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DEVELOPMENT OF A RECONCILIATION STRATEGY FOR THE OLIFANTS RIVER WATER SUPPLY SYSTEM

WP10197

Environmental Screening Report

Original

FINAL REPORT
December 2011

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Report no.: P WMA 04/B50/00/8310/12

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LIST OF REPORTS

Glossary of Terms

Allocatable Water
Water available to allocate for consumptive use.

Acid Mine Drainage
Polluted and acidic water decanting from mines and reaching the resource supply system.

Environmental Water Requirement
The quantity, quality and seasonal patterns of water needed to maintain aquatic ecosystems within a particular ecological condition (management category), excluding operational and management considerations.

Eutrophic
Ecology lacking oxygen: used to describe a body of water whose oxygen content is depleted by organic nutrients (eutrophication).

Existing Lawful Use
An existing lawful water use means a water use which has taking place at any time during a period of two years immediately before the date of commencement of the Natural Water Act or which has been declared an existing lawful water use under Section 33 of the National Water Act.

Fatal flaw
An environmental or social negative impact that is not possible to mitigate and significant enough to prevent the scheme from being able to be implemented.

Hypertrophic indicates a water body that is extremely eutrophic.

Integrated Water Resource Management (IWRM) Objectives
The objectives and priorities for water resource management, for a given time frame, which have been agreed by the parties as those which will best support the agreed socio economic development plans for the basin.

Internal Strategic Perspective
A DWA status quo report of the catchment outlining the current situation and how the catchment will be managed in the interim until a Catchment Management Strategy of a CMA is established.

IWRM Plans
A set of agreed activities with expected outcomes, time frames, responsibilities and resource requirements that underpin the objectives of IWRM.

Level of Assurance
The probability that water will be supplied without any curtailments. The opposite of Level of Assurance is the risk of failure.

Oligotrophic
Nutrient poor and oxygen rich, i.e. containing very little plant life and nutrients in its water, but rich in dissolved oxygen.

Red flag issue
A negative impact that, although significant, could be mitigated, but warrants special attention in the consideration of scheme alternatives.

Reserve
The Reserve is that portion of the natural flow that has to be available in a river or stream in order to sustain the aquatic ecology, and also to provide for basic human needs, in order to comply to Sections 16, 17 and 18 of the National Water Act (NWA), Act 36 of 1998. The Reserve is not a steady flow, but is a variable flow that mimics natural variations in flows in the river. The quantity that is required takes into account "normal" conditions, as well as drought conditions.

Resource Classification
A process of determining the management class of resources by achieving a balance between the Reserve needs and the beneficial use of the resources.

Validation and Verification
Validation is the process for verifying that the water use registrations on the Water Authorisation and Registration Management System (WARMS) were correctly done, and, Verification is the process for verifying that the water uses, registered in WARMS and in other data sources are lawful.

Diffuse irrigators
Irrigators who are not scheduled under any one of the Irrigation Boards or Water User Associations and who take their water directly from a river, i.e. from the run-of-river flows or from a farm dam in that particular river.

List of Abbreviations & Acronyms

AEC	Alternative Ecological Category
AMD	Acid Mine Drainage
ARC	Agricultural Research Council
BHN	Basic Human Needs
CMA	Catchment Management Agency
DDP	Dams and Development Project
DM	District Municipality
DMR	Department of Mineral Resources
DWA	Department of Water Affairs
EC	Ecological Category
E.Cond	Electrical Conductivity
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMF	Environmental Management Framework
ER	Ecological Reserve
EWR	Ecological Water Requirements (Ecological Component of the Reserve)
GRDM	Groundwater Resource Determination Management
GWW	Government Water Works
IB	Irrigation Board
IAP	Invasive Alien Plants (vegetation)
IDP	Integrated Development Plan
ISP	Internal Strategic Perspective
IWRM	Integrated Water Resources Management
KNP	Kruger National Park
LHWP	Lesotho Highlands Water Project
MAR	Mean Annual Runoff
MBCP	Mpumalanga Biodiversity Conservation Plan
MPRDA	Mineral and Petroleum Resources Development Act
MY	Million Years Ago
NEMA	National Environmental Management Act (107 of 1998)
NFSD	National Framework for Sustainable Development
NHRA	National Heritage Resources Act
NPV	Nett Present Value
NSBA	National Spatial Biodiversity Assessment
NWA	National Water Act (Act 36 of 1998)
NWRS	National Water Resource Strategy
OLEMF	Olifants Letaba Environmental Management Framework
OWAAS	Olifants Water Assessment and Availability Study
PES	Present Ecological State
REC	Recommended Ecological Category
SADC	Southern African Development Community
SDF	Strategic Development Framework
UN	United Nations
URV	Unit Reference Value
VEC	Valued Environmental Component
VRESAP	Vaal River Eastern Sub-system Augmentation Project
WCDM	Water Conservation Demand Management
WC	Water Conservation

WCD	World Commission on Dams
WDM	Water Demand Management
WMA	Water Management Area
WRC	Water Research Commission
WUA	Water User Association
WWTW	Waste Water Treatment Works

EXECUTIVE SUMMARY

The water requirements in the Olifants Water Management Area (WMA) and the adjacent areas of Polokwane and Mokopane, which are supplied from the Olifants, have increased substantially over the last number of years due to increased water use in a range of sectors, e.g. power generation, mining, the steel industry, urban development, eco-tourism and agriculture.

A reconciliation strategy, aimed at alleviating the current water deficits and at ensuring a sustainable water supply for the foreseeable future, is required for the basin and its water users.

The environmental screening focused on the possible schemes considered in the strategy and aims to:

- *summarise any key environmental or social issues that should be taken in account when considering and comparing options;*
- *identify any environmental or social "fatal flaws" or "red flags" associated with any of the projects; and*
- *identify environmental authorisations that will be required for any of the projects.*

The assessment is based on available documented information, and no site visits, field work or additional data collections were undertaken to verify or update the available information. Implementation of the Reserve (surface water, groundwater and water quality aspects) during construction and operational phases is assumed to be a condition of any proposed scheme. It is assumed that this will ensure that the aquatic ecology and requirements for basic human needs are adequately provided for and protected.

The most well-known conservation area is the Kruger National Park (KNP) located in the Lower Olifants sub-area of the Olifants WMA. There are two centres of endemism within the Olifants WMA: namely the Sekhukhuneland, and Wolkberg Centres of Endemism. These areas contain high levels of diversity with many species restricted entirely to these areas. As such they are of high priority in terms of conservation. The high biodiversity and the many unique plant species restricted to these areas means that they are particularly vulnerable.

The following reconciliation options were considered during the study:

- ***Reconciliation options that can reduce water requirements***
  - *Eliminating unlawful water use*
  - *Water Conservation and Water Demand Management (WC/WDM) in the irrigation sector*
  - *WC/WDM in the domestic water use sector*
  - *WC/WDM in the mining sector*
  - *Reducing assurances of supply*
  - *Compulsory licensing*
  - *Water trading*

- ***Reconciliation options that can increase water supply***
  - *Removal of invasive alien plants (IAPs)*

- *Refinements to System operating rules*
- *Rainfall enhancement through Cloud Seeding*
- *Groundwater development*
- *Water Transfers*
  - *Transferring treated effluent from the East Rand*
  - *Transferring more water from Vaal Dam*
  - *Water transfer from the Crocodile (West) River System*
- *Dam Options*
  - *Raising of the Blyderivierspoort Dam*
  - *New dam downstream of Rooipoort*
  - *New dam on the farm Godwinton in the Olifants River Gorge*
  - *New dam on the farm Chedle in the Olifants River Gorge*
  - *New dam on the farm Epsom in the Lower Olifants River*
  - *New dam on the farm Mica in the Lower Olifants River*
  - *New dam on the farm Madrid in the Lower Olifants River*
- *Utilising the acid mine drainage (AMD) in the Upper Olifants*
- *Desalination and transfer of seawater*

The strategy recommends the following options for implementation:

- *Water Conservation and Water Demand Management in all sectors;*
- *Reducing unlawful water use;*
- *Removal of Invasive Alien Plants;*
- *Development of Groundwater Schemes; and*
- *Treatment of decanting water from the coal mines in the Witbank Dam and Middelburg Dam Catchments.*

A water balance is achieved with the selected reconciliation options applied.

The Strategy encourages groundwater development in unstressed aquifers and the investigation of a regional water scheme with the Malmani dolomites as resource is recommended. Potential impacts on adjacent groundwater using landowners, surface flow and riverine ecology and groundwater dependent ecosystems could potentially be affected by groundwater development if it is not implemented sustainably.

The construction of bulk water supply infrastructure such as dams and pipelines with require environmental authorisation for which an environmental impact assessment process that includes a public participation process will have to be undertaken.

Any water transfers into the catchment will impact on the receiving streams due to an increase the flow and loss of natural variability will consequent ecological affects. Organisms from the donor catchment may also inevitably be transferred with the water.

The use of treated acid mine drainage can increase the system yield and improve the water quality. No significant impacts are expected.

Transferring treated effluent from the East Rand will require right of access and aquaduct servitudes and may result in water quality problems.

Transferring additional water from the Vaal Dam will also require servitudes for a pipeline and application of the Vaal River tariff will result in a high water price.

The raising of the Blyderivierspoort Dam or construction of any of the possible five new large dams identified will have potentially significant social and ecological impacts which will require a full environmental and social impact assessment and to which the hierarchy of mitigation measures (enhance, avoid, reduce, restore compensate, offset) will have to be applied.

Rainfall enhancement could increase the size and frequency of floods.

In addition to the small increase on utilisable yield from removal of invasive alien vegetation, this option will have a positive impact on biodiversity.

No fatal flaws have been identified for any of the options considered. The construction of large dams is expected to have the greatest ecological and social impacts.

Table of Contents

List of Tables

List of Figures

1 INTRODUCTION

1.1. BACKGROUND TO THE RECONCILIATION STRATEGY STUDY

The water requirements in the Olifants Water Management Area (WMA) and the adjacent areas of Polokwane and Mokopane, which are supplied from the Olifants, have increased substantially over the last number of years due to increased water use in a range of sectors, e.g. power generation, mining, the steel industry, urban development, eco-tourism and agriculture.

The Olifants River Catchment is currently perceived to be one of South Africa's most stressed catchments as far as water quantity and water quality is concerned.

A reconciliation strategy, aimed at alleviating the current water deficits and at ensuring a sustainable water supply for the foreseeable future, is required for the basin and its water users.

1.2. PURPOSE OF THE STUDY

The objective of this study is to develop a strategy that will set out a course of action to ensure adequate and sustainable reconciliation of future water requirements in the study area for at least 25 years. This study will:

- Investigate future water requirements scenarios for the Olifants WMA and adjacent supply areas of Polokwane and Mokopane;
- Investigate possible water conservation and water demand management (WC/WDM) interventions, groundwater interventions, re-use of treated effluent, and possible future surface water resource development options;
- Investigate possible scenarios for reconciling the requirements for water with the available resources; and
- Providing recommendations for development and implementation of interventions and actions required.

1.3. PURPOSE OF THIS REPORT

The purpose of this report is to present the results of the environmental screening of each of the schemes under investigation in order to:

- summarise any key environmental or social issues that should be taken in account when considering and comparing options;
- identify any environmental or social "fatal flaws" or "red flags" associated with any of the projects; and
- identify environmental authorisations that will be required for any of the projects.

A "fatal flaw" is an environmental or social negative impact that is not possible to mitigate and significant enough to prevent the scheme from being able to be implemented. A "red flag issue" is a negative impact that, although significant, could be mitigated, but warrants special attention in the consideration of scheme alternatives.

The screening exercise has been undertaken in the context of the existing Integrated Development Plans (IDPs), Strategic Development Frameworks (SDFs), as well as the Olifants Letaba Environmental Management Framework (OLEMF), and previous studies and investigations undertaken by the Department of Water Affairs (DWA) including the State of the Rivers reports, and the World Commission on Dams reports.

1.4. ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations apply to this assessment:

- The assessment is based on available documented information, and no site visits, field work or additional data collections were undertaken to verify or update the available information.
- Implementation of the Reserve (surface water, groundwater and water quality aspects) during construction and operational phases is assumed to be a condition of any proposed scheme. It is assumed that this will ensure that the aquatic ecology and requirements for basic human needs are adequately provided for and protected.
- The identification of environmental authorisations required is undertaken to provide an indication of the order of magnitude of assessment (e.g. Basic Assessment or Scoping and Environmental Impact Assessment), that will be required to implement the various options. It does not serve as a formal legal review of all requirements.

2 DESCRIPTION OF THE STUDY AREA

2.1. LOCALITY

The study area consists of the Olifants River Catchment and its immediate supply zones, *i.e*. the urban areas of Polokwane and Mokopane (**Figure 2.1**). The Olifants River System originates just within and east of Gauteng Province and the main stem flows in a northerly direction. Beyond Flag Boshielo Dam it changes direction eastwards, enters the Kruger National Park near Phalaborwa and flows further east, joining with the Letaba River and then Moçambique. The Massingir Dam is just beyond the border in Moçambique. Further downstream the Olifants River joins the Limpopo River. The size of the whole Olifants WMA in South Africa is 54 570 m^2.

The study area falls within three provinces, namely Gauteng, Mpumalanga and Limpopo.

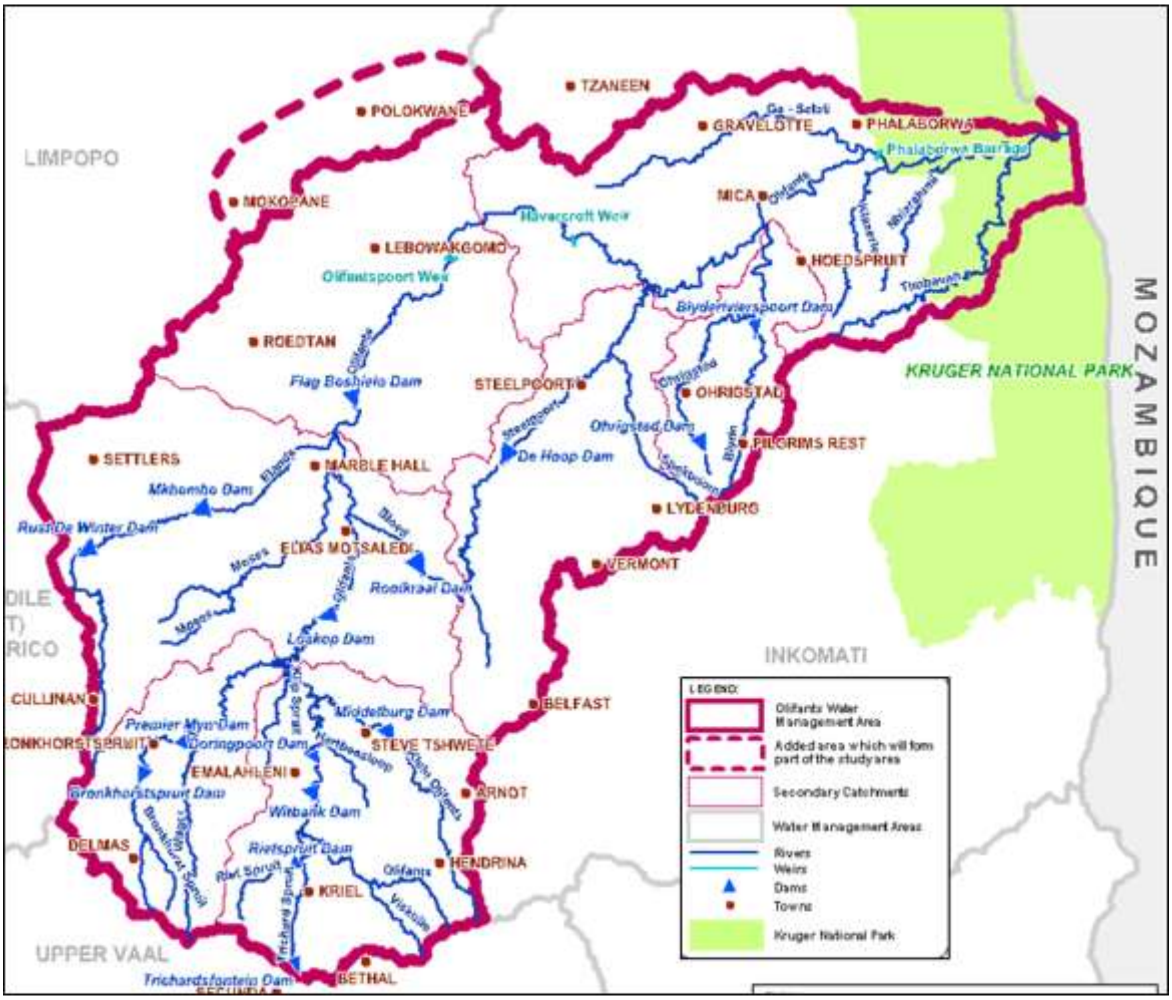


Figure 2.1: Study area

The draft Environmental Management Framework (EMF) identifies several environmental management zones within the Olifants WMA (see **Figure 2.2**) and the strategic Environmental Management Plan (EMP) provides guidelines for each zone.

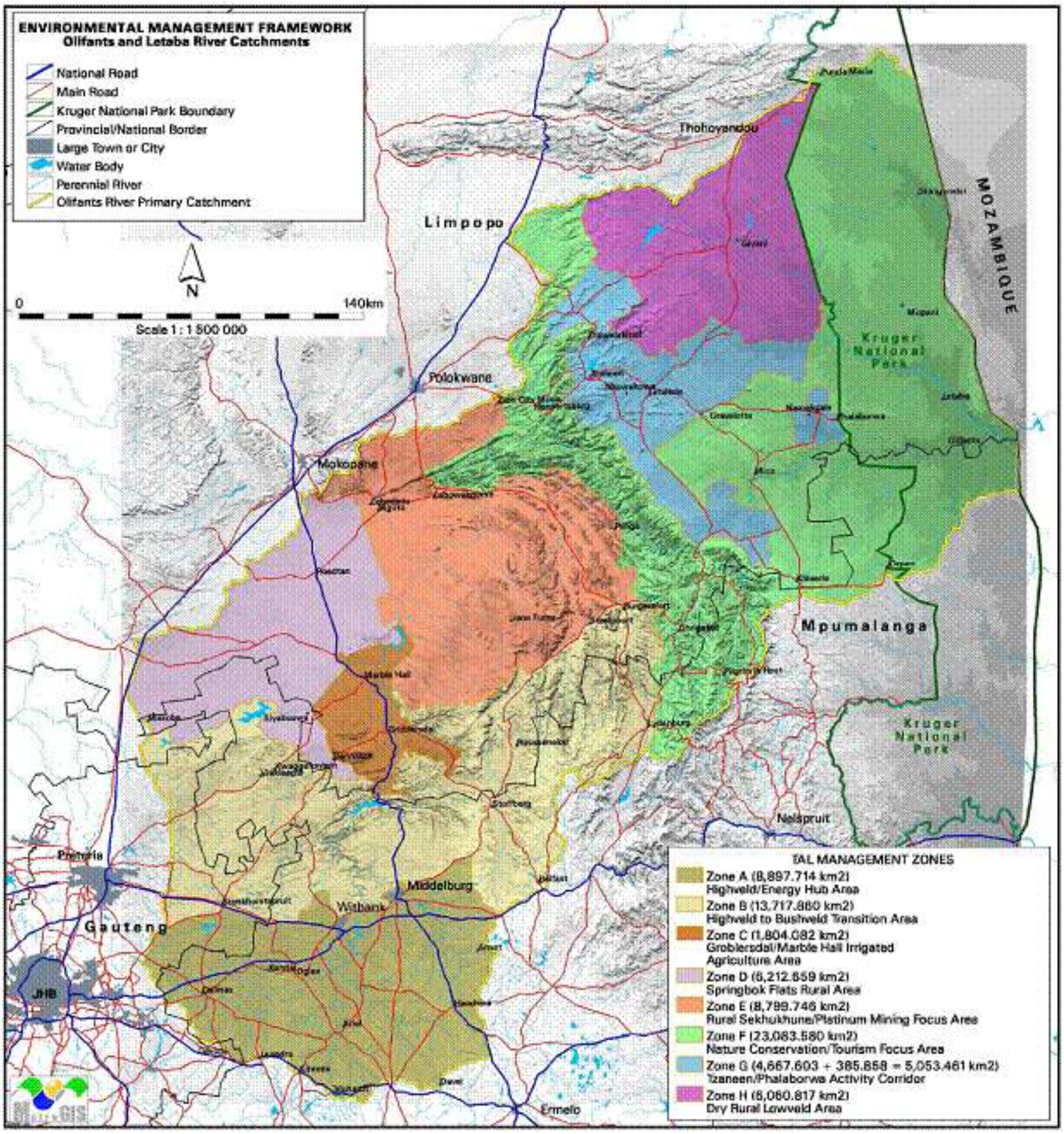


Figure 2.2: Environmental Management Zones in the Olifants Letaba catchments (source: DEA, 2009)

2.2. GEOLOGY

This section was adapted from the OLEMF. The geology of the study area is widely varied. The area contains exposed rocks from the early Precambrian Era 4600 million years ago (MY) all the way through to the Cenozoic Era 1.65 MY. It contains three of the basic rock types, namely sedimentary, igneous and metamorphic.

Archaean Granite and Gneiss Basal Complex is the oldest exposed rock formations in the area. This igneous rock was formed around 4600 MY to 2500 MY. It forms the basement rock complex for other rock systems. It occurs in the extreme east Lowveld part of the study area and consist mainly of old Granite and Gneis formations and primitive groups of schistose[1] rocks. The most important economic potential lies in the mining of granite and gneiss for use as polished stone and the occurrence of gold and other minerals in the greenstone lavas.

The Transvaal Sequence was formed around 2400 MY to 1800 MY. It consists of sedimentary rock laid down in a basin. It consists of the so-called Pretoria Series (after its typical form in the Pretoria area) composed of three quartzite layers (Timeball Hill, Daspoort and Magalies) with intervening shales and lavas. It forms the mountains of Sekhukuneland (eastern Bankenveld) at the edge of the Bushveld Basin as well as the bold escarpment of the Transvaal Drakensberg consisting of Black Reef Quartzite where the dramatic change in topography gives rise to dramatic scenic views and vistas.

The Bushveld Igneous Complex was formed in a series of magma surges around 2100 MY to 1800 MY. It is spread over the central part of the Transvaal basin. The area contains Red Granites and the Rooiberg Series in the central parts, as well as Norite in the east. The Bushveld Igneous Complex contains important minerals such as large quantities of platinum, small quantities of gold and silver and a variety of base metals.

The rocks of the Soutpansberg Group and Waterberg Basin were formed around 1800 MY. They are composed mostly of sedimentary rocks but may have intrusive volcanic rocks in places.

The Karoo Sequence was formed around 400 MY to 120 MY. It consists mainly of sedimentary rocks deposited horizontally in a vast basin, with a few satellite basins to the north. It is a relatively young plateau system that is in the slow process of being removed by erosion from the sub-Karoo surface. The Karoo Sequence contains bands of coal within the central sedimentary layers.

Alluvial deposits in the area have been formed as recently as 65 MY. They consist of sand created by the weathering of older rocks. The composition of these small loose grains varies depending on the source of rock.

2.3. LANDSCAPE, CLIMATE AND RAINFALL

The study area is large and the topography across the area is very varied. The topographical information correlates closely with the geological information. The area contains the Highveld, which is composed of undulating plains and pans, and a large open flat area, referred to as the Springbok Flats. These areas are divided from the Lowveld by the escarpment, which consists of various hills and mountain terrain. The Lowveld consists mainly of plains and undulating plains.

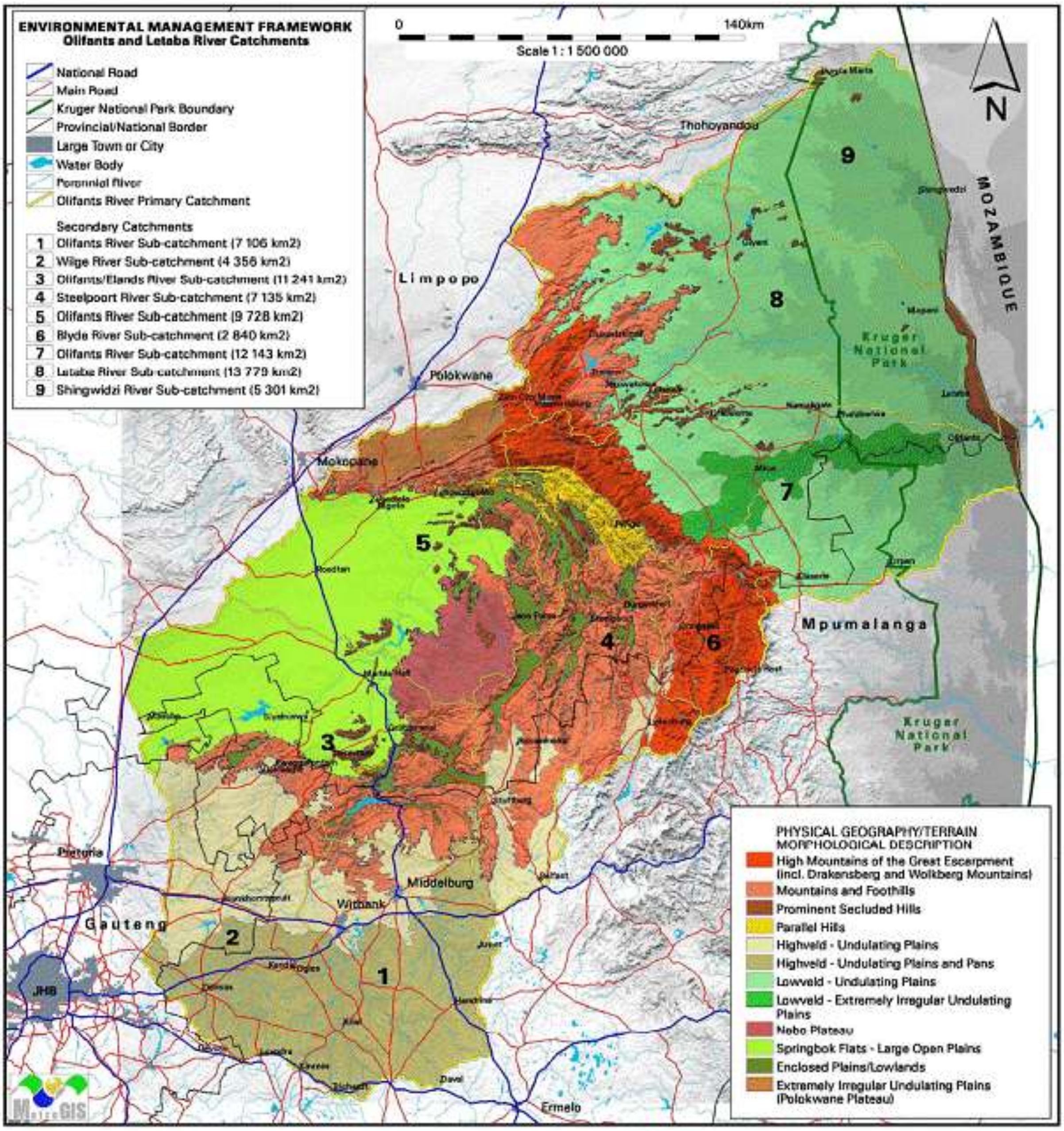


Figure 2.3: Physical geography / terrain morphological description (source: DEA, 2009)

The study area falls across four climatic regions, which include:

- The Highveld, with moderate maximum temperatures and cold winter nights, with severe frost occurring regularly;
- the Bushveld, with high maximum temperatures and cool winter nights without severe frost occurring;
- the escarpment, which partly lies in the mist belt, with moderate maximum temperatures and cool winter nights; and
- the eastern Lowveld with a hot sub-tropical climate.

The whole study area falls within the summer rainfall region. The mean annual precipitation within the study area varies greatly:

- Dry areas with 325 mm/annum to 550 mm/annum occur in parts of Sekhukhune and the northern parts of the eastern Lowveld;

- In the Highveld region and the southern part of the eastern Lowveld the rainfall varies between 550 mm/annum to 750 mm/annum;
- The escarpment receives a higher rainfall of between 750 mm/annum to 1000 mm/annum; and
- The Wolkberg area receives an annual rainfall exceeding 1 000mm/annum.

2.4. CONSERVATION AREAS

There are a number of ecologically important areas within the Olifants WMA and various conservation areas have been proclaimed (**Figure 2.4**) in the WMA (DWAF, 2004a):

- Blyde River Canyon Reserve;
- Klaserie Game Reserve;
- Thorny Bush Game Reserve;
- Umbabat Nature Reserve;
- Timbavati Nature Reserve;
- Wolkberg Wilderness Area;
- The Dawns Nature Reserve;
- Selati Game Reserve;
- Mount Sheba Game Reserve;
- Sterkspruit Nature Reserve;
- Lydenburg Nature Reserve;
- Gustav Klingbiel Nature Reserve;
- Ohrigstad Dam Nature Reserve, and
- Loskop Dam Nature Reserve.

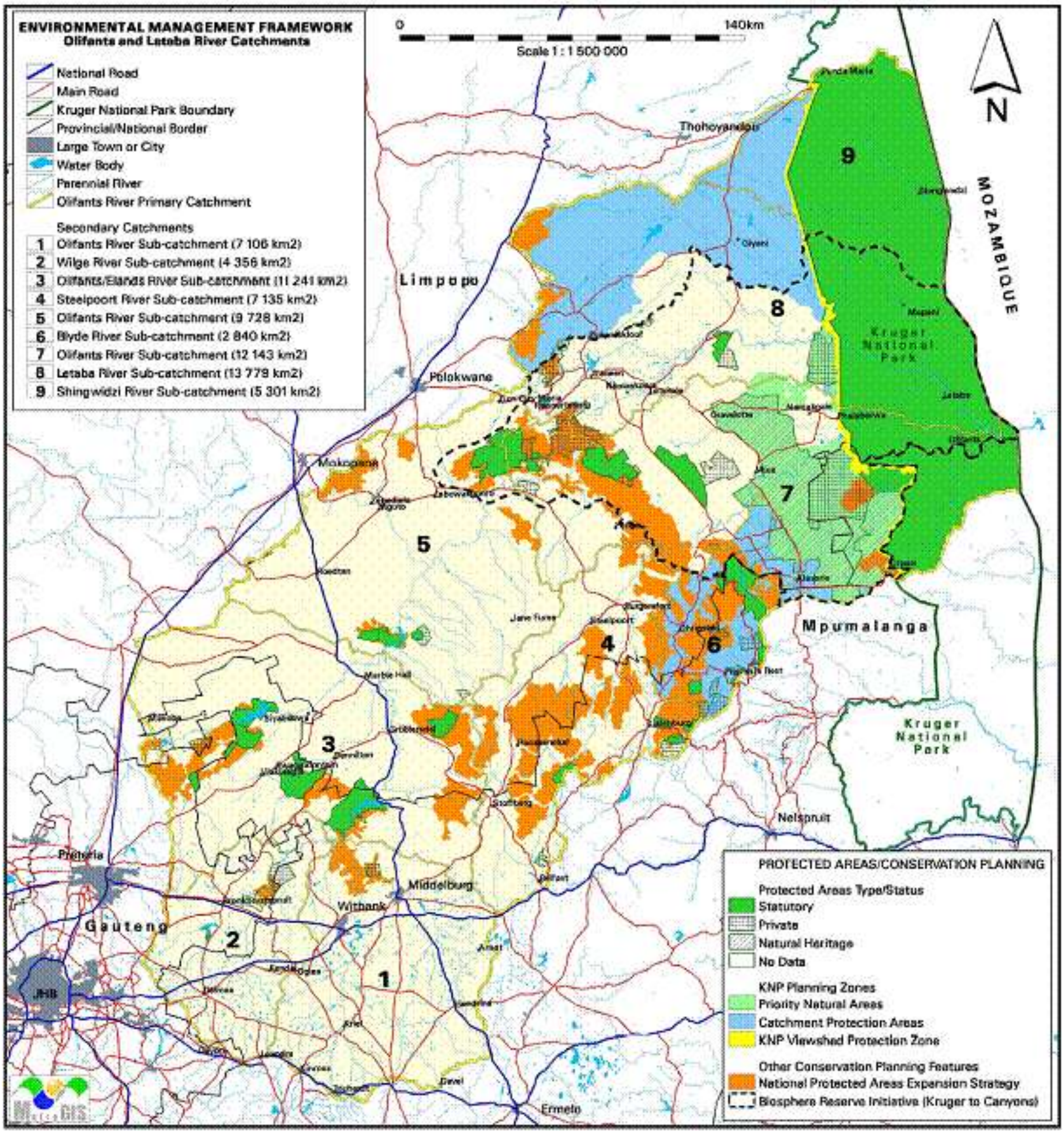


Figure 2.4: Protected areas and conservation planning (DEA, 2009)

The most well-known conservation area is the Kruger National Park (KNP) located in the Lower Olifants sub-area of the Olifants WMA. The Kruger to Canyons Biosphere reserve falls within the study area (**Figure 2.5**). There are other ecologically important areas in the WMA, which have not been proclaimed as conservancy areas. These include the Mohlapitse River, which was identified during the ecological Reserve determination study as an ecologically important area due to the numerous cool mountain streams that join the Olifants River. The mix of hot and cold waters provides habitat with a high diversity and numerous red data and endemic fish species and frogs occur in these environments. The Mohlapitse River also has several wetlands. It is important to maintain the status quo as far as flow and water quality regimes are concerned in this area of the WMA.

There are also numerous pans and wetlands located in the Upper Olifants Sub-area. Many of these pans and wetlands are under threat by mining. This is due to undermining, mining through or the use of the pans for the storage and evaporation of saline mine water.

There are also numerous gorges. The more important gorges are located upstream of the Mozambique border in the Kruger National Park; in the transition from the Highveld to the Lowveld; and upstream of Loskop Dam.

There are two centres of endemism (**Figure 2.5**) within the Olifants WMA: namely the Sekhukhuneland, and Wolkberg Centres of Endemism. The Sekhukhuneland Centre of Endemism is entirely within the catchment while approximately half of the Wolkberg Centre of Endemism is within the catchment. These Centres of Endemism contain high levels of diversity with many species restricted entirely to these areas. As such they are of high priority in terms of conservation. The high biodiversity and the many unique plant species restricted to these areas means that they are particularly vulnerable.

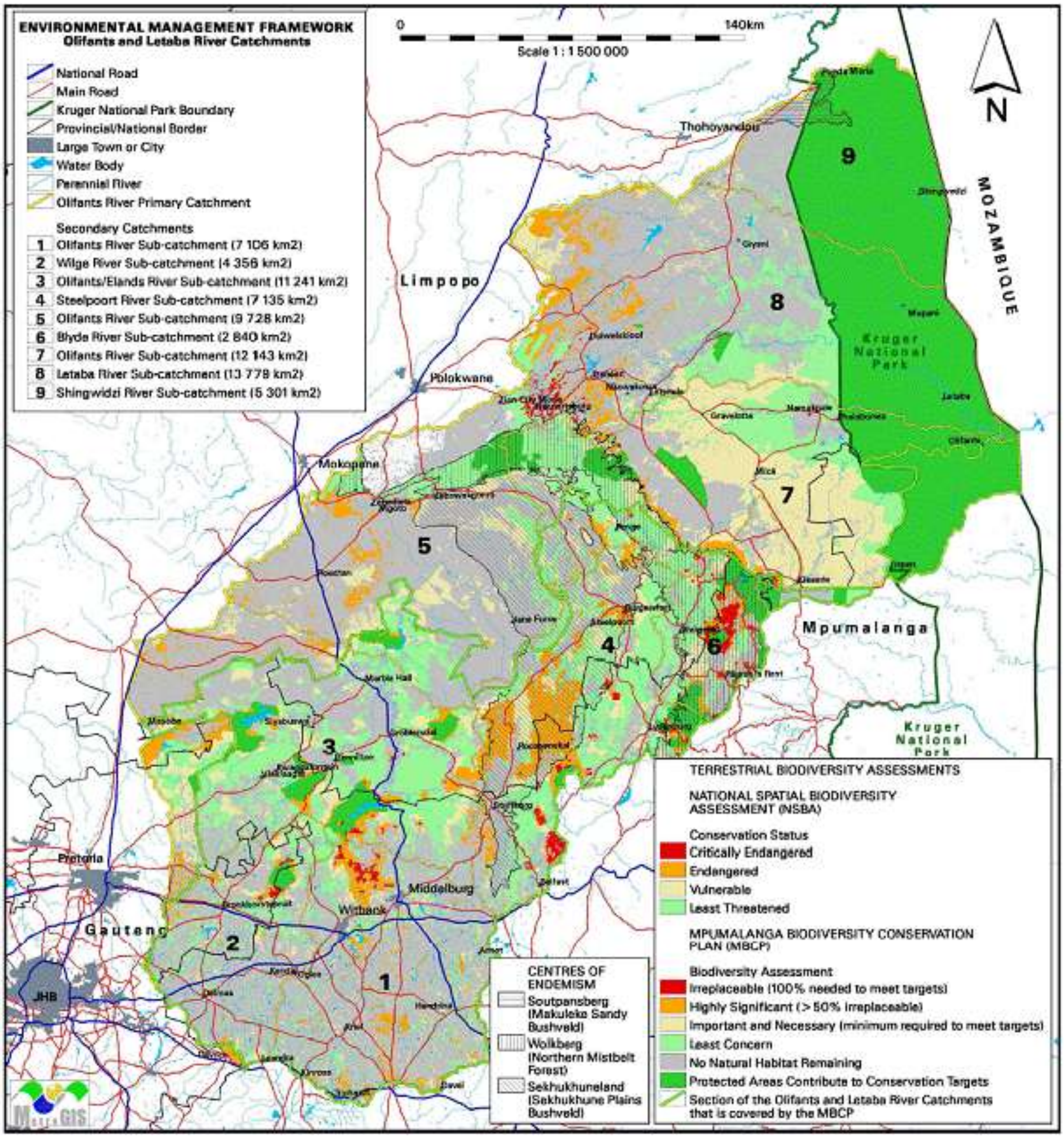


Figure 2.5: Threatened Ecosystems (source: DEAT, 2009)

The **Wolkberg Centre** is extremely rich floristically. More than 40 species endemic/near endemic to the dolomites and more than 90 to the quartz- and shale-derived substrates occur in the area. These figures are conservative, with more taxa likely to be added as knowledge of the flora improves.

The three families with the largest number of endemics on the quartzitic and related rock types are the Asteraceae, Iridaceae and Liliaceae. The asteraceous genus *Helichrysum,* with 10 species being the most prolific in producing endemics. *Gladiolus* has more than ten species endemic to the region as a whole. The Liliaceae is the family with the largest number of dolomite endemics to the region as a whole, followed by the Euphorbiaceae, Lamiaceae and Acanthaceae. For mosses, the Wolkberg Centre is one of the main southern African centres of diversity and a secondary centre of endemism.

Significantly, nearly all the endemics (notably the quartzitic ones) are grassland species. Most of the taxa endemic to the Wolkberg Centre appear to be palaeoendemics. The Wolkberg Centre, especially the arid dolomite areas, shares many species with the adjacent Sekhukhuneland Centre, several of which are endemic to the combined region.

The vegetation of the **Sekhukhuneland Centre** has never been studied in detail. It is usually mapped as Mixed Bushveld. However, floristically the bushveld of Sekhukhuneland Centre is quite unique and certainly deserves recognition as a separate type. The *Kirkia wilmsii*, a species that is relatively rare in other parts of the Mixed Bushveld is a characteristic tree of this area. Vegetation differences between the north- and south-facing aspects of the mountains are often striking. Intriguing vegetation anomalies associated with heavily eroded soils are present throughout the region.

The flora of the Sekhukhuneland Centre is still poorly known, with many apparently endemic species awaiting formal description. Families particularly rich in Sekhukhuneland Centre endemics include the Anacardiaceae, Euphorbiaceae, Liliaceae, Lamiaceae and Vitaceae. A still-to-be-described monoptypic genus of the Alliaceae is endemic also. The area around Burgersfort is reputed to have the highest concentration of *Aloe* species in the world. The Leolo Mountains harbour relic patches of Afromontane Forest, Fynbos-type vegetation and several Sekhukhuneland Centre endemics. There are also some rare wetlands in the summit area.

2.5. AQUATIC ECOLOGY

The following section was adapted from extractions from the State of the Rivers Reports for the Olifants and Letaba River Systems.

The upper reaches of the Olifants River Catchment are characterised mainly by mining and agricultural activities. Over-grazing and highly erodable soils result in such severe erosion, in parts of the middle section that, after heavy rains the Olifants River has a red-brown colour from all the suspended sediments.

- The Steelpoort River is in a fair to unacceptable ecological state;
- overgrazing, and dryland cultivation throughout the area surrounding the Spekboom, Steelpoort, Beetgekraal, and Waterval Rivers including within the riparian zone, leads to erosion, which causes high silt levels in the rivers;
- high silt levels in the aforementioned rivers, increases the risk of flooding and leads to the smothering of in-stream habitats and fish gills resulting in loss of invertebrate and fish species;
- runoff from mines and other activities lowers the water quality in the Steelpoort River;
- on the Olifants River the riparian vegetation is overgrazed and over utilised. As a result, riverbanks are collapsing due to erosion and sedimentation occurs in the riverbed;
- downstream of the Rust de Winter Dam, on the Elands River, flow is extremely regulated with very infrequent releases which has a severe impact on in-stream biota because the river is often dry;

- artificial flow regimes in the Elands River caused by ecologically insensitive releases of water from the Rhenosterkop Dam change the riverbed, causes erosion and results in undesirable habitat conditions for in-stream biological communities;
- the Olifants River, upstream of the Flag Boshielo, is impacted by agricultural activities, runoff from commercial agricultural areas contains agro-chemicals, which cause eutrophication or contamination of water, either of which can impair the health of invertebrates and fish;
- riparian vegetation on both the Elands River and the Olifants River is in a very degraded state due to overgrazing and over utilization and as a result, riverbanks are collapsing due to erosion, and sedimentation occurs in the riverbed;
- alien vegetation along the banks of the Olifants and Elands River include Eucalypts (*Eucalyptus spp*.) Sesbania (*Sesbania punicea*) and Seringa (*Melia azedarach*);
- mining, predominantly for coal, and other industrial activities around the Wilge, Bronkhorstspruit, Klein Olifants and Olifants Rivers are the main contributors to poor in-stream and riparian habitat conditions where acid leachate from mines is a primary contributor to poor water quality and instream conditions;
- in some parts around the above mentioned rivers, access roads, mostly related to mining and industrial activities, have resulted in severe disturbance of riparian habitats, and increased erosion of both land and riverbed;
- the riparian vegetation around the Wilge, Bronkhorstspruit, Klein Olifants and Olifants Rivers is under pressure from overgrazing in some parts, and alien plants such as wattles that occur within the riparian zone, competing with indigenous vegetation and reducing available water;
- water quality in the Olifants River is negatively impacted by the high acidity and high concentrations of dissolved salts in some of the tributaries, especially the Klip River;
- the Klipspruit receives mine effluent and a long term management plan will be required to cope with the problem, because contaminant loads inherited from mining activities are likely to persist for many years;
- intensive irrigation of crops (including fruit trees) extends from the Loskop Dam to Marble Hall and the heavy abstraction of water that this causes may reduce the water available for ecological functioning downstream;
- commercial agricultural activities reach up to the riverbanks of the Olifants River downstream of the Loskop Dam and the clearing of ground cover associated with these activities increases the potential for erosion as well as sedimentation in the river channel; a seasonal and ecologically insensitive releases from, or retention in, the Loskop Dam have an adverse impact on in-stream biological communities and cause erosion of the riverbed, through scouring; and
- the quality of the water in the Witbank Dam is poor, affecting the rivers downstream.

2.6. THE RESERVE

The Reserve is that portion of the natural flow that has to be available in a river or stream in order to sustain the aquatic ecology, and also to provide for basic human needs (BHN), in order to comply with Sections 16, 17 and 18 of the National Water Act (NWA), Act 36 of 1998. The Reserve is not a steady flow, but is a variable flow that mimics natural variations in flows in the river.

An Olifants Comprehensive Reserve Study was undertaken during 1999.

As part of the current study, the Eco-Classification was repeated in 2010. The main objective of redoing the Eco-Classification was to check how the Ecological Water Requirements (EWRs) would be affected by the new classification. It should be noted that the EWRs themselves (i.e. the flow pattern associated with an ecological category at a specific site) were not reassessed and are still the same as determined in the 1999 study.

The rule tables that were developed for the Reserve as part of the 1999 study make provision to release small floods (called freshets) from the dams during the spawning season for fish.

The existing dams do not have sufficient release capacity to release these small floods, and in most cases they can be generated downstream of the dams from the tributaries and the catchment below the dam. These small floods were therefore removed from the rule tables.

Provision in the strategy has therefore only been made for that portion of the Reserve that is practically implementable. This will reduce the available yield of the whole system by 157 million m^3/a in order to maintain the ecological categories at their recommended levels. The full Reserve with the flood component would have reduced the available yield by 221 million m^3/a.

2.7. MUNICIPAL AREAS AND TOWNS

The study area falls within the jurisdiction of the following District Municipalities (DM):

- Mopani DM;
- Ehlanzeni DM;
- Sekhukhune DM;
- Capricorn DM;
- Waterberg DM;
- Nkangala DM;
- Gert Sibande DM; and
- Metsweding DM.[1]

[1] Metsweding District Municipality was incorporated into Tshwane Metro during the course of the study.

2.8. SOCIO-ECONOMICS

2.8.1 Population

According to the 2007 population data, the OLEMF (including the Letaba Catchment) area has an estimated total population of 8,8 million (DEA, 2009), with 59 % of the population distributed within the Greater Sekhukhune, Vhembe, Mopani, Capricorn and Waterberg districts (**Figure 2.6**).

The highest percentage population of the people in the area fall under the age of 24, (58 % falls within the age category of 0-24). The Greater Sekhukhune district has the largest percentage of people within this age category. More than 60 % of the district's total population falls within the aforementioned category.

Most of the EMF area has a high poverty rating with the majority of the economically active people earning an annual income of not more than R 19 200 or R 1 600 per month. According to the 2001 economic data, a combined total population of 66 % of economically active people of Nkangala, Ehlanzeni and Gert Sibande districts earn not more than R 1 600 per month.

In the Greater Sekhukhune, Mopani, Vhembe, Capricorn, and Waterberg districts, the 2007 economic data indicate that a combined total population of 88 % of economically active people earn not more than R 1 600 per month. Of this, 60 % do not have an income.

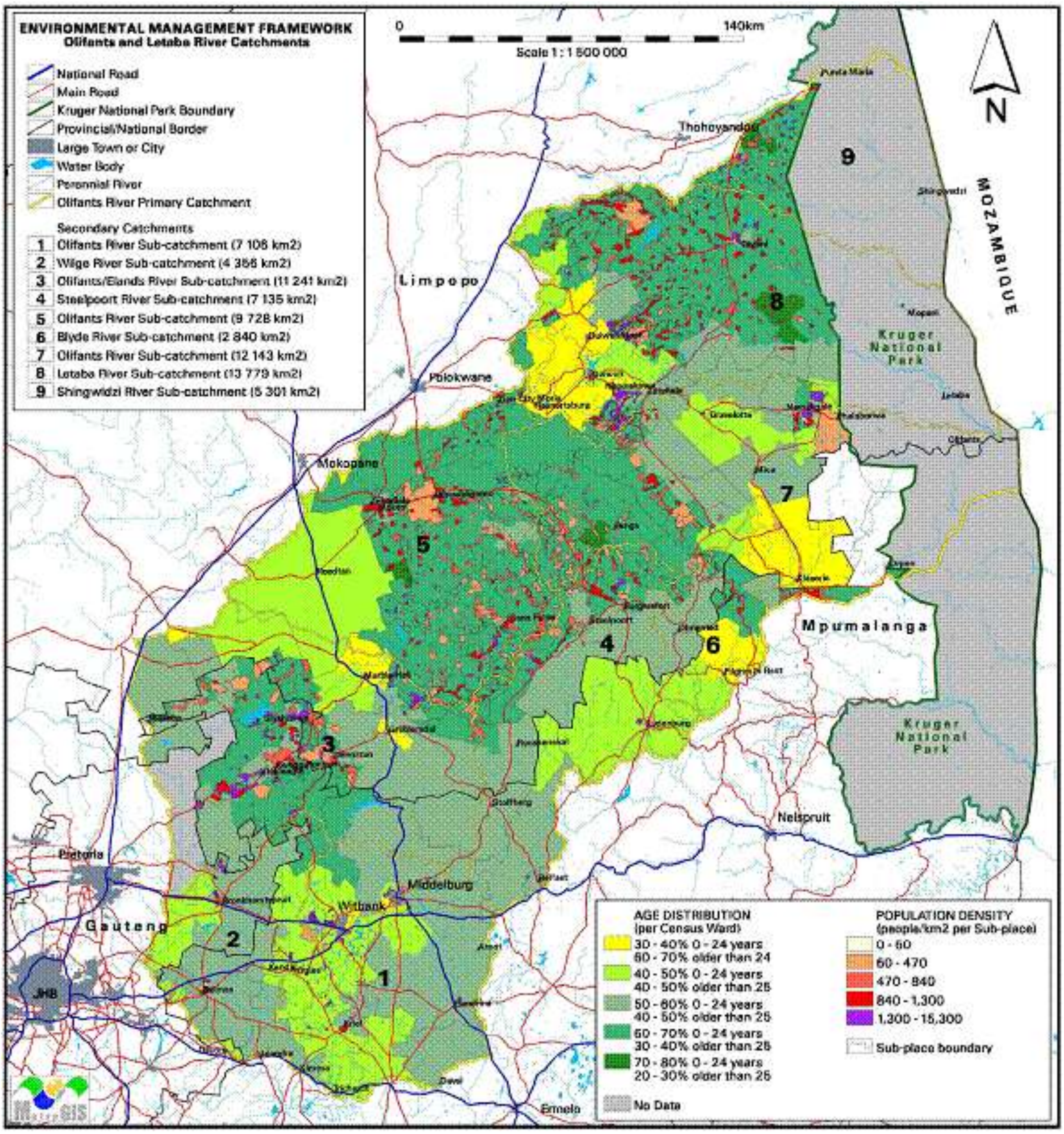


Figure 2.6: Population structure (source: DEA, 2009)

In the Nkangala, Ehlanzeni, and Gert Sibande districts, 67 % of the combined total population has no schooling, whilst 14 % has Grade 12 and 3 % has post-high school qualifications.

A combined total population of 19 % of the Greater Sekhukhune, Mopani, Vhembe, Capricorn and Waterberg Districts has no schooling, whilst 17 % has Grade 12 and 6 % has post-high school qualifications.

2.8.2 Landuse

The main economic sectors in the study area are mining, agriculture, forestry and tourism. Detailed land use information is presented in **Table 2.1**.

Table 2.1: Use of land / Land cover (source: DEA, 2009)

	Surface Area in (km^2)	Percentage %
Indigenous Forest	374.157	0.51
Woodland	14 643.211	19.89
Thicket and Bushland (including Herbland)	21 656.643	29.41
Grassland	11 066.547	15.03
Planted Grass	17.389	0.02
Forest Plantation	1 231.863	1.67
Water Body / Wetland	580.843	0.79
Bare Rock and Soil (Natural)	180.490	0.25
Degraded Land	7 229.180	9.82
Irrigated Agriculture	1 941.989	2.64
Dryland Agriculture	11 886.193	16.14
Urban / Built-up (Residential)	2 236.441	3.04
Urban / Built-up (Smallholdings)	84.268	0.11
Mining / Industrial	495.973	0.67
TOTAL AREA	**73 630.049**	**100**

2.8.3 Tourism

The tourism sector has been identified as one of the growing sectors in the OLEMF area. The KNP, situated along the easternmost edge of the study area, is the major economic driver of this sector. The park includes the Sabi Sabie Game Reserves, Timbavatie and Manyeleti Reserve, Thornbush Game Reserve and the Klaserie Reserve which have been integrated with the KNP as private concessions enabling animals to move freely without the fencing. Measures are being put in place to safe-guard the KNP which is facing threats of encroachment from mining and agricultural activities as well as the formal and informal housing schemes around the area.

The Blyde River Canyon has been identified has a potential tourism destination. It is a majestic area which forms part of the Transvaal-Drankensberg Escarpment with breathtaking views of the Blyde River Canyon and gorge, Blyderivierspoort Dam, the Three Rondawels, Bourkes Luck Potholes, Gods Window and Pinnacle. Past investigations review that the Blyde Canyon and Mariepskop (state forest) are to be proclaimed as one National Park, as well as to acquire National Heritage status due to their ecological diversity and unique geology. This initiative will also help conserve the over-stressed Olifants River Catchment. Other opportunities in this regard include the generation of income and employment linked to eco-tourism; and the initiation of forestry programmes at Mariepskop where commercial timber is produced.

The Loskop Dam has great potential as a tourist destination. This however, has not been capitalised on. To realise its full potential the main focus must be on tourism marketing and awareness; and development of future tourism plans that focus on agri- and eco-tourism attraction that safeguard cultural and natural heritage of the area whilst creating employment opportunities and developing skills.

There is a need to fully exploit other sectors in the study area besides mining, agriculture and tourism. The aforementioned economic sectors must capitalise on promoting labour intensive secondary sectors such as manufacturing and agri-processing, construction, transport and communication sectors. These sectors will help maximise the development potential in the area and stimulate growth, which will eventually lead to an improvement in basic provision, roads and infrastructure as well as housing and dwelling. This will in turn benefit the development of the retail and commercial sectors and contribute towards skills development within the area.

2.9. SYSTEM DESCRIPTION

The study area consists of the Olifants River Catchment and its adjacent supply zones, i.e. the urban areas of Polokwane and Mokopane to the north west of the basin. The Olifants River catchment has several large dams located in the upper and middle reaches. The earlier dams were constructed to supply large irrigation schemes, while later dams were constructed to meet growing domestic, industrial and mining water requirements. All the dams are operated independently of each other. However water court orders require releases from Middelburg Dam, Witbank Dam and Loskop Dam but these orders do not seem to have been upheld in recent times.

While the majority of water users obtain their water from the major dams, there are also a large number of water users who obtain their water from farm dams, and run-of-river abstraction, referred to in this report as diffuse water use. There is also a significant supply to irrigators and mines from groundwater. The reconciliation strategies developed as part of this study do not address water shortages of these diffuse water users.

In the upper part of the catchment, water use is mainly for power generation, mining and urban use, although run-of-river irrigation is also practised. In the upper parts of the Wilge River and Bronkhorstspruit there is significant abstraction for irrigation from groundwater (dolomite). In the middle part of the catchment most water is used for irrigation, while at the lower end of the catchment the Kruger National Park (KNP) requires that there is sufficient flow in the river to maintain the ecological integrity of the system. These conflicting requirements pose a significant challenge in the reconciliation process.

2.10. CURRENT WATER USE

For the analysis of the surface water and groundwater requirements and availability, the Olifants Catchment has been divided into three management zones as illustrated in **Figure 2.7**.

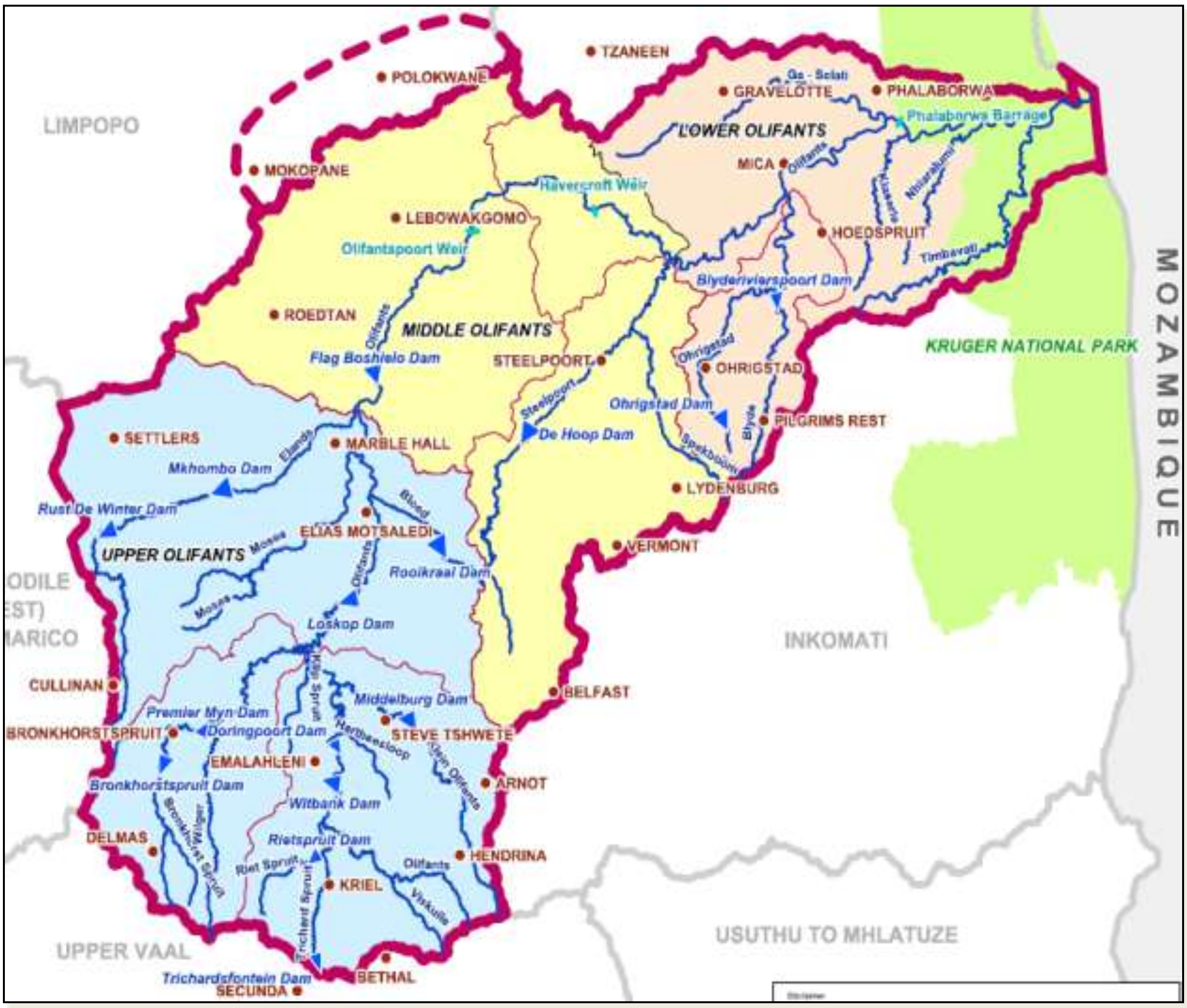


Figure 2.7: Management Zones of the Olifants Catchment

The current water use in the irrigation, domestic and industrial, mining, power generation and forestry sectors is summarised in **Table 2.2**.

Table 2.2: Summary of Water Requirements (Units: million m^3/a)

Management Zone	Irrigation	Urban	Rural	Industrial	Mining	Power Generation	Total
Upper Olifants	249	93	4	9	26	228	**609**
Middle Olifants	81	56	22	0	28	0	**187**
Lower Olifants	156	29	3	0	32	0	**220**
Total	**486**	**178**	**29**	**9**	**86**	**228**	**1016**

Note: The requirements are at different assurances of supply. They have all been converted to a 1:50 year assurance of supply in this table.

2.11. WATER AVAILABILITY

2.11.1 Groundwater

Groundwater is available throughout the Olifants WMA, although varying in quantities depending upon the hydrogeological characteristics of the underlying formations.

The overall results of the Groundwater Yield Model (AGES, 2008) indicated that there is a surplus of groundwater in the order of 70 million m^3/a.

A hydrogeological yield map of the Olifants WMA is shown in **Figure 2.8**.

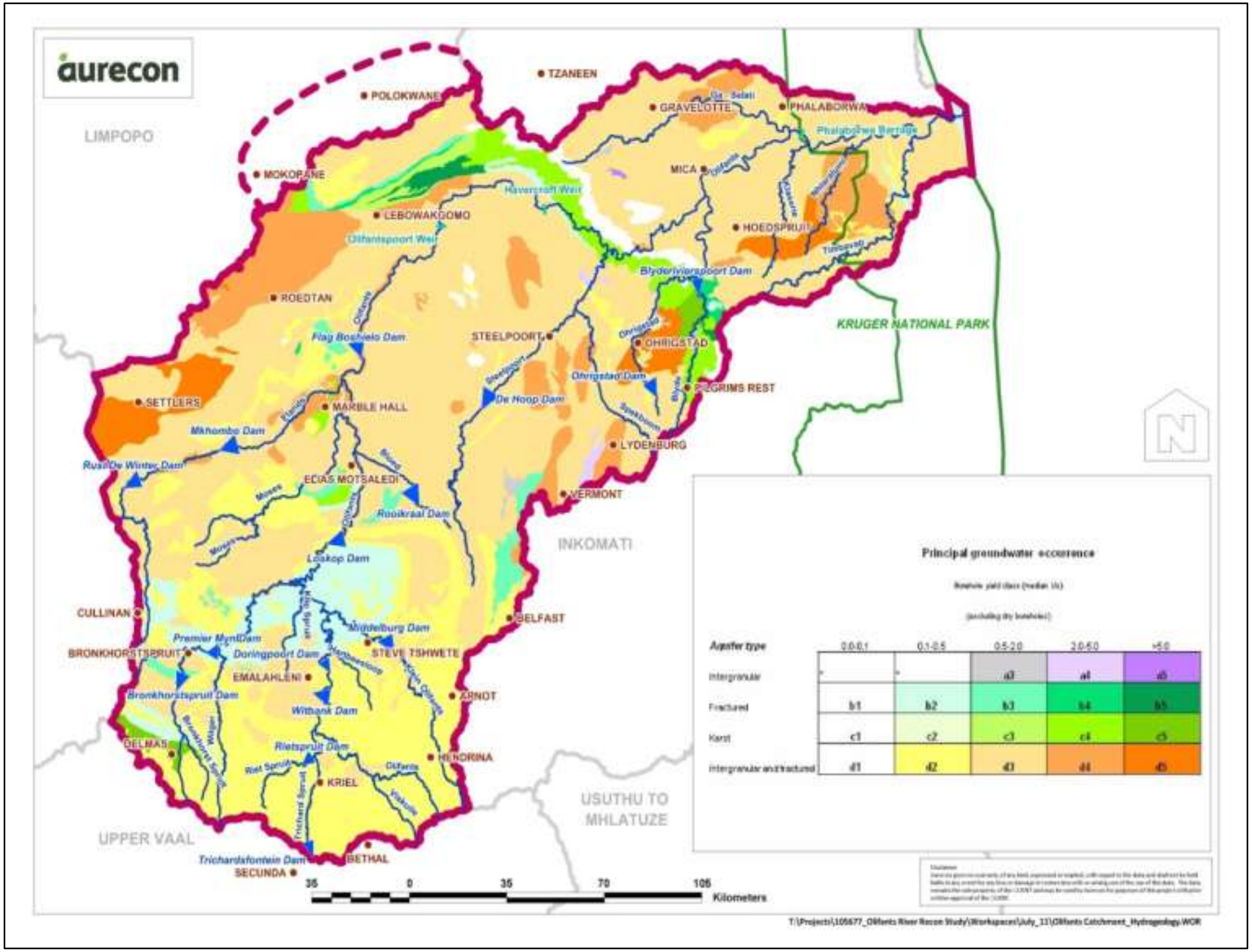


Figure 2.8: Groundwater availability map for the Olifants Basin

Groundwater development in unstressed aquifers must be encouraged. A possible regional water scheme with the Malmani dolomites as resource should be investigated. The impact of groundwater abstraction from the Malmani dolomites must be explored further in order to establish whether there is any impact on the surface water base flow in the Olifants River.

2.11.2 Surface Water

The significant dams with their historical and 1:50 year yields are listed in **Table 2.3**.

In addition to the yield of the major dams listed in **Table 2.3** there are a large number of farm dams in the Olifants River catchment that contribute to the yield of the system. There are also many water users, mostly irrigators, that abstract water directly from the river and these run-of-river supplies also form part of the water resource equations. The yield related to farm dams and run-of-river abstractions are referred to further as diffuse sources.

Table 2.3: Large Dams in the Olifants River Catchment

Dam	Management Zone	Full Supply Capacity (million m^3)	Historic Firm Yield (million m^3/a)	1:50 Year Yield (million m^3/a)
Bronkhorstspruit	Upper	58.9	16.9	23.5
Middelburg	Upper	48.4	12.6	14.0
Wilge	Upper	1.6	6.7	8.0
Witbank	Upper	104.0	29.5	33.0
Loskop	Upper	374.3	161	168
Rust de Winter	Upper	27.3	9.8	11.7
Mkombo with Weltevreden weir	Upper	205.8	11.7	14.0
Flag Boshielo	Middle	1788	53.0	56.0
De Hoop (under construction)	Middle	347.4	98.0	99.0
Ohrigstad	Lower	13.2	18.9	19.8
Buffelskloof	Middle	5.4	14.7	14.7
Der Bruchen	Middle	9.0	8.3	8.3
Belfast	Middle	5.5	5.7	5.7
Lydenburg	Middle	1.1	2.5	2.5
Blyderivierspoort	Lower	54.6	110	130
Phalaborwa Barrage	Lower	5.7	42	49

Note: Yields are before meeting the EWR water requirements

Table 2.4 summarises the diffuse water resources of the study area.

Table 2.4: Diffuse Water Resources (Units: million m^3/a)

Management Zone	Full Supply Capacity of Minor Dams	Yield of Farm Dams and Run-of-River
Upper Olifants	327	128
Middle Olifants	60	71
Lower Olifants	40	49
Total	**427**	**248**

There are several large water transfers from the Upper Komati and the Vaal Systems to supply the six power stations located in the Upper Olifants catchment. These transfers are estimated at 228 million m^3/a.
The incremental future decant also known as Acid Mine Drainage (AMD) from the coal mines in the Upper Olifants Management Zone can be regarded as direct additional yield. In the case of the Witbank Dam catchment this value is approximately 12 million m^3/a and that of the Middelburg Dam catchment 10 million m^3/a, i.e. approximately 22 million m^3/a in total which will become available over a period of 20 years. However this water will require treatment since the river system does not have the capacity to dilute the AMD to an acceptable quality.

The projected growth in available yield is shown in **Figure 2.9**.

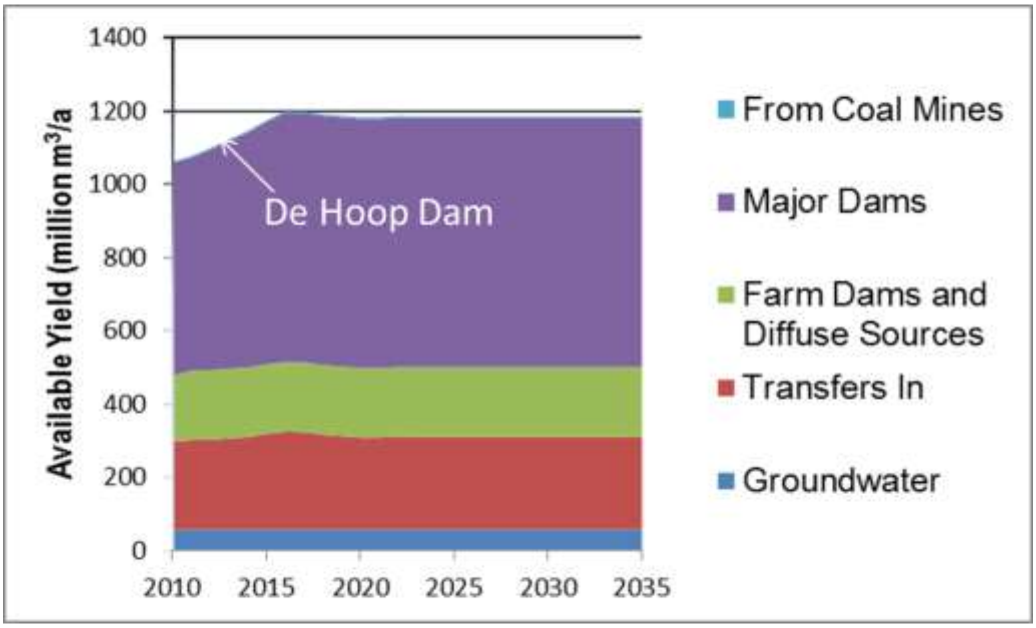


Figure 2.9: Growth in available yield

2.12. WATER QUALITY

There are a number of water quality concerns in the catchment, primarily downstream and close to point sources of pollution. This is often due to lack of treatment or poor management of treatment works, with required effluent standards not being met.

A separate water quality management strategy is being developed to address the water quality management issues.

The water quality in the study area is generally acceptable for use, although there are limited locations where it is only tolerable and it is unacceptable at two sampling points, however, at many stations there is an upward trend in pollution.

Localised water quality problems must be addressed by intensified compliance monitoring and enforcement and by reducing pollution at source.

The water quality in the system will not influence the water availability, but immediate attention should be given to the upward trends shown in Error! Reference source not ound. so that the water quality does not impact on the availability of the resource.

An issue that will require specific attention is the increasing decant of acid mine drainage. On the one hand it represents a potential source of water if treated properly, while on the other hand it represents a threat to future water quality if uncontrolled decanting is allowed to occur.

3 FRAMEWORK FOR ENVIRONMENTAL ASSESSMENT

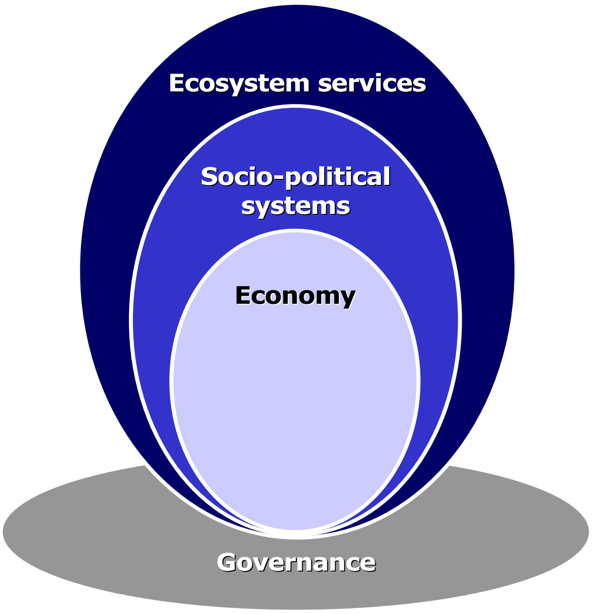
3.1. SUSTAINABLE WATER RESOURCES DEVELOPMENT

The environmental screening includes a summary of key environmental or social issues that should be taken in account when considering and comparing options, and identifies environmental or social “fatal flaws” or “red flags” associated with each of the options. The overall framework for this analysis is underpinned by sustainability principles.

Sustainable development, as defined in the Preamble of National Environmental Management Act (NEMA), (Act No. 107 of 1998) “means the integration of social, economic and environmental factors into planning, implementation and decision-making so as to ensure that development serves present and future generations.”

Accordingly, the assessment of options/environmental screening considered the social soundness, ecological integrity and economic growth potential of all options, taking due cognisance that the three dimensions will seldom be in perfect balance, and are often dictated by local circumstances. Note should be taken however those economic factors are the primary driver for the development of water resources in the Olifants WMA, and the screening process considers the social and biophysical dimensions of each option, in terms of their direct and immediate impacts, but also their indirect and long term effects.

The National Framework for Sustainable Development (NFSD) further emphasises that ‘*In South Africa [...], the situation of continuing inequality, accompanied by a deteriorating resource base, makes it imperative for us to go beyond thinking in terms of trade-offs and the simplicity of the “triple bottom line”. We must acknowledge and emphasise that there are non-negotiable ecological thresholds; that we need to maintain our stock of natural capital over time; and that we must employ the precautionary principle in this approach. We must accept that social, economic and ecosystem factors are embedded within each other, and are underpinned by our systems of governance*.’ (DEAT, 2008)



The economic system, socio-political system and ecosystem are seen as embedded within each other, and then integrated via the governance system that holds all the other systems together within a legitimate regulatory framework.

Sustainability implies the continuous and mutually compatible integration of these systems over time; sustainable development means making sure that these systems remain mutually compatible as the key development challenges are met via specific actions and interventions to eradicate poverty and severe inequalities.

Our Principles
The "first order" or fundamental principles relate to those fundamental human rights that are guaranteed in the Constitution, and underpin the very nature of our society and system of governance. These principles affirm the democratic values of: • Human dignity and social equity • Justice and fairness • Democratic governance
The substantive principles address the content or conditions that must be met in order to have a sustainable society. These principles are based on sustainable development principles already enshrined in South African law (notably the National Environmental Management Principles set out in section 2 of NEMA, but also in other legislation such as the National Heritage Resources Act, the National Forests Act and the Development Facilitation Act). The substantive principles underscore a cyclical and systems approach to achieving sustainable development and are as follows: • Efficient and sustainable use of natural resources • Socio-economic systems are embedded within, and dependent upon, eco-systems • Basic human needs must be met to ensure resources necessary for long-term survival are not destroyed for short term gain
The process principles establish a few clear principles that apply specifically to the implementation of the national framework for sustainable development. These include: • Integration and innovation • Consultation and participation • Implementation in a phased manner

3.2. GUIDELINES AND POLICIES REGARDING LARGE DAMS

The National Water Act emphasises sustainability and equity as fundamental principles for water resources management, which should promote equitable access to water, as well as efficient, sustainable and beneficial use of water resources in the public interest.

Meeting water needs while dealing with the environmental and social challenges is central to ensure sustainable water resource development.

In many cases, water services are best provided through a mix of options, large scale, small scale, supply side and demand side. Dams are one of the options available to meet specific water (or energy) needs, however, large dams are typically associated with very high social and environmental costs. If the construction of a dam is the preferred option to bridge the gap between supply and demand of water (or energy), a number of guidelines can be followed to manage the associated social and environmental impacts.

The 'World Commission on Dams' (WCD) was created in 1998 and conducted the first comprehensive, global, and independent review of the performance and impacts of large dams, as well as of the options available for water and energy development. The WCD adopted five core values designed to improve decision-making (relating to water and energy development) and which informed the entire WCD's work: equity; efficiency; participatory decision-making; sustainability and accountability.

The WCD's approach was based on the recognition of rights and assessment of risks, notably of all rights at risk. This approach involves a thorough examination of the rights context for a proposed project in order to identify legitimate claims and entitlements and provide the basis for effective identification of stakeholders. Within this framework, the WCD identified a series of seven strategic priorities providing a 'principled and practical way forward

BOX 1: *World Commission on Dams - Seven Strategic Priorities:*

1. ***Gaining public acceptance***
   Public acceptance of key decisions is essential for equitable and sustainable water and energy resources development.
2. ***Comprehensive options assessment***
   The appropriate development response to needs for water, food and energy is identified from a range of policy, institutional and technical options. The selection is based on comprehensive and participatory assessment (of each option), considering social, environmental, economic and financial aspects equally.
3. ***Addressing existing dams***
   Management and operation practices must adapt continuously to changing circumstances over the project's life in order to optimise benefits from existing dams, address outstanding social issues and strengthen environmental mitigation and restoration.
4. ***Sustaining Rivers and livelihoods***
   Dams can have irreversible impacts and avoiding impacts through site selection and project design is a priority. It is essential to protect and restore ecosystems at river basin level.
5. ***Recognising entitlements and sharing benefits***
   Mutually agreed and legally enforceable mitigation and development provisions must translate into successful mitigation, resettlement and development to ensure that affected people improve their livelihoods.
6. ***Ensuring compliance***
   Compliance with applicable regulation, criteria and guidelines and project-specific agreements at all stages of project planning and implementation is necessary to ensure public trust and confidence.
7. ***Sharing Rivers for peace, development and security***
   Storage and diversion of water on transboundary rivers should the subject of agreement between States with the view of promoting mutual self-interest for regional co-operation and peaceful collaboration.

for decision-making' (see **Box 1**). A series of guidelines were also adopted `with the view of advancing those priorities. The guidelines were subsequently contextualised for South Africa by the 'South African Multi-stakeholder Forum on the World Commission on Dams'. The emphasis on a participatory approach is covered in the South African legal framework, especially NEMA and NWA, which make provision for equitable and inclusive decision-making.

The Forum identified three priority recommendations:

- addressing social impacts,
- enhancing governance of water and energy resources development,
- promoting river health and sustainable livelihoods.

The United Nations Environment Programme's 'Dams and Development Project' (DDP) was established in 2001 to follow on from the WCD with the goal of promoting improved decision-making, building on the work of the WCD. The DDP produced a report in 2007 entitled *Dams and Development – Relevant practices for improved decision-making*, aimed at ensuring environmental and social sustainability of dams by promoting an integrated approach dealing with the entire basin when planning, developing and managing water resources, recognising upstream and downstream interlinkages and being aware of particular stakeholder interests and areas of potential conflict (UNEP, 2007).

3.3. BASIS FOR WATER RECONCILIATION

The following aspects were taken into account and formed the basis for water reconciliation:

- South Africa will meet its international obligations.
- The water for basic human needs (BHN) will be supplied.
- The Reserve is a priority – ecological Water Requirements to meet the recommended ecologic category (REC) will be maintained.
- All unlawful water use will be eliminated.
- Water for strategic users for the benefit of the country must receive priority before any other economic development.
- Water for socio-economic development within the policy parameters of the government will be provided.
- There will be no increase in total water allocations for irrigation.
- There will be no increase in forestry areas

4 ENVIRONMENTAL AUTHORISATIONS REQUIRED

4.1. ASSUMPTIONS, LIMITATIONS AND INFORMATION SOURCES

This chapter includes a preliminary screening of the environmental authorisations that are likely to be required for each of the infrastructure development project options under consideration. It is based on the understanding of the environment and development options obtained from a desktop review of available information, and not verified by any site visits, and is not intended to be an exhaustive environmental-legal review. It should also be noted that authorisation requirements will change with time as environmental legislation is subject to frequent amendment.

4.2. OVERVIEW OF POSSIBLE ENVIRONMENTAL AUTHORISATIONS REQUIRED

4.1.1 Environmental Authorisation

GN 544 of 2010 lists activities that require environmental authorisation for which a **Basic Environmental Assessment** is required. GN 545 of 2010 lists activities that require environmental authorisation for which an **Environmental Impact Assessment (EIA)**, including Scoping and Impact Assessment phases, is required. In the case where the project includes activities listed in both GN 544 and 545, a full EIA is required to obtain environmental authorisation.

GN 546 of 2010 lists additional activities requiring Environmental Authorisation in specified geographical areas, in terms of Section 24(2)(b) of NEMA:

24 (2) *The Minister, or an MEC with the concurrence of the Minister, may identify-*

(b) geographical areas based on environmental attributes, and as specified in spatial development tools adopted in the prescribed manner by the environmental authority, in which specified activities may not commence without environmental authorisation from the competent authority.

The Olifants Letaba EMF has identified a number of environmental attributes within the study area, including for instance threatened ecosystems, steep slopes, and National Parks view-shed protection areas. These attributes are designed to provide inputs to the national and provincial system currently being developed. A number of activities are also identified as requiring environmental authorisation if located in one or more specified geographical areas.

Furthermore, Section 24(2)(c) makes provision for the exclusion of activities for which environmental authorisation is normally required in specific geographical areas:

24 (2) *The Minister, or an MEC with the concurrence of the Minister, may identify-*

(c) geographical areas based on environmental attributes, and specified in spatial development tools adopted in the prescribed manner by the environmental authority, in which specified activities may be excluded from authorisation by the competent authority.

The EMF identifies a number of activities to be excluded from authorisation in built up areas as identified in the EMF.

4.1.2 Heritage Permits

Section 34 (1) of the National Heritage Resources Act, 1999 says that no person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority.

Section 38 (1) of the National Heritage Resources Act, 1999 states that:
Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as –

(a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length;
(b) the construction of a bridge or similar structure exceeding 50 m in length;
(c) any development or other activity which will change the character of a site–
    (i) exceeding 5 000 m^2 extent; or
    (ii) involving three or more existing erven or subdivisions thereof; or
    (iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or
    (iv) the costs of which exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources agency;
(d) the re-zoning of a site exceeding 10 000 m2 in extent; or
(e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources agency, must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

4.1.3 Waste Management Licences

GN 718 lists Waste Management Activities in respect of which a waste management licence is required; these include various activities associated with the <u>storage</u> of waste, reuse, recycling and recovery of waste, <u>treatment</u> of waste (which includes the remediation of contaminated land) and disposal of waste. The Schedule to the Notice distinguishes between two categories of waste management activities which require licensing and for which a basic assessment process (for Category A Waste Management Activities) or an

Environmental Impact Assessment process (for Category B Waste Management Activities) must be conducted.

Generally, Category A activities involve general waste while Category B involve hazardous waste.

4.1.4 Water Use Licences

According to Chapter 4 of the National Water Act (Act 36 of 1998) (NWA), all water users must have permission to do so. This aspect is termed as Permissible Water Use. There are several different ways in which Permissible Water Uses are exercised.

People who use small amounts of water are automatically authorised to do so under "Schedule 1" of the NWA.

Larger amounts of water used by any entity could impact negatively on the water resource and must therefore be authorised in one of the following methods:

- General Authorisations, where a user may use water without a license provided that water use is exercised within the constraints of the General Authorisation as published in the Government Gazette; or
- Water use authorisation through a license.

A water use license is a legal document issued by the DWA. It entitles a water user to utilise water in accordance with the requirements of the NWA and conditions specified within the license. The maximum period that a water use license may be issued for is 40 years. The NWA requires that every license issued must be reviewed at least every five years.

Water use activities which require a license have been specified in section 21 of the NWA and include the following:

a) Taking water from a resource, such as from a stream, river, estuary, wetland or aquifer;
b) Storing water , such as a dam
c) Impeding or diverting the flow of water, for example when the flow of a river is changed during the building of bridges or roads;
d) Stream flow reduction activities, which currently only apply to forestry activities
e) Controlled activities, such as irrigation with wastewater;
f) Discharging waste water directly into a water resource;
g) Disposal of waste water into dams or ponds or land based disposal facilities such as waste sites, slimes dams etc.;
h) Disposal of water which contains waste or has been heated from any industrial or power generation activity;
i) Altering the bed, banks or course of a water course, for example when a water course is turned into a canal, or sand mined from the beds etc.;
j) Removal of underground water for activities such as mining;
k) Recreation, such as water sports like boating, swimming etc.

The DWA has also published a number of General Authorisation notices, which allow certain types of developments to proceed without water use licences in certain areas. These General Authorisations are valid for a period of five years from publication and are therefore reviewed every five years.

4.1.5 Authorisations required for specific options

Construction or Raising of Dams

The following regulated activities will or may be required for the construction or raising of dams:

Table 4.1: Listed activities in terms of the EIA Regulations, NEM: Waste Act and NEM: Air Quality Act that may apply to the raising or construction of a dam

Number and date of the relevant notice	Activity No (s) (in terms of the relevant or notice):	Description of each listed activity:
No. R 544 of 2010	9	The construction of facilities or infrastructure exceeding 1000 metres in length for the bulk transportation of water, sewage or storm water: (i) with an internal diameter of 0.36 metres or more; or (ii) with a peak throughput of 120 litres per second or more, Excluding where: a) Such facilities or infrastructure are for bulk transportation of water, sewage or storm water drainage inside a road reserve; or b) Where such construction will occur within urban areas but further than 32 metres from a watercourse, measures from the edge of the watercourse.
No. R 544 of 2010	11	The construction of: (i) canals; (ii) channels; (iii) bridges; (iv) dams; (v) weirs; (vi) bulk storm water outlets structures; (vii) marinas; (viii) jetties exceeding 50 square metres in size; (ix) slipways exceeding 50 square metres in size; (x) buildings exceeding 50 square metres in size; or (xi) infrastructure or structures covering 50 square metres or more where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.
No. R 544 of 2010	12	The construction of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, with a combined capacity of 50000 cubic metres or more, unless such storage falls within the ambit of activity 19 of Notice 545 of 2010.
No. R 544 of 2010	13	The construction of facilities or infrastructure for the storage, or for the storage and handling, of a dangerous good, where such storage occurs in containers with a combined capacity of 80 but not exceeding 500 cubic metres.
No. R 544 of 2010	18	The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock or more than 5 cubic metres from:

Number and date of the relevant notice	Activity No (s) (in terms of the relevant or notice):	Description of each listed activity:
		(i) a watercourse; (ii) the sea; (iii) the seashore; (i) the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater- but excluding where such infilling, depositing , dredging, excavation, removal or moving: a) is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or b) occurs behind the development setback line.
No. R 544 of 2010	22	The construction of a road, outside urban areas: (i) with a reserve wider than 13,5 meters or, (ii) where no reserve exists where the road is wider than 8 metres, or (iii) for which an environmental authorisation was obtained for the route determination in terms of activity 5 in Government Notice 387 of 2006 or activity 18 in Notice 545 of 2010.
No. R 544 of 2010	26	Any process or activity identified in terms of section 53(1) of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004).
No. R 544 of 2010	37	The expansion of facilities or infrastructure for the bulk transportation of water, sewage or storm water where: a) the facility or infrastructure is expanded by more than 1000 metres in length; or b) where the throughput capacity of the facility or infrastructure will be increased by 10% or more– excluding where such expansion: (i) relates to transportation of water, sewage or storm water within a road reserve; or where such expansion will occur within urban areas but further than 32 metres from a watercourse, measured from the edge of the watercourse.
No. R 544 of 2010	39	The expansion of: (ii) canals; (iii) channels; (iv) bridges; (v) weirs; (vi) bulk storm water outlet structures; (vii) marinas; within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, where such expansion will result in an increased development footprint but excluding where such expansion will occur behind the development setback line.
No. R 544 of 2010	40	The expansion of: (i) jetties by more than 50 square metres; (ii) slipways by more than 50 square metres; or (iii) buildings by more than 50 square metres (iv) infrastructure by more than 50 square metres within a watercourse or within 32 metres of a watercourse, measured from

Number and date of the relevant notice	Activity No (s) (in terms of the relevant or notice):	Description of each listed activity:
		the edge of a watercourse, but excluding where such expansion will occur behind the development setback line.
No. R 544 of 2010	41	The expansion of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, where the combined capacity will be increased by 50000 cubic metres or more.
No. R 544 of 2010	42	The expansion of facilities for the storage, or storage and handling, of a dangerous good, where the capacity of such storage facility will be expanded by 80 cubic metres or more.
No. R 544 of 2010	47	The widening of a road by more than 6 metres, or the lengthening of a road by more than 1 kilometre: (i) where the existing reserve is wider than 13,5 meters; or (ii) where no reserve exists, where the existing road is wider than 8 metres – excluding widening or lengthening occurring inside urban areas.
No. R 544 of 2010	52	The expansion of facilities or infrastructure for the transfer of water from and to or between any combination of the following: (i) water catchments; (ii) water treatment works; or (iii) impoundments; where the capacity will be increased by 50 000 cubic metres or more per day, but excluding water treatment works where water is treated for drinking purposes.
No. R 544 of 2010	55	The expansion of a dam where: (i) the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, was originally 5 metres or higher and where the height of the wall is increased by 2,5 metres or more; or (ii) where the high-water mark of the dam will be increased with 10 hectares or more.
No. R 545 of 2010	3	The construction of facilities or infrastructure for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of more than 500 cubic metres.
No. R 545 of 2010	5	The construction of facilities or infrastructure for any process or activity which requires a permit or license in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent and which is not identified in Notice No. 544 of 2010 or included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case that Act will apply.
No. R 545 of 2010	10	The construction of facilities or infrastructure for the transfer of 50 000 cubic metres or more water per day, from and to or between any combination of the following: (i) water catchments, (ii) water treatment works; or (iii) impoundments, excluding treatment works where water is to be treated for drinking purposes.

Number and date of the relevant notice	Activity No (s) (in terms of the relevant or notice):	Description of each listed activity:
No. R 545 of 2010	15	Physical alteration of undeveloped, vacant or derelict land for residential, retail, commercial, recreational, industrial or institutional use where the total area to be transformed is 20 hectares or more; except where such physical alteration takes place for: (i) linear development activities; or agriculture or afforestation where activity 16 in this Schedule will apply.
No. R 545 of 2010	17	The extraction or removal of peat or peat soils, including the disturbance of vegetation or soils in anticipation of the extraction or removal of peat or peat soils.
No. R 545 of 2010	18	The route determination of roads and design of associated physical infrastructure, including roads that have not yet been built for which routes have been determined before 03 July 2006 and which have not been authorised by a competent authority in terms of the Environmental Impact Assessment Regulations, 2006 or 2009, made under section 24(5) of the Act and published in Government Notice No. R. 385 of 2006,— (i) it is a national road as defined in section 40 of the South African National Roads Agency Limited and National Roads Act, 1998 (Act No. 7 of 1998); (ii) it is a road administered by a provincial authority; (iii) the road reserve is wider than 30 metres; or the road will cater for more than one lane of traffic in both directions.
No. R 545 of 2010	19	The construction of a dam, where the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, is 5 metres or higher or where the high-water mark of the dam covers an area of 10 hectares or more.
No. R 545 of 2010	20	Any activity which requires a mining right or renewal thereof as contemplated in sections 22 and 24 respectively of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002).
No. R 545 of 2010	21	Any activity which requires an exploration right or renewal thereof as contemplated in sections 79 and 81 respectively of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002).
No. R 545 of 2010	22	Any activity which requires a production right or renewal thereof as contemplated in sections 83 and 85 respectively of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002).
No. R 545 of 2010	23	Any activity which requires a reconnaissance permit as contemplated in section 74 of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002), excluding where such reconnaissance is conducted by means of a fly over.
No. R 545 of 2010	26	Commencing of an activity, which requires an atmospheric emission license in terms of section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), except where such commencement requires basic assessment in terms of Notice of No. R544 of 2010.
No. 718 of 3 July 2009	Category A (1)	The storage, including the temporary storage of general waste at a facility that has the capacity to store in excess of $100m^3$ of general waste at any one time, excluding the storage of waste in lagoons.
No. 718 of 3 July 2009	Category A (9)	The biological, physical or physico-chemical treatment of general waste at a facility that has the capacity to process in excess of 10 tons of general

Number and date of the relevant notice	Activity No (s) (in terms of the relevant or notice):	Description of each listed activity:
		waste per day.
No. 718 of 3 July 2009	Category A (11)	The treatment of effluent, wastewater or sewage with an annual throughput capacity of more than 2000 cubic metres but less than 15000 cubic metres.
No. 718 of 3 July 2009	Category A (16)	The disposal of domestic waste generated on premises in areas not serviced by the municipal service where the waste disposed does not exceed 500kg per month.
No. 718 of 3 July 2009	Category A (11)	The treatment of effluent, wastewater or sewage with an annual throughput capacity of more than 2000 cubic metres but less than 15000 cubic metres.
No. 718 of 3 July 2009	Category B (7)	The treatment of effluent, wastewater or sewage with an annual throughput capacity of 15000 cubic metres or more.
No. R 248 of 31 March 2010	2.2	Storage and handling of Petroleum Products (except liquefied petroleum gas), where permanent immobile liquid storage tanks exceed 500 cubic metres cumulative tankage capacity at a site.

Construction or upgrading of water transfer pipelines

The following regulated activities will or may be required for the construction of a bulk water supply pipeline:

Table 4.2: Listed activities in terms of the EIA Regulations and NEM: Waste Act that may apply to the construction of water transfer pipelines

Number and date of the relevant notice	Activity No (s) (in terms of the relevant or notice):	Description of each listed activity:
No. R 544 of 2010	9	The construction of facilities or infrastructure exceeding 1000 metres in length for the bulk transportation of water, sewage or storm water: (i) with an internal diameter of 0.36 metres or more; or (ii) with a peak throughput of 120 litres per second or more, Excluding where: a) Such facilities or infrastructure are for bulk transportation of water, sewage or storm water drainage inside a road reserve; or b) Where such construction will occur within urban areas but further than 32 metres from a watercourse, measures from the edge of the watercourse.
No. R 544 of 2010	11	The construction of: (i) canals; (ii) channels; (iii) bridges; (iv) dams; (v) weirs; (vi) bulk storm water outlets structures; (vii) marinas; (viii) jetties exceeding 50 square metres in size; (ix) slipways exceeding 50 square metres in size; (x) buildings exceeding 50 square metres in size; or (xi) infrastructure or structures covering 50 square metres or more

Number and date of the relevant notice	Activity No (s) (in terms of the relevant or notice):	Description of each listed activity:
		where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.
No. R 544 of 2010	18	The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock or more than 5 cubic metres from: (i) a watercourse; (ii) the sea; (iii) the seashore; (iv) the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater- but excluding where such infilling, depositing , dredging, excavation, removal or moving: a) is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or b) occurs behind the development setback line.
No. R 544 of 2010	13	The construction of facilities or infrastructure for the storage, or for the storage and handling, of a dangerous good, where such storage occurs in containers with a combined capacity of 80 but not exceeding 500 cubic metres.
No. R 544 of 2010	26	Any process or activity identified in terms of section 53(1) of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004).
No. R 544 of 2010	22	The construction of a road, outside urban areas: (i) with a reserve wider than 13,5 meters or, (ii) where no reserve exists where the road is wider than 8 metres, or (iii) for which an environmental authorisation was obtained for the route determination in terms of activity 5 in Government Notice 387 of 2006 or activity 18 in Notice 545 of 2010.
No. R 544 of 2010	37	The expansion of facilities or infrastructure for the bulk transportation of water, sewage or storm water where: a) the facility or infrastructure is expanded by more than 1000 metres in length; or b) where the throughput capacity of the facility or infrastructure will be increased by 10% or more– excluding where such expansion: (i) relates to transportation of water, sewage or storm water within a road reserve; or where such expansion will occur within urban areas but further than 32 metres from a watercourse, measured from the edge of the watercourse.
No. R 544 of 2010	39	The expansion of: (i) canals; (ii) channels; (iii) bridges; (iv) weirs; (v) bulk storm water outlet structures; (vi) marinas; within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, where such expansion will result in an increased

Number and date of the relevant notice	Activity No (s) (in terms of the relevant or notice):	Description of each listed activity:
		development footprint but excluding where such expansion will occur behind the development setback line.
No. R 544 of 2010	52	The expansion of facilities or infrastructure for the transfer of water from and to or between any combination of the following: (i) water catchments; (ii) water treatment works; or (iii) impoundments; where the capacity will be increased by 50 000 cubic metres or more per day, but excluding water treatment works where water is treated for drinking purposes.
No. R 545 of 2010	10	The construction of facilities or infrastructure for the transfer of 50 000 cubic metres or more water per day, from and to or between any combination of the following: (i) water catchments, (ii) water treatment works; or (iii) impoundments, excluding treatment works where water is to be treated for drinking purposes.
No. R 545 of 2010	17	The extraction or removal of peat or peat soils, including the disturbance of vegetation or soils in anticipation of the extraction or removal of peat or peat soils.
No. 718 of 3 July 2009	Category A (11)	The treatment of effluent, wastewater or sewage with an annual throughput capacity of more than 2000 cubic metres but less than 15000 cubic metres.
No. 718 of 3 July 2009	Category A (16)	The disposal of domestic waste generated on premises in areas not serviced by the municipal service where the waste disposed does not exceed 500kg per month.
No. 718 of 3 July 2009	Category A (11)	The treatment of effluent, wastewater or sewage with an annual throughput capacity of more than 2000 cubic metres but less than 15000 cubic metres.
No. 718 of 3 July 2009	Category B (2)	The reuse and recycling of hazardous waste
No. 718 of 3 July 2009	Category B (4)	The biological, physical or physico-chemical treatment of hazardous waste at a facility that has the capacity to receive in excess of 500 kg of hazardous waste per day.
No. 718 of 3 July 2009	Category B (5)	The treatment of hazardous waste using any form of treatment regardless of the size or capacity of such a facility to treat such waste.
No. 718 of 3 July 2009	Category B (7)	The treatment of effluent, wastewater or sewage with an annual throughput capacity of 15000 cubic metres or more.
No. 718 of 3 July 2009	Category B (9)	The disposal of any quantity of hazardous waste to land.

Treatment of Acid Mine Drainage

Table 4.3: Listed activities in terms of the NEM: Waste Act that may apply to the treatment of Acid Mine Drainage

Number and date of the relevant notice	Activity No (s) (in terms of the relevant or notice):	Description of each listed activity:
No. 718 of 3 July 2009	Category A (11)	The treatment of effluent, wastewater or sewage with an annual throughput capacity of more than 2000 cubic metres but less than 15000 cubic metres.
No. 718 of 3 July 2009	Category A (11)	The treatment of effluent, wastewater or sewage with an annual throughput capacity of more than 2000 cubic metres but less than 15000 cubic metres.
No. 718 of 3 July 2009	Category B (2)	The reuse and recycling of hazardous waste.
No. 718 of 3 July 2009	Category B (4)	The biological, physical or physico-chemical treatment of hazardous waste at a facility that has the capacity to receive in excess of 500 kg of hazardous waste per day.
No. 718 of 3 July 2009	Category B (5)	The treatment of hazardous waste using any form of treatment regardless of the size or capacity of such a facility to treat such waste.
No. 718 of 3 July 2009	Category B (7)	The treatment of effluent, wastewater or sewage with an annual throughput capacity of 15000 cubic metres or more.
No. 718 of 3 July 2009	Category B (9)	The disposal of any quantity of hazardous waste to land.

Abstraction of groundwater

No environmental authorisation required.

Removal of Invasive Alien Plants (IAPs)

No environmental authorisation required.

Borrow Areas

A government water works (GWW) infrastructure may be made up of a dam, pipeline, pump station, canal, weir, water purification facilities, electricity supply stations / systems, sewage works, hazardous waste lagoon, etc. or combinations thereof. Bulk water supply infrastructure is usually developed by the Department of Water Affairs.

For many of the options under consideration, material from borrow areas or quarries may be required. In the case of a DWA development, compliance with the Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002), (MPRDA) is fulfilled by taking such material from the property of government water works wherever possible, and using it on the same government water works for improving the safety of that government water works. (Section 106 (3) of the MPRDA states “any land owner or lawful occupier of land who lawfully takes sand, stone, rock, gravel or clay for farming or for effecting improvements in connection with such land or community development purposes, is exempt from the provisions of the subsection (1) as long as the sand, stone, rock, gravel or clay is not sold or disposed of’.) In the event of fill or similar material having to be acquired from outside the bounds of the government water works for improvement of those works, then the contents of Regulation gazette no. 792 of 25 July 2004 which addresses the exemption of organs of State from certain provisions of the MPRDA are noted, which state that the Minister of Minerals and Energy, acting in terms of Section 106 (1) of that act" hereby exempt the Department of Water Affairs and Forestry from the provisions of Section 16, 20, 22 and 27 of the said act in respect of any activity to remove any mineral for the construction and maintenance of dams, harbours, road and railway lines and for purposes incidental thereto." However, in such cases the department although exempted from such provisions must submit an Environmental Management Programme for approval in terms of Section 39 (4) of the Act, and in so doing should make it clear that the EMP, is submitted for approval and that DWA is not an applicant.

A Memorandum of an Understanding between the Department of Water Affairs and the Department of Mineral Resources concerning the financial provision associated with rehabilitation of quarries and borrow areas used for the construction or maintenance of dams or any other water resource infrastructure has also been signed. Where approval is sought for an environmental management programme for quarries or borrow area outside the footprint of a government water works, a copy of this Memorandum of Understanding should be included in the submission with confirmation that the cost of rehabilitating such quarry or borrow area is included in the approved budget for the construction works associated with the dam safety rehabilitation programmes activities of the dam in question.

If a Municipal Water Service provider is developing the infrastructure then the normal permits from DMR will be required.

5 OPTIONS FOR REDUCING WATER DEMAND

Reconciliation options that can reduce water requirements are:

- Eliminating unlawful water use;
- Water Conservation and Water Demand Management (WC/WDM) in the irrigation sector;
- WC/WDM in the domestic water use sector;
- WC/WDM in the mining sector;
- Reducing assurances of supply;
- Compulsory licensing; and
- Water trading.

6 OPTIONS FOR INCREASING WATER SUPPLY

Reconciliation options that can increase water supply are:

- Removal of invasive alien plants (IAPs)
- Refinements to System operating rules
- Rainfall enhancement through Cloud Seeding
- Groundwater development
- Water Transfers
  - Transferring treated effluent from the East Rand
  - Transferring more water from Vaal Dam
  - Water transfer from the Crocodile (West) River System
- Dam Options
  - Raising of the Blyderivierspoort Dam
  - New dam downstream of Rooipoort
  - New dam on the farm Godwinton in the Olifants River Gorge
  - New dam on the farm Chedle in the Olifants River Gorge
  - New dam on the farm Epsom in the Lower Olifants River
  - New dam on the farm Mica in the Lower Olifants River
  - New dam on the farm Madrid in the Lower Olifants River
- Utilising the acid mine drainage (AMD) in the Upper Olifants
- Desalination and transfer of seawater

6.1. REMOVAL OF INVASIVE ALIEN PLANTS (IAPS)

The impact of IAPs described in the Final Strategy Report of this study shows that 21 million m^3/a yield is taken up by these plants. The complete removal of IAPs will increase the yield by this volume. Working for Water Teams are already working at 6 different sites within the WMA. In view of the fact that there is a continuous growth of IAPs and regrowth on cleared areas, which will need follow-up treatment, it will be difficult and costly to eradicate all IAP in a short time span. It was therefore assumed that at least 50% of the 21 million m^3 will be gained over the planning period of the strategy.

This option would result in the following positive impacts:

- The annual yield of the system could increase by 21 million m^3.
- IAPs would be replaced by indigenous vegetation resulting in a positive impact on biodiversity.

6.2. REFINEMENTS TO SYSTEM OPERATING RULES

The dams within the Olifants River are currently mostly operated independently, with little or no consideration of the state of storage of other dams or the system as an integrated system. The exception is the water supply to Phalaborwa that can be supplied from the Phalaborwa Barrage and/or from the Blyderivierspoort Dam. A recently completed report on the operating rules of the Blyderivierspoort Dam indicates that a significant yield of 40 million m^3/a can be obtained from the Phalaborwa Barrage if supported by occasional releases from Blyderivierspoort Dam.

The additional yield of 40 million m^3/a was already accounted for when determining the system yield since the operating rule is already being applied and the additional yield could therefore not be added again.

It is probable that further yield can be gained if other dams (e.g. Loskop Dam, Witbank Dam, Middelburg Dam, De Hoop Dam and Flag Boshielo Dam) are operated as a system but this would require a separate study. No reliable information on the expected additional yield was available, but this should be studied as soon as possible. The further study will be a recommendation of this strategy.

This measure is fairly simple to implement and the cost will be relatively low. It can also show quick results.

The lead time for implementing System Operating Rules would be approximately 2 years.

No significant negative environmental impacts are associated with this option.

6.3. RAINFALL ENHANCEMENT THROUGH CLOUD SEEDING

Cloud seeding was found to benefit the yield of farm dams but not the runoff to the Vaal catchment, when practiced in the Bethlehem area of the southern Free State. The programme has since been moved to the escarpment areas of the Eastern Cape, where some measure of success was experienced in increasing the rainfall over commercial tree plantations. [Eales, et. Al, 1996]

Such a programme could possibly be replicated for the Olifants catchment. The possible benefits and costs would need to be properly investigated. This would require a pilot project to assess the benefits and costs.

For the purpose of this strategy this option was not further explored or considered as a result of the possible negative social and environmental impacts that were pointed out.

Rainfall enhancement could increase the size and frequency of floods. There could also potentially be an impact on the Reserve, but this is difficult to predict.

6.4. GROUNDWATER DEVELOPMENT

6.4.1 Description

Groundwater is the only source of water supply in many places, especially rural areas, where it is used mainly for domestic and stock watering purposes. **Figure 2.8** shows the principal groundwater occurrence in the various aquifer types across the basin calculated from the borehole yields on the National Groundwater Data Base (NGDB). It is clear from the map that almost 80 to 90% of boreholes in aquifers across the basin yield less than 2ℓ/s. The map confirm the previous conclusions that the higher yielding aquifers are the karst and fractured karst aquifers in the Delmas and Escarpment area and the

Intergranular and Fractured aquifers in the Springbok Flats and Hoedspruit areas. Generally new groundwater development can only be used for domestic and stock watering and supply for small villages supplied by well fields. The high yielding aquifers in the Springbok Flats, Delmas and Zebediela areas are stressed and the only potential high yielding aquifer for development is the karst or dolomite aquifers of the Eastern Escarpment.

In the Olifants WMA Strategies (DWA ISP, 2004) it is stated that there is still further development potential of the groundwater resources. However, detailed studies will be required at the local level to determine the additional potential sustainable yield. Two general groundwater development options can be considered to improve the available water resources in the future.

These are:

- The development of the under-exploited groundwater resource of the Escarpment Dolomite Aquifer;
- Conjunctive use of groundwater and surface water.

The exploitation potential of the Escarpment Dolomite Aquifer was investigated by Ages (2009). The water balance model they developed for this relatively-unexploited dolomite in the northern escarpment area of the Olifants River indicated that the groundwater balance in the dolomite aquifers is positive (60 – 90 million m^3/a) and can be used for future development as a regional groundwater resource. The topography, however, is mountainous and the population is sparse. A detailed study will be required to investigate the best localities for development and areas (communities) that will benefit from supply from this resource.

A possible regional water supply scheme could consider the construction of a weir on the farm Godwinton on the Olifants River as an option to recharge surface water back into the dolomite formation where it can be abstracted for bulk supply to areas with low water resources. The proposed weir will block the river flow and push water back upstream, providing an opportunity for recharge to take place into structural features in the dolomite. The locality of the weir is about 25 to 30 kilometres downstream from where the Olifants River enters the dolomite formation in the escarpment. The river bed level falls about 50 m over this distance, indicating the weir height required to inundate the full river reach which is on dolomite. This water could then be distributed to new users through new infrastructure. Conjunctive groundwater/ surface water use is applicable to groundwater resources with unacceptable drinking water quality, e.g. where boreholes yield water which contains natural fluorides or nitrates. Poor quality groundwater can be used conjunctively (diluted) with surface water to reduce the parameters to acceptable levels. The conjunctive use with surface water can reduce the salinity of groundwater resources and reduce the cost of treatment for selected uses. Groundwater can replace surface water use in agricultural to make it available for domestic use. A detailed investigation is required to select the areas where conjunctive use with groundwater resources can be implemented.

For the purpose of this reconciliation strategy, it was assumed that only half of the estimated groundwater potential of 70 million m^3/a can be exploited. By studying the groundwater availability map of **Figure 2.8**, it was further assumed that the breakdown of the 35 million m^3/a, exploitable groundwater between the management zones will be as follows:

- Upper Olifants 5 million m^3/a
- Middle Olifants 15 million m^3/a, and
- Lower Olifants 15 million m^3/a.

The effect of groundwater abstraction on the surface water flow is still uncertain. If, for example, water is abstracted from the Malmani Dolomite aquifer, and it reduces the low flow in the Olifants River somewhere lower downstream, it could have an impact on the ecological environment in that stretch of river. This aspect needs to be carefully investigated.

For the purposes of the Preliminary Reconciliation it is assumed that only 35 million m^3/a (50% of the reported available yield) can be exploited and that groundwater projects will progressively be developed over the next 16 years.

6.4.2 Comparative environmental assessment of groundwater options

The following issues have been identified:

- Potential environmental impacts of well fields are dewatering or lowering of sustainable yield of the local aquifer due to mismanagement or over utilisation. If the utilisation of well fields is not monitored and managed in a sustainable manner it may impact on adjacent landowners using ground water.
- Groundwater abstraction may negatively impact on the surface water flow. If, for example, water is abstracted from the Malmani Dolomite aquifer, and it reduces the low flow in the Olifants River somewhere downstream, it could have an impact on the ecological environment in that stretch of river. This aspect needs to be carefully investigated.
- Potential contamination of the local aquifer by means of surface activities such as on-site sanitation, landfill sites, leaking or unlined or over flowing sewage treatment works (oxidation dams) also poses a threat to the access to clean groundwater resources for use by communities and industries.
- **Figure 6.1** indicates the location of terrestrial ecosystems in South Africa that, according to SANBI, are expected to be dependent on groundwater. Any use of groundwater that impacts on the groundwater level could impact negatively on the ecology in these areas. In the Olifants River catchment the areas identified as having a medium probability of being aquifer dependent are associated with the dolomitic areas in the catchment.

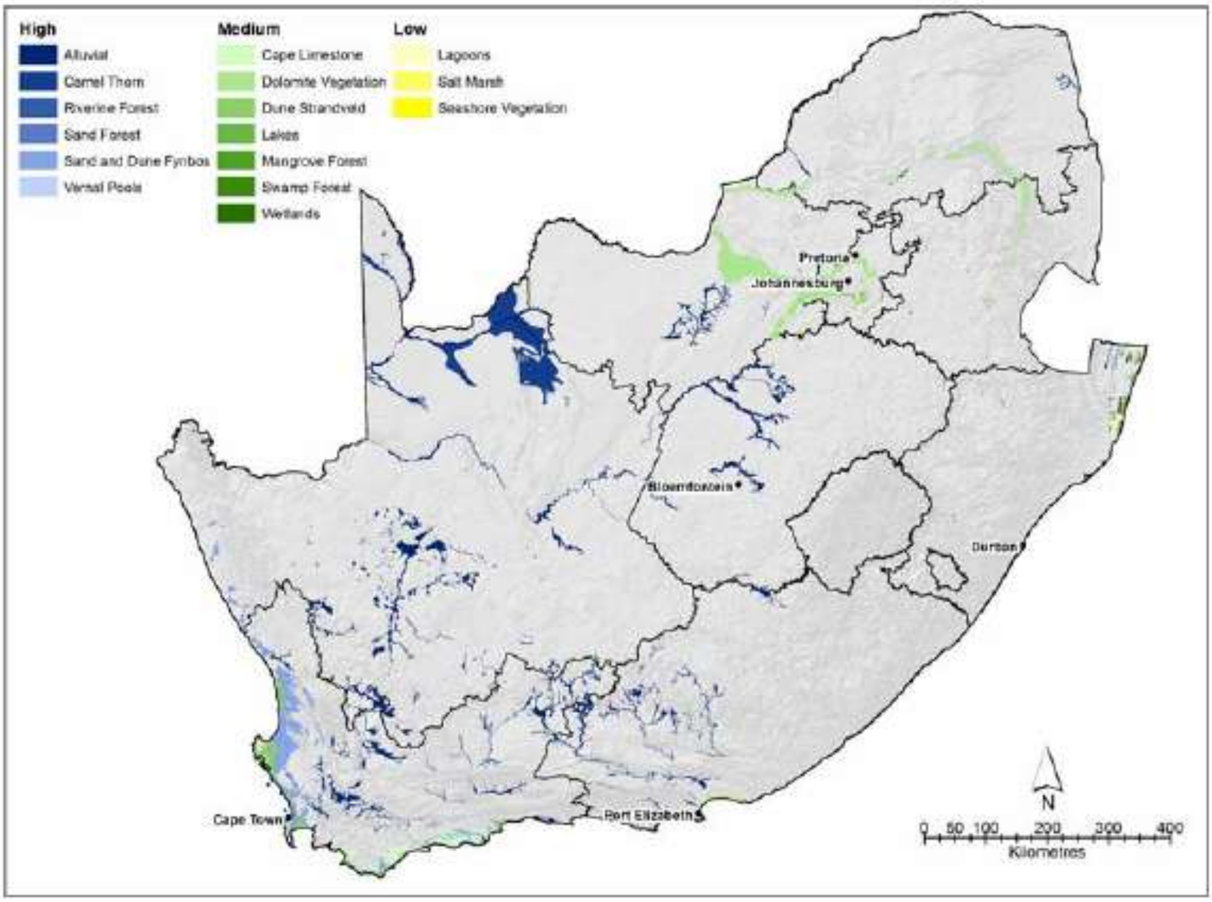


Figure 6.1: Groundwater dependent ecosystems in South Africa (No fatal flaws have been identified)

6.5. WATER TRANSFERS

6.5.1 Transferring treated effluent from the East Rand

It is possible to pump treated effluent from the Vaal System over the catchment divide into a tributary of the Upper Olifants River. For this assessment, the seven most suitable treatment works in the Vaal River Basin were selected. The concept of the project is shown on the map in **Figure 6.2** and the details are given in **Table 6.1.**

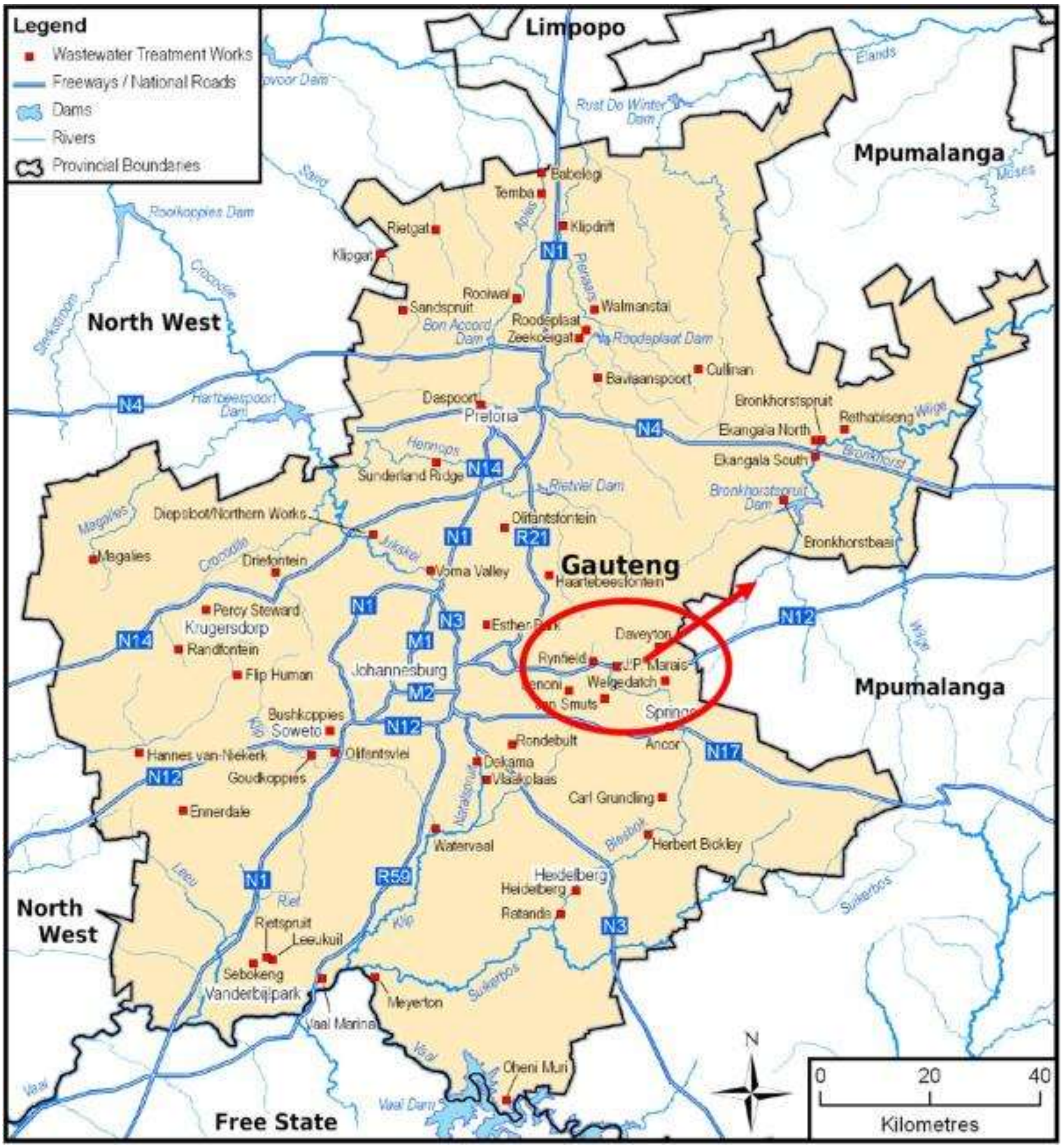


Figure 6.2: Waste Water Treatment Works in Ekurhuleni

While the water is assumed to comply with the "general standard", this is considered to be unacceptably high in nutrients for discharge into the Olifants System, so provision has been made for tertiary treatment (potentially reverse osmosis) of the effluent so as to have a maximum phosphate content of 0,1 mg/ℓ.

The effluent will, as far as possible, be pumped from one Waste Water Treatment Works (WWTW) to another, with a central collection point at Daveyton. There the effluent will be treated before being pumped over the divide to the Olifants catchment to a point about 10 km north of Delmas.

Table 6.1: Details of assumed Treated Effluent Schemes

WWTW	Location	Capacity (Mℓ/d)	Assumed Yield[1]		Pipeline							Pumps (kW)	Dam (Ml)	Cost (R Million)	URV (R/m³)
			(million m³/a)	(m³/s)	Destination	(m³/s)	Km	Start El	High pnt	End El	Diam				
Daveyton	Daveton	16	4.7	0.148	Discharge pt	1.213	21.6	1 590	1 633	1 536	900	650	17	301	0.81
JP Marais	Benoni	15	4.4	0.139	Daveyton	0.445	9	1 597	1 629	1 590	600	310	6	96	0.67
Rynefield	Benoni	13	3.8	0.120	JP Marais	0.120	3.9	1 605	1 608	1 597	300	62		35	1.05
Benoni	Benoni	10	2.9	0.093	JP Marais	0.093	9.7	1 653	1 657	1 597	300	27		65	2.32
Jan Smuts	Brakpan	10	2.9	0.093	JP Marais	0.093	7.2	1 602	1 605	1 597	400	48		42	1.25
Welbedacht	Springs	35	10.2	0.324	Daveyton	0.620	7	1 577	1 607	1 602	700	424	9	96	0.62
Ancor	Springs	32	9.3	0.296	Welbedacht	0.296	12.5	1 573	1 573	1 601	500	260		121	1.44
		131	38.3	1.213			70.9							466	3.83[2]
Tertiary Treatment Works at Daveyton WWTW: Capacity 136 Mℓ/day														657	3.48
													TOTAL (Excl VAT)	**1 123**	**7.31**

1 Assumed equal to 80% of capacity

2 Weighted averages accumulated along the route

The discharge point has not yet been investigated in terms of the receiving stream's capacity, so it might be necessary to move this further downstream, or to undertake river protection measures.

The effluent from these WWTWs currently flows into the Vaal River and has been taken into account in the calculation of the Vaal River System yield. Transferring this water to the Olifants will mean that the next Vaal River augmentation scheme after the Lesotho Highlands Water Project-Phase II (LHWP2), which has a tariff of R6.14/m^3 will be required sooner than otherwise. LHWP2 will only be able to supply water by 2021 by when there will already be shortages on the Vaal. Their actual current and likely future discharges have not been determined at this stage, and only their design capacities are known. Because of the seasonal peaks typical of effluent discharges, it has been assumed that 80% of the capacity will be available to transfer on a continuous basis. The combined yield of the selected works is then 38.3 million m^3/a.

Preliminary estimates of costs and Unit Reference Values (URVs) based on 2010 cost levels, for this option is also given in **Table 6.1**. While this scheme obviously lends itself to being implemented in phases, it has been assumed at this stage that the entire scheme will be implemented at once.

Comparative environmental assessment of transferring treated effluent from the East Rand

The following issues have been identified:

- New servitudes for pipeline routes over private farmland and/or urban areas will be required.
- Increased stream flows in the Olifants River will increase vegetation on riverbanks.
- Possible contamination (hormones, etc.) could endanger aquatic life along the river.
- Recreation on the river banks might be impacted by aesthetic effects.
- Water quality in the Bronkhorstspruit Dam will potentially deteriorate (increased nutrient and dissolved salts levels), with possible algae growth which could have an impact on recreation at the dam and on the river.
- Potential health risk to recreational users of the river and dam should they become contaminated over time (*e.g.* with hormones, pathogens), or should algal growth become problematic.
- Possible reduced flows in the Crocodile-West catchment.

No fatal flaws have been identified.

6.5.2 Transferring more water from Vaal Dam

DWA has recently commissioned a scheme (the Vaal River Eastern Sub-System Augmentation Project (VRESAP) scheme) which pumps 160 million m^3/a of raw water from the Vaal Dam to the Vaal-Olifants watershed. This water is fully committed to Sasol at Secunda in the Vaal catchment and ESKOM in the Upper Olifants catchment. This scheme comprises a 1 900 mm diameter pipe over 110 km, to Knoppiesfontein on the Watershed, from where it gravitates down a 20 km long pipe to discharge into the Trichardtspruit, a tributary of the Olifants River.

This scheme could be duplicated to transfer another 160 million m^3/a, into the upper Olifants River. The costs of the VRESAP scheme, escalated to 2010, amounts to about R3 500 million. The Nett Present Value (NPV) of operational and maintenance costs amounts to R4 923 million which gives a URV of R3.60/m^3. It should, however, be noted that the Vaal River raw water tariff must be paid for all water supplied from that area. Considering that the water will only be available after the construction of LHWP2, this tariff will be significant. While the tariff is not yet known, the URV of the LHWP2 is R6.14/m^3. Augmentation of the Vaal after LHWP2 will also have to be brought forward.

Comparative environmental assessment of transferring more water from the Vaal Dam

This option would consist in duplicating the VRESAP scheme and the potential impacts would therefore be the same. In particular, the following issues have been identified:

- New servitudes for pipeline routes over private farmland and/or urban areas will be required.
- Increased stream flows in the Olifants River will increase vegetation on riverbanks and could impact on the implementation of the Reserve.
- Impacts on conservation areas, wetlands and roads will have to be taken into account when selecting a pipeline route.
- The Vaal River raw water tariff applies for all water supplied from that area. This tariff will be significant as the water will only be available after the construction of the next phase of the Lesotho Highlands Water Project (LHWP).
- Organisms from the Vaal Dam will inevitably be transferred with the water and could impact on the ecology of the receiving water body. Water is, however, already being transferred from the Vaal Dam, and this effect will not be new.

No fatal flaws have been identified.

6.5.3 Water transfer from the Crocodile (West) River System

Flows in the Crocodile (West) river are continuously increasing as a result of increasing discharges from numerous waste water treatment works (WWTW) which discharge into various tributaries of the main stem river. These works collect effluent from the whole of the City of Tshwane and the northern half of Johannesburg, totalling a considerable volume. However, much of this water enters the Crocodile (West) River relatively far downstream on the westward flowing river, and the cost of pumping the furthest water to the Olifants River would be exorbitant.

There are also water requirements in other areas which may be supplied from the Crocodile (West) System and these include the supplies to Tshwane and Johannesburg Metros and augmenting the Mokolo System.

In other studies for DWA, the increase in the yield of existing dams, as a result of the increasing inflows on the Crocodile (West) and its tributaries have been calculated. This study focused on the available increasing yield of the closest dams, as listed in **Table 6.2**.

Table 6.2: Water Available from selected Crocodile (West) River Dams (million m^3)

Dam	2015	2020	2030
Hartebeespoort dam	24.0	29.0	58.5
Klipvoor Dam	0	4.7	17.0
Roodeplaat dam	26.5	36.0	33.0

Source: BKS, Support to the Mokolo-Crocodile WAP Team (Draft)

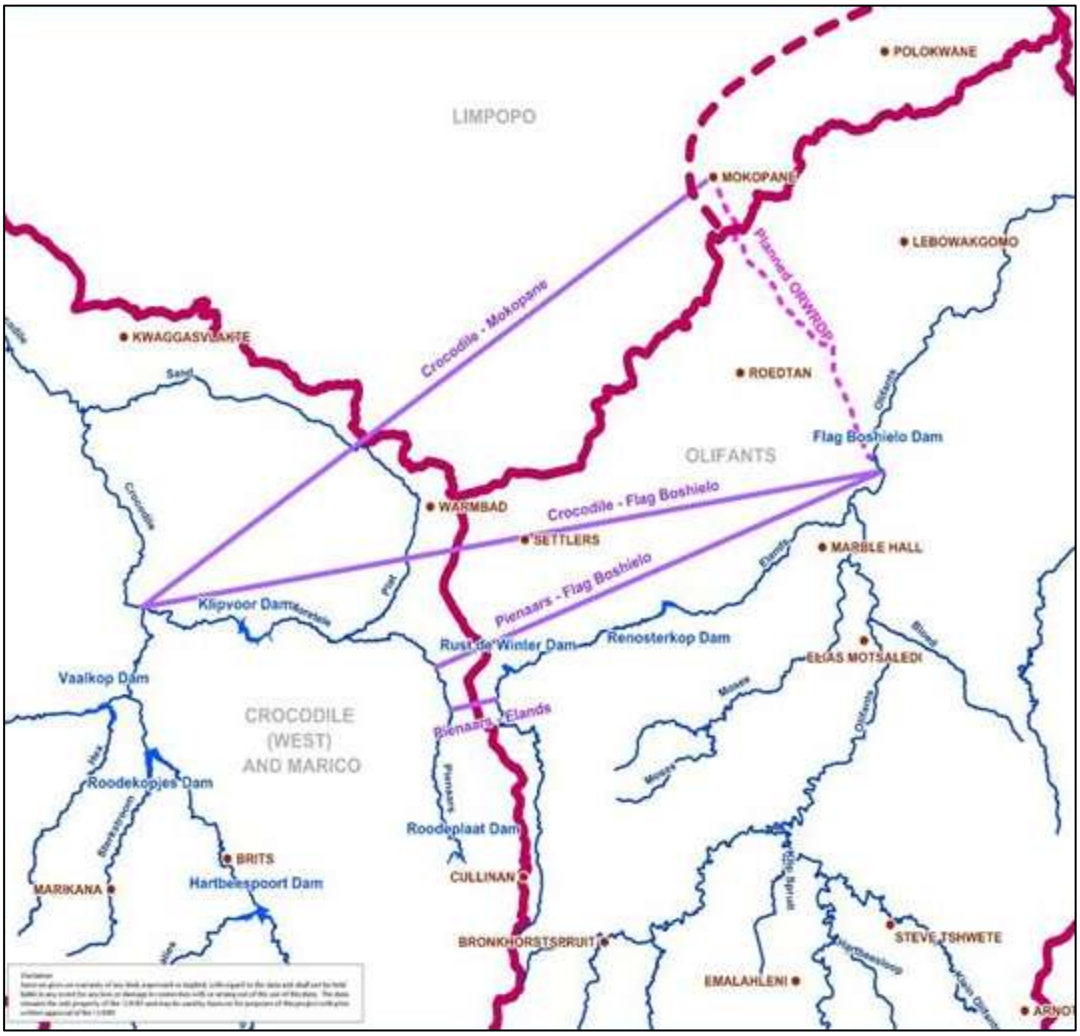


Figure 6.3: Crocodile (West) – Olifants transfer options

As shown on **Figure 6.3** and in **Table 6.2** four options have been considered, namely:

i) To abstract water from a weir on the Pienaars river some 40 km downstream of Roodeplaat Dam and pump it in a 12 km long pipeline to discharge it into a tributary of the Elands river. The water would then flow down the river for 10 km, through the Rust De Winter Dam, another 45 km down the river, through the Mkhombo Dam and another 70 km down the river to the Flag Boshielo dam. The rivers are known to suffer from high losses and to calculate the URV it has been assumed that only 50% of the water pumped will reach Flag Boshielo Dam. Despite the apparently relatively low costs, uncertainty about the extent of the losses which occur, and the possibility that very little water might reach the Flag Boshielo Dam, result in this option being considered a high risk and it is not favoured.

ii) To abstract water from a weir on the Pienaars river some 55 km downstream of Roodeplaat Dam and pump it through a 115 km long pipeline, to discharge into the Elands river just upstream of the Flag Boshielo Dam.

iii) To abstract water from the Crocodile river just downstream of the confluence of the Moretele river confluence and pump it through a 180 km long pipeline, to discharge it just upstream of the Flag Boshielo Dam.

iv) To abstract water from the Crocodile river just downstream of the confluence of the Moretele river confluence and pump it through a 180 km long pipeline, to discharge it at Pruissen outside Mokopane. This alternative would replace a scheme planned by DWA (ORWRDP-2B) to transfer water from Flag Boshielo to the same point, making that volume of water available for other users in the Olifants region. The cost of that scheme must be compared with the cost of first transferring the water from the Crocodile to Flag Boshielo Dam and the transferring it to Mokopane.

The estimated cost of each of the four options is set out in **Table 6.3**, as well as the URVs. The Pienaars-Elands option is by far the cheapest, but the transmission losses along the Elands River are a point of great uncertainty.

Table 6.3: Details of Crocodile (West) Transfer Options

Transfer Option	Pipe Length (km)	Supply (million m^3/a)	Cost (million m^3/a)	URV (R/m^3)
i) Pienaars - Elands	12	30/15	213	1.57
ii) Pienaars – Flag Boshielo Dam	115	30	1 268	3.82
iii) Crocodile – Flag Boshielo	180	60	3 926	6.43
iv) Crocodile - Mokopane	180	25	3 728	14.51
ORWRDP-2B: Flag Boshielo - Mokopane	**72**	**25**	**1 034**	**5.37**

An important observation is that the Pienaars-Flag Boshielo Dam (Option ii) added to the planned ORWRDP-2B pipeline from Flag Boshielo Dam to Mokopane, is actually cheaper (has a lower URV) than option (iv), the pipeline from the Crocodile (West) River directly to Mokopane. Was this not the case, the ORWRDP-2B pipeline would have to be reconsidered. The reason for the high URV is the high pumping cost to lift the water over the Crocodile-Mogalakwena watershed.

The following environmental issues have been identified:

- The Pienaars River has high nutrients which could impact on the water quality in the Olifants river.
- New servitudes for pipeline routes over private farmland and/or urban areas will be required.
- Increase stream flows in the Olifants River will increase vegetation on riverbanks and could impact on the implementation of the Reserve.
- Impacts on conservation areas, wetlands and roads will have to be taken into account when selecting a pipeline route.
- Organisms from the Crocodile West River system will inevitably be transferred with the water and could impact on the ecology of the receiving water body.

No fatal flaws have been identified.

6.6. DAM OPTIONS

The existing ratio of storage to MAR indicates that yield can be increased through storage.

A number of options have been investigated but it is probable that only one will be sufficient to meet future requirements.

The economics of dam construction for agriculture is generally unfavourable. Upstream dams will significantly reduce the yield of any downstream dams.

6.6.1 Raising of the Blyderivierspoort Dam

The existing Blyderivierspoort Dam at the location shown on Error! Reference source not found. **Figure 6.4** is a gravity arch structure in a particularly narrow section of the Blyde River canyon.

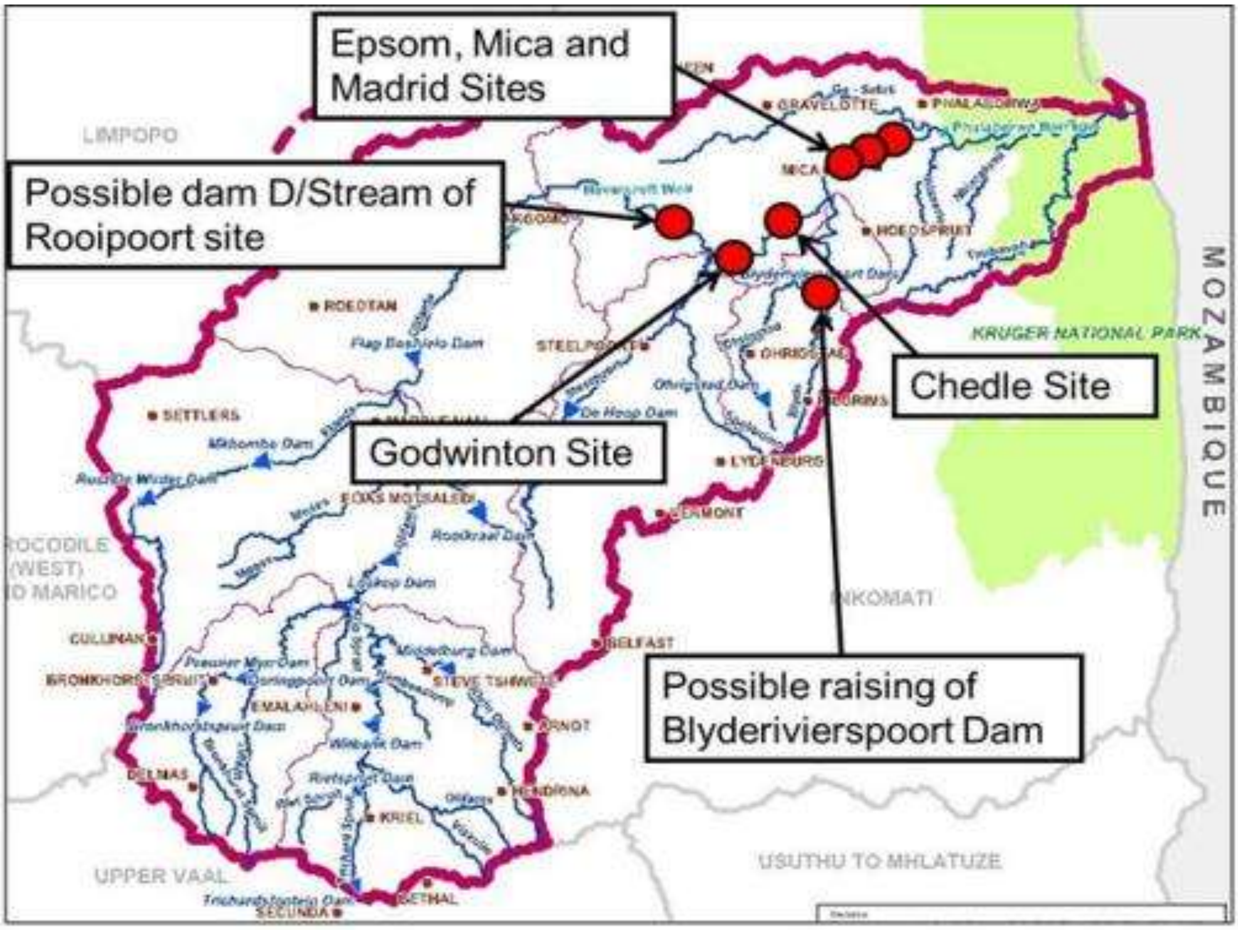


Figure 6.4: Possible Dam sites

The existing storage capacity is 54,6 million m^3/a, which is only 20% of the present day MAR. This means that there is scope for raising. However, a site visit showed that the site is ideal for the height of the existing dam and raising the dam will pose some challenges.

Topographically, an extension of the left flank will need to run at an upstream angle along the highest route up a flat ridge, and there is no left flank to take the thrust from a gravity arch any higher than the current level.

The most recent dam safety evaluation reported that the original geotechnical investigation had concluded that the site was unsuitable for an arch dam due to the weak rock, particularly at the higher levels of the existing structure. Of particular concern was the presence of a narrow band of shale near the top of the existing structure, and the dam safety evaluation expressed concern that two blocks on the left flank were at risk of failure if the shale had weathered as a result of saturation by the water in the dam. Converting the existing structure to a gravity dam will reduce the resulted stresses in the foundation and would ameliorate this problem.

It is therefore proposed that the dam can be raised by flattening the downstream slope and designing the existing structure as a gravity dam which, in plan, follows the existing structure. This will allow the alignment to kink at the flanks of the existing structure. While it has been assumed for the costing undertaken for this study, that the raised flanks will also be gravity structures, it is much more likely that the raised left flank will be in the form of an embankment.

The stability of the ridge on the left bank must also be investigated as part of any future studies. Raising the dam by 35 m and 55 m has been considered. The 55 m raising will increase the yield of the dam by 110 million m³. The estimated cost of such a project will be R2.98 billion with a URV of R2.99/m³.

Comparative environmental assessment of raising the Blyderivierspoort Dam

The following issues have been identified:

- The Blyderivierspoort Dam is in a protected area in terms of the Mpumalanga Biodiversity Conservation Plan (MBCP) (**Figure 6.11**) and contributes to conservation targets.
- The site is situated in a highly sensitive area, at the interface of 3 bioregions (Central Bushveld bioregion, Mesic Highveld Grassland and Lowveld bioregion) (**Figure 6.6**), within the Wolkberg centre of endemism (**Figure 6.5**) characterised by high biodiversity and many unique plant species which are of high priority in terms of conservation.
- In addition to construction related impacts, the raising of the dam would result in the permanent loss of biodiversity.
- 120 ha of additional land would be inundated for 15 m raising, 285 ha for 35 m raising, mostly forestry.
- The Blyderivierspoort Dam is located in Zone F: nature conservation/tourism focus, in terms of the OLEMF (**Figure 6.7**); the main priority in this area with respect to water is that water supply in the KNP is not affected.
- Raising the Blyderivierspoort Dam would result in reduced flows downstream, these are however not considered significant provided the EWRs are met in the lower Blyde and through the KNP.
- No infrastructure will be inundated.
- The raising of the dam may involve potential visual impacts.

Failure to meet the EWRs in the lower Blyde and through the KNP is a potential fatal flaw.

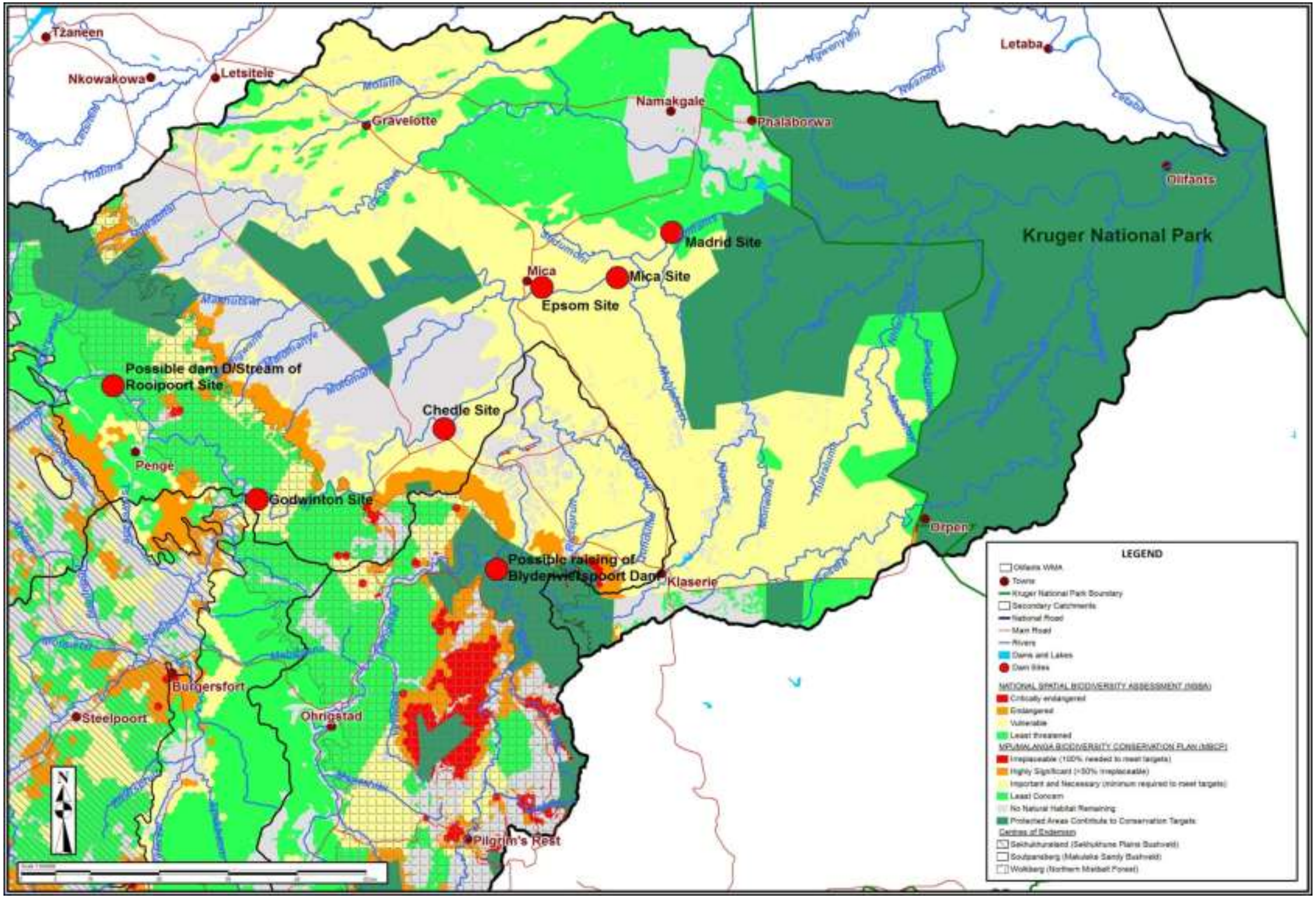


Figure 6.5: Location of dam sites in relation to biodiversity conservation

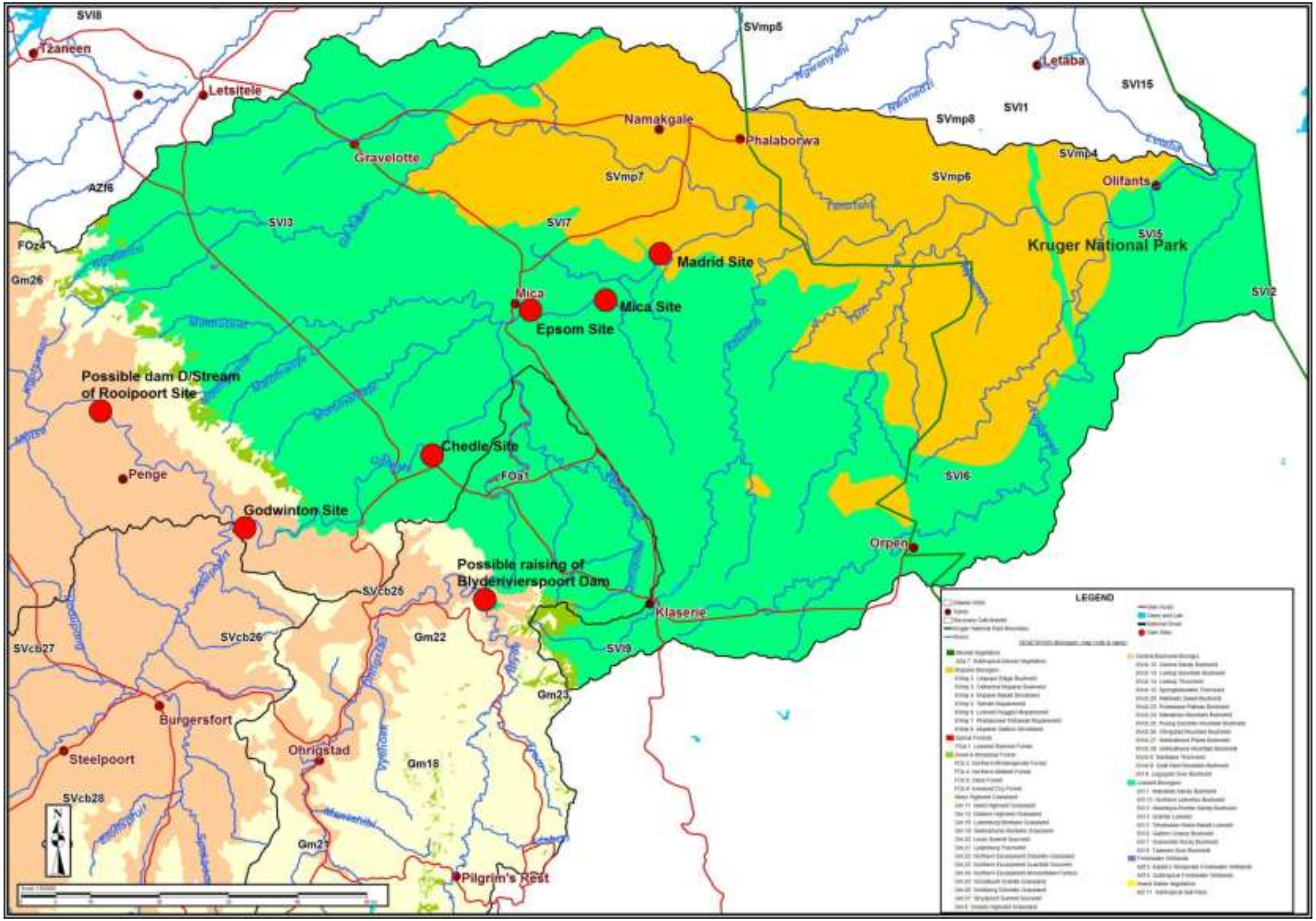


Figure 6.6: Dam sites in relation to vegetation

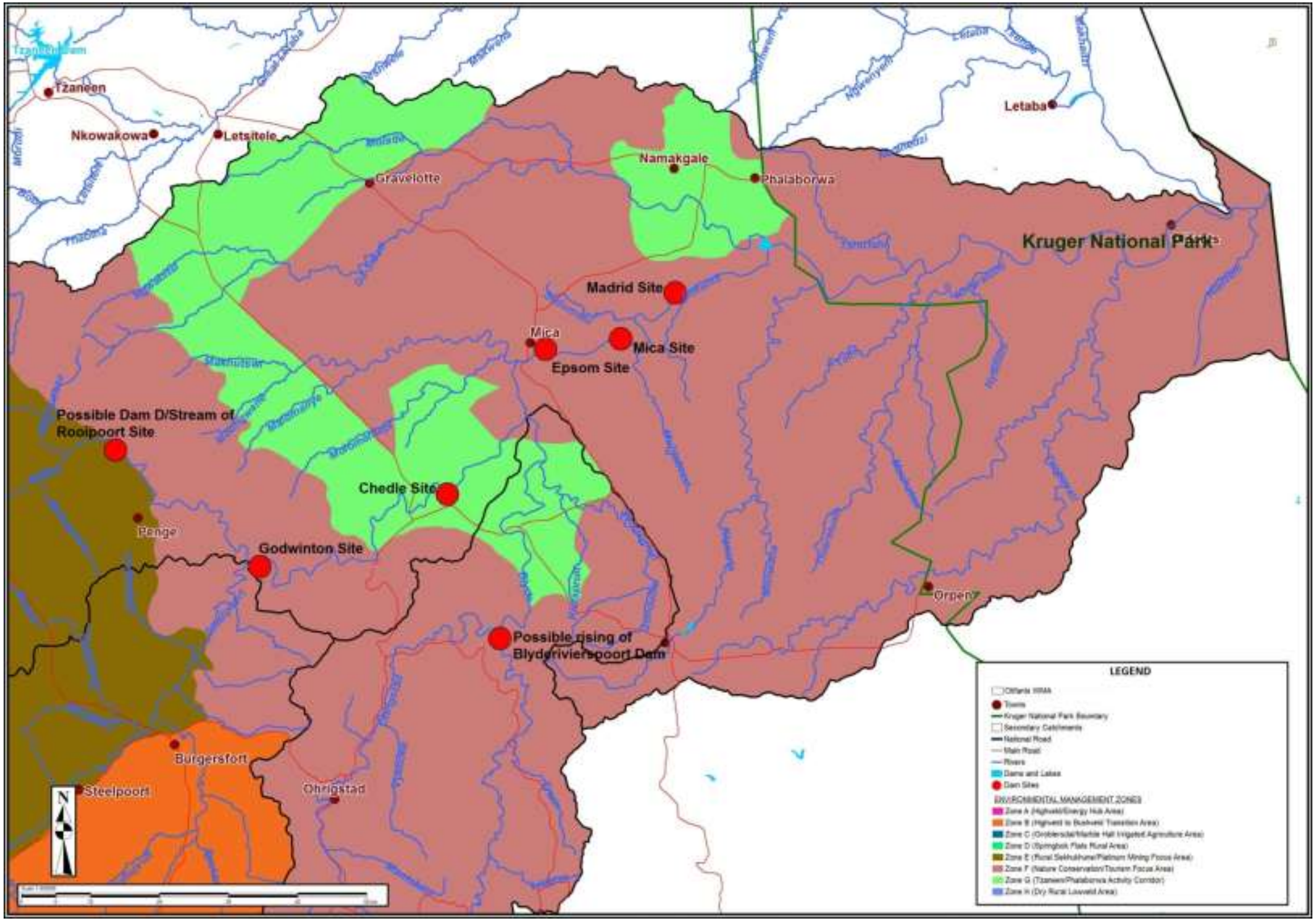


Figure 6.7: Dam sites in relation to Environmental Management Zones

6.6.2 New dam downstream of Rooipoort

In 1993 and again in 2001, DWA undertook feasibility studies for a possible dam on the Olifants River at Rooipoort, see **Figure 6.8**, but found that the dam was not very favourable for a number of reasons:

- The yield was relatively small because of the many upstream dams;
- Geotechnical investigations established that the dam had particularly unfavourable foundations;
- The dam would have flooded two provincial roads which would cost as much to relocate as the cost of the dam wall; and
- The dam would flood all or part of some 12 villages, requiring relocation of more than 300 households.

In 2007, DWA undertook a study to compare the Rooipoort Dam with the proposed De Hoop dam on the Steelpoort River. It was found that for the same construction cost, the De Hoop Dam yield was twice as much as the Rooipoort Dam, and did not have the serious social impacts as the Rooipoort Dam. The De Hoop site was therefore selected, and the dam is currently under construction.

A dam at a site identified some 20 km, show in **Figure 6.8**, downstream of Rooipoort might be more favourable, with a slightly higher yield, being downstream of the Mohlapitse tributary, and with fewer social impacts, but this has not been studied at this time.

As part of this study, yields have been recalculated for the Rooipoort dam using the same assumptions regarding upstream catchment conditions as for the other dams described below. Costs have been escalated to 2010 levels from previous 2007 estimates.

The yield is estimated at 59 million m^3/a and the cost will be in the order of R1140 million with a URV of R2,14/m^3.

Any dam on the Middle Olifants River similar to the Rooipoort site is likely to require the relocation of households together with schools, businesses, etc. and could also inundate significant areas of irreplaceable agricultural land. The impact is provisionally assessed as high.

Feasibility studies for a possible dam on the Olifants River at Rooipoort (**Figure 6.8**) have found that the site was not favourable for a number of reasons. (DWAF, 2004d).

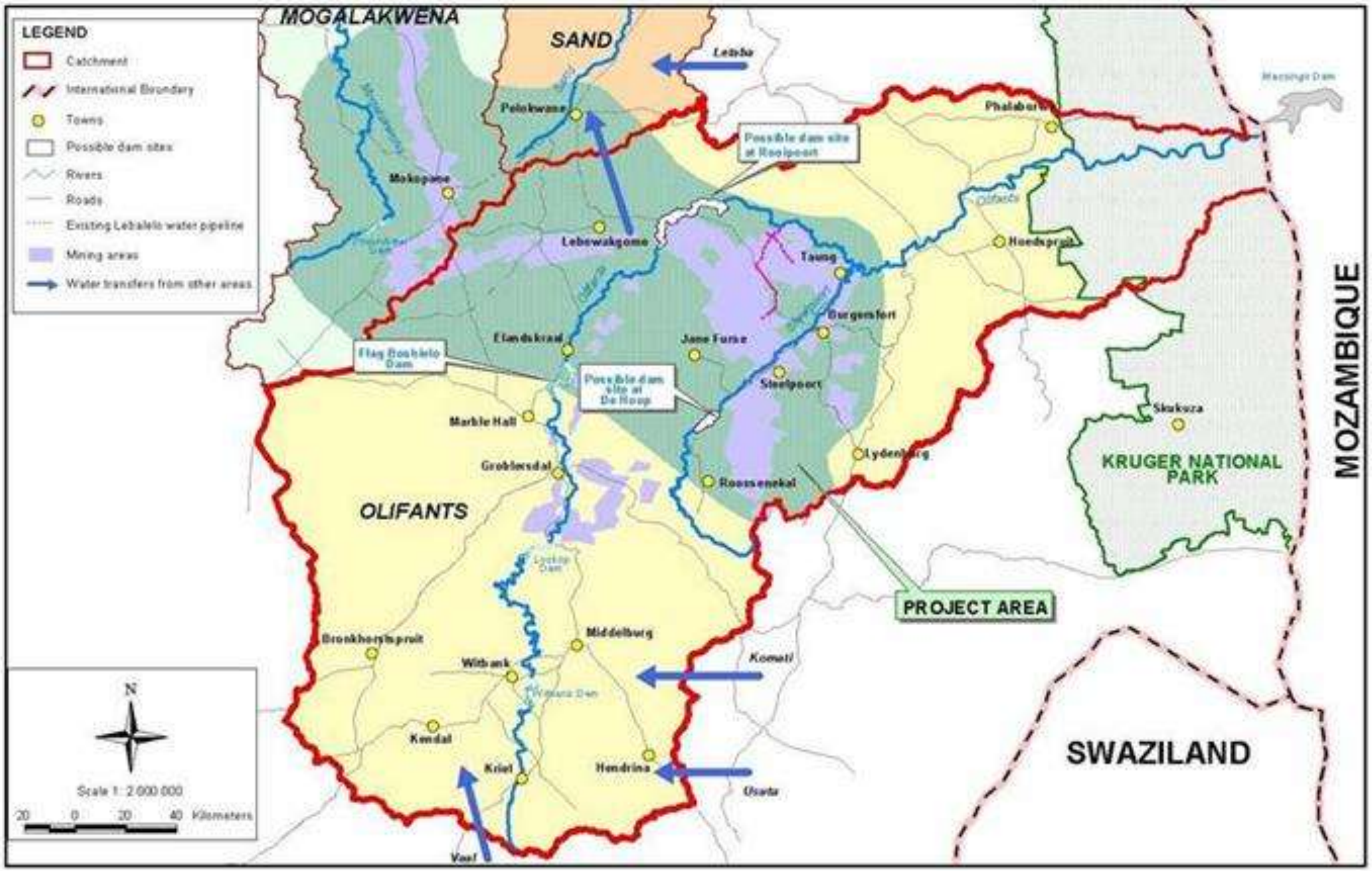


Figure 6.8: Proposed dam site at Rooipoort

A dam at a site identified some 20 km downstream of Rooipoort might be more favourable, with a slightly higher yield, being downstream of the Mohlapitse tributary, and with relatively few social impacts, although this has not been studied at this point in time.

Comparative environmental assessment of a new dam downstream of the Rooipoort Dam site

The following issues have been identified:

- The proposed dam site downstream of Rooipoort is located in the Wolkberg centre of endemism (**Figure 6.5**) characterised by high biodiversity and many unique plant species which are of high priority in terms of conservation.
- The site is situated in an area of medium environmental sensitivity (**Figure 6.10**).
- Although it is classified as least concern in terms of the Mpumalanga Biodiversity Conservation Plan (MBCP), the site is located within an area earmarked for the National Protected Areas Expansion Strategy **(Figure 6.9**) and as such is a focus area for contributing to biodiversity. It is also at the edge of the Biosphere Reserve Initiative (Kruger to Canyons).
- Any dam on the Middle Olifants River similar to the Rooipoort site is likely to require the relocation of households, schools, businesses, etc. and could also inundate significant areas of irreplaceable agricultural land. The impact is provisionally assessed as high.
- The dam will result in sedimentation.

This option raises a number of potential red flags in terms of its social impacts; failure to meet the EWRs in this part of the river system is a potential fatal flaw.

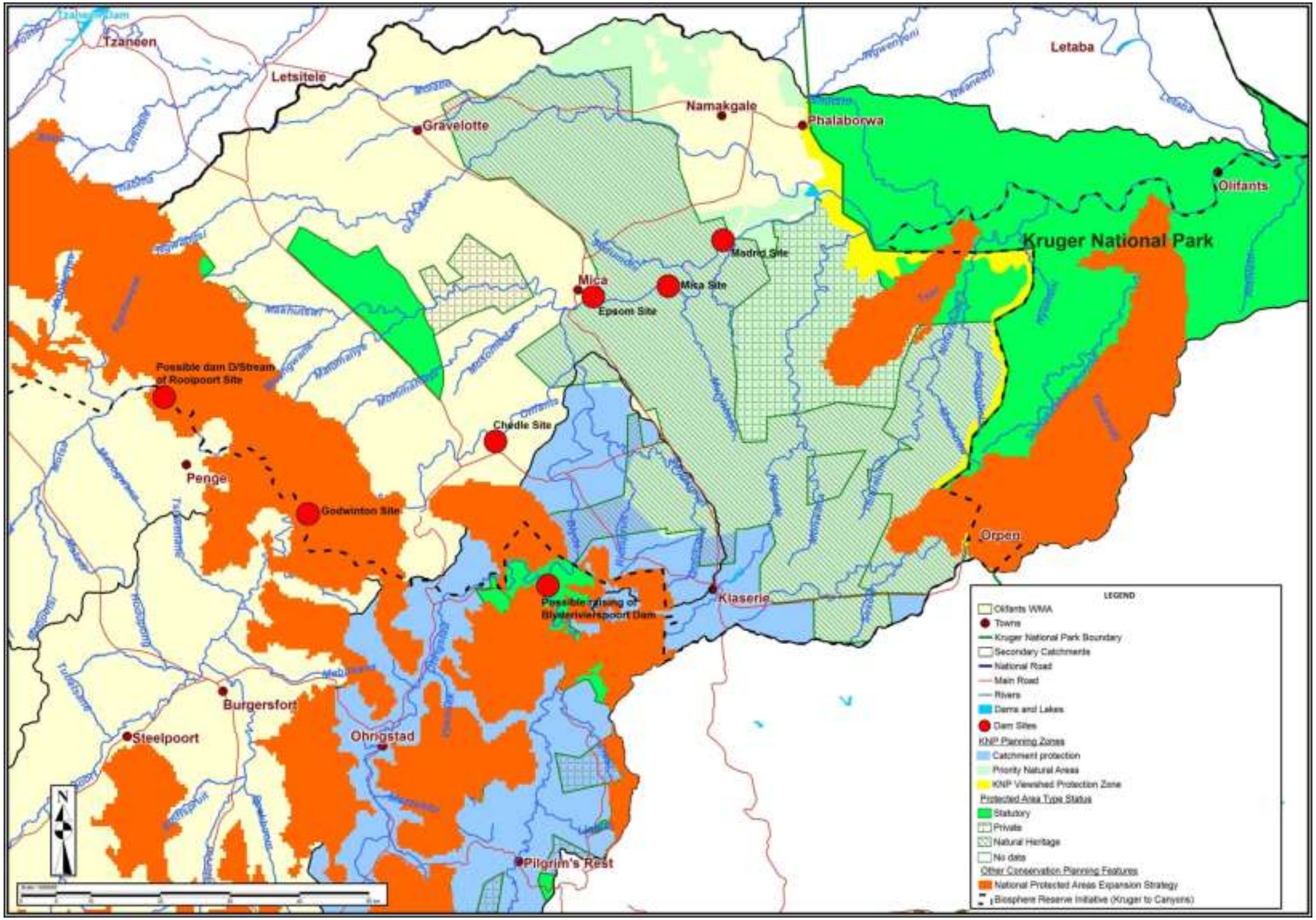


Figure 6.9: Dam sites in relation to conservation planning

6.6.3 New dams in the Olifants River Gorge

The Olifants River Gorge stretches for 152 km from the Steelpoort River confluence to the Strydom tunnel. Within this reach, the only access to the river is at the Ga-Madin village at 145 km.

Two potential dam sites have been identified on this reach, as indicated on **Figure 6.4**, namely:

(i) Godwinton, at km 12; and

(ii) Chedle, at km 140.

The Godwinton site is underlain by dolomite with chert beds. The Chedle site is underlain by micaceous graphitic shale inter-layered with sandy shale, but pushes the water back into the dolomite area which extends upstream to well beyond the maximum dam water levels.

The typical cavernous nature of dolomites means that the foundations of the Godwinton site must be proven by detailed geotechnical investigations. More important is the possibility of both dams draining into the dolomites, either putting water into an enormous and inaccessible sink, or perhaps providing additional storage. Detailed investigations will be required of water table levels around the dam basin. It will be required to determine whether water will drain into or out of the dams, and to what extent.

Another opportunity, as yet quite unexplored, is that the dolomitic geology in the vicinity of the Godwinton and Chedle sites could allow for the underground storage of Olifants River water by directing this into dolomitic caverns as artificial recharge. If this water could be stored in, and recovered from, these dolomitic aquifers it could reduce or even eliminate the need for a storage structure. Whilst this opportunity is at this stage uncertain, more certainty would be an outcome of the geological studies required by a feasibility study into the construction of Godwinton or Chedle, and may warrant investigation in its own right.

Both sites are topographically suitable for very high dams, but the maximum height is limited by the resultant flooding of a number of villages on the banks of the Steelpoort River. For the purpose of this report, it has been assumed that the full supply level (FSL) should be limited to 610 masl (MFL 620 masl) making the Godwinton Dam 60 m high and the Chedle Dam 70 m.

The Godwinton site is particularly well located to supply water to the major pump station currently being planned at Steelpoort as part of the ORWRDP-2, should it be necessary to supplement supplies from De Hoop Dam.

Either of these dams would yield in the order of 100 million m^3/a. The cost estimates for both of these dams, i.e. R52 million for Godwinton and R111 million for Chedle could be gravely underestimated because of the difficulties of access to the sites. The URVs of the two dam sites of R0,23 /m^3 and R0,29/m^3 respectively could also be much higher because of inaccessibility for construction equipment, but will still be the lowest URVs of all the development options.

Comparative Environmental Assessment of new dams in the Olifants River gorge

The following issues have been identified:

- Due to the geology characterising both sites, there is a possibility of both dams draining into the dolomites, either putting water into an enormous and inaccessible sink, or perhaps providing additional storage. Detailed investigations will be required of water table levels around the dam basin and to determine whether water will drain into or out of the dams, and to what extent. If the water could be stored in, and recovered from, these dolomitic aquifers it could reduce or even eliminate the need for a storage structure.
- The maximum height of both dams is limited by the resultant flooding of a number of villages on the banks of the Steelpoort River. Assuming that the full supply level (FSL) should be limited to 610 masl (MFL 620 masl), making the Godwinton Dam 60 m high and the Chedle Dam 70 m, construction of the dams would require the relocation of some 30 households and a school. Raising the FSL by 20 m would flood an additional 65 households.
- The environmental impact of both the Godwinton and Chedle Dams on the pristine river gorge is expected to be high.

The following issues have been identified for the Godwinton site:

- The proposed Godwinton Dam site is located in the Wolkberg centre of endemism (**Figure 6.5**), characterised by high biodiversity and many unique plant species which are of high priority in terms of conservation.
- Biodiversity in the area is classified as important and necessary in terms of the Mpumalanga Biodiversity Conservation Plan (MBCP), and as vulnerable in terms of the National Spatial Biodiversity Assessment (NSBA) (**Figure 6.5**).
- The site is located within an area of medium environmental sensitivity (**Figure 6.10**) earmarked for the National Protected Areas Expansion Strategy and as such is a focus area for contributing to biodiversity. It is also at the edge of the Biosphere Reserve Initiative (Kruger to Canyons) (**Figure 6.9**).
- It is located in Zone F in terms of the OLEMF: nature conservation/ tourism focus (**Figure 6.7**).

The following issues have been identified for the Chedle site:

- There is no natural habitat remaining at the proposed Chedle Dam site according the Mpumalanga Biodiversity Conservation Plan (MBCP) (**Figure 6.5**) and the environmental sensitivity in the area is very low (**Figure 6.10**). As a result the impact in terms of biodiversity conservation (**Figure 6.9**) would be lower than the Godwinton site. The site is however located within the Biosphere Reserve Initiative (Kruger to Canyons).

This option raises some potential red flags, failure to meet the EWRs in this part of the river system is a potential fatal flaw.

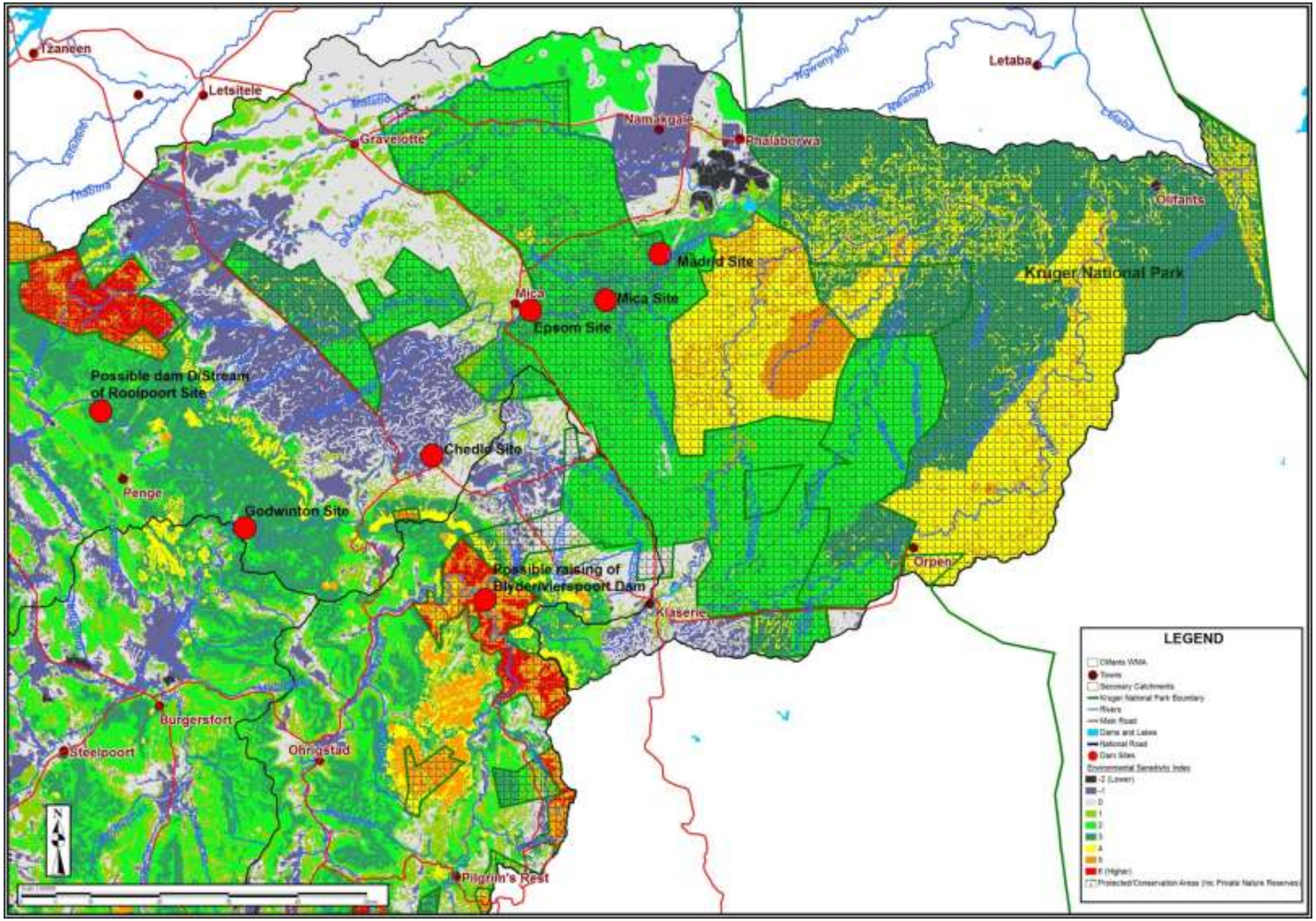


Figure 6.10: Dam sites in relation to environmental sensitivity

6.6.4 New dams in the Lower Olifants River

To maximise the yield from the Olifants River, it is necessary to capture the flow from all the major tributaries. The reach immediately downstream of the Blyde River confluence has therefore been examined and three possible dam sites, shown in **Figure 6.4**, have been identified, namely:

(i) Epsom
(ii) Mica
(iii) Madrid

The Epsom site is located immediately downstream of the Blyde/Olifants confluence, which makes it favourable in that water will be stored in both river valleys. The valley is relatively flat and a 50 m high dam (FSL 430 masl) would require a 1,7 km long dam wall, plus a 150 m long saddle dam. A 60 m high dam would require a 3 km long wall. The 50 m high dam will flood relatively small areas of irrigated land on both the Olifants and Blyde Rivers, but the areas have not been estimated as this would be very dependent on tail water effects.

The Mica site is located 8 km downstream of the Blyde River confluence, and the Madrid site is some 20 km further downstream. Neither site is topographically very suitable, being in a flat valley, and both sites will require long dam structures. Both sites are limited to a dam wall height of approximately 60m and even at this level will require significant saddle dams to close low spots between surrounding hills.

The main difference between the two sites is the infrastructure, which would be inundated and which would need to be relocated. The R40 provincial road and a railway line cross the Olifants River at Mica, and R530 crosses the Makhutswi tributary near its confluence with the Olifants.

A dam at the Madrid site (**Figure 6.4**) would inundate all three bridges (R40, R530 and rail), which would need to be replaced at a much higher level with high approach fills, and the roads and railway line would have to be relocated over a significant distance. Some 3,5 km of the R530 would be inundated.

The Mica Dam site is located downstream of only the R530 road bridge. Although a portion of the railway line will need to be relocated, its bridge need not be affected. However, restriction on the dam wall height limits the storage capacity of the Mica site to only 514 million m^3, which is equivalent to 0,5 Mean Annual Runoff (MAR), while at the same site the Madrid site can store 1 700 million m^3 or 1,5 MAR.

All three options will inundate significant areas of relatively pristine riverine vegetation, but this is considered to be a relatively low impact. The main biophysical impact will be on the downstream river ecology, especially through Kruger National Park, and depending on the extent to which EWRs are met, the impact could be anywhere between positive to severely negative.

Only the Madrid and Epsom dams have been costed, and for the more favourable Epsom dam, the cost was estimated at R4 820 million, which is very high. Either dam would however yield approximately 286 million m³/a provided there are no new upstream dams which results in a relatively favourable URV of R1,58/m³. The Madrid dam could yield more, but at a higher URV.

Located in the Lowveld: extremely Irregular undulating Plains.

The following issues have been identified for the Epsom site:

- The valley is relatively flat and a 50 m high dam (FSL 430 masl) would require a 1,7 km long dam wall, plus a 150 m long saddle dam. A 60 m high dam would require a 3 km long wall. The 50 m high dam will flood relatively small areas of irrigated land on both the Olifants and Blyde Rivers. The extent of these areas has however not been estimated and would be very dependent on tail water effects.

The following issues have been identified for the Mica and Madrid sites:

- Neither site is topographically very suitable, being in a flat valley, nor will both sites get away with short dam structures. Both sites are limited to a dam wall height of approximately 60m and even at this level will require significant saddle dams to close low spots between surrounding hills.
- Both sites would require infrastructure to be relocated. The R40 provincial road and a railway line cross the Olifants River at Mica, and R530 crosses the Makhutswi tributary near its confluence with the Olifants. A dam at the Madrid site would inundate all three bridges (R40, R530 and rail), which would need to be replaced at a much higher level with high approach fills, and the roads and railway line would have to be relocated over a significant distance. Some 3,5 km of the R530 would be inundated. The Mica Dam site is located downstream of only the R530 road bridge. Although a portion of the railway line will need to be relocated, its bridge need not be affected.
- Only the Madrid Dam has been costed and the cost was estimated at R4 504 million, which is very high. The dam would however yield approximately 286 million m³/a which results in a relatively favourable URV of R1,71 / m³.
- The biodiversity at the proposed Mica Dam site is classified as important and necessary in terms of the Mpumalanga Biodiversity Conservation Plan (MBCP), and as vulnerable in terms of the National Spatial Biodiversity Assessment (NSBA) (**Figure 6.5**).
- The biodiversity at the proposed Madrid Dam site is classified as least concern in terms of the Mpumalanga Biodiversity Conservation Plan (MBCP), and as least threatened in terms of the National Spatial Biodiversity Assessment (NSBA) (**Figure 6.5**).

All 3 sites are located in a protected area in terms of natural heritage and in a priority natural area (**Figure 6.9**). Environmental sensitivity is rated as medium. All three options will inundate significant areas of relatively pristine riverine vegetation, but this is considered to be a relatively low impact. Madrid would presumably cause the least impact in terms of biodiversity.

The main biophysical impact will be on the downstream river ecology, especially through the KNP, and depending on the extent to which EWRs are met, the impact could be anywhere between positive to severely negative. Failure to meet the EWRs in this part of the river system is a potential fatal flaw.

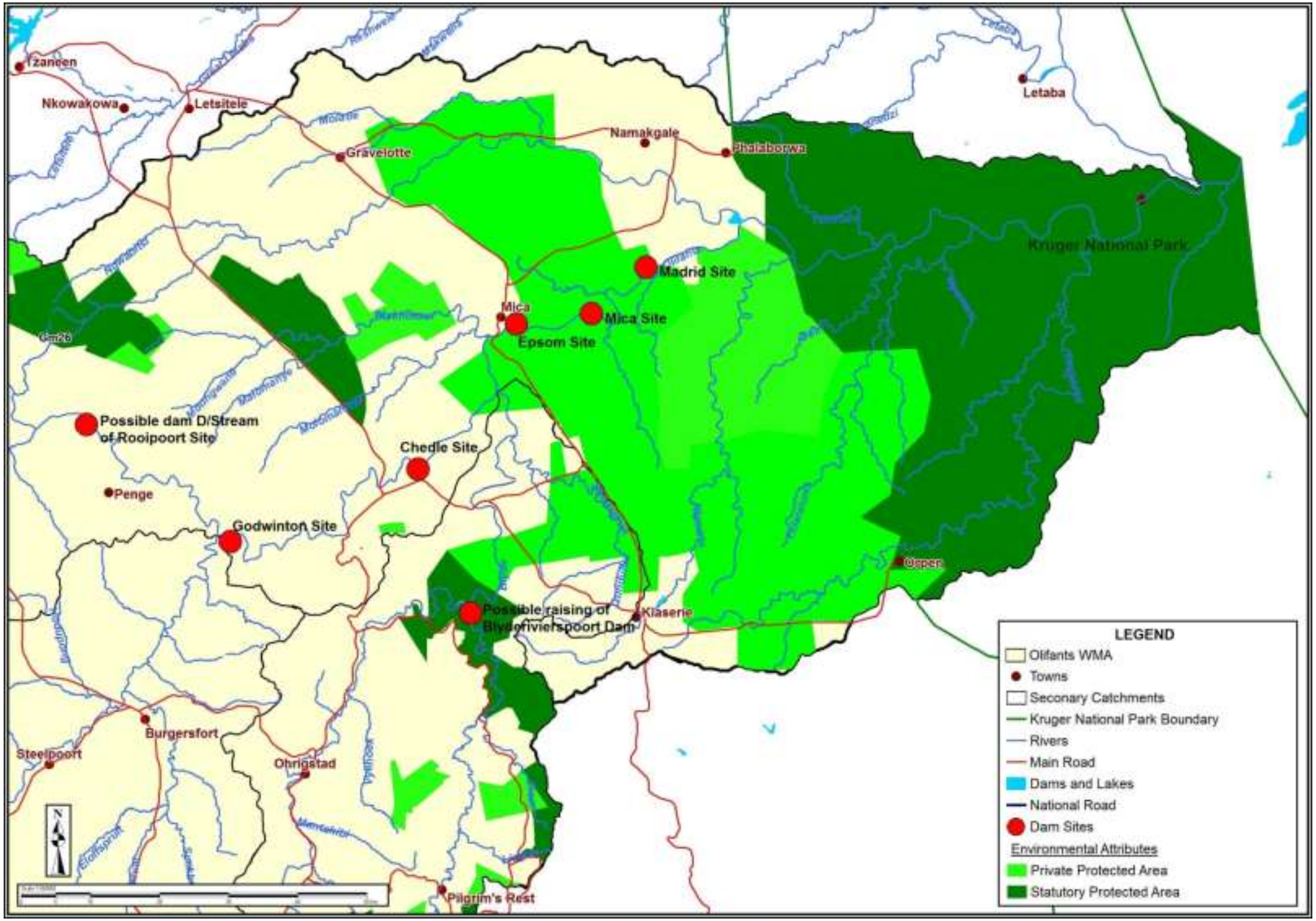


Figure 6.11: Dam sites in relation to protected areas

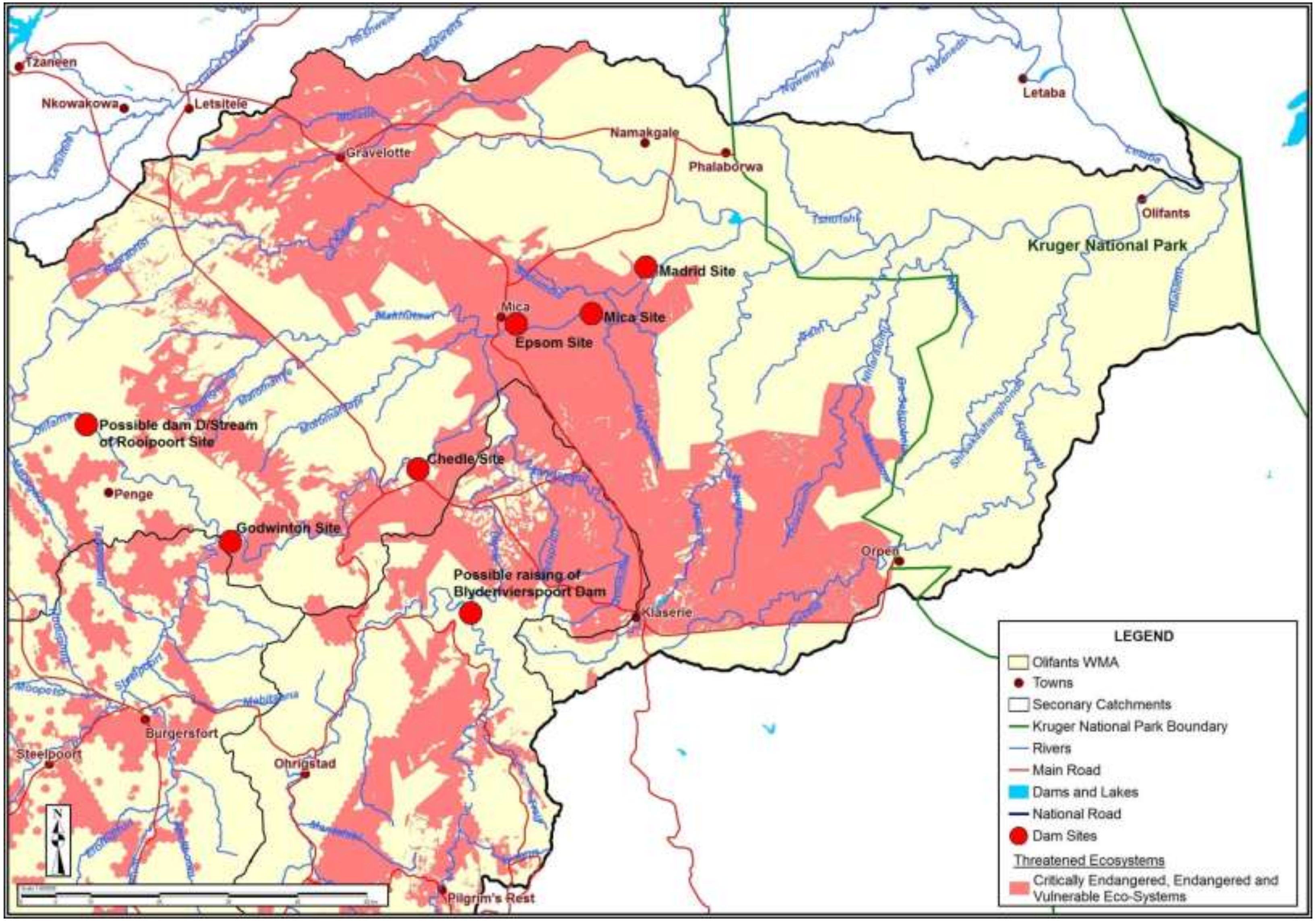


Figure 6.12: Dam sites in relation to threatened ecosystems

6.7. UTILISING THE ACID MINE DRAINAGE (AMD) IN THE UPPER OLIFANTS

Acid mine drainage (AMD) is associated with mining activities where the mines dewater their works in order to be able to extract coal. This is associated with both underground and open cast mining.

The relatively high permeability of rehabilitated open cast mines and utilisation of the underground storage in the decommissioned mine workings can increase the system yield. Similarly, the shafts and galleries of decommissioned underground mines can be used as storing capacity for underground water, which will also increase the system yield. The contaminated nature of the water makes treatment or dilution of this underground water from decommissioned mines essential.

It is important to note that much of this water, from dewatering of presently operating mines and decant from decommissioned mines, would have returned to the river as base flow even without any mining. The increase in reliable yield has been quantified in a detailed study, (Golder, 2011) and is relatively small at present, but will reach a peak in approximately 5 years (2015) for the Witbank Dam Catchment and in approximately 2030 for the Middelburg Dam catchment.

Modelling by Golder Associates has shown that an additional future yield of 22 million m^3/a can be expected (See Section 5.2.4).

The treatment and re-use of acid mine drainage water has already been implemented with reverse osmosis plants which supply drinking water to Emalahleni and townships of Steve Tshwete LM. The Emalahleni Water Reclamation Plant has a capacity of 9 million m^3/a and the optimum plant has a capacity of 5.5 million m^3/a. To provide additional capacity to meet the additional yield of 22 million m^3/a, is expected to cost approximately R75 million with a URV of R6.31 /m^3.

It should be noted that the mines are legally obliged to treat all AMD, not just the additional yield, before returning it to the river. This water, if treated to potable standards, can be used to supply domestic users, but the capital cost will be substantially more than that quoted above.

Use of treated AMD can increase the system yield and improve water quality in the system. No significant environmental impacts are associated with this option provided AMD is treated or diluted adequately.

No fatal flaws have been identified.

6.8. DESALINATION AND TRANSFER OF SEAWATER

With South Africa bordered by ocean to the east, south and west, it cannot be said that the country will ever be short of water per se. Rather, the problem is the quality of that water and the location relative to the majority of users in the central highveld of the country. The option of desalination of sea water and pumping it to the Olifants river basin has not been considered independently in this study and the following information is quoted from a study on the DWA by BKS, “Assessment of the Ultimate Potential and Future Marginal Cost of Water Resources in South Africa”. (DWA, 2010)

Table 6.4: Details of desalination options

Capacity (million m^3/a)	Pipeline		Power Required Desalination + Pumps (MW)	Cost (R Million)	URV (R/m^3)
	Length (km)	Diameter (mm)			
100	490	1 700	90 + 80	12 970	44.45
200	490	2 250	179 +159	19 400	59.84

The water was assumed to be abstracted and desalinated near Lake Sibaya on the KZN coast. The alternative of abstracting water in Mozambique would result in a shorter pipeline and would also need to be investigated, but any optimisation study must also consider other South African users, and the details in the table must be considered as the guiding URVs.

Table 6.5: Main Summary and Findings

Water Source/ Infrastructure Component	Positive Impacts	Negative Impacts (Red flags)	Potential Fatal Flaws	Recommendation
Groundwater development		• Potential dewatering or lowering of sustainable yield of the local aquifer. • Potential impact on groundwater users in terms of access. • Potential impact on surface water flow resulting in negative downstream impacts. • Potential contamination of the local aquifer • Potential health risk for groundwater users • Potential impact on groundwater dependent ecosystems	None identified.	• Ensure that groundwater resources are developed in a sustainable manner. • Strict compliance monitoring can ensure that groundwater use does not result in long-term pollution and depletion of the groundwater resources.
Transfer of treated effluent from the East Rand		• Potential deterioration of surface water quality if effluent discharged is not treated to an acceptable standard. • Potential health risk. • Vaal River augmentation scheme will be required sooner than otherwise.	None identified.	
Transfer more water from the Vaal Dam		• Impact on wetlands: should be carefully assessed and mitigated. • Cost: the water could become too expensive and prevent development. • Possible system losses en route. • Transfer of organisms.	None identified.	• The long-term sustainability of this option needs to be further investigated.
Raising of Blyderivierspoort Dam		• Impact on a protected area and conservation targets. • Area is characterised by high biodiversity and many unique plant species which are of high priority in terms of conservation. • In addition to construction related impacts, the raising of the dam would result in the permanent loss of biodiversity. • 120 ha of additional land would be inundated for 15 m raising, 285 ha for 35 m raising, mostly forestry.	• Failure to meet the EWRs in the lower Blyde and through the KNP is a potential fatal flaw.	• This option is expected to have a significant impact on the natural environment.

Water Source/ Infrastructure Component	Positive Impacts	Negative Impacts (Red flags)	Potential Fatal Flaws	Recommendation
		• The raising of the dam may involve potential visual impacts.		
New Dam downstream of Rooipoort		• Likely to require the relocation of households, schools, businesses, etc. • Likely to inundate significant areas of irreplaceable agricultural land.	• Potential irreversible socio-economic impacts.	• The long-term sustainability of this option needs to be further investigated.
New Dams in the Olifants River Gorge	• If the water could be stored in, and recovered from, the dolomitic aquifers it could reduce or even eliminate the need for a storage structure.	• Flooding of a number of villages on the banks of the Steelpoort River resulting in relocation of a number of households and a school. • High impact on the pristine river gorge. • Risk of draining into the dolomites	• Potential irreversible ecological and social impacts.	
New Dams in the Lower Olifants River	• Improvement of downstream river ecology if EWRs are met.	• Require infrastructure to be relocated (roads, bridges and a railway line). • High capital costs. • Will flood areas of irrigated land on the Olifants and Blyde Rivers.	• Potential severe negative impact on downstream river ecology, especially through Kruger National Park, if EWRs are not met.	
Utilise Acid Mine Drainage in the Upper Olifants	• Increased system yield	• Impacts associated with treatment process.	None identified.	
System operating rules	• Improved efficiency and use of available resource. • Cost effective • Additional water available.	None identified.	None identified.	
Rainfall enhancement		• Could increase the risk of flooding. • Could impact on the implementation of the Reserve.		
Removal of Invasive Alien Plants	• Increase annual flows. • Address IAP problem in the study area and improve the state of biodiversity.	None identified.	None identified.	

Water Source/ Infrastructure Component	Positive Impacts	Negative Impacts (Red flags)	Potential Fatal Flaws	Recommendation
Water Transfer from the Crocodile (West) River System		• Impacts will be related to changes in flows.		
Sealing of canals	• positive impact on the land below the canal	• Sealing will probably require opening the joints before injecting a sealant, and can only be done while the canal is empty, *i.e.* during a few dry weeks per year. It may therefore have to be done gradually over a few years, or require some impact on the irrigators if done in one effort.	None identified.	

7 CONCLUSION AND RECOMMENDATIONS

Some of the options under consideration involve significant negative environmental impacts; however, these can be mitigated. The options involving new dams raise potential red flags that should be investigated further.

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