	0.2		0.13	
Atrazine	ug/l		100		48.8	100		78.5	
Pathogens	counts/ 100ml *E. coli*	130		130					

Table 4: Water quality RQOs for the major dams in the Olifants catchment (excludes Letaba and Shingwedzi)

Variable	**Units**	**Witbank Dam**	**Bronk-horst-spruit Dam**	**Doorn-poort Dam**	**Losko p Dam**	**Rust De Winter Dam**	**Flag Boshie lo Dam**	**Tontel-doos Dam**	**Vlug-kraal Dam**	**Buffels -kloof Dam**	**Ohrig-stad Dam**	**Middel -burg Dam**	**Mkho mbo Dam**
Chloride (Cl)	mg/L												
TDS	mg/L												
EC	mS/m	85		85	85		85			85		85	
SO4	mg/L	200		200	200		200			200		200	
pH	units	5.9-8.8		5.9-8.8								5.9-8.8	5.9-8.8
Phosphate	mg/L P	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Nitrate-Nitrite	mg/L N												
TIN	mg/L	1	1	1	1	1	1	1	1	1	1	1	1

Variable	Units	Witbank Dam	Bronkhorstspruit Dam	Doornpoort Dam	Loskop Dam	Rust De Winter Dam	Flag Boshielo Dam	Tonteldoos Dam	Vlugkraal Dam	Buffelskloof Dam	Ohrigstad Dam	Middelburg Dam	Mkhombo Dam
Ammonia	mg/L N												
Chl-*a* phytoplankton	ug/l	20	20	20	20	20	20	20	20			20	20
Akalinity	mg/L (CaCO)												
Turbidity	NTU												
Dissolved oxygen	mg/L												
Temperature													
Suspended Solids	mg/L												
F	mg/L	2.5			2.5								
Al	mg/L	0.105			0.105								
As	mg/L	0.095			0.095								
Cd(hard)	ug/l	3			3								
Cr (VI)	ug/l	121			121								
Cu hard	ug/l	6			6								
Hg	ug/l	0.97			0.97								
Mn	mg/L	0.99			0.99								
Pb hard	ug/l	9.5			9.5								
Se	mg/L	0.022			0.022								
Zn	ug/l	25.2			25.2								
Chlorine	ug/l	3.1 free Cl			3.1 free Cl								
Endosulfan	ug/l												
Atrazine	ug/l												
Pathogens	counts/100ml *E. coli*												

Letaba sub-catchment

The draft water quality related RQOs for the Letaba sub-catchment (as gazetted flor comment in Government Gazette 39614, GN 54, 22 January 2016) are set out in Table 5.

Table 5: Water Quality RQOs set for Letaba sub-catchment areas

Catchment Area/ site	**Water quality parameter**
Letaba River, B81B-00264; B81B-00247	***Water quality RQOs immediately applicable.***
	Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than 0.015 mg/L PO4-P (Aquatic ecosystems: driver).
	Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the Target Water Quality Range (TWQR) for toxics.
Letsitele River, B81D-00271	***Water quality RQOs immediately applicable.*** • Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than or equal to 0.025 mg/L PO4-P (Agriculture - irrigation: driver). • Ensure that electrical conductivity (salt) levels are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver). • Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics.
	Phase 1: Select an instream monitoring point and develop a baseline of data for faecal coliforms and E. coli. ***Phase 2: Water quality RQOs become applicable once a database of information has been produced.*** Meet faecal coliform and *E.coli* targets for recreational (full contact) use: Meet the TWQR of 0-130 counts per 100 ml (DWAF, 1996a).
Letaba River, B81F-00200; B81C-00245; B81E-00244; B81F-00212; B81F-00215; B81F-00218; B81F-00231	***Ortho-phosphate RQO immediately applicable, i.e. before implementation of Nwamitwa Dam.*** Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.025 mg/L PO4-P. ***Ortho-phosphate RQO applicable after implementation of Nwamitwa Dam.*** Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.015 mg/L PO4-P (Aquatic ecosystems: driver).
	Electrical Conductivity RQO immediately applicable, i.e. before implementation of Nwamitwa Dam. Ensure that electrical conductivity (salt) levels are within Acceptable limits: 95th percentile of the data must be less than or equal to 55 mS/m,

Catchment Area/ site	Water quality parameter
	Electrical conductivity (salt) RQO applicable after implementation of Nwamitwa Dam. Ensure that electrical conductivity (salt) levels are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Industry Cat 3: driver)
	pH RQO is immediately applicable. Ensure that pH stays within Ideal limits: 5th and 95th percentiles of pH data must be between 6.5 and 8.0 (Aquatic ecosystems: driver).
	Toxics RQOs are immediately applicable. Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics.
Letaba River, B81J-00219; B81J-00209	***Water quality RQOs immediately applicable.*** • Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.025 mg/L PO4-P (Aquatic ecosystems: driver). • Ensure that electrical conductivity (salt) levels are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Industry Cat 3: driver). • Ensure that pH stays within Acceptable limits: 5th and 95th percentiles of pH data must be between 6.5 and 8.4 (Industry Cat 3: driver). • Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics.
	Phase 1: Select an instream monitoring point and develop a baseline of data for turbidity. ***Phase 2: Turbidity RQO becomes applicable once a database of information has been produced.*** Ensure that turbidity or clarity levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).
Klein Letaba River, B82G-00135 up to Giyani	***Ortho-phosphate RQO immediately applicable, i.e. before the*** ***implementation of water resource developments in the Klein Letaba*** ***River.*** Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P. ***Ortho-phosphate RQO applicable after the implementation of water resource developments in the Klein Letaba River.***

Catchment Area/ site	**Water quality parameter**
	Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than or equal to 0.075 mg/L PO_4-P (Aquatic ecosystems: driver).
	Phase 1: Select an instream monitoring point and develop a baseline of data for faecal coliforms and E. coli. ***Phase 2: Water quality RQOs become applicable once a database of information has been produced.*** Meet faecal coliform and *E. coli* targets for recreational (full contact) use: Meet the TWQR of 0-130 counts per 100 ml (DWAF, 1996a).
	Phase 1: Select an instream monitoring point and develop a baseline of data for turbidity. ***Phase 2: Turbidity RQO becomes applicable once a database of information has been produced.*** Ensure that turbidity or clarity levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff events. (Aquatic ecosystems: driver).
	Toxics RQOs immediately applicable. Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics
Water quality: Downstream Giyani	***Ortho-phosphate RQO immediately applicable.*** Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than or equal to 0.125 mg/L PO_4-P (Aquatic ecosystems: driver).
	Electrical conductivity (salt) RQO immediately applicable. Ensure that electrical conductivity (salt) levels are within Acceptable limits: 95th percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver). ***Phase 1: Select an instream monitoring point and develop a baseline of data for faecal coliforms and E. coli.*** ***Phase 2: Water quality RQOs become applicable once a database of information has been produced.*** Meet faecal coliform and *E. coli* targets for recreational (full contact) use: Meet the TWQR of 0-130 counts per 100 ml (DWAF, 1996a).
	Phase 1: Select an instream monitoring point and develop a baseline of data for turbidity. ***Phase 2: Turbidity RQO becomes applicable once a database of information has been produced.*** Ensure that turbidity or clarity levels stay within Acceptable limits: A moderate

Catchment Area/ site	Water quality parameter
	change from present with temporary high sediment loads and turbidity during runoff events. (Aquatic ecosystems: driver). ***Toxics RQOs immediately applicable.*** Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics.
Letaba River, B83D-00255; B83A-00220; B83A-00230; B83A-00235; B83A-00252; B83D-00250; B83E-00265	***Water quality RQOs immediately applicable.*** • Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (Aquatic ecosystems: driver). • Ensure that electrical conductivity (salt) levels are within Acceptable limits: 95th percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver). • Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics.
	Phase 1: Select an instream monitoring point and develop a baseline of data for turbidity. ***Phase 2: Turbidity RQO become applicable once a database of information has been produced.*** Ensure that turbidity or clarity levels stay within Ideal limits: A small change from natural state (Aquatic ecosystems: driver).

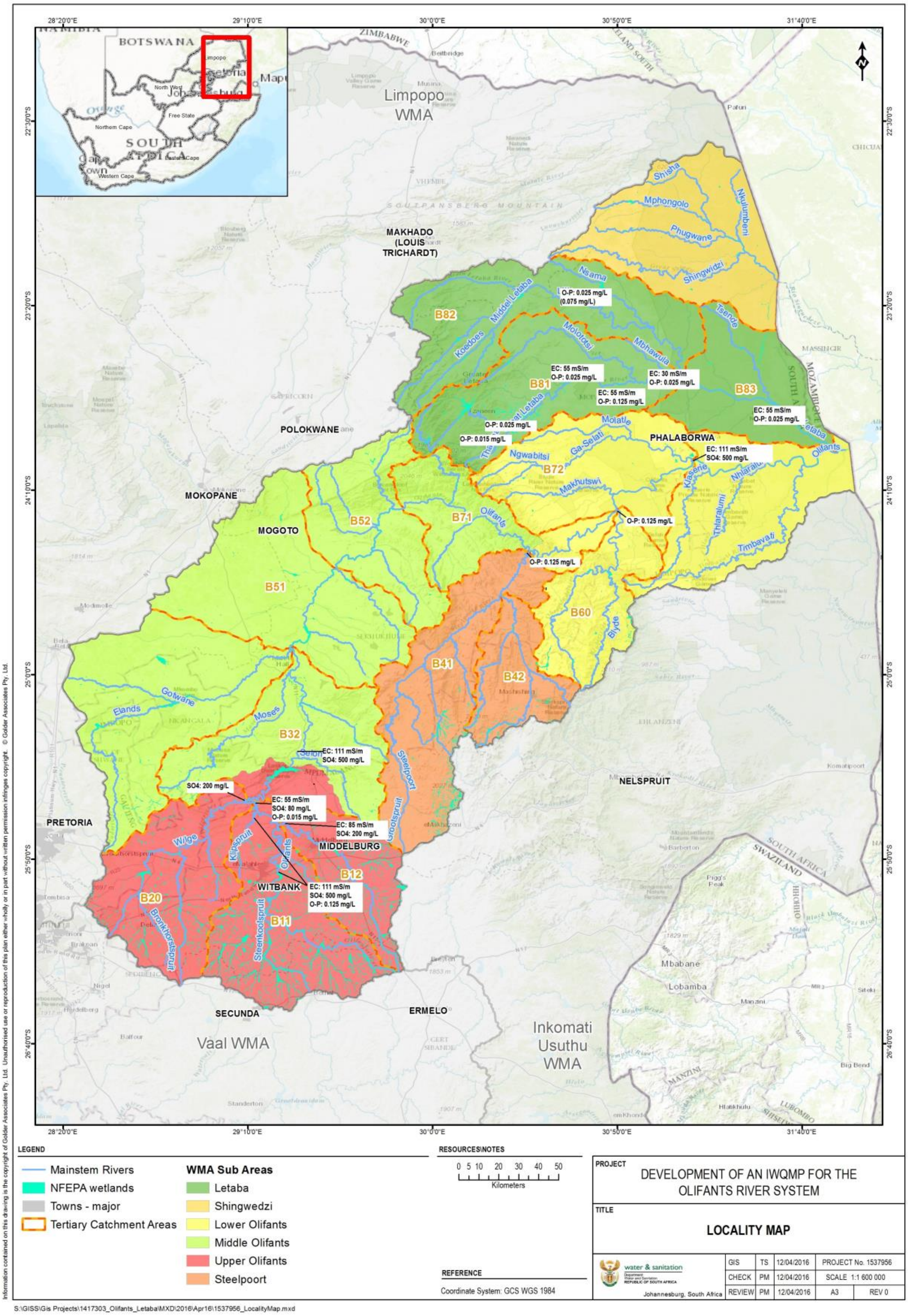

Figure 6: Olifants River System showing areas for which RQOs have been set showing EC, sulphate and ortho-phosphate

4.4 STRATEGIC INTENT FROM PREVIOUS STUDIES

The Management Classes established by the classification of water resources and the subsequent RQO development support a level of protection of the resources in the Olifants River System, all of which have been developed with considerable stakeholder participation. Implementation of the Reserve and the RQOs will now need to drive that protection.

In addition the recommendations from the Reconciliation Studies need to be assessed and taken forward.

4.5 PRELIMINARY MANAGEMENT OPTIONS IDENTIFIED THROUGH PREVIOUS STUDIES

Olifants Reconciliation Study

The following interventions were highlighted in the Olifants Reconciliation Strategy:

Water Conservation /Water Demand Management (WC/ WDM) - Irrigation

Water Management Plans (WMPs) for the Loskop and Hereford Irrigation Boards showed that there are approximately 13 million m^3/a of avoidable losses in their distributions systems. The 21 million m^3/a currently in the water balances will have to be reduced accordingly and the implications on the water resource supply risks need to be assessed in as part of future analysis. This intervention needs to be investigated as soon as possible and savings should already start in 2016 and is scheduled over a 10-year period.

WC/ WDM - Urban

Although some of the Local Municipalities do have successful WC/WDM initiatives underway (such as Steve Tshwete Local Municipality and Tshwane Metropolitan Municipality), many of the large municipalities are not actively involved at the Strategy Steering Committee, which leaves a knowledge gap. Phalaborwa and eMalahleni will have to be approached by DWS to obtain information regarding any initiatives and to track success with those initiatives. The successes already achieved need to be translated into benefits to the Supply System and tracked against the IP targets. First savings are required in 2016 over a 5-year period.

WC/WDM - Mining

The target for this intervention has most probably already been reached through activities undertaken by Palabora Copper. The company is working towards reducing all raw water inputs through a number of reuse interventions at the mine. Additional sources of information on this might increase the target for this water use sector.

Eliminate unlawful water use

Some validation and verification work has started on an ad hoc basis by DWS: Mpumalanga Regional Operation and directives have been given to offenders where water use transgressions occurred. The Validation and Verification process is now a DWS: Head Office Function and PSP's are being appointed currently. Some enforcement of obvious illegal users has taken place upstream from Middelburg Dam and in the Ogies-area. The current water balances assume the first reductions in unlawful use will commence in 2016 and will reach the expected maximum savings over a 10-year period.

Development of groundwater resources

Groundwater development was seen as the largest contributor to make more water available in the 2012 Strategy. However recent desktop investigations showed that the amount of groundwater estimated in the 2012 Strategy might be substantially less and further detailed investigation into this intervention is now underway by DWS.

Removal of invasive alien plants

The Working for Water Programme of the Department of Environment and Tourism has cleared a total of 359 km^2 of the potential of 1990 km2 (2012 Strategy) AIP's. This achievement has to be translated into estimated volumes and tracked against the intervention targets. This intervention spans the complete planning horizon of the current Strategy.

Treatment of mine water

There are several mining companies that already constructed or who are planning to construct mine water treatment plants in the areas of the Upper Olifants River Catchment. The SSC maintains a list of the structures already in place as well as planned for the future on a six monthly basis and adapt the Strategy accordingly. This intervention is therefore on schedule, but the current full implementation target in 2016 might have to be revised due to delays in the implementation of some of the schemes.

Municipal effluent re-use

Polokwane and Mokopane have historically treated their municipal effluent and sold the treated water to mining and industrial water users. Emalahleni has the biggest potential for effluent reuse but it is unclear if the LM has started any such initiative. This intervention will have to be monitored on an ongoing basis and treatment capacity needs to be upgraded as effluent grows in accordance with the water requirement projections, spanning over the whole planning horizon. The current planned treatment works and adjusted projections of water requirements might affect the current projected targets and might have to be revised in future.

Letaba Reconciliation Study

The following measures are envisaged for the Letaba system to maintain a water balance between the water needs and availability up to the year 2040.

(i) Ebenezer Dam to support users in the Groot Letaba System as in the past, by releasing water to Tzaneen Dam when it reaches low storage levels. Support from Ebenezer to Polokwane should not exceed 16.2 million m^3/a, which is in line with the average observed transfer over the last 10 to 13 years (as was incorporated in the projected water balances), although their current allocation is 12 million m^3/a. Further augmentation to Polokwane should therefore take place from the Olifants River System and not from Ebenezer Dam.

(ii) Plan and implement WC/WDM in the domestic water use sector. Targeted savings of at least 9 million m^3/a need to be obtained within the domestic/industrial water use sector and need to be achieved not later than the year 2020.

(iii) Continue with the implementation of the Groot Letaba Water Development Project (GLeWaP) as approved by the Minister of DWA and gazetted on 21 December 2012. The GLeWaP entails the following:

   a. The raising of the existing Tzaneen Dam by 3m to improve the assurance of supply to the users.

   b. A new major storage dam on the Groot Letaba River just downstream of the Nwanedzi River confluence, at the site known as Nwamitwa on Janetsi Farm 463LT (Nwamitwa Dam). The proposed Nwamitwa Dam, developed to a level of 479.5 m above mean sea level will increase the high assurance yield, and it is envisaged that first water will be stored by 2019, and

   c. Development of bulk potable water supply infrastructure mainly to serve rural communities without adequate water supplies.

(iv) Implement the Ecological Water Requirements (EWR) in the Groot Letaba for the scenario proposed by the Classification Study, once Nwamitwa Dam starts to deliver water.

(v) Additional monitoring of flows and dam balances are required to improve the confidence in the yield estimates of Thabina, Modjadji, and Thapane dams.

(vi) Groundwater is an important water resource, and in some areas the current level of use exceeds the availability. High level catchment wide groundwater assessments however indicate that additional groundwater abstraction is possible, as reflected on the water balances. These resources need to be exploited.

(vii) Augmentation is required from the Groot Letaba System after Nwamitwa Dam is in place, to the support areas currently receiving water from, Thapane and Thabina dams

(viii) Augment the Modjadji Dam supply area from the Middle Letaba System, after the demand load on the Middle Letaba sub-system was reduced sufficiently by means of support from the Integrated Nandoni system.

(ix) Nandoni Dam needs to support part of Giyani as well as the already committed Middle Letaba Dam supply areas.

(x) Replace the Middle Letaba canal connecting Middle Letaba and Nsami dams, with a pipeline to reduce losses.

(xi) The actual water use needs to be monitored to confirm which water requirement scenario (projection) should be applied over the long term and whether this requires some adjustment to the strategy.

5. INTERNATIONAL OBLIGATIONS

The Olifants River is a tributary of the Limpopo River which is shared by South Africa, Botswana, Zimbabwe and Mozambique and originates at Trichardt, east of Johannesburg, and flows through to the Kruger National Park. The Letaba River joins the Olifants River upstream of the border into Mozambique, thereafter the Olifants joins the Limpopo River before discharging into the Indian Ocean. The Shingwidzi River flows through the Kruger National Park becoming the Rio Shingwidzi in Mozambique. The Shingwidzi currently has no reserve, classification or RQOs set.

The Olifants River is affected by a multitude of coal mining activities and acid mine drainage, large irrigation projects spread throughout the basin increase salt and agro-chemical concentrations in receiving rivers, and high sediment loads occur during flood events in non-perennial rivers[1].

The water quality status of the Letaba and Luvuvhu River is driven by the intensive irrigated agriculture and has resulted in the use of a wide range of pesticides over the past decades. The majority of Shingwedzi sub-basin falls within the Kruger National Park and the Transfrontier Park. Outside of the Parks the land use is mainly subsistence agriculture and informal urban settlements. Concerns have been raised about poor land use practises that take place into the flood plain of the river.

Water quality concerns in the Letaba sub-basin are driven by diffuse pollution, such as afforestation in the upper sub-basin (turbidity, fertilisers), agricultural runoff from intensive cultivated lands, mainly bananas and citrus (fertilisers, salts, nutrients, pesticides), dense communities close to rivers (microbiological, litter, turbidity), and

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[1] LIMCOM (2013) Limpopo River Basin Monograph, LRBMS-81137945: Determination of the EWRs: Water Quality Specialist Report.

animal grazing and watering (microbiological, turbidity). Water quality impacts are related to salinisation, the release of pesticides and herbicides into the environment and elevated nutrient levels.

Mozambique is situated at the downstream end of most of the Limpopo River and its east flowing tributaries, i.e. the Olifants River. Many of the water quality concerns therefore originate outside of their borders. In the Olifants sub-basin elevated sulphate concentrations and salinity have been recorded; a legacy of the intensive use of the river in South Africa. Elevated metal concentrations were found which in some cases exceeded Mozambican standards. However, there was a general reduction in metal concentrations in a downstream direction, probably due to sedimentation and adsorption onto sediment particles. It was speculated that the metals originated from upstream mining areas. Salinity show a steady increase in a downstream direction even though the quality is still classified as tolerable for domestic water supply and irrigation.

This trend for the shared basin is seen globally, whereby freshwater ecosystems are in serious decline due largely to rapid population and economic growth. Climate change will add further pressure on shared water systems resulting in major impacts by aggravating significantly the challenge of establishing and sustaining cooperation between the states that share watercourses. Therefore, the equitable and sustainable allocation, and management of water across international borders is a crucial requisite for sustaining aquatic ecosystems and maintaining their ecological functions and services such as clean water, food and flood control in support of human well-being and the environment. To this end, South Africa shares transboundary basins with other Member States where water quality management is an international priority for many countries. South Africa is a signatory to a number of international conventions, treaties and protocols. Some of these have been ratified. The ratification of conventions, treaties and protocols involves all organs of state and thereby, constitutes government policy. These are elaborated on in the next section.

5.1 TRANSBOUNDARY PROTOCOLS AND OBLIGATIONS

5.1.1 International Obligations

The Sustainable Development Goals (SDGs)

The 17 UN Sustainable Development Goals (SDGs), which replaced the Millennium Development Goals (MDGs) are a new, universal set of goals, with targets and indicators that UN Member States will be expected to use to frame and guide their agendas and political policies over the next 15 years.

Figure 7: The Sustainable Development Goals

Goal 6 relates directly to the water sector and seeks to "ensure availability and sustainable management of water and sanitation for all." The achievement of this and other SDGs (such as Goals 3; 9; 12; and 14) can be constrained by poorly managed water including lack of cooperation in flood and droughts management, lack of adequate water supplies and sanitation provision all of which can be linked to weak institutions, lack of information and inadequate infrastructure. The strive towards attainment of these goals is binding for South Africa especially given the links between water quality management and ensuring high quality potable water for fulfilling Goal 6.

The 'Helsinki Rules on the Uses of the Waters of International Rivers'

Although the title of the Rules refers to international rivers only, Article I states that the Rules are applicable to the use of the waters of an international drainage basin. Such a drainage basin is defined as "a geographical area extending over two or more States determined by the watershed limits of the system of waters, including surface and underground waters, flowing into a common terminus"[2]. As such, the Helsinki Rules also apply to groundwater connected to surface water.

Article V of the Helsinki Rules states that the relevant factors to be considered include: i) the avoidance of unnecessary waste in the utilization of waters of the basin; ii) the practicability of compensation to one or more of the co-basin states as a means of adjusting conflicts among uses; and iii) the degree to which the needs of a basin state may be satisfied, without causing substantial injury to a co-basin state The Rules devote a separate chapter to each of pollution, navigation and timber

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[2] Salman, S, M, A. 2007 The Helsinki Rules, the UN Watercourses Convention and the Berlin Rules: Perspectives on International Water Law. Water Resources Development, Vol. 23, No. 4, 625–640

floating. Some of the bilateral treaties in South Africa also made specific reference to the Helsinki Rules such as the 1992 Agreement between Namibia and South Africa on the Establishment of a Permanent Water Commission[3].

UN-Convention on the Law of the Non-Navigational Uses of International Watercourses (UN, 1997)

UN-Convention on the Law of the Non-Navigational Uses of International Watercourses (UN, 1997). The UN Convention provides general principles and rules to guide states in negotiating future agreements on specific watercourses. It looks at management of a river system as a whole and addresses issues such as flood control, water quality, erosion, sedimentation, salt-water intrusion and living resources (UN, 1997; Salman, 2007). It is the only global legal instrument codifying, clarifying and developing minimum substantive and procedural standards for transboundary water cooperation.

African Water Vision (AU) 2015

The African Water Vision 2025 is central water related policy instrument of the AU that provides the long term framework for water development in Africa. The Vision is supported by a series of high-level policy statements stressing the importance of and underscoring the commitment of African leaders to water resources development for improved and optimized use of the continent’s water resources for social and economic development on the continent. Among the important targets that the Vision sets for sustainable development and management of water resources for Limpopo Basin is the one for “shared management of international water basins to stimulate efficient mutual regional economic development; and ensuring adequate water for life supporting ecosystems.

The Water Law (1991) and the Water Policy (2007) of Mozambique gives priority to environmental requirements over all other uses, except domestic use, whereas in South Africa, the National Water Act (36 of 1998) provides for the so-called ‘reserve’, comprised of the Basic Human Needs Reserve (BHN) and the Ecological Reserve (ER). The Reserve has priority of supply before any other water user. Section 36 of NWA requires licensing of the stream flow reduction activities as another form of water use. Section 36 (2) describes the stream flow reduction activity as an activity that is likely to reduce the availability of water in a watercourse to the Reserve, to meet international obligations, or to other water users significantly[4].

Hyogo Framework for Action (UN, 2005–2015)

This is a global agreement signed by over 180 countries under the auspices of the UN that calls on governments to enhance and support disaster risk assessment and related processes. In order for disaster reduction to be successful, the local application of disaster risk reduction measures remains imperative. The Hyogo

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[3] Salman, S, M, A. 2007 The Helsinki Rules, the UN Watercourses Convention and the Berlin Rules: Perspectives on International Water Law. Water Resources Development, Vol. 23, No. 4, 625–640

[4] LIMCOM (2013) Limpopo River Basin Monograph, LRBMS-81137945: Legal and Policy Review

Framework for Action assists the efforts of nations and communities to become more resilient to, and cope better with the hazards that threaten their development gains. The viewpoint of the Hyogo Framework for action is that the communities should benefit from the decisions taken at a strategic level. Both South Africa and Moçambique have adopted climate change strategies, as well as frameworks for disaster management.

Other international obligations that South Africa has ratified include:

- **Wetlands of International Importance -** The Convention of wetlands of International importance, especially as Waterfowl Habitat (RAMSAR) dated 2 February 1971 was signed and ratified by South Africa on 12 March 1975. The Convention was amended on 3 December 1982.

- **Transboundary movement of hazardous wastes -** The Convention on the Control of Transboundary Movement of Hazardous Waste and their Disposal dated 1989 (Basel Convention) came into force in South Africa on 5 August 1994. The principles encompassed in the Convention entail the recognition that:

i) Transboundary movement of hazardous and other wastes poses an increasing threat to human health and the environment;

ii) States should regulate waste disposal and its movement in a manner designed to protect human health and the environment;

iii) Hazardous wastes should preferably be disposed in the state it is generated in and states should cooperate in this regard. However, transboundary movement of hazardous waste is allowed if the wastes are inputs to reuse. Parties are prohibited from exporting hazardous wastes if the state receiving the import has not agreed to this import in writing; and from transporting and disposing of hazardous waste if not authorised to conduct these operations.

- **Biological diversity -** The Convention on Biological Diversity opened for signature on 5 June 1992. This convention was signed and ratified by South Africa on 4 June 1993 and 2 November 1995 respectively. The convention aims to achieve international cooperation on the conservation of biological diversity and sustainable use of living natural resources worldwide.

- **Climate change -** The United Nations Framework Convention on Climate Change dated 9 May 1992 was signed and ratified by South Africa on 15 June 1993 and 29 August 1997 respectively. The Convention aims to regulate the greenhouse gas concentration in the atmosphere, which could result in climate change of a nature impeding sustainable economic development or food production. This also includes greenhouse gases such as carbon dioxide and/or methane inter alia produced within sewage treatment processes and subsequent handling and disposal of sewage sludge by means of waste incinerators.

5.1.1.1 Regional Protocols and Agreements

Revised SADC Protocol on Shared Water Courses

The Revised SADC Protocol is the key instrument for transboundary water management in the SADC region that establishes a legally binding framework for transboundary water management. The generic provisions of the Revised SADC Protocol are drafted in line with the provisions of the UN Watercourse Convention, thus reflecting contemporary international water law (SADC, 2000; Aurecon et al, 2013[5]). With signing (and ratifying) the Revised SADC Protocol the SADC Member States have expressly undertaken to adhere to the rules of international water law shared by most states in the world relating to the utilisation and management of the resources of shared watercourses (Article 3 (3)). In line with these rules of international water law the Revised SADC Protocol contains the principles of “equitable and reasonable utilisation” (Article 3 (7)) and the “duty to prevent significant harm” (Article 3 (8)) (SADC, 2000). It furthermore, among others, contains provisions dealing with notification and consultation requirements regarding planned measures and rules on pollution prevention, reduction and control. Significantly, the Revised SADC Protocol establishes an institutional framework at the regional level for the implementation of the instrument. In Article 5 it establishes the SADC Water Sector Organs and mandates them as well as Shared Watercourse Institutions with the implementation of the Protocol.

Through the Protocol, the SADC Water Division works together with SADC Member States in supporting, facilitating and coordinating the implementation of regional water related activities. This is done at regional, transboundary basin and national levels. The SADC has an advocacy objective to ensure that the shared water resources of the region are managed, protected, and used in a sustainable manner. This is encapsulated in a range of policy documents (SADC, 2010; AURECON *et al*, 2013).

The SADC Water Division has a number of work programmes which are all part of the Regional Strategic Action Plan. Launched in 2011, Regional Strategic Action Plan III has the focus of strengthening the enabling environment for regional water resources governance, management and development through the application of IWRM at the regional, river basin, and Member State and community levels. As such the key challenges being faced within the transboundary basins (such as Limpopo basin, Orange-Senqu, and Inkomati among others) include water allocation, water quality management and disaster management. These challenges can be seen within the various support activities of the SADC Water Division.

Regional Strategic Action Plans (RSAP)

Over the years SADC has embarked on a number of a number of approaches to improving water security and these have been informed by practices elsewhere in the

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[5] LIMCOM (2013) Limpopo River Basin Monograph, LRBMS-81137945: Legal and Policy Review

world. A number of these began with the 1st Regional Strategic Action Plan on Integrated Water Resources Management (RSAP – IWRM) in 1999 to 2004, as well as the subsequent RSAPII; III and now RSAP IV; have been improved over the years. The fundamental basis was to first develop and sustain a sound enabling environment, consisting of building resilient and effective policies and institutional frameworks and capacity building. The sound enabling environment help build a solid foundation for infrastructure development which will also help to improve resilience to the impacts of climate change and variation. Infrastructure development in turn creates a platform for economic development including industrialisation which creates jobs and alleviate poverty. These approaches form the foundation of the options dealt with in the appraisal case.

5.1.1.2 Bilateral/ Multilateral Agreements

Some key bilateral/multilateral agreements to which South Africa is a party/member include:

- **Rivers of mutual interest -** The agreement between Portugal (Mozambique), Swaziland and the Republic of South Africa dated 13 October 1964, concerning rivers of mutual interest, was signed and ratified by South Africa.
- **Republic of South Africa and the Republic of Moçambique, 1996** - Agreement between the Government of the Republic of South Africa and the Government of the Republic of Moçambique on the Establishment and Functioning of the Joint Water Commission.
- **Republic of South Africa and the Republic of Moçambique, 1994** - Agreement between the Government of the Republic of South Africa and the Government of the Republic of Moçambique for the Establishment of a Joint Permanent Commission for Co-operation.
- **Republic of South Africa and the Republic of Portugal, 1971 -** Agreement between the Government of the Republic of South Africa and the Government of the Republic of Portugal in regard to rivers of mutual interest, 1964-Massingir dam.
- **Republic of South Africa and the Republic of Portugal, 1964** - Agreement between the Government of the Republic of South Africa and the Government of the Republic of Portugal in regard to rivers of mutual interest and the Cunene River Scheme.
- **Republic of South Africa and Republic of Moçambique, 1986 -** Agreement Between the Government of The Republic of Botswana, the Government of The People's Republic of Moçambique, the Government of The Republic of South Africa and the Government of The Republic of Zimbabwe Relative to the Establishment of the Limpopo Basin Permanent Technical Committee

- **Republic of South Africa and Republic of Moçambique, 1994 -** Agreement between the Government of the Republic of South Africa and the Government of the Republic of Moçambique for the Establishment of a Joint Permanent Commission for Co-operation.
- **Establishment of Limpopo Watercourse Commission, 2003** - Agreement between the Republic of Botswana, the Republic of Moçambique, the Republic of South Africa and the Republic of Zimbabwe on the Establishment of the Limpopo Watercourse Commission (LIMCOM).

5.1.1.3 Basin-wide agreements

The LIMCOM agreement establishes the LIMCOM as a technical advisor to the member states on matters relating to the development, utilisation and conservation of the water resources of the Limpopo. The agreement only specifies the functions of the Commission and the international legal rules that determine water management in the Limpopo and within the framework of which the Commission needs to provide its advice, are contained in the Revised SADC Protocol and the bilateral agreements, not in the LIMCOM Agreement itself.

In terms of legal requirements, both the Revised SADC Protocol on Shared Watercourses as well as the LIMCOM-Agreement oblige states to regularly exchange information. As part of the assessment for the Limpopo Monographs, a SWOT Analysis was conducted and revealed the following opportunities and challenges/threats[6]:

OPPORTUNITIES	THREATS/CHALLENGES
▪ Existence of the benefit sharing options in the basin e.g. energy trading arrangements under SAPP	▪ Increasing demand for use and vulnerability of available water resources on the Limpopo system
▪ Poverty alleviation forms a key developmental policy objective for all the Limpopo basin states	▪ Existence of inconsistencies between sector policies both within as well as between basin countries
▪ National Policies on agriculture and irrigation recognise the need for water efficiency, since irrigation is the major water user in the basin	▪ Need for a common basin mechanism for carrying out environmental flow assessment
▪ Commitment towards IWRM principles reiterate by SADC regional water frameworks facilitates harmonization process	▪ Lack of an effective mechanism for basin wide management of natural disasters and dam safety

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[6] LIMCOM (2013) Limpopo River Basin Monograph, LRBMS-81137945: Legal and Policy Review

Whilst none of these specifically pull out water quality as an issue, issues around quality definitely contributes to these challenges. These water quality challenges are further exacerbated by the variabilities in seasonal and inter-annual flow[7].

5.2 NEXT STEPS

As with the Orange-Senqu basin, South Africa sits in a position of relative privilege (compared to its neighbours) when it comes to the shared water basins, mainly being positioned upstream. The South African Development Community (SADC), of which South Africa and Mozambique are signatories of, have adopted the Revised Protocol on Shared Water Resources, i.e. SADC Protocol and thereby obligates both countries to cooperate on the management of the shared water resource.

Furthermore, South Africa has entered into bilateral and international agreements that govern the management of transboundary water resources and ensures that South Africa is compliant with those protocols. Chapter 10 of the National Water Act (Chapter 10) specifically deals with International Water Management and provides for institutions to implement these protocols.

The following recommendations were made to LIMCOM in order to stabilise the deterioration in water quality and to start rehabilitating some of the most polluted river reaches and tributaries:

- **Water quality monitoring and information generation** –as with most trans-boundary basins, monitoring of water quality, data storage and dissemination across the Limpopo River Basin is not ideal. The monitoring of heavy metals in the last 2-3 years has provided the evidence required, not only to understand the causes of the crocodile death that occurred in recent years, but also the source of pollution, so that it can be managed better in the future. Therefore, it was recommended that LIMCOM develop minimum standards for water quality monitoring and information systems, and then encourage basin countries to adhere to these.
- **Extension of the Groundwater Resources Information Project (GRIP) –** This has kicked off in the South African part of the Limpopo Basin and should be implemented in the member states to increase the data sets in these countries for future evaluations. This will help in the understanding around groundwater reserve, its quality and the recharge required.
- **Water quality objectives** – the development of a common set of water quality objectives for the Limpopo basin should be facilitated by LIMCOM and then encourage basin states to develop and implement their own objectives and strategies for the tributary rivers to meet these main stem river objectives.

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[7] LIMCOM (2013) Limpopo River Basin Monograph, LRBMS-81137945: Determination of the EWRs: Water Quality Specialist Report.

- **Pollution source management** – Once water quality management objectives have been developed and accepted by the basin states, then LIMCOM should encourage them to develop source management objectives to control pollution sources. LIMCOM can facilitate this process and ensure that the linkages to other components of the basin management strategy are developed.

Creating working transboundary water governance structures requires development of trust between stakeholders and an effectively functioning governance framework requires that information is easily available and accessible. The SADC strategy advocates that member states must communicate on the IWRM approach, cooperation on water, climate change, variability and water-related disasters. To this end, there is currently a strategy underway for the Limpopo Basin to assist the basin states with its monitoring compliance. Water quality is one of the aspects to be monitored, however, it should be noted that whilst the legal framework around this for shared water courses is complex, there is evidence of strong cooperation between South Africa and Mocambique. It is hoped that this strategy promotes regular information exchange rather than exchanges due to incidences, such as crocodile deaths.

In addition, there exists the Inco-Maputo agreement between SA and Mozambique that as a specific Annexure on water quality monitoring, but to date there are no clear steps for implementing it. This has been seen with a number of agreements.

Overall compliance monitoring needs to be improved and prioritised. However, the willingness for cooperation in uncertainty is a good foundation from which to move forward for both South Africa and Mozambique and issues around the Olifants.

PART 2: DESCRIPTION OF THE CATCHMENT AREA

6. OVERVIEW

The Olifants River System, comprising the Olifants, Letaba and Shingwedzi catchments, is a highly utilised and regulated catchment. The spatial extent of the area includes 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 total catchment area is 73 730 km^2. The sub-catchment areas are set out in Table 6.

Table 6: Sub- catchment areas (km^2)

Sub-catchment	Quaternary catchments	Area
Upper Olifants	B11A - L; B12 A – E; B20 A - J	11 461 km^2
Middle Olifants	B32 A – J; B31 A – H; B51 A- H; B52 A- H; B71 A- F	22 791 km^2
Steelpoort	B41 A – K; B42A - H	7 127 km^2
Lower Olifants	B60 A- J; B72 A – K; B71G, J and H; B73 A - J	12 612 km^2
Letaba	B81 A – J; B82 A – J; B83 A - E	14 429 km^2
Shingwedzi	B90A - H	5 310 km^2

The Olifants River originates at Trichardt, east of Johannesburg, and flows through to the Kruger National Park. The Letaba River joins the Olifants River upstream of the border into Mozambique, thereafter the Olifants joins the Limpopo River before discharging into the Indian Ocean. The Shingwidzi River flows through the Kruger National Park becoming the Rio Shingwidzi in Mozambique.

Priority dams and their purpose are listed in Table 7.

Table 7: Priority dams in the catchment and their purpose

Dam Name	Quaternary	Dam number	River	Year Established	FSC (Mm^3)	Purpose
Witbank	B11G	B1R001	Olifants	1971	104.0	Domestic (urban), industrial use
Doornpoort	B11J	-	Olifants	1925	9.2	Recreation, domestic (urban)
Middelburg	B12C	B1R002	Klein Olifants	1978	48.4	Domestic (urban), industrial
Bronkhorstspruit	B20C	B2R001	Bronkhorstspruit	1950	57.9	Industrial, domestic

Dam Name	Quaternary	Dam number	River	Year Established	FSC (Mm³)	Purpose
						(urban)
Wilge Dam (Premier Mine)	B20F	-	Wilge	1909	1.7	Domestic (urban), industrial, mining
Loskop	B32A	B3R002	Olifants	1939	374.3	Irrigation, domestic (rural), recreation
Roodepoort	B32B	B3R004	Selons	1968	1.8	Irrigation
Rust De Winter	B31C	B3R001	Elands	1934	27.2	Irrigation
Mkhombo/ Weltevreden Weir	B31F	B3R005	Elands	1980	205.8	Domestic (urban & rural), industrial, irrigation
Rooikraal	B32F	B3R003	Bloed	1921	2.1	Irrigation
Flag Boshielo	B51B	B5R002	Olifants	1987	103.0	Irrigation, industrial, domestic (urban & rural)
Belfast	B41A	-	Langspruit	1973	4.4	Domestic (urban)
Tonteldoos	B41C	B4R001	Tonteldoos	1954	0.6	Irrigation
Vlugkraal	B41C	B4R002	Vlugkraal	1959	0.4	Irrigation
Der Bruchen	B41G	-	Groot Dwars	1989	7.3	Irrigation, mining
De Hoop	B41H	B4R007	Steelpoort	2012	347.4	Domestic (urban & rural), mining, industrial
Lydenburg Dam	B42B	-	Sterk	1977	1.1	Domestic (urban), industrial
Buffelskloof	B42F	B4R004	Watervals	1972	5.4	Irrigation
Ohrigstad Dam	B60E	B6R001	Ohrigstad	1955	14.4	Irrigation
Blyderivierpoort	B60D	B6R003	Blyde	1974	56.5	Irrigation, domestic (urban), recreation
Tours	B72E	B7R003	Ngwabitsi	1988	5.5	Domestic
Phalaborwa Barrage	B72D	B7R002	Olifants	1966	5.7	Domestic (urban), industrial
Klaserie	B73A	B7R001	Klaserie	1959	5.8	Irrigation

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. It is also understood from discussions with the DWS Regional Office that there have been applications to resuscitate old gold mines in the Malamulele area of the Shingwedzi catchment. The coal mines provide coal for power generation, the local market and for export through the port at Richards Bay. The catchment is home to several large thermal power stations (Arnot, Duvha, Hendrina, Kendal, Matla, Kriel and Kusile), which provide energy to large portions of the country. These industrial, power generation and mining sectors are of strategic importance.

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 and the upper Selati catchment. A large informal economy exists in the Middle Olifants, with many resource-poor farmers dependent upon ecosystem services. The area 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 Olifants Catchment has a population of approximately 4.8 million (4 755 469) people (Census 2011). Increased densities occur in the areas of larger cities such as Emalahleni, Tzaneen, Giyani, Phalaborwa, Groblersdal and Marble Hall and towns and settlements such as Laklaagte, Siyabuswa, Jane Furse, Ga-Kgapane and Ka-Matlani.

The demographic characteristics of the Olifants Catchment are varied from upstream to downstream with the highest diversity of demographic groups typically occurring in the southern reaches and less diverse groups in the northern reaches. This is attributed to the variation in economic development of the landscape. Toward the southern extent of the catchment urbanisation and land use intensity increases toward Gauteng province and the cities of Emalahleni and Middelburg. The northern reaches are less developed, characterised by a greater proportion of smaller towns, settlements and rural land uses.

A large proportion of the catchment is not economically active (45%), with a further quarter (24%) of the population being unemployed. Only a third of the population (31%) are employed of which 68% are done so in the formal sector (Figure 8). The most common income groups between households are the R 9 601 to R 19 600 and the R 19 601 to R 38 200 a month belonging to 20% and 21% of households. 14% of households earn no income at all (Figure 9). These employment and income characteristics are again skewed toward higher levels of employment and economic activity toward the southern reaches of the catchment and less towards the less developed northern reaches.

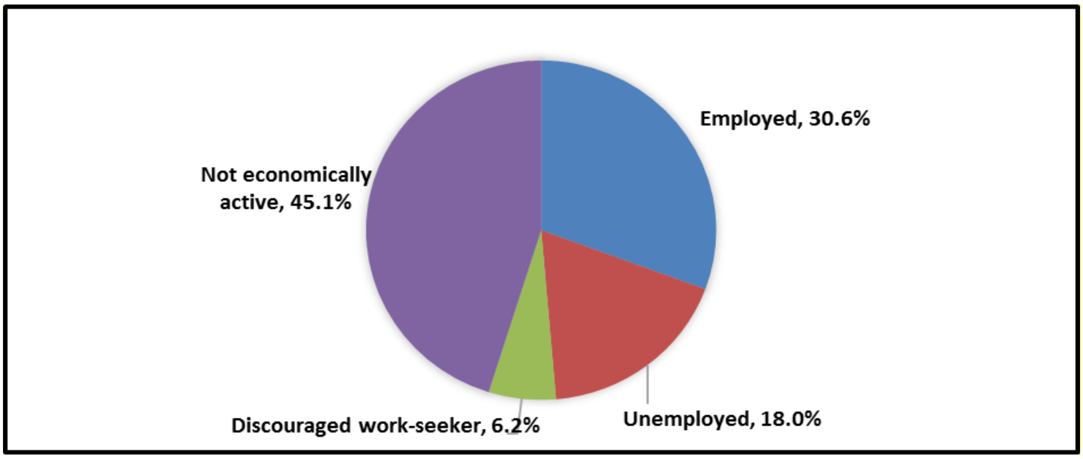

Figure 8: Employment status (Age 15-64) demographics in the Olifants Catchment (Census 2011)

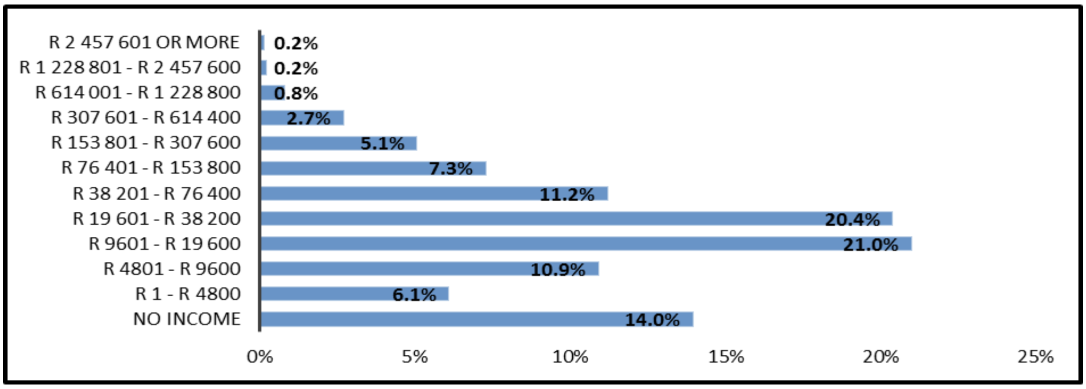

Figure 9: Income group per households in the Olifants Catchment (Census 2011).

6.1 UPPER OLIFANTS SUB-CATCHMENTS

6.1.1 Bio-physical environment

The Upper Olifants catchment covers an area of 11 461 km^2, falling mainly within the Gauteng and Mpumalanga Provinces (Figure 10). The area includes the towns of Bronkhorstspruit, Delmas, Douglas, Kriel, Kinross, Ogies, Evander, Secunda, Bethal, eMalahleni and Steve Tshwete. The Upper Olifants catchment is the most urbanised of the four sub-catchments, with the majority of the urban population located in eMalahleni and Steve Tshwete.

There are extensive coal mining activities in the catchment, both for export through Richards Bay and for use in the active coal fired power stations located in the catchment. The presence of coal also led to the establishment of the steel manufacturing industries located in eMalahleni and Steve Tshwete.

The catchment is located in the Highveld region, with moderate maximum temperatures and cold winter nights, with severe frost occurring regularly. It is a summer rainfall area, with maximum temperatures experienced in January and minimum temperatures occurring in July. The peak rainfall months are January and

February and rainfall occurs generally as thunderstorms. Average annual rainfall varies between 550 mm - 750 mm/a, with evaporation well in excess of the rainfall.

6.1.2 Water Resources system

The Upper Olifants comprises three sub-catchments as indicated in Table 8 and includes the upper Olifants River, Klein Olifants River and Wilge River. Dams in the catchment include Witbank Dam, Middelburg Dam, Bronkhorstspruit Dam and Trichardsfontein Dam.

Table 8: Upper Olifants sub-catchment areas

Sub-Catchment	**Sub-catchment area with main river**	**Quaternary catchments**	**Gross area (km^2)**
Upper Olifants	Olifants River	B11A - L;	4 714 km^2
	Klein Olifants	B12 A – E;	2 391 km^2
	Wilge/ Bronkhorstspruit River	B20 A - J	4 356 km^2

River flow in the area is highly seasonal and depends on groundwater base flows – especially during the drier, winter months of the year. The MAR of the catchment is 318.2 Mm^3/year and 174.84 Mm^3/year for the B11 + B12 and B20 quaternary catchments respectively. Relatively large volumes of water (approximately 172 Mm^3/year) are transferred into the upper Olifants River catchment from the Komati, Vaal and Usutu catchments to the south and east as part of the transfer scheme. Most of this water is used consumptively as cooling water in the coal-fired power plants that are situated in the catchment.

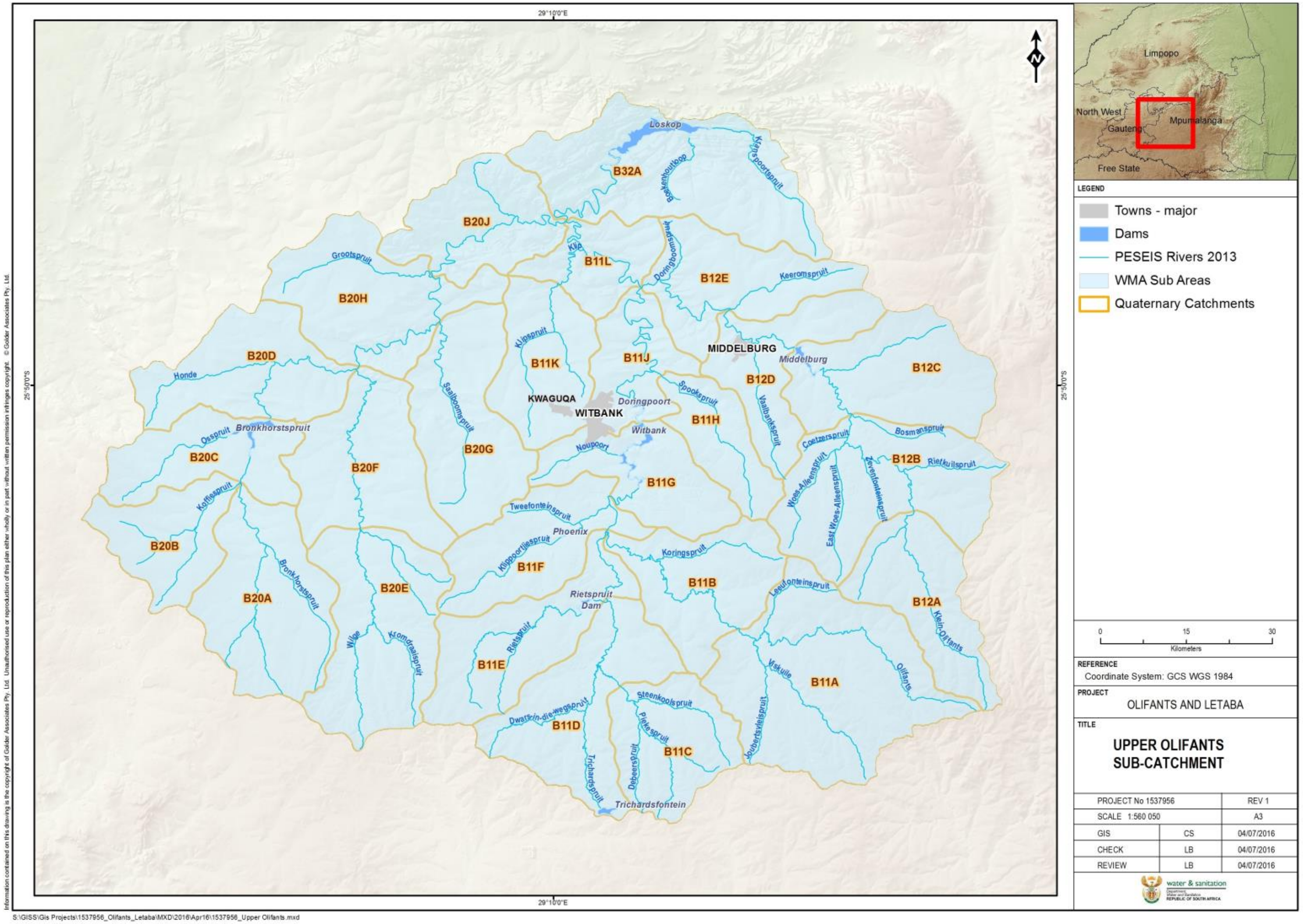

Figure 10: Upper Olifants sub-catchment

6.1.3 Demography

The population within the Upper Olifants sub-catchment is approximately 940 thousand (938 230) people with the highest densities residing within wards closely associated with the large cities (Figure 11). This sub-catchment has the highest diversity of races in the Olifants, with 78% of the population being black, 18% white and 2% being other races. Languages spoken vary greatly with the major languages being isiZulu (35%), Afrikaans (18%), IsiNdebele (15%), Sepedi (10%) and English (6%) (Census 2011).

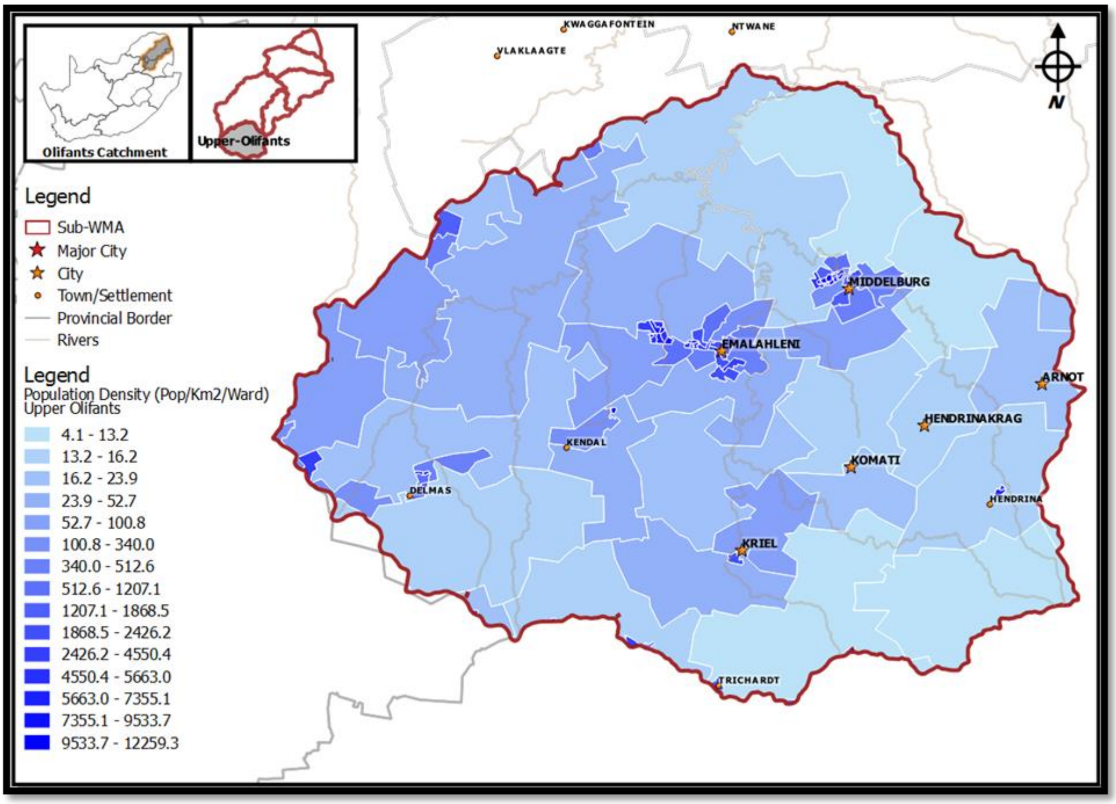

Figure 11: Population density (pop/Ha) by ward in the Upper Olifants sub-catchment (Census 2011)

Relative to other catchments a smaller proportion (30%) of the working-age population are not economically active. Of the economically active population, 20% are unemployed and a comparatively large 50% are employed. Of the employed population, 74% and 11% are employed in the formal and informal sectors respectively. The largest income group in the sub-catchment earns between R 19 601 and R 38 200 per month include 18% of households and the second largest earning between R 38 201 and R 76 400 at 16% of households. 13% of households have no income and 3% earn less than R4 800 a month.

A large proportion of households (69%) reside within concrete or brick homes (Figure 12) and approximately 55.4% have access to piped water within their properties (Figure 14). A high proportion (72%) has access to flushing toilets with a smaller percent (20%) utilising pit latrines (Figure 13). This sub-catchment has the highest proportion of informal dwellings (18.5%) within the Olifants River System (Figure 12).

Most households (88%) have access to water provided by the municipality, with 6% and 4% having access to water through boreholes and water tanks respectively (Figure 15). Many households in the sub-catchment have access to electricity for lighting (81%), cooking (74%) and heating (62%) purposes. The secondary energy alternative is coal, being used by 6% and 13% for cooking and heating purposes respectively (Figure 16).

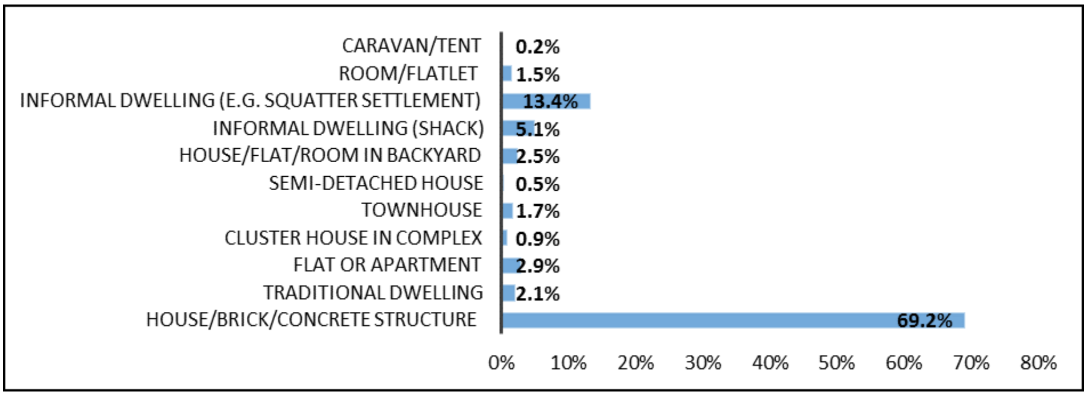

Figure 12: Dwelling demographic of the Upper-Olifants Sub-Catchment (Census 2011)

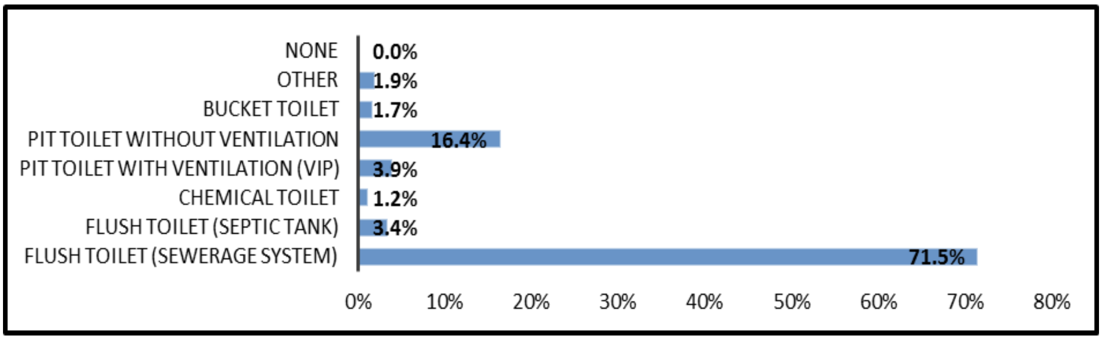

Figure 13: Toilet system demographic in the Upper-Olifants Sub-Catchment (Census 2011)

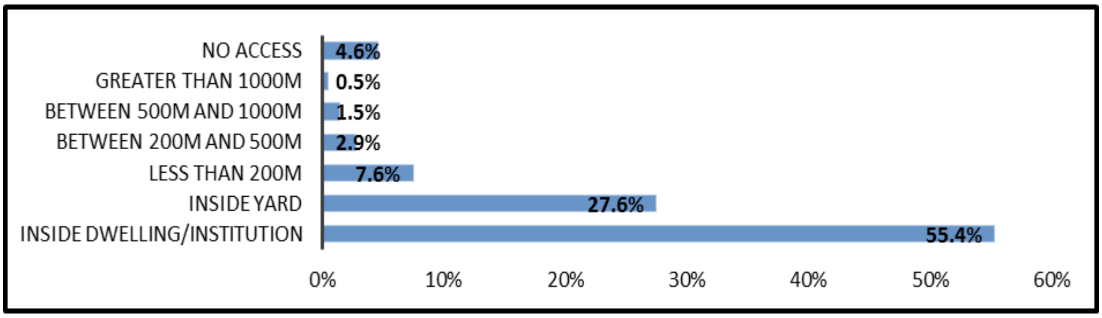

Figure 14: Water access demographic of households in the Upper-Olifants Sub-Catchment (Census 2011)

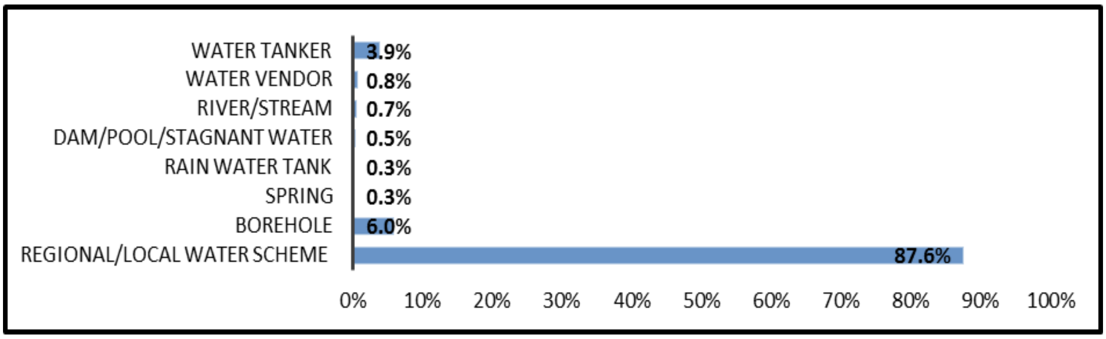

Figure 15: Source of water of households in the Upper-Olifants Sub-Catchment (Census 2011)

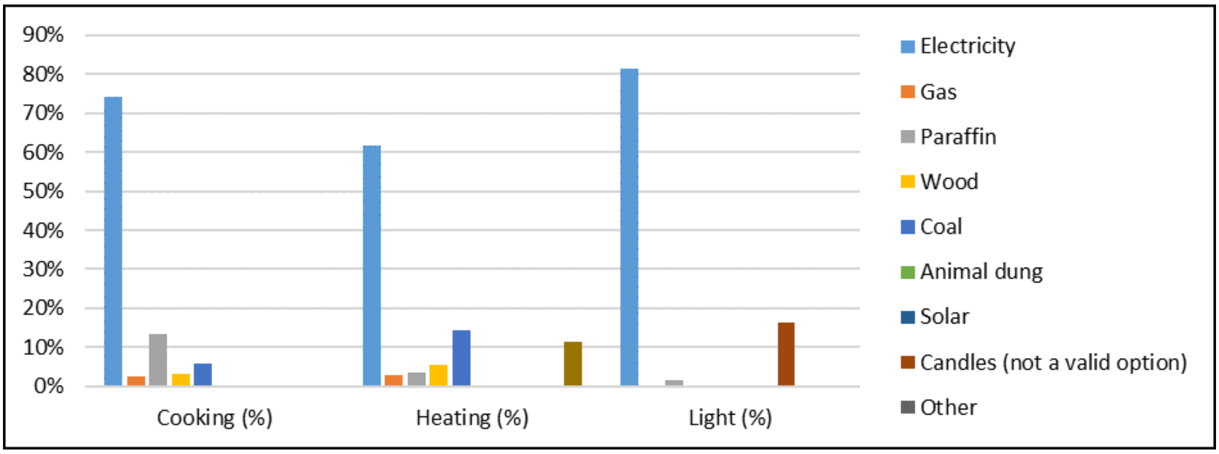

Figure 16: Energy type and use of households in the Upper Olifants Sub-Catchment (Census 2011)

6.1.4 Developmental attributes

The Upper Olifants catchment area is characterized by intensive coal mining and associated energy and manufacturing economy. The area includes a large number of coalmines, steel industry, urban areas and return flows and is highly used and impacted. Secondary economic activities include dryland agriculture and a wide variety of industrial and commercial sectors.

In the upper reaches of the Olifants catchment the economically exploitable ore reserves in several of the older coal mines have been worked out and the mines have been abandoned or are under a ‘care and maintenance’ routine managed by the Department of Water Affairs. However, in recent years, the Department of Mineral Resources (DMR) has granted a large number of permits for additional exploration, prospecting and mining activities – principally for coal deposits – in the upper reaches of the Olifants catchment, which will ultimately increase the impact of mining in the Olifants River.

6.1.5 Land Use

The land-use of the Upper Olifants catchment is dominated by mining, industry and agriculture.

Agriculture

Agricultural practices include dry land crops (approximately 2 458 km^2), five (5) commercial feedlots and afforestation (mainly eucalyptus, 39 km^2). Alien vegetation in the area is limited (< 2 km^2).

Industrial

The main industrial activities in the Upper Olifants River catchment, located in eMalahleni, Steve Tshwete, Bronkhorstspruit and Ekandustria include:

- Ferrometals,
- Transalloys,
- Highveld Steel and Vanadium,
- Vanchem,
- Witbank Abattoir,
- Colombus Steel,
- Middelburg Ferrochrome,
- Kanhym Feedlot, and
- MacCain.

Mining and Power Stations

Extensive coal mining takes place in this area. The coal mines provide essential fuel to the local power stations as well as to the domestic and international markets. Power stations in the catchment include:

- Arnot,
- Duvha,
- Hendrina,
- Kendal,
- Kriel,
- Matla, and
- Kusile (still under construction).

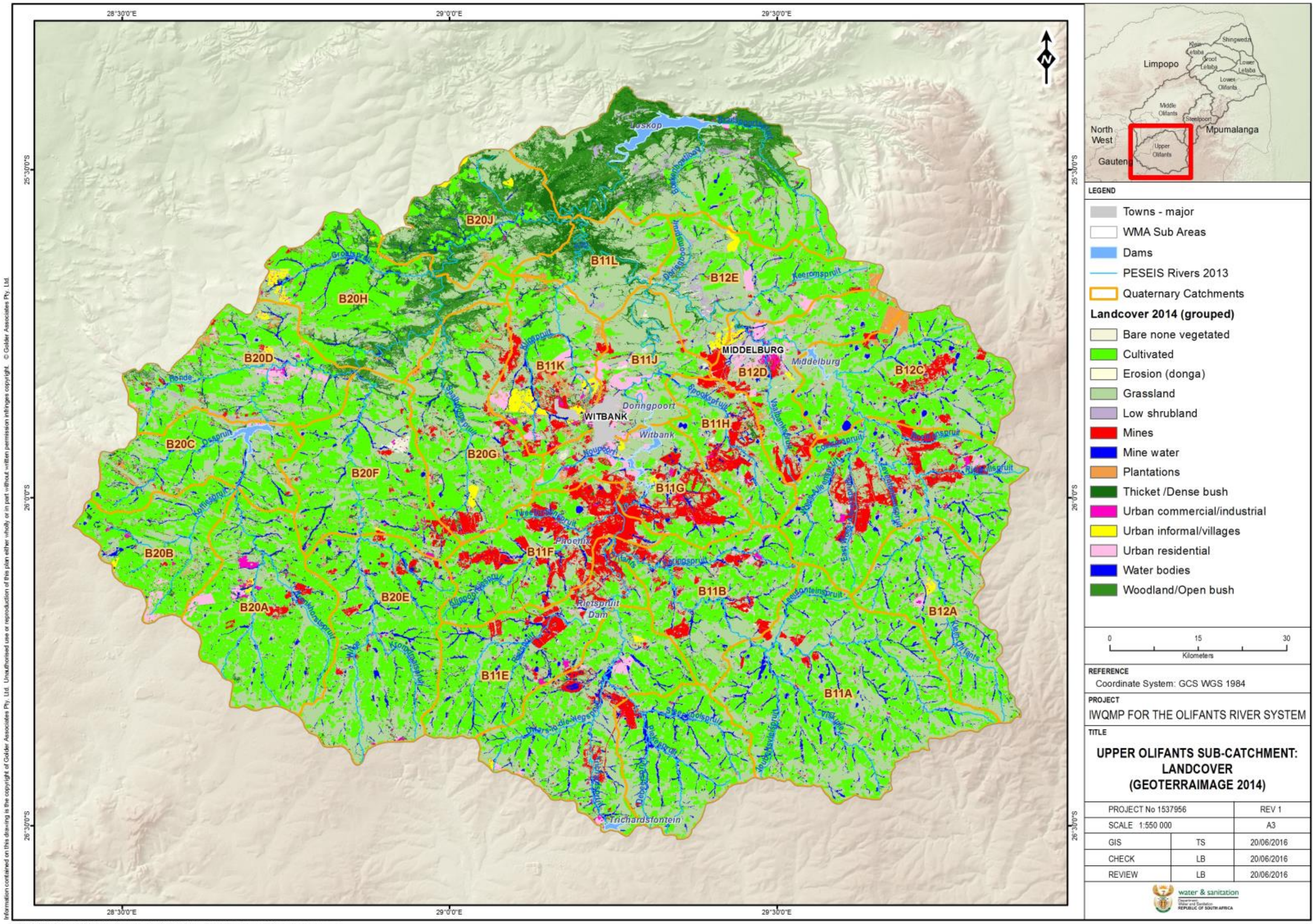

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Figure 17: Upper Olifants sub-catchment land cover

6.2 MIDDLE OLIFANTS SUB-CATCHMENTS

6.2.1 Bio-physical environment

The Middle Olifants sub-catchment covers an area of 22 791 km^2, the largest area in the WMA. There are no metropolitan areas situated in the area however it includes the larger towns of Cullinan, Kwamhlanga, Marble Hall, Groblersdal and Roedtan and the Local Municipalities of Polokwane, Lepelle-Nkumpi, Fetakgomo and Makhuduthamaga.

Several rural townships are also located in the area including Lebowakgomo, Burgersfort, Lydenburg and Belfast and numerous settlements that fall within the municipal boundaries.

The Flag Boshielo Dam, the Bloed, Klipspruit and Grass Valley Rivers are located in this catchment. Several protected areas occur within the catchment and include Mbusa, Moutse, Kwaggavoetpad and Schuinsdraai Nature Reserves.

The economy is characterised by some intensive irrigation agriculture (specifically around Marble Hall and Groblersdal), commercial dryland agriculture (in the Springbok Flats region), some subsistence agriculture and some platinum mining. Pasture is the most common crop type, followed by maize. High value crops include citrus and grapes.

Topography, vegetation and climate

The Middle Olifants River flows through the Middleveld region which is also known as the Springbok Flats and ends in the mountainous region of the Drakensberg. Rainfall on the Springbok Flats does not make a significant contribution to the surface water resources of the Olifants River.

The region between Loskop Dam and the Tuduma River downstream of Flag Boshielo Dam falls within 'The Bushveld Complex' and is dominated overwhelmingly by the Rashoop Granophyre Suite and Lebowa Granite Suite subdivisions of the Bushveld Complex (Cawthorn et al., 2006). There are also elements of the Pretoria Group (Martini et al., 2001). The most prominent rock types in the region are: mudrock, quarzitic sandstone, ironstone, quartzite and feldspar. The Bushveld Complex is economically important as according to Cawthorn et al. (2006) the Bushveld Complex contains some of the largest deposits of major mineral deposits: the platinum group elements, chromium, vanadium, fluorite andelusite with base and precious metals including tin, copper, silver and gold as well as dimension stone (gabbro, norite and granite) (Cawthorn et al., 2006).

The Middle Olifants falls within the Savannah Biome which usually has an herbaceous layer dominated by grass with a discontinuous or open tree layer.

Rainfall is strongly seasonal and falls mainly in summer. The mean annual temperature ranges between 14°C in the southwest to more than 22°C in the north. Maximum temperatures are usually experienced in January and minimum temperatures occur on average in July. It is a summer rainfall area (October to March) with peak rainfall in January and February, generally as thunderstorms. The mean annual precipitation (MAP) ranges between 500 and 800 mm. Evaporation generally exceeds precipitation and can be as high as 2 000 mm on the Springbokvlakte.

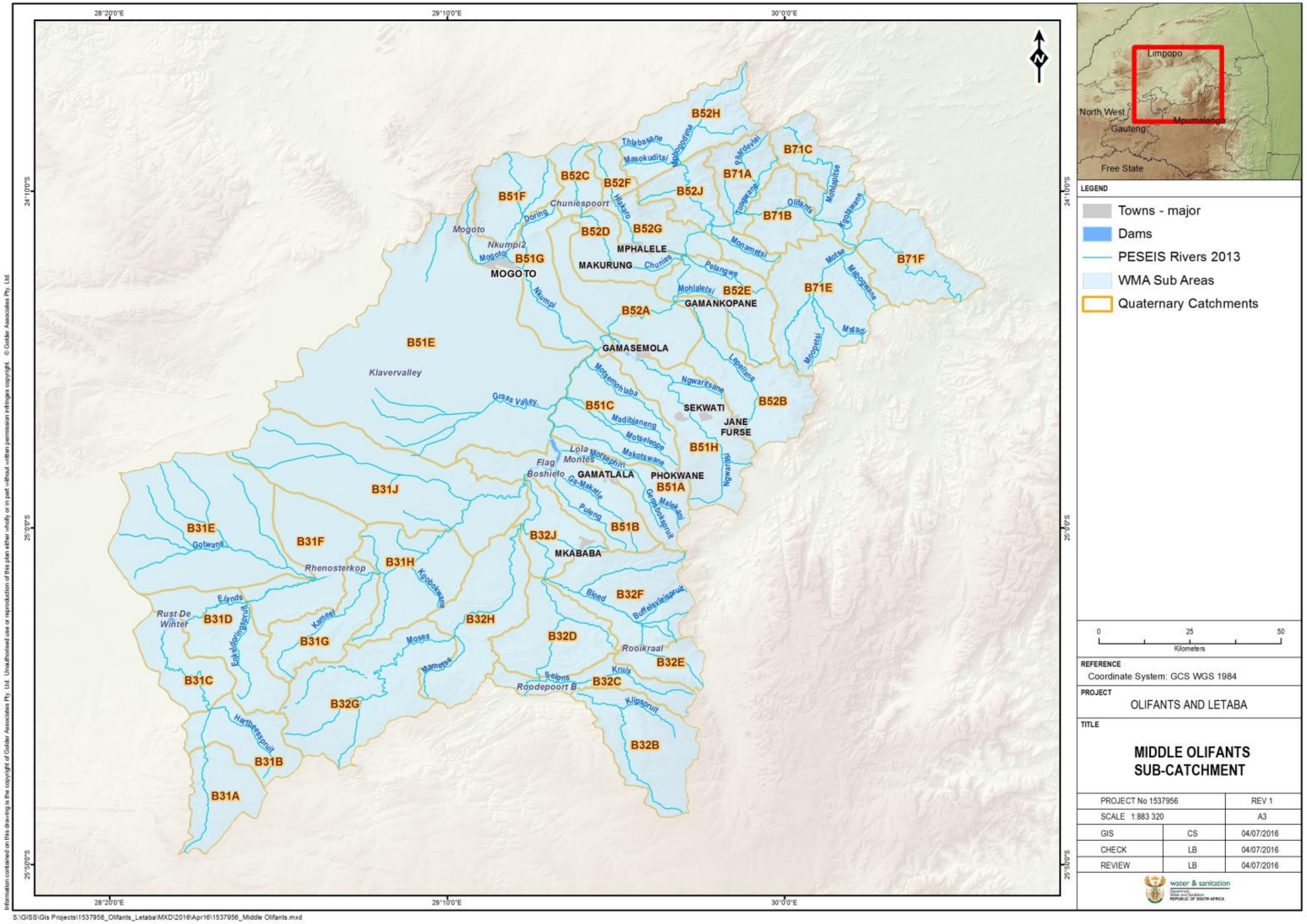

Figure 18: Middle Olifants sub-catchment

6.2.2 Water Resources system

The MAR for the Middel Olifants catchment is 481 Mm^3/a. Major tributaries are the Selons River, Moses River, Bloed River and the Elands River, confluencing with the Olifants River upstream of the Flag Boshielo Dam.

The major dams in the catchment include the Rust de Winter Dam, Rhenosterkop Dam, Rooikraal Dam (in Bloed River) and the Flag Boshielo Dam. Many smaller farm dams are also found in the area. The major dams have a combined capacity of 143 Mm^3 and a firm yield of 69.5 Mm^3/a. The combined capacity of small and minor dams in the catchment is 3.4 Mm^3.

Downstream of the dam there are a number of small tributaries that enter the Olifants River indicated in Figure 18.

The Middle Olifants sub-catchment comprises 5 main catchment areas listed in Table 9.

Table 9: Middle Olifants sub-catchment areas

Sub-Catchment	Sub-catchment areas with main river	Quaternary catchments	Gross area (km^2)
Middle Olifants	Olifants River	B32 A - J	4 293 km^2
	Elands/ Moses Rivers	B31 A - H	6 148 km^2
	Olifants River	B51 A- H	6 170 km^2
	Olifants River	B52 A - H	3 558 km^2
	Olifants River	B71 A - F	2 622 km^2

Large dams in the Middle Olifants sub-catchment are listed in Table 10. In addition to the yield of the major dams listed there are a large number of farm dams in the Olifants River catchment that contribute to the yield of the system (DWS, 2011).

Table 10: Large dams in the Middle Olifants sub-catchment (DWS, 2011)

Name	Full supply capacity (million m^3)	Historic firm yield (million m^3)	1:50 Year Yield (million m^3)
Flag Boshielo	1 788	53.0	56.0
De Hoop	347.4	65.0	66.0*
Buffelskloof	5.4	14.7	14.7
Der Bruchen	9.0	8.3	8.3
Belfast	5.5	5.7	5.7
Lydenburg	1.1	2.5	2.5
***** *After meeting the EWR water requirements. The yield of De Hoop Dam reduces from 99 million m3/a to 66 million m3/a as a result of the EWR requirements*			

	Full supply capacity of minor dams	**Yield of farm dams and run-of river**
Small dams	60	71

The Flag Boshielo Dam supplies downstream users which include the platinum and chrome mines, agriculture, domestic use and the transfer of water from the Olifants WMA to Polokwane in the Limpopo WMA. Effluent is transferred from Polokwane to mines near Mogalakwena. This volume represents an additional source that remains in the Middle Olifants which has been included as a transfer in since this volume would otherwise have flowed out of the area.

The water entering the Middle Olifants through the Loskop Dam includes a large contribution from return flows from the municipal wastewater treatment works (WWTW) serving eMalahaleni and Steve Tshwete Local Municipal areas and excess mine water from mines in the Upper Olifants sub-catchment, the quality of which is not always acceptable.

6.2.3 Demography

The Middle-Olifants Sub-catchment has the largest population of all sub-catchments in the Olifants with approximately 1.7 Million people (1 771 163). The population densities increase around the towns and settlements of Kwaggafontein, Jane Furse, Vlaklaagte and Siyabuswa (Figure 19). 98% of the residing population are black and Sepedi is spoken by 63% of the population with IsiNdebele being spoken by 18% (Census 2011).

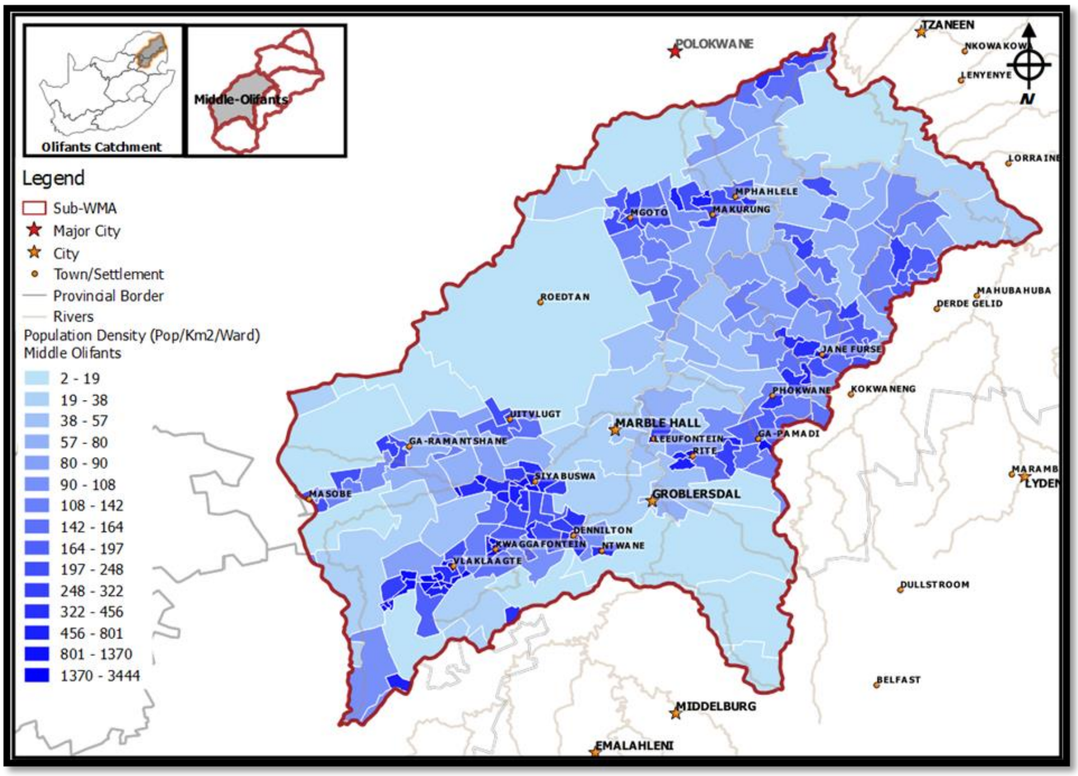

Figure 19: Population density (pop/Ha) by ward in the Middle Olifants sub-catchment (Census 2011)

Just less than half (49%) of the population in the Middle-Olifants Sub-Catchment are not economically active while only 25% have jobs and the rest are looking for employment. Most (62%) of the employed population are employed in the formal sector and the rest in the private and informal sectors. The predominant income groups of households are the R 9 601 to R19 600 and the R19 601 to R38 200 belonging to 24% and 22% of households respectively. 14% of households have no income and 6% earn less than R 4 800 a month.

The majority of households reside within brick and concrete structures (87%) (Figure 20), most of which have access to piped water (within their homes, in their yards or within 200m) (Figure 22). The greatest proportion being 59% having access to a tap in their homes or yard. A relatively large proportion of 18% has no access to piped water whatsoever. 83% of households use pit latrines as toilets (Figure 21). The source of water used comes mostly from regional and local water schemes (65%) and boreholes (14%) while 7% of households get their water from natural sources such as rivers and streams (Figure 23).

Electricity is the leading source of energy in the sub-catchment with 62%, 51% and 90% of households using it for cooking, heating and lighting purposes respectively (Figure 24). Wood follows as the predominant alternative with 29% and 28% using it for cooking and heating.

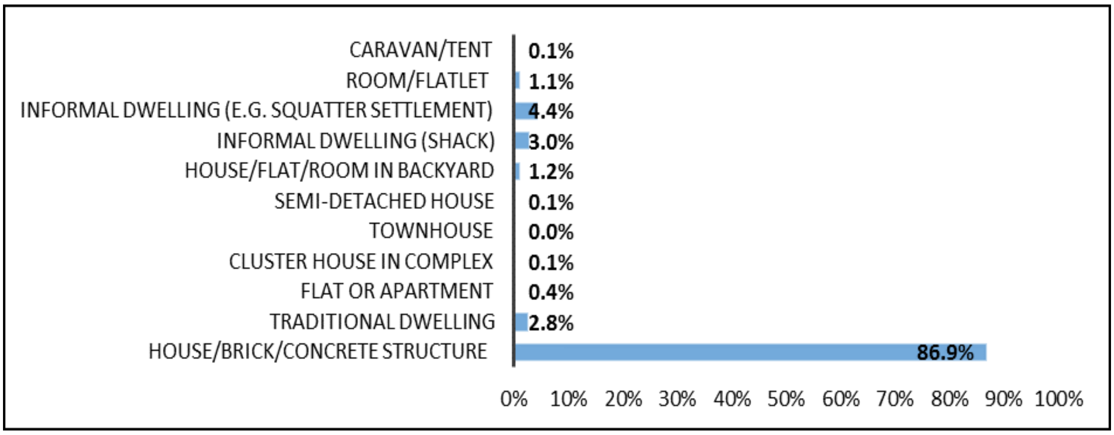

Figure 20: Dwelling demographic of the Middle Olifants sub-catchment (Census 2011)

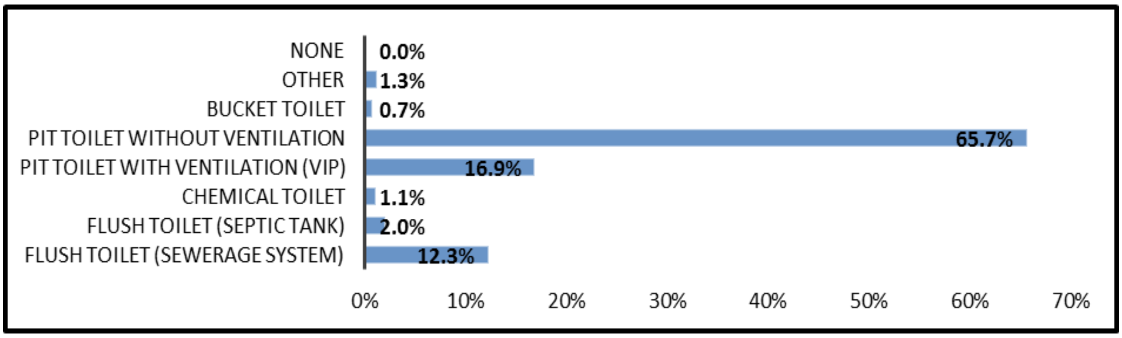

Figure 21: Toilet system demographic in the Middle Olifants sub-catchment (Census 2011)

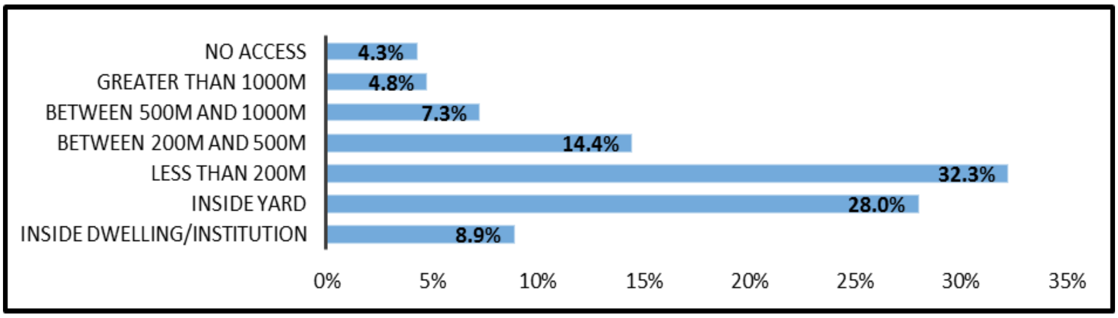

Figure 22: Water access demographic of households in the Middle-Olifants Sub-Catchment (Census 2011)

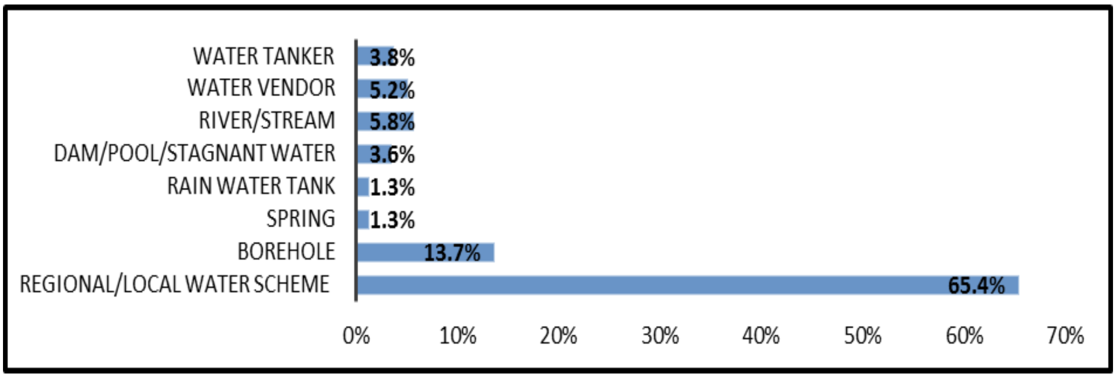

Figure 23: Source of water of households in the Middle-Olifants Sub-Catchment (Census 2011)

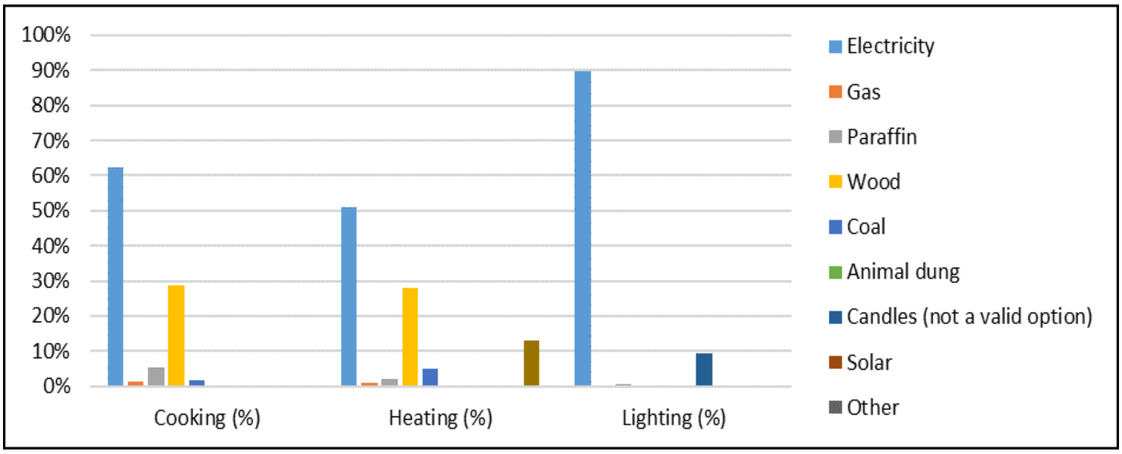

Figure 24: Energy type and use of households in the Middle-Olifants Sub-Catchment (Census 2011)

6.2.4 Developmental attributes

The Middle Olifants is largely rural in nature dominated by commercial agriculture, grazing, light manufacturing, associated activities and tourism.

The irrigation sector is by far the largest water user in the Olifants River catchment, and particularly the Middle Olifants sub-catchment with an estimated requirement of 486 million m^3/a (adjusted to 98% assurance of supply), comprising 48% of the water requirements within the Olifants catchment.

Intensive irrigation agriculture occurs around the Marble Hall and Groblersdal areas. Commercial dryland agriculture and some subsistence agriculture takes place in the Springbok Flats region. The agricultural sector in the region is relatively stable and will continue to make an important contribution to the regional economy. Protected areas in the Middle Olifants include Mbusa, Moutse, Kwaggavoetpad and Schuinsdraai Nature Reserves.

6.2.5 Land Use

Land use in the Middle Olifants is characterised by scattered rural settlements located in the Elands River catchment and extensive agriculture practised in the irrigation schemes drawing water from the Loskop Dam and the Olifants River. The major towns in the lower part are Groblersdal, Marble Hall and the urban settlements located in the Western Highveld area of the Elands River catchment.

Agricultural activities

Dryland crops are cultivated on approximately 1 500 km^2. Severe land degradation is experienced in the Middle Olifants sub-area. The main agricultural activities are maize and wheat.

Urban Areas

The main District Municipalities and municipalities in the Middle Olifants sub-catchment are:

- Nkangala District Municipality:
  - Thembisile Local Municipality: and
  - Dr JS Moroka Local Municipality
- Metsweding District Municipality:
  - Nokeng tsa Taemane Local Municipality; and
  - Kungwini Local Municipality.
- Waterberg District Municipality:
  - Modimolle Local Municipality;
  - Mookgopong Local Municipality; and
  - Bela-Bela Local Municipality.
- Greater Sekhuhune District Municipality:
  - Greater Marble Hall Local Municipality;
  - Elias Motsoaledi Local Municipality;
  - Makhuduthamaga Local Municipality;
  - Greater Tubatse Local Municipality; and
  - Fetakgomo Local Municipality.

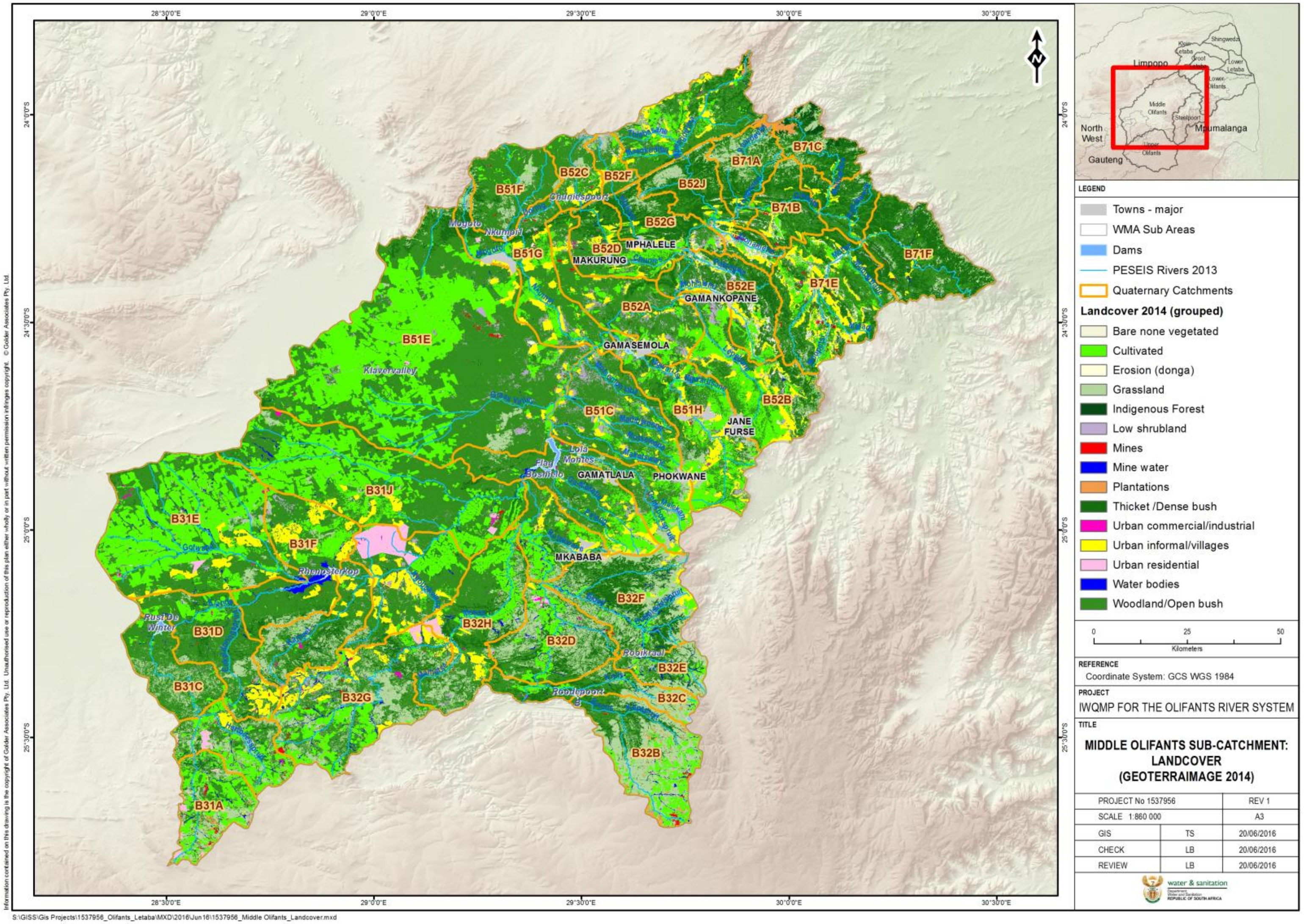

Figure 25: Middle Olifants land cover

- Capricorn District Municipality
    - Polokwane Local Municipality;
    - Lepelle Nkumpi Local Municipality; and
    - Mogalakwena Local Municipality (very small portions).

6.3 STEELPOORT SUB-CATCHMENT

6.3.1 Bio-physical environment

The Steelpoort sub-catchment (7 136 km^2) corresponds to the catchment of the Steelpoort River and its tributaries, the Dwars and Spekboom Rivers. Other rivers include the Klip, Klein Dwars, Tonteldoosloop, Witpoort and Waterval Rivers. The catchment starts from the Grootspruit River in the south; up to its confluence in the north with the Olifants River main stem and includes the towns of Belfast in the south, Steelpoort in the north and Roossenekal.

Rainfall occurs predominantly in the summer months (October – March), with January generally experiencing the heaviest rain. The mean annual rainfall for the area range between 600-1000 mm. Thunderstorms, with the associated low infiltration of the soil and erosion in mountainous areas, are common.

Average daytime summer temperatures vary between 19°C and 22°C while the winter averages are between 13°C and 19°C. Early morning frost occurs in low-lying areas. High evaporation occurs in the warm areas and evaporation rates are about 80 percent higher during summer than in winter.

The economy is characterized by mining, manufacturing, some irrigation for agriculture and tourism.

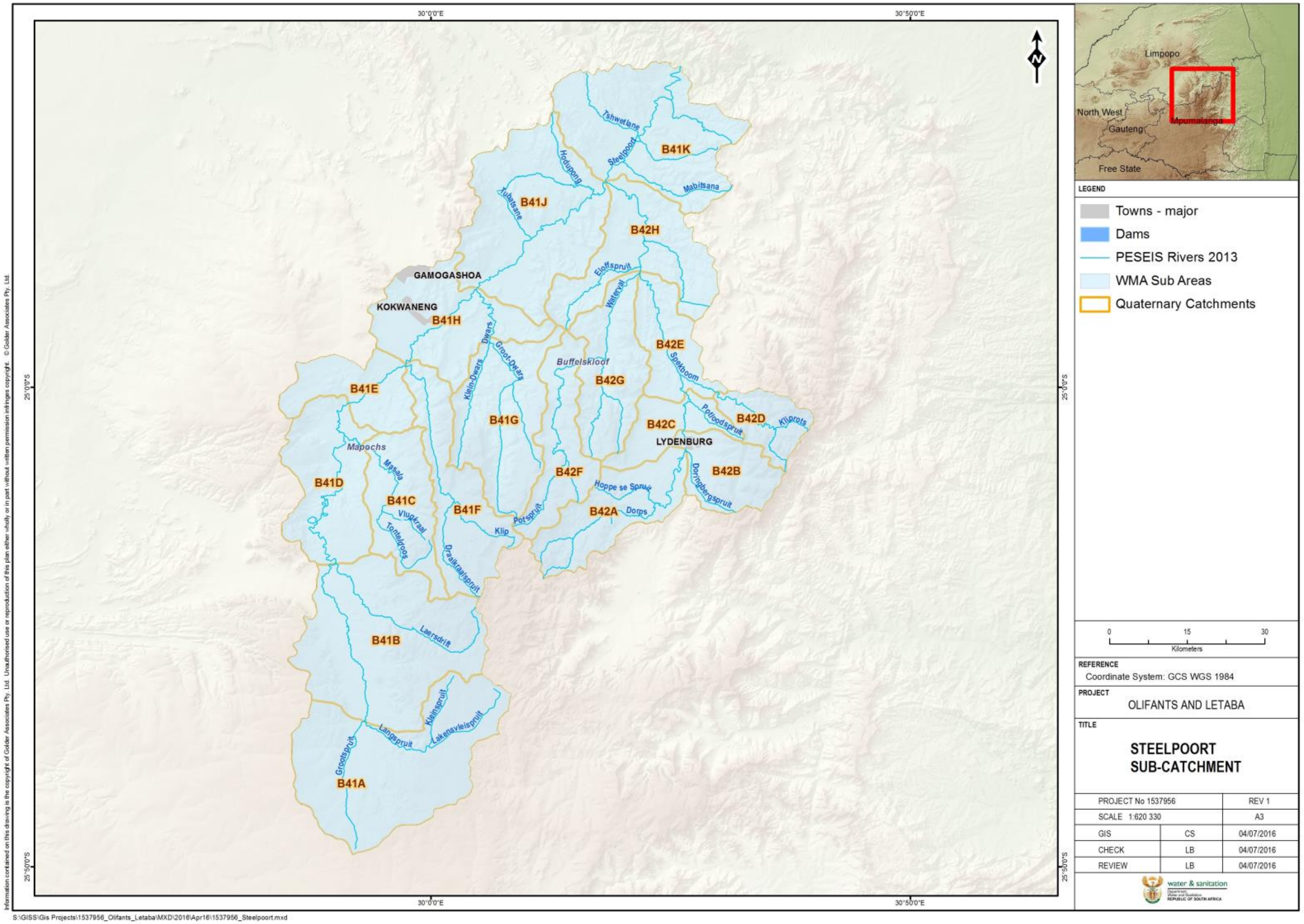

Figure 26: Steelpoort sub-catchment

6.3.2 Water Resources system

The catchment has a MAR of 396 Mm^3. There are three major dams in the catchment with a combined capacity of 17 Mm^3 and a firm yield of 18.7 Mm^3/a. The combined capacity of small and minor dams in the catchment is 20.4 Mm^3.

There are seven controlled irrigation schemes in the catchment, with a combined scheduled irrigation area of 8 621 ha. Infrastructure other than main dams include 118.08 km canal systems and 5.9 km pipelines.

6.3.3 Demography

The Steelpoort Sub-Catchment has a population of approximately 345 thousand people (345220). The population is most dense in the areas of Lydenburg, Kokwaneng and Derde Gelid (Figure 27). This population is predominantly black (94%) followed by a much smaller proportion of white residents (5%) (Figure 28). Sepedi is the chief language spoken by 70% of the population with other languages being Afrikaans (5%), IsiNdebele (6%), IsiZulu (5%), and SiSwati (7%) (Census 2011).

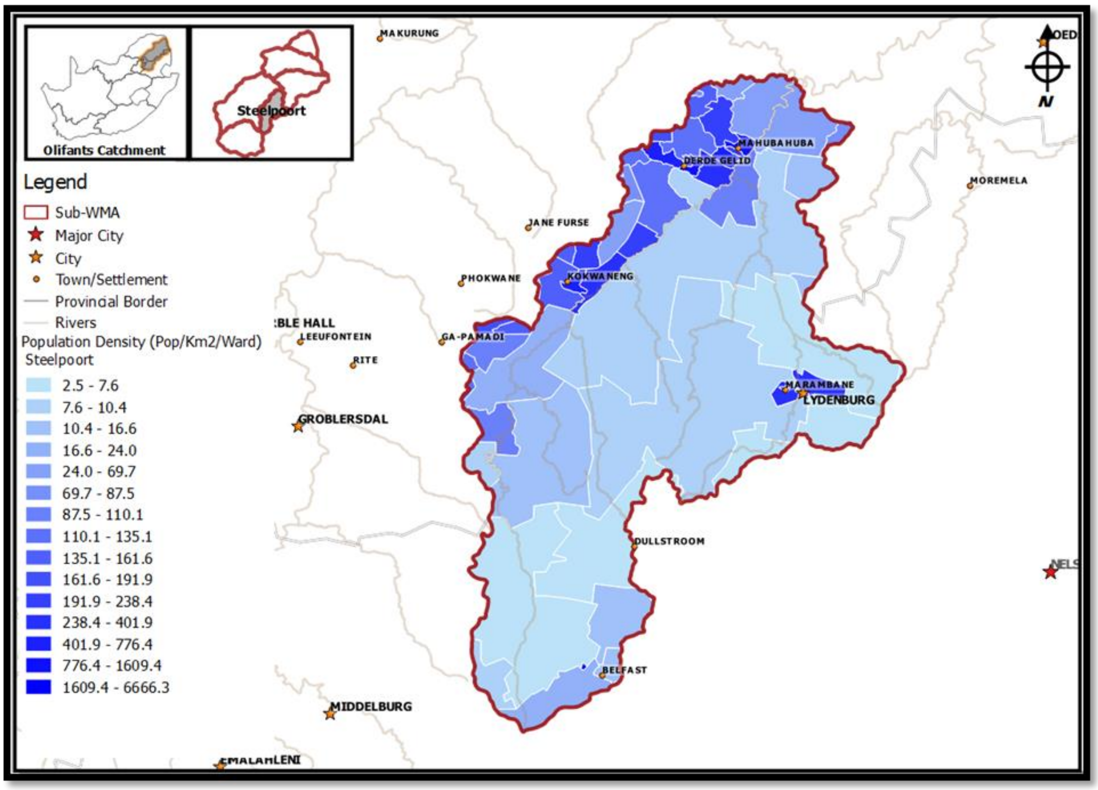

Figure 27: Population density (pop/Ha) by ward in the Steelpoort Sub-Catchment (Census 2011)

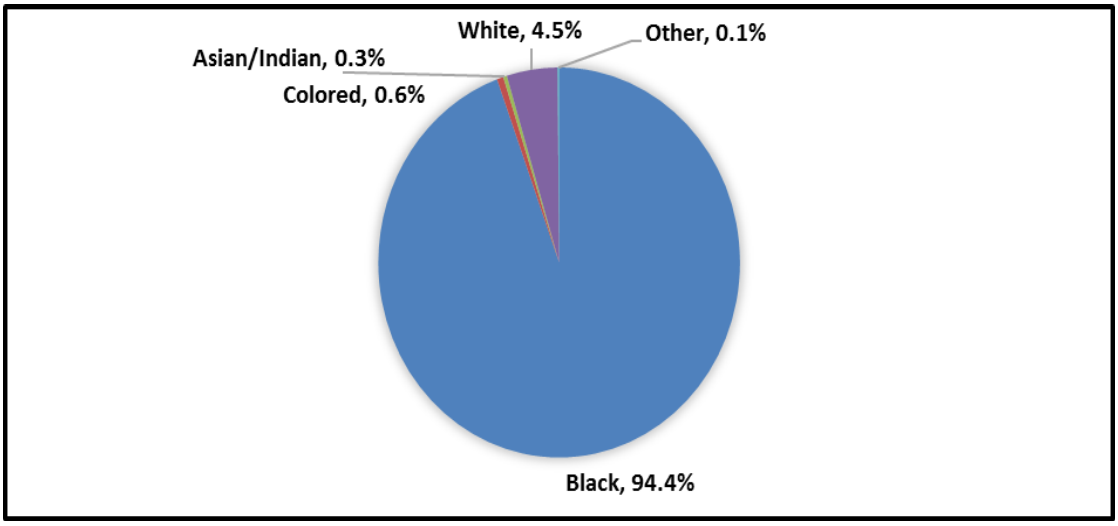

Figure 28: Population demographics of the Steelpoort Sub-Catchment (Census 2011)

A quarter of the population has little (10%) to no (15%) formal education (Figure 29). Approximately 30% of the population in the Steelpoort has received a higher level of education, with 25% having completed secondary education and 5% higher education.

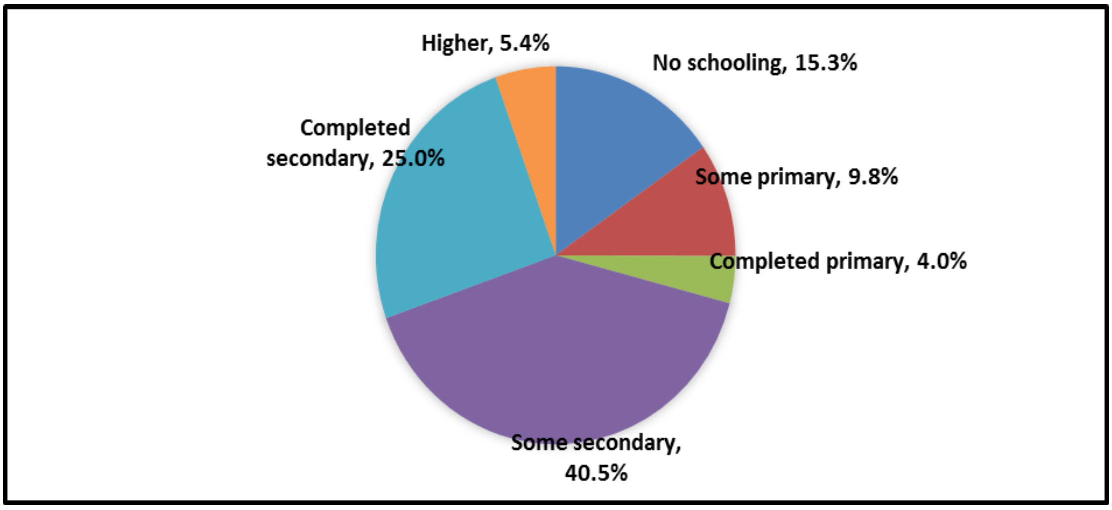

Figure 29: Education level demographics in the Steelpoort Sub-Catchment (Census 2011)

A large proportion (43%) of the population are not economically active (Figure 30). A further 26% are unemployed and are actively seeking employment. The remaining 31% are employed mostly in the formal sector. Income groups in this catchment are relatively diverse: 17.6 % of households earning in the R 9 601 to R 19 600 range and 19.2% of households earning in the R 19 601 to R 38 200 income range (Figure 31). 15% of households have no income and 5% earn less than R 4 800 per month.

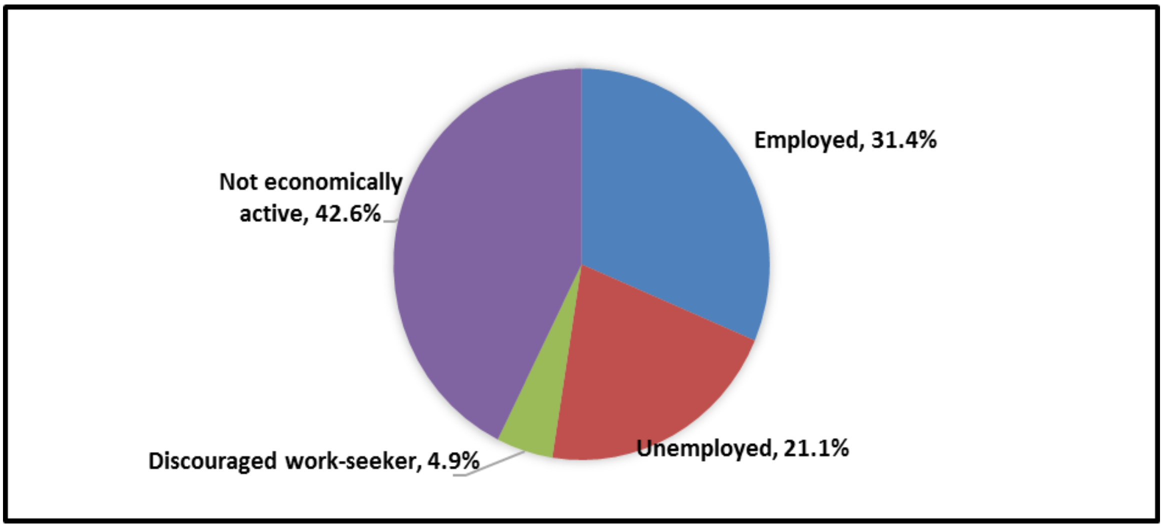

Figure 30: Employment status (Age 15-64) demographics in the Steelpoort Sub-Catchment (Census 2011)

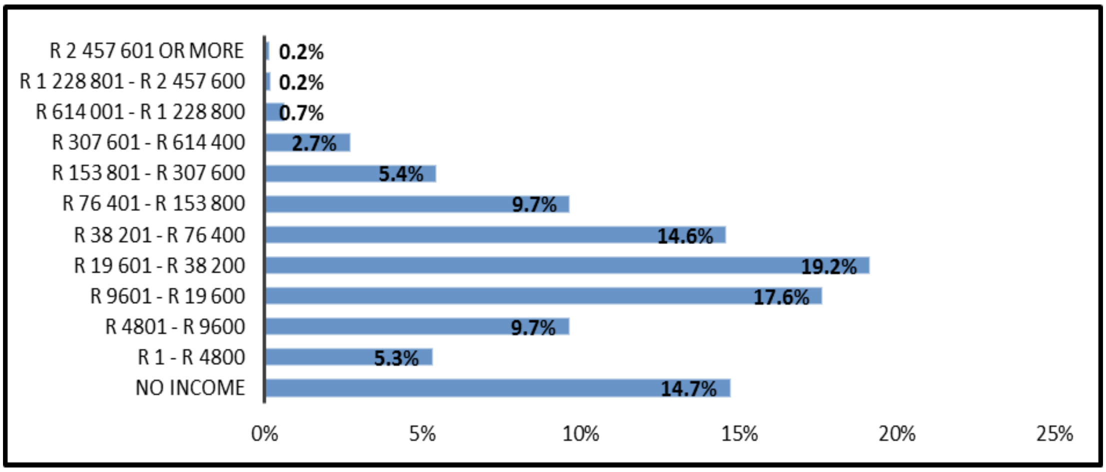

Figure 31: Income group per households in the Steelpoort Sub-Catchment (Census 2011)

Similarly to the Middle-Olifants, the Steelpoort has a comparatively smaller proportion (14%) of households living in informal dwellings (shack) and a larger proportion of households (76%) living in brick and concrete structures (Figure 32). Most households have access to piped water with approximately 66% of access being evenly spread through homes, yards and within 200m of homes (Figure 34). A relatively large 21% of households have no access to piped water. The source of water in the sub-catchment is predominantly from municipal water schemes and boreholes (71%), but 15% do get their water directly from natural sources (i.e. Rivers and springs) (Figure 35). The most commonly used toilets are pit latrines with (6%) and without (57%) ventilation. 30% of households have access to flushing toilets that are connected to the sewer system (Figure 33).

Electricity is the main source of energy in the sub-catchment, used by most households for lighting (82%) but less so for cooking (61%) and heating (48%)

(Figure 36). Wood is the second most used source of energy predominantly being used for cooking (25%) and heating (27%).

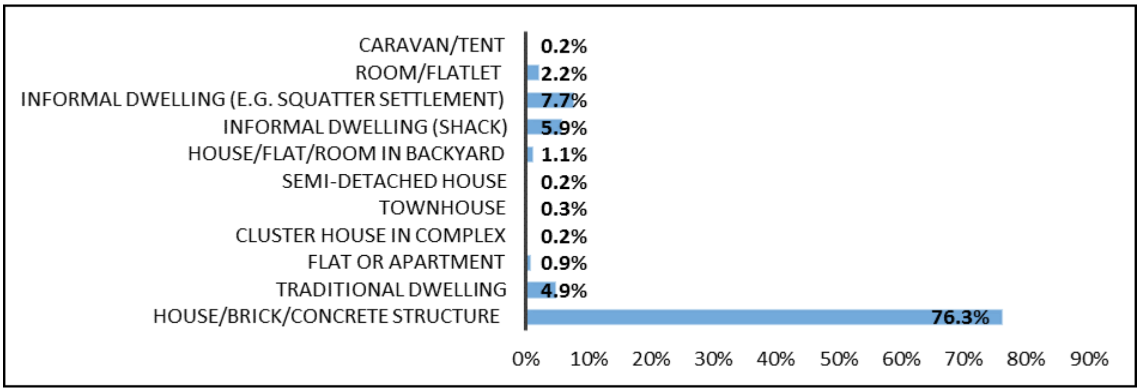

Figure 32: Dwelling demographic of the Steelpoort Sub-Catchment (Census 2011)

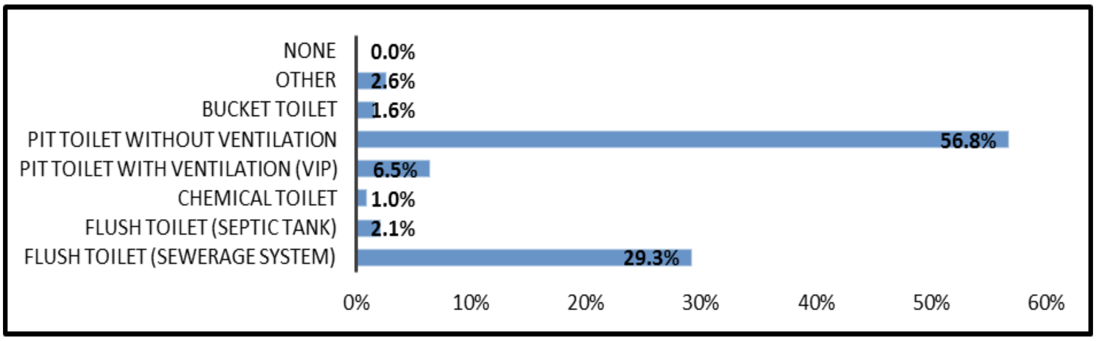

Figure 33: Toilet system demographic in the Steelpoort Sub-Catchment (Census 2011)

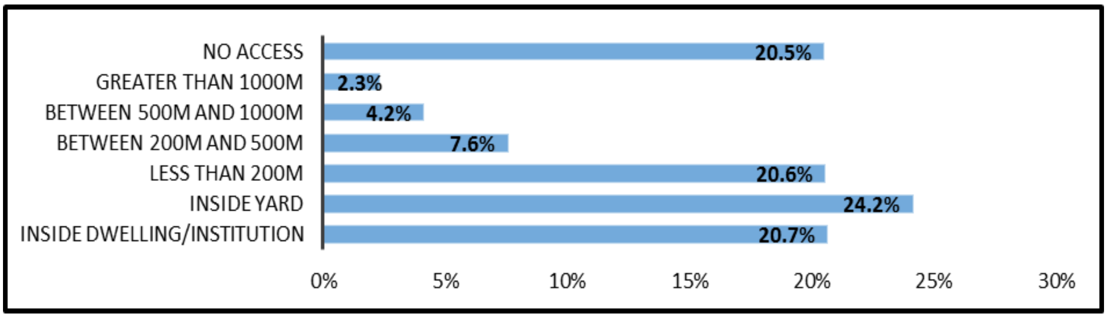

Figure 34: Water access demographic of households in the Steelpoort Sub-Catchment (Census 2011)

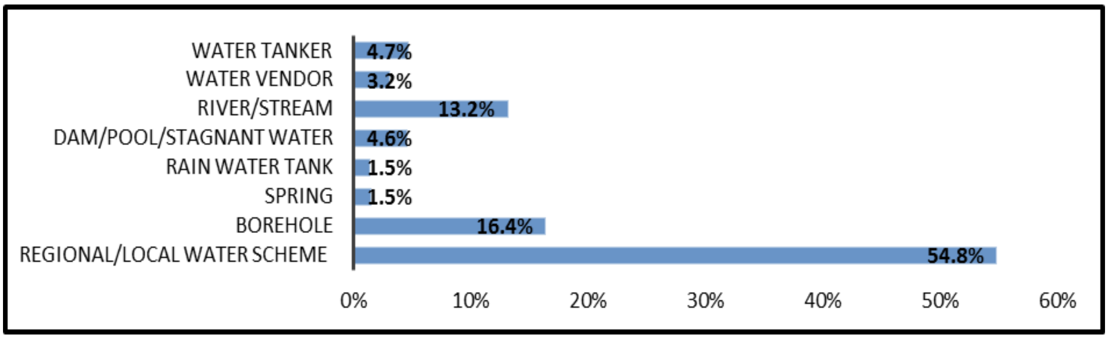

Figure 35: Source of water of households in the Steelpoort Sub-Catchment (Census 2011)

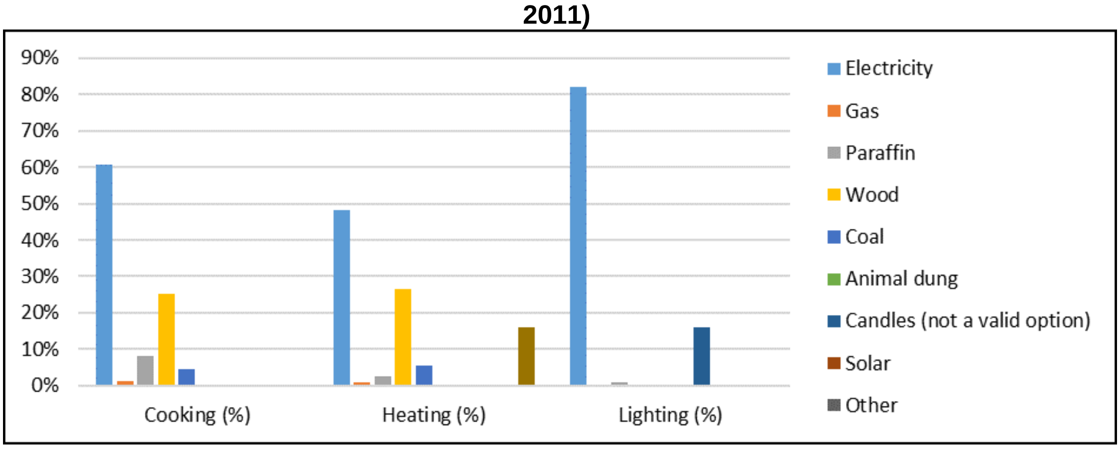

Figure 36: Energy type and use of households in the Steelpoort Sub-Catchment (Census 2011)

6.3.4 Developmental attributes

There are three major platinum mining operators present in the catchment (Amplats, Impala Platinum and Aquarius). Samancor operates the Eastern Chrome Mine (ECM) situated close to Steelpoort, Xstrata Alloys operate both the Thornecliffe and Helena Chrome Mines near Steelpoort and Evraz Highveld Steel operates the Mapochs Mine near Roossenekal.

Samancor also operates the Tubatse Ferrochrome Plant (TFC) and Xstrata Alloys' Lion Ferrochrome Operation is located near Steelpoort.

Other mining products include granite and coal. The existing mines use mainly public and borehole water and a small amount of excess water pumped from the workings.

6.3.5 Land Use

The Steelpoort catchment is dominated by grassland, woodland and cultivated areas. The land-use cover is as follows:

- Irrigation crops: 94 km^2;
- Dryland crops: 605 km^2;
- Afforestation: 75 km^2; and
- Livestock and game: 20 500 units, mainly sheep.

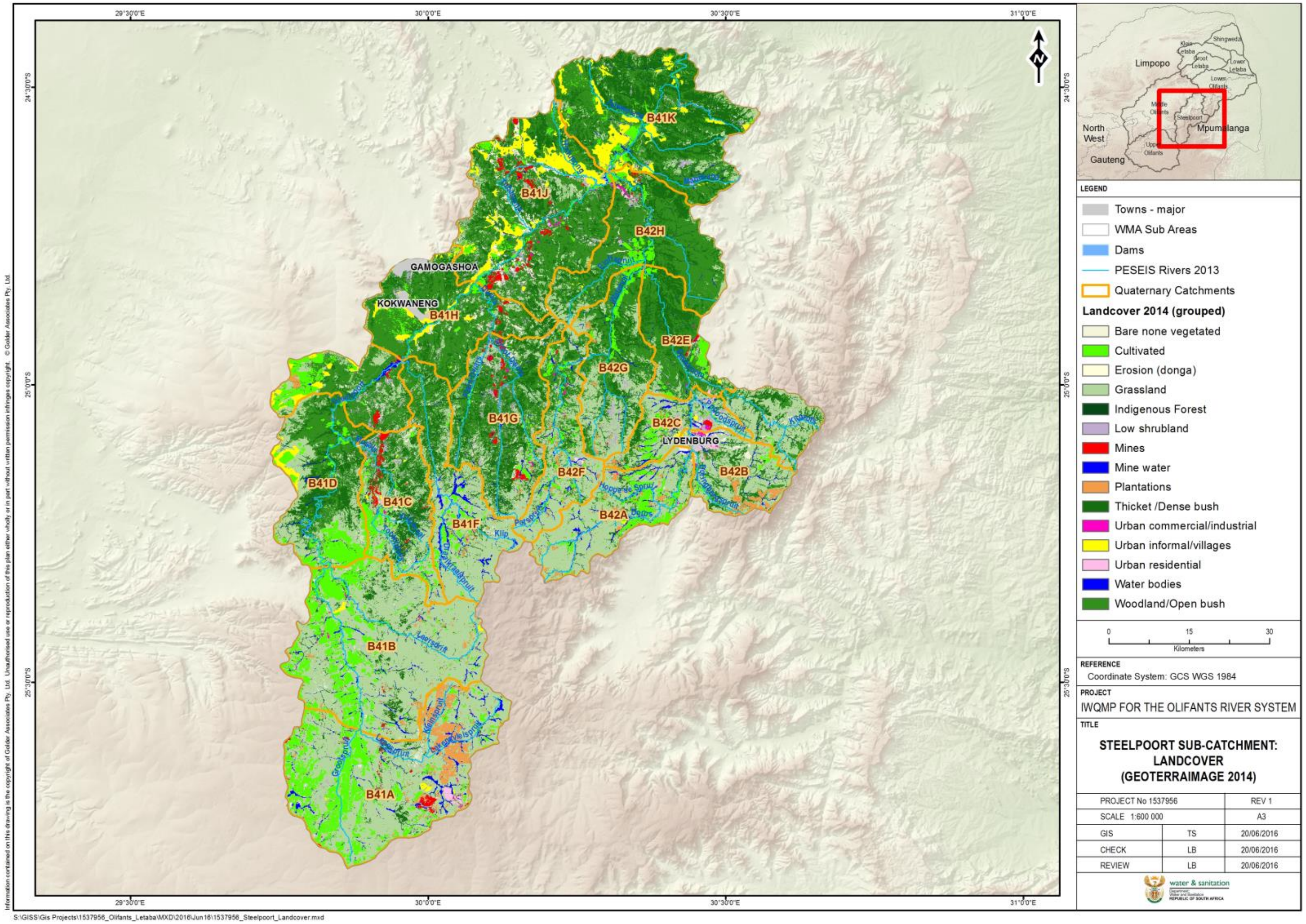

Figure 37: Steelpoort Land cover

6.4 LOWER OLIFANTS SUB-CATCHMENTS

6.4.1 Bio-physical environment

The Lower Olifants sub-area (12,154 km^2) represents the catchment of the Olifants River between the Steelpoort confluence and the Mozambique border. Two significant towns in the Lower Olifants River catchment are Phalaborwa and Hoedspruit. Rural residences are, to a large extent, in scattered informal villages with limited services and commerce. The catchment area also includes parts of the Kruger National Park (KNP) and is therefore of high conservation status. The main economic activity is eco-tourism.

The climate of the area tends to be hot and humid. The yearly average maximum temperature is around 29ºC; the annual average minimum is just under 16ºC. The hottest months of the year are usually December, January and February where temperatures routinely exceed 31ºC. The coolest months are June and July where the average minima and maxima are 9ºC and 24.7ºC respectively. The local weather system yields a subtropical climate with hot, humid summers and mild, dry winters. Day temperatures of above 35° in summer are a common phenomenon.

Like most other semi-arid regions of the world, the area is exposed to great variations in the amount of rainfall received in any one year. The average rainfall is around 500mm per annum. Rain usually falls between October and March, with a peak in December and January. On average there are thunderstorms for only 25 days of the year. High temperatures result in high evaporation rates.

6.4.2 Water Resources system

The Lower Olifants catchment includes the B60, B72 and B73 tertiary catchments. Phalaborwa and Hoedspruit source their water from the Phalaborwa Barrage but can be supplemented by releases from the Blyderivierpoort Dam.

In the Lower Olifants, water quality is affected by mining and industrial return flows from the Phalaborwa Mining and Industrial Complex. Discharge of mine effluent into the Selati River near Phalaborwa poses water quality problems downstream in the Kruger National Park. This lower part of the WMA is characterised by a deficit although users upstream of the Tzaneen Dam have an adequate supply.

Large-scale afforestation in the upper catchments has a large impact on the water resources. There might be limited scope for further improvements. Implementation of the Reserve however is critical and it must be noted that its implementation could result in serious socio-economic disruption in this sub-catchment.

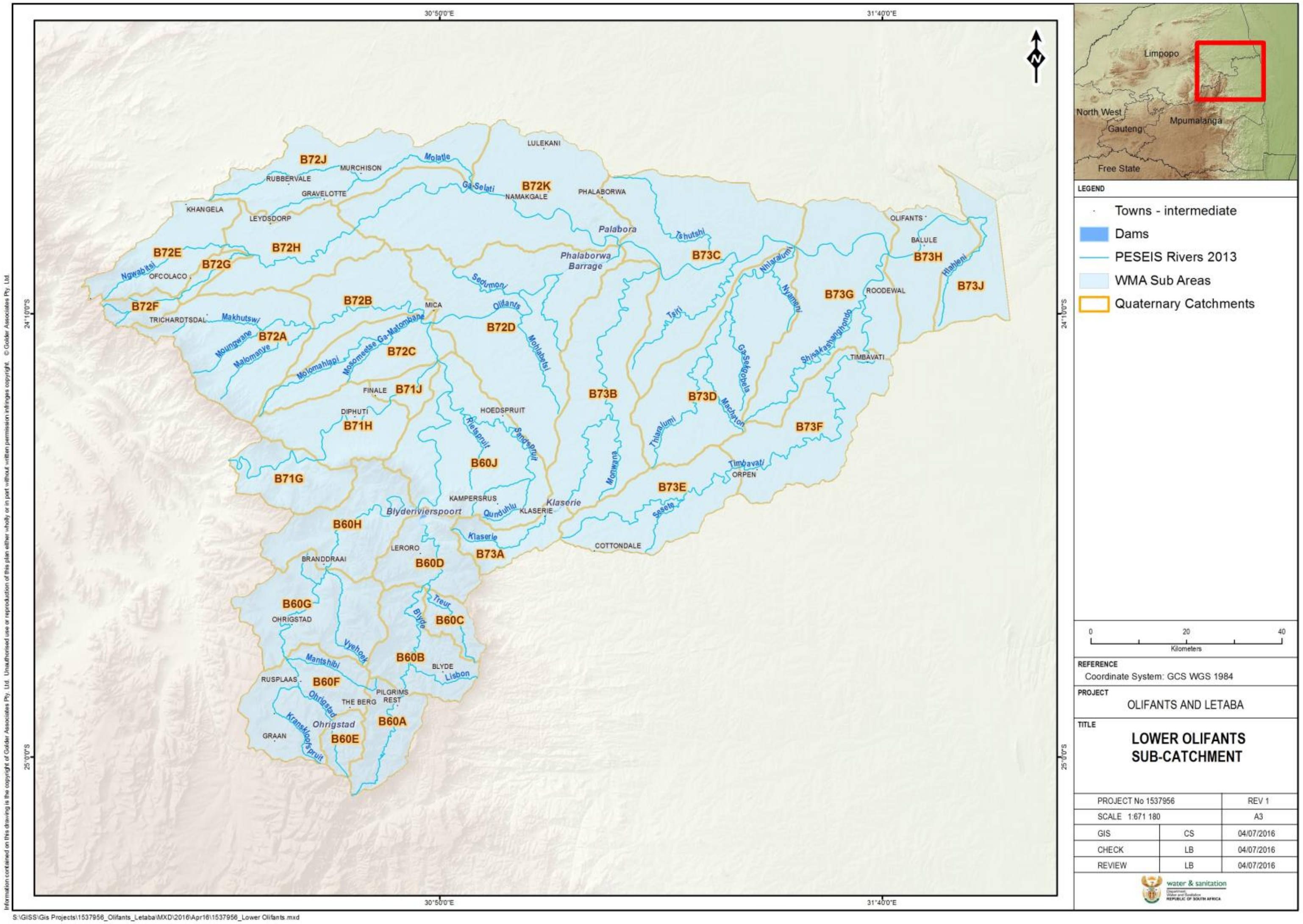

Figure 38: Lower Olifants sub-catchments

6.4.3 Demography

The population of the Lower-Olifants Sub-Catchment is approximately 350 thousand (350 933) of which most are black at 96% and 3% are white (Figure 40). Population density hotspots include areas surrounding Phalaborwa, Lorraine and Moremela (Figure 39). The languages predominantly spoken are Sepedi (59%) and Xitsonga (31%) (Census 2011).

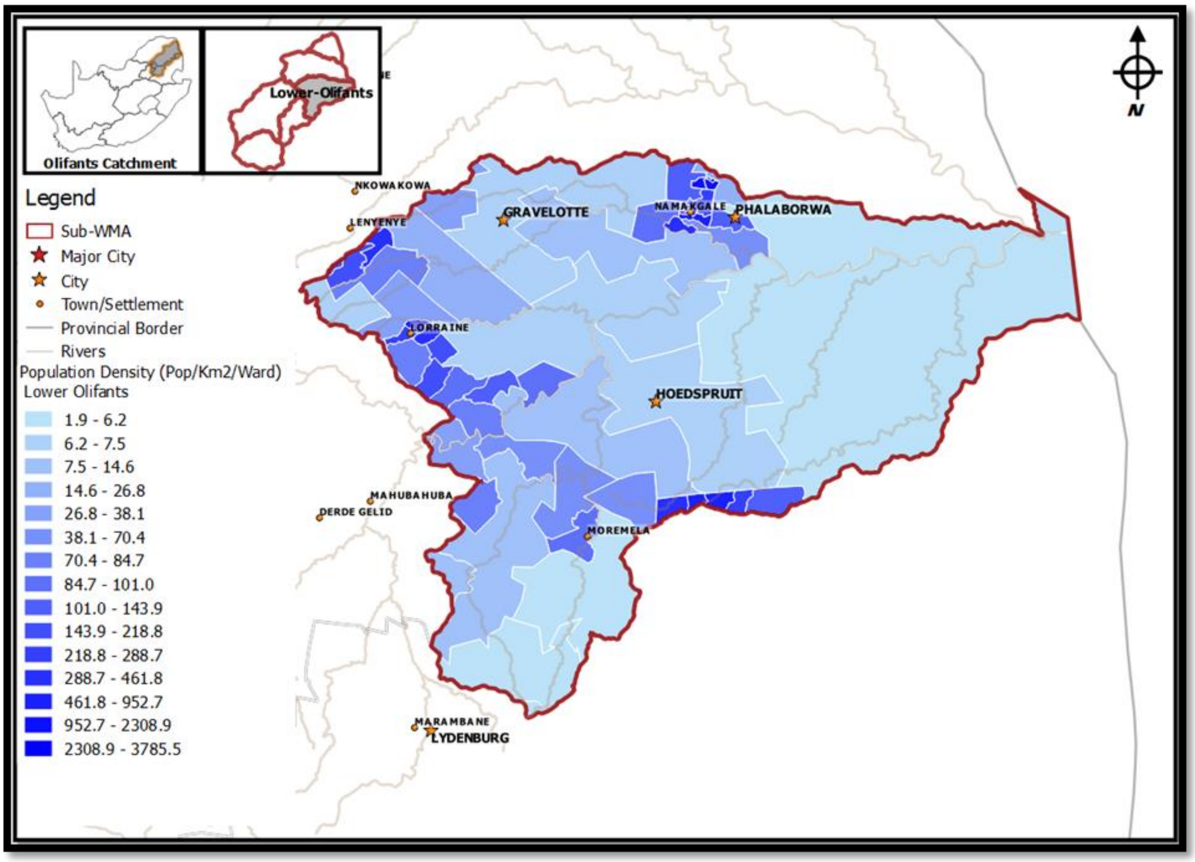

Figure 39: Population density (pop/Ha) by ward in the Lower-Olifants Sub-Catchment (Census 2011)

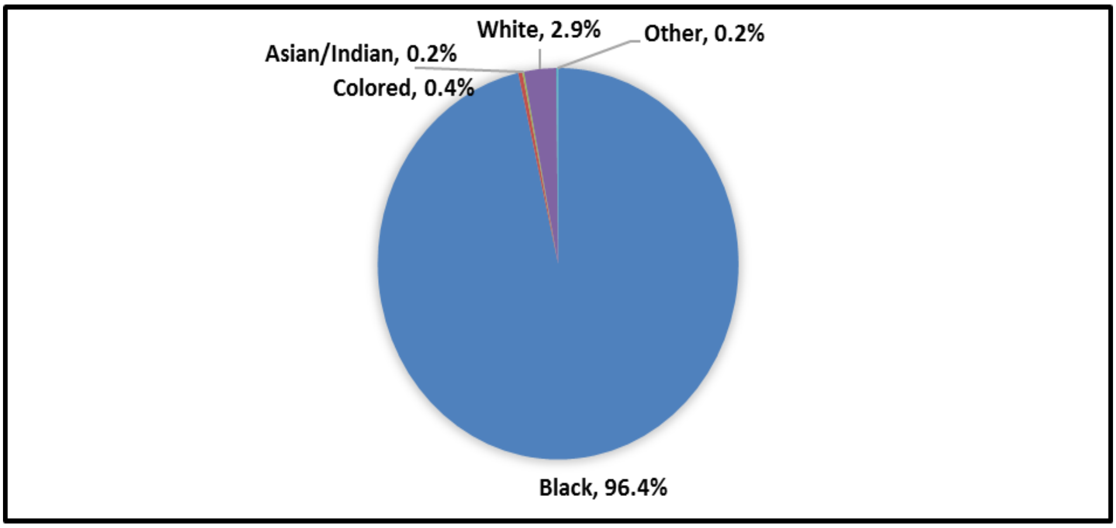

Figure 40: Population demographics of the Lower-Olifants Sub-Catchment (Census 2011)

Approximately a third of the sub-catchment has little (12%) to no (18%) formal education while approximately another third has a much higher level of education having completed secondary (23%) and obtained higher (6%) education (Figure 41).

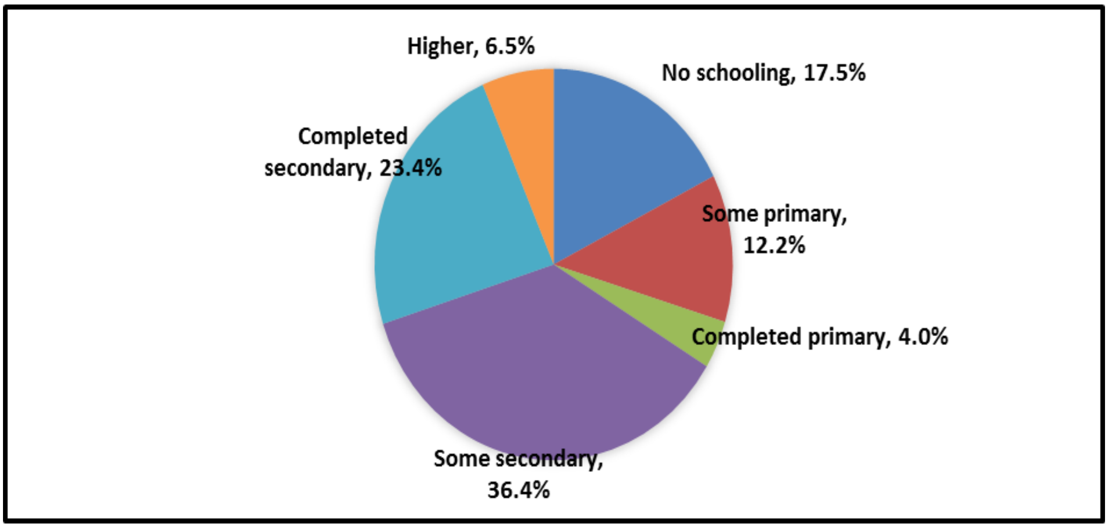

Figure 41: Education level demographics in the Lower-Olifants Sub-Catchment (Census 2011)

Almost half of the sub-catchment (47%) does not actively take part in the economy (Figure 42). Only 27% are employed, most of which in the formal sector (66%). The leading income groups per household are earnings between R 9601 to R 19 600 and R 19 601 to R 38 200 per month with 23% and 20% of households respectively (Figure 42). 14% of households have no income and 7% earn less than R 4 800 per month.

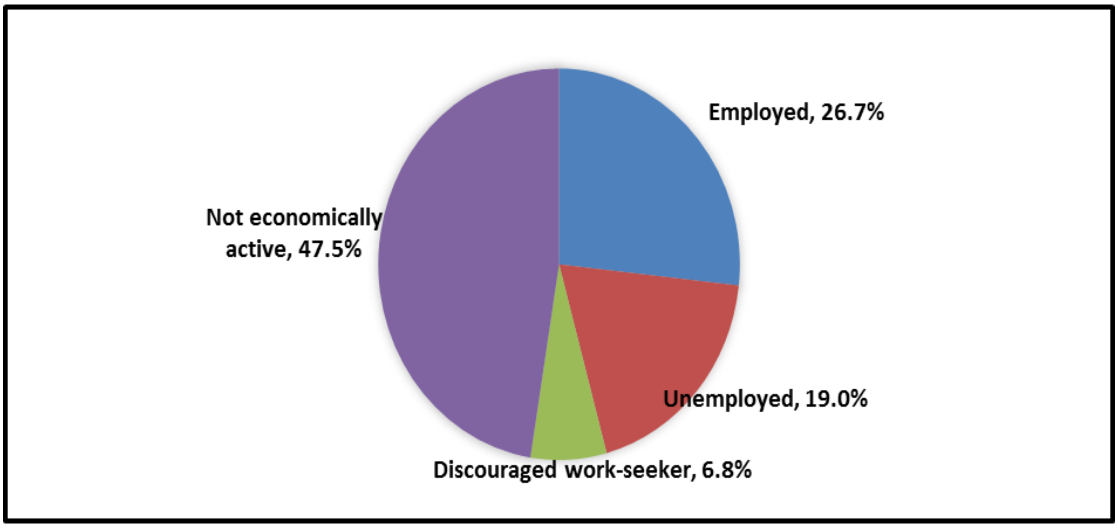

Figure 42: Employment status (Age 15-64) demographics in the Lower-Olifants Sub-Catchment (Census 2011)

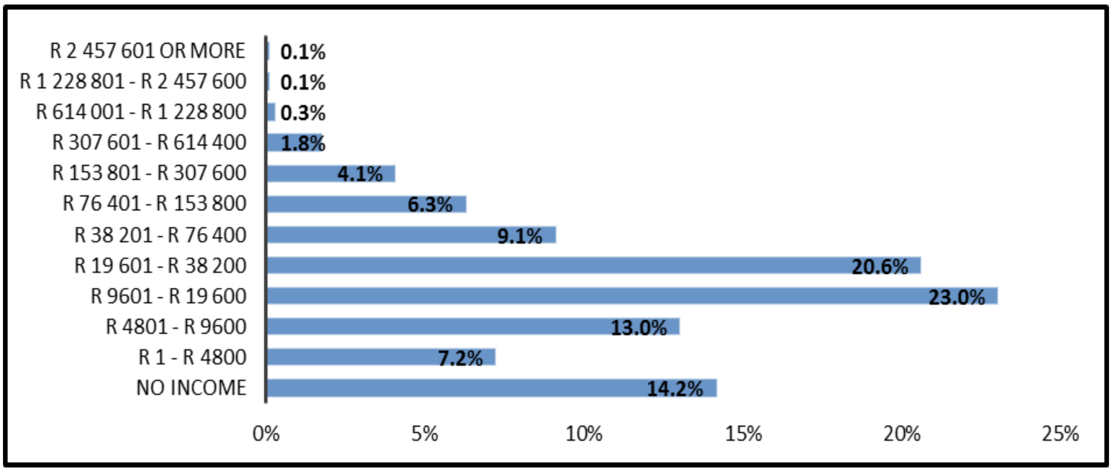

Figure 43: Income group per households in the Lower-Olifants Sub-Catchment (Census 2011)

Housing in the sub-catchment is chiefly characterised by brick and concrete houses (92%) and traditional made homes (4%) (Figure 44). 19% of households have access to piped water within their homes and another 38% in their yards (Figure 46). 32% need to leave their property to get access to piped water and another 13% do not have access at all. 74% of households utilise pit latrines and 24% have access to flushing toilets (Figure 45). Much of the sub-catchments water is sourced from the municipality (59%) and boreholes (15%) (Figure 47). A large proportion of households get their water through more natural sources such as rivers or streams (13%) and dams (6%).

Electricity is used by 89% of households for lighting purposes (Figure 44). Both wood and electricity are used to a similar degree for cooking and heating purposes

(Approximately 48% and 40% respectively). 19% of households do not use energy for heating.

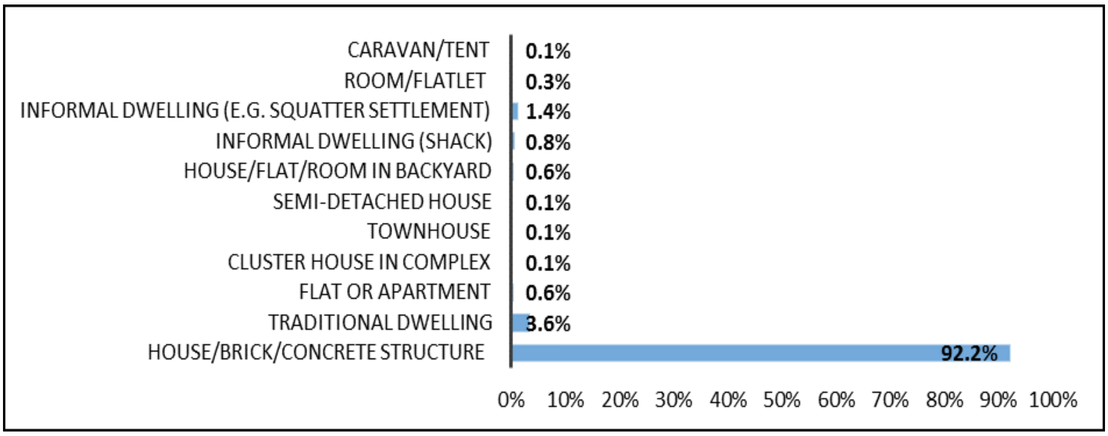

Figure 44: Dwelling demographic of the Lower-Olifants Sub-Catchment (Census 2011)

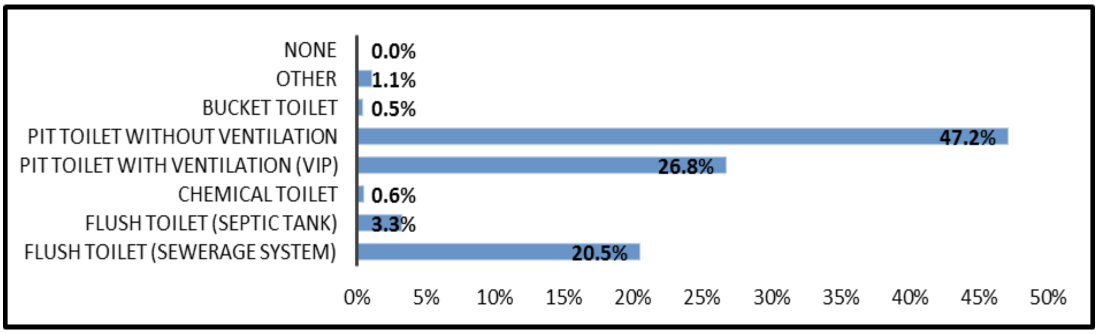

Figure 45: Toilet system demographic in the Lower-Olifants Sub-Catchment (Census 2011)

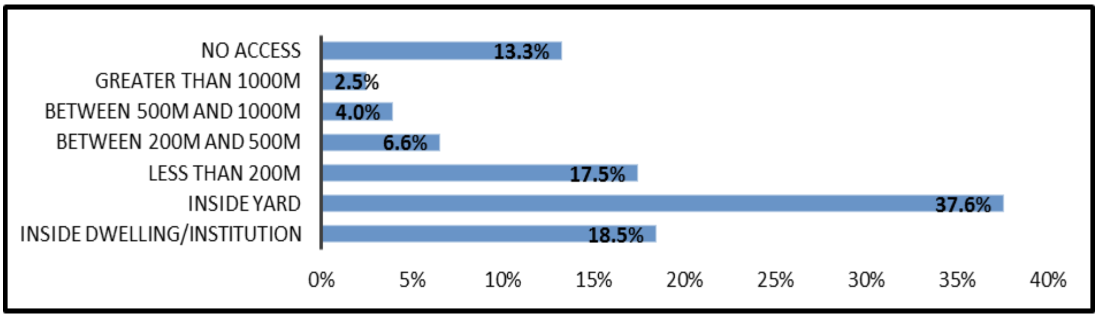

Figure 46: Water access demographic of households in the Lower-Olifants Sub-Catchment (Census 2011)

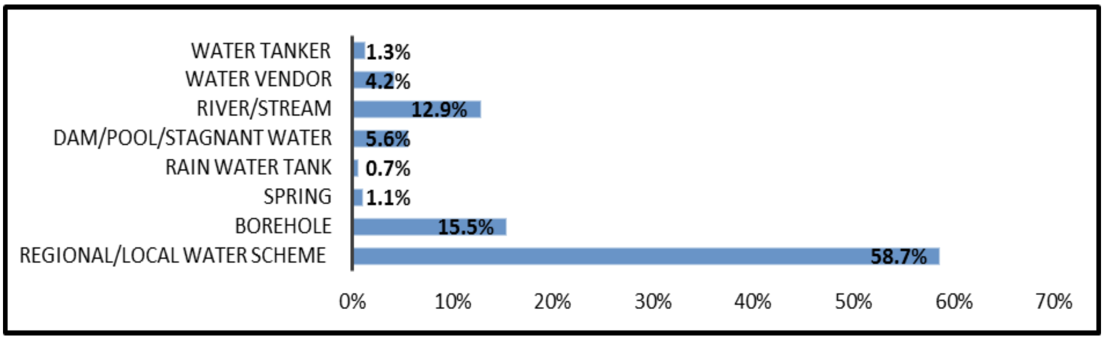

Figure 47: Source of water of households in the Lower-Olifants Sub-Catchment (Census 2011)

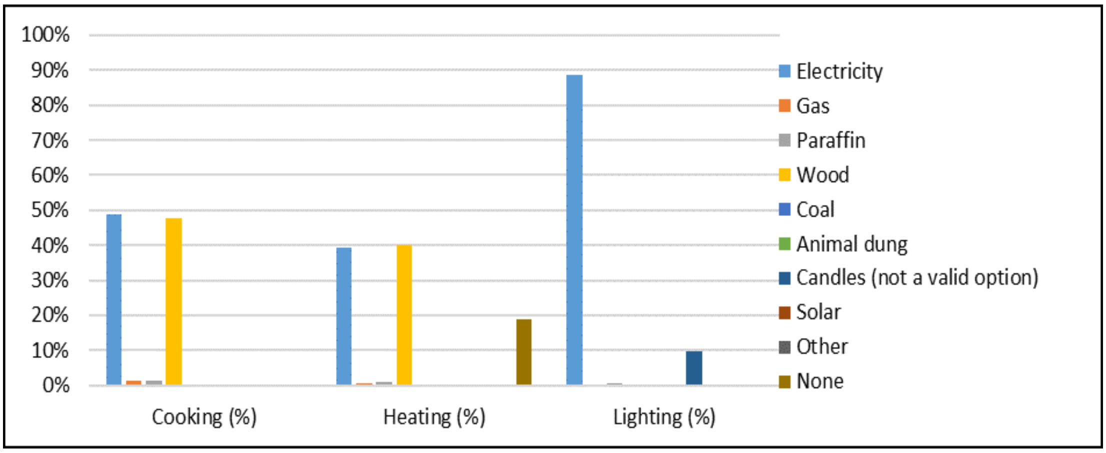

Figure 48: Energy type and use of households in the Lower-Olifants Sub-Catchment (Census 2011)

6.4.4 Developmental attributes

Tourism is an important economic activity in the Lower Olifants and contributes to employment created in the Trade, Accommodation and Transport sectors. There is also mining in the Lower Olifants sub-area, with the main mining activity being the copper and phosphorus mining taking place in the vicinity of Phalaborwa.

6.4.5 Land Use

The Lower Olifants sub-catchment is characterized by intensive agriculture (especially near Hoedspruit), rural subsistence, and eco-tourism and light commercial activities. The area under dryland, irrigated and subsistence agriculture incorporates approximately 23 659 ha. The agriculture, hunting, forestry and fishing sector supply the largest number of jobs in the Lower Olifants.

Mining activities include the Phalaborwa Mining Company and Foskor, which receive water from the Phalaborwa Water Board, and are the major water users among the mines. Products in this area include copper, emeralds, asbestos, magnetite, phosphate, clay, feldspar, slate, fertilizer, gold, mica, crushed stone, platinum, andalusite and chrome.

Irrigation in the Lower Olifants is extensive with nearly 12 000 ha within irrigation schemes. The Lower Olifants River catchment contains a section of the Kruger National Park.

6.5 LETABA SUB-CATCHMENT

6.5.1 Bio-physical environment

The Letaba River catchment is located in the Limpopo Province and covers a total area of 13 400 km^2. The Letaba River catchment is drained by the Groot Letaba River and its major tributaries the Klein Letaba, Middle Letaba, Letsitele and Molototsi rivers. From the confluence of the Klein and Groot Letaba Rivers, the Letaba River flows through the Kruger National Park until it joins the Olifants River near the border with Mozambique.

The topography of the Letaba varies from a zone of high mountains in the west through low mountains and foothills to the low lying plains in the east. The mountainous zone or Great Escarpment includes the northern portion of the Drakensberg mountain range and the eastern Soutpansberg, which both extend to the western parts of the water management area, and the characteristic wide expanse of the Lowveld to the east of the escarpment. The highest peaks have an elevation of more than 2 000 m above mean sea level (amsl). This zone is deeply incised by the major tributaries. The low lying plains cover most of the area and has gentle to flat slopes.

Rainfall mostly occurs during the summer of which peak rainfall months are January and February with mean annual precipitation (MAP) of 612 mm. The annual temperature ranges from 18°C in the mountainous areas to more than 28°C in the northern and eastern parts of the area. The highest temperatures occur in January and the coldest in July.

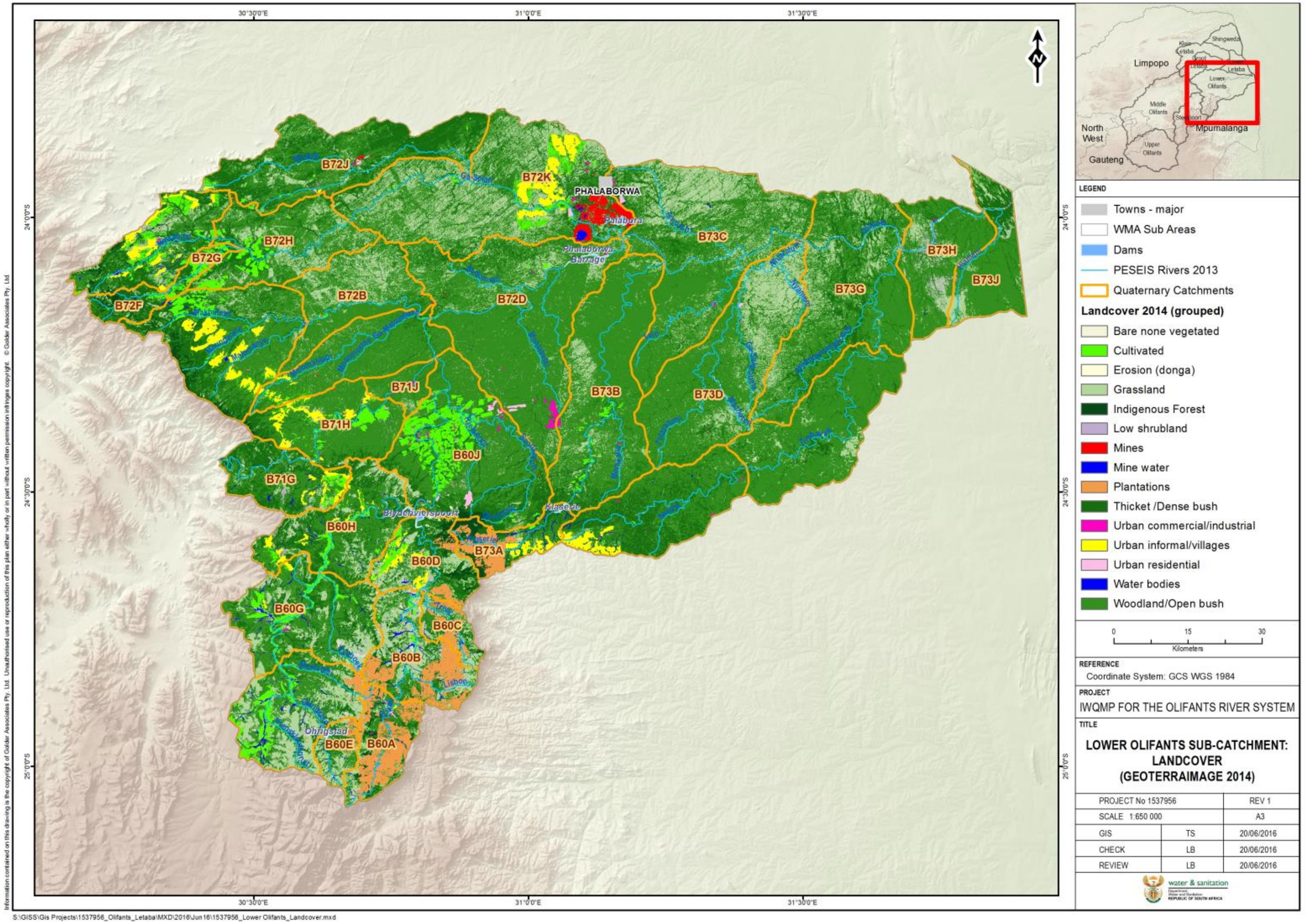

Figure 49: Lower Olifants land cover

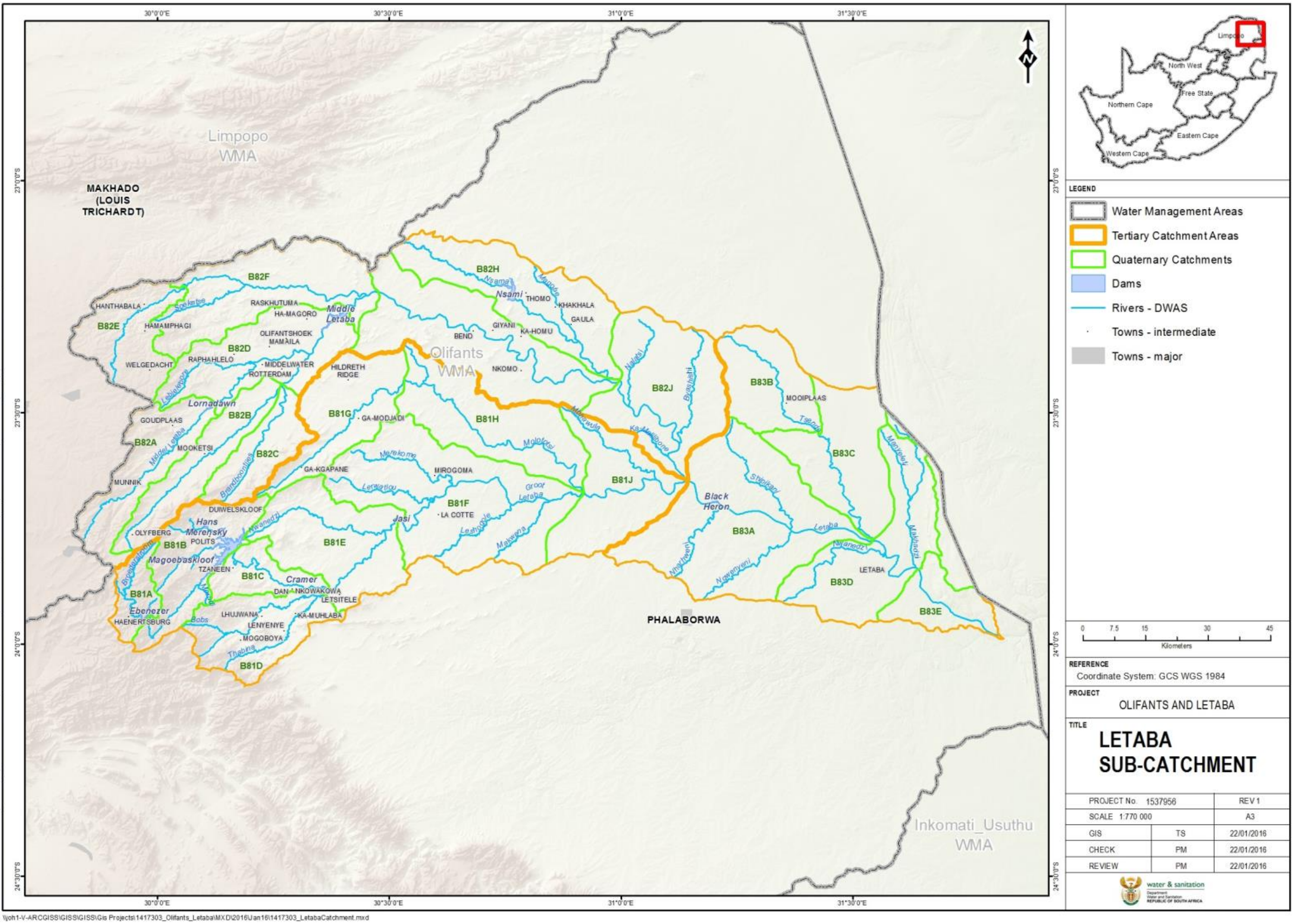

Figure 50: Letaba sub-catchment

6.5.2 Water Resources system

The gross surface water availability in the Groot Letaba sub-area is estimated at 168 Mm^3/a, which is derived from the yield of the Tzaneen and Ebenezer dams as well as significant run-of-river abstractions. The Tzaneen Dam, if operated in isolation, provides a yield of approximately 60 Mm^3/a. However, when operated in a systems context to supply water to irrigators downstream only when the run-of-river flows are inadequate, the total yield is much greater. Hence the large gross yield of the system.

Mean annual runoff (MAR) is 574 Mm^3. More than 20 major dams have been constructed in the Groot Letaba River catchment. The Tzaneen Dam on the Groot Letaba River and the Middel Letaba Dam are the two largest dams in the Limpopo Province. Other large dams in the catchment include the Ebenezer, Magoebaskloof, Nsami and Modjadji Dams.

6.5.3 Demography

There are approximately 1.1 million (1 110 335) people residing in the Letaba Sub-Catchment of which the highest densities are in the areas of Tzaneen, Ga Kgapane and Giyani (Figure 61). The vast majority are black (97%) much less being white (2%) (Figure 52). Two main languages are spoken in the area, these are Xitsonga (46%) and Sepedi (35%) and to a lesser degree Tshivenda (12%) (Census 2011).

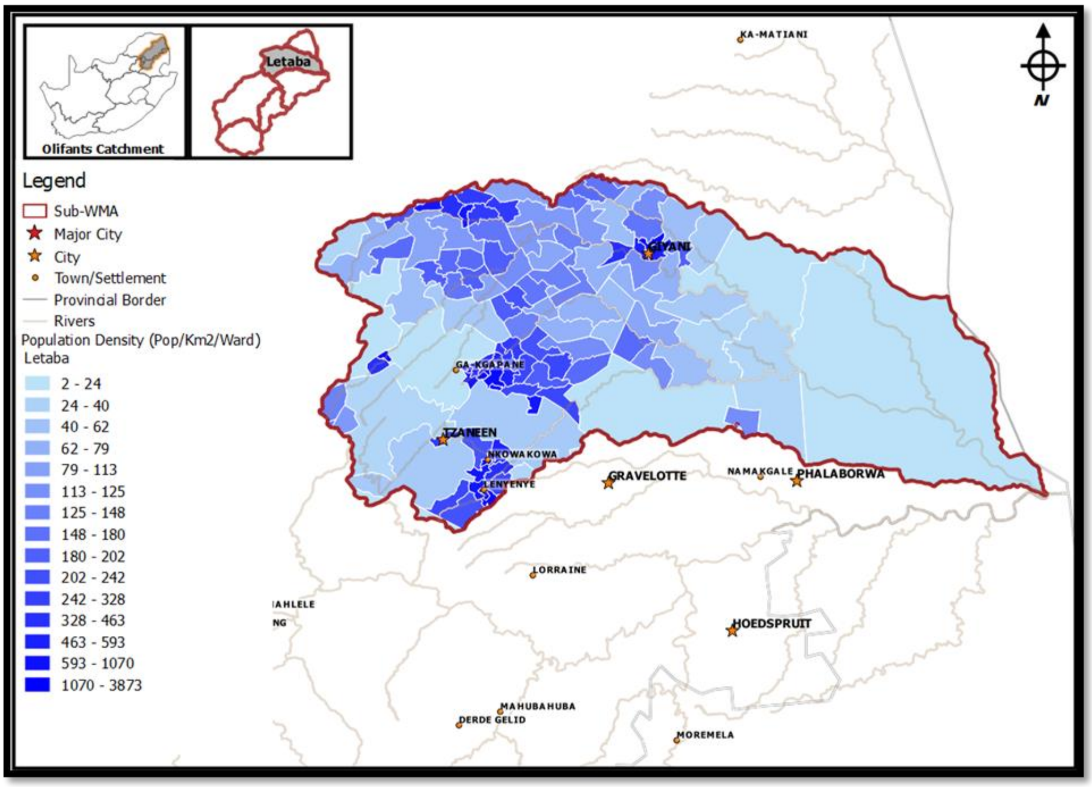

Figure 51: Population density (pop/Ha) by ward in the Letaba Sub-Catchment (Census 2011)

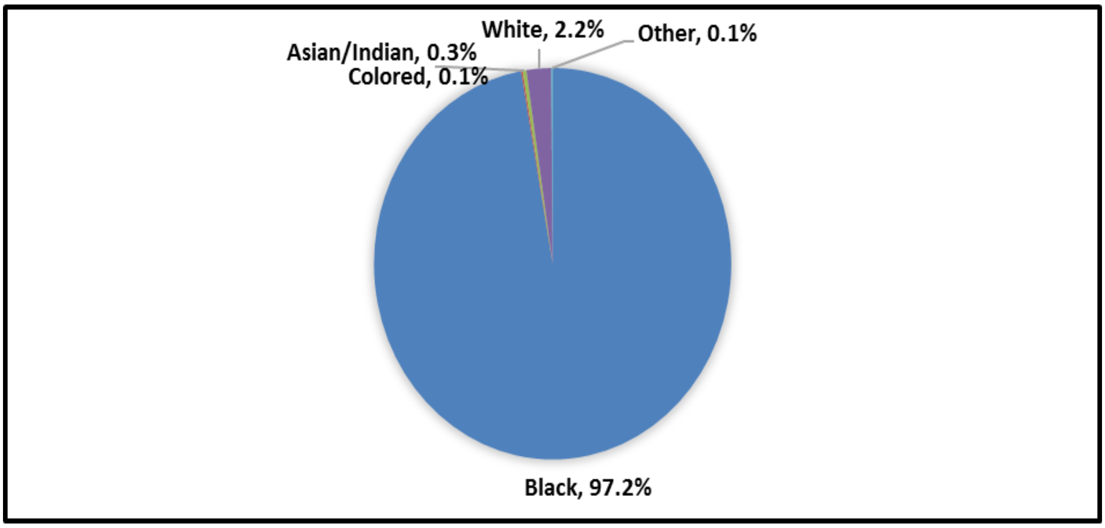

Figure 52: Population demographics of the Letaba Sub-Catchment (Census 2011)

A third of the Letaba population have little to no formal education (33%), with only 11% having some primary and 22% having no formal education at all (Figure 53). Another third have some secondary education and the last third are relatively well educated having completed secondary education (21%) and have had higher education (8%).

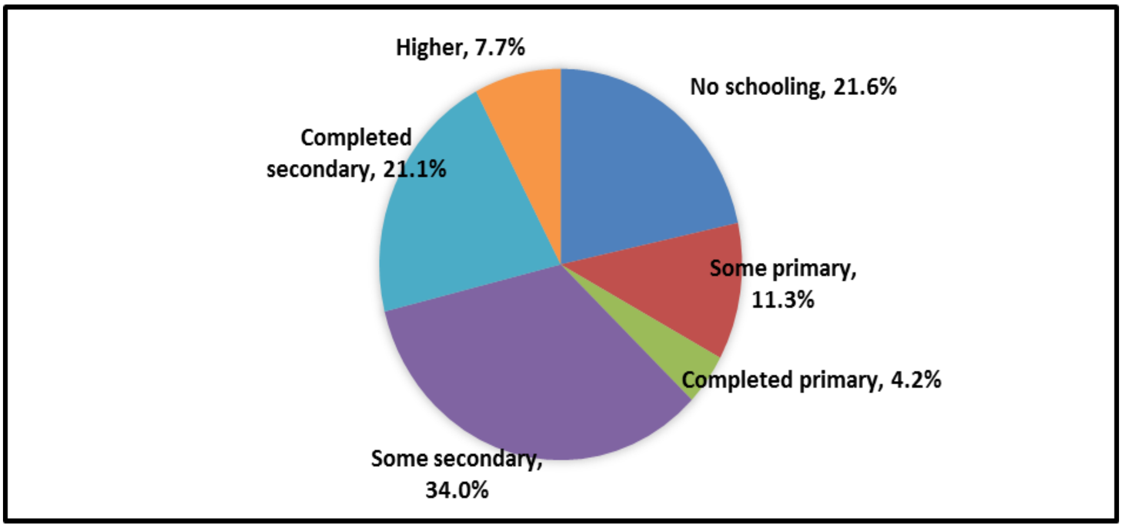

Figure 53: Education level demographics in the Letaba Sub-Catchment (Census 2011)

More than half (51%) of the residents in the Letaba Sub-Catchment are not economically active (Figure 54). Only half of residents who are economically active are actually employed, with the rest looking for employment. Of the employed individuals, 65% are employed in the formal sector (Census 2011). The largest income group of 24% of households earn between R9601 and R 19600 a month closely followed by 21% of the R19601 to R38200 income group (Figure 55). 14% of households in the catchment have no income and 8% earn less than R 4 800 a month.

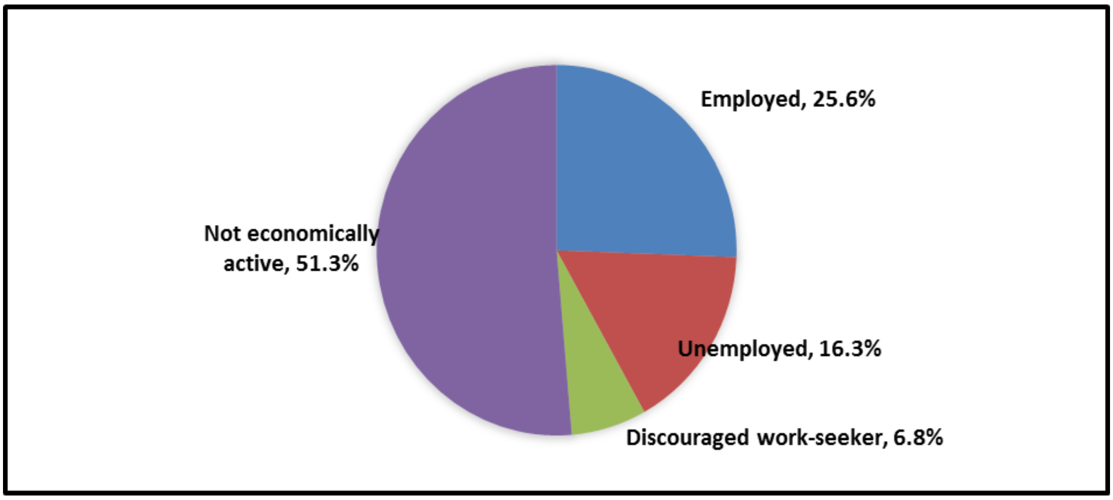

Figure 54: Employment status (Age 15-64) demographics in the Letaba sub-catchment (Census 2011)

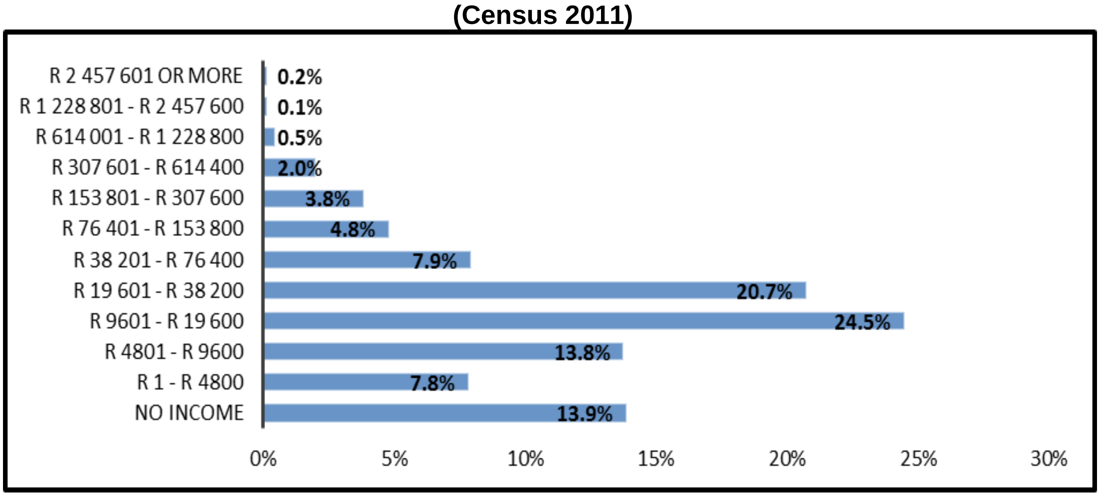

Figure 55: Income group per households in the Letaba Sub-Catchment (Census 2011)

Although most of the sub-catchments households live within brick or concrete houses (89%) (Figure 56), only 15% have piped water within their homes however 31% have access in their yards and 22% within 200m of their homes (Figure 58). 16% of residents have no access to piped water. The majority of households get their water from the municipality (58%) with a smaller yet substantial proportion using boreholes (19%) (Figure 59). The rest get water through more traditional and natural means.

Only 19% of households have flushing toilets therefore households in the sub-catchment predominantly use pit toilets with 58% and 20% of households using ventilated and non-ventilated pit latrines (Figure 57).

Energy use varies greatly with its purpose with most households (88%) having access to electricity for lighting (Figure 56). Electricity is still a common source of energy for cooking and heating however wood is the predominantly used source for these purposes being used by 61% and 48% respectively.

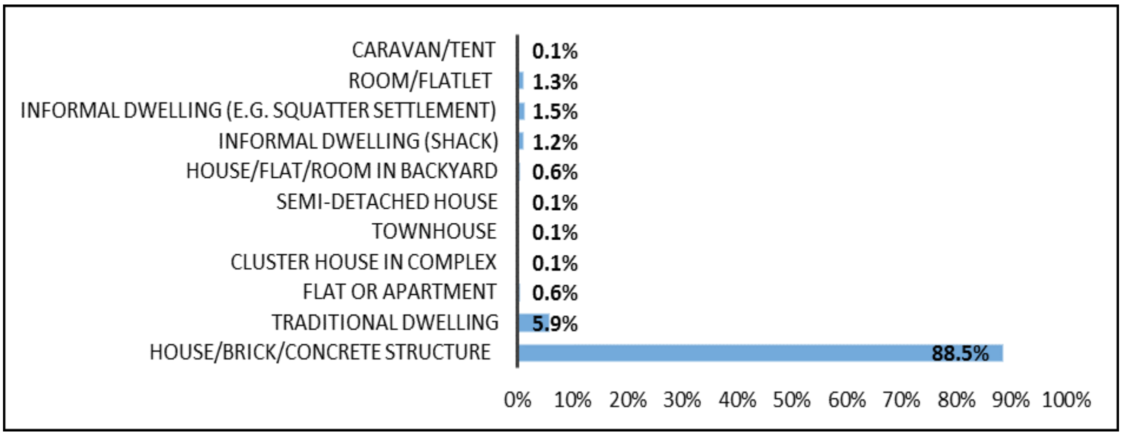

Figure 56: Dwelling demographic of the Letaba Sub-Catchment (Census 2011)

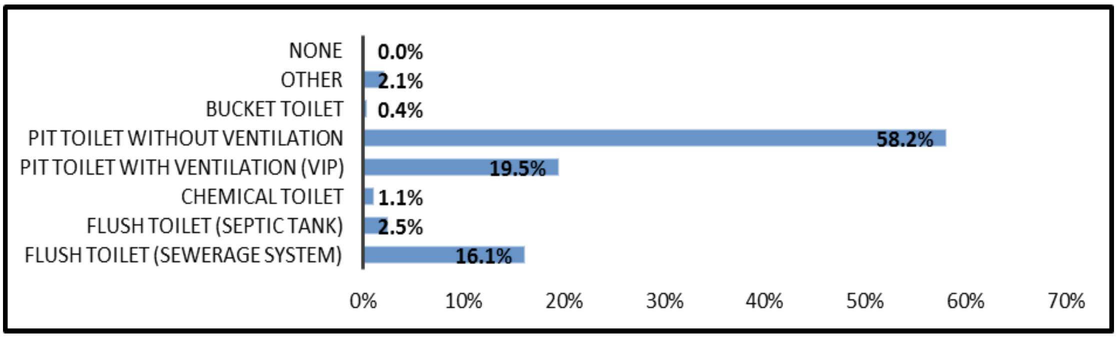

Figure 57: Toilet system demographic in the Letaba Sub-Catchment (Census 2011)

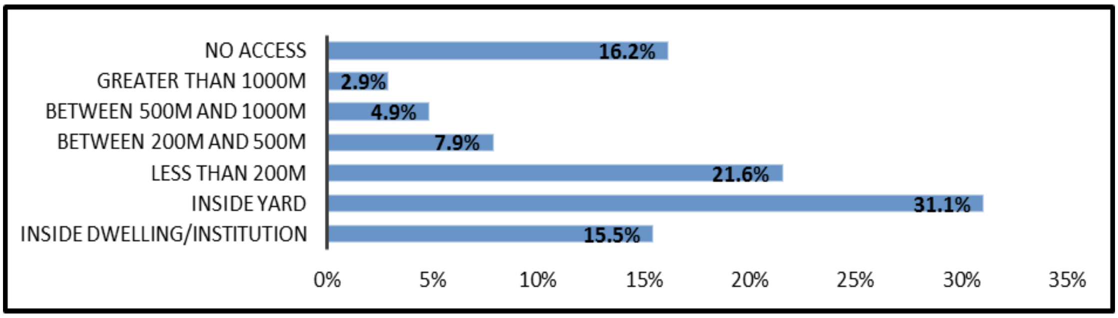

Figure 58: Water access demographic of households in the Letaba Sub-Catchment (Census 2011)

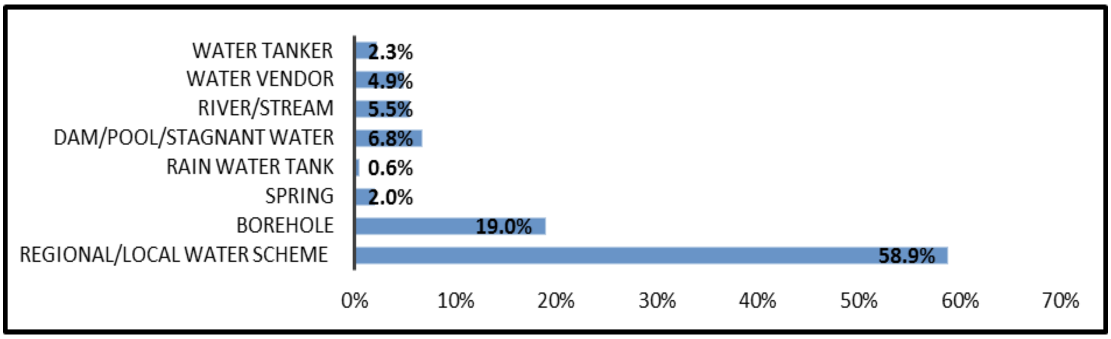

Figure 59: Source of water of households in the Letaba Sub-Catchment (Census 2011)

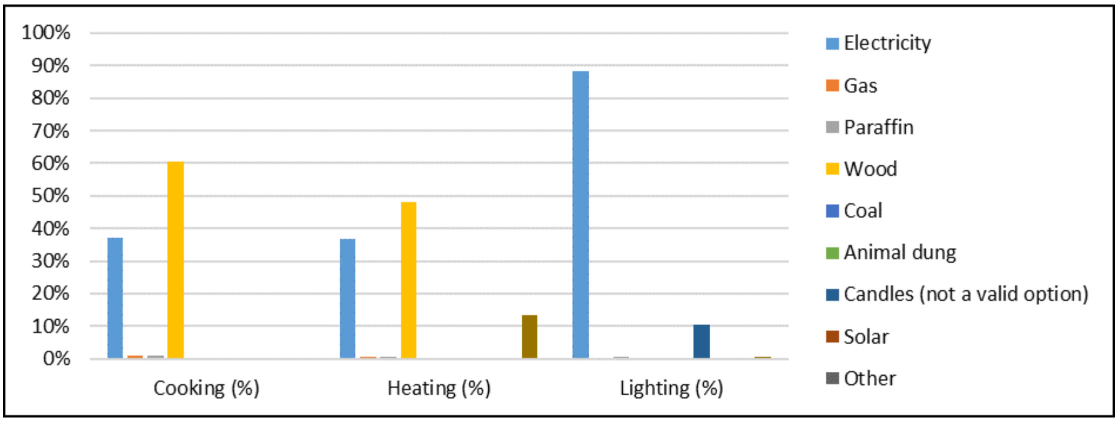

Figure 60: Energy type and use of households in the Letaba Sub-Catchment (Census 2011)

6.5.4 Developmental attributes

The economy of the study area is based on forestry, tea, subtropical fruits, summer crops, vegetables and livestock farming. Subsistence farming plays a major role in the economy of the catchment. Ecotourism is regarded as a core industry of the catchment.

6.5.5 Land Use

The Letaba River catchment is a highly productive agricultural area with mixed farming including cattle ranching, game farming, dry land crop production and irrigated cropping. Agriculture, with the irrigation sector in particular, is the main base of the economy of the region. The total area irrigated measures about 242 km^2. These areas occur mainly along the Groot Letaba River, and its tributaries, the Middle Letaba, Lower Klein Letaba, and the Letsitele Rivers.

Permanent fruit crops (i.e. bananas, citrus and mangoes, 47%) and vegetable and grain cash crops (53%) are cultivated. Some 484 km^2 of pine and blue gum plantations have been established in areas with rainfall of more than 900 mm/a, mainly in the upper reaches of the Groot Letaba River catchment.

Forests have a negative impact on the hydrology through the reduction of runoff by interception and evapotranspiration. Reduction in runoff is estimated at about 52 Mm^3/a, about 25% of the natural runoff in those catchments were afforestation occurs. The impact of forests on rivers during low flows is particularly severe. Since most of the afforestation was planted and developed long before dams in the catchment were built, it is estimated that the firm yield of the major dams would have been about 10% higher without the afforestation.

Intensive irrigation farming is practised in the upper parts of the Klein Letaba River catchment, upstream and downstream of the Middle Letaba Dam, and particularly along the Groot Letaba and Letsitele Rivers, as well as in the upper Luvuvhu River catchment.

6.6 SHINGWEDZI SUB-CATCHMENT

6.6.1 Bio-physical environment

The Shingwidzi River is the northernmost river of the Olifants River WMA, joining it at the lower end of its basin. The Shingwidzi is a seasonal river whose riverbed is dry for prolonged periods. It drains the plain southeast of the Soutpansberg and originates about 40 km to the ESE of Thohoyandou. It flows eastwards across the Lowveld and through the Kruger National Park. The Shingwidzi River catchment (B90) covers a total area of 5 600km^2. The Shingwidzi River and its major tributaries the Shisha, Mphongolo and Phugwane drain the Shingwidzi River catchment.

Mean annual precipitation (MAP) varies between 700mm and 1500mm in the mountainous zone. The annual rainfall over the remainder of the sub-catchment ranges from 450mm to 800mm. More than 85% of the annual rainfall occurs during the summer months. Evaporation increases gradually from about 1 500mm/a in the west to 1 900mm/a in the east. About 60% of the evaporation occurs during the six summer months from October to March. Frost is rare.

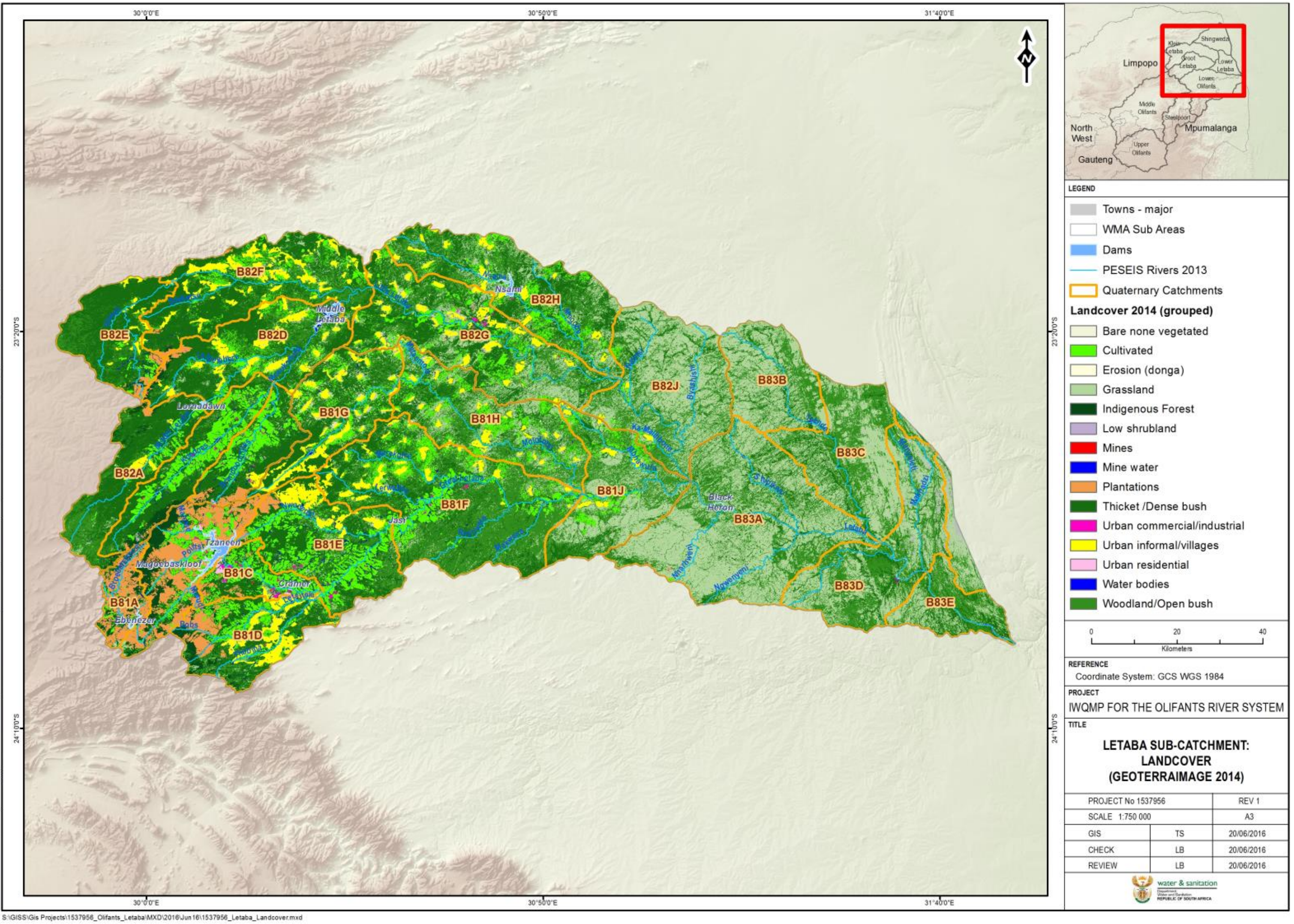

Figure 61: Letaba sub-catchment land cover

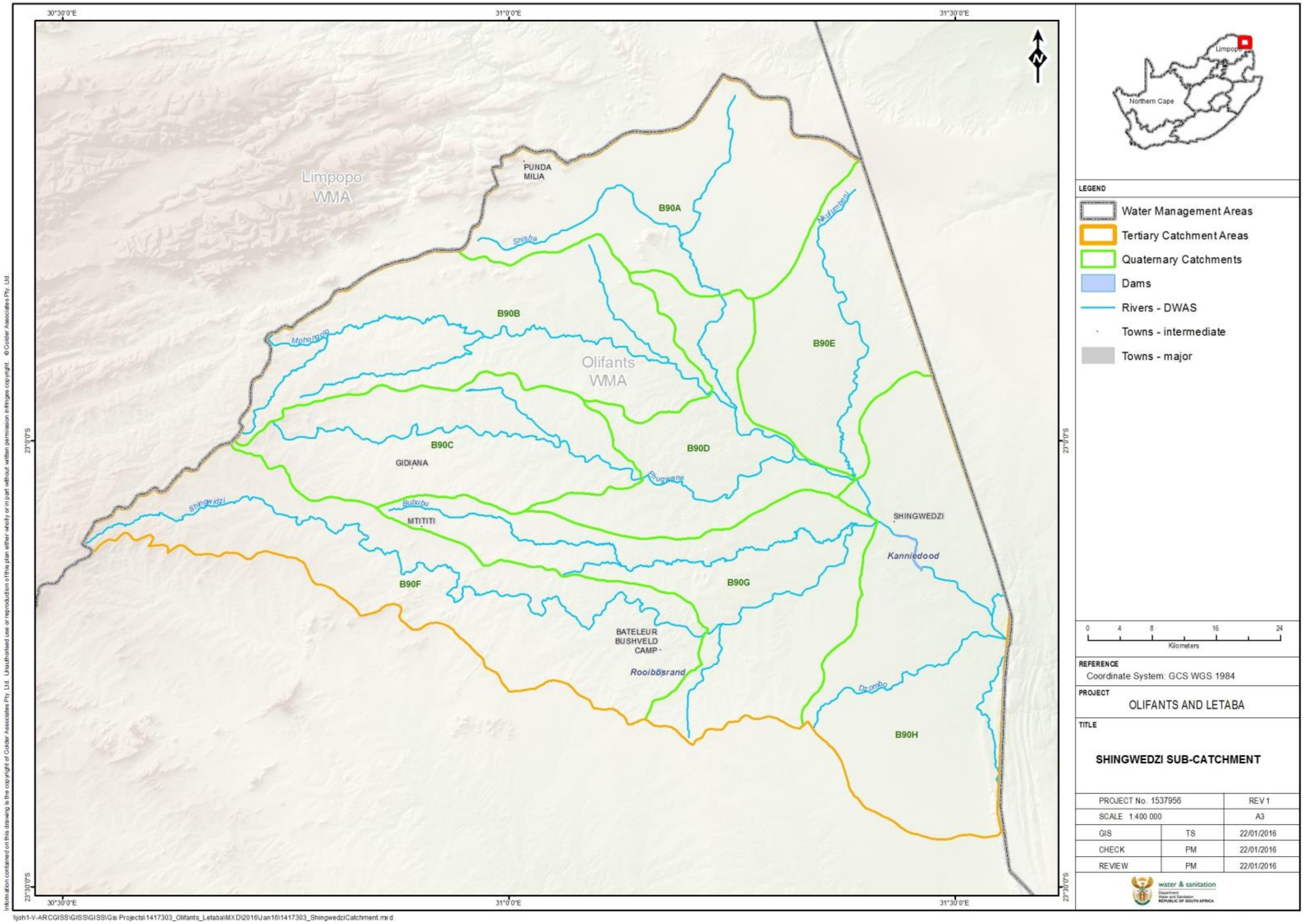

Figure 62: Shingwedzi sub-catchment

6.6.2 Water Resources system

The main rivers of the Shingwedzi basin are the Mandzoro River, Mphongolo River, Phugwane River, Gole River, Shisha River, Tshamidzi River, Bububu River and the Dzombo River. There are no major dams in these sub-areas because of the limited water resources and the non-availability of suitable sites. Some small dams have, however, been constructed in the Kruger National Park for game watering. Of these, the most notable are the Kanniedood Dam on the Shingwedzi River and the Engelhard Dam on the Letaba River. The Makuleke Dam is in the Mphongolo River. Further downstream the Shingwedzi flows close to the north eastern side of the Massingir Dam's reservoir and joins the Olifants River about 12 km down river from the dam wall.

For many water users, groundwater constitutes the only dependable source of water and its utilisation is of major importance. A large proportion of the rural domestic and stock watering requirements are supplied from groundwater for most of the rural settlements and villages. Groundwater is also used for game watering.

6.6.3 Demography

The Shingwedzi sub-catchment has a population of approximately 240 thousand (238 937) people with densities increasing around the rural areas of Ganolanani, Ka-Xikudu and Muthathi (Figure 63). Almost the whole population is black (99.7%) (Figure 64) speaking predominantly Xitsonga (90%) and to a lesser degree Tshivenda (9%) (Census 2011).

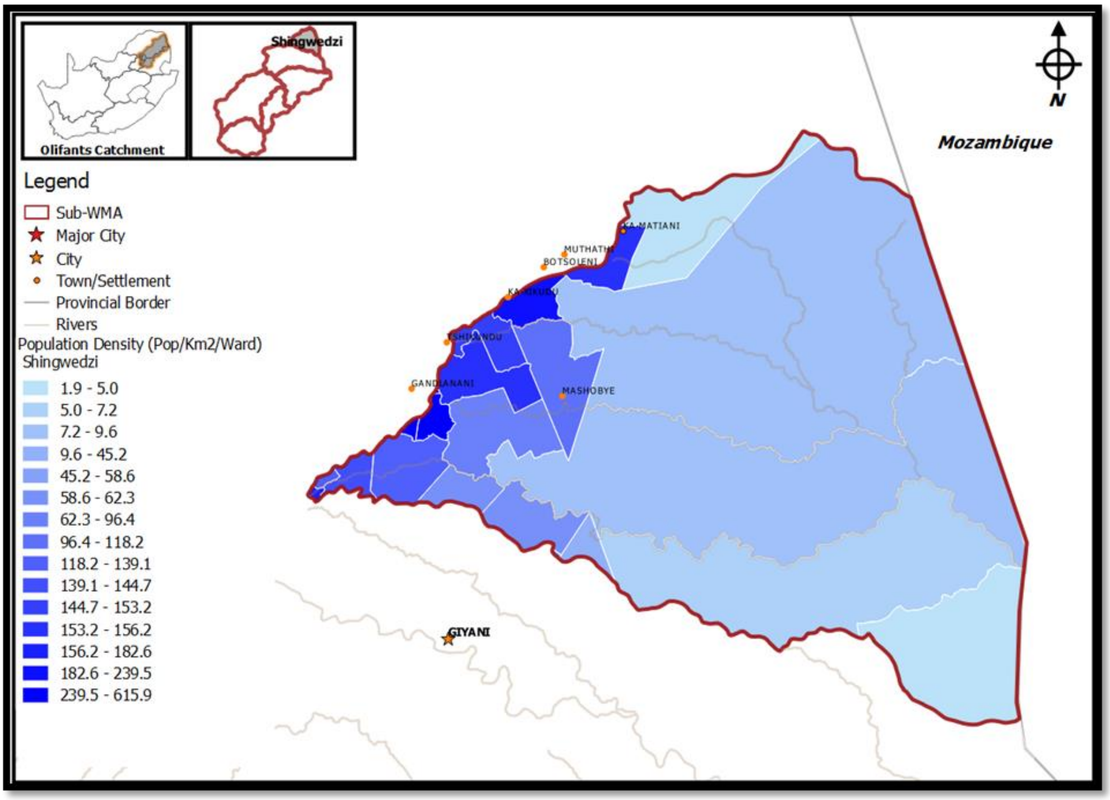

Figure 63: Population density (pop/Ha) by ward in the Shingwedzi sub-catchment (Census 2011)

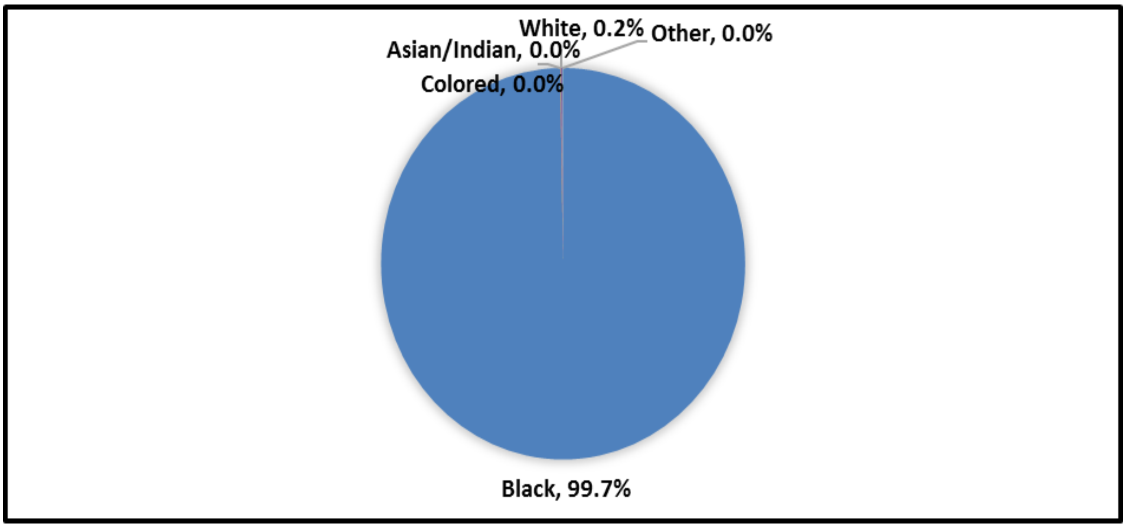

Figure 64: Population demographics of the Shingwedzi sub-catchment (Census 2011)

Education in the catchment is the lowest of all sub-catchments in the Olifants with 38% having little or no formal education and only 24% having completed secondary school or having higher education (Figure 65).

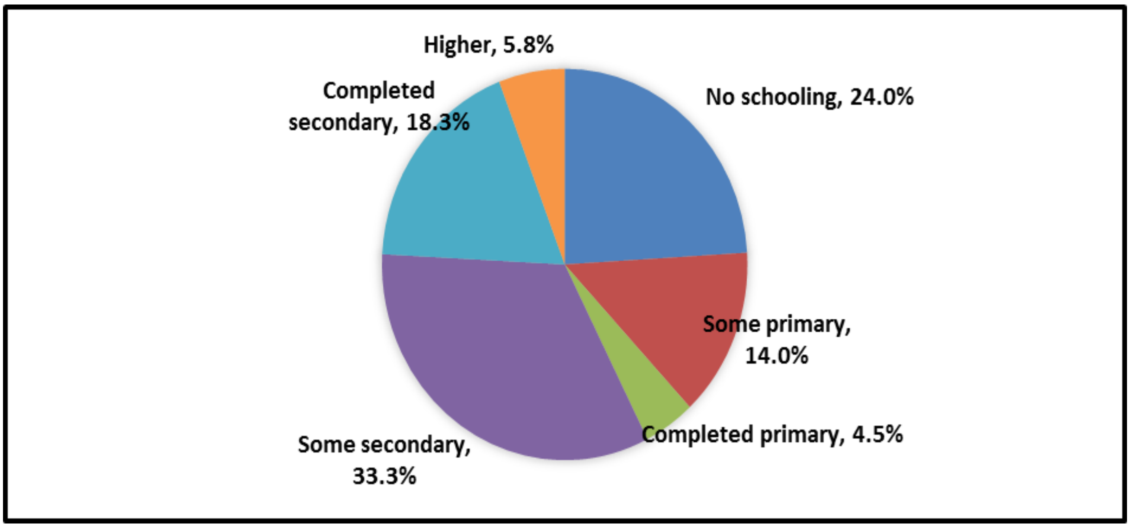

Figure 65: Education level demographics in the Shingwedzi sub-catchment (Census 2011)

Shingwedzi has the highest proportion of individuals (51%) that are economically inactive compared to other sub-catchments in the Olifants (Figure 66). To make matters worse 26% of the population are unemployed. Only 14% of residents in the region are employed of which 70% are employed in the formal sector. The average income groups are the lowest compared to neighbouring sub-catchments. The most common income groups being R 4 801 - R 9 600 (20%) and R 9 601 - R 19 600 (24%) (Figure 67). 14% of households have no income and 11% have a monthly income of less than R4 800.

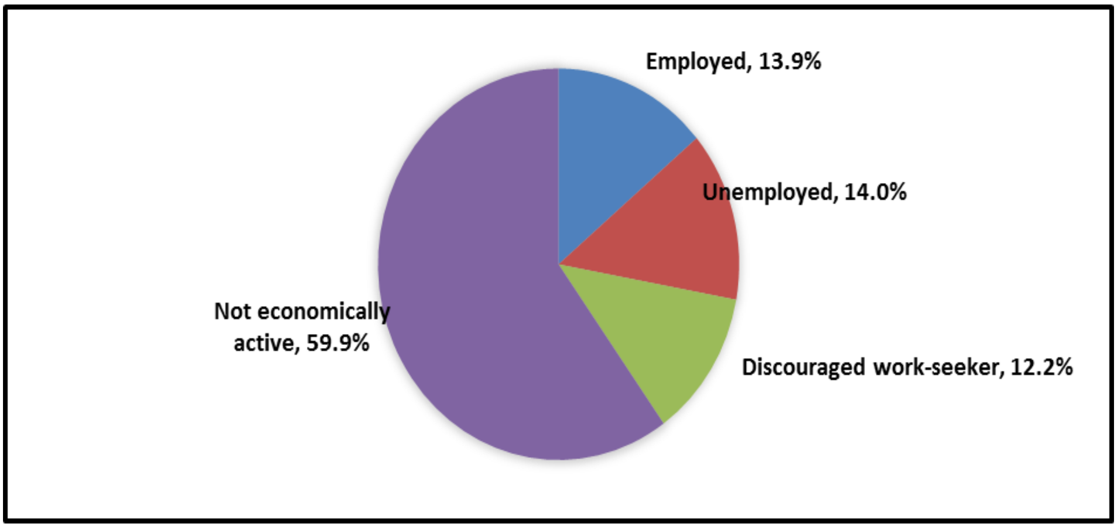

Figure 66: Employment status (Age 15-64) demographics in the Shingwedzi sub-catchment (Census 2011)

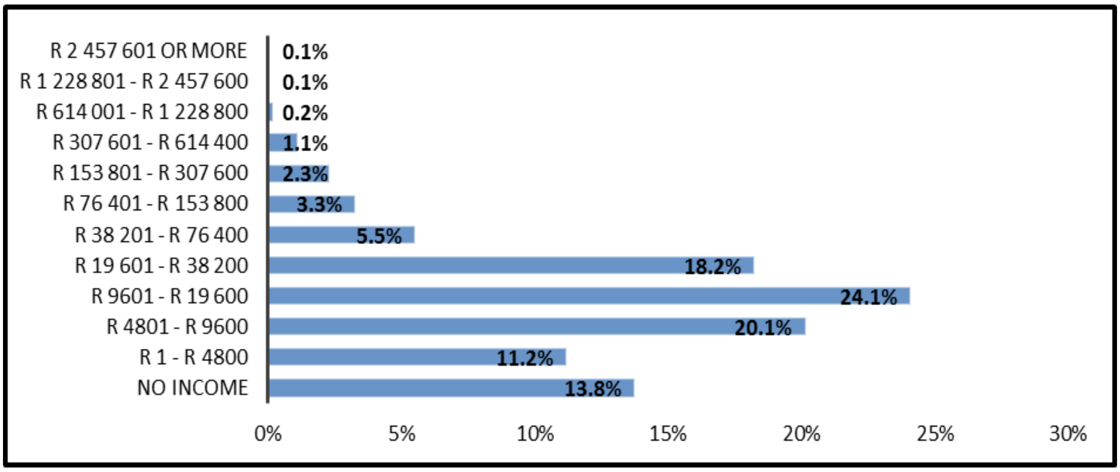

Figure 67: Income group per households in the Shingwedzi Sub-Catchment (Census 2011)

The characteristics of dwellings in the Shingwedzi sub-catchment are typically that of brick and concrete structures (75%) and traditional structures (23%) (Figure 68). Although this sub-catchment has the highest proportion of formal structures and the lowest proportion of informal dwellings (compared to other sub-catchments in the Olifants), piping infrastructure to these dwellings is minimal with only 9% of dwellings having piped water (Figure 70). Much of the households only have access to piped water in their yards (28%) or within 200m of their homes (32%). 26% have access further than 200m from their homes and 4% have no access to piped water. Most of this water comes from the municipal water scheme (83%) and to some lesser extent boreholes (10%) (Figure 71). As expected with the lack of plumbing within homes, only 9% of dwellings have flush toilet connected to a sewerage system (Figure 69). Most lavatories are pit toilets that are either ventilated (27%) or not (58%). Electricity is the key source of energy for lighting (85%) in the catchment however wood is the major source of energy for cooking (82%) and heating (73%) (Figure 68).

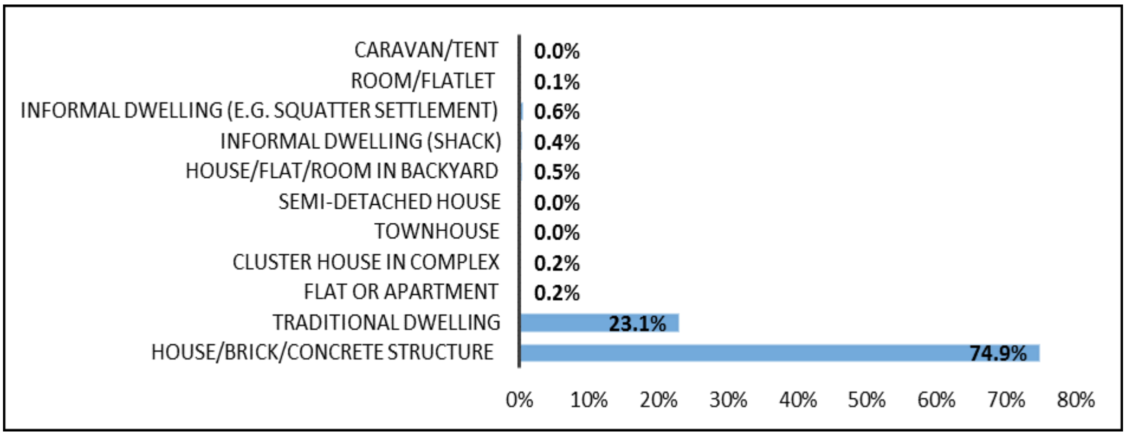

Figure 68: Dwelling demographic of the Shingwedzi sub-catchment (Census 2011)

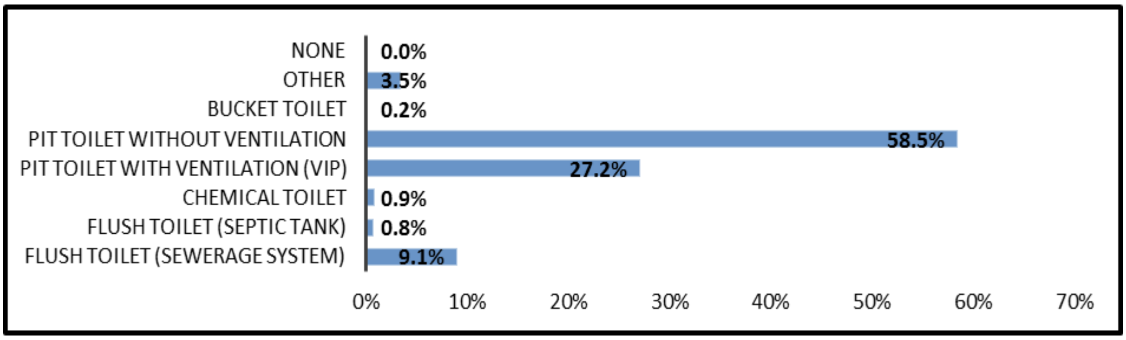

Figure 69: Toilet system demographic in the Shingwedzi sub-catchment (Census 2011)

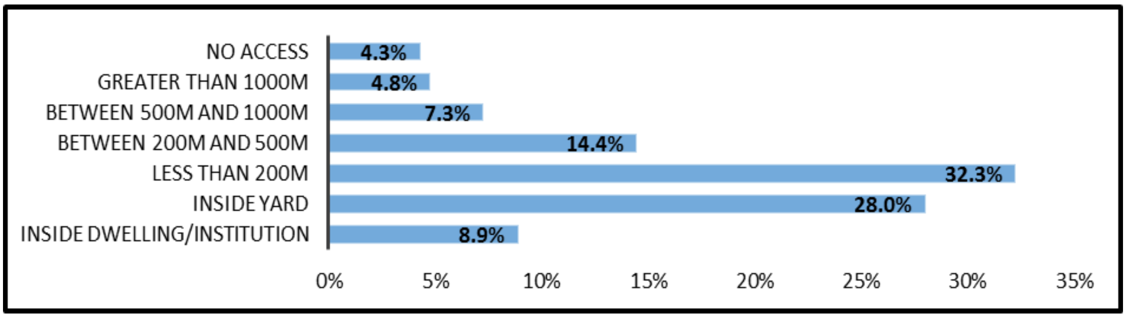

Figure 70: Water access demographic of households in the Shingwedzi sub-catchment (Census 2011)

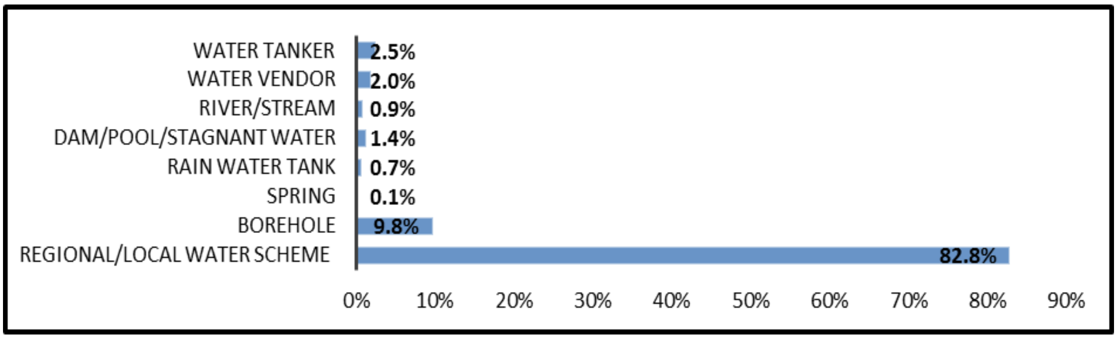

Figure 71: Source of water of households in the Shingwedzi Sub-Catchment (Census 2011)

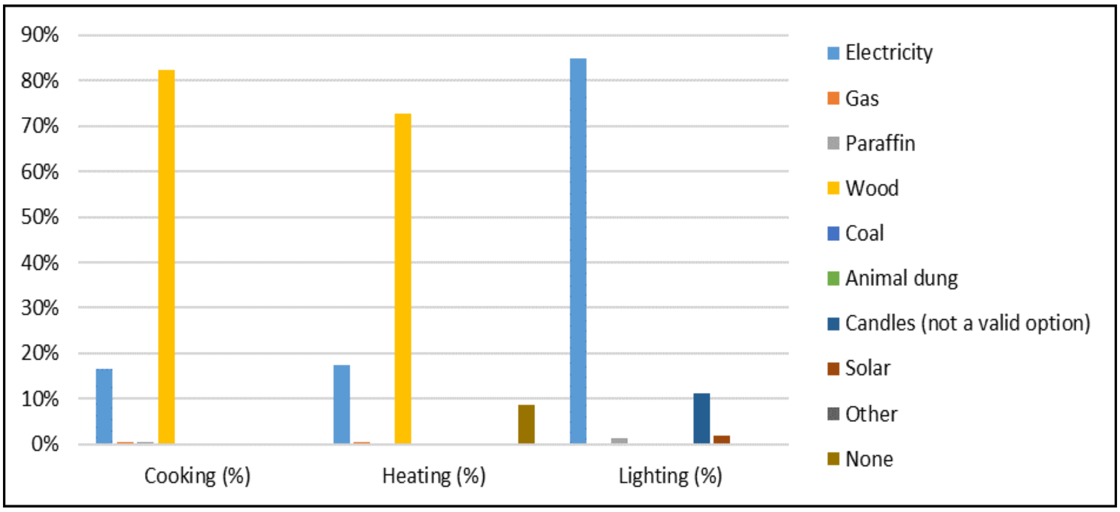

Figure 72: Energy type and use of households in the Shingwedzi Sub-Catchment (Census 2011)

6.6.4 Developmental attributes

The economy of the study area is based on tourism. Subsistence farming plays a minor role in the economy of the catchment. Ecotourism is regarded as a core industry of the catchment.

It has been noted by the DWS Regional Office that there is the potential for resuscitation of two gold mines in the Malamulele area.

6.6.5 Land Use

The dominant land use of the catchment is open bush and grassland. Most of the areas outside the Kruger National Park are dominated by rural settlements, informal farming and very little industrial development. Small scale mining operations, of which the majority is defunct, are dotted through the landscape.

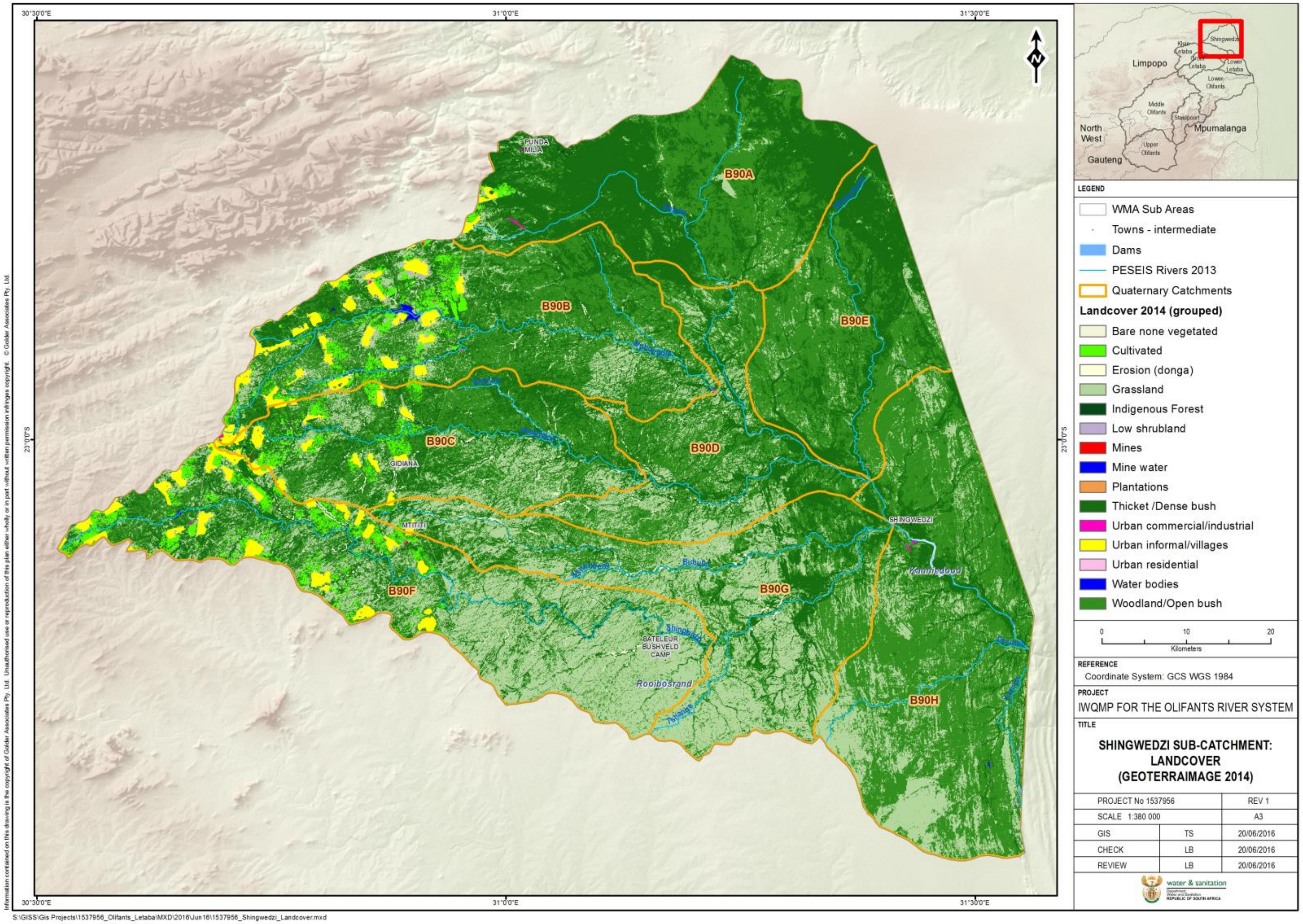

Figure 73: Shingwedzi sub-catchment land use

6.7 RECREATIONAL POTENTIAL OF THE OLIFANTS RIVER SYSTEM

The Olifants River System has a very large eco-tourism sector and all the major dams are recreational assets to the local communities. A number of holiday resorts, caravan parks, recreational and picnic areas, angling and boating clubs and the like are located along the river, most often where the impoundments and weirs are constructed.

PART 3: WATER QUALITY IN THE STUDY AREA

7. CURRENT WATER QUALITY (FITNESS FOR USE) STATUS

7.1 INTRODUCTION

The quality of any body of surface water or groundwater is a function of both natural and human influences. If there were no human influences water quality would be determined by the weathering of bedrock minerals, by the atmospheric processes of evapotranspiration and the deposition of dust and salt by wind, as well as by natural leaching of organic matter and nutrients from soil, hydrological factors that lead to run-off and by biological processes within the aquatic environment that can alter the physical and chemical composition of water.

The water quality of a particular body of water is determined by measuring the physical, chemical, aesthetic and biological characteristics (drivers). Typically, the fitness for use of the water is determined by comparing the physical, chemical, aesthetic and biological characteristics (drivers) of a water sample against water quality guidelines or standards for a particular water use. For example, in South Africa, drinking water quality standards (SANS 241) are designed to enable the provision of clean and safe water for human consumption, thereby protecting human health. The South African Water Quality Guidelines series (DWAF, 1996) is essentially a series of documents that was developed based on different user specifications (including use by the following sectors: domestic, industrial, livestock watering, irrigation and aquatic ecosystems) and were based on scientifically assessed acceptable levels of toxicity to either humans or aquatic organisms.

Declining water quality has become a global issue of concern as human populations grow, industrial and agricultural activities expand, and climate change threatens to cause major alterations to the hydrological cycle.

The Olifants River system faces a number of water quality challenges impacting on both surface water and groundwater including salinisation, sedimentation, nutrient enrichment, microbial and agrochemical pollution, all at different scales within the sub-catchments of the WMA. Pollution originates from both point and non-point sources, including discharges from municipal wastewater treatment works and diffuse source pollution from tailings facilities, urban areas and agricultural lands. In respect of the Olifants WMA, diffuse sources of pollution are dominant.

Over the years significant catchment development, including industrial growth and power stations, widespread mining activities, especially in the upper catchments, irrigation and formal and informal urbanisation has impacted on the surface water and groundwater resources of the Olifants River System. The objective of this chapter is to present the current chemical water quality status of the Olifants River and major tributaries in order to determine the extent of the impacts and to identify the most significant issues of concern.

The following approach was used to assess the current water quality:

- The spatial extent of the task was confirmed by determining the strategic monitoring points (levels 1 to 4) within the catchment study area at which an assessment of the water quality would be done;
- Existing WQPLs (old RWQOs) for the Olifants River and its tributaries within the catchment area were then collated to assess gaps and agree where further WQPLs need to be established;
- Historical monitoring data for these strategic points within the system was then collected, primarily from the Department; and
- An analysis of the data (of at least the past 10 years) was then conducted using a simple excel spreadsheet and pivot table was set up to determine statistics and plot trends from which issues of concern relating to increasing pollution were then identified. A copy of the dataset analysed is included electronically as an addendum to this report and may be added to as the project progresses. The final spreadsheets, statistics and trend graphs will be made available to the DWS at the end of the project, however the initial datasets used for the various sub-catchments are already included.

In the next step of the project a more detailed assessment will be undertaken to compare the data against the WQPLs that will be set.

7.2 IDENTIFICATION OF STRATEGIC MONITORING POINTS

Considering the DWS Water Management Systems database, as well as other available data, the monitoring points described in the sections to follow have been assessed and found to have adequate data from which water quality trends could be assessed. Sites where data with at least 12 samples were taken since 2010 were assessed.

Definition of levels of monitoring points:

Level 1: water quality and/ or quantity monitoring points on the main stem Olifants River.

Level 2: water quality and/ or quantity monitoring points at the lowest point on the main tributaries.

Level 3: upstream water quality and/ or quantity monitoring points on minor tributaries.

Level 4: water quality and/ or quantity monitoring points at point sources.

7.2.1 Level 1 monitoring points

Level 1 monitoring points have been identified at the points indicated in Table 11 and Figure 74 on the main stem of the Olifants River.

Table 11: Level 1 monitoring points on the Olifants main stem

ID on map	Quaternary	WMS ID (weir ID)	Description	Co-ordinates	
UO22	B11A	188428	R38 to Bethal on Olifants	-26.22189	29.63056
UO23	B11A	188423	Weltevreden U/S Forzando Colliery	-26.21369	29.58069
UO24	B11A	188424	Halfgewonnen at Bridge D/S of Sudor Coal on Olifants	-26.23278	29.52644
UO25	B11A	188420	Middelkraal U/S of Bridge on R35 to Bethal on Olifants	-26.22281	29.46264
UO26	B11B	188588	Vaalkranz upstream of New Clydesdale Colliery on Olifants	-26.13638	29.34495
UO27	B11B	188536	Van Dyksdrift at R544 Bridge U/S Douglas Colliery on Olifants	-26.10731	29.32319
UO30	B11F	90410 (B1H5)	Olifants River at Wolvekrans	-26.00639	29.25389
UO28	B11G	88607	Wolvekrans at Brune Bridge U/S Duvha Power Station D/S Douglas Colliery on Olifants	-26.00083	29.29222
UO29	B11G	192642	U/S Witbank Dam at Witbank Dam - Duvha Road Bridge	-25.9736	29.28483
UO31	B11G	90412 (B1H10)	Witbank Dam on Olifants River: downstream Weir	-25.89167	29.30417
UO33	B11J	188530	Witbank Municipal Area at R555 Bridge D/S Witbank Dam + Riverview STW on Olifants	-25.82161	29.29419
MO1= MO18	B32B	90455 (B1H17)	Loskop Dam on Olifants River: downstream weir	-25.41667	29.35833
MO2	B32D	88595	Groblersdal at Bridge on Olifantsrivier (CH13) U/S of STW	-25.16167	29.41417
MO3	B32D	191682	Olifants River Olifants River Down Stream of Groblersdal STW	-25.12811	29.40483
MO4	B32E	193742 (B3H25)	Moganyaka Loskop Noord 12 JS - at Olifants River	-24.95861	29.39528
MO5	B32E	90444 (B3H1)	Olifants River at Loskop North	-24.92667	29.38944
MO6	B31J	191684	Olifants River Olifants River upstream of Flag Boshielo Dam	-24.88414	29.36064
MO7	B51E	90486 (B1H4)	Arabie Dam on Olifants River: downstream weir	-24.77444	29.42222

ID on map	Quaternary	WMS ID (weir ID)	Description	Co-ordinates	
LO4	B71H	1000009801	Olifants River D/S of Confluence with Tswenyane River	-24.43748	30.61947
LO5	B71H	1000009772	Olifants River on R36 Bridge from Ohrigstad to Tzaneen	-24.37975	30.6659
LO6	B71H	90506 (B7H9)	At Finale Liverpool on Olifants River	-24.33117	30.74164
LO1	B72D	1000009786	Olifants River at R40 Road Bridge from Hoedspruit to Mica	-24.18457	30.82616
LO2	B72D	90503 (B7H7)	At Oxford on Olifants River	-24.18389	30.82389
LO3	B72D	192539	Olifants River at Lepelle Northern Water Barrage near Dam Wall	-24.06908	31.14528
LO7	B73C	90512 (B7H15)	Olifants River at Mamba/Kruger National Park	-24.05889	31.23722
LO8	B73H	90515 (B7H17)	Olifants River at Balule Rest Camp/ Kruger National Park	-24.05167	31.73139

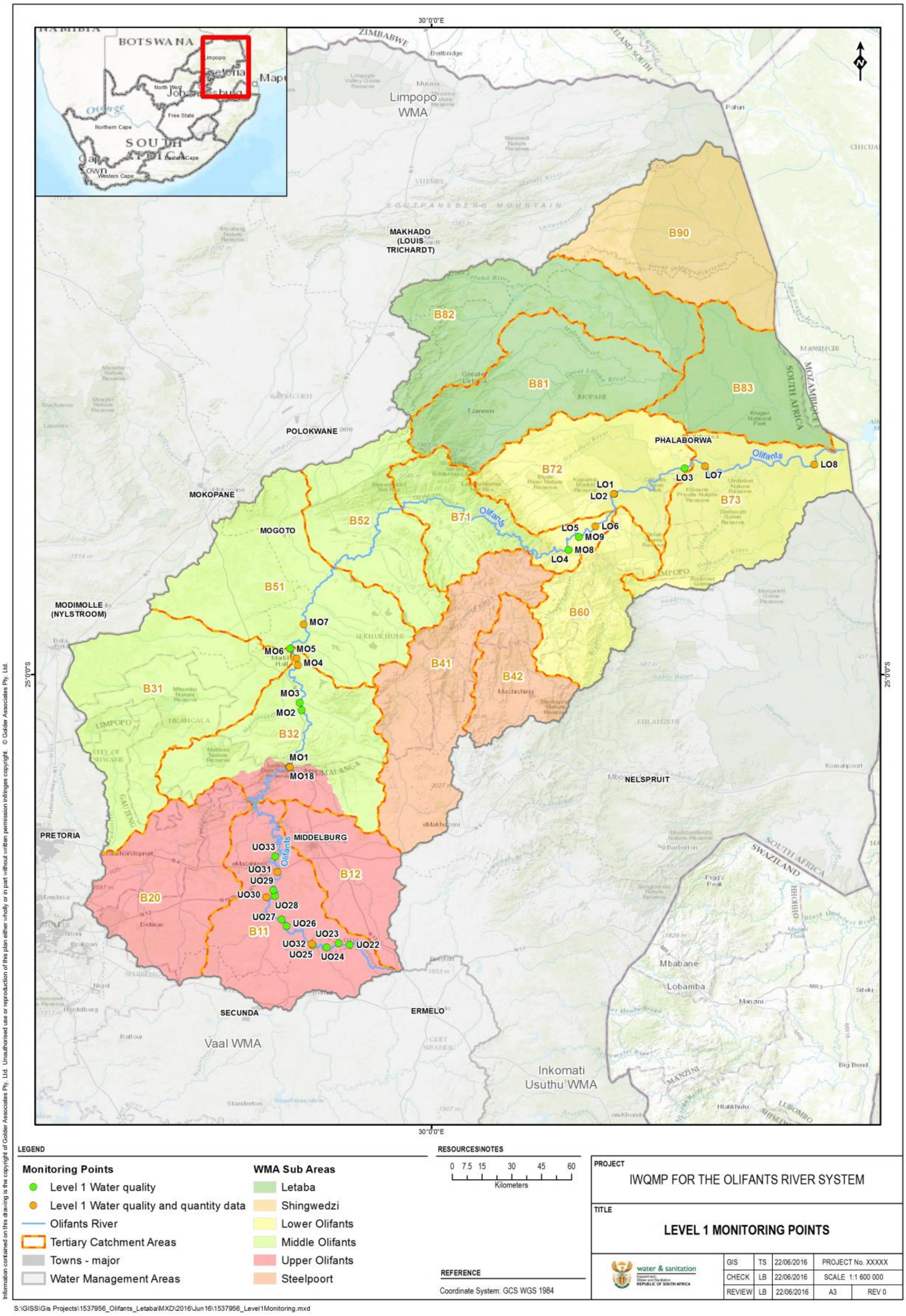

Figure 74: Level 1 monitoring points along the main stem Olifants River

7.2.2 Level 2 monitoring points

Upper Olifants sub-catchment

Level 2 monitoring points on the main tributaries in the Upper Olifants sub-catchment are set out in Table 12 and Figure 75.

Table 12: Level 2 monitoring points in the Upper Olifants sub-catchment

ID on map	Quaternary	WMS ID	Main Tributary	Co-ordinates	
UOX	B12A	188595	Klein Olifants	-26.10575	29.73422
UO1	B12B	90421	Bosmanspruit	-25.8828	29.64333
UO2	B12B	90423	Zevenfonteinspruit	-25.9553	29.65694
UO6	B12D	188386	Klein Olifants	-25.726	29.43686
UO7	B12C	188387	Klein Olifants	-25.8172	29.59022
UO10	B12B	188392	Woestalleenspruit	-25.9304	29.61881
UO14	B12B	188400	Klein Olifants	-25.9937	29.72731
UO21	B12B	192640	Klein Olifants	-25.9157	29.62881
UO34	B11J	90407	Spookspruit	-25.8183	29.33778
UO36	B11D	90411	Trichardspruit	-26.3558	29.21417
UO37	B11C	90415	Steenkoolspruit	-26.3056	29.27417
UO38	B11G	90417	Noupoortspruit	-25.9397	29.2575
UO42	B11E	192644	Rietspruit	-26.1702	29.22928
UO63	B11D	188448	Steenkoolspruit	-26.2575	29.24744
UO86	B11F	192643	Klippoortjiespruit	-26.038	29.22948
UO91	B20B	90437	Koffiespruit	-25.9947	28.66278
UO93	B20F	90441	Wilge River	-25.8267	28.88083
UO95	B20J	188223	Wilge River	-25.5788	29.12747
UO120	B20A	189562	Bronkhorstspruit River	-26.0103	28.67639
UO121	B20F	189564	Wilge River	-26.0444	28.86778
UO122	B20E	189565	Wilge River	-26.2322	28.85611
UO123	B20C	90443	Bronkhorstspruit River	-25.8869	28.72139

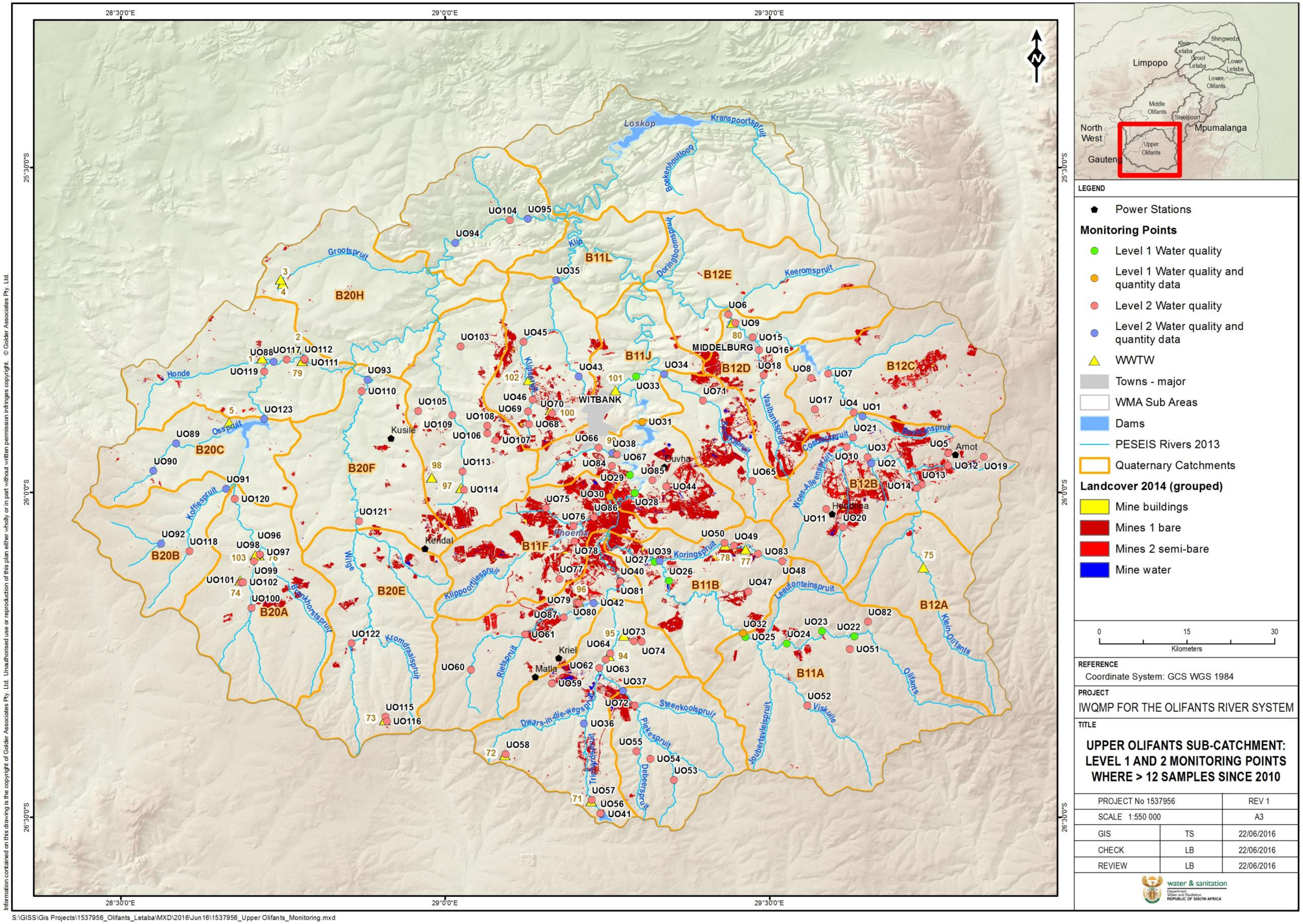

Figure 75: Monitoring points in the Upper Olifants sub-catchment

Middle Olifants sub-catchment

Level 2 monitoring points on the main tributaries in the Middle Olifants sub-catchment are set out in Table 13 and Figure 76.

Table 13: Level 2 monitoring points in the Middle Olifants sub-catchment

Map ID	Quaternary	WMS ID	River/ Stream	Co-ordinates	
MO15	B32H	189456	Moses River	-25.0036	29.34528
MO17	B32B	191822	Selons River	-25.3735	29.41983

Steelpoort sub-catchment

Level 2 monitoring points on the main tributaries in the Steelpoort sub-catchment are set out in Table 14 and Figure 77.

Table 14: Level 2 monitoring points in the Steelpoort sub-catchment

Map ID	Quaternary	WMS ID	River/ stream	Co-ordinates	
SP1	B41D	90467	Steelpoort River	-25.0289	29.85667
SP2	B41G	90471	Dwars River	-24.9125	30.10333
SP3	B41K	90473	Steelpoort River	-24.5528	30.37333
SP7	B41K	193091	Steelpoort River	-24.4835	30.41502
SP8	B41J	1000009845	Steelpoort River	-24.6594	30.30186
SP9	B41H	1000009846	Steelpoort River	-24.843	30.08685
SP10	B41D	1000009848	Dwars River	-25.0916	29.86389
SP11	B41H	1000009849		-24.909	30.1055
SP14	B41B	1000009853	Lakensvleispruit	-25.399	29.82566
SP15	B41B	1000009854	Laersdrift River	-25.3575	29.86707
SP20	B41G	192609		-24.9283	30.10819
SP22	B41D	192623	Steelpoort River	-25.0267	29.86017
SP23	B41B	188910	Groot Dwars River	-25.383	29.83792
SP25	B41F	190142	Steelpoort River	-25.1861	30.02297
SP27	B41H	190160	Steelpoort River	-24.9561	29.95706
SP35	B42B	90472	Dorps River	-25.0753	30.43889
SP37	B42E	1000009808	Spekboom River	-25.009	30.49958
SP42	B42H	188912	Waterval River	-24.6601	30.33681

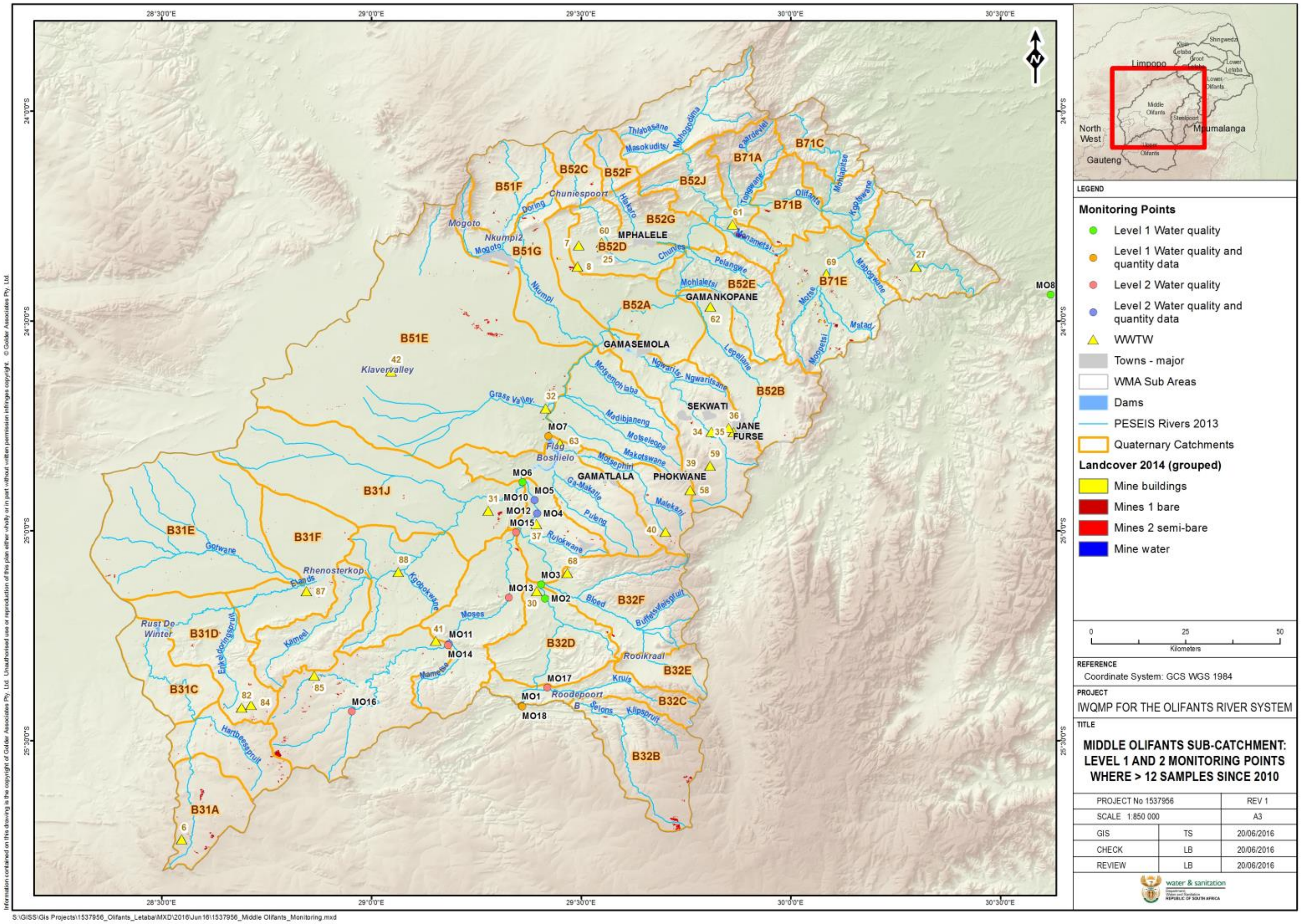

Figure 76: Monitoring points in the Middle Olifants sub-catchment

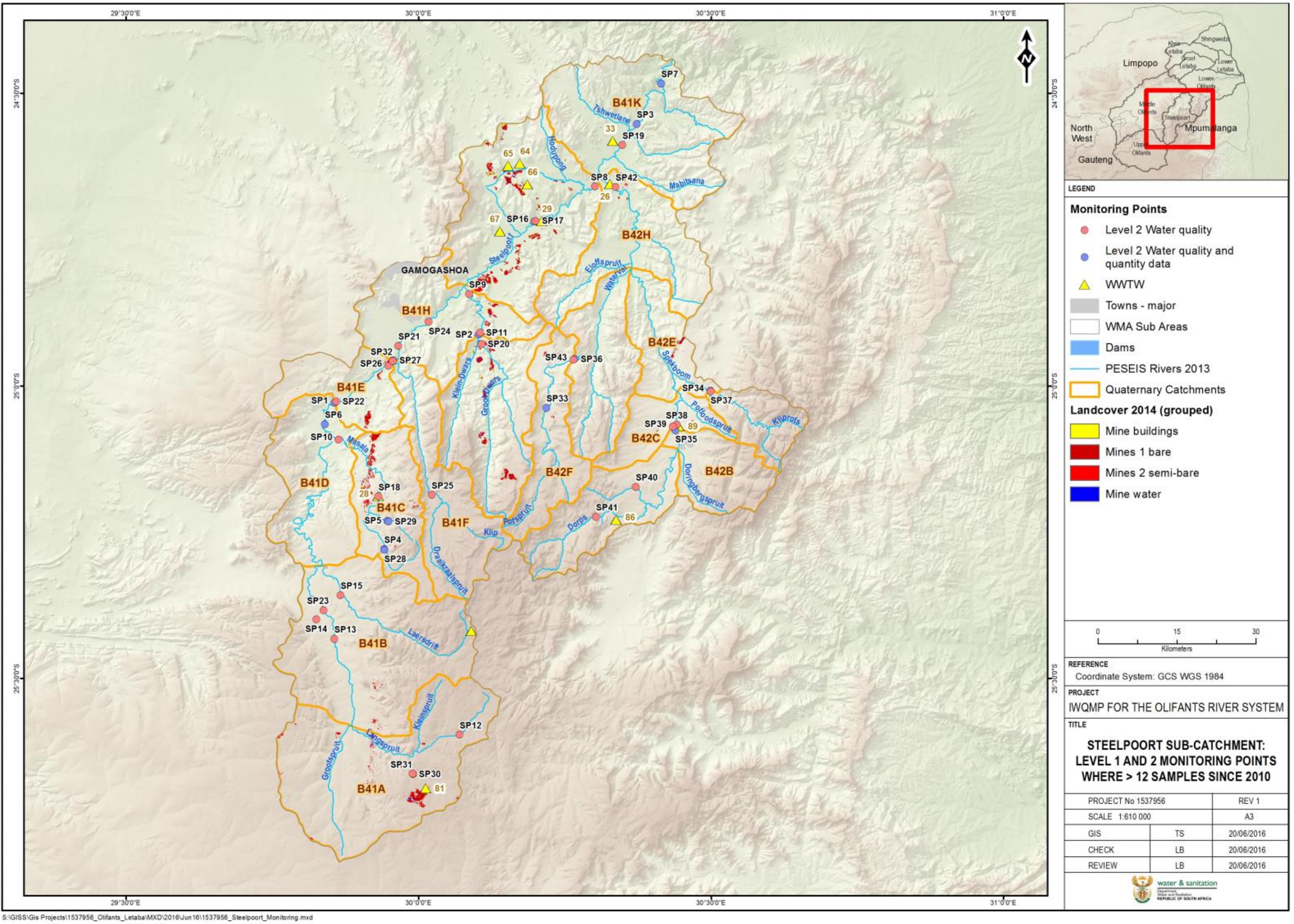

Figure 77: Monitoring points in the Steelpoort sub-catchment

Lower Olifants sub-catchment

Level 2 monitoring points on the main tributaries in the Lower Olifants sub-catchment are set out in Table 15.

Table 15: Level 2 monitoring points in the Lower Olifants sub-catchment

Map ID	Quaternary	WMS ID	River/ Stream	Co-ordinates	
LO9	B60B	90489	Blyde River	-24.6792	30.8025
LO10	B60C	90490	Treur River	-24.6861	30.815
LO15	B60J	90496	Blyde River	-24.5269	30.79361
LO16	B60J	188281	Blyde River	-24.3139	30.85594
LO19	B60F	1000009804	Ohrigstad River	-24.8677	30.56852
LO26	B60J	90499	Blyde River	-24.5369	30.7982

Letaba

Level 2 monitoring points on the main tributaries in the Letaba sub-catchment are set out in Table 16.

Table 16: Level 2 monitoring points on the main tributaries in the Letaba sub-catchment

Map ID	Quaternary	Station ID	River/ Stream	Co-ordinates	
Let1	B81J	B81 90524	Groot Letaba	-23.6581	31.05
Let2	B81E	B81 90525	Great Letaba	-23.8803	30.36694
Let3	B81D	B81 90526	Great Letaba	-23.8922	30.35583
Let4	B81B	B81 90527	Great Letaba	-23.8806	30.07972
Let5	B81F	B81 90528	Great Letaba	-23.6456	30.71861
Let6	B81B	B81 90542	Politsi River	-23.8167	30.0625
Let8	B81A	B81 90546	Broederstroom River	-23.8125	29.96667
Let16	B81C	B81 191499	Great Letaba	-23.8229	30.17367
Let20	B82G	B82 90539	Klein Letaba	-23.281	30.54306
Let25	B83D/ B83E	B83 90529	Great Letaba	-23.8386	31.64083
Let26	B83A	B83 90536	Great Letaba	-23.6486	31.14722

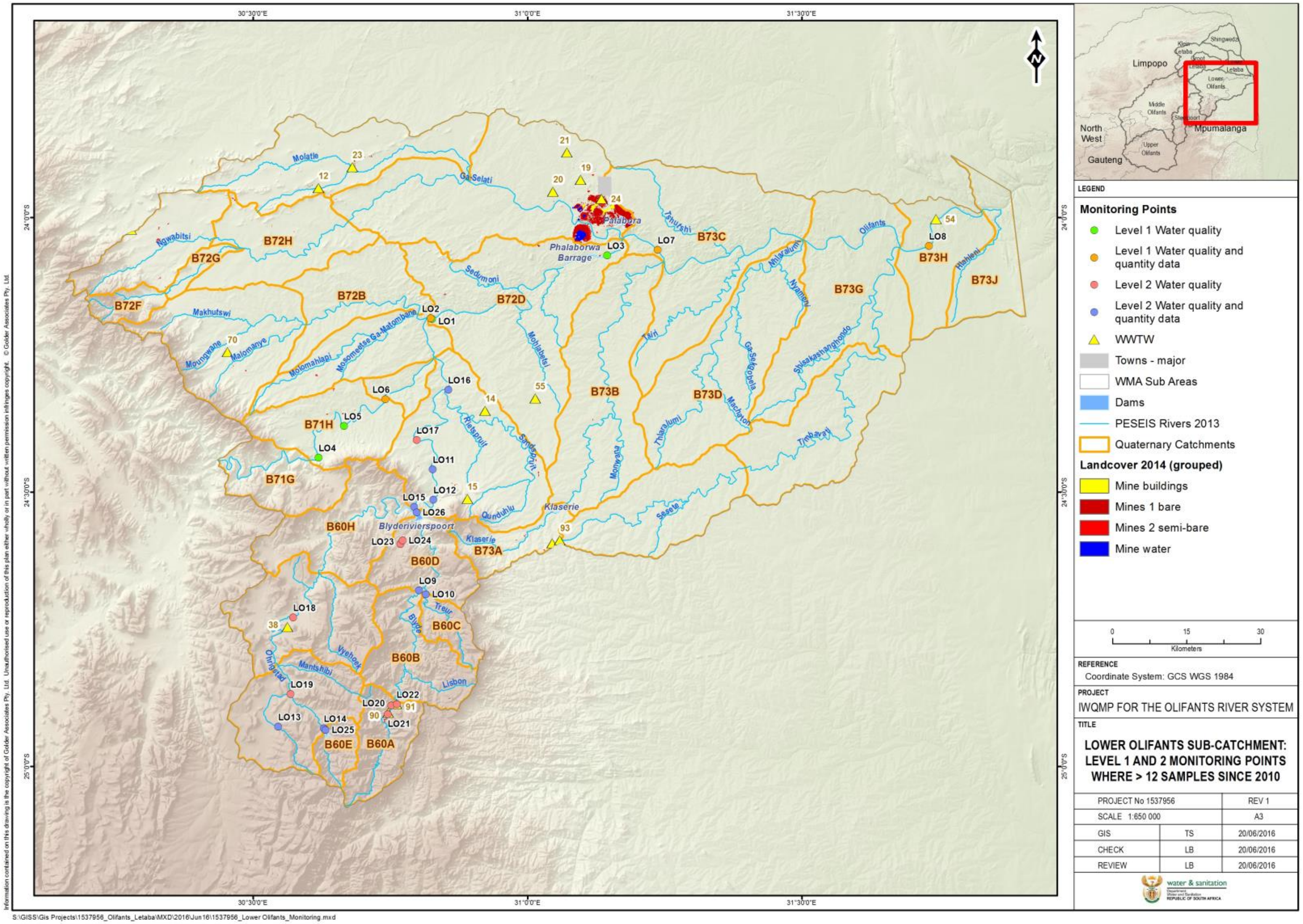

Figure 78: Monitoring points in the Lower Olifants sub-catchment

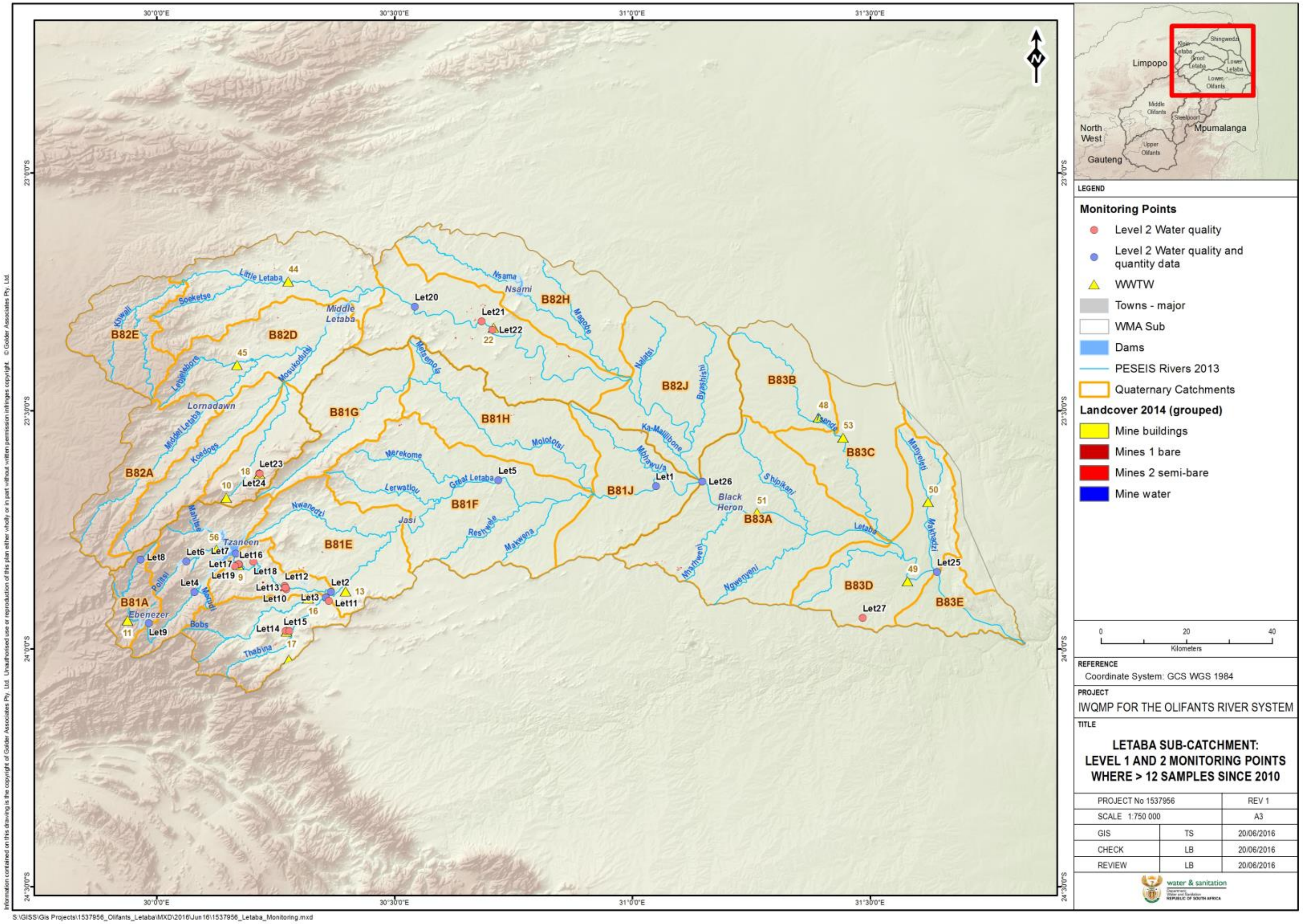

Figure 79: Monitoring points in the Letaba sub-catchment

Shingwedzi sub-catchment

Level 2 monitoring points on the main tributaries in the Shingwedzi sub-catchment are set out in Table 17 and

Figure 80.

Table 17: Level 2 monitoring points on the main tributaries in the Shingwedzi sub-catchment

Map ID	Quaternary	WMS ID	River/ Stream	Co-ordinates	
SW1	B90F	90582	Shingwidzi River	-23.2153	31.22
SW2	B90H	90583	Shingwidzi	-23.1361	31.45472
SW6	B90B	193797	Mphongolo	-22.889	31.03963

7.2.3 Level 3 monitoring points

Upper Olifants sub-catchment

Level 3 monitoring points on the minor tributaries in the Upper Olifants sub-catchment are set out in Table 18.

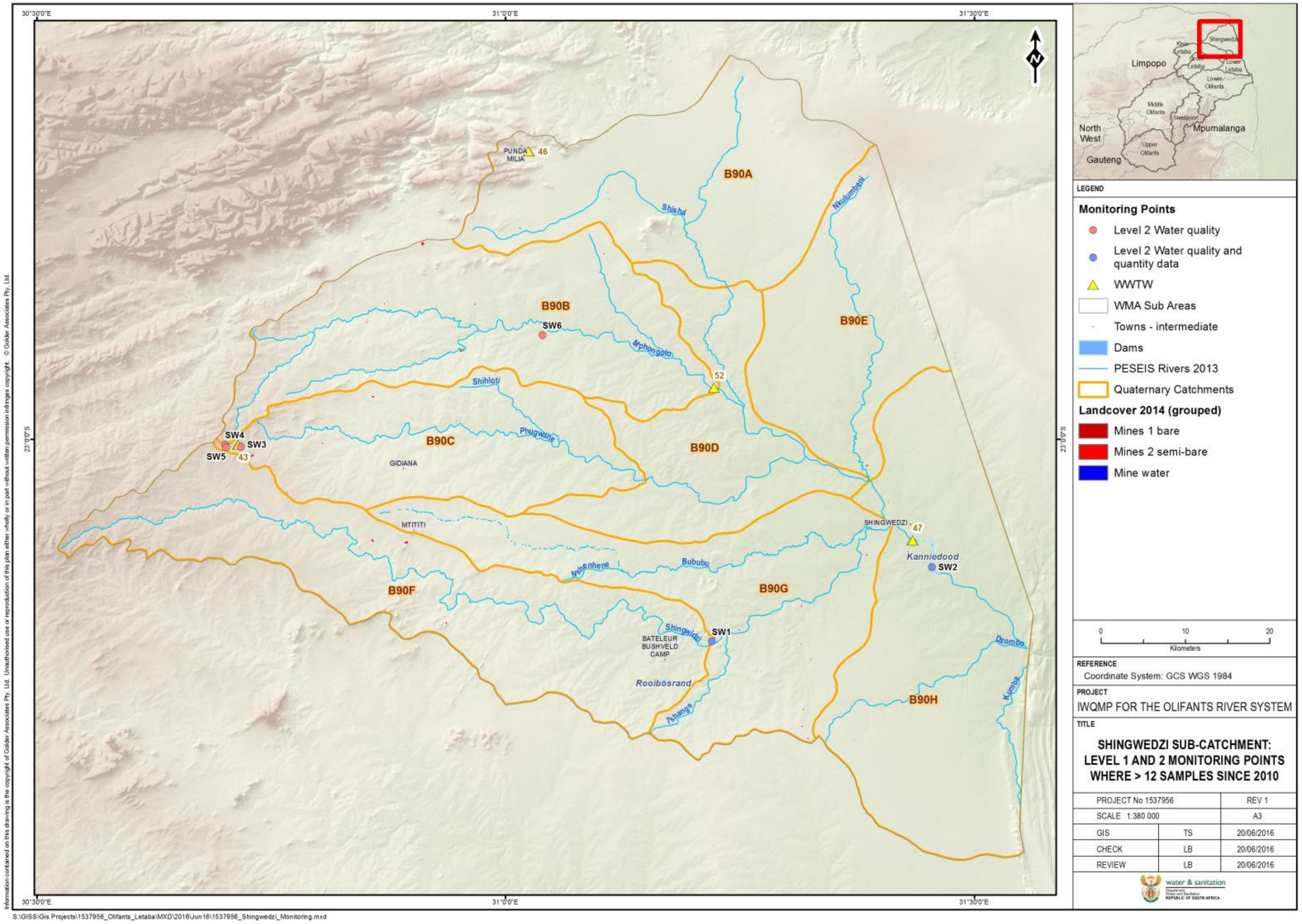

Figure 80: Monitoring points in the Shingwedzi sub-catchment

Table 18: Level 3 monitoring points on the minor tributaries in the Upper Olifants sub-catchment

Map ID	Quaternary	WMS ID	Main Rivers	Co-ordinates	
UO3	B12B	88505	Klein Olifants	-25.9456	29.65139
UO4	B12C	88506	Klein Olifants	-25.8767	29.62944
UO5	B12B	88587	Bosmanspruit	-25.9397	29.77556
UO8	B12C	188390	Goeiehoopspruit	-25.8241	29.56439
UO9	B12D	188391	Klein Olifants	-25.7391	29.44719
UO11	B12B	188396	Tributary of Woestalleenspruit	-26.0258	29.58747
UO12	B12B	188397	Rietkuilspruit	-25.9588	29.77514
UO13	B12B	188399	Klein Olifants	-25.9878	29.73456
UO15	B12D	188401	Klein Olifants	-25.7613	29.47372
UO16	B12D	188403	Vaalbankspruit	-25.7809	29.48386
UO17	B12C	188570	Arendsfonteinspruit	-25.8726	29.56969
UO18	B12D	188574	Vaalbankspruit	-25.8194	29.49106
UO19	B12B	191483	Unnamed tributary of Rietkuipsruit	-25.9452	29.83008
UO20	B12B	192639	Woestalleenspruit	-26.0536	29.61316
UO35	B11K	90408	Klipspruit (after confluence with Blesbokspruit)	-25.6733	29.17111
UO39	B11B	90418	Koringspruit (just u/s of confluence with Olifants)	-26.1058	29.33083
UO40 = UO81	B11E	90419	Steenkoolspruit	-26.1361	29.27
UO41	B11D	90420	Trichardspruit	-26.495	29.24111
UO45	B11K	185084	Klipspruit	-25.7682	29.121
UO46	B11K	185085	Brugspruit	-25.8571	29.1353
UO43	B11K	90430	Blesbokspruit	-25.8217	29.20611
UO44	B11G	88660	Boesmanskransspruit	-25.9911	29.34083
UO47	B11G	188422	Unnamed	-26.1528	29.4675
UO48	B11B	188425	Koringspruit	-26.1062	29.51936
UO51	B11A	188430	Bankspruit	-26.2415	29.62375
UO52	B11A	188431	Viskuile	-26.3281	29.55822
UO53	B11C	188433	Pieketspruit	-26.4428	29.35267
UO54	B11C	188435	Holfontein (Trib of Pieketspruit)	-26.4102	29.31642
UO55	B11C	188438	Rib of DeBeersspruit	-26.3985	29.295
UO49	B11B	188426	Koringspruit	-26.0822	29.44531
UO50	B11B	188427	Koringspruit	-26.078	29.43061
UO57	B11D	188440	Trichardspruit	-26.4737	29.22603

Map ID	Quaternary	WMS ID	Main Rivers	Co-ordinates	
UO58	B11D	188442	Tributary of Dwars-in-Die-Weg Spruit	-26.4031	29.09364
UO59	B11D	188444	Bakenlaagtespruit	-26.294	29.16475
UO61	B11E	188446	Rietspruit	-26.2186	29.12367
UO56	B11E	188439	Unnamed	-26.4942	29.23911
UO60	B11E	188445	Rietspruit	-26.2728	29.03994
UO62	B11D	188447	Steenkoolspruit	-26.2704	29.23769
UO68	B11K	188539	Brugspruit	-25.8952	29.12944
UO69	B11K	188540	Brugspruit	-25.8754	29.12786
UO71	B11H	188573	Spookspruit	-25.8588	29.39725
UO72	B11C	188589	Steenkoolspruit	-26.3282	29.2922
UO75	B11F	189428	Tweefonteinspruit	-26.0244	29.15556
UO76	B11F	189430	Tweefonteinspruit	-26.0519	29.19806
UO78	B11F	189510	Saaiwaterspruit	-26.0753	29.19944
UO81 = UO40	B11E	191615	Steenkoolspruit	-26.1374	29.26992
UO64	B11D	188449	Steenkoolspruit	-26.2476	29.2545
UO66	B11G	188537	Noupoortspruit	-25.9313	29.23647
UO67	B11G	188538	Noupoortspruit	-25.9418	29.26483
UO70	B11K	188547	Brugsopruit tributary	-25.8785	29.16453
UO73	B11D	188602	Tributary of Steenkoolspruit	-26.229	29.29087
UO74	B11D	188603	Tributary of Steenkoolspruit	-26.2296	29.30287
UO77	B11F	189438	Tributary of Klippoortjiespruit	-26.1333	29.17639
UO79	B11E	191473	Rietspruit	-26.1695	29.20303
UO80	B11E	191474	Rietspruit	-26.1702	29.20578
UO83	B11B	191637	Koringspruit	-26.0947	29.48258
UO88	B20D	90433	Bronkhorstspruit	-25.7989	28.73583
UO89	B20C	90434	Osspruit	-25.9247	28.58556
UO90	B20C	90436	Osspruit	-25.9667	28.55083
UO87	B11E	1000003173	Rietspruit	-26.1923	29.18263
UO92	B20B	90438	Tributary of Koffiespruit	-26.0789	28.56278
UO94	B20J	90442	Wilge River	-25.6161	29.01611
UO96	B20A	188730	Tributary of Bronkhorstspruit	-26.0808	28.71061
UO97	B20A	189110	Tributary of Bronkhorstspruit	-26.096	28.71516
UO98	B20A	189111	Tributary of Bronkhorstspruit	-26.0956	28.71465
UO99	B20A	188729	Tributary of Bronkhorstspruit	-26.1063	28.70586

Map ID	Quaternary	WMS ID	Main Rivers	Co-ordinates	
UO100	B20A	188894	Tributary of Bronkhorstspruit	-26.1781	28.702
UO103	B20G	88821	Kromdraaispruit	-25.7753	29.02389
UO104	B20J	100201	Wilge River	-25.5811	29.1
UO105	B20G	188188	Tributary of the Saalboomspruit	-25.8747	28.95861
UO106	B20G	188541	Grootspruit	-25.9089	29.06533
UO107	B20G	188542	Grootspruit	-25.9196	29.0785
UO108	B20G	188544	Grootspruit	-25.8974	29.06506
UO110	B20F	189412	Wilge	-25.8444	28.87167
UO117	B20D	189558	Bronhorstspruit RIver	-25.7956	28.75639
UO118	B20B	189559	Koffiespruit	-26.0906	28.60639
UO119	B20D	189561	Bronkhorstspruit River	-25.8142	28.72139
UO101	B20A	188678	Tributary of Bronkhorstspruit	-26.1387	28.68592
UO102	B20A	188610	Tributary of Bronkhorstspruit	-26.1384	28.689
UO109	B20G	188545	Saalklapspruit	-25.8811	29.01131
UO111	B20D	189462	Bronkhorstspruit River	-25.7964	28.78417
UO112	B20D	189463	Bronkhorstspruit River	-25.7947	28.78306
UO113	B20G	189464	Saalklapspruit-Saalboomspruit	-25.9678	29.02694
UO114	B20G	189465	Saalklapspruit-Saalboomspruit	-25.9958	29.02917
UO115	B20E	189469	Unnamed tributary of Wilge	-26.3453	28.90833
UO116	B20E	189470	Unnamed tributary of Wilge	-26.3522	28.91056

Middle Olifants sub-catchment

Level 3 monitoring points on the minor tributaries in the Middle Olifants sub-catchment are set out in Table 19.

Table 19: Level 3 monitoring points on the minor tributaries in the Middle Olifants sub-catchment

Map ID	Quaternary	WMS ID	River/ Stream	Co-ordinates	
MO11	B32G	90448	Moses River	-25.2694	29.18472
MO13	B32H	189413	Moses River	-25.1589	29.32833
MO14	B32G	189423	Moses River	-25.2722	29.18306
MO16	B32G	189553	Tributary of the Moses	-25.43	28.95361

Steelpoort sub-catchment

Level 3 monitoring points on the minor tributaries in the Steelpoort sub-catchment are set out in Table 20.

Table 20: Level 3 monitoring points on the minor tributaries in the Steelpoort sub-catchment

Map ID	Quaternary	WMS ID	River/ stream	Co-ordinates	
SP2	B41G	90471	Dwars River	-24.9125	30.10333
SP4	B41C	90475	Tonteldoos River	-25.2792	29.94167
SP5	B41C	90476	Vlugkraal River	-25.2303	29.9475
SP6	B41D	193090		-25.0655	29.84019
SP12	B41H	1000009849		-24.909	30.1055
SP13	B41A	1000009851	Mapochs River	-25.5959	30.0704
SP14	B41B	1000009852	Lakenvleispruit	-25.4321	29.85653
SP16	B41B	1000009853		-25.399	29.82566
SP17	B41J	1000009855	Steelpoort	-24.719	30.19901
SP18	B41J	1000009856	Steelpoort	-24.718	30.20074
SP19	B41C	1000009858		-25.1889	29.93194
SP21	B41G	192609		-24.9283	30.10819
SP24	B41H	192531	Steelpoort	-24.9316	29.96575
SP26	B41H	188915	Steelpoort	-24.8907	30.01744
SP27	B41E	190143		-24.9658	29.94892
SP28	B41H	190160	Steelpoort	-24.9561	29.95706
SP29	B41C	90480		-25.2797	29.942
SP30	B41C	90481		-25.2316	29.9493
SP31	B41A	188911		-25.6631	29.99092
SP32	B41A	193279		-25.6627	29.99028
SP33	B41H	194098		-24.9575	29.95629
SP34	B42F	90469	Potspruit	-25.0378	30.21917
SP36	B42E	B42 90470		-25.0081	30.49944
SP38	B42F	90478		-24.9542	30.26667
SP39	B42C	1000009850		-25.0661	30.442
SP40	B42C	1000008357		-25.0692	30.435
SP41	B42A	1000009778	Hoppe se Spruit	-25.1724	30.37176

Map ID	Quaternary	WMS ID	River/ stream	Co-ordinates	
SP43	B42H	188912		-24.6601	30.33681
	B42F	90483		-24.9552	30.2651

Lower Olifants sub-catchment

Level 3 monitoring points on the minor tributaries in the Lower Olifants sub-catchment are set out in Table 21 and Figure 78.

Table 21: Level 3 monitoring points on the minor tributaries in the Lower Olifants sub-catchment

Map ID	Quaternary	WMS ID	River/ Stream	Co-ordinates	
LO11	B60J	90491	Blyde River	-24.4586	30.8275
LO12	B60J	90492	Blyde River	-24.5139	30.82889
LO13	B60F	90493	Kranskloof Spruit	-24.9275	30.54611
LO14	B60E	90495	Ohrigstad River	-24.9303	30.62944
LO17	B60J	1000009799	Blyde River	-24.4051	30.79821
LO18	B60G	1000009803	Ohrigstad River	-24.7282	30.57359
LO20	B60A	1000009805	Morgenzon River	-24.889	30.7519
LO21	B60A	1000009806	Blyde River	-24.905	30.74586
LO22	B60A	1000009807	Blyde River	-24.8864	30.76208
LO23	B60D	192616	Kadishe River	-24.595	30.76883
LO24	B60D	192615	Kadishe River	-24.5882	30.77275
LO25	B60E	90498	Ohrigstad River	-24.9333	30.6322

Letaba sub-catchment

Level 3 monitoring points on the minor tributaries in the Letaba sub-catchment are set out in Table 22 and Figure 79.

Table 22: Level 3 monitoring points on the minor tributaries in the Letaba sub-catchment

Map ID	Quaternary	WMS ID	River/ Stream	Co-ordinates	
Let7	B81B	90543	Great Letaba	-23.8	30.16667
Let9	B81A	90549	Greatt Letaba	-23.9458	29.98389
Let10	B81D	187157	Greatt Letaba	-23.8748	30.27303
Let11	B81D	187159	Ritshidele Stream	-23.8992	30.3622
Let12	B81D	187161	Marive Stream	-23.8678	30.26919
Let13	B81D	187689	Great Letaba River	-23.8715	30.27068

Map ID	Quaternary	WMS ID	River/ Stream	Co-ordinates	
Let14	B81D	190449	Mokonyane River	-23.9628	30.27154
Let15	B81D	190450	Mokonyane River	-23.9628	30.27922
Let17	B81C	191500	Great Letaba	-23.822	30.1724
Let18	B81C	191501	Great Letaba	-23.8172	30.20358
Let19	B81C	191502	Great Letaba	-23.8259	30.16482
Let21	B82G	183878	Klein Letaba	-23.312	30.68342
Let22	B82G	183879	Klein Letaba	-23.3299	30.7064
Let23	B82C	190140	Mosukudutsi	-23.6314	30.21577
Let24	B82C	190141	Mosukudutsi	-23.6324	30.21691
Let27	B83D	191197	Nhlanganini River	-23.935	31.48444

Shingwedzi sub-catchment

Level 3 monitoring points on the minor tributaries in the Shingwedzi sub-catchment are set out in Table 23 and

Figure 80.

Table 23: Level 3 monitoring points on the minor tributaries in the Shingwedzi sub-catchment

Map ID	Quaternary	WMS ID	River/ Stream	Co-ordinates	
SW3	B90C	188499	Phugwane River	-23.0081	30.71813
SW4	B90C	190155	Phugwane River	-23.0056	30.70083
SW5	B90C	190183	Phugwane River	-23.0084	30.70203

7.2.4 Level 4 monitoring points

Point sources have been identified in the WMA. The majority relate to the discharge from municipal wastewater treatment works. While many of the wastewater treatment works, such as biofilters and oxidation ponds, are not authorised to discharge top a water resource, they are included here as many of them do have a discharge/ overflow to a water resource and irrigation of final effluent may occur on accassions.

Figure **81** shows the location of all of the municipal wastewater treatment works in the Olifants River System. Discharges from the mines, industries and power stations are limited and the Controlled Release Scheme that was implemented in the Upper Olifants catchment was stopped in 2014.

In the next step of the project, meetings will be set up with specific Environmental Officers for each sub-catchment to try and gain further insight into the level 3 and 4 monitoring points, specifically from the water use authorisations that have been issued or are currently being assessed.

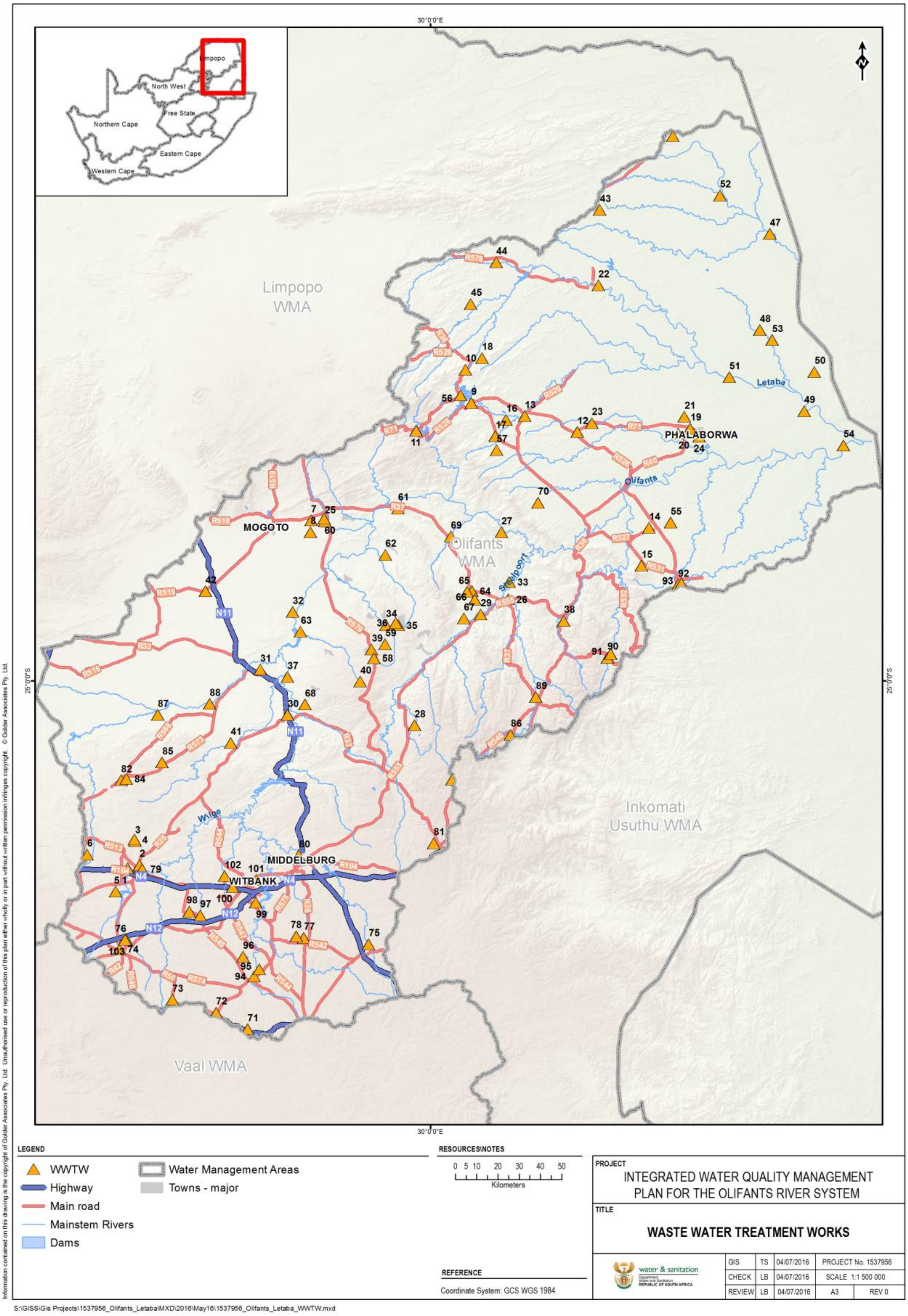

Figure 81: Municipal Wastewater Treatment Works in the Olifants River System

Upper Olifants sub-catchment

The wastewater treatment works in the Upper Olifants catchment are listed in Table 24.

Table 24: Wastewater Treatment Works in the Upper Olifants sub-catchment

WWTW name	WWTW Type (liquid)	WWTW (sludge)	Operational Capacity (Ml)	Highest risk areas			Authoris$^{n/.}$ type
				Effluent quality	Skills	Capacity/ no flow measurement devices	
Bronkhorstspruit	No data	No data	No data				Nk
Rethabiseng	Anaerobic ponds/ Facultative ponds		2.4	Non-compliance against discharge standards	Process Controller and supervisory skills	Load exceeds design capacity	Nk
Ekangala North	No data	No data	No data				Nk
Ekangala South	No data	No data	No data				Nk
Bronkhorstbaai	No data	No data	No data				Nk
Rayton	Activated sludge and BNR and Solar drying beds	No data	1.2	Non-compliance against discharge standards	Process Controller and supervisory skills		Nk
Trichardt	Biological filters	Solar drying beds	1.8	Non-compliance against discharge standards	Process Controller, supervisory and maintenance skills	Inadequate flow monitoring	No License
Delmas	Activated sludge and Integrated pond systems (lagoons)	Anaerobic digestion and Centrifugal dewatering	8	Non-compliance against discharge standards	Process Controller, supervisory and maintenance skills	Inadequate flow monitoring	No License
Kwazamokuhle/ Hendrina	Biological filters and anaerobic ponds/ Facultative ponds	Solar drying beds and composting	3.8	Non-compliance against discharge standards	Non-compliance against draft 813 regarding process controllers		License
Botleng	Activsted sludge	Anaerobic digestion and Solar drying beds	4	Non-compliance against discharge standards	Process Controller, supervisory and maintenance skills	Inadequate flow monitoring	License
Komati	Activated sludge	Solar drying beds	1.26	Non-compliance against discharge standards	Non-compliance against draft 813 regarding process controllers		Nk

WWTW name	**WWTW Type (liquid)**	**WWTW (sludge)**	**Operational Capacity (Ml)**	**Highest risk areas**			**Authoris$^{n/.}$ type**
				Effluent quality	**Skills**	**Capacity/ no flow measurement devices**	
Blinkpan	Activated sludge	Solar drying beds	0.53	Non-compliance against discharge standards	Non-compliance against draft 813 regarding process controllers		Nk
Bronkhorstspruit (Gauteng)	No data						Nk
Boskrans	Activated sludge	DAF thickening and Belt press dewatering	30	Non-compliance against discharge standards	Non-compliance against draft 813 regarding process controllers		License
Kwamhlanga East	Anaerobic ponds/ Facultative ponds and Maturation ponds	None specified	0.49	Non-compliance against discharge standards	Process Controller, supervisory and maintenance skills	Inadequate flow monitoring	Nk
Dullstroom	Activated sludge	Anaerobic sludge and Solar drying beds	1	Non-compliance against discharge standards	Process Controller, supervisory and maintenance skills	Inadequate flow monitoring	Nk
Kwamhlanga West	Aerated ponds/ Oxidation ponds	None specified	0.49	Non-compliance against discharge standards	Process Controller, supervisory and maintenance skills	Inadequate flow monitoring	Nk
Tweefontein	Activated sludge	Solar drying beds	0.75	Non-compliance against discharge standards		Inadequate flow monitoring	Nk
Vaalbank	Aerated ponds/ Oxidation ponds	None specified	0.06	Non-compliance against discharge standards	Process Controller and supervisory skills	Inadequate flow monitoring	Nk
Siyabuswa	Activated sludge	Solar drying beds and Sludge lagoon/ pond	10	Non-compliance against discharge standards		Inadequate flow monitoring	License
Ga Nala (Kriel)	No data	No data					License
Thubelihle	No data	No data					License
Rietspruit	Activated sludge	Anaerobic digestion and Solar drying beds	4.9	Non-compliance against discharge standards	Process Controller, supervisory and maintenance skills	Inadequate flow monitoring	License
Phola	Anaerobic ponds/ Facultative ponds and Biological filters	NI	4.9	Non-compliance against discharge standards	Process Controller, supervisory and maintenance skills	Inadequate flow monitoring	License
Wilge	No data	No data					License
Naauwpoort	Activated sludge	Anaerobic digestion and Solar drying beds	4.9	Non-compliance against discharge standards	Process Controller, supervisory and maintenance skills	Inadequate flow monitoring	License

WWTW name	**WWTW Type (liquid)**	**WWTW (sludge)**	**Operational Capacity (Ml)**	**Highest risk areas**			**Authoris$^{n/.}$ type**
				Effluent quality	**Skills**	**Capacity/ no flow measurement devices**	
Ferrobank	Biological filters	Anaerobic sludge and Solar drying beds	14.1	Non-compliance against discharge standards	Process Controller, supervisory and maintenance skills	Inadequate flow monitoring	License
Klipspruit	Activated sludge and biofilters	Anaerobic sludge	10	Effluent monitoring	Process Controller, supervisory and maintenance skills	Inadequate flow monitoring	License
Riverview	Activated sludge and biofilters	Anaerobic digestion and Solar drying beds	10	Non-compliance against discharge standards	Process Controller, supervisory and maintenance skills	Inadequate flow monitoring	License

Note: Nk: not known/ undetermined;

Middle Olifants sub-catchment

The wastewater treatment works in the Middle Olifants catchment are listed in Table 25.

Table 25: Wastewater Treatment Works in the Middle Olifants sub-catchment

WWTW name	**WWTW Type (liquid)**		**WWTW (sludge)**	**Operational Capacity (Ml)**	**Highest risk areas**			**Authoris$^{n/.}$ type**
					Effluent quality	**Skills**	**Capacity/ no flow measurement devices**	
Lepelle-Nkumpi	Lebowakgomo Oxidation Ponds 1 WWTW		Aerated ponds/ Oxidation ponds	1.9	Poor effluent compliance	Technical skills	Flow monitoring	License
Lepelle-Nkumpi	Lebowakgomo Industrial WWTW		Activated sludge	3	Poor effluent compliance	-	Hydraulic and organic overload	Nk
Lepelle-Nkumpi	Lebowakgomo RWWTW (Middelkop)		-	-	-	-	-	License
Fetakgmomo/ Greater Tubatse	Penge WWTW		Anaerobic / Facultative ponds	0.5	Poor effluent monitoring	Technical skills	Flow monitoring	License
Elias Motsoaledi	Groblersdal WWTW		Activated sludge and BNR	5	Poor effluent monitoring	Technical skills	Flow monitoring	License
Ephraim Mogale	Marble Hall WWTW		Aerated/ Oxidation ponds	5.6	Poor effluent compliance	Technical skills	Flow monitoring	License
Ephraim Mogale	Elandskraal WWTW		Anaerobic / Facultative ponds	0.5	Poor effluent monitoring	Technical skills	Flow monitoring	License
Makhuduthamaga	Jane Furse LCH		-	-	-	-	-	License

WWTW name	**WWTW Type (liquid)**		**WWTW (sludge)**	**Operational Capacity (Ml)**	**Highest risk areas**			**Authoris$^{n/.}$ type**
					Effluent quality	**Skills**	**Capacity/ no flow measurement devices**	
	WWTW							
Makhuduthamaga	Jane Furse Hospital WWTW		-	-	-	-	-	License
Makhuduthamaga	Jane Furse Oxidation Ponds WWTW		Anaerobic ponds/ Facultative ponds	1	Poor effluent monitoring	Technical skills	Flow monitoring	License
Lepelle-Nkumpi	Lebowakgomo Oxidation Ponds 2		Anaerobic / Facultative ponds	1	Poor effluent monitoring	Technical skills	Flow monitoring	Permit
Fetakgmomo/ Greater Tubatse	Atok Mine Residents WWTW		-	-	-	-	-	Nk
Fetakgmomo/ Greater Tubatse	Sekhukhune College WWTW		-	-	-	-	-	Nk
Ephraim Mogale	Tompi Seleka Ponds WWTW		-	-	-	-	-	Nk
Mookgophong	Thusang (Roedtan)		Anaerobic / Facultative ponds	No Information	Poor effluent compliance	Technical skills	Flow measurement	Nk
Ephraim Mogale	Manapsane		-	-	-	-	-	License
Makhuduthamaga	Phatametsane		-	-	-	-	-	Nk
Elias Motsoaledi	Dennilton		Aerated/ Oxidation ponds	1	Poor effluent monitoring	Technical skills	Flow monitoring	Nk
Makhuduthamaga	Glen Cowie		-	-	-	-	-	License
Makhuduthamaga	Nebo		Anaerobic / Facultative ponds	2	Poor effluent monitoring	Technical skills	Flow monitoring	Nk
Makhuduthamaga	Jerusalem		-	-	-	-	-	Nk
Fetakgmomo/ Greater Tubatse	Mecklenburg-B		Anaerobic / Facultative ponds	0.3	Poor effluent monitoring	Technical skills	Flow monitoring	Nk
Elias Motsoaledi	Motetema-A		Anaerobic / Facultative ponds	0.4	Poor effluent monitoring	Technical skills	Flow monitoring	Nk

Note: Nk: not known/ undetermined

Steepoort sub-catchment

The wastewater treatment works in the Steelpoort sub-catchment are listed in Table 26.

Table 26: Wastewater Treatment Works in the Steelpoort sub-catchment

WWTW name	WWTW Type (liquid)	WWTW (sludge)	Operational Capacity (Ml)	Highest risk areas			Authoris$^{n/.}$ type
				Effluent quality	Skills	Capacity/ no flow measurement devices	
Tubatse	Anaerobic ponds/ Facultative ponds	Solar drying beds	1	Effluent monitoring	Technical skills	Flow monitoring	License
Mokgorwane 1							License
Mokgorwane 2							Nk
Doornbosch							Nk
Ga-Mapodile	Anaerobic ponds/ Facultative ponds	None specified	0.2	Effluent monitoring	Technical skills	Flow monitoring	Nk
Mohlakwana							License
Belfast	Activated sludge and Maturation ponds	Anaerobic sludge and Solar drying beds	3.5	Effluent quality compliance	PC, supervisory and maintenance skills	Flow monitoring	Nk
Burgersfort WWTW	Activated sludge	Solar drying beds and Thermo-chemical treatment	1.5	Effluent compliance	Technical skills	Flow monitoring	License
Roossenekal WWTW	Biological filters	Solar drying beds	0.4	Effluent monitoring	Technical skills	Flow monitoring	License
Coromandel (farm)							Nk

Note: Nk: not known/ undetermined

Lower Olifants sub-catchment

The wastewater treatment works in the Lower Olifants sub-catchment are listed in Table 27.

Table 27: wastewater treatment works in the Lower Olifants sub-catchment

WWTW name	WWTW Type (liquid)	WWTW (sludge)	Operational Capacity (Ml)	Highest risk areas			Authoris$^{n/.}$ type
				Effluent quality	Skills	Capacity/ no flow measurement devices	
Ohrigstad							General
Pilgremsrest farm							Nk
Pilgremsrest							No License
Acornhoek	Aerated ponds/ Oxidation ponds	None specified	0.42		PC and supervisory skills	Inadequate flow monitoring	License

WWTW name	WWTW Type (liquid)	WWTW (sludge)	Operational Capacity (Ml)	Highest risk areas			Authoris$^{n/.}$ type
				Effluent quality	Skills	Capacity/ no flow measurement devices	
Acornhoek2							License
Gravelotte							Nk
Josephine							Nk
Phalaborwa mine							Nk
Phalaborwa	Activated sludge	Sludge lagoon/ pond	8	Poor effluent compliance	PC and supervisory skills		Nk
Namakgale	Biological filters	Composting	6.3	Poor effluent compliance	PC and supervisory skills	Inadequate flow monitoring	Nk
Lulekani	Biological filters	Anaerobic digestion, Solar drying beds and composting	3.5	Poor effluent compliance	PC and supervisory skills	Inadequate flow monitoring	Nk
Sekororo Sewerage							Nk
Hoedspruit (Drakensig) WWTW							Nk
Kampersrus WWTW							Nk
KNP Olifants WWTW - Oxidation Ponds							Nk

Note: Nk: not known/ undetermined

Letaba and Shingwedzi sub-catchments

The wastewater treatment works in the Letaba and Shingwedzi sub-catchments are listed in Table 28.

Table 28: Wastewater Treatment Works in the Letaba and Shingwedzi sub-catchments

WWTW name	WWTW Type (liquid)	WWTW (sludge)	Operational Capacity (Ml)	Highest risk areas			Authoris$^{n/.}$ type
				Effluent quality	Skills	Capacity/ no flow measurement devices	
Tzaneen WWTW	Biological filters	Solar drying beds and composting	8	Effluent non-compliance	Inadequate process control skills		Nk
Modjadjiskloof (Duiwelskloof) WWTW	None specified	None specified	Nk	Effluent non-compliance		Inadequate design capacity and flow measurement	Nk
Haenertsburg WWTW							Nk
Letsitele WWTW							Nk
Nkowankowa WWTW	Biological filters	Sludge lagoon/ pond	4.5	Effluent non-compliance	Inadequate process control skills		Nk
Lenyenye WWTW	Aerated ponds/ Oxidation ponds	None specified	1	Effluent non-compliance	Inadequate process control skills		Nk
Ga-Kgapane WWTW	Biological filters	Anaerobic digestion	4	Effluent non-compliance	Inadequate process		Nk

WWTW name	**WWTW Type (liquid)**	**WWTW (sludge)**	**Operational Capacity (Ml)**	**Highest risk areas**			**Authorisn/. type**
				Effluent quality	**Skills**	**Capacity/ no flow measurement devices**	
					control skills		
Giyani WWTW	Biological filters and Oxidation ponds	Solar drying beds	2.1	Effluent non-compliance	Inadequate process control skills		Nk
Senwamokgope WWTW	None specified	None specified	Nk	Effluent non-compliance	Inadequate process control skills	Inadequate design capacity and flow measurement	Nk
KNP Mopani WWTW - Oxidation Ponds							Nk
KNP Letaba WWTW - Oxidation Ponds							Nk
KNP - Makhadzi Picnic Spot							Nk
KNP - Shimuweni Oxidation Ponds							Nk
KNP - Tsendze Rest Camp							Nk
Hans Merensky							Nk
Dr CN Phatudi (Shiluvane) Hospital							Nk
Malamulele WWTW	Biological filters	Anaerobic digestion and Solar drying beds	3	Effluent compliance		process control	Nk
Hlanganani Ponds WWTW							Nk
KNP Punda Maria WWTW							Nk
KNP Shingwedzi WWTW - Oxidation Ponds							Nk
KNP - Sirheni Bush Camp Oxidation Ponds							Nk

Note: Nk: not known/ undetermined

7.3 WATER QUALITY PLANNING LIMITS

7.3.1 Overarching policy

The term Resource Water Quality Objectives (RWQO) has been replaced with Water Quality Planning Limits (WQPL). This will help remove confusion between RQOs and RWQOs. The policy of DWS (DWAF, 2005c) regarding WQPLs is that they should:

- Ultimately allow realisation of the catchment vision (developed as part of the classification study);
- Give effect to the water quality component of gazetted RQOs;
- Where necessary, express more detailed stakeholder needs than those accounted for in the development of the RQOs;

- May equal these gazetted RQOs, however may be set at a finer spatial/or temporal resolution to assist the regulator in determining water quality parameters and limits to include in Water Use Authorisations in order to achieve the RQOs set downstream;
- Dictate the tolerable level of impact collectively that may not be exceeded by upstream users; and
- Determine the need for and extent of waste discharge charges.

Based on the principles of flexibility and adaptive management WQPLs may be revised, following due process, in the following circumstances:

- The baseline ecological data upon which the WQPLs have been based change because new data has become available. WQPLs may therefore be revised/ modified based on the new information that has come to light;
- Significant changes to the vision for a particular catchment (through due process that would involve changes to the classification);
- The present WQPLs are inconsistent with the vision;
- Water treatment technology improves and becomes more cost effective. WQPLs can be made more stringent supporting protection of the water resource.
- Other drivers such as political decisions for socio-economic development, or national or presidential imperatives could form the basis for WQPLs to be modified to support these, also having followed due process.

7.3.2 Water Quality Planning Limits for the Olifants River System

As part of the development of an Integrated Water Resources Management Plan for the Upper and Middle Olifants Catchments (DWAF, 2009) RWQOs that will now be referred to as WQPLs were determined. These are set out in the sections to follow.

These WQPLs will be assessed based on the Reserve – currently being updated, Classification and RQO studies undertaken and described earlier.

Current water quality variables

The water quality variables for which WQPLs have been and are to be determined must reflect the pollution sources and water uses in the study area. The main land use activities in the Olifants River System which contribute to diffuse pollution are mining, power stations, industry, urban developments and agriculture. The point source discharges are mostly from the wastewater treatment works (in most cases, municipal) and limited mining and industrial discharges.

However, the bigger portion of pollution in the Olifants River System is from non-point sources of pollution from mining, industry, agriculture and urbanisation. The pollution from these sources can reflect as acidity, salinity, nutrients, toxicity and microbiological related water quality.

The variables that describe the water quality can be divided into physical, chemical (inorganic), chemical (organic), nutrients, metals and microbiological quality.

Physical variables

The physical variables include pH, electrical conductivity, temperature, dissolved oxygen, suspended solids and turbidity.

Chemical

The water quality variables included to describe the chemical (inorganic) quality are calcium, magnesium, sodium, potassium, boron, alkalinity, chloride, sulphate, fluoride, total dissolved solids and sodium adsorption ratio (SAR). The chemical (organic) quality can be described by oils and greases and dissolved organic carbon.

Metals

The metals that were included in the WQPLs are dissolved forms of aluminium, iron, manganese and chromium. Iron, aluminium and manganese are found in mining and industrial water, while chromium is specifically related to the metal industries.

Nutrients

The nutrients are ammonia, nitrate, phosphate, total phosphorus and total inorganic nitrogen.

Microbiology

The water quality variables used to assess and manage the microbiological aspect is E-Coli and Chlorophyll a.

Considering the issue of emerging contaminants, including Endocrine Disrupting Compounds (EDC), there may be additional variables that should be added.

7.3.3 Existing WQPLs for the Olifants River System

In developing the WQPLs for the 2009 study, the controlling water use that determined the selection of the WQPLs is also given in the tables (Tables 29, 30, 31, 32 and 33) to follow. The following abbreviations were used for the water users:

- PS – present water quality status: the 95 percentile concentration determined over the period 1997 to 2006 was used. The 50 percentile for nutrients and the 5 and 95 percentiles for pH.
- AER – Aquatic Ecological Reserve as determined in the 2001 study.
- AET – Aquatic eco-toxicological test results

- AB11 – Aquatic water quality set in the preliminary Ecological Reserve for quaternary catchments B11C and B11D.
- ITWQR – Irrigation TWQR used for salt sensitive crops.
- IMS – Irrigation requirement used for moderately salt sensitive crops.
- SW – Stock watering
- DI – Domestic informal water use
- DF – Domestic formal use
- RIC – Recreation intermediate contact
- RFC – Recreation full contact
- PRWQ – Current RWQO, based on previous studies.
- IND - Industrial

During DWAF 2002 study to develop an Integrated Water Resource Model of the Upper Olifants River (Loskop Dam) Catchment (DWAF, 2002a), the Loskop Dam catchment was subdivided into 30 Management Units. The location and extent of the Management Units are shown in Figure 82 and were based on water supply infrastructure, land use, water quality profile, flow measuring stations, water quality monitoring points and quaternary catchments. The purpose of the Management Units was to aid in the management of water quality by establishing control/compliance points at the downstream ends of the management units. The management units were extended to cover the Middle Olifants area of the study area.

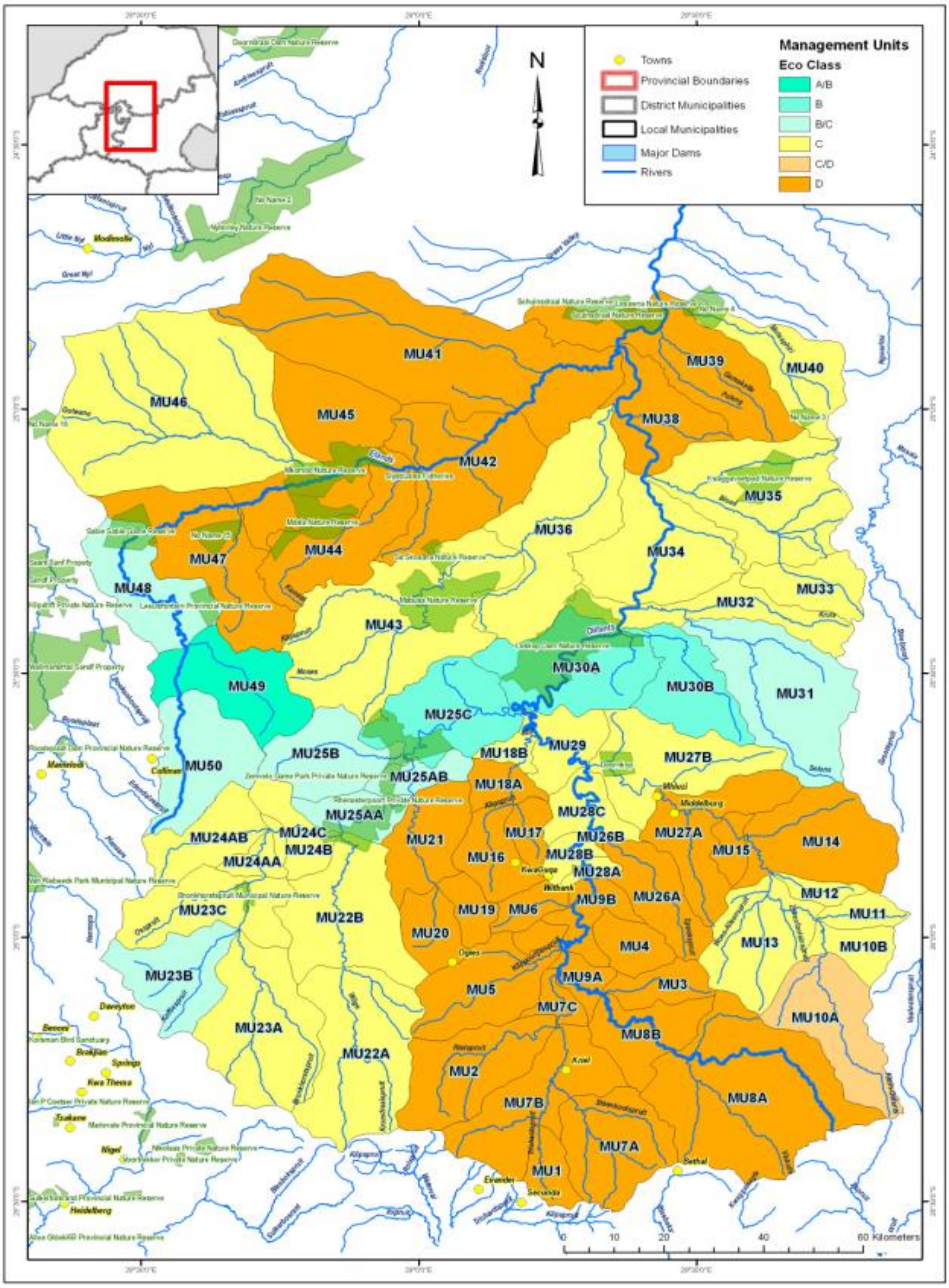

Figure 82: Management Units described the IWRMP Report (DWAF, 2009)

While these Management Units are included in the tables in this report, they will be assessed further in the next phases of the study to see whether they align to the RDM studies.

Table 29: WQPL for Witbank Dam Management Units

		Management Units									
Parameter	**Units**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Witbank Dam**
Conventional											
Alkalinity ($CaCO_3$)	mg/L	120	-	-	-	-	-	-	-	120	120
Conductivity	mS/m	35	70	90	90	70	90	70	60	70	70
Dissolved organic carbon	mg/L	10	10	10	10	10	10	10	10	10	10
Dissolved oxygen	% Sat	70	70	70	70	70	70	70	70	70	70
pH	-	6.5 to 8.4	6.5 to 8.4	6.5 to 8.4	6.5 to 8.4	6.5 to 8.4	6.5 to 8.4	6.5 to 8.4	6.5 to 8.4	6.5 to 8.4	6.5 to 8.4
SAR	$meql^{0.5}$	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Suspended solids	mg/L	-	25	25	25	25	-	-	-	-	25
Total dissolved solids	mg/L	240	450	650	650	650	650	450	440	450	450
Turbidity	NTU	100	50	50	50	50	-	-	-	-	50
Major Ions											
Calcium	mg/L	24	150	150	150	150	150	150	40	150	32
Chloride	mg/L	20	25	175	175	25	50	25	25	25	25
Fluoride	mg/L	0.75	1	1	1	1	1	1	1	1	1
Magnesium	mg/L	15	70	80	80	70	80	70	25	70	20
Potassium	mg/L	25	50	50	50	50	50	50	50	50	25
Sodium	mg/L	30	70	115	115	70	115	70	70	70	70
Sulphate	mg/L	30	200	620	840	380	380	140	80	200	155
Nutrients and Biological											
Ammonia*	mg/L	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
Inorganic nitrogen (total)	mg/L	6	6	6	6	6	6	6	6	6	6
Nitrate	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.02
Phosphate	mg/L	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	0.25
Phosphorus (total)	mg/L	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.05
Chlorophyll *a*	mg/L	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.015
E. coli	# per 100mL	130	130	130	130	130	130	130	130	130	130
Metals (dissolved)											
Aluminium	mg/L	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Boron	mg/L	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Chromium (VI)	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron	mg/L	1	1	1	1	1	1	1	1	1	0.1
Manganese	mg/L	0.18	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.18

Table 30: WQPL for Middelburg Dam Management Units

		Management Units						
Parameter	**Units**	**10**	**11**	**12**	**13**	**14**	**15**	**Mid Dam**
Conventional								
Alkalinity ($CaCO_3$)	mg/L	-	-	-	-	-	85 - 120	120
Conductivity	mS/m	90	90	90	90	90	90	70
Dissolved organic carbon	mg/L	10	10	10	10	10	10	5
Dissolved oxygen	% Sat	70	70	70	70	70	70	-
pH	-	6.5-8.4	6.5-8.4	6.5-8.4	6.5-8.4	6.5-8.4	6.5-8.4	6.5 – 8.5
SAR	$meql^{0.5}$	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Suspended solids	mg/L	-	-	-	-	-	5	-
Total dissolved solids	mg/L	650	650	650	650	650	650	450
Turbidity	NTU							
Major Ions								
Calcium	mg/L	150	150	150	150	150	150	32
Chloride	mg/L	30	30	30	30	30	30	30
Fluoride	mg/L	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Magnesium	mg/L	80	80	80	80	80	80	70
Potassium	mg/L	40	40	40	40	40	40	25
Sodium	mg/L	70	70	70	70	70	70	70
Sulphate	mg/L	400	150	400	400	400	400	200
Nutrients and Biological								
Ammonia	mg/L	0.007	0.007	0.007	0.007	0.007	0.007	0.007
Inorganic nitrogen (total)	mg/L	0.9	0.9	0.9	0.9	0.9	0.9	0.25
Nitrate	mg/L	6	6	6	6	6	6	6
Phosphate	mg/L	0.07	0.07	0.07	0.07	0.07	0.07	0.02
Phosphorus (total)	mg/L	0.18	0.18	0.18	0.18	0.18	0.18	0.05
Chlorophyll *a*	mg/L	0.02	0.02	0.02	0.02	0.02	0.02	0.015
E. coli	# per 100mL	130	130	130	130	130	130	130
Metals (dissolved)								
Aluminium	mg/L	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Boron	mg/L	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Chromium (VI)	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron	mg/L	1	1	1	1	1	1	0.1
Manganese	mg/L	0.18	0.18	0.18	0.18	0.18	0.18	0.18

Table 31: WQPL for the Wilge Catchment Management Units

		Management Units				
Parameter	**Units**	**23,24**	**22**	**16, 17, 18**	**26**	**19, 20, 21, 25**
Conventional						
Alkalinity ($CaCO_3$)	mg/L	120	120	120	120	85
Conductivity	mS/m	40	40	120	90	70
Dissolved organic carbon	mg/L	10	10	10	10	10
Dissolved oxygen	% Sat	70	70	70	70	70
pH	-	6.5-8.4	6.5-8.4	6.0-9.0	6.5-8.4	6.5-8.4
SAR	Meq/L	1	1	2	2	1
Suspended solids	mg/L	-	-	-	-	-
Total dissolved solids	mg/L	280	280	820	650	450
Turbidity	NTU	-	-	-	-	-
Major Ions						
Calcium	mg/L	25	25	150	150	80
Chloride	mg/L	20	20	60	20	20
Fluoride	mg/L	0.5	0.5	0.75	0.75	0.5
Magnesium	mg/L	20	20	100	100	20
Potassium	mg/L	10	10	50	20	10
Sodium	mg/L	20	20	115	70	20
Sulphate	mg/L	30	60	500	400	120
Nutrients and Biological						
Ammonia*	mg/L	0.007	0.007	0.007	0.007	0.007
Inorganic nitrogen (total)	mg/L	2.5	2.5	2.5	2.5	2.5
Nitrate	mg/L	6	6	6	6	6
Phosphate	mg/L	0.05	0.05	0.05	0.05	0.05
Phosphorus (total)	mg/L	0.25	0.25	0.25	0.25	0.25
Chlorophyll *a*	mg/L	0.02	0.02	0.02	0.02	0.02
E. coli	# per 100mL	130	130	130	130	130
Metals (dissolved)						
Aluminium	mg/L	0.02	0.02	0.2	0.02	0.02
Boron	mg/L	0.5	0.5	0.5	0.5	0.5
Chromium (VI)	mg/L	0.05	0.05	0.05	0.05	0.05
Iron	mg/L	1	1	1	1	1
Manganese	mg/L	0.18	0.18	1	0.4	0.18

Table 32: WQPL for Loskop Dam Incremental Management Units

		Management Units			
Parameter	**Units**	**16, 17, 18**	**26**	**27, 28, 29, 30**	**Loskop Dam**
Conventional					
Alkalinity ($CaCO_3$)	mg/L	120	120	120	85
Conductivity	mS/m	120	90	90	40
Dissolved organic carbon	mg/L	10	10	10	10
Dissolved oxygen	% Sat	70	70	70	70
pH	-	6.0-9.0	6.5-8.4	6.5-8.4	6.5-8.4
SAR	$meql^{0.5}$	2	2	2	1.5
Suspended solids	mg/L	-	-	-	-
Total dissolved solids	mg/L	820	650	650	260
Turbidity	NTU	-	-	-	-
Major Ions					
Calcium	mg/L	150	150	150	32
Chloride	mg/L	60	20	175	25
Fluoride	mg/L	0.75	0.75	0.75	0.75
Magnesium	mg/L	100	100	70	20
Potassium	mg/L	50	20	50	10
Sodium	mg/L	115	70	70	25
Sulphate	mg/L	500	400	120	120
Nutrients and Biological					
Ammonia*	mg/L as N	0.007	0.007	0.007	0.007
Inorganic nitrogen (total)	mg/L as N	6	6	6	6
Nitrate	mg/L as P	0.05	0.05	0.05	0.02
Phosphate	mg/L as N	2.5	2.5	2.5	0.2
Phosphorus (total)	mg/L as P	0.25	0.25	0.25	0.05
Chlorophyll *a*	mg/L	0.02	0.02	0.02	0.02
E. coli	# per 100mL	130	130	130	130
Metals (dissolved)					
Aluminium	mg/L	0.2	0.02	0.02	0.02
Boron	mg/L	0.5	0.5	0.5	0.5
Chromium (VI)	mg/L	0.05	0.05	0.05	0.05
Iron	mg/L	1	1	1	1
Manganese	mg/L	1	0.4	0.4	0.18

Table 33: WQPL for the Middelburg Olifants Catchment Management Units

		Management Units			
Parameter	**Units**	**31, 32, 33, 34, 35, 38, 39, 40**	**36, 43**	**41, 42**	**44, 45, 46, 47, 48, 49, 50**
Conventional					
Alkalinity ($CaCO_3$)	mg/L	-	-	-	-
Conductivity	mS/m	90	30	90	40
Dissolved organic carbon	mg/L	-		-	-
Dissolved oxygen	% Sat	70	70	70	70
pH	-	6.5-8.4	6.5-8.4	6.5-8.4	6.5-8.4
SAR	meql$^{0.5}$	1.5	1.5	1.5	1.5
Suspended solids	mg/L	-	-	-	-
Total dissolved solids	mg/L	650	210	650	260
Turbidity	NTU	-	-	-	-
Major Ions					
Calcium	mg/L	32	15	32	25
Chloride	mg/L	100	25	100	30
Fluoride	mg/L	0.75	0.75	0.75	0.75
Magnesium	mg/L	70	10	70	20
Potassium	mg/L	25	10	10	15
Sodium	mg/L	70	40	70	40
Sulphate	mg/L	200	20	200	20
Nutrients and Biological					
Ammonia*	mg/L as N	0.007	0.007	0.007	0.007
Inorganic nitrogen (total)	mg/L as N	6	6	6	6
Nitrate	mg/L as P	0.07	0.07	0.07	0.05
Phosphate	mg/L as N	3.5	3.5	3.5	20.5
Phosphorus (total)	mg/L as P	0.35	0.35	0.35	0.25
Chlorophyll *a*	Mg/L	0.02	0.02	0.02	0.02
E. coli	# per 100mL	130	130	130	130
Metals (dissolved)					
Aluminium	mg/L	0.02	0.02	0.02	0.02
Boron	mg/L	0.5	0.5	0.5	0.5
Chromium (VI)	mg/L	0.05	0.05	0.05	0.05
Iron	mg/L	1	1	1	1
Manganese	mg/L	0.18	0.18	0.18	0.18

7.3.4 New WQPLs

Gaps

WQPLs have not yet been set for the Steelpoort sub-catchment, the greater part of the Middle Olifants sub-catchment, the Lower Olifants sub-catchment, the Letaba sub-catchment and the Shingwedzi sub-catchment.

Proposed approach in developing WQPLs

The proposed approach in developing new WQPLs for these areas will be to:

- Align with the results of the Reserve (update), the classification and RQOs that have been set;
- Consider all the water users in the area; and
- The Department's South African Water Quality Guidelines (DWAF, 1996 or any update) will be used as the basis to determine the WQPLs in the areas where WQPLs have not yet been set and where no guidance is available for certain variables from the Reserve and RQOs.

Water Users

The water users in the sub-catchments include:

- Irrigation and domestic use in the Middle Olifants;
- Mining, industry, irrigation and domestic use in the Steelpoort;
- Irrigation, limited mining and domestic use in the Middle Olifants;
- Irrigation, limited mining and domestic use in the Letaba; and
- Irrigation and domestic use in the Shingwedzi.

In all cases recreation and aquatic ecosystems will need to be considered as tourism is a key economic driver for all the areas.

7.4 SALINITY STATUS

7.4.1 SO_4/ [Total Anions] ratio

Data was received from the DWS RQIS for SO_4/ [total anions] ratio for various monitoring points in the Olifants River System. This type of assessment assists in differentiating the signature of coal mines. This was done by using the SO_4/ [total anions] ratio as a marker for risk, based on Dr Pete Ashton's CSIR report (Ashton et al, 2011). Sulphate on its own has insignificant health effects even at 400 mg/l, but when the ratio of sulphate to the other ions starts to change, this is often a warning that AMD is occurring upstream.

Dr Ashton used a SO_4/Cl ratio, however this was amended by Dr Silberbauer by determining the SO_4/ total anions] ratio, which provides a more convenient number in the range 0.0 to 1.0 and avoids bias when total alkalinity is very high or low. A high SO_4/[total anions] ratio is considered indicative of AMD and suggests that further investigation and analysis are needed.

It is intended as a rough filter and where hotspots are identified in this manner it follows that sampling and analysis should be done to confirm whether there has been a significant change in the water quality.

Based on the 95 percentiel data the following (arbitrary) ranges were applied to produce a risk category that are included as Appendic D to this report.

0 – <0.2	No risk potential	Blue
0.2 – <0.4	Small risk potential	Green
0.4 – <0.6	Perceptible risk potential	Yellow
0.6 – <0.8	High Risk potential	Orange
0.8 – 1	Severe Risk potential	Red

The catchments of the Upper Olifanrs indicate no risk to perceptible risk in quaternary catchments B11A, C, D E and J, all of which are in rge upper parts of the catchmemt. A high to severe risk potential is noted in the middle to lower parts of B11: B11A (lower), B11B, F, G, H and K. this is not uinexpected as it shows the severe impacts of the coal mining sector.

The Klein Olifants sub-catchment (B12 A and B) indicate a small to perceptible risk, however B12 C and D show mostly high to severe risks in the lower paerts of these drainage regions.

The area in the vicinity of Delmas (B20A) shows a small to perceptible risk around the coal mines located in this area. The lower regions of the Bronhorstspruit and the Wilge catchment (B20 B, C, D, F and G) indicate a no to small risk potential.

The areas on B20G (Saalboomspruit) and B20J on the Wilge indicate a high to severe risk which means that even though the concentrations are still relatively low, the sulphate: total anions ratio indicates that the upstream activities are having an impact on the lower Wilge River and its tributaries.

Moving below Loskop Dam the ratios show a perceptible to high risk range, however the Elands and Moses rivers currently has a no risk rating. The impacts from mining can however still be seen in the main stem.

The salinity decrease to a small to no risk lower down in the catchment. The Steelpoort tertiary catchment (B41) currently shows a no risk ratio although there is a small risk noted in the Spekboom catchment. In h eMiddl eoLIfants around Arabie and Flag Boshileo Dam the risk increases to a perceptible risk potential. Downstream of the mines in Phalaborwa the risk again increases to a perceptible to high risk.

7.5 SALINITY STATUS AT LEVEL 1 MONITORING POINTS

The data retrieved from the WMS system for the points set out in Table 11 were used to assess the water quality along the main stem Olifants River and the points set out in Table 34 were subsequently used to determine a first order sulphate load to the catchment at the weirs noted.

Table 34: Monitoring stations used to determine a first order sulphate load

Station	Catchments added (not in tributaries)	Location
B1H5	B11A-F	Wolwekrans Weir
B1H10	B11G	Witbank Dam Release
B3R002	B11J; B11L; B32A	Loskop Dam Release
B3H1	B32B-J	U/S of Flag Boshielo
B5H4	B51A-B	Flag Boshielo Release
B7H7	B51C-H; B52; B71; B72A-C	Oxford (D/S Blyde)
B7H15	B72D	Mamba KNP, downstream of the Ga-Selati confluence with the Olifants River

7.5.1 Trends observed

Boxplots showing the trends for total dissolved solids (TDS) and sulphate (SO_4) along the main stem Olifants are shown in Figure 83 and Figure 84. The Upper Olifants is clearly impacted on by the coal mines. The upstream EC averages and sulphate concentrations are on the whole within the 111 mS/m and 500 mg/L set as part of the RQOs, however considering the 95% (data included as Appendix B) there is concern in the Upper Olifants where the EC along the main stem ranges between 75 and 142 mS/m and 75 and 850 mg/L for sulphate. At the Loskop Dam B32 90455 just downstream of the dam the 95% values for EC (50.1) and sulphate (146.42 mg/L) are above the RQOs of 55 mS/m (EC) and 80 mg/L (sulphate).

The reason for the spike at B32 193742 is unclear as the upstream land uses appear to be irrigation and the Moganyaka village.

The impacts from the mining at Phalaborwa is clear from the increased TDS and sulphate at monitoring point B73 90512 just downstream of the confluence with the Ga-Selati and B73 90515 which is at least 50 kilometres downstream. The 95% EC value at this point is 200 mS/m and sulphate 699 mg/L: considerably higher than the 111 mS/m and 500 mg/L set respectively as part of the RQOs for the Lower Olifants.

However, the trend graphs at these points shows that there has been an improvement in water quality over the past few years, however it may not yet be fit for purpose.

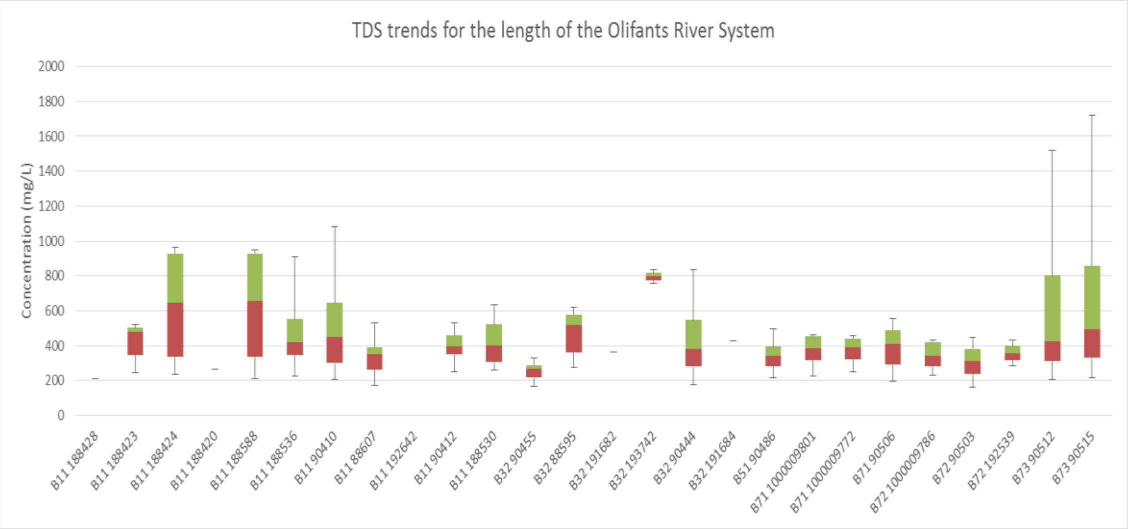

Figure 83: Box plots showing total dissolved solids (mg/L) trends along the main stem Olifants River

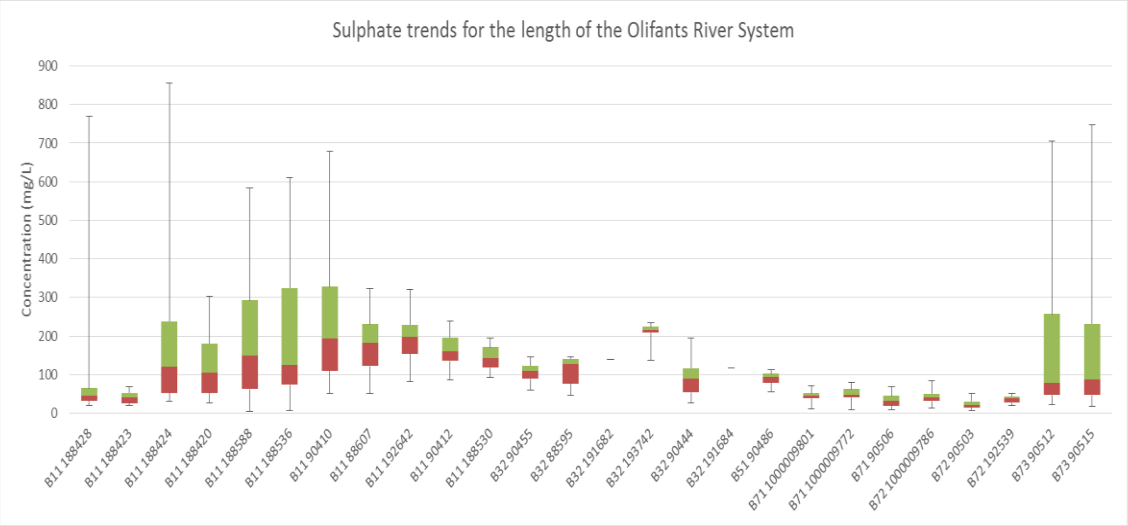

Figure 84: Box plots showing sulphate (mg/L) trends along the main stem Olifants River

Figure 85 illustrates the positive and negative trends along the main stem Olifants River.

7.5.2 Current loads to the system

The current sulphate loads to the system are illustrated in

Figure 86.

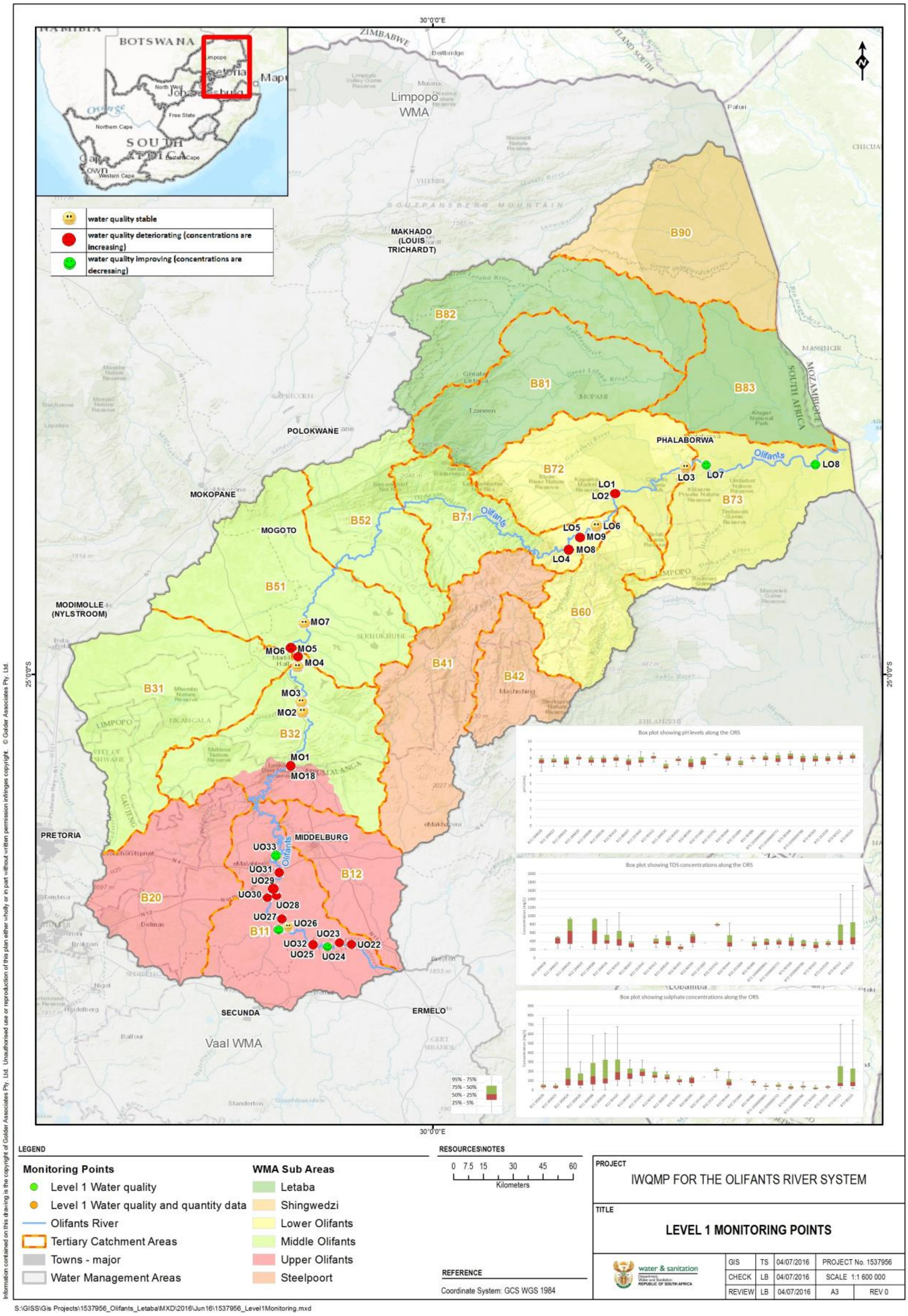

Figure 85: Positive and negative trends at the points along the main stem Olifants River

Sulphate (2000-2014):

🟢 - 🟡 100 🔴 200

	Measured Load: (kg/d)	Measured Flowrate: (Ml/d)	Calculated Concentration: (mg/l)	Avg Measured Concentration
Wolwekrans Weir	46 805	481	🟢 97	269
Catchment Balance	16 042	59	🔴 271	
Dam Abstraction	-11 883	-102	116	
Witbank Dam				
Dam Release	50 964	438	🟡 116	177
Spookspruit	21 435	40	🔴 536	928
Klein Olifants	42 799	167	🔴 256	496
Klipspruit	37 351	122	🔴 306	398
Wilge	32 672	529	🟢 62	
Catchment Balance	42 381	802	🟢 53	
Dam Abstraction	-42 424	-391	108	
Loskop Dam				
Dam Release	185 178	1 707	🟡 108	
Catchment Balance	-29 889	-263	🟡 114	
Loskop North	155 289	1 444	🟡 108	
Elands River	5 505	88	🟢 63	
Catchment Balance	-33 488	24	🟢 -1 425	
Dam Abstraction	-655	-8	82	
Flag Boshielo				
Dam Release	126 651	1 547	🟢 82	
Steelpoort	13 568	890	🟢 15	
Blyde River	6 986	626	🟢 11	
Catchment Balance	3 920	384	🟢 10	
Oxford	151 125	3 447	🟢 44	
Ga-Selati	22 757	128	🟡 178	
Catchment Balance	7 674	-207	🟢 -37	
Mamba	181 556	3 368	🟢 54	

Not full accurate record

Figure 86: Sulphate loads determined for the Main stem Olifants River

7.6 EUTROPHIC STATUS: LEVEL 1 MONITORING POINTS

7.6.1 Methodology

The data retrieved from the WMS system for the points set out in Table 11 were used to assess the water quality along the main stem Olifants River.

The following points (Table 35) were subsequently used to determine a first order phosphate load to the catchment at the weirs noted.

Table 35: Monitoring stations used to determine a first order phosphate load

Station	Catchments Added (not in Tributaries)	Location
B1H5	B11A-F	Wolwekrans Weir
B1H10	B11G	Witbank Dam Release
B3R002	B11J; B11L; B32A	Loskop Dam Release
B3H1	B32B-J	U/S of Flag Boshielo
B5H4	B51A-B	Flag Boshielo Release
B7H7	B51C-H; B52; B71; B72A-C	Oxford (D/S Blyde)
B7H15	B72D	Mamba KNP, downstream of the Ga-Selati confluence with the Olifants River

7.6.2 River system trends observed

The average trends for ortho-phosphate and nitrate along the main stem Olifants River are illustrated in Figure 87 and Figure 88.

The orthophosphate and nitrate concentrations along the main stem Olifants River clearly indicate impacts from wastewater treatment works and urbanisation as well as from the agricultural sector in the upper part of the Upper Olifants sub-catchment and the Middle Olifants, especially at B11 188530 which is downstream of the town of Witbank in the eMalahaleni Local Municipality and the Riverview wastewater treatment works. In all cases average orthophosphate measured exceeds the RQOs set at 0.125 mg/L for the rivers and 0,025 mg/L for the dams. Nitrate concentrations are mostly within the RQOs set (ranging from 0.7 mg/L in B11L to 4 mg/L), except at B11 188530 which is downstream of the town of Witbank in the eMalahaleni Local Municipality and the Riverview wastewater treatment works.

The peak at B11 188423 is upstream in the Upper Olifants sub-catchment and it appears that it may be from the agricultural sector, rather from urbanisation or a wastewater treatment works in this case.

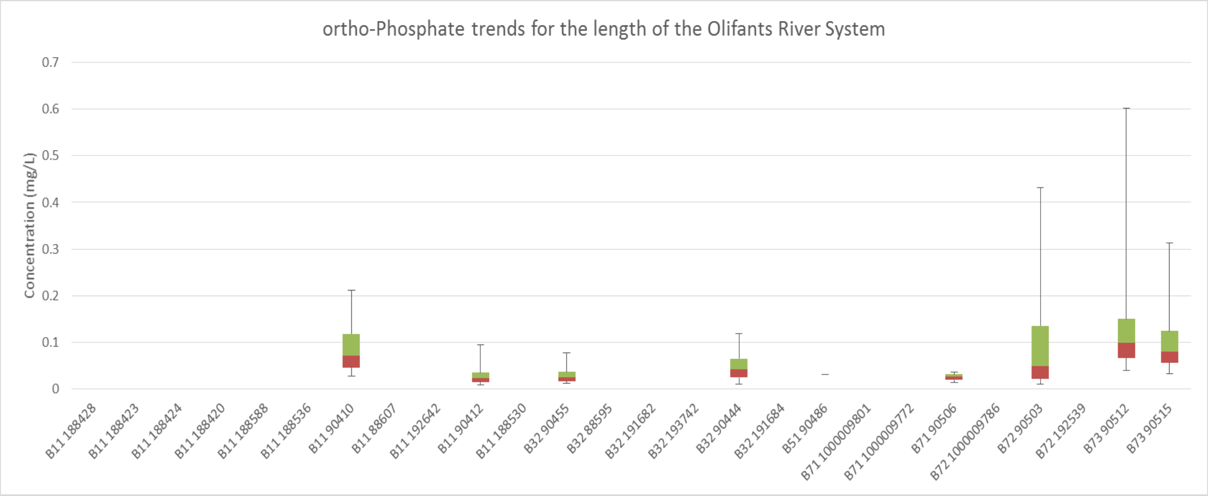

Figure 87: Box plots showing ortho-phosphate concentrations along the main stem Olifants River

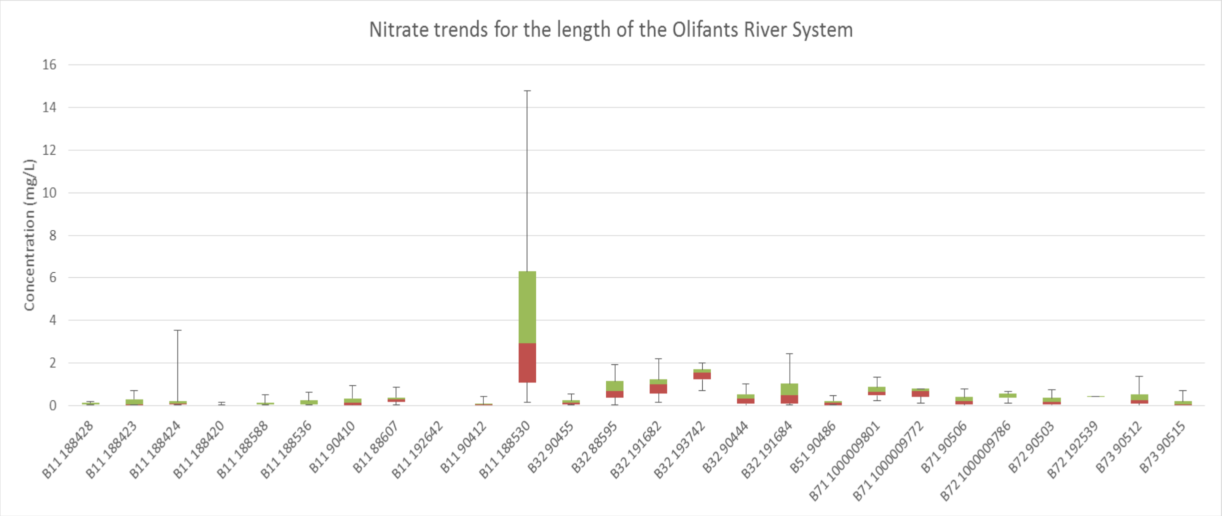

Figure 88: Box plots showing nitrate concentrations along the main stem Olifants River

7.6.3 First order phosphate loads

First order phosphate loads have been determined for the main stem Olifants River System and are illustrated in Figure 89.

7.6.4 Trophic status of impoundments

Eutrophication is a process of nutrient enrichment of a system and it is used to classify the stage at which this process is at any given time in a particular water body[8].The 'trophic status' of the water body is therefore used as a description of the water quality status of a water body, with regard to nutrient enrichment. The following classification terms and colour coding (Table 36) are provided by the DWS National Eutrophication Monitoring site[8] for easy reference.

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[8] https://www.dwa.gov.za/iwqs/eutrophication/NEMP/report/trophicmethod.htm

Table 36: Colour codes, classification naming and description (DWS, NEMP[8])

Class	Description
Oligotrophic	Low in nutrients and not productive in terms of aquatic animal and plant life.
Mesotrophic	Intermediate levels of nutrients, fairly productive in terms of aquatic animal and plant life and showing emerging signs of water quality problems.
Eutrophic	Rich in nutrients, very productive in terms of aquatic animal and plant life and showing increasing signs of water quality problems.
Hypertrophic	Very high nutrient concentrations where plant growth is determined by physical factors. Water quality problems are serious and can be continuous.

Table 38 sets out a simplified method for classifying trophic status classes as used by the DWS NEMP. Note the use of medians rather than means to reduce the effect of irregular monitoring and occasional outliers on the results.

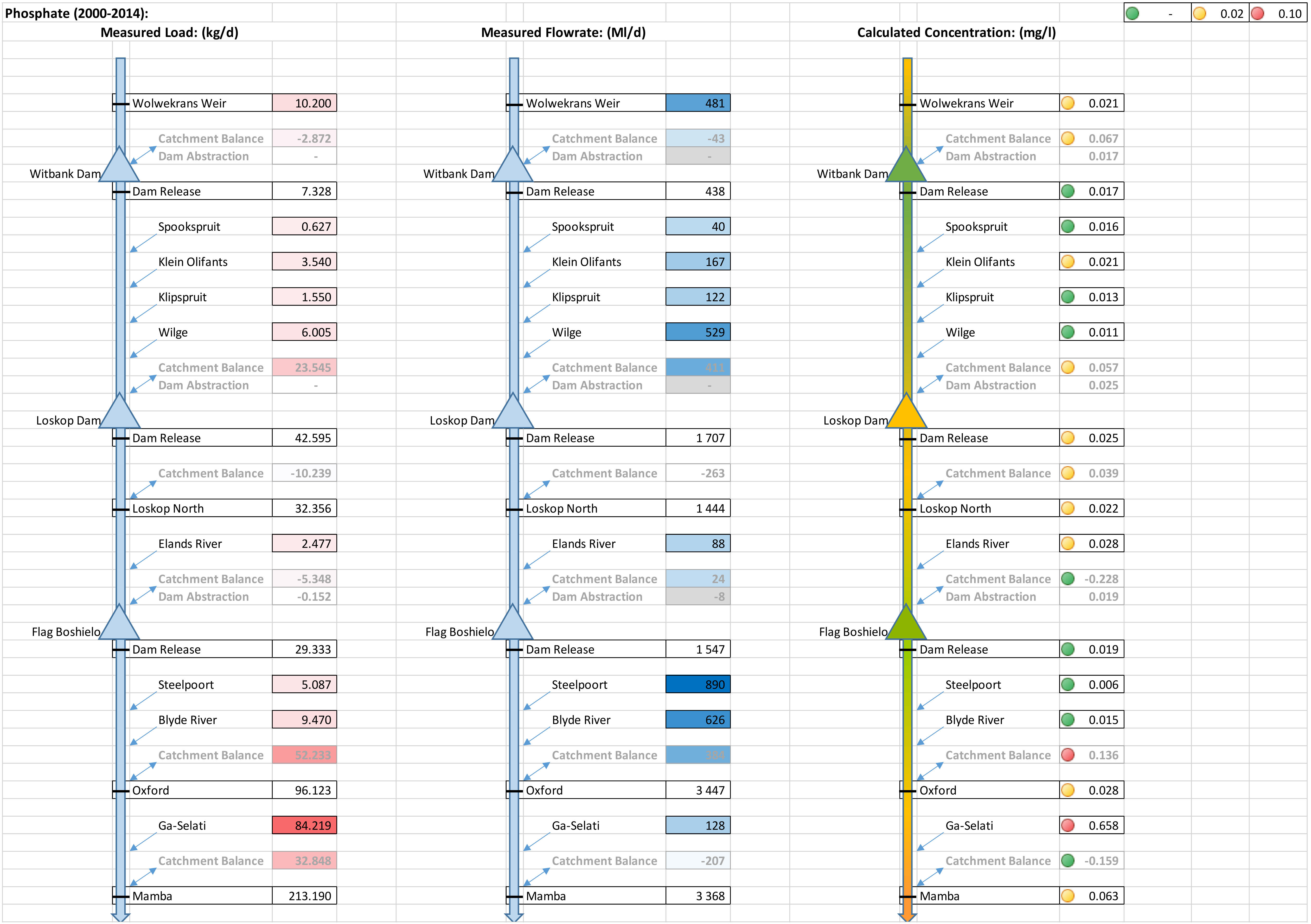
Table 37: Simplified method for classifying trophic status classes[8]

Statistic	Unit	Current trophic status:			
Median annual chlorophyll a	µg/*L*	0<x≤10	10<x≤20	20<x≤30	>30
		Oligotrophic	Mesotrophic	Eutrophic	**Hypertrophic**
		(low)	(moderate)	(significant)	**(serious)**
		Potential for algal and plant productivity:			
Median annual total phosphorus (TP)	mg/L	x≤0.015	0.015<x≤0.047	0.047<x≤0.130	>0.130
		negligible	moderate	significant	**serious**

The latest Chlorophyll a and TP for various sites within the Olifants River System are set out in Table 38. Based on the median chlorophyll a concentrations, in most cases the water resource is in an oligotrophic to mesotrophic state. However where total phosphorous (TP) has been measured there is a moderate to significant potential for algal growth and plant productivity, with the Bronkhorstspruit Dam water quality having a serious potential for algal growth and the Olifants River at the weir at Oxford in the Lower Olifants also having a serious potential for algal growth. This point is downstream of the confluence with the Blyde River on the Olifants. Upstream of this confluence on the Blyde River and Rietspruit there is extensive irrigation taking place.

Table 38: Eutrophication potential at various sites within the Olifants River System

Name and description of site	**Chl a µg/L (Median)**	***n***	**TP mg/L (Median)**	***n***
B1H019 Naauwpoort 335 JS on Noupoortspruit			0.055	*1*
B4R001Q01 Mapochsgronde 500 JS - Tonteldoos Dam on Tonteldoosloop near Dam Wall	0.3	*2*	0.027	*2*
B1H010Q01 Witbank Dam on Olifants River: downstream Weir			0.03	*2*
B1R001Q01 Witbank Dam on Olifants River: near Dam Wall	19.5	*8*	0.053	*1*
B1H012Q01 at Rondebosch U/S Middelburg on Klein Olifants			0.024	*2*
B1R002Q01 Middelburg Dam on Klein Olifants River: near Dam Wall	2.3	*12*	0.018	*2*
B1H015Q01 Middelburg Dam on Little Olifants River: downstream			0.024	*4*
B2H010Q01 Bronkhorstspruit Dam on Bronkhorst Spruit: Return to River			0.13	*2*
B2R001Q01 Bronkhorstspruit Dam on Bronkhorstspruit near Wall	17.9	*10*	0.064	*6*
B2H003Q01 at Bronkhorstspruit on Bronkhorstspruit			0.061	*2*
B3R001Q01 Kliprand 76 JR - Rust de Winter Dam on Elandsrivier: near Dam Wall	6.6	*10*	0.036	*4*
B3R005Q01 Rhenosterkop 157 IR - Rhenosterkop Dam on Elandsrivier: near Dam Wall	0.7	*10*	0.051	*6*
B3R002Q01 Loskop 81 JS - Loskop Dam on Olifantsrivier: near Dam Wall			0.038	*1*
B3H015Q01 Loskop Dam on Olifants River: Left Canal			0.032	*2*
B3H017Q01 Loskop Dam on Olifants River: Down Stream Weir			0.022	*2*
Belfast Dam near Dam Wall	18.1	*8*	0.056	*2*
B4R002Q01 Mapochsgronde 500 JS - Vlugkraal Dam on Vlugkraalrivier: near Dam Wall	0.3	*3*	0.025	*3*
De Hoop 886 KS - at Dam Wall of de Hoop Dam	3.9	*3*		
B4R004Q01 Buffelkloof 382 KT - Buffelskloof Dam on Watervalrivier: near Dam Wall	0.3	*1*	0.01	*3*
B5R002Q01 Arabie 685 KS - Flag Boshielo (Arabie) Dam on Olifantsrivier: near Damwall	12.2	*4*	0.041	*2*
B6R001Q01 Ohrigstaddam Natuurreservaat - Ohrigstaddam on Ohrigstadrivier: near Dam Wall	1.7	*1*		
B7H007Q01 at Oxford on Olifants River	0.3	*1*	0.206	*2*
B8R001Q01 Ebenezer Dam - Ebenezer Dam on Groot-Letaba: near Dam Wall	1.4	*3*		
B8R003Q01 Turksvygbult 550 LT - Magoebaskloof Dam on Politsirivier: near Dam Wall	4.2	*2*		
B8R005Q01 Doornhoek 535 LT - Tzaneen Dam on Groot Letaba: near Dam Wall	2.9	*2*		
B8R011Q01 Modjadjes 424 LT Ga-Matswe - Modjadji Dam on Molototsi near Dam Wall	3.6	*2*		
B8R007Q01 Sterkrivier 97 LT - Middle Letaba Dam on Middel Letaba: near Dam Wall	1.9	*9*	0.01	*2*
B8R009 Nsami at Nsami Dam near Dam Wall	3.8	*10*	0.042	



Phosphate (2000-2014):

🟢 -	🟡 0.02	🔴 0.10

		Measured Load: (kg/d)	Measured Flowrate: (Ml/d)	Calculated Concentration: (mg/l)
	Wolwekrans Weir	10.200	481	🟡 0.021
	Catchment Balance	-2.872	-43	🟡 0.067
	Dam Abstraction	-	-	0.017
Witbank Dam	Dam Release	7.328	438	🟢 0.017
	Spookspruit	0.627	40	🟢 0.016
	Klein Olifants	3.540	167	🟡 0.021
	Klipspruit	1.550	122	🟢 0.013
	Wilge	6.005	529	🟢 0.011
	Catchment Balance	23.545	411	🟡 0.057
	Dam Abstraction	-	-	0.025
Loskop Dam	Dam Release	42.595	1 707	🟡 0.025
	Catchment Balance	-10.239	-263	🟡 0.039
	Loskop North	32.356	1 444	🟡 0.022
	Elands River	2.477	88	🟡 0.028
	Catchment Balance	-5.348	24	🟢 -0.228
	Dam Abstraction	-0.152	-8	0.019
Flag Boshielo	Dam Release	29.333	1 547	🟢 0.019
	Steelpoort	5.087	890	🟢 0.006
	Blyde River	9.470	626	🟢 0.015
	Catchment Balance	52.233	384	🔴 0.136
	Oxford	96.123	3 447	🟡 0.028
	Ga-Selati	84.219	128	🔴 0.658
	Catchment Balance	32.848	-207	🟢 -0.159
	Mamba	213.190	3 368	🟡 0.063

Figure 89: First order phosphate loads for the main stem Olifants River

7.7 MICROBIOLOGICAL STATUS: LEVEL 1 MONITORING POINTS

There is no microbiological data available for the main stem Olifants River. This is seen as a major gap in the area and will need to be assessed.

7.8 GENERAL TRENDS IN RESPECT OF OTHER PHYSICAL AND CHEMICAL VARIABLES: LEVEL 1 MONITORING POINTS

Figures Figure 90, Figure 91 and Figure 92 illustrate the trends of average pH, magnesium, calcium and chloride along the Olifants River main stem. The pH remains within the average range of pH WQPL (6.5-8.4) set for most of the Upper Olifants catchments in 2009. The 95% data (Appendix B) also exhibits values within the average range of pH WQPL (6.5-8.4).

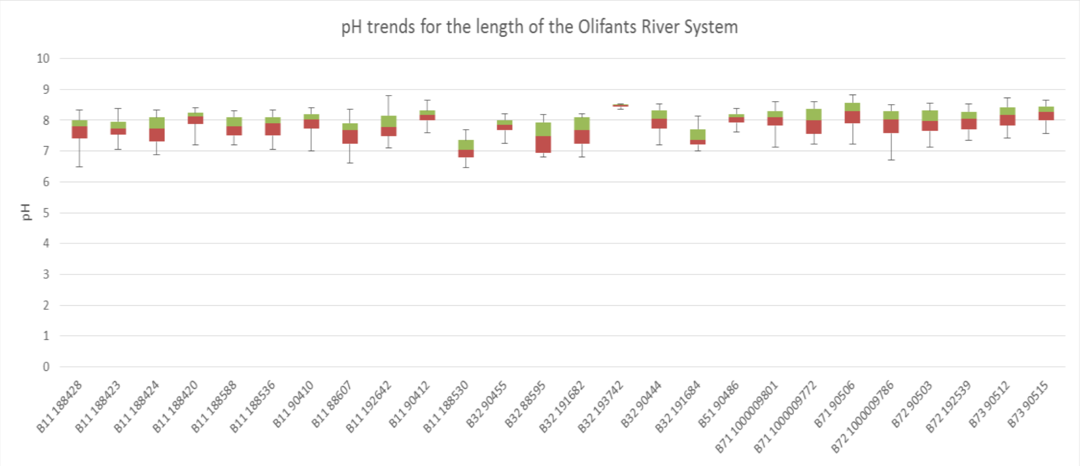


Figure 90: Box plots showing pH trends along the Olifants River main stem

Average magnesium and calcium concentrations along the main steam Olifants River are set out in Figure 91 and Figure 92 respectively and indicate fairly stable levels along the length of the river. However there are two spikes. The reason for the spike at B71 1000009801 (downstream confluence with the Tswenyane River) is unclear and will need further investigation, and the reason for the spike at B72 192539 (at Lepelle Northern Water Barrage at the dam wall) may be from the mining taking place just upstream (approximately 1.5 km) of this site. This will also be corroborated with Lepelle Northern Water.

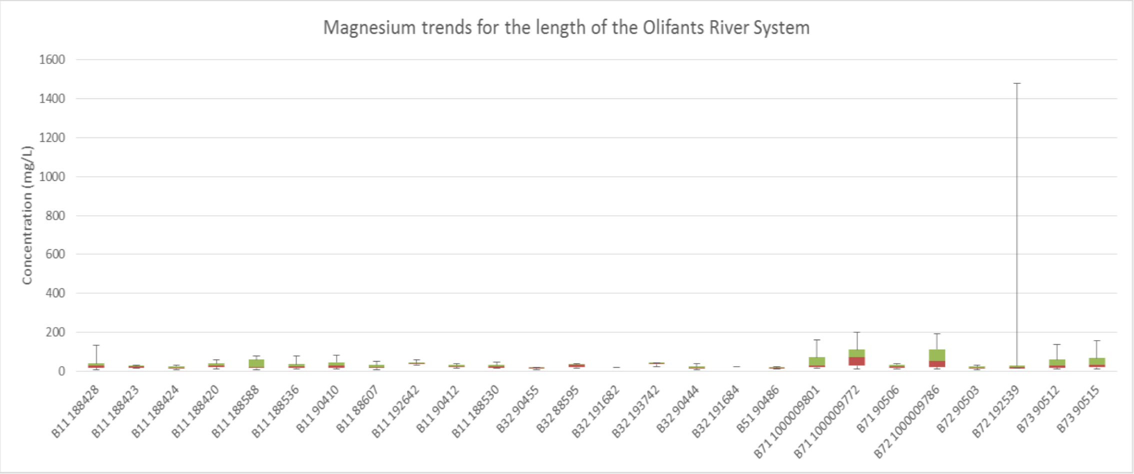


Figure 91: Box plots showing magnesium trends along the Olifants River main stem

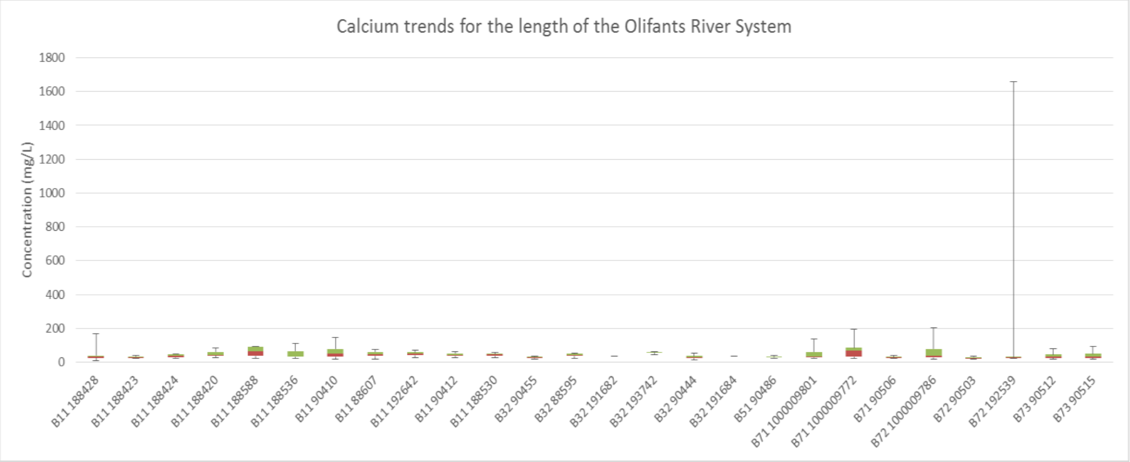


Figure 92: Box plots showing calcium trends along the Olifants River main stem

The increasing levels of chloride in the Middle to Lower Olifants is likely due to the irrigation occurring in these areas, with extensive irrigation occurring upstream of site B32 193742 at Moganyaka.

7.9 CURRENT STATUS AND WATER QUALITY TRENDS IDENTIFIED ON THE MAJOR TRIBUTARIES: LEVEL 2 AND 3 MONITORING POINTS

Water quality results for the Level 2 monitoring points are included as Appendix B to this report. The following observations are made and are in alignment with results from the CSIR (2013) report.

Figure 93, Figure 94 and Figure 95 illustrate the current water quality status for 95 or 50 percentile data for total dissolved solids, sulphate, ortho-phosphate, ammonia, pH, chloride and magnesium, assessed against the strictest fitness for use category showing ideal, acceptable and unacceptable statuses as green, blue or red respectively, as well as improving, constant or deteriorating trends (☺, 😐 or ☹ respectively), for the Upper and Middle Oifants and Steelpoort sub-catchnments, further described in the sections to follow.

Upper Olifants sub-catchment

Water quality statistics are given in Appendix B in the electronic Excel spreadsheet. The Upper Olifants catchment is the most impacted catchment in the study area.

The EC ranges from 30.89 mS/m to 270 mS/m with 50% of the samples exceeding the RQO of 111 mS/m. TDS ranges from 227 mg/L to 2 700 mg/L. Sulphate concentrations range from 22 mg/L to 1 823.58 mg/L. The 95% for pH values in this sub-catchment are within the 7.5 – 8.5 range, however there are some instances where pH is at pH 4.8.

The most impacted catchment appears to be the Woestalleenspruit which drains to Middelburg Dam.

The Wilge River is the most unimpacted however, the sulphate concentration at Waterval on the Wilge River (B20 188223) already exceeds the RQO of 200 mg/L (213 mg/L).

Nutrient enrichment is also of concern with ortho-phosphate values being well above the RQO of 0.125 mg/L and nitrate concentrations also exceed the 4 mg/L RQO at various stations.

Middle Olifants sub-catchment

The limited data available in the Middle Olifants on the Moses and Selons River indicates 50% ranges of ortho-phosphate as 0.0 to 0.04 mg/L which is within the RQO of 0.125 mg/L.

The 95% TDS (403 mg/L), EC (100 mS/m) and sulphate (191 mg/L) concentrations in the Moses River indicate some impacts from the dispersed mining activities.

The 95% TDS (168 mg/L), EC (30 mS/m) and sulphate (35 mg/L) concentrations in the Selons River are well within the RQOs set of EC (111 mS/m) and sulphate (500 mg/L).

pH in these two catchments is slightly alkaline with pH 8.1 in the Moses River and 8.2 in the Selons River.

Steelpoort sub-catchment

The electrical conductivity in the Steelpoort sub-catchment ranges from 18.37 to 124.5 mS/m and total dissolved solids concentrations range from 92 mg/L t o 980 mg/L (Steelpoort River at Alverton) indicating the impacts from mining. pH values are > 8 in most cases tending to a slight alkaline state.

The nutrients in the Steelpoort catchment are not of a major concern with ortho-phosphate mostly <0.05 mg/L. Nitrates are elevated on the Dwars River (9mg/L) downstream of the Two Rivers mine, although no RQOs have been set for nitrate in the this sub-catchment.

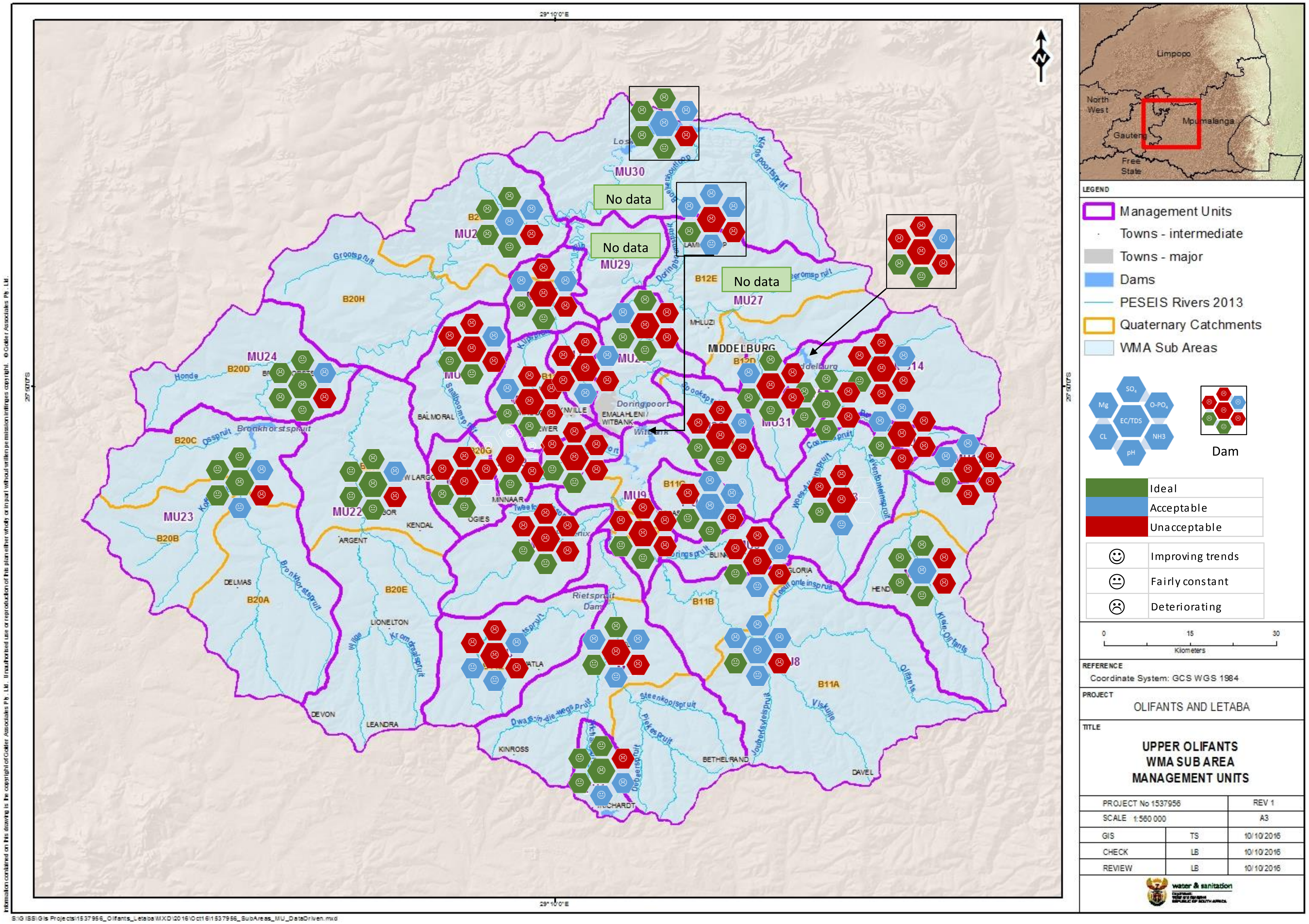


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Figure 93: Upper Olifants sub-catchment water quality status map

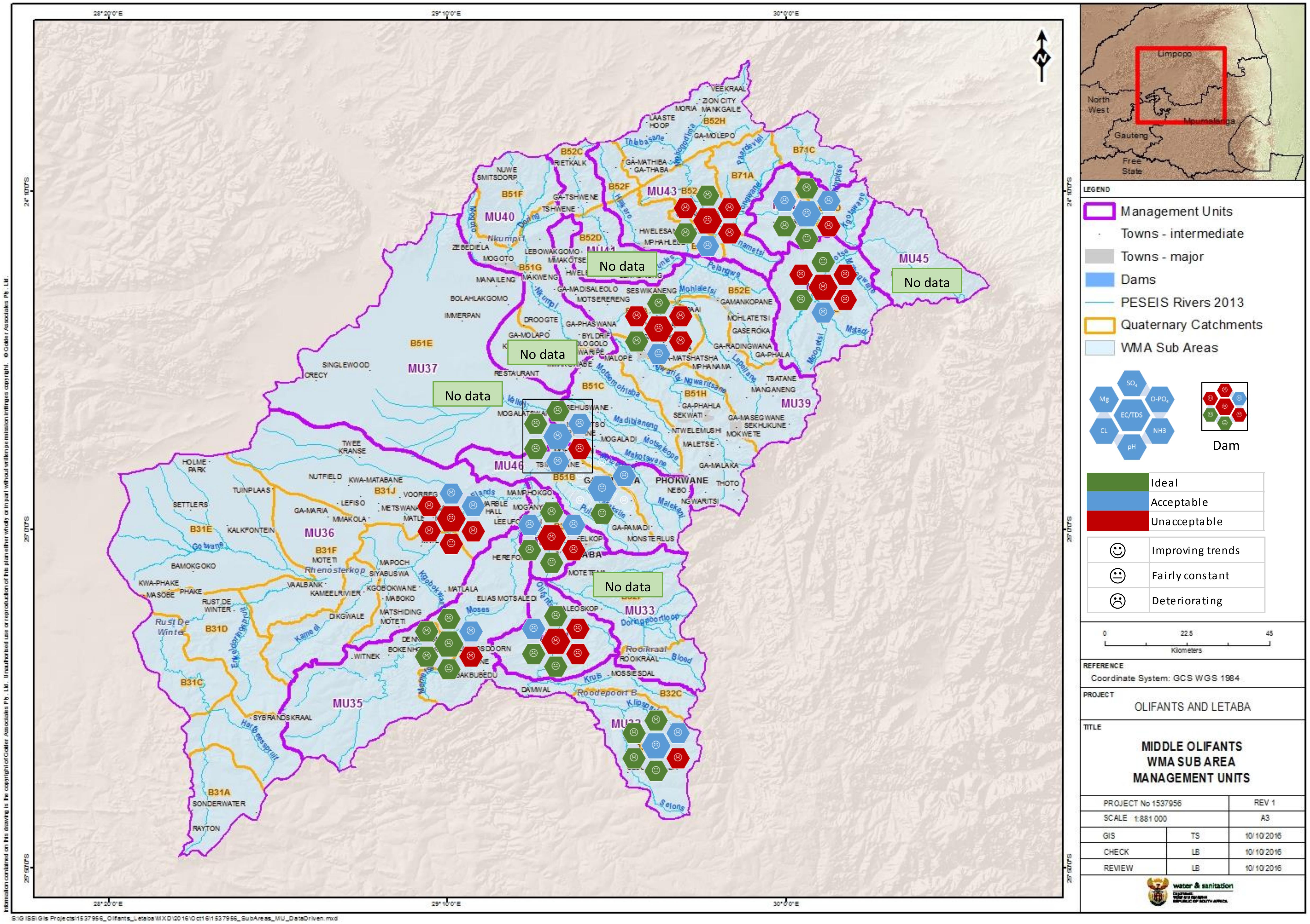

Figure 94: Middle Olifants sub-catchment water quality status map

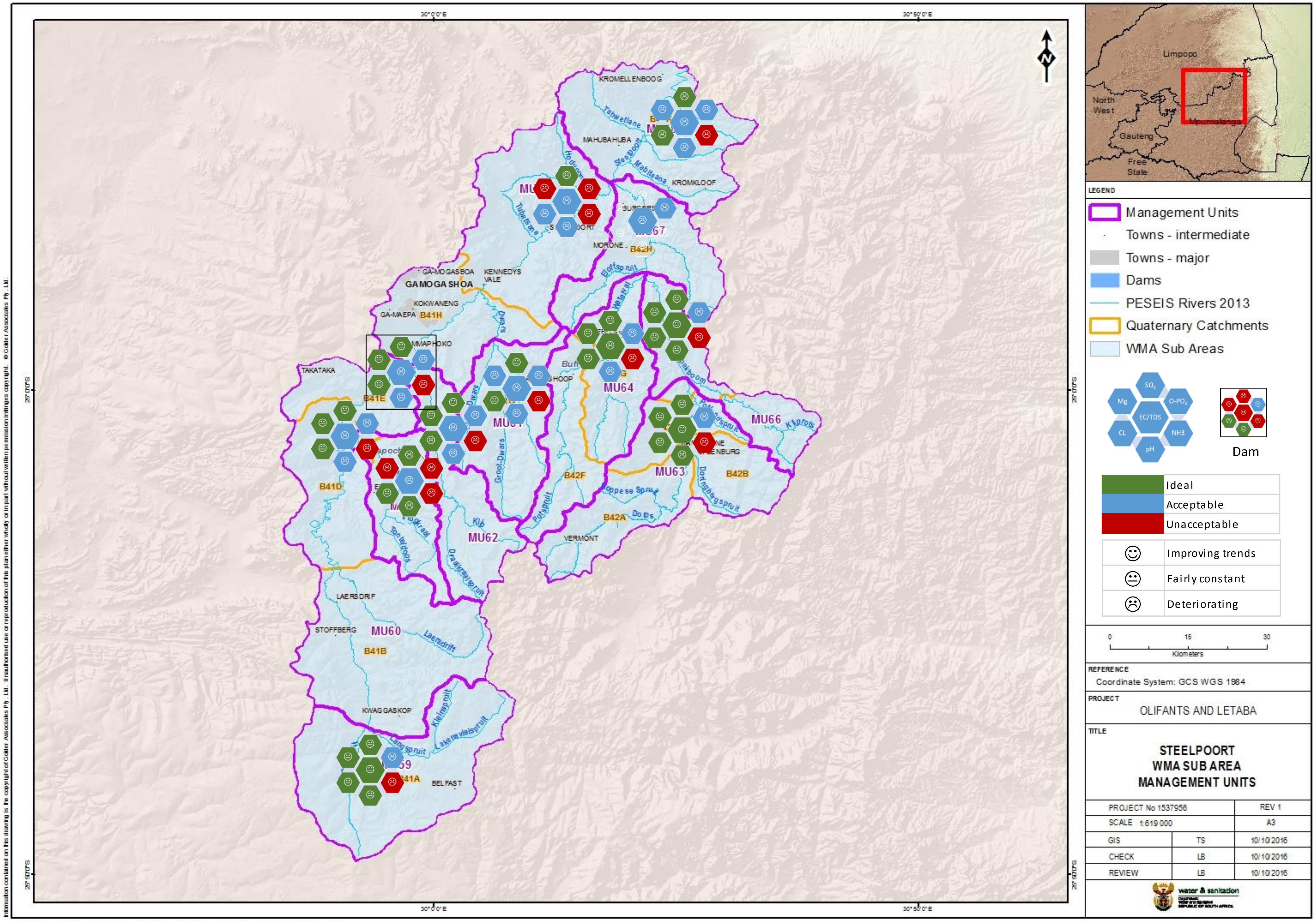

Figure 95: Steelpoort sub-catchment water quality status map

Lower Olifants sub-catchment

The nutrients in the Lower Olifants range from 0.03 mg/L to 0,5 mg/L on the Ohrigstad River at the R36 bridge. The RQO set for this catchment is 0.125 for ortho-phosphate. Nitrate concentrations are all below 1mg/L, well within the RQO of 4 mg/L. The other concern in this catchment is in the Ga-Selati. There is very limited data upstream in the catchment and after the confluence with the Olifants the impact sfrom the mine are very visible.

Figure 96 illustrates the current water quality status for 95 or 50 percentile data for total dissolved solids, sulphate, ortho-phosphate, ammonia, pH, chloride and magnesium, assessed against the strictest fitness for use category showing ideal, acceptable and unacceptable statuses as green, blue or red respectively, as well as improving, constant or deteriorating trends (☺, 😐 or ☹ respectively).

Letaba sub-catchment

The following water quality data has been taken from the Luvuvhu/Letaba Reconciliation Strategy as the current data is limited.

The Groot Letaba starts just upstream of Dap Naude Dam in the Magoebaskloof area where the river is known as the Broederstroom. Water quality in the dam is excellent when compared against the DWAF, 1996 Water Quality Guidelines. The river flows south to the Ebenezer Dam through plantations. Water quality of the Ebenezer Dam is excellent, however is surrounded by recreational facilities and plantations, so ongoing monitoring of the dam is important for early detection of any potential nonpoint pollution sources. Downstream of the Ebenezer Dam the river becomes Groot Letaba flowing northeast. At the point upstream of the Tzaneen Dam water quality is still of excellent quality.

The tributaries entering the Tzaneen Dam are Politsi River starting in the Magoebaskloof on which the Magoebaskloof Dam is located and Mahitse River starting in the Magoebaskloof.

Sampling point 188764 just downstream of the dam indicates excellent water quality in the river when compared against the DWAF, 1996 Water Quality Guidelines. The dam is surrounded by residential and irrigation so ongoing monitoring of the dam is important for early detection of any potential non-point pollution sources which already indicated that nutrient levels are slightly elevated showing some impact from activities around the dam. Water quality points downstream of the Tzaneen domestic wastewater treatment works indicate impacts with increased nutrient levels: phosphate (1 mg/L); nitrate (4.5 mg/L) and ammonia (1.2 mg/L). Some eutrophication is visible in the river. Impacts from irrigated plantations (possibly citrus along the river) also show further impacts from the irrigated areas. There are also several irrigation dams which overflow to the Groot Letaba.

At point B8H9 just before the confluence with the Lesitele tributary nutrients are still elevated. The Lesitele flows through densely populated areas. In addition, water quality results show the impacts from the Nkowankowa domestic wastewater treatment works, ponds which appear to be in the flood plain. The discharge quality is poor with phosphate (7mg/L), ammonia (13 mg/L) and nitrates of (15.6 mg/L). The Thabina tributary joins the Letsitele River just before it's confluence with the Groot Letaba. The Thabina flows through the Leyeenyee settlement and water quality shows impacts from the oxidation ponds and urban run-off.

Sampling point 187692 at the Gravelotte/Tzaneen Road about 5 kilometres downstream of the confluence, shows improved water quality. The Great Letaba Irrigation Scheme covers an extensive area along the river to the border of the Hans Merensky Game Park. Further downstream along the river at point B8H008 the water quality deteriorates (electrical conductivity (101.5 mS/m), TDS (710 mg/L), sodium (138.5 mg/L) and chloride of 192.7 mg/L. Nutrients are low with phosphate (0.08 mg/L), nitrate (0.35 mg/L) and ammonia (0.11 mg/L). This is at the confluence of the Klein Letaba and the border of the KNP.

The river samples taken do not include bacteriological samples. Based on the poor operation of the domestic wastewater treatment works it can however be expected that the bacteriological quality will be poor downstream of these points.

The main impacts on the Soeketse River are limited runoff from small villages and small-scale farming. An unnamed tributary enters the Soeketse just upstream of the Ha-Mashamba village. There are a few well defined tributaries passing through the village. There are no water quality monitoring sites on this stretch of the Klein Letaba.

Drainage to Brandboontjies River is through the densely populated town of Ka-Kgapane and includes discharge from a domestic wastewater treatment works. Sampling point 190140 is on Modubatse tributary downstream of the domestic wastewater treatment works. Water quality at this point is poor with elevated nutrients: nitrates (23.2 mg/L), ammonia (5.3 mg/L), phosphate (7.4 mg/L). Downstream of this in the Brandboontjies tributary the major land use is agriculture.

Just below the start of the Middle Letaba (approximately 22 kilometres downstream) the Ga-Mokolo and Ga-Sekgopo settlements show extensive small-scale farming, up stream of the Lornadawn Dam. Extensive agriculture lines the Middle Letaba. The first monitoring point is at the Middle Letaba Dam. Water quality shows electrical conductivity of 45 mS/m and total dissolved solids of 324 mg/L. Nutrients are low. The Klein Letaba joins the Middle Letaba after the Middle Letaba Dam. The river is now known as the Klein Letaba. An irrigation channel from the Middle Letaba Dam follows the course of the river with several smaller irrigation dams ending at the R582 road. There is very little flow in the river as it passes through the town of Giyani. Water quality in the river just upstream of the town and domestic wastewater treatment works at sampling point 183878 indicates impacts from the town. Electrical conductivity (93.7 mS/m), total dissolved solids (656 mg/L), phosphate (0.5mg/L), nitrates (0.2 mg/L) and ammonia (22 mg/L). Sampling point 183879 downstream of the Giyani domestic wastewater treatment works, shows further impacts from the town and wastewater treatment works, with increased concentrations of phosphate (8.4 mg/L), nitrate (7.5 mg/L) and ammonia (27 mg/L). Downstream of the town of Giyana there is extensive small-scale farming. The Nsami tributary enters the Klein Letaba River about 41 kilometres upstream of the confluence of the Groot and Klein Letaba.

The Hudson Ntsanwisi (Nsami) Dam is located on the middle parts of the Nsami River passing through the town of Makosha. Water quality in the dam is good with electrical conductivity (33.8 mS/m), total dissolved solids (241 mg/L), phosphate (0.04 mg/L), nitrates (0.08 mg/L) and ammonia (0.098 mg/L), well within the WQGs. The Magobe tributary enters the Nsami River just before the border of the KNP where the Klein Letaba flows along the border before the confluence with the Groot Letaba. There are several non-perennial tributaries entering the Letaba in the KNP upstream of the Engelhard Dam just before the Moçambique border. Water quality from the Letaba domestic wastewater treatment works is poor with phosphate (9.4 mg/L), nitrate (58 mg/L) and ammonia (37 mg/L). It is likely that this is having an impact on the dam: electrical conductivity (83.5 mS/m), total dissolved solids (719 mg/L), phosphate (0.044 mg/L), nitrate (0.6 mg/L), ammonia (0.88 mg/L). In addition the inflow from Makhadzi River to the dam is a poor quality with electrical conductivity (126 mS/m), total dissolved solids (962 mg/L), nitrate (1.86 mg/L), ammonia (0.4 mg/L) and phosphate (0.19 mg/L).

Figure 97 illustrates the current water quality status for 95 or 50 percentile data for total dissolved solids, sulphate, ortho-phosphate, ammonia, pH, chloride and magnesium, assessed against the strictest fitness for use category showing ideal, acceptable and unacceptable statuses as green, blue or red respectively, as well as improving, constant or deteriorating trends (☺, 😐 or ☹ respectively).

Shingwedzi sub-catchment

The town of Malamulele is located on the Shingwidzi River. The water quality point downstream of the town and the domestic wastewater treatment works of Malamulele show elevated levels of electrical conductivity (92 mS/m); TDS (644 mg/L); pH 8.4; phosphate (6.2 mg/L); nitrate (7.9 mg/L) and ammonia (13 mg/L) clearly indicating poor management of the domestic wastewater treatment works (biofilter) which enters a small irrigation dam. This joins the Phungwane River. Points within the village indicate diffuse pollution from the town. The Phungwane River enters the Mpongolo River. The dam on the Mpongolo is surrounded by some villages including

Makuleke village, as well as pivot systems further west suggesting that this is an irrigation dam.

B9H2 is located on the Shingwedzi River just before the confluence with an unnamed tributary approximately 120 kms downstream of the origin at a small impoundment in the Kruger National Park. Water quality is poor, indicating possible mobilisation of contaminants due to animal activity during low flow or it can be a natural occurrence. Similar results are indicated on the river just before it leaves the KNP into Mozambique.

The river samples taken do not include bacteriological samples. Based on the poor operation of the domestic wastewater treatment works it can however be expected that the bacteriological quality will be poor downstream of these points.

Figure 98 illustrates the current water quality status for 95 or 50 percentile data for total dissolved solids, sulphate, ortho-phosphate, ammonia, pH, chloride and magnesium, assessed against the strictest fitness for use category showing ideal, acceptable and unacceptable statuses as green, blue or red respectively, as well as improving, constant or deteriorating trends (☺, 😐 or ☹ respectively).

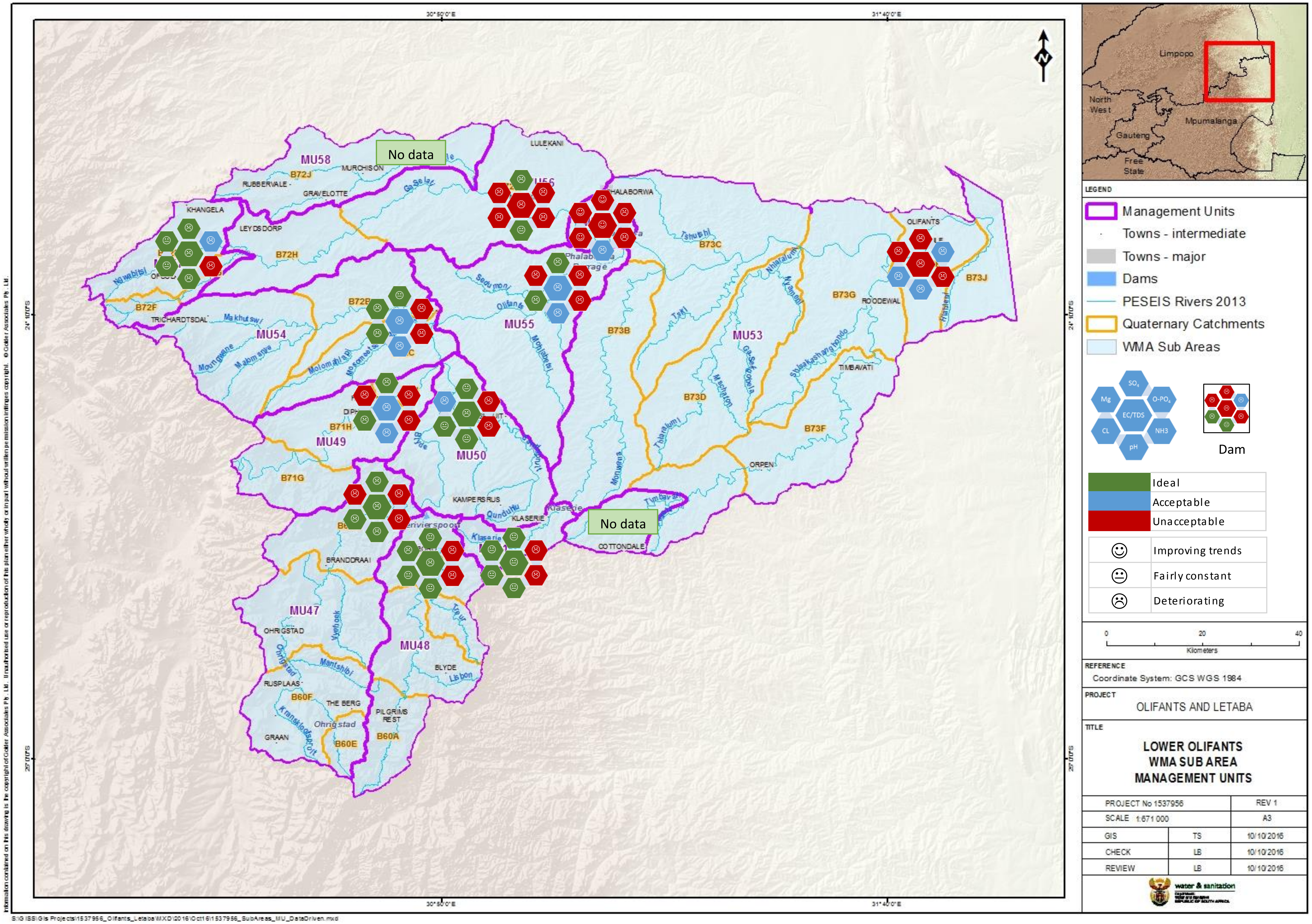

Figure 96: Lower Olifants sub-catchment water quality status map

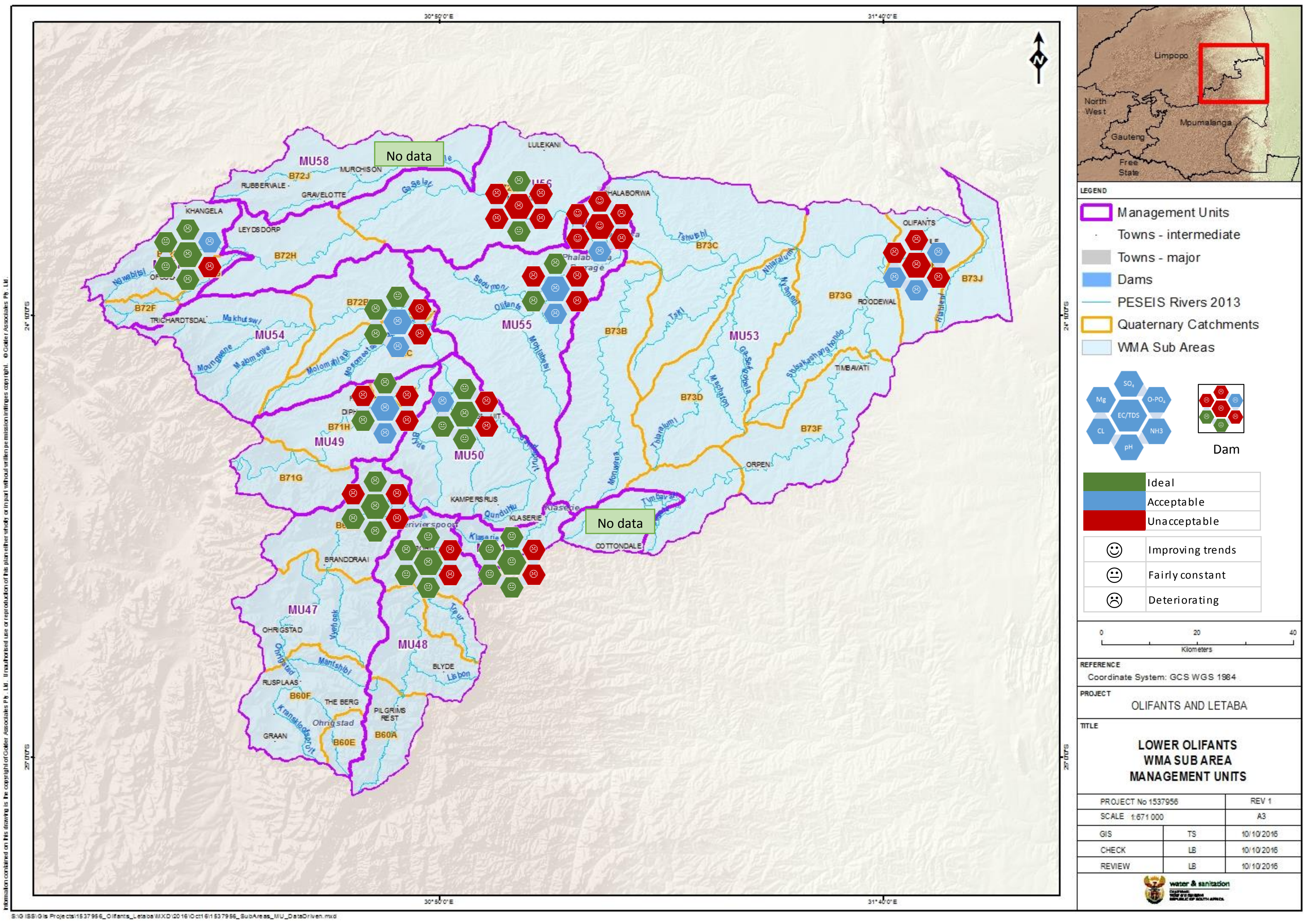

Figure 97: Letaba sub-catchment water quality status map

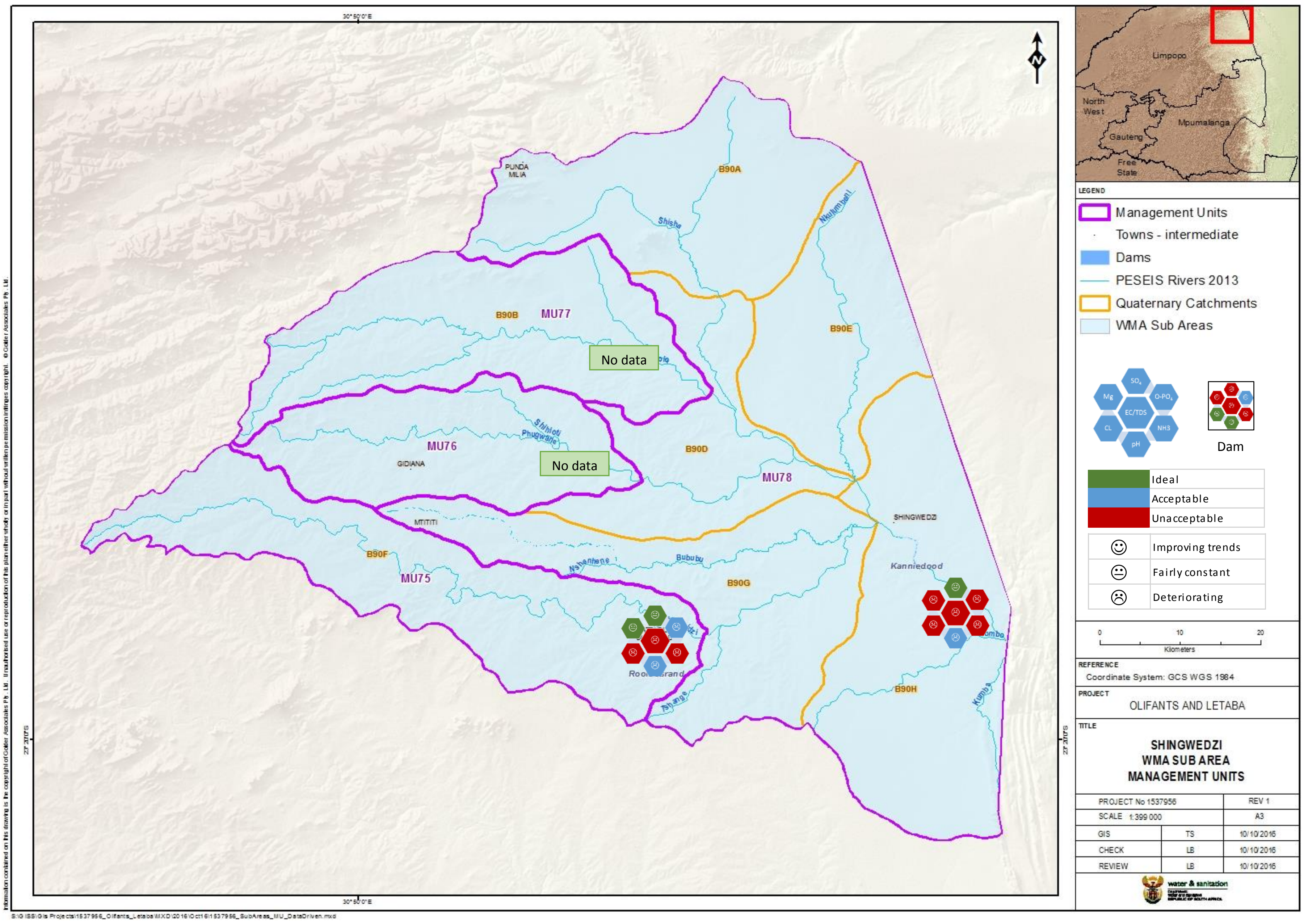

Figure 98: Shingwdezi sub-catchment water quality status map

8. GROUNDWATER

8.1 GEOLOGY

The geology of the study area represents the basis for the aquifer types as well as mining activities for gold (Murchison Sequence) base metals (Rustenburg Layered Suite), coal (Ecca Group), and alkali base metals (Phalaborwa Alkaline Complex).

The 2009 Groundwater Reserve Determination by SRK Consulting for the then Olifants WMA includes a well-defined summary of the geological formations which comprises of a multiplicity of formations and ages. A short summary of the geology is as follows (oldest to youngest):

- Basement gneisses, comprising the Goudplaats and Makhutsi Gneiss representing the southern part of the basement gneisses.
- Murchison Sequence – south (an east\north-east trending linear schist belt consisting of greenstone formations) comprises the Gravelotte Group (volcano-sedimentary sequence, folded and metamorphosed to green schist facies) and Rooiwater Igneous Complex (layered intrusive gabbro norites, magnetite seams, and diorite);
- Basement Granites – a number of granite suites have intruded the basement gneisses and include the following (i) Nelspruit Suite, (ii) Voster Granite, and (iii) Moshimole Suite;
- Transvaal Supergroup – outcrops in three main areas, namely: along the Drakensburg Mountain Range (escarpment), in the Delmas area, and west of Groblersdal and Marble Hall. The sequence is divided into the following groups: (i) Wolksburg Group (clastic sediments, and andesitic lavas), (ii) Chuniespoort Group (alternating layers of dolomitic, banded iron formation and chert), (iii) Pretoria Group (thick sequence of interlayered shale, lavas and quartzites), and (iv) Rooiberg Group (feldspathic quartzites, arkose and shales with interbedded rhyolites);
- Bushveld Complex – a massive layered igneous complex (Rustenburg Layered Suite consisting of intrusive ultramafic rocks, overlain by the Rashoop Granophyre Suite (acidic rocks) and Lebowa Granite;
- Karoo Supergroup outcrops in the Witbank, Kriel and Hendrina areas, the Springbok Flats area, and within the north eastern portion of the WMA situated in the Kruger National Park. This sedimentary sequence is capped by a basaltic lava and comprises the following groups: (i) Dwyka Formation (glacial tillite), (ii) Ecca Group (shales and sandstone layers and coal deposits); (iii) Irrigasie Formation (sandstone, shales and mudstones) (iv) Clarens Formation (sandstone, grit and mudstone), and (v) Letaba Formation (basaltic cap lava);

The important geological formations and features as described in the 2006 Letaba Catchment Reserve Determination – Groundwater Report by WSM are:

- Goudplaats and Makhutsi Gneiss consisting of grey biotite gneiss and migmatite. The gneisses form the Lowveld valley in the east and underlay >50% of the Letaba WMA;
- Murchison Sequence – north (an east\north-east trending linear schist belt consisting of greenstone formations preserved in the basement gneisses) consisting of three occurrences in the catchment, (i) Giyani Group (variety of volcano-sedimentary rocks), (ii) Gravelotte Group (links to the Olifants WMA), (iii) the Pietersburg Group (metamorphic rocks), and (iv) the Rooiwater Complex (as described below linked to the Gravelotte Group);
- Bandolierskop Complex (highly metamorphosed unit infolded in to the basement gneisses);
- Transvaal Group – Wolkberg Group (quartzites, shale and basalt);
- Karoo Supergroup – consisting of (i) Letaba Formation (basalts) which shields most of the eastern parts of the Letaba WMA overlying (ii) the Tshipise Formation (aeolian sandstone) occurring on the western margin of the basalts, and on the eastern boundary of the catchment, (iii) the Tshokwane and Jozini Formations (granophyre and rhyolite respectively) forming the catchment boundary (high land area).

8.2 AREAS OF IMPACT

The water quality was assessed based on the Water Quality Guideline for Domestic Use (DWAF, 1996). The following observations were made:

- The groundwater quality in the study area varies from <450 mg/L TDS which is ideal to >2 400 mg/L TDS, however elevated/ rising nitrate values are a serious concern;
- The dependence between groundwater and surface water in the study area varies from Insignificant (<1% groundwater baseflow reduction when utilised) to High (>30% groundwater baseflow reduction when utilised).

Figure 99 shows the quaternary catchments where water quality monitoring is currently still taking place. It is noted that monitoring has decreased considerable and will need to be revived to get a better indication of the concerns. Areas of concern relating to water quality contamination from wastewater treatment works, specifically oxidation ponds are outlined in red.

Figure 100 illustrates where the groundwater has an impact on the surface water. This is particularly evident in the Upper Olifants and Steelpoort sub-catchments and the Phalaborwa area in the Lower Olifants. The areas of over utilisation are also indicated.

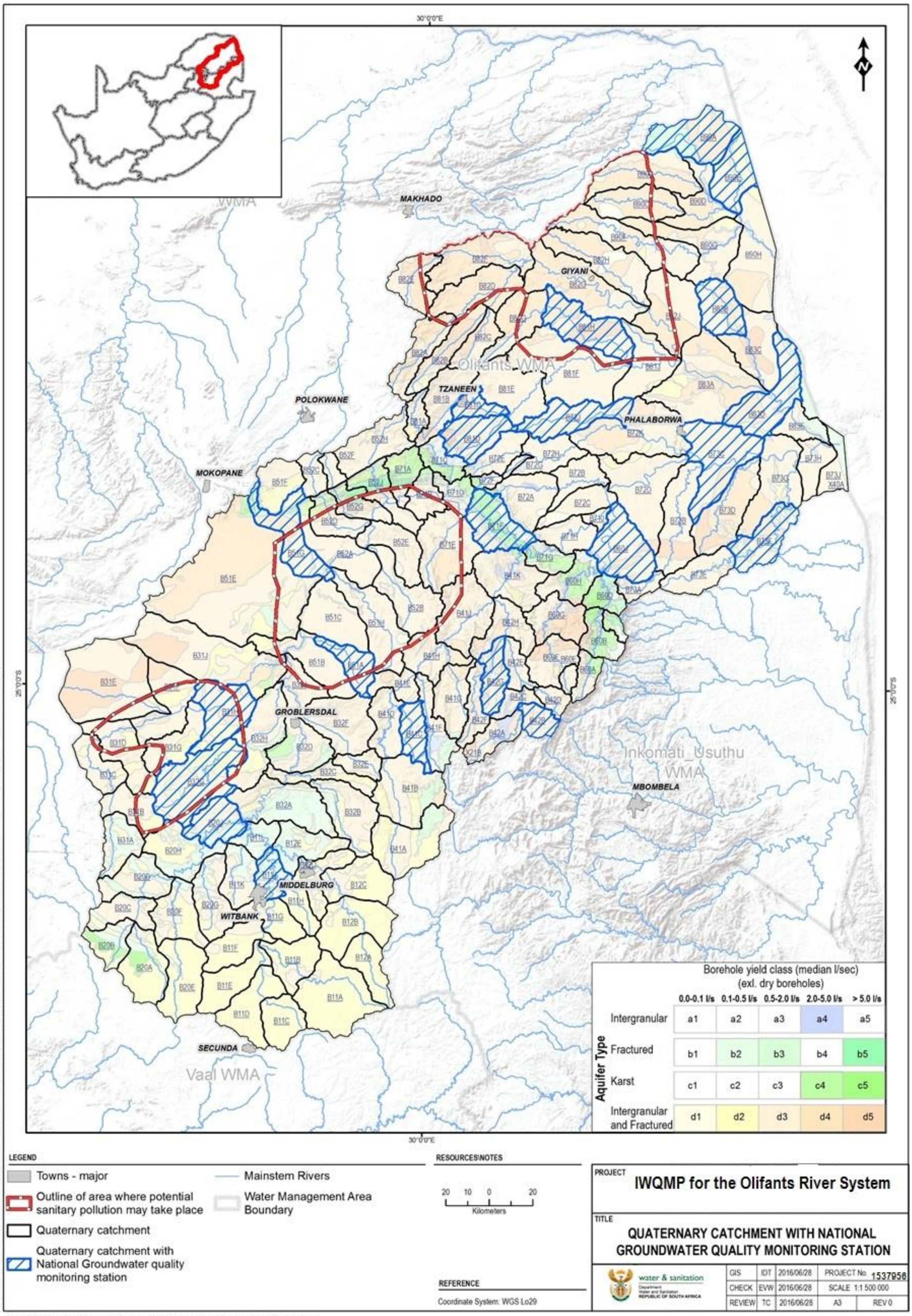

Figure 99: Quaternary catchments where groundwater quality monitoring is taking place

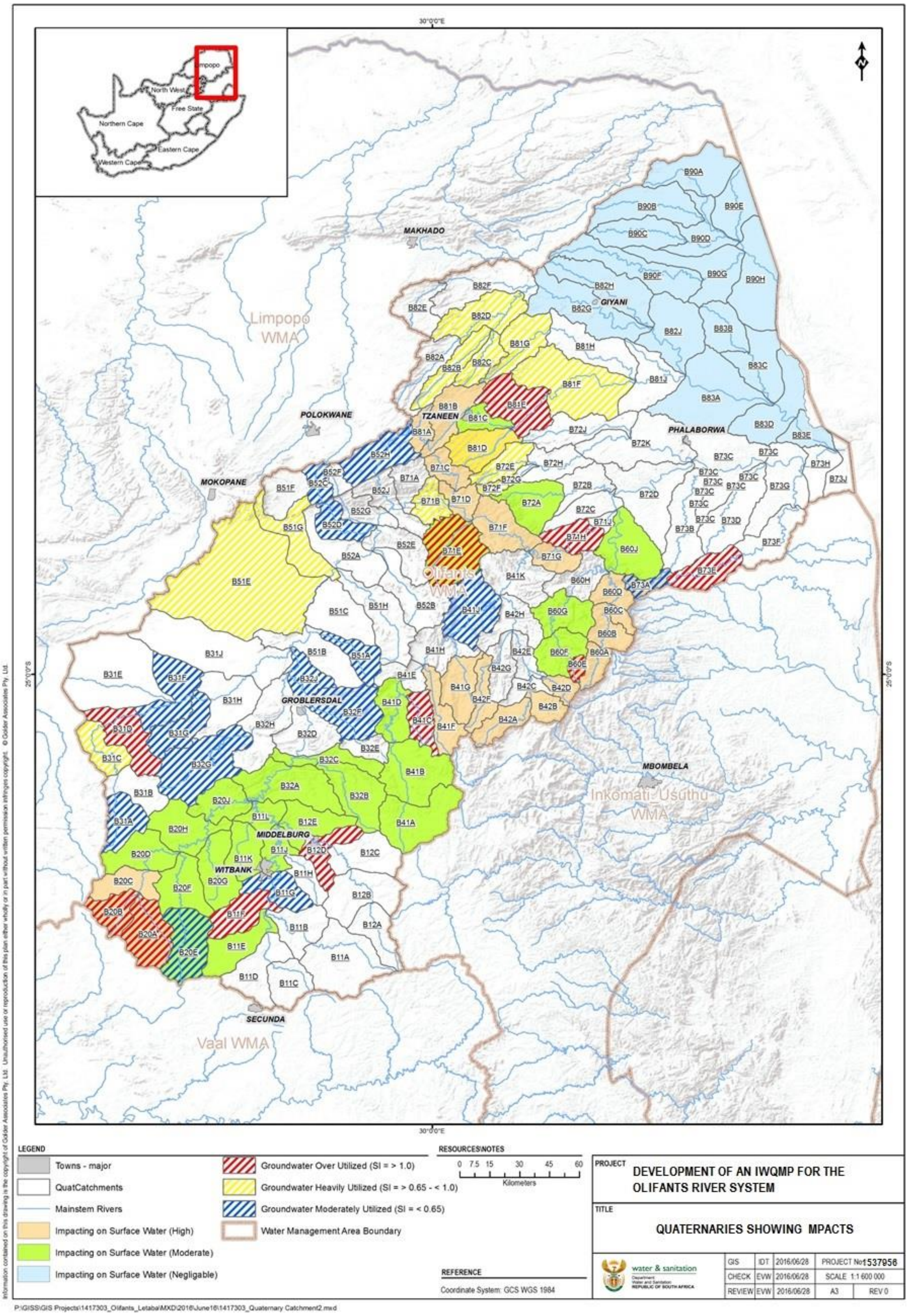

Figure 100: Quaternary catchments where groundwater impacts have been noted

There are 6 hotspot areas indicated in

Figure 101 that need immediate intervention (updated based on the selection proposed in the Ages Group, 2009 report):

- The Delmas Dolomite Aquifer (B20A and B20B) where irrigation in the order of 6 Mm^3/a, is abstracted from a spatially limited aquifer. The risks are sinkhole formation and direct recharge of poorly treated sewer water into the aquifer system.
- Similar to Delmas is the Zebediela Dolomite Aquifer (B51E and B51G), although over-abstraction is the concern here;
- The Springbok Flats Karoo Aquifer (B51E) where 10-12 Mm^3/a, is abstracted for irrigation. Historic abstractions were much higher, i.e. 43 MCM/a (estimated aquifer recharge was ~40 Mm^3/a). The concern here is that abstractions are focussed on specific areas, i.e. not a diffused abstraction pattern;
- Highveld coal mining area at Witbank-Middelburg-Kriel Karoo Coal Aquifers (B11K, B11J, B11H and B12D) where water quality is more affected than quantity.
- Steelpoort mining and community water supply aquifer areas (B41J and B41K) where groundwater quantity and quality is affected; and
- Kruger National Park and Bushbuckridge Catchments (B73J, B73H, and B73F) where groundwater sustains community water and riparian vegetation; and
- The upper Letaba River catchments (i.e. B81D and –E) where the groundwater baseflow contribution to the lower, downstream QC's are impacted by surface water abstractions and afforestation.

The groundwater quality in the study area varies significantly; from Ideal/Good in the recharge areas (high relief QC's) to Marginal throughout the study area. Groundwater quality in certain areas such as the Upper Olifants Coal Area is deteriorating due to AMD development which has a serious impact on the local surface water resources due to interflow decanting into drainages. What is, however, a concern throughout the study area is the steady increase of nitrates in the groundwater and is directly linked to irrigation practices (i.e. The Springbok Flats) and high-density populated areas – three specific areas have been identified where regional nitrate pollution as the result of sanitary practices (pit latrines) are probably the cause. Local groundwater resources in the Giyani Region (QC B82G –Little Letaba River) are significantly impacted by nitrate pollution and the effect is probably irreversible.

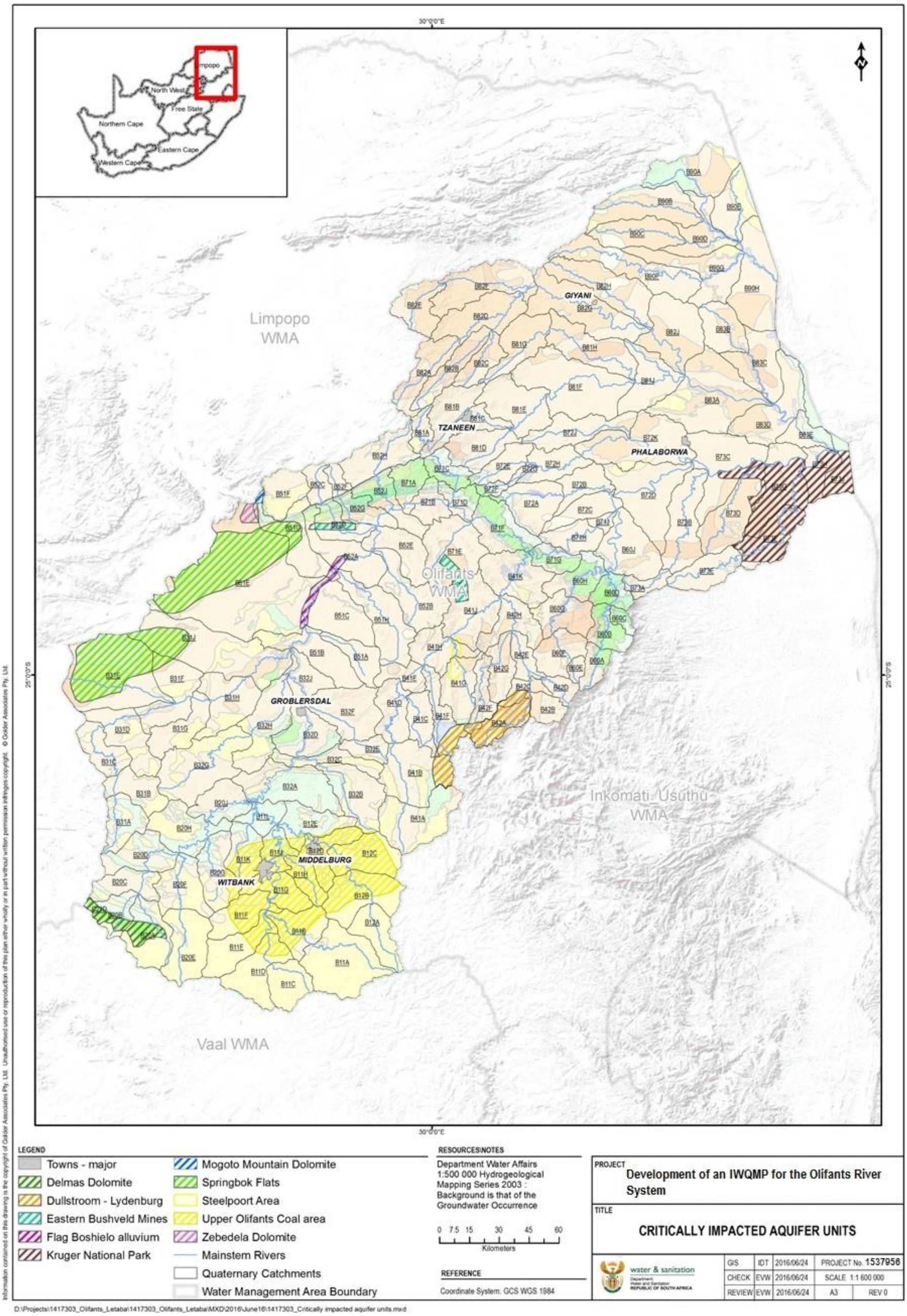

Figure 101: Critically impacted groundwater areas

9. WETLANDS

Figure 103 shows the wetlands in the Olifants River System in relation to the Olifants, Letaba and Shingwidzi Rivers. Figure 103 shows the Olifants River System priority wetlands indicating the majority fall within the Upper Olifants and Steelpoort sub-catchments.

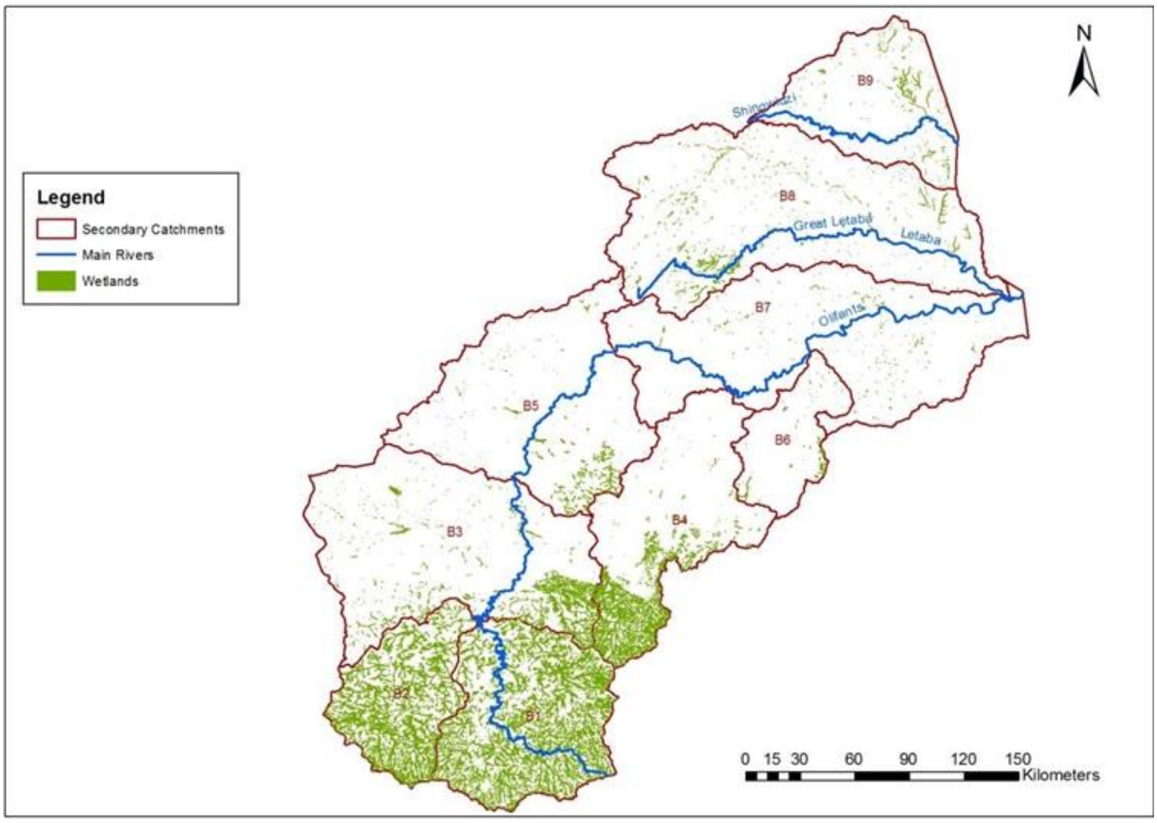

Figure 102: Wetlands in relation to the 3 major rivers in the Olifants River System

There is considerable concern around the wetlands in the Upper Olifants catcment where loss of wetlands due to mining through them and/or not rehabilitating when damaged, impacts on the ability of the catchment to filter the water.

Further detailed studies will be undertaken when each sub-catchment is considered and management options are considered. This will be done in close collaboration with the team undertaking the Reserve study update. To date the following priority wetland catchments have been identified:

- B11A – headwaters of Olifants River;
- B11C – headwaters of Steenkoolspruit River;
- B12A – headwaters of Klein-Olifants River;
- B20A – headwaters of Wilge River;
- B20C – headwaters of Bronkhorstspruit River;
- B20E – Osspruit River, tributary to Bronkhorstspruit;
- B41A – headwaters of Steelpoort;
- B41B - headwaters of Steelpoort;

- B41F – Klip River, tributary to Steelpoort (includes Ramsar Site);
- B60B – Lispon River, tributary of Blyde; and
- B60C – headwaters of Treur River.

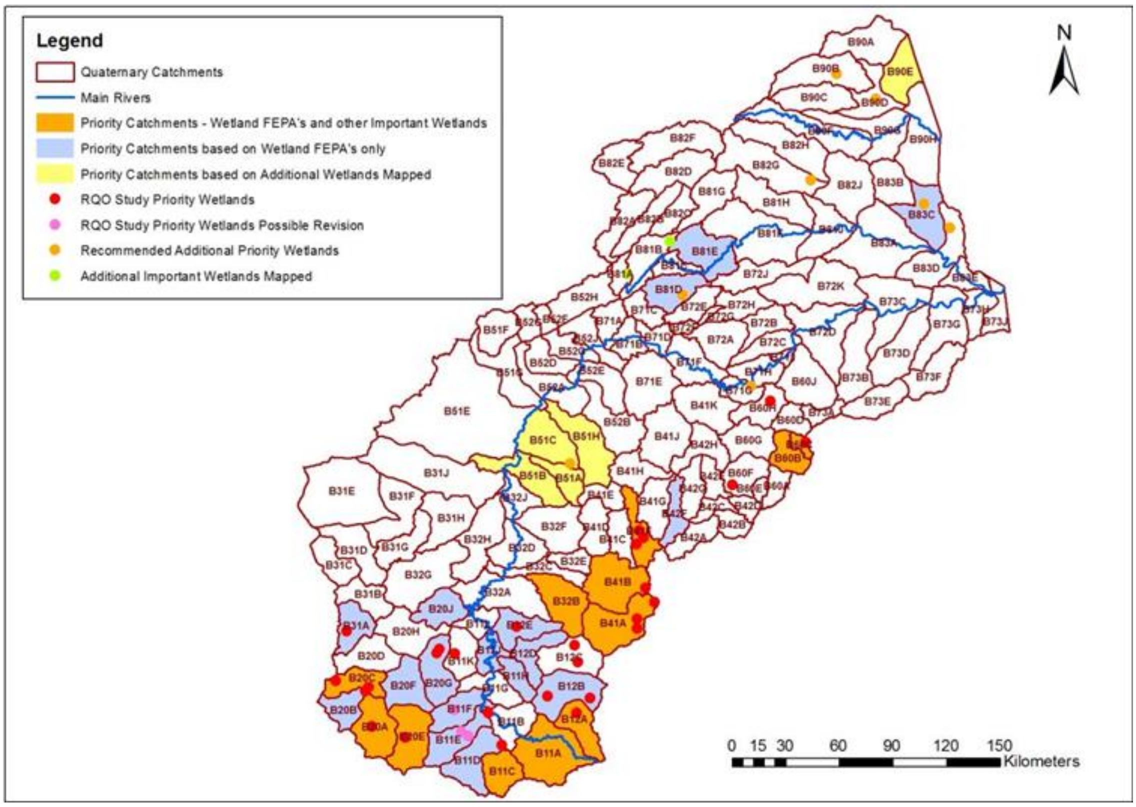

Figure 103: Priority wetlands in the Olifants River System

10. WATER QUALITY STATUS RELATIVE TO IMPACT SOURCES

10.1 ISSUES IDENTIFIED AS POTENTIAL OR KNOWN THREATS TO THE OLIFANTS RIVER SYSTEM

The major issues identified as existing or potential threats to the Olifants River System include:

- Mining;
- Wastewater discharge;
- Urban run-off;
- Industrial; and
- Agricultural activities.

10.1.1 Mining

The main mining activity in the Olifants catchment is related to coal, platinum, vanadium, chrome, copper and phosphate. The coal mining is located in the upper reaches of the catchment around eMalahleni, Middelburg and Delmas. The platinum, chrome and vanadium mines are located in the Steelpoort and Middle Olifants areas of the WMA while the copper and phosphate mining occurs in the lower Olifants around Phalaborwa. The coal mining in the upper areas of the Olifants catchment is extensive and is still growing.

The management of mining activities in the WMA is crucial to the management of water quality both in the short term to alleviate the current salt loads being released and long term to manage the impacts of mine closure and mine decants. While the complex dynamics of this situation is accepted in terms of maintaining base flows in the system, permitting active mining, and promoting wider socio-economic imperatives, a major intervention in terms of current mining development practices is required if the upper Olifants river catchment is to remain sustainable.

In terms of the mines in the upper catchment the excess water in these systems has been managed using the controlled release scheme which started in 1996. However with the growth in the volumes of excess water, there is insufficient assimilative capacity available in the system for the controlled release scheme to deal with the excess water. Urgent attention is required to upgrade the water management system to achieve compliance.

A number of the mines are reaching the end of their economic lives and the mine workings will start filling up to ultimately decant. This water will be polluted and the volumes will be large enough to impact significantly on the regional water quality. The major mining houses are aware of this problem and plans are being developed to treat the excess mine water. Mine water reclamation schemes have already been constructed which are supplying water for potable use to the local municipalities. These schemes have to be developed and coordinated to address the future decants. The reclamation of the excess mine water has been earmarked as the future source of water to meet the growing water requirements in the upper areas of the Olifants catchment.

There are a number of defunct mines in the catchment. Some of these mines are abandoned (ownerless) and are decanting into the river system. Acid mine drainage from abandoned and operational coal mines is impacting on the Olifants specifically in the upper catchment.

10.1.2 Wastewater discharges

The majority of the wastewater treatment works associated with the local municipalities are producing an effluent which does not meet their authorisation requirements. The works are discharging wastewater which contains high organic, nutrient and microbiological loads to the river systems. The organics result in reduction in dissolved oxygen concentrations and anaerobic conditions which detrimentally impacts on the health of the aquatic system. The high nutrient concentrations lead to eutrophic conditions in the river systems and dams. The trophic status of the upper reaches of Loskop Dam which receives effluent from the major treatment works of the Emalahleni and Steve Tshwete Local Municipalities has been classified as eutrophic with periodic outbreaks of the toxic blue green algae.

Not only do the wastewater treatment works have to be operated and maintained correctly but the license conditions should be reviewed to implement more stringent discharge standards regarding nutrients in particular phosphorus. Concerns have been expressed about the impacts of nutrient enrichment downstream of wastewater treatment discharges (e.g. the Klein Olifants River). Excessive growth of filamentous algae has occurred downstream of discharges which has impacted on the habitats of aquatic organisms.

Mismanagement of wastewater treatment works and sewage pollution from smaller towns throughout the catchment area are also on the increase resulting in nutrient enrichment in a number of catchments. The lack of compliance of wastewater discharges from the many wastewater treatment plants in the WMA is a growing threat and is of serious concern.

In addition, design capacity must be assessed in terms of the volumes being received and the plans to upgrade where necessary due to population increases, or differenttypes of effluent being received. Vandalism and staff safety at the WWTW must also be considered, as this may influence the final effluent quality.

Tables 39, 40, 41, 43, 43, and 44 list the WWTW and whether incidents occurring are sporadic regular or periodic. In developing the sub-catchment strategies, this will help to prioritise those WWTW that need immediate, short or long-term intervention. One –on-one sessions will be set up with relevant Environmetal Officers.

Table 39: Wastewater Treatment Works in the Upper Olifants sub-catchment

Map ID	Wastewater Treatment Works Name	Wastewater Treatment Works Process	Incidents
1	Bronkhorstspruit	Activated Sludge	Sporadic
2	Rethabiseng	Activated Sludge	Sporadic
3	Ekangala North	Oxidation ponds	Sporadic
4	Ekangala South	Oxidation ponds	Sporadic
5	Bronkhorstbaai	Activated Sludge	Sporadic
6	Rayton WWTW	Activated Sludge	Sporadic
70	Sekororo Sewerage	Oxidation ponds	Regular
71	Trichardt	Oxidation ponds	Sporadic
72	Kinross	Oxidation ponds	Sporadic
73	Leandra	Oxidation ponds	Sporadic
74	Delmas	Activated sludge	Sporadic
75	Kwazamokhule/ Hendrina	Oxidation ponds	Sporadic
76	Botleng	Activated sludge	Sporadic
77	Komati	Oxidation ponds	Sporadic
78	Blinkpan	Bio-filter	Sporadic
79	Bronkhorstspruit (Gauteng)	Bio-filter	Sporadic
80	Boskrans	Bio-filter	Sporadic
81	Belfast	Activated sludge	Sporadic

82	Kwamhlanga 2	Activated sludge	Sporadic
83	Dullstroom	Advanced - e.g. dialysis, reverse osmosis	Sporadic
84	Kwamhlanga 1	Activated sludge	Sporadic
85	Tweefontein	Activated sludge	Sporadic
87	Vaalbank	Activated sludge	Sporadic
88	Siyabuswa	Activated sludge	Sporadic
94	Ga Nala	Activated sludge	Sporadic
95	Thubelihle	Activated sludge	Sporadic
96	Rietspruit	Activated sludge	Sporadic
97	Phola	Oxidation ponds	Sporadic
98	Wilge	Bio-filter	Sporadic
99	Naauwpoort	Activated sludge	Sporadic
100	Ferrobank	Bio-filter	Sporadic
101	Klipspruit	Activated sludge	Sporadic
102	Riverview	Activated sludge	Sporadic
103	Botleng	Activated sludge	Sporadic

Table 40: Wastewater Treatment Works in the Middle Olifants sub-catchment

Map ID	Wastewater treatment works name	Wastewater treatment works process	Incidents
7	Lebowakgomo Oxidation Ponds 1	Activated sludge	Regular
8	Lebowakgomo Industrial	Oxidation ponds	Regular
25	Lebowakgomo WWTW (Middelkop)	Activated sludge	Periodic
26	Burgersfort WWTW	Activated sludge	Regular
27	Penge WWTW	Activated sludge	Regular
28	Roossenekal WWTW	Bio-filter	Periodic
30	Groblersdal WWTW	Activated sludge	Periodic
31	Marble Hall WWTW	Activated sludge	Periodic
32	Elandskraal WWTW	Oxidation ponds unlined	Periodic
34	Jane Furse LCH WWTW	Oxidation ponds unlined	Regular
35	Jane Furse Hospital WWTW	Oxidation ponds unlined	Periodic
36	Jane Furse Oxidation Ponds	Oxidation ponds unlined	Sporadic
60	Lebowakgomo Oxidation Ponds 2	Oxidation ponds unlined	Periodic
61	Atok Mine Residents WWTW	Oxidation ponds unlined	Periodic
62	Sekhukhune College WWTW	Oxidation ponds unlined	Periodic
63	Tompi Seleka Ponds WWTW	Oxidation ponds unlined	Periodic
42	Thusang (Roedtan)	Oxidation ponds unlined	Sporadic

Table 41: Wastewater Treatment Works in the Steelpoort sub-catchment

Map ID	Wastewater treatment works Name	Wastewater treatment works Process	Incidents
37	Leeufontein (Mokganyaka) WWTW	Oxidation ponds unlined	Regular
38	Ohrigstad WWTW	None	Sporadic
39	Phokwane Ponds WWTW	Oxidation ponds unlined	Sporadic
40	Monsterlus (Hlogotlou) WWTW	Oxidation ponds unlined	Sporadic
41	Dennilton WWTW	Oxidation ponds unlined	Sporadic
33	Praktiseer WWTW	Oxidation ponds unlined	Regular
58	Nebo Ponds WWTW	Oxidation ponds unlined	Sporadic

Map ID	Wastewater treatment works Name	Wastewater treatment works Process	Incidents
59	St Rita's WWTW	Oxidation ponds unlined	Periodic
64	Dilokong Hospital WWTW	Oxidation ponds unlined	Periodic
65	Maandagshoek Mine Residents WWTW	Oxidation ponds unlined	Periodic
66	Winterveld Mine Residents WWTW	Oxidation ponds unlined	Periodic
67	Mapodile Ponds WWTW	Oxidation ponds unlined	Periodic
68	Motetema	Activated sludge	Periodic
69	Mecklenberg (Moroke) Ponds WWTW	Oxidation ponds unlined	Periodic
29	Steelpoort (Tubatse) WWTW	Activated sludge	Periodic

Table 42: Wastewater Treatment Works in the Lower Olifants sub-catchment

Map ID	Wastewater treatment works Name	Wastewater treatment works Process	Incidents
86	Emshinini	Activated sludge	Sporadic
89	Lydenburg	Activated sludge	Sporadic
90	Pilgrim's Rest	Activated sludge	Regular
91	Coromandel	Activated sludge	Regular
92	Acornhoek	Oxidation ponds	Sporadic
93	Tintswalo Hospital	Oxidation ponds	Sporadic
12	Gravelotte WWTW	Oxidation ponds unlined	Periodic
23	Murchison WWTW	Bio-filter	Periodic
24	Foskor Mine WWTW	Bio-filter	Sporadic
19	Phalaborwa WWTW	Bio-filter	Regular
20	Namakgale WWTW	Bio-filter	Sporadic
21	Lulekani WWTW	Bio-filter	Regular

Table 43: Wastewater Treatment Works in the Letaba sub-catchment

Map ID	Wastewater treatment works Name	Wastewater treatment works Process	Incidents
9	Tzaneen WWTW	Activated sludge	Regular
10	Modjadjiskloof (Duiwelskloof) WWTW	Oxidation ponds unlined	Regular
11	Haenertsburg WWTW	None	Regular
13	Letsitele WWTW	None	Regular
14	Hoedspruit (Drakensig) WWTW	Bio-filter	Sporadic
15	Kampersrus WWTW	None	Sporadic
16	Nkowankowa WWTW	Bio-filter	Regular
17	Lenyenye WWTW	Oxidation ponds unlined	Regular
18	Ga-Kgapane WWTW	Bio-filter	Regular
22	Giyani WWTW	Bio-filter	Regular
45	Senwamokgope WWTW	Oxidation ponds unlined	Regular
46	KNP Punda Maria WWTW	Oxidation ponds unlined	None
47	KNP Shingwedzi WWTW - Oxidation Ponds	Bio-filter	None

Map ID	**Wastewater treatment works Name**	**Wastewater treatment works Process**	**Incidents**
48	KNP Mopani WWTW - Oxidation Ponds	Oxidation ponds unlined	None
49	KNP Letaba WWTW - Oxidation Ponds	Oxidation ponds unlined	None
50	KNP - Makhadzi Picnic Spot	Oxidation ponds unlined	None
51	KNP - Shimuweni Oxidation Ponds	Oxidation ponds unlined	None
52	KNP - Sirheni Bush Camp Oxidation Ponds	Oxidation ponds unlined	None
53	KNP - Tsendze Rest Camp	Oxidation ponds unlined	None
54	KNP Olifants WWTW-Oxidation Ponds	Oxidation ponds unlined	None
55	DPW Hoedspruit AFB WWTW	Package Plant	None
56	Hans Merensky	Bio-filter	None
57	Dr CN Phatudi (Shiluvane) Hospital	Oxidation ponds unlined	Regular

Table 44: Wastewater Treatment Works in the Shingwedzi sub-catchment

Map ID	**Wastewater treatment works Name**	**Wastewater treatment works Process**	**Incidents**
43	Malamulele WWTW	Activated sludge	Regular
44	Hlanganani Ponds WWTW	Oxidation ponds unlined	Sporadic

10.1.3 Urban run-off

The issue of urbanisation is linked to the above concerns related to wastewater treatment works to some degree, however it also relates to the uncontrolled development and urban sprawl that is being experienced in many of the urbanised centres of the upper, middle and lower catchment areas, but also to growth in settlements in many smaller towns. Lack of, poor and improper planning is leading to large quantities of pollutants entering storm water return flows, as well as runoff from un-serviced areas which are draining to various tributaries that report to the Olifants, Letaba and Shingiwdzi Rivers. Informal, unsewered human settlements along the river banks of tributaries or in the close vicinity of the main-stem rivers are posing a threat to regional water quality and ecological integrity, especially eutrophication (nutrient enrichment) and human health. Integrated planning approaches are needed to be addressed through relevant institutional structures to improve the situation.

10.1.4 Industrial pollution

There are large steel foundries located in Middelburg and eMalahleni. The coal mining in the upper catchment is associated with large thermal power stations. The Phalaborwa Complex and Foskor located in the lower reaches of the Ga-Selati River catchment are home to mineral production facilities.

Concerns have been raised about the impacts of the industrial developments on the water resources within the Olifants WMA. While the new mines and industries are being designed to achieve compliance with best practice guidelines and regulations, the majority of the mines and industries are old with legacy issues which require upgrades of the water management systems. Water quality deterioration in the vicinity of the industrial and mining complexes has been identified as a potential threat, and needs to be addressed to understand the extent of the impact.

10.1.5 Agricultural activities

Extensive irrigation occurs in the vicinity of the Loskop Dam, along the lower reaches of the Olifants River, near the confluence of the Blyde and Olifants rivers, as well as in the Steelpoort valley and upper Selati catchment. Rain-fed cultivation is undertaken in the southern and north-western parts, with grain and cotton as main products. Intensive irrigation farming is practised in the upper parts of the Klein Letaba River catchment (upstream and downstream of the Middle Letaba Dam), and particularly along the Groot Letaba (downstream of the Tzaneen Dam) and Letsitele rivers.

Fertilizers, herbicides and pesticides from agricultural activities are also having a negative impact on water resources in the WMA, which is also a contributing factor to the increase in nutrient levels that are observed. Agricultural runoff has the potential to contribute nutrients and toxic organic chemicals associated with herbicides and pesticides to the water resource. The potential certainly exists in the Olifants WMA for contributions of these pollutants to the river system from agricultural areas. The water quality monitoring network has not allowed for the quantification of the contribution of organic pollutants from agriculture, in particular the intensive irrigation areas to the river system.

The intensive irrigated agriculture and afforestation in the Letaba River has resulted in the use of a wide range of pesticides over the past decades. Most of these pesticides are categorised as Persistent Organic Pesticides (POPs).

The unacceptable phosphate values that occur all the way into the Kruger National Park are largely attributable to the use of fertilizers for the intensive agriculture. Elevated levels of Chlorophyll-*a* and algal growth are of concern in the Olifants River Systems as a result of the high nutrients, river regulation and high lowveld temperatures. Water quality impacts are expected to relate to salinisation, the release of pesticides / herbicides into the environment and elevated nutrient levels.

10.1.6 Future predicted impacts

Pollution is having a negative effect on the water quality of the water resources in many catchments (related to mining, agricultural activities, urbanisation and settlements). The initial evaluation of information has identified the following as key aspects in the Olifants River System that have a bearing on its future management and operation:

- Non-compliant wastewater treatment works contributing to organic, microbiological and nutrient loads to the river system is significant and is a serious threat to the water resources of the WMA. This situation appears to be continuing unabated, and until such time as this matter is addressed by all the role players at the appropriate levels, water quality management goals will not be achieved. This must be prioritised by the larger municipalities as well as local authorities of the smaller towns and will form part of the implementation plan for this project;
- Mining activities are impacting significantly on the water quality of the water resource system which is changing the characteristics of some of the water resources to such an extent that loses its ecological infrastructure value. Complete or partial loss of wetlands, and impacts on water quality due to mining activities has, and continues, to impact on the water resource system of the WMA. Decisions around future mining need to be informed by a better understanding of the cumulative long-term effects on the water resource system. A strategy needs to be developed and implemented to deal with the water discharging from the defunct mines as well as existing mines post-closure and will form part of the implementation plan for this project;
- Runoff from commercial agricultural areas contains agro-chemicals, which are causing eutrophication or contamination of water;
- Erosion, turbidity and sediment deposition are diminishing the potential of the hydrological system; and
- Loss of natural filters such as wetlands are also resulting in an increase in sediments in the water, increased erosion and terrestrial alien invasion.

11. WATER QUALITY IMPACTS ON WATER USERS

A range of water related problems are currently being experienced by water users in the Olifants River System due to the current water quality status. For the purposes of the discussion to follow a water related issue is identified as a concern if it requires or will require a re-evaluation of management options or application of treatment technology.

11.1 DOMESTIC USE

The main suppliers of water in the area are the District Municipalities (in some cases Locxal Municipalities) and Lepelle Northern Water. In respect of water supply and treatment to potable standards there are a number of issues experienced by the water suppliers in the system. Problems can be experienced at various stages of the treatment process such as the raw water intakes, the treatment plant or the distribution system. Nutrient enrichment currently observed in the Olifants River System is not yet at a critical phase, however it can add considerable expense when having to treat water to a quality acceptable for potable consumption.

The eMalahleni Water Reclamation Plant treats excess mine water to potable standard and feeds directly into the eMalahleni Reservoir.

Sulphate and chloride at high concentrations in domestic water are the primary determinants associated with accelerated corrosion. At concentrations above 200mg/L of either sulphate or chloride corrosion problems can be expected. In the Upper Olifants catchment the 95 percentile values for sulphate can be as high as 770 mg/L. It is unlikely that human health effects would be experienced at these concentrations although aesthetically (taste and odour) the water would be unacceptable.

Chlorides (95 percentiles) in the Upper Olifants are mostly < 50 mg/L however these increase to > 100mg/L to 150 mg/L in the Middle and Lower Olifants.

Microbiological contamination due to release of poorly treated wastewater is likely to be of concern for domestic users, especially in the area of villages in the Middle and Lower Olifants, as well as the upper reaches of the Letaba and Shingwidzi where water may be used directly from the river. This was confirmed by the study undertaken by the CSIR in 2012/ 2013 (CSIR, 2013).

Limited data is available on emerging contaminants such as pesticides, pharmaceuticals and metals which make their way into water resources. These may be endocrine disrupting contaminants (EDC) and have both a human health impact and ecological health impact.

11.2 INDUSTRIAL WATER USE

No water is abstracted from the Olifants River catchment to meet the water requirements of the power stations because of the poor water quality and the associated costs it will have for Eskom. Instead clean water is transferred in from adjacent catchments for use in the power stations. (DWA, 2011). The power stations also supply potable water to the towns that have been developed to house the mine and power station personnel. Some towns, such as Kriel/ Thubelihle draw water for domestic use directly from the water transfer pipelines. In this respect:

- The Upper Vaal system can supplement the Usutu system;
- The Usutu system can supplement the Komati system; and
- The Vaal system, via the VRESAP pipeline, can augment both systems.

In summary, except for Kusile Power Station where water consumption will increase as operation commences, the water requirements for the power generation sector in the study area will decrease by 25% over the next 18 years from a total of 589 ML/d to 443 ML/d (data provided by Eskom). The decrease is mainly driven by the move towards eventual closure of the Hendrina, Arnot, and Komati Power Stations.

11.3 AGRICULTURAL USE

The high TDS concentrations in the Upper, Middle and Lower Olifants River and Steelpoort is a potential threat to the agricultural sector, as it could be impacting on crop production. High TDS waters are known to reduce the yields of crops and eventually limit the range of crops that can be grown.

The presecence of nuisance algae is a potential problem that could impact on the supply of water for irrigation. This is of particular concern in the Loskop area where considerable irrigation takes place. The distribution of nutrient rich water can impact on the efficient abstraction, transfer, pumping, calibration of weirs and distribution of irrigation water, which could result in losses from canals. These impacts could have economic implications on agricultural users.

A further problem of algae present in irrigation waters is that it could affect the efficiency of the irrigation system used, for example drip and centre pivot irrigation systems can become blocked. While the exact impact of the algae present in the Olifants River on irrigation systems has not been determined it is believed that it could present a problem in the future.

11.4 RECREATIONAL WATER USE

The Olifants River System has a few impoundments where full contact recreational water use can take place. This is not to the same extent as in the Vaal system because of the potential risk posed by the presence of predators such as crocodiles and hippopotami. However the potential for algal blooms will impact negatively on the non-contact and intermediate contact recreational potential.

Microbiological contamination is also likely to impact negatively on the recreational water use which could impact on tourism in the area.

11.5 AQUATIC ECOSYSTEMS AND BIOTA

While the aquatic ecosystem and biota is not a water user *per se*, but inherently components of the water resource, it is important nevertheless to highlight the issues being faced by the ecological system with respect to the current water quality in the Olifants River. There have been a number of fish kills in the Olifants River System as well as concern saround the crocodile population in Loskop Dam.

12. WATER QUALITY MONITORING PROGRAMME STATUS

12.1 DEPARTMENT OF WATER AND SANITATION

Upper Olifants sub-catchment

The Upper Olifants is well covered however there are gaps in the number of monitoring points in the Grootspruit and Kromdraaispruit.

Middle Olifants sub-catchment

There are large gaps in data and monitolring points in the tributaries of the Middle Olifants including those listed below, however the seasonal trends of water availability must be assessed in more details in the next steps of this project.

- Bloed River;
- Elands River;
- Nkumpi River;
- Ngwaritsi River;
- Lepellane River;
- Chunies River;
- Mohlaletsi River;
- Mphogodima River;
- Monametsi River;
- Tongwane River;
- Motse River; and
- Mohlapitse River.

Steelpoort sub-catchment

Gaps in the Steelpoort sub-catchment include:

- Langspruit;
- Grootspruit;
- Spekboom River:
- Waterval River:
- Eloffspruit;
- Hodupong River;
- Mabitsana River; and
- Tshevetlane River.

Lower Olifants sub-catchment

- Ga-Selati River

Letaba sub-catchment

There are large gaps in the Letaba sub-catchment including:

- Nwanedzi River;

- Makwena River;
- Koedoes River;
- Mosukudutsi River;
- Middle Letaba River;
- Nsama River;
- Tsenda River;
- Ngwenyeni River; and
- Shipikani River.

Shingwedzi sub-catchment

Gaps in the Shingwedzi sub-catchment include:

- Shingwidzi River;
- Bububu River;
- Phugwane River;
- Mphongolo River;
- Shisha River; and
- Nkulumbeni River.

12.2 MONITORING BY OTHER INSTITUTIONS

12.2.1 Municipalities

Local municipalities are meant to undertake monitoring as part of their water use authorisation. This data should then be submitted to DWS or the relevant WMI. This does not appear to be happening. Up and downstream water quality monitoring is undertaken by the DWS/ WMI officials however it is not clear where this data is stored and what action is taken when results are received.

12.2.2 Mines and Industries

Mines and industries report on water quality monitoring as part of their water use authorisation conditions, however it is not clear where this data is stored and what action is taken when results are received.

12.2.3 Others

Various other organisations, such as Award and MOSA, are undertaking water quality monitoring in the catchment. The data is however not always made available to the DWS/ WMI.

12.3 GAPS IDENTIFIED

The following gaps and inadequacies have been identified with regard to water quality monitoring and monitoring programmes:

- In the various studies undertaken there are differences in:
    - Variables analysed for various studies;
    - Time periods and scales of the monitoring;
    - Analytical methods;
    - Laboratories used for the analysis; and
    - Differences in data collection and poor data storage (especially in the DWS).
- Lack of integration between the monitoring programmes of the National Programme and Regional Offices and data is not always uploaded to the WMS database;
- There appears to be limited co-ordination between the Resource Quality Information Services and the Departmental Regional Offices/ WMIs regarding the location of monitoring stations, sampling frequency and analyses performed;
- Monitoring programmes are stopped due to contracts expiring;
- There is a lack of integration between various governmental organisations and other organisations undertaking catchment studies with regards to the monitoring programmes and monitoring;
- There appears to be no integration or co-operation between the Department and the Water Boards with regard to monitoring of the Olifants River System;
- Data from the monitoring stations have in many instances proved to be incomplete (information gaps) or insufficient (limited data sets). The data sets were fragmented and in cases their reliability was questionable;
- Monitoring stations were not always suitably located and thus in some instances the most downstream point on the tributaries were too high up in the catchment. Thus the lower catchment impacts were not accounted for.
- The water quality monitoring variables currently analysed are largely concentrated on chemical constituents. At present very little information is available of the aquatic health of the water resources of the catchment and microbiological monitoring is not taking place;
- Not all monitoring points include flow measurements which limit the extent of water quality analysis at some points, and the determination of loads;

- No validation processes are in place to verify the data that has been captured (no validation of methods, sampling, analysis, etc.). This therefore sometimes raises questions about the validity of the data that is available on the Department databases;
- No continuous monitoring of water quality is practised in the Olifants River System. In impacted catchments the continuous monitoring of key water quality variables such as EC is needed for use with the flow monitoring stations to accurately assess the loads and compliance with WQPLs; and
- Not all chemicals of concern are monitored, for example, there is a lack of data on pesticides and metals.

12.4 RECOMMENDATIONS

There is a definite need to improve, align and integrate the monitoring network in the Olifants River System to adequately address the information needs and support IWRM. Co-operation between various organisations needs to take place to allow adequate monitoring to take place in respect of:

- Sampling locations;
- Frequency of monitoring; and
- Parameters measured.
- With Level 1, 2 and 3 monitoring points having been confirmed through this task, a comprehensive and integrated monitoring programme for these points can be agreed upon between all relevant stakeholders;
- The current “fragmented” programmes can be built upon to ensure that all the monitoring points deliver the same information needs, as required, in a consistent and co-ordinated manner.
- The location of the monitoring gauges, especially those at level 2 points must be reviewed to ensure that they in fact are located at the most downstream point just before confluence with the Olifants River. It may also be necessary to install monitoring gauges in the upper reaches of all the tributaries to determine background qualities.
- Water quality monitoring must be consistently carried out at all monitoring points according to the agreed upon monitoring programme to enable all strategic points to build up credible data sets. This is specifically needed in those areas where gaps have been identified.
- To maximise the monitoring in the system, the Department, WMI, local authorities, Water Boards, and other key water users including mines, industries

and agriculture should co-ordinate their monitoring programmes to support effective and efficient capacity and resource utilisation;

- It may be necessary to enter into co-operative agreements regarding sharing of water quality information (free of charge);
- The water quality monitoring variables currently analysed are largely concentrated on chemical constituents. The monitoring system therefore needs to be extended to include biological and microbiological parameters, as well as metals and other emerging contaminants, such as targeted pesticides in areas where these are used. Chlorophyll a and total phosphorus, total nitrogen, chemical oxygen demand and dissolved oxygen levels should also be included as variables to be monitored;
- Stream flow monitoring must be considered at all Level 1 and 2 water quality monitoring points to allow for trend analysis and determination of loads;
- Data capturing needs to be improved as many of the stations are missing recent monitoring data, or have gaps of a few years in the information;
- Compliance monitoring and the capturing of compliance data should be revitalised/re-emphasised, in order to determine the true extent of the impacts on the water resources of the Olifants River System. This would include monitoring of the point source discharges from mines, industries, wastewater treatment works, irrigation canals, etc. that report to the Olifants River or its major tributaries.
- It is also important to install air quality monitoring devices especially in the Upper Olifants sub-catchment to start determining the impact of atmospheric deposition on the water quality;
- The monitoring needs can be phased into immediate, medium term and long term plans to ensure that the information needs are achieved.

13. INSTITUTIONAL STRUCTURES

13.1 WATER MANAGEMENT INSTITUTIONS

13.1.1 Catchment Management Agencies

The Olifants Catchment Management Agency has not yet been established, however the WMI is in place and is located in Bronkhorstspruit.

13.1.2 Catchment Forums

The following catchment forums are in place:

- Olifants River Forum;
- Olifants, Levhuvu/ Letaba and Inkomati (OLLI) Forum;
- Upper Olifants Catchment Management Forum;

- Middle Olifants Catchment Management Forum;
- Lower Olifants Catchment Management Forum; and
- Intercompany Water and Waste Management Committee
- It is not clear whether the Controlled Release Scheme Committee (was stopped in 2015 pending review) will be started again.

13.1.3 Water User Associations

The following Water Users Associations (WUA) and Irrigation Boards are in place in the Olifants WMA:

- Sekhukhune WUA;
- Tubaste WUA;
- Delmas WUA;
- Mogaba WUA;
- Ilanga WUA;
- Lebalelo WUA;
- Lower Lepelle WUA;
- Loskop Irrigation Board;
- Dwars Irrigation Board
- Central Steelpoort & Skepboom Irrigation Boards;
- Letaba WUA
- Lower Blyde River WUA;
- Thabina Irrigation Scheme;
- Middle Letaba WUA; and
- Nwamitwa/ Luphe WUA.

13.2 OTHER INSTITUTIONS

The main District Municipalitys and municipalities in the Middle Olifants are:

- Gert Sibande District Municipality:
    - Govan Mbeki Local Municipality; and
    - Msukaligwa Local Municipality; and
    - Albert Luthuli (a very small portion).
- Sedibeng District Municipality:

  - Lesedi Local Municipality (very small portion).
- Ekurhuleni District Municipality:
  - Ekurhuleni Local Municipality (very small portion).
- Nkangala District Municipality:
  - Delmas Local Municipality;
  - eMalahleni Local Municipality;
  - Steve Tshwete Local Municipality;
  - Highlands Local Municipality
  - Thembisile Local Municipality: and
  - Dr JS Moroka Local Municipality
- Metsweding District Municipality:
  - Nokeng tsa Taemane Local Municipality; and
  - Kungwini Local Municipality.
- Waterberg District Municipality:
  - Modimolle Local Municipality;
  - Mookgopong Local Municipality; and
  - Bela-Bela Local Municipality.
- Greater Sekhuhune District Municipality:
  - Greater Marble Hall Local Municipality;
  - Elias Motsoaledi Local Municipality;
  - Makhuduthamaga Local Municipality;
  - Greater Tubatse Local Municipality; and
  - Fetakgomo Local Municipality.
- Capricorn District Municipality
  - Polokwane Local Municipality;
  - Lepelle Nkumpi Local Municipality; and
  - Molemole Local Municipality
- Mopani District Municipality
  - Greater Tzaneen Local Municipality;
  - Greater Letaba Local Municipality;
  - Greater Giyani Local Municipality;
  - Ba-Phalaborwa Local Municipality;

  - Maruleng Local Municipality; and
  - LIMDMA33 Local Municipality.
- Ehlanzeni District Municipality
  - Thaba Chweu Local Municipality;
  - Bushbuckridge Local Municipality; and
  - MPDMA32 Local Municipality.
- Vhembe District Municipality:
  - Makhado Local Municipality; and
  - Thulamela Local Municipality.

Other important Institutions that have undertaken, are undertaking studies or may be planning studies in the WMA:

- Award;
- National Departments suchas Deaprtment of Mineral Resources;
- Strategic Water Partners Network (SWPN);
- LIMCOM (Limpopo Water Course Commission); and
- Middle Olifants South Africa (MOSA).

PART 4: CONCLUSIONS, GAPS AND PRIORITIES

14. CONCLUSIONS AND RECOMMENDATIONS

14.1 SUMMARY OF THE CURRENT SITUATION

A spectrum of issues in the Olifants River System have been identified including salinization, nutrient enrichment, metal contamination and concerns around emerging contaminants.

The greatest impact is seen in the Upper Olifants catchment from mines and urbanisation which impacts considerably on downstream users. Impacts from agriculture and poor functioning municipal wastewater treatment works are the main pollution sources in the other sub-catchments, except for the mines in the Phalaborwa area that have a major impact on the lower reaches once the Olifants River enters the Kruger National Park.

14.2 FOCUS AREAS REQUIRING ATTENTION

The following specific areas require some degree of immediate intervention to ensure the sustainability of the water resources in the Olifants River System:

- **Data collection, handling and management**

The water quality data of the surface water resources data captured by the Department for the system, although exhibiting some gaps, is available and useable. However, data of the water users in the system especially wastewater discharge information from mines and wastewater treatment works is extremely difficult to obtain, even though this is a reporting requirement of the water use authorisation.

It is important that data gathering and handling and monitoring receive a high priority as such information forms the basis for water quality management within the system. This applies to all historical and future water resources related data as well as co-ordinating with other organisations.

- **Lack of WQPLs**

WQPLs were developed for the Upper Olifants, however there are no WQPLs for the other sub-catchments. These will need to be developed and the existing WQPLs will need to be aligned with the RDM studies.

- **Impacts of the mining activities and mine closure**

The management of mining activities in the system, especially in the Upper Olifants sub-catchment, is crucial to the management of water quality both in the short term to alleviate the current salt loads being released to the Witbank, Middleburg and Loskop Dams and long term to manage the impacts of mine closure and mine decants. While the complex dynamics of this situation is accepted in terms of maintaining base flows in the system, permitting active mining, and promoting wider socio-economic imperatives, a major intervention in terms of current mining development practices is required if the situation in the Upper Olifants sub-catchment, Steelpoort sub-catchment and Phalaborwa area is to be alleviated.

Of further concern is the final decant points and the management of Water Reclamation Plants within the system once all the mines within this area close down. Closure plans that incorporate the Water Reclamation need to be developed by the mines.

- **Management of wastewater treatment works discharges**

The lack of compliance of wastewater discharges (authorised and non-authorised) from the many smaller wastewater treatment plants in the system to discharge standards, as well as constant incidents at those wastewater treatment works that are not authorised to discharge, is of great concern. The Green Drop results indicate that this situation is not improving, and until such time as this matter is addressed by all the role players at the appropriate levels, water quality management goals will not be achieved and the risks to human and ecosystem health will increase and negatively affect tourism.

- **Urbanisation**

This focus area is linked to the above issue of wastewater treatment works to some degree, however it also related to the uncontrolled development and urban sprawl that is being experienced in many of the urbanised centres of the Olifants WMA. Lack of, poor and improper planning is leading to large volumes of contaminated water from sewer leaks in the urbanised areas and run-off in informal areas entering storm water drains draining to various tributaries that flow to the Olifants River. This aspect requires an integrated planning approach that needs to be taken up with the appropriate structures if the situation is to improve.

- **Irrigation Schemes**

A strategy to optimise water use and reduce the impact of irrigation return flows (links to land-use) need to be developed in collaboration with the relevant WUA and National and Provincial Departments. The intervention strategy will require water quantity, WCWDM and water quality approaches. By improving water quality, the water may be made available to other users in the WMA.

- **Waste Discharge charges**

The Waste Discharge Charge System needs to be introduced as soon as possible. Loads need to be determined for catchments where pollution is severe and allocated to the relevant impactors. Load reduction requirements need to be determined so the impactors are made aware of how much load they will need to reduce by and can budget for specific interventions.

- **Research needs**

Decision-making with imperfect and incomplete data and information is never easy, and there are considerable risks associated with it. With funding the necessary research, and ensuring that data is shared across organisations, it will be possible to reduce the risks of decision-making by improving the knowledge base, and especially extending long-term studies in the Olifants River system.

- **Monitoring**

Strengthening of the water quality monitoring programme of the Olifants River System in an integrated manner is a key requirement – this includes both ground and surface water monitoring. There needs to be the ability to conduct continuous, relevant routine monitoring.

Most often, when incidents such as fish kills occur, it is handled as an emergency situation and improvements to the monitoring is not continued once the problem clears up. Early warning systems, such as continuous dissolved oxygen monitoring should be considered.

- **Integrated management**

Environmental and conservation issues need to be placed within the context of social and economic uses of the river by the community and therefore requires the perception of local residents, landowners, the water industry and other stakeholders to be taken into account. Science has an important role to play in the decision-making process.

Integrated management should be adaptive, constantly producing new mechanisms, ideas and tools. This can only be achieved with solutions and activities at the local level with political and managerial support. In this context awareness creation and education at all levels plays a fundamental and unique role. Public participation and awareness, practical focus, skills development and institutional capacity are some of the essential components of integrated water resource management.

14.3 EXISTING MANAGEMENT STRATEGIES

The Environmental Management Framework developed for the Olifants and Letaba catchments in 2009 by DWS and Environmental Affairs needs to be considered.

Existing management strategies developed during the Reconciliation Strategy and now in the implementation phase must be built on and aligned with this proposed IWQMP for the Olifants River System.

The project currently being undertaken by DWS to develop a National Water Quality Management Strategy must be consulted and the IWQMP for the Olifants River System must be aligned to the principles identified.

15. REFERENCES

Ashton, P. J., Dabrowski, J. M., 2011. *An overview of surface water quality in the Olifants River catchment. Tech. Rep. KV 293/11, Water Research Commission, Pretoria*.

DWAF, Department of Water Affairs and Forestry, 1997: *A White Paper on a National Water Policy for South Africa*. April 1997

DWAF, Department of Water Affairs and Forestry, 1998. Water Law Implementation Process – *A Strategic plan for the Department of Water Affairs and Forestry to facilitate the implementation of Catchment Management in South Africa*

Department of Water Affairs and Forestry, 2003. Water Quality Management Series, Sub-series Ni. MS 8.3. *A Guide to conduct Water Quality Catchment Assessment Studies: In support of Water Quality Management Component of a catchment Management Strategy*. Edition, Pretoria

Department of Water Affairs and Forestry, 2003. Development of an Integrated Water Resource Management Plan for the Upper and Middle Olifants catchment

Department of Water Affairs. 2009. *Development of a Reconcilliation Strategy for the Olifants River System*: Final Reconciliation Strategy

Department Of Water Affairs, South Africa, 2014. *Development of a Reconcilliation Strategy for the Luvuvhu and Letaba Water Supply System*: Final Reconciliation Strategy

Department of Water Affairs, South Africa, January 2013. *Classification of Significant Water Resources in the Olifants Water Management Area (WMA 4):* Management Classes of the Olifants WMA. Report No: RDM/WMA04/00/CON/CLA/0213

Department of Water Affairs, South Africa, January 2013.National Water Resources Strategy, Second Edition

Government Gazette No 37999, Notice 819 of 2014. Department of Water and Sanitation, National Water Act, 1998, (Act No.36 Of 1998) Proposed Classes of Water Resources for the catchments of the Olifants

Government Gazette No 37999, Notice 823 of 2014. Department of Water and Sanitation, National Water Act, 1998, (Act No.36 of 1998) Proposed Classes of Water Resources for the Letaba Catchment

16. GLOSSARY OF TERMS

Term	**Definition**
Alkalinity	Capacity of water to neutralize acids by its content of bicarbonates, carbonates, and/or hydroxides – The buffer capacity of a water body.
Chemical Oxygen Demand	Measurement of the amount of oxygen used in the chemical break-down of organic matter in water. Is a good indicator of the total amount of organic waste.
Effluent	The treated water discharged by a wastewater treatment plant
Metals	Metallic elements with high atomic weights e.g., copper, mercury, chromium, cadmium, arsenic or lead. Heavy metals can damage living things at low concentrations and tend to accumulate in the food chain.
Indirect Reuse	Introduction of treated wastewater into a water reservoir, either an aquifer or a surface water body for mixing and assimilation with the objective of providing an environmental buffer.
Nutrients	Elements essential for plant or animal growth. Major nutrients include nitrogen, phosphorus, carbon, oxygen, sulphur, and potassium.
Pathogens	Disease-causing biological agents such as a bacteria, viruses or fungi.
Pollution	An undesirable change in the physical, chemical, or biological characteristics of air, water, soil, or food that can adversely affect the health, activities, or survival of humans or other living organisms.
Reclaimed water	Wastewater that has been treated to levels suitable for reuse.
Salinisation	The process by which the concentration of dissolved solids in inland waters is increased.
Suspended Solids	Material suspended in water, which includes a wide range of sizes of material, from colloids (0.1 μm) through to large organic

	and inorganic particulates.
Total dissolved solids	A measure the inorganic salts (and organic compounds) dissolved in water.
Toxicant	A chemical capable of producing an adverse response (effect) in a biological system at concentrations that might be encountered in the environment, seriously injuring structure or function or producing death. Examples include pesticides, heavy metals and biotoxins.
Wastewater	Liquid waste discharged by domestic residences, commercial properties, industry, agriculture, which often contains some contaminants that result from the mixing of wastewater from different sources.
Water quality	Water quality refers to the chemical, physical, biological, and radiological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose
Water Quality Monitoring	The complexity of water quality as a subject is reflected in the many types of measurements of water quality indicators. These indicators can be subdivided into 2 classes, those measuring the drivers (e.g. physical, chemical, microbiological, radiological, habitat); and those measuring the responses (e.g. biological integrity/biota)

APPENDIX A

SUMMARY OF RDM DATA (ELECTRONIC)

APPENDIX B

WATER QUALITY STATISTICS (ELECTRONIC)

APPENDIX C

DEMOGRAPHIC AND CENSUS DATA

Demographic characteristics of the Olifants Catchment and subsequent sub-catchments found within it were identified using Census data (2011). Ward level data was allocated to corresponding sub-catchments. Artificial ward boundaries did not directly correspond to geographic sub-catchment boundaries. Wards with greater than 50% of their area within a sub-catchment were appointed to that sub-catchment. The allocation of wards to each sub-catchment can be seen in Table C1.

A total of 488 wards were used to represent the demographic nature of the Olifants Catchment, with 112, 42, 197, 18, 36, and 83 representing the Letaba, Lower-Olifants, Middle-Olifants, Shingwedzi and Upper-Olifants Sub-Catchments respectively (Table C2**Error! Reference source not found.**).

Table C1: The allocation of wards as indicators for population demographics of sub-catchments in the Olifants Catchment

Number of wards within each sub-catchments							
Province/Local Municipality	**Letaba**	**Lower-Olifants**	**Middle-Olifants**	**Shingwedzi**	**Steelpoort**	**Upper-Olifants**	**Grand Total**
Gauteng			**2**			**6**	**8**
City of Tshwane Metropolitan Municipality			2			5	7
Ekurhuleni Metropolitan Municipality						1	1
Limpopo	**112**	**34**	**133**	**18**	**25**		**322**
Ba-Phalaborwa Local Municipality	4	13					17
Bela-Bela Local Municipality			2				2
Elias Motsoaledi Local Municipality			26		4		30
Ephraim Mogale Local Municipality			16				16
Fetakgomo Local Municipality			13				13
Greater Giyani Local Municipality	26			4			30
Greater Letaba Local Municipality	29						29
Greater Tubatse Local Municipality		3	9		19		31
Greater Tzaneen Local Municipality	30	4					34
Lepele-Nkumpi Local Municipality			29				29
Makhado Local Municipality	19						19
Makhuduthamaga Local Municipality			29		2		31

Number of wards within each sub-catchments							
Province/Local Municipality	**Letaba**	**Lower-Olifants**	**Middle-Olifants**	**Shingwedzi**	**Steelpoort**	**Upper-Olifants**	**Grand Total**
Maruleng Local Municipality		14					14
Molemole Local Municipality	1						1
Mookgopong Local Municipality			2				2
Mutale Local Municipality				1			1
Polokwane Local Municipality	2		7				9
Thulamela Local Municipality	1			13			14
Mpumalanga		**8**	**62**		**11**	**77**	**158**
Bushbuckridge Local Municipality		4					4
Dr JS Moroka Local Municipality			31				31
Emakhazeni Local Municipality					4		4
Emalahleni Local Municipality						34	34
Govan Mbeki Local Municipality						3	3
Msukaligwa Local Municipality						1	1
Steve Tshwete Local Municipality						29	29
Thaba Chweu Local Municipality		4			7		11
Thembisile Local Municipality			31			1	32
Victor Khanye Local Municipality						9	9
Grand Total	**112**	**42**	**197**	**18**	**36**	**83**	**488**

Table C2: Census data by sub-catchments in the Olifants Catchment (Census 2011).

Demographic group	**Sub-Catchment**													
Population Demographic	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
Black	1078901	97.17	338439	96.44	1739062	98.19	238937	99.73	325950	94.42	740815	78.96	4462104	93.83
Colored	1473	0.13	1292	0.37	2684	0.15	102	0.04	2004	0.58	15673	1.67	23228	0.49
Asian/Indian	3862	0.35	531	0.15	3238	0.18	88	0.04	1151	0.33	9914	1.06	18784	0.39
White	24710	2.23	10131	2.89	23268	1.31	372	0.16	15676	4.54	167586	17.86	241743	5.08
Other	1371	0.12	531	0.15	2868	0.16	84	0.04	436	0.13	4240	0.45	9530	0.20
Total	**1110335**	**100**	**350933**	**100**	**1771163**	**100**	**239588**	**100**	**345220**	**100**	**938230**	**100**	**4755469**	**100**
	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
Language	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
Afrikaans	22129	2.05	8048	2.34	26486	1.52	182	0.08	16490	4.88	161274	17.82	234609	5.05
English	14285	1.32	4975	1.45	20052	1.15	1425	0.60	6509	1.93	51739	5.72	98985	2.13
IsiNdebele	2377	0.22	978	0.28	317826	18.29	47	0.02	20229	5.99	130665	14.44	472122	10.17
IsiXhosa	937	0.09	656	0.19	8380	0.48	45	0.02	2375	0.70	25859	2.86	38252	0.82
IsiZulu	3809	0.35	3414	0.99	82513	4.75	153	0.06	17405	5.15	312957	34.59	420251	9.05
Sepedi	380793	35.21	203061	59.08	1086759	62.55	238	0.10	235987	69.84	91932	10.16	1998770	43.06
Sesotho	28132	2.60	9979	2.90	36365	2.09	190	0.08	5654	1.67	35310	3.90	115630	2.49
Setswana	1920	0.18	1351	0.39	75014	4.32	59	0.02	2521	0.75	15517	1.71	96382	2.08

SiSwati	1674	0.15	3736	1.09	21004	1.21	366	0.15	23349	6.91	42499	4.70	92628	2.00
Tshivenda	124467	11.51	1300	0.38	6780	0.39	20197	8.53	1051	0.31	5094	0.56	158889	3.42
Xitsonga	501078	46.33	106182	30.90	56119	3.23	213963	90.33	6309	1.87	31966	3.53	915617	19.72
Total	**1081601**	**100**	**343680**	**100**	**1737298**	**100**	**236865**	**100**	**337879**	**100**	**904812**	**100**	**4642135**	**100**
Education	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
No schooling	128005	21.59	32994	17.54	177857	18.75	27319	24.04	29399	15.29	45419	7.58	440993	16.74
Some primary	67116	11.32	22941	12.20	121694	12.83	15862	13.96	18801	9.78	58151	9.70	304565	11.56
Completed primary	25136	4.24	7475	3.97	40718	4.29	5154	4.54	7732	4.02	23299	3.89	109514	4.16
Some secondary	201527	33.99	68431	36.38	326978	34.47	37854	33.31	77850	40.50	212195	35.40	924835	35.10
Completed secondary	125377	21.15	44060	23.42	223062	23.51	20822	18.32	47982	24.96	193935	32.35	655238	24.87
Higher	45769	7.72	12189	6.48	58360	6.15	6635	5.84	10458	5.44	66433	11.08	199844	7.58
Total	**592930**	**100**	**188090**	**100**	**948669**	**100**	**113646**	**100**	**192222**	**100**	**599432**	**100**	**2634989**	**100**
Employment Group	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
Employed	169942	25.59	56915	26.73	256439	24.66	18562	13.85	67392	31.37	326036	49.71	895286	30.65
Unemployed	108207	16.30	40514	19.03	206486	19.86	18820	14.05	45385	21.12	106290	16.21	525702	18.00
Discouraged work-seeker	44951	6.77	14434	6.78	71176	6.85	16372	12.22	10438	4.86	24094	3.67	181465	6.21
Not economically active	340879	51.34	101062	47.46	505593	48.63	80241	59.88	91630	42.65	199484	30.41	1318889	45.15
Total	**663979**	**100**	**212925**	**100**	**1039694**	**100**	**133995**	**100**	**214845**	**100**	**655904**	**100**	**2921342**	**100**

Labour Sector	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
In the formal sector	112038	64.72	38380	66.28	163050	62.37	13180	69.61	46477	68.01	245018	73.89	618143	67.83
In the informal sector	32956	19.04	10978	18.96	53154	20.33	3456	18.25	12138	17.76	38511	11.61	151193	16.59
Private household	24227	13.99	7317	12.64	39258	15.02	1949	10.29	7785	11.39	39388	11.88	119924	13.16
Do not know	3903	2.25	1231	2.13	5980	2.29	348	1.84	1934	2.83	8661	2.61	22057	2.42
Total	**173124**	**100**	**57906**	**100**	**261442**	**100**	**18933**	**100**	**68334**	**100**	**331578**	**100**	**911317**	**100**
Income Group	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
No income	41657	13.87	13487	14.19	63627	14.37	8400	13.75	13175	14.74	36113	13.16	176459	13.97
R 1 - R 4800	23573	7.85	6884	7.24	26416	5.96	6841	11.20	4765	5.33	8785	3.20	77264	6.12
R 4801 - R 9600	41342	13.76	12391	13.03	49107	11.09	12306	20.15	8632	9.66	14316	5.22	138094	10.93
R 9601 - R 19 600	73493	24.47	21903	23.04	104915	23.69	14720	24.10	15772	17.65	34612	12.61	265415	21.01
R 19 601 - R 38 200	62257	20.73	19601	20.62	99351	22.43	11145	18.25	17120	19.16	48160	17.55	257634	20.40
R 38 201 - R 76 400	23854	7.94	8695	9.15	47915	10.82	3383	5.54	13053	14.61	44921	16.37	141821	11.23
R 76 401 - R 153 800	14427	4.80	6005	6.32	27145	6.13	2009	3.29	8646	9.68	34026	12.40	92258	7.30
R 153 801 - R 307 600	11504	3.83	3895	4.10	15764	3.56	1398	2.29	4867	5.45	26890	9.80	64318	5.09
R 307 601 - R 614 400	6008	2.00	1673	1.76	6421	1.45	676	1.11	2429	2.72	17159	6.25	34366	2.72
R 614 001 - R 1 228 800	1369	0.46	281	0.30	1312	0.30	108	0.18	585	0.65	6530	2.38	10185	0.81

R 1 228 801 - R 2 457 600	443	0.15	124	0.13	507	0.11	52	0.09	179	0.20	1825	0.67	3130	0.25
R 2 457 601 or more	462	0.15	123	0.13	427	0.10	34	0.06	137	0.15	1085	0.40	2268	0.18
Total	**300389**	**100**	**95062**	**100**	**442907**	**100**	**61072**	**100**	**89360**	**100**	**274422**	**100**	**1263212**	**100**
Dwelling Characteristics	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
House/brick/concrete structure	264972	88.54	87321	92.21	383410	86.87	45675	74.94	67595	76.26	187493	69.16	1036466	82.52
Traditional dwelling	17733	5.93	3397	3.59	12218	2.77	14091	23.12	4387	4.95	5651	2.08	57477	4.58
Flat or apartment	1665	0.56	591	0.62	1709	0.39	120	0.20	821	0.93	7893	2.91	12799	1.02
Cluster house in complex	231	0.08	87	0.09	515	0.12	131	0.21	214	0.24	2559	0.94	3737	0.30
Townhouse	433	0.14	82	0.09	215	0.05	6	0.01	287	0.32	4722	1.74	5745	0.46
Semi-detached house	295	0.10	49	0.05	604	0.14	7	0.01	161	0.18	1326	0.49	2442	0.19
House/flat/room in backyard	1887	0.63	574	0.61	5094	1.15	280	0.46	1015	1.15	6747	2.49	15597	1.24
Informal dwelling (shack)	3448	1.15	792	0.84	13037	2.95	229	0.38	5243	5.92	13741	5.07	36490	2.91
Informal dwelling (e.g. squatter settlement)	4406	1.47	1359	1.44	19263	4.36	345	0.57	6794	7.67	36299	13.39	68466	5.45
Room/flatlet	3815	1.27	294	0.31	4951	1.12	36	0.06	1923	2.17	4162	1.54	15181	1.21
Caravan/tent	345	0.12	131	0.14	298	0.07	27	0.04	195	0.22	487	0.18	1483	0.12
Total	**299268**	**100**	**94696**	**100**	**441345**	**100**	**60952**	**100**	**88632**	**100**	**271084**	**100**	**1255977**	**100**
Toilet System	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)

Flush toilet (sewerage system)	42772	16.14	17663	20.52	52326	12.27	4452	9.06	24815	29.28	191633	71.49	333661	28.29
Flush toilet (septic tank)	6644	2.51	2852	3.31	8573	2.01	374	0.76	1808	2.13	9067	3.38	29318	2.49
Chemical toilet	2890	1.09	488	0.57	4868	1.14	419	0.85	835	0.99	3163	1.18	12663	1.07
Pit toilet with ventilation (VIP)	51742	19.52	23043	26.77	71947	16.87	13351	27.16	5480	6.47	10465	3.90	176028	14.92
Pit toilet without ventilation	154133	58.16	40636	47.20	280102	65.67	28733	58.46	48176	56.85	44034	16.43	595814	50.51
Bucket toilet	1052	0.40	391	0.45	3122	0.73	94	0.19	1386	1.64	4560	1.70	10605	0.90
Other	5680	2.14	974	1.13	5371	1.26	1708	3.48	2210	2.61	5064	1.89	21007	1.78
None	112	0.04	42	0.05	197	0.05	18	0.04	36	0.04	83	0.03	488	0.04
Total	**265025**	**100**	**86089**	**100**	**426506**	**100**	**49149**	**100**	**84746**	**100**	**268069**	**100**	**1179584**	**100**

Water Access	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
Inside dwelling/institution	46459	15.46	17587	18.50	64144	14.48	5436	8.90	18468	20.67	151953	55.37	304047	24.07
Inside yard	93312	31.06	35744	37.60	196137	44.28	17115	28.02	21584	24.15	75670	27.57	439562	34.79
Less than 200m	64830	21.58	16622	17.49	66835	15.09	19704	32.26	18393	20.58	20758	7.56	207142	16.40
Between 200m and 500m	23728	7.90	6260	6.59	20997	4.74	8827	14.45	6775	7.58	7888	2.87	74475	5.90
Between 500m and 1000m	14665	4.88	3805	4.00	9648	2.18	4447	7.28	3712	4.15	4074	1.48	40351	3.19
Greater than 1000m	8852	2.95	2384	2.51	4887	1.10	2926	4.79	2091	2.34	1456	0.53	22596	1.79

No access	48577	16.17	12662	13.32	80289	18.13	2633	4.31	18343	20.53	12629	4.60	175133	13.86
Total	**300423**	**100**	**95064**	**100**	**442937**	**100**	**61088**	**100**	**89366**	**100**	**274428**	**100**	**1263306**	**100**
Source of Water	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
Regional/local water scheme	170327	58.86	54865	58.67	280867	65.43	49457	82.79	47031	54.81	234821	87.59	837368	68.31
Borehole	54937	18.98	14472	15.48	58645	13.66	5828	9.76	14113	16.45	16056	5.99	164051	13.38
Spring	5905	2.04	1009	1.08	5596	1.30	75	0.13	1324	1.54	684	0.26	14593	1.19
Rain water tank	1722	0.60	654	0.70	5625	1.31	391	0.65	1258	1.47	689	0.26	10339	0.84
Dam/pool/stagnant water	19620	6.78	5272	5.64	15300	3.56	813	1.36	3969	4.63	1289	0.48	46263	3.77
River/stream	15960	5.52	12041	12.88	24783	5.77	539	0.90	11326	13.20	1769	0.66	66418	5.42
Water vendor	14192	4.90	3974	4.25	22158	5.16	1166	1.95	2716	3.17	2234	0.83	46440	3.79
Water tanker	6712	2.32	1230	1.32	16294	3.80	1468	2.46	4073	4.75	10535	3.93	40312	3.29
Total	**289375**	**100**	**93517**	**100**	**429268**	**100**	**59737**	**100**	**85810**	**100**	**268077**	**100**	**1225784**	**100**
Energy for Cooking	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
Electricity	111094	36.98	46587	49.01	275483	62.19	10043	16.44	54216	60.67	203269	74.07	700692	55.47
Gas	3190	1.06	1236	1.30	5784	1.31	324	0.53	1192	1.33	7348	2.68	19074	1.51
Paraffin	3149	1.05	1386	1.46	24160	5.45	263	0.43	7134	7.98	36878	13.44	72970	5.78
Wood	181723	60.50	45346	47.70	127125	28.70	50281	82.33	22407	25.07	8972	3.27	435854	34.50
Coal	242	0.08	89	0.09	7871	1.78	18	0.03	3930	4.40	16314	5.94	28464	2.25

Animal dung	87	0.03	46	0.05	1287	0.29	12	0.02	133	0.15	241	0.09	1806	0.14
Solar	210	0.07	91	0.10	471	0.11	22	0.04	138	0.15	398	0.15	1330	0.11
Other	44	0.01	12	0.01	50	0.01	3	0.00	22	0.02	418	0.15	549	0.04
None	648	0.22	264	0.28	706	0.16	110	0.18	189	0.21	584	0.21	2501	0.20
Total	**300387**	**100**	**95057**	**100**	**442937**	**100**	**61076**	**100**	**89361**	**100**	**274422**	**100**	**1263240**	**100**
Energy for Heat	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
Electricity	110891	36.92	37382	39.33	226020	51.03	10664	17.46	42994	48.11	169752	61.86	597703	47.31
Gas	1724	0.57	700	0.74	4050	0.91	288	0.47	879	0.98	7957	2.90	15598	1.23
Paraffin	2225	0.74	925	0.97	8627	1.95	141	0.23	2209	2.47	9879	3.60	24006	1.90
Wood	144409	48.07	37998	39.97	123544	27.89	44478	72.82	23746	26.57	15045	5.48	389220	30.81
Coal	384	0.13	73	0.08	21422	4.84	27	0.04	4759	5.33	39757	14.49	66422	5.26
Animal dung	198	0.07	79	0.08	1296	0.29	137	0.22	166	0.19	353	0.13	2229	0.18
Solar	407	0.14	95	0.10	559	0.13	51	0.08	185	0.21	555	0.20	1852	0.15
Other	6	0.00	1	0.00	13	0.00	1	0.00	2	0.00	26	0.01	49	0.00
None	40144	13.36	17805	18.73	57407	12.96	5293	8.67	14423	16.14	31103	11.33	166175	13.15
Total	**300388**	**100**	**95058**	**100**	**442938**	**100**	**61080**	**100**	**89363**	**100**	**274427**	**100**	**1263254**	**100**
Energy for Light	Letaba		Lower-Olifants		Middle-Olifants		Shingwedzi		Steelpoort		Upper-Olifants		Grand Total	
	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)		
Electricity	264695	88.11	84278	88.65	396820	89.59	51930	85.02	73502	82.24	223238	81.35	1094463	86.64

Gas	366	0.12	116	0.12	512	0.12	84	0.14	184	0.21	825	0.30	2087	0.17
Paraffin	1712	0.57	566	0.60	2710	0.61	865	1.42	705	0.79	4088	1.49	10646	0.84
Candles (not a valid option)	31225	10.39	9177	9.65	40811	9.21	6862	11.23	14417	16.13	44767	16.31	147259	11.66
Solar	1086	0.36	583	0.61	1054	0.24	1210	1.98	243	0.27	649	0.24	4825	0.38
None	1327	0.44	347	0.37	1039	0.23	129	0.21	322	0.36	853	0.31	4017	0.32
Total	**300411**	**100**	**95067**	**100**	**442946**	**100**	**61080**	**100**	**89373**	**100**	**274420**	**100**	**1263297**	**100**

APPENDIX D

SULPHATE TO MAJOR ANIONS RATIOS

WMS ID	Monitoring Point Name	Quaternary Catchment	95% P
188423	Weltevreden U/S Forzando Colliery On Olifants	B11A	0.157
188430	Vlaklaagte @ R38 U/S Of Confluence With Olifants On Bankspruit		0.186
90416	B1H018Q01 Olifants River At Middelkraal		0.366
188420	Middelkraal U/S Of Bridge On R35 To Bethal On Olifants		0.583
90416	B1H018Q01 Olifants River At Middelkraal		0.62
188424	Halfgewonnen @ Bridge D/S Of Sudor Coal On Olifants		0.688
188431	Kalabasfontein On R38 U/S Olifants On Viskuile		0.788
188422	Leeuwfontein @ R35 Road To Bethal On Leeuwfontein Spruit	B11B	0.182
188425	Geluk D/S Of Gloria Mine On Koringspruit		0.438
188426	Koornfontein D/S Koornfontein Mine On Koringspruit		0.611
188588	Vaalkranz Upstream Of New Clydesdale Colliery On Olifants		0.635
188587	Kleinfontein 49 Is D/S Leeuwfonteinspruit & Block 8 Shaft Of Goedehoop Colliery		0.784
188536	Van Dyksdrift At R544 Bridge U/S Douglas Colliery On Olifants		0.891
188427	Koornfontein Blinkpan D/S Komati Sewage Works On Koringspruit		0.893
192764	Us Goedehoop On Goedehoopspruit		0.895
90418	B1h020q01 At Vaalkranz U/S Vandyksdrift On Koringspruit		0.911
188438	Klipkraal On Tributary Of Debeerspruit	B11C	0.125
188435	Holfontein On Tributary Of Piekespruit		0.171
188589	Witbank U/S Isibonelo Colliery On Steenkoolspruit		0.176
188436	Klipkraal On Debeerspruit		0.19
188433	Palmietfontein On Piekespruit		0.218
90415	B1h017q01 At Aangewys D/S Isibonelo Colliery On Steenkoolspruit		0.283
188443	Onverwacht @ R547 Kinross Kriel Road On Dwars-In-Die-Weg Spruit	B11D	0.106
188440	Trichardtsfontein D/S Of Trichardt Stw On Trichardspruit		0.257
188439	Trichardt D/S Of Trichardsfontein Dam On Trichardspruit		0.262
90420	B1h022q01 Trichardt D/S Trichardsfontein Dam On Trichardspruit		0.265
90411	B1h006 Rietfontein On Trichardspruit		0.278
188444	Bakenlaagte U/S Matla & Kriel Power Stations On Spruit On Bakenlaagte		0.292
188442	Zondagskraal D/S Kinross Stw On Tributary Of Dwars-In-Die-Weg Spruit		0.301

WMS ID	**Monitoring Point Name**	**Quaternary Catchment**	**95% P**
188448	Kriel D/S Onverwachtspruit U/S Kriel Stw On Steenkoolspruit		0.424
188447	Onverwacht U/S Onverwachtspruit D/S Isobonelo Colliery On Steenkoolspru Uit		0.441
88942	Zstov01 Onverwacht @ Kriel-Ogies Road D/S Kriel Collieries On Onverw Wacht Spruit		0.488
188603	Dorsfontein U/S Of Dorstfontein Mine On Steenkoolspruit Tributary		0.502
188449	Kriel D/S Kriel Stw On Steenkoolspruit		0.512
188602	Rietkuil At 547 Road Bridge D/S Dorstfontein Mine On Steenkoolspruit Tributary		0.664
191474	Lehlaka Park Roodepoort 40 Is - D/S Of Rietspruit Wwtw On Tributary Of Rietspruit	B11E	0.341
191615	Middeldrift 42 Is - Near Road Bridge On Steenkoolspruit		0.361
188446	Vierfontein U/S Kriel Block 6 & D/S Matla Colliery On Rietspruit		0.463
192644	B1h028 Rietspruit Dam -		0.487
90419	B1h021q01 Steenkool Spruit At Middeldrift		0.542
188445	Vlakpan U/S Kriel Block 6 & Matla Collieries On Rietspruit		0.642
1.00E+09	Frischgewaagd D/S Of Kriel Block 6 Colliery @ R545 Road Bridge On Rietspru Uit		0.709
90410	B1h005q01 Olifants River At Wolvekrans	B11F	0.843
189430	Klipplaat At Road Bridge On Tweefonteinspruit		0.851
189428	Tweefontein Upstream Of Tweefontein United Collieries On Tributary Of Tw Weefonteinspruit		0.882
192643	Tweefonteinspruit U/S Kleinkopje		0.882
90480	B4r001q01 Mapochsgronde 500 Js - Tonteldoos Dam On Tonteldoosloop Near Dam Wall	B11G	0.076
90480	B4r001q01 Mapochsgronde 500 Js - Tonteldoos Dam On Tonteldoosloop Near Dam Wall		0.101
188533	Welverdiend Upstream Of Douglas Colliery On Stream On Welverdiend		0.277
192642	U/S Witbank Dam @Witbank Dam - Duvha Road Bridge		0.706
88607	Wolvekrans @ Brune Bridge U/S Duva Power Station D/S Douglas Colliery O On Olifants (Zolwd15)		0.724
188538	Naauwpoort 335 Js Downstream Of Naauwpoort Sewage Works On Noupoortspruit		0.773
90417	B1h019 Naauwpoort 335 Js On Noupoortspruit		0.861
188535	Enkeldebosch U/S Douglas Colliery On Stream On Enkeldebosch		0.927
188537	Witbank Municipal Area @ R 544 Bridge D/S Landau Colliery & U/S Naauwpoort Stw		0.93
88660	Driefontein D/S Middelburg Mine South Section & Douglas Colliery On Boes Smankransspruit		0.931
192638	Us/Witbank Dam		0.955
188531	Wolvenfontein D/S Bank 5 & U/S Bank 2 & Bankfontein Dam On Spookspruit	B11H	0.787
90407	B1h002 At Elandspruit On Spookspruit		0.958

WMS ID	Monitoring Point Name	Quaternary Catchment	95% P
90407	B1h002 At Elandspruit On Spookspruit		0.971
188573	Rietfontein 314 Js D/S Middelburg Mine North Section On Spookspruit		0.986
188195	River View Upstream Of Sewage Works On Olifants	B11J	0.357
191685	Olifants River Olifants U/P Of Riverview Stw East Of Works		0.544
188530	Witbank Municipal Area At R555 Bridge D/S Witbank Dam & Riverview St Tw On Olifants		0.589
90412	B1h010q01 Witbank Dam On Olifants River: Downstream Weir		0.66
90431	B1r001q01 Witbank Dam On Olifants River: Near Dam Wall		0.676
90431	B1r001q01 Witbank Dam On Olifants River: Near Dam Wall		0.686
188539	Schoongezicht Upstream Of Trans Alloys On Brugspruit	B11K	0.456
188540	Schoongezicht Downstream Of Trans Alloys On Brugspruit		0.662
88671	Zbles-Pin Blesboklaagte @ Pine Ridge (Ks3) On Blesbokspruit		0.854
188547	Kwaguqa Witbank @ Bridge To Ferrobank U/S Ferrobank Stw On Brugsprui It Tributary		0.866
185085	Kwaguqa D/S Ferrobank Stw U/S Of Water Treatment Plant On Brugspruit T		0.877
90430	B1h032q01 At Blesbok On Blesbokspruit		0.897
185084	Hartbeestspruit @ Bridge D/S Brugspruit Treatment Plant Klipspruit Stw & Kro Omdraai Mine On Brugspruit		0.898
88684	Zbrug-Dft Brug Spruit At Driefontein - Witbank Mun Area		0.917
90408	B1h004q01 Klip Spruit At Zaaihoek		0.92
88685	Zbrug-Sgz At Schoongezicht (Ks5) On Brugspruit Tributary		0.983
188596	Vlakfontein 179 Is Upstream Kwazamokuhle Sewage Works On Klein-Olifantsrivier	B12A	0.211
188595	Vlakfontein 179 Is @ Road Bridge D/S Kwazamokuhle Stw On Klein-Olifantsrivier		0.543
188399	Bankvalei At Bridge 4043 U/S Kwagga On Tributary Of Klein Olifants Fro Om Schoonoord	B12B	0.172
188400	Bankvalei @ Bridge 3714 U/S Kwagga & Kromdraai Section On Klein Olifan Nts		0.246
188394	Boschmanskop U/S Hendrina Ps & Optimum Colliery On Driefontein Tributary Of Eastern WoestAlleen Spruit		0.298
188404	Driepan U/S Of Optimum On Zevenfonteinspruit		0.362
188396	Hendrina Power Station - Downstream On Hendrina Tributary Of Woes-All Leen Spruit		0.534
188397	Rietkuil @ Bridge 2936 U/S Kwagga D/S Arnot Ps On Rietkuilspruit		0.551
88587	Znrri02 Rietkuil U/S Kwagga & D/S Arnot Ps On Northern Trib Of Rietk Kuilspruit		0.595
191483	Nooitgedacht 493 Js - D/S Of Arnot Wwtw On Unnamed Tributary Of Rietkuilspruit		0.6
192639	Boesmanspruit Dam		0.687
192640	Klein Olifants River & Coetzeerspruit		0.888

WMS ID	Monitoring Point Name	Quaternary Catchment	95% P
90422	B1h024q01 At Optimus Lapa Dam On Eastern Woes-Alleen Spruit		0.917
188392	Woestalleen D/S Of Woestalleen Colliery On Woes-Alleenspruit		0.919
88714	Zcowo01 Woestalleen At R65 Bridge D/S Eikeboom On Coetzerspruit		0.924
188390	Groenfontein U/S Of Middelburg On Goeiehoopspruit	B12C	0.433
188570	Arendsfontein @ R65 Bridge D/S Khanhym Abbatoir & Eikeboom On Arendsfontei Inspruit		0.616
188388	Groenfontein U/S Of Middelburg On Arendsfontein Spruit		0.715
90432	B1r002q01 Middelburg Dam On Klein Olifants River: Near Dam W		0.781
90432	B1r002q01 Middelburg Dam On Klein Olifants River: Near Dam W		0.789
188387	Zaaiplaats U/S Of Middelburg On Klein Olifants		0.896
88506	Zkoha06 Hamelfontein D/S Mines On Klein Olifants		0.915
90413	B1h012q01 At Rondebosch U/S Middelburg On Klein Olifants		0.92
188574	Vaalbank Upstream Of Industrial Activities (Columbus & Mfc) On Vaalba Ankspruit	B12D	0.565
188401	Middelburg @ Meijersbrug D/S Of Vaalbankspruit On Klein Olifants		0.614
188403	Midelburg Industrial Area U/S Of Confluence With Klein Olifants On Vaa Albankspruit		0.629
188386	Middelburg Town + Townlands D/S Of Boskrans Sewage Works On Klein Olifa Ants		0.713
188391	Middelburg Town + Townlands U/S Of Boskrans Sw On Klein Olifants		0.749
90414	B1h015q01 Middelburg Dam On Little Olifants River: Downstream		0.765
90414	B1h015q01 Middelburg Dam On Little Olifants River: Downstream		0.809
188894	S21 Wolvenfontein @ R50 Bridge To Leandra On Bronkhorstspruit Tr Ributary	B20A	0.04
188676	S3 Witklip Midwat Delpark Residential Area On Bronkhorstspruit Tributary		0.081
188779	S15 Middelburg (Leeuspruit) D/S Of Pump Sta & U/S Bronkhorstspru Uit		0.101
188610	S8 Delmas @ Low Water Bridge D/S Delmas Stw On Unnamed Stream From Witklip		0.114
188675	Witklip U/S Delpark Residential Area On Bronkhorstspruit Tributary		0.144
188730	S10 Hekpoort @ N12 D/S Pump Station On Bronkhorstspruit		0.158
189110	S12 Middelburg Upstream Of New Sewage Works On Bronkhorstspruit Tributary		0.17
189111	S13 Middelburg Downstream Of New Sewage Works On Bronkhorstsprui It Tributary		0.192
188652	S9 Middelburg In Well Field A Delmas On Bronkhorstspruit Tri Ibutary		0.197
188608	S1 Witklip @ Witklip Dam		0.208
188678	S4 Witklip U/S Of Delmas Sewage Works On Bronkhorstspruit Tribu Utary @ Stw		0.218
188732	S17 Middelburg (Leeuspruit) Midway Botleng New Extention On Bron Nkhorstspruit Tributary 2		0.42

WMS ID	**Monitoring Point Name**	**Quaternary Catchment**	**95% P**
188729	S14 Middelburg 231 Ir Botleng (Leeuspruit) U/S Pump Station On Bronkhorstspruit Trib 2		0.446
188731	S16 Leeuwpoort (Leeuspruit) @ R42 Upstream Of Botleng New Extent Tion On Bronkhorstspruit Tributary		0.589
90438	B2H008Q01 At Rietvalei On Tributary Of Koffiespruit	B20B	0.174
90439	B2H009Q01 At Olifantsfontein On Koffiespruit		0.181
90437	B2H007Q01 At Waaikraal On Koffiespruit		0.24
90434	B2H004Q01 Os Spruit At Boschkop	B20C	0.155
90436	B2H006Q01 Os Spruit At Witpoort		0.202
90433	B2H003Q01 At Bronkhorstspruit On Bronkhorstspruit	B20D	0.161
90441	B2H014Q01 At Onverwacht On Wilgerivier	B20F	0.495
188188	Eenzaamheid Balmoral At N4 West Of R545 Interchange	B20G	0.14
188542	Elandsfontein 309 Js Upstream Of Elandsfontein Colliery On Grootspruit		0.841
188545	Doornrug @ R104 Bridge D/S Of Highveld Steel On Saalklapspruit		0.852
188541	Hartebeestlaagte 325 Js Downstream Of Elandsfontein Colliery On Grootspruit		0.957
88821	Waschbank D/S Kromdraai Mine On Kromdraaispruit (ZKMWS01)		0.993
188223	B2H016 At Waterval On Wilge River	B20J	0.781
100201	Waterval @ R544 Bridge D/S Bronkhorstspruit Riv & Highveld Steel On W Wilgerivier		0.838
90442	B2H015Q01 At Zusterstroom On Wilgerivier		0.888
90445	B3H003Q01 Elands River At Kameelrivier	B31C	0.053
90460	B3R001Q01 Kliprand 76 Jr - Rust De Winter Dam On Elandsrivier: Near Dam Wall		0.135
90466	B3R005Q01 Rhenosterkop 157 Ir - Rhenosterkop Dam On Elandsrivier: Near Dam Wall		0.101
90457	B3H020Q01 Rhenosterkop Dam On Elands River: Down Stream Weir	B31G	0.075
90458	B3H021Q01 Elands River At Scherp Arabie	B31J	0.311
90462	B3R002Q01 Loskop 81 Js - Loskop Dam On Olifantsrivier: Near Dam Wall	B32A	0.684
90462	B3R002Q01 Loskop 81 Js - Loskop Dam On Olifantsrivier: Near Dam Wall		0.69
90455	B3H017Q01 Loskop Dam On Olifants River: Down Stream Weir	B32C	0.683
88595	Groblersdal At Bridge On Olifantsrivier (Ch13) U/S Of Stw	B32D	0.467
90448	B3H007Q01 Moses River At Uitspanning/Dennilton	B32H	0.149
90448	B3H007Q01 Moses River At Uitspanning/Dennilton		0.205
90444	B3H001Q01 Olifants River At Loskop North	B32J	0.578
193279	Belfast Dam Near Dam Wall	B41A	0.152

WMS ID	Monitoring Point Name	Quaternary Catchment	95% P
1.00E+09	L40 Lakenvlei Spruit At R540 Bridge From Dullstroom To Belfast		0.222
1.00E+09	L42 Steelpoort River At R33 Bridge From Belfast To Stoffburg	B41B	0.167
1.00E+09	L43 Blinkwater River At R33 Bridge From Belfast To Groblersdal		0.225
1.00E+09	L44 Witpoort River At R555 Bridge From Steelpoort To Stoffberg		0.243
90481	B4r002q01 Mapochsgronde 500 Js - Vlugkraal Dam On Vlugkraalrivier: Near Dam Wall	B41C	0.092
1.00E+09	L48 Hoofstadloop River D/S Of Roosenekal Sewage Works		0.093
90481	B4r002q01 Mapochsgronde 500 Js - Vlugkraal Dam On Vlugkraalrivier: Near Dam Wall		0.102
90476	B4h017q01 Vlugkraal Dam On Vlugkraal River: Down Stream Weir		0.103
90475	B4h016q01 Tonteldoos Dam On Tonteldoos River: Down Stream W		0.113
1.00E+09	L49 Hoofstadloop River U/S Roosenekal Sewage Works D/S Of Weir		0.169
90482	B4r003q01 Mapochs Dam On Masala River: Near Dam Wall	B41D	0.109
90477	B4h020q01 Mapochs Dam On Masala River: Down Stream Weir		0.133
193090	B4h024q01 Steelpoort River @ Tigershoek (De Hoop Upper)		0.141
1.00E+09	L31 Mapoch S River At R555 Bridge From Steelpoort To Roosenekal		0.152
90467	B4h003q01 Steelpoort River At Buffelskloof		0.155
190143	De Hoop Upstream Of Proposed Dam Wall On Steelpoort River	B41E	0.139
1.00E+09	L30 Klip River At Bridge R555 Road From Steelpoort To Roosenekal		0.139
190142	Draaikraal 48jt 25km Before Confluence With Steelpoort On Klip River	B41F	0.142
90471	B4h009q01 Dwars River At Dwarsrivier	B41G	0.106
1.00E+09	L32 Dwars River At R577 Bridge D/S Of Two Rivers Mine	B41H	0.089
190160	Steelport Park Downstream Of Proposed Dehoop Dam Wall On Steelpoort River		0.136
192531	L79 Steelpoort River At R555 Bridge D/S Of De Hoop Dam		0.139
1.00E+09	L29 Dwars River At R555 Bridge From Steelpoort To Roosenekal		0.184
1.00E+09	L27 Steelpoort River At R37 Bridge From Burgersfort To Pietersburg	B41J	0.196
1.00E+09	L46 Steelpoort River At Bridge D/S Of Steelpoort Sewage Works		0.243
1.00E+09	L45 Steelpoort River U/S Of Steelpoort Sewage Works		0.247
193091	B4H025Q01 Steelpootr River @ Taung	B41K	0.131
90473	B4H011Q01 Steelpoort River At Alverton		0.159
1.00E+09	L37 Dorps River On R540 Bridge From Lydenburg To Dullstroom	B42A	0.107
1.00E+09	L36 Hoppe River At R540 Bridge From Lydenburg To Dullstroom		0.175

WMS ID	**Monitoring Point Name**	**Quaternary Catchment**	**95% P**
90472	B4H010Q01 At Lydenburg Nature Reserve On Dorpsrivier	B42B	0.028
1.00E+09	L34 Dorps River D/S Of Lydenburg Sewage Works	B42C	0.098
1.00E+09	L35 Dorps River U/S Lydenburg Sewage Works At R37 Bridge		0.16
1.00E+09	L19 Spekboom River On R37 Bridge From Lydenburg To Ohrigstad	B42D	0.221
90470	B4H007Q01 Little Spekboom River At Potloodspruit		0.239
90469	B4H005Q01 Waterval River At Moddersspruit	B42F	0.028
90478	B4H021Q01 Buffelkloof Dam On Waterval River: Down Stream We	B42G	0.105
90483	B4R004Q01 Buffelkloof 382 Kt - Buffelskloof Dam On Watervalrivier: Near Dam Wall		0.108
90483	B4r004q01 Buffelkloof 382 Kt - Buffelskloof Dam On Watervalrivier: Near Dam Wall		0.117
90488	B5r002q01 Arabie 685 Ks - Flag Boshielo (Arabie) Dam On Olifantsrivier: Near Damwall	B51B	0.471
1.00E+09	L22 Olifants River D/S Of Flag Boshielo Dam At Bridge After Weir		0.539
90488	B5R002Q01 Arabie 685 Ks - Flag Boshielo (Arabie) Dam On Olifantsrivier: Near Damwall		0.548
90486	B5H004Q01 Arabie Dam On Olifants River: Down Stream Weir	B51E	0.546
1.00E+09	L21 Ngwaritsi River At Bridge 1km From Apel Cross Towards Flag Boshielo Dam	B51H	0.424
1.00E+09	L24 Olifants River At Brdge From Lebowakgomo To Jane Furse	B52A	0.53
1.00E+09	L23 Lepellane (Mhlaletsi) River At The Bridge At Strydkraal	B52B	0.19
1.00E+09	L20 Tudumo River At Bridge On Road From Lebowakgomo To Tooseng	B52D	0.067
90484	B5h002q01 Olifants River At Zeekoegat	B52G	0.665
1.00E+09	L25 Olifants River At R37 Bridge From Burgersfort To Polokwane (Pietersburg)	B52J	0.47
1.00E+09	L16 Morgenzon River Before Confluence With Blyde River	B60A	0.254
1.00E+09	L17 Blyde River U/S Of Pilgrims Rest Sewage Works D/S Of T.G.M.E		0.305
1.00E+09	L18 Blyde River D/S Of Pilgrims Rest Sewage Works		0.329
90490	B6h003q01 Willemsoord On Treurrivier	B60C	0.042
90490	B6h003q01 Willemsoord On Treurrivier		0.248
192615	L83 Kadishe River Downstream Of Matibidi Hospital	B60D	0.006
192616	L82 Kadishe River Upstream Of Matibidi Hospital		0.013
90489	B6h001q01 Blyde River At Willemsoord		0.25
90498	B6r001q01 Ohrigstaddam Natuurreservaat - Ohrigstaddam On Ohrigstadrivier: Near Dam Wall	B60E	0.075
90498	B6r001q01 Ohrigstaddam Natuurreservaat - Ohrigstaddam On Ohrigstadrivier: Near Dam Wall		0.229
90498	B6r001q01 Ohrigstaddam Natuurreservaat - Ohrigstaddam On Ohrigstadrivier: Near Dam Wall		0.24

WMS ID	**Monitoring Point Name**	**Quaternary Catchment**	**95% P**
90493	B6h006q01 Kranskloof Spruit At Krugerspost	B60F	0.174
90495	B6h011q01 Ohrigstad Dam On Ohrigstad River: Down Stream Weir		0.202
1.00E+09	L15 Ohrigstad River At R36 Bridge From Lydenburg To Ohrigstad		0.21
1.00E+09	L14 Ohrigstad River At R36 Bridge From Ohrigstad To Tzaneen	B60G	0.128
90499	B6r003q01 Blyderivierpoort 595 Kt - Blyderivierspoortdam On Blyderivier: Near Dam Wal	B60H	0.145
90499	B6r003q01 Blyderivierpoort 595 Kt - Blyderivierspoortdam On Blyderivier: Near Dam Wal		0.164
90492	B6h005 Driehoek On Blyderivier	B60J	0.144
90496	B6h014q01 Blyderivierspoort Dam On Blyde River: D/S Flow Se		0.18
90491	B6h004q01 Blyde River At Chester		0.215
1.00E+09	L10 Blyde River At R527 Bridge From Ohrigstad To Hoedspruit		0.221
188281	B6h017 Middlesex On Blyde		0.242
90510	B7h013q01 Mohlapitse River At Mafefes/Horn Gate	B71D	0.066
1.00E+09	L26 Motse River At R37 Bridge From Burgersfort To Pietersburg	B71E	0.054
192537	L56 Olifants River D/S Of Confluence With Motse River At The Pump Station	B71F	0.275
1.00E+09	L13 Tswenyane River 100m Before Confluence With Olifants River	B71G	0.044
1.00E+09	L11 Olifants River U/S Of Confluence With Tswenyane River		0.171
1.00E+09	L1 Olifants River On R36 Bridge From Ohrigstad To Tzaneen	B71H	0.299
90506	B7h009q01 At Finale Liverpool On Olifants River		0.349
1.00E+09	L12 Olifants River D/S Of Confluence With Tswenyane River		0.359
1.00E+09	L2 Makhutswi River At R530 Bridge From The Oaks To Phalaborwa	B72C	0.231
1.00E+09	L8 Olifants River At R40 Road Bridge From Hoedspruit To Mica	B72D	0.262
192539	L55 Olifants River At Lepelle Northern Water Barrage Near Dam Wall		0.335
90503	B7h007q01 At Oxford On Olifants River		0.356
90500	B7h002q01 Ngwabitsi River At Tours	B72E	0.166
90511	B7h014q01 Selati River At Calais	B72G	0.114
90505	B7h008q01 Selati River At Masungarivier/ Selati Ranch	B72H	0.138
90508	B7h010q01 Ngwabitsi River At Harmony		0.159
1.00E+09	L3 Selati River At R530 Road Bridge From Mica To Phalaborwa	B72K	0.147
1.00E+09	L4 Selati River Bridge From Phalaborwa Town To Lepelle N. Barrage		0.509
90518	B7H019Q01 Ga-Selati River At Loole/Foskor		0.591

WMS ID	Monitoring Point Name	Quaternary Catchment	95% P
90521	B7R001Q01 Guernsey 81 Ku - Klaserie (Jan Wassenaar) Dam On Klaserierivier Near Dam Wall	B73A	0.094
1.00E+09	L9 Klaserie River At R40 Bridge From Acornhoek To Klaserie		0.215
90502	B7H004Q01 Klaserie River At Fleur De Lys		0.223
90512	B7H015Q01 Olifants River At Mamba/Kruger National Park	B73C	0.371
90515	B7H017Q01 Olifants River At Balule Rest Camp/Kruger National Park	B73H	0.256
90515	B7H017Q01 Olifants River At Balule Rest Camp/Kruger National Park		0.428
190528	KNP 1 05/08 Kruger National Park 1km Downstream Of Letaba Confluence On Olifants	B73J	0.289

APPENDIX E

FIELD VISIT NOTES: 26 TO 29 JULY 2016

INTEGRATED WATER QUALITY MANAGEMENT PLAN FOR THE OLIFANTS RIVER SYSTEM

SITE VISIT REPORT

26 JULY TO 29 JULY 2016

water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

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APPENDICES

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1. ROUTE TAKEN

A site visit was undertaken in the Olifants Water Management Area during the week of the 26 to 29 July 2016. **Table 45** summarises the route taken over the four days.

Table 45: Route taken

	Depart from:	**Route**	**Overnight at:**
DAY 1	Tzaneen	• R36 towards Politsi/ Duiwelskloof/ Goudsplaas to N1 • Turn right onto R 578 and follow until ***Middle Letaba*** Dam (across Dam wall) • Left at R 81 towards Giyani – go across ***Klein Letaba*** bridge; first right at Shell garage on corner; left at circle, at split keep left, first right, follow to Nsama Dam. • Go back same way across Klein Letaba bridge; • At R 529 (23°20'7.21"S; 30°40'15.20"E) turn left and follow; cross ***Molototsi River***; • Left at ***Groot Letaba*** (23°40'26.64"S; 30°36'33.86"E) and then left immediately across the bridge (23°41'3.67"S; 30°36'39.62"E); • Just after Mahale-A village, turn right (23°40'56.90"S: 30°59'36.54"E) and follow road to R 71, • Turn left to Phalaborwa.	Phalaborwa
DAY 2	Phalaborwa	• From R 71 to Polokwane, turn left onto R40 – will cross the ***Ga-Selati*** just upstream of the mines; • Turn right onto R 526 – will cross the Ga-Selati; • Stay on R 71 and turn left (23°51'53.35"S; 30°23'38.75"E) just before ***Groot Letaba*** River bridge • Left onto R 36; follow and will cross the ***Ngwabitsi River***; • Continue on R36 to T-junction at The Oaks, will cross ***Ga-Selati, Makhutswi and Malomanye Rivers***; • Will cross the ***Olifants*** just before the T-junction; • At T-junction turn right onto R 36; towards the Strydom tunnel; • Follow the road to Lydenburg – on the way will cross the ***Ohrigstad, Spekboom*** and tributary of the ***Dorps Rivers.***	Lydenburg
DAY 3	Lydenburg	• Follow R 37 to Burgersfort • From Burgersfort take R555 past De Hoop Dam • Turn right on R 33 to Loskop • Will cross a tributary of the ***Bloed River*** just below Rooikraal Dam (25°17'25.45"S; 29°39'2.83"E) and more tributaries and the Bloed River further along; • Will cross the ***Olifants*** just before Groblersdal	Loskop
DAY 4	Loskop	From Loskop take the N11 towards Marble Hall; Will cross the ***Moses River*** just before Marble Hall; Stay on the N11 through Marble Hall (take a right onto R 33 and then does a curve back on to N11);	Home

	Depart from:	Route	Overnight at:
		Turn left onto R 573 (***Elands River*** will be on RHS) – (could perhaps first just drive to Eland River bridge (about 1,5 km further) and then turn back); Follow road through Siyabuswa/ Witfontein/ Kwaggafontein; cross the ***Klipspruit***; Turn left at R 544 (25°21'56.96"S; 28°51'51.46"E) – Vlaklaagte Ridge on RHS; pass Gemsbokspruit Village on RHS, will cross several ***Moses River tributaries***; Travel through Verene-C Village staying on R544; cross ***Wilge River*** (25°34'51.68"S; 29° 5'56.38"E) Turn right just after crossing the Wilge River (25°35'9.42"S; 29° 6'9.92"E); Will cross the Wilge again at (25°37'0.25"S; 29° 0'58.73"E); Turn left on to the R25 towards Bronkhorspruit - will cross the ***Bronkhorstpruit River***; Follow the R25 to the N4;	

2. SAMPLES TAKEN

2.1 Monitoring points

Twenty surface water samples were collected at the sites described in Table 46 and sent to the laboratory for the chemical analyses set out below.

Table 46: Sample point identification and description

Sample ID	Description
LET1	At Groot Letaba on R71 at Lesitele
LES1	At gauging weir on Lesitele River: B8H010;
MLD	Middle Letaba Dam
GLET	Groot Letaba at bridge
GSUS	Ga-Selati River on R40
GSD	Ga-Selati downstream at Foskor
Oxford	Olifants River at Three bridges (Oxford weir?)
DL	Dorps River just outside Lydenburg
MS-LYD	Marambane-Schoemans on R 37 near Lydenburg
WV	Watervals River on R37
DR555	Dwars River just after Steelpoort on R555

Sample ID	**Description**
SP1	Steelpoort River DS De Hoop Dam on R 555
MR555	Mapochs River downstream of the Mapochs Mine (currently not operational) on the R555
UR555	Unnamed tributary at Laersdrift just before Stoffberg on R555
BR	Bloed River on R33 before Groblersdal
OLIGD	Olifants River at Groblersdal
Moses	Moses River downstream of Marble Hall on the N11
UNED	Unnmaed (mMameetse River?) on the R 25, tributary of the Moses River at Elandsdoring-A Village
WR544	Wilge River on R544
ZKR104	Zaalklapspruit on R104

The following chemical analyses were undertaken on each of the samples collected.

- pH @25°C
- Temperature
- Electrical Conductivity @25°C (mS/m)
- Total Dissolved Solids
- Dissolved Oxygen
- Alkalinity
- Turbidity
- Ammonia (NH_3)
- Chloride
- Nitrite (NO_2-N)
- Nitrate (NO_3 -N)
- Phosphate (PO_4-P)
- Sulphate
- Total Phosphorus (P)
- Total Kjedahl Nitrogen (N)
- Dissolved Calcium
- Dissolved Magnesium
- Dissolved Potassium
- Dissolved Sodium

Field analysis was done for electrical conductivity (mS/cm), pH and temperature (°C), photos taken and notes made at each of the sites.

3. FIELD RESULTS

The field results for each of the samples are recorded in

Table ***47***. Based on the land use and specific activities at each site, specific constituents of concern are also noted.

Table 47: Field results for samples taken

Sample ID	**Description**	**Notes**	**Potential CoC**	**pH**	**EC (mS/ cm)**	**Temp (°C)**

Sample ID	**Description**	**Notes**	**Potential CoC**	**pH**	**EC (mS/ cm)**	**Temp (°C)**
LET1	At Groot Letaba on R71 at Lesitele	Considerable hyacinth growth upstream of the bridge; Fruit processing plant discharging downstream of the bridge;	Nutrients	-	0.18	17
No sample taken	Nkowankowa WWTW	Very poor condition; overgrown; no chlorination for years; no support from municipality (according to assistant process controller on site); flow meter appeared to be working; considerable seepage at screens;	Nutrients; microbial	-	-	-
LES1	At gauging weir on Lesitele River: B8H010;	Downstream Nkowankowa STW which is in very poor condition; Domestic users came down to the river to do washing (laundry); Cattle drink at same spot;	Microbial; nutrients	7.92	0.27	16.7
No sample taken	Lesitele area	Chicken farms; Irrigation canals; Urban village	Microbial; nutrients; pesticides	-	-	-
No sample taken	Giyani Road	Pesticide use on orchards - trees painted with fungicide? Feedlots just outside Giyani;	Pesticides; nutrients	-	-	-
No sample taken	Road to Middle Letaba Dam – R578	Dry river except for a few ‘puddles’; Community members were washing clothes in the dry river bed; appeared to have dug holes to get to the sub-surface water;	Microbial; nutrients			
MLD	Middle Letaba Dam	Recreational – fishermen present; Evidence of use of dam for traditional purposes;		8.24	0.22	17.5
GLET	Groot Letaba at bridge	Upstream of confluence with Klein Letaba; Sand mining under the bridge – considerable disturbance of river bed and banks Weir but measuring device damaged; Hippo’s upstream of weir	Sediments	8.23	0.38	18.9
GSUS	Ga-Selati River on R40	Downstream of WWTW;		8.01	1.18	18.3

Sample ID	**Description**	**Notes**	**Potential CoC**	**pH**	**EC (mS/ cm)**	**Temp (°C)**
		Upstream Bosveld fertiliser Sand mining downstream of bridge; Some disturbances upstream of the bridge				
No sample taken	Johns Dam	Being cleaned out		-	-	-
GSD	Ga-Selati downstream at Foskor			8.24	2.11	19.4
No sample taken	Gravelotte Road	Murchison Mine	metals		-	-
No sample taken	Ga-Selati at R 40	Dry river bed		-	-	-
No sample taken		Crossed Makhutswi and Malomanye Rivers; dry				
Oxford	Olifants River at Three bridges (Oxford weir?)	Good flow; sample taken from bridge as no access to river ; Game reserves on either side		8.65	0.46	22
No sample taken	Along R 530 to Lydenburg	Followed R530 to Lydenburg – on the way crossed the Ohrigstad (some flow), Considerable irrigation; Spekboom (some flow) and tributary of the Dorps Rivers – no access to get samples; Chrome processing plant just before Lydenburg;	Nutrients; pesticides?	-	-	-
DL	Dorps River just outside Lydenburg	Urban; WWTW?	Nutrients; microbial	8.14	bdl	8.7
MS-LYD	Marambane-Schoemans on R 37 near Lydenburg	Natural		7.98	0.37	9.1
No sample taken	R37 between Lydenburg and Burgersfort	Considerable irrigation	Nutrients; Pesticides?	-	-	-
No	Channel off Waterval	Downstream irrigation area (no	Nutrients;	8.18	0.45	12.3

Sample ID	**Description**	**Notes**	**Potential CoC**	**pH**	**EC (mS/ cm)**	**Temp (°C)**
sample taken	just before Steelpoort turn	sample taken, just field measurements)	Pesticides?			
WV	Watervals River on R37	Downstream irrigation area – citrus, vegetables	Nutrients; Pesticides?	7.83	0.46	11.5
No sample taken	Burgersfort and Steelpoort area	Considerable impacts from mines: chrome, platinum	TDS, Sulphate; metals	-	-	-
DR555	Dwars River just after Steelpoort on R555	Natural area; downstream XX dam and Two Rivers Platinum mine?	TDS, metals	8.4	0.57	14.3
SP1	Steelpoort River DS De Hoop Dam on R 555	Use by locals for domestic purposes – bathing, drinking; Cattle also drinking at the river		8.38	0.24	17.3
MR555	Mapochs River downstream of the Mapochs Mine (currently not operational) on the R555	Mapochs Mine (currently not operational); Considerable turbidity	TDS, turbidity, metals	7.94	0.31	15.3
UR555	Unnamed tributary at Laersdrift just before Stoffberg on R555	Natural area, some cultivation		7.8	0.14	13.1
No sample taken	R33 to Groblersdal	Some cultivation: citrus, mielies; large Game farm area	Nutrients	-	-	-
BR	Bloed River on R33 before Groblersdal	Natural area below farm dam;	Nutrients	7.62	0.53	16.5
OLIGD	Olifants River at Groblersdal	Urban impacts, irrigation, below Loskop Dam; community collecting water for domestic purposes (bathing, laundry); said that they drink the water on occasion	Nutrients, microbial, pesticides?	8.27	0.88	15.5
Moses	Moses River downstream of Marble Hall on the N11	Urban impacts, irrigation	Nutrients, microbial, pesticides?	7.73	0.62	9.5
UNED	Unnmaed (mMameetse River?) on the R 25, tributary of the Moses River at Elandsdoring-A Village	Not flowing much; urban village	Nutrients, microbial,	7.51	0.38	11.2

Sample ID	**Description**	**Notes**	**Potential CoC**	**pH**	**EC (mS/ cm)**	**Temp (°C)**
WR544	Wilge River on R544	Some irrigation, downstream Bronkhorstspruit Dam	Nutrients, microbial,	7.57	0.6	12.9
ZKR104	Zaalklapspruit on R104	Downstream mining, urban villages,	Nutrients, microbial, salinity	7.28	1.19	8.9

Various photographs are included as Appendix A.

4. LABORATORY RESULTS

The laboratory results are included in Table 48. Parameters of concern are highlighted in red.

Table 48: Laboratory results

Parameters	Units	LET 1	LES 1	MLD	GLET	GSUS	GSD	Oxford	DL	MS-LYD	WV	DR555	SP1	MR555	UR555	BR	OLIGD	Moses	UNED	WR544	ZKR104
		26\07\16	26\07\16	26\07\16	26\07\16	27\07\16	27\07\16	27\07\16	28\07\16	28\07\16	28\07\16	28\07\16	28\07\16	28\07\16	28\07\16	28\07\16	28\07\16	29\07\16	29\07\16	29\07\16	29\07\16
pH @25°C		7.3	7.08	7.98	7.91	7.86	8.32	8.47	7.66	7.75	7.95	8.51	8.52	7.92	7.84	7.42	8.53	8.1	7.61	7.35	7.18
Temperature	°C	18.9	19	18.8	18.90	19.00	19.2	19.1	19.8	19.3	19.9	19.5	19.5	19.3	17.5	17.5	19.4	19.1	20.3	19.5	20
EC @25°C	µS/cm	95	213	197.4	335	1047	1975	417	209.6	329	420	483	210.5	266	135.3	432	745	1100	313	538	1000
TDS	mg/l	74.30	169.10	155.60	267.00	836.00	1 556	324	187.8	255	329	386	168.7	209.2	104.2	373	590	868	248	419	772
Dissolved Oxygen	mg/l	7.31	5.25	8.18	8.24	6.58	8.11	7.92	7.22	7.69	7.99	8.42	8.47	7.18	8.6	7.8	8.64	7.73	7.3	7.88	8.42
Alkalinity	mg/l	46	72	106	92	356	370	196	104	132	250	212	126	140	82	64	228	236	154	48	34
Turbidity	NTU	1.9	1.8	8.6	5.2	7.8	3.3	2.9	2.5	8.6	5	4.1	1.1	444	2.7	2.9	1.1	2.4	4.7	1.1	1.3
Ammonia (NH_3)	mg/l	0.02	1.08	0.05	0.05	0.88	0.07	0.02	0.46	0.78	0.01	0.02	<0.02	0.58	0.04	0.05	0.02	0.02	0.05	0.04	<0.02
Chloride	mg/l	20.48	35.04	24.42	27.20	272.79	367.59	44.54	15.60	38.47	22.20	26.50	14.75	18.00	10.00	35.85	45.82	255.70	39.61	35.03	46.03
Nitrite (NO_2-N)	mg/l	0.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.10	0.15	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrate (NO_3 -N)	mg/l	4.57	21.83	2.18	2.75	50.81	10.82	4.85	6.82	22.18	3.16	15.84	1.53	5.11	0.49	2.91	10.62	16.17	0.35	6.53	17.45
Phosphate (PO_4-P)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Sulphate	mg/l	7.15	13.03	7.77	24.59	119.34	1131.25	49.45	12.00	31.19	24.04	44.72	11.84	36.20	4.74	296.66	304.73	498.73	17.95	388.78	521.25
Total Phosphorus (P)	ug/l	68	325	63	43	1548	849	58	125	147	44	46	54	103	50	58	58	54	42	54	55
Total Kjedahl Nitrogen (N)	mg/l	1.5	2.2	1.7	1.5	2.2	1.8	1.7	2	2.4	1.4	2.4	1.3	2.7	2	1.5	1.8	2	1.4	1.8	2.1
Dissolved Calcium	mg/l	6.4	14.3	16	17.6	48.6	105.1	32.7	17.2	25.9	21.4	40.6	26.3	29.1	14.5	39.7	46.5	67.6	29.5	56	122.3
Dissolved Magnesium	mg/l	3.7	7.5	10	11.8	48.3	152.6	26.3	12.9	17.7	34.9	37.7	11.1	17.5	7.3	20.7	47.1	45.7	13.1	23.1	43.8
Dissolved Potassium	mg/l	1.4	2.5	4.9	2.6	10.3	43.5	2.3	1.7	5	3.4	0.7	1.8	1.2	0.9	7	3	6.2	2.8	4.8	11.7
Dissolved Sodium	mg/l	9.2	20.5	16.4	43	142.3	201.6	31.4	8.4	22.3	34	26.8	10.8	14.4	6.7	39.4	77.4	153.2	29.9	34.7	62.4

Table 49: Notes on sites where concerns highlighted

Sample ID	**Description**	**Notes**
LES1	At gauging weir on Lesitele River: B8H010;	This point is downstream of the Nkowankowa WWTW which is in very poor condition and this is confirmed by the elevated ammonia and very high nitrates (22 mg/L) at this point.
GSUS	Ga-Selati River on R40	This site is located approximately 800 m downstream of the tributary to which the WWTW discharges; confirmed by elevated TDS (836 mg/L), extremely high nitrates (50.8 mg/L), ammonia (0.88 mg/L) and chlorides (273 mg/L)
GSD	Ga-Selati downstream at Foskor	This downstream point showing contributions by the mines: elevated TDS (1 556 mg/L); nitrate (11 mg/L) and increased chlorides from the mines (367 mg/L); sulphates (1 131 mg/L).
MS-LYD	Marambane-Schoemans on R 37 near Lydenburg	This site showed very high nitrates (22mg/L); It is unclear where this nitrate is emanating from as there is no evidence of any activity that would be generating such high nitrates.
DR555	Dwars River just after Steelpoort on R555	Downstream Platinum mines – elevated nitrates (16 mg/L) due to blasting;
MR555	Mapochs River downstream of the Mapochs Mine (currently not operational) on the R555	Mapochs Mine (currently not operational); Considerable turbidity – other water chemistry is not very poor.
BR	Bloed River on R33 before Groblersdal	Natural area below farm dam; elevated sulphate (297 mg/L) potentially emanating from upstream fertiliser use;
OLIGD	Olifants River at Groblersdal	Urban impacts, irrigation, below Loskop Dam – still showing impacts from Upper Olifants: sulphates (303 mg/L); Nitrates (11 mg/L); TDS (590 mg/L); slightly elevated chlorides (45 mg/L).
Moses	Moses River downstream of Marble Hall on the N11	Considerable irrigation – google earth shows extensive irrigated areas on this tributary – high chlorides (256 mg/L); sulphates (498 mg/L); nitrates (16.2 mg/L); TDS (868 mg/L); possible use of $CaSO_4$ fertilisers
WR544	Wilge River on R544	Some irrigation– elevated levels of TDS (419 mg/L); sulphate (389 mg/L) and nitrate (6.5 mg/L) – impacts from Upper Olifants mines, Bronkhorstspruit WWTW,
ZKR104	Zaalklapspruit on R104	Upstream mining activities – TDS (772 mg/L); sulphate (521 mg/L0 and nitrates (17.5 mg/L); may also be some impacts from Phola WWTW

APPENDIX A

PHOTOGRAPHS

LET 1: Groot Letaba on R71 at Lesitele

LES1: At gauging weir on Lesitele River: B8H010

MLD: Middle Letaba Dam

GLET: Groot Letaba at bridge

GSUS: Ga-Selati River on R40

GSD: Ga-Selati downstream at Foskor

Oxford: Olifants River at Three bridges (Oxford weir)

DL: Dorps River just outside Lydenburg

MS-LYD: Marambane-Schoemans on R 37 near Lydenburg

WV: Watervals River on R37

DR555: Dwars River just after Steelpoort on R555

SP1: Steelpoort River DS De Hoop Dam on R 555

MR555: Mapochs River downstream of the Mapochs Mine (currently not operational) on the R555

UR555: Unnamed tributary at Laersdrift just before Stoffberg on R555

BR: Bloed River on R33 before Groblersdal

OLIGD: Olifants River at Groblersdal

Moses: Moses River downstream of Marble Hall on the N11

UNED: Unnamed (mMameetse River?) on the R 25, tributary of the Moses River at Elandsdoring-A Village

R544: Wilge River on R544

ZKR104 Zaalklapspruit on R104

APPENDIX F
PSC 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 G
BROADER STAKEHOLDERS

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
Johann van Aswegen	DWS, Planning and technical support
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