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THE DEVELOPMENT OF THE LIMPOPO WATER MANAGEMENT AREA NORTH RECONCILIATION STRATEGY

WATER REQUIREMENTS AND RETURN FLOWS

FINAL

DECEMBER 2015

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Limpopo Water Management Area North Reconciliation Strategy

Date: December 2015

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- **Phase 2: Study Implementation**
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Executive summary

The Study Area of the Limpopo Water Management Area (WMA) North refers to the Limpopo WMA as defined in the first National Water Resources Strategy (NWRS-1).

The purpose of this report was to assess the historic water use and return flows for all water users in the Study Area as well as to determine projected future water requirements and return flows. Two water requirement scenarios were formulated (high and low) taking into account potential developments in mining, industry and power generation, current and potential inter-basin water transfer schemes, agricultural activities as well as domestic demographic projections. Return flow volumes from domestic users (via wastewater treatment works, WwTW) and irrigation are also reported in this document.

Water requirements

At the 2010-development level, the investigation indicated that the highest water user in the Study Area was the irrigation sector at 465 million m^3/a. No future growth was assumed for the irrigation sector. The assumption of no growth was also applied to commercial forestry, livestock water and streamflow reducers such as invasive alien plants (IAP). The total water requirement for the Study Area in 2010 was determined at 644 million m^3/a.

The future water requirements were evaluated in terms of the water users as described in the historic water requirements. Growth in the water requirements of the domestic, mining, industrial and power generation user sectors were considered with all other water users (irrigation, afforestation and alien vegetation) kept constant at the 2010-development level. The fastest growth in projected future water requirements was observed in the mining, industrial and power generation sector with an increase from 44 million m^3/a in 2010 to a projected 218 million m^3/a in 2040. Two scenarios were evaluated for the domestic water users. The high scenario projects a 2040 water requirement of 102 million m^3/a whilst the low scenario projects a water requirement of 105 million m^3/a.

*The total water requirements in the Study Area are summarised in **Table E1**.*

Irrigation return flows

The volume of return flows generated from irrigation at the various development levels was determined using Modelled Irrigation Block return flows in WRSM2000 and controlled by means of a return flow factor. The details of this analysis are explained in the Hydrological Analysis: Volume 1 – Main Report (PWMA 01/000/00/02914/3)*. The total return flows for the Study Area at the 2010-development level were determined to be 36 million m^3/a. This value is linked to the irrigation requirements and will thus remain constant assuming no growth in the irrigation sector in future.*

Table E1: Summary of total water requirements in the Limpopo WMA North

Matlabas River catchment	Water requirements (million m^3/a)			
Sector / type	**2010**	**2020**	**2030**	**2040**
Irrigation	4.7	4.7	4.7	4.7
Domestic	0.0	0.0	0.0	0.0
Mining, industrial and power generation	0.0	6.0	6.0	6.0
Livestock	2.3	2.3	2.3	2.3
IAP and commercial forestry	0.0	0.0	0.0	0.0
Total Matlabas water requirements	**7.0**	**13.0**	**13.0**	**13.0**
Mokolo River catchment	**Water requirements (million m^3/a)**			
Sector / type	**2010**	**2020**	**2030**	**2040**
Irrigation	40.2	40.2	40.2	40.2
Domestic	4.6	5.2	6.1	7.0
Mining, industrial and power generation	18.3	35.8	86.3	110.4
Livestock	2.1	2.1	2.1	2.1
IAP and commercial forestry	0.0	0.0	0.0	0.0
Total Mokolo water requirements	**65.2**	**83.3**	**134.7**	**159.7**
Lephalala River catchment	**Water requirements (million m^3/a)**			
Sector / type	**2010**	**2020**	**2030**	**2040**
Irrigation	69.8	69.8	69.8	69.8
Domestic	2.8	3.2	3.6	3.9
Mining, industrial and power generation	0.0	0.0	0.0	0.0
Livestock	2.4	2.4	2.4	2.4
IAP and commercial forestry	1.2	1.2	1.2	1.2
Total Lephalala water requirements	**76.2**	**76.6**	**77.0**	**77.3**
Mogalakwena River catchment	**Water requirements (million m^3/a)**			
Sector / type	**2010**	**2020**	**2030**	**2040**
Irrigation	99.4	99.4	99.4	99.4
Domestic	29.9	37.1	47.9	56.3
Mining, industrial and power generation	15.3	24.8	37.8	37.8
Livestock	11.5	11.5	11.5	11.5
IAP and commercial forestry	2.6	2.6	2.6	2.6
Total Mogalakwena water requirements	**158.7**	**175.4**	**199.3**	**207.6**
Sand River catchment	**Water requirements (million m^3/a)**			
Sector / type	**2010**	**2020**	**2030**	**2040**
Irrigation	221.6	221.6	221.6	221.6
Domestic	55.8	60.7	69.4	77.8
Mining, industrial and power generation	10.6	29.8	54.8	60.2
Livestock	4.4	4.4	4.4	4.4
IAP and commercial forestry	1.2	1.2	1.2	1.2
Total Sand water requirements	**293.6**	**317.7**	**351.4**	**365.2**
Nzhelele River catchment	**Water requirements (million m^3/a)**			
Sector / type	**2010**	**2020**	**2030**	**2040**
Irrigation	29.1	29.1	29.1	29.1
Domestic	9.0	9.7	11.1	12.0
Mining, industrial and power generation	0.0	3.7	7.3	4.0
Livestock	0.8	0.8	0.8	0.8
IAP and commercial forestry	4.1	4.1	4.1	4.1
Total Nzhelele water requirements	**43.0**	**47.3**	**52.4**	**50.0**
TOTAL LIMPOPO WMA NORTH	**643.6**	**631.2**	**713.3**	**710.7**

The domestic and industrial water availability for the Study Area was sourced from the All Towns, Updated All Towns Reconciliation Strategies and the Capricorn Master Plan and together with the projected water requirements used to determine water balances for all the catchments within the Study Area.

It is recommended that the mining, industrial and power generation water requirements be updated as more detailed information is released by the relevant stakeholders. Additionally, the water availability information for the Study Area should be updated with data and results reported in the Groundwater Assessment and Utilisation (PWMA 01/000/00/02914/5) *and* Yield Analysis (WRYM) (PWMA 01/000/00/02914/7) *reports.*

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LIST OF UNITS

a	annum
ha	hectare
kℓ	kilolitre
km	kilometer
km^2	square kilometre
ℓ/c/d	liter per capita per day
ℓ/s	litre per second
m	metre
m^3	cubic meter
m^3/a	cubic meter per annum
Mℓ/d	megalitre per day
mm	millimetre
$m^3/ha/a$	cubic meter per hectare per annum

LIST OF ABBREVIATIONS AND ACRONYMS

AECOM	AECOM SA (Pty) Ltd
ARC	Agricultural Research Council
BIC	Bushveld Igneous Complex
CoAL	Coal of Africa Limited
D: NWRP	Directorate: National Water Resource Planning
DM	District Municipality
DTI	Department of Trade and Industry
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
GSP	Greater Soutpansberg Project
IAP	Invasive Alien Plants
IPP	Independent Power Producer
LEIP	Limpopo Eco-Industrial Park
LM	Local Municipality
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MBET	Marapong-Boikarabelo Effluent Transfer
MCWAP	Mokolo-Crocodile Water Augmentation Project
ORWRDP	Olifants River Water Resources Development Project
RSA	Republic of South Africa
SEZ	Special Economic Zone
Stats SA	Statistics South Africa
WCWDM	Water Conservation and Water Demand Management
WMA	Water Management Area
WR2005	Water Resources of South Africa - 2005
WR2012	Water Resources of South Africa - 2012
WR90	Water Resources of South Africa - 1990
WRPM	Water Resources Planning Model
WRSM2000	Water Resources Simulation Model 2000
WRYM	Water Resources Yield Model
WTW	Water treatment works
WwTW	Wastewater treatment works
ZINWA	Zimbabwe National Water Authority

1 INTRODUCTION

1.1 APPOINTMENT OF THE PSP

The Department of Water and Sanitation (DWS), then Department of Water Affairs (DWA) appointed **AECOM SA (Pty) Ltd** in association with three sub-consultants **Hydrosol**, **Jones and Wagener** and **VSA Rebotile Metsi Consulting** with effect from 1 March 2014 to undertake the **Limpopo Water Management Area North Reconciliation Strategy**.

1.2 BACKGROUND TO THE PROJECT

The DWS (then DWA) identified a need for the development of the Limpopo Water Management Area (WMA) North Reconciliation Strategy. The Limpopo WMA North refers to the Limpopo WMA described in the first edition of the *National Water Resource Strategy* (NWRS-1) published in 2004. The 19 initial WMAs were consolidated into nine WMAs during 2012 and acknowledged in the second edition of the *National Water Resource Strategy* (NWRS-2) of 2013. The newly defined Limpopo WMA also includes the original Crocodile (West) and Marico WMA as well as the Luvuvhu River catchment, previously part of the Luvuvhu and Letaba WMA. However, these additional areas will not be part of this Reconciliation Strategy.

The Limpopo WMA North comprises of six main river catchments; Matlabas, Mokolo, Lephalala, Mogalakwena, Sand and Nzhelele and are shown in Figure 1.1. The very small Nwanedi River catchment forms part of the Nzhelele River catchment. Most of these river catchments rely on their own water resources and are managed independently from neighbouring catchments. This implies that some river catchments require separate and independent reconciliation strategies whilst others need integrated water management reconciliation strategies.

The main urban areas within the WMA include Mokopane, Polokwane, Mookgophong, Modimolle, Lephalale, Musina and Louis Trichardt. Approximately 760 rural communities are scattered throughout the WMA, mostly concentrated in the central region. The main economic activities are irrigation and livestock farming as well as expanding mining operations due to the vast untapped mineral resources in the area. The water resources, especially surface water resources, are heavily stressed due to the present levels of development. It is crucial that water supply is secured and well managed.

The most western area of the Limpopo WMA North, the Matlabas River catchment, is a dry catchment with no significant dams and with a low growth potential for land-use development.

The large Mokolo Dam, in the Mokolo River catchment, supplies water to the Matimba Power Station, Medupi Power Station, Grootegeluk Coal Mine, the Lephalale Local Municipality (LM) as well as a number of downstream irrigators. The dam is able to meet the bulk of the current requirements but will in future rely on transfers from other WMAs to meet the water requirements at a sufficiently high assurance of supply.

The middle reaches of the Lephalala River catchment have a high conservation value with irrigation activities dominant in the remainder of the catchment. Irrigation in this area is supplied by surface water and alluvial aquifer abstraction.

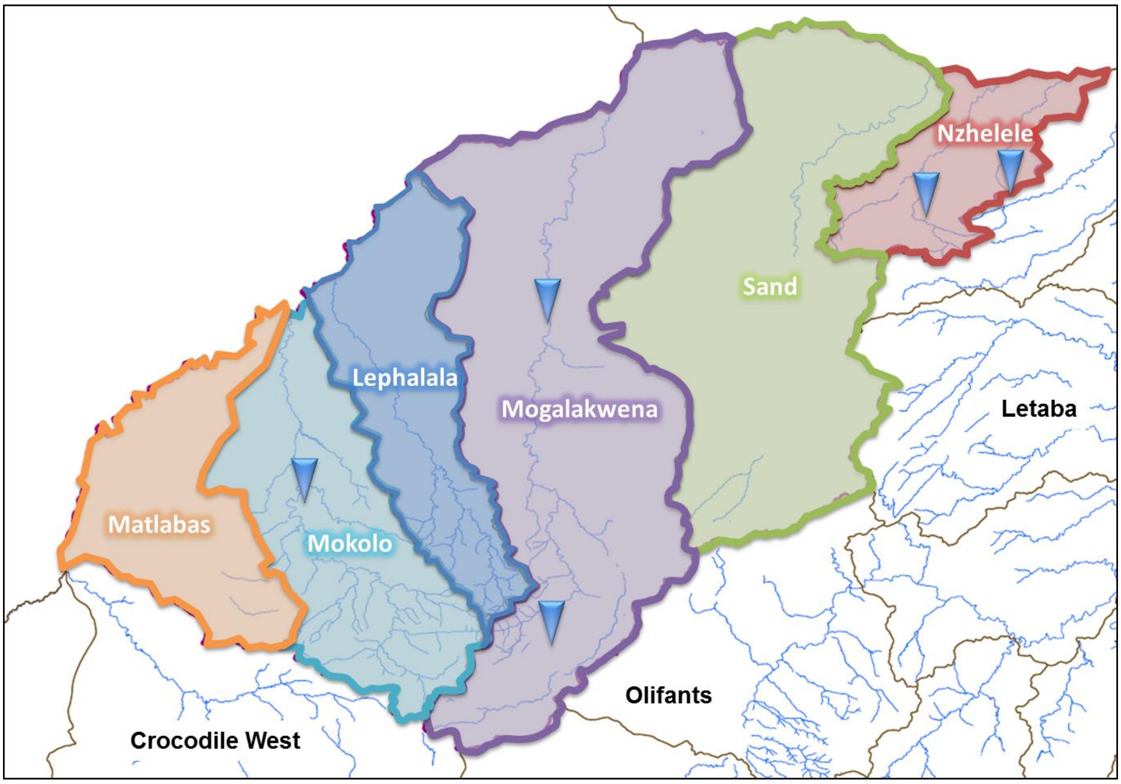

Figure 1.1 Overview of the catchments of the Limpopo WMA North

The bulk of the water resources in the Mogalakwena River catchment have been fully developed. The Doorndraai Dam is over-allocated. Additional water to support the rapid expanding mining activities in the vicinity of Mokopane needs to be augmented by transfers from the Flag Boshielo Dam in the adjacent Olifants River Catchment. Glen Alphine Dam presently supplies water to emerging farmers, who has not yet taken up their full allocated quota, and is expected to supply the growing domestic requirements in future.

Groundwater resources in the Mogalakwena and the Sand river catchments have been extensively utilised, and possibly over-exploited by the dominating irrigation sector. The expanding urban and industrial requirements of Polokwane and Makhado LMs, currently supplied by Albasini Dam, rely heavily on water transfers from adjacent WMAs. This includes transfers from the Ebenezer Dam, Dap Naude Dam, Flag Boshielo Dam and Nandoni Dam in the Olifants WMA.

Domestic and irrigation water in the small but highly developed Nzhelele River catchment is supplied through the Mutshedzi Dam Regional Water Supply Scheme and the Nzhelele Dam Regional Water Supply Scheme as well as extensively from groundwater resources. The inflows to the Mutshedzi and Nzhelele dams have been reduced as a result of afforestation upstream of these dams. The area is in deficit due to the over-allocation and over development of irrigation.

The Sand and Nzhelele river catchments have high coal mining potential but the availability of local water resources may limit future mining development.

1.3 STUDY AREA

The Limpopo WMA North is the most northern WMA in South Africa and refers to the area described as the Limpopo WMA in NWRS-1. Refer to **Figure 1.2** for the location and general layout of the Study Area. The areas indicated in grey show the additional catchment and WMA areas included in the Limpopo WMA as per NWRS-2 and which do not form part of the Study Area for this reconciliation strategy.

The Limpopo WMA North forms part of the internationally shared Limpopo River Basin which also includes sections of Botswana, Zimbabwe and Mozambique. The Limpopo River forms the entire length of the northern international border between South Africa and Botswana and Zimbabwe before flowing into Mozambique and ultimately draining into the Indian Ocean. The dry Limpopo WMA North is augmented with transfers from the adjacent Letaba, Olifants and Crocodile West river catchments. No transfers are currently made from the Limpopo WMA North to other WMAs.

The main rivers in the Study Area, which form the six major catchment areas, are the Matlabas, Mokolo, Lephalala, Mogalakwena, Sand and Nzhelele rivers. These rivers, together with other smaller tributaries, flow northwards and discharge into the Limpopo River.

The climate over the Study Area is temperate and semi-arid in the south to extremely arid in the north. Mean annual rainfall ranges from 300 mm to 700 mm with the potential evaporation well in excess of the rainfall. Rainfall is seasonal with most rainfall occurring in the summer with thunderstorms. Runoff is low due to the prevalence of sandy soils in the most of the Study Area, however, loam and clay soils are also found.

The topography is generally flat to rolling, with the Waterberg on the south and the Soutpansberg in the north-east as the main topographic features. Grassland and sparse bushveld shrubbery and trees cover most of the terrain.

The southern and western parts of the WMA are mainly underlain by sedimentary rocks, whilst metamorphic and igneous rocks are found in the northern and eastern parts. With the exception of some alluvium deposits and dolomites near Mokopane and Thabazimbi, these formations are mostly not of high water bearing capacity. The mineral rich Bushveld Igneous Complex extends across the south-eastern part of the WMA, and precious metals are mined at various localities throughout the area. Large coal deposits are found in the north-west.

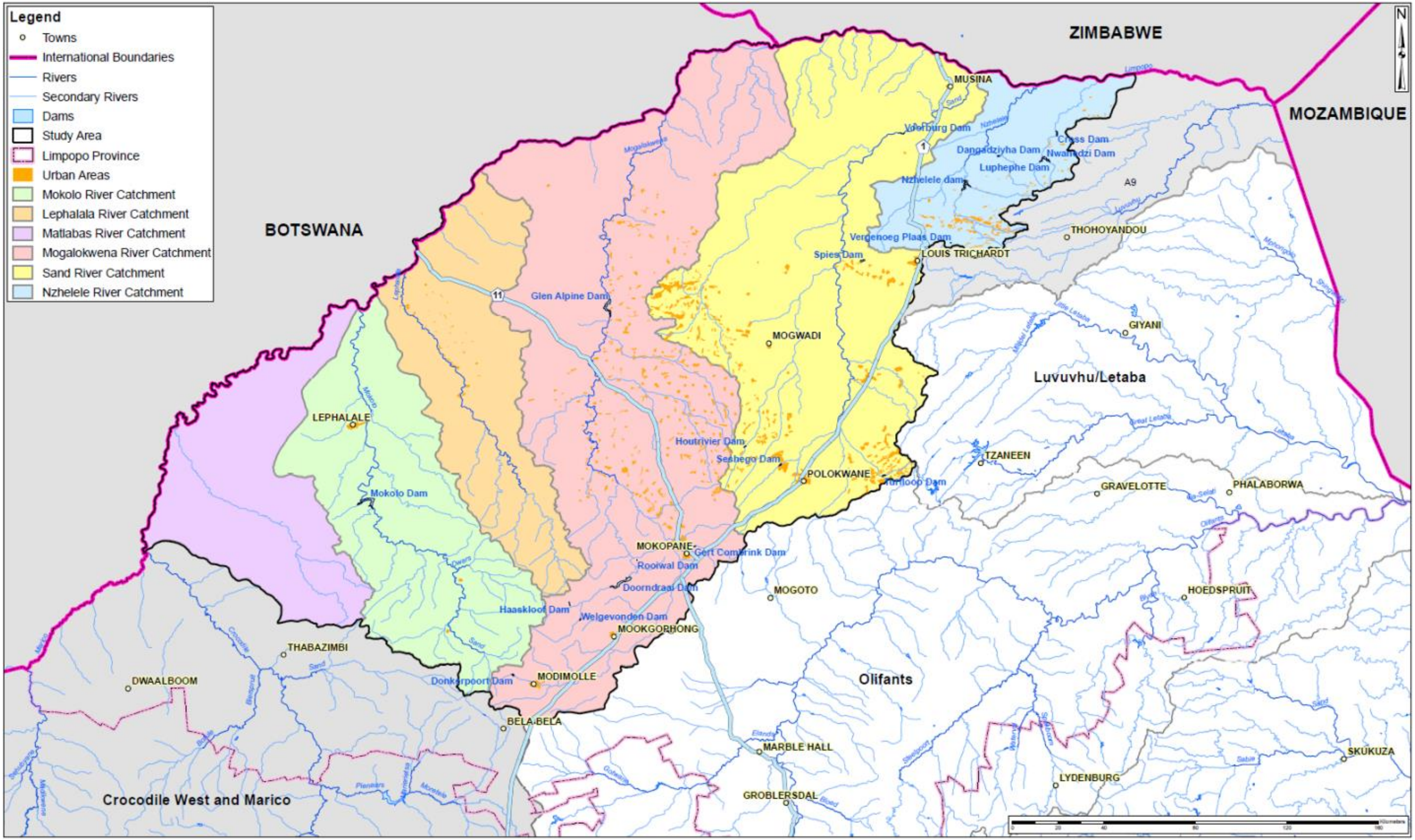

Figure 1.2 General layout of the Study Area

Several wildlife and nature conservation areas have been proclaimed in the WMA, of which the Nylsvley Nature Reserve, Mapungubwe National Park and the Marekele National Park are probably the best known.

1.4 MAIN OBJECTIVES OF THE STUDY

The main objective of the study is to formulate a water resource reconciliation strategy for the entire Limpopo WMA North up to 2040. The reconciliation strategy must a) address growing water demands as well as water quality problems experienced in the catchment, b) identify resource development options and c) provide reconciliation interventions, structural and administrative/ regulatory. To achieve these objectives, the following aspects are included in the study:

- Review of all available information regarding current and future water requirements projections as well as options for reconciliation;
- Determine current and future water requirements and return flows and compile projection scenarios;
- Configure the system models (WRSM2000 rainfall-runoff catchment model, also known as the Pitman Model, the Water Resources Yield Model (WRYM) and the Water Resources Planning Model (WRPM) in the Study Area at a quaternary catchment scale, or smaller, where required, in a manner that is suitable for allocable water quantification. This includes updating the hydrological data and accounting for groundwater surface water interaction;
- Assess the water resources and existing infrastructure and incorporate the potential for Water Conservation and Water Demand Management (WCWDM) and water reuse as reconciliation options; and
- Develop a preliminary short-term reconciliation strategy followed by a final long-term reconciliation strategy.

1.5 PURPOSE AND STRUCTURE OF REPORT

This report aims to provide an accurate and detailed account of the water use within the Study Area river catchments. Using existing data from various sources the reports purpose was to determine the water requirements across all water use sectors and to compile an estimate of the historical requirements and impacts of in-catchment water use.

Additionally, taking into account all perceived development, population growth rates and an improvement in the living standards of those living within the WMA, the report provides an estimation of what the future water requirements within the Limpopo WMA North will be between 2010 and 2040.

1.6 OVERVIEW OF THE STUDY AREA

A brief overview of each of the six major catchments that comprises the Study Area is provided and summarised in **Table 1.1**.

Table 1.1 Summary of catchment area, runoff, precipitation and evaporation characteristics

Catchment	Tertiary catchment	WR2005[1]				
		Gross area (km^2)	Net area (km^2)	MAR[2] (million m^3/a)	MAP[3] (mm/a)	MAE (mm/a)
Matlabas	A41	6 014	3 612	50.5	516	1 899
Mokolo	A42	8395	7610	263.7	558	1 807
Lephalala	A50	6 725	5 041	143.3	490	1 880
Mogalakwena	A61	5 452	5 227	163.0	614	1 750
	A62	5 795	5 584	68.9	479	1 883
	A63	8 067	6 981	40.5	391	2 014
Sand River	A71	12 307	11 932	70.2	392	1 820
	A72	3 462	2 592	16.3	406	1 924
Nzhelele/ Nwanedzi	A80	4 203	4 064	15.0	115	1 746

Note: (1) WR2005 = Water Resources of South Africa - 2005
(2) MAR = Mean Annual Runoff
(3) MAP = Mean Annual Precipitation

1.6.1 Matlabas River catchment (A41)

The Matlabas River catchment is a dry catchment with non-perennial flow and hence no sustainable yield from surface water. The limited water use in this catchment is mostly from groundwater, which is under-exploited. The majority of the water required in this catchment is for irrigation purposes with the very small local population abstracting water from boreholes for personal use.

1.6.2 Mokolo River catchment (A42)

The Mokolo River catchment is located in the higher rainfall portion of this WMA and is also the most developed catchment from a water resources point of view. The Mokolo Dam is the largest dam in the WMA and provides water for a multitude of uses, the most important being the supply to the Matimba Power Station and Grootegeluk coal mine. There is also a significant amount of irrigation from groundwater. Groundwater is under-utilised and could be used to support increased domestic requirements, provided the water quality is acceptable. High future water requirements are expected as a large amount of mining potential has been identified within the Waterberg Coal Field which falls within this catchment.

1.6.3 Lephalala River catchment (A50)

The Lephalala River catchment has limited water resources. Irrigation takes place mainly in the higher rainfall upper reaches where there are a large number of farm dams, while lower in the catchment irrigators make use of water from alluvial aquifers. Nevertheless, the catchment appears to be stressed and no new allocations should be made for irrigation purposes. Additional water for domestic purposes should be sourced from groundwater. The middle reaches of the Lephalala catchment has a high conservation value.

1.6.4 Mogalakwena River (A61 to A63)

The Mogalakwena River catchment has limited surface water resources but large groundwater resources, which have already been extensively exploited by the irrigation sector. There is a rapid expansion of mines in the area and the water supply to these mines must be secured as a matter of priority. Additional water resources are groundwater and transfers from the Olifants River catchment.

1.6.5 Sand River catchment (A71)

The Sand River catchment is a dry catchment with very limited surface water resources. However, it has exceptional groundwater reserves which have been fully and possibly over-exploited, mostly by irrigation. The water requirements are large compared to the rest of the WMA, but again irrigation is the largest water user. Although the urban requirements are high, a large portion amount of water is supplied through transfers from other WMAs.

1.6.6 Nzhelele River catchment (A80A to A80G)

The Nzhelele River catchment is small and is dominated by irrigation, with a small area of afforestation and domestic use by the rural sector. Nzhelele Dam is the second largest dam in the Limpopo WMA North and provides most of the water requirements in this catchment while groundwater is also extensively used.

1.6.7 Nwanedzi River catchment (A80H to A80J)

The Nwanedzi River catchment is a small catchment in the north-eastern corner of the WMA characterised by over-allocated and over-developed large areas under irrigation. The locations of the catchments are shown in **Figure 1.1** and **Figure 1.2.**

1.7 OBJECTIVES OF WATER REQUIREMENTS AND RETURN FLOWS ANALYSES

1.7.1 Domestic water requirements

The main objectives of the current and future water requirements and return flows analyses of the Limpopo WMA North were to:

- Determine the water requirements for all the water user sectors within the study are at the current development level.
- Estimate, based on previous studies, local knowledge and growth or development rates, the water requirements over the entire study period (1920 to 2010) for input into the WRSM2000 hydrological modelling study.
- Use expected development and development zones, growth rates and levels of service to predict the water requirements for each user sector for the next 30 years (i.e. from 2010 to 2040).

1.7.2 Irrigation water requirements

The main scope of the irrigation water requirements were:

- the quantification of current water use;
- determination of the legality and the quantities of water that the users are legally entitled to;
- reporting on the lawfulness and extent of water use in terms on Section 35 of the National Water Act;
- provision of water use patterns for use as input in the modelling of water within the Limpopo WMA;
- evaluation of the efficiency of water use in the agricultural sector, and
- a final report with documentation of all the results, assumptions, inputs and recommendations.

An *Irrigation Assessment Report (PWMA 01/000/00/02914/4/1),* was compiled by a sub-consultant (Scheoman en Vennote) and is reported as a supporting document to the *Water Requirements Report (PWMA 01/000/00/02914/4).*

1.8 METHODOLOGY

The following steps were undertaken in order to meet the objectives as described above:

- The data regarding water use, and return flows from previous studies and reports were collected, evaluated and collated.
- This database was then altered to consider common areas – namely quaternaries.
- The data was compared with WARMS and GRIP databases and any anomalies identified.
- Irrigation water requirements were determined through the hydrological modelling process, using irrigated areas from the *Validation and Verification Study* (DWA, 2013a).
- Planned and expected developments were investigated and the necessary water required for these determined.
- Domestic and urban future water requirements were determined based on Census 2011 data, and population trends and growth rates.
- Scenario based long term future water requirements for all users were developed.
- Confidence levels on the data obtained were provided where necessary.

2 HISTORIC AND CURRENT WATER REQUIREMENTS

2.1 OVERVIEW

The main sources of information for the domestic water requirements, inclusive of the urban industries, were as follows:

- *All Towns Studies* (DWA, 2011);
- *Updated All Towns Studies*;
- *Capricorn Bulk Water Services Master Plan* (AECOM, 2014); and
- *DWS: Limpopo and Luvuvhu WMA: SMP Details*.

In order to create a database of all of the necessary information from the various sources a common reference was required. It was decided that for ease of use during the modelling processes the data would be presented on a quaternary basis.

Upon summarising the necessary information from the All Towns Studies the end results was a table separated in terms of water supply area – as each study has been presented. Where applicable for the few supply areas recently updated, the Updated All Towns Study then took priority. This data set was then converted to a quaternary basis by determining the % of each Study Area that falls within each quaternary and then using this ration to determine the water requirements of that supply area in a particular quaternary. These were then grouped to determine the total domestic supply in a particular quaternary.

The Capricorn Bulk Water services Master Plan was also grouped according to quaternary and replaced portions of the data from the All Towns Studies, where applicable.

Lastly, the *Limpopo and Luvuvhu WMA: SMP Details* were used as an upper limit for the water availability from a particular source or within a particular catchment. Thus, in certain circumstances the water availability was reduced to coincide with these upper limits.

The primary water users were identified within the Study Area as the following:

- Irrigation;
- Domestic (urban and rural);
- Industry (power generation and other industry); and
- Mining.

These various sectors were examined and the current (2010) water demand requirements were determined based on the information provided by the sources listed previously.

The *Validation and Verification Study* (DWA, 2013a) produced areas under irrigation as well as composite crop types for all of those areas. These values were included in the WRSM2000 modelling process and the volumes required by the irrigation areas determined through the modelling.

The total water requirements per sector show that irrigation in the Study Area accounts for the most significant portion of the water requirements. This is followed by domestic requirements (including urban industry but not power stations and mines).

In **Sections 2.2** to **2.5**, each of the primary water users will be evaluated with regards to their water requirements at the 2010-development level.

2.2 IRRIGATION WATER REQUIREMENTS

The water requirements for irrigation are the highest in the Study Area, accounting for more than 75% of the total water required. In order to determine the volumes the results obtained through the *Validation and Verification Study* completed by Schoeman and Partners (DWA, 2013a) were included in the WRSM2000 modelling process. Based on a composite crop, determined through combining all of the water requirements of all the various crop types, the requirements for each quaternary catchment were determined through the model and summarised. Reported in **Table 2.1** and **Table 3.2** are the current irrigated areas and water requirements, respectively, as determined through the WRSM2000 modelling process. The irrigation requirements are further classified into those supplied from surface water (Rivers and schemes) and those supplied from groundwater.

In order to determine the historic water requirements for the irrigation within the Study Area the results from the validation and verification study for 1998 and 2010 were used. From 1998 back to 1920 the irrigation areas and growth rates as presented in the WR2005 study were used. The results of these predictions can be seen in **Figure 2.1**, where the dotted lines represent the historical projections and the solid lines represent the known data from the *Validation and Verification Study* (DWA, 2013a).

Table 2.1 Current irrigated areas per catchment

River catchment	Irrigated area (km^2)		
	Surface water	Groundwater	Total
Matlabas	2.54	2.20	4.74
Mokolo(1)	91.86	9.49	101.35
Lephalala	52.57	30.43	83.00
Mogalakwena	59.06	61.61	120.66
Sand	27.49	243.46	270.94
Nzhelele	27.70	5.74	33.44
TOTAL	**261.21**	**352.92**	**614.13**

Note: (1) As in the "Updating the Hydrology and Yield Analysis in the Mokolo River Catchment" Study (DWA, 2007)

Table 2.2 Irrigation water requirements per catchment

River catchment	Irrigation water requirements (million m3/a)		
	Surface water	Groundwater	Total
Matlabas	2.41	2.32	4.73
Mokolo[(1)]	36.98	3.18	40.16
Lephalala	42.91	26.90	69.81
Mogalakwena	39.41	60.00	99.41
Sand	53.59	168.05	221.64
Nzhelele	25.16	3.93	29.08
TOTAL	**200.46**	**264.36**	**464.82**

Note: (1) As in the "Updating the Hydrology and Yield Analysis in the Mokolo River Catchment" Study (DWA, 2007)

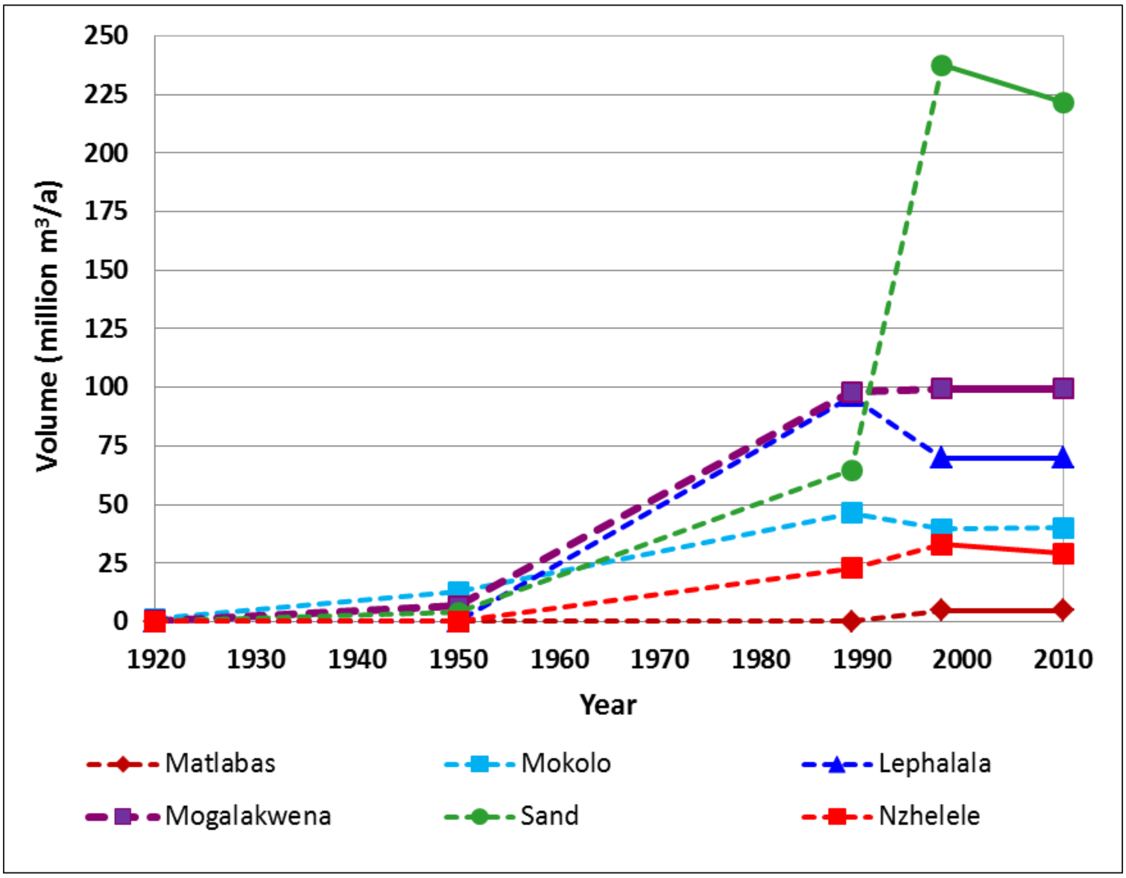

Figure 2.1 Historical and current irrigation water requirements

2.3 DOMESTIC WATER REQUIREMENTS

Domestic water requirements, inclusive of local industries such as the Polokwane Smelter and other smaller urban industries throughout, make up the second largest water user in the Study Area.

There are seven major urban centres found within the WMA namely Modimolle, Mookgophong, Lephalale, Mokopane, Polokwane, Makhado and Musina. These areas form the bulk of the domestic water requirements; however, there are also a large number of smaller rural areas which source water primarily through groundwater resources and sand aquifers.

Surface water sources provide the highest amount of available supply for the domestic and industrial usage within the supply area at 72 million m^3/a. Whilst the available groundwater supplies approximate to 40 million m^3/a. It should be noted, however, that a significant portion of the available surface water to the catchment is sourced from the surrounding WMA's and this trend is set to increase in the future. Currently water is transferred into the catchment from Ebenezer Dam, Olifants-Sand Transfer, Dap Naude Dam and Nandoni Dam. Additionally, the surface water supply to Modimolle through Donkerpoort Dam is supported by Roodeplaat Dam via the Magalies pipeline – this has been operational since 1995. Within the Study Area there are six dams which are used for domestic water supply; these are Houtrivier Dam, Mokolo Dam, Donkerpoort Dam, Welgevonden Dam, Doorndraai Dam and Mutshedzi Dam. The other significant dams within the Study Area; Glen Alpine, Nwanedzi, Luphephe and Nzhelele Dams, do not have any domestic abstractions and are used mainly for irrigation.

Reported in Table 2.3 are the domestic water requirements within the Study Area at the 2010 development level.

Table 2.3 Domestic water requirements at 2010 development level

Catchment	Source	Water requirements (million m^3/a)
Mokolo	Surface water	3.83
	Groundwater	0.77
	Sub-total	**4.60**
Lephalala	Surface water	0.00
	Groundwater	2.80
	Sub-total	**2.80**
Mogalakwena	Surface water	10.43
	Groundwater	19.47
	Sub-total	**29.90**
Sand	Surface water	13.96
	Groundwater	41.84
	Sub-total	**55.80**
Nzhelele	Surface water	3.68
	Groundwater	5.32
	Sub-total	**9.00**
Study Area	**Total**	**102.10**

It is evident from **Table 2.3** that the Sand catchment is dominant in terms of the domestic water requirements. The Matlabas catchment is however not reflected in **Table 2.3** because this catchment does not have any settlements. Commercial farming is practiced on the entire catchment and residents provide their own water from boreholes. It is also assumed that no settlements will form in this catchment in the future thus resulting in the future domestic requirements remaining at zero.

A detailed evaluation of the future domestic water requirements and socio-economic status of the Study Area is reported in the *Socio-Economic perspective on future water requirements report (PWMA 01/000/00/02914/4/3)* (DWS, 2015)

2.4 MINING AND INDUSTRIAL WATER REQUIREMENTS

There are a number of mines across the Study Area and these have a significant role to play in the water requirements of the Study Area. The mines are key economic performers for the WMA and country and it is necessary for them to be accommodated in the water allocations. There is, however, limited data available for the determination of mining water requirements – especially for the smaller operations.

The mining of unexploited resources in the Platreef, Waterberg and Soutspanberg/Makhado/Musina regions are a key development strategy for the Province and will require significant water resources to be successful in the future. These developments have been accounted for in future water requirements reported in **Section 3**.

Within the All Towns studies the industries falling within the urban areas have been accounted for under "Domestic Demand". However, what is not included in these demands are the power stations. As the study period is from 1920 to 2010 the only power station considered in the "current" water requirements scenario is Matimba Power Station. For the future water requirements, however, Medupi and Boikarabelo Power Plants are incorporated into the future water requirements.

Reported in **Table 2.4** are the mining and industrial (power generation) water requirements for the base year (2010) per catchment.

It should be reiterated, however, that there is limited data available for the determination of historic and current mining and industrial water requirements, especially for the smaller operations, as reported in **Table 2.4**.

Table 2.4 Mining and industrial water requirements at 2010 development level

Catchment	Source	Water requirements (million m^3/a)
Matlabas	Surface water	0.00
	Groundwater	0.00
	Sub-total	**0.00**
Mokolo	Surface water	18.26
	Groundwater	0.00
	Sub-total	**18.26**
Lephalala	Surface water	0.00
	Groundwater	0.00
	Sub-total	**0.00**
Mogalakwena	Surface water	1.21
	Groundwater	2.08
	Transfers	7.67
	Sub-total	**10.96**
Sand	Surface water	0.00
	Groundwater	14.97
	Sub-total	**14.97**
Nzhelele	Surface water	0.00
	Groundwater	0.00
	Sub-total	**0.00**
	Total	**44.19**

2.5 STREAMFLOW REDUCERS

2.5.1 Invasive alien plants

Invasive Alien Plants (IAPs) tend to utilise more water compared to indigenous plant species and subsequently reduce the available runoff in a catchment. The IAP distribution and extent were obtained from the latest IAP survey report – the *National Invasive Alien Plant Survey* (ARC, 2010), conducted by the Agricultural Research Council (ARC). The survey provides information on the spatial distribution, the predominant species and the compacted densities of the IAP per quaternary catchment.

A comprehensive evaluation of the effects of IAPs on streamflow was undertaken as part of this study. Refer to *Hydrological Analysis: Volume 1 – Main Report (PWMA 01/000/00/02914/3)* for detailed information in this regard. Reported in Table 2.5 is a summary of the IAP distribution and the estimated 2010-development level runoff reduction used as input to the WRSM2000.

Table 2.5 Summary of IAP distribution and estimated runoff reduction for 2010-development levels in the Study Area

River catchment	Condensed area (km^2)	Area In riparian (km^2)	% in riparian zone	2010 development runoff reduction (million m^3/a)
Matlabas	0.0	0.0	0.0	0.0
Mokolo(1)	26.2	0.1	1.8	0.0
Lephalala	12.6	0.1	3.7	1.2
Mogalakwena	83.5	0.1	1.3	2.6
Sand	134.3	0.1	0.6	1.0
Nzhelele	59.0	0.0	0.0	2.1
TOTAL	**315.5**	**0.4**	**7.3**	**6.9**

Note: (1) As in the "Updating the Hydrology and Yield Analysis in the Mokolo River Catchment" Study (DWA, 2007)

2.5.2 Commercial forestry

Afforestation is confined to the high rainfall regions (> 800 mm/a) on the slopes of the Soutpansberg mountains, in the upper reaches of the Nzhelele River catchment and quaternary catchments A71C and A71H of the Sand River catchment.

A comprehensive evaluation of afforestation growth of the study period was undertaken as part of this study. Refer to *Hydrological Analysis: Volume 1 – Main Report (P WMA 01/000/00/02914/3)* for detailed information in this regard. Reported in this section is a summary of the area covered by afforestation at the 2010-development level in Table 2.6 and the afforestation growth over the study period in Table 2.7.

Table 2.6 Afforestation in the Study Area at 2010-development

Catchment	Quaternary	Current afforestation area (km^2)			
		Eucalyptus	Pine	Wattle	Total
Sand	A71C	0.86	0.00	0.10	1.00
	A71H	3.67	4.48	0.00	8.20
	Total A71	**4.54**	**4.48**	**0.10**	**9.10**
Nzhelele	A80A	6.08	11.53	0.00	17.6
	A80B	0.53	0.89	0.00	1.40
	A80D	0.18	0.00	0.00	0.20
	A80E	0.09	0.00	0.00	0.10
	Total A80	**6.87**	**12.42**	**0.00**	**19.30**
Total Study Area		**11.41**	**16.90**	**0.10**	**28.40**

Table 2.7 Historic growth of afforestation in the Study Area

Catchment	Quaternary	Growth in afforestation areas (km^2)					
		1920	1930	1940	1986	1998	2010
Sand	A71C	0.44	0.59	0.78	0.82	0.97	0.96
	A71H	3.69	4.98	6.63	6.96	8.26	8.15
	Total Sand	**4.13**	**5.57**	**7.41**	**7.78**	**9.23**	**9.11**
Nzhelele	A80A	7.98	10.75	14.33	15.04	17.83	17.61
	A80B	0.64	0.87	1.16	1.21	1.44	1.42
	A80D	0.08	0.11	0.14	0.15	0.18	0.18
	A80E	0.04	0.05	0.07	0.07	0.09	0.09
	Total Nzhelele	**8.74**	**11.78**	**15.7**	**16.47**	**19.54**	**19.3**
Total Study Area		**12.87**	**17.35**	**23.11**	**24.25**	**28.77**	**28.41**

The impact of afforestation on the water resources in the Study Area is considered negligible, reducing the runoff in the Nzhelele River catchment by approximately 2 million m^3/a, and 0.2 million m^3/a in the Sand River catchment.

2.5.3 Livestock watering

Livestock watering is primarily supplied from surface water resources. The tendency to convert land-use from irrigation to livestock farming, particularly game farming in the Mokolo, Lephalala and Sand river catchments, has increased the stock watering requirements. Table 2.8 provides a summary of the livestock watering requirements within the Study Area per river catchment.

Table 2.8 Livestock water requirements in the Study Area at the 2010-development level

River catchment	Water requirement (million m^3/a)
Matlabas	2.28
Mokolo	2.11
Lephalala	2.39
Mogalakwena	11.49
Sand	4.39
Nzhelele	0.75
TOTAL	**23.41**

2.6 SUMMARY OF WATER REQUIREMENTS AT THE 2010-DEVELOPMENT LEVEL

A summary of the water requirements at the 2010-development level, as sourced from the *Validation and Verification Study* (DWA, 2013a) and the *All Towns Studies* (DWA, 2011), is presented in **Table 2.9**. It is important to note that some of the irrigation water requirements are not supplied from water resources within the Study Area (i.e. from water resources not fed by runoff generated in the Study Area), but from the Limpopo River main stem and associated sand aquifers (DWS, 2015).

Table 2.9 Summary of total water requirements in the Limpopo WMA North at the 2010-development level

Sector	Source	Water requirements (million m^3/a)						
		Matlabas	Mokolo	Lephalala	Mogalakwena	Sand	Nzhelele	Total
Irrigation	Surface water(1)	2.41	36.98	42.91	39.41	53.59	25.16	200.46
	Groundwater	2.32	3.18	26.9	60	168.05	3.93	264.38
	Sub-total	**4.73**	**40.16**	**69.81**	**99.41**	**221.64**	**29.09**	**464.84**
Domestic	Surface water	0	3.83	0	10.43	13.96	3.68	31.9
	Groundwater	0	0.77	2.8	19.47	41.84	5.32	70.2
	Sub-total	**0**	**4.6**	**2.8**	**29.9**	**55.8**	**9**	**102.1**
Mining and power generation	Surface water(2)	0	18.26	0	8.88	0	0	27.14
	Groundwater	0	0	0	6.46	10.6	0	17.06
	Sub-total	**0.00**	**18.26**	**0.00**	**15.34**	**10.60**	**0.00**	**44.20**
IAP(3)	Surface water	0	0	1.18	2.58	0.99	2.13	6.88
Afforestation(3)	Surface water	0	0	0	0	0.16	2.01	2.17
Livestock	Surface water	2.28	2.11	2.39	11.49	4.39	0.75	23.41
Catchment total	Surface water	4.69	61.18	46.48	72.79	73.09	33.73	291.96
	Groundwater	2.32	3.95	29.7	85.93	220.49	9.25	351.64
	Total	**7.01**	**65.13**	**76.18**	**158.72**	**293.58**	**42.98**	**643.60**

Note: (1) Includes supply from irrigation schemes.

(2) Includes the transfer of treated effluent from Polokwane and Mokopane to the Mogalakwena Platinum Mine.

(3) Reduction in runoff.

3 FUTURE WATER REQUIREMENTS

In order to estimate the future requirements of the Limpopo WMA North, it was important to understand the trends in each of the various water user sectors. The primary sectors included:

- Irrigation;
- Domestic;
- Industry; and
- Mining.

Each of the aforementioned sectors is discussed in detail in the following sections and is followed by necessary predictions for the next 30 years (2010-2040).

3.1 STATUS AND DEVELOPMENTS OVERVIEW

3.1.1 Matlabas

It is interesting to note that throughout all of the All Towns studies there is not one regional/water supply area that overlaps into the Matlabas. This catchment is dominated by agriculture and any domestic water use comes from farmers or very small communities who source water from local groundwater resources.

3.1.2 Mokolo

The Mokolo catchment contains both mines and power stations and is a primary target for the development of both of these. The Medupi Power Plant and the Boikarabelo Power Plant should both be operational in the near future and will have significant water requirements. Additionally, there is opportunity for Coal mines to be developed further on the Waterberg Coal Field, these will be used for the power plants.

Currently the Mokolo Dam is the major water source for the catchment and is allocated for irrigation, mining, domestic and industry. However, in the near future with all of the expected development taking place additional water will be required. At there are few alternate dam sites and the lower portion of the catchment is relatively dry, there are limited options within the catchment to source this water from outside of groundwater. Thus, the Mokolo-Crocodile Water Augmentation Project (MCWAP) Phase II is underway to utilise the return flows from Gauteng which are deposited into the Crocodile River to be transferred into the Mokolo catchment. The details of this project can be found in the reports as listed in Table 3.1.

3.1.3 Lephalala

Irrigation is the dominant water requirement in the Lephalala, as is the case with the other catchments. The only known mine within this catchment is the “Oaks” mine, which has been mined since 1999 by De beers and was at some point their smallest diamond mine, the mine was closed in 2008 (Hill, 2008).

There is not a large amount of development expected within this catchment as there are no major urban centres or new areas for mining development. Additionally, as there has been a general decline in the amount of irrigation within the WMA it is expected that this trend will continue.

Table 3.1 List of MCWAP study reports

Title	Report number
Inception Stage	
Inception Report	P RSA A000/00/9609
Pre-feasibility Stage	
Supporting Report 1: Water Requirements	P RSA A000/00/8809
Supporting Report 2: Water Resources	P RSA A000/00/8909
Supporting Report 3: Guidelines for Preliminary Sizing, Costing and Economic Evaluation of Development Options	P RSA A000/00/9009
Supporting Report 4: Dams, Abstraction Weirs and River Works	P RSA A000/00/9109
Supporting Report 5: Mokolo River Development Options	P RSA A000/00/9209
Supporting Report 6: Water Transfer Scheme Options	P RSA A000/00/9309
Supporting Report 7: Social and Environmental Screening	P RSA A000/00/9409
Feasibility Stage	
Supporting Report 8a: Geotechnical Investigations Phase 1	P RSA A000/00/8409
Supporting Report 8b: Geotechnical Investigations Phase 2	P RSA A000/00/8709
Supporting Report 9: Topographical Surveys	P RSA A000/00/8509
Supporting Report 10: Requirements for the Sustainable Delivery of Water	P RSA A000/00/8609
Supporting Report 11: Phase 1 Feasibility Stage	P RSA A000/00/8209
Supporting Report 12: Phase 2 Feasibility Stage	P RSA A000/00/8309
Main Report: MCWAP Feasibility Study Technical Module Summary Report	P RSA A000/00/8109

3.1.4 Mogalakwena

The Mogalakwena is home to the Northern limb of the Bushveld Igneous Complex (BIC) – which is home to more than half of the world’s platinum, vanadium, chromium and refractory minerals and is the largest layered intrusion in the world. Thus, significant mining development through the Platreef project is expected within this catchment. Currently, mining is taking place at the Mogalakwena Mine, which is just north of Mokopane and at the Venetia Mine in the lower reaches of the catchment. Irrigation again is the largest demand within the catchment, followed by domestic requirements. With the increase in economic activity near Mokopane it is expected that the domestic requirements of the catchment will increase and containing another urban centre, Modimolle, the urbanisation factor should enhance this trend.

3.1.5 Sand

The Sand catchment is home to the highest domestic water requirements in the Study Area. These revolve around the Polokwane region and are supported largely by surface water resources from outside of the WMA, namely Olifanstpoort, Ebenezer Dam and Dap Naude Dam. From within the catchment the Houtrivier Dam and groundwater are utilised. Upon comparing the results of naturalised mean annual runoff (MAR) for the Sand catchment, it is clear that there is a large discrepancy between the water being used within the catchment and the amount of water available naturally. That is the reason for the transfers.

Irrigation is again a large water user within this catchment, and mining, being limited to the copper mines surrounding Musina until these closed in 1992, is also set to play a role again with the future water requirements as production at Vele Mine begins again.

3.1.6 Nzhelele

The Nzhelele catchment is home to the area between both Makhado (Louis Trichardt) and Musina and as such, large amounts of development are expected within this catchment. Currently the bulk water users follow the same trend as most of the other catchments – mostly irrigation and domestic usage with some mining. The Nzhelele catchment also obtains water from outside the catchment, and is set to do this more going forward with transfers from Nandoni Dam to Makhado.

There are also potential mining developments in the area, with Coal of Africa looking to develop the Chadupi and Makhado Projects.

There are good water resources available in the catchment with three large dams (Nzhelele, Luphephe and Nwanedi) used primarily for irrigation schemes downstream. A small portion of the Soutpansberg also enters the upper reaches of the catchment, and thus, there is a large difference between the rainfall in the mountainous upper reaches and the relatively flat lower reaches of the catchment.

3.2 IRRIGATION FUTURE WATER REQUIREMENTS

Irrigation is the dominant water user in the Study Area, comprising 78% of the total water requirement. The main crops within the Study Area include tobacco and citrus. Dryland cultivation with crops such as grain sorghum and cotton are also practised.

The estimated irrigated area at the 2010-development level is 666 km² with an annual water requirement of 465 million m³. However, 152 km², with a water requirement of 146 million m³, is directly supplied from the Limpopo River main stem and associated sand aquifers. Approximately 57% of the irrigation is supplied from groundwater and 36% from surface water with only 7% from regulated government irrigation schemes. Approximately 48% of the total irrigated area is located in the dry Sand River catchment, supplied mainly by groundwater resources.

No significant irrigation growth is expected in the Study Area due to the limited water resources. Furthermore, a large number of irrigation farmers are converting to game farming. This happens at a greater scale in the Mokolo, Lephalala and Sand river catchments with a consequent reduction in the irrigation water requirement.

3.2.1 Expected development

No growth is assumed for the irrigation water requirements in the Study Area. Therefore the water requirements reported in **Table 2.2** will remain constant throughout the entire study period.

3.3 DOMESTIC FUTURE WATER REQUIREMENTS

The domestic water requirements for the Study Area were comprehensively evaluated by Glen Steyn & Associates and are reported alongside the socio-economic projections in the *Socio-Economic perspective on future water requirements report (PWMA 01/000/00/02914/4/3).*

The evaluation of the domestic water requirements was based mainly on the population figure per catchment. Two databases (Census 2011 and DWS settlement population figures) were used to determine a population figure that best represents the current population of the Study Area. This is necessary as both these data bases have weaknesses that will either under- or over count the population of an area.

3.3.1 Census database

The Census population figure is based on a door to door count and is considered the official national population figure. The drawback in this database being that, historically the census took place at 5 year intervals, but this has been extended to 10 years. This large gap between Census surveys creates uncertainty of the population and household sizes for years over that 10 year gap. As a method of minimizing this uncertainty, Statistics South Africa (Stats SA) conducts smaller community surveys at certain intervals between Censuses. The objective of community surveys is to collect socio-economic data, demographic trends, levels of employment, etc. in order to bridge the gap between censuses as well as assist the government and private sector in planning as well as various monitoring programmes.

Only about 280 000 households are surveyed nationwide for community surveys thus making community survey less representative compared to Census data.

3.3.2 DWS settlement population

This database is based in the so called rooftop count methodology. DWS uses satellite images to count the number of rooftops across the entire country on an annual basis. The rooftop count figure is then multiplied by an estimated household size. This methodology is accurate in rural areas but can be problematic in areas where multiple households live under one roof which has a high incidence in urban areas. **Table 3.2** gives a summary of the current demographics for the Study Area comparing the two before mentioned databases. It is evident from **Table 3.2** that the

DWS population figure is 2.3% higher on the total figure than the Stats SA Census 2011 figure. This difference in population figures is because the DWS rooftop count method is using household sizes from the 2006/2007 Stats SA community survey. These household sizes are slightly higher than the Census 2011 household sizes.

Table 3.2 Summary of Study Area demographics

Indicator	Number
Total population according to Stats SA Census 2011	1 897 664
Total population according to DWS Form G for 2011	1 941 592
River catchments	6
District Municipalities	3
Local Municipalities	12
Wards	186
Settlements according to Stats SA	713
Settlements according to DWS	881

Sources: Stats SA, Census 2011 and DWS LP Settlements Form G

This variance between the Stats SA and DWS made it necessary to develop a population figure that combines the strong points of both databases with the aim of minimising the effects of the inherent drawbacks of the separate databases. The combination of the databases creates a planning population (DWS, 2015) for the Study Area. This figure uses the DWS rooftop count figure, which is updated annually, and multiplies it with the Census 2011 household sizes instead of the 2006/2007 Community survey household sizes. This value is then increased by 4%, derived from the National Transport Master Plan for Limpopo, to provide for circular migration.

3.3.3 Expected development and changes in water requirements

It is assumed that the water service levels within the project area will increase progressively. Two development scenarios are reported in the *Socio-Economic perspective on future water requirements report (PWMA 01/000/00/02914/4/3).* The base scenario, reported in **Table 3.3**, assumes that street tap water service levels will be reduced from 38% of the project area population in 2011 to 26.5% in 2020.

Yard connections are assumed to increase to 52% in 2020. This scenario also assumes that the per capita water consumption for street tap services will increase to 30ℓ/d and that water losses can be reduced to 15% of direct consumption through effective WCWDM. This scenario then results in change in domestic water requirements of 93.1 million m^3/a in 2011 to 128.07 million m^3/a in 2040 for the entire project area.

Table 3.3 Domestic water requirement projections for Study Area: Base scenario

Year	Indicator	Home connection	Yard connection	Communal	Total
2011 Losses 28.2%	Planning population	467 810	744 958	752 820	1 965 588
	Level of service (factor)	0.238	0.379	0.383	1
	Consumption rate (ℓ/c/d)	180	80	60	
	Total consumption (kℓ/d)	84 206	59 597	45 169	188 972
	Provision for water losses and peak demand (kℓ/d)	40 587	28725.6	21771.6	91084.3
	Total residential requirement (million m³/a)	**45.5**	**32.2**	**24.4**	**102.2**
2020 Losses 25.7%	Annual population growth rate %: 2011-2020				0.849
	Level of service (factor)	0.22	0.49	0.29	1
	Planning population	465 476	1 036 741	613 582	2 115 799
	Consumption rate (ℓ/c/d)	180	80	60	
	Total consumption (kℓ/d)	83 786	82 939	36 815	203 540
	Provision for water losses and peak demand (kℓ/d)	38 290	37 903	16 824	93 018
	Total residential requirement (million m³/a)	**44.6**	**44.1**	**19.6**	**108.2**
2030 Losses 23%	Annual population growth rate %: 2021-2030				0.79
	Level of service (factor)	0.20	0.61	0.19	1
	Planning population	456 590	1 392 600	433 761	2 282 950
	Consumption rate (ℓ/c/d)	180	90	60	
	Total consumption (kℓ/d)	82 186	125 334	26 026	233 546
	Provision for water losses and peak demand (kℓ/d)	35 340	53 894	11 191	100 425
	Total residential requirement (million m³/a)	**42.9**	**65.4**	**13.6**	**121.9**
2040 Losses 20%	Annual population growth rate %: 2031-2040				0.94
	Level of service (factor)	0.02	0.70	0.10	1
	Planning population	499 467	1 748 134	249 733	2 497 335
	Consumption rate (ℓ/c/d)	180	90	60	
	Total consumption (kℓ/d)	89 904	157 332	14 984	262 220
	Provision for water losses and peak demand (kℓ/d)	35 962	62 933	5 994	104 888
	Total residential requirement (million m³/a)	**45.9**	**80.4**	**7.7**	**134.0**

The alternative scenario, reported in Table 3.4, assumes that water losses cannot be reduced at all and that the improvement in water service levels will be slower such that 20% of households are still on communal services by 2040. Based on these assumptions, the 2040 domestic water requirement is estimated at 137.7 million m^3/a.

Table 3.4 Alternative scenario for domestic water requirements

Year	Indicator	Home connection	Yard connection	Communal	Total
2011	Planning population	467 810	744 958	752 820	1 965 588
	Level of service (factor)	0.238	0.379	0.383	1.000
	Consumption rate (ℓ/c/d)	180	80	60.0	
	Total consumption (kℓ/d)	84 206	59 597	45 169	18 8972
	Provision for water losses and peak demand (kℓ/d)	40 587	28 726	21 772	91 084
	Total residential requirement (million m³/a)	**45.5**	**32.2**	**24.4**	**102.2**
2020	Annual population growth rate %: 2011-2020				0.85
	Level of service (factor)	0.22	0.48	0.30	1
	Planning population	465 476	1 015 583	634 740	2 115 799
	Consumption rate (ℓ/c/d)	180	80	60.0	
	Total consumption (kℓ/d)	83 786	81 247	38 084	203 117
	Provision for water losses and peak demand (kℓ/d)	40 385	39 161	18 357	97 902
	Total residential requirement (million m³/a)	**45.3**	**43.9**	**20.6**	**109.9**
2030	Annual Pop Growth Rate %: 2021-2030				0.79
	Level of service (factor)	0.20	0.55	0.25	1
	Planning population	456 590	1 255 623	570 738	2 282 950
	Consumption rate (ℓ/c/d)	180	90	60.0	
	Total consumption (kℓ/d)	82 186	113 006	34 244	229 437
	Provision for water losses and peak demand (kℓ/d)	39 614	54 469	16 506	110 588
	Total residential requirement (million m³/a)	**44.5**	**61.1**	**18.5**	**124.1**
2040	Annual Population Growth Rate %: 2031-2040				0.94
	Level of service (factor)	0.20	0.60	0.20	1
	Planning population	499 467	1 498 401	499 467	2 497 335
	Total consumption (kℓ/d)	180	90	60	
	Total consumption (kℓ/d)	89 904	134 856	29 968	254 728
	Provision for water losses and peak demand (kℓ/d)	43 334	65 001	14 445	122 779
	Total residential requirement (million m³/a)	**48.6**	**72.9**	**16.2**	**137.8**

These two scenarios form a growth envelope that describe the best and worst case scenario, as shown in figure, for possible growth in the domestic water requirement for the project area. These are both high level projections of the domestic water requirements and are subject to change depending on how effective the WCWDM strategies are, population growth rates and changes in water service levels.

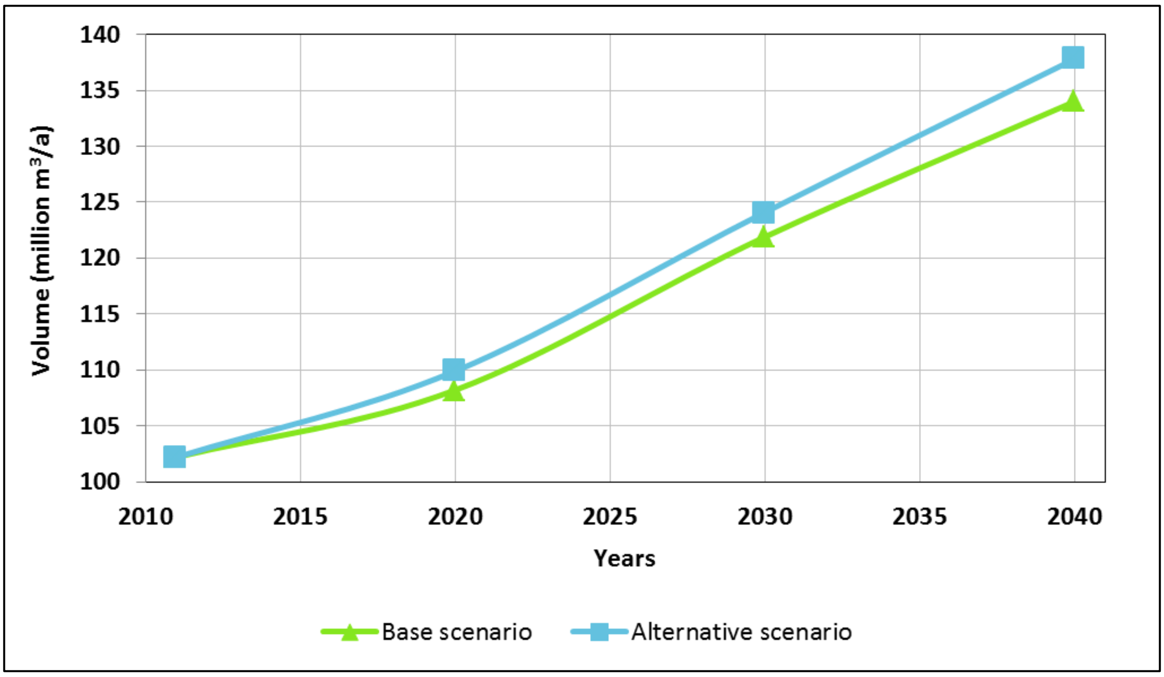

Figure 3.1 Domestic water requirements growth envelope

Population growth rates are in a long term decline. Population projections at settlement levels indicate that the average project area population growth rate could be 0.79% per year from 2021 to 2030. For the last part of the domestic water requirements projections it is estimated that the project area population will on average by 0.94% per year from 2030 to 2040.

3.3.4 Summary of future domestic requirements

A detailed evaluation of the domestic water requirements per catchment (DWS, 2015) is reported in the *Socio-Economic perspective on future water requirements report (PWMA 01/000/00/02914/4/3)* and detailed calculation tables, derived from this report, of domestic water requirements per catchment are reported in **Appendix B**.

As in the historic and current domestic water requirements reported in **Section 2**, the Matlabas catchment is taken as having no settlements. It is assumed that no new settlements will for in this catchment thus resulting in a domestic water requirement of zero in the analysis of future water requirements.

Domestic water requirements for the five catchments are significantly different due to differences in population figures and water service levels.

3.4 INDUSTRY AND POWER FUTURE WATER REQUIREMENTS

3.4.1 Background

At the base year development level (2010), the only major industrial and power generation operation that was operational within the Study Area was Eskom's Matimba Power station. More developments within the power generation and industrial sectors are expected to operate in this area. These will be evaluated in this section and incorporated into the water balances for the relevant catchments.

3.4.2 Expected development and changes in water requirements

Expected industrial and power generation developments are expected to take place within the Matlabas, Mokolo, Mogalakwena and Sand River catchments. In addition to the Matimba and Medupi power stations, situated in the Mokolo catchment, up to three additional power stations may be developed.

The Boikarabelo Power Station will be developed to supply power to the Boikarabelo coal mining project located in the Matlabas catchment. The water requirements for this development will be supplied by Marapong's treated effluent via the Marapong-Boikarabelo Effluent Transfer (MBET) project. Resource Generation has signed a contract with Lephalale LM to upgrade the current Marapong wastewater treatment works (WwTW) in the Lephalale area to 16 Mℓ/d as well as to operate and maintain this WwTW. The treated effluent will then be pumped to stage two of the firm's planned Boikarabelo mine site. The Boikarabelo project is expected to be operational towards the end of 2017.

Eskom's Medupi Power Station, is a Greenfield coal-fired power plant located west of Lephalale town and is currently being constructed. When completed, the power station will be the fourth largest coal driven plant in the southern hemisphere and is expected to be the largest dry-cooled power station in the world. The water requirements for this project are expected to be supplied via the MCWAP project. Either another large power station or three to four smaller independent power producer (IPP) stations are considered for the Lephalale area and will be supplied by MCWAP.

Another industrial development, situated in the Sand catchment, is the Anglo Platinum Smelter. The water requirement for this industrial user is expected to be supplied from the Sand catchment or additional transfers from the adjacent Olifants River catchment and has been taken into consideration in the relevant water balance.

In addition to these developments, the Limpopo Eco-Industrial Park (LEIP) and the Musina Special Economic Zone (SEZ) will be developed in the Sand River catchment. These two developments are discussed in **Sections 3.6.2** and **3.6.3** of this document.

3.4.3 Summary of future industry and power requirements

The water requirements for the Eskom power stations (Matimba and Medupi) will be supplied from the MCWAP Phase II project. This project is evaluated in detail as part of the *Reconciliation Strategy for the Crocodile West River System* and the water requirements for power generation in the Mokolo catchment reported in **Table 3.5** are sourced from the before mentioned Crocodile West River System reconciliation study.

Table 3.5 Water requirements for power generation to be supplied by MCWAP (million m^3/a)

Project	2010	2015	2020	2025	2030	2035	2040
Matimba Power Station	4.67	3.60	3.60	3.60	7.60	7.60	7.60
Medupi Power Station	0.66	6.00	10.40	15.40	15.40	15.40	15.40

As mentioned in **Section 3.4.2**, the water requirements for the Boikarabelo project will be supplied via the MBET project in conjunction with groundwater abstractions by the Boikarabelo mine site. The Anglo Platinum smelter on the other hand is expected to be supplied from the water resources within the Sand river catchment. Reported in **Table 3.6** are the water requirements and preliminary timeline for the smelter and the Boikarabelo project.

Table 3.6 Water requirements and timeline for Boikarabelo Project and Anglo Platinum smelter (million m^3/a)

Project	2010	2015	2020	2025	2030	2035	2040
Boikarabelo Project - groundwater supply	0.00	0.00	2.13	2.13	2.13	2.13	2.13
Boikarabelo Project - MBET	0.00	0.00	5.84	5.84	5.84	5.84	5.84
Anglo Platinum Smelter	0.00	0.73	0.73	0.73	1.10	1.10	1.10

It should be noted that the water volumes reported in **Table 3.6** for the Boikarabelo project are for both the mining and the power plant operation and are not the water requirement but are the water allocation volumes as confirmed by Boikarabelo mine.

3.5 MINING FUTURE WATER REQUIREMENTS

3.5.1 Background

Mining operations in the Study Area are large water users and there are a number of current and potential developments within the WMA. The information reported in this section is a combination of three databases. The first data base used is that containing information sourced from various technical and environmental impact studies released by the various mines. Also included in this database is information sourced via telephonic and email communication to the various mining operations.

The second database used contains data pertaining to water requirements within the Matlabas and Mokolo catchments. This data was determined as part of the Crocodile West Reconciliation Strategy. In areas where these two databases do not have information or have incomplete information, an analysis and estimate by Glen Steyn and Associates (2015) was used to source the relevant data.

3.5.2 Expected development and changes in water requirements

There are various potential mining developments expected in the Study Area, these range from coal mining operations to platinum mining operations and each of these will have an effect on the water requirements of the catchments in which they are situated and on the water requirements of the Study Area as a whole.

The most prominent mining developments are expected to take place in the Mokolo, Sand and Mogalakwena River catchments. No growth is expected, in terms of water requirements, within the Nzhelele, Matlabas and Lephalala River catchments. Although some mining operations such as the Boikarabelo project and Makhado mine are located within the Matlabas and Nzhelele catchments respectively, it is expected that their water requirements will not be supplied from the catchments they are in but instead will be transferred from neighbouring catchments.

Possibly the biggest mining development expected to take place within the Study Area is the Greater Soutpansberg mining project situated on the border between the Sand and the Nzhelele river catchments near the town of Mopane and Makhado (see **Figure 3.2**). This development is a consolidation of nine mining operations over three regions and is expected to be fully operational in 2030. This development is discussed in detail in **Section 3.6.4**. This is one of many mining operations expected to be developed in the Study Area. Reported in **Table 3.7** is a list of the anticipated mining operations in the Study Area, expected year when operations will commence, the catchment in which they are located and the catchment from which the water requirements is expected to be supplied from.

3.5.3 Summary of future mining requirements

It stands to reason that all the aforementioned mining operations will increase the water requirements of the Study Area, depending on the type of operations and production rate of the operations. The scenario reported in this document is based on the operations that have been confirmed to be proceeding with developments. Operations that have not released information, are not proceeding or are in early exploration stages are not included in the mining water requirements.

The mining water requirements are not a reflection of the location of the mine but rather reflect on where the water requirements will be supplied from. For example, some of the consolidated operations within the Greater Soutpansberg Project (GSP) are in the Nzhelele River catchment; however, the water requirements for the entire GSP are expected to be supplied from the Sand River catchment. The water requirements for the GSP would then be reflected under the Sand River catchment and not the Nzhelele River catchment.

Table 3.7 Summary of anticipated mining developments

Mining operation	Expected start	Location(5)	Expected water source
Akanani	2020	Mogalakwena	
Berenice(1)		Sand	
Boikghantso(4)		Mogalakwena	
Boikarabelo Coal Mine	2017	Matlabas	MBET / Groundwater
Buffalo Flourspar mine(1)		Mogalakwena	
Bushveld Tin project(3)		Mogalakwena	
Bushveld Vanadium project(3)		Mogalakwena	
Glenover Phosphate mine(4)		Matlabas	
Grassvalley(3)	2016	Mogalakwena	Mogalakwena GW
GSP	2030	Nzhelele / Sand	Sand / Luvuvhu and Letaba transfers
Ironveld	2019	Mogalakwena	Flag Boshielo
Krone-Endora Alluvial project(4)		Mogalakwena	
Limpopo West Coal Mine (previously Mafutha) – Phase 2(1)		Matlabas	
Limpopo West Coal Mine (previously Mafutha) – Phase 3(1)		Matlabas	
Makhado Coal mine	2019	Nzhelele	Sand
Mokopane Bushveld mineral project(3)		Mogalakwena	
Platreef project	2020	Mogalakwena	ORWRDP transfers
Rooipoort Platinum Project(1)		Mogalakwena	
Temo Coal mine	2018	Matlabas	Mokolo / MCWAP-2
Thabametsi Coal Mine	2018	Matlabas	Mokolo/ MCWAP-2
Vele Coal mine	2017	Sand	Sand groundwater
Zebediela(4)		Mogalakwena	
Volspruit project	2018	Mogalakwena	Mogalakwena groundwater
War springs(2)		Mogalakwena	
Waterberg Joint Venture	2014	Matlabas	Mokolo/ MCWAP-2
Zandrivierspoort	2019	Sand	Sand groundwater / Luvuvhu and Letaba transfers

(1) Development is not proceeding
(2) Development is in early exploration stages
(3) Data is being evaluated and compiled by mining company and is not available to the public yet
(4) Development is in pre-feasibility/feasibility stage
(5) This refers to the location of the mining infrastructure, not the water source for operations

Based on these conditions, the mining water requirements per catchment are reported in Table 3.8.

Table 3.8 Mining future water requirements (million m^3/a)

Catchment	2010	2015	2020	2025	2030	2035	2040
Matlabas(1)	0.00	0.00	7.97	7.97	7.97	7.97	7.97
Mokolo	11.20	14.11	35.77	61.99	86.34	89.92	110.42
Lephalala	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mogalakwena	1.59	4.20	14.73	19.84	25.87	25.87	25.87
Sand	4.20	0.73	26.70	36.00	43.48	49.08	49.08
Nzhelele	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**16.99**	**19.04**	**85.17**	**125.8**	**163.66**	**172.84**	**193.34**

Note: (1) Combination of GW availability and MBET transfer from Mokolo River catchment

3.6 KEY DEVELOPMENTS

3.6.1 The Mutasshi/Musina corridor bulk water supply

The proposed Mutasshi/Musina development corridor is a strategic supply hub initiative which is composed of a new infant port, freight and logistics gateway, as well other sub components of the development such as;

- The proposed LEIP;
- The proposed Trade Centre;
- The proposed expansion of mining activities and
- The proposed expansion of agricultural activities in the Nzhelele Valley and surrounding areas.

According to the Technical Feasibility report for this development, the development corridor is expected to run from Makhado through Musina and ending at Beit-Bridge on the border with Zimbabwe. The development encompasses the entire Makhado and Musina Local Municipalities and is expected to dramatically increase the level of economic activities in the area (DWA, 2013b). The objective of this development is to transform this region into a major hub for industrial and economic developments.

a) Water demand centres

The main water demand centres that were considered in the Mutasshi / Musina technical feasibility study are as follows;

- Weipe / Pontdrift Farms;
- Venetia Mine;
- Vele Colliery;
- Musina Town;
- Nzhelele Farms; and
- GSP (CoAL)

It is necessary to highlight the water requirements for Musina LM in anticipation of the major developments that will be occurring in the area. The water balances reported in this section are determined from a combination of information sourced from the Mutasshi / Musina development technical feasibility study and modelling of agricultural water use is based on the data and information obtained during the validation and verification project commissioned by the Limpopo regional office of the DWS. A water Balance for Musina LM based only on the technical feasibility study is reported in **Appendix C**.

b) *Musina LM water balance*

The first water balance takes into consideration four sources of water over a study period of 2010 to 2044 (DWA, 2013b). Intervention options are not considered in the first water balance but are included in the second water balance in order to highlight the impact that they could have on the system. **Table 3.9** reports the demand centres in the LM along with their associated water requirement over the study period. **Table 3.10** reports the current and projected water availability in the LM without taking into consideration any interventions.

Table 3.9 Musina LM demand centres and water requirements (million m^3/a)

Sector	2010	2015	2020	2025	2030	2035	2040	2044
Musina town	6.57	7.96	9.34	10.658	11.972	15.5	18.5	21.5
Venetia Mine	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20
Vele Colliery	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
Irrigation(1)	87.79	87.79	87.79	87.79	87.79	87.79	87.79	87.79
Other	0.37	0.37	7.45	9.38	11.32	11.32	11.32	11.315
Total	**99.30**	**100.69**	**109.15**	**112.40**	**115.65**	**119.18**	**122.18**	**125.18**

Note: (1) Information sourced from DWS and Validation and Verification Study

Table 3.10 Musina LM Water sources and projected availability (million m^3/a)

Sector	2010	2015	2020	2025	2030	2035	2040	2044
Nzhelele Dam	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00
Groundwater harvest potential	30.45	30.45	30.45	30.45	30.45	30.45	30.45	30.45
Groundwater abstraction	93.37	93.37	93.37	93.37	93.37	93.37	93.37	93.37
Over abstraction of groundwater	62.92	62.92	62.92	62.92	62.92	62.92	62.92	62.92

Based on the information sourced from the technical feasibility study, it is evident that there is no water shortages at the major demand centres within the Musina LM, however there are large volumes of over abstracted groundwater in the area.

A possible way to reduce the over abstracted volumes is through the introduction of a new water sources. A possible intervention that is evaluated in the technical feasibility is Zhove Dam on Umzingwane River in Zimbabwe. It has been established that at least 30 million m^3/a of water can be purchased from the Zimbabwe National Water Authority (ZINWA) as soon as requirements have been met. The Umzingwane River is a tributary of the Limpopo River which joins the Limpopo River approximately 5km upstream of Beitbridge border post (DWA, 2013b).

If this intervention option is implemented, the water from Zhove Dam can be used to meet the water requirements of the GSP, provide for the shortfall experienced by the Nzhelele Valley Irrigation Farmers Association and reduce the strain on groundwater resources by reducing volumes of over abstracted groundwater.

In the second water balance takes into consideration the same demand centres as reported in Table 3.9, however the anticipated effects of Zhove Dam are now included in the water sources as reported in Table 3.11.

Table 3.11 Musina LM water sources and projected availability - reduced GW over-abstraction (million m^3/a)

Sector	2010	2015	2020	2025	2030	2035	2040	2044
Nzhelele Dam	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00
Groundwater harvest potential	30.45	30.45	30.45	30.45	30.45	30.45	30.45	30.45
Groundwater abstraction	93.37	93.37	93.37	93.37	93.37	93.37	93.37	93.37
Over abstraction of groundwater	62.92	62.92	32.92	32.92	32.92	32.92	32.92	32.92

Table 3.12 Potential water supply from Zhove Dam (million m^3/a)

Option	2010	2015	2020	2025	2030	2035	2040	2044
Zhove Dam	0.00	0.00	30.00	30.00	30.00	30.00	30.00	30.00

Based on the information at hand, it seems that Musina LM does, at current development, have the resource capacity to support the development of the Mutasshi/Musina development corridor. The water requirements of the proposed inland port, transport hub and supply centre can be met from the present source. The proposed LEIP is expected to make extensive use of water recycling technology as part of the design and will require minimal additional water to the existing Musina LM requirement. A detailed evaluation of this development is reported in *Development of feasibility for the Mutasshi/Musina Corridor Bulk Water Supply – Final Technical feasibility Study Report (DWA – Contract: WP10634)* (DWA, 2013b).

3.6.2 Limpopo Eco-Industrial Park

As mentioned in **Section 3.6.1**, the LEIP is considered one of the main developments expected to take place as part of the Mutasshi / Musina development corridor. The LEIP is situated approximately 14km South West of Musina town in the Study Area. The LEIP development is aimed at being the first zero solid waste eco-industrial park in the world. Main components of this development are:

- Coke and power generation plant;
- Gas to liquid plant;
- Brick making plant;
- Plasma waste gasification plant; and
- Wastewater treatment plant.

The brick making plant and the plasma waste gasification plant are expected to use the waste from the operations listed as well as waste from the entire Musina special economic zone, in their manufacturing processes. This will result in the formation of a closed loop between a chain of industries that will benefit each other.

This LEIP provides even more opportunities in areas such as eco-tourism; environmental management; education and training. To develop these opportunities, the LEIP will house various facilities such as a Visitor's Centre, an Industrial Ecology Faculty, an entire Eco-Tourism area as well as Training Facilities. Another exciting initiative is the Business Incubator. A facility that will be set up to provide opportunities for Small, Medium and Micro Enterprises (SMMEs) to stimulate and support the entrepreneurial spirit (Eco-Industrial Solutions, 2015).

The water requirements associated with the LEIP are, in the long run, expected to be relatively low. However, at this stage, there is limited information on what the expected water requirements at full operation are expected to be. Estimations by Glen Steyn & Associates (2015) indicated that initial water requirement estimates for the LEIP at 14.61 million m^3/a in 2030.

A preliminary timeline for the development and operation of the LEIP is reported in **Table 3.13**.

Table 3.13 Initial timeline and water requirement estimates for the LEIP (million m^3/a)

User	2011	2020	2030	2040
LEIP	0.00	7.30	14.61	14.61

Source: Estimates by Glen Steyn and Associates, 2015

The water requirements reported in **Table 3.13** have been incorporated into the Sand River catchment water balance.

3.6.3 Musina Special Economic Zone

The SEZ Project is a joint development between the Department of Trade and Industry (DTI) and the Limpopo Government with the objective of establishing two special economic zones in the province. The first economic zone, located at Musina, will be focusing on coal beneficiation while the other, located in the Greater Tubatse LM, focuses on platinum beneficiation.

The second SEZ is located outside of the Study Area and there are no expected water transfers from the Study Area to this development. This development will thus not be evaluated in the context of the report.

The Musina SEZ is currently in early planning stages and thus there is limited information available on the possible future water projections. Preliminary estimates from the Pre-Feasibility study suggest a water requirement of 14.61 million m^3/a in 2030. A preliminary timeline for the development and operation of the Musina SEZ is reported in **Table 3.14**.

Table 3.14 Initial timeline and water requirement estimates for the Musina SEZ (million m^3/a)

User	2011	2020	2030	2040
Musina SEZ	**0.00**	**7.30**	**14.61**	**14.61**

Source: Estimates by Glen Steyn and Associates, 2015

3.6.4 Coal of Africa Limited - Greater Soutpansberg Project

The GSP is a coal mine development project that is 74% owned by Coal of Africa Limited (CoAL) with the remaining 26% held by Rothe Investment (Pty) Ltd, a Black Economic Empowerment as contemplated in the Mining Charter. This development is consolidation of nine projects in three regions;

- Mopane Project;
- Jutland;
- Voorburg;
- Makhado Project;
- Generaal;
- Telema / Gray (previously Makhado Extension);
- Mount Stuart;
- Makhado;
- Chapudi Project;
- Chapudi;
- Chapudi West; and
- Wildebeesthoek.

All the above mentioned projects are situated to the north of the Soutpansberg in the Limpopo Province and are expected to be in full operation in 2030. **Figure 3.2** shows the anticipated location of the mines in relation to each other as well as to Musina and Makhado town.

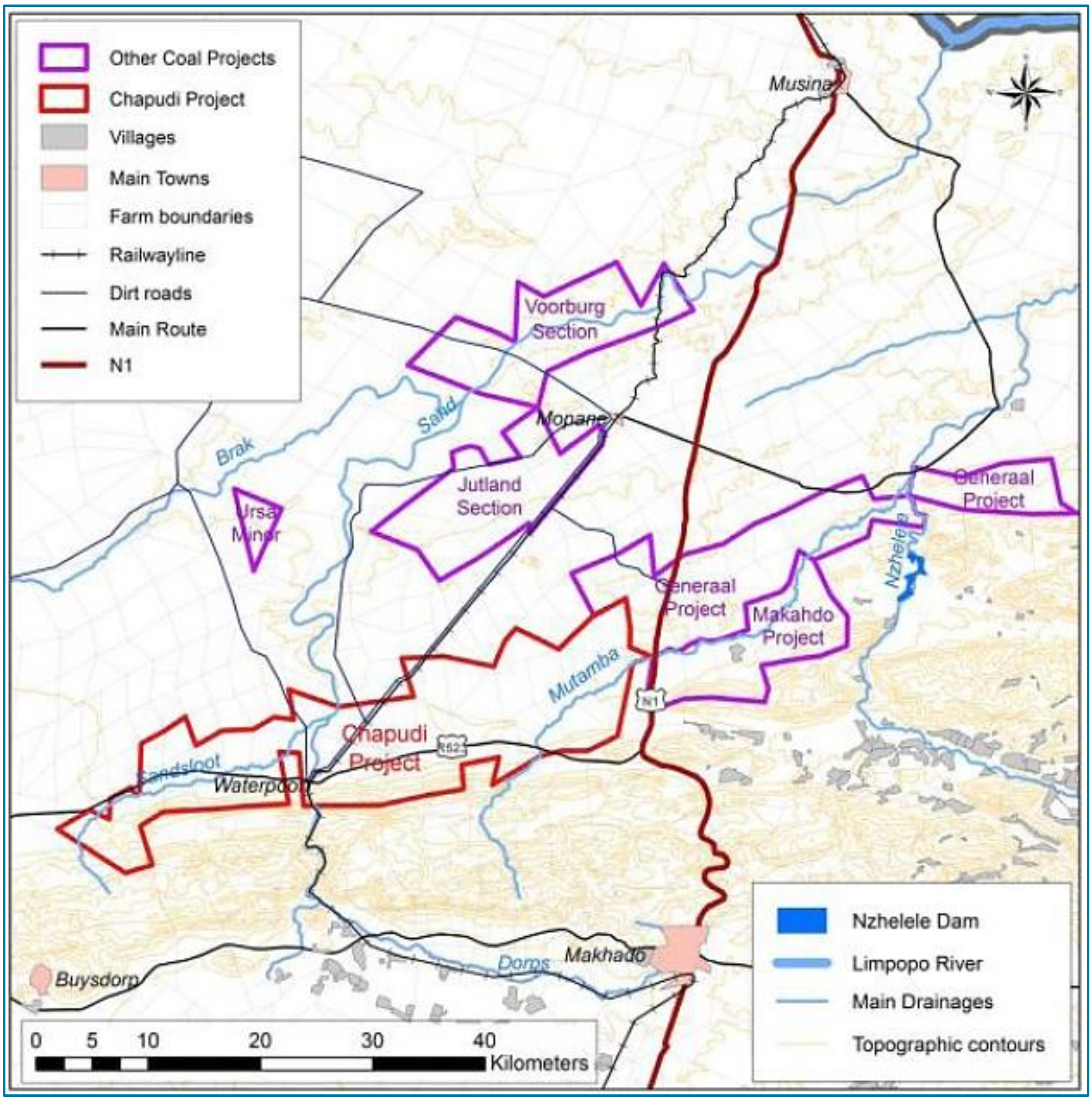

Figure 3.2 Project Locality for the Greater Soutpansberg Project

Source: WSM Leshika: Chapudi Groundwater Specialist Report, 2013

A preliminary schedule for these operations indicates that the Makhado project is expected to be the first to begin operating in 2016. Each of the projects will require an average of 3.65 million m^3/a of water. The life of a mine for each of the projects is approximated at 20 years. Reported in Table 3.15 is the expected growth of water requirements for the GSP from 2001 to 2030. It is expected that the water requirement at full operation (2030) will remain constant for the foreseeable future.

Table 3.15 Estimated water requirement for the Greater Soutpansberg Project (million m^3/a)

Mine	2011	2020	2030
Makhado	0.00	3.32	3.32
Chapudi	0.00	0.00	4.02
Mopane	0.00	0.00	2.78
Generaal	0.00	0.00	4.02
Total	**0.00**	**3.32**	**14.13**

Source: Company Records from Coal of Africa Ltd and confirmed in January 2014

The water requirements of the mines are expected to be supplied from the following sources:

- Groundwater (boreholes and seepage into the mining pits);
- Storm water run-off impounded on site;
- Sewage effluent release from Makhado; and
- Abstraction from the Sand River

Of the projects listed in **Table 3.15**, only the Generaal Project is expected to have a portion of its water requirements supplied from Nzhelele Dam (through a buy-out of existing abstraction rights), however, for the purposes of this report, the water requirements of the entire GSP are taken into consideration under the Sand River catchment water balance.

3.7 OTHER WATER USERS

The major water users in the Study Area are domestic, irrigation and industrial and mining, however there are other, smaller users in the project area that must be taken into consideration in order to develop a strategy that is as representative as possible of reality.

Water users that will be considered in this section are the following;

- Shopping centres
- Office blocks
- Schools and institutions of higher education
- Hospitals and Clinics
- Municipal buildings (Prisons, police stations, etc.)

These water users are unique because most of them do not have permanent residents but instead are active during specific hours of the day. Water users such as schools and office blocks are examples of water users that would only be active during office hours and then having zero water use in late afternoons and at night. Care must be taken in the estimations of theses water requirements.

The water requirements reported in this section were estimated by Glen Steyn and Associates and are reported in the *Socio-Economic perspective on future water requirements report (PWMA 01/000/00/02914/4/3).*

4 RETURN FLOWS AND WATER RE-USE

4.1 RETURN FLOWS

The determination of the irrigation return flows were simulated in WRSM2000 using the WQT-SAPWAT irrigation Block (RR) Module. A detailed evaluation of the methodology and input files used in this analysis is described in the *Hydrological Analysis: Volume 1 – Main Report (P WMA 01/000/00/02914/3)*.

The average annual irrigation water requirement and return flows at the 2010-development level were determined from the irrigated areas as summarised in **Table 4.1**. A detailed table of the historic irrigated areas per quaternary catchment is reported in **Table C.2** of **Appendix C**.

Table 4.1 Historic growth of irrigated areas

Catchment	Growth in irrigation areas (km^2)				
	1920	1950	1989	1998	2010
Matlabas total	0.00	0.00	0.00	7.37	7.39
Matlabas (excluding Limpopo River)	0.00	0.00	0.00	4.44	4.46
Mokolo total[1]	2.97	32.16	117.24	99.49	101.36
Mokolo (excluding Limpopo River)[1]	2.97	32.16	117.24	99.49	101.36
Lephalala total	0.00	0.18	137.90	83.00	82.99
Lephalala (excluding Limpopo River)	0.00	0.18	87.67	63.75	63.74
Mogalakwena total	0.51	7.42	111.28	133.91	133.93
Mogalakwena (excluding Limpopo River)	0.51	7.42	110.95	112.46	112.48
Sand total	0.00	4.77	78.98	324.31	298.91
Sand (excluding Limpopo River)	0.00	4.77	78.98	290.30	270.97
Nzhelele total	0.00	0.00	26.16	48.30	41.48
Nzhelele total (excluding Limpopo)	0.00	0.00	26.14	37.59	33.28
Study area	**3.48**	**44.53**	**471.56**	**696.38**	**666.06**
Study area (excluding Limpopo)	**3.48**	**44.53**	**420.98**	**608.03**	**586.29**

Note: (1) As per the "Updating the Hydrology and Yield Analysis of the Mokolo River Catchment" Study (DWA, 2007).

The focus of this study is on the water resources fed by runoff generated within the Study Area and therefore exclude irrigated areas that are supplied from the Limpopo River main stem and associated aquifers. The total irrigated areas per catchment include areas that are supplied from the main stem, however, the areas that exclude the Limpopo River are used in WQT-SAPWAT simulations.

4.1.1 Return flow volumes

Modelled Irrigation Block return flows in WRSM2000 are controlled by means of a return flow factor. The return flow factor was adjusted by the user, in an iterative process, until the average annual return flow volumes (as a percentage of supply) given in the *Validation and Verification Study* were achieved. Furthermore, flows routed through the Irrigation Block return flow channel can be selected to be either net return flow or total return flow. The total return flow is calculated as the sum of two components:

- The amount of return flow generated as a direct result of the irrigation applied; and
- The runoff that would have been generated under natural conditions by the irrigated catchment area.

The return flows reported in this section are net return flow volumes (direct result of applied irrigation), determined as percentage of supply. These return flows, as reported in **Table 4.2**, are linked to the 2010-development level irrigation requirements and because no growth is assumed for irrigation water requirement, return flow volumes will also experience no growth.

Table 4.2 Net return flows volumes per catchment (million m^3/a)

Total catchment / quaternary	Average annual irrigation return flows (million m^3/a)			
	Surface water	Groundwater	Scheme	Total
Matlabas	0.19	0.19	0.00	0.38
Mokolo	2.53	0.27	0.53	3.33
Lephalala	3.25	1.90	0.00	5.15
Mogalakwena	2.42	4.17	0.58	7.17
Sand	3.67	13.38	0.00	17.05
Nzhelele	0.69	0.42	1.78	2.89
Study area	**12.75**	**20.34**	**2.89**	**35.98**

4.2 POTENTIAL FOR WATER RE-USE

The premise of water reuse is the evaluation of the available effluent from wastewater treatment works (WwTW) and then deciding whether the effluent, through the application of advanced treatment processes, can be reused for irrigation, process water, potable water or direct discharge into the river system. The acceptability of treated effluent is based on ratings derived from the Green Drop report.

Reported in this section is the quantity of effluent that is available as potential water for reuse, different types of advanced processes that can be applied to effluent. Where no information was available regarding the operation capacity of the WwTW's, it was assumed based on information available in the Green Drop report. If the WwTW in question was a small facility such as an oxidation pond, the operational capacity was assumed to be less than 2 Mℓ/d.

4.2.1 Effluent quantity

The task in this section of the reconciliation study was to identify opportunities for the reuse of treated sewage effluent within the Study Area, focusing of the current impact of this source on the receiving environment.

An investigation into the number of wastewater treatment plants in the Study Area was conducted. These were then classified, first into those with and without river discharge, followed by classification according to operational capacity of the plants with river discharges. The information reported was sourced from the 2013 Green Drop report, obtained from DWS Limpopo, and where no information was available; the assumptions as described in **Section 4.2** were applied.

Reported in **Table 4.3** are the effluent availability figures for the Study Area, these indicate that 75% of the WwTW's, produce over 95% of the available effluent and thus have a large effect on the water quality of the river system.

Table 4.3: Number of WwTW's and available effluent

Description	Number of WwTW
Total number of WwTW in Study Area	24 plants (108.0 Mℓ/d or 39.4 million m^3/a)
Total number of with river discharge	9 plants (52.8 Mℓ/d or 19.3 million m^3/a)
Number of plants < 2 Mℓ/d	11
Number of plants 2-6 Mℓ/d	7
Number of plants > 6 Mℓ/d	6

For the purposes of this task, the focus will be on the plants that discharge into river systems as this water has an effect on downstream users. The issue that arises regarding the use of the treated effluent is the quality and social acceptability of the effluent. The quality is depended on the treatment processes that the custodians of the plants are willing to pay for and the overall feasibility of the plants.

4.2.2 Treatment processes and unit costs

There are various processes that can be applied in treatment plants, each with their associated advantages and disadvantages. This section provides an overview of advanced treatment processes as well as cost analyses for conventional water treatment works, wastewater treatment works and advanced processes.

For details on the evaluation of potential reuse refer to the supporting document *Opportunities for Water Reuse (PWMA 01/000/00/2914/10/1)*.

5 INTER-BASIN TRANSFERS

5.1 BACKGROUND

The Study Area is relatively water-scarce region and one way to address severe water shortages is through the development of bulk water transfer schemes. Transfer schemes can be classified as intra-basin or inter-basin transfer schemes. Intra-basin schemes constitute transfer schemes within the country, from one country to another or from one sub-basin to another. Inter-Basin transfers are schemes that transfer water from one river basin (catchment) to another.

There are currently a number of inter-basin schemes that transfer water into the Study Area and all occur within South Africa. There are no schemes, existing or potential, transferring water out of the WMA. The purpose of this section is to evaluate the transfer schemes that are currently operational as well as potential transfer schemes with regards to water volumes being transferred into the WMA.

5.2 EXISTING TRANSFERS

At the base year (2010) development level, there were seven major transfer schemes taking place within the Study Area. The locations of these transfer schemes relative to major dams and town is reported on **Figure A.1** in **Appendix A**.

5.2.1 Ebenezer-Polokwane transfer

The largest of these transfer schemes was the Ebenezer-Polokwane transfer which is one of three schemes transferring water to the Polokwane City cluster. This scheme is operated and maintained by Lepelle Norther Water. At the base year development levels, this scheme was transferring 17 million m^3/a of water from Ebenezer Dam to Polokwane, which has a 1:50 year yield allocation of only 12 million m^3/a. According to the *Development of a Reconciliation Strategy for all towns in the Northern Region – Polokwane Local Municipality (Contract WP 9711),* the volume transferred by this scheme is expected to remain at 10 million m^3/a until 2030.

5.2.2 Dap Naude-Polokwane transfer

This is the second of three schemes transferring water into Polokwane city and is operated by Polokwane LM. Dap Naude dam, which is the source of this scheme, is located in the Luvuvhu and Letaba WMA (as defined in the NWRS-1) and has a 1:50 year yield allocation of 6.53 million m^3/a. At the base year development level however, this scheme was transferring 6.5 million m^3/a into Polokwane LM.

5.2.3 Olifantspoort-Polokwane transfer

This is the third transfer scheme into the Polokwane LM, the source of which (Olifantspoort Weir) is located in the Olifants WMA, is operated and maintained by Lepelle Northern Water. The water supplied to Polokwane through this scheme is drawn from the Olifantspoort Weir in the Olifants River and treated at a 38 Mℓ/d

WTW before it is pumped to Polokwane. At the base year development level, Polokwane was allocated 11.3 million m^3/a from this scheme and was transferring the full allocation at the 2010 development level.

5.2.4 Mutshedzi-Makhado transfer

This is the first of three schemes transferring water into Makhado town and surrounding villages. The source of this scheme is the Mutshezi dam located within the Nzhelele catchment where water is drawn from the dam and treated at a 3.6 Mℓ/d WTW before being delivered to 28 villages, Makhado town and the Makhado tomato-processing factory. These water users have a water allocation of 4.35 million m^3/a, however at the base year development levels, the actual volume being transferred by this scheme was 3.66 million m^3/a.

5.2.5 Nandoni-Makhado transfer

The source of this transfer scheme, Nandoni Dam, is located in the Luvuvhu and Letaba WMA and transfers water to Louis Trichardt. Main users associated with this scheme, urban users, have a water allocation of 5.8 million m^3/a. At the current development level however, only 3.2 million m^3/a was transferred to Louis Trichardt.

5.2.6 Albasini-Makhado transfer

This transfer scheme transported water from Albasini Dam in the Luvuvhu and Letaba WMA to provide for the urban water requirements of the Louis Trichardt – Tshikota cluster. Water is drawn from the Albasini Dam (allocation of 2.4 million m^3/a) on the Luvhuvhu River and treated at the 5.7 Mℓ/d WTW at the dam before being pumped to Louis Trichardt/Tshikota. The full allocation is currently being pumped to Louis Trichardt, however, the supply to Louis Trichardt have been replaced by water from Nandoni Dam since 2011.

5.2.7 Roodeplaat-Modimolle and Mookgopong transfer

This transfer scheme supplies the urban water requirements for Modimolle. The source for this scheme is the Roodeplaat Dam which is situated in the adjacent CRW catchment. The existing transfer scheme transfers 3 million m^3/a.

5.2.8 Summary of existing transfer schemes

The aforementioned transfer schemes only account for those currently in operation. Reported in **Table 5.1** is summary of all the current transfer schemes into the Study Area along with the catchments into which the transfer is occurring.

Table 5.1 Summary of existing water transfer schemes

Transfer scheme	Source catchment	Recipient catchment	Volume allocated (million m^3/a)
Ebenezer / Polokwane	Luvuvhu and Letaba	Sand River	12.00
Dap Naude / Polokwane	Luvuvhu and Letaba	Sand River	6.53
Olifantspoort / Polokwane	Olifants	Sand River	11.30
Mutshedzi-Makhado	Nzhelele	Nzhelele	3.66
Nandoni-Louis Trichardt	Luvuvhu and Letaba	Sand River	5.80
Albasini-Louis Trichardt	Luvuvhu and Letaba	Sand River	2.40
Roodeplaat-Modimolle	Crocodile West	Mogalakwena	3.00

5.3 FUTURE TRANSFERS

A number of studies and strategies are being investigated into potential schemes that could be developed to address water availability within the Study Area. The locations of these transfer schemes relative to major dams and town is reported on Figure A.2 in Appendix A.

5.3.1 Mokolo-Crocodile Water Augmentation Project

The MCWAP transfer scheme has two phases. Phase 1 entails a pipeline parallel to the existing pipeline from the Mokolo Dam to the Lephalale (Elisras) area to supply an additional 13 million m^3/a to the current supply 17 million m^3/a supply from the dam. Phase 2 of the transfer scheme (MCWAP-2) entails a transfer via pipeline from the Crocodile River (West) at Vlieëpoort near Thabazimbi to the Lephalale area. Until the commissioning of Phase 2 of MCWAP, Mokolo Dam will be operated at a higher risk in order to meet the growing water requirements. The total water allocation from MCWAP-1 or the Mokolo Dam is 29.4 million m^3/a. Current indications suggest that the growing water requirements would exceed the available Mokolo River system yield by 2019, by which time MCWAP-2A should be operational.

MCWAP-2A is expected to transfer 100 million m^3/a into the Mokolo River catchment.

5.3.2 Klipvoor Dam to Modimolle and Mookgopong

As stated in Section 5.2.7, there is currently an operational transfer scheme into Modimolle and Mookgopong, however, it is approximated that 8.5 million m^3/a will be required in this area by 2040. This scheme is a potential intervention that, in addition to the existing Roodeplaat-Modimolle and Mookgopong transfer could address the increase in water requirements. Preliminary investigations indicate that water can be transferred from either the existing Magalies Water pipeline from Klipdrift WTW, or from a proposed new WTW and pipeline from the Klipvoor Dam. Assuming that the water requirement is including the water being supplied by the Roodeplaat Transfer, this scheme would then supply an additional 5.5 million m^3/a.

5.3.3 Flag Boshielo – Mogalakwena and Aganang Local Municipalities (ORWRDP-2B and 2G)

With the expansion of mining activities in the Mokopane-Mogoto area, early estimates of future water requirements estimate additional water requirements in the order of 20 million m^3/a. As part of the *Olifants River Water Resources Development Project* (ORWRDP), the construction of the infrastructure to transfer water from the Flag Boshielo Dam in the Olifants WMA, to supply the new mining areas in Mokopane started in 2012. A number of additional phases are being investigated to meet the growing water requirements, but these will only be implemented if required (DWS, 2015). At the time of finalising this report, a transfer of 50 million m^3/a is planned to supply the Mogalakwena and Aganang local municipal areas as well as mining developments in the area.

5.3.4 Glen Alpine-Molemole West Supply Area transfer

The Molemole West Supply Area falls within the Molomole LM and have a combined current water requirement of 1.5 million m^3/a which is currently supplied by local groundwater aquifers. The current resources are fully utilised and will not be able to meet future water requirements.

The Glen Alpine-Molemole West Supply Area transfer scheme has been identified as a potential scheme to augment domestic groundwater supply to the Molemole West Supply Area from the Glen Alpine Dam. A volume of 2.02 million m^3/a is potentially available from the dam to supply the area, however, in conjunction with groundwater use only 0.6 million m^3/a have to be transferred to meet the future requirement.

5.3.5 Nandoni-Matoks pipeline

The Matoks Supply Area is located in the eastern portion of the Molemole LM. The area is currently supplied by groundwater which is over-utilised. DWS proposed that 4.66 to 5.5 million m^3/a be transferred from the Nandoni Dam to Matoks via a pipeline to relieve the groundwater use and to meet future water requirements.

5.3.6 Nandoni-Makhado transfer

This transfer supplies the Makhado and Louis Trichardt area. The first phase of the transfer can supply up to 5.8 million m^3/a and replaces the supply transfer from Albasini Dam to Louis Trichardt. An additional 5.8 million m^3/a from the Nandoni Dam (totalling 11.6 million m^3/a) is planned to be transferred by 2017 to the area.

5.3.7 Zhove Dam transfer

This is a potential intervention that was considered as part of the feasibility study for the Mutasshi/Musina Corridor Bulk Water Supply (see **Section 3.6.1**). The aforementioned study established that at least 30 million m^3/a of raw water can be purchased from the Zimbabwe National Water Authority (ZINWA) (DWA, 2013b).

Should this scheme be implemented, the water released from Zhove Dam would be abstracted as surface water from the Limpopo River on the Zimbabwe river banks.

5.3.8 Summary of potential transfer schemes

The aforementioned transfer schemes account for all the known potential transfer schemes. A summary of the potential transfer schemes, source and recipient catchments and the expected transfer volumes are reported in Table 5.2.

Table 5.2 Summary of potential transfer schemes

Transfer scheme	Source catchment	Recipient catchment	Volume (million m^3/a)
MCWAP 1	Mokolo River	Mokolo	13.0
MCWAP 2	Crocodile West River	Mokolo	100.0
Klipvoor-Modimolle and Mookgopong	Crocodile West River	Mogalakwena	8.5
ORWRDP: Flag Boshielo-Mokopane	Olifants River	Mogalakwena	50.0
Glen Alpine-Molemole West	Sand River	Sand River	2.02
Nandoni-Matoks pipeline	Luvuvhu and Letaba	Sand River	4.66 - 5.5
Nandoni-Louis Trichardt	Luvuvhu and Letaba	Sand River	8.6 – 11.6
Zhove Dam	Umzingwane (Zimbabwe)	Sand River	30.0

6 CONCLUSIONS

A summary of the main conclusions drawn from the *Water Requirements and Return Flows report (P WMA 01/000/00/02914/4)* is listed below:

- Obtaining sufficient and reliable information was difficult as detailed information about future mining and industrial water requirements are not readily available. Where information was not available, estimations and assumptions were made in order to provide a point to work from.
- Irrigation was the largest water requirement in the Study Area (464.8 million m^3/a) at the 2010-development level and due to the assumption of no growth in this sector, the requirement remains constant until the end of the study period.
- Commercial forestry had the lowest water requirements in the Study Area at the 2010-development level (2.2 million m^3/a) and based on the same assumptions applied to the irrigation water requirement, this requirement remains constant throughout.
- The fastest growth in water requirements is expected to occur in the mining and industry sector. The water requirement increases from 17.0 million m^3/a at the base year development level to 192.9 million m^3/a in 2040.
- The rapid increases in mining and industrial activities also fuels urbanisation thus resulting in an increase in domestic water requirements.
- Water requirements for livestock watering and IAP are 23.4 and 6.9 million m^3/a respectively. The approach used to model streamflow reducers such as IAPs is described in the *Hydrological Analysis: Volume 1 – Main Report (P WMA 01/000/00/02914/3)*
- An analysis of the wastewater treatment works within the Study Area indicates that there is a potential for an additional 126 Mℓ/d of water that could be acquired through effluent treatment. A detailed analysis on opportunities for water reuse in the Study Area is reported in *Opportunities for Water Reuse (PWMA 01/000/00/2914/10/1).*
- WCWDM approaches are not taken into consideration in this report, but are evaluated in detail in the *Water Conservation and Water Demand Management (WCWDM) Status report (PWMA 01/000/00/02914/4/2)*.
- The water requirements for the Study Area are summarised in **Figure 6.1** for the 2010 and anticipated 2025 and 2040 development levels.
- Total return flows generated as a result of direct result of irrigation are 36.0 million m^3/a.

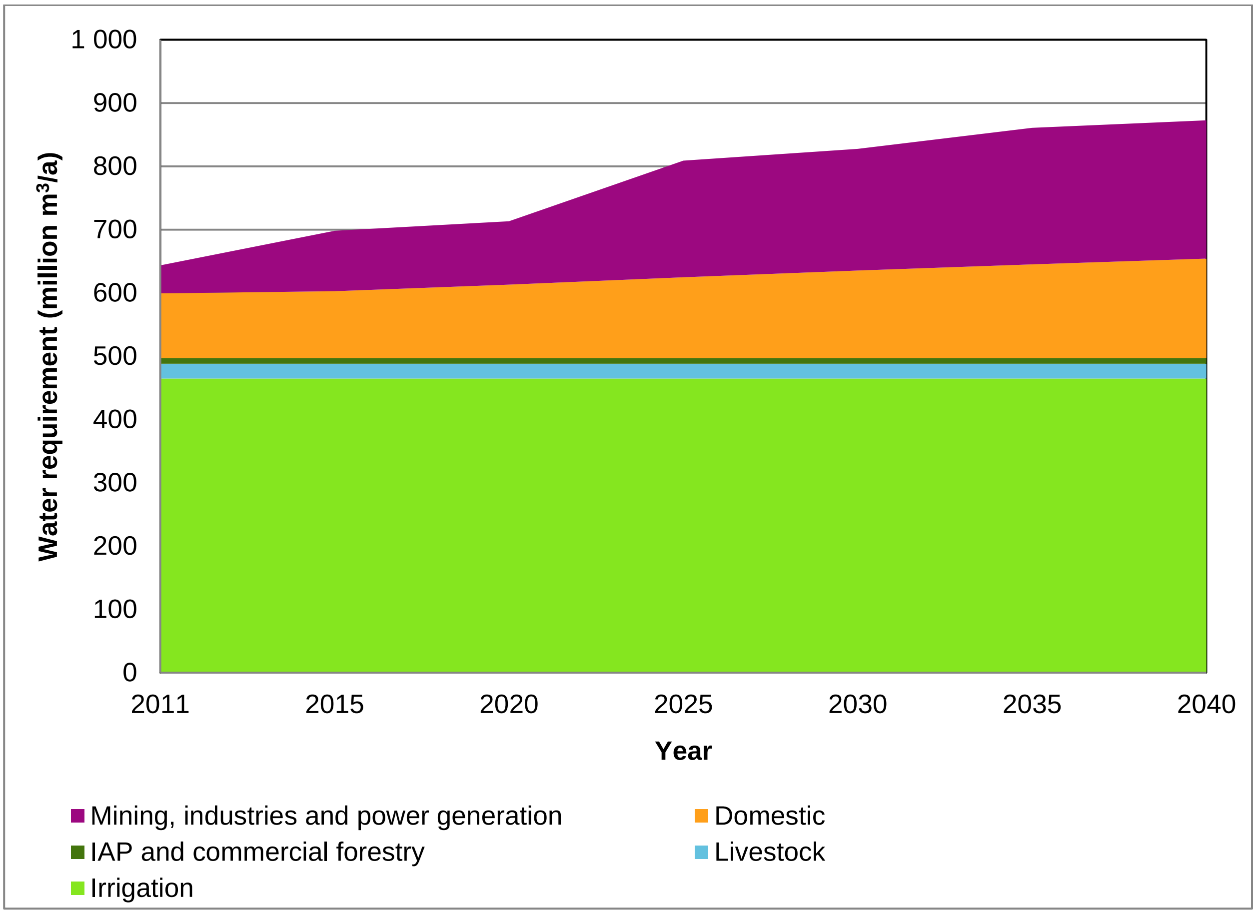

Figure 6.1 Study area water requirement summary

7 RECOMMENDATIONS

Based on the water requirements investigation undertaken as part of the *Limpopo WMA North Reconciliation Strategy* and the conclusions discussed in **Section 6,** the following is recommended:

- As stated in **Section 3.5.2**, some information on the water requirements for mining operations is currently unavailable. This gives an incomplete image of specific the future water requirements for the Study Area. It is therefore recommended that the values reported in this document be updated if and when new or additional information is released by mining corporations or water service providers.
- Data sourced from other studies, such as the *Reconciliation Strategy for the Crocodile West River System*, should be updated in this study if and when it is updated in those other studies.

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Appendix A

Maps

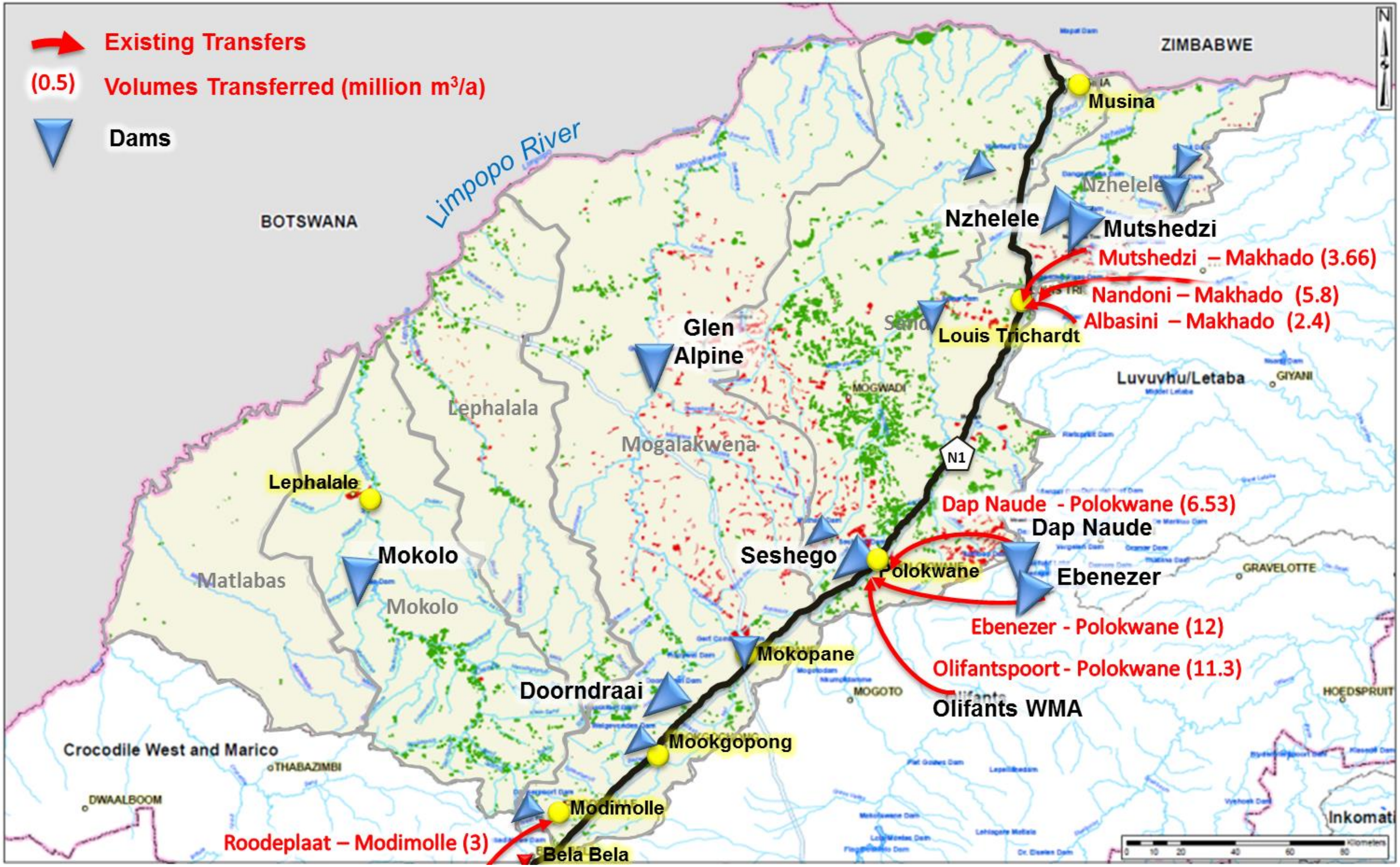

Figure A.1 Current inter-basin transfer schemes (current allocations)

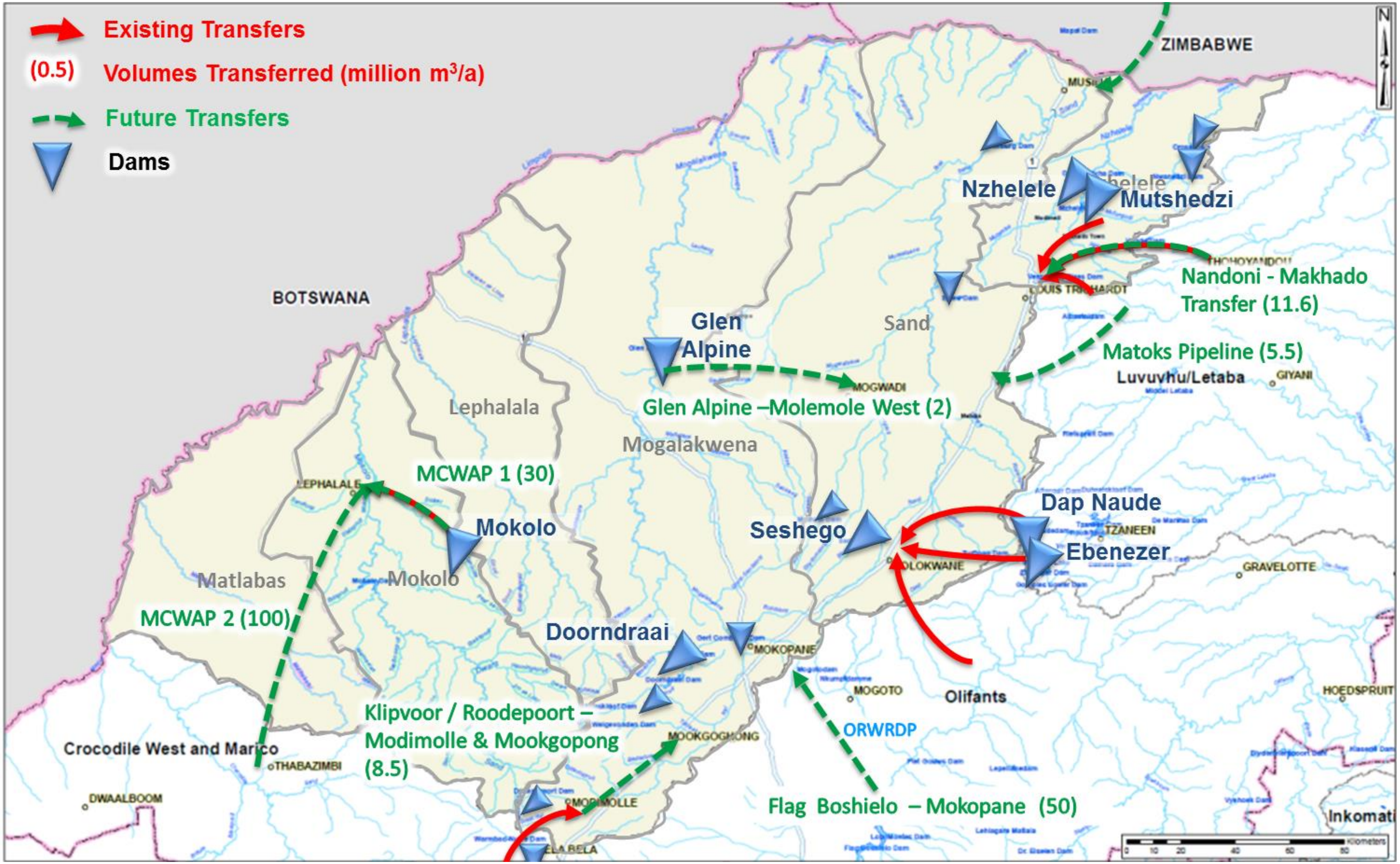

Figure A.2 Future inter-basin transfer schemes

Appendix B

Domestic water requirement and demographic projections per catchment

Table B.1 Domestic water requirement projections for the Lephalala River catchment

Year	Indicator	Home connection	Yard Connection	Communal	Total
2011 Losses 29.7%	Planning population	6 504	18 932	40 223	65 658
	Level of service (factor)	0.10	0.29	0.61	1
	Consumption rate (ℓ/c/d)	180	80	60	
	Total consumption (kℓ/d)	1 171	1 515	2 413	5 099
	Provision for water losses and peak demand (kℓ/d)	582	753	1 199	2 534
	Total residential requirement (million m³/a)	**0.64**	**0.83**	**1.32**	**2.79**
2020 Losses 27%	Annual population growth rate %: 2011-2020				0.46
	Level of service (factor)	0.15	0.4	0.45	1
	Planning population	10 257	27 352	30 771	68 379
	Consumption rate (ℓ/c/d)	180	80	60	
	Total consumption (kℓ/d)	1 846	2 188	1 846	5 881
	Provision for water losses and peak demand (kℓ/d)	868	1 028	868	2 764
	Total residential requirement (million m³/a)	**0.99**	**1.17**	**0.99**	**3.16**
2030 Losses 24.3%	Annual population growth rate %: 2021-2030				0.49
	Level of service (factor)	0.15	0.6	0.25	1
	Planning population	10 762	43 047	17 936	71 745
	Consumption rate (ℓ/c/d)	180	90	60	
	Total consumption (kℓ/d)	1 937	3 874	1 076	6 888
	Provision for water losses and peak demand (kℓ/d)	858	1 716	477	3 051
	Total residential requirement (million m³/a)	**1.02**	**2.04**	**0.57**	**3.63**
2040 Losses 20%	Annual population growth rate %: 2031-2040				0.49
	Level of service (factor)	0.15	0.75	0.1	1
	Planning population	11 294	56 472	7 530	75 296
	Consumption rate (ℓ/c/d)	180	90	60	
	Total consumption (kℓ/d)	2 033	5 083	451.8	7567.2
	Provision for water losses and peak demand (kℓ/d)	813	2 033	181	3 027
	Total residential requirement (million m³/a)	**1.04**	**2.60**	**0.23**	**3.87**

Table B.2 Domestic water requirement projections for the Mokolo River catchment

Year	Indicator	Home connection	Yard connection	Communal	Total
2011 Losses: 25.2%	Planning population	34 694	22 683	10 861	68 238
	Level of service (factor)	0.51	0.33	0.16	1
	Consumption rate (ℓ/c/d)	180	80	60	
	Total consumption (kℓ/d)	6 245	1 815	652	8 712
	Provision for water losses and peak demand (kℓ/d)	2 823	820	295	3 938
	Total residential requirement (million m³/a)	**3.3**	**1.0**	**0.3**	**4.6**
2020 Losses: 23%	Annual population growth rate %: 2011-2020				1.66
	Level of service (factor)	0.5	0.4	0.1	1
	Planning population	3 9219	31 375	7 844	78 438
	Consumption rate (ℓ/c/d)	180	80	60	
	Total consumption (kℓ/d)	7 059	2 510	471	10 040
	Provision for water losses and peak demand (kℓ/d)	3 036	1 079	202	4 317
	Total residential requirement (million m³/a)	**3.7**	**1.3**	**0.2**	**5.2**
2030 Losses: 20.6%	Annual population growth rate %: 2021-2030				1.64
	Level of service (factor)	0.48	0.42	0.1	1
	Planning population	43 828	38 349	9 131	91 308
	Consumption rate (ℓ/c/d)	180	90	60	
	Total consumption (kℓ/d)	7 889	3 451	548	11 888
	Provision for water losses and peak demand (kℓ/d)	3 203	1 401	222	4 827
	Total residential requirement (million m³/a)	**4.0**	**1.8**	**0.3**	**6.1**
2040 Losses: 20%	Annual population growth rate %: 2031-2040				1.74
	Level of service (factor)	0.46	0.44	0.1	1
	Planning population	49 315	47 171	10 721	107 206
	Consumption rate (ℓ/c/d)	180	90	60	
	Total consumption (kℓ/d)	8 877	4 245	643	13 765
	Provision for water losses and peak demand (kℓ/d)	3 551	1 698	257	5 506
	Total residential requirement (million m³/a)	**4.5**	**2.2**	**0.3**	**7.0**

Table B.3 Domestic water requirement projections for the Mogalakwena River catchment

Year	Indicator	Home connection	Yard connection	Communal	Total
2011 Losses: 28.5%	Planning population	111 958	266 601	227 939	606 499
	Level of service (factor)	0.18	0.44	0.38	1
	Consumption rate (ℓ/c/d)	180	80	60	
	Total consumption (kℓ/d)	20 153	21 328	13 676	55 157
	Provision for water losses and peak demand (kℓ/d)	9 774	10 344	6 633	26 751
	Total residential requirement (million m³/a)	**10.9**	**11.6**	**7.4**	**29.9**
2020 Losses 26%	Annual population growth rate %: 2011-2020				0.18
	Level of service (factor)	0.18	0.52	0.3	1
	Planning population	110 934	320 478	184 891	616 303
	Consumption rate (ℓ/c/d)	180	80	60	
	Total consumption (kℓ/d)	19 968	25 638	11 094	56 700
	Provision for water losses and peak demand (kℓ/d)	9185	11 794	5 103	26 082
	Total residential requirement (million m³/a)	**10.6**	**13.7**	**5.9**	**30.2**
2030 Losses 23.3%	Annual population growth rate %: 2021-2030				0.22
	Level of service (factor)	0.16	0.64	0.2	1
	Planning population	100 793	403 173	125 992	629 958
	Consumption rate (ℓ/c/d)	180	90	60	
	Total consumption (kℓ/d)	18 143	36 286	7 560	61 988
	Provision for water losses and peak demand (kℓ/d)	7 856	15 712	3 273	26 841
	Total residential requirement (million m³/a)	**9.5**	**19.0**	**4.0**	**32.4**
2040 Losses 20%	Annual population growth rate %: 2031-2040				0.5
	Level of service (factor)	0.15	0.75	0.1	1
	Planning population	97 282	486 412	64 855	648 549
	Consumption rate (ℓ/c/d)	180	90	60	
	Total consumption (kℓ/d)	17 511	43 777	3 891	65 179
	Provision for water losses and peak demand (kℓ/d)	7 004	17 511	1 557	26 072
	Total residential requirement (million m³/a)	**8.9**	**22.4**	**2.0**	**33.3**

Table B.4 Domestic water requirement projections for the Sand River catchment

Year	Indicator	Home connection	Yard connection	Communal	Total
2011 Losses: 28%	Planning population	283 621	389 807	351 739	1 025 167
	Level of service (factor)	0.28	0.38	0.34	1
	Consumption rate (ℓ/c/d)	180	80	60	
	Total consumption (kℓ/d)	51 052	31 185	21 104	103 341
	Provision for water losses and peak demand (kℓ/d)	24 505	14 969	10 130	49 604
	Total residential requirement (million m³/a)	**27.6**	**16.8**	**11.4**	**55.8**
2020 Losses:25.5%	Annual population growth rate %: 2011-2020				1.28
	Level of service (factor)	0.25	0.5	0.25	1
	Planning population	285 875	571 749	285 875	1 143 499
	Consumption rate (ℓ/c/d)	180	80	60	
	Total consumption (kℓ/d)	51 458	45 740	17 153	114 350
	Provision for water losses and peak demand (kℓ/d)	23 413	20 812	7 804	52 029
	Total residential requirement (million m³/a)	**27.3**	**24.3**	**9.1**	**60.7**
2030 Losses: 23%	Annual population growth rate %: 2021-2030				1.10
	Level of service (factor)	0.23	0.57	0.2	1
	Planning population	292 038	723 746	253 946	1 269 729
	Consumption rate (ℓ/c/d)	180	90	60	
	Total consumption (kℓ/d)	52 567	65 137	15 237	132 941
	Provision for water losses and peak demand (kℓ/d)	22 604	28 009	6 552	57 165
	Total residential requirement (million m³/a)	**27.4**	**34.0**	**8.0**	**69.4**
2040 Losses 20%	Annual population growth rate %: 2031-2040				1.29
	Level of service (factor)	0.214	0.686	0.1	1
	Planning population	306 745	983 304	143 339	1 433 387
	Consumption rate (ℓ/c/d)	180	90	60	
	Total consumption (kℓ/d)	55 214	88 497	8 600	152 312
	Provision for water losses and peak demand (kℓ/d)	22 086	35 399	3 440	60 925
	Total residential requirement (million m³/a)	**28.2**	**45.2**	**4.4**	**77.8**

Table B.5 Domestic water requirement projections for the Nzhelele River catchment

Year	Indicator	Home connection	Yard connection	Communal	Total
2011 Losses: 28.7%	Planning population	30 545	48 546	120 935	200 027
	Level of service (factor)	0.15	0.24	0.60	1
	Consumption rate (ℓ/c/d)	180	80	60	
	Total consumption (kℓ/d)	5 498	3 884	7 256	16 638
	Provision for water losses and peak demand (kℓ/d)	2 678	1 891	3 534	8 103
	Total residential requirement (million m³/a)	**3.0**	**2.1**	**3.9**	**9.0**
2020 Losses 26%	Annual population growth rate %: 2011-2020				0.51
	Level of service (factor)	0.15	0.45	0.4	1
	Planning population	31 377	94 131	83 672	209 180
	Consumption rate (ℓ/c/d)	180	80	60	
	Total consumption (kℓ/d)	5 648	7 531	5 020	18 199
	Provision for water losses and peak demand (kℓ/d)	2 598	3 464	2 309	8 371
	Total residential requirement (million m³/a)	**3.0**	**4.0**	**2.7**	**9.7**
2030 Losses: 23.4%	Annual population growth rate %: 2021-2030				0.53
	Level of service (factor)	0.15	0.6	0.25	1
	Planning population	33 032	132 126	55 053	220 210
	Consumption rate (ℓ/c/d)	180	90	60	
	Total consumption (kℓ/d)	5 946	11 891	3 303	21 140
	Provision for water losses and peak demand (kℓ/d)	2 580	5 161	1 434	9 175
	Total residential requirement (million m³/a)	**3.1**	**6.2**	**1.7**	**11.1**
2040 Losses 20%	Annual population growth rate %: 2031-2040				0.58
	Level of service (factor)	0.15	0.75	0.1	1
	Planning population	34 935	174 673	23 290	232 897
	Consumption rate (ℓ/c/d)	180	90	60	
	Total consumption (kℓ/d)	6 288	15 721	1 397	23 406
	Provision for water losses and peak demand (kℓ/d)	2 515	6 288	559	9 362
	Total residential requirement (million m³/a)	**3.2**	**8.0**	**0.7**	**12.0**

Appendix C

Water use and return flows

Table C.1 Water requirements projections for Musina LM

Sector	2010	2015	2020	2025	2030	2035	2040	2044
Musina town	6.57	7.96	9.34	10.66	11.97	15.50	18.50	21.50
Venetia Mine	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20
Vele	0.37	0.37	0.37	0.37	0.37	0.37	.037	0.37
Irrigation	146.00	146.00	146.00	146.00	146.00	146.00	146.00	146.00
Other	0.37	0.37	7.45	9.38	11.32	11.32	11.32	11.32
Total	**157.5**	**158.9**	**167.4**	**170.6**	**173.9**	**177.3**	**180.4**	**183.4**

Table C.2 Historical growth of irrigated areas supplied from surface water and groundwater sources in the Limpopo WMA North

Catchment / quaternary		Network element	Supplied from	Irrigation areas (km^2)				
				1920	1950	1989	1998	2010
Matlabas	A41A		Groundwater	0.00	0.00	0.00	0.30	0.30
	A41B	RR4	Dams	0.00	0.00	0.00	0.08	0.08
	A41C		Groundwater	0.00	0.00	0.00	2.63	2.63
	A41D	RR2	Surface water	0.00	0.00	0.00	0.48	0.48
		RR6	Groundwater	0.00	0.00	0.00	1.55	1.55
	A41E	RR3	Surface water	0.00	0.00	0.00	1.99	1.99
		RR7	Groundwater	0.00	0.00	0.00	0.36	0.36
Matlabas total				**0.00**	**0.00**	**0.00**	**7.37**	**7.39**
Matlabas (excluding Limpopo River)				**0.00**	**0.00**	**0.00**	**4.44**	**4.46**
Mokolo[1]	A42A		Surface water	0.40	4.36	17.63	19.14	18.10
			Groundwater	0.00	0.01	0.50	1.50	1.41
	A42B		Surface water	0.41	4.44	16.56	14.90	14.56
			Groundwater	0.01	0.11	0.70	1.22	1.29
	A42C		Surface water	0.47	5.10	18.88	16.71	17.07
			Groundwater	0.02	0.17	1.10	2.13	3.13
	A42D		Surface water	0.22	2.37	7.82	4.66	4.35
			Groundwater	0.00	0.00	0.00	0.00	0.10
	A42E		Surface water	1.09	11.84	40.13	26.73	18.45
			Groundwater	0.00	0.01	0.60	1.94	1.85
	A42F		Surface water	0.28	3.03	10.91	8.94	8.59
			Groundwater	0.02	0.22	1.00	1.49	1.54
	A42G		Surface water	0.00	0.01	0.02	0.02	0.77
			Groundwater	0.00	0.00	0.00	0.00	0.00
	A42H		Surface water	0.01	0.06	0.16	0.00	1.86
			Groundwater	0.00	0.00	0.00	0.00	0.00
	A42J		Surface water	0.03	0.31	0.83	0.00	8.11
			Groundwater	0.01	0.13	0.40	0.11	0.18
Mokolo total				**2.97**	**32.16**	**117.24**	**99.49**	**101.36**
Mokolo (excluding Limpopo River)				**2.97**	**32.16**	**117.24**	**99.49**	**101.36**

Catchment / quaternary		Network element	Supplied from	Irrigation areas (km²)				
				1920	1950	1989	1998	2010
Lephalala	A50A	RR1	Dams	0.00	0.16	12.31	12.31	12.31
			Groundwater	0.00	0.00	0.02	0.02	0.02
	A50B	RR3	Dams	0.00	0.02	1.82	1.82	1.82
	A50C	RR4	Rivers & dams	0.00	0.00	2.12	2.12	2.12
	A50D		Groundwater	0.00	0.00	0.11	0.11	0.11
	A50E	RR7	Rivers and dams	0.00	0.00	12.90	12.90	12.90
			Groundwater	0.00	0.00	0.02	0.02	0.02
	A50F	RR8	Rivers and dams	0.00	0.00	0.33	0.32	0.32
	A50G	RR9	Dams	0.00	0.00	1.15	1.90	1.90
		RR10	Groundwater	0.00	0.00	0.42	0.70	0.70
	A50H	RR11	Surface water	0.00	0.00	40.39	15.41	15.41
			Groundwater	0.00	0.00	50.08	19.10	19.10
	A50J	RR13	Surface water	0.00	0.00	5.78	5.79	5.79
		RR14	Groundwater	0.00	0.00	10.45	10.47	10.47
Lephalala total				**0.00**	**0.18**	**137.90**	**83.00**	**82.99**
Lephalala (excluding Limpopo River)				**0.00**	**0.18**	**87.67**	**63.75**	**63.74**
Mogalakwena	A61A	RR2	Surface water	0.10	1.39	1.39	1.54	1.54
		RR6	Surface water	0.09	1.29	1.29	1.43	1.43
		RR30	Groundwater	0.10	1.44	1.44	1.60	1.60
	A61B	RR5	Surface water	0.00	0.00	0.42	0.37	0.38
			Groundwater	0.00	0.00	0.33	0.30	0.30
	A61C	RR7	Surface water	0.00	0.00	1.59	2.07	2.07
		RR36	Groundwater	0.00	0.00	2.76	3.60	3.60
	A61D	RR11	Surface water	0.00	0.00	0.26	0.26	0.26
		RR31	Groundwater	0.00	0.00	3.41	3.43	3.43
	A61E	RR15	Surface water	0.00	0.00	0.01	0.06	0.06
		RR37	Groundwater	0.00	0.00	1.77	10.10	10.10
	A61F	RR20	Surface water	0.00	0.00	0.18	0.57	0.57
		RR32	Groundwater	0.00	0.00	0.99	3.04	3.04
	A61G	RR21	Surface water	0.00	0.00	0.61	0.78	0.78
		RR33	Groundwater	0.00	0.00	0.39	0.50	0.50
	A61H	RR23	Surface water	0.00	0.00	30.16	11.19	11.18

Catchment / quaternary		Network element	Supplied from	Irrigation areas (km^2)				
				1920	1950	1989	1998	2010
		RR24	Surface water	0.00	0.00	30.16	11.19	11.18
		RR34	Groundwater	0.00	0.00	2.97	1.10	1.10
	A61J	RR26	Surface water	0.00	0.00	10.15	7.49	7.50
		RR28	Surface water	0.00	0.00	0.95	0.70	0.70
		RR29	Scheme	0.00	0.00	4.53	3.35	3.35
		RR35	Groundwater	0.00	0.00	2.88	2.13	2.13
	A62A	RR38	Surface water	0.00	0.00	3.55	2.42	2.42
		RR39	Groundwater	0.00	0.00	0.72	0.49	0.49
	A62B	-		0.00	0.00	0.00	0.00	0.00
	A62C	-		0.00	0.00	0.00	0.00	0.00
	A62D	RR40	Groundwater	0.03	0.47	0.56	0.81	0.81
	A62E	-		0.00	0.00	0.00	0.00	0.00
	A62F	RR41	Surface water	0.00	0.00	0.00	0.24	0.24
		RR42	Groundwater	0.00	0.00	0.00	3.55	3.55
	A62G	RR43	Groundwater	0.00	0.00	0.00	0.01	0.01
	A62H	-		0.00	0.00	0.00	0.00	0.00
	A62J	RR44	Groundwater	0.00	0.00	0.00	0.53	0.53
	A63A	RR1	Scheme	0.00	0.00	0.04	1.49	1.49
		RR2	Groundwater	0.00	0.00	0.49	20.29	20.29
	A63B	RR3	Scheme	0.03	0.42	1.56	3.85	3.85
		RR4	Groundwater	0.01	0.23	0.87	2.15	2.15
	A63C	RR7	Surface water	0.00	0.00	0.00	1.90	1.90
		RR9	Groundwater	0.00	0.00	0.00	1.54	1.54
			Surface water	0.00	0.00	0.00	2.84	2.84
			Groundwater	0.00	0.00	0.00	2.31	2.31
	A63D	RR5	Scheme	0.06	0.99	2.21	2.22	2.22
		RR6	Groundwater	0.08	1.19	2.65	2.66	2.66
	A63E	RR8	Surface water	0.00	0.00	0.00	1.24	1.24
		RR10	Groundwater	0.00	0.00	0.00	0.59	0.59
			Surface water	0.00	0.00	0.00	1.86	1.86
			Groundwater	0.00	0.00	0.00	14.14	14.14
Mogalakwena total				**0.51**	**7.42**	**111.28**	**133.91**	**133.93**
Mogalakwena (excluding Limpopo River)				**0.51**	**7.42**	**110.95**	**112.46**	**112.48**

Catchment / quaternary		Network element	Supplied from	Irrigation areas (km^2)				
				1920	1950	1989	1998	2010
Sand	A71A	RR1	Rivers	0.00	0.00	0.20	0.97	0.98
		RR2	Dams	0.00	0.00	0.34	2.86	1.68
		RR3	Groundwater	0.00	0.00	8.52	44.49	41.90
	A71B	RR4	Groundwater	0.00	0.00	3.16	10.30	10.05
	A71C	RR5	Rivers	0.00	0.00	0.11	1.34	0.52
		RR6	Dams	0.00	0.00	0.48	2.51	2.36
		RR7	Groundwater	0.00	0.00	6.88	32.13	33.87
	A71D	RR8	Dams	0.00	0.01	0.04	0.10	0.33
		RR9	Groundwater	0.00	0.14	1.01	9.55	8.24
	A71E	RR10	Dams	0.00	0.01	0.09	0.41	0.41
		RR11	Groundwater	0.00	0.40	3.17	15.10	15.18
	A71F	RR12	Dams	0.00	0.17	0.74	0.80	0.98
		RR13	Groundwater	0.00	2.85	12.08	15.23	16.04
	A71G	RR24	Rivers	0.00	0.01	0.07	0.21	0.22
		RR14	Dams	0.00	0.02	0.15	0.52	0.46
		RR15	Groundwater	0.00	0.88	6.50	23.69	19.55
	A71H	RR16	Rivers	0.00	0.01	0.03	0.32	0.11
		RR17	Dams	0.00	0.04	0.09	0.45	0.36
		RR18	Groundwater	0.00	0.23	0.50	3.69	1.95
	A71J	RR19	Rivers	0.00	0.00	1.58	4.28	4.15
		RR20	Dams	0.00	0.00	0.14	0.08	0.36
		RR21	Groundwater	0.00	0.00	8.02	21.41	21.03
	A71K	RR22	Rivers	0.00	0.00	1.57	0.73	0.55
		RR23	Groundwater	0.00	0.00	9.66	2.80	3.38
	A71L	RR25	Dams	0.00	0.00	0.00	15.37	12.63
		RR26	Groundwater	0.00	0.00	0.00	39.86	38.36
			Surface water	0.00	0.00	0.00	34.01	27.94
	A72A	RR1	Dams	0.00	0.00	0.47	1.34	1.00
		RR2	Groundwater	0.00	0.00	13.38	31.79	28.17
	A72B	RR3	Rivers	0.00	0.00	0.00	0.40	0.40
		RR4	Groundwater	0.00	0.00	0.00	7.57	5.75
Sand total				**0.00**	**4.77**	**78.98**	**324.31**	**298.91**
Sand (excluding Limpopo River)				**0.00**	**4.77**	**78.98**	**290.30**	**270.97**

Catchment / quaternary		Network element	Supplied from	Irrigation areas (km^2)				
				1920	1950	1989	1998	2010
Nzhelele	A80A	-		0.00	0.00	0.00	0.00	0.00
	A80B	RR1	Dams	0.00	0.00	0.13	0.83	0.78
		RR2	Groundwater	0.00	0.00	0.06	0.17	0.36
	A80C	-		0.00	0.00	0.00	0.00	0.00
	A80D	RR9	River	0.00	0.00	0.03	0.14	0.14
	A80E	RR10	River	0.00	0.00	0.13	0.28	0.13
		RR3	Groundwater	0.00	0.00	1.38	2.55	1.41
	A80F	RR4	Groundwater	0.00	0.00	1.76	0.34	0.44
		RR5	Scheme (canal)	0.00	0.00	22.32	5.72	5.58
	A80G	RR11	River	0.00	0.00	0.00	0.30	0.13
		RR6	Groundwater	0.00	0.00	0.05	2.69	3.39
		RR7	Dams	0.00	0.00	0.00	0.33	0.16
		RR8	Scheme (canal)	0.00	0.00	0.28	22.84	19.65
			Surface water	0.00	0.00	0.02	2.03	1.70
	A80H	-		0.00	0.00	0.00	0.00	0.00
	A80J	RR10	River	0.00	0.00	0.00	1.39	1.11
			Surface water	0.00	0.00	0.00	8.48	6.36
			Groundwater	0.00	0.00	0.00	0.20	0.14
Nzhelele total				**0.00**	**0.00**	**26.16**	**48.30**	**41.48**
Nzhelele total (excluding Limpopo)				**0.00**	**0.00**	**26.14**	**37.59**	**33.28**
Limpopo WMA North				**3.48**	**44.53**	**471.56**	**696.38**	**666.06**
Limpopo WMA North (excluding Limpopo)				**3.48**	**44.53**	**420.98**	**608.03**	**586.29**

Notes

(1) As per the "Updating the Hydrology and Yield Analysis of the Mokolo River Catchment" Study (DWA, 2007).

(2) Irrigation areas indicated in grey text is supplied form the Limpopo River main stem and associated sand aquifers – hence not from the water resources fed by runoff generated in the Study Area.

Table C.3 Annual average irrigation water requirements per quaternary catchment at the 2010-development level

Catchment / quaternary		Average annual irrigation requirement (million m^3/a)					
		Supplied by sources fed from Study Area runoff				Supplied from Limpopo River	TOTAL
		Surface water	Ground-water	Scheme	Total		
Matlabas	A41A	0.00	0.19	0.00	0.19	0.00	0.19
	A41B	0.05	0.00	0.00	0.05	0.00	0.05
	A41C	0.00	0.00	0.00	0.00	0.00	0.00
	A41D	0.56	1.81	0.00	2.37	0.00	2.37
	A41E	0.00	0.00	0.00	0.00	2.12	2.12
Matlabas total		**0.61**	**2.00**	**0.00**	**2.61**	**2.12**	**4.73**
Mokolo[1]	A42A	7.33	0.52	0.00	7.85	0.00	7.85
	A42B	5.56	0.35	0.00	5.91	0.00	5.91
	A42C	5.80	0.96	0.00	6.76	0.00	6.76
	A42D	1.19	0.00	0.00	1.19	0.00	1.19
	A42E	7.27	0.73	0.00	8.00	0.00	8.00
	A42F	3.76	0.62	0.00	4.38	0.00	4.38
	A42G	0.01	0.00	0.37	0.38	0.00	0.38
	A42H	0.00	0.00	0.83	0.83	0.00	0.83
	A42J	0.00	0.00	4.86	4.86	0.00	4.86
Mokolo total		**30.92**	**3.18**	**6.06**	**40.16**	**0.00**	**40.16**
Lephalala	A50A	8.43	0.01	0.00	8.44	0.00	8.44
	A50B	1.33	0.00	0.00	1.33	0.00	1.33
	A50C	1.31	0.00	0.00	1.31	0.00	1.31
	A50D	0.00	0.08	0.00	0.08	0.00	0.08
	A50E	10.83	0.02	0.00	10.85	0.00	10.85
	A50F	0.29	0.00	0.00	0.29	0.00	0.29
	A50G	1.62	0.60	0.00	2.22	0.00	2.22
	A50H	14.68	0.00	0.00	14.68	18.20	32.88
	A50J	0.00	0.00	0.00	0.00	12.41	12.41
Lephalala total		**38.49**	**0.71**	**0.00**	**39.20**	**30.61**	**69.81**
Mogalakwena	A61A	2.06	1.11	0.00	3.17	0.00	3.17
	A61B	0.25	0.20	0.00	0.45	0.00	0.45
	A61C	1.30	2.26	0.00	3.56	0.00	3.56
	A61D	0.17	2.24	0.00	2.41	0.00	2.41
	A61E	0.05	8.78	0.00	8.83	0.00	8.83
	A61F	0.22	1.18	0.00	1.40	0.00	1.40
	A61G	0.49	0.32	0.00	0.81	0.00	0.81
	A61H	14.92	0.73	0.00	15.65	0.00	15.65
	A61J	3.71	0.96	1.51	6.18	0.00	6.18
	A62A	2.12	0.45	0.00	2.57	0.00	2.57
	A62B	0.00	0.00	0.00	0.00	0.00	0.00

Catchment / quaternary		Average annual irrigation requirement (million m³/a)					
		Supplied by sources fed from Study Area runoff				Supplied from Limpopo River	TOTAL
		Surface water	Ground-water	Scheme	Total		
	A62C	0.00	0.00	0.00	0.00	0.00	0.00
	A62D	0.00	0.64	0.00	0.64	0.00	0.64
	A62E	0.00	0.00	0.00	0.00	0.00	0.00
	A62F	0.15	2.28	0.00	2.43	0.00	2.43
	A62G	0.00	0.00	0.00	0.00	0.00	0.00
	A62H	0.00	0.00	0.00	0.00	0.00	0.00
	A62J	0.00	0.31	0.00	0.31	0.00	0.31
	A63A	0.00	17.39	1.28	18.67	0.00	18.67
	A63B	0.00	1.50	2.68	4.18	0.00	4.18
	A63C	0.00	0.00	0.00	0.00	5.62	5.62
	A63D	0.00	2.89	2.41	5.30	0.00	5.30
	A63E	0.00	0.00	0.00	0.00	17.23	17.23
Mogalakwena total		**25.44**	**43.24**	**7.88**	**76.56**	**22.85**	**99.41**
Sand	A71A	2.04	32.27	0.00	34.31	0.00	34.31
	A71B	0.00	6.78	0.00	6.78	0.00	6.78
	A71C	2.01	23.62	0.00	25.63	0.00	25.63
	A71D	0.22	5.44	0.00	5.66	0.00	5.66
	A71E	0.14	5.26	0.00	5.40	0.00	5.40
	A71F	0.37	6.12	0.00	6.49	0.00	6.49
	A71G	0.34	9.59	0.00	9.93	0.00	9.93
	A71H	0.25	1.02	0.00	1.27	0.00	1.27
	A71J	3.30	15.42	0.00	18.72	0.00	18.72
	A71K	0.51	3.12	0.00	3.63	0.00	3.63
	A71L	0.00	0.00	0.00	0.00	84.94	84.94
	A72A	0.53	14.97	0.00	15.50	0.00	15.50
	A72B	0.22	3.16	0.00	3.38	0.00	3.38
Sand total		**9.93**	**126.77**	**0.00**	**136.70**	**84.94**	**221.64**
Nzhelele	A80A	0.00	0.00	0.00	0.00	0.00	0.00
	A80B	0.38	0.17	0.00	0.55	0.00	0.55
	A80C	0.00	0.00	0.00	0.00	0.00	0.00
	A80D	0.09	0.00	0.00	0.09	0.00	0.09
	A80E	0.08	0.82	0.00	0.90	0.00	0.90
	A80F	0.00	0.32	4.00	4.32	0.00	4.32
	A80G	0.21	2.53	14.69	17.43	1.26	18.69
	A80H	0.00	0.00	0.00	0.00	0.00	0.00
	A80J	0.00	0.00	0.00	0.00	4.53	4.53
Nzhelele total		**0.76**	**3.84**	**18.69**	**23.29**	**5.79**	**29.08**
Limpopo WMA North		**106.15**	**179.73**	**32.63**	**318.52**	**146.30**	**464.82**

Note: (1) As in the "Updating the Hydrology and Yield Analysis in the Mokolo River Catchment" study (DWA, 2007).

Table C.10 Annual average irrigation return flows per quaternary catchment at the 2010-development level

Catchment / quaternary		Average annual irrigation return flows (million m³/a)			
		Surface water	Groundwater	Scheme	Total
Matlabas	A41A	-	-	-	0.00
	A41B	0.01	0.00	0.00	0.01
	A41C	-	-	-	0.00
	A41D	0.06	0.17	0.00	0.23
	A41E	0.13	0.02	0.00	0.15
Matlabas total		**0.19**	**0.19**	**0.00**	**0.38**
Mokolo[1]	A42A	0.59	0.04	0.00	0.63
	A42B	0.44	0.03	0.00	0.47
	A42C	0.52	0.09	0.00	0.61
	A42D	0.10	0.00	0.00	0.10
	A42E	0.58	0.06	0.00	0.64
	A42F	0.30	0.05	0.00	0.35
	A42G	0.00	0.00	0.02	0.02
	A42H	0.00	0.00	0.12	0.12
	A42J	0.00	0.00	0.39	0.39
Mokolo total		**2.53**	**0.27**	**0.53**	**3.33**
Lephalala	A50A	0.80	0.00	0.00	0.80
	A50B	0.12	0.00	0.00	0.12
	A50C	0.11	0.00	0.00	0.11
	A50D	-	-	-	0.00
	A50E	0.70	0.00	0.00	0.70
	A50F	0.02	0.00	0.00	0.02
	A50G	0.14	0.05	0.00	0.19
	A50H	1.07	1.33	0.00	2.40
	A50J	0.29	0.52	0.00	0.81
Lephalala total		**3.25**	**1.90**	**0.00**	**5.15**
Mogalakwena	A61A	0.13	0.07	0.00	0.20
	A61B	0.02	0.01	0.00	0.03
	A61C	0.11	0.19	0.00	0.30
	A61D	0.01	0.15	0.00	0.16
	A61E	0.00	0.60	0.00	0.60
	A61F	0.01	0.08	0.00	0.09
	A61G	0.02	0.02	0.00	0.04
	A61H	1.19	0.06	0.00	1.24
	A61J	0.30	0.08	0.12	0.50
	A62A	0.17	0.04	0.00	0.20
	A62B	-	-	-	0.00
	A62C	-	-	-	0.00
	A62D	0.00	0.04	0.00	0.04

Catchment / quaternary		Average annual irrigation return flows (million m³/a)			
		Surface water	Groundwater	Scheme	Total
	A62E	-	-	-	0.00
	A62F	0.02	0.23	0.00	0.25
	A62G	0.00	0.00	0.00	0.00
	A62H	-	-	-	0.00
	A62J	0.00	0.01	0.00	0.01
	A63A	0.00	1.10	0.08	1.18
	A63B	0.00	0.11	0.20	0.31
	A63C	0.23	0.19	0.00	0.41
	A63D	0.00	0.21	0.17	0.38
	A63E	0.21	0.99	0.00	1.20
Mogalakwena total		**2.42**	**4.17**	**0.58**	**7.17**
Sand	A71A	0.17	2.72	0.00	2.90
Sand	A71B	0.00	0.57	0.00	0.57
Sand	A71C	0.18	2.08	0.00	2.26
Sand	A71D	0.02	0.44	0.00	0.45
Sand	A71E	0.02	0.62	0.00	0.64
Sand	A71F	0.03	0.50	0.00	0.53
Sand	A71G	0.03	0.89	0.00	0.92
Sand	A71H	0.03	0.10	0.00	0.13
Sand	A71J	0.16	0.74	0.00	0.89
Sand	A71K	0.03	0.20	0.00	0.23
Sand	A71L	2.94	2.78	0.00	5.72
Sand	A72A	0.05	1.54	0.00	1.59
Sand	A72B	0.01	0.21	0.00	0.22
Sand total		**3.67**	**13.38**	**0.00**	**17.05**
Nzhelele	A80A	-	-	-	0.00
Nzhelele	A80B	0.05	0.02	0.00	0.08
Nzhelele	A80C	-	-	-	0.00
Nzhelele	A80D	0.02	0.00	0.00	0.02
Nzhelele	A80E	0.01	0.09	0.00	0.10
Nzhelele	A80F	0.00	0.01	0.16	0.17
Nzhelele	A80G	0.16	0.28	1.62	2.06
Nzhelele	A80H	-	-	-	0.00
Nzhelele	A80J	0.45	0.01	0.00	0.46
Nzhelele total		**0.69**	**0.42**	**1.78**	**2.89**
Limpopo WMA North		**12.75**	**20.34**	**2.89**	**35.98**

Note: (1) As in the "Updating the Hydrology and Yield Analysis in the Mokolo River Catchment" study (DWA, 2007).