water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal Area

FINAL

FINAL STRATEGY

FEBRUARY 2013

WATER REQUIREMENTS AND AVAILABILITY RECONCILIATION STRATEGY FOR THE MBOMBELA MUNICIPAL AREA

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Executive summary

Water use within the Mbombela Local Municipality (MLM) has increased rapidly over the last few years and the available water resources will soon be insufficient to supply the users within the municipal area at an acceptable level of assurance. A strategy is therefore required to ensure continued water supply to this region over the medium to long term.

The MLM does not occupy a single clearly defined catchment, but straddles the Crocodile (East) and Sabie River catchments. Much of the water flowing through the municipal area is derived from upstream catchments.

Towns in the municipal area include Nelspruit, Hazyview, White River, Rocky Drift, Ngodwana, Matsulu, the Nsikazi area, and Kaapschehoop. The MLM also forms part of the bigger Ehlanzeni District Municipality.

The purpose of this study is to develop a Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal area. Information from existing studies has been reviewed, updated and integrated into a reconciliation strategy that will meet the specific water services requirements of the MLM, within the visionary framework and strategy of the Inkomati Catchment Management Agency (ICMA) and promoting and supporting the sustainable development of the available water resources in the Crocodile and Sabie River catchments.

The primary objectives of this study are to:

- *Address growing water requirements as well as water quality problems experienced in the catchment;*
- *Assess current water availability and water deficit/surplus;*
- *Identify resource management and development options, and*
- *Recommend and sequence management and structural reconciliation interventions.*

The reconciliation of water requirements with the available water resources within the Mbombela Municipal Area has been evaluated in terms of the following eight water demand centres:

- *Nelspruit (including Mataffin, the Agricultural College and Matumi Golf Course);*
- *White River Town (including White River Country Estate and Rocky Drift);*
- *Hazyview;*
- *Nsikazi North;*
- *Nsikazi South;*
- *Karino Plaston Corridor;*
- *Matsulu, and*
- *Smaller centres, i.e. Kaapschehoop, Ngodwana and Elandshoek.*

The founding principles for water allocation for the Mbombela LM areas must be based on the policies and regulations of the Department of Water Affairs and the Inkomati CMA. These are summarised briefly as: recognition of international water sharing obligations and protection of the environment as first priorities. Thereafter development and allocation of the *water resource shall be sustainable, an implication of which is that water use must be shown to be efficient.*

This study is focused on water for domestic and industrial use and is not specifically investigating additional irrigation use. However, where opportunities for conjunctive use (i.e. domestic and irrigation use) present themselves, these have been evaluated and reported on.

Several options for reconciling increasing water demands with the current supply are considered in this study. These options can be broadly categorised into options which reduce the water demand, such as water conservation and water demand management (WC/WDM), and those that augment the water resource, such as water transfers and the construction of dams. Even assuming a high level of success in reducing water losses, the water resources will need to be augmented in the not-to-distant future.

Several augmentation options were investigated, broadly classified as local and regional schemes. Local schemes, such as the Boschjeskop Dam on the Nels River and the raising of the Ngodwana Dam are two local options considered while the Montrose Dam (at the confluence of the Elands and Crocodile River), the Mountain View Dam (on the lower Kaap River) and the Strathmore Dam (an off channel Dam near the confluence of the Kaap and Crocodile rivers) have been considered as regional schemes.

During the evaluation of the eight demand centres, it became apparent that per capita water use within the Mbombela municipal area is one of the highest in the country. This will need to be addressed before embarking on the construction of dams. If there is unlawful use within the upstream catchment, this will also need to be addressed as a priority. There is a separate process in progress to identify and eradicate unlawful water use.

The preliminary strategy for each demand centre is summarised as follows:

Nelspruit
- *WC/WDM*
- *Removal of Invasive Alien Plants (IAPs)*
- *Groundwater development*
- *Construct a new dam at Boschjeskop on the Nels River*

White River/Rocky's Drift
- *WC/WDM*

Karion/Plaston Corridor
- *WC/WDM*
- *Groundwater development*
- *System Operating Rules Primkop and upstream dams*

Nsikazi South
- *WC/WDM*
- *Groundwater development*

Matsulu

- *WC/WDM*
- *Groundwater development*
- *Water reallocation*

Elandshoek/Kaapschehoop/Ngodwana

- *Groundwater development*
- *Rain and Fog harvesting*

*Within the Sabie River catchments (**Hazyview** and **Nsikazi South)**, the options are limited. At this stage only one mechanism (other than WC/CDM) for sourcing water has been identified. This is to trade with existing irrigation and possibly re-allocate some water for domestic use.*

It became apparent during this evaluation that while the analysis of each demand centre was a useful exercise, certain regional strategies, if implemented, could resolve the water supply situation for many of the water demand centres simultaneously. Furthermore, these multi-target strategies, or regional schemes, appear to be the most promising. Three possible schemes have been identified which could make more water available within the Crocodile River catchment than required within the foreseeable future by the Mbombela Municipality. These three schemes are:

- *The Montrose Dam*
- *The Mountain View Dam, and*
- *The Strathmore off-channel storage dam*

Each of these dams could make more than 50 million m^3/annum of additional water (after meeting the ecological Reserve) available for use. Since this is more than the future domestic requirements, the suggestion is that these could form part of a larger regional scheme which supplies surplus water to emerging irrigators in the Lower Crocodile River and/or to irrigators in Mozambique.

The Mountain View and Strathmore options are considerably more economical than the Montrose Dam option and the recommendation is made that the Montrose Dam should not be considered further. This then leaves only the Mountain View and Strathmore dams. These options, located in the Kaap River and lower Crocodile respectively, are somewhat more complex than the Montrose and Boschjeskop options in that they are located either downstream or in a different catchment to the demand centres in the Mbombela Municipal Area. However, water can be gravitated from Mountain View Dam to Matsulu hence freeing up water for abstraction from the Crocodile River for Nelspruit and/or Nsikazi South. A similar more extensive water swop can be made with irrigators on the lower Crocodile.

List of Acronyms and Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
BHN	Basic Human Needs
BWB	Bushbuckridge Water Board
DM	District Municipality
DWA	Department of Water Affairs (previously DWAF)
EC	Electrical Conductivity
EWR	Ecological Water Requirements
FSA	Full Supply Area
FSL	Full Supply Level
HIV	Human Immunodeficiency Virus
IAPs	Invasive Alien Plants
IDP	Integrated Development Plan
IWAAS	Inkomati Water Availability Assessment Study
ICMA	Inkomati Catchment Management Agency
MAR	Mean Annual Runoff
MBWS	Mbombela Bulk Water Strategy
MIG	Municipal Infrastructure Grant
MLM	Mbombela Local Municipality
MMC	Manganese Metal Company
NRW	Non-Revenue Water
NWA	National Water Act
LM	Local Municipality
PES	Present Ecological State
PRV	Pressure reducing valve
RCC	Roller Compacted Concrete
PMF	Probable Maximum Flood
PSP	Professional Service Provider
SADC	South African Development Community
SANS	South African National Standard
SBC	Spot Building Counts
SDF	Spatial Development Plan
StatsSA	Statistics South Africa
TDS	Total Dissolved Solids
URV	Unit Reference Value
WAR	Water Allocation Reform
WDC	Water Demand Centre
WC/WDM	Water Conservation Water Demand Management
WMA	Water Management Area
WSP	Water Service Provider
WTW	Water Treatment Works

WWTW	Waste Water Treatment Works

Units of Measurement

Cusecs	Cubic feet per second
ha	hectare
km	kilometre
ℓ/s	litres per second
Mℓ/day	Megalitres per day
Million m^3/a	Million cubic metres per annum
m^3/s	Cubic metres per second
ℓ/c/d	litre per capita per day

1 INTRODUCTION

1.1 PURPOSE OF THIS STUDY

The water use within the Mbombela Local Municipality (MLM) has increased rapidly over the last few years and the available water resources will soon be insufficient to supply the users within the municipal area at an acceptable level of assurance. A strategy is therefore required to ensure continued water supply to this region over the medium to long term.

The MLM does not occupy a single clearly defined catchment, but straddles the Crocodile (East) and Sabie River catchments as shown in

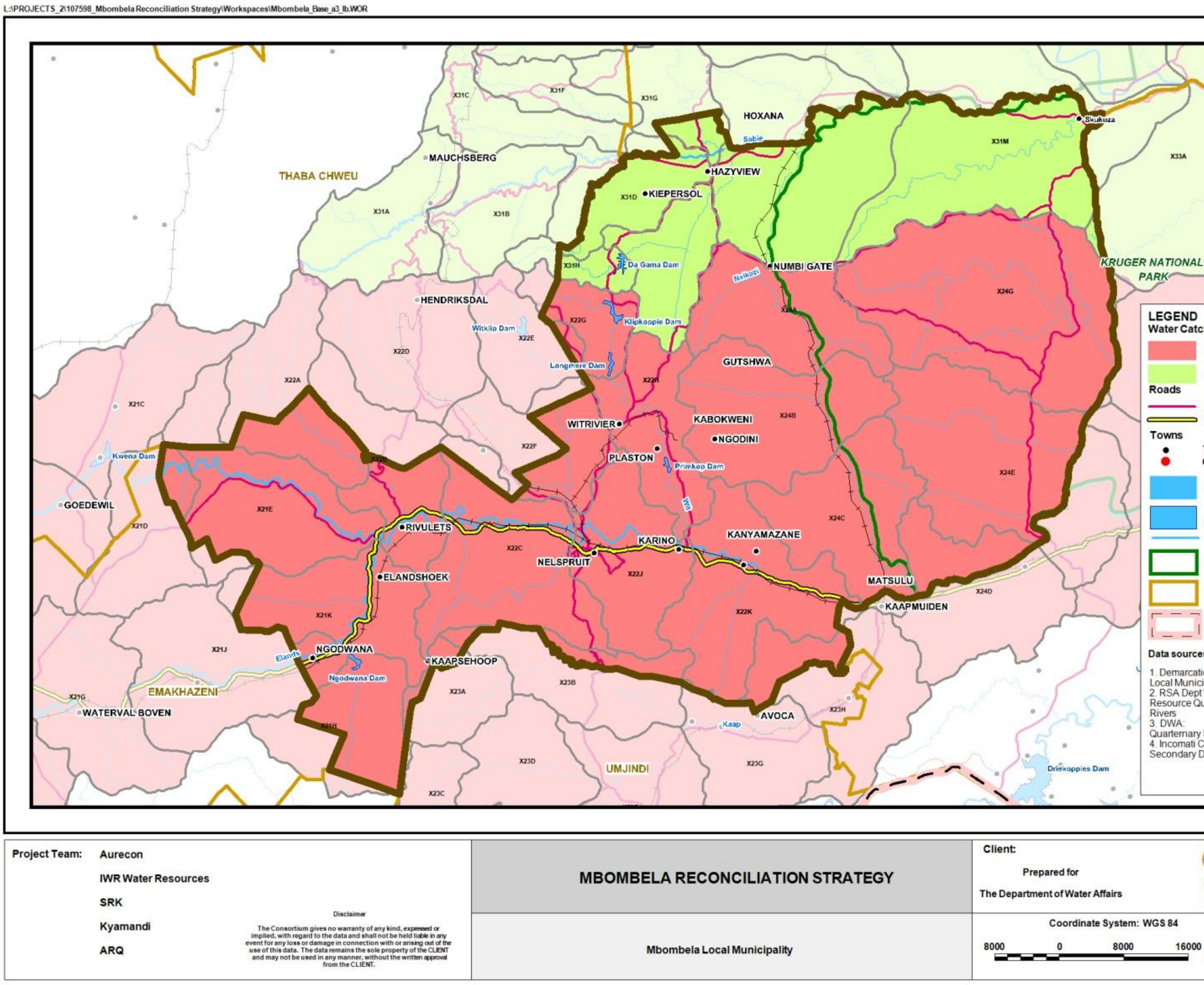

Figure 1.1. Much of the water flowing through the municipal area is derived from upstream catchments.

Towns in the municipal area include Nelspruit, Hazyview, White River, Rocky Drift, Ngodwana, Matsulu, the Nsikazi area, and Kaapschehoop as shown in

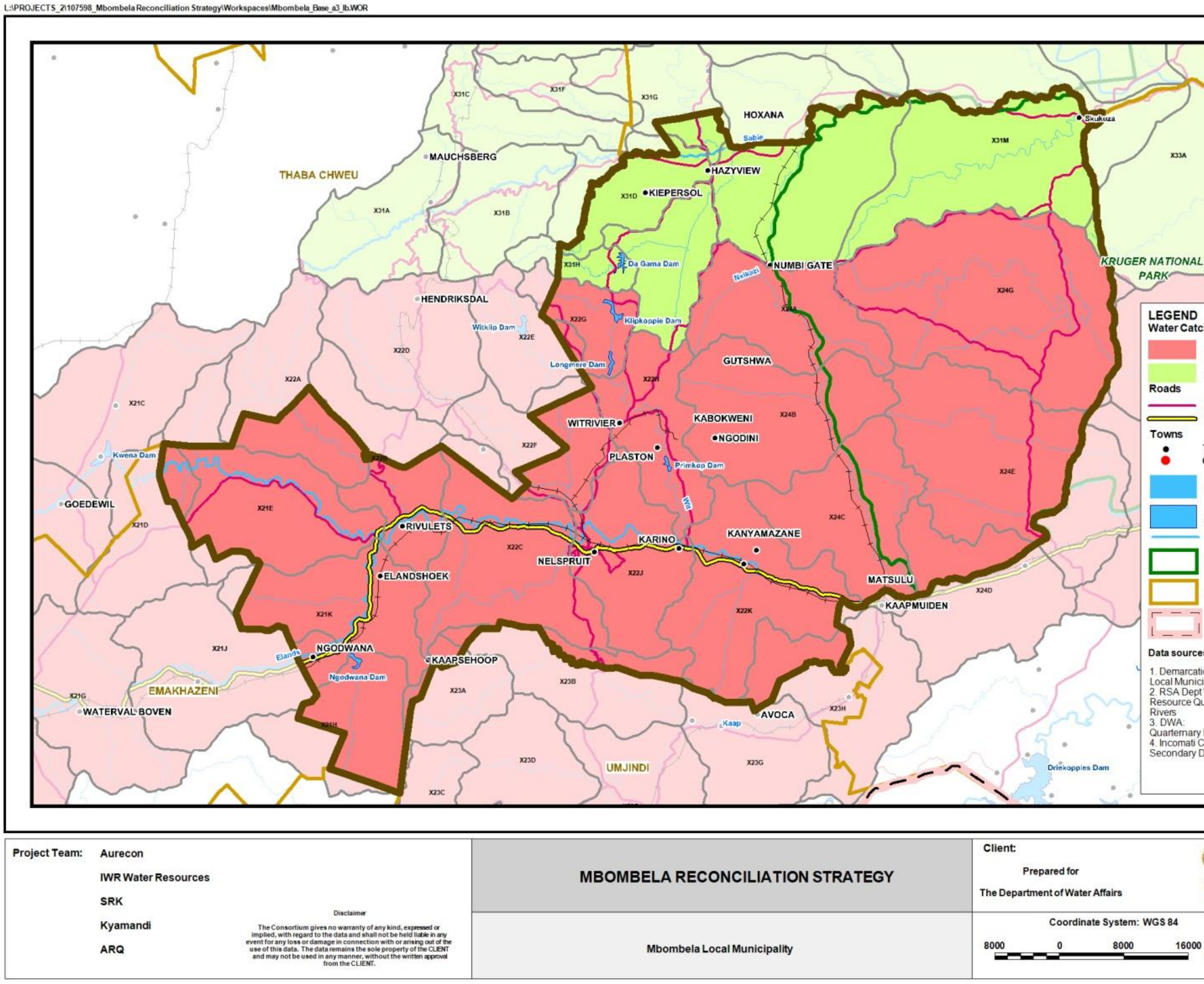

Figure 1.1. The MLM also forms part of the bigger Ehlanzeni District Municipality.

The purpose of this study is to develop a Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal area. Information from existing studies will be reviewed, updated and integrated into in a reconciliation strategy that will meet the specific water services requirements of the MLM, within the visionary framework and strategy of the Inkomati Catchment Management Agency (ICMA) and promoting and supporting the sustainable development of the available water resources in the Crocodile and Sabie River catchments.

The primary objectives of this study are to:

- Address growing water requirements as well as water quality problems experienced in the catchment;
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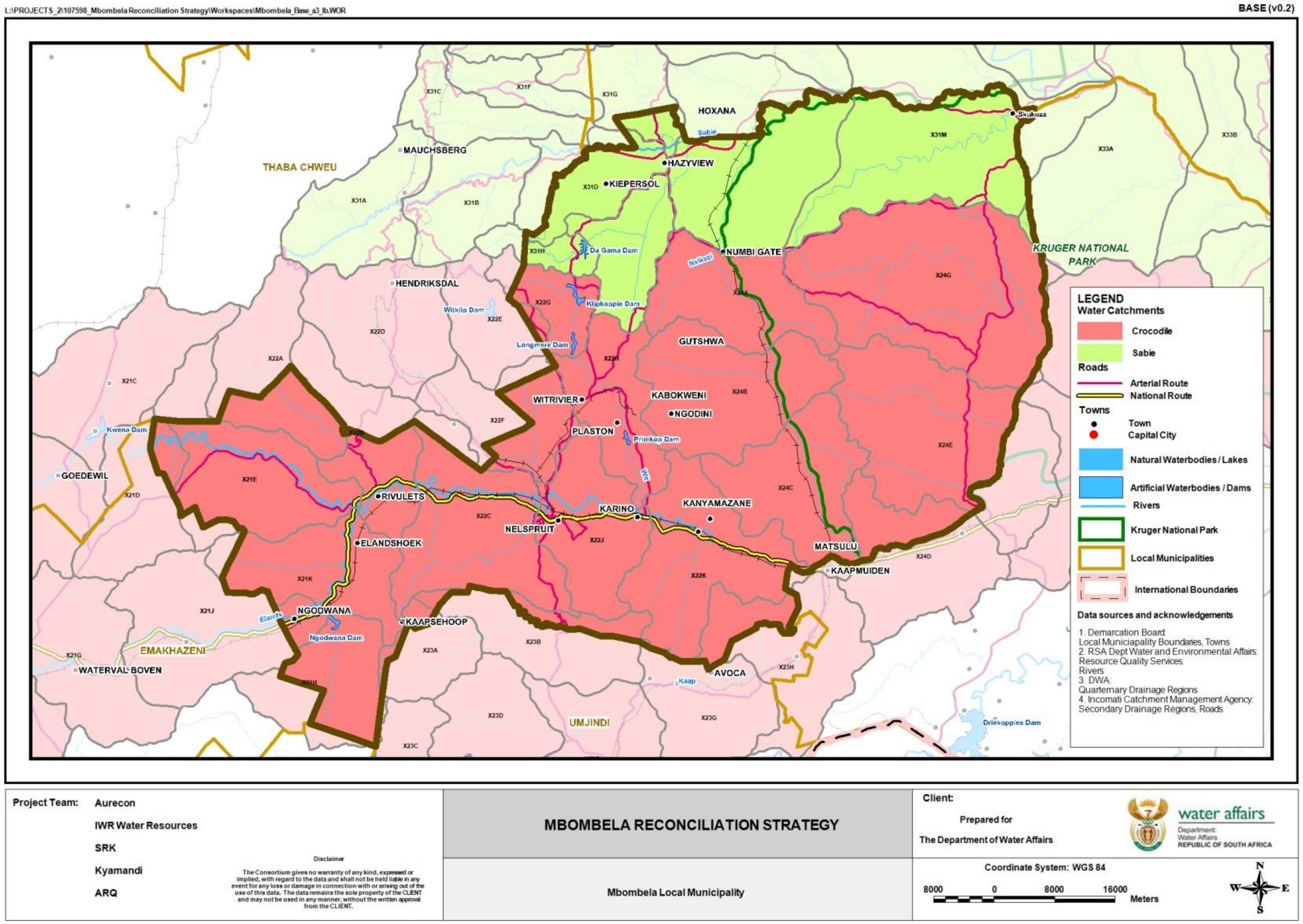


Figure 1.1: Study area with catchments

1.2 PURPOSE OF THIS REPORT

The two main deliverables for this study are the Preliminary and Final Water Reconciliation Strategies for the Mbombela Municipal Area. The Preliminary Strategy was based on available information which could be collected since the inception of the study. The Preliminary Strategy Report formed the basis for further discussion and for exchanging ideas with the stakeholders. It must be emphasised that the Preliminary Strategy was based on assumptions that were made where uncertainties and information gaps existed, and that these uncertainties and lack of data had to be further investigated. This Final Reconciliation Strategy therefore contains improved information and inputs from the stakeholders.

1.3 REPORT STRUCTURE

Following the Introduction, this report gives an overview of the study area in which administrative and catchment boundaries, water demand centres (WDCs), infrastructure, institutions, and the extent of irrigation, commercial forestry and invasive alien plants, etc. are described.

The next chapter deals with founding principles and the selection criteria to be used when decisions in respect of reconciliation options need to be taken.

The projected water balance situation for each of the WDCs is then analysed up to 2035, and the water surplus / deficit for each WDC determined. Based on this, possible intervention scenarios are described and a preferred scenario for each WDC is then chosen. These scenarios contain the preferred reconciliation interventions and their sequencing, and will form the basis of the strategies for the WDCs.

The report concludes with a chapter on implementation arrangements.

2 OVERVIEW OF THE STUDY AREA

2.1 ADMINISTRATIVE BOUNDARIES OF THE MBOMBELA LOCAL MUNICIPALITY

The MLM is part of the Ehlanzeni District Municipality (EDM) together with Bushbuckridge LM, Thaba Chweu LM, Nkomazi LM and Umjindi LM. MLM borders the Bushbuckridge LM and Thaba Chweu LM in the North and North-West respectively. It borders the Nkomazi LM to the east and Umjindi LM to the South. The MLM further borders Highlands LM to the West (Part of Nkangala DM), and to the South West MLM also borders Albert Luthuli LM, (part of Gert Sibanda DM), for a short distance. The municipal boundaries are shown in **Figure 2.1**.

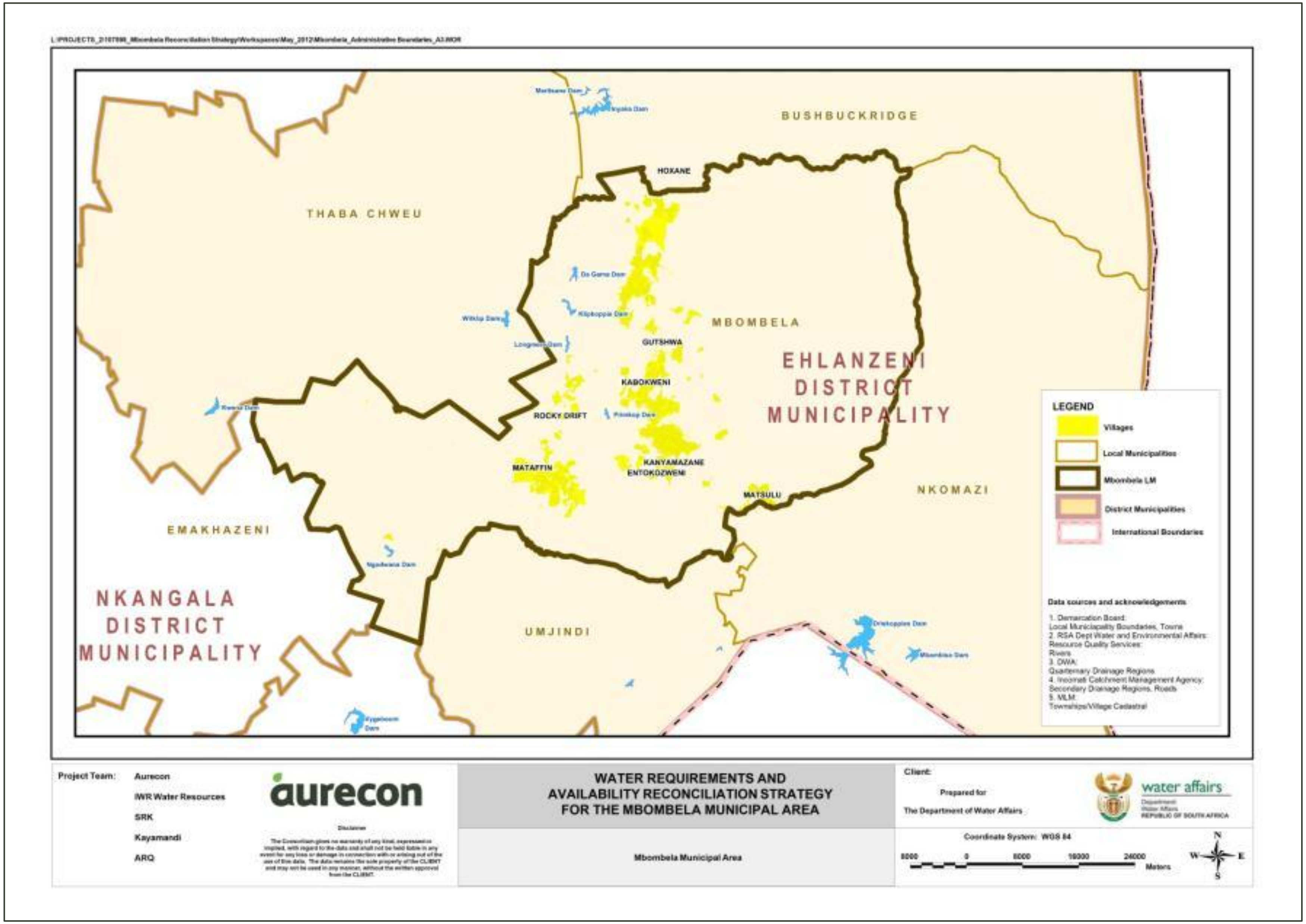


Figure 2.1: Boundaries of municipalities proximal to Mbombela Local Municipality

2.2 WATER DEMAND CENTRES

The main current water use sectors in the MLM area are:

- Domestic Urban;
- Domestic Rural;
- Industrial;
- Commercial Forestry (Streamflow Reduction Activity), and
- Irrigation.

This study focuses on the Domestic and Industrial water use sectors, since these two sectors are experiencing high growth in water demand, while the water demands in the irrigation and forestry water use sectors are expected to remain constant over the planning period.

The urban and rural areas that contribute to the water demand of the MLM area are spread over a very large portion of the MLM area. These urban and rural areas can be divided into eight distinct WDCs (or urban/rural clusters) as shown on the map in **Figure 2.2.** These WDCs are listed below.

- Nelspruit (including Mataffin, the Agricultural College and Matumi Golf Course);
- White River Town (including White River Country Estate and Rocky Drift);
- Hazyview;
- Nsikazi North;
- Nsikazi South;
- Karino Plaston Corridor;
- Matsulu, and
- Smaller centres, i.e. Kaapschehoop, Ngodwana and Elandshoek.

Industrial development is mainly centred in and around Nelspruit, Ngodwana and Rocky Drift.

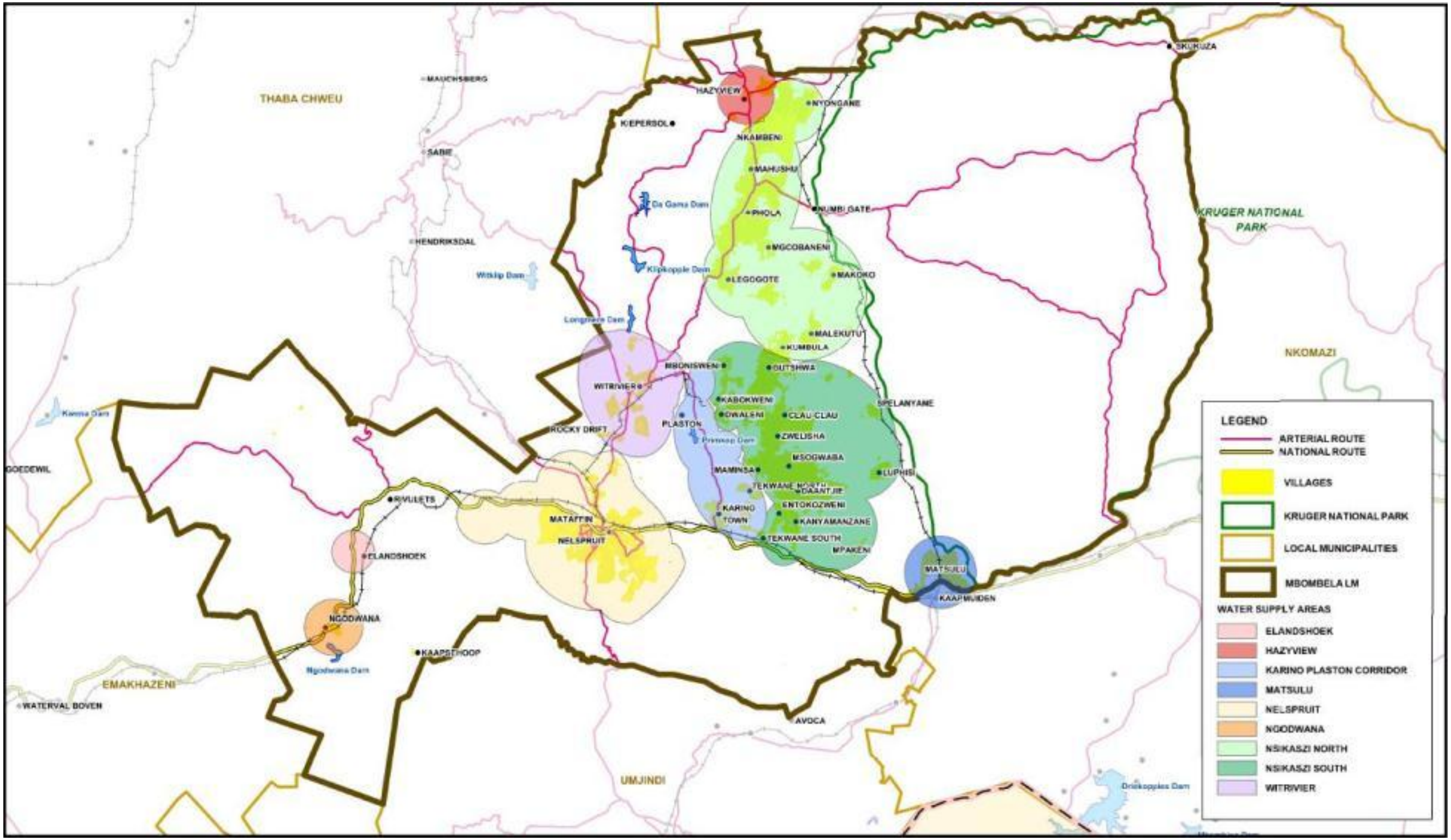


Figure 2.2: Water demand centres

The highest growth in both population and industrial activity is expected within an area known as the Golden Triangle. One leg of the triangle stretches from the N4 split with the two alternative toll roads eastwards to Nelspruit and further east to Matsulu. The second leg stretches from Matsulu northwards to Hazyview, and the third leg extends from Hazyview south-westwards to the N4 split. The three legs of the triangle represent respectively the commercial/industrial Development zone, the rural Development Zone and the Tourism Development Zone. The Mbombela Golden Triangle is shown in **Figure 2.3.**

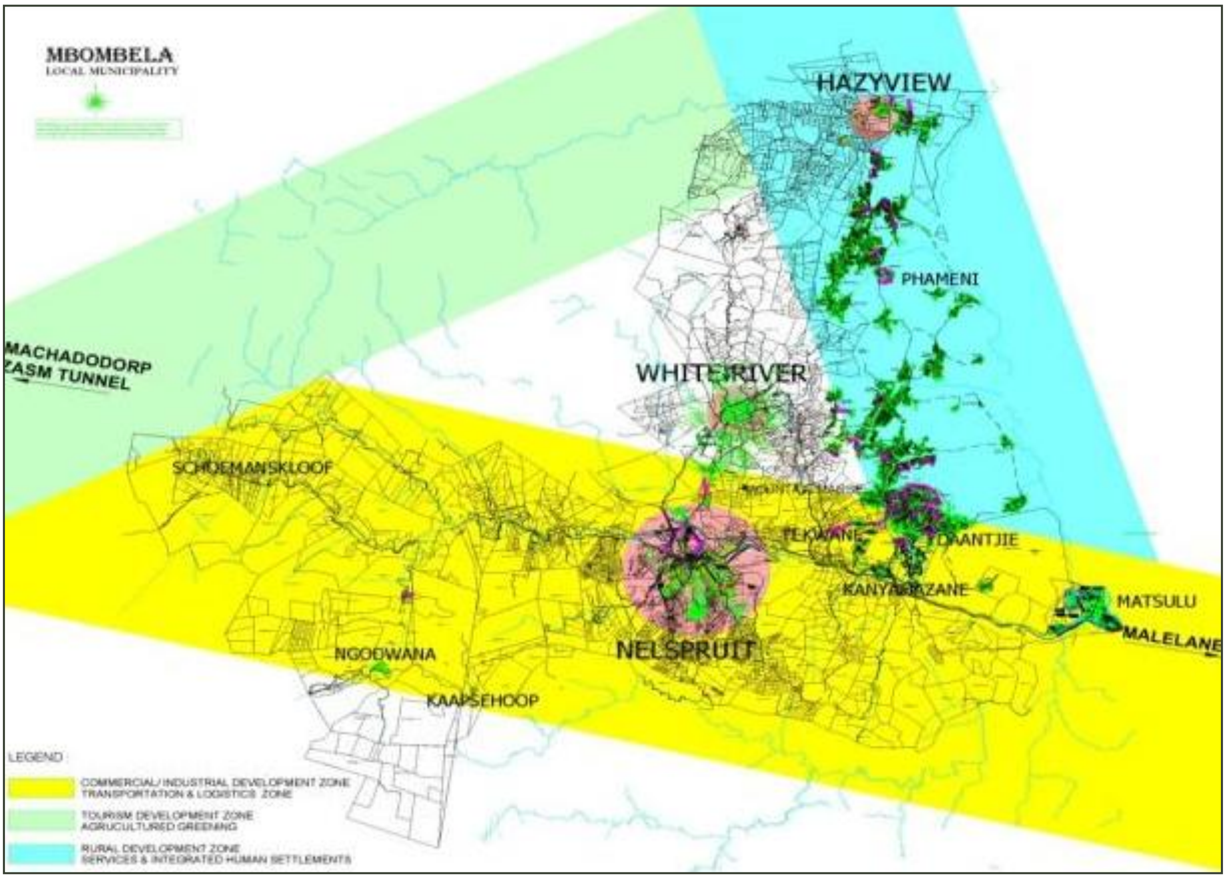


Figure 2.3: The Mbombela Golden Triangle

The growth in water requirements will be significantly higher within the Mbombela Golden Triangle than within the rest of the study area. This growth will be described for each WDC in later chapters.

2.3 WATER SUPPLY INSTITUTIONS

MLM is the Water Services Authority (WSA) in the municipal area. There are three water service providers (WSP) in the municipal area namely, MLM, Sembcorp (Silulumanzi) and Bushbuckridge Water Board (BWB). BWB is responsible for bulk water supply in Nsikazi North and Nsikazi South. Sembcorp is responsible for bulk water supply in Nelspruit, which includes Mataffin, and also Matsulu. MLM is responsible for water supply in Hazyview and White River.

2.4 OVERLAPPING CATCHMENTS AND WATER RESOURCES

The MLM boundaries do not follow the watersheds, with the result that there is no relation between catchment boundaries and the municipal boundaries. This poses quite a challenge since a portion of a WDC can fall in one catchment and the remainder in another.

The MLM overlaps with two main tributaries of the Incomati River, namely the Crocodile and the Sabie Rivers. Only a portion of the catchments of these two tributaries falls within the MLM area. It is therefore crucial to take the whole catchment of the Crocodile and Sabie tributaries into consideration when the water resources of the MLM area are studied, especially the catchment area upstream of the MLM area. The boundaries of the two catchments in relation to that of the MLM are shown in **Figure 2.4**.

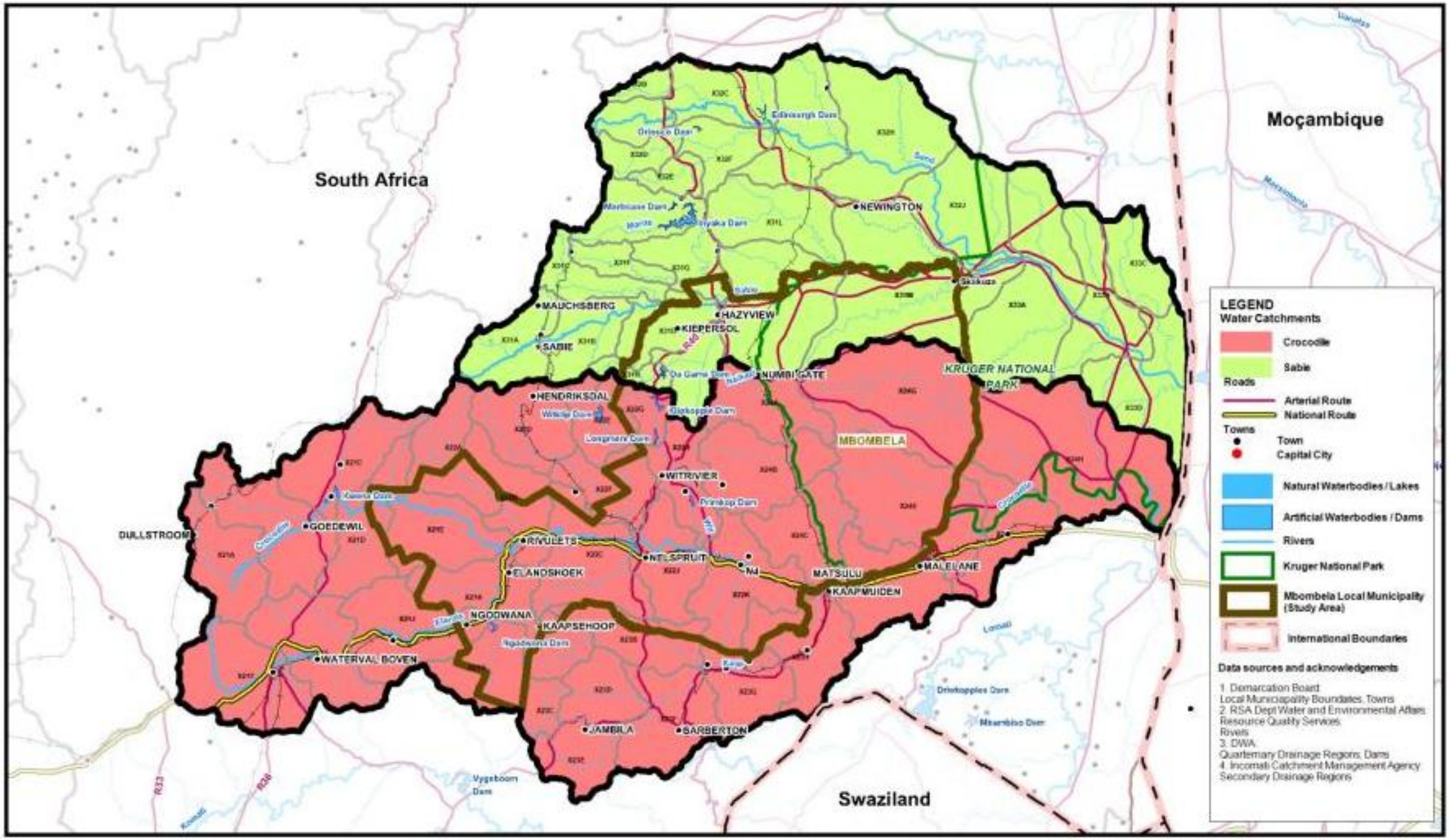


Figure 2.4: The Crocodile and Sabie River catchments and the boundaries of the MLM area

The area formed by the three tributaries of the Incomati River, i.e. the Komati, Crocodile and Sabie Rivers, has been proclaimed by the Department of Water Affairs (DWA) as the Inkomati Water Management Area (WMA) in terms of Government Gazette Notice, 1 October 1999 no. 20491.

This area is currently managed by the Inkomati Catchment Management Agency (ICMA).

2.5 THE RESERVE

The National Water Act (Act 36 of 1998) (NWA) requires that some water must be left in rivers in order to sustain their ecological functioning. This water is referred to in the NWA as the Ecological Reserve. The Ecological Reserve, together with the Human Needs Reserve, is the only water use with the right to water, and as such receives the highest priority of water supply. Thus the ecological water requirements (EWR) of the Reserve need to be determined and taken into account as part of any process to reconcile water requirements with the available water resource.

The EWR of both the Crocodile and Sabie River catchments have been determined (DWA, 2010). For the Crocodile River it was decided to maintain the Present Ecological State (PES) of the river (Class C) by maintaining the current flow regime. Whilst this implies that compulsory licencing will not be needed to meet the Ecological Reserve (as suggested in previous studies), it also implies that increased water abstractions are not possible. It is stated in the Reserve Study report (DWA, 2010d) that should new dams be constructed in the Crocodile River catchment to augment the water resource, higher EWRs will become applicable in order to meet the recommendations of the ecologists. These higher EWRs have been taken into account when determining the available water resource. A more likely scenario is that the EWRs will be re-assessed if and when new dams are built.

In the case of the Sabie River, a Class A/B Reserve has been recommended to maintain the river in its PES. As a result, the Sabie River is now fully allocated and additional allocations are not possible without augmenting the water resource. Should a lower management class result from the Resource Classification process then water will become available for allocation. This scenario is included in the report as a possible intervention to make water available for allocation.

2.6 WATER RESOURCE INFRASTRUCTURE IN OVERLAPPING CATCHMENTS

The MLM is situated within the Inkomati WMA which forms part of the larger Incomati River Basin shared by the Republic of Mozambique, the Kingdom of Swaziland and the Republic of South Africa.

The municipal area does not occupy a single clearly defined catchment, but straddles the Crocodile (East) and Sabie River catchments.

There are a number of medium-sized dams in both catchments, but only one big dam in each catchment. The dams in the Crocodile catchment are summarised in **Table 2.1**:

Table 2.1: Major dams in the Crocodile catchment

Dam	Fully supply capacity (FSC)		Full supply area (FSA) (km^2)	Construction date
	million m^3	%MAR		
Kwena Dam	158,9	134%	12,5	1984
Witklip Dam	12,69	64%	1,88	1969
Klipkopje Dam	11,87	63%	2,31	1959
Longmere Dam	4,32	17%	0,96	1942
Primkop Dam	1,97	5%	0,41	1970
Ngodwana Dam	10,00	17%	1,00	1983

Source: *RSA Department of Water Affairs and Forestry: Dam Safety Office, 2006*

The dams in the Sabie catchment are summarised in **Table 2.2**:

Table 2.2: Details of medium size and major dams in the Sabie River catchments

Dam	Fully supply capacity (FSC)		Full supply area (FSA) (km^2)	Construction date
	million m^3	%MAR		
Inyaka Dam	123,7	156%	8,11	2000
Da Gama Dam	13,6	66,5%	1,29	1971

Source: *RSA Department of Water Affairs and Forestry: Dam Safety Office, 2006*

2.7 IRRIGATION

The rural area surrounding Mbombela's urban centres is characterized by extensive irrigation, most of it regulated by numerous Irrigation Boards but also some limited diffuse irrigation along various tributaries. Most prominent, is the large Crocodile River Major Irrigation Board which stretches from Dullstroom in the West to Komatipoort in the East. In **Figure 2.5** the areas of jurisdiction of the irrigation boards or water user associations in the Crocodile and Sabie River catchments are shown. A total of 28,271ha of irrigation (225.7 million m^3 per annum) is supported by Kwena Dam, with a further 1,632 ha allocated above Kwena Dam, though not formally administered by the Crocodile River Irrigation Board.

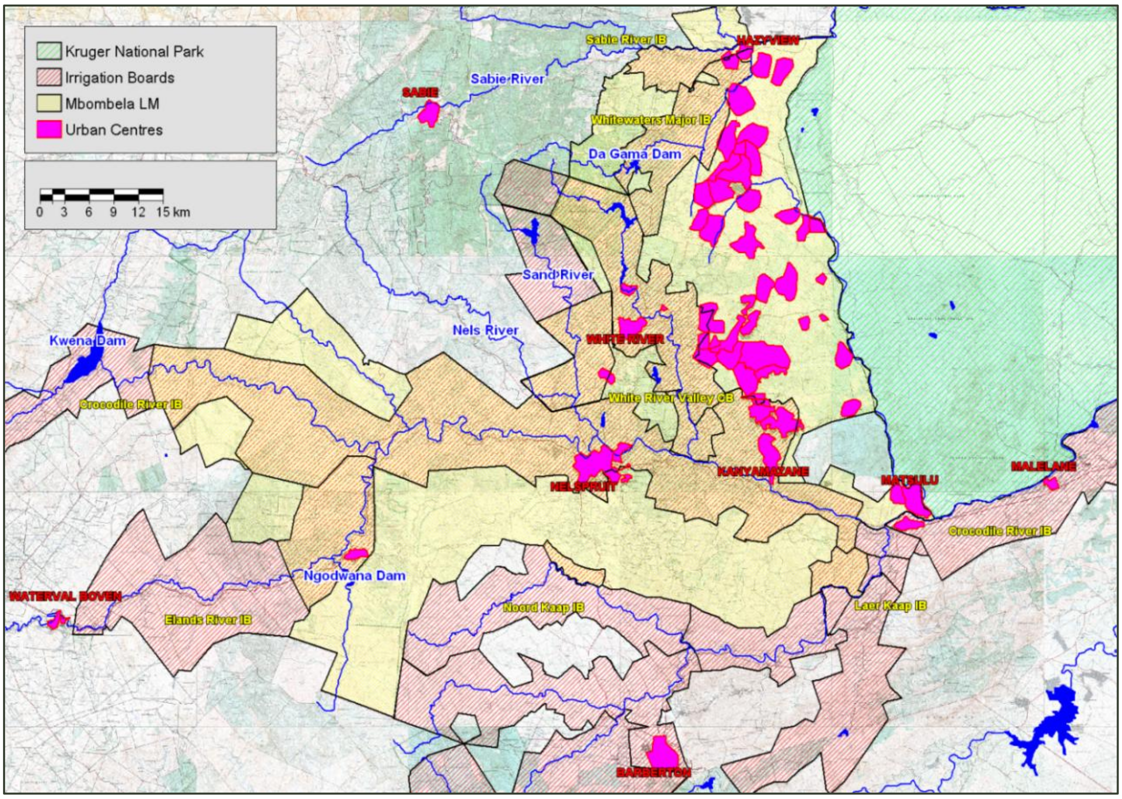


Figure 2.5: Irrigation Boards within and around the Mbombela DM area

A considerable amount of irrigation agriculture falls within the municipal area, estimated at about 15 000 ha with a water requirement of 147 million m^3/annum. However, to consider only the irrigation within the municipal area is misleading since upstream irrigators will reduce the river flow within the municipal area. Also, irrigators downstream of the municipal area have water use allocations and a legitimate expectation that enough water will be allowed to flow through the municipal area to meet their water demands at an acceptable level of assurance.

Table 2.3 summarises the estimated water requirements within the Crocodile and Sabie River catchments and indicates the portion that lies within the Mbombela Municipal area. Note that this table excludes irrigation in the Kaap and Sand tributaries since they are not relevant to this study.

Table 2.3: Irrigation within the Crocodile and Sabie River catchments

Catchment	Irrigation requirement (million m^3/annum)
Crocodile catchment	
Upstream of Mbombela	95
Within Mbombela	114
Downstream of Mbombela	209

Catchment	Irrigation requirement (million m^3/annum)
Crocodile catchment	
Sabie catchment	
Upstream of Mbombela	7
Within Mbombela	33
Downstream of Mbombela	9

2.8 STREAM FLOW REDUCTION ACTIVITIES

There are large areas of forestry within both the Crocodile and Sabie River catchments and it is a well-established fact that exotic plantations such as Pine, Eucalyptus and Wattle reduce the amount of water that would otherwise flow in the rivers in the catchments where the plantations are located. As with irrigation, the afforested areas within the MLM area are not the only concern since forestry upstream of Mbombela reduces river flow that could otherwise conceivably be used for domestic or industrial use within the municipal area.

The streamflow reduction within the Crocodile and Sabie Rivers is indicated in **Table 2.4**. It must be pointed out that there is not a clear relationship between streamflow reduction and yield: water trading with forestry, which is an option, therefore needs to be carefully considered. For example, removing all the forestry from the Crocodile (excluding the Kaap River) and Sabie River (excluding the Sand River) catchments would increase the mean annual runoff (MAR) of these catchments by 122 and 81 million ^{3}/annum respectively, but this water will mostly be in the form of increased floods. The yield made available by removing forestry is discussed further under trading options. (See sections 5 – 12). As a rule of thumb for the Sabie and Crocodile catchments, between one third to one fifth of the streamflow reduction will become available as high assurance yield, should forestry plantations be removed.

Table 2.4: Streamflow reduction due to afforestation within the Crocodile and Sabie River catchments

Catchment	Streamflow reduction (million m^3/annum)
Crocodile catchment	
Upstream of Mbombela	70
Within Mbombela	52
Downstream of Mbombela	0
Sabie catchment	
Upstream of Mbombela	69

Catchment	Streamflow reduction (million m^3/annum)
Within Mbombela	12
Downstream of Mbombela	0

2.9 INVASIVE ALIEN PLANTS

Invasive alien plants (IAPs) have a similar effect to exotic forests in that they reduce the runoff that would have flowed in the river under natural conditions. The difference between exotic forests and IAPs is that IAPs tend to invade riparian zones where water is more readily available and hence can consume much more water than licenced forestry. Also, unless controlled, IAPs will spread and result in increased reductions in runoff.

As part of the Inkomati Water Availability Assessment Study (IWAAS) (DWA, 2009), the areas of IAPs were quantified and the streamflow reduction was estimated. Working for Water (WfW) subsequently completed a national study (Kotze, 2010) and updated estimates of IAPs from the WfW study have therefore been used for this Mbombela Strategy. The estimated streamflow reduction due to IAPs is given in **Table 2.5**. It worth noting that while IAPs in riparian zones are the biggest concern for water resource managers, there appear to be very limited riparian IAPs remaining within the Crocodile and Sabie River catchments. The invaded areas are almost exclusively upland, that is, out of the riparian zone. This can be attributed to the efforts of WfW who focused their IAP removal efforts on the riparian zones.

Table 2.5: Streamflow reduction due to IAPs within the Crocodile and Sabie River catchments

Catchment	Streamflow reduction (million m^3/annum)	Estimated yield increase due to removal of IAPs
Crocodile catchment		
Upstream of Mbombela	17	8
Within Mbombela	10	1
Downstream of Mbombela	~0	~0
Sabie catchment		
Upstream of Mbombela	~0	~
Within Mbombela	1,0	0,5
Downstream of Mbombela	~0	~0

Removal of IAPs does not generally result in a large increase in yield compared to the increase in runoff. However, it is interesting to note that due to the location of the Kwena Dam and the operation of the Kwena Dam within a systems context, it seems as if removing IAPs from the Crocodile River, (especially from upstream of the

Kwena Dam) will result in a significant increase in the system yield. It has been established that the infested area in the Kwena Dam catchment is as high as 77 km^2 The removal of IAPs in the Primkop Dam catchment could also improve the yield of Primkop Dam significantly. There is approximately 17.5 km^2 IAPs upstream of this dam.

2.10 RAIN WATER HARVESTING

In many rural areas, reticulated water supply is not available from major dams and less capital-intensive set-ups including boreholes, run-of-river supply and rainwater harvesting serve as the main sources of water. Increased rainwater harvesting is also seen as one of the adaptation measures to climate change (Kundzewicz *et al*.,2007). In South Africa, where 2.1 million people have no access to water supply infrastructure, The Department of Water Affairs (DWA) has implemented a pilot domestic Rainwater Harvesting (RWH) project meant to improve food security in rural areas by providing water for home gardening (De Lange, 2006). Duncker (2000) pointed out that some households also use this water for drinking and other purposes. Water resource management and water supply in Mbombela Municipal boundary is facing major challenges due to the limited water resources and increasing uncertainties caused by climate change.

In light of the above challenges, Mbombela Municipality should encourage installation of rainwater harvesting systems in its rural water supply. Rooftop Rain Water Harvesting (RWH) systems normally consist of a small impervious catchment area (roof area in this case) and a storage tank of 2 500 or 5 000 litres.

Using software developed by the Institute for Water Research (DA Hughes, 2013), rainwater harvesting for three types of dwellings were analysed. Firstly, small RDP houses with roof areas of 40 m^2, average small to medium houses (150 m^2), and large house (300 m^2). Based in these analyses, the following conclusions were reached:

- Rainfall harvesting is not a solution on it own but can supplement the water supply and hence reduce the demand on stressed systems.
- Due to the limited surface area of RDP houses, rainwater harvesting does not provide a sustainable source of water for rural water use. Pumping and treatment costs will be reduced through rainwater harvesting but this needs to be compared with the cost of providing rainwater harvesting infrastructure.

- The amount of water that can be harvested from medium to large houses in the Mbombela municipal area is significant and will reduce the demand on the domestic water demands currently supplied from the Crocodile and Sabie Rivers by about 5%.

Based on the above it is recommended that all houses with a roof area in excess of 150 m^2 be fitted with rainwater harvesting systems (with 5 000 litre tanks). As a starting point the approval of all new developments should be subject to the inclusion of rainwater tanks. Implementing rainfall harvesting on existing properties will be more problematic due to the cost involved but this could be achieved through pricing strategies.

3 CONSIDERATIONS FOR SELECTING THE MOST APPROPRIATE RECONCILIATION OPTIONS

3.1 INTRODUCTION

Before looking at the water requirements and the status of the water resources in respect of each water demand centre, it is necessary to agree on specific founding principles that will be generic for all water demand centres. These principles are described in the following section. Thereafter a set of criteria need to be agreed upon which will be used for each water demand centre for choosing between identified reconciliation options.

3.2 FOUNDING PRINCIPLES

The founding principles for water allocation for the MLM areas were based on the policies and regulations of the Department of Water Affairs and the ICMA. These policies and regulations:

- Recognise South Africa's International Obligations in terms of the Southern African Development Community (SADC) Revised Protocol on Shared Water Courses in terms of which there should be fair and equitable sharing of the water resource between South Africa and Mozambique.
- Balance the social and economic water requirements and the protection of the environment to achieve sustainable development.
- Ensure that water is used efficiently.
- Eliminate all unlawful water use.

The following founding principles for water allocation in the MLM were adopted:

- Principle 1: Water for basic human needs in the study area will be made available. Together with this, appropriate sanitation must be provided.
- Principle 2: The EWR will be met as soon and in the best practical way. The water required to maintain, and where agreed, improve the environmental status of the Sabie and Crocodile River catchments, should be reserved.
- Principle 3: Water for strategic use for the benefit of the country (e.g. water supply to power stations) will receive priority above any other economic development.
- Principle 4: Water for economic growth in the study area, within the policy parameters of the government, will be provided.
- Principle 5: There will be no further expansion of total irrigation and total forestry.

3.3 ENVIRONMENTAL SCREENING OF OPTIONS

3.3.1 Process

Each proposed water reconciliation option was first put through a process of environmental screening, which may produce a "no-go" result or a "fatal flaw". A reconciliation option returning a "no-go" result or a "fatal flaw" in the environmental screening process was not considered further.

The environmental screening process comprised the following steps:

- Summarise any key environmental or social issues that should be taken into 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.

3.3.2 Information gathering

The assessment was based on available documented information: no site visits, field work or additional data collection were undertaken to verify or update the available information.

3.3.3 The Reserve

Implementation of the Reserve was assumed to be condition of any proposed scheme. It was assumed that this would ensure that the aquatic ecology and requirements for basic human needs were adequately provided for and protected.

3.3.4 Environmental impact assessment

The construction of bulk water supply infrastructure such as dams and pipelines would require an environmental impact assessment which would include a public participation process.

3.3.5 Groundwater

In terms of groundwater development, the potential impacts on the groundwater of adjacent landowners were assessed, as well as impacts on the surface flow, riverine ecology and groundwater-dependent ecosystems: potentially these could all be affected by groundwater development if not sustainably implemented.

3.3.6 Inter-catchment transfers

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

3.4 SELECTION CRITERIA

3.4.1 Introduction

Each Scenario which met the principles set out above and achieved acceptable water balance was assessed against the following criteria:

3.4.2 Political priorities

The priorities of the relevant government departments of South Africa should be weighed against the possible intervention options for water reconciliation.

3.4.3 Water resources implications or implications in assurance of supply

Although the objective is to achieve a water balance it was possible that in some scenarios there could be a lower assurance of supply or a greater likelihood of restrictions or longer periods of restrictions than in other scenarios.

3.4.4 Flood mitigation

The extent to which the scenario will assist in flood mitigation (e.g. as result of additional storage) was assessed. A scenario that included a dam with significant storage will assist in flood mitigation when the dam is not operated at full storage level.

3.4.5 Drought mitigation

The extent to which the scenario will assist with drought mitigation was assessed. A scenario that includes a new dam will assist with drought mitigation in some areas.

3.4.6 Environmental benefits

The effectiveness of flow regulation in achieving low flow EWRs in river reaches where that is not currently possible was assessed.

3.4.7 Environmental impacts

A variety of environmental impacts were assessed, including:

- The impact on downstream flow regimes;
- Barriers to migration, and
- Inundated habitats.

3.4.8 Social benefits

The main social benefits will arise from:

- Job creation, both temporary during construction and permanently from the economic development; and/or
- The extent to which disruption to communities will be minimised.

3.4.9 Economic assessment

Unit Reference Value (URV), i.e, the cost per m3 of water supplied from the scheme made available by the management intervention. This allows scenarios to be compared.

3.4.10 Required institutional capacity

Each scenario was examined in the light of the following questions:

- Is there significant institutional capacity requirements involved with the implementation of this scenario?
- To what extent can the existing institutional capacity be utilised:
- What additional resources are required to implement this scenario,
- To what extent will this option help to develop institutional capacity?

3.4.11 Impact on governance and institutional development

The positive impact that the proposed scenario will have on governance and institutional development was considered.

3.4.12 Water quality impacts

The extent to which the scenario would have a beneficial or detrimental impact on the water quality was assessed.

3.4.13 Hydropower potential

Some scenarios include the construction of dams with greater hydropower generating potential for than others. Factors that affect the generation of hydropower were examined, including the:

- Height of the dam;
- Flow rate and regularity of flow releases out of the dam, and
- Demand for electricity in the vicinity of the dam.

4 BASE POPULATION ESTIMATE AND GROWTH SCENARIOS

4.1 BASE POPULATION

To understand MLM and all its components, reference must be made to factors which impact on the area from a historical perspective. This information provided a picture of trends and impacts which informed future population growth. For the purposes of this discussion, data from Statistics' was used.

A 2010 base population figure was used as the starting point for the demographic modelling. Demographic information was sourced from various municipal documents and previous studies. The various sources however each provide a different 2010 population figure, as highlighted in **Table 4.1**.

Table 4.1: Base population comparison

Source	2010 Population
Municipal IDP	527 203
Municipal SDF	546 411 (MBWS historic)
MBWS (low scenario)	543 178
MBWS (high scenario)	553 460
DWA 2008 (Mbombela WSDP)	776 386

Due to the discrepancies highlighted in **Table 4.1** and the difficulty in comparing data on a lower level, the base population was recalculated and determined by making use of Statistics' data and sub place information from 2009 Spot Building Counts (SBC), as well as by creating new sub places where large concentrations of development and growth were evident. A comparison of the existing data against the results of the recalculated figures is given in **Table 4.2**

Table 4.2: Base population comparison between calculated base and other sources

Source	2010 Population
This Study calculated base (low scenario)	548 467
This Study calculated base (high scenario)	550 024
Municipal IDP	527 203
Municipal SDF	546 411 (MBWS historic)
MBWS (low scenario)	543 178
MBWS (high scenario)	553 460
DWA 2008 (Mbombela WSDP)	776 386

The base population for 2010 was split between the various WDCs in the study area. The high population base figure of 550 024 for 2010 is depicted in **Figure 4.1.**

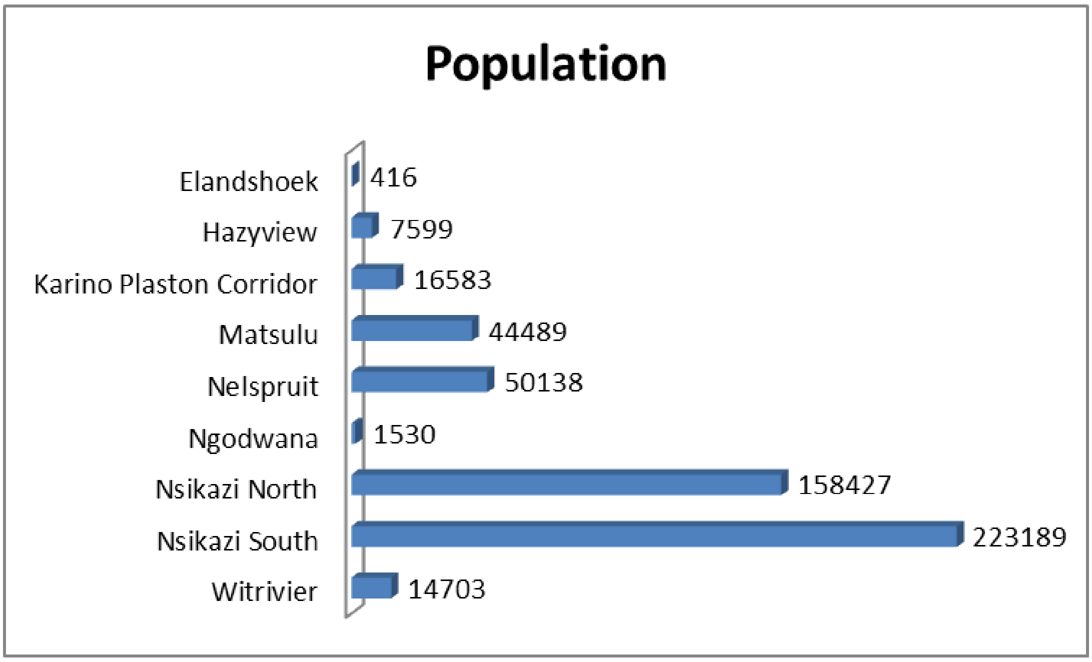


Figure 4.1: Population figures per WDC

As can be seen in **Figure 4.1**, the majority of people in the MLM are located in the Nsikazi North and South WDC, with approximately 72% of the total population of the municipality residing in these two areas. The WDCs with the lowest population are Elandshoek and Ngodwana, which are located to the west of Nelspruit. Approximately 33 000 people stay outside of WDCs, and have not been indicated in **Figure 4.1.**

4.2 GROWTH SCENARIOS

It was necessary to develop different growth scenarios for development since smaller settlements in MLM will not grow at the same rate as larger nodes such as Hazyview, White River and Nelspruit, as the factors affecting each area vary, according to their individual characteristics.

Low and high growth scenarios were developed for each WDC to take into account various development determinants (or "push and pull" factors) that would alter the projected growth and resultant population size. The following demographic development determinants were identified as factors likely to cause different water resource responses:

- Migration;
- Mortality;
- Fertility, and
- Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS), etc.

There are indications of the presence of large numbers of immigrants into South Africa, who place enormous pressure on already over-extended and under-supplied social services (e.g. schools, clinics) and infrastructural services (e.g. water, electricity, etc.). Population predictions thus took immigration into account and determined the implications for future population distribution and resource needs.

Population projections, however, also need to account for internal movement, which will ultimately lead to differences in population figures between areas in a local municipality due to inherent internal movement dynamics of population. Whilst very little information was available about migration patterns on a municipal level, it is however a fact that a lack of sufficient job opportunities to accommodate the economically active population, together with apartheid policies of influx control, has entrenched a migratory labour pattern on the country.

This pattern is very much evident from Census information, which indicated a discrepancy in the gender structure. Male absenteeism is higher in many rural areas. Substantially fewer females form part of the migrant labour pattern.

Other demographic alterations could result from changes in perceived fertility, mortality rates and HIV/AIDS infection rates. According to data from Statistics SA, the fertility rate has declined slightly from an average of 2, 92 children per woman in 2001 to 2, 35 children in 2011. Whilst still high, the infant mortality rate has declined from an estimated 53 per 1 000 in 2001 to 38 per 1 000 in 2011.

Life expectancy at birth is noted to have declined between 2001 and 2005 but has since increased steadily from 2005 onwards to 2011, partly due to the roll-out of antiretroviral medication. The increase in life expectancy at birth is expected to continue due to breakthroughs in medical technologies, improved education, improved living conditions, etc.

The total number of persons living with HIV/AIDS in South Africa increased from an estimated 4, 21 million in 2001 to 5, 38 million by 2011. In 2011 an estimated 10, 6% of the total population was HIV positive. Approximately one-fifth of South African women in their reproductive ages were found to be HIV-positive. HIV prevalence is expected to increase in future.

The above demographic trends influencing population growth were taken into account for both the growth scenarios designed for the MLM. This is discussed in more detail in the following subsections.

4.2.1 Low growth scenario

For the low growth scenario, it is expected that natural population growth in the MLM will follow historical trends. Little development will take place within the municipal boundaries, due to fairly low economic growth and the lack of large industries establishing in the MLM. Due to low economic growth, in-migration into the area is expected to be low, as few additional employment opportunities will become available which normally attract large numbers of people. The prevalence of HIV is expected to increase steadily, putting further strain on population growth.

4.2.2 High growth scenario

In the high growth scenario, the local economy is expected to prosper, and new industries will establish in the MLM due to its strategic regional location in terms of especially the N4 Maputo Corridor. Due to increased development and new industries, employment opportunities are expected to increase, which in turn will attract more people from outside the municipal areas to the municipality. The major economic nodes in the municipality (Nelspruit, Hazyview and White River) will mostly be the preferred destination for jobseekers, not only from other the surrounding rural areas, other local municipalities and Provinces (especially Limpopo), but also from Mozambique.

Higher in-migration into the area will in turn require additional social (schools, hospitals, community centres, etc.) and infrastructure (water, electricity, sanitation, etc.) services, as well as housing development to accommodate the additional population moving into the area. The proposed university will attract large numbers of people, which will increase the demand for especially housing and retail and commercial facilities. Table 4.3 shows the projected low and high growth scenario for each WDC.

Table 4.3: Summary of population growth per WDC

WDC	Growth scenario	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Elandshoek	Low	2,4%	2,1%	1,8%	1,5%	**1,9%**
	High	2,4%	2,1%	1,8%	1,5%	**1,9%**
Hazyview	Low	1,0%	0,9%	0,8%	0,7%	**0,9%**
	High	1,2%	1,1%	1,0%	0,9%	**1,1%**
Karino Plaston Corridor	Low	8,1%	7,4%	4,5%	1,6%	**5,4%**
	High	9,8%	8,0%	3,8%	2,3%	**5,9%**
Matsulu	Low	3.3%	3.3%	3.3%	3.3%	**3.3%**
	High	3.3%	2.8%	2.3%	1.8%	**1.3%**
Nelspruit	Low	2,5%	2,2%	1,9%	1,7%	**2,1%**
	High	2,9%	2,7%	2,5%	2,3%	**2,6%**
Ngodwana	Low	0,0%	0,0%	0,0%	0,0%	**0,0%**
	High	0,0%	0,0%	0,0%	0,0%	**0,0%**
Nsikazi North	Low	1,0%	0,9%	0,8%	0,6%	**0,8%**
	High	1,3%	1,2%	1,1%	0,8%	**1,1%**
Nsikazi South	Low	0,7%	0,1%	0,2%	0,4%	**0,4%**
	High	0,9%	0,6%	0,7%	0,8%	**0,7%**
White River	Low	1,8%	1,6%	1,4%	1,2%	**1,5%**
	High	2,3%	2,1%	1,8%	1,6%	**2,0%**

5 RECONCILIATION STRATEGY FOR NELSPRUIT (INCLUDING MATAFFIN, THE AGRICULTURAL COLLEGE AND MATUMI GOLF COURSE)

5.1 POPULATION GROWTH

The low and high population growth scenarios for Nelspruit are shown in **Table 5.1** and **Figure 5.1**. The population of the Nelspruit WDC is expected to grow steadily up to 2030, with an average growth rate of 2,1% in the low growth scenario, and 2,6% in the high growth scenario.

Table 5.1: Low and high population growth for Nelspruit

Year	2009	2010	2015	2020	2025	2030
Low	48 703	49 907	56 388	62 777	68 975	74 912
High	48 703	50 138	57 976	66 239	74 831	83 658

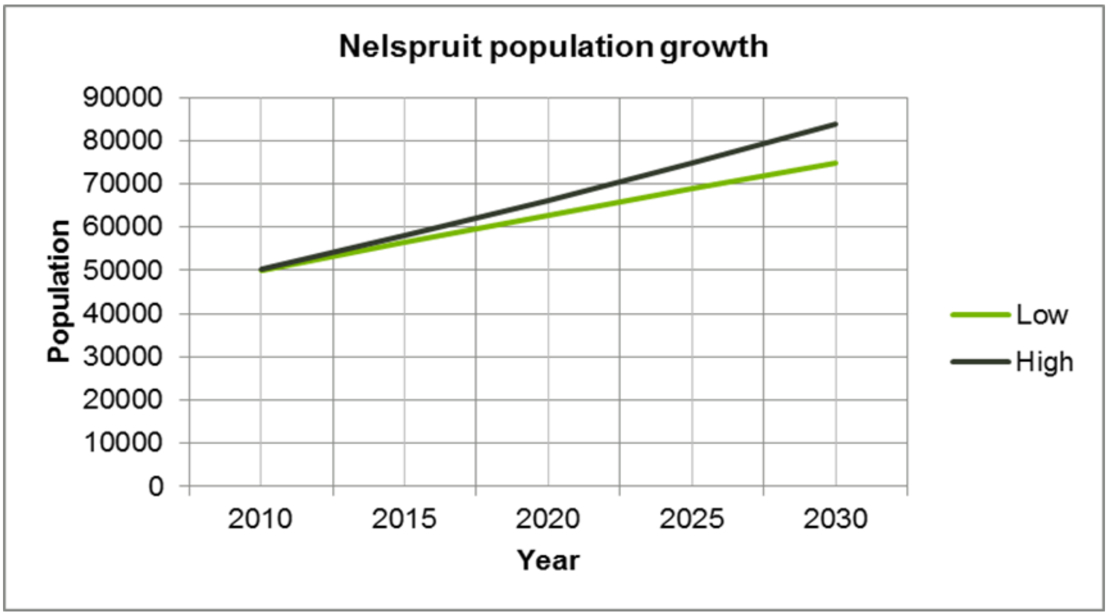


Figure 5.1: Low and high population growth for Nelspruit

During the course of documentation of this preliminary water reconciliation strategy, there were rumours of a new university and hospital for Nelspruit which might influence growth rate for the town. It now seems that the rumours will become a reality and the impact on the population growth rate of these developments will be studied and covered in the continuation study.

A further factor that needs to be taken into account in the continuation study is the high number of daily visitors to Nelspruit and employees that work in Nelspruit but live somewhere else. Such temporary increases in population could have a significant impact on the water demand of the town.

5.2 CURRENT WATER USE

Sembcorp (Silulumanzi) is the WSP in Nelspruit. Water is abstracted from the Crocodile River, treated and distributed.

The bulk abstraction records for Sembcorp show that during 2011/12 a volume of 15,08 million m^3 was abstracted from the Crocodile River for supply to the Nelspruit area. Of this volume 1,29 million m^3 was supplied to Rocky Drift, Phumulani and White River which is in a separate water demand centre. This volume also includes the supply to Mattafin which is estimated on 0,13 million m^3/a. The current water use in Nelspruit is therefore 13,98 million m^3/a (38,30 Mℓ/day).

5.2.1 Domestic water use

The current domestic use in Nelspruit is 24,84 Mℓ/day or 9,07 million m^3/a.

5.2.2 Industrial water use

The current industrial water use in Nelspruit is estimated to be 13,45 Mℓ/day or 4.91 million m^3/a. The larger industrial water users in the Nelspruit area include Mondipak, Manganese Metal Company, Delta EMD, Nelspruit Abattoir and Coke with an average daily demand of 2,35 Mℓ/day or 0,86 million m^3/a.

It was recently pointed out by MLM that the domestic water use should be further broken down into commercial water use (e.g. schools, shops, hospitals, etc.) and pure domestic water use that is being used by households.

An analysis of the water use in the MLM area can be broken up as follows:

- Domestic 67%
- Commercial 28%
- Industrial 6%

It therefore appears that the commercial water use had already been grouped under Industrial. This aspect will be further analysed for the purpose of the final strategy.

5.3 PROJECTED FUTURE WATER REQUIREMENTS

5.3.1 Domestic water requirements

It was anticipated that domestic use will steadily increase up to 2030. The projected domestic future water requirements for the high and low scenarios are shown in **Table 5.2** and **Table 5.3** respectively.

Table 5.2: Projected domestic water requirements in million m^3/a

Year	2010	2015	2020	2025	2030
Low	8,39	8,82	9,23	9,60	9,89
High	8,56	9,89	11,30	12,77	14,28

Table 5.3: Projected domestic water requirements in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	23,00	24,17	25,28	26,31	27,11
High	23,44	27,11	30,97	34,99	39,11

5.3.2 Industrial water requirements

It was anticipated that industrial use will also steadily increase up to 2030 and are shown in **Table 5.4** and **Table 5.5**.

Table 5.4: Projected industrial water requirements in million m^3/a

Year	2010	2015	2020	2025	2030
Low	4,61	5,22	5,82	6,39	6,96
High	4,63	5,36	6,12	6,91	7,73

Table 5.5: Projected industrial water requirements in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	12,64	14,30	15,94	17,52	19,06
High	12,69	14,68	16,77	18,94	21,18

5.3.3 Commercial water requirements

Water supply to shopping centres, schools, hospitals, etc. should be regarded neither as industrial water nor as domestic water, as it pushes up the unit consumption per person giving a skewed reflection of the unit consumption. However, this information is not readily available. It is recommended that this be studied in more detail during the continuation phase.

5.4 HIGH AND LOW SCENARIO WATER REQUIREMENT PROJECTIONS

The projected low and high scenario water requirements (including both domestic and industrial use) within the Nelspruit area, are shown in **Table 5.6** and **Table 5.7** below.

Table 5.6: Projected low and high scenario projections for domestic and industrial use in million m^3/a.

Year	2010	2015	2020	2025	2030
Low	13,01	14,04	15,05	16,00	16,85
High	13,19	15,25	17,42	19,68	22,01

Table 5.7: Projected low and high scenario projections for domestic and industrial use in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	35,64	38,47	41,22	43,82	46,16
High	36,13	41,78	47,74	53,93	60,29

5.5 WATER RESOURCE AVAILABILITY

5.5.1 Groundwater availability

The geology of the study area as shown on the hydrogeological map in **Figure 5.2** consists of grey and white granites south of Nelspruit, and potassic gneiss to the north of the city. Northwest southeast striking diabase dykes are present in the area. The aquifer present is classified as an inter-granular and fractured aquifer according to the 1:500 000 hydrogeological map (1:500 000 Hydrogeological Map Series of the Republic of South Africa – Nelspruit 2530, (DWAF, 1999)). The occurrence of groundwater is mainly associated with the deeper weathered zones, whereas fault zones and dyke contacts represent other groundwater occurrences.

The groundwater yield potential is classed as “low”, with potential yields between 0,1 to 0,5 ℓ/s in the granite and 0,5 to 2,0 ℓ/s in the gneiss. According to Vegter (1995) the probability of drilling a successful borehole is below 40%. The possibility of drilling a borehole yielding more than 2 ℓ/s is only 20% to 30% in the granite, and 10% to 20% in the gneiss.

It was therefore concluded that groundwater availability is generally low and will require further detailed investigations for development.

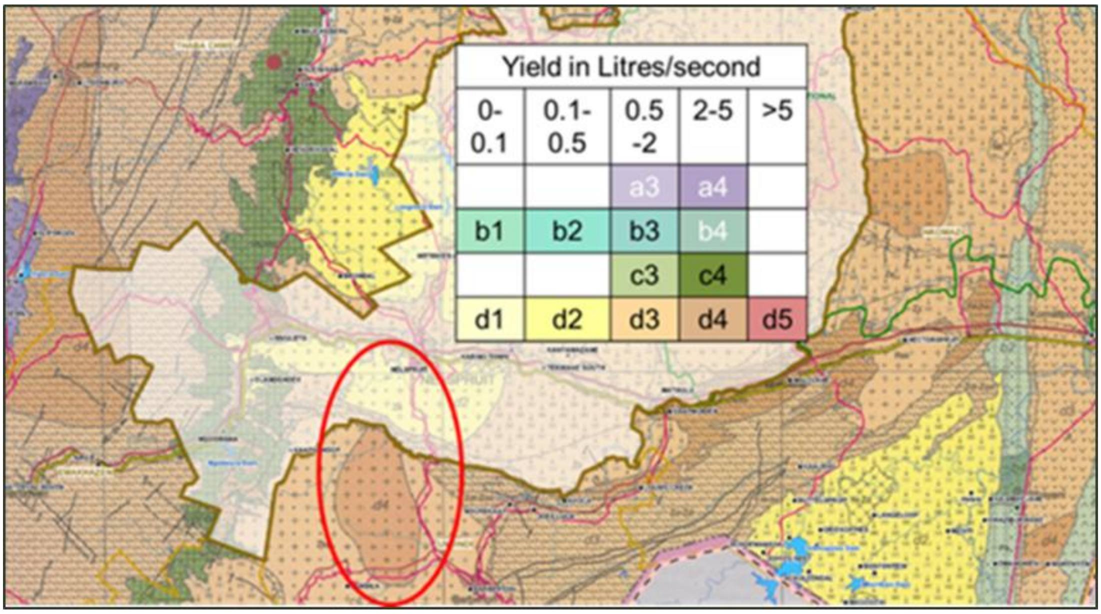


Figure 5.2: Location of possible site ground water resources for Nelspruit

5.5.2 Surface water availability

Nelspruit obtains all its water from the Crocodile River, with the flow in the river being regulated by releases from the Kwena Dam. Water is diverted from the Crocodile River into an unlined canal which then gravitates water to the treatment plant. Since there are large irrigation requirements downstream of Nelspruit (see **Table 2.4**) as well as international and ecological requirements, which are met by releases from the Kwena Dam, the flow in the river at Nelspruit's abstraction point is always more than sufficient for Nelspruit's current and future water requirements. However, Nelspruit should not exceed its licensed water allocation of 14,60 million m^3/a or the town will encroach on the water releases that are earmarked for downstream users, for meeting the Reserve requirements and for meeting the international obligations.

From time to time the cross-border flows drop to the minimum cross border flow requirement (as documented in the Piggs Peak agreement) which is currently set at 2,0 m^3/s at the border of the two countries. The Crocodile River contributes 0,9 m^3/s of this amount.

The minimum ecological flow at the outlet of the Crocodile River has also been set at 0,9 m^3/s. Should Nelspruit abstract more than its current allocation it will jeopardise the cross-border flows as well as the ecological flow requirements, especially during times of drought. Hence there is a need to find additional water resources or to reduce the water demand, in order to ensure a sustainable water supply for all users in the catchment.

5.6 WATER QUALITY

5.6.1 Sources of pollution

The water quality at the intake works of Nelspruit's s Water Treatment Works (WTW), which is located on the Crocodile River, is generally good. The main water quality impact upstream of Nelspruit is the Ngodwana paper mill, but the water in the Elands River is sufficiently diluted with water released from the Kwena Dam into the Crocodile River.

The Kingstonvale Waste Water Treatment Works (WWTW) contributes to the high nutrient loads in the Crocodile River which can affect users downstream of Nelspruit. This has become specifically evident after the special water quality standards were set in 2009 leading to lower compliance, since the plant was designed for the general and not special standards.

The Manganese Metal Company (MMC) and Delta industries also from time to time release manganese-rich water into the Nelspruit sewer system when they experience failures of their water treatment processes. This discharge is then received by the Kingstonvale WWTW. This situation is however carefully monitored, with 24 hours sampling on industrial effluent clients and on Sembcorp who operate the Kingstonvale WWTW.

Another source of manganese pollution is the Gladdespruit tributary of the Crocodile River. Pollution in the Gladdespruit might affect the quality of water supplied to

Nelspruit itself, as the confluence of Crocodile and Gladdespruit Rivers is located just above the diversion weir of the Nelspruit intake canal. Diffuse source releases from Papa Quarry at the confluence with the Gladdespruit are a source of increased Manganese concentrations in the Crocodile River. Sampling of this raw water has been adjusted to monitor the manganese on a more frequent basis at the Nelspruit WTW.

Afforestation in the catchment of the Nels River causes an increase in manganese background values, an increase in sediment loads and a decrease in pH values during logging operations.

Runoff from agricultural areas has increased electrical conductivity (EC), trace elements and nutrients.

Littering is a huge problem along the entire Crocodile River and in Nelspruit itself.

5.6.2 Actual water quality versus water quality objectives

DWA's water quality standards and guidelines are met in the Crocodile River and its tributaries in the vicinity of Nelspruit in terms of the 90^{th} percentile for pH, conductivity, total dissolved solids, chlorides and sulphates. However, ammonia levels in the discharge stream from Kingstonvale WWTW previously exceeded the DWA standard by more than a factor of 10. This anomaly was also caused by the application of stricter special standards, for which the plant was not designed.

The situation has improved since the WSP obtained Blue and Green Drop status for the WTW and WWTW respectively.

Overall, the water quality in the Crocodile River at the intake of the abstraction works of the Nelspruit domestic/industrial water supply network is good, and hence water quality has no effect on water availability for Nelspruit (i.e. no special treatment or dilution water is required). A water safety plan is in place and is being implemented.

5.6.3 Trend analyses

Sampling has been taking place in the Crocodile River at Weltevreden since 1972 and data is available until June 2011. A total of 1 251 electrical conductivity (EC) measurements are available. The EC varies between 3,86 and 90,3. EC has been steadily increasing since 2000, but appears to have stabilised. The increase could possibly be ascribed to rapid urbanisation, since the same trend is observed for phosphate and ammonia.

5.7 THE WATER BALANCE

5.7.1 Current water balance with no interventions

When the water licence for Nelspruit was considered, it was stipulated that the present ecological state of the river and the current flow regime would be maintained, and that international obligations would be met. The current allowable abstraction rate and volume of Nelspruit was therefore carefully determined: this rate and volume may not be exceeded. The current licensed abstraction volume is 14,6 million m^3/a. This volume is regarded as the current water allocation for Nelspruit, (including Mataffin, the Agricultural College, and Matumi Golf Course).

Nelspruit and its associated water supply areas have therefore not exceeded their licenced abstraction as yet, but they are at risk of doing so shortly.

5.7.2 Future water balance with no interventions

The projection of the future water requirements of Nelspruit and its supply areas for the high and low growth scenarios is summarised in **Table 5.7.**

Without any interventions, the water supply to Nelspruit will remain within the licenced volume until about 2018, as shown in **Figure 5.3.**

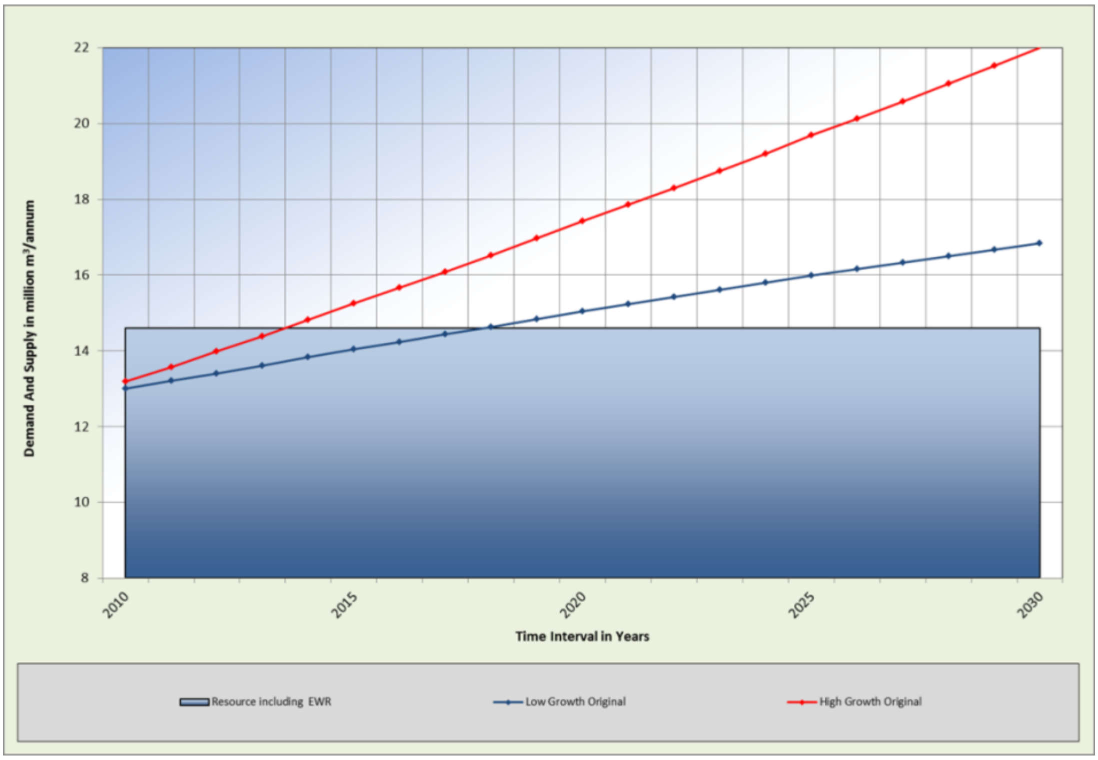


Figure 5.3: Nelspruit's water balance without any interventions

From the graph it can be seen that Nelspruit and its water supply areas may experience deficits from 2013 in the case of the high growth scenario and from 2018 in the case of the low growth scenario. The conclusion can therefore be drawn that some form of intervention will be necessary in future in order to meet the water requirements of Nelspruit and its supply areas, particularly in the case of high growth.

5.8 POSSIBLE INTERVENTION OPTIONS

5.8.1 Reconciliation options that will reduce water requirements

5.8.1.1 Water Conservation and Water Demand Management

Status quo and strategy

The Nelspruit WDC is operated and maintained under concession by Sembcorp Silulumanzi under the jurisdiction of MLM. The demand centre comprises mostly formal areas with formal infrastructure which means that metering, billing and cost recovery systems are in place and are operated adequately.

Sembcorp Silulumanzi has already put a Water conservation/Water Demand Management (WC/WDM) business plan in place and is in the process of implementing it. The strategic actions suggested by this Reconciliation Strategy are set out in **Table 5.8**. Sembcorp Silulumanzi should ensure that all these actions are covered in its business plan. The plan should be adopted even if all the actions are not being implemented.

Table 5.8: WC/WDM Status quo assessment and strategy

Status quo	Strategy
Institutional and legal assessment	
• Sembcorp Silulumanzi is well structured and has sufficient capacity to implement WC/WDM but training and increased capacity is required in WC/WDM section. • The WSP uses the municipal bylaws which are currently under review but have their own customer charter. • The relationship with the municipality and politicians has improved and this should be improved ever further.	• Appoint additional staff to increase WC/WDM section and implement training programme. • Enforce bylaws to promote WC/WDM. • Setup WC/WDM task team, chaired by senior official or MEC to meet on monthly basis to address WC/WDM issues. This should improve communications between organisations, highlight problem areas and transfer skills.
Financial assessment	
• The existing metering, billing and cost recovery system is fully operational. • Non-revenue water (NRW) is in the order of 27%. • Water tariffs are cost reflective and organisation runs on business principles. • A rising block water tariff structure is in place to promote WC/WDM. • Meter reading acceptable but can improve. • Billing is informative.	• Considering the scarcity of water in the area, consideration could be given to increase the top domestic tariff to around R15/kℓ which is in line with metro councils. • Provide training to meter readers to improve meter reading and reporting.

Status quo	Strategy
Social assessment	
• The relationship with the community is generally positive. • Water is paid for but not valued very highly and excessive garden watering is a common phenomenon. • WSP has an effective customer call centre and promote reporting of leaks.	• Promote water wise gardening and implementation of rain water harvesting in formal areas. • Expand schools awareness programme to promote reporting of leaks and water wise practices.
Technical assessment	
• There is sufficient macro management information available to perform a proper assessment of the water losses and potential savings. • Bulk metering, pressure management, sectorisation, and leak repairs are performed but can improve. • Pump stations are visited on a weekly basis and logged on the job card system. • Consumer meters are generally in excess of 8 years old and are considered the main contributor to the high NRW. • The WSP has existing loggers and leak detection equipment. • Existing telemetry system and control room. • Top consumers (approximately 120) are pro-actively monitored. • High pipe burst frequency (approximately 100 / month)	• Implement and maintain sectorisation to identify key problem areas, maintain pressure management and reduce pipe bursts. • Expand existing pressure management programme and focus on maintenance and monitoring. Will result in reduced number of pipe bursts and prolong infrastructure design life. An in-house maintenance department and job card system is already in place. • Pressure-reducing valves (PRVs) / zones must be continuously monitored to ensure discreteness and PRV settings. • Improve micro management information through proper sectorisation to obtain a better understanding of problem areas. • Implement a consumer meter replacement programme, starting with the top consumers, whereby 10% of all water meters are replaced per annum.
General observations	
• All four water treatment plants operated by the WSP received Blue Drop status which is an indication of a well-managed system. • Nelspruit is one of few systems to achieve Platinum Status (Blue Drop Status since the first Blue Drop awards in 2009) and is the second best managed system in the country with a score of 99,15%. • A water safety plan and management system is in place for the Nelspruit distribution systems.	• Maintain Blue Drop status and expand performance to water distribution network through proper management and control.

Performance indicators

The key performance indicators for the Nelspruit demand centre are summarised in **Table 5.9**.

Table 5.9: Key performance indicators for Nelspruit WDC

Indicator	Current Value	Realistic Target Value 15% reduction	Optimistic Target Value 30% reduction
Annual input volume (million m³/annum)	13.98	11.88	9.79
Daily input volume (Mℓ/day)	38.3	32.5	26.8
Domestic Input volume (million m³/annum)	9.07	7.71	6.35
Population (2012)	53 137	-	-
Households (2012)	15 714	-	-
% Non-revenue water	27%	20%	15%
Litres/capita/day	720	612	504
m³/households/month	48.1	40.9	33.7
Domestic litres/c/d	467	397	327

Based on the unit consumption, it is clear that WC/WDM should be implemented as a matter of priority. The current consumption is almost three times the international accepted standard of approximately 180 litres per capita per day, after allowing for industrial and commercial use.

Top industrial consumers in the area include Mondipak, MMC, Delta EMD, Nelspruit Abattoir and ABI (Coke) with a combined average daily demand of 2,35 Mℓ/day.

Summary and conclusions

There is tremendous scope for WC/WDM in the Nelspruit area which will result in both reduction of non-revenue water and the total system input volume. The institutional capacity and skills are available to embark on such a programme and should focus on the following interventions:

- Zone metering and sectorisation to improve micro management information. This will assist with the identification of key water loss areas and reduce number of pipe bursts.
- Improved pressure management programme in conjunction with sectorisation and continuous monitoring.
- Consumer meter replacement programme whereby 10% of all consumer meters are replaced on an annual basis.
- Increase the high end of the domestic water tariffs to promote WC/WDM.
- Community awareness programme that promotes the value of water and water wise gardening.

5.8.1.2 *Removal of invasive alien plants*

The assumption was made that removal of IAPs upstream of the Nelspruit diversion works on the Crocodile River would make water available which could conceivably be allocated to MLM. This scenario was analysed and it was estimated that up to 8 million m^3/annum could be made available if the IAPs in the Crocodile catchment upstream of Nelspruit are removed. Since it is not realistic or cost effective to remove all IAPs, it is suggested that a more realistic estimate of increased yield would be half this amount, or 4 million m^3/annum.

It was assumed that only half of this value will become available at the diversion works for Nelspruit and that the other half will benefit the tributaries that flow into the Crocodile River downstream of the Nelspruit diversion works. This assumption needs to be further investigated for the purpose of the Final Reconciliation Strategy.

5.8.1.3 *Water requirement reduction measures for irrigation farmers upstream of the Nelspruit abstraction point*

There are a number of possible measures that can be implemented by upstream irrigators that will reduce their water demand on the water resource. This will then, in effect, increase the water availability at the Nelspruit abstraction point. These possible measures are:

<u>Eliminating unlawful water use</u>

The first step in developing a Water Allocation Reform (WAR) Plan for the WMA is through the validation and verification of water use. The ICMA therefore initiated a study named '*Finalise the data collection and lawfulness assessment in support of the verification of existing lawful use within the Inkomati Water Management Area*'. The three focus water uses for this study in terms of the NWA are Section 21(a) *Taking water from a water resource*, Section 21(b) *Storage of water* and Section 21(d) *Engaging in a stream flow reduction activity.*

The aims of the study will be to identify and stop unlawful water uses, and also to identify and quantify lawful water uses.

Since, pending the study, the extent of unlawful water use is not yet known; this particular intervention has not yet been taken into account in the reconciliation. It can be factored into the Final Reconciliation Strategy if a timeous reliable estimate of the unlawful water use upstream of Nelspruit is made.

<u>Compulsory Licensing</u>

The procedure for Compulsory Licensing is described in Sections 43 to 48 of the National Water Act 1998 (Act No. 36 of 1998). The process is started when the responsible authority issues a notice in the Government Gazette that water users must apply for licences within a certain period of time.

The NWA allows the Minister of Water Affairs to require the licensing of all water use, implying that nearly all existing users would be compelled to apply for a licence. The Minister considers all the licence applications, taking cognisance of the water availability, and may licence and where required reduce the existing uses to ensure that International Obligations and the Reserve (Basic Human Needs (BHN) and EWR) are met within the water balance. The Minister may also reallocate the available water in a fair and equitable manner.

The procedure makes provision for the compilation of a proposed allocation schedule and any water user will have the opportunity to object to his/her new water allocation within 60 days after the proposed allocation schedule has been published in the Government Gazette. After considering all objections, the Preliminary Allocation Schedules must be published and after a prescribed appeal period the Preliminary Schedule becomes the Final Allocation Schedule.

Compulsory Licensing for the irrigation sector can possibly be linked to a WC/WDM initiative. If curtailment of water entitlements is found to be the only way to achieve a water balance, the objective should be to minimise the economic impact on the water users and the consequent job losses. By applying WC/WDM together with Compulsory Licensing, the irrigators can reduce their water requirements while retaining their current levels of income. However, they must then be prevented from expanding their enterprise with the saved water: The saved water will then become available for reallocation when implementing Compulsory Licensing.

One issue linking Compulsory Licensing with WC/WDM is the timing of the process. If a WC/WDM initiative precedes a Compulsory Licensing process, the WC/WDM measures will be to the immediate advantage of the water user insofar that the water user may lawfully expand his/her enterprise with saved water. This implies that when Compulsory Licensing is implemented these (now efficient) users will not have WC/WDM as a way of making up for cuts in allocations, assuming that these users will then be operating at maximum efficiency.

It is not good practice to postpone any WC/WDM initiative in the irrigation sector if Compulsory Licensing is not ready to be implemented at the same time, e.g. if the Compulsory Licensing process has to wait for the processes of validation and verification of water entitlements. If Compulsory Licensing cannot start immediately, the linking of this process with the WC/WDM should rather not be considered. The linking of WC/WDM with the Purchasing of Water Entitlements could then instead be undertaken.

Compulsory Licensing as a standalone curtailment process can certainly reduce the water requirements on the system but should only be applied as a last resort to achieve a water balance since it may have significant social consequences, e.g. economic prejudice of the water users, job losses, etc. However it is a relatively inexpensive, but very tedious process.

5.8.1.4 Water reallocation through water trading

Purchasing water entitlements

Another approach to reduce water use would be for the Minister to levy an additional water use charge on all users of water in the Inkomati River WMA in terms of Section 57 of the NWA. This levy must be in accordance with the pricing strategy which provides for, inter alia, setting water use charges for achieving the equitable and efficient allocation of water (Section 56 (c) of the NWA). The financial contributions of all the water users would be ring-fenced and used to buy out water entitlements from those water users who are willing to sell, e.g. by tender process. This process can then be continued until the necessary water balance is achieved.

Alternatively the purchase of water entitlements can be funded from the fiscus. Whichever financing strategy is followed, the purchase of water entitlements can lead to unintended negative social consequences such as job losses for farm workers, and must therefore be considered with great caution. Checks and balances need to be built into the process to mitigate the social consequences. For example, irrigation farmers could be allowed to sell off only a portion of their entitlements that will not cause significant economic prejudice.

The linking of WC/WDM savings to such a selling opportunity is a possible measure that will not necessarily cause economic prejudice and social hardships. It means that a water user, after applying WC/WDM can offer a portion of his/her entitlement representing the amount of water saved, to the water resource authority at an agreed price. This option is attractive in the sense that it can be implemented almost immediately and is not dependent on completion of the entire validation and verification processes. It is only those water users who offer a portion of their water use entitlements for sale whose entitlements must be validated and verified and this can be done on an ad hoc basis.

The process is relatively inexpensive, either funding mechanism can be used, and it is easy to implement. However an appropriate policy within DWA needs to be developed, and user guidelines need to be prepared.

<u>Transfer of water use entitlements</u>
Transfer of water use entitlements is a mechanism whereby the water use entitlement of a water user or group of users can be acquired by a different water use sector. An example could be where an industry needs water and buys out all or part of the water entitlements of an irrigation farmer or group of farmers.

Transfer of water entitlements is based on the willing buyer / willing seller principle.

Water trading should be regulated as it could lead to severe social impacts and job losses if a commercial farming enterprise closes down. *Only if there is no other option and water is urgently needed in the short term, should the transfer of complete water entitlements be considered.* The partial purchase of water entitlements is preferred.

The option to transfer water entitlements is dependent on the administrative processes in terms of Section 25 of the NWA and the compiling of the contract between the buyer and seller and the issuing of the new water use licence.

5.8.2 Reconciliation options that will increase water supply

5.8.2.1 Groundwater development

As shown on the geological map of the area (**Figure 5.2**), several northwest/southeast-striking dykes and shear zones are present close to the city of Nelspruit. High potential groundwater resources are normally associated with these structural features. However, high density airborne magnetic survey of the area is required to identify the exact locality of these structural features. Targets along these structures need to be selected for geophysical traversing. It is recommended that the radon emanation technique (Levin, 2000) be applied to locate the optimum drilling position.

5.8.2.2 Dam Construction to increase storage and hence yield

A total of four potential sites have been evaluated for dam development so as to increase yield storage for MLM. These are categorised as either regional or local schemes. Regional schemes are those that can provide additional yield to the entire municipality while local schemes are those that would benefit only certain WDCs.

Table 5.10 summarises the information for the two local schemes which, if developed, would benefit Nelspruit. The two other regional schemes could of course also benefit Nelspruit and they are described in **Section 13**, *Regional Reconciliation Options that serve more than one Water Demand Centre*.

Table 5.10: Information for potential sites that would benefit Nelspruit

Dam Site	Type of Dam	Incremental Yield, million m^3/a	Capacity, million m^3	Additional Height/ Height, m	Cost Estimate, R (million)
Raising Ngodwana Dam	Earthfill embankment	7,0	100	15,0	550
Boschjeskop Dam	Earthfill embankment	19,5	125	51,6	831,5

The dams summarised above were initially envisaged and intended primarily to supply Nelspruit, but turned out to have a significantly higher yield than could possibly be justified for Nelspruit alone, and are therefore reclassified as regional dams. They are discussed in more detail in **Section 13.**

5.8.2.3 System operating rules

The water resources of the Crocodile River are managed through a recently developed real-time system which makes use of hydrodynamic flow-routing models coupled with longer term water resources models, to determine the required releases from the Kwena Dam and the level of restriction to be imposed on users during droughts. This modelling system is one of the most advanced in Southern

Africa and there are therefore limited options for making additional water available through improved system operation. The following options have been identified:

Better control of diffuse irrigation
An estimated 80% of the irrigation within the Crocodile River catchment falls within irrigation boards which exercise control over their users by applying restrictions during droughts and through compliance with allocations. The remaining 20% of users do not necessarily comply with restrictions recommended by the real-time system operation system. Inclusion of all irrigators into the system and the enforcement of the restriction rules could make additional water available.

Off channel storage
The NWA does not allow users to abstract water at rates above their allocation even at times of high river flow. Should an operating rule be instituted which allows irrigators to pump water into off channel dams during floods, this would make additional yield available within the system.

5.8.2.4 Water transfers from elsewhere

There is currently not much scope for water transfers from neighbouring catchments as most of the water is already allocated. There is a possibility of transferring water from the Kaap River to Nelspruit but such a transfer is not possible without the required infrastructure such as dams and bulk pipelines. This is a future possibility with two dams identified on the Kaap River in the Crocodile Reconnaissance Study (DWA, 2008).

5.9 ALTERNATIVE AND SELECTED RECONCILIATION SCENARIOS

The following reconciliation scenarios have been considered in order to achieve a water balance for the Nelspruit water demand centre:

5.9.1 Enforcement of (WC/WDM) measures only

A 15% water saving (industrial, commercial and domestic) will not be sufficient to overcome the water deficit from 2013 as far as the high growth water requirement scenario is concerned. However, it will postpone the water deficit on the low growth requirement scenario from 2018 to 2029, i.e. almost for the entire planning period. (See **Figure 5.4**)

5.9.2 Enforcement of WC/WDM measures, the removal of IAPs and ground water resource development

When the removal of IAPs and groundwater development are considered together with WC/WDM measures, a water balance can easily be achieved for the low growth scenario, but only up to 2020 for the high growth water requirement scenario. It was assumed that the IAPs removal programme will start showing benefits from 2014 and will reach its full 2 million m^3/a yield gain by the end of the planning period. The groundwater will have a very small impact of only 0,1 million m^3/a yield gain from 2015. (See **Figure 5.4**)

5.9.3 Enforcement of WC/WDM measures, the removal of IAPs, ground water resource development and raising of the Ngodwana Dam

The implementation of this scenario would result in the water requirements for Nelspruit being more than adequately met for the planning period. (See **Figure 5.4**)

5.9.4 Enforcement of WC/WDM measures, the removal of IAPs, ground water resource development and development of the Boschjeskop dam site

This scenario also results in more than adequate water resources for Nelspruit over the planning period. The construction of the Boschjeskop Dam or the raising of the Ngodwana Dam could be complete only from 2018 at the earliest, and it was assumed that both would take 5 years after commissioning to reach full yield. It therefore makes no difference which dam option is chosen from a water balance point of view: other criteria such as URV will determine which dam option should be selected.

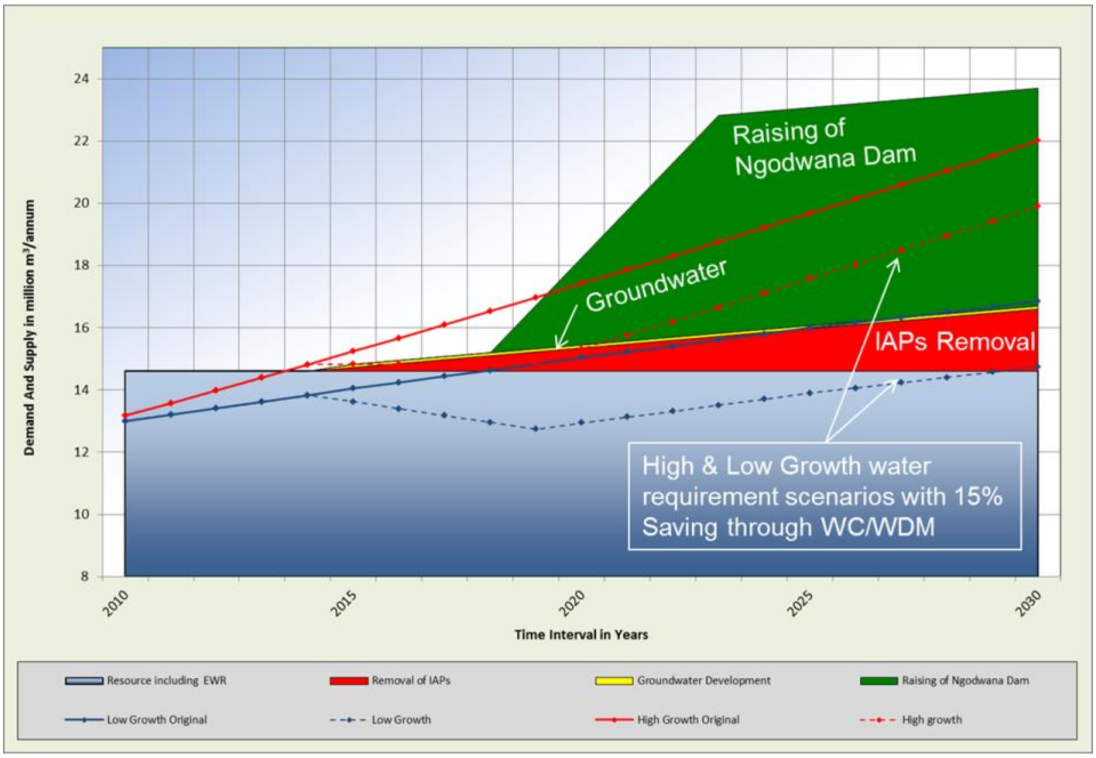


Figure 5.4: Water Reconciliation for Nelspruit WDC (Scenario 5.9.3)

5.10 RECONCILING THE WATER REQUIREMENTS WITH THE WATER RESOURCE

5.10.1 Water balance for selected reconciliation scenarios

Scenario 5.9.4 has been selected as the most appropriate intervention option for the reconciliation of the Nelspruit water balance, since the Boschjeskop Dam has a lower URV value than the raising of Ngodwana Dam and will have more than twice the yield. It could therefore also serve WDCs downstream of Nelspruit.

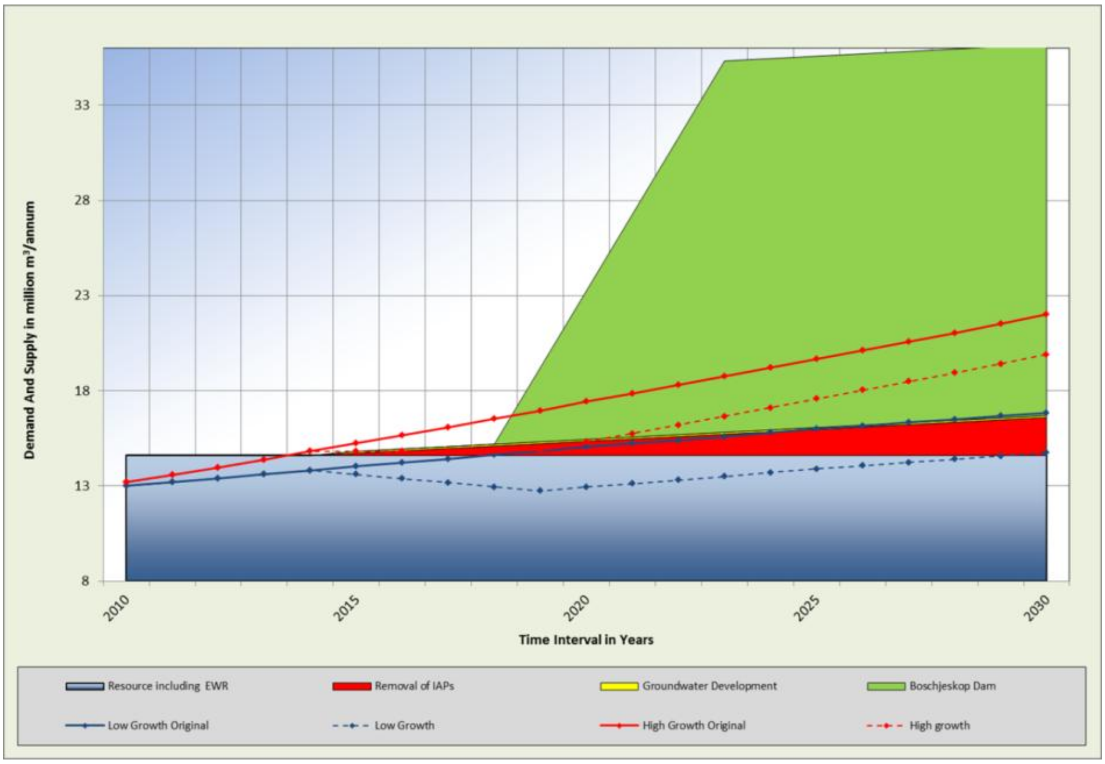


Figure 5.5: Water reconciliation for Nelspruit WDM with Boschjeskop Dam

5.10.2 Actions that need to be initiated as a matter of urgency

This scenario demonstrates that construction of a dam is necessary to achieve a water balance for Nelspruit within the planning period; the following actions will need to be undertaken as a matter of urgency.

5.10.2.1 Development of the WC/WDM plan and implementation strategy

MLM/Sembcorp Silulumanzi has already started to implement their WC/WDM business plan. They need to check that all the actions listed in **Table 5.8** are included in their plan and if not, they must update their plan accordingly. MLM and Sembcorp must seriously endeavour to save at least 15%. This is a conservative target and even better results can be achieved.

5.10.2.2 Removal of IAPs

Further investigations are necessary to establish the location and extent of IAP infestation and thereby confirm the yields that can be gained from their removal; this should be accomplished within a year of approval of this strategy. Thereafter a removal plan needs to be developed. Implementation can take up the remainder of the planning period.

5.10.2.3 Borehole siting

The best chance for a successful borehole is an area just south of Nelspruit (see **Figure 5.2**) outside the Mbombela municipal boundary. Boreholes need to be sited as explained under **Section 5.5.1**.

5.10.2.4 Feasibility study for Boschjeskop dam

A feasibility study for the Boschjeskop dam could be required but this needs to be weighed against regional development options (see Section 13). Another possible dam site on the Elands River is also being considered as part of this Reconciliation Study, and the conclusions will be discussed in the final Reconciliation Strategy Report.

6 WHITE RIVER TOWN (INCLUDING WHITE RIVER COUNTRY ESTATE AND ROCKY DRIFT)

6.1 POPULATION GROWTH

The low and high population growth scenarios for White River are shown in **Table 6.1** and **Figure 6.1** below. Based on the Statistics South Africa (StatsSA) and Eskom projections, the population of the White River WDC is expected to grow steadily until 2030, with an average growth rate of 1,5% in the low growth scenario, and 2,0% in the high growth scenario.

Table 6.1: Low and high population growth for White River WDC

Year	2009	2010	2015	2020	2025	2030
Low	14 370	14 625	15 970	17 248	18 448	19 574
High	14 370	14 703	16 487	18 265	20 013	21 719

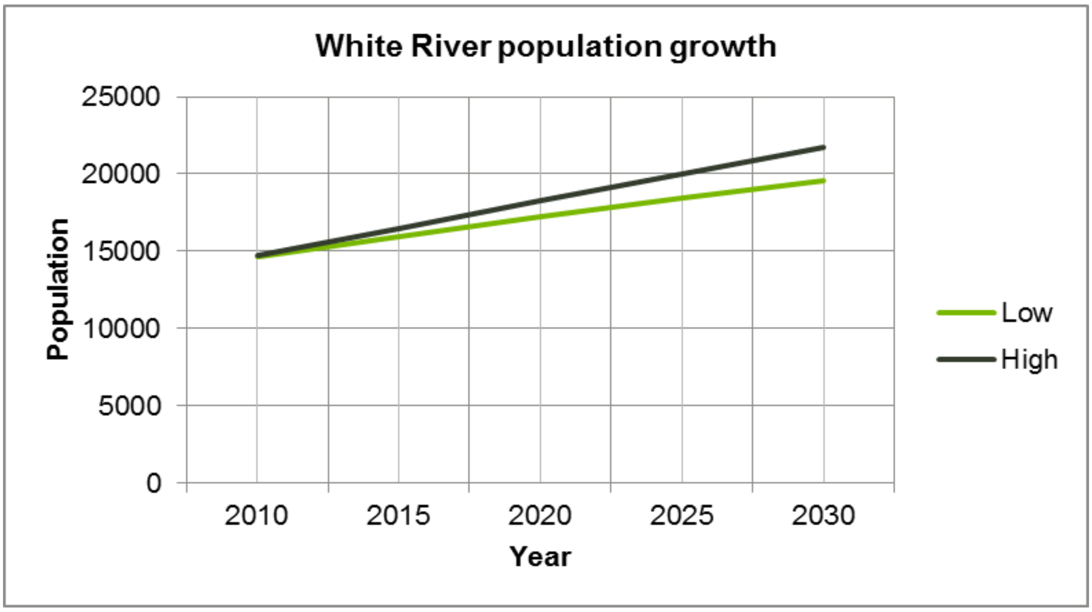


Figure 6.1: Low and high population growth for White River WDC

However, the above growth projections need to be revised when the Final Reconciliation Strategy is compiled as it has come to the attention of the authors that 4 000 new stands have been allocated to the township Phumlani and another 1 000 are being developed in White River.

6.2 CURRENT WATER USE

MLM is the WSP in the White River WDC. The WDC also includes White River Country Estate and the industrial area of Rocky Drift. White River receives water from three sources, namely Witklip Dam on the Sand River, Longmere Dam on the White River and the WTW in Nelspruit which takes water from the Crocodile River.

7 Mℓ/day is supplied from the two dams. The White River Country Estate also receives water from the Longmere Dam, from a separate 1 Mℓ/day WTW which serves only the country estate. There is also a borehole in town supplying 0,05 Mℓ/day. Water for Rocky Drift, Phumulani and White River is supplied from the Crocodile River.

6.2.1 Domestic water use

During 2011/2012 the total volume of water supplied from the Crocodile River for domestic use was 0,8 Mℓ/day. Total domestic use is 8,84 Mℓ/day or 3,22 million m^3/a.

6.2.2 Industrial water use

The industrial area of Rocky Drift is supplied from the Crocodile River. The current water use is 2,4 Mℓ/day or 0,88 million m^3/a.

6.3 PROJECTED FUTURE WATER REQUIREMENTS

6.3.1 Domestic water requirements

It is anticipated that domestic water use will increase steadily up to 2030. The White River Town Council has recently approved the development of a number of enterprises such as shopping centres, light industries etc. that will require commercial water. This will result in rapid growth in domestic water requirements in White River over the next 7 years. The projected domestic water requirements of the high growth scenario have been amended accordingly, and are shown in **Table 6.2** and **Table 6.3**, in million m^3/a and Mℓ/day respectively .

Table 6.2: Projected domestic water requirements in million m^3/a

Year	2010	2015	2020	2025	2030
Low	3,06	3,35	3,61	3,87	4,10
High	3,08	4,25	5,96	6,32	6,68

Table 6.3: Projected domestic water requirements in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	8,39	9,17	9,90	10,59	11,24
High	8,44	12,38	16,33	17,32	18,30

6.3.2 Industrial water requirements

The projected industrial water requirements of the high growth scenario are shown in **Table 6.4** and **Table 6.5** in million m^3/a and Mℓ/day respectively.

Table 6.4: Projected industrial water requirements in million m^3/a

Year	2010	2015	2020	2025	2030
Low	0,83	0,91	0,98	1,05	1,11
High	0,84	0,94	1,04	1,14	1,24

Table 6.5: Projected industrial water requirements in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	2,28	2,49	2,69	2,88	3,05
High	2,29	2,57	2,85	3,12	3,39

6.4 HIGH AND LOW SCENARIO WATER REQUIREMENT PROJECTIONS

The projected low and high scenario water requirements are shown in **Table 6.6** and **Table 6.7**.

Table 6.6: Projected low and high scenario projections in million m^3/a

Year	2010	2015	2020	2025	2030
Low	**3,90**	**4,25**	**4,60**	**4,91**	**5,21**
High	**3,92**	**5,46**	**7,0**	**7,46**	**7,92**

Table 6.7: Projected low and high scenario projections in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	**10,67**	**11,66**	**12,59**	**13,46**	**14,29**
High	**10,73**	**14,96**	**19,18**	**20,44**	**21,70**

6.5 WATER RESOURCE AVAILABILITY

6.5.1 Groundwater availability

The geology of the study area shown in **Figure 5.2** consists mainly of grey and white granite, with a small portion of potassic gneiss present to the south of White River. Several northwest/southeast striking diabase dykes are present in the area. The aquifer is classified as an inter-granular and fractured aquifer according to the 1:500 000 Hydrogeological map (1:500 000 Hydrogeological Map Series of the Republic of South Africa Nelspruit 2530, (DWAF 1999). Groundwater occurrence is associated mainly with the deeper weathered zones, with fault zones and dyke contacts hosting other groundwater occurrences.

The groundwater yield potential was classed as “low”, with potential yields of between 0,1 to 0,5 ℓ/s in the granite, and 0,5 to 2,0 ℓ/s in the gneiss. According to

Vegter (1995) the probability of drilling a successful borehole is below 40%.but the probability of drilling a borehole yielding more than 2 ℓ/s is only 10% to 20% in the larger part of the area. It was therefore concluded that the general groundwater availability is generally low, and would require further detail investigations for development.

6.5.2 Surface water availability

The town of White River and the industrial area of Rocky Drift receive their water from various sources. White River has an allocation of 0,75 million m^3/annum from the Witklip Dam on the Sand River, and a further allocation of 1,62 million m^3/annum from the Longmere Dam on the White River. The yield of the Witklip Dam was investigated in detail as part of a licence application for additional water for White River town (Mallory, 2010): it was concluded that the yield of the Witklip Dam is fully allocated, and that no new allocations can be made from this source.

The yield of the Longmere Dam was assessed as part of this Reconciliation Strategy. The Longmere Dam cannot be viewed in isolation, since it is supported by releases from the Klipkopje Dam. The yield of this system was estimated to be 10,1 million m^3/annum, while the allocation made to irrigators from this dam is approximately 10 million m^3/annum. The Klipkopje/Longmere system is therefore also fully allocated.

Until recently, Rocky Drift received water only from White River as part of their allocation from the Witklip and Longmere Dams, but more recently a pipeline was constructed from the Nelspruit WTW to Rocky Drift to supplement the water supply to this region. An allocation of 5 million m^3/annum has been made for Rocky Drift out of the Crocodile River. Abstractions from the Crocodile River for Rocky Drift are subject to the same constraints as abstractions for Nelspruit.

6.6 WATER QUALITY

6.6.1 Sources of pollution

The following water pollution threats currently exist in and around the town of White River:

- Rocky Drift is a light industrial area which has the potential for contaminated run-off during storm events.
- Forestry activities close to or within the riparian zone are the primary threat to the health of the riparian habitats and vegetation.
- Trout hatcheries are a threat to in-stream ecological health, through diversion of water for dams and weirs, which impact on the water flows in the area. Also, rivers may become enriched with nutrients from fish feed and waste.
- Although the White River WWTW are operated well within their design capacity, water is being discharged which does not comply with the licenced standards. The operation of the treatment works has however been improving over the past year.

- Rocky Drift has a small activated sludge plant and no monitoring is currently being undertaken. It is however a potential source of nutrients and possibly metals since it serves an industrial area.

6.6.2 Actual water quality versus water quality guidelines

Measurements at Rocky Drift show that none of the parameters measured exceeds the target water quality guidelines.

The available data is however limited, with a sampling record only since 2009. 17 EC measurements have been taken which varied between 9,92 and 49,3 mS/m. Seasonal variation in water quality data was observed. The EC remained stable with no upward trend for the period for which data is available.

6.6.3 Trend analyses

No significant trends were observed that hold a threat to White River and its people.

6.7 THE WATER BALANCE

6.7.1 Current water balance with no interventions

The current water use and water use allocations in accordance with DWA water use licences are shown in **Table 6.8.**

Table 6.8: Current water use and allocations – White River

Source	Abstraction million m^3/a	Licence million m^3/a	Comments
Witklip Dam via Sand River	0,75	0,75	
Longmere Dam	2,45	1,25	Currently abstraction for White River town 2,08 million m^3/a and 0,37 million m^3 for White River Country Estate. The agricultural allocation still needs to be converted into a domestic allocation for the Country Estate.
Borehole Kwik Spar	0,02	0,02	
Crocodile River	0,88	5,0	Allocation for White River and Rocky Drift
Totals	**4,1**	**7,02**	

From **Table 6.8** it can be seen that White River town and Rocky Drift do not experience any water deficits at present.

6.7.2 Future water balance with no interventions

A projection was made of the future water requirements of White River (including the country estate and Rocky Drift). The high and low growth scenarios for water requirements are shown in **Figure 6.2** .

The envisaged developments by the Town Council have been included in the high water requirement scenario, but this scenario should be re-assessed for the purpose of the Final Reconciliation Strategy to ensure that the Council's allocations are not excessive in terms of level of service.

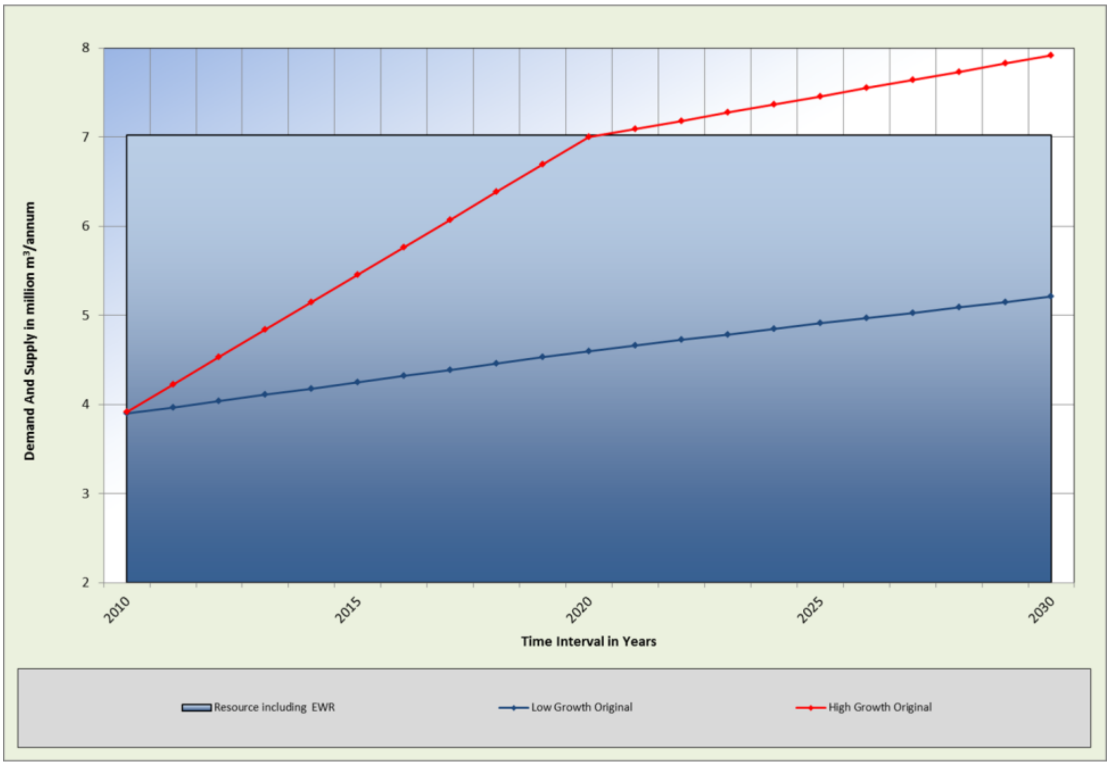


Figure 6.2 : Water balance graph for White River without any interventions

Without any interventions, the available water supply will remain the same as the licenced volume, i.e. 7,02 million m³/a.

From **Figure 6.2** it can therefore be seen that the low growth water requirement scenario can be easily supplied with the current allocation, but that a water deficit will occur from 2020 onwards with the amended high growth water requirement scenario.

6.8 POSSIBLE INTERVENTION OPTIONS

The only water deficits that have to be overcome are those that arise from 2020 onwards as a result of the high water requirement scenario. This can be done by reducing the water demand through WC/WDM measures. The current system losses in White River are 37%: there is therefore ample opportunity to reduce this.

The Demand Centre is operated and maintained by MLM. The demand centre comprises of mostly formal areas with formal infrastructure which enables metering, billing and cost recovery systems to take place adequately. Based on the available information, qualitative and quantitative scorecards, the assessment and proposed strategy summarised in **Table 6.9** were made:

Table 6.9: Status quo assessment and strategy

Status quo	Strategy
Institutional and legal assessment	
• Mbombela lacks capacity (45% vacancy) and necessary skills to implement WC/WDM. • There is no WC/WDM training. • The municipal bylaws are currently under review but not enforced. • There is no customer service charter. • The political support is acceptable but the understanding of the water business can improve.	• Appoint additional staff to fill vacancies and implement training programme. • Enforce bylaws to promote WC/WDM. • Setup WC/WDM task team, chaired by senior official or MEC to meet on monthly basis to address WC/WDM issues. This should improve communications between organisations, highlight problem areas and transfer skills. • Perform Councillor training programme on water business and WC/WDM. • Prepare a customer service charter.
Financial assessment	
• The relationship between the technical and finance department can improve with access to information being a problem. • The existing metering, billing and cost recovery system is fair but can improve. • Non-revenue water is estimated to be in the order of 35%. • Water tariffs are not cost reflective with limited input from technical department. A declining block water tariff structure is in place which does not promote WC/WDM. • Meter reading is not up to standard and often estimated. • Billing is informative and shows 2 months of consumption.	• The setup of a WC/WDM task team should improve the relationship with the finance department and access to information. • Provide training to meter readers to improve meter reading and reporting. • Water tariffs should be reviewed to become cost reflective and promote WC/WDM.
Social assessment	
• The relationship with the community is generally positive in formal income areas while strained in rural (informal) areas. • Water is paid-for in formal areas but not valued very high and excessive garden watering is a common phenomenon. • Illegal connections and non-payment	• Promote rain water harvesting in formal and informal areas. • Embark on community awareness programme that emphasise fixing of internal plumbing leaks. • Embark on schools awareness programme promoting reporting of leaks

Status quo	Strategy
prevalent in rural (informal) areas. • WSP has an effective customer call centre and promote reporting of leaks. • Rain water harvesting is promoted with Parks department.	and water wise practices.
Technical assessment	
• There is very little macro and no micro management information available to perform a proper assessment of the water losses and potential savings. • No zone metering, pressure management and sectorisation is being done. • Consumer meters are generally in excess of 5 years old and under recording. • The WSP has no loggers and leak detection equipment. • Existing telemetry system in some areas. • Top consumers are not pro-actively monitored. • Low pipe burst frequency (approximately 10/ week)	• Implement and maintain sectorisation to identify key problem areas. • Implement pressure management programme and focus on maintenance and monitoring. Will result in reduced number of pipe bursts and prolong infrastructure design life. • PRVs / zones must be continuously monitored to ensure discreteness and PRV settings. • Improve micro management information through proper sectorisation to obtain a better understanding of problem areas. • Implement a consumer meter replacement programme, starting with the top consumers, whereby 10% of all water meters are replaced per annum. • Monitor top consumers on a pro-active basis.
General observations	
• The White River and White River Country Estate WTWs received 90,8% and 91,54% respectively in the 2012 Blue Drop assessment indicating a well-managed water supply.	• Improve to obtain Blue Drop status and expand performance to water distribution network through proper management and control.

Table 6.10: White River Town performance indicators

Indicator	Current Value	Realistic Target Value 15% reduction	Optimistic Target Value 30% reduction
Annual input volume (million m³/annum)	4.1	3.49	2.96
Daily input volume (Mℓ/day)	11.2	9.5	8.1
Domestic Input volume (million m³/annum)	3.22	2.74	2.33
Population (2012)	15 595	-	-
Households (2012)	5 625	-	-
% Non-revenue water	Not available	30%	25%
Litres/capita/day	720	612	520

Indicator	Current Value	Realistic Target Value 15% reduction	Optimistic Target Value 30% reduction
m³/households/month	47.7	40.5	34.5
Domestic litres/c/d	566	472	435

The unit consumption is alarmingly high in White River. It may be that the domestic water use includes a component of commercial water use (i.e. shops, schools, etc.) but even if the domestic water use is reduced by ~ 30% to make provision for the commercial use, the unit water consumption is still very high: WC/WDM must be implemented as a priority.

6.9 SUMMARY AND CONCLUSIONS

There is scope for WC/WDM in the White River area which will result in both the reduction of non-revenue water and the total system input volume. There are, however, limited institutional capacity and skills available to embark on such a programme, and this situation should be resolved before focusing on the following interventions:

- Improve political support through a councillor awareness programme focusing on the water business.
- Review water tariffs to reflect cost of water and promote WC/WDM.
- Train meter readers and perform monthly audits to eliminate estimates and other inaccuracies.
- Develop and present community awareness programme that promotes the value of water and water wise gardening.
- Implement zone metering and sectorisation to improve micro management information. This will assist with the identification of key water loss areas and reduce number of pipe bursts.
- Instigate a Pressure management programme in conjunction with sectorisation and continuous monitoring.
- Initiate a consumer meter replacement programme whereby 10% of all consumer meters are replaced on an annual basis.
- Investigate the discrepancy between the values derived during the study and those used in the Blue Drop assessment.

6.10 SELECTED RECONCILIATION SCENARIOS

No reconciliation strategies other than WC/WDM measures were considered for the White River/Rocky Drift area, since the water balance can be achieved with WC/WDM measures only: Water is not being used efficiently in White River and this needs to be corrected.

There are a number of options available from which to source additional water for White River in future. These are:

- Raising of the Longmere Dam wall

- Increasing the supply from the Crocodile River, supported by one of the possible regional water supply schemes, namely the construction of Boschjeskop Dam or Montrose Dam, or the raising of the Ngodwana Dam wall.

The raising of the Longmere Dam does not look promising as it will only make ~ 1,5 million m^3/annum of additional water available. The most likely solution to the problem of meeting water shortages within the White River/Rocky Drift area, should they materialise, is to increase supplies from the Crocodile River, supported by a regional scheme. This should however only be considered after all necessary WC/WDM interventions have been implemented, and White River is using its water efficiently as a result.

Conservatively, a 20% saving for White River should already put the town in a positive water balance situation for the required planning horizon. The town could however save more than 20%. The water balance graph with 20% water savings through WC/WDM measures is shown in **Figure 6.3**.

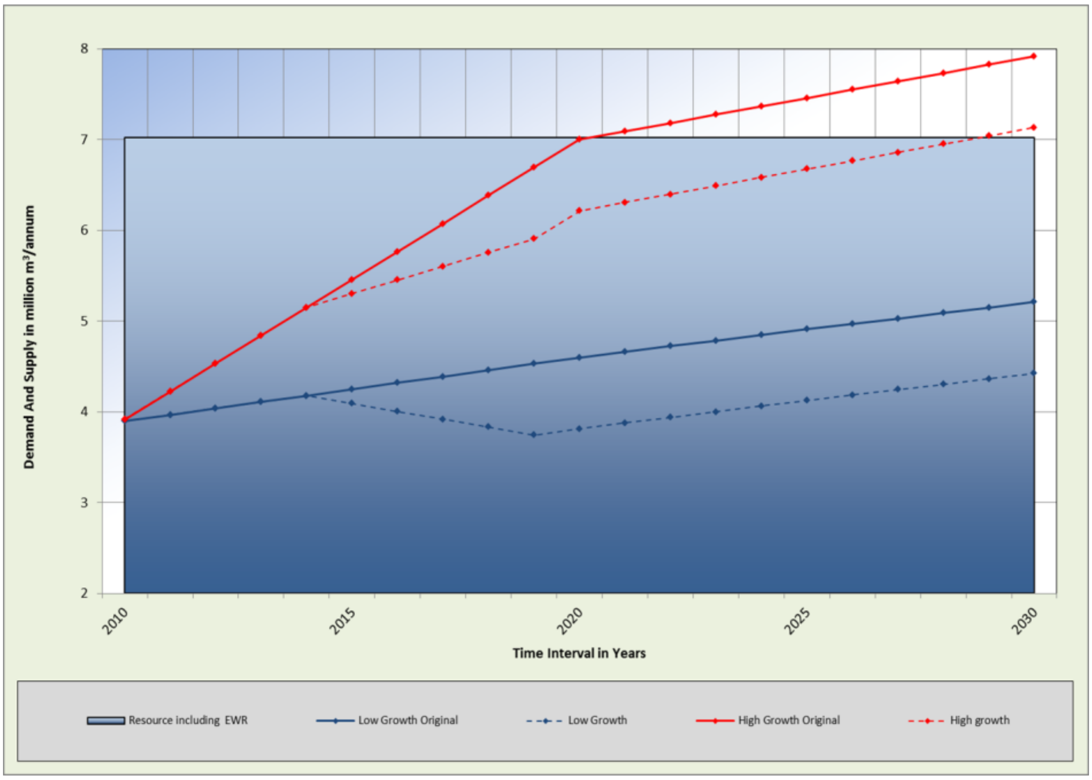


Figure 6.3: Water balance graph for White River with 20% savings through WC/WDM

7 KARINO/PLASTON CORRIDOR (INCLUDING AREAS IN NSIKAZI SOUTH NOT GETTING WATER FROM KANYAMAZANE, E.G. MAMELODI, TEKWANE NORTH AND EMOYENI)

7.1 POPULATION GROWTH

The low and high population growth scenarios for the Karino/Plaston Corridor are shown in **Table 7.1** and **Figure 7.1**. The population growth of the Karino/Plaston Corridor is expected to be the highest in the study area, with an average growth rate of 5,4% in the low growth scenario, and 5,9% in the high growth scenario. Population growth in the Karino/Plaston Corridor WDC is expected to be high between 2010 and 2015, after which it is expected to gradually slow down until 2030.

Table 7.1: Low and high population growth scenarios for Karino/Plaston Corridor

Year	2010	2015	2020	2025	2030
Low	16 583	24 479	34 980	43 487	41 079
High	16 583	26 490	38 968	47 069	52 673

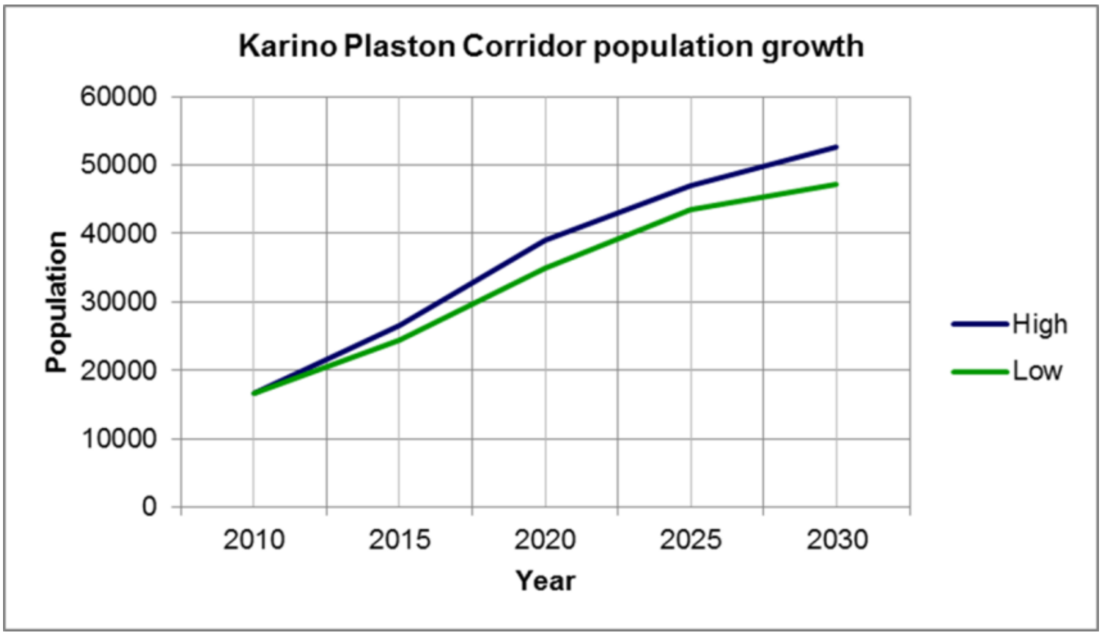


Figure 7.1: High and Low Population Growth scenarios for Karino Plaston Corridor

7.2 CURRENT WATER USE

Sembcorp Silulumanzi is the WSP for this demand centre.

7.2.1 Current domestic water use

There are two WTWs supplying water to the Karino/Plaston Corridor: One at Primkop Dam and the other next to the Crocodile River. The combined water use is 3,6 Mℓ/day. In future some of the areas receiving water from Nsikazi South will be supplied from this WDC.

7.2.2 Current industrial water use

There is currently no industrial water use in this WDC.

7.3 PROJECTED FUTURE WATER REQUIREMENTS

7.3.1 Projected domestic water requirements

The projected future domestic water requirements will follow the population growth levels in the area until 2030. The projected domestic use is shown in **Table 7.2** and **Table 7.3** in million m^3/a and in Mℓ/day, respectively.

Table 7.2: Projected water requirements in million m^3/a

Year	2010	2015	2020	2025	2030
Low	1,29	2,15	3,09	3,82	4,16
High	1,31	2,34	3,44	4,16	4,64

Table 7.3: Projected water requirements in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	3,54	5,89	8,47	10,47	11,40
High	3,60	6,41	9,42	11,40	12,71

7.3.2 Projected industrial water requirements

There are a number of Industrial Development Zones planned around the airport. The MLMs intention is to supply these industries with water from Primkop Dam, although this will have to be done through trading with the irrigators to whom the water is currently allocated.

The projected industrial use is shown in **Table 7.4** and **Table 7.5** in million m^3/a and in Mℓ/day, respectively.

Table 7.4: Projected industrial use in million m^3/a

Year	2010	2015	2020	2025	2030
Low	0,00	0,25	0,36	0,44	0,48
High	0,00	0,25	0,37	0,44	0,50

Table 7.5: Projected industrial use in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	0,00	0,68	0,98	1,22	1,32
High	0,00	0,69	1,01	1,22	1,36

7.4 HIGH AND LOW SCENARIO WATER REQUIREMENT PROJECTIONS

The projected low and high scenario water requirements are shown in **Table 7.6** and **Table 7.7** in million m^3/a and. in Mℓ/day, respectively.

Table 7.6: Projected industrial use in million m^3/a

Year	2010	2015	2020	2025	2030
Low	1,29	2,15	3,09	3,82	4,16
High	1,31	2,34	3,44	4,16	4,64

Table 7.7: Projected industrial use in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	3,54	5,92	8,45	10,51	11,37
High	3,60	6,44	9,47	11,43	12,79

7.5 WATER RESOURCE AVAILABILITY

7.5.1 Groundwater availability

The geology of the study area as shown on the geological map in **Figure 5.2** consists mainly of grey and white granite with several northwest/southeast striking diabase dykes present in the area. A northwest/southeast shear zone cuts through the area. The aquifer is classified as an inter-granular and fractured aquifer according to the 1:500 000 hydrogeological map (1:500 000 Hydrogeological Map Series of the Republic of South Africa Nelspruit 2530, DWAF, 1999)).

Groundwater occurrence is associated mainly with the deeper weathered zones, with fault zones and dyke contacts hosting other groundwater occurrences. The groundwater yield potential is classed as “low” with potential yields between 0,1 to 0,5 ℓ/s in the granite. According to Vegter (1995), the probability of drilling a successful borehole is below 40%, and of drilling a borehole yielding more than 2 ℓ/s only 10% to 20%. It is concluded that the groundwater availability is generally low, and would require further detailed investigations for development.

7.5.2 Surface water availability

The Karino/Plaston corridor receives water from two sources, firstly water from the Primkop Dam that was recently traded with irrigation allocations from this dam and secondly, water from the Crocodile River via a small, recently-constructed pump-station.

The supply from the Crocodile River is subject to the same water resources constraints as found in Nelspruit and Nsikazi South. The yield of the Primkop Dam was estimated to be 12 million m^3/annum, but this estimate needs to be reviewed once a better knowledge of upstream use and lawful allocations from this source becomes available from the Verification study, which is in progress. It is likely that additional water can be sourced from the Primkop Dam for Karino/Plaston.

7.6 WATER QUALITY

7.6.1 Sources of pollution

The following water pollution threats currently exist in the Karino/Plaston area:

- The Crocodile River is associated with domestic runoff, littering and an increase in nutrients.
- Irrigated agriculture in the area contributes to high nutrient loads and possibly high levels of pesticides and herbicides.
- Quarrying occurs along the lower Crocodile River before the confluence with the Kaap River which has the potential to increase turbidity and suspended solids in the river.
- Sand mining occurs along the Crocodile River.
- Upstream WWTWs (e.g. Kingstonvale or the one in the White River) pollute when they are not complying with standards. The Kingstonvale WWTW has Green Drop status: if maintained as such it would not necessarily represent a pollution threat.
- Manganese spills from upstream are possible if MMC and Delta experience failures which Kingstonvale WWTW cannot handle.

7.6.2 Actual water quality versus water quality objectives

The quality of abstracted water at Karino on the Crocodile River meets the DWA standard and guidelines with respect to all the measured parameters in terms of pH, EC, Dissolved Solids, chloride, sulphates and ammonia. Karino's waste water is not treated together with the waste water of Nsikazi South. Therefore, as far as Karino's waste water for downstream users is concerned, this waste water quality is not controlled at Karino itself.

7.6.3 Trend analyses

Sampling records were available from 1972. All the parameters comply with the water user requirements. EC varies between 6 and 86,1 mS/m with a median of 17 mS/m. There was an initial increasing trend from 1997 to 2003 in EC, however if the measurements are now compared on a month-to-month and a year-on-year basis, the levels whilst higher have stabilised. Measurements have not however been linked to flow rates in the river.

7.7 THE WATER BALANCE

7.7.1 Current water balance with no interventions

The present ecological state of the Crocodile River needs to be maintained and therefore the current licensed abstraction volume at Karino may not be exceeded. This current authorised abstraction is 1,3 million m^3/a from the Crocodile River. Water is also supplied from the Primkop Dam but the legality of this supply needs to be ascertained. The current abstractions and authorisations are provided in **Table 7.8.**

Table 7.8: Current abstractions and licences for Karino/Plaston

Source	Abstraction million m^3/a	Licence million m^3/a	Comments
Abstraction from Crocodile River	0,7	1,3	Licence issued on 26/02/2011 by DWA
Primkop Dam	0,7	0,3	No licence. Only verbal agreements to convert Primkop agricultural water to water for domestic consumption. Water from Primkop Dam is supplied to Tekwane North which is now regarded as part of the Karino/ Plaston water demand centre.
Total	**1,4**	**1,6**	

From the table it can be seen that the current water abstraction is in balance and does not exceed the available water in the resource.

7.7.2 Future water balance with no interventions

A projection was made of the future water requirements of Karino/ Plaston Corridor as described in **Section 7.1**. The high and low growth scenarios for water requirements are shown in **Figure 7.2**.

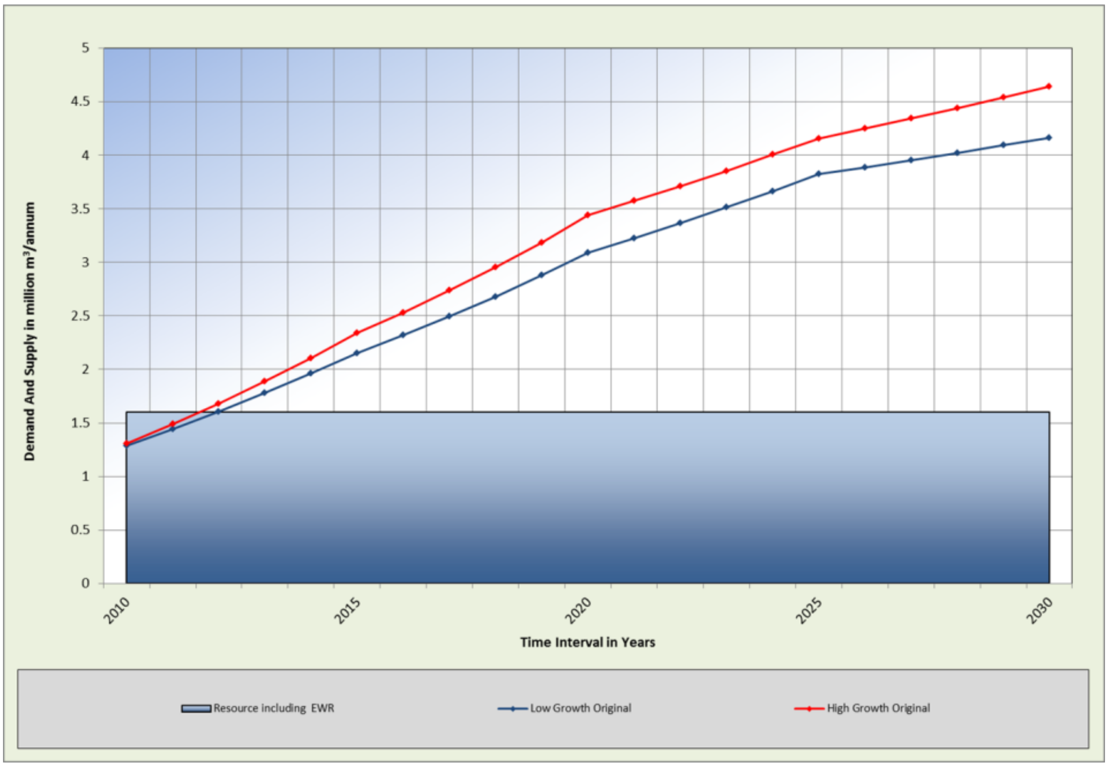


Figure 7.2: Karino/Plaston Corridor's future water balance without any interventions

Figure 7.2 shows that the water requirements of Karino/Plaston cannot be satisfied with the available water resource without further interventions.

7.8 POSSIBLE INTERVENTION OPTIONS

7.8.1 Reconciliation options that will reduce water requirements

7.8.1.1 Water conservation and water demand management

The Demand Centre which includes Mamelodi, Tekwane North and Emoyeni is operated and maintained under concession by Sembcorp Silulumanzi under the jurisdiction of MLM. The demand centre receives water from Primkop Dam, which is then treated at the WTW in the Broedershoek area. The treatment plant is operated by Sembcorp Silulumanzi. Most of the demand centre is formally developed and has formal infrastructure: the level of services is above RDP standards. There is a relatively smaller informal area with informal infrastructure within Emoyeni Township, which enables limited metering, billing and cost recovery to be undertaken, while the rest of the area has bulk and domestic meters.

The recommended WC/WDM measures for Karino Plaston Corridor are summarised in **Table 7.9**.

Table 7.9: Recommended WC/WDM measures for Karino Plaston Corridor

Status quo	Strategy
Institutional and legal assessment	
• Sembcorp Silulumanzi is well structured and has sufficient capacity to implement WC/WDM but training and increased capacity is required in WC/WDM section. • The WSP uses the municipal bylaws which are currently under review but have their own customer charter.	• Appoint additional staff to increase WC/WDM section and implement training programme. • Enforce bylaws to promote WC/WDM. • Setup WC/WDM task team, chaired by senior official or MEC to meet on monthly basis to address WC/WDM issues. This should improve communications between organisations, highlight problem areas and transfer skills.
Financial assessment	
• Metering, billing and cost recovery system is generally good. • Meter readers are outsourced. • There is a high level of non-paying consumers above 50%. • Water tariffs are cost reflective and organisation runs on business principles. • Non-revenue water is estimated above 50%. • A rising block water tariff structure is in place to promote WC/WDM. • Billing is informative.	• Improve level of service and supply to the area and consider installing meters in areas where there is no metering and billing taking place • Considering the scarcity of water in the area, consideration could be given to increase the top domestic tariff to around R15/kl which is in line with metro councils. • Provide training to meter readers to improve meter reading and reporting. Water Conservation tips should be included on the water bill.
Social assessment	
• The relationship with the community is generally fair. • WSP has an effective customer call centre and promote reporting of leaks. • Illegal connections and non-payment prevalent in rural (informal) areas. • High level of indigent's consumer profile. • Vandalism of infrastructure is a major concern.	• Improve the relationship with the community and focus on promoting payment for services through education and awareness. • Promote water wise gardening and implementation of rain water harvesting in formal areas. • Expand schools awareness programme to promote reporting of leaks and water wise practices.
Technical assessment	
• There is sufficient macro management information available to perform a proper assessment of the water losses and potential savings. • Bulk metering, sectorisation, and leak repairs are performed but can	• Implement and maintain sectorisation to identify key problem areas, maintain pressure management and reduce bursts. • Expand existing pressure management programme and focus on maintenance and monitoring. Will result in reduced

Status quo	Strategy
improve. • A large portion of the consumer meters are in excess of 8 years old and are considered the main contributor to the high NRW. • The WSP has existing loggers and leak detection equipment.	number of bursts and prolong infrastructure design life. • PRVs / zones must be continuously monitored to ensure discreteness and PRV settings. • Improve macro management information through proper sectorisation to obtain a better understanding of problem areas. • Implement a consumer meter replacement programme, starting with the top consumers, whereby 10% of all water meters are replaced per annum.
General observations	
• The Tekwane WTW received 97.97% while Karino WTW received 98,25% in the 2012 Blue Drop assessment which is an indication of a properly managed water supply. • A water safety plan and management system is already in place for the Karino distribution systems.	• Maintain Blue Drop status • Keep managing the distribution system efficiently.

Table 7.10: Performance indicators

Indicator	Current Value	Realistic Target Value 15% reduction	Optimistic Target Value 30% reduction
Annual input volume (million m³/annum)	1.3	1.11	0.91
Daily input volume (Mℓ/day)	3.6	3.0	2.5
Population (2012)	16 583	-	-
Households (2012)	Not available	-	-
Non-revenue water	Not available	-	-
Litres/capita/day	215	182	150
m³/household/month	-	-	-

The unit consumption of Karino Plaston Corridor is not far above the internationally-accepted standard of 180 litres per capita per day, but there is room for reducing this consumption. Realistic and optimistic target reductions of 15% and 30% respectively have been set.

Summary and conclusions

There is scope for WC/WDM in the Karino Plaston Corridor area, but it will not necessarily result in the reduction of non-revenue water and the total system input volume. The focus in this area should be on improving service delivery, removing illegal connections, fixing visible leaks and promoting community education and awareness, through the following actions:

- Implement a community awareness programme that promotes the value of water and water wise gardening.
- Ensure continuous water supply by improving Broedershoek WTW and the commissioning of Karino WTW.
- Improve political support through councillor awareness programme focusing on the water business.
- Review water tariffs to reflect cost of water and promote WC/WDM.
- Implement zone metering and sectorisation to improve micro management information. This will assist with the identification of key water loss areas and reduce number of pipe bursts.
- Train meter readers and perform monthly audits to eliminate estimates and other inaccuracies.
- Consider implementing pressure management in areas experiencing high pressures.
- Perform meter audit and cleaning to improve meter reading and accessibility.

7.8.1.2 Removal of IAPs

Some of the water for Karino is sourced from the Primkop Dam. Removal of IAPs upstream of Primkop Dam can make some additional water available. Based on the areas of IAPs upstream of Primkop Dam derived from the WFW report (Kotze, 2010), the runoff into Primkop could be increased by about 0,9 million m^3/annum.

This will result in an increased yield of about 0,4 million m^3/annum.

It was assumed that another 1,0 million/annum can be made available by removing IAPs from the Nels River.

7.8.2 Reconciliation options that will increase water supply

7.8.2.1 Groundwater development

As shown on the geological map of the area, several northwest/southeast striking dykes are present. A northwest/southeast striking shear zone cuts through the area. High potential groundwater resources are normally associated with these structural features. However, a high density airborne magnetic survey of the area is required to identify the exact locality of these structural features. Targets along these structures need to be selected for geophysical traversing. It is recommended that the radon emanation technique (Levin, 2000) be applied to locate the optimum drilling position.

It has been assumed that 200 000 m^3/a can be utilised from the groundwater resource.

7.8.2.2 Dam construction to increase yield storage

No dam construction was considered specifically for the Karino-Plaston demand centre. However, if any of the dam options for Nelspruit and Nsikazi South were to be pursued it would benefit Karino Plaston as well.

7.8.2.3 System operating rules

The operation of the Primkop Dam is complex, in that it is supplemented by pumping from the Crocodile River. This system has never been analysed in detail due to a lack of reliable information. Improved systems operation is likely to result in additional water available for allocations from this source. For the purposes of this 1st Order Strategy an estimated increase in water availability of 1 million m^3/annum has been assumed.

7.8.2.4 Water transfers from elsewhere

No options to transfer water in from other catchments could be identified.

7.9 SELECTED RECONCILIATION SCENARIOS

The following intervention scenarios have been analysed for the reconciliation of Karino/Plaston Corridor’s water balance. The effect of each of these scenarios on the water balance is depicted in **Figure 7.3.**

7.9.1 WC/WDM

The Karino water supply system must first be stabilised before noticeable results in terms of WC/WDM can be recorded. However, a target of 15% water saving is set for this WDC.

7.9.2 Development of groundwater

The shear zones east and west of Karino Plaston corridor should be investigated. 200 000 m^3/a was assumed from this resource.

7.9.3 Development of groundwater plus system operating rules for Primkop Dam

An additional yield of 1 million m^3/a from 2017 was assumed from this scenario. However, with this scenario, the full water demand is still not satisfied over the full planning period.

7.9.4 Development of groundwater plus system operating rules for Primkop plus removal of IAPs

This scenario improves the situation but still does not result in the attaining of a full water balance for Karino Plaston Corridor. A water balance for the low growth water requirement scenario from 2018 is however achieved.

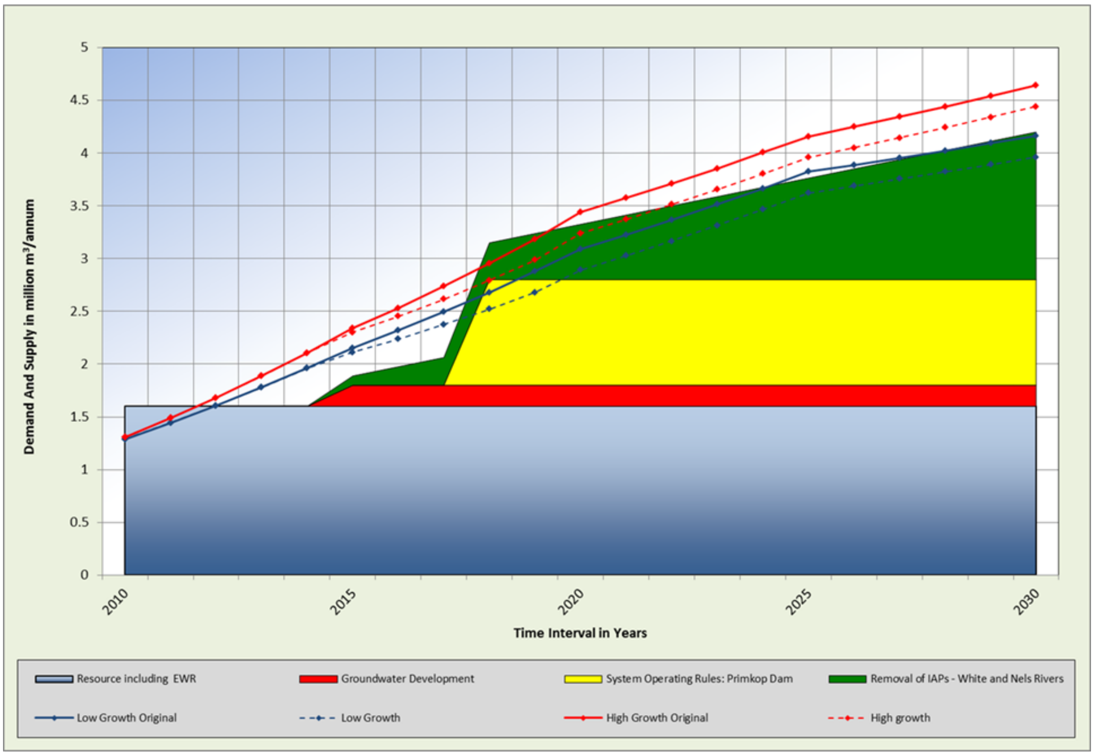


Figure 7.3: Water reconciliation for Karino Plaston Corridor

7.10 RECONCILING THE WATER REQUIREMENTS WITH THE WATER RESOURCE

7.10.1 Interventions needed

Figure 7.3 illustrates that for the Karino Plaston low growth scenario, a water balance can just be achieved by implementing all the suggested interventions. However, Karino Plaston will also benefit if any of the dam options suggested for Nelspruit are pursued, and the WDC will have an abundance of water. The following assumptions have been made regarding the implementation of this intervention:

- The groundwater target of 200 000 m^3/a will be reached by 2016, if a groundwater scheme is started in 2014.
- System operating rules can be implemented in a short space of time and the benefit can be reaped soon after implementation in 2018. The increase in yield was assumed to be 1 million m^3/a.
- The benefit of removing IAPs will gradually increase over the years in line with the removal of the plants.

7.10.2 Actions that need to be started as a matter of urgency

The following actions are required as a matter of urgency for the reconciliation of Karino/Plaston's water balance:

- Investigations need to be done to establish the extent of infestation of IAPs in the Primkop Dam catchment, and in the Nels River.
- Groundwater borehole siting using the techniques discussed in Paragraph 7.5.1 should be done as soon as possible.

- System operating rules for Primkop Dam must be developed as a matter of urgency. This action must be accompanied by an improved understanding of the water allocations, which will be derived from the Validation and Verification study.
- A WC/WDM plan must be developed as soon as possible, and approval for implementation of the plan must be obtained before 2014.

8 NSIKAZI SOUTH

8.1 POPULATION GROWTH

The low and high population growth scenarios for Nsikazi South are shown in **Table 8.1** and **Figure 8.1**. The population of the Nsikazi South is expected to grow steadily up to 2030, with an average growth rate of 0,4% in the low growth scenario, and 0,7% in the high growth scenario. A slight decline in growth is evident between 2015 and 2020 in both the low and high growth scenarios, after which the growth rate increases gradually up to 2030.

Table 8.1: Low and high population growth for Nsikazi South

Year	2009	2010	2015	2020	2025	2030
Low	219 118	220 699	228 251	229 609	232 417	237 660
High	219 118	220 933	231 171	237 981	246 199	255 605

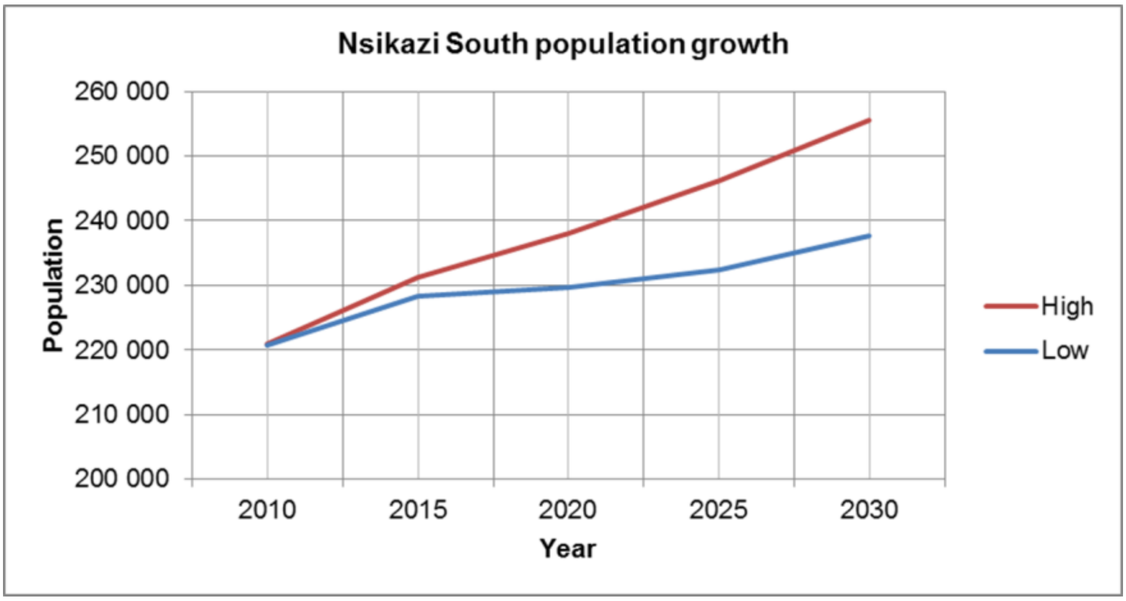


Figure 8.1: **Low and High Population Growth scenarios for Nsikazi South**

8.2 CURRENT WATER USE

Bushbuck Ridge Water Board (BWB) is the bulk WSP for Nsikazi South. MLM and Sembcorp are responsible for water distribution in the area. Sembcorp is responsible for water supply in the so-called concession area, which includes Tekwane South and Kanyamazane.

8.2.1 Domestic water use

Nsikazi South is supplied with water from the Nsikazi South Regional Raw water pump station, which is situated next to the Crocodile River. The water is pumped to the WTW works at Kanyamazane, from where it is distributed to Kanyamazane and

Pienaar/Msogwaba. The capacity of the WTW has been upgraded to handle 54 Mℓ/day, but it is operated at an average of 50 Mℓ/day.

There is also a second pump station, known as the emergency pump station, which pumps water to the old WTW which has a capacity of approximately 1,8 Mℓ/d.

There are some formal villages which have yard connections and water borne sewage systems. These include Kanyamazane and Kabokweni. Tekwane South and Emoyeni also have water borne sewage systems. The remainder of the villages are served by stand pipes.

There is also a package water treatment plant at Dwaleni, which replaced the old WTW. The capacity of the package plant is 0,6 Mℓ/day. A total groundwater supply of 0,34 Mℓ/day is also provided from various boreholes .

The total volume of water treated for Nsikazi South is therefore 52,7 Mℓ/d or 19,3 million m^3/a. This can be regarded as Nsikazi South's current water use.

8.2.2 Industrial water use

There is an industrial area in Nsikazi South which is supplied with water from Factories Reservoir. The current water use is approximately 0,8 Mℓ/day.

8.3 PROJECTED FUTURE WATER REQUIREMENTS

8.3.1 Domestic water use

The domestic water use is expected to follow the same growth trend as population growth up to 2030.

8.3.2 Industrial water use

The industrial use is expected to stay the same for Nsikazi South. New industrial developments around the Kruger Mpumalanga Airport will be supplied with water from Primkop Dam forming part of the Karino Plaston Corridor WDC.

8.4 HIGH AND LOW SCENARIO WATER REQUIREMENT PROJECTIONS

The projected low and high scenario water requirements are shown in **Table 8.2** and **Table 8.3.**

Table 8.2: Projected water requirements in million m^3/a

Year	2010	2015	2020	2025	2030
Low	19,2	19,8	19,9	20,2	20,6
High	19,2	20,1	20,6	21,3	22,1

Table 8.3: Projected water requirements in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	52,6	54,3	54,6	55,3	56,5
High	52,6	55,0	56,6	58,5	60,7

8.5 WATER RESOURCE AVAILABILITY

8.5.1 Groundwater availability

The geology of the study area, as shown on the geological map (**Figure 5.2**) comprises grey and white coarse grained biotite granite in the western part of the area while the southern part and the eastern section along the boundary of the Kruger National Park consists of potassic gneiss. Several east west striking diabase dykes, as well as diabase sills are present in the north, and northwest/southeast shear zones cut through the area. Northwest/southeast striking dykes are present in the southern part of the area.

The aquifer is classified as an inter-granular and fractured aquifer according to the 1:500 000 hydrogeological map (1:500 000 Hydrogeological map series of the Republic of South Africa Nelspruit 2530 (DWAF, 1999)). Groundwater occurrence is associated mainly with the deeper weathered zones, as well as with fault zones and dyke contacts..

The groundwater yield potential is classed as low, with potential yields between 0,1 and 0,5 ℓ/s in the granite, and 0,5 to 2,0 ℓ/s in the gneiss. According to Vegter (1995) the probability of drilling a successful borehole in the western part is below 40%.The probability of drilling a borehole yielding more than 2 ℓ/s is between 10 and 30%. In the east and northern areas the probability of drilling a successful borehole is between 40 to 60%, and of drilling a borehole yielding more than 2 ℓ/s is between 30 to 40%.

It is concluded that groundwater is generally available, but will require detailed investigations for development.

8.5.2 Surface water availability

The situation at Nsikazi South is the same as at Nelspruit, i.e. relying largely on water supplied from the Crocodile River. As discussed in **Section 5 (Nelspruit)**, the Crocodile River is fully allocated and probably over-utilised due to unlawful abstractions. Additional allocations to Nsikazi South from the Crocodile will therefore encroach on both the Reserve and South Africa's international obligations. Therefore, further allocations can only be considered if interventions are implemented that will result in a higher yield.

Nsikazi South also makes use of abstractions from streams but these are not sustainable, and most of them are unlawful. Nevertheless, it is suggested that they continue to be operated until such time as a more sustainable solution can be found to the water resources and water supply situation.

8.6 WATER QUALITY

8.6.1 Sources of pollution

Pollution sources upstream of Nsikazi South which can affect the drinking water quality in Nsikazi South must be considered, as well as pollution sources within the township itself.

More information is required regarding the water quality immediately upstream of the Nsikazi South abstraction works in the Crocodile River[1]. The water quality at Nsikazi South can be affected by upstream WWTW (e.g. Kingstonvale, Nelspruit), by fertilisers used by upstream irrigators, by upstream industries, etc.

However, no extraordinary problem was reported regarding the upstream water quality, and it is therefore suspected that the quality of the incoming water is adequate, and that the water is fit for treatment and use in Nsikazi South.

As far as the water flowing out from Nsikazi South is concerned, there are a number of possible pollution sources:

- Littering is a huge problem all along the Crocodile and Sabie Rivers, and Nsikazi South is no exception.
- The Kanyamazane WWTW complies with the general standards of DWA, but it was not designed for the special standards imposed on the works. In a self-assessment, the risk on this plant was determined to have increased from 43% to 45%. The WWTW is however operated efficiently.

The discharging effluent from Kabokweni WWTW has had a 3% chemical compliance over the past year: The works received a 70% Risk Index during the recent Green Drop Assessment.

8.6.2 Trend analyses

8.6.2.1 Kabokweni

Water quality sampling downstream from Kabokweni started in mid-2009. With the exception of ammonia, all the parameters comply with the water users' requirements. The ammonia exceeds the requirements both for the aquatic environment and for drinking water standards. EC varies between 15,4 and 70,8 mS/m, with a median of 59,4 mS/m. EC is stable over the monitoring period on a year on year and month on month basis. The results of the water quality sampling measurements have not been linked to flow rates in river.

Ammonium shows a minimum concentration of 0,025 mg/ℓ as N and maximum of 7,02 mg/ℓ as N and a median of 1,31 mg/ℓ as N.

[1] This will hopefully be covered in the final reconciliation strategy.

8.6.2.2 Kanyamazane

Sampling downstream from Kanyamazane started in 2009 on a weekly basis.

TDS values are high, with a median of 394 mg/ℓ and a 90th percentile of 417 mg/ℓ. The average value for suspended solids from July 2011 to June 2012 is 19,2 mg/ℓ. The 90th percentiles of both phosphates and ammonium, (6,2 mg/ℓ as P and 4,7 mg/ℓ as N) are high. Confirmation is required as to whether this is due to upstream pollution, or if it is caused by the WWTW itself. A ferric dosing trial has commenced to reduce the phosphate non-compliance.

8.7 THE WATER BALANCE

8.7.1 Current water balance with no interventions

The present ecological state of the Crocodile River needs to be maintained, and therefore the current licensed abstraction volume for Nsikazi South may not be exceeded. This current authorised abstraction is 18,3 million m^3/a as summarised in **Table 8.4**.

Table 8.4: Current abstraction and licences for Nsikazi South

Source	Abstraction million m³/a	Licence million m³/a	Comments
Raw water pump station on Crocodile River	18,3	18,3	
Emergency pump station on Crocodile River (Kanyamazane)	0,7	0,7	
Kabokweni package plant	0,2		No authorisation
Various boreholes	0,1	0,1*	Not certain which boreholes are authorised
Total	**19,3**	**19,1**	

* Assumed licences have been issued for all boreholes

The current abstraction of 19,3 million m^3/a is almost in balance with the available licence value of 18,3 million m^3/a.

8.7.2 Future water balance with no interventions

A projection was made of the future water requirements of Nsikazi South and its supply areas. The high and low growth scenarios for water requirements are shown in **Table 8.1.**

Without any interventions, the water supply will remain on the licenced volume throughout the projection period, as shown in **Figure 8.2.**

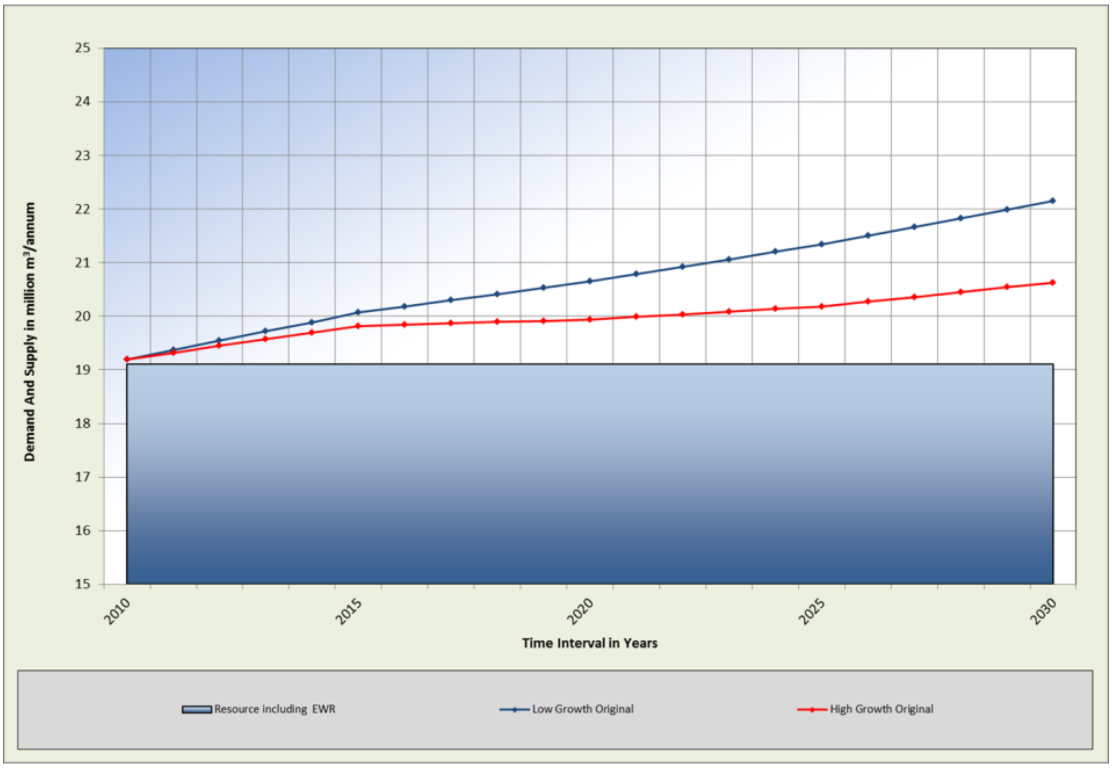


Figure 8.2: Nsikazi South future water balance without any interventions

The current deficit will increase over time as a result of the growing water demand if no interventions are implemented, as shown in **Figure 8.2.**

8.8 POSSIBLE INTERVENTION OPTIONS

8.8.1 Reconciliation options that will reduce water requirements

8.8.1.1 WC/WDM

Nsikazi South is operated and maintained under concession by Sembcorp under the jurisdiction of MLM with the treatment plant operated by BWB. Parts of the Nsikazi South WDC are informal with low levels of services. There is however a relatively large formal area with formal infrastructure: viz. Kanyamazane, Tekwane South and Entokozweni Townships, where metering, billing and adequate cost recovery systems are implemented.

Table 8.5: Status quo assessment and strategy

Status quo	Strategy
Institutional and legal assessment	
• The relationship with the municipality and politicians has improved lately. • Sembcorp Silulumanzi is well structured and has sufficient capacity to implement WC/WDM but training and increased capacity is required in WC/WDM section. • The WSP uses the municipal bylaws which are currently under review but have their own customer charter.	• Set up WC/WDM task team, chaired by senior official or MEC to meet on monthly basis to address WC/WDM issues. This should improve communications between organisations, highlight problem areas and transfer skills. • Conduct water business and awareness training to councillors to promote WC/WDM. • Appoint additional staff to increase WC/WDM section and implement training programme. Develop partnerships with the legal departments as well as the SAPS and put bylaw enforcement back on track to promote WC/WDM.
Financial assessment	
• Non-revenue water is estimated at above 50%. • Water tariffs are cost reflective and organisation runs on business principles. • A rising block water tariff structure is in place to promote WC/WDM. • Meter reading acceptable but can improve. • Billing is informative • Metering and billing is generally problematic or non-existing and associated with reluctance to pay and illegal connections. • High level of non-payments.	• Metering and billing will not improve until the level of service has improved and the overall system is stable. • Consider installing water restricting devices to curb daily consumption. • Improve relationship with the consumers and the leadership and focus on promoting payment for services through the councillors and through community education and awareness.
Social assessment	
• The relationship with the community is generally positive. • Infrastructure vandalism and illegal connection is problematic in the area. • Water is paid for but not valued very highly and excessive garden watering is a common phenomenon. • WSP has an effective customer call centre and promote reporting of leaks.	• Undertake a comprehensive community awareness programme to promote water efficient practices and make community aware that problems will not be solved without their support. • Promote fixing of internal plumbing leaks. • Deploy community plumbers to assist with fixing leaks and creating awareness. • Consider hosepipe ban or restricted garden watering until system has

Status quo	Strategy
	stabilised. • Improve schools awareness campaigns.
Technical assessment	
• There is sufficient macro management information available to perform a proper assessment of the water losses and potential savings. • The system is characterised by intermittent supply and poor service. • Bulk metering and leak repairs are taking place. • High prevalence of illegal connections with consumers trying to gain access to water supply. • Reactive maintenance in the area.	• Improve the level of services and focus on providing continuous supply which should reduce illegal connections. • Meter all non-domestic consumers in the area such as car washes. • Improve pressure management and maintain the satisfactory operating pressures. • Consider undertaking an internal leak audit and repair exercise for indigent and non-paying consumers to drastically reduce the NRW. • Implement a consumer meter replacement programme, starting with the top consumers, whereby 10% of all water meters are replaced per annum.
General observations	
• Water treatment plants operated by Bushbuckridge Water received 84,61% in the 2012 Blue Drop assessment. There is room for improvement. • A water safety plan and management system is already in place for the Kanyamazane distribution systems.	• Improve to achieve Blue Drop status and provide proper supply.

Table 8.6: Performance indicators

Indicator	Current Value	Realistic Target Value 15% reduction	Optimistic Target Value 30% reduction
Annual Input volume (million m^3/annum)	19.3	16.41	13.51
Daily input volume (Ml/day)	52.8	44.9	37.0
Population	225000	-	-
Households (2012)	-	-	-
Non-revenue water	> 50%	40%	30%
Litres / capita / day	235	200	164
m^3 / household / month	-	-	-

The unit consumption in this area is relatively high. Some areas have water borne sewerage systems, but there are also areas with pit latrines on average, 235 ℓ/c/d is too high. It is understood that certain WC/WDM measures have already been implemented and this work needs to be expanded. The WSP must ensure that all the actions in **Table 8.5** receive the necessary attention.

Summary and conclusions

There is scope for WC/WDM in the Nsikazi South area but these measures will not necessarily result in the reduction of non-revenue water and the total system input volume. The main focus in this area should be on improving service delivery, fixing visible leaks, and creating community and institutional awareness programmes through the following interventions:

- Improve service delivery and strengthen the relationship with community.
- Ensure continuous supply by improving Kanyamazane WTW operation and maintenance.
- Deploy community plumbers to fix internal plumbing leaks and create WC/WDM awareness.
- Improve political support through a councillor awareness programme focusing on water.
- Maintain bulk meters to provide accurate macro management information.
- Implement a community awareness programme that promotes the value of water and water wise gardening.
- Establish a culture of payment for water.
- Introduce zone metering and sectorisation to improve micro management information. This will assist with the identification of key water loss areas and reduce the number of pipe bursts.
- Maintain pressure management programme in conjunction with sectorisation and continuous monitoring.

8.8.1.2 Removal of IAPs

The removal of IAPs in the upper parts of the Crocodile catchment will benefit Karino Plaston. The removal of IAPs between Karino Plaston and Nsikazi South will not result in a significant benefit.

8.8.1.3 Purchasing WC/WDM savings from irrigation farmers

This has been discussed in detail under **Section 5.8.1.**

8.8.1.4 Purchasing water entitlements from irrigation farmers

This has been discussed in detail under **Section 5.8.1.**

8.8.2 Reconciliation options that will increase water supply

8.8.2.1 Groundwater development

As shown on the geological map of the area (**Figure 5.2**) several northwest/southeast striking dykes are present. A northwest/southeast striking shear zone cuts through the area. (See **Figure 8.3**)

Groundwater resources with a potentially high yield are normally associated with these structural features. However, a high density airborne magnetic survey of the area is required to locate these structural features and select targets for more detailed geophysical traversing. It is recommended that the radon emanation technique (Levin, 2000) be applied to locate optimum drilling targets.

It is expected that at least 200 000 m^3/a can be obtained from the ground water resources.

8.8.2.2 Dam construction to increase yield storage

Strathmore, Mountain View and Montrose dam sites are the regional schemes that have been evaluated to increase yield storage. The development of either one of these dams, or of those listed in **Section 5.8.2.2** would make more water available in the Crocodile River, and thereby to Nsikazi South. The details of these schemes are summarised in **Table 8.7.**

Table 8.7: Details of evaluated regional dam sites

Dam site	Type of Dam	Incremental Yield, (million m^3/a)	Capacity (million m^3)	Additional height/ Height (m)	Cost Estimate (R million)
Strathmore	Off-channel concrete dam	35	22	22	220
Mountain View	RCC arch dam	60	150	72,9	360
Montrose	Clay core rock fill /RCC gravity composite structure	65	217	97	2 810

The most economically viable regional scheme for development is Mountain View. It is considered as a reconciliation option that would benefit Nsikazi South's water balance.

The local dam that has been earmarked for Nelspruit, i.e. Boschjeskop, can also be considered as a reconciliation option for Nsikazi South, as Nelspruit will not require the full yield of this dam within the planning horizon and there are additional options available for Nelspruit in the very long term. As indicated in **Table 5.10** the Boschjeskop Dam has a yield of 19,5 million m^3/a.

8.8.2.3 System operating rules

The operating system for the Crocodile River is already one of the most advanced in the country: There are limited options for making additional water available through improved system operation.

8.8.2.4 Water transfers from elsewhere

Water transfer from the Kaap River is possible, as described for Nelspruit. Such a transfer scheme will benefit more than one WDC and will benefit all the WDCs which take water from the Crocodile River.

8.9 SELECTED RECONCILIATION SCENARIOS

The following intervention scenarios have been considered for reconciliation of the Nsikazi South's water balance:

8.9.1 Continuing and expanding the WC/WDM measures

It is acknowledged that the water supply system is not 100% stable, and is prone to interruptions at places within Nsikazi South. It will therefore be very difficult to properly monitor leakage unless the system is stabilised. There are however measures that can be taken (e.g. raising public awareness, establishing a culture of payment, etc.): a target of 15% water saving is regarded as achievable.

The implementation of this scenario would make available an additional 2 million m^3/a in the Crocodile River. This scenario would satisfy the growth in water demand over the years, but the current deficit still remains and will be in constant deficit throughout the planning horizon. (See **Figure 8.3 – Scenario 8.8.1**)

8.9.2 WC/WDM and groundwater development

The shear zones immediately west of Nsikazi South provide an opportunity for the development of more groundwater. It is not expected that more than 200 000 m^3/a can be provided from this resource.

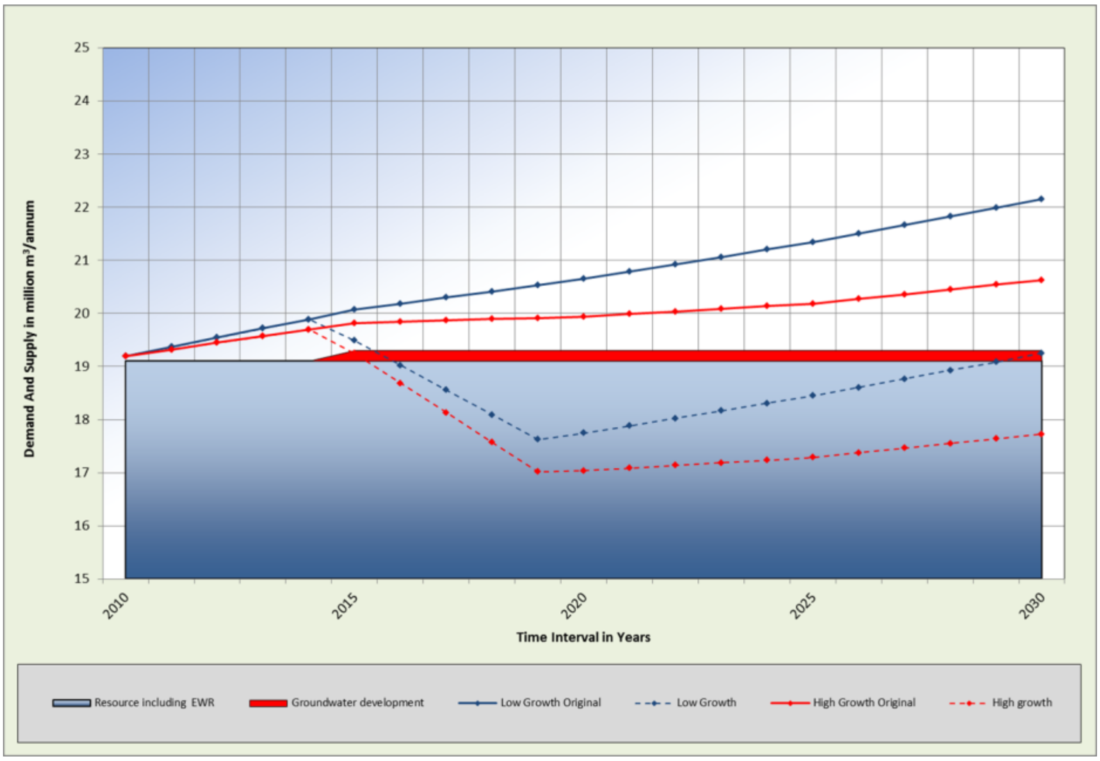


Figure 8.3: Water reconciliation for Nsikazi South

8.10 RECONCILING THE WATER REQUIREMENTS WITH THE WATER RESOURCE

8.10.1 Water balance for selected reconciliation scenarios

Scenario 8.9.2 was selected as the appropriate intervention option for Nsikazi South's water balance. The water requirement curve lies below the water supply line for the entire planning period, although temporary water restrictions may be necessary until the benefit of the WC/WDM measure have been achieved.

8.10.2 Actions that need to be started as a matter of urgency

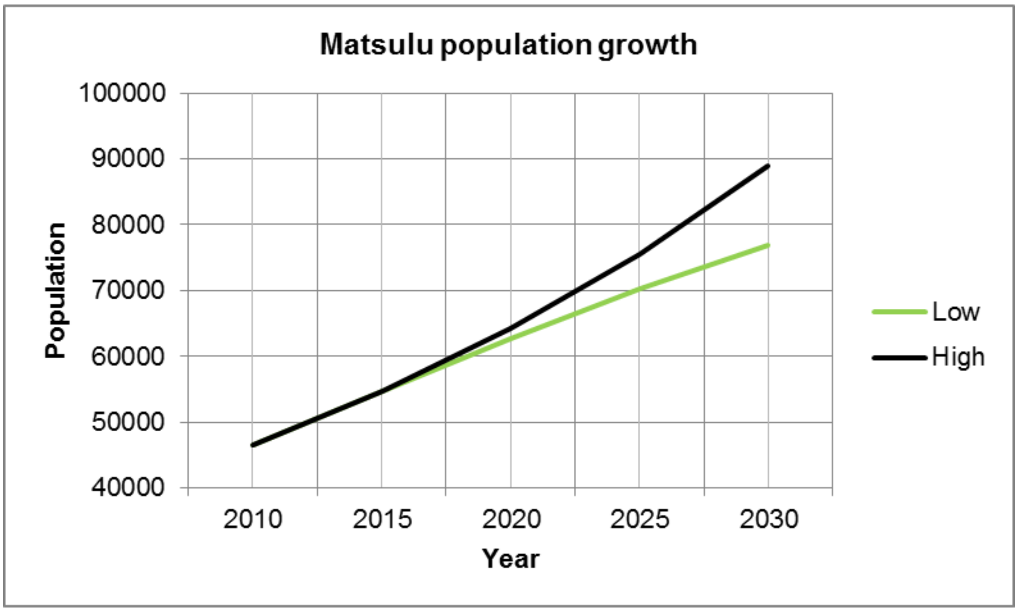
The following actions need to be undertaken as a matter of urgency:

- The abstraction works and distribution system for Nsikazi South need urgent repair in order to stabilise the interrupted water supply and subsequently enable the WSP to enforce WC/WDM measures.
- The development of Boschjeskop dam as an intervention option for Nelspruit will also benefit Nsikazi South. This can be regarded as a back-up in case the required results are not obtained from WC/WDM.
- Groundwater can be developed which will help to overcome the water shortages.

9 MATSULU

9.1 POPULATION GROWTH

The low and high population growth scenarios for Matsulu are shown in **Table 9.1**



and **Figure** 9.1. During the Preliminary Strategy phase of this study, Sembcorp Silulumanzi indicated that the population growth should be much higher than documented in this study's Demographics and Future Water Requirements Report. An updated house count was therefore done using the 2007 and 2011 aerial photographs. It was found that the number of houses increased from 10 528 in 2007 to 11 983 in 2011 which translates to an increase of 3.29% per year. It was therefore assumed that this growth rate will continue for the future years as a high growth scenario and that the growth rate will reduce steadily after 4 years with 0.5% every 5 years until it stabilises at 1% for a low growth scenario.

Table 9.1: Low and high population growth for Matsulu

Year	2009	2010	2015	2020	2025	2030
Low	45 039	46 521	54 694	62 762	70 285	76 805
High	45 039	46 521	54 694	64 303	75 601	88 883

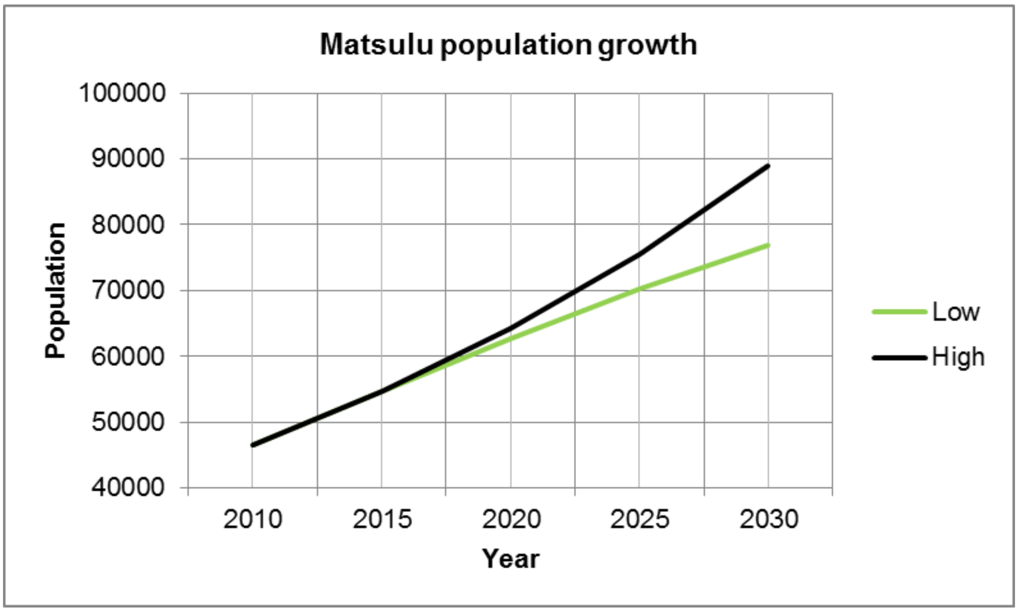


Figure 9.1: Low and high population growth for Matsulu

9.2 CURRENT WATER USE

Sembcorp is the WSP for Matsulu. Water is abstracted from the Crocodile River, then treated and distributed to Matsulu. The current domestic water use is 4,4 million m^3/a, or 12 Mℓ/day. According to Sembcorp an extension of the current WTW capacity of 12 Mℓ/d is planned to 24 Mℓ/d in two phases of 6 Mℓ.d/ each. These expansion plans do not appear to have considered the limited water resource available at the current abstraction point in the Crocodile River.

9.2.1 Domestic water use

The domestic use is 4,4 million m^3/a.

9.2.2 Industrial water use

There is no industrial use in Matsulu. There is some commercial use, but a breakdown between domestic and commercial use is not available.

9.3 PROJECTED FUTURE WATER REQUIREMENTS

9.3.1 Domestic water use

It is anticipated that domestic use will increase up to 2030 in line with the population growth. The projected domestic future water requirements are shown in **Table 9.2** and **Table 9.3**.

Table 9.2: Projected domestic water requirements in million m^3/a

Year	2010	2015	2020	2025	2030
Low	4,4	5.1	5.9	6.6	7.2
High	4,4	5.1	6.1	7.1	8.4

Table 9.3: Projected domestic water requirements in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	12,0	14.1	16.2	18.1	19.8
High	12,0	14.1	16.6	19.5	22.9

9.4 WATER RESOURCE AVAILABILITY

9.4.1 Groundwater availability

The geology of the study area as shown on the geological map (**Figure 5.2**) consists of biotite-trondhjemite gneiss to the north and west of the town. To the south and east the area is underlain by undifferentiated basaltic rocks and schists, and interlayered with banded iron formation. No dykes or structural features are shown on the geological map.

The aquifer is classified as an inter-granular and fractured aquifer according to the 1:500 000 hydrogeological map (1:500 000 Hydrogeological Map Series of the Republic of South Africa Nelspruit 2530 (DWAF, 1999)). The occurrence of groundwater is associated mainly with the deeper weathered and fractured zones. The groundwater yield potential in the gneiss is classed as low, with potential yields between 0,5 ℓ/s to 2,0 ℓ/s, and high in the basaltic and schist formations, between 2,0 ℓ/s and 5,0 ℓ/s. According to Vegter (1995) the probability of drilling a successful borehole in the gneiss is below 40%, and of drilling a borehole yielding more than 2 ℓ/s only 20 to 30%. The probability of drilling a successful borehole in the basaltic and schist formations is between 40 and 60% and the chance of drilling a borehole yielding more than 2 ℓ/s is between 30 and 40%. It was concluded that the general groundwater availability was generally low to the north and west of the town, but good to the south and east. This will require further, more detailed investigations for development.

9.4.2 Surface water availability

The situation at Matsulu is the same as at Nelspruit and Nsikazi South, i.e. relying largely on water from the Crocodile River. As discussed in **Section** 5 **(Nelspruit)**, the Crocodile River is already fully allocated and probably over-utilised due to unlawful abstractions. Additional allocations to Matsulu from the Crocodile River, without interventions to increase the yield of the system, will therefore encroach on the Reserve, internal obligations and downstream water users.

The Matsulu pump station is located downstream of the confluence of the Crocodile and Kaap River: hence Matsulu also has access to water from the Kaap River. The Kaap River is, however, also over-utilised, and there is currently no surplus water available from the Kaap River unless the yield of the Kaap River is increased by means of a dam such as Mountain View Dam. This is discussed in **Section 13**.

The Matsulu abstraction weir in the Crocodile Rivers provides insufficient supply from time to time, owing to the presence of the Kaapmuiden Weir and Van Graan canal upstream. Water is diverted through this canal, runs through a hydropower generator, and is discharged back into the river downstream of the Matsulu abstraction point. See Section 9.10 where a possible solution for this problem is suggested.

9.5 WATER QUALITY

9.5.1 Sources of pollution

The water abstracted from the river at the Matsulu pump is fit for domestic use after treatment. At this stage, no records of the water quality upstream in the river have been found.. The Matsulu WTW off-take is situated upstream of the Matsulu WWTW. Treated water from the WWTW can impact on lower water users in the river.

The Matsulu WWTW has only a 58% chemical discharge compliance with the Greendrop Assessment suggesting an increased risk of deterioration. It needs to be noted however, that the Matsulu WWTW plant has the second lowest risk in Mbombela, although this risk increased from 35% to 36% over the last year.

9.5.2 Trend analyses

DWA is currently only sampling the inlet at the WWTW. The closest downstream monitoring point in the Crocodile River is at Malalane. Sembcorp Silulumanzi is however conducting upstream and downstream analyses from the WWTW on a weekly basis. A trend has not as yet been studied by the PSP.

9.6 THE WATER BALANCE

9.6.1 Current water balance with no interventions

The present ecological state of the Crocodile River needs to be maintained: therefore the current licensed abstraction volume of 4,4 million m^3/a at Matsulu may not be exceeded.

The current abstractions and authorisations are summarised in **Table 9.4.**

Table 9.4: Current abstractions and licences for Matsulu

Source	Abstraction million m^3/a	Licence million m^3/a	Comments

Source	Abstraction million m³/a	Licence million m³/a	Comments
Abstraction from Crocodile River	4,4	4,4	Licence issued by DWA. The current abstraction equals the authorised amount
Total	**4,4**	**4,4**	

From the table it can be seen that the current water abstraction equals the authorised resource for Matsulu.

9.6.2 Future water balance with no interventions

A projection was made of the future water requirements over the full planning period for Matsulu. The high and low growth scenarios for water requirements are shown in

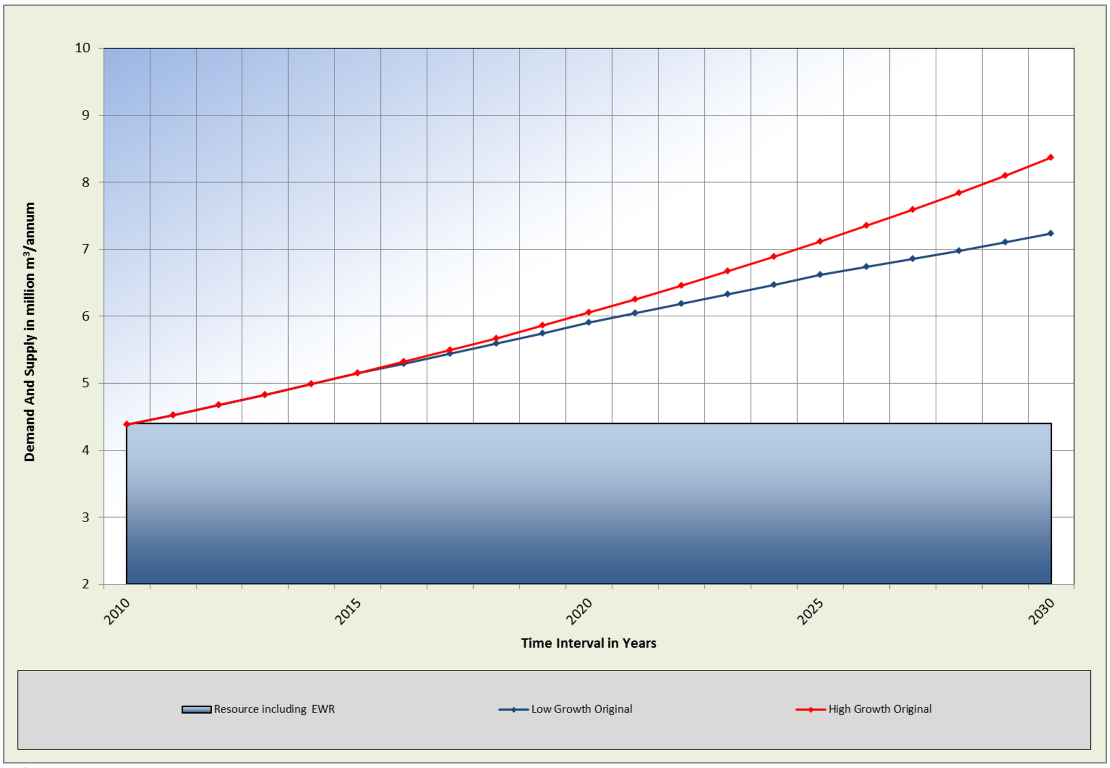


Figure 9.2.

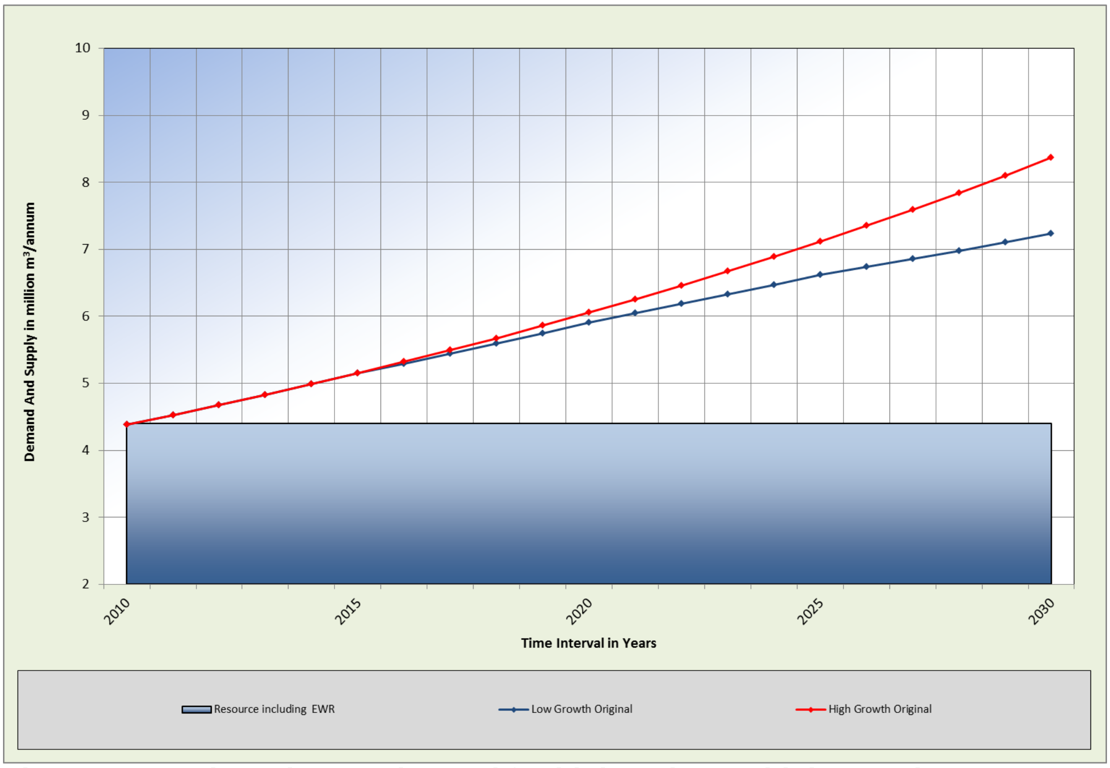


Figure 9.2: Projected water demand for high and extra high growth water requirement scenarios and the available water resource

9.7 POSSIBLE INTERVENTION OPTIONS

9.7.1 Reconciliation options that will reduce water requirements

9.7.1.1 WC/WDM

Water services at Matsulu are operated and maintained under concession by Sembcorp Silulumanzi under the jurisdiction of MLM. Most of the demand centre is formal, with formal infrastructure which allows adequate metering, billing and cost recovery , however there is also a relatively small area with informal infrastructure.

A WC/WDM plan has already been compiled by Sembcorp Silulumanzi but has not yet been formally released. The WSP is of opinion that 20% water saving could be achieved for this WDC. The actions in **Table 9.5** in terms of WC/WDM are required and Silulumanzi must ensure that they are all covered in their implementation plan.

Table 9.5: Status quo assessment and strategy

Status quo	Strategy
Institutional and legal assessment	
• Sembcorp Silulumanzi is well structured and has sufficient capacity to implement WC/WDM but training and increased capacity is required in WC/WDM section.	• Setup WC/WDM task team, chaired by senior official or MEC to meet on monthly basis to address WC/WDM issues. This should improve communications between organisations,

Status quo	Strategy
• The relationship between the stakeholders in this supply area is generally good. • The relationship with the municipality and politicians has improved but can be better.	highlight problem areas and transfer skills. • Appoint additional staff to increase WC/WDM section and implement training programme • Conduct water business and awareness training to councillors to promote WC/WDM.
Financial assessment	
• Non-revenue water is estimated at above 50%. • Metering, billing and cost recovery system is generally good. • Water tariffs are cost reflective and organisation runs on business principles • Very high level of non-paying consumers estimated at 60%. • A rising block water tariff structure is in place to promote WC/WDM • Water bill is informative.	• Metering and billing will not improve until the level of service has improved and the overall system is stable. • Consider installing water restricting devices to curb daily consumption. • Improve level of service and supply to the area and consider installing meters in areas where there is no metering and billing taking place
Social assessment	
• The relationship with the community leaves room for improvement. • Since limited consumers are paying for services, water wastage through excessive garden watering is evident in the area. • There is a high level of low income earners and indigents. • WSP has an effective customer call centre and promote reporting of leaks. • There are school awareness programmes taking place, targeting two schools on monthly basis. • Infrastructure vandalism and illegal connections is generally problematic.	• Continue with comprehensive community awareness programmes to promote water efficient practices. • Promote fixing of internal plumbing leaks. • Deploy community plumbers to assist with fixing leaks and creating awareness. • Consider hosepipe ban or restricted garden watering until system has stabilised. • Make community aware that problems will not be solved without their support.
Technical assessment	
• There is macro management information available to perform a proper assessment of the water losses and potential savings. • Bulk metering in place, no sectorisation reservoirs are interconnected. • The system is characterised by intermittent supply and poor service. • High prevalence of illegal connections with consumers trying to gain access to water supply.	• Maintain reading the bulk meters on a monthly basis and monitor input volumes and keep updating management information. • Stabilise the supply and focus on providing continuous supply which should reduce illegal connections. • Implement and maintain sectorisation to identify key problem areas maintain pressure management and reduce bursts.

Status quo	Strategy
• Aging infrastructure and high pressures. • Internal plumbing leakages are problematic in the area.	• Implement pressure management and install PRV's in critical areas experiencing high pressures and monitor on a monthly basis.
General observations	
• Matsulu water treatment plant operated by Sembcorp Silulumanzi received 96% in the 2012 Blue Drop assessment which is an indication of a well-managed water supply. • A water safety plan and management system is already in place for the distribution system.	• Maintain Blue Drop status and expand performance to water distribution network through proper management and control.

Table 9.6: Performance indicators

Indicator	Current Value	Realistic Target Value 20% reduction	Optimistic Target Value 30% reduction
Annual Input volume (million m^3/annum)	4.4	3.74	3.08
Daily input volume (Ml/day)	12.0	10.2	8.4
Population	49 633		
Households (2012)	12 377		
Non-revenue water	82,7%		
Litres / capita / day	243	206	170
m^3 / household / month	29.6	25.2	20.7

Based on the unit consumption of Matsulu it is clear that WC/WDM should be implemented as a matter of priority. The current consumption is higher than the international accepted standard of approximately 180 litres per capita per day.

<u>Summary and conclusions for WC/WDM</u>

There is scope for WC/WDM in the Matsulu area which will result in both reduction of non-revenue water and the total system input volume. The effort of Sembcorp Silulumanzi so far with compiling a WC/WDM implementation plan is appreciated and the WSP is encouraged to maintain this progress. There is limited capacity and skills available to embark on such a programme which should be resolved before focusing on the following interventions:

- Improve political support through a councillor awareness programme focusing on water.
- Implement zone metering and sectorisation to improve micro management information. This will assist with the identification of key water loss areas and reduce number of pipe bursts.
- Undertake a community awareness programme that promotes the value of water and water wise gardening.
- Maintain satisfactory operating pressure: install PRVs in areas experiencing high pressure, and ensure that operating pressures never exceed the DWA regulatory standard of 9 Bar.
- Train meter readers and perform monthly audits to eliminate estimates and other inaccuracies.
- Perform meter audit and cleaning to improve meter reading and accessibility.
- Implement sectorisation in the areas where practicable into smaller manageable discrete zones to aid effective monitoring of the network.

9.7.1.2 Removal of IAPs

This option has already been considered for Karino/Plaston: Matsulu will receive no benefit from the IAP removal initiatives further up the catchment.

9.7.1.3 Water trading – purchase water entitlements from upstream farmers

The purchase of water entitlements from irrigators can be considered. This option should however only be implemented with great caution as it could have several social consequences. Fallow irrigation lands with willing sellers and where no farm worker job losses are likely should be targeted first.

The precise quantification of the areas of available irrigation lands that could possibly become available for trading have to await the completion of the validation and verification processes. In order to get a very provisional idea of the possibilities, a reconnaissance level investigation along the Elands (tributary of the Crocodile River) and Sabie Rivers was done of aerial photography and satellite imagery, supported by limited ground truthing. Caution should however be exercised when interpreting results obtained by such purely remote means, since some aspects related to current and historical water use are not evident from remote imagery. A definitive assessment of water use will require direct interaction with stakeholders, including property owners and water management authorities.

The reconnaissance level investigation showed that of the 2 683 ha scheduled irrigation along the Elands River, approximately 1200 ha was not being used at the time of the aerial photograph or satellite image. This does not necessary imply that these lands are lying fallow or that their entitlements will become for sale, but merely provides an indication of a possible outcome of a more detailed future survey. The volume of water associated with this 1200 ha of land is in the order of 7 million m^3/a. should the survey be expanded to the full irrigated area along the Crocodile River this volume would increase.

It will be seen from Figure 9.4 under Section 9.8 below that less than 3 million m^3/a will be needed to achieve a water balance. It can therefore be confirmed that this could be a reconciliation possibility with relatively low expected social impacts.

9.7.2 Reconciliation options that will increase water supply

9.7.2.1 Groundwater development

One of the few options to increase water availability in this area is groundwater development. However, only a small augmentation can be expected from this resource. Borehole siting must be done as described under **Paragraph 9.4.1**. It was assumed that 100 000 m^3/a will become available with groundwater development.

It is recommended that groundwater development focus on the basaltic and schist formations to the south and east of the town. These formations extend across the district boundary into the Umjindi District area east of Kaapmuiden. Although no major geological structural features are indicated on the geological map (**Figure 5.2**), the 1:500 000 hydrogeological map (1:500 000 Hydrogeological Map Series of the Republic of South Africa Nelspruit 2530, (DWAF, 1999) of the area indicates a good potential for groundwater in these formations. Modern geophysical technology is capable of identifying potential water bearing-structures. High density airborne magnetic survey of the area will be required to identify the exact locality of these structural features. Targets along these structures need to be selected for geophysical traversing. It is recommended that the radon emanation technique (Levin, 2000) be applied to locate the optimum drilling positions.

9.7.2.2 Dam construction to increase yield storage

Matsulu's water deficit is relatively small and a large dam cannot be justified to meet only Matsulu's needs. However, if a dam is built for Nelspruit, Matsulu will also benefit as it is situated on the Crocodile River downstream of Nelspruit: Any of the dam options described under **Paragraph 5.8.2.2** would suffice. The best option will be indicated by the result of an options analysis of the different dam sites. A dam on the Kaap River (such as the proposed Mountain View Dam) could benefit Matsulu directly through a gravity-fed water supply scheme. This is discussed under **Section 9.7.2.4**.

9.7.2.3 System operating rules

Since the operating system of the Crocodile River is already one of the most advanced in the country, there are limited options for making additional water available through improved system operation.

9.7.2.4 Water transfers from elsewhere

Matsulu is situated very close to the confluence of the Crocodile and Kaap Rivers. The Kaap River, which is a tributary of the Crocodile, does not fall within the municipal area. It is possible to transfer water from the Kaap River to Matsulu: this would need to be accompanied by the construction of a dam, since the run-of-river yield is fully utilised. There is also potential for using groundwater from the dolomites situated to the south of Matsulu in the Kaap river catchment.

9.8 SELECTED RECONCILIATION SCENARIOS

The following reconciliation scenarios have been considered in order to achieve a water balance for the Matsulu water demand centre:

9.8.1 Implementing WC/WDM only (20% water saving)

The effect of WC/WDM measures can be seen in **Figure 9.3**. Implementing this measure will reduce the demand to the extent that the water demand curves are sufficiently drawn down to indicate that the high water demand scenario will now be satisfied by the water supply. The extra high water demand curve however is not drawn low enough by implementing this intervention, indicating that water deficits will still occur over the entire planning period in terms of this scenario.

9.8.2 WC/WDM and borehole development

As can be seen on the second graph in **Figure 9.3,** only a small improvement is expected with groundwater development. The water deficit still remains.

9.8.3 WC/WDM and groundwater development and water reallocation by purchasing water from irrigators

This scenario can meet demand completely as reflected in **Figure 9.3**, although the social consequences need to be considered carefully. The focus should be on fallow lands that are no longer irrigated, that the loss of which to agriculture will subsequently not lead to major job losses.

9.8.4 WC/WDM and groundwater development and dam construction

Matsulu can also benefit if a dam is built for Nelspruit. All indications are that with moderate water savings and trading of water use with irrigators, there will be no need to build a dam only for Matsulu.

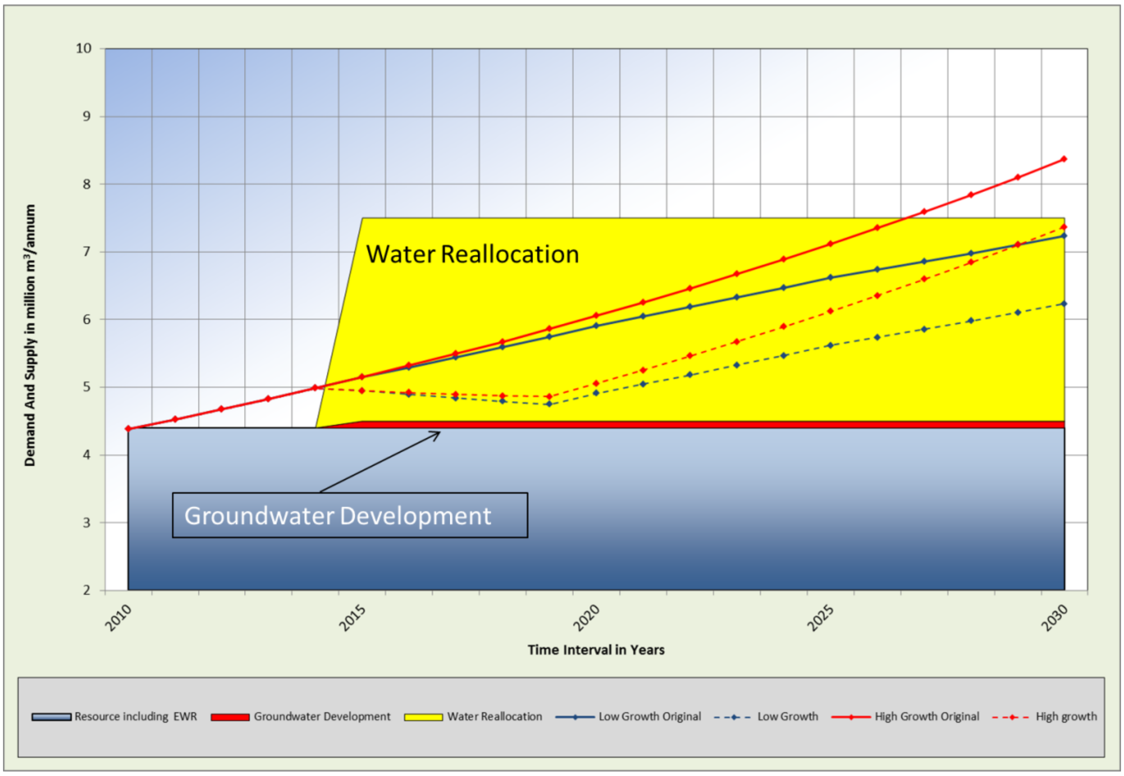


Figure 9.3: Water balance for Matsulu with possible interventions

9.9 RECONCILING THE WATER REQUIREMENTS WITH THE WATER RESOURCE

9.9.1 Water balance for selected reconciliation scenarios

The selected scenario for reconciliation of Matsulu water balance is shown in Paragraph 9.8.3, and summarised in Figure 9.3. However, this will require careful consideration of the social issues associated with purchasing of water entitlements from irrigation farmers.

9.9.2 Actions that need to be started as a matter of urgency

The following immediate actions are seen as necessary:

- Develop an implementation plan for WC/WDM in Matsulu.
- Investigate the possibility of groundwater development further. Undertake borehole siting in accordance with the methodology suggested in paragraph 9.4.1.
- Investigate the possibility of purchasing water entitlements from upstream irrigators who are not currently practicing irrigation and where social consequences will be relatively low. This action is necessary for the situation where the decision is taken that no dam will be built.

9.10 TEMPORARY WATER SHORTAGES AT THE MATSULU ABSTRACTION WORKS

9.10.1 Introduction

In times of low flow in the Crocodile River the pumps at the Matsulu abstraction point runs dry owing to a diversion work upstream. The river flow then bypasses the Matsulu abstraction works through the Van Graan canal and this water is only returned to the river at a point downstream of the Matsulu abstraction works. This poses a serious problem to Sembcorp and a possible solution to overcome this problem must be found.

9.10.2 Background

The Kaapmuiden Weir diverts water from the Crocodile River on portion 29 of the farm Kaapmuiden 212 JU into the Van Graan canal. Water flows into the canal through two sluice gate openings, one of which seems to be without a sluice gate at present. From here, the canal conveys water across the property to a two-turbine hydro-electric plant on portion 73 of the farm, before discharging all water back into the river, roughly 5 km further downstream. Abstraction from the canal between the abstraction and discharge points appears to be limited to opportunistic subsistence farming by residents of Matsulu.

The canal and diversion are both legal, authorised under Permit 51E issued on 6 March 1984 in terms of which up to 7.8 m^3/s may be diverted through the canal. The only condition is that no consumptive use of water may take place from the canal and all water is to be returned to the river. For this reason, downstream irrigators are not impacted.

However, the abstraction point for Matsulu lies between the canal diversion and discharge point (See Figure 9.5) and when the river is low, it has frequently happened in the past that the canal diverts most, even all of the river’s flow. Very little water was, under those conditions, and then allowed to reach the Matsulu abstraction point. Historical correspondence on record at DWA refers to disputes between Mr. Van Graan and the (then) government of KaNgwane going back to the 1980s and early 1990s. Steadily growing water requirements by Matsulu since then suggests the problem might become worse in future.

Permit 51E made no allowance for Matsulu’s domestic abstraction and only stipulated that at least 0.1 m^3/s should remain in the river at all time for environmental purposes. In this respect, at least, the permit is clearly unsatisfactory. Matsulu’s abstraction was periodically interrupted throughout the 1980s and early 1990 and the recurrence of the problem at the time resulted in pipes being installed in the canal (probably during the late 1980s), allowing emergency discharge back to the river during periods of low flow in the river. Two discharge pipelines, one 300 mm diameter and the other 200 mm diameter have been laid from the canal to the river. The smaller pipe is permanently open but the 300 mm pipe is operated by a manual valve and is opened only on request by SembCorp during periods of low flow.

It is uncertain whether this valve is fully and timeously opened by the owners of the canal during periods of low flow or, indeed, whether the two pipelines are sufficient for the Matsulu abstraction works

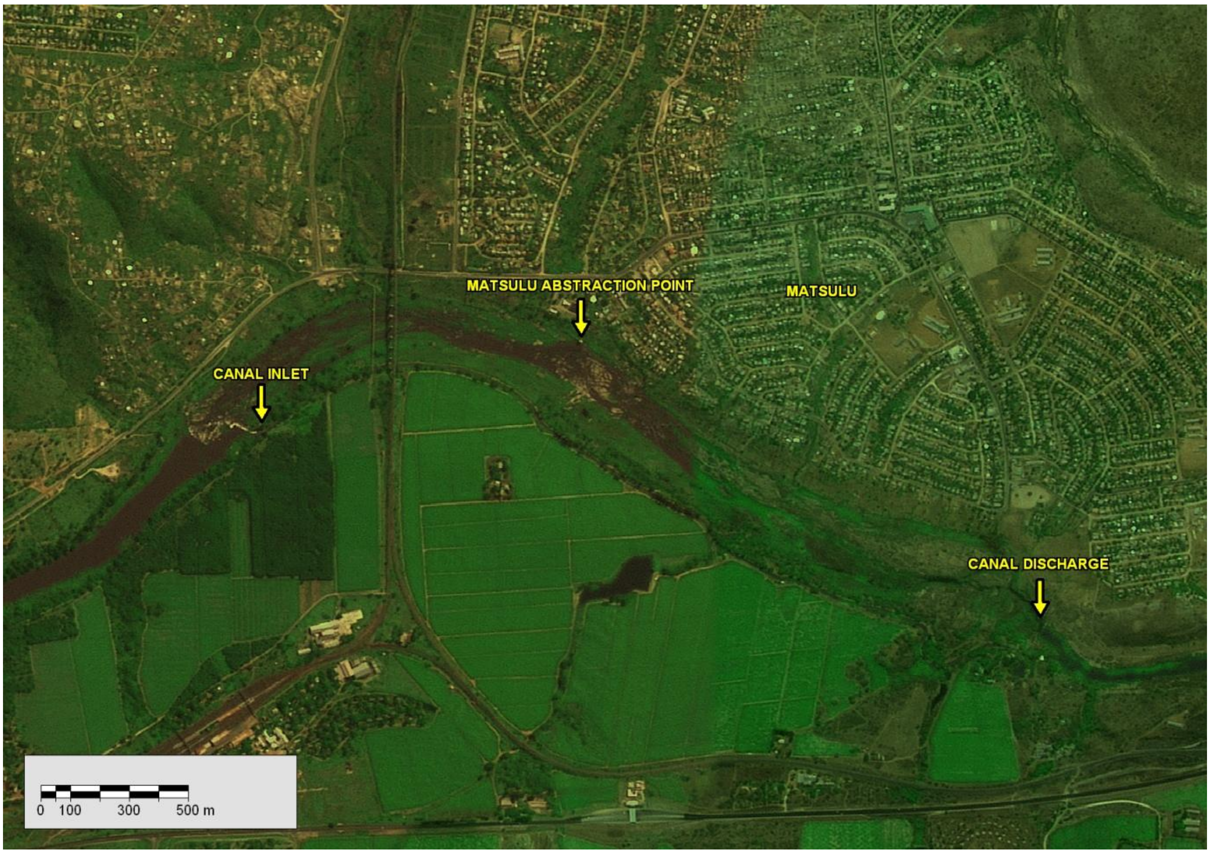


Figure 9.5: Kaapmuiden weir and Van Graan canal

9.10.3 Possible solutions

The possible solutions offered below should be verified during times of low flow in the river, at a time when conditions of water shortage exist. Recent flows in the river were too high and the possible solutions could not be thoroughly assessed when this report was finalised (see Figure 9.6).

Figure 9.6: Kaapmuiden weir and inlet to the Van Graan canal

The following need to be established during a further site inspection when the flow in the river is low and Matsulu reports water shortages.

- That the sluice gates at the weir are intact and in good working condition.
- That the 300 mm dia and 200 mm dia pipelines are free from any blockages, that the 300 mm dia pipe's control valve is in working condition and that it is fully and timeously opened during times of low flow in the river when requested by Silulumanzi.
- That Silulumanzi is not over-abstracting at the Matsulu abstraction works and that they are adhering to their licence conditions.

If the above has been verified, and Matsulu's water-related problems persist, the following possible solutions could be investigated:

9.10.1.1 Revising the permit for the Van Graan canal and issuing a new licence in terms of the National Water Act, 1998 (Act 26 of 1998)

The original permit 51E made no allowance for domestic requirements of Matsulu, even though the requirement was known to exist at the time, or became evident soon after the permit was issued.

The flow requirement in the river for the Matsulu abstraction works is 0.3 m^3/s (based on the 12 Mℓ/day existing abstraction works and the 12 Mℓ/day planned extension) over and above the 0.1 m^3/s for environmental flow requirements. Based on this, reasonable grounds exist to argue for an increase in the 100 ℓ/s minimum flow requirement stipulated in Permit 51E to 400 ℓ/s.

Replacing Permit 51E with a license and altering any of the permit conditions, even the permissible flow rates, is allowed within the legal framework of the compulsory licensing process. While the requirements of the canal owner should be considered, Section 22(7)(b) of the National Water Act does address reductions in existing lawful uses to (i) rectify an over-allocation of water use from the resource in question; or to (ii) rectify an unfair or disproportionate water use. These two conditions may conceivably exist here.

The replacement of the permit with an amended licence will have practical implications. Measuring flumes will then need to be constructed at the inlets of the two pipelines to monitor the flow. If both the pipelines can't handle 400 ℓ/s a further pipeline from the canal needs to be constructed. Alternatively the Kaapmuiden weir needs to be modified so that it can measure low flows (e.g. equipping it with a V-notch), the intake gates need to be refurbished so that the flow in the river can be set on 400 ℓ/s during times of low flows

9.10.1.2 Moving the Matsulu abstraction works

The Matsulu abstraction pumps could possibly be moved to a point downstream of the turbine discharge point of the Van Graan canal or immediately upstream of the Kaapmuiden weir where a domestic pump has historically existed

9.10.1.3 Supplying Matsulu under gravity from the Mountain View Dam

If the Mountain View Dam option is chosen as one of the long term strategies for the water reconciliation, the problem could automatically solve itself since Matsulu can then be supplied under gravity from the dam and the abstraction from the Crocodile River will no longer be required. This however could take a long time and the lead time for dam construction of the size of Mountain View Dam is approximately 5 years. One of the first two above options should therefore rather be considered.

10 OTHER WATER DEMAND CENTRES (ELANDSHOEK, NGODWANA, KAAPSCHE HOOP,)

10.1 POPULATION GROWTH

10.1.1 Elandshoek

Only one growth scenario was developed for Elandshoek, a small town situated to the west of Nelspruit. The expected population growth for Elandshoek is summarised in **Table 10.1** and shown in **Figure 10.1**.

Table 10.1: Expected population growth for Elandshoek

Year	2009	2010	2015	2020	2025	2030
Low & High	406	416	467	517	565	610

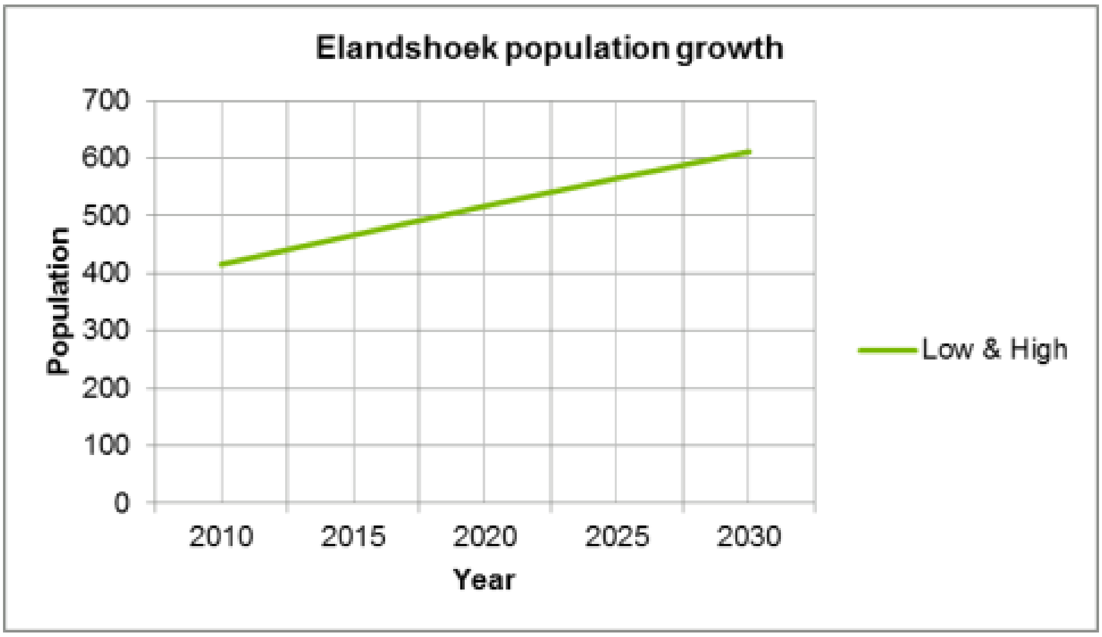


Figure 10.1: Elandshoek Population Growth

10.1.2 Ngodwana and Kaapschehoop

No population growth is expected for Ngodwana: it is expected to stay constant at 1 530 residents.

Kaapschehoop is a weekend/holiday town with 177 permanent residents. It has a maximum overnight accommodation for an additional 390 visitors.

10.2 CURRENT WATER USE

10.2.1 Domestic water use

10.2.1.1 Elandshoek

Elandshoek receives its water from a mountain stream which gravity feeds into a 1 Mℓ/day WTW. The current water use 0,148 Mℓ/day.

10.2.1.2 Ngodwana

Ngodwana takes water from the Ngodwana Dam: the current domestic use is 0,5 million m^3/a or 1,37 Mℓ/day.

10.2.1.3 Kaapschehoop

There is no surface water supply in the town, the only water source is groundwater. However, the groundwater quality is low, due to high concentrations of iron.

10.2.1.4 Industrial water use

The SAPPI paper mill at Ngodwana is the largest single industrial user in the municipal area, using approximately 38,4 Mℓ/day or 14,0 million m^3/a.

10.3 PROJECTED FUTURE WATER REQUIREMENTS

10.3.1 Domestic water use

The projected domestic water requirements for each of the three towns are summarised in **Table 10.2** and **Table 10.3**.

Table 10.2: Domestic use for Elandshoek, Ngodwana and Kaapschehoop in million m^3/a.

Year	2010	2015	2020	2025	2030
Elandshoek	0,025	0,028	0,032	0,034	0,037
Ngodwana	0,500	0,500	0,500	0,500	0,500
Kaapschehoop	0,031	0,031	0,031	0,031	0,031

Table 10.3: Domestic use for Elandshoek, Ngodwana and Kaapschehoop in Mℓ/day.

Year	2010	2015	2020	2025	2030
Elandshoek	0,069	0,078	0,086	0,094	0,102
Ngodwana	1,370	1,370	1,370	1,370	1,370
Kaapschehoop	0,086	0,086	0,086	0,086	0,086

10.3.2 Industrial water use

SAPPI have indicated that they would also need additional water in terms of their proposed expansion plans for the Ngodwana paper mill. However, at this stage they have not quantified their additional future water requirements.

10.4 HIGH AND LOW SCENARIO WATER REQUIREMENT PROJECTIONS

The total projected water requirements for the three towns are shown in **Table 10.4** and **Table 10.5**.

Table 10.4: Water requirement projections for Elandshoek, Ngodwana and Kaapschehoop in million m^3/a.

Year	2010	2015	2020	2025	2030
Elandshoek	0,025	0,028	0,032	0,034	0,037
Ngodwana	14,50	14,50	14,50	14,50	14,50
Kaapschehoop	0,031	0,031	0,031	0,031	0,031
Total	**14,56**	**14,56**	**14,56**	**14,57**	**14,57**

Table 10.5: Water requirement projections for Elandshoek, Ngodwana and Kaapschehoop in Mℓ/day.

Year	2010	2015	2020	2025	2030
Elandshoek	0,07	0,08	0,09	0,09	0,10
Ngodwana	39,73	39,73	39,73	39,73	39,73
Kaapschehoop	0,09	0,09	0,09	0,09	0,09
Total	**39,88**	**39,89**	**39,90**	**39,91**	**39,91**

10.5 WATER RESOURCE AVAILABILITY

10.5.1 Groundwater availability

The Malmani dolomite, which is underlain by the Black Reef Quartzite, is the most important geological unit impacting on both the surface and groundwater of the area. The dolomite dips beneath the Timeball Hill Shales to the west, but in the Kaapschehoop and Elandshoek areas, the dolomite and Black Reef are underlain by lava or granitic rocks.

In the Montrose area, serpentinised magmatic formations are present. These rocks, which are classed as inter-granular and fractured are (according to the 1:500 000 Hydrogeological map) host to the highest-yielding aquifer, with a potential yield greater than 5 ℓ/s. Both the dolomite and lava rock occurrences are classed as karst, and are inter-granular and fractured, with both types of formation yielding 2,0 to 5,0 ℓ/s. However the shales, which are also classed as inter-granular and fractured, only yield 0,5 to 2,0 ℓ/s.

In the dolomites and associated formations, the probability of drilling a successful borehole lies between 40 and 60%, and of drilling a borehole yielding more than 2 ℓ/s is between 40 and 50%. (Vegter 1995). The probability of drilling a successful borehole in the shales is greater than 40% and of drilling a borehole yielding more than 2 ℓ/s between 20 to 30%.

It is therefore concluded that the general groundwater availability is good, but requires further detailed investigations for development. DWA (1999) undertook an Intermediate Reserve Determination for the X2H catchment, and set the groundwater allocation for the significant water resources at 78 x 10 million m^3/a. This allocation was set on the basis that:

- Groundwater levels do not decline, and groundwater quality does not deteriorate
- Groundwater abstraction does not impact on the flow in the river.

Kaapschehoop is dependent on groundwater, but groundwater sources in and around Kaapschehoop are rich in iron. Alternative sources of water are therefore being sought for this village.

10.5.2 Surface water availability

SAPPI, which operates a paper mill at Ngodwana, is by far the largest water user within the Ngodwana demand centre. Water for the mill is sourced from the Ngodwana Dam which has an estimated yield of 21 million m^3/annum. In addition, SAPPI have apparently purchased water rights from irrigators in the Elands River. This needs to be confirmed and verified.

Another small user in the Ngodwana demand centre is Elandshoek, which sources water from the Crocodile River. Water quality is a problem since the Elands downstream of the SAPPI paper mill is polluted with industrial effluent. .An alternative water source for Elandshoek must therefore be found.

10.6 WATER QUALITY

10.6.1 Sources of pollution

Water quality sampling records are available from 1972. All the parameters comply with the water user requirements. EC varies between 6 and 86,1 mS/m with a median of 17 mS/m. There was an initial increasing trend from 1997 to 2003 in EC, however if the measurements are now compared on a month to month and year on year basis the levels are now higher, but have stabilised. The results of the sampling measurements have not been linked to flow rates in river.

10.6.2 Trend analyses

Seasonal water quality variations are observed. Data from only 16 water quality samples is available from February 2009 to January 2012, of which chemical analysis has been done on only 4 samples. Observations are not linked to flow rates in the river.

It can be concluded that TDS is stabilised from a month on month and year on year comparison for available data from 2009 to 2012.

10.7 THE WATER BALANCE

10.7.1 Current water balance with no interventions

Elandshoek, Ngodwana and Kaapschehoop currently experience no water shortages, but they do experience water quality problems. Elandshoek and Kaapschehoop will need to supplement their water in future.

No future water supply problems are foreseen for Ngodwana (both the village and the factory), since the dam yield exceeds the future water demand.

The water requirements of Elandshoek and Kaapschehoop are very small and can easily be met from groundwater.

10.7.2 Reconciliation options that will reduce water requirements

No formal WC/WDM initiative is envisaged. The residents need to be encouraged to use water sparingly.

10.7.3 Reconciliation options that will increase water supply

10.7.3.1 Rainfall harvesting

Both villages (Elandshoek and Kaapschehoop) are situated in high rainfall areas, and additionally the fog density and frequency of occurrence at Kaapschehoop is one of the highest in the country. Both villages can therefore promote the use of rainwater harvesting among their residents for augmenting water supply, while fog harvesting using nets is an additional possibility at Kaapschehoop. Based on other pilot studies, approximately 5 to 10 ℓ/day can be harvested per m^2 of net. The fog harvesting yield is however very site specific, and it is therefore recommended that a pilot fog harvesting system be erected at Kaapschehoop.

10.7.3.2 Groundwater development

A study undertaken by DWA (1999) showed that 40% of boreholes in this area are dry, and that a further 40% yield less than 0,3 ℓ/s. From this, DWA concluded that groundwater is not utilised to any great extent. Several structural features such as faults and dykes are shown on the geological map, and linear structures cutting through the dolomitic formations are visible on satellite imaginary. High potential groundwater resources are normally associated with these structural features. Utilising the dolomitic aquifer to store groundwater for release from a weir could be considered as a development option. The construction of such a weir upstream from the Montrose Falls can be considered. Structural features crossing the Crocodile River need to be identified that can be recharged by the filling of the weir. However, a high density airborne magnetic survey of the area is required to identify the exact locality of these structural features. Targets along these structures need to be selected for detailed geophysical traversing. It is recommended that the radon emanation technique (Levin, 2000) be applied to locate the optimum drilling position.

10.8 SELECTED RECONCILIATION SCENARIOS

The potential for augmenting water supplies through rainwater harvesting should be investigated for the villages of Elandshoek and Kaapschehoop, and for fog harvesting at Kaapschehoop.

Additional boreholes can also be drilled to maintain a sustainable water supply to these two villages.

11 HAZYVIEW

11.1 POPULATION GROWTH

The low and high population growth scenarios for Hazyview are summarised in **Table 11.1** and depicted in **Figure 11.1**. The population of the Hazyview is expected to grow steadily until 2030, with an average growth rate of 0,9% in the low growth scenario, and 1,1% in the high growth scenario.

Table 11.1: Low and high population growth for Hazyview

Year	2009	2010	2015	2020	2025	2030
Low	7 506	7 583	7 981	8 356	8 708	9 034
High	7 506	7 599	8 080	8 537	8 968	9 372

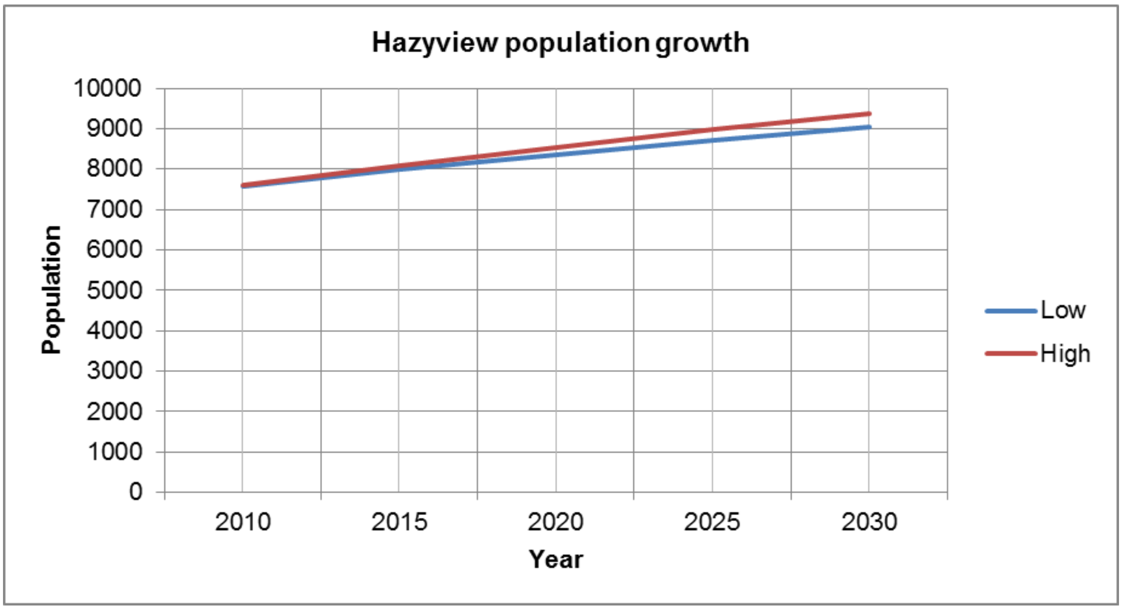


Figure 11.1: Low and high population growth for Hazyview

11.2 CURRENT WATER USE

MLM is the WSP in Hazyview. The town receives water from the Sabie River via the Sabie Irrigation Board canal and from a pump station on the Sabie River.

11.2.1 Domestic water use

Hazyview has an allocation of 3,25 Mℓ/day. MLM also has a pump station with a capacity of 2,6 Mℓ/day on the Sabie River which is used when the canal is not in operation or when the water provided from the canal needs to be supplemented. The current water use is 3,8 Mℓ/day or 1,39 million m^3/a.

11.2.2 Industrial water use

There is no industrial water use in Hazyview.

11.3 PROJECTED FUTURE WATER REQUIREMENTS

11.3.1 Domestic water requirements

The projected water requirements are expected to increase in line with population growth, increasing steadily up 2030. **Table 11.2** and **Table 11.3** shows projected domestic water requirements.

11.3.2 Industrial water requirements

No future industrial water requirements are projected.

11.4 HIGH AND LOW SCENARIO WATER REQUIREMENT PROJECTIONS

The projected low and high scenario water requirements are summarised in **Table 11.2** and **Table 11.3**.

Table 11.2: Projected water requirements in million m³/a

Year	2010	2015	2020	2025	2030
Low	1,38	1,46	1,52	1,59	1,65
High	1,39	1,47	1,56	1,64	1,71

Table 11.3: Projected water requirements in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	3,79	3,99	4,18	4,35	4,52
High	3,80	4,04	4,27	4,48	4,69

11.5 WATER RESOURCE AVAILABILITY

11.5.1 Groundwater availability

The geology of the study area as shown on the geological map (**Figure 5.2**) consists mainly of potassic gneiss. Several east/west striking diabase dykesand sills are present in the area, and a northwest/southeast shear zone occurs close to the town. The aquifer is classified as an inter-granular and fractured aquifer according to the 1:500 000 hydrogeological map (1:500 000 Hydrogeological Map Series of the Republic of South Africa Nelspruit 2530 (DWAF, 1999)). The occurrence of groundwater is associated mainly with the deeper weathered zones, whereas fault zones and dyke contacts represent other groundwater occurrences. The groundwater yield potential is classed as low, with potential yields of between 0,5 to 2,0 ℓ/s likely in the gneiss. According to Vegter (1995) the probability of drilling a successful borehole in this area is between 40 to 60%, and of drilling a borehole yielding more than 2 ℓ/s is between 30 to 40%. It is concluded that groundwater is generally available but will require detailed investigations for development.

11.5.2 Surface water availability

Hazyview's main source of water is the Sabie River via the Sabie River Irrigation Board Canal. Water is diverted from the Sabie River some 15 km upstream of Hazyview into the canal, which traverses the right bank of the Sabie River and discharges unused water back into the Sabie River at Hazyview. The town of Hazyview has an allocation of 1,33 cusecs (37,66 ℓ/s) from this canal. The town also operates a small pump station on the Sabie River near the town which is used periodically either when the canal is empty due to maintenance procedures, or when the canal delivers insufficient water.

There is a perception that there is surplus water in the Sabie River and that the water supply problems of Mbombela can be solved simply by allocating more water from this source. The water resource of the Sabie River was therefore analysed in detail, and the results of the analysis reported in the Water Requirements and Water Resources report. A summary of this analysis is presented in this Strategy report.

Two scenarios were modelled during the assessment of the water resources of the Sabie River. Firstly, a present day situation based on current abstractions from the river was modelled, and secondly a scenario in which the full allocations already made from the Sabie River is supplied.

The current situation and future water use/allocation are summarised in **Table 11.4**.

Table 11.4: Summary of current (2012) and future water requirements within the Sabie River catchment (excluding the Sand River)

Scenario	Current (million m^3/a)	Future (million m^3/a)
Irrigation	49	52
Domestic	27	30
Transfer to the Sand River	8	20
Ecological Water Requirements	0	180
Available yield	~100	~0

Based on this analysis it was concluded that while there appears to be ample water currently available within the Sabie River catchment, this water has been allocated to the ecological Reserve and to the Sand River catchment. Transfers to the Sand River from the Inyaka Dam are currently in the order of 8 million m^3/annum and this will increase by a further 12 million m^3/annum with the completion of the Inyaka water treatment plant early in 2013. The implementation of the Reserve has recently commenced and entails increased releases from the Inyaka Dam.

The water resource currently available to Hazyview is therefore equivalent to their allocation from the system.

11.6 WATER QUALITY

11.6.1 Sources of pollution

Forestry activities close to or within the riparian zone are the primary threat to the health of the riparian habitats and vegetation. Trout farming is also a threat to in-stream ecological health. The diversion of water for dams and weirs impacts on the flows in the area, and rivers downstream of trout farms become enriched with nutrients from fish feed and waste.

The Hazyview WWTW is currently being operated 50% above its design capacity, resulting in discharge of poor quality water and a low level of compliance, which can affect downstream users and Nsikazi North.

The water quality in the Sabie River indicates unacceptable levels of phosphates throughout the catchment. This is due to return flows from WWTWs, the large surface area dense settlements in Bushbuckridge that are mainly un-serviced, and runoff from the intensively fertilised cultivation of subtropical fruits.

The water quality trends in the Sabie River indicate increasing nutrient and turbidity levels. The turbidity trend is due to over grazing, and the removal of vegetation for firewood from the slopes of the river valley in the Bushbuckridge area. The increasing nutrient levels are due to the use of fertilisers for the growth of sub-tropical fruits, and sewage waste (both formal, and un-serviced).

11.6.2 Actual water quality versus water quality objectives

Hazyview sewage effluent conforms to the DWA Standard and guidelines as far as the parameters for pH, conductivity, TDS, chloride, sulphates and phosphates are concerned, but ammonia levels exceed the standard by a factor of more than 10.

11.6.3 Trend analyses

Water quality sampling only started in mid-2008. However no sampling or recorded measurements are available for 2009 and 2010. All the parameters, with the exclusion of ammonia, comply with the water user requirements. The levels for ammonia exceed the standard for both the aquatic environment and drinking water. EC varies between 4,24 and 100 mS/m with a median of 46,7 mS/m. Too few samples have been analysed for phosphates and ammonia to be able to make logical conclusions regarding the trend of these parameters.

11.7 THE WATER BALANCE

11.7.1 Current water balance with no interventions

The current water use allocations are summarised in **Table 11.5.**

Table 11.5: Current water use and allocations – Hazyview

Source	Abstraction million m^3/a	Licence million m^3/a	Comments
Current abstraction from Sabie Irrigation Board canal	1,39	1,2	Agreement with Sabie Irrigation Board to abstract 37,7 ℓ/s (1,33 cusecs)
Abstraction from Sabie River		0,03	Authorisation lost but it is 30 ℓ/s abstraction only if there is no water in the Sabie Canal or when there is a shortage of water in the canal, i.e. this is only a back-up and not an added allocation
Totals	**1,39**	**1,2**	

The figures reveal that Hazyview is currently experiencing a water deficit in terms of their allocation. Whilst this can be mitigated if water is pumped from the Sabie River whilst abstracting from the canal, such an abstraction would be unlawful.

11.7.2 Future water balance with no interventions

A projection was made of the future water requirements of Hazyview and the high and low growth water requirements are shown in **Error! Reference source not found.**.

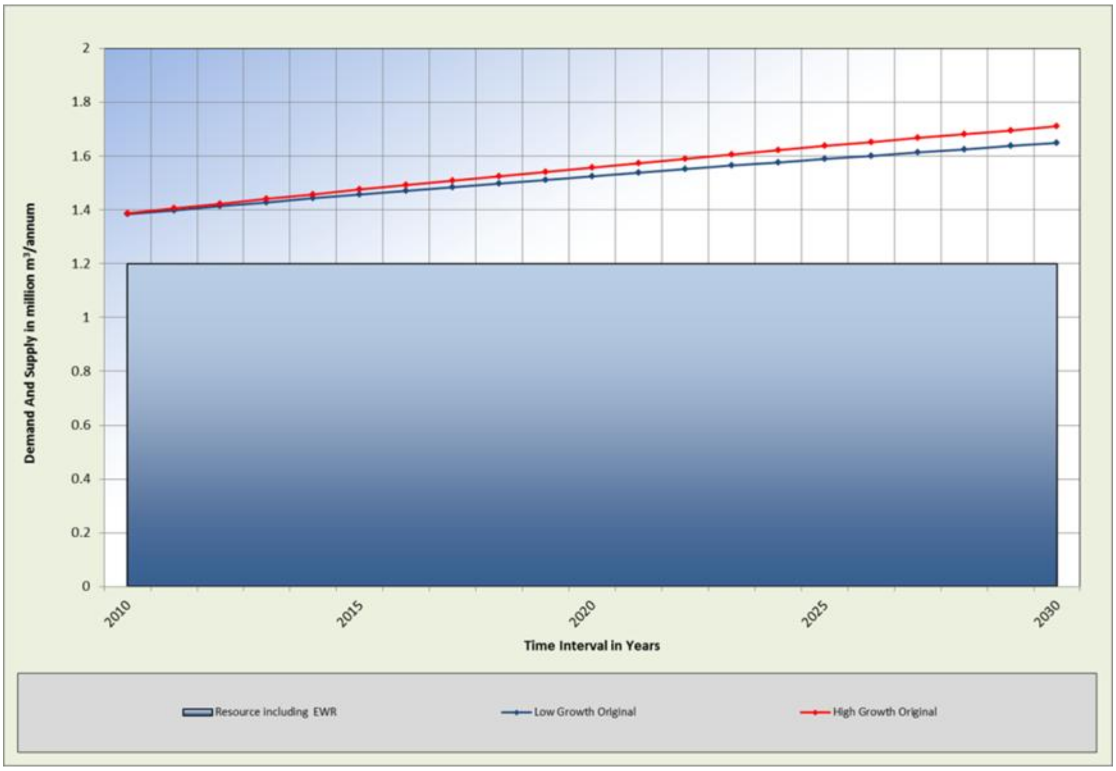


Figure 11.2: Hazyview water balance without any interventions

From the graph it can be seen that the current water deficit will increase over time without any interventions.

11.8 POSSIBLE INTERVENTION OPTIONS

11.8.1 Reconciliation options that will reduce water requirements

11.8.1.1 WC/WDM within Hazyview

The Hazyview water demand centre is operated and maintained by MLM. The centre consists of mostly formal areas with formal infrastructure which enables adequate metering, billing and cost recovery systems to take place. Based on the available information, qualitative and quantitative scorecards, the assessment and proposed strategy shown in **Table 11.6** were made, and the key performance indicators summarised in Table 11.7 were identified.

Table 11.6: Status quo assessment and strategy

Status quo	Strategy
Institutional and legal assessment	
• Mbombela lacks capacity (45% vacancy) and necessary skills to implement WC/WDM. • There is no WC/WDM training. • The municipal bylaws are currently under review. • There is no customer service charter. • The level of political support is acceptable but the understanding of the water business can improve.	• Appoint additional staff to increase the capacity of the WC/WDM section and implement a training programme. • Enforce bylaws that promote WC/WDM. • Setup WC/WDM task team, chaired by senior official or MEC to meet on monthly basis to address WC/WDM issues. This should improve communications between organisations, highlight problem areas and transfer skills. • Perform Councillor training programme on water business and WC/WDM. • Prepare a customer service charter.
Financial assessment	
• The relationship between the technical and finance department can improve with access to information being a problem. • The existing metering, billing and cost recovery system is fair but can improve. • Non-revenue water is in the order of 46%. • Water tariffs are not cost reflective with limited input from technical department. • A declining block water tariff structure is in place which does not promote WC/WDM. • Meter reading is not acceptable and often estimated. • Billing is informative showing 2 months of consumption.	• The setup of a WC/WDM task team should improve relationship with finance department and access to information. • Provide training to meter readers to improve meter reading and reporting. • Water tariffs should be reviewed to become cost reflective and promote WC/WDM.
Social assessment	
• The relationship with the community is generally positive in formal income areas while strained in rural (informal) areas. • Water is paid for in formal areas but not valued very highly and excessive garden watering is a common phenomenon. • Illegal connections and non-payment prevalent in rural (informal) areas. • WSP has an effective customer call centre and promotes reporting of leaks. • Rain water harvesting is promoted with Parks department.	• Promote rain water harvesting in formal and informal areas. • Embark on community awareness programme that emphasise fixing of internal plumbing leaks. • Embark on schools awareness programme promoting reporting of leaks and water wise practices.
Technical assessment	

Status quo	Strategy
• There is very little macro and no micro management information available to perform a proper assessment of the water losses and potential savings. • No zone metering, pressure management and sectorisation are being done. • Consumer meters are generally in excess of 5 years old, and under recording. • The WSP has no loggers and leak detection equipment. • Existing telemetry system in some areas. • Top consumers are not pro-actively monitored. • Low pipe burst frequency (approximately 10/ week).	• Implement and maintain sectorisation to identify key problem areas. • Implement pressure management programme and focus on maintenance and monitoring. Will result in reduced number of pipe bursts and prolong infrastructure design life. • PRVs / zones must be continuously monitored to ensure discreteness and PRV settings. • Improve micro management information through proper sectorisation to obtain a better understanding of problem areas. • Implement a consumer meter replacement programme, starting with the top consumers, whereby 10% of all water meters are replaced per annum. • Monitor top consumers on a pro-active basis.
General observations	
• The Hazyview WTW received 87,97% in the 2012 Blue Drop assessment which is an indication of a properly managed water supply.	• Improve to obtain Blue Drop status and expand performance to water distribution network through proper management and control.

Table 11.7: Performance indicators for Hazyview

Indicator	Current Value	Target Value 30%
Annual Input volume (million m^3/annum)	1.39	0.97
Daily input volume (Ml/day)	3.8	2.7
Population (2012)	7839	-
Households (2012)	2484	-
Non-revenue water	Not available	20%
Litres / capita / day	485	340
m^3 / household / month	46.6	32.6

Based on the high per capita unit consumption recorded in Table 11.7,, it is clear that WC/WDM should be implemented as a matter of priority. The current consumption is more than double the international accepted standard of approximately 180 litres per capita per day. This high unit consumption is excessive, and no further interventions should be considered before this situation is corrected. A water saving target of 30% is therefore set for Hazyview.

Summary and conclusions

There is scope for WC/WDM in the Hazyview area which will result in both reduction of non-revenue water and the total system input volume. There are limited institutional capacity and skills available to embark on such a programme which should be resolved before focusing on the following interventions:

- Improve political support through a Councillor awareness programme focusing on the water business.
- Review water tariffs to reflect cost of water and promote WC/WDM.
- Train meter readers and perform monthly audits to eliminate estimates and other inaccuracies.
- Perform meter audit and cleaning to improve meter reading and accessibility.
- Devise and implement a community awareness programme that promotes the value of water and water wise gardening.
- Implement zone metering and sectorisation to improve micro management information. This will assist with the identification of key water loss areas and reduce number of bursts.
- Implement a pressure management programme in conjunction with sectorisation and continuous monitoring.
- Undertake a consumer meter replacement programme whereby 10% of all consumer meters are replaced on an annual basis.

11.8.1.2 Removal of IAPs

Removal of IAPs upstream of the Da Gama Dam and upstream of the Sabie Irrigation Board canal could theoretically make water available for allocation to Hazyview. However, according to the latest WFW survey there are negligible areas of IAPs in these catchments, so this does not appear to be a viable option for this area.

11.8.1.3 Water demand reduction measures in the irrigation sector

Similar to the situation described for Nelspruit in **Section 5.8.1.1**, measures can be implemented by irrigators upstream from Hazyview's abstraction points in the Sabie River to reduce their water demand, which will - in effect increase the water availability at the Hazyview abstraction point. These possible measures are:

- Eliminating unlawful water use (if any) upstream of the Hazyview abstraction point. The volume of unlawful water use in the Sabie River is not known at this stage, and is unlikely to be quantified in time for the completion of this study. It is however, an option that needs to be monitored in future.
- Compulsory licensing (Refer to **Section 5.8.1.3**. The same argument as for Nelspruit will apply.
- Water reallocation (Refer to **Section 5.8.1.3.** The same argument as for Nelspruit will apply.)

11.8.2 Reconciliation options that will increase water supply

11.8.2.1 Groundwater development

As shown on the geological map of the area (**Figure 5.2**) several east/west striking dykes are present close to Hazyview. A northwest/southeast striking shear zone is located to the east of the town. Potentially high-yielding groundwater resources are normally associated with this type of structural feature. However, a high density airborne magnetic survey of the area is required to accurately locate these structural features. Targets along these structures need to be selected for more detailed geophysical traversing. It is recommended that the radon emanation technique (Levin, 2000) be applied to locate the optimum drilling targets. It is assumed that 200 000 m³/a of groundwater can be found from this resource.

11.8.2.2 Dam construction to increase yield storage

There are no dam development options that would increase the yield in the Sabie catchment to benefit Hazyview.

11.8.2.3 System operating rules

A similar real-time operational model to that of the Crocodile River system is under development for the Sabie system. The Sabie real-time model includes a flow forecasting model which will help predict river flows for the week ahead, based on rainfall forecasts. This should reduce unnecessary releases into the river from Inyaka Dam and will save some water. This model is now in its testing phase: it is too early to recommend new allocations based on the potential savings due to improved operation, but this is a possibility in future.

11.8.2.4 Water transfers from elsewhere

There is no scope for transfers into the Sabie from other catchments, since the neighbouring catchments are considerably more stressed than the Sabie River catchment.

11.9 SELECTED RECONCILIATION SCENARIOS

The reconciliation scenarios evaluated to balance Hazyview’s water balance are as follows:

11.9.1 Implementation of WC/WDM measures by MLM

The implementation of WC/WDM measures is a DWA requirement for all water service providers. Although a target saving of 30% will almost balance Hazyview’s current water use and water requirements, the high growth scenario runs into deficit again in 2024 (See **Error! Reference source not found.**). The water requirement based on the international standard of 180 ℓ/c/d is also shown even after a 30% water saving. It is clear that water use in Hazyview remains way above this international standard under all the scenarios considered.

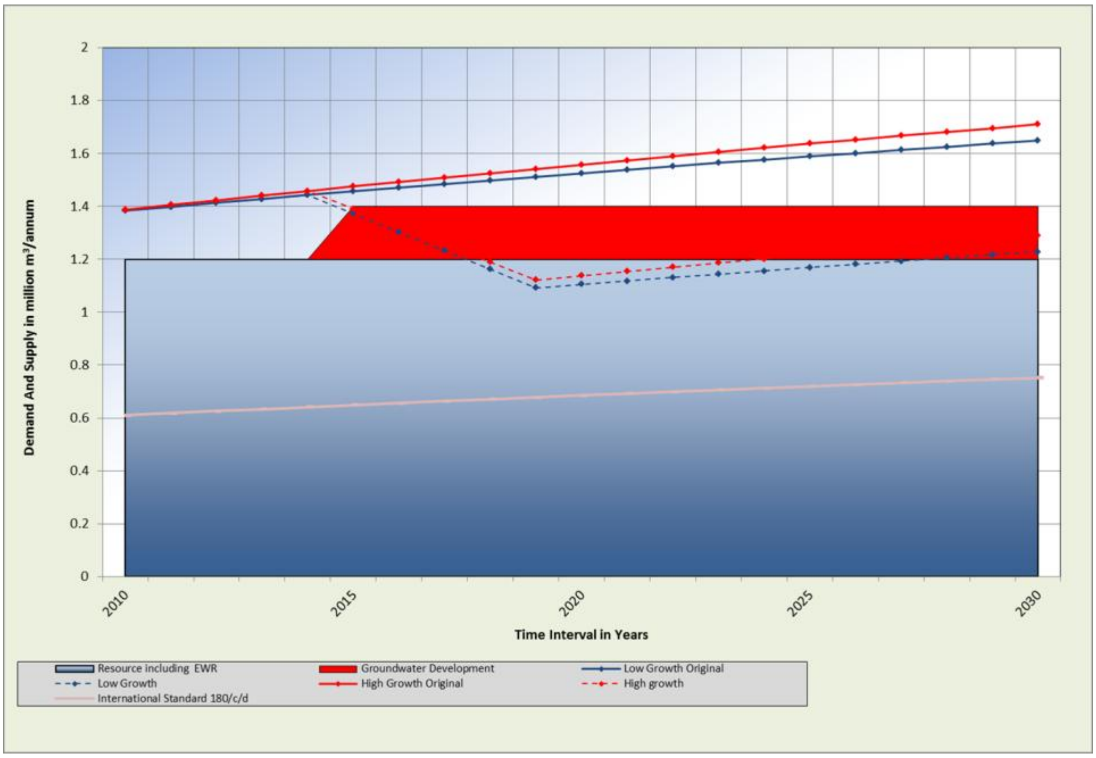


Figure 11.3: Water reconciliation for Hazyview

11.9.2 Implementation of WC/WDM measures by MLM, ground water resource development and lowering the Reserve requirement for the Sabie River

Although the Reserve in the Sabie River catchment has been determined and is now being implemented, the Classification process (to commence early next year) will allow stakeholders to make informed choices between water for development, and water for the ecology.

Currently, the Reserve is essentially "taking up" all water not used for domestic or irrigation purposed in order to maintain the current ecological state of the river: It is possible that water could be made available for domestic allocation through a downward adjustment or refinement of the quantity of water allocated to the ecological Reserve. This scenario would more than adequately meet the water resource requirement for Hazyview over the planning period but will require buy in from stakeholders. It is therefore considered as an option only if the available yield from the reduction of irrigation demand is insufficient to balance Hazyview's water use and water requirements. It is important to note that the additional yield obtained from the lowering of the amount allocated to the Reserve would also benefit the WDC of Nsikazi North, downstream of Hazyview.

11.10 RECONCILING THE WATER REQUIREMENTS WITH THE WATER RESOURCE

11.10.1 Water balance for selected reconciliation scenarios

The reconciliation of the Hazyview can be achieved by only implementing WC/WDM measures and utilising ground water.

11.10.2 Actions that need to be started as a matter of urgency

MLM needs to embark on the development of the WC/WDM plan and implementation strategy based on the strategy described in **Section 11.8.2** for Hazyview, with a view towards rolling it out over a 5 year period, starting in the 2014/15 financial year.

12 NSIKAZI NORTH

12.1 POPULATION GROWTH

The low and high population growth scenarios for Nsikazi North are summarised in **Table 12.1** and depicted graphically in **Figure 12.1**. The population of the Nsikazi North is expected to grow steadily until 2030, with an average growth rate of 0,8% in the low growth scenario, and 1,1% in the high growth scenario.

Table 12.1: Low and high population growth scenarios for Nsikazi North

Year	2009	2010	2015	2020	2025	2030
Low	156 417	157 909	165 584	173 009	180 032	185 421
High	156 417	158 427	168 870	178 977	188 576	196 423

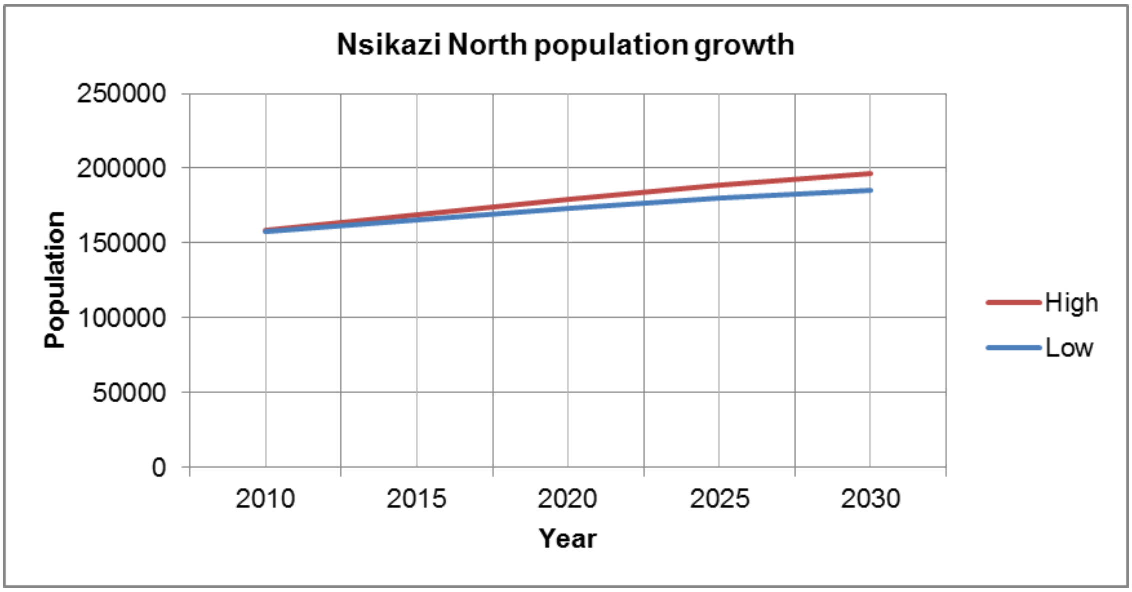


Figure 12.1: Low and high population growth scenarios for Nsikazi North

12.2 CURRENT WATER USE

BWB is the bulk WSP for Nsikazi North and MLM is responsible for the distribution of water to the users.

12.2.1 Domestic water use

The main water supply for Nsikazi North comes from the Sabie River. Water is abstracted at the Nsikazi North Regional Raw Water pump station and pumped to Nyongane booster pump station where the water is chlorinated and distributed. The distribution of water to villages is according to a valve schedule: most villages get water twice a week. There are also package plants supplying water to Majika, Msadza and Mnganduzweni. The mode of service in most of the area is via stand pipes.

There is a Memorandum of Understanding between MLM and BLM to supply water from the Hoxane WTW to Nsikazi North. The WTW was constructed by DWA and consists of 4 x 9 Mℓ/day units. The mechanical and electrical works were, however, not completed and the intention is to commission the two incomplete units and supply 18 Mℓ/day to Nsikazi North. Although there should be more than sufficient water to supply the population in this area with a generous per capita rate, the reality is that the service delivery is very poor. The reason for this is not entirely clear but is probably due to excessive losses and illegal connections.

MLM does not want to depend on BBLM for treated water and plans to construct a 30 Mℓ/day WTW at Nyongane. MLM appointed a PSP to design the WTW and also to apply for Municipal Infrastructure Grant (MIG) funding. A water use licence for this additional abstraction has not been issued.

12.2.2 Industrial water use

There is no industrial water use in Nsikazi North.

12.3 PROJECTED FUTURE WATER REQUIREMENTS

12.3.1 Domestic

The projected domestic water requirements are summarised in **Table 12.2** and **Table 12.3**.

12.3.2 Industrial water use

No industrial water requirements are projected for Nsikazi North.

12.4 HIGH AND LOW SCENARIO WATER REQUIREMENT PROJECTIONS

The projected low and high scenario water requirements are summarised in **Table 12.2** and **Table 12.3**.

Table 12.2: Projected water requirements in million m³/a

Year	2010	2015	2020	2025	2030
Low	10,66	11,18	11,68	12,16	12,52
High	10,70	11,40	12,09	12,73	13,26

Table 12.3: Projected water requirements in Mℓ/day

Year	2010	2015	2020	2025	2030
Low	29,21	30,63	32,01	33,31	34,30
High	29,31	31,24	33,11	34,89	36,34

12.5 WATER RESOURCE AVAILABILITY

12.5.1 Groundwater availability

The geology of the study area as shown on the geological map (**Figure 5.2**) consists of grey and white coarse grained biotite granite in the western part, while the eastern section along the border of the Kruger National Park, and the southern part of the area consists of potassic gneiss. Several east/west striking diabase dykes and sills are present in the north, and northwest/southeast shear zones cut through the area. Northwest/southeast striking dykes are present in the southern part of the area.

The aquifer is classified as an inter-granular and fractured aquifer according to the 1:500 000 hydrogeological map (1:500 000 Hydrogeological Map Series of the Republic of South Africa Nelspruit 2530 (DWAF, 1999). The occurrence of groundwater is associated mainly with the deeper weathered zones, whereas fault zones and dyke contacts represent other potential groundwater targets. The groundwater yield potential is classed as low, with potential yields between 0,1 and 0,5 ℓ/s in the granite, and 0,5 to 2,0 ℓ/s in the gneiss. According to Vegter (1995) the probability of drilling a successful borehole in the western part is below 40% whilst the probability of drilling a borehole yielding more than 2 ℓ/s is between 10 and 30%. In the east and northern areas, the probability of drilling a successful borehole is between 40 to 60%, and of drilling a borehole yielding more than 2 ℓ/s is between 30 to 40%. It is concluded that groundwater is generally available but requires detailed investigations for development.

12.5.2 Surface water availability

Nsikazi North obtains most of its water from the Sabie River, abstracted at the Northern Nsikazi Regional raw water pump station. Currently these works are operating at maximum capacity. As discussed under **Section 11** (Hazyview), while there is currently surplus water available in the Sabie River, this water has been allocated and will be taken up shortly. Additional water can therefore not be made available from the Sabie River for Nsikazi North.

In addition to the Sabie River, Nsikazi North also obtains water from streams and a dam constructed by the Provincial Department of Agriculture. Many of these abstractions are not licenced and may not be sustainable. Nevertheless, it is suggested that they continue until such time as a more sustainable solution can be found to the water resources and water supply situation of Nsikazi North.

12.6 WATER QUALITY

12.6.1 Sources of pollution

Typical impacts on water quality from rural and informal settlements relate to poorly managed or absent sanitation systems, to littering, and to solid wastes being washed into the rivers and streams, elevating the levels of nutrients in the river and increasing bacteriological counts.

Small scale agriculture which takes place in the catchment may result in an increase in the levels of pesticides and of nutrients from fertilisers in the rivers.

12.6.2 Trend analysis

Water quality monitoring data is available from sampling being done by DWA for the Nsikazi North region. This takes place on the North Sand River which is upstream from Nkumbeni but downstream from Hazyview, and on the Nsikazi River at Matlabantu. Activities at this latter sampling point have however been suspended since 2001.

Sampling has been taking place since 1969 in the north Sand River. The 90th percentile for TDS is 156 mg/ℓ. Ammonium has been steadily increasing since 2006 and the 90th percentile is 0,098 mg/ℓ as N with the median being 0,043 mg/ℓ as N.

12.7 THE WATER BALANCE

12.7.1 Current water balance with no interventions

The present ecological state of the Sabie River needs to be maintained. Therefore the current licensed abstraction volume for Nsikazi North from the Hoxane Weir may not be exceeded. The current authorised abstraction from the Sabie River is 8,03 million m^3/a .

The licensed abstraction for Nsikazi North is augmented from other resources as indicated in **Table 12.4**.

Table 12.4: Licensed abstraction for Nsikazi North

Source	Abstraction million m³/a	Licence million m³/a	Comments
Nsikazi North raw water pump station on Sabie River	8,18	8,03	Authorisation slightly exceeded
Package plants on tributaries	1,84	0,25	Only Mshadza is authorised for 0,25 million m^3/a. No authorisations for Majika, Manzini and Mnganduzweni abstractions.
Mjejane borehole station	0,37	0,16	Authorisation exceeded
Various other boreholes	0,33	0,33*	Uncertain which of the individual boreholes are authorised.
Totals	**10,72**	**8,77**	

* Assumed licences have been issued for all boreholes.

The current abstraction exceeds the total of the authorised volumes. There is uncertainty regarding which of the boreholes have been licensed, but it was assumed that the total volume of 0,33 million m^3/a indicated in **Table 12.4** as abstraction from "various other boreholes" is indeed authorised. This gives a total water availability of 8,77 million m^3/a.

The current water abstraction is 10,72 million m^3/a and it can therefore be seen that this system is already in deficit with the water requirements exceeding the water availability. Interruption in water supply is a regular occurrence in Nsikazi North: The water supply system "runs dry" regularly owing to these interruptions and the water requirements are exceeding the water availability.

12.7.2 Future water balance with no interventions

The projected water requirements of Nsikazi North for both the high and low growth scenarios are summarised in **Table 12.2** and **Table 12.3**.

Without appropriate interventions the current water deficit will increase and the situation will deteriorate as shown in **Figure 12.2**.

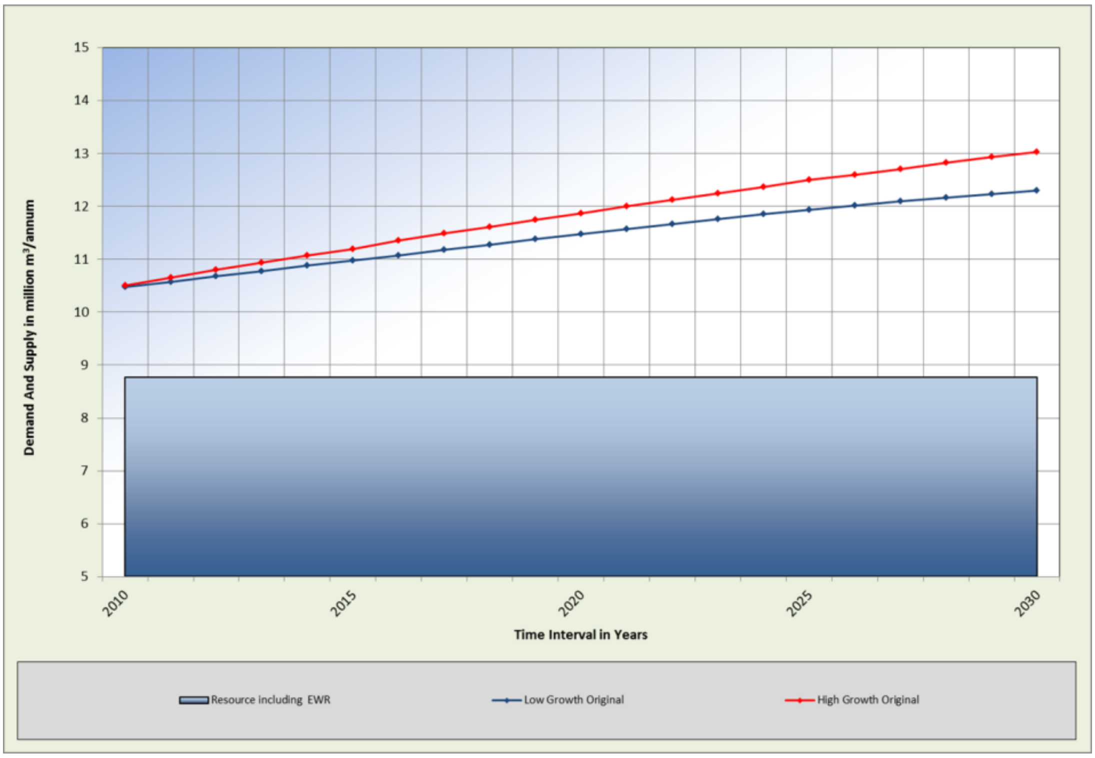


Figure 12.2: Water balance graph for Nsikazi North without any interventions

A water deficit of 4,255 million m^3/a is expected by the year 2030 if no further interventions are implemented and if the current water abstractions are maintained.

12.8 POSSIBLE INTERVENTION OPTIONS

12.8.1 Reconciliation options that will reduce water requirements

12.8.1.1 WC/WDM

The Nsikazi North demand centre is operated and maintained by MLM with the treatment plants operated by BWB. The WDC consists of mostly informal areas with informal infrastructure which have no bulk and domestic metering: billing and cost recovery are not taking place. **Table 12.6** summarises the situation in Nzikasi North and the resulting recommended WC/WDM actions, whilst Table 12.6 summarises the performance indicators determined for Nsikazi North.

Table 12.5: Situation analysis and WC/WDM strategy

Status quo	Strategy
Institutional and legal assessment	
• Mbombela lacks capacity (45% vacancy) and necessary skills to implement WC/WDM. • There is no WC/WDM training. • The municipal bylaws are currently under review. • There is no customer service charter. • The political support is acceptable but the understanding of the water business can improve • The relationship between the municipality and politicians has improved.	• Setup WC/WDM task team, chaired by senior official or MEC to meet on monthly basis to address WC/WDM issues. This should improve communications between organisations, highlight problem areas and transfer skills. • Perform Councillor training programme on water business and WC/WDM. • Appoint additional staff to increase WC/WDM section and implement training programme • Conduct water business and awareness training to councillors to promote WC/WDM. • Develop partnerships with the legal departments as well as the SAPS and put bylaw enforcement back on track to promote WC/WDM.
Financial assessment	
• Non-revenue water is estimated at above 50%. • Metering and billing is non-existing.	• Engage with the community to improve level of services and consider installing water meters. • Consider installing water restricting devices to curb daily consumption. • Improve relationship with the consumers and the leadership and focus on promoting water savings and payment for services through the councillors.
Social assessment	

Status quo	Strategy
• The relationship with the community is generally negative. • High level of low income earners and indigents consumer base. • Infrastructure vandalism and illegal connection is problematic in the area. • Rain water harvesting is promoted through Parks Department. • No community education and awareness.	• Undertake a comprehensive community awareness programme to promote water efficient practices and make the community aware that problems will not be solved without their support. • Promote fixing of internal plumbing leaks. • Consider a hosepipe ban or restrict garden watering until system has stabilised. • Promote schools water awareness campaigns in the area.
Technical assessment	
• There is no macro management information available to perform a proper assessment of the water losses and potential savings. • No bulk metering in the area • The system is characterised by intermittent supply and poor service. • High prevalence of illegal connections with consumers trying to gain access to water supply. • No WC/WDM such as pressure management and sectorisation is being done. • Insufficient support structures and materials.	• Install bulk meters and focus on obtaining macro management information. • Improve level of services and focus on providing continuous supply which should reduce illegal connections. Thereafter inspect and eliminate illegal connections. • Consider undertaking an internal leak audit and repair exercise for indigent consumers to reduce water losses. • Deploy community plumbers to assist with fixing leaks and creating water use awareness.
General observations	
• Water treatment plants operated by BWB received 59,28% in the 2012 Blue Drop assessment which is an indication of a poor supply.	• Improve to achieve Blue Drop status and provide proper supply.

Table 12.6: Performance indicators for Nsikazi North

Indicator	Current Value
Annual Input volume (million m^3/annum)	10.7
Daily input volume (Ml/day)	29.3
Population (2012)	163648
Households (2012)	38850
Non-revenue water	> 50%
Litres / capita / day	179
m^3 / household / month	23.0

The unit consumption in Nsikazi North appears to be within the international standard of 180 ℓ/c/d, but the distribution of water is uneven across the area and major water wastage takes place, with the result that some occupants receive small quantities of water, some even below the RDP level of service.

Interruptions in water supply are one of the main causes of this uneven distribution of water. As a result it will be extremely difficult to implement WC/WDM in this area. Pressure control can, for instance, not be exercised if the system is not permanently under pressure. It is therefore crucial that the water supply to Nsikazi North is stabilised as a matter of priority.

Certain WC/WDM actions can still be implemented, such as water use awareness campaigns, combatting illegal connections, installing meters, etc. Full WC/WDM implementation should take place once the supply system is stable. No water savings have been assumed for the water balance of Nsikazi North.

12.8.1.2 Removal of IAPs

The most recent WFW survey indicates negligible areas of IAPs in the Nsikazi North area, so removal of IAPs does not appear to be an option that would make more water available in this area. However, since Nsikazi North obtains its water mostly from the Sabie River, removal of alien vegetation upstream of the Hoxani weir could potentially make more water available, although current indications are that there are negligible areas of IAPs in the Sabie River catchment: this needs to be confirmed.

12.8.1.3 Water requirement reduction measures for irrigation upstream of the Nsikazi North abstraction point

There are a number of possible measures that can be implemented by upstream irrigators that will reduce their water demand on the water resource which will, in effect, increase the water availability at the Nsikazi North water abstraction point in the Sabie River. These possible measures are:

<u>Eliminating unlawful water use</u>

There is currently no information available on the volume of unlawful water use taking place in the Sabie River catchment upstream of Hoxane Weir. The information may be available when the final strategy document is compiled.

<u>Compulsory licensing</u>

The compulsory licensing process is described for Nelspruit under **Section 5.8.1.3**: The same principle would apply for the Sabie catchment. Compulsory licensing linked to WC/WDM is one way of minimising economic prejudice amongst the irrigation farmers, and ensuring that the irrigators do not expand their irrigation lands with saved water. The purchasing of partial water entitlements (see below: *water reallocation*) is preferential to compulsory licensing, which should be regarded as a last resort.

Water reallocation

As described for Nelspruit under **Section 5.8.1.3**, water trading is a promising option for achieving the water balance in the Nsikasi North area. There are two types of water trading:

- Purchasing partial water entitlements, whereby irrigation farmers are encouraged to save water by applying WC/WDM, and to offer their water savings for sale to the ICMA. This process must be properly regulated: a policy for its regulation is required from the DWA.
- Transfer of full water entitlements. This type of water trading entails the purchase of scheduled water from irrigators. This option must be approached with great caution as it can have social consequences (e.g. farm workers losing their jobs). Irrigation lands that are lying fallow, where irrigators are keen to sell and that are without the possibility of social hardships as a result of job losses, could possibly be targeted.

The precise quantification of the areas of available irrigation lands that could possibly become available for trading have to await the completion of the validation and verification processes. In order to get a very provisional idea of the possibilities, a reconnaissance level investigation along the Sabie River has been carried out with aerial photography and satellite imagery, supported by limited ground truthing. Caution should however be exercised when interpreting results obtained by such purely remote means, since some aspects related to current and historical water use are not evident from remote imagery. A definitive assessment of water use will require direct interaction with stakeholders, including property owners and water management authorities.

The reconnaissance level investigation showed that of the 46 million m^3/a allocated to irrigation along the Sabie River, lands which approximately require 7 million m^3/a were not being used at the time of the aerial photograph or satellite image. This does not necessary imply that these lands are lying fallow or that their entitlements will become for sale, but merely provides an indication of a possible outcome of a more detailed future survey.

It will be seen from Figure 12.4 under Section 12.10 below that approximately 4 million m^3/a will be needed to achieve a water balance. It can therefore be confirmed that this could be a reconciliation possibility with relatively low expected social impacts.

12.8.2 Reconciliation options that will increase water supply

12.8.2.1 Groundwater development

As shown on the geological map of the area (**Figure 5.2**), several northwest/southeast striking dykes are present. A northwest/southeast striking shear zone cuts through the area, as shown in **Figure 12.3**. High potential groundwater resources are normally associated with these structural features. However, a high density airborne magnetic survey of the area is required to accurately locate these structural features. Targets along these structures need to be selected for more detailed geophysical traversing. It is recommended that the radon emanation technique (Levin, 2000) be applied to locate the optimum drilling targets.

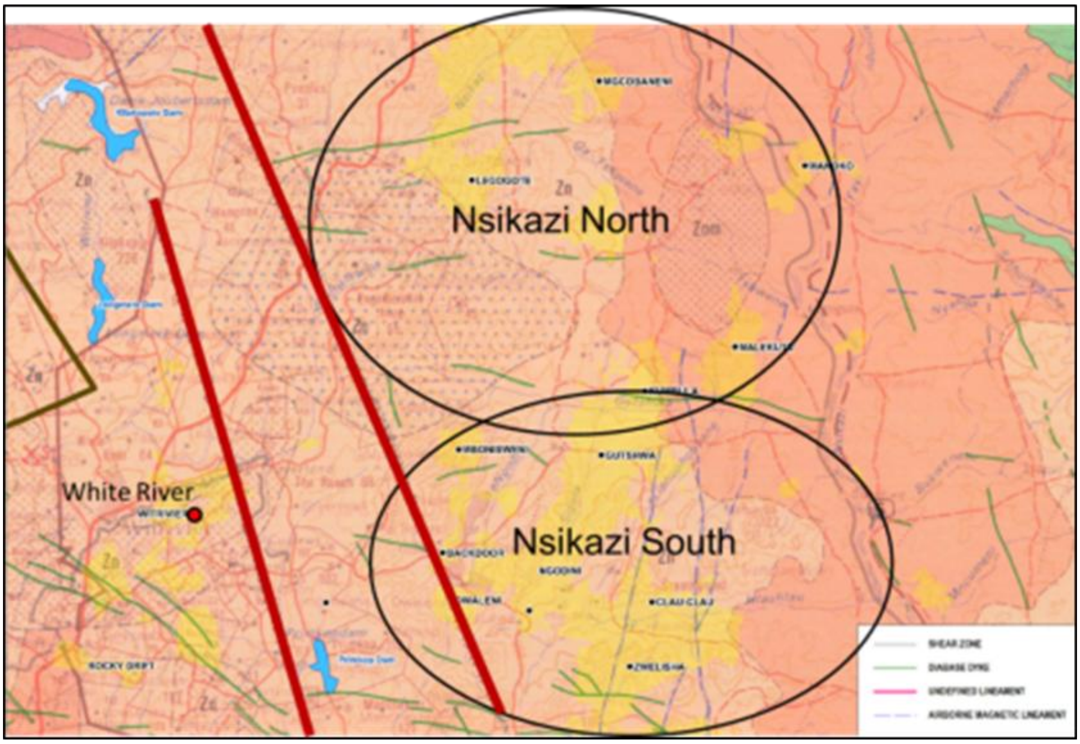


Figure 12.3: Shear zones west of Nsikazi North

It is expected that at least another 200 000 m^3/a can be obtained from the groundwater resource.

12.8.2.2 Dam construction to increase yield storage

The dam construction options that have been evaluated do not result in increased yield within the Sabie River catchment.

12.8.2.3 System operating rules

As indicated for Hazyview under **Section 11.8.2.3**, a real-time operational model for optimising releases from Inyaka Dam is under development. As the model is currently in its testing phase, it is too early to confirm its success. No additional / saved water has been taken into account for this preliminary strategy but this can be reconsidered when developing the final strategy.

12.8.2.4 Water transfers from elsewhere

Most of Nsikazi North is situated in the Crocodile catchment. Water is transferred from the Sabie catchment into the Crocodile catchment: As water requirements grow in Nsikazi North, more water may be transferred from the Sabie River.

12.8.2.5 Eliminating unlawful water use upstream of Nsikazi North abstraction point

The amount of water that would become available from implementing this option will only be confirmed once the verification exercise currently being undertaken by the ICMA is finalised. It is therefore not possible to illustrate the impact of this intervention on the water balance for Nsikazi North at this time.

12.8.2.6 Lowering the Reserve requirement for the Sabie River

It is possible that more water could become available as a result of the classification process. If so, some of this additional water could be made available to Nsikazi North. Conversely, the classification process might however result in. an increase in the amount of water required for the ecological Reserve.

12.9 SELECTED RECONCILIATION SCENARIOS

Whilst WC/WDM is normally the first option that should be implemented by WDC, it would be difficult to implement in this case, due to the regular water shortages and water interruptions on the system. When the reservoirs run dry, the residents tend to open their taps in the hope that some water will go through at some time. Whilst this practice obviously leads to water wastages once supplies are restored, it would be very difficult to convince these residents to save water when the system is not functioning properly. The first priority is therefore to stabilise the water supply system by providing the necessary standby pumps, and by preventing further interruptions in supply. This in itself will not necessarily make more water available, but once the system is stable, a WC/WDM initiative can be launched.

The options that were selected for augmenting the water supply of Nsikazi North are:

12.9.1 Development of groundwater

It was assumed that another 200 000 m^3/a can be supplied through this option. This option is not sufficient to balance the water use and water requirement for Nsikazi North.

12.9.2 Groundwater development plus purchase of water entitlements from irrigators

It is expected that the remaining deficit can be made up through this option. This means that approximately 4 million m^3/a need to be purchased. This option can however only be implemented in two years' time when the DWA policy is in place and could take 3 years for the full quantity of water to become available. In the meantime the MLM should continue with the package plants on farm dams to augment the deficit in the short term.

12.10 RECONCILING THE WATER REQUIREMENTS WITH THE WATER RESOURCE

12.10.1 Water balance for selected reconciliation scenarios

The appropriate scenario that is tentatively selected for the reconciliation of the Nsikazi North water balance is the combination of ground water resource development, and purchasing water entitlements from the irrigators upstream of the abstraction point in the Sabie River. This is illustrated in

Figure 12.4. There remains a deficit in the water balance for the first few years of the planning horizon, but it is hoped that this can be addressed by continuing to utilise the temporary package plants at the farm dams.

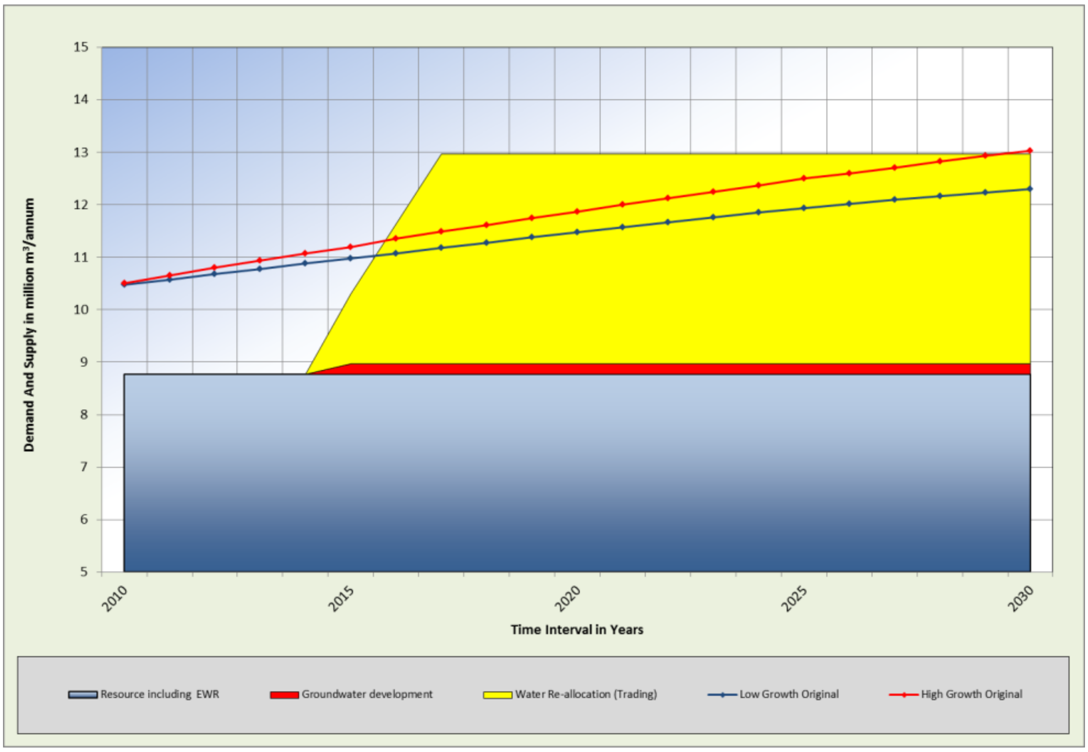


Figure 12.4: Nsikazi North's water balance graph assuming an additional yield made available by purchasing water entitlements from irrigators upstream.

12.10.2 Actions that need to be started as a matter of urgency

- Although no WC/WDM savings can be expected at this time from the water users, due to the current instability of the water supply system, WC/WDM awareness raising initiatives need to be launched so that water users will cooperate in saving water over the longer term.
- Boreholes need to be sited along the shear zones as described under **Paragraph 11.8.2.1**.
- The verification and validation exercise commissioned by the ICMA needs to be completed as a matter of urgency in order for the reconciliation of water balance for Nsikazi North to be finalised. Illegal water use, if any, should be eliminated in preference to purchasing legal water entitlements.

- The policy for the purchasing of water entitlements needs to be finalised by DWA, and an initiative needs to be launched and facilitated by the responsible water authorisation authority.

13 REGIONAL RECONCILIATION OPTIONS THAT SERVE MORE THAN ONE WATER DEMAND CENTRE

13.1 INTRODUCTION TO REGIONAL WATER SUPPLY SCHEMES

While the analysis of reconciliation options for each of the identified water demand centres has been addressed in this report, the possibility of a scheme or schemes that will supply more than one centre has been alluded to. The identified schemes are described in more detail below. Medium term options comprise the construction of a dam at Boschjeskop, or the raising of the Ngodwana Dam wall, with the construction of Montrose Dam, Mountain View Dam or Strathmore Dam as long term options. The latter three options are described in Section 14 of this report. A combination of any of these dams is also possible, but given their relatively large yields when compared with the required water demands, only one of these scheme will be required at this stage.

The Montrose and Mountain View dams, if built to their economically optimum sizes, would make more yield available than is required within the projected time frame of this project, i.e. up to 2035. The possibility of a joint regional scheme which supplies both domestic/industrial and irrigation water requirement is also an option.

13.2 BOSCHJESKOP DAM

The possible Boschjeskop Dam is well described in a report (DWAF 2008), from which the following information has been sourced:

13.2.1 Site location and description

- The dam site is located on the Nels River, a tributary of the Crocodile.
- This dam cannot directly supply Nelspruit via the Crocodile River, since the Nels joins the Crocodile River downstream of the Nelspruit WTW.
- However, abstraction points for Nsikazi South and Matsulu are downstream of the confluence.
- Additional water taken by MLM from the Crocodile River can be released from Boschjeskop to maintain the flow for downstream users as compensation.
- The left flank of the dam basin is gently sloping while the right flank is significantly steeper.
- The basin will flood a road, which will require re-routing.

13.2.2 Proposed dam

- An earthfill dam with a Roller Compacted Concrete spillway is proposed, owing to available materials and deep weathering.
- The uncontrolled spillway will be about 75 m long, with a unit discharge of 27,6 $m^3/s/m$.
- An Ogee-shaped spillway crest with Roberts Splitters is proposed.

13.2.3 Site geology

- The 1: 250 000 hydrogeological map (1:500 000 Hydrogeological Map Series of the Republic of South Africa Barberton 2530 (DWAF, 1999) indicates an unverified shear zone in river section.
- There are good founding conditions in the river section, allowing the construction of a central concrete spillway.
- Due to deep weathering on the flanks, construction of an embankment is suggested.
- There is probably no hard rock quarry site close to the site, but a search is still warranted. The most likely source of aggregate is from the Black Reef quartzites, located probably 20 to 30 km away.
- The weathered granite soils are suitable for embankment material, especially semi-pervious material.

The characteristics of Boschejskop Dam site are provided in **Table 13.1** and the area/capacity versus height curves are depicted in **Figure 13.1**.

Table 13.1: Characteristics of Boschjeskop Dam site

Type of dam	Earthfill embankment
Longitude	30° 52' 51"
Latitude	25° 21' 07"
River	Nels
Probable upstream slope	1:3
Probable downstream slope	1:2,5

(Source: DWAF, 2008)

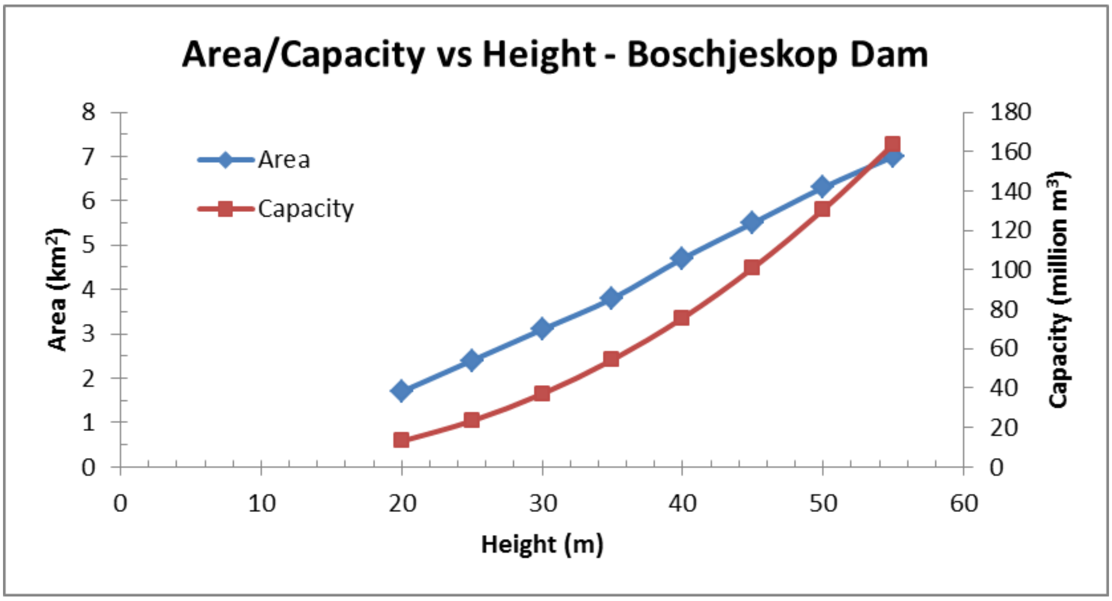


Figure 13.1: Area / Capacity versus Height curves for the Boschejskop Dam site

The Capacity versus Yield curve (after allowing for the EWR) for the proposed dam is shown in **Figure 13.2** and Unit Reference Value (URV) versus Yield curves are provided in **Figure 13.3**. Discount rates of 6%, 8% and 10% have been used in order to reflect the sensitivity of the URVs.

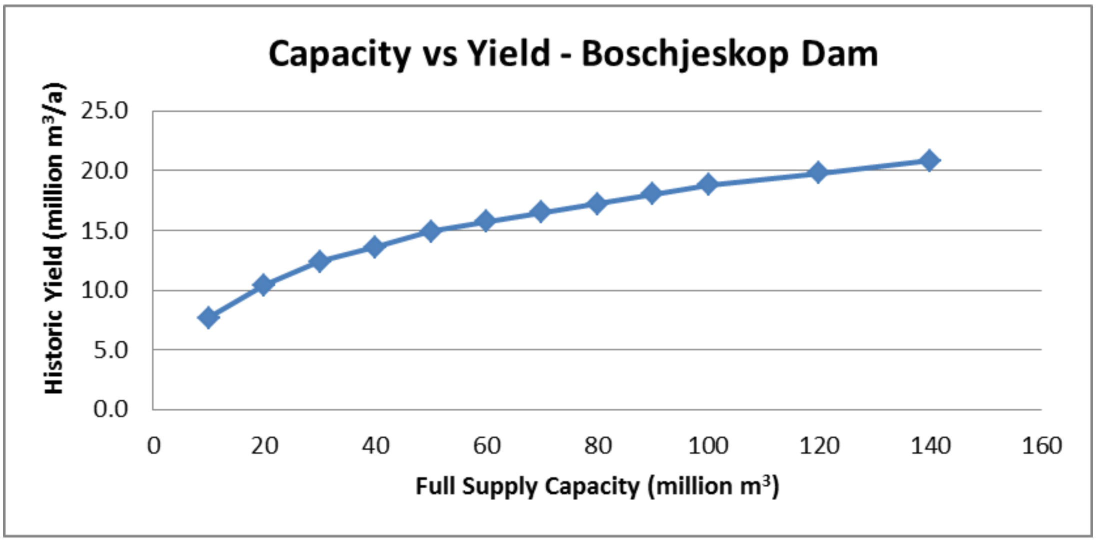


Figure 13.2: Capacity vs yield curve of Boschjeskop Dam (after allowing for the EWR)

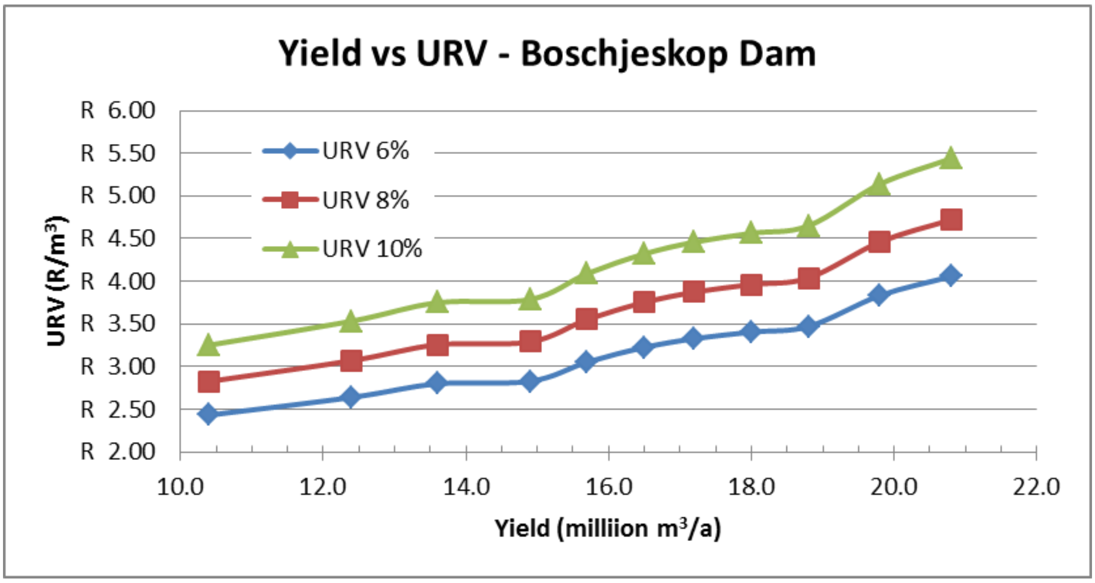


Figure 13.3: Yield vs URV curve of Boschjeskop Dam

13.2.4 Environmental considerations

- Six faunal species of conservation importance (one critically endangered, two vulnerable) have been identified in this catchment.
- One floral species of conservation importance (critically endangered) has been identified.
- The proposed site is adjacent to the Wolkberg Centre of Endemism.
- The area contains seepage wetlands and valley bottom wetlands.
- Two aquatic faunal species of conservation importance have been identified (one endangered, one least concern).
- The Quaternary Catchment (X22F) in which the dam is located has high ecological importance and sensitivity.
- This proposed dam site is not fatally flawed.

13.3 NGODWANA DAM (RAISING)

The Ngodwana Dam is an existing dam near the Ngodwana Sappi Mill in Mpumalanga. This option involves raising the wall of the existing Ngodwana Dam.

13.3.1 Site location and description

- The dam is located on the Ngodwana River, a tributary of the Elands, 32 km south-west of Nelspruit.
- The raising of the wall was evaluated as part of this project.
- The site is asymmetrical, with the left bank steeper than the right.
- The physical characteristics of the dam are summarised in **Table 13.2**.
- The Area/Capacity vs Height /Capacity vs Additional Yield and URV curves are provided in **Figure 13.4**, **Figure 13.5** and **Figure 13.6** respectively.

13.3.2 Proposed dam

- The existing dam is an earth embankment, and the proposed means of raising will also be earthfill.
- The spillway is a side channel spillway.

13.3.3 Site geology

- The site's geology has not been investigated. This information will be included in any further assessment of the raising of the dam.

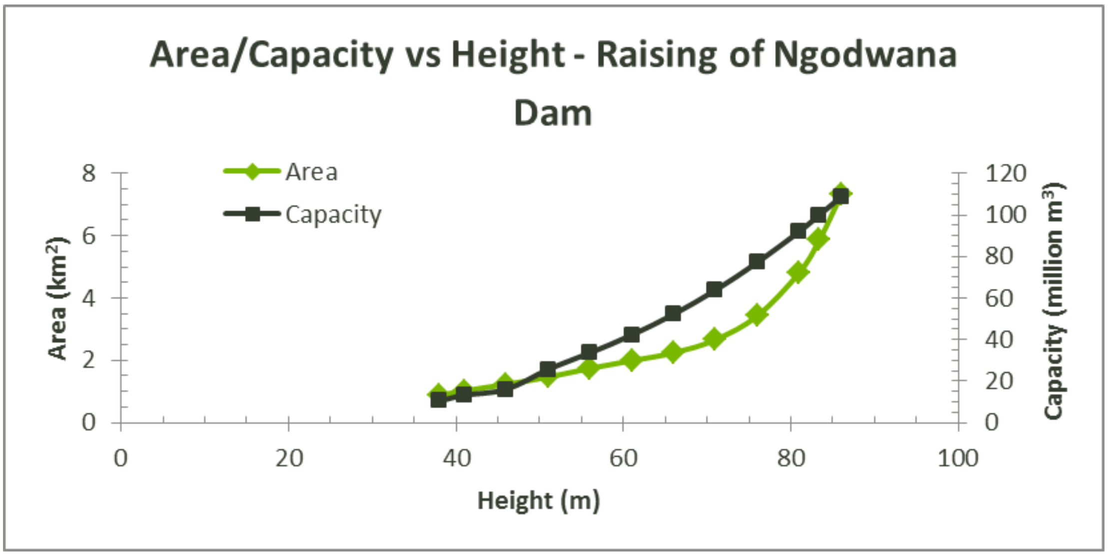


Figure 13.4: Physical characteristics of Ngodwana Dam basin

Table 13.2: Characteristics of Ngodwana Dam (Raising)

Type of dam	Clay cored rock fill / RCC gravity composite
Longitude	30° 40' 57"
Latitude	25° 35' 21"
River	Ngodwana
Probable upstream slope	1:3
Probable downstream slope	1:2

(Source: DWAF, 2008)

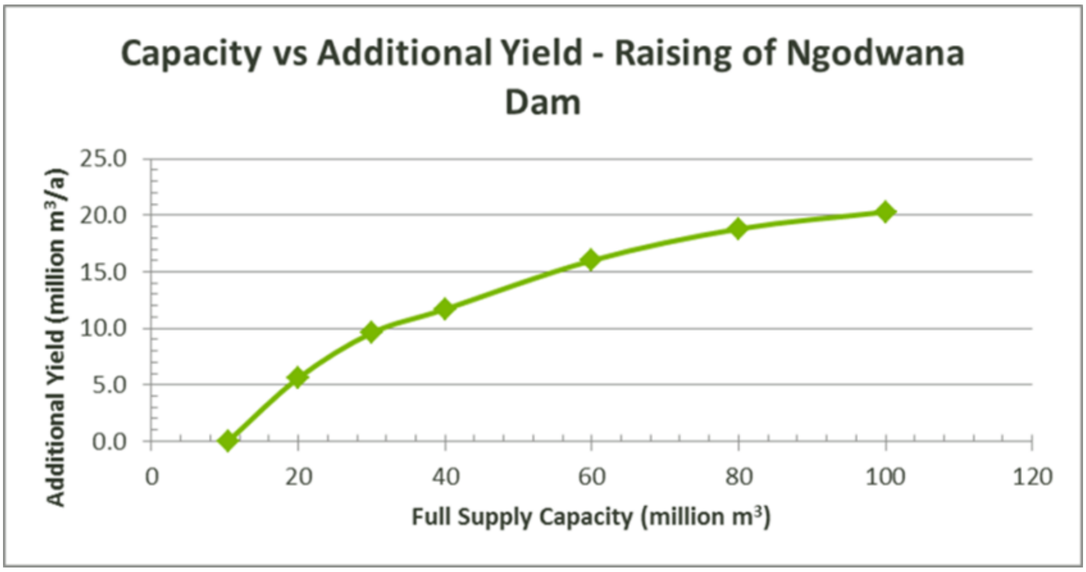


Figure 13.5: Capacity vs Yield curve of Ngodwana Dam (Raising)

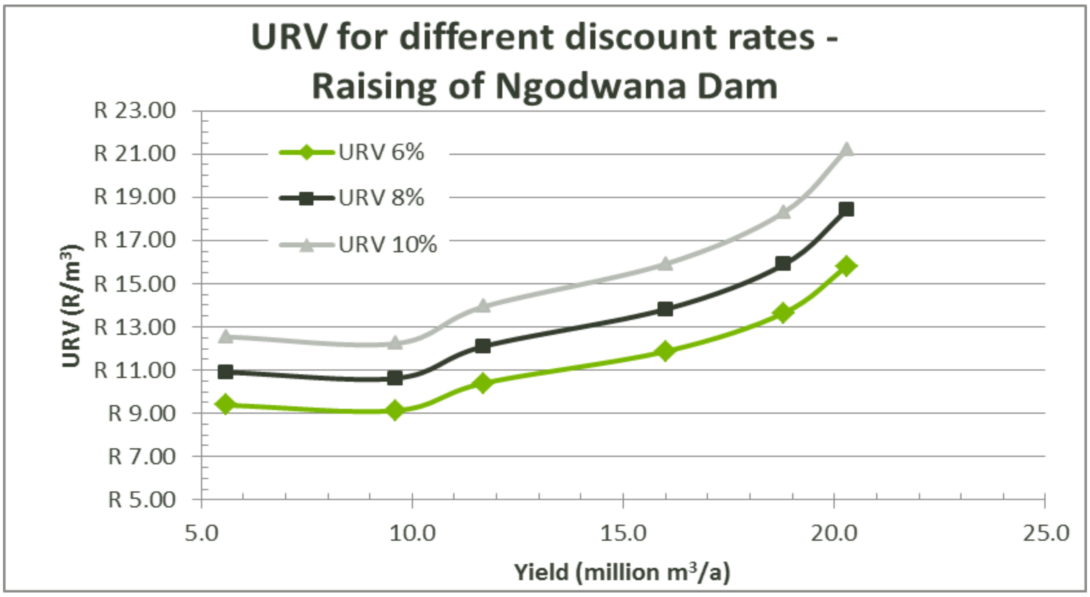


Figure 13.6: Yield vs URV curve of Ngodwana Dam (Raising)

13.3.4 Environmental considerations

- The environmental impacts of raising this dam would be limited by the fact that there is already a dam on the site.
- An additional 40 ha of bushveld would be flooded by raising the dam (currently 87 ha are inundated).
- The proposed dam raising is not fatally flawed.

14 LONG TERM, REGIONAL RECONCILATION OPTIONS

14.1 MONTROSE DAM

The site's location, the basin, the characteristics of the proposed dam and the site geology are all described in a report (DWAF 2008), from which the following information is taken:

14.1.1 Site description and location

- The proposed site for the dam is located on the Crocodile River, 2 km downstream of the confluence with the Elands River.
- The site is asymmetrical, with the left bank significantly steeper than the right.

14.1.2 Proposed dam

- Owing to the deep soils on the right flank, a clay cored rock fill/RCC gravity composite structure is envisioned.
- An uncontrolled spillway length with a length of 120 m and unit discharge of 46,5m^3/s/m is envisaged.
- An ogee-shaped crest provided with Roberts Splitters is proposed.

14.1.3 Site geology

- There is a massive granite outcrop on the left flank which suggests that a concrete spillway, possibly extending to the river section, is an option.
- The deeply-weathered right flank is better suited to the construction of an embankment flank.
- The deeply weathered right flank is possibly pervious, necessitating the construction of a cut-off.
- There are several potential hard rock quarry sites for construction material within the dam basin.
- The granite at the site appears massive and unweathered, and is assumed to be suitable for use as coarse aggregate or rip-rap.
- The sandy overburden/weathered soft rock granite from other areas close to the dam can be used for embankment fill material (semi-pervious).
- Alluvial deposits downstream of the dam may contain sufficient clay for impervious core material, or failing this, for semi-pervious material.
- There is sand available for use as fine aggregate or filter materials possibly from completely weathered granites, blended with crusher run.

The Area/Capacity vs Height, Capacity vs Yield and URV curves are depicted in Figure **14.2**, and **Figure 14.3** respectively, whilst Table 14.1 summarises the characteristics of the proposed dam.

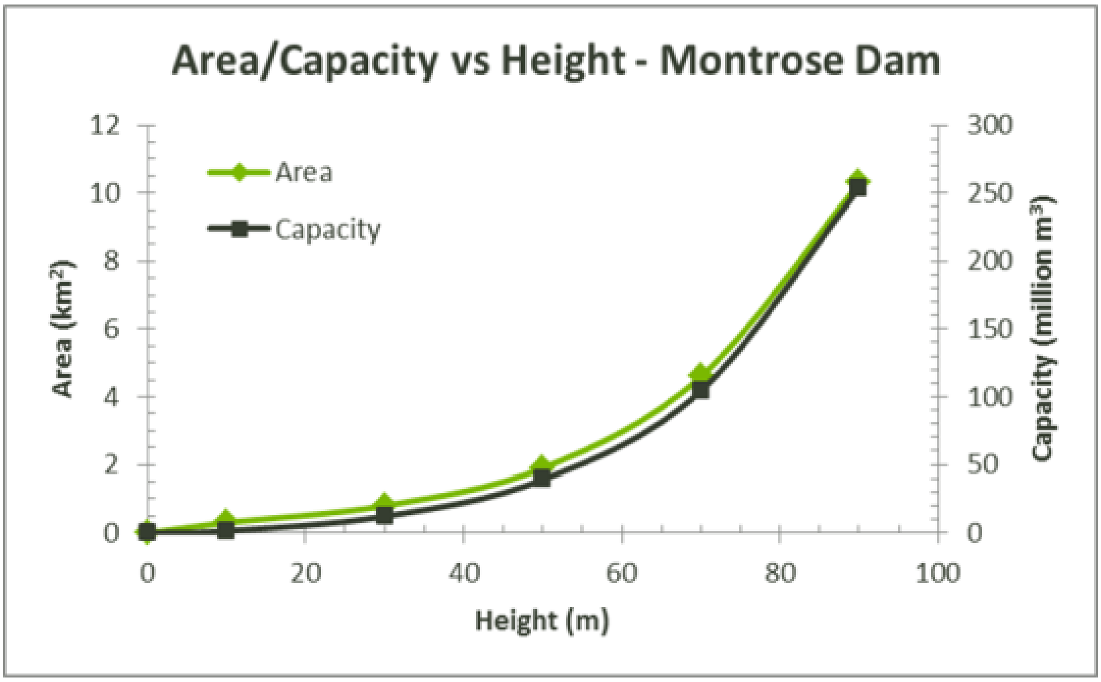


Figure 14.1: Area/capacity vs height – Montrose Dam option

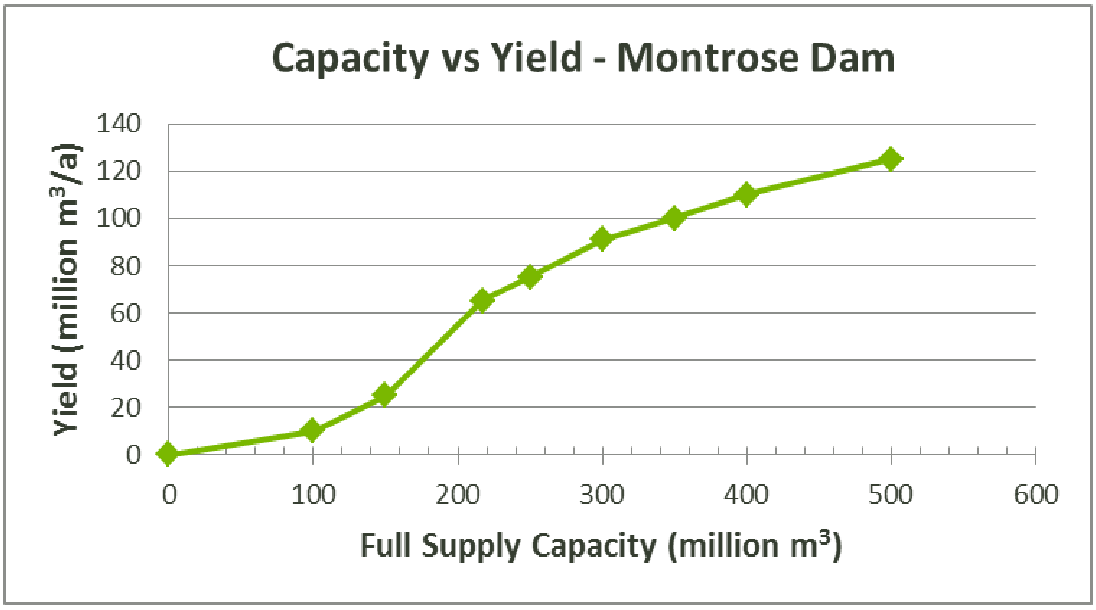


Figure 14.2: Yield vs capacity curve of the Montrose Dam option (after allowing for the EWR)

Table 14.1: Characteristics of Montrose Dam

Type of dam	Clay cored rock fill / RCC gravity composite
Longitude	30° 43' 34"
Latitude	25° 27' 17"
River	Crocodile
Probable upstream slope	1:1,75
Probable downstream slope	1:1,6

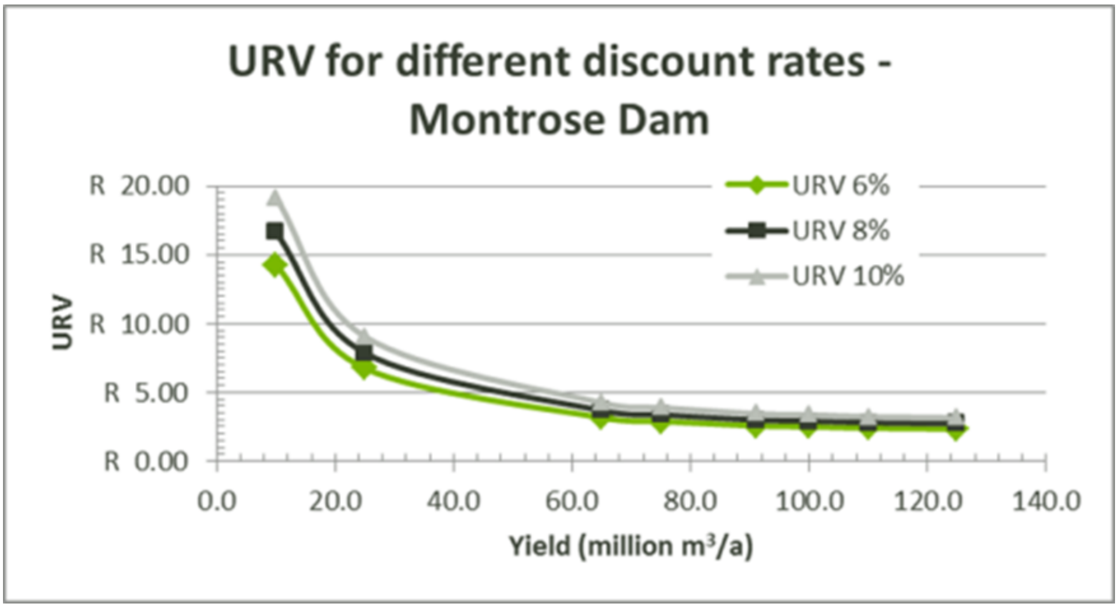


Figure 14.3: URV curves - Montrose Dam option

14.1.4 Infrastructural impacts

The impoundment of the dam would back up into both the Crocodile and Elands rivers and, depending on the full supply level (FSL), would flood the interchange where the R539 and the N4 National Highway join on the western side of the gorge. A length of the N4 running along the length of the impoundment would also be inundated, as well as a length of railway line. The cost of rerouting of the road and railway has been included in the costing of this dam.

14.1.5 Environmental considerations

- The dam basin contains seepage wetlands and valley bottom wetlands present.
- The X22B quaternary catchment in which the dam site is located has a high ecological importance and sensitivity; ecological category B/C.
- The inundation of the Elands River above Montrose Falls on the Crocodile River would bring the rare and genetically distinct Bushveld Small-scale Yellow fish into contact with populations downstream. This could lead to the extinction of the rare species of fish. In order to avoid this, the dam wall would have to be less than 30 m high so as not to inundate the falls.

- This proposed dam could be fatally flawed due to the potential inundation of the Montrose Falls.

14.2 STRATHMORE OFF-CHANNEL DAM

The Strathmore am has been included in this report as a possible alternative to the Mountain View Dam. An off-channel storage dam generally has a lower environmental impact than an in-channel dam. The site's location, the basin, the proposed dam and the site geology are all described in a report (DWAF 2008), from which the following is information has been sourced:

14.2.1 Site description

- The proposed dam site is located on the Jam Tin Creek, a tributary of the Crocodile River, 46 km east-south-east of Nelspruit.
- Depending on the final wall height, the construction of this dam could require the construction of at least two separate dam walls.

14.2.2 Proposed dam

- The dam would probably consist of two walls, but if the dam is in excess of 35m, a third dam wall would be necessary.
- A side-channel spillway located on the right bank of the easternmost dam wall is proposed, discharging into a concrete lined spillway chute located on the slopes of the line of hills.

14.2.3 Site geology

- The presence of magnesite deposits and active mines in the basin could be problematic.
- The absence of a visible outcrop at the westernmost site implies that an embankment dam is best suited to this location.
- Shallow bedrock occurs on the flanks of the easternmost site.
- A deep excavation will be required in the river section if a concrete dam is to be built at the easternmost site.
- A concrete dam would satisfy the requirements for the spillway.
- The basin is underlain by schists, volcanic lavas and cherts, all of which could be used for construction materials.
- There are extensive agricultural lands under sugar cane in the basin. Their expropriation would have a cost implication.
- It should be possible to use the basin soils as embankment fill, and depending on these soils' permeability, some could be suitable as impervious core material.
- There are no obvious sources of hard rock identified as quarry sites for coarse aggregate or rip-rap, but the presence of abandoned mines in the area suggests that hard rock can possibly be sourced from mine waste dumps.
- Sands suitable for fine aggregate or filter materials are unlikely to be found within the basin, these need to be imported from the vicinity of the Crocodile River.

The Area/Capacity vs Height, Capacity vs Yield and URV curves for the Strathmore Dam option are shown in **Figure 14.4**, **Figure 14.5** and **Figure 14.6** respectively.

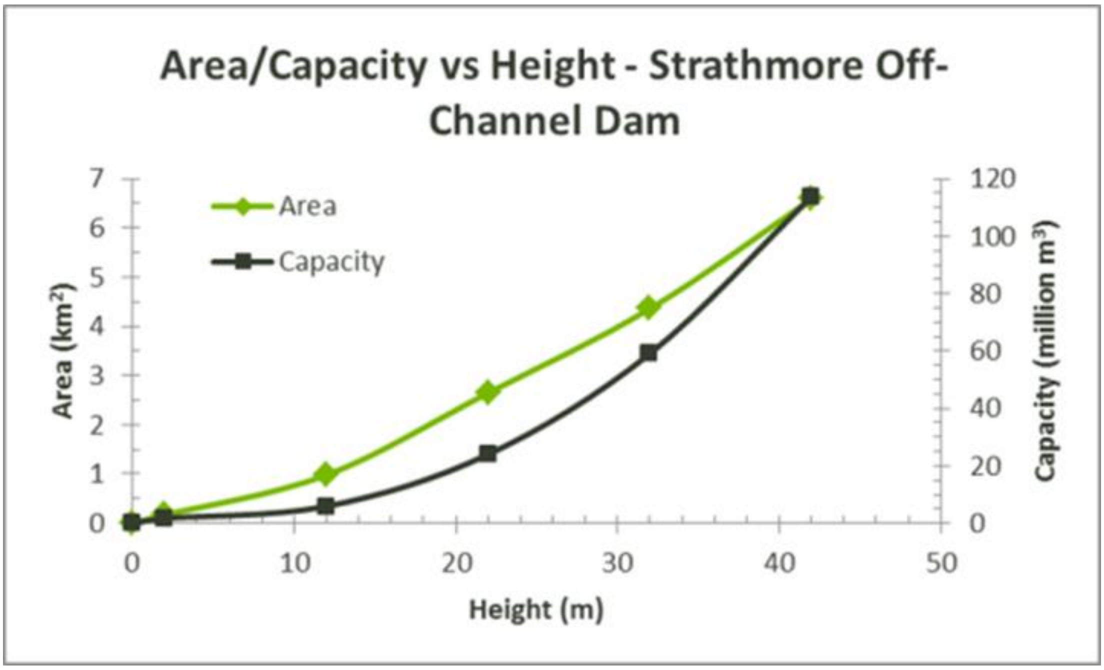


Figure 14.4: Physical characteristics of Strathmore off-channel dam basin

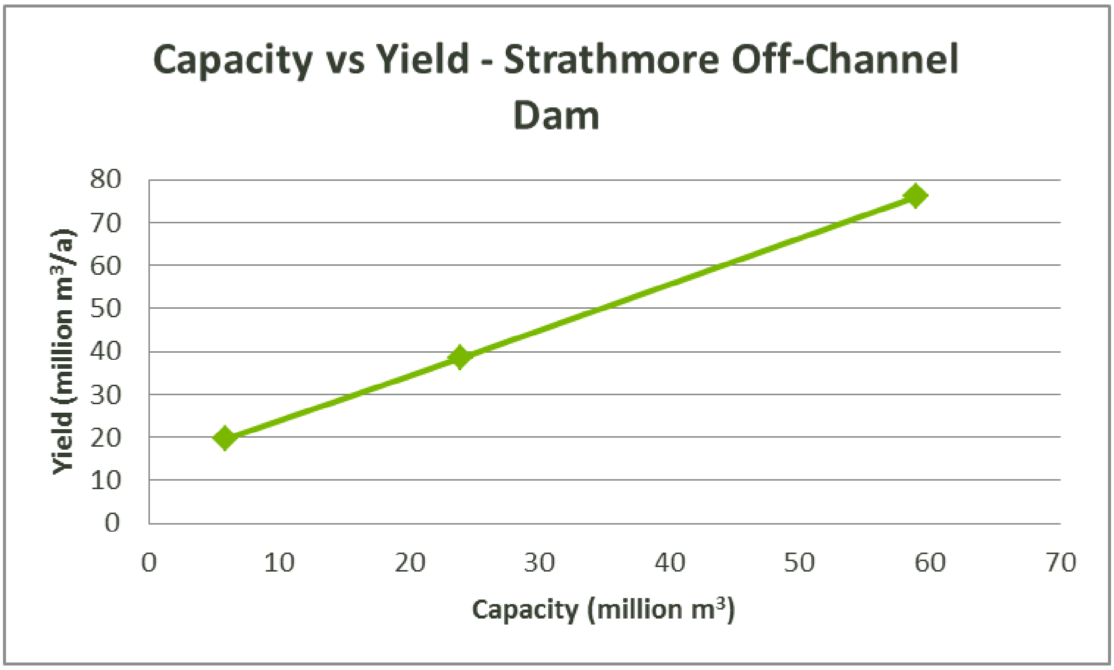


Figure 14.5: Capacity vs yield curve of Strathmore off-channel Dam

(Source: DWAF, 2008)

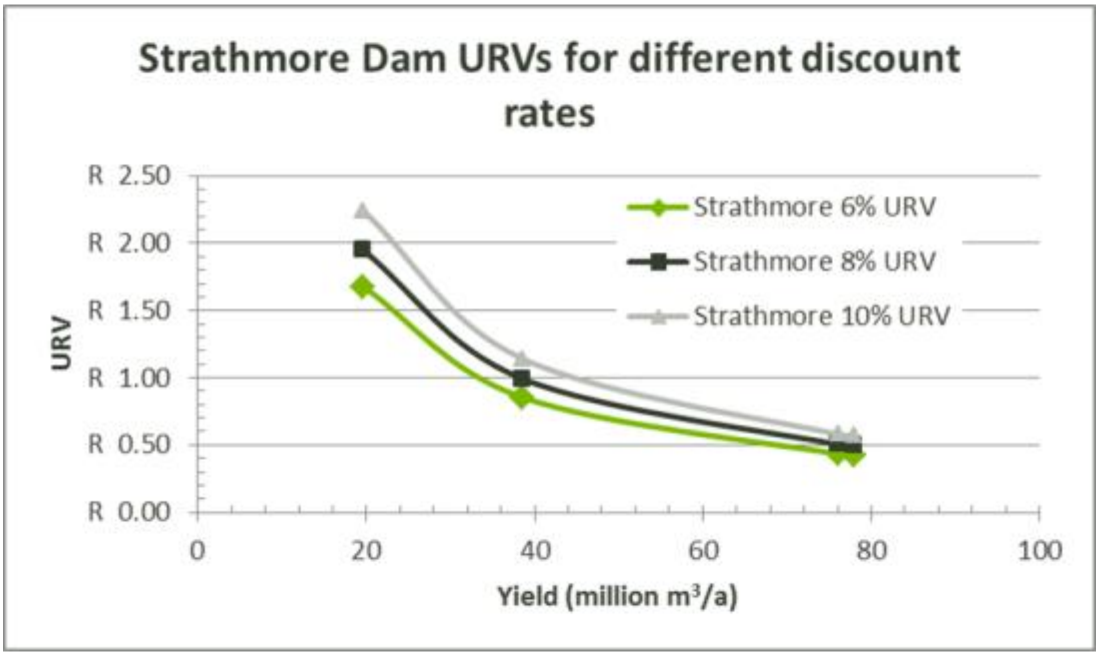


Figure 14.6: Yield vs. URV curve of Strathmore off-channel Dam

Table 14.2: Characteristics of Strathmore Dam

Type of dam	Clay cored rock fill / RCC gravity composite
Longitude	31° 25' 31''
Latitude	25° 32' 07''
River	Jam Tin Creek
Probable upstream slope	1:3
Probable downstream slope	1:2

14.2.4 Environmental considerations

- Three faunal species of conservation importance (one critically endangered, two vulnerable) have been identified within the basin.
- The area contains seepage wetlands.
- One aquatic faunal species of conservation importance was identified (least concern).
- The Quaternary catchment X24D in which the dam basin is located has a high ecological importance and sensitivity; ecological category C.
- The proposed dam site is not fatally flawed.

14.3 MOUNTAIN VIEW DAM

The site's location, the basin, the proposed dam and the site geology are all well described in a report (DWAF 2008), from which the following information has been sourced:

14.3.1 Site description

- The site is asymmetrical and steeply sided, with left the flank slightly steeper than the right.

14.3.2 Proposed dam

- Using the steep and solid flanks, it is proposed that the dam be configured as a RCC arch dam.
- A central uncontrolled spillway of 120 m length with a unit discharge of 39,4 m^3/s/m at the Probable Maximum Flood (PMF) is proposed.
- Diversion of water from the Crocodile River during flood events to the dam via a canal is feasible (requiring a canal length of 35-40 km), resulting in an increased yield for the dam. The full implications of this suggested enhancement will be investigated should the Mountain View Dam be selected as the preferred development option.

14.3.3 Site geology

- The site is suited to the construction of a mass concrete gravity structure.
- The massive granite gneiss bedrock within the river section would further be resistant to scour, a concrete apron is probably unnecessary.
- There appears to be suitable construction material available within the basin, with potential hard rock quarry sites and sand deposits identified, although no testing has yet been conducted.
- Both coarse aggregate and fine aggregate (sand) are likely to be obtained within the dam basin.

The Area/Capacity vs Height, Capacity vs Yield and URV vs Yield Curves are shown on **Figure 14.7**, **Figure 14.8** and **Figure 14.9** respectively, whilst the physical characteristics are summarised in **Table 14.2.**

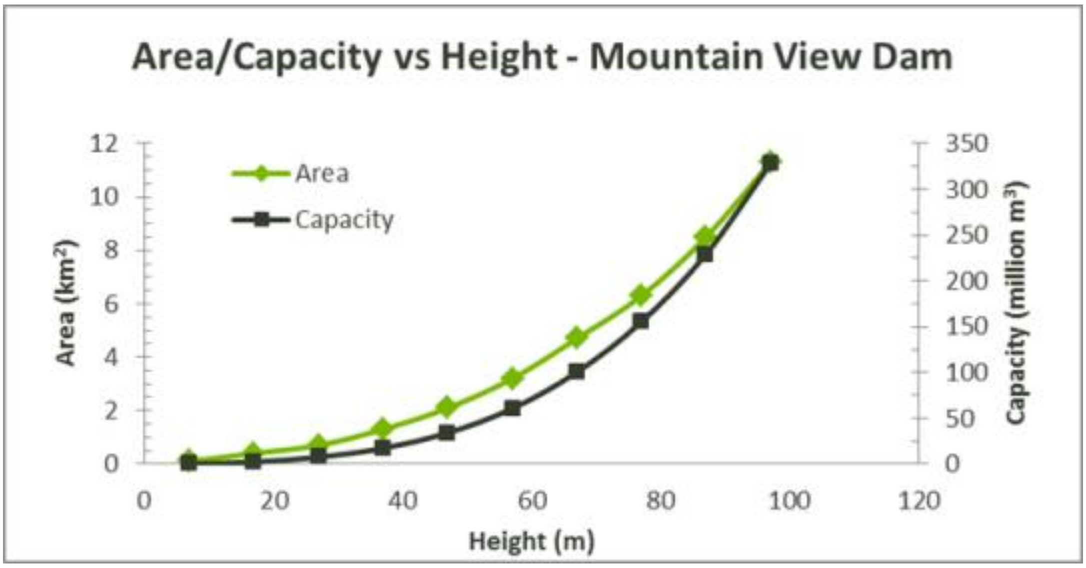


Figure 14.7: Physical characteristics of Mountain View Dam basin

Table 14.3: Physical characteristics of Mountain View Dam

Type of dam	RCC arch dam
Longitude	31° 16' 15"
Latitude	25° 36' 45"
River	Kaap
Probable upstream slope	1:0,231
Probable downstream slope	1:0,046

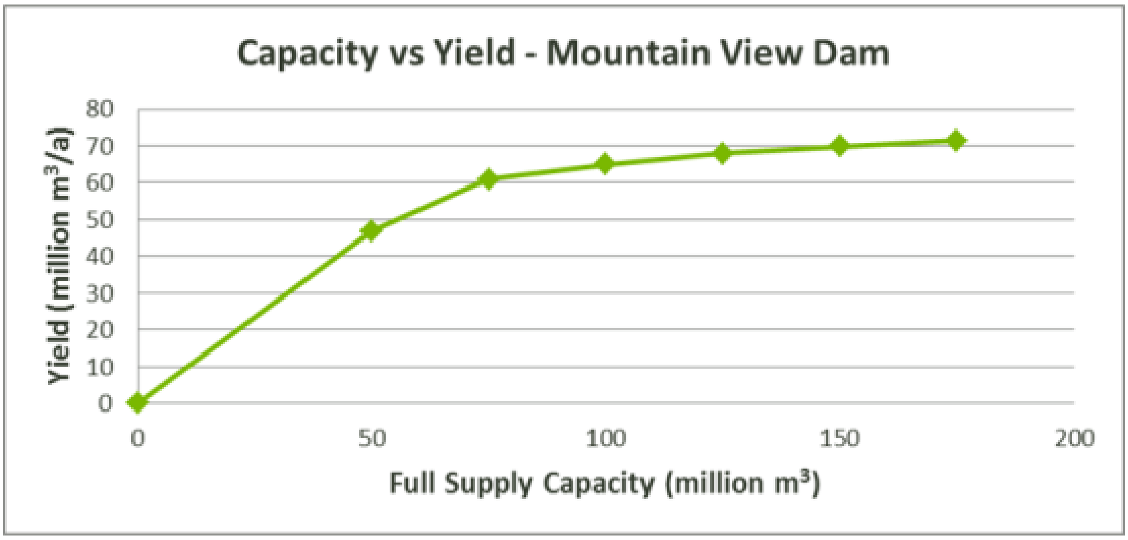


Figure 14.8: Capacity vs yield curve of Mountain View Dam

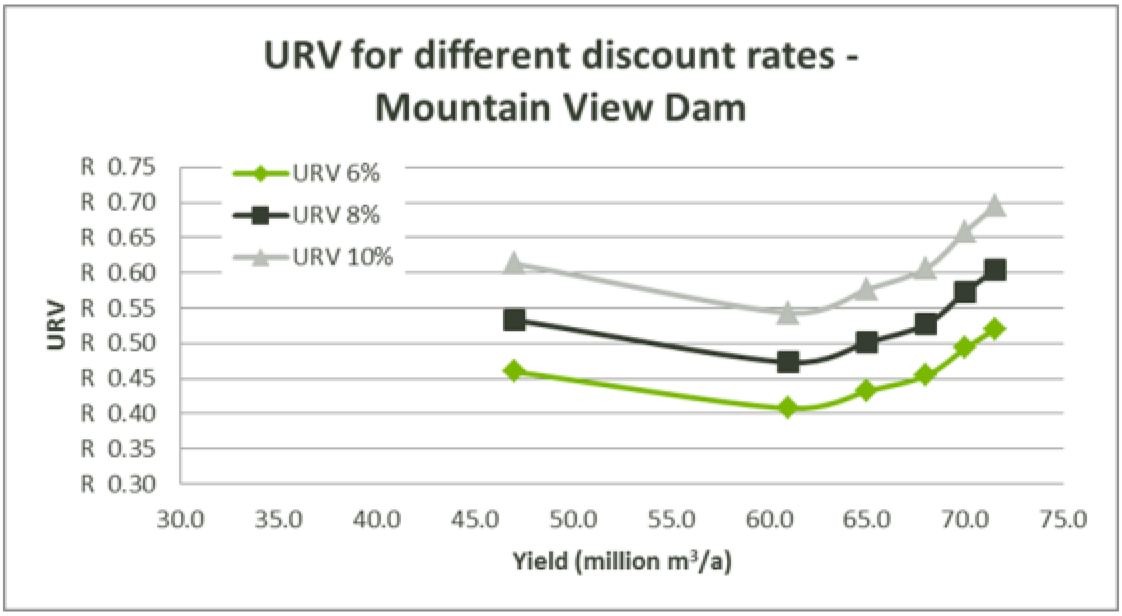


Figure 14.9: Yield vs. URV curve of Mountain View Dam

14.3.4 Environmental considerations

- The dam basin contains both seepage wetlands and valley bottom wetlands.
- The X23H quaternary catchment in which the site is located has moderate ecological importance and sensitivity; ecological category B/C.
- The dam site is not fatally flawed.

14.4 SELECTED DAM SITES

There are several options to increase the water supply to the MLM area and the region as a whole, and it might become necessary to consider a new dam as one of the options. The dam options have been categorised into medium-term options, which can meet the future water requirements of the MLM at least up to the end of 2035, and those schemes which can make even more water available and hence can be considered for the longer term and/or conjunctive use options in which the water is supplied to the Mbombela domestic and industrial and other water use sectors, e.g. the irrigators.

14.4.1 Medium term, local reconciliation options

The Boschjeskop and Ngodwana dam, given the limited additional yield that they can make available to the Crocodile River System and hence the MLM area, are considered to be medium term solutions for reconciling the water requirements and water resources. The graph shown in **Figure 14.10** compares the two URVs for these dams based on a discount rate of 8%.

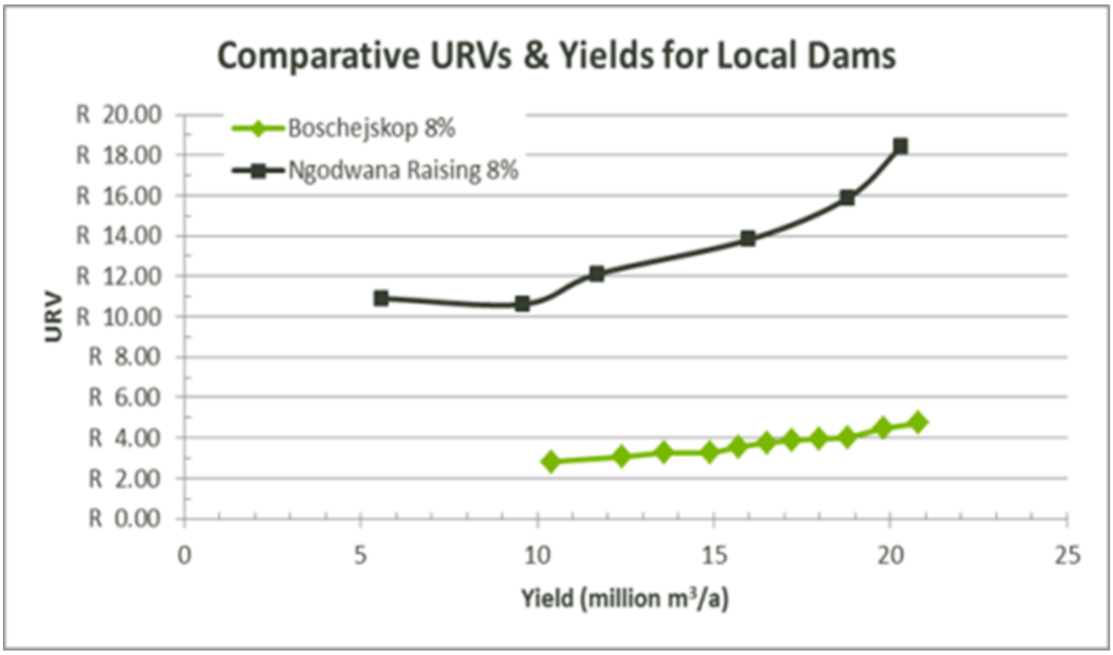


Figure 14.10: Comparative URVs and yields of local dams

It is evident from analysis that raising Ngodwana Dam will be far more costly than constructing a new Dam at Boschjeskop. It is therefore recommended that the raising of Ngodwana Dam as a possible augmentation option should not be pursued further in this study.

It has also become clear that either dam can supply more than the local demands, and this should be borne in mind when considering the Regional dams below.

14.4.2 Long term, regional reconciliation options

There are three options that provide more than sufficient additional water for the future water demands of the MLM area, and which are therefore considered to be long term options. These are the Montrose Dam, the Mountain View Dam, and the Strathmore Dam.

It is evident from the graph in **Figure 14.11** that for the range of yields defined by Mountain View Dam, (approximately 40 – 60 million m^3/a), both Mountain View Dam and the Strathmore Dam offer a far more economical yield than Montrose Dam. Since the Mountain View Dam and the Strathmore Dam have similar URVs, and neither have fatal flaws, they should both be considered before Montrose Dam for further evaluation by means of a feasibility study.

It must be borne in mind that the Strathmore Dam will be an off-channel dam and that the cost of the construction of the feeder canal from the Crocodile River has not been taken into account when comparing URVs: This may sway the scale in the favour of the Mountain View Dam option.

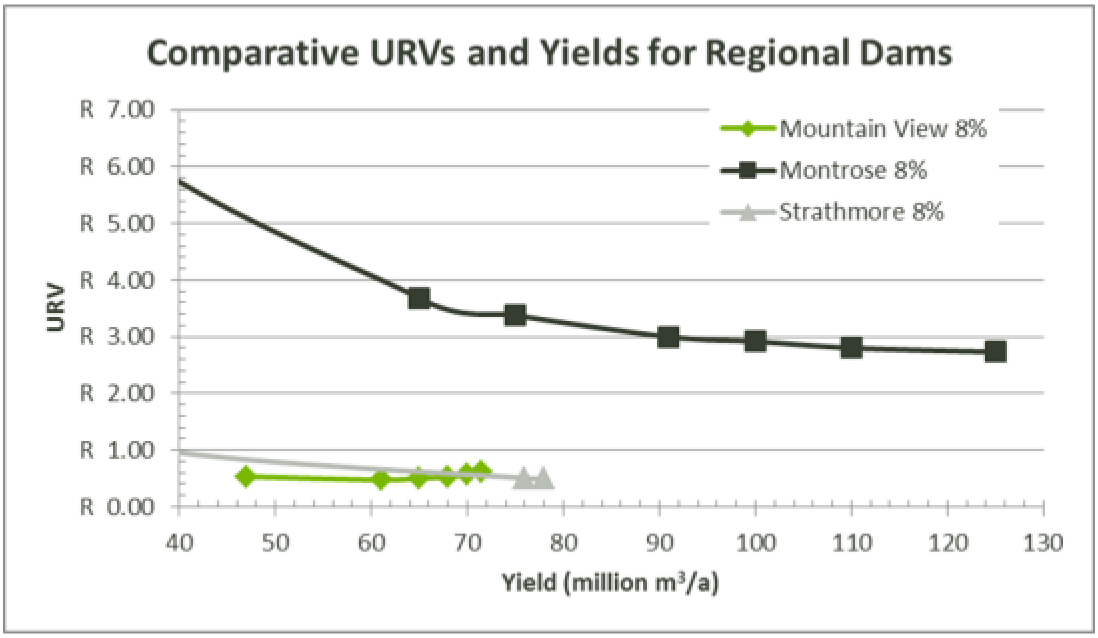


Figure 14.11: Comparative URVs and yields of regional dams

14.5 MONITORING NETWORK

The hydrological monitoring network consists of flow and rainfall gauges. These are essential for understanding and quantifying the rainfall/runoff process in the Crocodile and Sabie catchments, from which Mbombela obtains their water. The hydrological network was not evaluated as part of this Reconciliation Strategy study. However, the conclusion from the IWAAS study was that the flow gauging in the Inkomati WMA is adequate but the process and capturing of data from dams and gauges in the White River area is inadequate. Due to major discrepancies in the data within this area an acceptable hydrology model calibration was not possible in this area. This problem, identified in 2008, has yet to be addressed.

The distribution and number of rainfall gauges in the Crocodile and Sabie River catchments is inadequate for high confidence hydrological modelling. Due to the closure of several rainfall gauges over the last 15 years, improving on the existing hydrological models (and hence water resources assessment) will be difficult if not impossible. The ICMA recently took the initiative to install 15 new automatic real-time rainfall gauges within the Inkomati CMA. While these will not help in the short-term to improve the hydrological calibrations, these gauges are essential to the real-time operation of the system and will lead to improved quantification of the water resource of the Mbombela municipal area over time.

DWA have embarked on a comprehensive study to evaluate South Africa's hydrological network and recommend improvements to this. This study will commence early in 2013. This should result in an improved hydrological network in the future.

15 OVERARCHING RECONCILATION STRATEGY FOR THE MBOMBELA MUNICIPAL AREA

15.1 INTRODUCTION

The reconciliation of water requirements with the available water resources within the MLM area has been evaluated in terms of eight separate WDCs. During this evaluation it became apparent that while this was a useful exercise, the implementation of certain strategies could resolve the water supply situation for a number of the WDCs simultaneously. Furthermore, these multi-target strategies, or regional schemes, appear to be the most promising. This section therefore describes the preferred options and how they will resolve the water balance for the whole MLM area.

The Crocodile River catchment and the Sabie River catchment are two separate systems and are dealt with separately.

15.2 OVERALL WATER BALANCE IN THE CROCODILE RIVER CATCHMENT

Figure 15.1 shows the water balance for the Crocodile River catchment in the MLM area before any interventions are undertaken. This shows that the system as a whole is just in balance, but the gradually increasing water demands will result in a water deficit in the near future. This implies that when the next severe drought occurs, water use will need to be severely restricted should there be no progress with reducing losses by implementing the suggested WC/WDM measures.

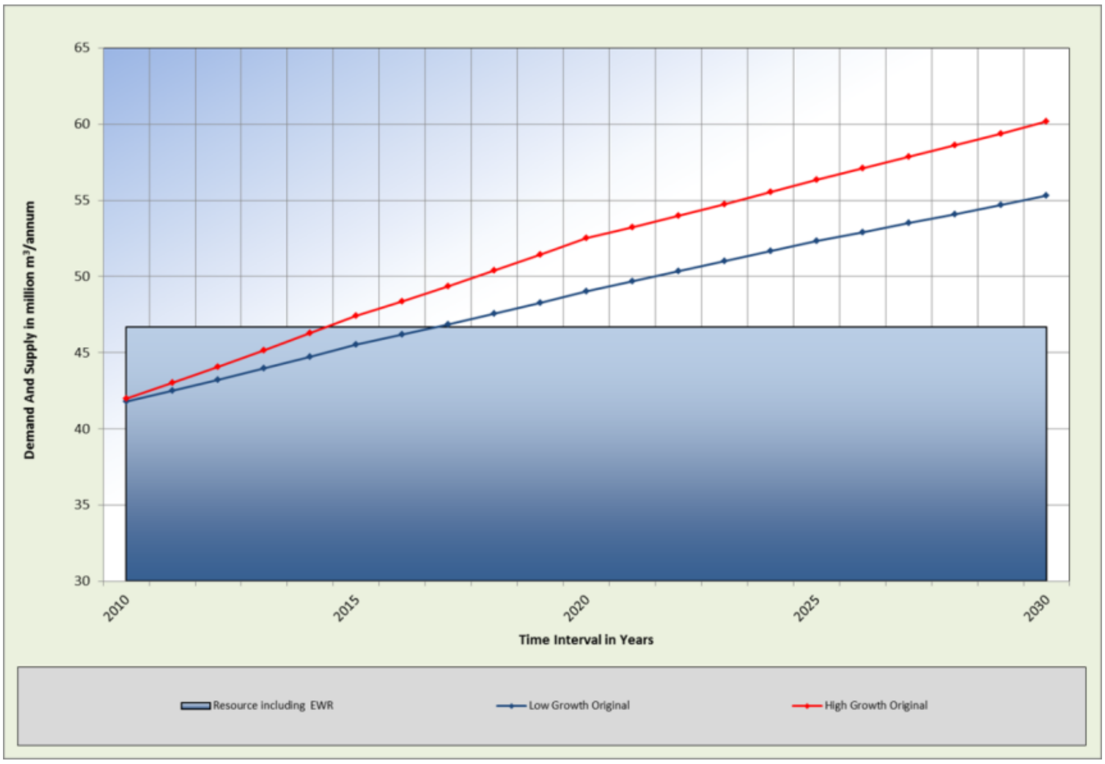


Figure 15.1: The water balance of MLM in the Crocodile River catchment without interventions

15.3 INTERVENTION MEASURES IN THE CROCODILE CATCHMENT

The recommended intervention is to firstly implement WC/WDM measures to reduce the water demand, then to increase the water supply via less intensive capital investment interventions, e.g. developing and implementing system operating rules, developing groundwater resources, removing IAPs, and reallocating water through water trading. **Figure 15.2** illustrates that a water balance can just be achieved over the planning period by implementing these measures.

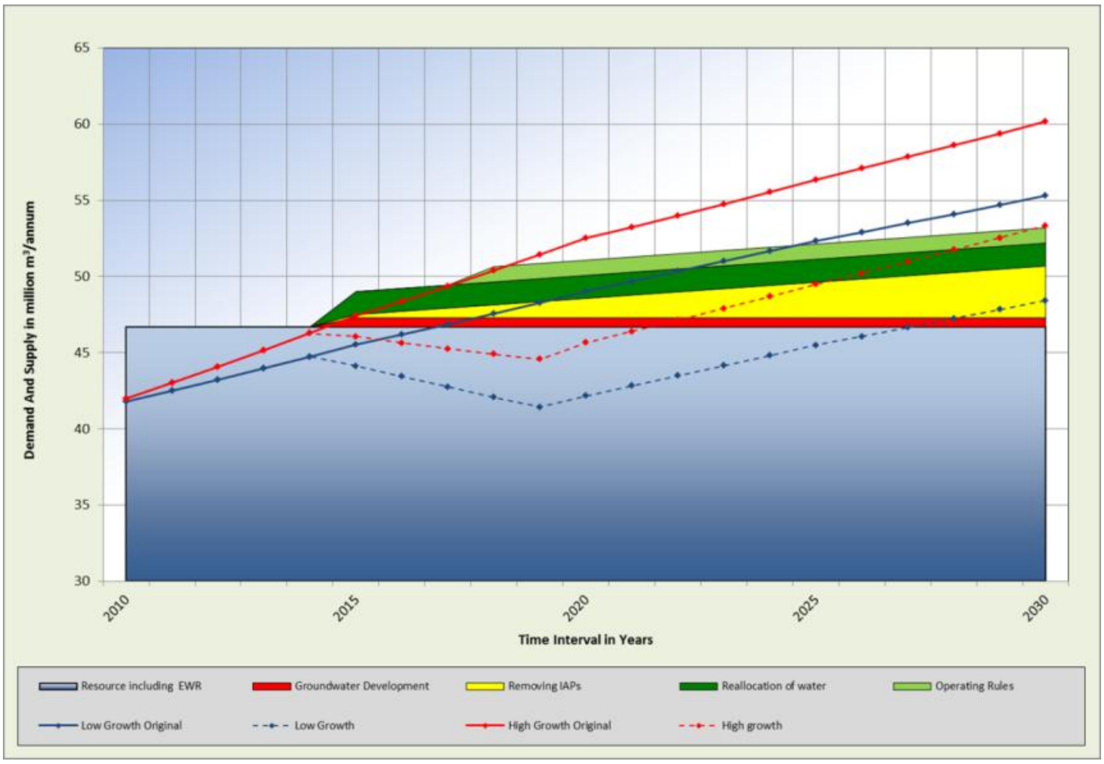


Figure 15.2: The water balance of the MLM with various interventions

The water reconciliation graph in Figure 15.2 must, however be interpreted with caution. It shows that the system will have no water deficits and will be in balance as a result of the non-capital intensive interventions. Although this is indeed the picture for the entire MLM in the Crocodile Catchment, the measures for reducing water demand or increasing the water supply will not necessarily be able to satisfy local water shortages everywhere. It could be impractical or expensive to transfer a local surplus in one WDC to another with a local water deficit, especially if water needs to be pumped upstream.

15.4 LOCAL SCHEMES FOR THE CROCODILE RIVER CATCHMENT

Of the two local schemes evaluated (construction of Boschjeskop Dam and raising of the Ngodwana Dam), the construction of Boschjeskop Dam is by far the most favourable option. This dam can increase the available yield available to MLM by about 20 million m^3/annum, which is more than enough to meet the growing demands for all the individual WDCs within the planning horizon of this study.

The water balance, including the effect of constructing dam such as Boschjeskop Dam, is illustrated in **Figure 15.3.**

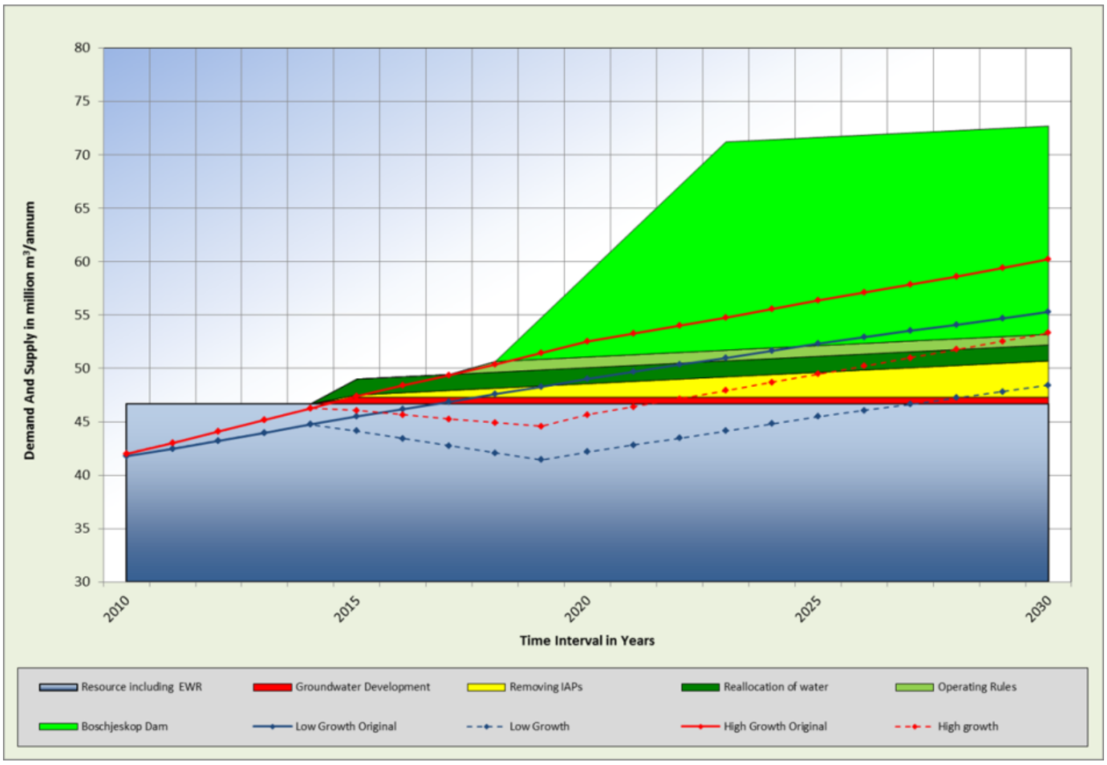


Figure 15.3: Water balance for MLM in the Crocodile catchment with interventions including the construction of Boschjeskop Dam

15.5 REGIONAL OPTIONS FOR THE CROCODILE RIVER CATCHMENT

Three potential schemes have been identified which could make more water available within the Crocodile River catchment than will be required by MLM within the foreseeable future. These three schemes are:

- The Montrose Dam
- The Mountain View Dam, and
- The Strathmore off-channel storage dam

Each of these dams could make more than 50 million m^3/annum of additional water (after meeting the ecological Reserve) available for use. Since this is more than the foreseeable domestic requirements, it is suggested that these could form part of a larger regional scheme to supply surplus water to emerging irrigators in the Lower Crocodile River and/or to irrigators in Mozambique.

The Mountain View Dam and Strathmore Dam options are considerably more economical than the Montrose Dam option, leading to the recommendation that the Montrose Dam should not be considered further, leaving only the Mountain View and Strathmore dams with similar URVs under consideration.

These options, located in the Kaap River and lower Crocodile River respectively, are somewhat more complex than the Montrose and Boschjeskop options, in that they are located either downstream of or in a different catchment to the WDCs in the MLM area. However, water can be gravitated from Mountain View Dam to Matsulu, hence making water available for abstraction from the Crocodile River for Nelspruit and/or Nsikazi South. A similar, more extensive water swop can be made with irrigators on the lower Crocodile River.

The ecological flow implications of these water swops would need to be investigated since they would entail a change in flow regime of the lower Crocodile and Kaap Rivers. Other than this caveat, there do not appear to be any serious flaws in either the Mountain View Dam or Strathmore Dam options. It is recommended that these two options be subjected to a feasibility study.

15.6 OVERARCHING STRATEGY FOR MLM IN THE SABIE RIVER CATCHMENT

Figure 15.4 shows the water balance for the MLM in the Sabie River Catchment before any intervention. It shows that the system is already in deficit and that this deficit will grow over time if no interventions are implemented.

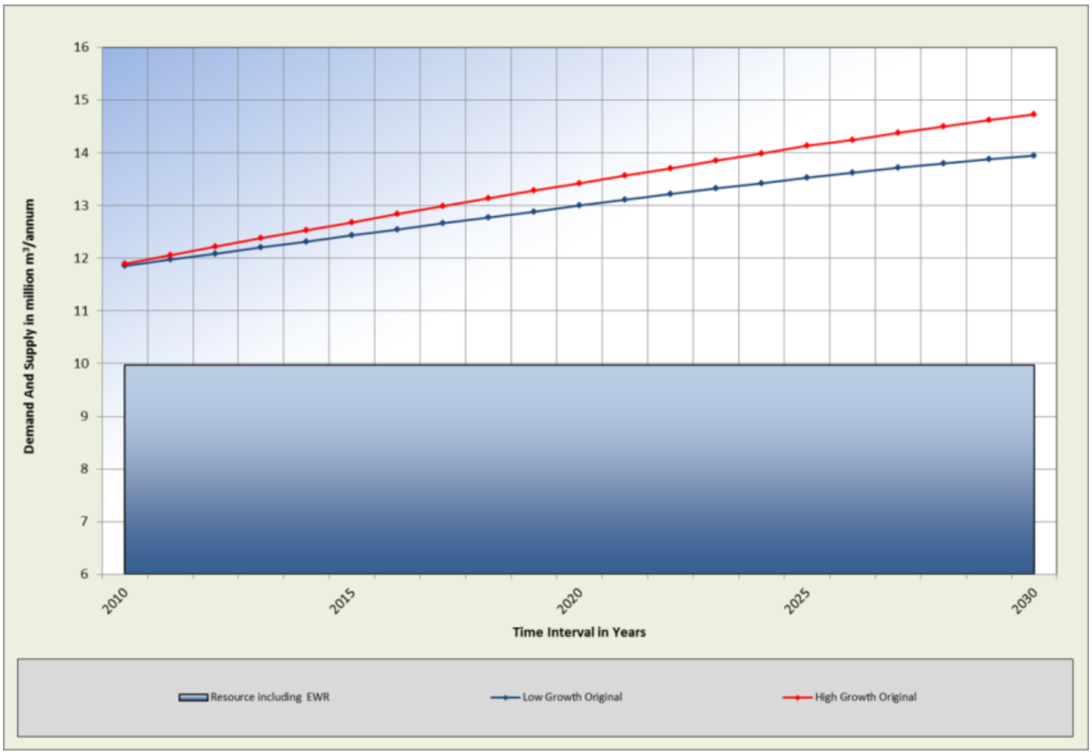


Figure 15.4: Water balance of MLM in the Sabie River catchment without interventions

15.7 INTERVENTION MEASURES IN THE SABIE RIVER CATCHMENT

As described for each of the individual WDCs, it is not desirable to build a dam in the Sabie River, both because there is no appropriate dam site and because the river is categorised as an A/B class river, which means that it is still near pristine ecological conditions and should preferably be maintained as such. The only viable options available at this point in time, therefore are WC/WDM for Hazyview, groundwater development for both Hazyview and Nsikazi North, and water reallocation through water trading in Nsikazi North. **Figure 15.5** shows that a water balance can be achieved with these measures, but shortages can be expected in the early years.

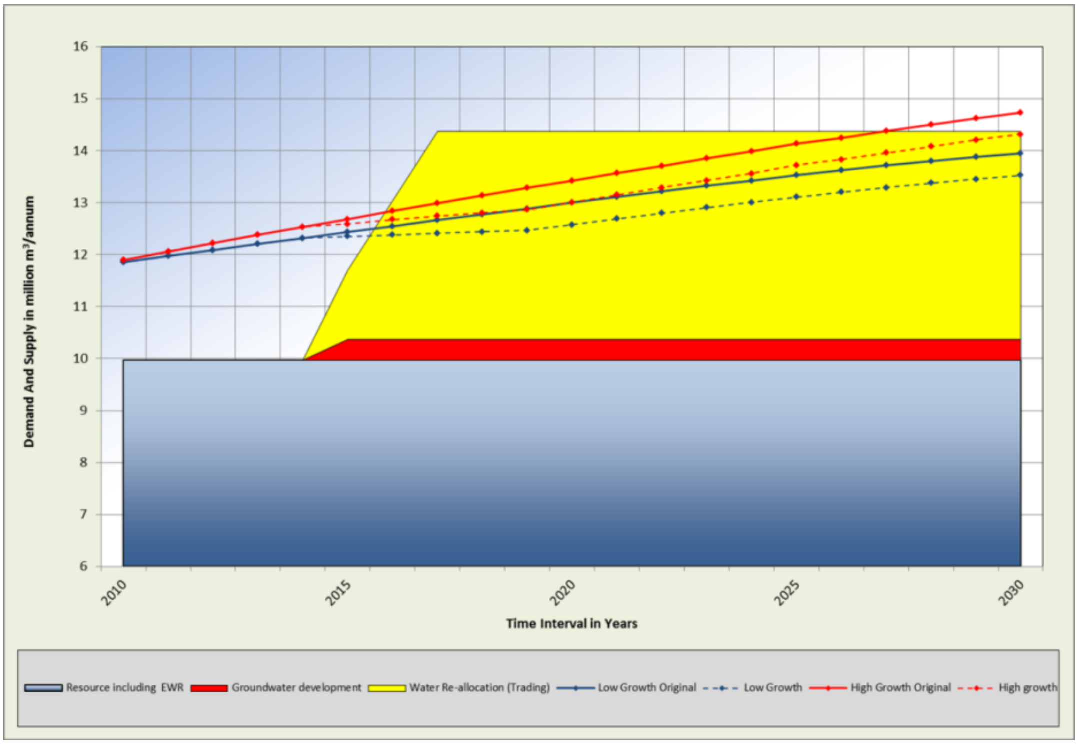


Figure 15.5: Water balance for MLM in the Sabie River with interventions

16 IMPLEMENTATION ARRANGEMENTS

It must be realised from the outset that DWA, as custodian of the country's water resources, is only facilitating the process of water reconciliation *planning*, and that *implementation* is the responsibility of several other institutions.

16.1 INSTITUTIONAL RESPONSIBILITIES

The following entities will play a crucial role in all aspects of implementation of the strategy:

- DWA Regional Office
- ICMA
- MLM
- Sembcorp Silulumanzi
- BRB
- Irrigation Boards and Water User Associations
- Industries
- Nature Conservation Institutions

Table 16.1 outlines the different interventions that have been considered for achieving a water balance, the required actions and the institutional responsibility for those actions. It should be noted that the responsibility allocations and target dates are indicative. A detailed action plan needs to be compiled in which the actions will be broken down further, with descriptions of specific responsibilities and time lines. This will however form part of the implementation process.

Table 16.1: Institutional responsibilities and target dates

Intervention	Brief Description of Actions	Primary Responsibility	Comments	Target Date
Addressing the unlawful irrigation use (Compliance monitoring and Enforcement)	• Validation and verification	ICMA	In process	Not considered as the extent of unlawful irrigation is unknown. Could be considered in the Final Strategy or Continuation Study.
	• Directives to unlawful water users	ICMA and DWA	DWA will advise the CMA on the correct procedure	
	• Legal action where needed	ICMA and DWA	DWA Legal Services to assist the ICMA	
	• Maintenance of lawful water use in controlled areas	IBs / WUAs	Supervised by Regional Office and ICMA	

Intervention	Brief Description of Actions	Primary Responsibility	Comments	Target Date
WC/WDM Urban	• Infrastructure measures such as pressure management; mains replacement; Leak detection and repair	MLM and Silulumanzi	A WC/WDM implementation plan must be developed for each water demand centre	All plans by end of 2014 ready for implementation
	• Canvassing public collaboration such as public awareness on efficient appliances, water efficient gardening, retrofitting, friendly and informative billing, etc.	MLM, Silulumanzi and the broad public	Awareness launches to be arranged by water MLM. Could be assisted by DWA Water Use Efficiency.	All plans by end 2014 ready for implementation
	• Water pricing	DWA Head Office and MLM	In line with Water Pricing Strategy	
WC/WDM in the irrigation sector and trading of water savings	• Announcement of DWA policy whereby irrigators can trade their saved water • Implementation of the policy	DWA Head Office DWA Regional Office, ICMA	Not considered as the outcome is very uncertain	
Water Trading (Purchase of full water)	• Develop policy and guidelines	DWA HO	Necessary to build in check and balances	End 2014
Removal of IAPs	• Removal of plants	Working for Water Teams	CMAs, IBs, WUAs, Forestry Companies, Local Municipalities can all perform this function and should collaborate	On-going. Removal must be faster than the growth of IAPs. Reduce IAPs by at least 50% over planning horizon.

Intervention	Brief Description of Actions	Primary Responsibility	Comments	Target Date
			with the DWA Working for Water Teams	
	• Rehabilitate land and re-establish indigenous vegetation	WfW Teams		
	• Follow up and maintenance	WfW Teams		
Groundwater Development	• Borehole siting • Drilling • Infrastructure development	MLM	Licenses (if applicable) to be issued by DWA Regional Offices in collaboration with ICMA	Ongoing from 2013
Operationalization of the Reserve	• Finalise Water Resource Classification	DWA HO		End 2013
	• Review current operating rules and monitoring network	DWA Regions, IBs, WUAs, MLM, Silulumanzi, Bushbuck Ridge WB		End 2014
	• Monitor and adjust	DWA Regions, IBs, WUAs, MLM, Silulumanzi, Bushbuck Ridge WB		Beginning of 2015
Options Analysis on identified Dams	• Options analysis	DWA HO	Decision is needed on best dam option	End 2014
New dam constructed	• Feasibility Study	DWA HO	Decision is needed on optimum dam site	End 2015
	• Design	DWA HO	Can be outsourced	End 2016
	• Tendering	Implementing Agency	E.g. TCTA	End 2017
	• Construction	Implementing	Outsourced	End 2020

Intervention	Brief Description of Actions	Primary Responsibility	Comments	Target Date
		Agency		
	• Commissioning and handover	Implementing Agency and DWA RO	A medium term local dam such as Boschejskop can be done quicker	End 2022
System Operating Rules for Sabie River	• Devise rules for efficient water distribution out of Inyaka Dam	DWA HO in collaboration with DWA Region	Not considered for water balance as outcome is still unknown	End 2014
Operation rules for Primkop Dam	• Optimise water distribution out of Primkop Dam	Irrigators and MLM		End 2013

17 RECOMMENDATIONS FOR FURTHER WORK

Recommendations for further work can be divided into two categories, i.e.:

- Further work recommended for the continuation study.
- Further studies recommended by other role players than NWRP.

17.1 FURTHER WORK FOR THE CONTINUATION STUDY

- Determine the extent of unlawful irrigation (in progress)
- Confirm the extent of alien plant infestation above Kwena Dam
- Investigate the expansion of the monitoring network.
- Undertake a house count from 2012 aerial photos and adjust population figures.
- Develop operating rules for Primkop and upstream dams.
- Split water demand into domestic, industrial and commercial use for all WDCs.
- Consider water reuse possibilities for Nelspruit.
- Investigate the problem with Matsulu abstraction works which runs short of water as a result of the Kaapmuiden diversion weir and canal.
- Capturing of data from dams and gauges in the White River area needs to be improved.
- Introduce regulations on compulsory rain water harvesting systems for all new dwellings with roof top areas bigger than 150 m^2.
- Determine the water requirement growth as a result of the hospital and university in Nelspruit.
- Obtain information regarding the proposed water allocations by White River town council. Will that water be used efficiently? What is the level of service?

17.2 FURTHER STUDIES BY ROLE PLAYERS OTHER THAN NWRP

The following further work/studies are required:

- A more detailed study into the groundwater potential of the area. This entails low level aerial magnetic surveys of potential areas and radon gas monitoring.
- The Classification of the water resources of the Sabie River. This will provide updated information on the utilisable water available in the Sabie River.
- Validation and verification of the water use in the Crocodile and Sabie River catchments. This is in progress.

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