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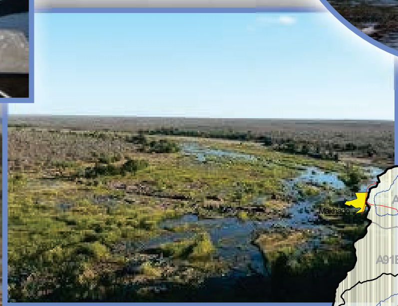
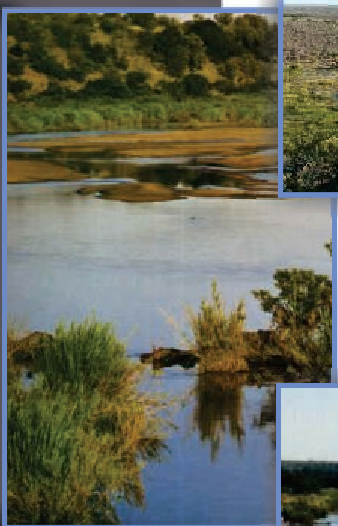
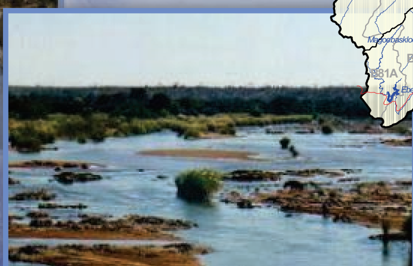
Water Affairs
REPUBLIC OF SOUTH AFRICA

DIRECTORATE: NATIONAL WATER RESOURCE PLANNING

Development of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System

FINAL RECONCILIATION STRATEGY




FINAL

JANUARY 2015

DEVELOPMENT OF A RECONCILIATION STRATEGY FOR THE LUVUVHU AND LETABA WATER SUPPLY SYSTEM

RECONCILIATION STRATEGY (January 2015)

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LIST OF REPORTS

The following reports form part of this study:

Report Title	Report number
Inception Report	P WMA 02/B810/00//1412/1
Literature Review Report	P WMA 02/B810/00//1412/2
Water requirements and Return Flow Report	P WMA 02/B810/00//1412/3
Rainfall analysis report	P WMA 02/B810/00//1412/4
Hydrology report (includes IAP)	P WMA 02/B810/00//1412/5
Water Conservation and Water Demand Management Report	P WMA 02/B810/00//1412/6
Water re-use report	P WMA 02/B810/00//1412/7
Water Quality Assessment Report	P WMA 02/B810/00//1412/8
Groundwater utilization scenarios	P WMA 02/B810/00//1412/9
Yield Analysis Report (include EWR)	P WMA 02/B810/00//1412/12
Planning Analysis Report	P WMA 02/B810/00//1412/13
Water Supply Schemes, Social and Environmental Aspects	P WMA 02/B810/00//1412/14
Final Reconciliation Strategy Report	**P WMA 02/B810/00//1412/15**
Executive Summary of Final Reconciliation Strategy	P WMA 02/B810/00//1412/16
Demographic and Economic Development Potential	P WMA 02/B810/00//1412/17

DEVELOPMENT OF A RECONCILIATION STRATEGY FOR THE LUVUVHU AND LETABA WATER SUPPLY SYSTEM

Reconciliation Strategy Report

(January 2015)

EXECUTIVE SUMMARY

The Department of Water Affairs (DWA) has identified the need for the Reconciliation Study for the Luvuvhu-Letaba catchment. The study area is almost fully developed and demands from the Letaba River currently exceed the yield capability of the system. Regulation for the Letaba catchment is mainly provided by Middle Letaba, Ebenezer and Tzaneen Dams. In the Luvuvhu catchment the recently completed Nandoni Dam will be used in combination with Albasini, Vondo and Damani dams to be managed as one system. It is expected that the total yield from this combined system will be fully utilized by around 2030, considering only the current planned projected demands. The yield of the Albasini Dam has reduced over the years and as a consequence the dam is over allocated. The Shingwedzi catchment is situated almost entirely in the Kruger National Park and for all practical purposes no sustainable yield is derived from surface flow in the Shingwedzi catchment.

The main objective of the study is to compile a Reconciliation Strategy that will identify and describe water resource management interventions that can be grouped and phased to jointly form a solution to reconcile the water requirements with the available water for the period up to the year 2040 and to develop water availability assessment methodologies and tools applicable to this area that can be used for decision support as part of compulsory licensing to come. The development of the strategy requires reliable information on the water requirements and return flows (wastewater) as well as the available water resources for the current situation and likely future scenarios for a planning horizon of thirty years.

To achieve the above objectives, the following main aspects will be covered in the study:

- *Update the current and future urban and agricultural water requirements and return flows;*

- *Assess the water resources and existing infrastructure;*

- *Configure the system models (WRSM2005, WRYM, WRPM) in the Study Area at a quaternary catchment scale, or finer where required, in a manner that is suitable for allocable water quantification;*

- *To firm up on the approach and methodology, as well as modelling procedures, for decision support to the on-going licensing processes;*
- *To use system models, in the early part of the study, to support allocable water quantifications in the Study Area and, in the latter part of the study, to support ongoing licensing decisions, as well as providing information for the development of the Reconciliation Strategy;*
- *Formulate reconciliation interventions, both structural and administrative/regulatory;*
- *Document the reconciliation process including decision processes that are required by the strategy; and*
- *Conduct stakeholder consultation in the development of the strategy.*

***The reconciliation strategy is the primary deliverable of the study** and a synthesis of all the available information collected as well as investigations carried out during the study period will be presented in this report in a summarised format. This report contains water balances with intervention scenarios that provides possible solutions to make sufficient water available for the planning period up to the year 2040*

Context of study

The Luvuvhu and Letaba rivers flow through the Kruger National Park, join the Olifants River just upstream of the Mozambique border from where it flows into the Massingir Dam located in in Mozambique. The Luvuvhu and Letaba River Systems can therefore be classified as directly supporting international obligations (Mozambique). Consequent thereof, any agreement between South Africa and Mozambique and Environmental Requirement flows for the Kruger National Park will have to be honoured.

Previous agreements between South Africa and Portugal still remain and in terms of these agreements, there are no limitations to further developments in the catchment by South Africa. The Government of South Africa is also a signatory to the Revised Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region. The character of this protocol promotes inter alia the sustainable, equitable and reasonable utilisation of shared watercourse systems and avoiding causing any negative impact to the neighbouring state.

An important aspect that has been written into the draft NWRS (2nd Edition) is the consolidation of certain WMAs to be managed by a single CMA. It will impact on the current Luvuvhu Letaba WMA and in future the Luvuvhu catchment will become part of the Limpopo catchment to form a WMA and the Letaba catchment will become part of the Olifants catchment to form a separate WMA.

This water reconciliation strategy by DWA will be an input to the future CMS once the agency gets established. It is important that this reconciliation strategy is also in harmony with the to-be-established NWRS (2nd Edition)

System description

The study area comprises of the water resources of the catchment of the Luvuvhu, Mutale, Letaba and Shingwedzi rivers, linked to adjacent systems by inter-basin transfers.

The Groot Letaba River catchment utilize water from the Groot Letaba River and its tributaries with existing storage dams such as Dap Naude, Ebenezer, Magoebaskloof, Vergelegen, Hans Merensky, Tzaneen, Thabina and Modjadji dams to supply water to various towns including Polokwane, Tzaneen, Haenertsburg, Modjadjiskloof and also to a number of rural villages. Water use in the Groot Letaba catchment is dominated by irrigation. In the Middle and Klein Letaba river catchment the water supply schemes are the Sekgopo and Tshitale/Sekgosese borehole schemes, as well as the Middle Letaba and Giyani water schemes using Middle Letaba and Nsami dams as their main resource of water. Some of the Middle Letaba water supply schemes also supply potable water to other sub-catchments, being Groot Letaba River and Luvuvhu/Vondo River catchments. The surface water resources within the Letaba catchment are extensively developed. Faced with water shortages of increasing severity and frequency over the years, the main consumptive users of water have from time to time compete for the limited supplies and experienced significant levels of restrictions. This has resulted in the degradation of the riverine ecosystem. The water resources of the Groot Letaba are not sufficient to meet all its requirements all of the time.

A Feasibility Study of the Development and Management Options for the Letaba catchment proposed several options for augmenting water supply from the Groot Letaba River. These included some management interventions, as well as the construction of a dam at Nwamitwa and the possible raising of Tzaneen Dam. The Minister of Environmental and Water Affairs approved the implementation of the Groot Letaba Water Development Project (GLeWaP) and a notice in accordance with Section 110 of the National Water Act declaring the Minister's intent to implement the GLeWaP was gazetted on 21 December 2012.

Due to significant water supply shortages already experienced in the Middle Letaba Nsami dam sub-system, the construction of a pipeline from Nandoni Dam in the Luvuvhu River to Nsami Dam has already commenced. This pipeline will convey raw water from Nandoni Dam to the treatment plant at Nsami Dam.

The Luvuvhu River Catchment is located in the north-eastern corner of South Africa. It rises near to Louis Trichardt (Makhado) and flows in a north-easterly direction to its junction with the Limpopo River near to Pafuri.

Nandoni Dam and Xikundu Weir together with the existing Albasini, Vondo, Phiphidi and Tshakhuma dams and the associated bulk purified water supply infrastructure are known as the Luvuvhu River Government Water Scheme. Nandoni Dam started to store water during 2002/03 and was able to augment the flow in the river from the winter of 2003. This scheme is *managed as an integrated system to supply water for domestic/industrial, irrigation and for the ecological component of the reserve. Current planning is that the Nandoni system will in future partly of fully support a large number of Rural Water supply Schemes and towns. The main bulk distribution pipeline is still under construction and most of these areas are not yet supported from Nandoni Dam.*

Significant irrigation developments from surface and groundwater upstream of Albasini Dam resulted in a decrease in the yield available from Albasini Dam, to such and an extend that the irrigation scheme downstream of Albasini Dam can very seldom be supplied with water from the dam, as the dam struggles to meet the urban/industrial demand of Makhado. As result of land claims large areas that were previously irrigated is currently not utilised, although these areas still have allocations from several of the existing dams. It is currently not clear whether these allocations will in future again be utilised for irrigation purposes.

There are no major dams in the Shingwedzi basin due to the limited water resources and the non-availability of suitable dam sites. Rural Water Schemes that operate in this catchment includes North and South Malamulele East RWS, which has its source as the Malamulele Weir, Xikundo Weir and Minga Weir in the Luvuvhu River. Parts of the Middle Letaba RWS Malamulele West, Giyani sub-systems F1 & F2 are located within the Shingwedzi catchment, currently receiving water from the Middel Letaba – Nsami sub-system. Water for a small irrigation area of 270ha is sourced from the Makuleke Dam on the Mphongolo River a tributary of the Shingwedzi River.

The water resources in the Mutale catchment are still underdeveloped as limited storage structures exist in this sub-catchment. Mukumbani Dam in the upper reaches of the Tshirovha River supplying water to the Mukumbani Tea Estate is the only dam in this catchment. The surface water appears to be of reasonable quality and has not been polluted to any great extent by the present developments. The Vondo North Rural RWS and the Damani RWS are both partly located in the Mutale catchment and are supplied with water from Vondo and Damani dams respectively, which are both located in the Luvuvhu River catchment.

The remainder of the Rural Water Supply Schemes are supplied from Mutale surface (50%) and groundwater resources (50%), almost similar volumes used from both sources. Some irrigation did exist in the past, it is however uncertain how much of the irrigation is currently still practised.

The Reserve

The Reserve is that portion of the natural flow that has to be available in a river or stream in order to sustain the aquatic ecology, and also to provide for basic human needs. The work carried out in the Letaba Classification Study consolidated the Ecological Water Requirement (EWR) scenarios for application in the water balances assessment of this study. EWR scenarios were formulated to reflect the implication on the available yield as shown later in the document and further details will be given in the main document.

Hydrological Analysis

There were quite a number of uncertainties around the previous available hydrology such as low confidence water use assumptions, losses in the systems, impact of groundwater use on the available surface water flows etc. The recently completed Groot Letaba Water Development Project (GLeWaP) study strongly recommended the complete update and recalibration of the Groot Letaba hydrology to confirm the yield results for the proposed Nwamitwa Dam and the raising of Tzaneen Dam. For the first time groundwater-surface water interaction was taken into account in the generation of the natural flow sequences, by applying the techniques and simulation models that have been developed by DWS and the Water Research Commission.

A detailed Water Resources Simulation (WRSM2000) hydrological model was configured and calibrated as well as verification of simulated flows was done at the 23 sites throughout the Study Area. Adaptions were made to calibrations at dam balances to achieve reasonable dam level comparisons. Natural runoff simulations could be done for the entire Luvuvhu and Letaba catchment based on reasonable calibration of the WRSM2000 at key points, and parameter transfer to areas not covered by the calibration.

Confidence in the simulation results for each catchment was determined based on criteria such as rainfall, water- and land-use as well as the quality of observed calibration data. It was found that 57% of the natural Study Area MAR had a confidence level higher than 70%. A further 30% had a confidence level of between 50% and 70% and 13% had a confidence level of lower than 50%. The main reasons for the low confidence areas are the bad distribution of rainfall stations and the large areas of no or unacceptable flow gauging.

It was estimated that the total groundwater requirement at 2010 development levels was 160 million m^3/a in the study area. Only approximately 110 million m^3/a can be supplied from groundwater and this has an impact of approximately 58 million m^3/a on surface water runoff reduction. This clearly shows the importance of simulating groundwater and related use in combination with surface runoff and usage, which was carried out for the first time as part of this study. The runoff generated in the study area with 2010 groundwater abstractions taken into account, was estimated as 1 274 million m^3/a of which 38.5% is from the Groot Letaba, 12.1% from Klein Letaba, 30% from the Luvuvhu, 12.2% from the Mutale and 7.2% from the Shingwedzi River.

Current and projected water requirements

To determine the volume of water needed, information was gathered on the water requirements of the different sectors. The water use Validation Study served as the primary source of historical water use data. Groundwater resources play an important role in the water supply within this study area with approximately 22% of the total water requirement imposed on groundwater. The irrigation sector uses most of the groundwater with 29% of the irrigation supplied from groundwater. The total groundwater requirement is estimated to be almost 160 million m^3/a at the 2010 development level.

***Table i** summarises the water requirement for the Luvuvhu and Letaba River System for the all the user sectors, listing the 2010 water use as well as estimates for the indicated components up to the year 2040.*

Table i: Total High growth water requirements (values in million m^3/a)

Catchment & Description	User description	Demand projection (million m^3/a)						
		2010	2015	2020	2025	2030	2035	2040
Groot Letaba	All users	332.7	338.7	345.1	351.9	355.4	358.9	362.7
Klein Letaba	All users	129.7	135.9	142.6	149.8	152.9	156.1	159.5
Luvuvhu/Singwedzi	All users	126.04	132.9	176.6	191.4	196.6	201.0	204.3
Mutale	All users	8.2	8.9	9.5	10.2	10.6	11.1	11.6
Total Demand in study area		**596.70**	**616.31**	**673.73**	**703.27**	**715.53**	**727.04**	**738.06**
Total study area	Reduction in runoff due to IAP	11.3	11.3	11.3	11.3	11.3	11.3	11.3
Total study area	Forestry reduction in runoff	79.7	79.7	79.7	79.7	79.7	79.7	79.7
Total Demand and runoff reduction requirements in study area		**687.70**	**707.31**	**764.73**	**794.27**	**806.53**	**818.04**	**829.06**

The possible estimated savings through WC/WDM in the urban and rural domestic sector was determined for each of the Water Services Schemes and for the larger towns in the study area and was estimated to be in the order of 9 million m^3/a, representing an overall saving of 8%. Within the irrigation sector very limited (if any) savings can be achieved, as most of the irrigation schemes are already experiencing severe water shortages. In the case of commercial irrigation schemes, irrigators have in most cases already improved their irrigation efficiency to get maximum use from the available water.

Water availability

*Yield analyses were undertaken based on the revised hydrology for all major dams and relevant sub-systems. **Table ii** provides a summary of the yield results for existing and possible future infrastructure, indicating the high assurance yield (1 in 50 year or 98% assurance) and the low assurance yield (1 in 20 year or 95% assurance) which is mainly used for irrigation purposes.*

The Ground Water Harvest Potential (Seward and Seymour, 1996) provides a basis for the evaluation of the volume of groundwater resources. The Harvest Potential for the study area was determined as 271 million m^3/a. It is however not possible to abstract all the ground water available. The Harvest Potential was then reduced by an exploitation factor, determined from borehole yield data, to obtain an exploitation potential, i.e. the portion of the Harvest Potential which can practically be exploited. The Exploitation Potential for the study area was on this basis determined as 184 million m^3/a. Approximately 81% of the groundwater within the study area can be regarded as potable due to water quality limitations in some areas. The Potable volume of groundwater that can be exploited within the study area was estimated as 158 million m^3/a. When only considering the groundwater available within the water services schemes, the potable exploitation potential within the schemes amounts to only 80 million m^3/a.

Groundwater use and availability were assessed and although there are areas where the use exceeds the potable exploitable groundwater potential, there still remain areas where further groundwater abstractions are possible.

Table ii: Existing and possible future System yield results

Dam name	FSV	Yield (million m^3/a)		
	(million m^3)	HFY)	1 in 20 year	1 in 50 year
1) Dap Naude plus Ebenezer	**72.8**	**36.2**	**43.8**	**40.5**
2) Magoebaskloof plus Vergelegen	**9.9**	**6.4**	**14.7**	**12.9**
3) Hans Merensky	**5.1**	**3.4**	**5.2**	**4.8**
4)Tzaneen raised	**182.4**	**45**	**60.0**	**51.7**
5) Tzaneen raised plus Nwamitwa	**369.0**	**61**		
6) Tzaneen raised plus Nwamitwa & EWR	**369.0**	**49**		
7) Thabina	**2.6**	**3.1**	**4.1**	**3.7**
8) Middel Letaba plus Nsami	**206.1**	**20.6**	**31.0**	**24.3**
9) Thapane	**1.07**	**1.1**	**1.6**	**1.4**
10) Modjadji	**7.2**	**3.5**	**4.4**	**3.8**
11) Makuleke	**13.0**	**0.1**		
12) Albasini	**28.4**	**1.4**	**3.7**	**2.5**
13) Vondo	**30.6**	**16.8**	**25.0**	**21.9**
14) Phiphidi	**0.19**	**0.2**		
15) Damani	**12.9**	**4.8**	**5.7**	**5.3**
16) Nandoni plus weirs	**166.1**	**62**	**83.0**	**70.0**
17) Tshakuma	**2.47**	**1.4**	**1.8**	**1.5**
Possible Future dams				
1) Paswane dam	**90.0**	**43.0**	**64.5**	**55.0**
2) Xikundu Dam	**139.0**	**51.0**	**71.5**	**62.5**
3) Crystalfontein Dam with EWR	**96.0**	**5.4**	**-**	**-**
4) Majosi Dam with EWR	**29.0**	**4.6**	**-**	**-**
5) Rambuda Dam	**13.5**	**12.6**	**18.7**	**16.7**
6) Tswera Dam	**131**	**53.0**	**69.4**	**62.1**
7) Thengwe Dam	**116**	**51.0**	**-**	**-**

Water Quality

The water quality trends in the middle to lower Luvuvhu River indicate a deterioration of the phosphates, nitrates and ammonia levels. The water quality of the Luvuvhu main catchment has remained very good, and on the whole falls within the interim RWQOs.

In general the water quality of the Shingwedzi River catchment has remained very good, it however shows contamination from the domestic wastewater treatment works, as well as general urban pollution from the larger villages.

The water quality of the Groot Letaba catchment has remained very good in the upper reaches of the catchment, moving towards a slight deterioration further downstream due to low flow conditions. The Great Letaba Irrigation Scheme covers an extensive area along the river to the border of the Hans Merensky Game Park. Further downstream along the river at the gauging point B8H008, the water quality deteriorates with TDS (710 mg/l), sodium (138.5 mg/l) and chloride of 192.7 mg/l. This is at the confluence of the Klein Letaba and the border of the KNP.

The current water quality down the Klein Letaba River indicates ideal values of ammonia, sulphates and nitrates, with unacceptable phosphate values which are as a result of a number of WWTWs and waste disposal sites, leading to eutrophication.

Considering the number of densely populated and informal settlements in the study area and the potential for water use directly from the resources, bacteriological monitoring in the study area is inadequate, and needs to be increased at points up and downstream of the urban areas, and specifically wastewater treatment works. This will also give a better understanding of the potential for cholera outbreaks.

The wastewater treatment works in the study area need to be upgraded to improve the quality of the effluent being discharged, as this is impacting on human health and increased eutrophication potential in the study area, which will in turn impact on other water users such as irrigation farmers and water treatment plants.

The current and future water balance

At the Screening Workshop held in April 2012, intervention options were identified for consideration in the study as measures to reconcile the water requirement and availability. These consisted of options to reduce the water requirements as well as those that increase the water supply. The identified options are listed below for the indicated catchment areas:

Options applicable to all Areas:

- *Water Conservation & Water Demand Management*
- *Development of groundwater resources*

Groot Letaba Catchment Options:

- *Raising of Tzaneen Dam.*
- *Construction of Nwamitwa Dam.*
- *Bulk Water Supply Infrastructure to distribute water from Nwamitwa Dam.*
- *Artificial recharge at Mulele on the Molototsi River.*
- *Groundwater regional scheme in conjunction with surface scheme.*

Middel and Klein Letaba Catchment Options:

- *Replacement of Middel Letaba canal with pipeline – reduce canal losses.*
- *Transfer Scheme from Nandoni Dam.*

• Construction of new dam on Klein Letaba River:

- *– Majosi Dam, or*
- *– Crystalfontein Dam*

<u>Luvuvhu Mutale and Shingwedzi Catchment Options:</u>

• Transfer water from Luvuvhu to Shingwedzi

• Reconsider Louis Trichardt (Makhado) water supply combination using Albasini, Nandoni and smaller water resource schemes

• Raising Vondo Dam.

• Mid Dzindi possible dam

• Latonyanda possible dam

• Paswane possible dam

• Xikundu possible dam

• Possible new dams on Mutale (Rambuda, Tswera & Thengwe)

*Annual water balance diagrams were prepared for all the systems listed in **Table ii**, using the indicated yields, selecting options with the lowest URV's as well as the projected water requirements for the respective areas.*

The water balances take into account the assurance of supply as required by different water use sectors. Water supply to urban/Industrial and rural domestic users is always provided at a higher assurance than water supply to irrigation. For the purpose of the water balances, a 98% assurance was assumed to be applicable to the urban/Industrial and rural domestic sector and a 95% assurance to the irrigation sector. The 98% assurance relates to shortages in supply that will on average be experienced once in 50 years (1 in 50 year) and the 95% assurance for irrigation, to shortages experienced on average once in 20 years (1 in 20 year). In several areas the actual supply to irrigation is well below the 95% assurance due to overutilization of the water resources. In some of these areas the irrigators were able to adapt to these low assurances, in which case the lower assurance of supply to irrigation was accepted for the purpose of the water balance. This approach was followed as there were insufficient water resources to improve the assurance of supply to irrigation in those areas.

The water balances indicated that the implementation of interventions will be critical to ensure sufficient water supply to the year 2040 for almost all the small and large water supply systems. In many of the sub-systems deficits are currently observed and in some areas these deficits are quite severe.

Reconciling the Water Requirements with the Water Resource

The three major sub-systems, the Groot Letaba, the Middle Letaba Nsami and the Luvuvhu sub-system, are currently managed as individual systems. Within each of these there are a number of smaller sub-systems which are in some cases linked to the main sub-system. It is *therefore required to prepare separate reconciliation balances and strategies that will cover each sub-system within the study area. This is necessary to identify the particular timeline and magnitude of interventions required during the planning horizon. Sub-system specific balances and strategies were therefore prepared, taking into account the existing linkages, currently planned links as well as proposed future links, to be able to obtain positive water balances over the planning period.*

The executive summary will mainly focus on the three major sub-systems as they to a large extent also capture the smaller sub-systems. The Mutale system water balances will also be included and described within the executive summary as significant future developments are expected to take place within the Mutale basin.

Groot Letaba Main System

Smaller sub-systems in the Groot Letaba which is not linked to the main water supply system are the Hans Merensky and Magoebaskloof Vergelegen dam sub-systems. Findings from their related water balances are briefly summarised below.

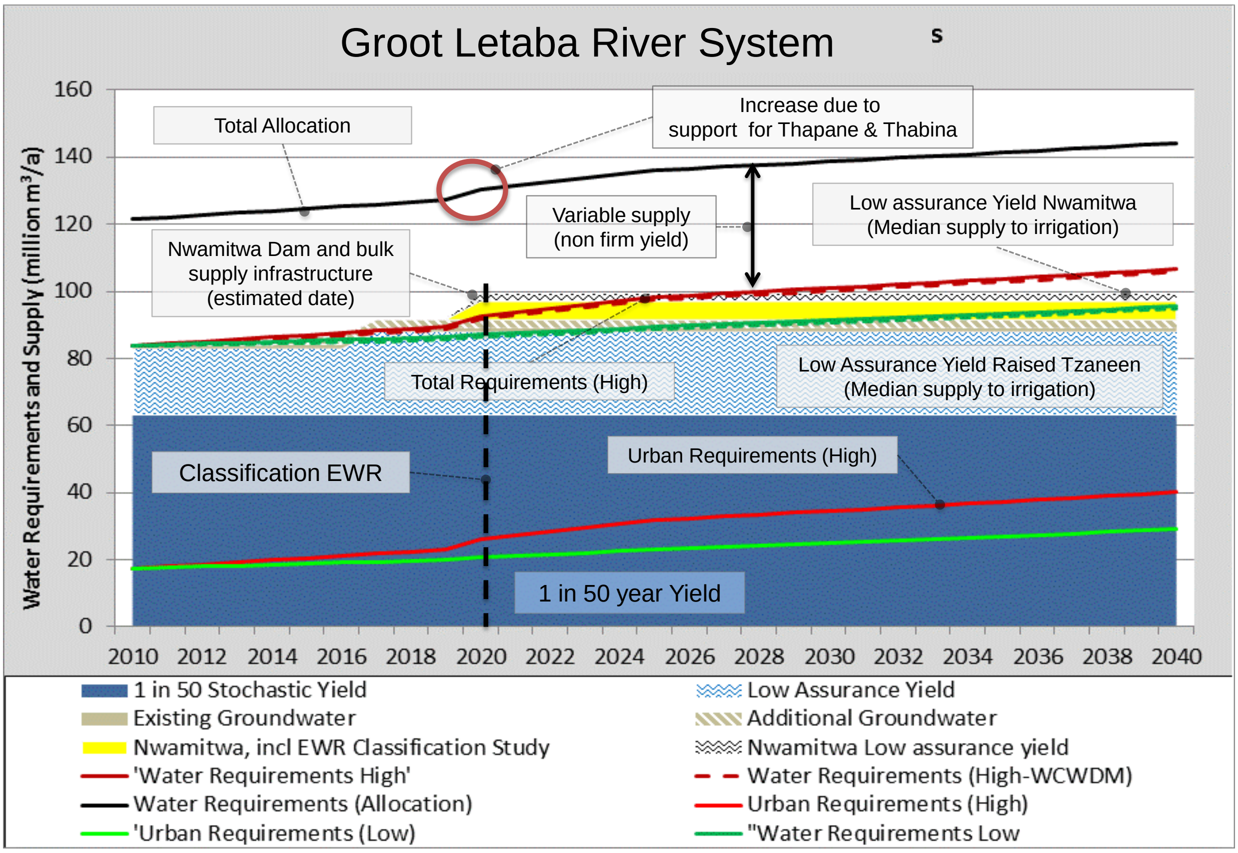
- *Hans Merensky Dam water balance clearly showed that the available yield is more than sufficient to support the irrigation and showed a slight excess of approximately 0.7 million m^3/a in the sub-system. No growth in demand is foreseen and this sub-system is thus in balance over the planning period to the year 2040.*

- *Magoebaskloof Vergelegen dam sub-system water balance showed that the urban requirements can easily be met at the required 98% assurance over the entire planning period. With the full irrigation allocation taken up over time, a small deficit is expected in future. For irrigation purposes the small deficit should not be a problem, as long as the irrigators are willing to operate at a slightly lower assurance. When the irrigators take up their full allocation it will not be possible to support any additional domestic requirements.*

The water balance for combined Dap Naudé Ebenezer dam sub-system showed that the system is in balance for the entire planning period up to 2040, but will not be able to support further growth in demands. During times of severe droughts, Ebenezer Dam is used to support Tzaneen Dam and is thus considered to be part of the Groot Letaba Main system.

The water services schemes forming part of the Groot Letaba Main system are Siluwane-Nondweni Extended RWS, Ritavi/Letaba RWS, Tzaneen/Modjadjiskloof and Ritavi ll RWS. To be able to improve the water supply in this severely stressed system all the identified intervention options, need to be implemented. As this system is already severely stressed, the irrigators supplied from the Groot Letaba main system, developed a very strict operating rule currently imposed on the system to regulate the supply to irrigation. When this rule is implemented, the irrigators receive on average approximately 62% of their allocation.

Figure i: Water balance and reconciliation scenario for the Groot Letaba Main System



Even with all the proposed intervention options in place, the Groot Letaba Main system will still not be able to supply the full irrigation allocation at a reasonable assured yield. It is thus of utmost importance that the irrigation users continue with this restriction rule, which will require some adjustments when the raising of Tzaneen Dam was completed and again when Nwamitwa Dam starts to deliver water. The water balance as given in ***Figure i*** *includes the assumption that the current assurance of supply to the irrigators, will be maintained over the planning period.*

Most of the smaller sub-systems that support part of the rural domestic requirements in or close to the Groot Letaba Main system supply area also require augmentation in future. These include the Thapane and Thabina sub-systems. The deficits as determined from their individual water balances were included in the Groot Letaba Main system water demand projection from 2020 onwards, to coincide with the time when Nwamitwa Dam start to deliver water. Deficits in the Modjadji sub-system are expected from 2017 onwards. As the Groot Letaba Main system with all intervention options included can only remain in balance until 2030, it was decided to rather impose the deficits in the Modjadji sub-system on the Middle Letaba sub-system and not on the Groot Letaba.

The Groot Letaba Main system water balance contains the following elements.

- *Total yield (high and low assurance) of 84 million m^3/annum, reflecting an average supply of about 60% to the irrigators.*

- *Implementation of Water Conservation and Demand Management in the urban sector (dashed red line).*
- *Raising of Tzaneen Dam, main purpose is to improve the assurance of supply.*
- *Once Nwamitwa Dam is implemented (see yellow area), water is supplied to the areas currently receiving water from Thabina and Thapane dams.*
- *Ebenezer Dam is used to support users receiving water from Tzaneen Dam when Tzaneen Dam reaches low storage levels.*
- *The excess water in Ebenezer Dam is made available to support users receiving water from Tzaneen Dam.*
- *Water from existing and additional groundwater resources for target areas was added as yield.*
- *Implemented the low flow Ecological Water Requirements for the scenario proposed by the Classification Study.*

The interventions options incorporated in the reconciliation balance for Groot Letaba Main system can only supply the target water requirement scenario (High growth with WC/WDM) up to the year 2030.

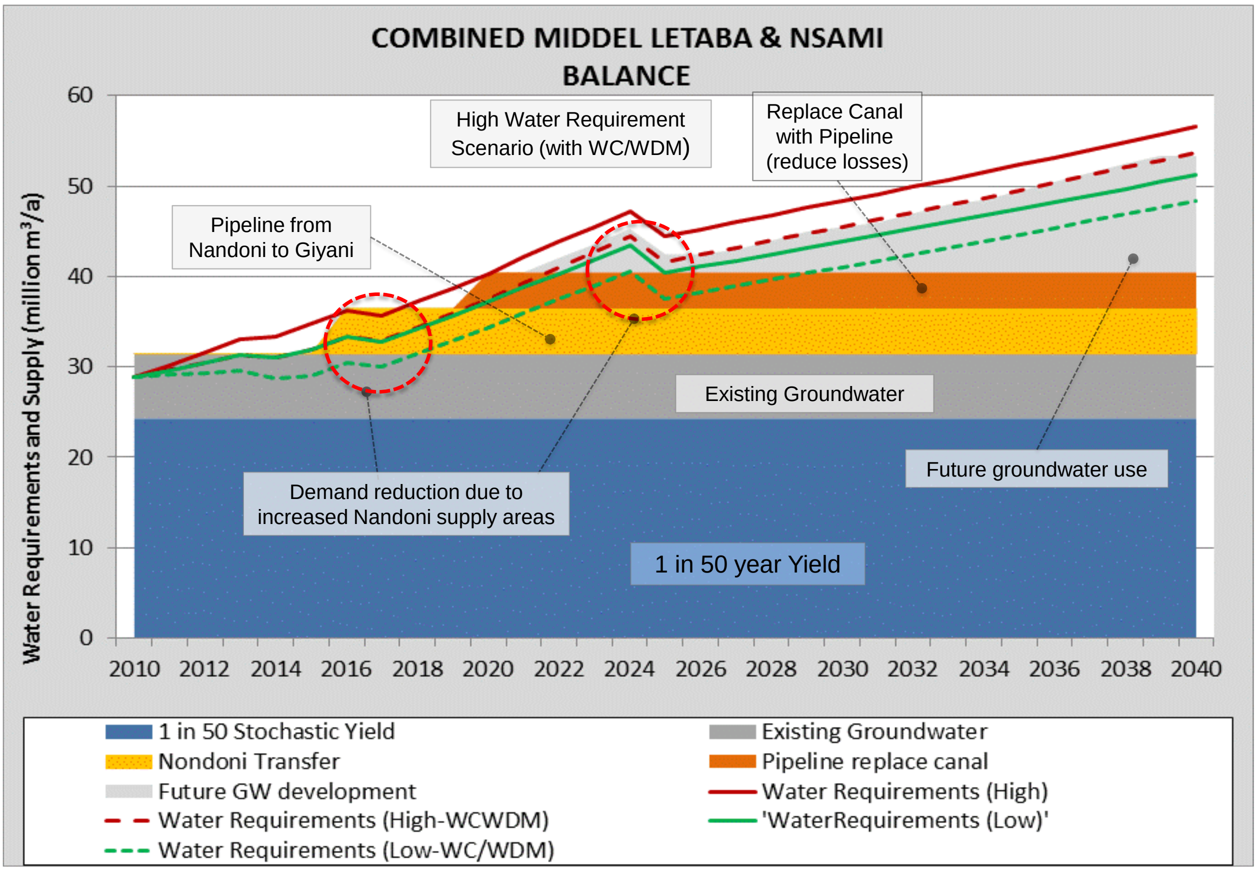
Middle Letaba Nsami System

The Middle Letaba Nsami system is already in deficit from 2012 onwards, even when taking into account that the total demand imposed on the system is reduced from certain years onwards, when portions of the water service schemes currently supplied Middle Letaba Dam, starts to receive support from Nandoni Dam. The possible Majosi and Crystalfontein dams were also evaluated as potential intervention options, but both resulted in fairly high URVs, and were therefore not used within the reconciliation scenario. These two dams might still be options to consider in the future beyond 2040.

The Middle Letaba Nsami System water balance contains the following elements

- *Yield of both dams as well as the existing groundwater resources.*
- *Implementation of Water Conservation and Demand Management in the urban sector (dashed red line).*
- *Transfer from Nandoni Dam, indicated by the orange augmentation option.*
- *Some of the current Middle Letaba supply areas were already committed to receive water from Nandoni Dam by 2017 and some later by approximately 2024, reducing the load on Middle Letaba Dam as indicated by the drop in demands as shown by the red and green demand projection lines.*
- *Replacement of the canal transferring water from Middel Letaba Dam to the waterworks at Nsami Dam with a pipeline option as indicated by the brown intervention option.*
- *Developing additional groundwater resources from 2022.*

Figure ii: Water balance and reconciliation scenario for the Middel Letaba Nsami System



By implementing all these interventions, sufficient water can be made available to supply the high water requirement scenario with WC/WDM until 2040.

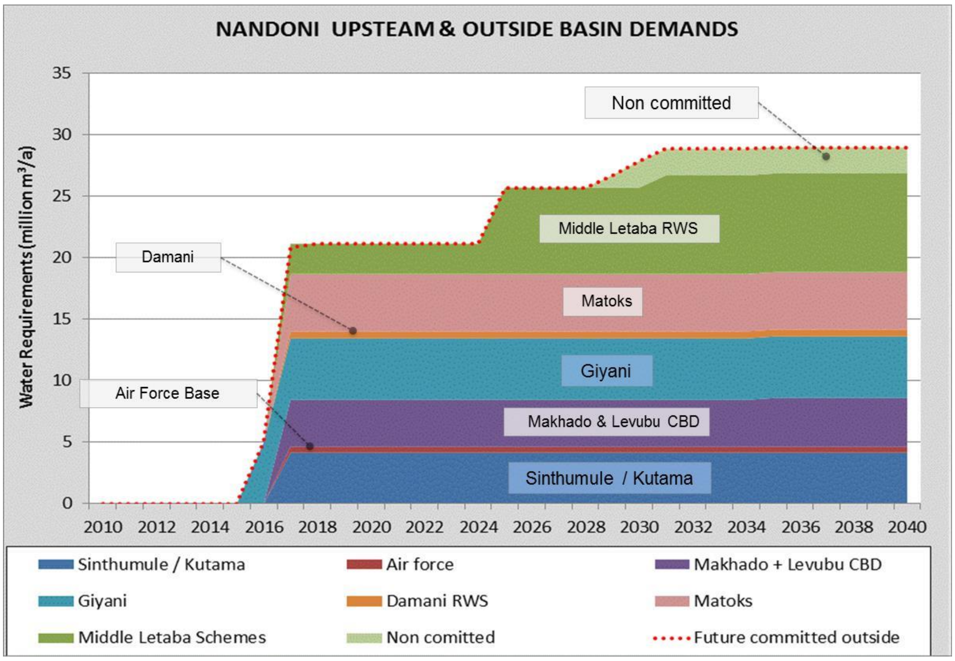
<u>Luvuvhu System</u>,

The Luvuvhu system comprises several sub-systems of which some are currently linked. Nandoni Dam is the largest storage dam in the system and was only completed in 2004. Nandoni Dam will support almost all the sub-systems within, as well as some located outside the Luvuvhu catchment. This will result in links between all the main supply systems within the Luvuvhu catchment, as well as to several sub-systems outside the catchment. Deficits that still exist in the smaller sub-systems will be imposed as a demand on the larger Nandoni Dam system, as it is currently the only sub-system with significant surplus yield available in the Luvuvhu catchment.

*A substantial volume of approximately 28 million m^3/a from the Nandoni yield was already committed to several other water services schemes located outside the supply area. A summary of these supply commitments are given in **Figure iii**.*

The main water resources forming part of this integrated system are Nandoni Dam and the weirs downstream of Nandoni Dam, Vondo, Phiphidi and Tshakuma dams, with support from two run off river abstractions and related package plants at Dzindi and Dzingae, as well as groundwater abstractions.

Figure iii: Support committed from Nandoni Dam in support other water services schemes



*The Nandoni yield shown in the water balance (**Figure iv**) represents the yield available from Nandoni Dam in combination with the downstream weirs. The Greater Thohoyandou yield refers to the combined system yield from Vondo, Phiphidi and Tshakuma dams as well as the two package plants.*

Deficits is expected to occur in this system from 2031 onwards, for both water use sectors, urban/rural domestic and irrigation. This system is thus already slightly over allocated; although a relative small portion of the allocated future demands centres are currently receiving water from Nandoni Dam.

The Nandoni and Greater Thohoyandou integrated System water balance contains the following elements:

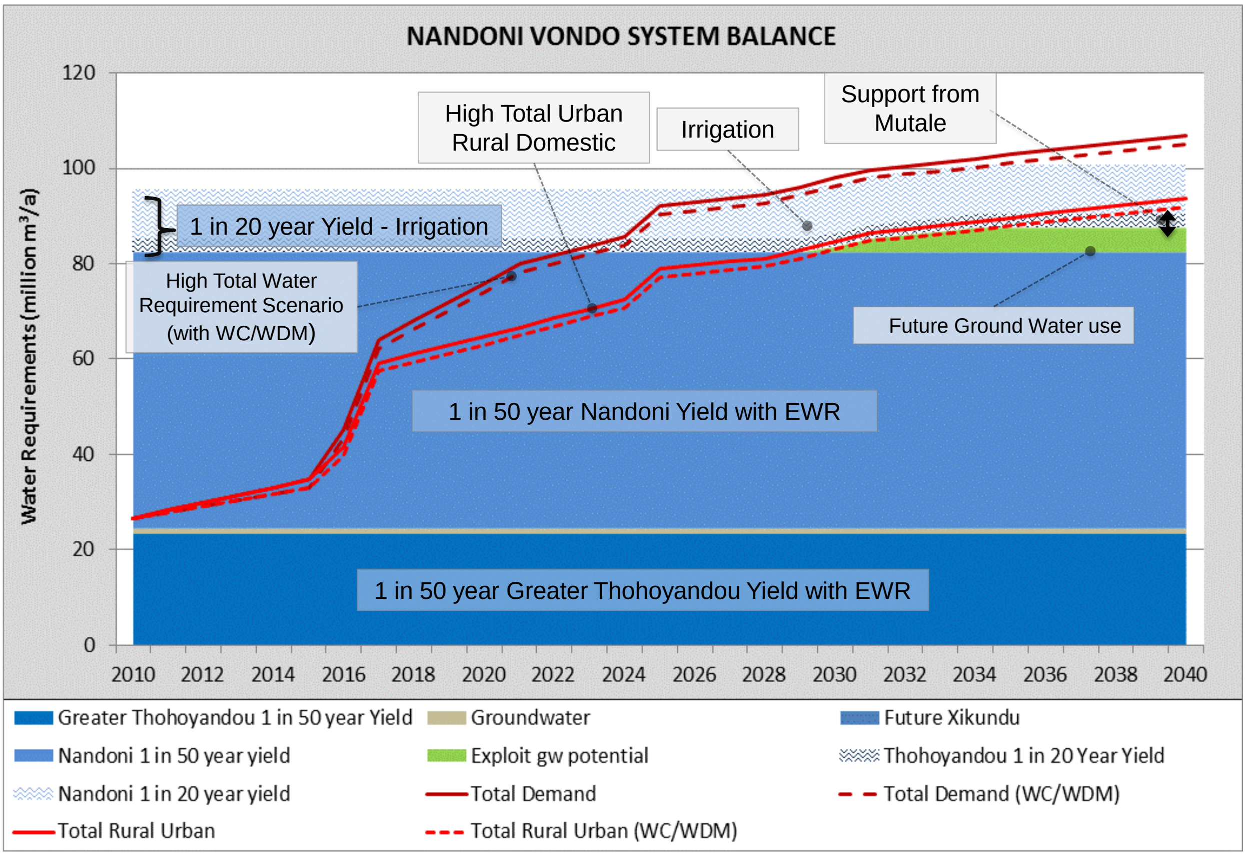
- *Total 1 in 50 year yield of 82 million m^3/a plus an incremental 1 in 20 year yield of 13 million m^3/a, resulting in a total yield of 95 million m^3/a.*

- *The Greater Thohoyandou sub-system includes Vondo, Tshakhuma, and Phiphidi dams as well as two runoff river package plants.*

- *Increased groundwater resources from 2030 onwards.*

- *Several areas located outside the Luvuvhu catchment were also committed to receive water from Nandoni Dam. These areas include Sinthumule/Kutama, Makhado, Giyani, Matoks, Middle Letaba supply areas as well as areas currently supplied from Damani Dam of which the bulk is located in the Mutale catchment. The inclusion of the deficits from these areas is evident in the sudden steep increases shown on the urban demand projection curve.*

Figure iv: Water balance Nandoni and Greater Thohoyandou integrated System



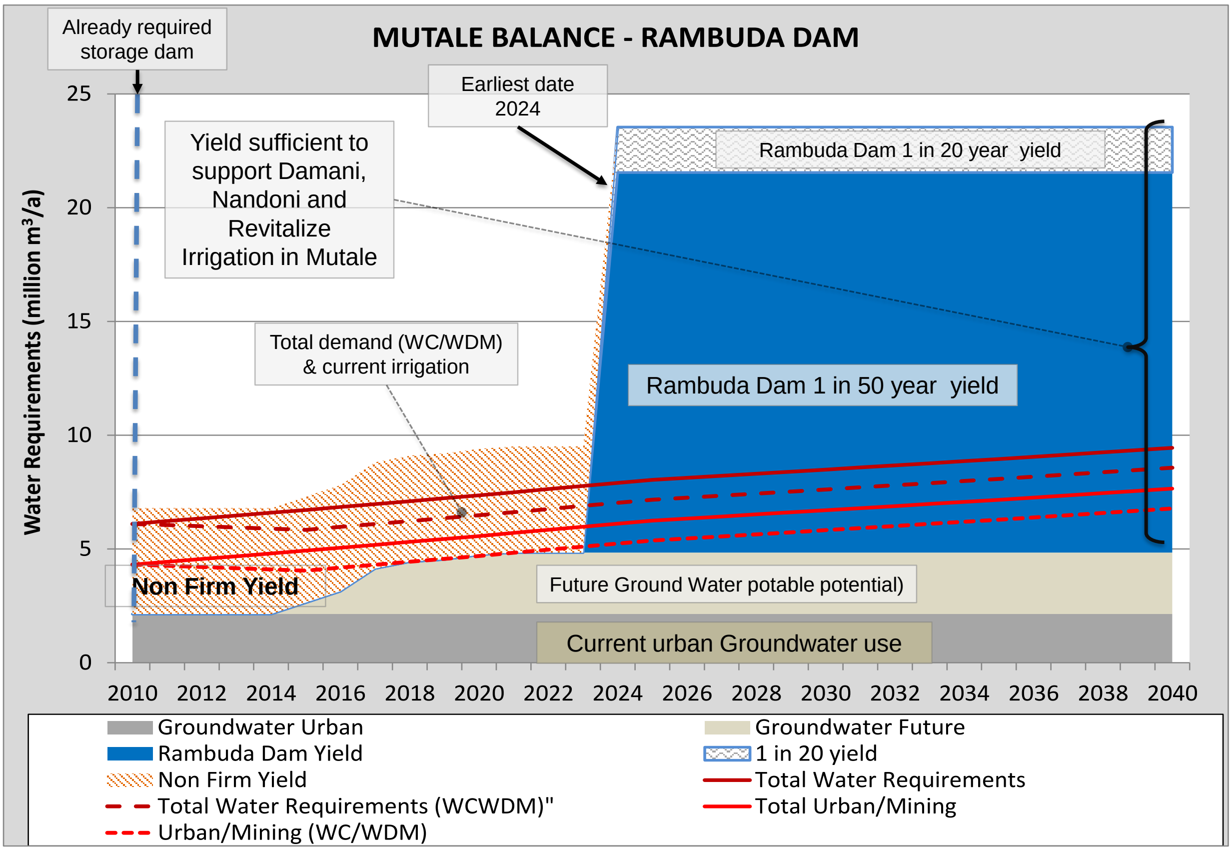
By implementing these interventions the system is able to supply the growth in demands until 2035. By then a dam in the Mutale River is an option that was identified for possible future support. Another possibility to increase the The Nandoni Dam sub-system yield is to better utilise the incremental flow downstream of Nandoni Dam by increasing the abstractions from the existing downstream weirs as well as to increase the weir capacities and the implementation of realtime monitoring. This option however still need to be investigated.

<u>Mutale System</u>

*At 2010 development level a significant portion of the rural domestic requirement is supplied from sources with a non-firm yield and an unacceptable low level of assurance. Intervention options that can be implemented fairly quickly are WC/WDM and further exploitation of groundwater resources as indicated in **Figure v**.*

From the "Mutale River Water Resources Investigation" study the possible Rambuda downstream Dam and the Tswere Dam were identified as the most promising dam sites. The Rambuda Dam size is limited due to foundation problems at the site, while Tswera Dam can be constructed to quite a large capacity. Both these two possible future dams yield significantly more than the projected 2040 urban rural domestic requirement including the current irrigation in the Mutale basin.

Figure v: Mutale System water balance with intervention options – Rambuda Dam



The WC/WDM and additional groundwater resources can only maintain a positive water balance for the water supply to the urban and rural domestic requirements from 2018 to 2021. The earliest possible date to have a new storage dam in place was taken as 2024.

The Rambuda Dam site location relative to the demand centres is expected to be the preferred option as it will result in the least pumping costs. The dam size is unfortunately limited due to foundation problems. For the purpose of the executive summary only the water balance with the possible future Rambuda Dam is shown.

The possible Rambuda Dam can however provide more than sufficient yield to supply the existing irrigation requirements and the projected Mutale rural domestic requirements until 2040. The remaining yield vailable after supplying the Mutale system requirements will be sufficient to cover the deficits in the Integrated Nandoni system and to revitalise some of the irrigation in the Mutale basin.

Actions required

<u>A number of short term actions are required</u>. They are:

- *Verification of water entitlements from current Verification study. Once the extent of unlawful irrigation water use has been determined, the Department of Water Affairs need to prepare a compliance monitoring and enforcement plan. Areas where the removal of unlawful water use will impact significantly on the water resources need to be re-evaluated and water balances adjusted accordingly.*

- *Monitor water use to confirm water requirement projections before implementing options.*

- *Water Conservation and Water Demand Management. Implementation of these plans need to start in 2015*

- *Monitor observed flows and storage levels at strategic points. Quite a number of existing gauging points require attention to be able to provide reliable and very essential data required to be able to manage this system properly, and to be able to do sensible and realistic future planning of water resources and related assured water supply to users.*

- *Clarify future irrigation developments and revitalisation of previous irrigation schemes.*

- *Set clear targets for the construction of bulk water distribution systems.*

- *Continuous integration between Water Balances and water supply planning to water services schemes need to take place.*

<u>The following medium to long-term actions is required:</u>

- *Commission a Bridging study on the possible development and revitalisation of irrigation in the Mutale River.*

- *Pipeline to replace the canal between Middel Letaba and Nsami dams Initiate an investigation to determine the most viable and cost effective pipeline route and size for the pipeline. This needs to be followed by the design, preparation of tenders, tender procedure, construction and commissioning of the construction work.*

- *Commission Classification study on the Luvuvhu and Mutale rivers.*

- *Investigate the possible increase of the Nandoni sub-system yield by improved utilising of downstream incremental flows.*

- *Commission Feasibility studies on groundwater development in relevant areas.*

- *Commission Feasibility studies on the construction of storage dam in the Mutale River.*

The Luvuvhu Letaba Reconciliation Strategy in a Nutshell

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

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

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

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

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

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

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

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

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

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

(vii) **Augmentation is required from the Groot Letaba System after Nwamitwa Dam is in**

place, to the support areas currently receiving water from, Thapane and Thabina dams

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

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

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

(xi) **Nandoni Dam to be used to support the already committed areas located outside as well as inside the Luvuvhu catchment.**

(xii) **Remove unlawful use upstream of Albasini Dam, based on findings from the validation and verification process.**

(xiii) **Use a possible dam in the Mutale River (Rambuda or Tswera dam) to create additional yield in the system to augment future requirements in the Mutale and Luvuvhu.**

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

(xv) **Investigate the possibility of increasing the yield of the Nandoni sub-system by improving the utilising of incremental flows downstream of Nandoni Dam. This can be done by increasing the abstractions at the existing downstream weirs, by increasing the storage capacity of these weirs and by using real time monitoring.**

Development of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System

Reconciliation Strategy

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Acronyms

ACRU	Agrohydrological Modelling System
BID	Background Information Documents
CBO	Community Based Organisation
DA	Drainage Area
DM	District Municipality
DPLG	Department of Provincial and Local Government
DWA	Department of Water Affairs
EFR	Environmental Flow Requirement
EMA	Ecological Management Area
GIS	Geographical Information System
GRIP	Groundwater Resource Information Project
IAPs	Interested and Affected Parties
IFR	In stream Flow Requirements
IWRM	Integrated Water Resource Management
LLRS	Development of Water of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System
NGDB	National Groundwater Database
NGO	Non-Governmental Organisation
RWQO	River Water Quality Objectives
SAGDT	South African Groundwater Tool
SSC	Study Steering Committee
STW	Sewer Treatment Works
TDS	Total Dissolved Solids
URV	Unit Reference Value
WC	Water Conservation
WDM	Water Demand Management
WMA	Water Management Area
WRC	Water Research Commission
WRP	WRP Consulting Engineers (Pty) Ltd.
WRSS	Water reconciliation Strategy Study
WRPM	Water Resources Planning Model
WRYM	Water Resources Yield Model
WSA	Water Service Authority
WSAs	Water Service Authorities
WSP	Water Service Providers

Development of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System

Reconciliation Strategy (September 2014)

1 INTRODUCTION

1.1 BACKGROUND

The Department of Water Affairs (DWA) has identified the need for detail water resource management strategies as part of their mandate and continuing planning initiatives with the overarching objective to formulate intervention measures that will ensure enough water can be made available to supply the water requirements for the next twenty to thirty years.

The DWA Directorate: National Water Resource Planning (NWRP) therefore commenced the strategy development process in 2004, by initially focusing on the water resources supporting the large metropolitan clusters, followed by the systems supplying the smaller urban areas to systematically cover all the municipalities in the country.

As part of this process the need for the Reconciliation Study for the Luvuvhu and Letaba River systems was also defined. These systems are almost fully developed and water requirements from the Letaba River currently exceed the yield capability of the system. Storage regulation for the Letaba is provided by Middle Letaba, Nsami, Ebenezer and Tzaneen Dams.

The Reconciliation Strategy incorporated approved water resource development projects such as the Groot Letaba Water Development Project (GLeWaP), which is a key initiative by the DWA to support the social and economic development strategy for the Limpopo Province. The project encompasses the raising of Tzaneen Dam by 3 meters, construction of a large dam on the Groot Letaba River just downstream of the Nwanedzi River confluence, at the site known as Nwamitwa on the Janetsi Farm 463LT (Nwamitwa Dam), as well as the development of bulk potable water supply infrastructure to serve rural communities without adequate water supplies.

Nandoni Dam, located in the Luvuvhu basin was completed in 2004 and in combination with Albasini, Vondo, Tshakhuma and Damani dams, provide water through bulk conveyance infrastructure (existing and proposed) to Thohoyandou, Louis Trichardt (Makhado), Malamulele, Matoks, Majosi and the proposed pipeline that will transfer water to Giyani.

Intensive irrigation farming is practised in the upper parts of the Klein Letaba River catchment (upstream and downstream of the Middle Letaba Dam), the Groot Letaba (downstream of the Tzaneen Dam) and Letsitele Rivers, as well as in the upper Luvuvhu River catchment. Vegetables (including the largest tomato production area in the country), citrus and a variety of sub-tropical fruits such as bananas, mangoes, avocados and nuts are grown. Large areas of the upper catchments have been planted with commercial forests in the high rainfall parts of the Drakensberg escarpment and on the Soutpansberg.

The area, particularly the Groot Letaba sub-area, is a highly productive agricultural area with mixed farming, including cattle ranching, game farming, dry land crop production and irrigated cropping. Agriculture, with the irrigation sector in particular, is the main base of the economy in the region.

Large scale utilization of the groundwater resource occurs mostly downstream of the Albasini Dam in the Luvuvhu catchment, where it is used by irrigators as well as in the vicinity of Thohoyandou where it is used to supply rural communities.

The limited mineral resources in the Luvuvhu basin are dominated by deposits of cooking coal in the northeast, near Masisi. In addition to irrigation water supply from the dams in the study area, towns, villages and rural settlements are also supplied with potable water.

DWA and other institutions involved in the management of the water resource and supply systems of the Luvuvhu-Letaba catchments, have in the past carried out various studies on intervention measures to improve the water supply situation. The knowledge base that has been created by these studies, provide a sound and essential platform from which the Reconciliation Strategy was developed.

Detail water use and hydrological studies were carried out as part of the strategy development process, to enhance the level of confidence of the reconciliation balances and fill gaps that where identified from previous investigations.

The objectives of the study and reconciliation strategy are described in further detail in the following section.

1.2 MAIN OBJECTIVES OF THE STUDY

The main objective of the study was to compile a Reconciliation Strategy that identifies and describe water resource management interventions that can be grouped and phased to jointly form a solution to reconcile the water requirements with the available water for the period up to the year 2040. The study also entail the developing water availability assessment methodologies and tools applicable to this area, that can be used for decision support as part of licensing and possibly compulsory licensing in future. The development of the strategy requires reliable information on the water requirements and return flows (wastewater) as well as the available water resources for the current situation and likely future scenarios for a planning horizon of thirty years.

To achieve the above objectives, the following main aspects were covered in the study:

- Update the current and future urban and agricultural water requirements and return flows;
- Assess the water resources and existing infrastructure;
- Configure the system models (WRSM2005, WRYM, WRPM) in the Study Area at a quaternary catchment scale, or finer where required, in a manner that is suitable for allocable water quantification;
- To firm up on the approach and methodology, as well as modelling procedures, for decision support to the on-going licensing processes;

- To use system models, in the early part of the study, to support allocable water quantifications in the Study Area and, in the latter part of the study, to support ongoing licensing decisions, as well as providing information for the development of the reconciliation strategy;
- Formulate reconciliation interventions, both structural and administrative/regulatory;
- Document the reconciliation process including decision processes that are required by the strategy; and
- Conduct stakeholder consultation in the development of the strategy.

1.3 STUDY AREA

The study area comprises of the water resources of the catchment of the Luvuvhu, Mutale, Letaba and Shingwedzi rivers, linked to adjacent systems as indicated by the inter-basin transfers on **Figure 1.1**. This area represents the area covered by tertiary catchments A91, A92, B81, B82, B83 and B90. Adjacent areas supplying water to these catchments as well as getting water from this catchment are also part of the study area.

The Luvuvhu-Letaba Study Area is located in the north-eastern corner of South Africa, where it borders on Zimbabwe in the north and on Mozambique along the eastern side. It falls entirely within the Limpopo Province, and adjoins the Olifants and Limpopo river systems to the south and west respectively. The Study area forms part of the Limpopo River Basin, an international river shared by South Africa, Botswana, Zimbabwe and Mozambique.

Approximately 35% of the land area of the Study Area along the eastern boundary falls within the Kruger National Park. The rivers flowing through the park are of particular importance to the maintenance of ecosystems.

The confluence of the Luvuvhu and Limpopo rivers forms the common point where South Africa borders on both Zimbabwe and Mozambique. The Shingwedzi River first flows into the Rio des Elephantes (Olifants River) in Mozambique, which then joins the Limpopo River.

The two main branches of the Letaba River, the Klein and Groot Letaba, have their confluence on the western boundary of the Kruger National Park. The Letaba River flows into the Olifants River just upstream of the border with Mozambique (**Figure 1.1).**

The topography is marked by the northern extremity of the Drakensberg range and the eastern Soutpansberg, which both extend to the western parts of the water management area, and the characteristic wide expanse of the Lowveld to the east of the escarpment. Climate over the water management area is generally sub-tropical, although mostly semiarid to arid. Rainfall usually occurs in summer and is strongly influenced by the topography.

Along the western escarpment rainfall can be well over 1 000 mm per year, while in the Lowveld region in the eastern parts of the water management area rainfall decreases to less than 300 mm per year and the potential evaporation is well in excess of the rainfall. Grassland and sparse bushveld shrubbery and trees cover most of the terrain, marked by isolated giant Boabab trees.

The geology is varied and complex and consists mainly of sedimentary rocks in the north, and metamorphic and igneous rocks in the south. High quality coal deposits are found near Tsikondeni and in the northern part of the Kruger National Park. The eastern limb of the mineral rich Bushveld Igneous Complex touches on the southern parts of the Study Area. With the exception of sandy aquifers in the Limpopo River valley, the formation is of relatively low water bearing capacity. A wide spectrum of soils occurs in the Study Area, with sandy soils being most common.

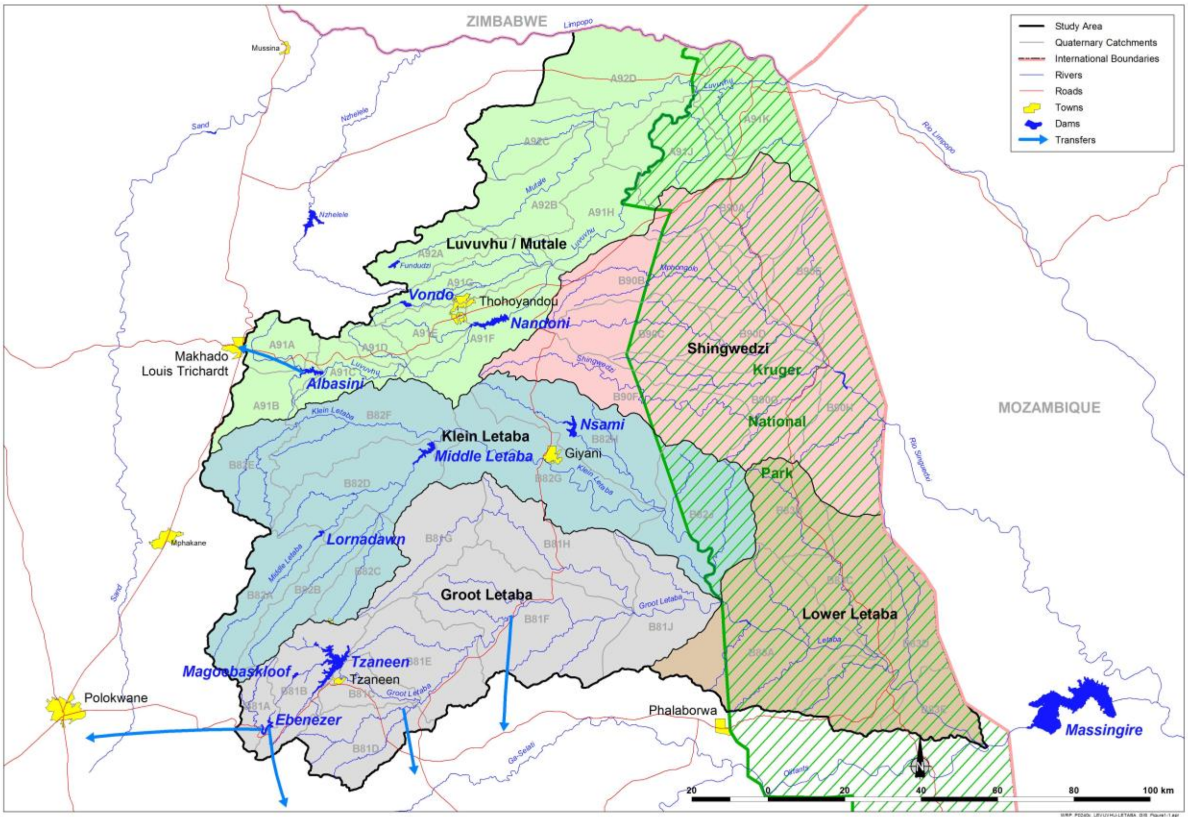


Figure 1.1: Study Area

1.4 PURPOSE AND LAYOUT OF THIS REPORT

The purpose of this report is to present the reconciliation strategy which is the primary deliverable of the study and a synthesis of all the available information collected as well as investigations carried out during the study period. The report contain water balances with intervention scenarios that provides possible solutions to make sufficient water available for the planning period up to the year 2040.

The report is structured as follows:

- **Chapter 1** (Introduction), describes the rationale for the study, the study area, gives general background information and an overview of the study procedure.

- **Chapter 2** (Context of the study and System Description), presents how the study relates to prevailing international, national as well as other parallel processes. This chapter also describes the system and its main components.

- **Chapter 3** (Hydrology), sumarises the hydrology work carried out as well as the related results and recommendations.

- **Chapter 4**, describes the water needs within the different water use sectors as well as with the current and projected future water requirements.

- In **Chapter 5**, the possible option of Water Re-use in different areas of the study area are described.

- **Chapter 6** summarises the possibilities and findings related to WC/WDM in the urban/industrial, rural domestic and irrigation sectors.

- The water quality assessment is presented in **Chapter 7** providing a summary of the current water quality status in the different sub-sytems and related recommendations

- **Chapter 8** In this chapter groundwater and surface water availability is presented, also providing a summary of the yield analysis assumptions and results for the scenarios that were analysed.

- The current and future water balances for the situations where no interventions are implemented are discussed in **Chapter 9**. These serve as motivation why further interventions are required in the different sub-system.

- The possible intervention options and scenarios (both demand and supply side option) are described in **Chapter 10** In this chapter information on the costs (economic comparison), environmental screening, international obligations and water availability are synthesised to formulate several motivated reconciliation scenarios consisting of different combinations of interventions.

- The outcome (reconciled water balances for each sub-system) for the propsed scenario as applicable to each sub-system are presented in **Chapter 11** with the focus on the future water balance graphs and with relevant commentary on each water balance.

- All previous chapters are distilled into the reconciliation strategy, as reflected in **Chapter 12**, “Luvuvhu Letaba Reconciliation Strategy in a Nutshell”.

- Relevant Risk and Uncertainties, Implementation Arrangement and Recommendation for Further Investigation are contained in **Chapters 13**, **14** and **15** respectively.

1.5 STUDY PROCEDURE

The study activities have been divided into various tasks as presented schematically in the Logical Flow Diagram as shown in **Figure 1.2**.

The overarching study approach was to develop reconciliation strategies in two stages. The first stage involved developing scenarios of possible future reconciliation options which included various assessments to firm up on certain uncertainties that were identified when the study was commissioned. The intention was that the First Stage Reconciliation Strategy will be presented to Stakeholders for comments and then to identify the need for possible further investigations that may be required in the period leading up to the development of the final Reconciliation Strategy.

The technical process started with a literature survey and review of current information with the Summary Report of previous and current studies as a deliverable, (DWA, 2012).

The Preliminary Screening of Options was performed at a preliminary screening workshop which was held on 25 April 2012 where a list of possible reconciliation options were evaluated by a group of key stakeholders who had to decide which options should be investigated further.

The next three steps of the technical process, i.e. baseline evaluation, investigation of reconciliation options and assessment of environmental impacts all led to the development of the preliminary reconciliation strategy. The gaps in the preliminary reconciliation strategy were investigated and the reconciliation options were refined.

The development of the final Reconciliation Strategy is the last step in the technical process.

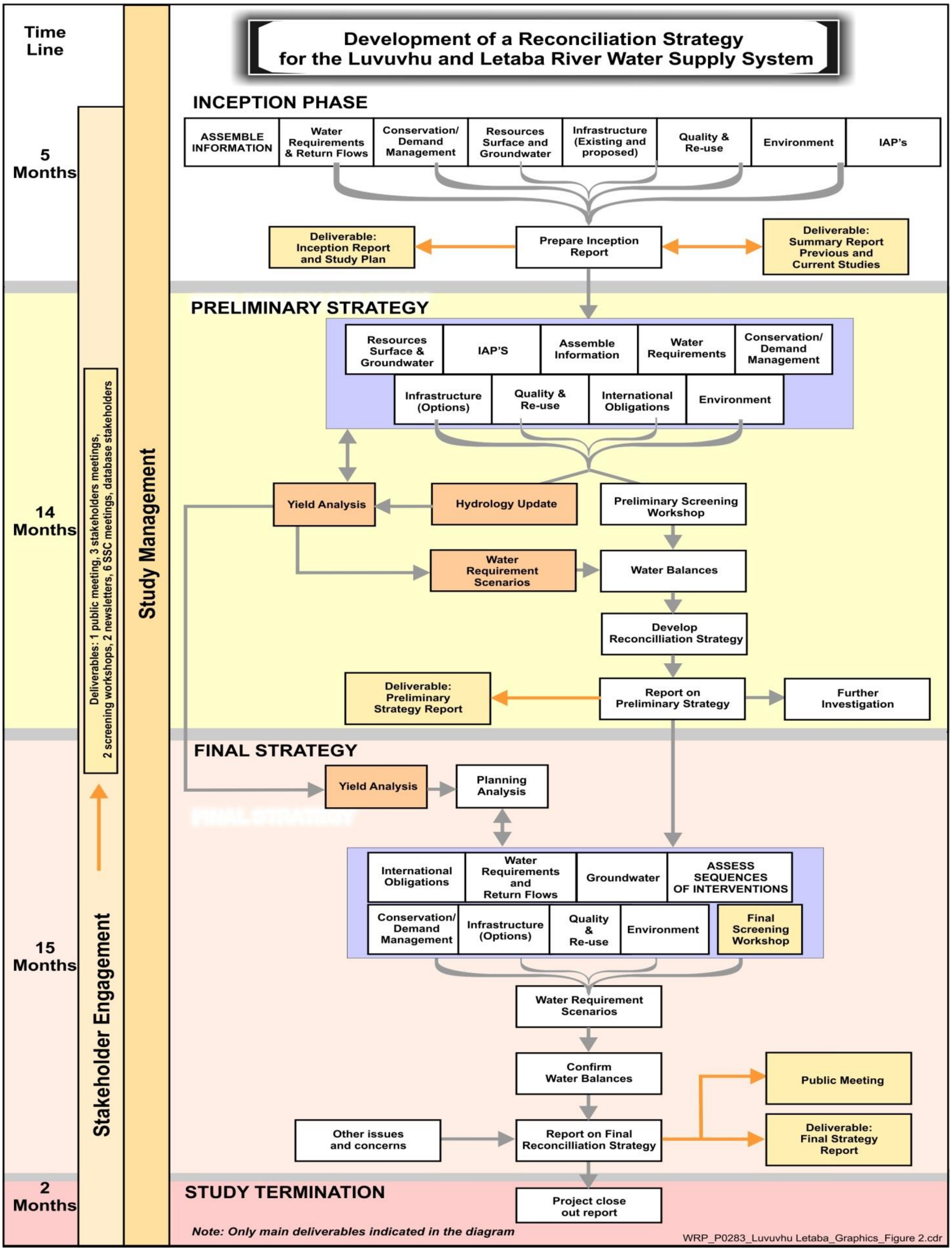


Figure 1.2: Logical Flow Diagram

The reports which will support the two main deliverables, i.e. the preliminary and final strategies, are the following:

- Literature Review Report
- Starter Document Preliminary Screening Workshop
- Water requirements and Return Flow Report
- Rainfall analysis report
- Hydrology report
- Water Conservation and Water Demand Management Report
- Water re-use report
- Water Quality Assessment Report
- Groundwater utilization scenarios
- Yield Analysis Report (Includes IAP & EWR)
- Planning Analysis Report
- Water Supply Schemes Report &Social and Environmental Aspects
- Demographic and Economic Development Potential

2 CONTEXT OF STUDY AND SYSTEM DESCRIPTION

2.1 INTERNATIONAL OBLIGATIONS

The Luvuvhu and Letaba rivers flow through the Kruger National Park, join the Olifants River just upstream of the Mozambique border from where it flows into the Massingir Dam located in in Mozambique. The current inter-basin transfers which affect the Luvuvhu and Letaba River systems and ultimately the Mozambique water resources, are shown on the Study Area Locality Map (**Figure 1.1**).

The Luvuvhu and Letaba River Systems can therefore be classified as directly supporting international obligations (Mozambique). Consequent thereof, any agreement between South Africa and Mozambique and Environmental Requirement flows for the Kruger National Park will have to be honoured.

In 1971 Portugal and South Africa agreed to raise Massingir Dam with no compensation payable to South Africa. Portugal accepted that water in the Olifants River will decrease. South Africa may not use Massingir water except for domestic and stock drinking purposes.

Previous agreements between South Africa and Portugal still remain and in terms of these agreements, there are no limitations to further developments in the catchment by South Africa. The Government of South Africa is also a signatory to the Revised Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region. The character of this protocol promotes inter alia the sustainable, equitable and reasonable utilisation of shared watercourse systems and avoiding causing any negative impact to the neighbouring state. There are specific provisions in terms of which State Parties shall exchange information and consult each other and, if necessary, negotiate the possible effects of planned measures on the condition of a shared watercourse.

2.2 NATIONAL WATER RESOURCE STRATEGY

The National Water Act, 1998 (Act 36 of 1998) (National Water Act, 1998) places an obligation on the Minister of Water Affairs to establish a National Water Resource Strategy (NWRS), (Section 5 of the NWA). Section 9 of the same act requires that a Catchment Management Agency (CMA) must establish a Catchment Management Strategy (CMS). This CMS must be in harmony with the NWRS. In the absence of a CMA, the Department is responsible for managing a Water Management Area (WMA) and it was for this reason that the Department developed an Internal Strategic Perspective (ISP) for each WMA about a decade ago. The main purpose of the ISP was to establish synergy between DWA National Water Resource Planning in Head Office and the respective Regional Offices. The ISPs, similar to the CMSs, also had to be in line with the NWRS.

The first NWRS was established in 2004 and the second edition NWRS has been promulgated and is currently being implemented.

An important aspect that has been written into the draft NWRS (2nd Edition) is the consolidation of certain WMAs to be managed by a single CMA. It will impact on the current Luvuvhu Letaba WMA and in future the Luvuvhu catchment will become part of the Limpopo catchment to form a WMA and the Letaba catchment will become part of the Olifants catchment to form a separate WMA.

This water reconciliation strategy by DWA will be an input to the future CMS once the agency gets established. It is important that this reconciliation strategy is also in harmony with the to-be-established NWRS (2nd Edition).

2.3 PARALLEL INITIATIVES

Several studies on the Luvuvhu and or Letaba River basins or part thereof were considered during the development of the reconciliation strategy and include the following:

- Validation and Verification of Water use in Luvuvhu-Letaba catchment.
- Development of Reconciliation Strategies for All Towns in the Northern Region.
- Continuation of the Northern Planning Region All Town Reconciliation Strategies
- Operating Rules for Standalone dams.
- Groot Letaba Development Project.
- Classification of Water Resources and determination of the Resource Quality Objectives (RQOs) in the Letaba Catchment.
- Socio-Economic and Ecological Impacts of Water Restrictions in the Letaba Catchment.

Not all the reconciliation strategies from the “All Towns in the Northern Region Study” had been completed at the time of the literature review. The study team however ensured alignment between this study and those All Town Strategies that were updated as part of the continuation phase.

The “Operating Rules for Standalone dams study” was in the process of being undertaken and the study team contacted the related team members undertaking the study with the aim of sourcing information that was available at the time. Draft reports for some of the dams were available and were requested. Ongoing liaising took place with the various studies in order to insure that relevant information was sourced and incorporated into the reconciliation strategy.

Classification of Water Resources and determination of the Resource Quality Objectives (RQOs) in the Letaba Catchment" was commissioned by the Chief Directorate Resource Directed Measures of the Department of Water Affairs (DWA) in September 2012. The final proposed EWR's to be implemented in the Letaba catchment were incorporated in the water balances presented in subsequent sections.

2.4 SYSTEM DESCRIPTION

2.4.1 Current status of Letaba systems

The Letaba River catchment is drained by the Groot Letaba River with its major tributaries being the Klein Letaba, Middle Letaba, Letsitele and Molototsi rivers. The Groot Letaba River catchment utilize water from the Groot Letaba River and its tributaries to supply water to various towns including Polokwane, Tzaneen, Haenertsburg, Modjadjiskloof and also to a number of rural villages. Water use in the Groot Letaba catchment is dominated by irrigation. In the Middle and Klein Letaba river catchment the water supply schemes are the Sekgopo and Tshitale/Sekgosese borehole schemes, as well as the Middle Letaba and Giyani water schemes using Middle Letaba and Nsami dams as the main resources of water. Some of the Middle Letaba water supply schemes also supply potable water to other sub-catchments, being Groot Letaba River and Luvuvhu River catchments.

The surface water resources within this sub-catchment are extensively developed with a large number of small to major dams constructed to meet domestic (urban and rural), irrigation and industrial water needs. Faced with water shortages of increasing severity and frequency over the years, the main consumptive users of water have from time to time compete for the limited supplies and experienced significant levels of restrictions. This has resulted in the degradation of the riverine ecosystem. The water resources of the Groot Letaba are not sufficient to meet all its requirements all of the time.

There are several medium to large dams in this catchment and the water is treated at nine different treatment plants. These dams include Dap Naude, Ebenezer, Magoebaskloof, Vergelegen, Hans Merensky, Tzaneen, Thabina, Middel Letaba, Nsami, Thapane and Modjadji dams. All the water supply schemes in the Groot Letaba River catchment, except the Modjadji scheme, form part of the inter-linked Letaba Regional Water Supply Scheme. The infrastructure between the schemes is not necessarily linked, but upstream infrastructure and water use, impacts on the water availability at further downstream scheme components.

The Modjadji scheme utilizes water from the Molototsi River. It is located adjacent to the Groot Letaba River system, but operates on its own, without any significant effect on the Groot Letaba River system.

Water schemes with its source in the Groot Letaba River catchment, but supplying water users located outside its boundaries are the Dap Naude Dam Scheme, Polokwane Government RWS, Ebenezer Dam Water Scheme and Ritavi II Water Schemes.

The Middle Letaba/Nsami canal transfers water from the Middle Letaba Dam to the Nsami Dam. The Middle Letaba/Nsami bulk water supply scheme can be sub-divided into three main sections:

- 89 Villages supplied from a treatment works at Middle Letaba Dam.
- 29 Villages supplied from a treatment works (Malamule West (Mapuve) Water Works) located adjacent to the canal between Middle Letaba Dam and Nsami Dam.
- 58 Villages and Giyani Town supplied from the treatment works at Nsami Dam.

Due to significant water supply shortages already experienced in this sub-system, the construction of a pipeline from Nandoni Dam in the Luvuvhu River to Nsami Dam has already commenced. This pipeline will convey raw water from Nandoni Dam to the treatment plant at Nsami Dam.

The groundwater development potential in the majority of the catchment is moderate, with significant portions of the catchment having high groundwater potential, particularly in the south and west. There are portions of the catchment with low groundwater development potential, particularly in the north and east of the catchment. Groundwater-surface water interaction is particularly important in the western parts of the catchments where the ratio of base flow reduction for a unit of groundwater abstracted is high.

Significant areas of commercial plantations (afforestation) and some indigenous forests occur in the wetter parts of this catchment area, mainly in areas with an average MAP of around 900 mm. These areas are concentrated in the upper reaches of the Groot Letaba, Letsitele, Middle Letaba and Klein Letaba River catchments.

A Feasibility Study of the Development and Management Options (DWAF, 1998) for the Letaba catchment proposed several options for augmenting water supply from the Groot Letaba River. These included some management interventions, as well as the construction of a dam at Nwamitwa and the possible raising of Tzaneen Dam. The 2010 Groot Letaba River Water Development Project (DWA, 2010a) investigated the Nwamitwa Dam option further. It was recommended that an embankment type earth fill dam should be constructed at Nwamitwa, with a central ogee spillway with a full supply level of 479.5 masl. This will ensure that sufficient yield is obtained to meet the anticipated future water requirements of the area surrounding Nwamitwa Dam, minimise expropriation costs and limit the amount of evaporation from the proposed dam.

A labyrinth spillway option was recommended for the raising of Tzaneen Dam as it is the most cost effective solution and has the lowest future maintenance costs.

The Minister of Environmental and Water Affairs approved the implementation of the Groot Letaba Water Development Project (GLeWaP)(DWA,2010a) and a notice in accordance with Section 110 of the National Water Act declaring the Minister's intent to implement the GLeWaP was gazetted on 21 December 2012. This project consists of the following infrastructure components:

- The raising of the existing Tzaneen Dam by 3m to improve the assurance of supply
- A new major storage dam on the Groot Letaba River just downstream of the Nwanedzi River confluence, at the site known as Nwamitwa on Janetsi Farm 463LT (Nwamitwa Dam)
- Development of bulk potable water supply infrastructure mainly to serve rural communities without adequate water supplies.

It is envisaged that the first water will be stored in Nwamitwa Dam by 2019. The purpose of the project is:

- To meet the projected growing primary water requirements to a 20 year planning horizon at an acceptable assurance of supply in parts of the Mopani District Municipality, and specifically the Greater Tzaneen and Greater Letaba Local Municipalities.
- To prevent further degradation of the riverine ecosystem by implementing the recently signed-off preliminary Reserve determined in compliance with the National Water Act.
- To minimize further lowering of the assurance of availability of water supplies to the irrigation sector for the existing development.
- To make water available for the establishment of resource-poor farmers in the irrigated agriculture sector.

2.4.2 Current status of the Luvuvhu systems

The Luvuvhu River Catchment is located in the north-eastern corner of South Africa. It rises near to Louis Trichardt (Makhado) and flows in a north-easterly direction to its junction with the Limpopo River near to Pafuri. The Luvuvhu River is the main river in the catchment, and is a tributary of the Limpopo River, which is an international water course, shared by South Africa, Botswana, Zimbabwe and Mozambique. The Luvuvhu River transverses the northern section of the Kruger National Park, where the Luvuvhu (Lanner) Gorge and the Pafuri floodplain are prominent features.

Nandoni Dam and Xikundu Weir together with the existing Albasini, Vondo, Phiphidi and Tshakhuma dams and the associated bulk purified water supply infrastructure are known as the Luvuvhu River Government Water Scheme. Nandoni Dam started to store water during 2002/03 and was able to augment the flow in the river from the winter of 2003. This scheme is managed as an integrated system to supply water for domestic/industrial, irrigation and for the ecological component of the reserve. Damani, Mambedi and Frank Ravelle dams are also part of the Luvuvhu River System, but are used to supply local water requirements and are therefore managed independently. Mambedi Dam was severely damaged during a flood event and is no longer in use.

The Xikundu / Malamulele sub-system consists of three weirs and respective water works, which are the Mhinga Weir and Treatment Works, Malamulele Weir and Treatment Works and Xikundu Weir and Treatment Works. The sub-system covers the Tshifundi RWS, Lambani RWS, North Malamulele East RWS and South Malamulele East RWS.

Current planning is that the Nandoni system will in future partly of fully support a large number of Rural Water supply Schemes and towns which include the following:

- Malamulele West RWS
- Vondo Central (Includes Thohoyandou)
- Vondo East RWS
- Vondo North RWS
- Vondo South RWS
- Tshakhuma RWS
- North Malamulele East RWS
- South Malamulele East RWS
- Tshifundi RWS
- Lambani RWS
- Valdeiza GWS
- Levubu CBD
- Tshitale RWS
- Makhado RWS (Includes Louis Trichardt (Makhado) Town)
- Air Force Base
- Sinthumule Kutama RWS
- Matoks (Botlokwa, Ntabiseng, Ramakgopa)
- Northern Regions of the Middle Letaba RWS – Elim/Vleifontein, Vyeboom, Majosi and a transfer to Giyani (This support will reduce the current demand imposed on the Middle Letaba/Nsami system)

The main bulk pipeline is still under construction and most of these areas are not yet supported from Nandoni Dam. Currently water from Nandoni Dam is already used to support part of Malamulele West RWS, parts of Thohoyandou and releases water to support the abstractions from Malamulele Weir, Xikundu Weir and Mhinga Weir. Releases in support of the EWR in the Kruger National Park are also made from Nandoni Dam.

There are relatively large groundwater resources in this catchment. Large scale utilization of the groundwater resources occurs mostly downstream of the Albasini Dam where it is used by irrigators and in the vicinity of Thohoyandou where it is used to supply rural communities.

Significant irrigation developments from surface and groundwater upstream of Albasini Dam resulted in a decrease in the yield available from Albasini Dam, to such and extend that the irrigation scheme downstream of Albasini Dam can very seldom be supplied with water from the dam as the dam struggles to meet the urban/industrial demand of Louis Trichardt (Makhado). The Albasini irrigation scheme now mainly relies on groundwater. As result of land claims large areas that were previously irrigated is currently not utilised, although these areas still have allocations from several of the existing dams. It is currently not clear whether these allocations will in future again be utilised for irrigation purposes. In the water balances, provision was made in most cases to over time revitalise these irrigation areas. When the water balances showed that there is no water available for this purpose, these irrigation developments were mentioned, but excluded from the final balances.

2.4.3 Current status of the Shingwedzi catchment

The Shingwedzi sub-area is a head-water catchment which drains into Mozambique and is situated almost entirely in the Kruger National Park. For all practical purposes, no sustainable yield is derived from surface flow in the Shingwedzi catchment. Water use from runoff in this catchment is negligible. There are no transfers out of this sub-catchment area.

There are no major dams in the Shingwedzi basin due to the limited water resources and the non-availability of suitable dam sites. Some small dams have, however, been constructed in the Kruger National Park for game watering. Of these, the most notable are the Kanniedood Dam on the Shingwedzi River and the Engelhard Dam on the Letaba River. A small eartfill dam used to support part of the water demands of the Maphophe Community was washed washed away during the 2000 flood. The earth dam is positioned at a point where it commands 2% of quaternary catchment B90B. Based on the updated hydrology developed as part of this study the yield that can be obtained from this dam is in the order of 0.007 million m^3/annum. This is extremely small and do not warrant the revitalization of this dam.

Rural Water Schemes that operate in this catchment includes North and South Malamulele East RWS, which has its source as the Malamulele Weir, Xikundo Weir and Minga Weir in the Luvuvhu River. Parts of the Middle Letaba RWS Malamulele West, Giyani sub-systems F1 & F2 are located partly within the Shingwedzi catchment, currently receiving water from the Middel Letaba – Nsami sub system. An area of Maphophe Community 270 ha was developed for irrigation in 1988. Water for this irrigation is sourced from the Makuleke Dam on the Mphongolo River a tributary of the Shingwedzi River.

2.4.4 Current status of the Mutale catchment

The Mutale catchment is mostly semi-arid, with the majority of the runoff originating in the south western, wetter part of the catchment. More than 80% of the MAR originates from less than 40% of the catchment area. The flow in the Mutale River is partly naturally regulated by Lake Funduzi (about 20 million m^3 of active storage) in the upper reaches of the river. The water from the Mukumbani Dam in the upper reaches of the Tshirovha River is exported to the Mukumbani Tea Estate. No other significant dams exist in the Mutale catchment. The water resources in the Mutale catchment are still under developed as limited storage structures exist in this sub-catchment.

The surface water appears to be of reasonable quality and has not been polluted to any great extent by the present developments upstream of and in the immediate vicinity of the monitoring sites. The water quality is better upstream than further downstream of Tshikondeni Mine. The heavy metal content of the water at Tshikondeni Coal Mine seems to indicate that some pollution has occurred further downstream at Tshikondeni.

The Vondo North Rural RWS and the Damani RWS are both partly located in the Mutale catchment and are supplied with water from Vondo and Damani dams respectively, which are both located in the Luvuvhu River catchment.

The remainder of the Rural Water Supply Schemes are supplied from Mutale surface (50%) and groundwater resources (50%), at almost similar volumes used from both sources. Some irrigation did exist in the past, it is however uncertain how much of the irrigation is currently still practised.

The reduction in runoff as result of afforestation is currently one of the main users of water in the upper parts of this catchment.

3 HYDROLOGICAL ANALYSIS

3.1 BACKGROUND

There were quite a number of uncertainties around the previous available hydrology such as low confidence water use assumptions, losses in the systems, impact of groundwater use on the available surface water flows etc. A significant reduction in yield was for example experienced for Albasini and Middle Letaba dams, which could relate to significant increases in upstream development from both surface and groundwater resources. The recently completed Groot Letaba Water Development Project (GLeWaP) study strongly recommended the complete update and recalibration of the Groot Letaba hydrology to confirm the yield results for the proposed Nwamitwa Dam and the raising of Tzaneen Dam.

The main objectives of the hydrological analysis of the Luvuvhu, Letaba and Shingwedzi catchments were therefore to:

- Undertake a new comprehensive hydrological analysis to cover the Study period of 1920 to 2010 hydrological years, that includes the modelling of groundwater for the first time; and

- Generate time-series of natural monthly stream flows for defined incremental sub catchments, covering the entire catchment area over the selected study period.

- Account for groundwater-surface water interaction by applying the techniques and simulation models that have been developed by DWS (DWA, 2004) and the Water Research Commission.

3.2 WATER USE AND RELATED RESOURCES

Results in particularly from the validation component of the Validation and Verification (V&V) Study (DWA, 2013b) provided essential information to the hydrological analysis undertaken as part of this Study, including, most importantly:

- The current and historical characteristics of irrigation in the Letaba, Luvuvhu and Shingwedzi catchments, which include the extent of cultivated areas, crop types, irrigation systems and associated efficiencies, methodologies for irrigation volume calculations, sources of water and associated return flows. Detailed information regarding allocations and canal infrastructure capacities were also obtained from the V&V Study.

- The current and historical characteristics of water bodies, including the locality, size and volume-surface area relationships for small storage dams.

- The current and historical characteristics of the afforestation developments in the catchments in terms of the types and % distribution of trees in each quaternary catchment

Irrigation is the largest water user sector (70%) in the study area, and it was therefore essential to obtain the best information possible on irrigation developments in the study area. The second and third largest water use sectors are domestic and commercial forestry sector using 17% and 12% respectively. Invasive Alien Plants (IAP) requirements only make out the 2% of the total water requirements. It was estimated that the total groundwater requirement at 2010 development levels was 150 million m^3/a (12% of total) in the study area. Only approximately 110 million m^3/a can be supplied from groundwater and this has an impact of approximately 58 million m^3/a on surface water runoff-reduction. This clearly shows the importance of simulating groundwater and related use in combination with surface runoff and usage, which was carried out for the first time as part of this study.

3.3 WATER BODIES

The major reservoirs (and Lake Fundudzi) have a total capacity of approximately 740 million m^3, which is 56% of the study area’s natural MAR. The numerous smaller dams and weirs have an estimated total capacity of 81 million m^3 (6% of the natural MAR), which together with the major reservoir’s capacities amounts to 62% of the natural MAR of the study area being impounded.

3.4 RAINFALL RUNOFF MODELLING

With the help of DWA gauge inspection reports (DWA, 2009a & 2009b), a strict evaluation of the available stream flow and reservoir gauging data was undertaken. From this a total of 6 calibration sites and 5 verification sites were identified on the Luvuvhu and Mutale Rivers. On the Letaba there were 7 calibrations sites (mostly reservoirs) and 2 verifications sites. The Shingwedzi only had 1 calibration site and 3 verifications sites.

Very few of the flow measurements sites had very good data to calibrate against. Although there are several dam balances to calibrate against in the Letaba Catchment, dam balances are not accurate for low flow calibrations. The lower Groot Letaba has no usable monitoring data, since most stations has structural damage, siltation or inundation problems. In the Lower Groot Letaba, two gauges (B8H034 and B8H018) which measure both the Middel and the Groot Letaba have recently been fixed and in future better measurements of the total Groot and Middel Letaba flows can therefore be expected.

Several domestic supply reservoirs are not actively monitored. In the Luvuvhu catchment both Albasini and Vondo Dam balances are not very accurate. No dam balance exists for Nandoni Dam or Damani Dam. Fortunately the stream flow gauge at Mhinga measures the largest part of the Luvuvhu and is a relatively good gauge, except that no use at the gauge are being monitored.

A detailed Water Resources Simulation (WRSM2000) hydrological model was configured and calibrated as well as verification of simulated flows was done at the 23 sites throughout the Study Area. Adaptions were made to calibrations at dam balances to achieve reasonable dam level comparisons.

In ungauged (or no acceptable gauged data) areas such as the Lower Groot Letaba and the Lower Letaba, care was taken to ensure that simulated natural results are in line with the catchments climatic conditions and known calibrated results of other areas of the Letaba. Calibration also took into account groundwater recharge and base flow estimates for each catchment.

Natural runoff simulations could be done for the entire Luvuvhu and Letaba catchment based on reasonable calibration of the WRSM2000 at key points, and parameter transfer to areas not covered by the calibration. This was achieved by simulating runoff with the final calibration parameters, excluding all water and land uses. Another scenario of natural runoff was also produced i.e. long-term natural simulated runoff with Present Day development level groundwater abstraction over the whole period. The reduction in runoff due to Invasive Alien Plants and Afforestation was also calculated against the scenario where groundwater abstraction is included.

The summarised results from the hydrological analyses are provided in **Table 3-1** and **Figure 3.1** provides a spatial overview of the natural unit runoff distribution throughout the Study area.

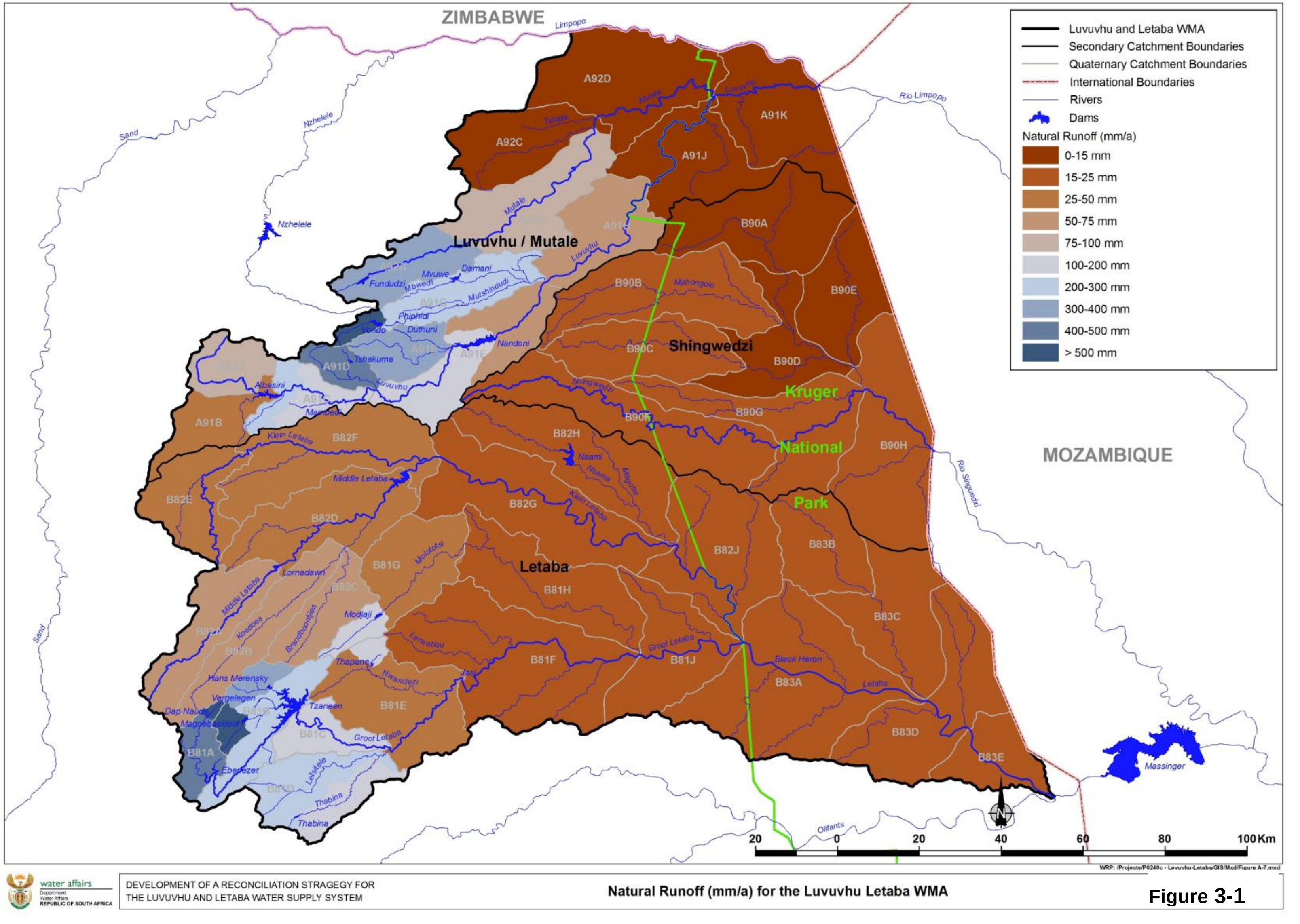
Confidence in the simulation results for each catchment was determined based on criteria such as rainfall, water- and land-use as well as the quality of observed calibration data. It was found that 57% of the natural Study Area MAR had a confidence level higher than 70%. A further 30% had a confidence level of between 50% and 70% and 13% had a confidence level of lower than 50%. The main reasons for the low confidence areas are due to bad distribution of rainfall stations and the large areas of no or unacceptable flow gauging.

Table 3.1: Simulation Results and Comparison with other Studies

Quaternary/ Quinary	Quin Area (km^2)	Quat Area (km^2)	This Study (1920 -2010)									Natural MAR		Unit Runoff		Natural MAR		Unit Runoff	
			MAE	MAP	Aridity	IAP(3)	AFF(3)	NMAR-GW(3)	NMAR(3)	%MAP	Unit runoff	1920 -2004				1925 -2004			
												million m^3/a		mm/a		million m^3/a		mm/a	
			mm/a	mm/a	-	million m^3/a				%	mm/a	This Study	WR2005(1)	This Study	WR2005(1)	This Study	Glewap (2)	This Study	Glewap (2)
A91A		232	1394	692	2.01	0.6	3.7	14.9	22.4	14%	97	22.8	17.0	98	73				
A91B		275	1593	616	2.59	0.1	0.1	5.2	10.8	6%	39	11.1	12.9	40	47				
A91C1	*107*		*1496*	*950*	*1.57*	-	*4.5*	*15.8*	*22.5*	*22%*	*210*	*22.8*		*213*					
A91C2 &F3	*175*		*1496*	*860*	*1.74*	-	*0.0*	*11.0*[5]	*23.5*	*16%*	*135*	*24.0*		*137*					
A91C& F3		282	1496	894		0.0	4.5	26.8	46.0	18%	163	46.7	55.2	166	148				
A91D1	*85*		*1444*	*1278*	*1.13*	-	*2.2*	*33.2*	*40.8*	*38%*	*482*	*41.2*		*486*					
A91D2	*47*		*1444*	*1315*	*1.10*	-	*5.4*	*23.6*	*23.6*	*38%*	*498*	*23.7*		*502*					
A91D		132	1444	1291		0.0	7.6	56.8	64.4	38%	488	64.9	46.0	492	348				
A91E		223	1444	1070	1.35	-	1.7	69.3	69.4	29%	311	70.2	69.0	315	309				
A91F1	*276*		*1647*	*860*	*1.92*	-	*0.0*	*30.3*	*30.3*	*13%*	*110*	*30.9*		*112*					
A91F2	*272*		*1647*	*667*	*2.47*	-	-	*13.6*	*13.6*	*7%*	*50*	*13.6*		*50*					
A91F1 &2		548	1647	764		0.0	0.0	43.8	43.9	10%	80	44.5	24.1	81	53				
A91G1	*48*		*1444*	*1943*	*0.74*	-	*2.4*	*49.5*	*49.5*	*53%*	*1030*	*49.2*		*1026*					
A91G2	*358*		*1444*	*943*	*1.53*	*1.1*	*0.0*	*79.1*	*79.3*	*23%*	*222*	*79.2*		*221*					
A91G		406	1444	1061		1.1	2.4	128.6	128.8	30%	317	128.4	117.3	316	289				
A91H		450	1646	727	2.26	-	0.0	27.3	27.3	8%	61	27.4	47.3	61	105				
A91J		570	1793	453	3.96	-	0.0	6.2	6.2	2%	11	6.5	15.7	11	28				
A91K		625	1845	376	4.91	-	0.0	3.2	3.2	1%	5	3.4	12.5	5	20				
A92A1	*282*		*1496*	*885*	*1.69*	*0.2*	*4.4*	*90.5*	*90.5*	*36%*	*321*	*86.8*		*308*					
A92A2	*47*		*1496*	*885*	*1.69*	-	-	*15.0*	*15.0*	*36%*	*319*	*15.1*		*322*					
A92A		329	1496	885		0.2	4.4	105.5	105.5	36%	321	101.9	127.0	310	386				
A92B		565	1646	716	2.30	0.2	-	44.5	44.5	11%	79	44.0	37.8	78	67				
A92C		455	1845	426	4.33	-	-	4.6	4.6	2%	10	4.8	12.5	11	27				
A92D		560(4)	1893	303	6.25	-	-	0.8	0.8	0%	1	0.8	10.2	2	13				
LUVUVHU & MUTALE	**5652**		**1667**	**658**		**2.1**	**24.4**	**537.5**	**577.9**	**16%**	**102**	**577.4**	**604.4**	**102**	**102**				
B81A1	*14*		*1497*	*1570*	*0.95*	-	*1.6*	*9.5*	*9.5*	*43%*	*676*	*9.6*		*682*		73.9	48.8	435	288
B81A2	*156*		*1497*	*1178*	*1.27*	*0.7*	*15.1*	*66.0*	*66.2*	*36%*	*425*	*66.8*		*429*					
B81A		170	1497	1211		0.7	16.6	75.6	75.7	37%	446	76.4	56.9	450	336				
B81B4	*124*		*1497*	*1147*	*1.31*	*0.2*	*4.9*	*29.4*	*29.4*	*21%*	*237*	*30.1*	*29.7*	*242*	*240*	130.3	154.4	271	320
B81B2	*62*		*1497*	*1359*	*1.10*	*0.2*	*4.3*	*33.6*	*33.6*	*40%*	*543*	*34.0*	*39.9*	*548*	*623*				
B81B3	*89*		*1497*	*1147*	*1.31*	*0.2*	*4.7*	*27.3*	*27.7*	*27%*	*311*	*28.1*	*22.3*	*316*	*254*				
B81B1 A	*23*		*1497*	*1147*	*1.31*	-	-	*4.8*	*4.8*	*18%*	*210*	*4.9*	*52.2*	*214*	*254*				
B81B1	*183*		*1497*	*1147*	*1.31*	*0.2*	*9.7*	*38.0*	*38.7*	*18%*	*211*	*39.5*		*216*					
B81B		481	1497	1174		0.8	23.6	133.1	134.3	24%	279	136.5	144.1	284	299				
B81C		208	1497	870	1.72	1.6	1.5	26.0[5]	28.7	16%	138	29.2	31.8	140	153	133.5	117.9	195	172
B81D1	*180*		*1450*	*822*	*1.76*	*0.6*	-	*20.5*	*20.9*	*14%*	*116*	*21.6*	*47.3*	*120*	*225*				
B81D3	*28*		*1450*	*950*	*1.53*	-	-	*6.3*	*6.3*	*24%*	*224*	*6.4*		*227*					
B81D2	*269*		*1450*	*1000*	*1.45*	*3.5*	*10.7*	*79.2*	*80.6*	*30%*	*300*	*81.7*	*54.7*	*304*	*204*				

B81D		477	1450	930		4.2	10.7	106.0	107.9	24%	226	109.8	102.0	230	213				
B81E3	*255*		*1545*	*664*	*2.33*	*0.1*	*-*	*10.4*	*10.7*	*6%*	*42*	*11.0*	*8.5*	*43*	*33*				
B81E1	*198*		*1545*	*664*	*2.33*	*0.1*	*0.4*	*8.1[5]*	*8.4*	*6%*	*42*	*8.6*	*5.4*	*44*	*37*				
B81E4	*41*		*1545*	*750*	*2.06*	*-*	*-*	*4.7*	*4.7*	*15%*	*115*	*4.8*		*117*					
B81E2	*172*		*1545*	*664*	*2.33*	*-*	*-*	*7.0[5]*	*7.2*	*6%*	*42*	*7.5*	*8.7*	*43*	*33*	41.1	60.5	32	51
B81E		666	1545	669		0.2	0.4	30.2	31.0	7%	46	31.9	22.6	48	34				
B81F3	*430*		*1593*	*541*	*2.94*	*-*	*-*	*8.4[5]*	*8.5*	*4%*	*20*	*8.9*		*21*					
B81F1	*186*		*1593*	*541*	*2.94*	*-*	*-*	*3.7*	*3.7*	*4%*	*20*	*3.9*		*21*					
B81F2	*584*		*1593*	*541*	*2.94*	*-*	*-*	*11.5*	*11.5*	*4%*	*20*	*12.1*		*21*					
B81F		1200	1593	541		-	-	23.5	23.7	4%	20	24.9	41.3	21	34				
B81G2	*437*		*1593*	*624*	*2.55*	*-*	*-*	*13.4*	*13.6*	*5%*	*31*	*14.2*		*32*					
B81G1	*80*		*1593*	*850*	*1.87*	*0.2*	*0.1*	*12.0*	*12.0*	*18%*	*151*	*12.1*		*152*		53.7	53.7	23	23
B81G		517	1593	659		0.2	0.1	25.5	25.6	8%	50	26.3	18.6	51	36				
B81H		664	1647	508	3.24	-	-	9.6	9.7	3%	15	10.2	11.3	15	17				
B81J		568	1695	500	3.39	-	-	9.1	9.1	3%	16	9.6	15.4	17	27				
B82A		467	1544	712	2.17	0.6	0.3	26.7	28.2	8%	60	29.1	17.3	62	37				
B82B		406	1544	694	2.22	-	0.5	18.4[5]	23.1	8%	57	23.9	14.3	59	35				
B82C		300	1544	703	2.20	-	0.3	15.8[5]	17.2	8%	57	17.8	11.2	59	37				
B82D		632	1593	615	2.59	0.5	0.4	18.5	20.9	5%	33	21.6	13.2	34	21				
B82E		432	1593	648	2.46	0.4	0.4	11.2	11.3	4%	26	11.8	12.0	27	28				
B82F		760	1578	668	2.36	-	0.3	22.5	22.6	4%	30	23.6	42.8	31	56				
B82G		921	1646	524	3.14	-	-	15.2	15.2	3%	17	15.6	30.5	17	33				
B82H		749	1646	516	3.19	-	-	11.7	11.7	3%	16	12.0	23.6	16	32				
B82J		795	1694	540	3.14	-	-	14.4	14.4	3%	18	14.7	27.1	18	34				
B83A		1252	1744	511	3.41	-	-	19.6	19.6	3%	16	20.6	33.5	16	27				
B83B&C		1031	1799	563	3.20	-	-	17.4	17.4	3%	17	18.4	19.3	18	21				
B83D		714	1850	548	3.38	-	-	10.3	10.3	3%	14	10.8	20.6	15	29				
B83E		267	1893	582	3.25	-	-	4.7	4.7	3%	18	5.0	8.5	19	32				
LETABA		**13677**	**1642**	**623**		**9.1**	**55.1**	**644.8**	**662.2**	**8%**	**48**	**679.6**	**717.71**	**50**	**53**	**432.5**	**435.3**	**87**	**90**
B90A		611	1744	463	3.77	-	-	7.2	7.2	3%	12	7.4	5.1	12	8				
B90B		754	1646	468	3.52	-	-	12.1	12.1	3%	16	12.5	18.2	17	24				
B90C		535	1650	496	3.33	-	-	9.0	9.0	3%	17	9.3	2.1	17	4				
B90D		447	1694	469	3.61	-	-	5.9	5.9	3%	13	6.1	1.1	14	3				
B90E		474	1752	464	3.78	-	-	5.9	5.9	3%	12	6.1	1.0	13	2				
B90F		819	1650	537	3.07	-	-	19.1	19.1	4%	23	19.8	31.1	24	38				
B90G		698	1700	533	3.19	-	-	15.5	15.5	4%	22	16.0	10.8	23	16				
B90H1	*229*		*1793*	*536*	*3.35*	*-*	*-*	*5.0*	*5.0*	*4%*	*22*	*5.2*	*1.3*	*22*	*6*				
B90H2	*546*		*1793*	*536*	*3.35*	*-*	*-*	*11.8*	*11.8*	*4%*	*22*	*12.2*	*13.8*	*22*	*25*				
B90H		775	1793	536		-	-	16.8	16.8	4%	22	17.4	15.0	22	30.7				
SHINGWEDZI		**5113**	**1702**	**500**		**-**	**-**	**91.4**	**91.4**	**4%**	**18**	**94.5**	**84.4**	**18**	**17**				
TOTAL		**24442**	**1661**	**605**		**11.2**	**79.5**	**1273.8**	**1331.4**	**9%**	**54**	**1351.5**	**1406.5**	**55**	**57**				

Note: (1) From WR2005 publication (DWA,2008)
(2) From Glewap Study Hydrology Report (DWA, 2010a)
(3) Natural Mean Annual Runoff (NMAR), Natural Mean Annual Runoff with Present Day (2010) Development level groundwater abstraction (NMAR-GW), Reduction in runoff due to Invasive Alien Plants for NMAR-GW (IAP), Reduction in Runoff due to Afforestation for NMAR-GW (AFF)
(4) Quaternary catchment area reduced from WR2005 area since large part of the quaternary catchment does not flow into the Mutale but directly into the Limpopo River.
(5) Groundwater requirements had to be reduced to the total recharge of the catchment to simulated actual simulated supply.



ZIMBABWE
MOZAMBIQUE
Luvuvhu / Mutale
Shingwedzi
Letaba
Kruger
National
Park
Luvuvhu and Letaba WMA
Secondary Catchment Boundaries
Quaternary Catchment Boundaries
International Boundaries
Rivers
Dams
Natural Runoff (mm/a)
0-15 mm
15-25 mm
25-50 mm
50-75 mm
75-100 mm
100-200 mm
200-300 mm
300-400 mm
400-500 mm
> 500 mm
20
0
20
40
60
80
100 Km
DEVELOPMENT OF A RECONCILIATION STRAGEGY FOR THE LUVUVHU AND LETABA WATER SUPPLY SYSTEM
Natural Runoff (mm/a) for the Luvuvhu Letaba WMA

Figure 3-1

3.5 COMPARISON OF RESULTS WITH PREVIOUS STUDIES

The natural flow results from the simulation process overall compared well with previous Study results, however the higher runoff areas were found to be significantly higher than the WR2005 Study results and the lower runoff areas were found to be lower. A higher simulated value for Ebenezer Dam was observed between the GleWaP Study (DWA, 2010a) and the results for this Study.

Based on the observed supply over the years from the Middle Letaba, Nsami and Albasini dams, it was evident that those water supply systems performed much worse than the initial anticipated water supply capabilities when these schemes were planned. Comparing the hydrology obtained from the Luvuvhu Letaba Reconciliation Strategy study with the original hydrology, show the significant differences and confirms the poor performance of these water supply systems.

The natural flow record for Nsami Dam from the initial study carried out in 1997 covered the period 1920 to 1975 with a MAR of 9.47 million m^3/a and for the Middle Letaba Dam a MAR of 135 million m^3/a. The updated hydrology from the current study resulted in the MAR over the same record period (1920 to 1975) of 3.34 million m^3/a and 80.5 million m^3/a for the Nsami and Middle Letaba dam natural flow records, respectively.

Natural flow into Albasini Dam was previously estimated as 26.2 34 million m^3/a for the period 1924 to 1991. Results from the current study resulted in a MAR over the same record period of 17.12 million m^3/a when the upstream groundwater abstractions were included and 30.03 million m^3/a when groundwater abstraction were set to zero.

The much lower MAR's confirm the poor historic performance of the above mentioned dams and clearly illustrate the advantage of being able to simulate the groundwater surface water interaction, which was previously not possible.

3.6 RECOMMENDATIONS AND CONCLUSIONS (HYDROLOGICAL ANALYSIS)

It is crucial for the Reconciliation Strategy and future updates to the hydrology of the Study Area that the flow and reservoir monitoring should be maintained and improved. To enable monitoring of the Reconciliation Strategy it is also essential that water use monitoring should be expanded to track growth in requirements and the effects of reconciliation interventions such as Water Conservation and Water Demand Management activities.

3.6.1 Rainfall

The raw and patched datasets for the rain gauges were obtained from the WR2005 study, the Rain IMS and from DWA and were then assessed for usability. The raw data was only used to extend WR2005 patched rainfall gauges and, in some cases, when the station was omitted during the WR2005 Study for some reason. The data was further screened by visual inspection of the data, through standard stationary tests and by doing additional outlier detection for the period 1920 – 1989. A list of 96 patched point rainfall gauges was considered for further analysis after the initial screening.

Only 39 of 96 screened point rainfall stations were still open in 2010. Of these 82% of the open stations are located in the western 45% of the catchment, and only 8% in the eastern 55% of the catchment. That is a density of 1 open gauge per 361 km^2 in the western parts and 1 open gauge per 5000 km^2 in the eastern parts of the study area. In some catchment rainfall zones there were no point rainfall stations within the zone and only stations in adjacent zones could be used. Finally 42 unique stations were used to create acceptable catchment rainfall records, of which 18 was still open in 2010.

Serious consideration should be given to re-opening or installing of new rain gauges. Although the eastern parts of the catchment have very low rainfall, the total number of acceptable open gauges in this area, is inadequate.

3.6.2 Measured flows

In the Letaba Catchment all possible efforts should be made to ensure that at least the current monitoring is maintained, especially the newly fixed gauging stations B8H034 and B8H018 which measures the total flow from the Letaba. The problem still exist that none of the other measuring stations are reliable in the lower Groot Letaba. A possible solution could be to initiate measuring at Nondweni Weir, since Prieska Weir's (B8H017) structural problems seem to be too expensive to fix. However, with the construction of Nwamitwa Dam additional flow gauging will occur downstream from the dam and a dam balance for this dam should be kept as soon as possible after construction of the dam. The gauge downstream from the Middel Letaba Dam (B8H033) should be checked and the DT corrected if needed to.

On the Luvuvhu, it is recommended that gauge A9H001 should be reopened if at all possible, due to the strategic position of the gauge (upstream from Nandoni Dam, downstream from high runoff areas). The weir measurements at Latonyanda and Luvuvhu should continue. The gauge at the end of the Mutshindudi River (A9H025) should be maintained and improved if possible. A9H012 (Mhinga) and A9H013 (outlet of the Mutale River) is strategically very important and should be maintained.

The gauges on the Shingwedzi are monitored by the KNP. The DT's of all the gauges should be reviewed to review the apparent over estimation of the flows at these gauges.

3.6.3 Water use

Although 75% of the surface water use for domestic purposes is measured in the Letaba, some concerns exist about the metered use at Ebenezer and Tzaneen Dams (post 2007). Furthermore continuous water use monitoring at Thapane, Thabina and Vergelegen Dams are required. The new pipeline at Middel Letaba Dam should also be measured and it should be confirmed that all the use at Nsami Dam is measured. Releases from Modjadji Dam for irrigation should be monitored. Abstractions from the Letaba River for the regional water supply systems of Ritavi 1 and 2, Sekgopo and Sekgosese and Ba Phalaborwa, should also be monitored on a continuous basis.

Only 54% of the estimated domestic water use is being measured on the Luvuvhu and Mutale. Verification of the water use measurements at Vondo and Albasini Dam should be done post-2008. New continuous water use measurements should be initiated at A9H004 (Mutale Town), A9H012 (Mhinga Weir), Tshakuma Dam, Damani Dam, Xikundu Weir, Phiphidi Dam, Malamulele Weir and at Dzindi WTW.

On the Shingwedzi River the KNP should start continuously measuring water abstractions from B9H002, B9H003 and B9H004.

3.6.4 Reservoir data

Except for Nandoni Dam, all the dam surveys in the Study Area are older than 15 years and new surveys for all the major dams should be undertaken. Dam balances should be initiated for Thabina Dam, Thapane Dam, Modjadji Dam, Damani Dam and Nandoni Dam. Dam balances for most dams need to be improved or updated. See details in the hydrology report.

3.6.5 Losses

Large transmission losses were identified during the GleWaP and other studies on the lower reaches of the Letaba. It was not possible to estimate these losses due to the following reasons;

- No acceptable gauging stations existed in this part of the Letaba.
- There is a short coming in the current WRSM2000 model where the transmission losses can only be specified as one monthly value and this water is lost in the water balance and not incorporated as an input to the groundwater module.
- Prieska Weir's (B8H017) sluice has been open since the 1996 floods due to a tree being stuck in the sluice gate. This already might account for the perceived losses on its own.

The Prieska Weir issue should be resolved by either continuously measuring the flow from the leaking sluice or by destroying the Prieska Weir.

4 CURRENT WATER USE AND PROJECTED WATER REQUIREMENTS

4.1 CURRENT WATER USE

4.1.1 URBAN/INDUSTRIAL AND RURAL DOMESTIC DEMANDS

Population growth estimations and the related economic growth characteristics within the study area formed the basis for the calculation of the urban/industrial and domestic water requirement calculations. The demographic component of this task forms a critical sub-task of the water requirements task.

Different growth scenarios for development were determined, as it is impossible for all the smaller settlements in the study area to grow at the same rate. The following demographic development determinants have been identified as likely factors to cause different water resource responses: migration, mortality, fertility, and HIV/AIDS, etc. Growth scenarios take economic development into account, as the smaller settlements and service areas in the study area will not grow at the same rate as larger economic nodes such as Tzaneen, Thohoyandou, Giyani and Louis Trichardt (Makhado).

For the moderate growth scenario, it is expected that population growth in the study area will largely follow historical growth trends, and a decrease in the overall population growth rate will be evident. Fertility rates will reduce, and mortality rates will remain fairly high. In addition to this, there is continuing out-migration to large economic hubs such as Gauteng, and internal migration exists from rural areas to urban nodes as people try to access employment and better services.

In the moderate growth scenario, economic growth remains relatively low. In the high growth scenario, economic growth will initially be low, but will peak in 20 years after which it will gradually flatten out. There is a large focus on the development of rural areas and the installation of infrastructure and services will result in declining out-migration to urban areas in search of improved services. Health services are expected to improve, which will result in declining mortality. Urbanisation levels within the study area are expected to decrease, and there is a focus on agriculture, mining and tourism development, especially in rural areas.

Three district municipalities, Capricorn, Mopani and Vhembe including several local municipalities are partly or fully located within the study area as shown in **Figure 4.1**.

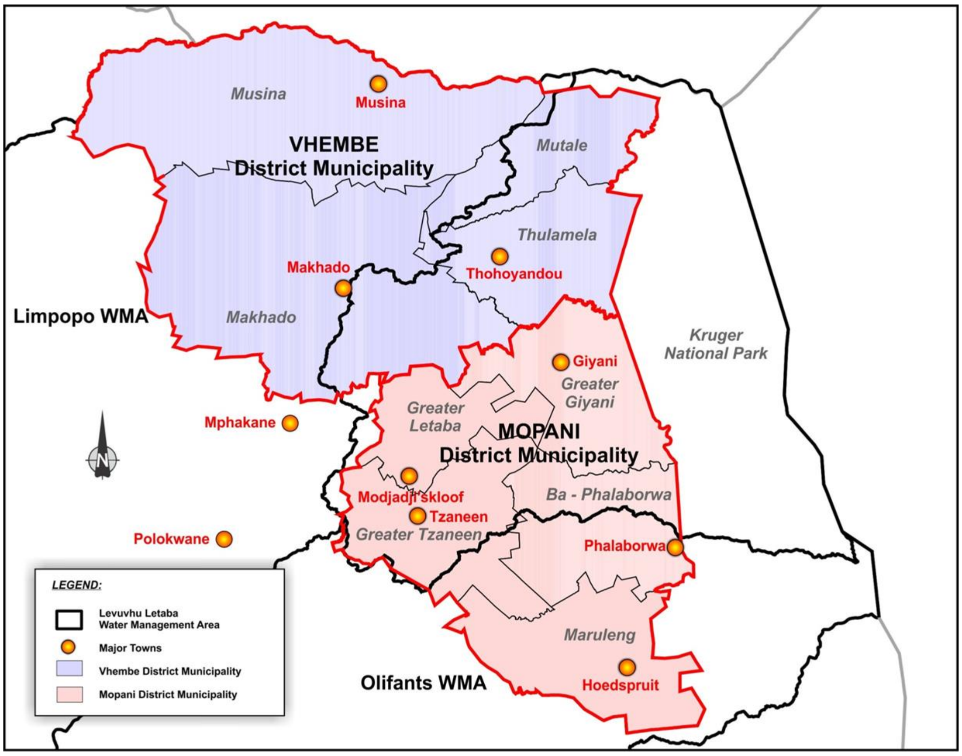


Figure 4.1: Location of District and Local Municipalities

The main towns located in the study area are Tzaneen, Giyani, Thohoyandou and Louis Trichardt (Makhodo) as well as several small towns.

Although Polokwane is located outside the main study area, it is partly supplied with water from the Groot Letaba basin and was therefore included in this study. Most of the local municipalities are very rural in nature, comprising of many rural villages (See **Figure 4.2**).

The DWA Directorate Water Services has sub-divided the area into several water supply schemes that were used as the basis for the water demand projections developed for this study. The locations of these schemes are shown on **Figure 4.2**. The villages and towns were grouped into these schemes.

Information on the current actual water use was obtained from the Validation Study and the hydrology related work carried out as part of this study. These demands were then aligned with those obtained from the demographic task which was based on typical per capita water use assumptions. **Table 4.1** provides a summary of the 2012 development level urban/industrial and rural domestic demands based on the process described.

From **Table 4.1** it is evident that approximately 14% of the total urban/industrial and rural domestic demand is supplied from groundwater. This portion is the highest in the Mutale catchments, where almost 47% of the demand is supplied from groundwater resources.

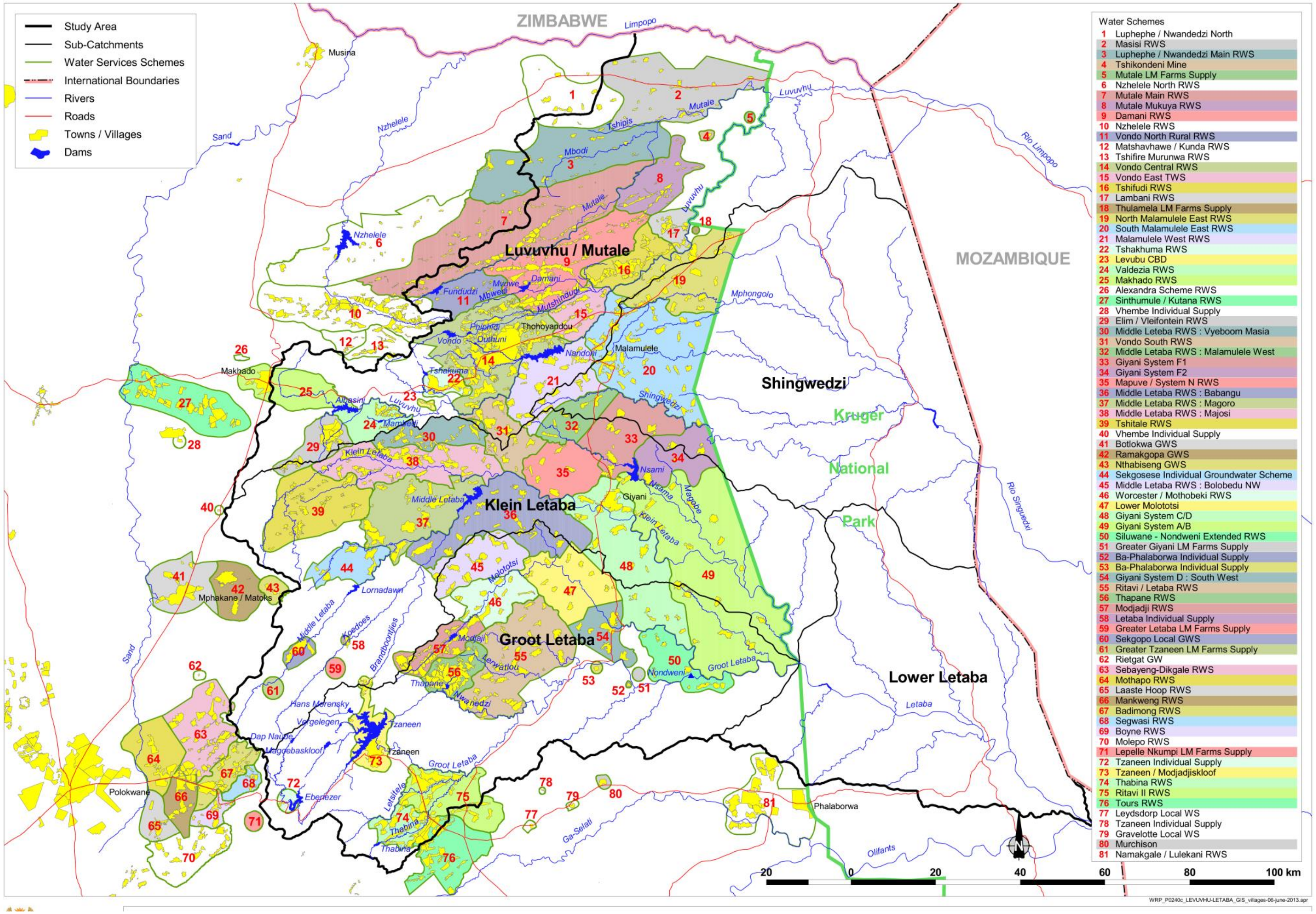


Figure 4.2. Water Services Schemes

Table 4.1: Urban/Industrial and rural domestic demands at 2012 development

Sub-catchment and and transfer descriptions	Demand (million m^3/a)		
	Total	From Surface Water	From Ground Water
Groot Letaba	31.21	27.80	3.41
Transfers to Polokwane	20.17	20.17	0.00
Middle Letaba	25.88	18.37	7.51
Letaba Total	**77.26**	**66.34**	**10.91**
Luvuvhu & Shingwedzi	36.85	33.77	3.08
Mutale	4.55	2.41	2.14
Luvuvhu Mutale Total	**41.40**	**36.18**	**5.22**
Total Urban & Rural schemes	**118.66**	**102.52**	**16.13**

4.1.2 Irrigation Water Requirements

Significant irrigation activities occur in the Upper and middle Groot Letaba as well as in the Upper Luvuvhu catchments. A wide range of crops are being irrigated in these areas from:

- Formal canal and run-of-river Government Water Schemes,
- farm dams,
- run-of-river, and
- groundwater resources.

The main crops grown under irrigation by commercial farmers in the study area include sub-tropical orchard crops such as avocados, citrus, tomatoes, bananas, macadamia nuts and litchi and high-value annual vegetable crops such as tomato.

The main crops grown on the smallholder irrigation schemes are vegetable crops such as cabbage, tomato, sweet potato, and field crops such as maize, chillie and dry bean.

Detailed information was obtained from the V&V Study (DWA, 2013b), the Water Management Plan for the Luvuvhu Government Water Scheme (DWA, 2012c), and a research paper on the transformation of Irrigation Boards to Water User Associations in South Africa (IWMI, 2004).

The main commercial irrigation schemes within the study area are the Ebenezer Dam Irrigation, Magoebaskloof Dam Irrigation, Hans Merensky Dam Irrigation, Tzaneen Dam Irrigation, Albasini Dam Irrigation, Levubu Canal Irrigation, Lutanyanda Canal Irrigation, Barotta Canal

Irrigation and Middle Letaba Irrigation Scheme. The irrigation area has in some of these schemes reduced significantly over time due to the lack of water as well as result of land claims in some areas. There is still uncertainty whether these irrigation schemes will be revitalised, specifically those affected by land claims.

Significant areas of smallholder irrigation were developed during South Africa's previous political dispensation in all the so-called black independent states of Venda, Labowa and Gazankulu. About 54 of these schemes totalling nearly 10 000ha exist within the Luvuvhu/Letaba catchment of which approximately 6 850ha is inactive with a possibility to revitalise in future (See **Table 4.2**).

Table 4.2: Current inactive smallholder irrigation areas

Sub-catchment	Area (ha)	Demand (million m^3/a)
Groot Letaba	2 258	17.39
Klein & Middle Letaba	1 217	9.37
Letaba Total	**3 475**	**26.76**
Luvuvhu	1751	13.48
Mutale	1 618	12.46
Luvuvhu Mutale Total	**3 369**	**25.94**
Total Irrigation	**6 844**	**52.70**

Most of them use run-of-river water extracted from weirs by small canals for flood irrigation or direct pumping to storage dams on the schemes. The Limpopo and Mpumalanga Provincial Departments of Agriculture have over the years attempted to revitalise many of these schemes in order to stimulate the rural economy of the provinces.

Unfortunately many of these efforts have not been successful for a number of reasons, including very unreliable water resources, and government is still committed to rehabilitate those schemes where a reasonable assurance of water supply can be established in the future.

Table 4.3 provides a summary of the 2010 development level irrigation in the study area and shows that a significant proportion of the irrigation demands are met from ground water resources, almost 30% on average. In the Luvuvhu catchment the irrigation component supplied from groundwater is the highest at 47% of the irrigation demand.

The irrigation demand is in most areas supplied at a very low assurance, specifically in the Groot Letaba downstream of Tzaneen Dam, where on average approximately 60% of the irrigation requirement is met.

Table 4.3: Irrigation demands at 2012 development

Sub-catchment and description	Demand (million m³/a)		
	Total	From Surface Water	From Ground Water
Groot Letaba	256.5	206.1	50.5
Middle Letaba	98.2	62.3	35.9
Letaba Total	**354.8**	**268.4**	**86.4**
Luvuvhu & Shingwedzi	99.4	50.5	49.0
Mutale	1.7	1.7	0.0
Luvuvhu Mutale Total	**101.1**	**52.2**	**49.0**
Total Irrigation	**455.9**	**320.6**	**135.4**

4.1.3 Commercial Forestry

There are significant commercial forestry activities in the upper Letaba and Luvuvhu Catchments. The information on the forestry areas and the distribution of the tree species was provided by the V&V Study (DWA, 2013b). A summary of the commercial forestry activities as well as the present day (2012) runoff reduction due to these activities in the study area is provided in **Table 4.4**.

Table 4.4: Commercial Forestry 2012 Development

Sub-catchment and description	Forestry 2012 Development Level	
	Reduction in runoff (million m³/a)	Area (km²)
Groot Letaba	52.9	354.9
Middle Letaba	2.2	58.9
Letaba Total	**55.1**	**413.8**
Luvuvhu & Shingwedzi *	20.0	139.6
Mutale	4.4	23.2
Luvuvhu Mutale Total	**24.4**	**162.8**
Total Forestry	**79.5**	**576.6**

Note *- There is no forestry in the Shingwedzi catchment

The reduction in surface runoff due to the commercial forestry is the highest in the Groot Letaba catchment, at almost 11% of the gross natural runoff.

4.1.4 Invasive Alien Plants

Invasive Alien Plants (IAP) reduces the available runoff in a catchment, more so than indigenous species. The highest density of IAPs in the Water Management Area is located around the main stem of the Groot Letaba River, downstream from Tzaneen Dam and in the lower reaches of the Mutale River.

Table 4.5: Invasive Alien Plants 2012 Development

Sub-catchment and description	IAP at 2012 Development Level	
	Reduction in runoff (million m^3/a)	Condensed Area (km^2)
Groot Letaba	7.7	84.2
Middle Letaba	1.4	50.4
Letaba Total	**9.1**	**134.6**
Luvuvhu & Shingwedzi*	1.8	15.4
Mutale	0.4	10.6
Luvuvhu Mutale Total	**2.2**	**26.0**
Total IAP	**11.3**	**160.2**

Note *- There is no IAPs in the Shingwedzi catchment

The IAP distribution and extent of IAP were obtained from the Agricultural Research Council's report National Invasive Alien Plant Survey (ARC, 2010). This latest survey provided the spatial distribution of IAPs in the study area as well as the predominant species per quaternary catchment and the compacted densities.

Table 4.5 provides the information processed from the survey that was used as input to the WRSM2000 model as well as the estimated present-day (2012) reduction in runoff due to IAP.

4.1.5 Total 2012 development level water requirement

The total 2012 demand, excluding runoff reduction due to afforestation and IAPs, that is imposed on the study area is 620 million m^3/a of which 471 million m^3/a is supplied from the Letaba catchment and 149 million m^3/a from the Luvuvhu/Mutale catchment. A very small portion of the total demand is supplied from the Singwedzi catchment and most of the requirements located in the Singwedzi catchment are supplied with water transferred from the Luvuvhu or Middle Letaba catchments through existing water supply schemes. Runoff reduction due to afforestation and IAPs cumulates to just over 90 million m^3/a, resulting in a total overall demand of 710 million m^3/a.

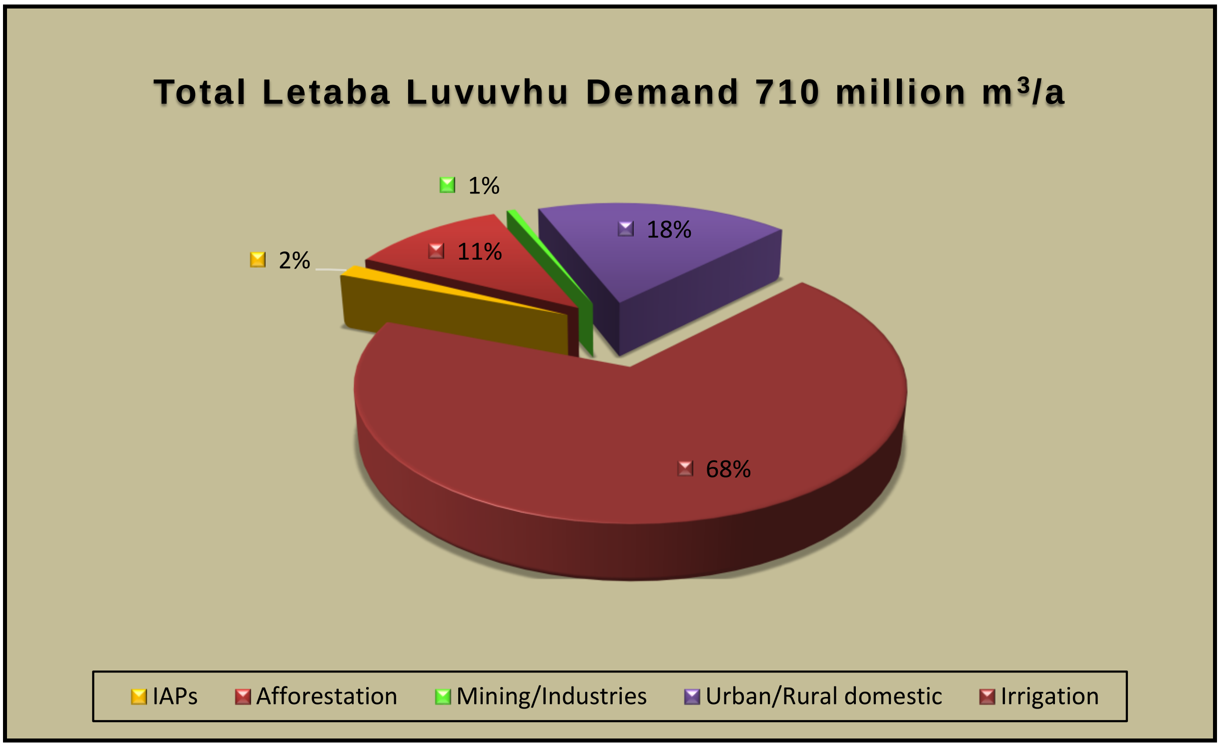


Figure 4.3. Total demand imposed on the Study area at 2012 development level

Groundwater resources play an important role in the water supply within this study area with approximately 25% of the total water requirement imposed on groundwater. The irrigation sector uses the most groundwater with 28% of the irrigation supplied from groundwater. This is followed by the Urban/Industrial & Rural domestic demand sector where 14% of this sector receives its water from ground water.

4.2 PROJECTED FUTURE WATER REQUIREMENTS

Population growth projections as discussed in **Section 4.1.1** was used as the main driver of the urban and rural domestic growth in water demands.

Increase in service levels over time was introduced resulting in an increase in the per capita water uses, specifically in those areas with currently low service levels.

In most of the sub-catchments within the study area, the water resources are already over allocated with very little if any scope for an increase in irrigation activities. No growth was therefore in general assumed for irrigation over the planning period as indicated in **Table 4.6.** The only exceptions were for the .Mutale catchment where some growth were allowed when a new dam is in place as well as in the Luvuvhu catchment where the allocated irrigation is still in the process of development.

In **Section 4.1.2** and **Table 4.2** information is given on currently inactive small holder irrigation which the Limpopo and Mpumalanga Provincial Departments of Agriculture have over the years attempted to revitalise with limited success.

Table 4.6: Demand projections

Catchment & Scheme	User description	Demand projection (million m3/a)						
		2012	2015	2020	2025	2030	2035	2040
Groot Letaba								
Dap Naude	Polokwane	4	4	4	4	4	4	4
Ebenezer	Total Demand	29	29	29	29	29	29	30
Magoebaskloof & Vergelegen	Total Demand	5	6	11	15	15	16	16
Hans Merensky	Irrigation	5	5	5	5	5	5	5
Thabina	Thabina RWS Total (SW & GW)	5	6	7	9	10	10	11
Thapane	Thapane RWS (SW & GW)	2	2	2	3	3	3	3
Mojadji	Mojadji RWS	3	4	4	5	5	6	6
Tzaneen	Total Demand (Full irr allocation)	123	124	128	131	133	135	137
Total Schemes in Groot Letaba		**175**	**179**	**190**	**201**	**204**	**208**	**212**
Groot Letaba	Diffuse Irrigation	166	166	166	166	166	166	166
Total demand in Groot Letaba		**341**	**344**	**356**	**367**	**370**	**374**	**377**
Middle and Klein Letaba								
Nsami & Middle Letaba scheme	Total demand surface water	24	27	30	39	43	47	50
Nsami & Middle Letaba scheme	Total demand ground water	8	8	8	8	8	8	8
Nsami & Middle Letaba scheme	Irrigation	1	1	1	1	1	1	1
Klein Letaba	Diffuse users (SW & GW)	98	98	98	98	98	98	98
Total demand in Middle & Klein Letaba		**131**	**134**	**136**	**145**	**149**	**153**	**157**
Luvuvhu & Singwedzi								
Albasini	Total demand surface water	7	8	8	8	8	8	9
Albasini	Total demand Groundwater	4	4	4	4	4	4	4
Damani	Total demand surface water	3	4	9	11	12	12	13
Damani	Total demand Groundwater	0	0	0	0	0	0	0
Nandoni / Vondo/Tshakhuma	Total demand surface water	31	37	49	63	67	72	76
Nandoni / Vondo/Tshakhuma	Total demand Groundwater	4	4	4	4	4	4	4
Irrigation schemes	Total demand surface water	11	11	22	24	24	24	24
Total Schemes Luvuvhu/Singwedzi		**59**	**67**	**96**	**114**	**119**	**124**	**129**
Luvuvhu & Singwedzi	Diffuse users (SW & GW)	78	78	78	78	78	78	78
Total demand Luvuvhu/Singwedzi		**137**	**145**	**174**	**192**	**197**	**202**	**207**
Mutale								
Several water services schemes	Urban Rural domestic & Mining	5	5	6	6	7	7	8
Mutale	Irrigation	6	6	6	6	7	10	12
Total demand in Mutale		**11**	**11**	**12**	**12**	**14**	**17**	**20**
Total demand Luvuvhu/Singwedzi/Mutale		**148**	**156**	**185**	**204**	**211**	**220**	**227**
Total Demand in study area		**619**	**634**	**677**	**716**	**730**	**746**	**761**
Total study area	Reduction in runoff due to IAP	11	11	11	11	11	11	11
Total study area	Forestry reduction in runoff	80	80	80	80	80	80	80
Total Demand in study area	(Tzaneen irr allocation used)	**710**	**725**	**768**	**807**	**821**	**837**	**852**
Total Demand in study area	(Tzaneen average irr supply used)	**672**	**687**	**731**	**769**	**783**	**799**	**815**

Current estimates are that this might result in an increase in irrigation use of approximately 20 million m^3/a by 2040. This is however very difficult to predict and will depend largely on if and where the assurance of water supply to irrigation can be increased.

5 WATER RE-USE

There is limited information on return flows and planning in relation to wastewater use within the study area. Only three local municipalities have information on return flows. The Makhado Local Municipality plans to reuse effluent from their wastewater treatment works as an added source of water from 2015 onwards, with estimates of 1.33 million m^3/a for 2015, 1.45 million m^3/a for 2020, 1.58 million m^3/a for 2025 and 1.7 million m^3/a for 2030. However, there is no mention on how and where they intend re-using the wastewater.

The Greater Tzaneen Local Municipality indicates that a total volume of 5.22 million m^3/a is discharged from all the wastewater treatment works into the resource. There is no mention on the intentions of re-using the water. Greater Giyani Local Municipality indicates that a total volume of waste water received and treated is 0.95 million m^3/a. The treated effluent is not recycled and 0.8 million m^3/a volume of effluent is discharged into the Klein Letaba River.

The assessment of wastewater treatment works in the Luvuvhu/Letaba catchment has indicated the following:

- Most municipalities in this area do not measure the volume of effluent entering the WWTW or that discharged as treated effluent;
- In all cases where data was available the effluent discharged is also of poor quality with high nutrients and faecal contamination; and
- There are areas of water deficit where treated wastewater could be considered for agricultural or limited urban use.

It is recommended that should the option of treated wastewater reuse be considered, then the wastewater treatment works in the study area need to be upgraded and their operation optimised to improve the quality of the effluent being discharged. Currently the quality being discharged may have localised serious human health and ecological consequences and increased eutrophication potential in the study area, which will in turn impact on other water users such as irrigation farmers and water treatment plants.

6 WATER CONSERVATION AND DEMAND MANAGEMENT

6.1 THE MUNICIPAL WATER SUPPLY SECTORS

The study area includes or partly includes the Water Services Authorities of Vhembe DM and Mopani DM as well as their associated local municipalities. Also included is Polokwane Local Municipality which receives water from the Groot Letaba catchment. The location of the Local and District Municipalities are shown in **Figure 4.1.**

As part of the development of the overall Luvuvhu-Letaba Reconciliation strategy, the WC/WDM component of the study focused on the following key aspects:

- Preparing a baseline of current water losses and potential savings in the Luvuvhu-Letaba system;
- Completing WC/WDM performance score cards to identify strengths, weaknesses, opportunities and threats;
- Identifying potential interventions, complete with budgets and time lines;
- Preparing water balance diagrams for the municipalities under investigation complete with system yields versus demand curves, with and without WC/WDM;
- Developing high level WC/WDM strategies and business plans for the municipalities within the Luvuvhu-Letaba system.

The status quo review conducted for the WSAs revealed the critical challenges existing in the key demand centres which pose an impediment to service delivery and negatively impact on the implementation of WC/WDM in the catchment. In view of these challenges and arising from the discussions held with the WSAs and WSP', recommendations were made regarding the institutional, financial, social and technical aspects within the municipalities. These recommendations or strategies are briefly discussed in the following sections.

6.1.1 Institutional Strategy

The key intervention for the WSAs within the Luvuvhu-Letaba catchment will be to address the considerable vacancies or shortages in human resources and skills. Dedicated individuals or sections should ideally be established in order to drive Water Conservation and Demand Management. Specialised training in WC/WDM is pertinent to support the municipal personnel in undertaking the required water loss reduction activities, particularly at the management level where guidance and leadership is required to drive demand management. It is also crucial that the lines of communication are opened between the different municipal departments, in order to aid more efficient access to information, which will allow for more effective and coordinated planning. In this regard, an NRW steering committee comprising of the relevant councillors, finance representatives, communication and the technical department can be established to facilitate improved reporting and management of NRW. Procurement processes during and after the transition period must also be streamlined in order to enable swifter access to support structures, required for operations and maintenance tasks, which are necessary to mitigate water losses in the systems.

6.1.2 Social Strategy

Extensive and continuous consumer water education programmes are required, which will focus on the community and other key water users including agricultural users and institutions such as schools, which are potential avenues for the reduction of water losses. The installation of water efficient devices, as well as rain water harvesting; are also avenues which can further be explored for promotion and implementation in different sectors, which can aid water loss reduction at the consumer level, particularly in areas where metering and billing cannot immediately be effected, and where cost recovery is very low due to high indigent populations. Structures should also be put in place to support consumers in reporting leakage and other service related complaints, which should be captured electronically in order to allow proper tracking and analysis of water loss contributors and significant problem areas. The political leadership should ideally lead these interventions and provide substantial support in order to improve the sustainability of the community based interventions.

6.1.3 Financial Strategy

As a first step, meter audits should be undertaken for the non-domestic consumers in order to identify unmetered connections and non-functional meters, which could in the short term significantly, improve cost recovery. Furthermore, it is imperative that the tariff setting process include inputs from the technical departments, which could assist in making the tariffs increasingly effective in achieving the water use efficiency objectives. National Treasury has been very vocal on the dependency of municipalities on grant funding and has emphatically expressed the need for municipalities to actively demonstrate a commitment to proper budgeting, planning and cost recovery with a focus on demand side management as a first step in managing and more effectively utilising the available resources. The aforementioned require closer monitoring of consumers, particularly the top consumers, an effective system to capture and refer billing related complaints and progressive payment of services in the municipalities which must be supported and preceded by proper community awareness and education, and wide spread public engagement.

6.1.4 Technical Strategy

Measurement of the system input volumes as a first step is required to come to grips with the extent of water losses in the catchment, particularly in the Mopani District. Sectorisation and zone metering and monitoring is also required in the majority of the municipalities in the study area to aid in the micro management of the system, once bulk metering has taken place. The installation of meters is only the first step and will be altogether useless if the information is not captured and monitored on a monthly basis. Proper budgets must also be set aside for proactive infrastructure asset maintenance. There is a substantial maintenance backlog in the municipalities in the study area, with a significant number of access challenges being caused simply by the age of the existing infrastructure. Passive leak detection through community reporting would greatly enhance the ability of the WSPs to monitor the network and explore potential for pressure management in selected areas experiencing high pipe burst frequencies. The location of infrastructure also needs to be clarified in order to identify aspects of the network which are in a state that compromises the ability to provide services to the consumers. There is a need to develop digital as built drawings of the network, which must be accompanied by the development of a comprehensive asset register; that must incorporate critical information such as the age of the infrastructure, replacement period and cost, as well as the location of the assets. Through such interventions, substantial community based employment can be created, where indigent residents can be appointed and utilised to clean and locate the infrastructure.

6.1.5 Conclusions

Results from the study are summarised as follows:

- There is a large part of the study area which has formal infrastructure which enables effective metering and billing.
- The average consumption in the urban areas is very high and there is scope for reduction which is expected to reduce the total demand and non-revenue water.
- The rural areas are characterised by intermittent supply with limited cost recovery and consumers revert to illegal connections to obtain water.
- The average consumption in the rural areas is within the acceptable range, but there is huge inequality of supply. Any reduction will be redistributed with limited or no reduction in the total demand;
- The water tariffs in certain areas are not cost reflective and not promoting water conservation and water demand management
- The municipality lack funding to implement WC/WDM;
- The municipalities require additional staff to address and implement WC/WDM.
- Asset management lacks in some of the areas which impact on the assurance of supply;
- Municipalities are grant dependant and have very high debtors;

<u>Based on the above the following key strategic focus areas are recommended</u>:

- Raise WC/WDM awareness within the organisation by setting-up a WC/WDM task team, chaired by senior officials or MMC to meet on monthly basis to address WC/WDM issues;
- Fill vacant positions and provide training and capacity building
- Improve metering, reading, billing and cost recovery;
- Review the water tariff structure to be most cost reflective and promote WC/WDM;
- Improved tariff structures and cost recovery will increase revenue for the municipality, which can be used to address the backlog in maintenance and improve service delivery;
- Implementing metering and cost recovery in the rural areas do present several challenges and fixing internal plumbing leakage using local plumbers are recommended until such time that the system have stabilised and service delivery has improved;
- Implement awareness campaigns across all consumers to use water efficiently; and
- Improve management information through proper monthly reporting and record keeping. These reports should be discussed at the monthly EXCO meeting.

6.1.6 Possible savings

The possible estimated savings through WC/WDM for each of the Water Services Schemes and for the larger towns in the study area is summarised in **Table 6.1**. The estimated total saving is expected to be in the order of 9 million m^3/a, representing an overall saving of 8%.

Table 6.1: WC/WDM savings in Urban and rural domestic sectors

Town or Water Services Scheme	% Reduction	Reduction million m^3/a	2010 Demand (million m^3/a)	2015 Demand (million m^3/a)
Middle and Klein Letaba				
Elim / Vleifontein RWS	4%	0.110	2.280	2.920
Total Giyani System	10%	1.835	14.270	18.274
Total Middle Letaba RWS	9%	0.895	7.662	9.921
Total Middle Letaba & Nsami Supply Area	**9%**	**2.840**	**24.212**	**31.115**
Groot Letaba				
Haenertsburg	5%	0.031	0.584	0.611
Tzaneen Town	5%	0.154	2.946	3.087
Total Modjadji supply area	14%	0.489	2.880	3.554
Ritavi / Letaba RWS	5%	0.163	2.510	2.973
Ritavi II RWS	5%	0.591	9.305	11.820
Siluwane - Nondweni Extended RWS	16%	0.087	0.360	0.551
Thabina RWS	5%	0.284	4.176	5.684
Magoebaskloof Vergelegen Dam supply area	14%	0.334	2.160	2.388
Total Groot Letaba	**7%**	**2.134**	**24.921**	**30.667**
Luvuvhu				
Makhado	20%	0.776	3.600	3.8780
Greater Thohoyandou (Malamulele West,Vondo & Tshakhuma RWS's)	5%	1.175	18.582	23.5058
South Malamulele East RWS	5%	0.257	3.614	5.1424
Xikundu & Minga Weirs supply area	5%	0.304	4.396	6.0856
Damani RWS	5%	0.193	2.200	3.8581
Nandoni future supply areas				
Valdezia, Luvuvbu CBD & Tshitale	5%	0.073	1.225	1.467
Total Sinthumele / Kutama minus WC/WDM	5%	0.195	3.380	3.8912
Total from Matoks minus WC/WDM	5%	0.219	3.068	4.3797
Total Luvuvhu	**6%**	**3.192**	**36.465**	**52.2074**
Mutale				
Total from Mutale Main minus WC/WDM	20%	0.506	2.200	2.5319
Total from Mutale Mukuya minus WC/WDM	20%	0.065	0.287	0.3273
Total from Masisi minus WC/WDM	20%	0.115	0.499	0.5733
Total from Luphephe / Nwanedzi minus WC/WDM	20%	0.188	0.773	0.9390
Total Mutale	**20%**	**0.874**	**3.759**	**4.3716**
Total study Area	**8%**	**9.040**	**89.357**	**118.361**

Savings within the rural areas are in general small, with mainly the Mutale area showing a fairly high potential for WC/WDM savings. The observed water use for the Mutale area showed a relative high unit water consumption of almost 280 l/c/d, which is quite excessive for a mainly rural area. This therefore results in high possible savings that can be obtained through WC/WDM actions.

6.2 IRRIGATION SECTOR

A number of studies have been undertaken on Irrigation Water Conservation and Water Demand Management in the Luvuvhu/Letaba catchments. The most comprehensive are the "Middle Letaba Water Supply Scheme: WC/WDM Situation assessment (2003)" (DWAF, 2003b) and "The Development of a Comprehensive WC/WDM Strategic Business Plan for Luvuvhu/Letaba Water Management Area (DWA, 2010b).

These studies all point to the very limited (if any) savings that can be achieved from the irrigation sector, as most of the irrigation schemes are already experiencing severe water shortages. In the case of commercial irrigation schemes, irrigators have in most cases already improved their irrigation efficiency to get maximum use from the available water. This applies particularly to the large block of commercial irrigators supplied from Tzaneen Dam and irrigators from Albasini Dam where the survival strategy has been to move more and more to groundwater supply.

In the case of the smallholder irrigation schemes, the assurance of supply has become so low, that most schemes in the Study Area utilise irrigation water extremely diligently to maximise the benefit from the scarcely available water. This usually takes the form of drastically reduced areas planted (compared to the irrigable areas on the schemes) and sub-optimal application rates.

Nevertheless, there are always opportunities to improve water use efficiency and reduce losses and these are outlined below. However in the light of the very low assurance of supply, it is highly unlikely that any "savings", resulting from WC/WDM initiatives, will result in additional water availability for other uses.

The Water Act provides guidelines for the implementation of water conservation and water demand management in the irrigation sector and the Department of Water Affairs (DWA) has developed (WC/WDM) strategies and guideline documents for agriculture.

The Act requires that WC/WDM be driven primarily by Water User Associations (WUA) - or Irrigation Boards or Government Water Schemes until WUA's are established.

The core principal of a WUA (or its predecessor), in implementing water conservation and water demand management in the irrigation sector, is the development of a Water Management Plan (WMP). The WMP sets out benchmarks and best management practices for WC/WDM and a manageable and affordable programme for the implementation by both the water supplier, in the case of controlled- irrigation schemes and the irrigators over time. The water management plan is therefore the primary tool with which the irrigation sector can implement WC/WDM initiatives in controlled irrigation areas.

This approach is supported by all water management authorities and institutions in the Luvuvhu/ Letaba study area.

The key best management practices that have been identified to be addressed to improve irrigation water use efficiency in the study area are summarised here. These proposals are dealt with in more detail in the Irrigation report (DWA, 2014a):

Water measurement

Improved water measurements of the flow rates, duration and volume of flows at all the critical points which include the inflow and outflow at balancing dams, canals (as well as the canal tail ends) and pipelines, etc.

Installing water meters (using practical and cost effective telemetry) remains the highest priority as far as water management is concerned, as all problems point to the unavailability of water use information.

DWA also needs a sound information management system (IMS) to capture data from the meters. The IMS should be real-time and should provide the irrigators with information regarding the water currently available in the system, and with probabilities of rainfall events in coming days.

Incentives

Developing an incentive-based water pricing structures (sale-by-volume) to improve irrigation water-use-efficiency and reduce significant fluctuations in demand. However, the protection of irrigation water entitlements per farm should be secured.

Infrastructure upgrade in selected areas

Maintenance and refurbishment of the existing delivery canals as well as the siphons, in order to reduce leakage losses, improve flow rates and increase the head at diversion points.

The replacement of old canals with pipelines. For example, the high losses in the Middle Letaba Nsami canal could be reduced by approximately 4 million m^3/a, by replacing the canal with a pipeline.

Capacity building

Extension and training is needed to help irrigators identify ways to use less water. In this study the priority areas in terms of inefficiency were identified (priority quaternaries include A92A, A92C, B82F and B82J, B81H and B81J).

The institutional structures need to be strengthened in the study area to ensure that water losses at any point in the system can be linked to the person/organisation concerned.

7 WATER QUALITY

7.1 INTRODUCTION

The objective of the water quality review task is to use the available water quality data and water quality reports from previous studies to develop an understanding of the water quality profiles of the major rivers in the study area. The understanding achieved will be used to provide the qualitative input on the impact that the reconciliation options could have on water quality.

The study area was divided into four resource units, namely: Luvuvhu main and Mutale River catchment areas; the Shingwedzi River catchment area; the Groot Letaba catchment area; and Middle and Klein Letaba catchment areas.

7.2 WATER QUALITY STATUS

The water quality status of the Luvuvhu River is driven by intensive agriculture of sub-tropical fruits and afforestation in the upper catchment, the urban sprawl of Thohoyandou in the middle catchment and the KNP in the lower end of the catchment. The water quality trends in the middle to lower Luvuvhu River indicate a deterioration of the phosphates, nitrates and ammonia levels. The water quality of the Luvuvhu main catchment has remained very good, and on the whole falls within the interim RWQOs. The main concerns are the elevated nutrients and ammonia downstream of urban areas, as well as associated bacteriological contamination that can be expected. There is also limited contamination from the Tshikondeni mining area in the lower Mutale River catchment.

The majority of the Shingwedzi River's catchment falls within the KNP. Outside the KNP land use is mainly subsistence agriculture and informal urban settlements. In general the water quality of the Shingwedzi River catchment has remained very good, however shows contamination from the domestic wastewater treatment works, as well as general urban pollution from the larger villages.

The water quality of the Groot Letaba catchment has remained very good in the upper reaches of the catchment, moving towards a slight deterioration further downstream due to low flow conditions.

The Great Letaba Irrigation Scheme covers an extensive area along the river to the border of the Hans Merensky Game Park. Further downstream along the river at the gauging point B8H008, the water quality deteriorates (electrical conductivity (101.5 mS/m), TDS (710 mg/l), sodium (138.5 mg/l) and chloride of 192.7 mg/l. Nutrients are low with phosphate (0.08 mg/l), nitrate (0.35 mg/l) and ammonia (0.11 mg/l). This is at the confluence of the Klein Letaba and the border of the KNP. This deterioration accumulates further downstream as evidenced by the general increasing TDS trend.

The Middle and Klein Letaba rivers are in a moderately modified state, due mostly to densely populated settlements and agriculture above the Middle Letaba Dam and upper Klein Letaba

River. The current water quality down the Klein Letaba River indicates ideal values of ammonia, sulphates and nitrates, with unacceptable phosphate values which are as a result of a number of WWTWs and waste disposal sites, leading to eutrophication.

The Molototsi River's main land-use is rural informal settlements, with livestock and with limited subsistence and cultivated agriculture. The landscape is dry and when the river flows it carries a high sediment load due to the informal settlements and cultivated agriculture that takes place into the flood plain of the river.

7.3 RECOMMENDATIONS (WATER QUALITY)

Considering the number of densely populated and informal settlements in the study area and the potential for water use directly from the resources, bacteriological monitoring in the study area is inadequate, and needs to be increased at points up and downstream of the urban areas, and specifically of wastewater treatment works. This will also give a better understanding of the potential for cholera outbreaks.

The wastewater treatment works in the study area need to be upgraded to improve the quality of the effluent being discharged, as this is impacting on human health and increased eutrophication potential in the study area, which will in turn impact on other water users such as irrigation farmers and water treatment plants.

8 WATER RESOURCE AVAILABILITY

8.1 GENERAL

Several large dams are located in the study area. These are Dap Naude, Ebenezer, Magoebaskloof, Vergelegen, Hans Merensky, Tzaneen, Thabina, Middel Letaba, Nsami, Thapane and Modjadji in the Letaba catchment, Makuleke in the Shingwedzi catchment and Albasini, Vondo, Phiphidi, Damani, Nandoni and Tshakuma in the Luvuvhu catchment. Numerous smaller dams are also scattered over the study area, most of which are used for irrigation.

Groundwater is an important source of water in this study area, with approximately 22% of the total water requirement supplied from groundwater at 2012 development level. The groundwater surface water interaction was therefore accounted for explicitly in the rainfall-runoff modelling process. This involved the application of the Groundwater-Surface Water Interaction Model (GWSWIM), a methodology which was developed by groundwater specialist K Sami (DWA, 2004) and which has been incorporated as a sub-model into the WRSM2000 rainfall-runoff model. The methodology to simulate the interaction was recently incorporated into the WRYM and WRPM, and was used for the historical analysis of selected catchments where groundwater abstractions had a significant effect on the natural flows.

8.2 SURFACE WATER AVAILABILITY

8.2.1 Methodology

The yield capability of the different surface water resources was determined through simulation analysis of the entire study area, which includes a large number of separate surface water supply schemes as configured in the Water resources Yield Model (WRYM). The interaction between surface and groundwater was included in the modelling process by using the Groundwater-Surface Water Interaction Model recently incorporated in the WRYM. Some of the dams are operated as individual systems, used to supply a dedicated user group while other dams are used in combination with other dams as a combined water supply system, used to supply one or more user groups. This phenomenon was taken into account when the yield characteristics of a single dam or a system of dams were determined. Two types of yield analyses were carried out to determine the yield characteristics of the different systems and sub-systems and are referred to as historic firm yield (HFY) analysis and long-term stochastic yield analysis.

The historic firm yield analysis is based on an analysis period of 91 years from the 1920 to the 2010 hydrological year (i.e. October 1920 to September 2011). This analysis used the historic natural flow sequences derived for the 91 year record period. This corresponds with the updated and extended hydro-meteorological data sets developed during the hydrological analysis of the Study, as requested in the TOR. The Historic Firm Yield (HFY) is determined by means of an iterative process and is defined as the highest annual target draft that can be supplied from the system, without causing a failure over the analysis period. However, while the HFY provides a reasonable indication of the water resource capability of the system, it does not show the likelihood (or probability) that the water volume in question could be supplied without failure, since it is possible that a dry period may still occur, that is more severe than any period covered by the historical record.

The second type of analysis is a *long-term stochastic yield analysis*, which is undertaken by repeatedly analysing the WRYM system based on stochastically generated time-series of monthly historical natural incremental runoff volumes. These time-series, or sequences, are generated by the WRYM at run-time, based on the statistical parameters contained in the PARAM.DAT file, developed as part of the stochastic stream flow analysis of the Study. For this purpose 201, 91-year stochastically generated stream flow sequences were analysed.

The results of a long-term stochastic yield analysis include the assurance of supply associated with each of the target drafts analysed under a particular scenario, which, in turn, may be used to derive the yield-reliability characteristics (YRC) curve. This curve provides a graphical representation of the relationships between yield and reliability of supply, and is used as a basis for allocating a system's water resources to a group of users, with varying supply assurance criteria. Generally, the assurance characteristics of a particular target draft are expressed in terms of its recurrence interval (RI), which is defined as the average time period between failures. For example, if the RI is shown as "1:200" years, this implies, on average, one failure every 200 years, or a risk of failure of 1 in 200 = 0.5 % in any given year. This can also be expressed as an annual assurance of supply of 100 % – 0.5 % = 99.5 %.

8.2.2 Results from the Yield analyses for main water supply systems

Based on the results from the HFY analyses specific scenarios of the sub-systems analysed were selected for the long-term stochastic analyses. The results from these analyses are summarised in **Table 8.1,** covering in total 33 different scenarios and or sub-systems, of which some are for existing dams and others for possible future dams, as indicated in the table.

Dap Naudé and Ebenezer dams are used as a combined system to support the Polokwane Local Municipality by means of transfers to the Sand River catchment, as well as supporting the town of Tzaneen and irrigation located between Ebenezer and Tzaneen dams. Dap Naudé Dam; however, is only used in support of Polokwane. For this reason the yield characteristics were determined for both the dams separately as well as for the combined system. The irrigation supported from Ebenezer Dam is supplied under the same restriction rules that apply to the Tzaneen Dam irrigation component. Tzaneen Dam is currently over allocated, which results in a low assurance supply to the irrigation sector. The same low assurance of supply was thus applied to the irrigators between Ebenezer and Tzaneen dams.

Magoebaskloof Dam is used to support Vergelegen Dam, from where water is distributed for irrigation as well as urban and rural domestic purposes. Water from Magoebaskloof Dam is also used to support irrigation downstream of the dam. Due to this layout and related operating procedure, the yield was determined for Magoebaskloof Dam on its own as well as for the combined Magoebaskloof Vergelegen system. There are uncertainties on the total amount of irrigation to be supported from the Magoebaskloof Vergelegen Dam system, therefore two scenarios were considered, one where the larger part of the total demand was supplied at a low assurance and the other with the larger component was supplied at a firm yield.

The raising of Tzaneen Dam and the building of Nwamitwa Dam were both approved by parliament and will in future be used as a combined system. The raising of Tzaneen Dam will take place first, followed by the building of Nwamitwa Dam.

Yield analyses were therefore carried out for the existing Tzaneen Dam, the raised Tzaneen Dam as well as for the combined Tzaneen Dam Nwamitwa Dam system. The inclusion of Nwamitwa Dam will also make it possible for the system to better support the EWRs, which is of high importance for the Kruger National Park located downstream of all the developments in the Groot Letaba River catchment. Scenario 11, which includes the Low PES EWRs for sites 3, 4 and 5, was thus added as an additional option to analyse. Even with the raising of Tzaneen Dam and the inclusion of Nwamitwa Dam in the system, it will still not be possible to supply the irrigation demand imposed on the system at a high assurance. The concept of the irrigation component being supplied at a very low assurance was thus still applied for the combined Tzaneen Dam / Nwamitwa Dam system.

Table 8.1: Summary of HFY and long-term stochastic yield analyses results

Dam name	FSV (million m^3)	Yield (million m^3/a)				
		HFY(1)	1 in 20 year	1 in 50 year	1 in 100 year	1 in 200 year
1) Dap Naude	**3.7**	**3.1**				
2) Ebenezer	**69.1**	**32 (+6.0=38)**				
3) Dap Naude plus Ebenezer	**72.8**	**36.2**	**43.8**	**40.5**	**37.2**	**34.7**
4) Magoebaskloof	**4.8**	**7.2**				
5) Magoebaskloof plus Vergelegen	**9.9**	**6.4 (+4.6=11)**	**14.7**	**12.9**	**11.8**	**11.1**
6) Magoebaskloof plus Vergelegen	**9.9**	**2.3 (+12.8= 16.1)**				
7) Hans Merensky	**5.1**	**3.4**	**5.2**	**4.8**	**3.7**	**3.2**
8) Tzaneen	**155.7**	**44 (+37.7= 81.7)**				
9)Tzaneen raised	**182.4**	**45 (+37.6=82.6)**	**60.0**	**51.7**	**45.5**	**40.4**
10) Tzaneen raised plus Nwamitwa	**369.0**	**61 (+39.5=100.5)**				
11) Tzaneen raised plus Nwamitwa & EWR	**369.0**	**49 (+40.7=89.7)**				
12) Thabina	**2.6**	**3.1**	**4.1**	**3.7**	**3.4**	**3.2**
13) Middel Letaba	**184.3**	**18**				
14) Nsami	**24.1**	**0.2**				
15) Middel Letaba plus Nsami	**206.1**	**20.6**	**31.0**	**24.3**	**21.5**	**18.6**
16) Thapane	**1.07**	**1.1**	**1.6**	**1.4**	**1.2**	**1.1**
17) Modjadji	**7.2**	**3.5**	**4.4**	**3.8**	**3.4**	**3.2**
18) Makuleke	**13.0**	**0.1**				
19) Albasini	**28.4**	**1.4**	**3.7**	**2.5**	**1.9**	**1.6**
19b) Albasini excl GW	**28.4**	**7.9**				
20) Vondo	**30.6**	**16.8**	**25.0**	**21.9**	**20.5**	**18.9**
21) Phiphidi	**0.19**	**0.2**				
22) Damani	**12.9**	**4.8**	**5.7**	**5.3**	**4.8**	**4.5**
23) Nandoni	**166.1**	**56**				
24) Nandoni plus weirs	**166.1**	**62**	**83.0**	**70.0**	**64.0**	**58.0**
25) Tshakuma	**2.47**	**1.4**	**1.8**	**1.5**	**1.3**	**1.2**
Possible future dams						
26) Paswane dam	**90.0**	**43.0**	**64.5**	**55.0**	**50.8**	**46.3**
27) Xikundu Dam	**139.0**	**51.0**	**71.5**	**62.5**	**56.2**	**51.5**
28) Crystalfontein Dam with EWR	**96.0**	**5.4**	**-**	**-**	**-**	**-**
29) Majosi Dam with EWR	**29.0**	**4.6**	**-**	**-**	**-**	**-**
30) Rambuda Dam	**13.5**	**12.6**	**18.7**	**16.7**	**14.6**	**13.4**
31) Tswera Dam	**131**	**53.0**	**69.4**	**62.1**		
32) Thengwe Dam	**116**	**51.0**	**-**	**-**	**-**	**-**

Notes: (1) – Some dams are currently over utilised and the value in brackets shows the non-firm yield supplied over and above the firm yield.

A significant amount of groundwater use developed upstream of Albasini Dam over the years, which impacted on the yield available from Albasini Dam. With the surface water groundwater interaction model now available in the WRYM, it was for the first time possible to simulate the impact of these abstractions on the Albasini Dam yield. Scenario 19b clearly shows the increase in yield of 6.5 million m^3/a for Albasini Dam when all the upstream groundwater abstractions are eliminated.

The yield available from Nandoni Dam was determined for the dam on its own, as well as for Nandoni Dam used in conjunction with the three weirs downstream of the dam. Nandoni Dam should be operated to support the abstractions for rural domestic supply from these weirs. The support from Nandoni should only take place when there is not sufficient runoff from the downstream catchment to fully supply the current downstream abstractions as well as the possible future irrigation abstractions in this area. This approach is required to optimise the use of the local runoff. When Nandoni Dam is operated in this manner, it is possible to increase the Nandoni HFY from 56 to 62 million m^3/a, an increase of almost 11% in the yield.

8.2.3 Diffuse Water Resources

Numerous smaller dams are scattered over the study area, most of which supplies water for irrigation. The total storage of these small dams adds up to a significant volume of 113.5 million m^3/a (this compares with a total storage between that of Tzaneen and Ebenezer Dam), and a combined surface area of 42.3 km^2 when full. Runoff river abstractions are common in the higher rainfall areas and along perennial rivers. These diffuse water requirements and impoundments are all accounted for in the WRYM setup and the impacts of these abstractions and small dams are therefore included in the yield analyses and related water balances.

8.3 GROUNDWATER AVAILABILITY

The Ground Water Harvest Potential (Seward and Seymour, 1996) provides a basis for the evaluation of the volume of groundwater resources. The Harvest Potential is defined as the maximum volume of groundwater that is available for abstraction, without depleting the aquifer systems, and takes into account recharge, storage and drought periods. The Harvest Potential for the study area was determined as 271 million m^3/a.

It is however not possible to abstract all the ground water available. This is mainly due to economic and/or environmental considerations. The main contributing factor is the hydraulic conductivity or transmissivity of the aquifer systems. As no regional information is available, a qualitative evaluation has been done using available borehole yield information, as there is a good relationship between borehole yield and transmissivity.

The geometric mean of borehole yield was determined for each Quaternary catchment using information available from the National Ground Water Archive. The Harvest Potential was then reduced by an exploitation factor, determined from borehole yield data, to obtain an exploitation potential, i.e. the portion of the Harvest Potential which can practically be exploited. The Exploitation Potential for the study area was on this basis determined as 184 million m^3/a.

Groundwater quality is one of the main factors restricting the development of available groundwater resources. Although there are numerous problems associated with groundwater quality, some are relatively easily remediated.

Water quality data was obtained from boreholes in the study area and classified using the DWA's potable water quality standards for domestic consumption in terms of nitrates and total dissolved solids. The potable portion of groundwater was considered, as the water that was classified as ideal, good and marginal according to DWAF (1998) domestic water quality standards (Class 0,1 and 2). Groundwater classified as poor or unacceptable was considered not to be potable. Approximately 81% of the groundwater based on this evaluation can be regarded as potable. Poor water quality exists in parts of:

- A92C and D and is found in boreholes in the basalt and saline Karoo groundwater regions
- B81F, G and H in the low veld plains due to high levels of nitrate. These catchments are densely settled and associated with the removal of vegetation.
- B82D, G and H, shows elevated nitrates due to dense settlement and elevated salinity.
- B90B and C, F and G show elevated nitrates and salinity.

The Potable Groundwater Exploitation Potential was derived by multiplying the Exploitation Potential by the Portability Factor. The Potable volume of groundwater that can be exploited within the study area is 158 million m^3/a (**Table 8.2**).

The Exploitation Potential for the study area based on the GRAII data base (DWA, 2006) is however much higher at 607.21 million m^3/a. These exploitation potential values in GRAII were considered to be too high due to incorrect storage estimates. The data used in the calculation of the original GRAII report was thus re-examined. The aquifer storage volumes utilised (Murray, 2006) were considered to be too high and were recalculated, and subsequently the Exploitation Potential was recalculated by using the same methodology. This modified Exploitation Potential was calculated as 370 million m^3/a, which is considerable less but still much higher than the exploitation potential determined from the harvest potential.

The groundwater exploitation potential as obtained by these two different approaches are summarised on a quaternary basis in **Table 8.2** and results in a total potable exploitation potential of between 158 million m^3/a and 333 million m^3/a based on the two different approaches used.

Table 8.2: Potable Harvest and Exploitation Potential per quaternary catchment

Quat	Portability factor	Harvest Potential (million m^3/a)	Potable Harvest Potential (million m^3/a)	Potable Exploitation Potential (million m^3/a)	Potable modified GRAII Exploitation Potential (million m^3/a)
A91A	1.00	2.83	2.83	1.98	5.44
A91B	1.00	4.36	4.36	3.05	4.05
A91C	0.94	4.46	4.19	2.93	8.85
A91D	1.00	1.54	1.54	1.08	10.26

Quat	Portability factor	Harvest Potential (million m^3/a)	Potable Harvest Potential (million m^3/a)	Potable Exploitation Potential (million m^3/a)	Potable modified GRAII Exploitation Potential (million m^3/a)
A91E	0.94	2.94	2.76	1.93	10.73
A91F	0.82	8.15	6.68	4.01	5.84
A91G	0.97	3.40	3.30	2.31	26.53
A91H	0.96	3.83	3.68	2.58	7.75
A91J	0.87	4.07	3.54	2.13	4.52
A91K	0.95	6.97	6.62	4.63	2.43
A92A	1.00	2.76	2.76	1.93	24.52
A92B	1.00	4.67	4.67	3.27	18.67
A92C	0.73	3.00	2.19	1.53	6.24
A92D	0.76	3.20	2.43	1.70	3.33
B81A	1.00	2.72	2.72	1.36	9.90
B81B	1.00	7.72	7.72	5.40	22.87
B81C	0.71	3.35	2.38	1.43	2.20
B81D	0.95	7.80	7.41	5.19	9.51
B81E	0.99	8.98	8.89	5.33	9.37
B81F	0.97	14.46	14.03	9.82	9.97
B81G	0.65	6.77	4.40	3.08	4.95
B81H	0.78	7.92	6.18	4.32	3.74
B81J	0.66	6.42	4.24	2.96	3.43
B82A	0.85	7.34	6.24	3.74	5.67
B82B	0.94	6.48	6.09	3.65	6.54
B82C	1.00	4.76	4.76	3.33	5.08
B82D	0.97	10.08	9.78	6.85	5.33
B82E	0.67	6.39	4.28	3.00	3.05
B82F	0.86	12.01	10.33	7.23	7.78
B82G	0.85	11.08	9.42	6.60	6.07
B82H	0.70	8.50	5.95	4.16	3.57
B82J	0.56	6.39	3.58	2.50	4.23
B83A	0.88	12.01	10.57	7.40	12.21
B83B	0.95	3.53	3.35	2.35	6.02
B83C	0.95	4.73	4.49	3.14	6.79
B83D	1.00	6.64	6.64	4.65	8.66
B83E	1.00	2.48	2.48	1.49	2.22
B90A	0.91	5.51	5.01	3.01	4.11
B90B	0.77	7.51	5.78	4.05	4.76
B90C	0.68	5.68	3.86	2.70	2.93
B90D	1.00	3.49	3.49	2.44	3.00
B90E	0.95	3.78	3.59	1.80	2.43
B90F	0.52	8.38	4.36	3.05	3.34
B90G	0.75	5.76	4.32	3.02	5.51
B90H	1.00	6.20	6.20	4.34	9.13
Total		**271.05**	**234.09**	**158.47**	**333.52**

An analysis was undertaken to determine which of the water services supply schemes could feasibly be supplied by groundwater. This was undertaken by evaluating:

- The area of the scheme to determine aquifer recharge and harvest potential.
- Existing borehole capacity.
- Proportion of boreholes with potable water (Class 0, 1 and 2).
- Proportion of boreholes yielding > 2 l/s per second as an indicator of the feasibility of drilling boreholes that could be equipped with motorised systems.

Results are summarised in **Table 8.3.**

From **Table 8.2** the potable exploitation potential for the study area was given as 158 million m^3/a. When only considering the groundwater available within the water services schemes, the potable exploitation potential within the schemes amounts to only 80 million m^3/a (see **Table 8.3**).

Borehole yields for boreholes located within water supply schemes are in general sufficient (>20% exceed 2 l/s) to warrant groundwater supply. Low yields are encountered in the Sekgopo groundwater supply scheme in B82A and the Thapane rural water supply scheme in B81E, yet both of these schemes are reliant on groundwater.

Good quality groundwater exists throughout the study area, with the following exceptions: B81B exhibits elevated nitrates and TDS, however the numbers of boreholes sampled is small. B81F and H in the low veld plains exhibit high levels of nitrate. These catchments are densely settled and elevated nitrate is probably associated with the removal of vegetation.B82D, G and H, shows elevated nitrates due to dense settlement. B90B and C, F and G show elevated nitrates

Table 8.3: Water services schemes harvest potential, water quality and existing borehole capacity

Water Quality		Yield > 2l/s	
Red	>80% of boreholes	Dark green	>75%
Yellow	60-80% of boreholes	Light green	50-75%
Green	<60% of boreholes	Yellow	25-50%
		Red	<25%, geometric mean less than 1 l/s

No	Scheme	Median Yield l/s	BH>2l/s %	Harvest Potential (million m^3/a)	Potable exploitation potential (million m^3/a)	Existing BH capacity (million m^3/a)	Potable TDS %	Potable Nitrate %
1	LUPHEPHE/NWANEDZI NORTH	1.40	35.0	1.18	0.71	1.66	92	50
2	MASISI RWS	2.53	55.3	1.90	1.15	2.66	87	80
3	LUPHEPHE/NWANEDZI MAIN RWS	1.05	40.0	3.07	1.86	2.64	90	94
4	TSHIKONDENI MINE	2.50		0.04	0.02			
5	MUTALE LM FARMS SUPPLY	0.98		0.04	0.02			
7	MUTALE MAIN RWS	1.42	38.9	5.91	3.76	1.18	100	100
8	MUTALE MUKUYA RWS	1.79	43.8	1.35	0.89	0.77	100	100
9	DAMANI RWS	2.00	31.8	3.33	2.30	1.79	100	100
10	NZHELELE RWS	1.26	42.1	3.32	2.29	1.56	100	100
11	VONDO NORTH RURAL RWS	2.00	40.0	1.00	0.69	0.01	100	100
12	MATSHAVHAVE/KUNDA RWS	1.29	33.3	0.34	0.24	0.1		
13	TSHIFIRE MURUNWA RWS	11.25	100.0	0.69	0.48	0.15	100	100
14	VONDO CENTRAL RWS	1.01	37.3	5.93	3.73	2.67	100	95
15	VONDO EAST RWS	1.60	36.4	1.52	0.82	0.74	100	91
16	TSHIFUDI RWS	1.67	44.0	1.21	0.81	0.52	100	100
17	LAMBANI RWS	1.20	33.3	0.64	0.43	0.15	100	100

No	Scheme	Median Yield l/s	BH>2l/s %	Harvest Potential (million m^3/a)	Potable exploitation potential (million m^3/a)	Existing BH capacity (million m^3/a)	Potable TDS %	Potable Nitrate %
18	THULAMELA LM FARMS SUPPLY	1.46		0.02	0.01			
19	NORTH MALAMULELE EAST RWS	1.67	44.2	3.11	1.81	1.49	100	62
20	SOUTH MALAMULELE EAST RWS	2.00	47.4	6.55	3.12	2.01	100	53
21	MALAMULELE WEST RWS	1.39	36.2	3.85	1.79	1.2	100	62
22	TSHAKUMA RWS	2.25	50.0	0.70	0.47	0.51	100	100
23	LEVUBU CBD	3.50	100.0	0.11	0.07			
24	VALDEZIA RWS	1.26	20.0	1.68	1.11	1.25	100	100
25	MAKHADO RWS	2.00	48.5	2.22	1.52	0.37		
29	ELIM/VLEIFONTEIN RWS	3.90	67.4	1.93	1.26	2.96	100	96
30	MIDDLE LETABA RWS: VYEBOOM MASIA	3.00	66.7	2.29	1.37	1.72	90	55
31	VONDO SOUTH RWS	0.27	0.0	2.25	1.21	0.96	100	**74**
32	MIDDLE LETABA RWS: MALAMULELE WEST	1.35	41.7	1.43	0.62	0.61	98	63
33	GIYANI SYSTEM F1	1.19	36.0	2.80	1.23	0.65	80	47
34	GIYANI SYSTEM F2	1.88	46.7	2.17	0.96	1.02	100	65
35	MAPUVE/SYSTEM N RWS	1.50	38.1	2.25	1.27	0.55	100	38
36	MIDDLE LETABA RWS: BABANGU	1.50	41.4	5.94	3.61	1.75	100	51
37	MIDDLE LETABA RWS: MAGORO	2.04	50.0	5.42	3.59	2.98	100	56
38	MIDDLE LETABA RWS: MAJOSI	1.13	34.9	5.21	3.12	3.59	100	78
39	TSHITALE RWS	1.00	27.4	4.90	2.64	0.94	100	86
44	SEKGOSESE INDIVIDUAL GROUNDWATER SCHEME	2.25	50.0	1.99	1.35	2.28	100	88
45	MIDDLE LETABA: BOLOBEDU NW	1.76	39.0	2.72	1.30	1.82	100	88
46	WORCESTER/MOTHOBEKI RWS	2.83	55.6	2.06	0.95	1.86	92	57
47	LOWER MOLOTOTSI	4.03	60.0	3.03	1.64	1	91	56
48	GIYNAI SYSTEM C/D	2.59	61.6	6.04	3.37	5.29	88	77
49	GIYANI SYSTEM A/B	1.60	47.3	11.44	5.51	1.62	96	71

No	Scheme	Median Yield l/s	BH>2l/s %	Harvest Potential (million m^3/a)	Potable exploitation potential (million m^3/a)	Existing BH capacity (million m^3/a)	Potable TDS %	Potable Nitrate %
50	SILUWANE - NONDWENI EXTENDED RWS	1.55	41.4	1.89	1.10	1.41	98	83
51	GREATER GIYANI LM FARMS SUPPLY	1.25		0.09	0.06			
53	BA-PHALABORWA INDIVIDUAL SUPPLY	1.25		0.10	0.07		50	100
54	GIYANI SYSTEM D: SOUTH WEST	1.50	42.3	1.57	0.96	1.6	97	58
55	RITAVI/LETABA RWS	1.43	36.4	5.48	3.62	2.43	97	67
56	THAPANE RWS	0.70	15.1	1.50	0.93	0.42	100	95
57	MODJADJI RWS	1.00	28.9	1.75	0.86	1.01	99	93
58	LETABA INDIVIDUAL SUPPLY	0.70		0.06	0.03			
59	GREATER LETABA LM FARMS SUPPLY	0.70		0.30	0.17			
60	SEKGOPO LOCAL GWS	0.67	11.8	0.58	0.30	0.97	100	100
61	GREATER TZANEEN LM FARMS SUPPLY	0.80		0.33	0.17			
72	TZANEEN/HAERNETSBURG INDIVIDUAL SUPPLY	1.03	0.0	0.38	0.19			
73	TZANEEN/MODJADJISKLOOF	1.70	42.9	2.15	1.27	0.14	100	100
74	THABINA RWS	2.66	60.3	1.58	1.05	2.81		
75	RITAVI II RWS	1.84	40.0	3.96	1.66	2.21	100	100
76	TOURS RWS	2.50	57.4	4.13	2.75			
	TOTAL			**139.41**	**80.33**	**68.03**		

9 WATER BALANCE

9.1 CURRENT WATER BALANCES

There are a large number of sub-systems located within the study area of which most (8 sub-systems) are situated within the Groot Letaba catchment. In the Luvuvhu catchment four sub-systems were defined, although another three water balances were prepared for water services schemes located outside of the catchment, as these will in future be supplied from water resources of the Luvuvhu catchment. In the Klein Letaba catchment the two existing dams, Middle Letaba Dam and Nsami Dam were considered as one sub-system, as they are linked by means of a concrete lined canal to allow support from Middle Letaba Dam to Nsami Dam. Except for the existing Mukumbani Dam in the Mutale catchment, which supplies water to irrigation in the Upper Mutale, there is no other existing dam in the Mutale catchment supplying urban or rural domestic requirements. Most of the rural domestic demands in the Mutale catchment are supplied from river runoff abstractions and groundwater, as well as from transfers from the Luvuvhu catchment.

There are possible dams that were identified in previous studies which can be used in future to supply the Mutale demands, and for this reason a single water balance was prepared for the Greater Mutale system.

The rural domestic demands in the Shingwedzi catchment are to a large extend already supplied from sub-systems in the Luvuvhu and Klein Letaba catchments, in combination with support from local groundwater resources. The water services schemes covering the Shingwedzi catchment are therefore included in the water balances prepared for the relevant sub-systems in the Luvuvhu and Klein Letaba catchments.

Water balances for the purpose of the Luvuvhu-Letaba Reconciliation Strategy were prepared for the following sub-systems:

Groot Letaba Sub-systems

- Dap Naudé Dam
- Ebenezer Dap Naudé sub-system
- Hans Merensky Dam
- Magoebaskloof Vergelegen dams sub-system
- Thabina Dam
- Thapane Dam
- Modjadji Dam
- Groot Letaba River System (Tzaneen Dam & Nwamitwa Dam)

Klein Letaba Sub-systems

- Middle Letaba and Nsami dams sub-system

Luvuvhu sub-systems

- Albasini Dam
- Damani Dam
- Vondo Nandoni dams sub-system
- Sinthumule Kutana RWS scheme
- Matoks RWS scheme
- Airforce base
- Greater Thohoyandou water supply system

Mutale sub-systems

- Greater Mutale system

The water balances take into account the assurance of supply as required by different water use sectors. Water supply to urban/Industrial and rural domestic users is always provided at a higher assurance than water supply to irrigation. For the purpose of the water balances, a 98% assurance was assumed to be applicable to the urban/Industrial and rural domestic sector and a 95% assurance to the irrigation sector. The 98% assurance relates to shortages in supply that will on average be experienced once in 50 years (1 in 50 year) and the 95% assurance for irrigation, to shortages experienced on average once in 20 years (1 in 20 year). There are irrigation schemes where the actual supply to irrigation is well below the 95% assurance due to overutilization of the water resources. In some of these schemes the irrigators were able to adapt to the low assurances, in which case the lower assurance of supply to irrigation was accepted for the purpose of the water balance. This approach was followed as there were insufficient water resources to improve the assurance of supply to irrigation in those areas. Details of the water balances for the main sub-systems are given in **Sections 9.1.1** to **9.1.4**.

9.1.1 Groot Letaba sub-systems

Dap Naudé Water Balance

Dap Naudé Dam is the most upstream dam located in the upper reaches of the Groot Letaba river (Broederstroom tributary of Groot Letaba) in the Drakensberg mountains, and is used to transfer water to Polokwane located outside the study area. Polokwane LM has an allocation of 6.52 million m^3/a from Dap Naudé Dam, which far exceeds the yield available from this dam. This is confirmed by the last 34 years of actual abstractions from this dam, that varied from as low as 2.26 million m^3/a with the highest ever of 5.65 million m^3/a. The average over this period was 4.48 million m^3/a and over the last 10 years reduced to an average of 4.28 million m^3/a.

There is a court order in place that requires releases to be made from Dap Naudé Dam, which seldom happens in practice. The historic firm yield for Dap Naudé Dam was therefore determined for two scenarios, one with the court order releases and the other without. The Historical Firm Yield results were 2.1 million m^3/a and 3.1 million m^3/a respectively. Risk analyses that were carried for Dap Naude Dam considering the scenario with court order releases included, resulted in a 2.7 million m^3/a yield at a 98% assurance (1 in 50 year possibility of a failure) and 3.25 million m^3/a at a low assurance of 90% (1 in 10 year).

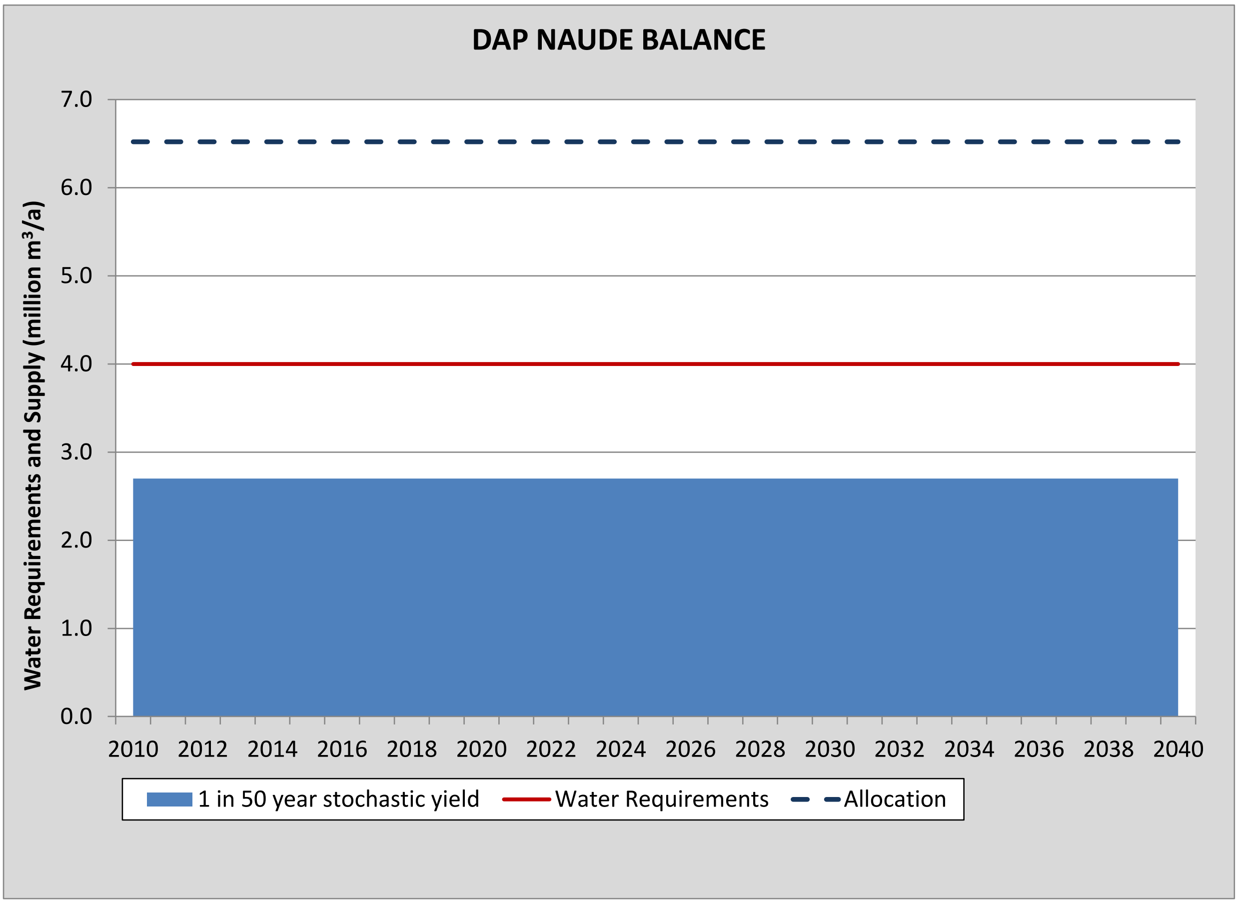


Figure 9.1: Dap Naudé Current Water Balance

This indicates that the average supply of 4.28 million m^3/a, was at a very low assurance. The size of the abstraction imposed on Dap Naudé Dam will play a role in the severity of the impact of the Dap Naude sub-system on the yield available from Ebenezer Dam. For the purpose of the analyses, a demand of 4 million m^3/a was imposed on Dap Naudé Dam, which is in line with the average abstractions for the past 10 years, rather than using the allocation of 6.25 million m^3/a from the dam or the historic firm yield of only 2.1 million m^3/a.

For the purpose of the water balance the 98% (1 in 50 year) assurance yield of 2.7 million m^3/a was used, representing the scenario where the court order releases were included. From the water balance shown in **Figure 9.1** it is clear that both the water allocation and average abstraction over the last 10 years are well above the 98% assured yield.

Ebenezer Dap Naudé sub-system Water Balance

Ebenezer Dam is located on the Broederstroom River downstream of Dap Naudé Dam and supply water to Tzaneen and irrigation located between Ebenezer and Tzaneen Dam, as well as to support Tzaneen Dam in dry periods. Water is also transferred from Ebenezer Dam to the Polokwane LM in support of urban/industrial and rural domestic water requirements.

The 2010 demand imposed on Ebenezer Dam includes a transfer of 16.2 million m^3/annum to Polokwane (average supply over the past 11 years, which is higher than the current allocation of 12 million m^3/a) as well as the support of 2.3 million m^3/a to Tzaneen town and 10.3 million m^3/a for irrigation located between Ebenezer and Tzaneen dams. The 2010 combined demand imposed on Ebenezer Dap Naudé sub-system amounts to 32.7 million m^3/a.

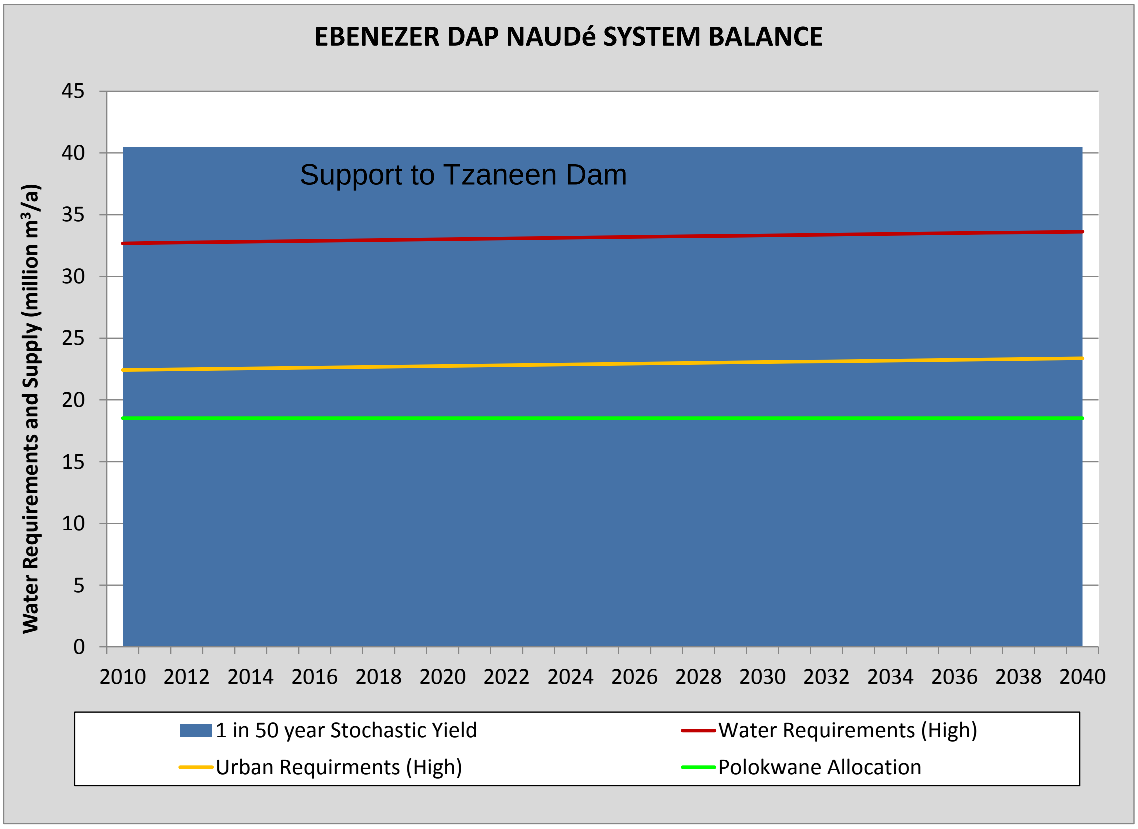


Figure 9.2: Ebenezer Dap Naudé sub-system Current Water Balance

In addition to the abstractions presented above, Ebenezer Dam also supports water to Tzaneen Dam during drought periods when the dam is at low levels. The remaining portion of the water balance is then utilised for support to Tzaneen Dam (see **Figure 9.2**). This was confirmed by the DWS Regional Office system operators and observed from the historical flow records downstream of Ebenezer Dam.

The combined allocation from Ebenezer and Dap Naudé dams to Polokwane LM is 18.52 million m^3/a, which is slightly lower than the 2010 actual transfer volume of 20.2 million m^3/a used in the yield analyses, as well as for the water balances prepared for Dap Naudé and Ebenezer dams.

Hans Merensky Dam Water Balance

The Hans Merensky Dam is located on the Ramadiepa River, which is a tributary of the Groot Letaba River, upstream of Tzaneen Dam. Water is supplied from the Hans Merensky Dam to irrigate agricultural land in the B81B catchment, of which some of the irrigation occurs on properties belonging to Westfalia Estates. The current irrigation demand to be supplied from Hans Merensky Dam amounts to 4.5 million m^3/a.

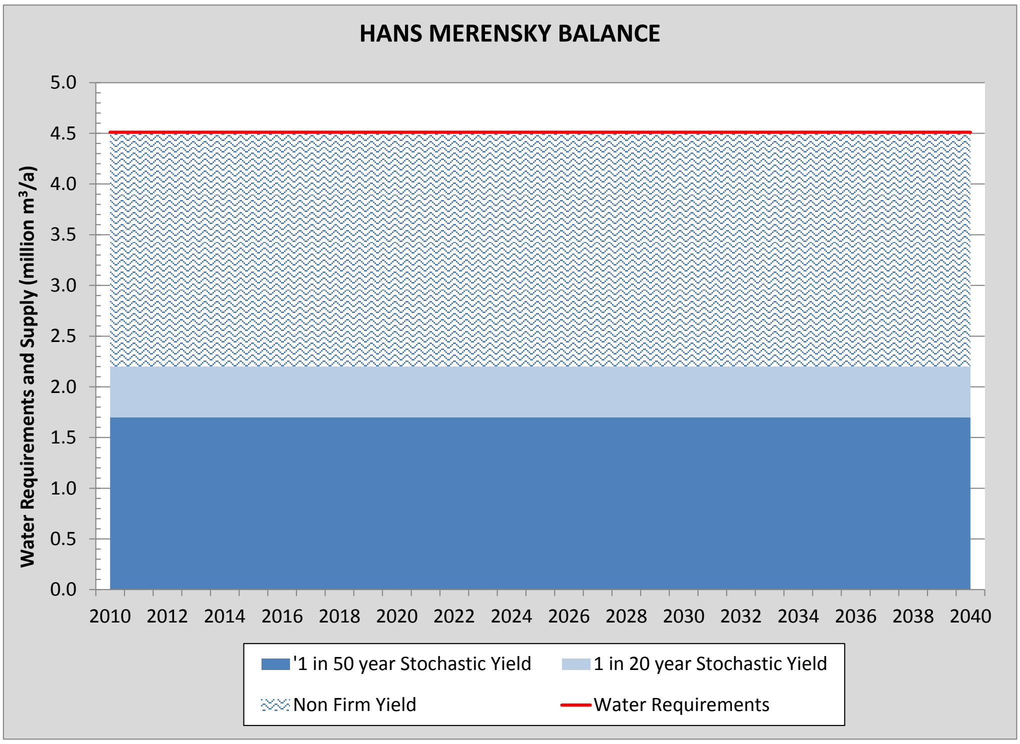


Figure 9.3: Hans Merensky Dam Current Water Balance

Since only irrigation is supplied from this dam, the 1 in 20 year (95% assurance) yield of 2.2 million m^3/a was applied in the water balance. The 1 in 50 year (98% assurance) yield of the dam is 1.7 million m^3/a.

Based on the 1 in 20 year (95% assurance) long term stochastic yield, only 50% of the irrigation requirement can be supplied at a firm yield 95%. The remainder of the irrigation will receive a non firm yield of 2.3 million m^3/a. The water supply from Hans Merensky is therefore similar to the irrigation supply from Tzaneen Dam where only 50% of the irrigation can receive a firm supply of 95% assurance.

Magoebaskloof Vergelegen dams sub-system Water Balance

The Magoebaskloof Dam is located on the Politsi River, which is a tributary of the Groot Letaba River, upstream of the Tzaneen Dam. It supplies the towns of Politsi, Duiwelskloof and Ga-Kgapane with domestic and industrial water. A canal is used to transfer water from the Magoebaskloof Dam to Vergelegen Dam, from where the towns are receiving their water. When Magoebaskloof Dam was built, the intention was to supply irrigation water to the Tzaneen Irrigation Board and Sapekoe Tea Estates. The Vergelegen Dam is mainly a balancing dam for accepting water from the Magoebaskloof Dam, although it receives some inflow from its own catchment. It has a storage capacity of 0.3 million m^3. The water from this sub-system was used to irrigate up to 1 000 ha on the Sapekoe Tea Estate. Currently only a small area is irrigated, utilizing approximately 3.2 million m^3/a. Of the total allocation, 70 ha have been bought by Donald Properties (ZZ2) and 930 ha belong to the Magoeba Tribe, which might exercise their allocation in future for irrigation.

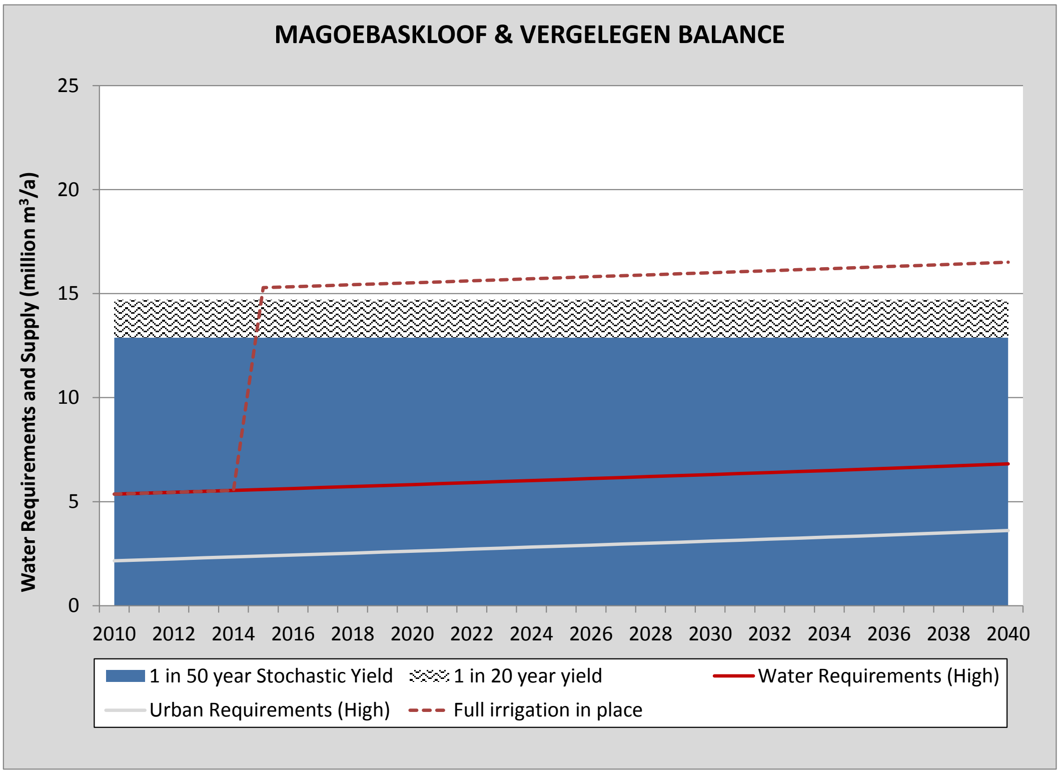


Figure 9.4: Magoebaskloof Vergelegen sub-system Water Balance

The future irrigation demands are difficult to estimate, as it depends on the extent to which the Magoeba Tribe will exercise their allocation for irrigation purposes. For the purpose of the water balances it was assumed that they will take up their full allocation in future. The current irrigation water use is estimated at 3.2 million m^3/a, and will increase to 12.3 million m^3/a when the full irrigation allocation is taken up.

From **Figure 9.4** it is evident that the urban requirements can easily be met at the required 98% assurance. With the full irrigation allocation taken up over time, a small deficit is expected in future, even with some of the irrigation supplied at a lower assurance of 95% (1 in 20 year risk of failure).

<u>**Thabina Dam Water Balance**</u>

Thabina Dam is located in the upper reaches of the Thabina River, a tributary of the Letsitele River which flows into the Groot Letaba River downstream of Tzaneen Dam, and upstream of the proposed Nwamitwa Dam.

Thabina Dam supply water to rural domestic requirements within the Thabina RWS, and the Thabina Irrigation Scheme (the first small-holder Irrigation Scheme to be registered as a Water User Association) which has 200 ha under flood irrigation. At present the water supply to irrigation is restricted to only 69ha (demand of 0.53 million m^3/a) for various reasons, including assurance of supply. This is almost in line with the incremental 95% assurance yield of 0.4 million m^3/a (difference between the 98% and 95% assurance yields), and should be sufficient to support the reduced (current) irrigation.

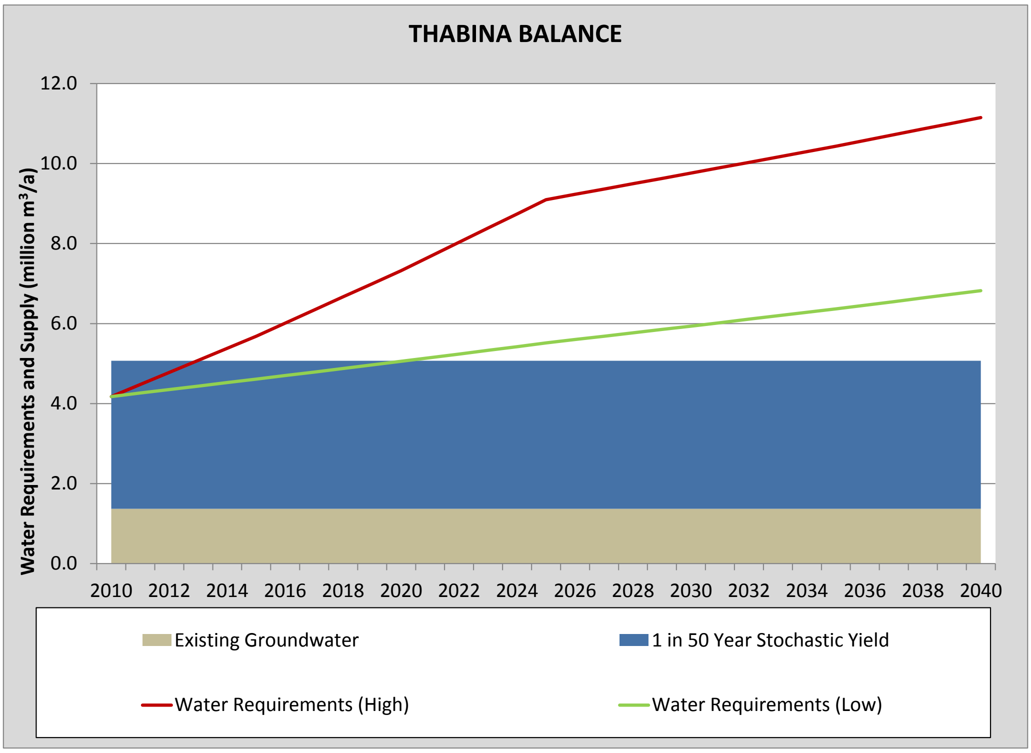


Figure 9.5: Thabina Dam Water Balance

The water balance (**Figure 9.5**) clearly shows that for the high water requirement, intervention is already required by 2013 to avoid shortages in supply. For the low demand projection however, intervention is only required from 2022 onwards.

<u>Thapane Dam Water Balance</u>

Thapane Dam is a relative small dam with a full supply volume of only 1.07 million m^3/a, and supply water to part of the rural domestic requirements in the Thapane RWS.

The dam is located on one of the tributaries in the upper reaches of the Nwandezi River that flows into the Groot Letaba River just upstream of the future Nwamitwa Dam.

Thapane Dam is already over allocated (**Figure 9.6**) and the water balance shows shortages are expected to occur from 2013 onwards.

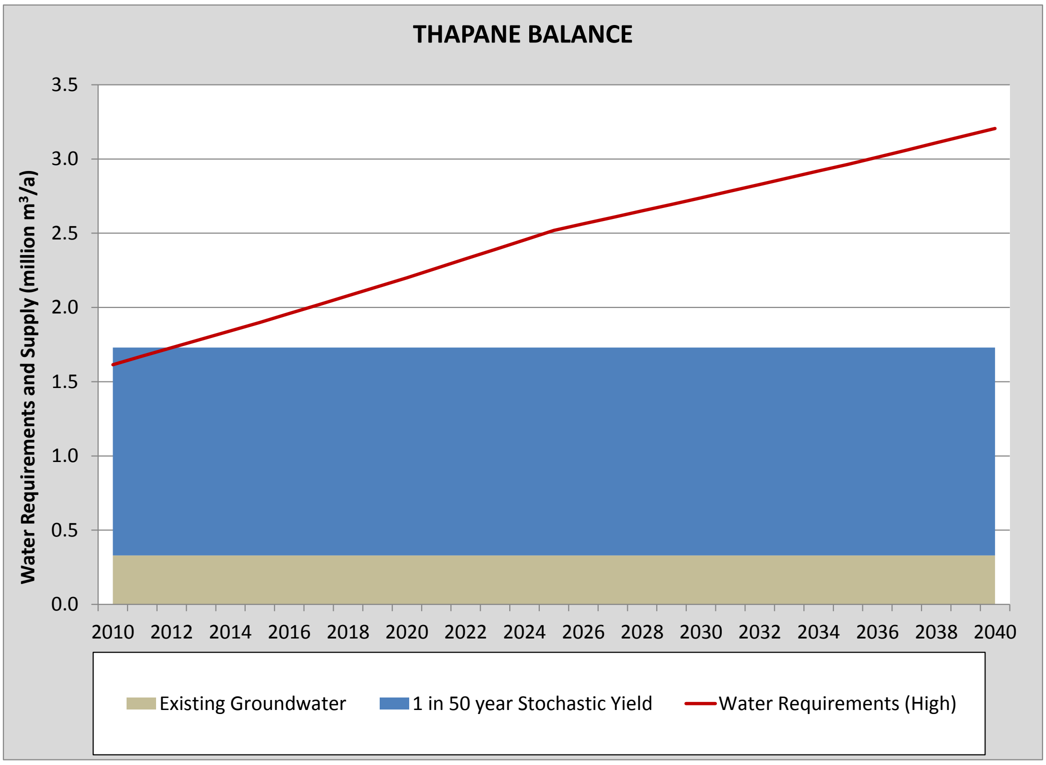


Figure 9.6: Thapane Dam Water Balance

Modjadji Dam Water Balance

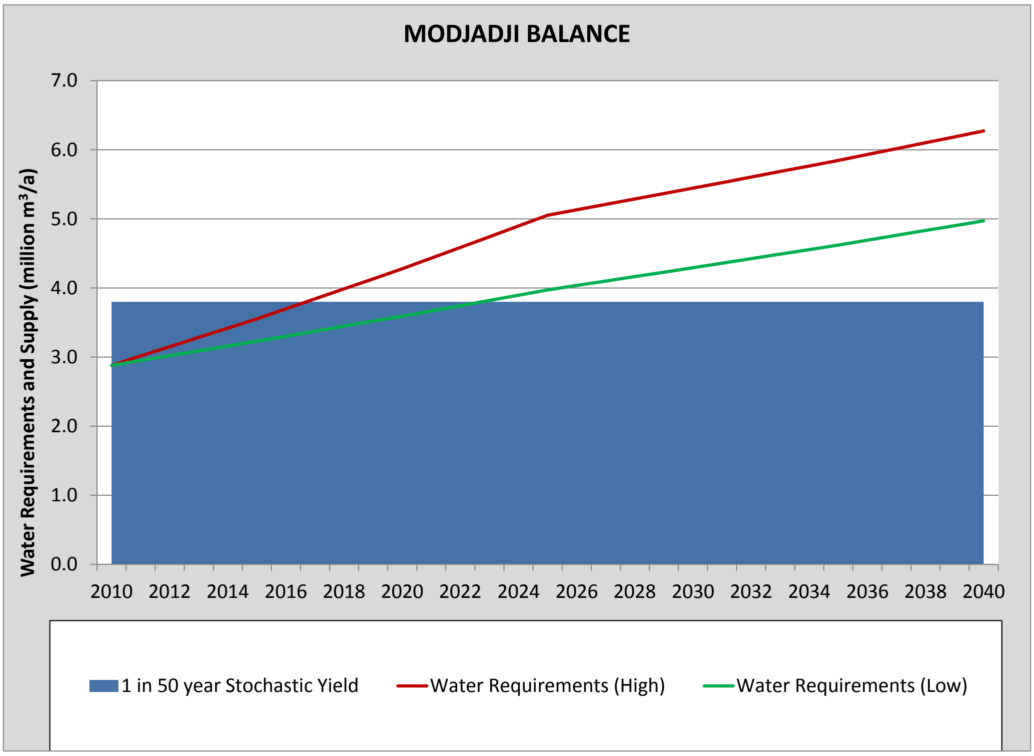


Figure 9.7: Modjadji Dam Water Balance

Modjadji Dam is located in the upper Molototsi River and supply water to rural domestic requirements in the Modjadji RWS

The Modjadji Dam sub-system is almost fully utilised as evident from **Figure 9.7** and will only be able to sustain the high demand until the year 2017.

Groot Letaba River System (Tzaneen Dam)

Tzaneen Dam is currently the main water resource supplying water to the Groot Letaba sub-system that includes a variety of domestic, irrigation and industrial users all along the Groot Letaba River down to the Kruger National Park (KNP), approximately 160 km downstream from the dam.

Several weirs are located in the Groot Letaba River downstream of Tzaneen Dam. These weirs provide balancing storage and are operated by the Groot Letaba WUA. The most downstream weir is the Nondweni Weir from where the flow into the KNP is regulated. DWA Tzaneen office, request the WUA to open or close releases from Nondweni Weir to correctly supply EWR flows to the KNP. The other upstream weirs are the Yamorna Weir, Junction Weir, Jassie Weir and Prieska Weir.

Water for irrigation purposes is abstracted directly from Tzaneen Dam as well as through releases from the dam into the river, where it is abstracted downstream directly from the river and via diversion weirs and canal distributions systems such as the Ledzee Canal, the Letaba North Canal, the N&N Canal system, the Masalal Canal on the right bank of the Great Letaba River which serves a rural community, an emerging farmer irrigation scheme, and commercial farmers downstream.

Tzaneen Dam supplies a number of urban/industrial and rural domestic users directly from the dam and also by means of releases downstream from the dam along the Groot Letaba River. These include the Town of Tzaneen supplied directly from the dam and those downstream of the dam such as the Ritavi/Letaba RWS, Ritavi II RWS and Siluwane-Nondweni Extended RWS, all supplied from the river releases and incremental runoff generated between Tzaneen Dam and the related abstraction points.

It is important to note that the operating rule applied for Ebenezer Dam dictates that when Tzaneen Dam is low (approximately 15% storage), water is released from Ebenezer Dam in support of Tzaneen Dam. Tzaneen and Ebenezer dams are therefore operated as a system and the application of this support is evident from the historical dam balance and flow data.

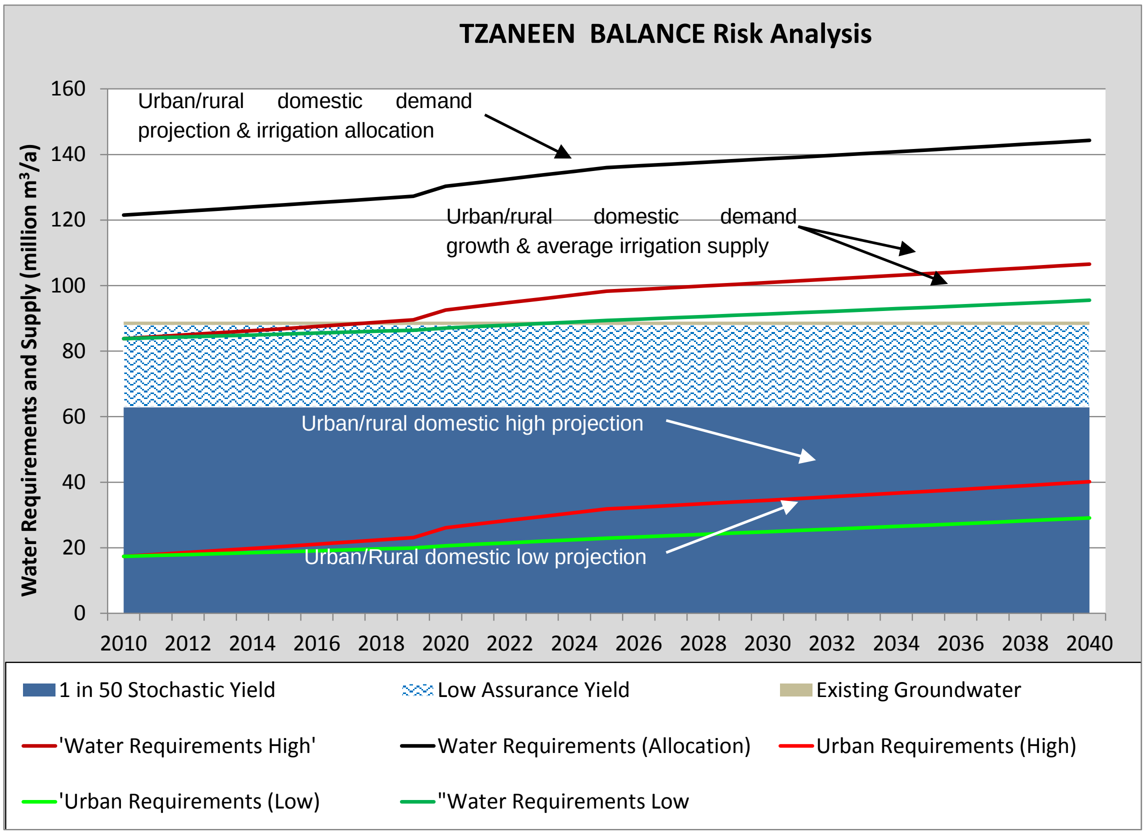


Figure 9.8: Groot Letaba Sub-system Water Balance

The yield shown in **Figure 9.8** includes the support from Ebenezer Dam as explained above.

The water balance of the Groot Letaba Sub-system is presented in **Figure 9.8**, where it is shown that the total water use (based on the full irrigation allocation) of 122 million m^3/annum in the year 2010, by far exceeds the 1 in 50 year yield of 63 million m^3/annum, and even the 1 in 20 year yield of 66 million m^3/a.

The subsystem yield applied in the water balance shown as 89 million m^3/a, was derived based on the average supply to the irrigation plus the other water users when applying the existing drought operating policy, see further discussion below.

The significant shortfall (difference between the water use based on the irrigation allocation and 95% assurance system yield) is managed through a restriction policy or rule where the irrigation abstraction is reduced to protect the urban users in the Groot Letaba Sub-system. Historical water supply data shows the average supply to irrigation was about 62% of their allocation over the past 13 years (e-mail dated 10 October 2013 from J Venter to T Nditwani (DWA,2013c). This was also evident from the simulation analysis carried out with the WRYM. Clearly a balance derived with the allocation is impractical and an alternative approach was followed where the average supply to irrigators was used as the irrigation water requirements, opposed to the total irrigation allocation.

The assumption in this approach is that the irrigation sector has adapted to this supply situation and it will be maintained at these levels in future.

The water requirements represented by the dark red and dark green lines (**Figure 9.8**) therefore include the average supply to irrigation of 66.4 million m^3/a (derived from a reference simulation analysis) (These lines are the total water requirements of all users, where the volume for irrigation is the average supply from the reference simulation analysis).

In the water balance for future years (shown in **Figure 9.8**) the irrigation supply remained unchanged and the increases on the red and green lines represents the expected growth in the urban sector to be supplied from the Groot Letaba System, as shown by the lighter red and green lines.

The results presented above clearly shows there are severe water shortages in the Groot Letaba River sub-system, and Ebenezer Dam must support Tzaneen Dam to achieve the balance situation presented in **Figure 9.8**. The high water requirement scenario (red line) can only be supplied until 2019, when assuming that on average only 62% of the irrigation demand will be supplied.

9.1.2 Klein Letaba sub-systems

The main water resources in the Klein and Middle Letaba catchment are the Middle Letaba Dam, located just upstream of the confluence of the Middle Letaba and Klein Letaba rivers and the Nsami Dam located on the Nsama River, a tributary of the Klein Letaba River near Giyani. These two dams are linked with a canal system that allows Middle Letaba Dam to support Nsami Dam. Users along the canal are also supplied by the releases from Middle Letaba Dam into the canal. This sub-system is currently used mainly to supply water to urban and rural domestic users, as well as a small irrigation component.

The 1987 Middle Letaba Dam design report indicated that the intended domestic supply component from this dam was 11.7 million m^3/a, at a 1 in 50 year assurance and 41 million m^3/a for 4 555 ha of the irrigation at a 1 in 20 year assurance. The 1 in 50 year yield of Middle Letaba Dam on its own was at the time estimated to be 56 million m^3/a. Of the 4 555ha originally foreseen for irrigation, only 2 400ha was finally developed for commercial and sub-sistance farmers. The water requirements for urban/domestic users however grew much faster than anticipated, as villages far to the south of Giyani on the banks of the Groot Letaba River and to the North West in the Luvuvhu River catchment area, were all supplied from the Middle Letaba Dam. By 1998 the urban/domestic demand already reached 15.7 million m^3/a.

The 2010 urban/rural domestic requirement imposed on this system is now at 20.2 million m^3/a, and the irrigation requirement has reduced to only 0.6 million m^3/a. This excludes the Malamulele West rural domestic requirement, which is now supplied from Nandoni Dam in the Luvuvhu River. The significant reduction in the irrigation demand, is amongst others, as result of the low level of water supply assurance. In 1992 and again in 1994/95 the Middle Letaba Dam failed hydrologically and was completely empty.

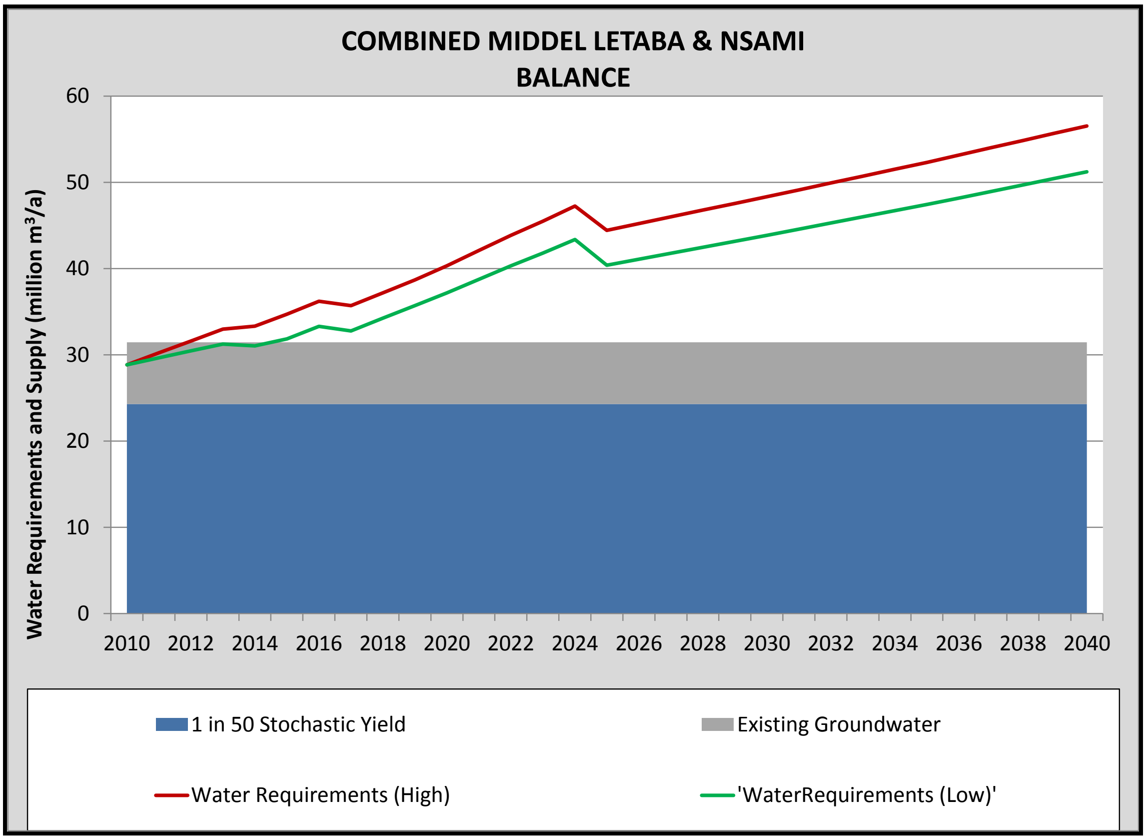


Figure 9.9: Middle Letaba Nsami Sub-system Water Balance

The new hydrology and related yield results from the current Luvuvhu Letaba Reconciliation Strategy study determined the 1 in 50 year Recurrence Interval or 98% assurance yield for the combined Middle Letaba Nsami sub-system to be 24.3 million m^3/a.

The water balance prepared for the Middle Letaba Nsami sub-system based on the latest demand projection and yield calculations is shown in **Figure 9.9.** The demand projection made provision that some of the current areas supplied from Middle Letaba Dam will in future be supplied from Nandoni Dam, resulting in the stepped reductions in the demand projection over time as shown on the balance graph. The water balance shows that even with some areas supplied from Nandoni Dam in future, significant shortages in supply still occur and is expected to start from 2014 onwards with the current combined utilisation of existing groundwater supply systems.

Significant deficits in water supply are expected in future, reaching a deficit of approximately 25 million by 2040 pointing to the need for interventions.

9.1.3 Luvuvhu sub-systems

Nandoni Dam was completed in 2004 while the bulk distribution infrastructure to convey water to the different demand centres is under construction with further extensions in the planning phase. All the sub-systems located within the Luvuvhu catchment as discussed further on in **Section 9.1.3** will be augmented from Nandoni Dam. The areas downstream of Nandoni Dam are already currently supported by means of releases from the dam, as well as the Malamulele West RWS which is supplied from the water treatment works at the dam. The individual water balances for each of these sub-systems indicate they are either already in deficit, or will be in deficit in the near future. The planned support from Nandoni Dam will to a large extent address all these deficits. Details of this are discussed in **Sections 10** and **11**.

Separate Water balances were required for each of these sub-systems, as Nandoni Dam will not necessary address the full deficit in each of them until 2040. Water balances were also prepared and included in this section for the demand centres located outside the study area, but according to current planning, will be supplied from Nandoni Dam in future. This was followed by a combined water balance for the total supply area envisaged to be supported from Nandoni Dam. This need to be done as a check to avoid the over allocation from Nandoni Dam.

Albasini Dam Water Balance

Albasini Dam is located in the headwaters of the Luvuvhu River and was built and commissioned in 1952. A canal system runs from the Albasini Dam, which is the primary canal of the scheme and traverses the government water scheme with the intent to supply irrigators on the left bank of the Luvuvhu River.

Albasini Dam is currently used to supply water to Louis Trichardt (Makhado) as well as to the Albasini Government Water Scheme (irrigation) downstream of Albasini Dam. The allocation to Louis Trichardt (Makhado) is 2.4 million m³/a. The total area under irrigation within the Albasini Government Water Scheme is 1 908ha. Based on a quota of 8 400 m³/ha/a it results in a total requirement of 16.02 million m³/a, excluding canal losses. The Albasini Government Water Scheme is however supplied from four different sources: Albasini Dam and canal, the Levubu Weir and canal, Latonyanda Stream weir and canal, as well as the Barotta Stream weir and canal system. Albasini Dam only supply water to 871ha of this irrigation with a total demand of 7.8 million m³/a.

Significant increases in abstraction over the years upstream of Albasini Dam resulted in a decrease in the yield of the dam. These developments mainly include abstractions for irrigation from farm dams, runoff river abstractions as well as abstractions from groundwater. Since the severe drought in 1983/84 significant shortages in supply to the irrigators supplied from the dam were experienced. These shortages increased over time and occurred more frequently, to such an extent that currently no water is supplied to the irrigators through the canal from Albasini Dam. This was recently experienced for quite some time, as the volume of water in Albasini Dam has consistently been very low for a number of years, and no water has therefore been released from the dam into the Albasini irrigation canals. As result of the reduction in supply from Albasini Dam over times, the irrigation supply area is now largely dependent on groundwater as its main source of water.

The water balance based on the new hydrology and updated demands, as prepared for the Luvuvhu Letaba Reconciliation Strategy Study is given in **Figure 9.10**. Two groundwater components are included in this balance. The one component refers to the groundwater used only for the urban/industrial sector and the other component the groundwater used for irrigation purposes. These two groundwater resources are distinctively different resources, with no impact on each other. The water balance clearly shows the significant deficits experienced in this sub-system and at 2010 development levels it is only possible to supply the urban sector water requirements and approximately 15% of the irrigation requirement from the surface water. Additional yield analyses (scenarios) were carried out for Albasini Dam which showed that for the option where all upstream irrigation is eliminated from the Albasini catchment, the Albasini HFY can increase to as much as 11.8 million m^3/a from the current 1.4 million m^3/a HFY.

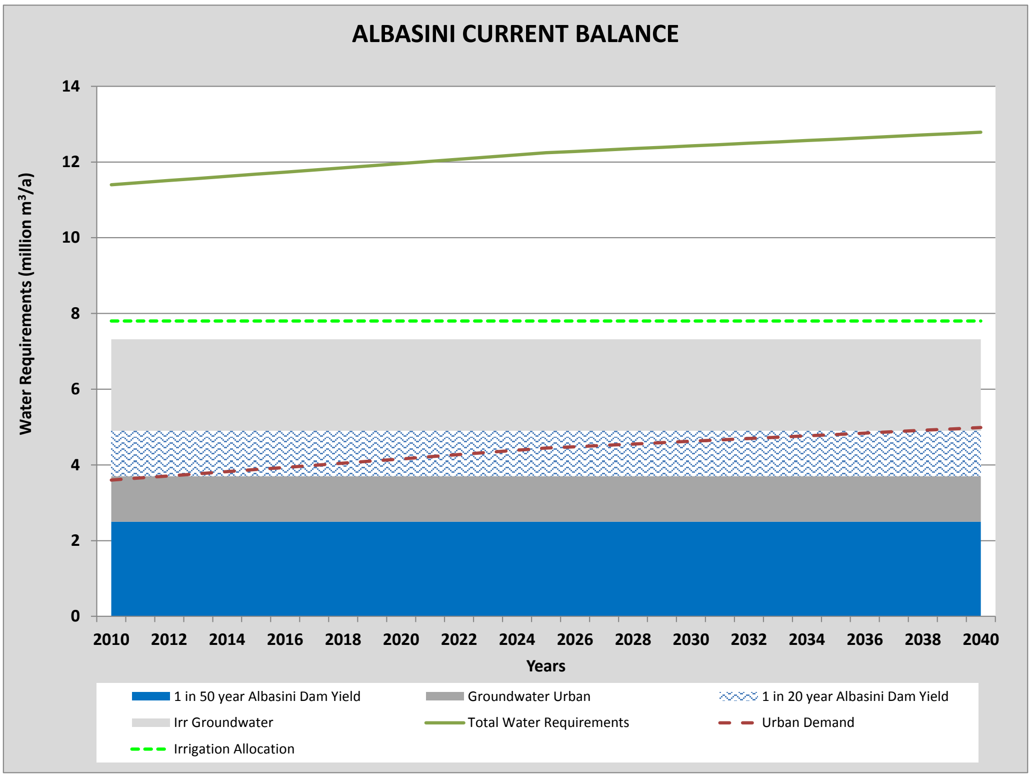


Figure 9.10: Albasini Dam Water Balance

The commercial forestry development upstream is resulting in a decrease in the Albasini HFY of approximately 3 million m^3/a. Based on the yield analysis results it is evident that with no or very limited upstream developments, the Albasini Dam yield would be sufficient to support the current demand imposed on the dam.

Damani Dam Water Balance

Damani Dam is located in the Mbwedi River, a tributary of the Mutshindudi River that flows into the Luvuvhu River close to the Xikundu Weir. The Damani Dam is primarily used to supply rural domestic requirements in the Damani RWS. This Rural Water Scheme stretches partly over the Luvuvhu and partly over the Mutale river catchments. There is also an allocation from Damani Dam for irrigation purposes which amounts to 4 million m^3/a, but is not yet utilised. For the purpose of the balance it was assumed that the irrigation allocation will be taken up from 2016 and fully utilised by 2020.

The increase in the rural domestic requirement is substantial and even with no irrigation requirements imposed on the dam, Damani Dam will only be able to sustain the domestic requirement until 2020. Deficits in this sub-system can however occur much earlier, depending on the rate of development of irrigation. By 2040 the deficit in this sub-system is expected to increase to over 7 million m^3/a when the full irrigation allocation is taken up.

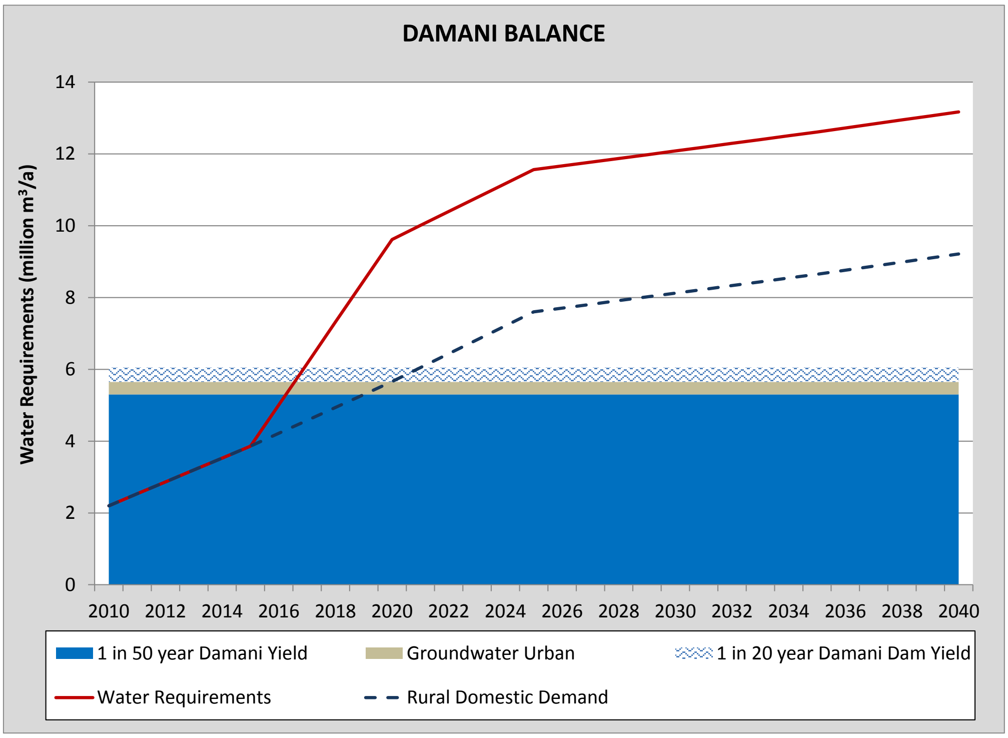


Figure 9.11: Damani Dam Water Balance

Water Balance for the Greater Thohoyandou water supply system

The Greater Thohoyandou water supply area is supplied from the following water resources. Note that the augmentation from Nandoni Dam was excluded from the current perspective and is treated as an intervention as discussed in **Section 11.4.3**:

- Vondo Dam initially as the main resource
- Tshakuma Dam
- Dzindi and Dzingae river runoff package plants
- Phiphidi Dam
- Groundwater sources.

The area supplied includes the following water services schemes, Vondo Central RWS, Vondo East RWS, Vondo North RWS, Vondo South RWS, Tshakuma RWS and Malamulele West RWS.

There is an allocation of 2.8 million m^3/a for irrigation from Vondo Dam, which was not utilized in 2010, but was since taken up again and fully utilised by 2012/13.

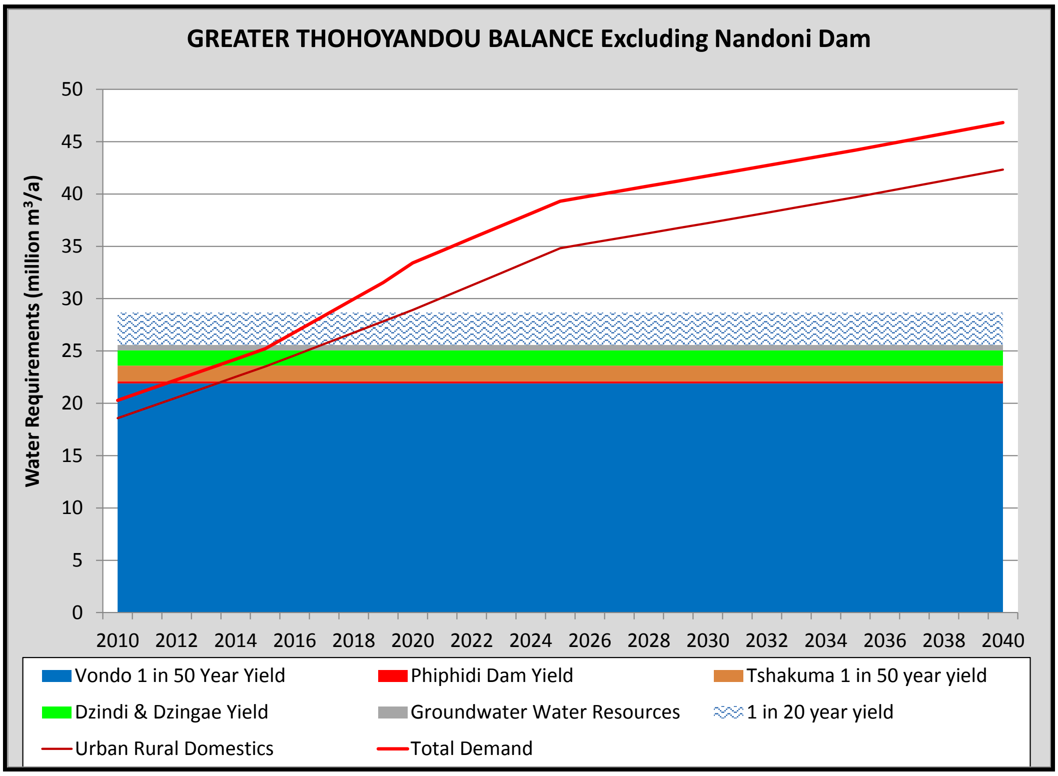


Figure 9.12: Greater Thohoyandou Water Balance

The water balance for this sub-system is given in **Figure 9.12** and shows that deficits is expected to occur from 2018 onwards. The deficit in this sub-system will increase to almost 20 million m^3/a by 2040 if no interventions are introduced.

Water Balances for small sub-systems outside the study area to be supplied from Nandoni Dam in future

These sub-systems are currently mainly supplied from groundwater resources, but will in future also be supported from Nandoni Dam. The following water services schemes are included:

- Sinthumule Kutana RWS
- Military Airforce Base near Louis Trichardt (Makhado)
- Botlokwa GWS
- Ramakgopa GWS
- Nthabiseng GWS

The last three groundwater schemes are also referred to as the Matoks area and will be combined in one water balance.

The Sinthumule Kutana RWS currently only receives water from groundwater which is capable of supplying only 0.94 million m^3/a of the total 2010 demand of 3.38 million m^3/a.

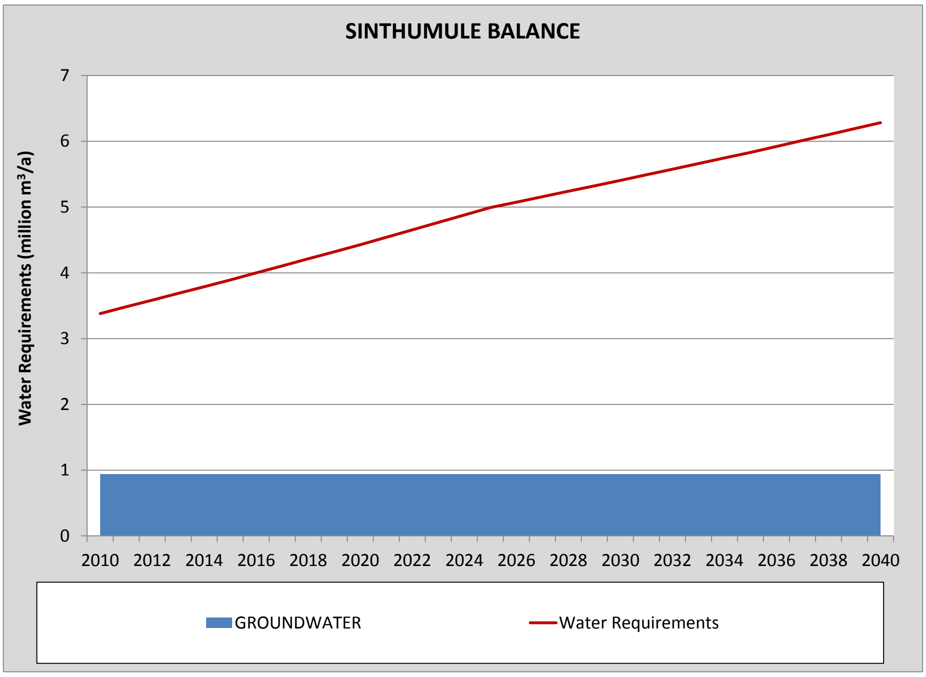


Figure 9.13: Sinthumule Kutana Water Balance

The large deficit for current and future development levels in the Sinthumule Kutana RWS is clearly evident from the water balance showed in **Figure 9.13**.

The Air Force Military Base near Louis Trichardt currently receives water from groundwater resources and only 0.28 million m^3/a, of the 0.58 million m^3/a demand can be supplied from the existing groundwater resources. The water balance is given in **Figure 9.14**.

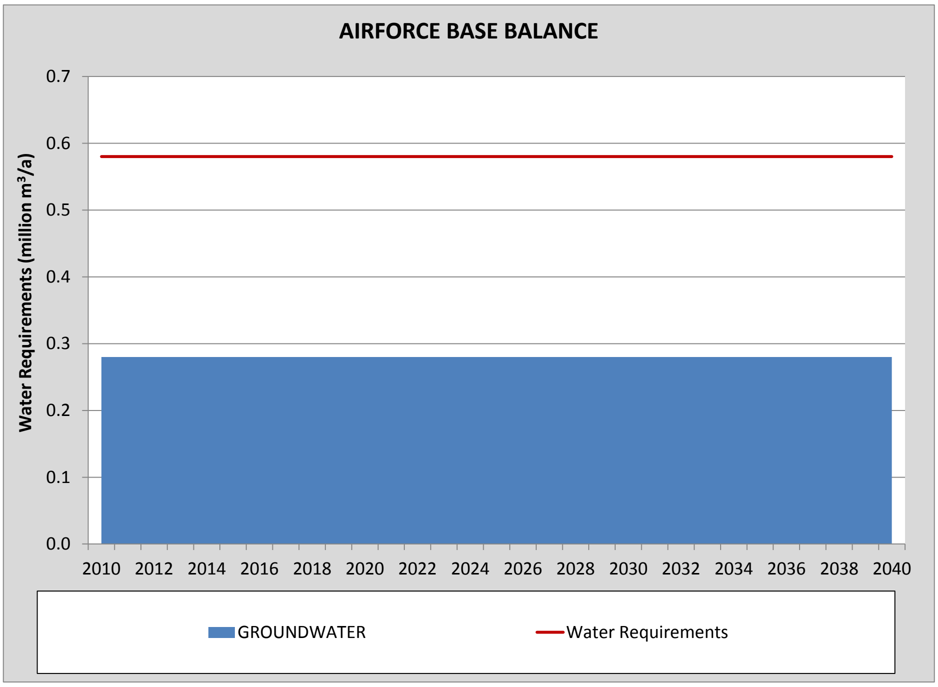


Figure 9.14: Air Force base Water Balance

Matoks is located in the Molemole LM in the Sand River catchment and includes the Botlokwa, Ramakgopa and Nthabiseng groundwater schemes.

Matoks receives only 0.7 million m^3/a from current groundwater resources. The 2010 demand is estimated at just over 3 million m^3/a, and is expected to increase significantly to over 9 million m^3/a by 2040.

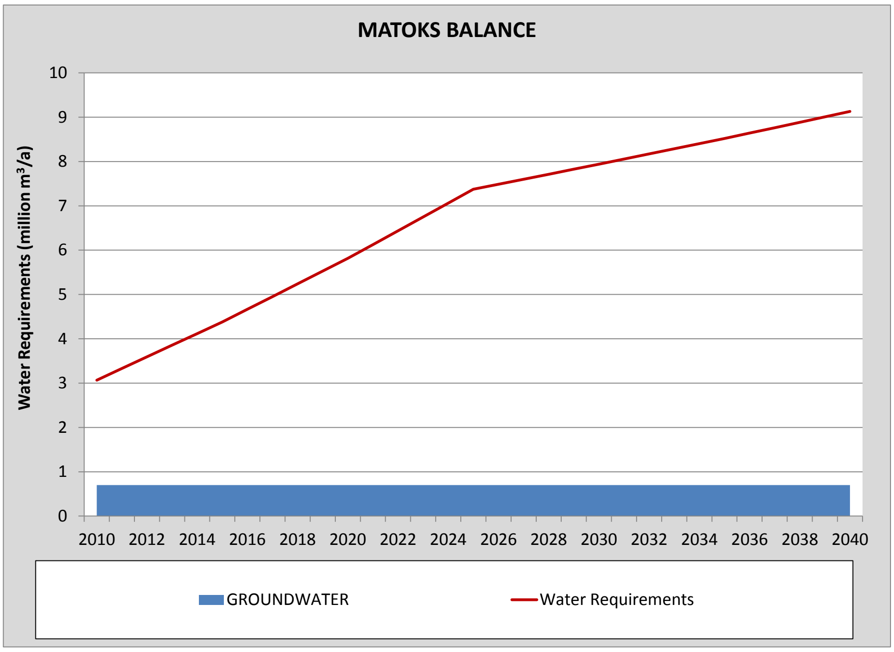


Figure 9.15: Matoks Water Balance

Although the total demand for each of these water services schemes is relatively small, the percentage deficit experienced in each of them is severe.

Water Balance for the entire Vondo Nandoni sub-system

The Greater Thohoyandou water supply area forms the main hub of the entire Vondo Nandoni sub-system. Nandoni Dam, the largest surface water resource in this catchment, is now forming part of the existing resources to this area, which is made possible by the bulk conveyance infrastructure distributing water into the Greater Thohoyandou water supply area. The demand centres or water services schemes currently supported by Nandoni Dam are still limited, but it is expected to increase significantly in the near future. As new water services schemes are linked to the supply network, significant increases in the demand is evident as can be seen from the demand projection shown in the water balance in **Figure 9.16**.

These increases in the demand due to water services schemes that is added or linked to Nandoni Dam, is based on already agreed allocations to each of these water services schemes and includes the 5 million m^3/a future transfer to Giyani. This means that the full growth in demand in each of these schemes is not necessarily met from Nandoni Dam (only the agreed allocation) and deficits can still occur in these schemes over time. There is no clear information available on the dates when these schemes will be phased in and it was assumed that the first group of schemes will be operational by 2017, the second group by 2025 and the last by 2031.

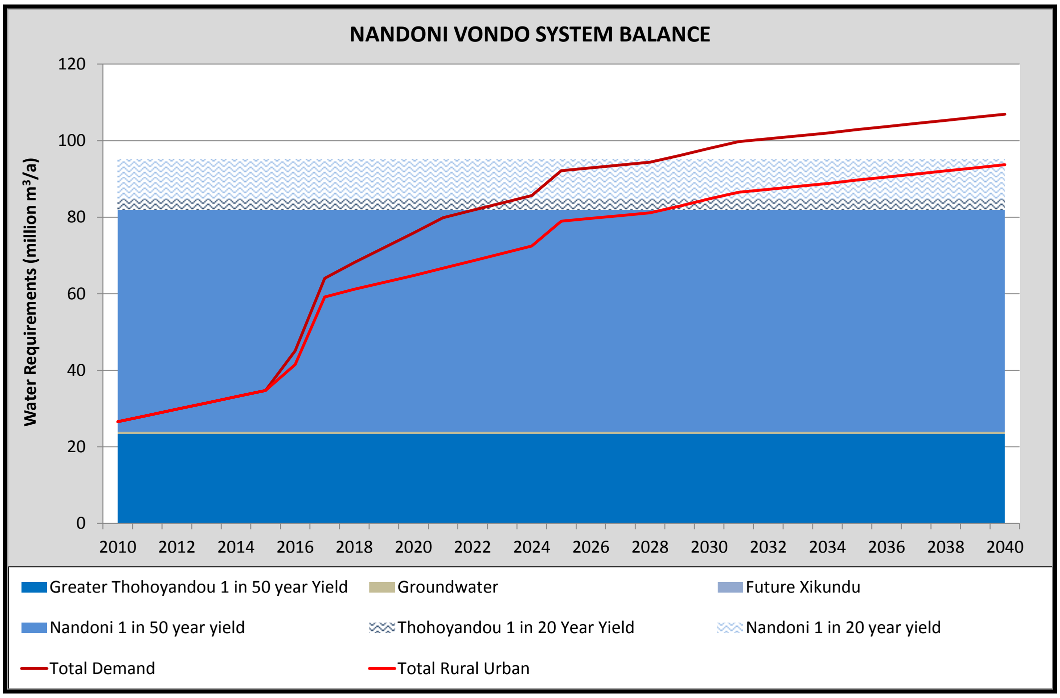


Figure 9.16: Entire Vondo Nandoni supply sub-system Water Balance

The full growth of the demands within the Greater Thohoyandou sub-system as well as for the water services schemes located downstream of Nandoni Dam, are included in the demand projection given in **Figure 9.16**. This demand projection include the following water services schemes of which the full growth will be supported from Nandoni Dam, as well as from the greater Thohoyandou existing resources, where applicable.

- Malamulele West RWS
- Tshakhuma RWS
- Vondo Central RWS
- Vondo East RWS
- Vondo North Rural RWS
- Vondo South RWS
- South Malamulele East RWS
- Lambani RWS
- North Malamulele East RWS
- Tshifudi RWS

In the given demand projection, the irrigation demand allocation from Vondo Dam was included and those from Nandoni Dam were phased in from 2016 and fully utilised by 2021. The EWRs were assumed to be in place from 2010 onwards, and is included in the yield results.

Based on the above mentioned assumptions, it is evident from **Figure 9.16** that the Vondo Nandoni sub-system will already be over allocated from 2030 onwards. This date will change depending on the final timing of the inclusion of the different demand centres, and the rate at which the irrigation developments will take place in reality.

9.1.4 Mutale River catchment sub-systems

The only existing storage dam of significance located in the Mutale catchment is the Mukumbani Dam, located in the upper reaches of the Tshirovha River. This dam supply water to the Mukumbani Tea Estate.

The Vondo North Rural RWS and the Damani RWS are both located partly in the Mutale and partly in the Luvuvhu catchment. These two water services schemes are supplied with water from Vondo and Damani dams respectively, which are both located in the Luvuvhu River catchment.

The remainder of the Rural Water Supply Schemes within the Mutale basin are supplied from the Mutale River and its tributaries as well as from groundwater resources on an almost 50-50 basis.

The water balance prepared for the Mutale catchment includes the following water services schemes:

- Mutale Main RWS
- Mutale Mukuya RWS
- Masisi RWS
- Luphephe/Nwandezi Main RWS

The Damani RWS and Vondo North Rural RWS were excluded from Mutale catchment water balance, as they both form part of the water balances prepared for the Luvuvhu River catchment. The mining water requirements for Tshikondeni Coal mine was included in the total demand projection and it was assumed the mining requirements remain the same over the planning period. The water balance as described above for the Mutale sub-system is given in **Figure 9.17**.

Since surface water use is mainly depended on river runoff abstractions, there is no clear indication of the yield and related assurance from these abstractions. For the purpose of the balance the current use from surface water resources was taken as the non-firm yield available. The current groundwater yield was derived from the current equipped boreholes.

Based on the water balance given in **Figure 9.17**, deficits in supply will start to occur from 2016 onwards. It is important to note that this water balance used a non-firm yield component, which is not acceptable for urban and rural domestic supply purposes. In terms of an acceptable firm yield at 98% assurance, deficits most probably already occur at 2010.

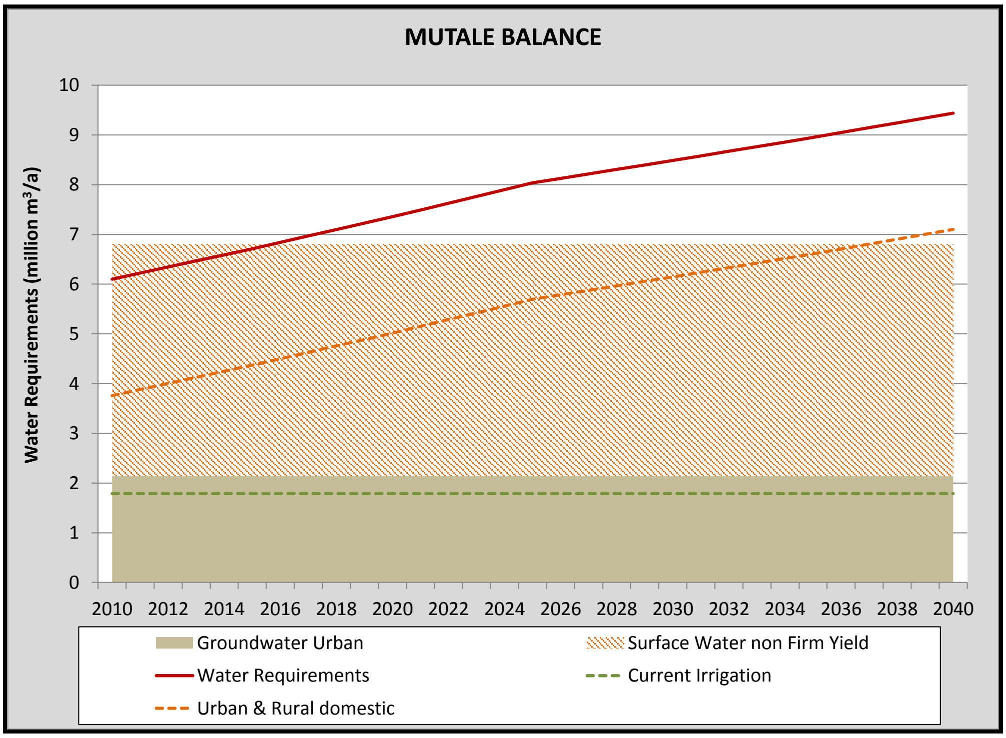


Figure 9.17: Mutale sub-system Water Balance

10 POSSIBLE INTERVENTION OPTIONS

Intervention options comprise the implementation of various combinations of reconciliation options over time and can be divided into two main categories of intervention options:

- Reconciliation options used to reduce the water requirements
- Reconciliation options that will increase the yield available from the existing water resources and includes surface as well as groundwater resources

10.1 RECONCILIATION OPTIONS THAT WILL REDUCE WATER USE

10.1.1 Water Conservation and Water Demand Management (WC/WDM) in the urban and rural domestic sector

Water conservation and water demand management (WC/WDM) has been identified as a strategic intervention that is essential to maintain a positive water balance in Luvuvhu and Letaba systems. This section provides a summary of the information documented in a separate study report that describes the potential for WC/WDM in the Urban Sector.

The focus of this component of the study was to develop a high level WC/WDM strategy and business plan for the Water Services Authorities that are supplied from the Luvuvhu and Letaba systems, as shown in **Table 10.1**.

Table 10.1: List of district and local municipalities evaluated in the study

Municipal Code	Municipality	Category	WSA
DC33	Mopani DM	C2	Yes
LIM331	Greater Giyani	B4	No
LIM332	Greater Letaba	B4	No
LIM333	Greater Tzaneen	B4	No
LIM334	Ba-Phalaborwa	B3	No
LIM335	Maruleng	B4	No
DC34	Vhembe DM	C2	Yes
LIM341	Musina	B3	No
LIM342	Mutale	B4	No
LIM343	Thulamela	B4	No
LIM344	Makhado	B4	No
DC35	Capricorn DM	C2	Yes
LIM354	Polokwane	B1	Yes

Notes: (1) The WSA column indicates whether or not the respective municipalities (local or district) are a Water Services Authority.
(2) The Category column identifies the municipality in accordance to population size

The WC/WDM assessment encompasses a review of the status quo and progress made with WC/WDM and the focus was on the following key aspects. (The reader is referred to the supporting report for more detail information.)

The Level of services (LOS) is applied as a measure to evaluate the standard of water services provided based on the population served by the WSAs and Water Service Providers (WSPs) to the respective communities, the information was taken from DWA: Free Basic Water reports and summarised in **Table 10.2**.

Water Services Audits were prepared based on information from the Ministerial None Revenue Water (NRW) assessments, augmented with other information sources, as well as modified to cover all the requirements of such audits. A database was populated with the basic information required to prepare the IWA (International Water Association) water balances for each municipality.

Where there was limited information available, estimates were made in order to complete the water audit for all ten municipalities within the WSAs listed above.

Based on the results it is apparent that non-revenue water challenges facing Vhembe and Mopani DM are similar in many respects to problems experienced by many other municipalities throughout South Africa. Payment for services is very low in the study area, and the consumers that are able to pay for services can maintain their domestic water supply systems. In the rural and low-income areas, however, many consumers who cannot afford to pay for their water, rely mostly on the free basic water allowances.

Table 10.2: Level of Services Profile based on population numbers for the Municipalities

Municipality	Above RDP Level Served	RDP Level Served	Below RDP Level Served	Total Population Served	Total Household Served
Mopani DM					
Greater Giyani	111 579	19 415	35 270	116 264	39 362
Greater Letaba	100 141	94 711	24 139	218 991	53 179
Greater Tzaneen	178 140	105 144	59 632	342 916	84 444
Ba-Phalaborwa	83 809	13 270	0	97 178	24 546
Maruleng	62 046	29 111	0	91 157	20 412
Sub-total	535 715	261 651	119 041	866 506	221 943
Vhembe DM					
Musina	34 972	5 356	0	40 328	12 694
Mutale	42 129	5 319	0	47 448	13 196
Thulamela	301 204	2 800	85 502	389 506	90 629
Makhado	268 255	78 625	59 471	406 351	96 062
Sub-total	646 560	92 100	144 973	883 633	212 581
Capricorn DM					
Polokwane	105 267	31 893	1 346	527 520	139 152
Total	1 287 542	385 644	265 360	2 277 659	573 676

The standard IWA Non Revenue Water Balance template was utilised to capture and calculate the water balances for each of the District Municipalities (WSAs), the results and key performance indicators are summarised in **Table 10.3** below.

Table 10.3: Summary of key performance indicators

Indicator	Vhembe DM	Mopani DM	Polokwane LM
Annual input volume (million m^3/a)	61.39	109.10	20.4
Daily input volume (Mℓ/d)	168	298	55
Population	1 179 296	1 247 491	631 318
Number of households	270 352	282 863	135 159
% Non-revenue water	<55%	<58%	45%
ℓ / capita / day	104	223	150
m^3 / household / month	19	28	19

Table 10.3 shows that the average water consumption is within the acceptable range, but non-revenue water is very high and it is expected that the water use is currently curbed by the poor supply (intermittent supply) in some areas. The results are based on estimates (in many instances no metered data is available) and the municipalities urgently need to address the poor management information.

In order to address water challenges in the study area, many WC/WDM interventions can be considered. Each municipality has its own unique problems to some extent, although the main underlying issues are often similar. Before deciding on how to address the problems, it is first necessary to understand them. To this end, an overview of all possible WC/WDM interventions is necessary so that potential measures can be assessed. A full WC/WDM strategy would normally include a wide range of interventions tailored to the specific problems identified in each area. The interventions would then be prioritised in such a manner that the maximum savings can be achieved for the minimum expense, and the implementation would be scheduled accordingly.

The potential impact of WCWDM on the future water requirements of Vhembe DM and its target water balance are shown in **Figure 10.1** and for Mopani DM in **Figure 10.2**.

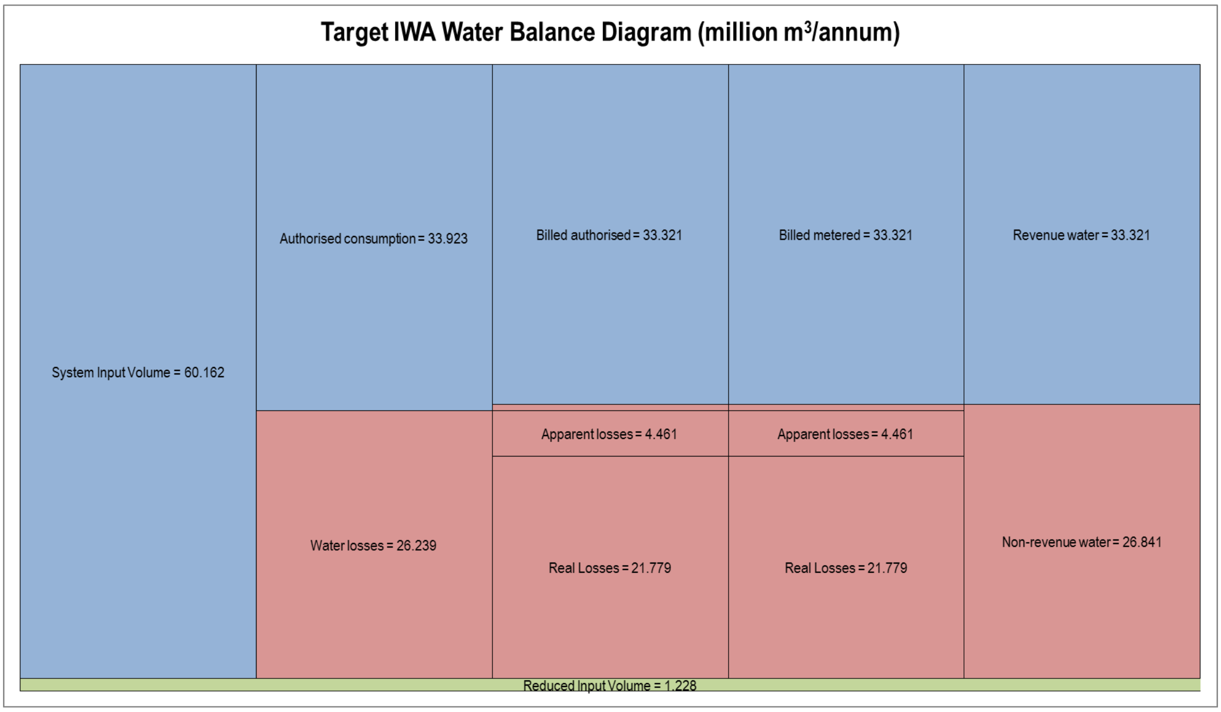


Figure 10.1: Vhembe DM target water balance diagram

The potential savings that can be achieved through the implementation of WC/WDM measures were estimated and are summarised in **Table 10.4**.

Possible savings are in general low and will mainly be achieved in the urban areas where the average consumption is very high and there is scope for reduction, which is expected to reduce the total demand and non-revenue water. In the rural areas intermittent supply with limited cost recovery is typically found and consumers also revert to illegal connections to obtain water.

The average consumption in these rural areas is in general within the acceptable range, but there is huge uneven distribution of supply. Any reduction is water use in some of the sub-areas, will be redistributed with limited or no reduction in the total demand.

The savings were phased in over a five year period for the purposes of the water balances.

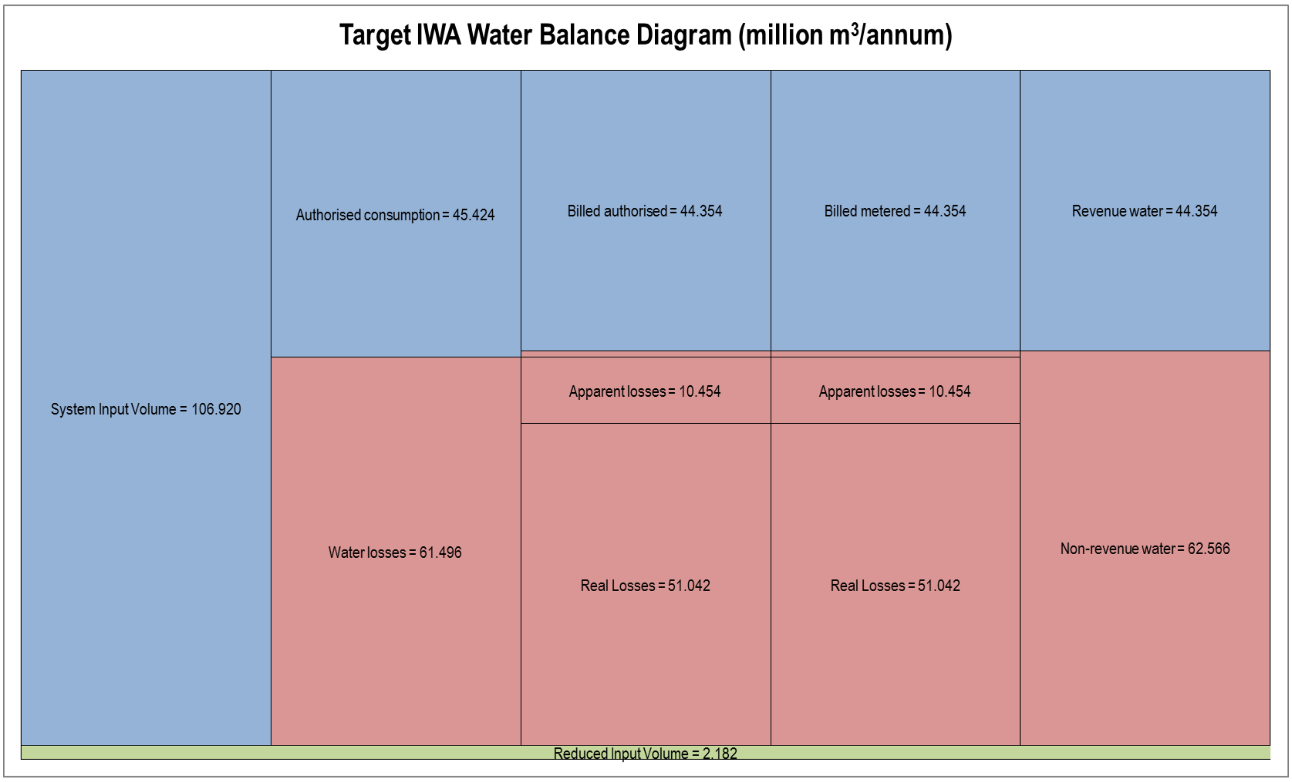


Figure 10.2: Mopane DM target water balance diagram

Table 10.4: Summary of target water savings

Town or Water Services Scheme	Percentage Reduction	Reduction (million m³/a)	2015 Demand (million m³/a)
Middle and Klein Letaba			
Elim / Vleifontein RWS	5%	0.194	3.883
Total Giyani System	10%	1.283	12.774
Total Middle Letaba RWS	9%	0.834	9.246
Total Middle Letaba & Nsami Supply Area	**9%**	**2.389**	**25.903**
Groot Letaba			
Haenertsburg	5%	0.031	0.611
Tzaneen Town	5%	0.154	3.087
Total Modjadji supply area	14%	0.489	3.554
Ritavi / Letaba RWS	5%	0.163	2.973
Ritavi II RWS	5%	0.591	11.820
Siluwane - Nondweni Extended RWS	16%	0.087	0.551
Thabina RWS	5%	0.284	5.684
Magoebaskloof Vergelegen Dam supply area	14%	0.334	2.388
Total Groot Letaba	**7%**	**2.134**	**30.667**

Town or Water Services Scheme	Percentage Reduction	Reduction (million m^3/a)	2015 Demand (million m^3/a)
Luvuvhu			
Makhado	20%	0.776	3.8780
Greater Thohoyandou (Malamulele West,Vondo & Tshakhuma RWS's)	5%	1.187	23.7497
South Malamulele East RWS	5%	0.257	5.1424
Xikundu & Minga Weirs supply area	5%	0.300	6.0075
Damani RWS	5%	0.193	3.8581
Nandoni future supply areas			
Valdezia, Luvuvbu CBD & Tshitale	5%	0.073	1.467
Total Sinthumele / Kutama minus WC/WDM	5%	0.195	3.8912
Total from Matoks minus WC/WDM	5%	0.219	4.3797
Total Luvuvhu	**6%**	**3.200**	**52.3732**
Mutale			
Total from Mutale Main minus WC/WDM	20%	0.506	2.5319
Total from Mutale Mukuya minus WC/WDM	20%	0.065	0.3273
Total from Masisi minus WC/WDM	20%	0.115	0.5733
Total from Luphephe / Nwanedzi minus WC/WDM	20%	0.188	0.9390
Total Mutale	**20%**	**0.874**	**4.3716**
Total study Area	**8%**	**8.598**	**113.315**

10.1.2 Middle Letaba Nsami Canal Losses reduction

The study (DWAF,2003) "Reconnaissance Study to Augment the Water Resources of the Klein Letaba and Middle Letaba River Catchments" completed in 2003 evaluated several dams sites, groundwater resources as well as management options to address the lack in water supply within the Middle Letaba Nsami Dam supply area.

One of the recommendations from the study was the reduction of the high losses in the Middle Letaba Nsami canal by replacing the canal with a pipeline. It was estimated that this will save approximately 4 million m^3/a, that can be utilised for urban/rural domestic or irrigation purposes.

The URV for this option is fairly low at 1.24 at 8% discount rate and was incorporated as a low cost intervention in the reconciliation scenarios.

10.1.3 Water Conservation and Water Demand Management (WC/WDM) in the Irrigation Sector

As indicated in **Section 6.2**, the very low assurance of supply for the irrigation sector has resulted in exceptional initiatives in the industry to maximise efficient use of the reducing water resources. The implementation of recommendations made, in the various studies on WC/WDM in the Luvuvhu and Letaba systems, on ways to reduce losses and improve irrigation efficiencies, may result in marginal "savings" but inevitably this "saved" water will be utilized within the irrigation sector to make up the deficits that are regularly experienced due to the low assurance of supply.

It is therefore recommended that no irrigation water savings, through potential WC/WDM initiatives, should be included in the reconciliation options under consideration.

10.2 RECONCILIATION OPTIONS THAT WILL INCREASE WATER SUPPLY

10.2.1 Groundwater Development

Groundwater resources is playing an important role in this study area and it is estimated that the current water use is in the order of 160 million m^3/a at 2010 development level. The Harvest Potential for the study area is estimated at 271 million m^3/a, and translates to a groundwater exploitation potential of just above 180 million m^3/a.

The potability of groundwater will also impact on the exploitation potential for potable use. A potability factor was applied to reduce the exploitation potential to the potable exploitation potential volume of 141 million m^3/a as shown in **Table 10.5**. The potable exploitation potential based on the GRAII data base are in most cases providing higher estimates and was included in the comparison with the 2010 demands supported from groundwater.

Table 10.5: The groundwater potable exploitation potential and current use per quaternary catchment

Groundwater Utilisation	Colour Code	% of Potable exploitation potential used
Over utilised		> 100%
Heavily utilised		70 to 100 %
Significantly Utilised		50 to 69%
Moderately utilised		40 to 49%
Lightly utilised		30 to 39%
Under utilised		0.1 to 29%
Not utilised		0%

Quat	Potable Exploitation Potential (million m^3/a)	Potable modified GRAII Exploitation Potential (million m^3/a)	Irrigation requirement (million m^3/a)	Urban/Rural Water requirement (million m^3/a)	% utilised in 2010	
					DWA	GRA II
A91A	1.98	5.44	8.99	0.15	462%	168%
A91B	3.05	4.05	7.9	0.32	270%	203%
A91C	2.93	8.85	28.47	0.54	990%	328%
A91D	1.08	10.26	6.88	0.08	644%	68%
A91E	1.93	10.73	0	0.16	8%	1%
A91F	4.01	5.84	0	0.27	7%	5%
A91G	2.31	26.53	0	0.28	12%	1%
A91H	2.58	7.75	0	0.52	20%	7%
A91J	2.13	4.52	0	0.04	2%	1%
A91K	4.63	2.43	0	0	0%	0%
A92A	1.93	24.52	0	0.2	10%	1%
A92B	3.27	18.67	0	0.17	5%	1%
A92C	1.53	6.24	0	0.36	24%	6%
A92D	1.7	3.33	0	0.56	33%	17%
B81A	1.36	9.9	0.15	0	11%	2%
B81B	5.4	22.87	2.64	0	49%	12%
B81C	1.43	2.2	5.47	0	383%	249%
B81D	5.19	9.51	1.13	3	80%	43%
B81E	5.33	9.37	22.7	0.14	429%	244%
B81F	9.82	9.97	12.46	0.73	134%	132%
B81G	3.08	4.95	5.06	0.5	181%	112%
B81H	4.32	3.74	2.62	1.2	88%	102%
B81J	2.96	3.43	0	0.12	4%	3%
B82A	3.74	5.67	1.48	0.19	45%	29%
B82B	3.65	6.54	20.31	0.38	567%	316%
B82C	3.33	5.08	11	0	330%	217%
B82D	6.85	5.33	0.52	1.28	26%	34%
B82E	3	3.05	1.45	0.24	56%	55%
B82F	7.23	7.78	1.43	1.73	44%	41%
B82G	6.6	6.07	0.6	1.67	34%	37%
B82H	4.16	3.57	0.16	0.46	15%	17%
B82J	2.5	4.23	0	0.13	5%	3%
B83A	7.4	12.21	0	0	0%	0%
B83B	2.35	6.02	0	0	0%	0%
B83C	3.14	6.79	0	0	0%	0%
B83D	4.65	8.66	0	0	0%	0%
B83E	1.49	2.22	0	0	0%	0%
B90A	3.01	4.11	0	0	0%	0%
B90B	4.05	4.76	0	0.06	1%	1%

Quat	Potable Exploitation Potential (million m³/a)	Potable modified GRAII Exploitation Potential (million m³/a)	Irrigation requirement (million m³/a)	Urban/Rural Water requirement (million m³/a)	% utilised in 2010	
					DWA	GRA II
B90C	2.7	2.93	0	0.07	3%	2%
B90D	2.44	3	0	0	0%	0%
B90E	1.8	2.43	0	0	0%	0%
B90F	3.05	3.34	0	0.36	12%	11%
B90G	3.02	5.51	0	0.03	1%	1%
B90H	4.34	9.13	0	0	0%	0%
Total	**158.47**	**333.52**	**141.42**	**15.94**	**99%**	**47%**

For the Letaba system, a groundwater abstraction of 80 million m³/a reduces runoff from 753 million m³/a to 727 million m³/a, with the most heavily impacted region being the Middle Letaba in catchments B82B and B82C, where runoff has been decreased by nearly 40%. In the Luvuvhu system a groundwater abstraction of 52 million m³/a reduces the MAR from 578 million m³/a to 538 million m³/a, with the upper Luvuvhu, A91A-C being the most heavily impacted with flow reductions of 33-50%. Base flow depletion is 10% in the Letaba system and 15% in the Luvuvhu.

Stressed catchments where the water use from groundwater is greater than 80% of the potable exploitation potential include: the upper Luvuvhu in the vicinity of Albasini Dam (A91A-D), the lower Groot Letaba in the vicinity of the proposed Nwamitwa dam (B81C-H), the Koedoes and Brandboontjies catchments, parts of the Middle Letaba system (B82B-C). The over utilising of the groundwater resources in general occur in the quaternary catchments where irrigation is one of the main users.

As explained in **Section 8.3** an analysis was undertaken to determine which of the water services supply schemes could feasibly be supplied from groundwater. The results from this analysis were then compared with the demands supplied from groundwater within these schemes as summarised in **Table 10.6**. Some of these schemes are located outside the study area and were thus not evaluated. Others only represent very small demands for individual or supply on farms which were not necessarily evaluated due to limited data availability.

Table 10.6 clearly shows that within several of these water services schemes the groundwater resources were already over utilised in 2010 (those in red) and as listed below.

- Levubu CBD
- Greater Letaba LM farms supply
- Tshikondeni Mine
- Thulamela LM farms supply
- Greater Letaba LM farms supply
- Greater Giyani LM farms supply
- Thabina RWS

Two of the schemes, Mutale LM Farms supply and Makhado RWS are heavily utilised, although not yet over utilised.

Several of the schemes are located in stressed quaternary catchments due to other users such as irrigation which include the following schemes:

- Ba-Phalaborwa
- Giyani system D: southwest
- Greater Giyani LM Farms Supply
- Letaba Individual Supply
- Ritavi / Letaba RWS
- Thapane RWS
- Valdezia RWS
- Modjadji RWS

Table 10.6: Water services schemes harvest potential, potable exploitation potential and current use

Groundwater Utilisation	Colour Code	% of Potable exploitation potential used
Over utilised		> 100%
Heavily utilised		70 to 100 %
Significantly Utilised		50 to 69%
Moderately utilised		40 to 49%
Lightly utilised		30 to 39%
Under utilised		0.1 to 29%
Not utilised		0%
Not evaluated		
Scheme located in		stressed quarterly

No	Water Services Scheme	Harvest Potential (million m^3/a)	Potable exploitation potential (million m^3/a)	Demands from G/W (million m^3/a)	Remaining potable exploitation potential (million m^3/a)	Potable exploitation potential % utilised
1	LUPHEPHE/NWANEDZI NORTH	1.18	0.71	0.25	0.46	35%
2	MASISI RWS	1.9	1.15	0.5	0.65	43%
3	LUPHEPHE/NWANEDZI MAIN RWS	3.07	1.86	0.77	1.09	41%
4	TSHIKONDENI MINE	0.04	0.02	0.06	-0.04	284%
5	MUTALE LM FARMS SUPPLY	0.04	0.02	0.02	0.00	96%
7	MUTALE MAIN RWS	5.91	3.76	0.7	3.06	19%

No	Water Services Scheme	Harvest Potential (million m³/a)	Potable exploitation potential (million m³/a)	Demands from G/W (million m³/a)	Remaining potable exploitation potential (million m³/a)	Potable exploitation potential % utilised
8	MUTALE MUKUYA RWS	1.35	0.89	0.11	0.78	12%
9	DAMANI RWS	3.33	2.30	0.35	1.95	15%
10	NZHELELE RWS	3.32	2.29	0	2.29	0%
11	VONDO NORTH RURAL RWS	1	0.69	0	0.69	0%
12	MATSHAVHAVE/KUNDA RWS	0.34	0.24	0	0.24	0%
13	TSHIFIRE MURUNWA RWS	0.69	0.48	0	0.48	0%
14	VONDO CENTRAL RWS	5.93	3.73	0.14	3.59	4%
15	VONDO EAST RWS	1.52	0.82	0.04	0.78	5%
16	TSHIFUDI RWS	1.21	0.81	0.27	0.54	33%
17	LAMBANI RWS	0.64	0.43	0	0.43	0%
18	THULAMELA LM FARMS SUPPLY	0.02	0.01	0.08	-0.07	595%
19	NORTH MALAMULELE EAST RWS	3.11	1.81	0.16	1.65	9%
20	SOUTH MALAMULELE EAST RWS	6.55	3.12	0.11	3.01	4%
21	MALAMULELE WEST RWS	3.85	1.79	0.21	1.58	12%
22	TSHAKUMA RWS	0.7	0.47	0.17	0.30	36%
23	LEVUBU CBD	0.11	0.07	0.08	-0.01	109%
24	VALDEZIA RWS	1.68	1.11	0.31	0.80	28%
25	MAKHADO RWS	2.22	1.52	1.2	0.32	79%
29	ELIM/VLEIFONTEIN RWS	1.93	1.26	0.48	0.78	38%
30	MIDDLE LETABA RWS: VYEBOOM MASIA	2.29	1.37	0.4	0.97	29%
31	VONDO SOUTH RWS	2.25	1.21	0.05	1.16	4%
32	MIDDLE LETABA RWS: MALAMULELE WEST	1.43	0.62	0.11	0.51	18%
33	GIYANI SYSTEM F1	2.8	1.23	0.23	1.00	19%
34	GIYANI SYSTEM F2	2.17	0.96	0.28	0.68	29%
35	MAPUVE/SYSTEM N RWS	2.25	1.27	0.17	1.10	13%
36	MIDDLE LETABA RWS: BABANGU	5.94	3.61	0.51	3.10	14%
37	MIDDLE LETABA RWS: MAGORO	5.42	3.59	1.05	2.54	29%
38	MIDDLE LETABA RWS: MAJOSI	5.21	3.12	0.88	2.24	28%
39	TSHITALE RWS	4.9	2.64	0.44	2.20	17%
44	SEKGOSESE INDIVIDUAL GROUNDWATER SCHEME	1.99	1.35	0.23	1.12	17%
45	MIDDLE LETABA: BOLOBEDU NW	2.72	1.30	0.44	0.86	34%
46	WORCESTER/MOTHOBEKI RWS	2.06	0.95	0	0.95	0%
47	LOWER MOLOTOTSI	3.03	1.64	0	1.64	0%
48	GIYNAI SYSTEM C/D	6.04	3.37	1.97	1.40	58%
49	GIYANI SYSTEM A/B	11.44	5.51	0.51	5.00	9%
50	SILUWANE - NONDWENI EXTENDED RWS	1.89	1.10	0	1.10	0%
51	GREATER GIYANI LM FARMS SUPPLY	0.09	0.06	0.08	-0.02	131%
53	BA-PHALABORWA INDIVIDUAL SUPPLY	0.1	0.07	0	0.07	0%

No	Water Services Scheme	Harvest Potential (million m^3/a)	Potable exploitation potential (million m^3/a)	Demands from G/W (million m^3/a)	Remaining potable exploitation potential (million m^3/a)	Potable exploitation potential % utilised
54	GIYANI SYSTEM D: SOUTH WEST	1.57	0.96	0.61	0.35	64%
55	RITAVI/LETABA RWS	5.48	3.62	0.26	3.36	7%
56	THAPANE RWS	1.5	0.93	0.3	0.63	32%
57	MODJADJI RWS	1.75	0.86	0	0.86	0%
58	LETABA INDIVIDUAL SUPPLY	0.06	0.03	0	0.03	0%
59	GREATER LETABA LM FARMS SUPPLY	0.3	0.17	0.38	-0.21	225%
60	SEKGOPO LOCAL GWS	0.58	0.30	0.19	0.11	64%
61	GREATER TZANEEN LM FARMS SUPPLY	0.33	0.17	0	0.17	0%
72	TZANEEN/HAERNETSBURG INDIVIDUAL SUPPLY	0.38	0.19	0	0.19	0%
73	TZANEEN/MODJADJISKLOOF	2.15	1.27	0	1.27	0%
74	THABINA RWS	1.58	1.05	2.25	-1.20	214%
75	RITAVI II RWS	3.96	1.66	0.75	0.91	45%
76	TOURS RWS	4.13	2.75		2.75	0%
	Total	**139.43**	**80.33**	**18.10**	**63.77**	**23%**
	Total (excluding schemes not evaluated)	**130.46**	**74.31**	**18.10**	**57.75**	**24%**

From **Table 10.6** it is evident that there are possibilities for future groundwater resource development in several of the water service schemes within the Mutale catchment, the Greater Thohoyandou water supply area as well as within the Middle Letaba Nsami system supply area.

One of the identified groundwater related intervention options involved the use of weirs along the lower Molototsi River using the impounded surface water to recharge the underlying alluvial sand aquifer. The alluvial groundwater in the Molototsi will then be abstracted to supply water to Mulele which forms part of the Lower Molototsi water supply scheme. The groundwater analysis indicated that the scheme could provide 0.05-0.055 million m^3/a without the construction of a weir, or 0.05-0.065 million m^3/a with a 1.3 m weir, depending on the level of assurance of supply selected. The benefit through artificial recharge is thus too small to be considered as a viable option.

The additional available groundwater presented in **Table 10.6** was applied as a source of water in the relevant reconciliation balance scenarios discussed in **Chapter 11**.

10.2.2 New Dams

Introduction:

The raising of Tzaneen Dam by 3m and the building of Nwamitwa Dam downstream of Tzaneen Dam on the Groot Letaba River, were both already approved by Parliament. These two options are both in the final design stage and URV's were therefore not determined for them as part of this study. All other options listed in this section is possible future options, to be considered and evaluated for inclusion as possible intervention options, to maintain a positive water balance in future for all sub-systems within the study area.

Raising of Tzaneen Dam (Groot Letaba):

Letaba River Basin "Feasibility Study of the Development and Management Options" (DWAF, 1998) was completed in 1998 and proposed the construction of a dam at Nwamitwa as well as the possible raising of Tzaneen Dam. These two options would enable additional water to be made available for primary water users and will make it possible to implement the ecological Reserve. This study was then followed by the Bridging Study in 2006 in order to re-assess the recommendations contained in the Feasibility Study in the light of developments that have taken place in the intervening 10 years. The official title of the study is "The Groot Letaba Water Development Project: Bridging Studies". (GLeWaP)

The gross storage capacity of the existing Tzaneen Dam is 157.3 million m^3 and will be increased to 193 million m^3 when the FSL is raised by 3m. Based on the results from the GLeWaP study the firm yield from the raised Tzaneen / Nwamitwa dam system would be increased from 60 to 64 million m^3 per annum as result of the 3 m raising.

One of the major conclusions from the GLeWaP study is that the hydrology used in the GleWaP Study did not adequately reflect the low flows in the system.

The GleWaP study recommended that a labyrinth spillway option be used for the raising of Tzaneen Dam. This is the most cost effective solution and has the lowest future maintenance costs.

One of the major tasks of the Luvuvhu Letaba Reconciliation Strategy Study was to re-do and recalibrates the hydrology for the entire study area. This was completed and updated yield analyses were performed for all relevant options. Results from this analysis indicated that the historic firm yield of Tzaneen Dam increased from 44 million m^3/a to 45 million m^3/a, thus an increase of only 1 million m^3/a. The raising of Tzaneen Dam also resulted in a slightly higher assurance of supply to the irrigators from a 60% to 61% average supply. This increase in yield does not reflect the yield increase when the raised Tzaneen is used in conjunction with Nwamitwa Dam.

Nwamitwa Dam (Groot Letaba):

As already mentioned under the Raising of the Tzaneen Dam option, the construction of Nwamitwa Dam was proposed as one of the future intervention options recommended by Letaba River Basin Feasibility Study and was further investigated in "The Groot Letaba Water Development Project: Bridging Studies". (GLeWaP).

The proposed Nwamitwa Dam is located on the Groot Letaba River downstream of Tzaneen Dam and just downstream of the confluence of the Nwandezi and Groot Letaba rivers. The

Nwamitwa Dam will be an embankment type earth fill dam with a central ogee spillway and a full supply level of 479.5 masl.

From the GleWaP study a Nwamitwa Dam with a FSL of 479.5 m, and capacity of 187 million m^3 was proposed as the preferred dam size, with a historical firm yield of 14 million m^3/a. Depending on assumptions regarding river losses, EWRs and adjustments to the extended hydrology, the historic firm yield from Nwamitwa Dam as obtained from the GleWaP study can be as low as zero and as high as 18 million m^3/a, depending on the assumptions made. Thus the recommendation from the GleWaP study to re-do the hydrology.

With the new hydrology and updated demands from the Luvuvhu Letaba Reconciliation Strategy Study and EWRs from the Reserve study, new yield analysis were carried out for the Nwamitwa Dam with a full supply volume of 186.6 million m^3/a. The new analysis showed an increase of 22.6 million m^3/a to the average supply from the combined Nwamitwa Raised Tzaneen sub-system, relative to the raised Tzaneen Dam on its own. When the Classification study EWRs were imposed on the system the total supply of the system dropped by 15.2 million m^3/a, showing an average increase of 7.4 million m^3/a in supply when Nwamitwa Dam is included. (All yield numbers presented in this paragraph are Historical Firm Yields)

Crystalfontein Dam (Klein Letaba):

The study (DWAF,2003) “Reconnaissance Study to Augment the Water Resources of the Klein Letaba and Middle Letaba River Catchments” completed in 2003 evaluated several dams sites and after a screening process two possible future dams Crystalfontein and Majosi dams were investigated further at a reconnaissance level. The purpose of these dams was stated to improve the poor water supply situation in the Klein and Middle Letaba catchment area and to accommodate the expected future growth in demands.

The Crystalfontein Dam site is located in the Klein Letaba River just before the confluence of the Klein and Middle Letaba rivers, with the existing Middle Letaba Dam located in the Middle Letaba River just upstream of this confluence. The two dams will thus be located close to each other, and water from the possible Crystalfontein Dam can then feed into the existing water distribution system currently used by the Middle Letaba Dam.

Crystalfontein Dam has a full supply capacity of 96 million m^3. Based on the new hydrology and updated demands from the Luvuvhu Letaba Reconciliation Strategy study, the historic firm yield for Crystalfontein Dam was determined as 6 million m^3/a and with the EWR included it reduces to 5.4 million m^3/a. The URV for Crystalfontein Dam with the EWR included was determined as 9.5 R/m^3 at an 8% discount rate.

Majosi Dam (Klein Letaba):

Majosi Dam is an alternative option to Crystalfontein Dam also evaluated in the study “Reconnaissance Study to Augment the Water Resources of the Klein Letaba and Middle Letaba River Catchments” as referred to in the section above. Majosi Dam site is located further upstream in the Klein Letaba River. The main advantage of a dam at the Majosi site is that a much smaller storage is required, as water can be diverted via a canal into the existing

Middle Letaba Dam. The Middle Letaba Dam is oversized for its runoff, and can therefore very well serve as the storage component for the water diverted from the Klein Letaba River.

Majosi Dam has a full supply level of 538 masl with a gross capacity of 29 million m^3. Majosi Dam in combination with its transfer canal and storage in Middle Letaba Dam resulted in an increase in yield of 5.5 million m^3/a as obtained at Middle Letaba Dam. When the EWR is imposed on Majosi Dam this yield benefit drops to 4.6 million m^3/a. The URV for Majosi Dam with the EWR included was determined as 8.94 R/m^3 at an 8% discount rate.

Latonyanda Dam and Lower Latonyanda Dam (Upper Luvuvhu):

The 1997 Luvuvhu River Dam Feasibility Study (DWAF, 1997) investigated both the Mutoti Dam (renamed to Nandoni) as well as the Latonyanda Dam on the Latonyanda River, intended to augment water supplies to Louis Trichardt (Makado). The Latonyanda Dam proved to not be economically viable and the recommendation was made to construct the Nandoni Dam, which was then constructed and completed in 2004.

For the purpose of the Luvuvhu Letaba Reconciliation Strategy study it was decided to re-evaluate the possible Latonyanda Dam as an alternative resource for the irrigation currently supplied from Albasini Dam, as the hydrology and system demands were updated. There is also the option to select a site further downstream on the Latonyanda River, below the confluence with the tributary from the existing Tshakhuma Dam, which is referred to as the Lower Latonyanda Dam.

Both the Latonyanda and Lower Latonyanda possible dams has a gross full supply capacity of 96.40 million m^3/a. The historic firm yield determined for Latonyanda Dam is 7.8 million m^3/a and 8.1 million m^3/a for the Lower Latonyanda Dam. The Latonyanda Dam resulted in a decrease in the yield at Nandoni Dam of 4 million m^3/a. The net increase in the system yield is thus only 3.8 million m^3/a, which is very low for an additional storage of 96.4 million m^3 (see Paswanae Dam yield of 43 million m^3/a for a 90 million m^3 storage). This option was therefore not investigated further.

Possible Xikundu Dam (Lower Luvuvhu):

The possible Xikundu Dam is located at the existing Xikundu Weir in the Luvuvhu River. This dam site was as the Paswane Dam site, identified as one of the key large dam sites in the central basin from the 1990 Water Resources Planning of the Luvuvhu River Basin Study (DWA, 1990). Xikundu possible dam is located downstream of the confluence of the Mutshindudi and Luvuvhu rivers. Xikundu and Paswane dams will be mutually exclusive as the one will highly impact on the yield of the other dam.

The gross capacity for the possible Xikundu Dam is 139 million m^3 and resulted in a historic firm yield of 51 million m^3/a and 1 in 50 year stochastic yield of 62.5 million m^3/a. The URV for the possible Xikundu Dam is 0.71 R/m^3 at an 8% discount rate, and very low, although slightly higher than that obtained for Paswane Dam. (Note URV based on HFY and without releases for the EWR).

Xikundu Dam was an option considered during the Pre-feasibility study for Nandoni Dam. From the Xikundu dam site, fish need to migrate upstream into the Mutshindudi River. The proposed dam wall at Xikundu would prevent fish movement and therefore from an ecological viewpoint, this option was found to be unacceptable.

Possible Paswane Dam (Lower Luvuvhu):

The 1990 Water Resources Planning of the Luvuvhu River Basin Study (DWA, 1990) identified the Possible Paswane Dam as one of the key large dam sites in the central basin with good potential. Paswane Dam is located on the downstream end of the Mutshindudi River before its confluence with the Luvuvhu River, which is downstream of the existing Nandoni Dam. The Paswane Dam will therefore not impact on Nandoni Dam and vice versa.

The gross capacity of the possible Paswane Dam was taken as 90 million m^3 and provided a historic firm yield of 43 million m^3/a with a 1 in 50 year stochastic yield of 55 million m^3/a. The URV for this option is very low at 0.69 at an 8% discount rate, and clearly a viable future option from an economic point of view. (Note the URV was based on the HFY and without releases for the EWR)

Similar to the proposed Xikundu Dam, fish need to migrate upstream from the Luvuvhu River into the Mutshindudi River. A dam in the Lower Mutshindudi River would therefore prevent the movement of fish and was on the same basis as Xikundu Dam eliminated from further analyses.

Possible Rambuda downstream Dam (Upper Mutale):

From the “Mutale River Water Resources Investigation” study (DWAF, 1999) the possible Rambuda downstream Dam and the Tswere Dam were identified as the most promising dam sites and therefore included in the evaluations carried out for the Luvuvhu Letaba Reconciliation Strategy study. The Rambuda downstream site only allows for a relative small dam with a gross capacity of 20 million m^3.

The historic firm yield for Rambuda Dam is 12.6 million m^3/a, with the 1 in 50 year stochastic yield at 16.7 million m^3/a. This resulted in a URV of 1.9 R/m^3 at an 8% discount rate which is reasonable.

Possible Tswere Dam (Middle Mutale):

The yield for three possible dam sizes were determined for this site, a large (storage 220 million m^3), medium (storage 114 million m^3) and small dam (storage 22 million m^3) with historic firm yields of 65, 53 and 21 million m^3/a respectively. As the projected future demand in the Mutale system is not high, it was decided to carry out risk analysis only on the medium size Tswera Dam. This resulted in a 1 in 50 year yield of 62.1 million m^3/a. When imposing desktop level EWR requirements on Tswera Dam, a reduction in yield for the medium size dam of 17 million m^3/a was evident. The related URV is 0.83 R/m^3 and is significantly less than that obtained for Rambuda Dam.

Possible Thengwe Dam (Lower Mutale):

Three possible dam sizes at the Thengwe Dam site was analysed for yield purposes, a large (storage 239 million m^3), medium (storage 101 million m^3) and small (storage 20 million m^3) dam. The historic firm yield obtained for the three sizes were 70, 50 and 20 million m^3/a respectively. As for the Tswere Dam option URVs were only determined for the medium size dam resulting in an URV of 0.58 R/m^3, that is even lower that the Tswere Dam URV. The main disadvantage of this dam site is that it is located far downstream of the bulk of the demand centres and will involve high pumping costs and distribution infrastructure to supply the water to the users.

10.2.3 Re-using Sewage Effluent

There is limited information on return flows and planning in relation to wastewater use within the Study Area. Only three local municipalities have information on return flows. The Makhado Local Municipality plans to reuse effluent from their wastewater treatment works as an added source of water from 2015 onwards, with estimates of 1.33 million m^3/a for 2015, 1.45 million m^3/a for 2020, 1.58 million m^3/a for 2025 and 1.7 million m^3/a for 2030. However, there is no mention on how and where they intend re-using the wastewater.

The Greater Tzaneen Local Municipality indicated that a total volume of 5.2 million m^3/a is discharged from all the wastewater treatment works into the river. There is no mention on the intentions of reusing the water.

Greater Giyani Local Municipality indicated that a total volume of waste water received and treated is 0.95 million m^3/a. The treated effluent is not recycled and 0.8 million m^3/a volume of effluent is discharged into the Klein Letaba River.

The assessment of wastewater treatment works in the Luvuvhu/Letaba catchment has indicated the following:

- Most municipalities in this area do not measure the volume of effluent entering the WWTW or that discharged as treated effluent;
- In all cases where data was available, the effluent discharged is also of poor quality with high nutrients and faecal contamination; and
- There are areas of water deficit where treated wastewater could be considered for agricultural or limited urban use.

It is recommended that should the option of treated wastewater reuse be considered, then the wastewater treatment works in the study area need to be upgraded and their operation optimised to improve the quality of the effluent being discharged. Currently the quality being discharged may have serious human health and ecological consequences, as well as increased eutrophication potential in the study area. This will in turn impact on other downstream water users such as irrigation farmers and water treatment plants.

10.2.4 System Operating Rules

System operating rules refers to how water is utilised, transferred or released from regulating storage structures in a water resource system. Inter-reservoir transfer or release rules influence the yield of dams or sub-systems and drought restriction rules are an essential measure to protect water users against complete supply failures, by preventing situations where dams are completely depleted during drought periods. The following operating rules were applied in the analysis when determining the yield for the sub-systems.

- Raised Tzaneen Dam in combination with Nwamitwa Dam. The existing operating rule or policy for Tzaneen Dam encompasses drought restrictions that ensure a portion of the irrigation water use to be supplied at a high assurance and to protect the supply to urban domestic users. This operating rule defines that the supply to irrigation will be restricted by 50% as soon as the dam level drops below the 95% storage in the dam.

  A similar rule was applied to the raised Tzaneen Dam, as well as for the raised Tzaneen Dam in combination with the future Nwamitwa Dam.

  With Nwamitwa Dam in place, it is important to operate Nwamitwa Dam at low levels before releases in support of Nwamitwa Dam are made from Tzaneen Dam. This reduces evaporation losses from Nwamitwa Dam considerably, and results in a higher combined system yield.

  The irrigators abstracting water from the river reach between Tzaneen Dam and Ebenezer Dam are restricted on the same bases as the irrigators supplied from Tzaneen Dam, even if there is water available in Ebenezer Dam. When Tzaneen Dam is at low levels, water is released from Ebenezer Dam to support Tzaneen Dam. The water balance presented for the Groot Letaba Sub-system indicates that Tzaneen Dam is over allocated, even with the support from Ebenezer Dam. It is therefore essential to operate Ebenezer and Tzaneen dams as a system.

  Specific release rules to comply with the EWRs (low and high flow events), as determined in the Classification process, were applied in the analysis where Nwamitwa Dam was implemented. Appropriate release capability is required from the dam and operational decision support procedures need to be implemented to optimise the abstraction from the system and to comply with the EWRs.

- Nandoni Dam supply water to support rural/domestic, irrigation and release water for the EWRs downstream of the dam. These downstream rural/domestic abstractions take place at three different weirs located in the Luvuvhu River, being the Malamulele Weir, the Xikundu Weir and the Minga Weir. Between these weirs and Nandoni Dam, a significant volume of runoff enters the Luvuvhu River and should as far as possible be utilised to limit the releases from Nandoni Dam. By doing so, the combined sub-system yield for Nandoni Dam and downstream weirs is increased from 56 million m^3/a to 62 million m^3/a. Due to this benefit, operational procedures with real time decision support should be developed and implemented to maximise the utilisation of the runoff generated downstream of Nandoni Dam, while meeting the Ecological Water Requirements in the river and Kruger National Park.

- Middle Letaba Dam and Nsami Dam should be operated as a combined system. By doing so the system yield is increased from 18.2 million m^3/a to 20.6 million m^3/a. The yield available from the combined system will increase further, once the losses on the canal system linking the two resources, were reduced or eliminated.

10.2.5 Removal of Alien Invasive Plants

The removal of alien invasive plants (AIP) is estimated to increase the runoff in the Letaba catchment by 8.3 million m^3/a and in the Luvuvhu Mutale catchments by a further 2.2 million m^3/a on average. The bulk of the alien invasive invitations in the Letaba catchment occur in the Letsitele catchment and along the Groot Letaba, between Tzaneen Dam and the confluence with the Letsitele River. Removing the AIPs in these two areas will result in an increase of almost 6 million m^3/a in the MAR.

Quaternary catchment A91A upstream of Albasini Dam and A91H on the Lower Luvuvhu just upstream of the Kruger National Park includes the bulk of the AIP in the Luvuvhu catchment. By removing the AIP in these two quaternary catchments will increase the MAR by 1.7 million m^3/a.

Focussing only on the above mentioned four quaternary catchments for the removal of AIP will regain approximately 7.7 million m^3/a of the potential 10.5 million m^3/a runoff reduction.

10.2.6 Removal of unlawful water use

Currently only the Validation part of the Validation and Verification process is completed. The validation component focuses on the current irrigation and the irrigation development during the qualifying period. The verification process is where it is determined whether the irrigation is lawful or not. At this stage, it is difficult to estimate how much of the current irrigation developments are unlawful. It is however expected, that in general most of the current irrigation will be lawful. There might however be some exceptions.

Due to over allocation of various sub-systems, irrigation was already cut back significantly of which the Middle Letaba irrigation developments as well as irrigation from Albasini Dam are good examples. Irrigation from the Groot Letaba River, in particular those supplied or partly supplied from Tzaneen Dam, has introduces severe restriction rules, that cuts back the irrigation allocation by 50%, when the storage in Tzaneen Dam drops below 95%.

Large previously irrigated areas are currently inactive, mainly due to land claims although in some cases also as result of a very low assurance of water supply. It is unclear if these previously irrigated areas will be reintroduced in future.

At this stage no reduction in irrigation demand was included in the reconciliation strategy water balances to cater for the removal of unlawful irrigation water use. The situation needs to be reassessed and if necessary the reconciliation balances be revised once the verification process has been completed.

11 RECONCILING WATER REQUIREMENTS WITH THE IDENTIFIED WATER RESOURCE: SCENARIOS

11.1 INTRODUCTION

The water balances presented in **Section 9** indicate that the implementation of interventions will be critical to ensure sufficient water supply to the year 2040 for almost all the small and large water supply systems. In many of the sub-systems deficits are currently observed and in some areas these deficits are quite severe.

The three major sub-systems, the Groot Letaba, the Middle Letaba Nsami and the Luvuvhu sub-system, are currently managed as individual systems. Within each of these there are a number of smaller sub-systems which are in some cases linked to the main sub-system. It is therefore required to prepare separate reconciliation balances and strategies that will cover each sub-system within the study area. This is necessary to identify the particular timeline and magnitude of interventions required during the planning horizon. Sub-system specific balances and strategies were therefore prepared, taking into account the existing linkages, currently planned links as well as proposed future links, to be able to obtain positive water balances over the planning period.

11.2 GROOT LETABA RIVER MAIN SYSTEM

The Groot Letaba River main system comprise the Ebenezer Dam and Tzaneen Dam as the major resources, with the raising of Tzaneen Dam and building of Nwamitwa Dam as the already approved future options to increase the system yield. Dams upstream of these dams are Dap Naude, Magoebaskloof and Hans Merensky dams, which are all operated individually and are not supporting the Groot Letaba River main system.

Other dams of importance in the Groot Letaba River catchment are Thapane, Thabina and Modjadji dams, which are mainly supplying rural/domestic requirements that are partly linked to or will in future be linked to the Groot Letaba Main system. It is therefore important to view the water balances of these individual sub-systems in conjunction with the water balance of the Groot Letaba Main system.

11.2.1 Dap Naudé and Ebenezer sub-systems

Both dams are transferring water to the Polokwane LM. Ebenezer Dam is however also support Tzaneen town, Tzaneen Dam as well as irrigation abstracting water from the river reach between Ebenezer and Tzaneen dams.

Polokwane has an allocation of 6.52 million m^3/a from Dap Naudé Dam, and is the only user supplied from this dam, except for court order releases that need to be made into the river from Dap Naudé Dam. The allocation to Polokwane from Ebenezer Dam is 12 million m^3/a, thus a total allocation from the Upper Groot Letaba to Polokwane of 18.52 million m^3/a.

- The water balance given in **Section 9.1.1** showed that the Dap Naudé Dam yield at 98% assurance is 2.7 million m^3/a, and at 90% assurance 3.25 million m^3/a, which is well below the allocation of 6.52 million m^3/a. The 6.52 allocation can thus only be supplied at a very low assurance. This is confirmed by the average actual abstractions from Dap Naudé Dam over the 10 year period 2000 to 2010 of 4.25 million m^3/a. Over the same 10 year period Polokwane has abstracted on average 16.5 million m^3/a from Ebenezer Dam, which is above their allocation of 12 million m^3/a. This resulted in a total abstraction of 20.75 million m^3/a, that exceeds their total allocation of 18.52 million m^3/a from the Upper Groot Letaba. For the purposes of the system analyses and related water balances, 4 million m^3/a was abstracted from Dap Naudé Dam and 16.2 million m^3/a from Ebenezer Dam, providing a total abstraction of 20.2 million m^3/a, which is in excess of their allocation, but in line with their total average abstraction from the two dams over the given 10 year period.

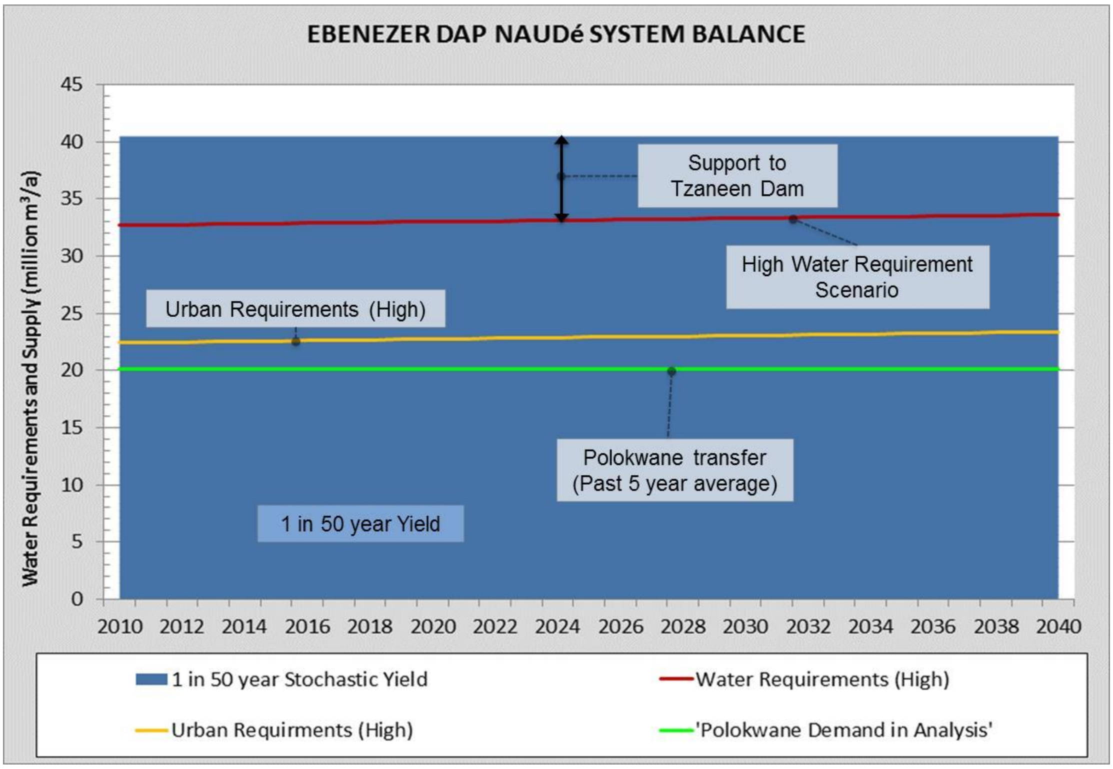


Figure 11.1 Ebenezer Dap Naudé sub-system water balance

Using these transfer volumes a water balance for the combined system was prepared. From the water balance (**Figure 11.1**) it is evident that the 20.2 million m^3/a transfer to Polokwane can be supplied at a 98% (1 in 50 year yield) assurance. The 1 in 50 year yield still available above the High water requirement scenario is used for support to Tzaneen Dam as shown in the water balance in **Section 9.1.1** for the Tzaneen Dam sub-system.

The combined Dap Naudé Ebenezer dam sub-system is therefore in balance for the entire planning period up to 2040.

11.2.2 Hans Merensky Dam sub-system

Hans Merensky Dam is only supplying water for irrigation purposes. The water balance given in **Section 9.1.1** clearly showed that the available yield is more than sufficient to support the irrigation and showed a slight excess of approximately 0.7 million m^3/a in the sub-system. No growth in demand is foreseen and this sub-system is thus in balance over the planning period to the year 2040.

11.2.3 Magoebaskloof and Vergelegen dam sub-system

This sub-system supply both urban and irrigation requirements. The water balance given in **Figure 11.2** clearly shows that the urban requirements can easily be met at the required 98% assurance over the entire planning period.

With the full irrigation allocation taken up over time, a small deficit is expected in future, even with the irrigation supplied at a lower assurance of 95% (1 in 20 year risk of failure). For irrigation purposes the small deficit should not be a problem, as long as the irrigators are willing to operate at a slightly lower assurance. It is at this stage not certain when and whether or not the full irrigation allocation will be taken up.

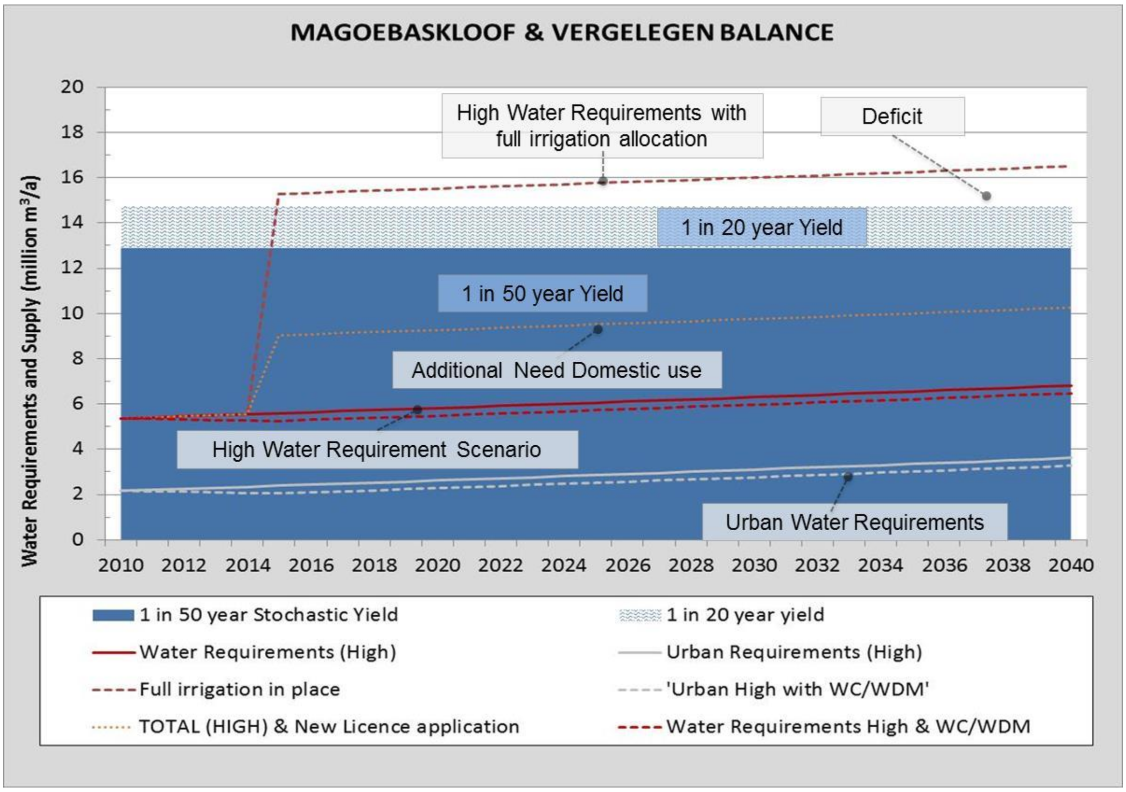


Figure 11.2 Magoebaskloof Vergelegen sub-system water balance

Lepelle Northern Water (LNW) has submitted a licence application for the abstraction of water from Magoebaskloof Vergelegen dam system. The water will be abstracted at the Vergelegen Dam and treated at the existing Politsi Water Treatment Works. LNW has an existing allocation of 2 million m^3/a, and is requesting to increase the allocation to 5.475 million m^3/a. This additional need for domestic use was added onto the water balance. From the balance it is evident that the requested increased LNW can be supplied only in combination with the current irrigation. When the irrigators take up their full allocation, it will however not be possible to support this additional domestic requirement.

Negotiations between the affected parties are required to resolve this need within the given yield capability of the sub-system.

11.2.4 Groot Letaba River Main system

The water services schemes forming part of the Groot Letaba Main system are Siluwane-Nondweni Extended RWS, Ritavi/Letaba RWS, Tzaneen/Modjadjiskloof and Ritavi ll RWS (see **Figure 11.4**). To be able to improve the water supply in this severely stressed system all the intervention options as summarised in **Table 11.1**, need to be implemented.

The irrigation restriction policy or operating rule is not a new intervention option, as this entails the policy that was put into place by the irrigation users on their own initiative, to increase the assurance of supply for a portion of the irrigation water requirements, protect the supply to urban and rural domestic users, as well as to prevent the resource from complete failure during drought periods. As this system is already severely stressed, the irrigators developed a very strict operating rule currently imposed on the system to regulate the supply to irrigation. This rule (among other detail) defines that irrigators only obtain their full allocation when the dam is above 98.3%. The irrigators are cut to 50% of their allocation when the dam is below 95%, and are cut to zero when the dam reaches 15%. When this rule is implemented, the irrigators receive on average approximately 62% of their allocation. From the water balance given in **Figure 11.3** it is clear that it is not possible to supply the total irrigation allocation at an assurance which is in general considered as reasonable for irrigation purposes.

The water balance and reconciliation scenario presented in **Figure 11.3** are based on results from simulation risk analysis (stochastic analysis), where the median (50 percentile) supply, as opposed to the allocation, form the basis of the balance graph. The figure below shows the median supply that can be obtained from the system for the indication options. The premises for these results was that the irrigation assurance of supply profile is maintained (as was determined for the "current" situation) and the increased supply volumes are provided at a high assurance (98%) resembling the profile for the domestic water use.

The water services schemes forming part of the Groot Letaba Main system are Siluwane-Nondweni Extended RWS, Ritavi/Letaba RWS, Tzaneen/Modjadjiskloof and Ritavi ll RWS (see **Figure 11.4**). To be able to improve the water supply in this severely stressed system all the intervention options as summarised in **Table 11.1**, need to be implemented.

The irrigation restriction policy or operating rule is not a new intervention option, as this entails the policy that was put into place by the irrigation users on their own initiative, to increase the assurance of supply for a portion of the irrigation water requirements, protect the supply to

urban and rural domestic users, as well as to prevent the resource from complete failure during drought periods.

Table 11.1: Groot Letaba Main system intervention options

Intervention Option	Contribution (million m^3/a)	Date	Remarks
Water Conservation and Water Demand Management in Urban Sector	0.8	2015	Saving
Irrigation restriction policy or operating rule	38% Reduction below allocation	2010	Reduction in average supply to irrigation
Raising of Tzaneen Dam (GleWaP)	1	2017	Additional yield, improved assurance of supply
Implement Nwamitwa Dam (GleWaP)	6.2	2019 (1)	Additional yield 5.5 High assurance 0.7 Low Assurance
Classification EWR	Variable	2020	Reserve releases
Additional groundwater development (Commission Feasibility Study)	>2.5	2018	Additional yield

Note (1) – Estimated date when Nwamitwa Dam will be operational.

As this system is already severely stressed, the irrigators developed a very strict operating rule currently imposed on the system to regulate the supply to irrigation. This rule (among other detail) defines that irrigators only obtain their full allocation when the dam is above 98.3%. The irrigators are cut to 50% of their allocation when the dam is below 95%, and are cut to zero when the dam reaches 15%. When this rule is implemented, the irrigators receive on average approximately 62% of their allocation. From the water balance given in **Figure 11.3** it is clear that it is not possible to supply the total irrigation allocation at an assurance which is in general considered as reasonable for irrigation purposes.

The water balance and reconciliation scenario presented in **Figure 11.3** are based on results from simulation risk analysis (stochastic analysis), where the median (50 percentile) supply, as opposed to the allocation, form the basis of the balance graph for the irrigation water use. **Figure 11.3** shows the median supply that can be obtained from the system for the indication options. The premises for these results was that the irrigation assurance of supply profile is maintained (as was determined for the “current” situation) and the increased supply volumes are provided at a high assurance (98% or 1 in 50 year yield) resembling the profile for the domestic water use.

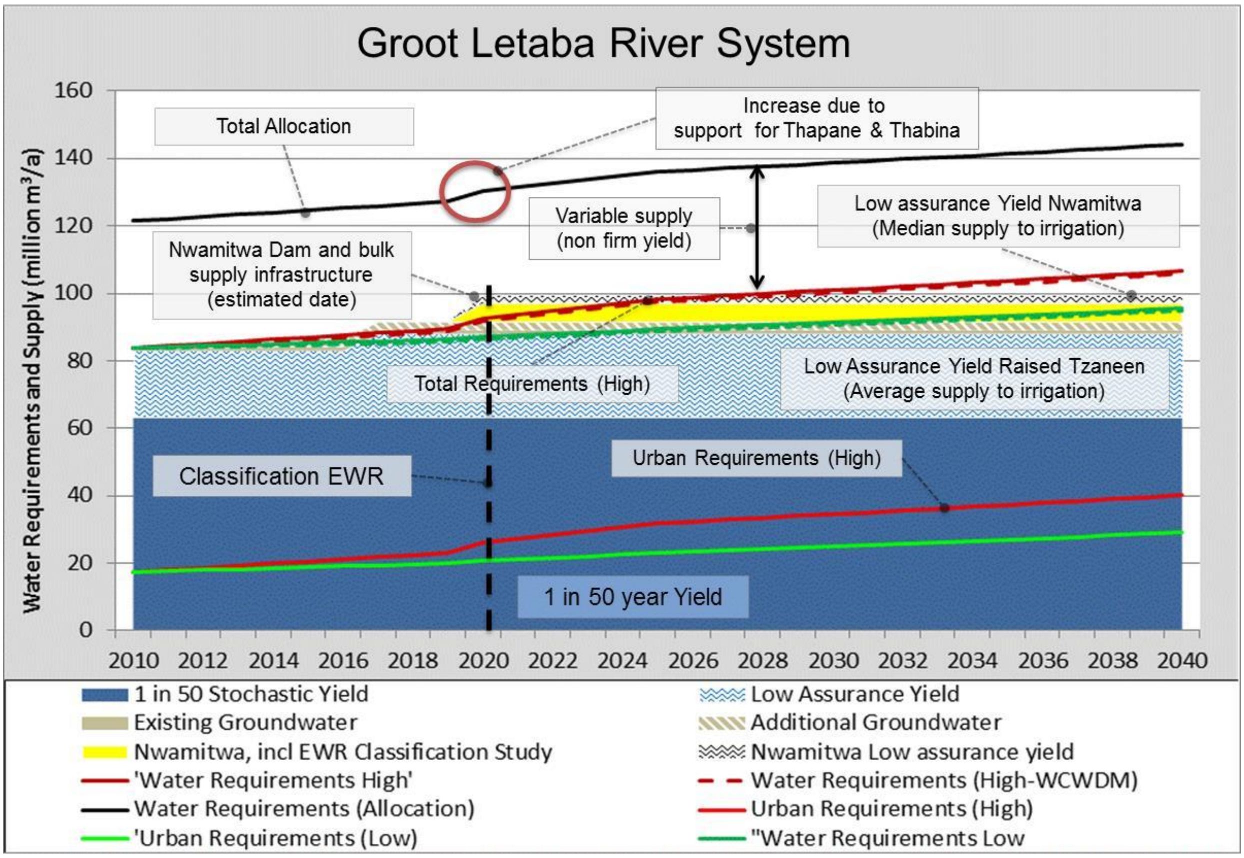


Figure 11.3 Groot Letaba Main system water balance

Even with all the proposed intervention options in place, the Groot Letaba Main system will still not be able to supply the full irrigation allocation at a reasonable assured yield. It is thus of utmost importance that the irrigation users continue with this rule, which will require some adjustments when the raising of Tzaneen Dam was completed and again when Nwamitwa Dam starts to deliver water. The water balance as given in **Figure 11.3** includes the assumption that the current assurance of supply to the irrigators will be maintained over the planning period.

One of the purposes of the GleWaP is to prevent further degradation of the riverine ecosystem. For this reason a reserve classification study was carried out and the final proposed EWR obtained from the Classification study was applied in the yield analyses for preparing the given water balance. The inclusion of the classification study EWR resulted in a reduction of 16.8 million m^3/a, of the 95% assured yield from Nwamitwa Dam.

The additional groundwater development was limited to 2.5 million m^3/a, and is expected to be obtained mainly within the Siluwane-Nondweni Extended RWS, the Ritavi II and Tzaneen/Modjadjiskloof schemes. This volume need to be confirmed by a feasibility study on groundwater development within this area.

Most of the smaller sub-systems support part of the rural domestic requirements in or close to the Groot Letaba Main system supply area also require augmentation in future. These include the Thapane and Thabina sub-systems. The deficits as determined from their individual water balances (see **Figures 11.5** and **11.6**) were included in the Groot Letaba Main system water demand projection from 2020 onwards, to coincide with the time when Nwamitwa Dam start to deliver water.

The interventions options incorporated in the reconciliation balance for Groot Letaba Main system can only supply the target water requirement scenario (High growth with WC/WDM) up to the year 2030.

11.2.5 Sub-systems with links to the Groot Letaba Main system

The systems that are linked to the Groot Letaba Main system include Thapane, Thabina and Modjadji dam sub-systems. **Figure 11.4** shows their location relative to Tzaneen Dam and the future Nwamitwa Dam, as well as the locations of the other related water services schemes and supply areas. The water services supply schemes are indicated by the red numbers shown on the map, with the names of the relevant schemes listed in the key index of the map.

The Water Services Schemes and their related supporting dams are listed in **Table 11.2**. The Giyani System D: South West (no 54) was included in the GleWap study as part of the possible area that can be supported from Nwamitwa Dam. Results from the reconciliation strategy study however showed that there is not sufficient yield available from the Groot Letaba Main system, to be able to meet those demands (See **Figure 11.3**) and it therefore remained part of the Middle Letaba Nsami supply system in this reconciliation scenario.

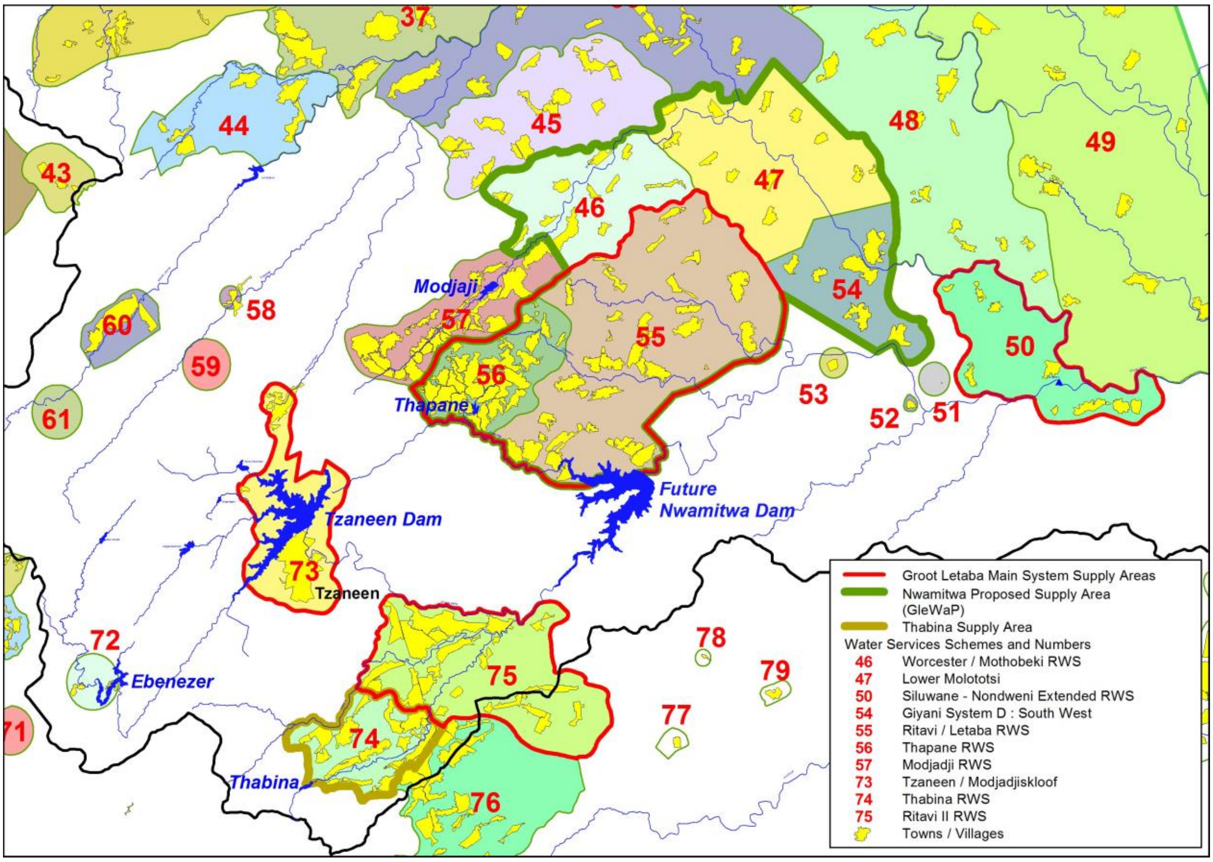


Figure 11.4 Location of current and future storage dams and related Urban and Rural domestic supply areas within and close to the Groot Letaba Main system.

Table 11.2: Water services shames and supporting dams

Dam	Water Services Supply Area number						
Tzaneen (1)	73	75	55	50			
Modjadji (1)	57	46(3)	47(3)				
Thapane(1)	56(3)						
Thabina(1)	74						
Raised Tzaneen & Nwamitwa(2)	56(3)	46(3)	47(3)	73	75	55	50

Note:(1) – Water services schemes currently supplied from the dam

(2) – Water services schemes to be supplied/supported in future from the dam

(3) – When Nwamitwa Dam is in place these water services schemes will be supported from more than one dam

Water balances for these individual sub-systems indicate the magnitude and timing of the support required from the larger Groot Letaba Main system. This can however only occur from the time when Nwamitwa Dam is in place, and the increased yield in the Groot Letaba Main system become available.

Thapane Dam water supply sub-system

The water balance given in **Section 9.1.1** showed that the current Thapane sub-system without any intervention options will only remain in balance until 2012 and requires an intervention from 2013 onwards.

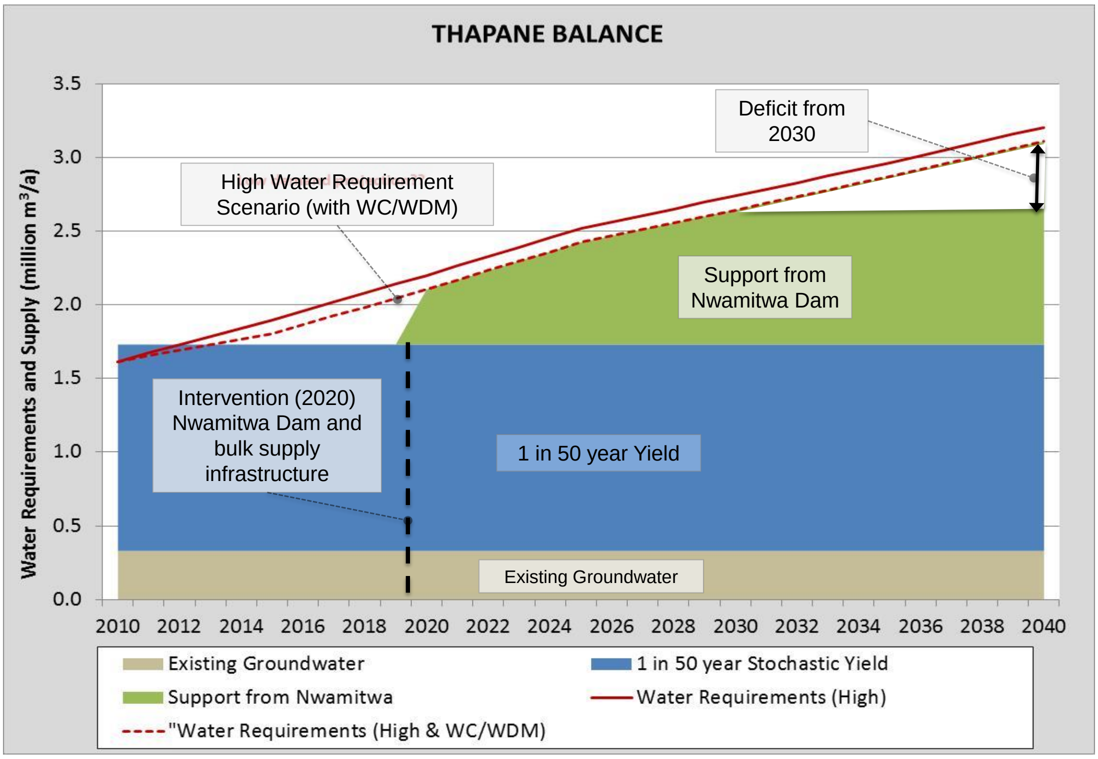


Figure 11.5 Thapane sub-system water balance

Table 11.3: Thapane sub-system intervention options

Intervention	Contribution (million m^3/a)	Date	Remarks
Water Conservation and Water Demand Management in Urban Sector	0.1	2015	Saving
Bulk supply Infrastructure to augment from Groot Letaba System	1.4	2020(1)	Indicated volume required by 2040

Note (1) – Estimated date when Nwamitwa Dam will be operational.

Only two intervention options were identified, water conservation and demand management (WC/WDM) and secondly support from Nwamitwa Dam (Groot Letaba Main system). The impact of WC/WDM is relatively small and will only keep the system in balance until 2014.

Support from Nwamitwa can on the earliest become available by 2020, but will be sufficient to keep the sub-system in balance until 2030. The support required from the Groot Letaba Main system to Thapane was include as an additional demand imposed on the Groot Letaba Main system as indicated on **Figure 11.3**. The Thapane sub-system will however still experience a small deficit over the period 2014 to 2020 until Nwamitwa Dam start to deliver water.

Thabina Dam water supply sub-system

The water balance (see **Figure 11.6**) shows that for the high water requirement, intervention is already required by 2013 to avoid significant shortages in supply. For the low demand projection however, intervention is only required from 2022 onwards.

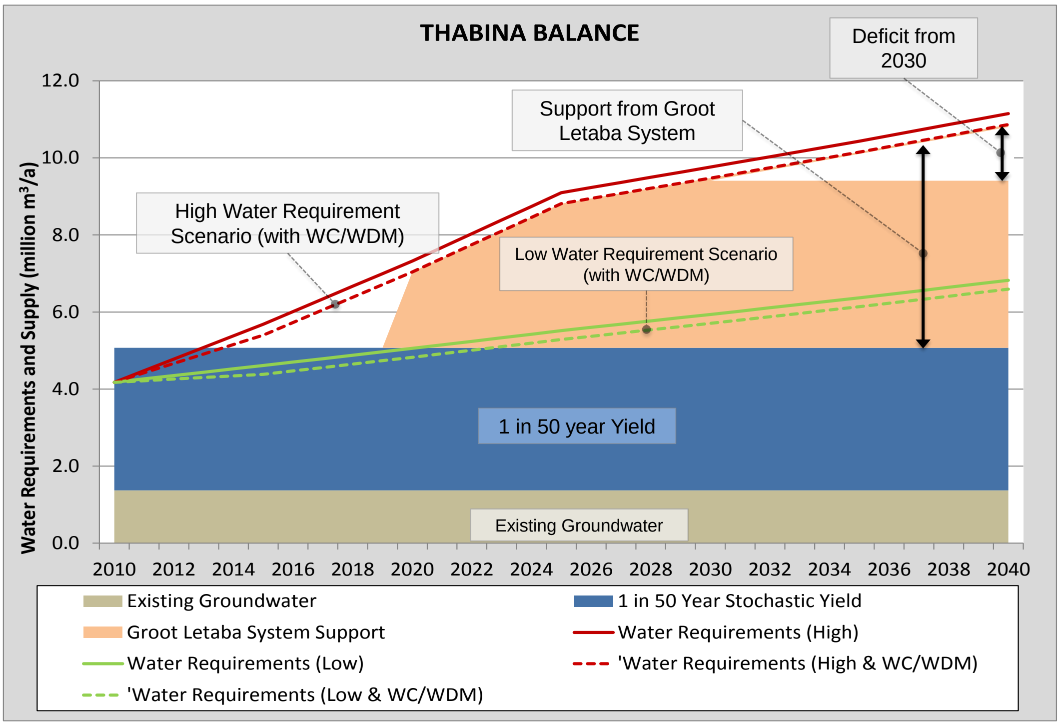


Figure 11.6 Thabina sub-system water balance

The GleWaP study did not show the Thabina supply area as one of the areas that requires support from Nwamitwa Dam in future. Except for water conservation and demand management there is no other intervention option identified for this sub-system. For this reason it was decided to include the expected deficit in this sub-system as part of the demand imposed on the Groot Letaba Main system (see **Figure 11.3**), but only once Nwamita Dam is in place.

Similar to the Thapane sub-system small deficits in supply will be expected between 2014 and 2020 until Nwamitwa Dam starts delivering water.

Details of the intervention options recommended for the Thabina Dam sub-system is given in **Table 11.4**.

Table 11.4: Thabina sub-system intervention options

Intervention	Contribution (million m^3/a)	Date	Remark
Water Conservation and Water Demand Management in Urban Sector	0.3	2015	Saving
Bulk supply Infrastructure to augment from Groot Letaba System	5.8	2019(1)	Indicated volume required by 2040

Note (1) – Estimated date when Nwamitwa Dam will be operational.

Modjadji Dam water supply sub-system

Deficits in the Modjadji sub-system are expected from 2017 onwards (**Figure 11.7**). Through the implementation of water conservation and demand management the balance can be maintained until 2020.

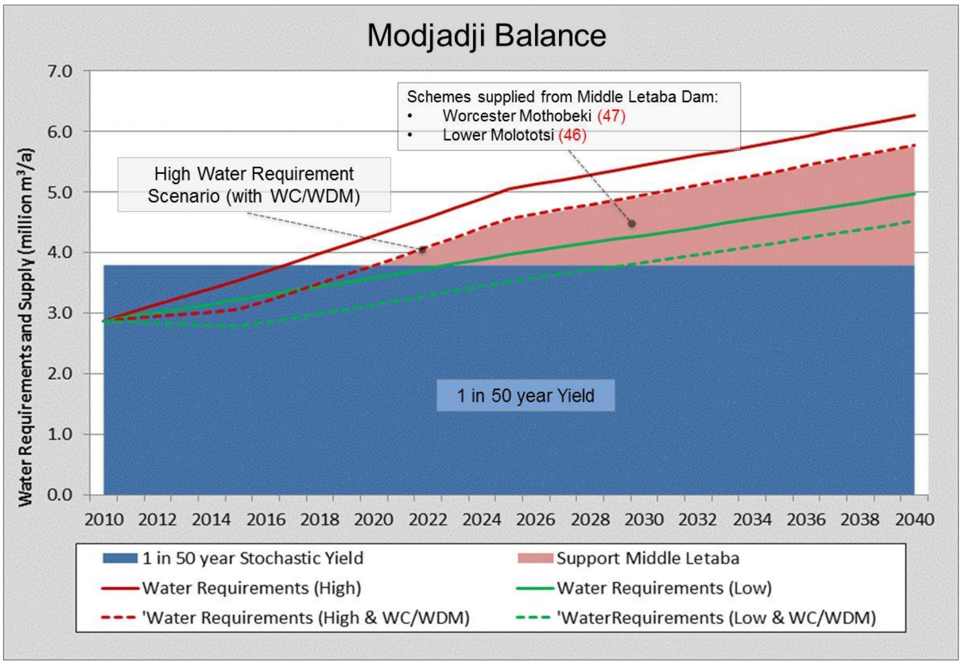


Figure 11.7 Modjadji sub-system water balance

As the Groot Letaba Main system with all intervention options included can only remain in balance until 2030, it was decided to rather impose the deficits in the Modjadji sub-system on the Middle Letaba sub-system and not on the Groot Letaba as indicated in the GleWaP study.

Although the Middle Letaba system is currently over allocated, a significant portion of the demand load will be taken off from the Middle Letaba system, due to support provided from Nandoni Dam to demand centres currently receiving water from the Middle Letaba sub-system (See Middle Letaba Water Balance in **Figure 11.8**).

From **Figure 11.4** it can be seen that water services schemes 46 and 47 which are currently supplied from Modjadji Dam are both bordering directly to the water services supply schemes 45 (Middle Letaba Bolebedu) and 36 (Middle Letaba Babangu) receiving water from the Middle Letaba sub-system. It should therefore be fairly easy to extend the water supply from schemes 45 and 36 into schemes 46 and 47 to support the growth in the latter two water services schemes.

By following this approach it should be possible for the Modjadji sub-system to maintain the water balance until 2040.

Table 11.5: Modjadji sub-system intervention options

Intervention	Contribution (million m^3/a)	Date	Remark
Water Conservation and Water Demand Management in Urban Sector	0.3	2015	Saving
Bulk supply Infrastructure to augment from Middle Letaba System	2.2	2020	Indicated volume required by 2040

11.3 MIDDLE LETABA NSAMI SYSTEM

From **Figure 9.9** in **Section 9.1.2** it is apparent that this system is already in deficit from 2012 onwards, even when taking into account that the total demand imposed on the system is reduced from certain years onwards, when portions of the water service schemes currently supplied from Middle Letaba starts to receive support from Nandoni Dam. The water services schemes that will receive support from Nandoni Dam include Malamulele West, Elim/Vleifontein, Middle Letaba Majosi and Middle Letaba Vyeboom Masia, as indicated on **Figure 11.7.**

The intervention options incorporated in the reconciliation balance for the Middle Letaba Nsami system include the following:

- Water conservation and water demand management
- Transfer from Nandoni to Giyani

- Reduce canal losses by replacing canal with a pipeline
- Development of additional groundwater resources
- Support from Nandoni to Malamulele West, Elim/Vleifontein, Middle Letaba Majosi and Middle Letaba Vyeboom Masia

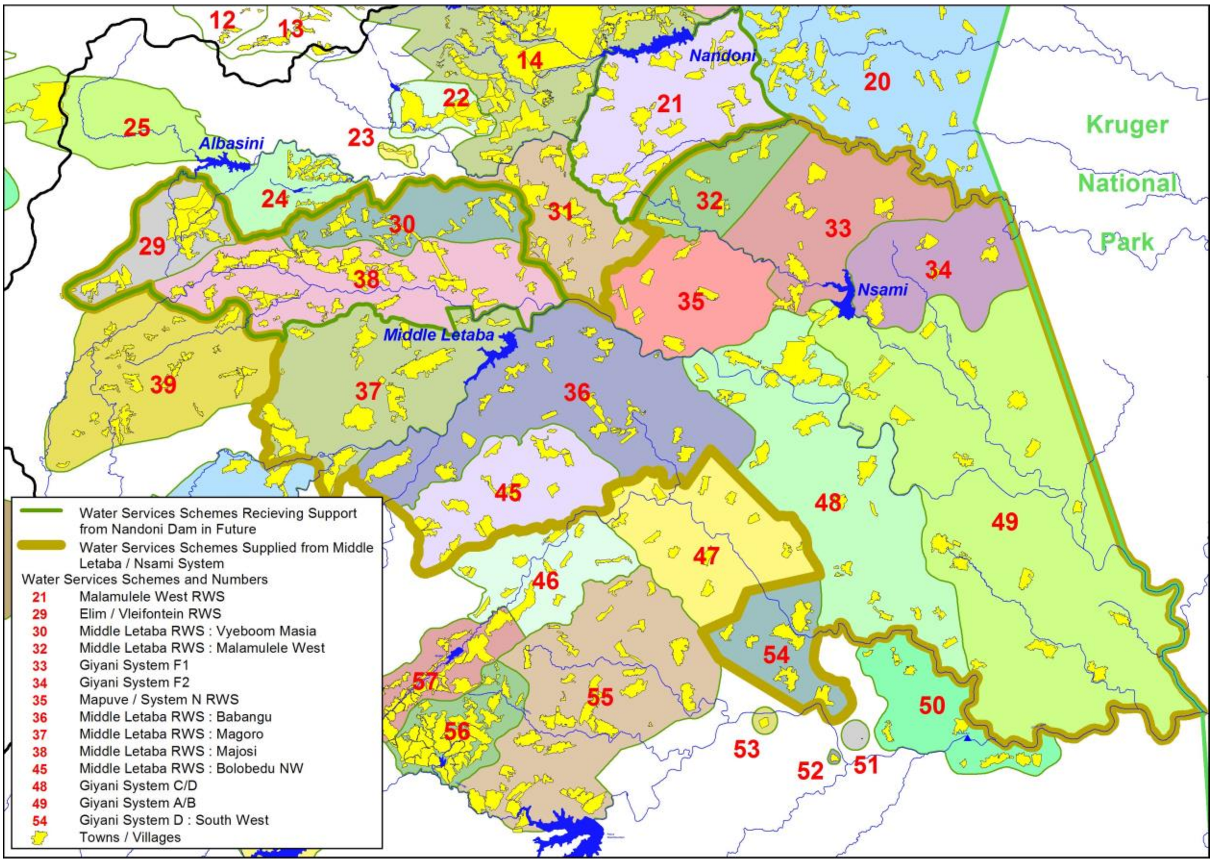


Figure 11.7 Location of Urban and rural domestic water services schemes supplied from the Middle Letaba Nsami system.

The possible Majosi and Crystalfontein dams were also evaluated as potential intervention options, but both resulted in fairly high URVs, and were therefore not used within this reconciliation scenario. These two dams might still be options to consider in the future beyond 2040.

The demand projection used in the Middle Letaba Nsami water balance as given in **Figure 11.8** includes the growth components for water services schemes 46 (Worcester/Mothobeki) and 47 (Lower Molototsi) within in the Modjadji sub-system, which requires support from the Middle Letaba Dam in future.

The recommended intervention options contained in the reconciliation scenario for the Middle Letaba Nsami system enable the system to maintain a positive water balance over the planning period. Details of the different intervention options are summarised in **Table 11.6.**

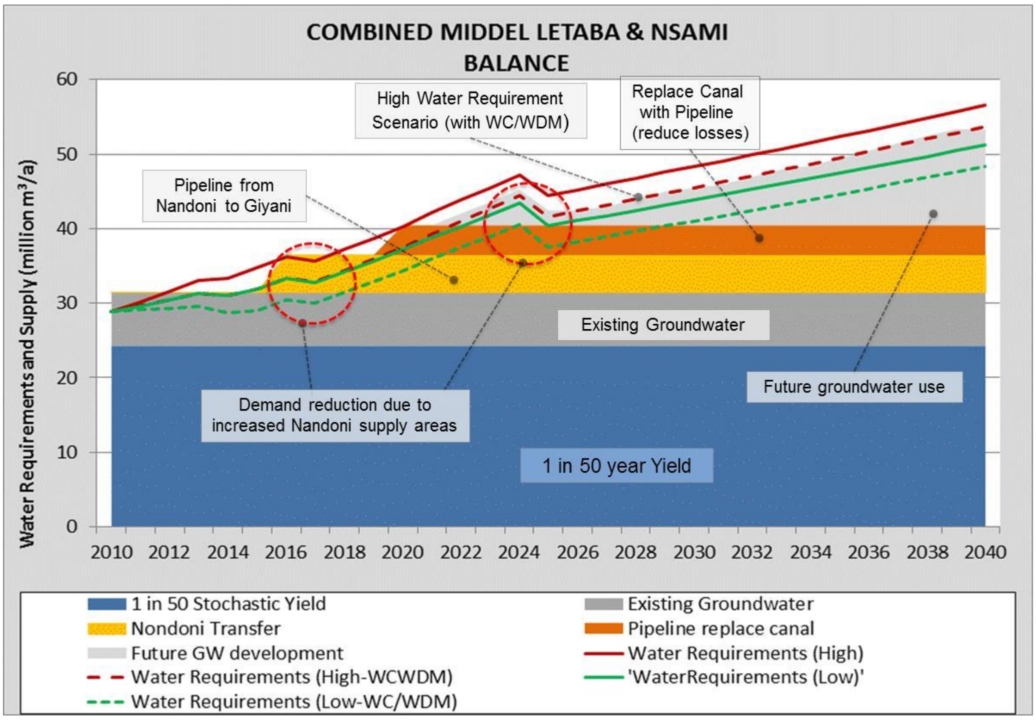


Figure 11.8 Middle Letaba Nsami system water balance

Table 11.6: Middle Letaba Nsami system intervention options

Intervention	Contribution (million m^3/a)	Date	Remark
Water Conservation and Water Demand Management in Urban Sector	2.8	2015	Saving
Pipeline from Nandoni Dam	5	2016	Additional yield
Pipeline to replace canal between Middle Letaba and Nsami dams	4	2016	Saving in losses
Supply from Nandoni Dam to committed areas	3	2017	Augmentation (2 Phases)
	7.7	2025	
Groundwater Developments in supply areas (Commission Feasibility Study)	12.9	2021	Additional yield

Future groundwater developments is one of the major intervention options and it is very important to first commission a groundwater development feasibility study, to determine viability of this resources in future.

11.4 LUVUVHU SYSTEM

The Luvuvhu system comprises several sub-systems of which some are currently linked. Nandoni Dam is the largest storage dam in the system and was only completed in 2004. Nandoni Dam will support almost all the sub-systems within, as well as to some located outside the Luvuvhu catchment. This will result in links between all the main supply systems within the Luvuvhu catchment, as well as to several sub-systems outside the catchment. To be able to reconcile the water requirements within the Luvuvhu system with the water resources in this system, one first needs to complete the reconciliation process on the smaller sub-systems, before the reconciliation can be carried out for the large system, that includes Nandoni Dam and its entire future supply area. Deficits that still exist in the smaller sub-systems will in this process be imposed as demand on the larger Nandoni Dam system, as it is currently the only sub-system with significant surplus yield available.

The following sub sections will therefore first focus on the water balances prepared for the smaller sub-systems.

11.4.1 Albasini Dam sub-system

The Albasini Dam sub-system is one of the most stressed sub-systems within the larger Luvuvhu system. The Albasini Dam sub-system currently mainly supply water to Louis Trichardt (Makhado) and when sufficient water is available from the dam, support is also given to irrigation having an allocation of 7.3 million m^3/a from Albasini Dam, but very seldom receives water from the dam. There is limited links from the Makhado water service scheme to the Sinthumule Kutana RWS, and it is seldom utilised to support Sinthumule Kutana, as the surface water resources is insufficient for Louis Trichardt (Makhado) town on its own. (See the location of the relevant water services schemes in **Figure 11.9**)

A pipeline is currently under construction to support demand centres that are currently supplied from the Albasini sub-system, with water transferred from Nandoni Dam. Sufficient water will be provided from Nandoni to also address the shortages currently experienced in the Sinthumule Kutana RWS as well as in the nearby Air Force Base, just to the south of Sinthumule Kutana RWS.

The water supplied from Nandoni Dam will only be used to support the urban/industrial and rural domestic sectors and not to augment irrigation requirements.

The water balance for the Albasini sub-system supplying only water to the Makhado RWS is shown in **Figure 11.10**. This balance shows that water conservation and water demand management actions need to start as soon as possible. This will ensure that sufficient yield is available until approximately 2026, under the condition that no water is supplied to irrigation.

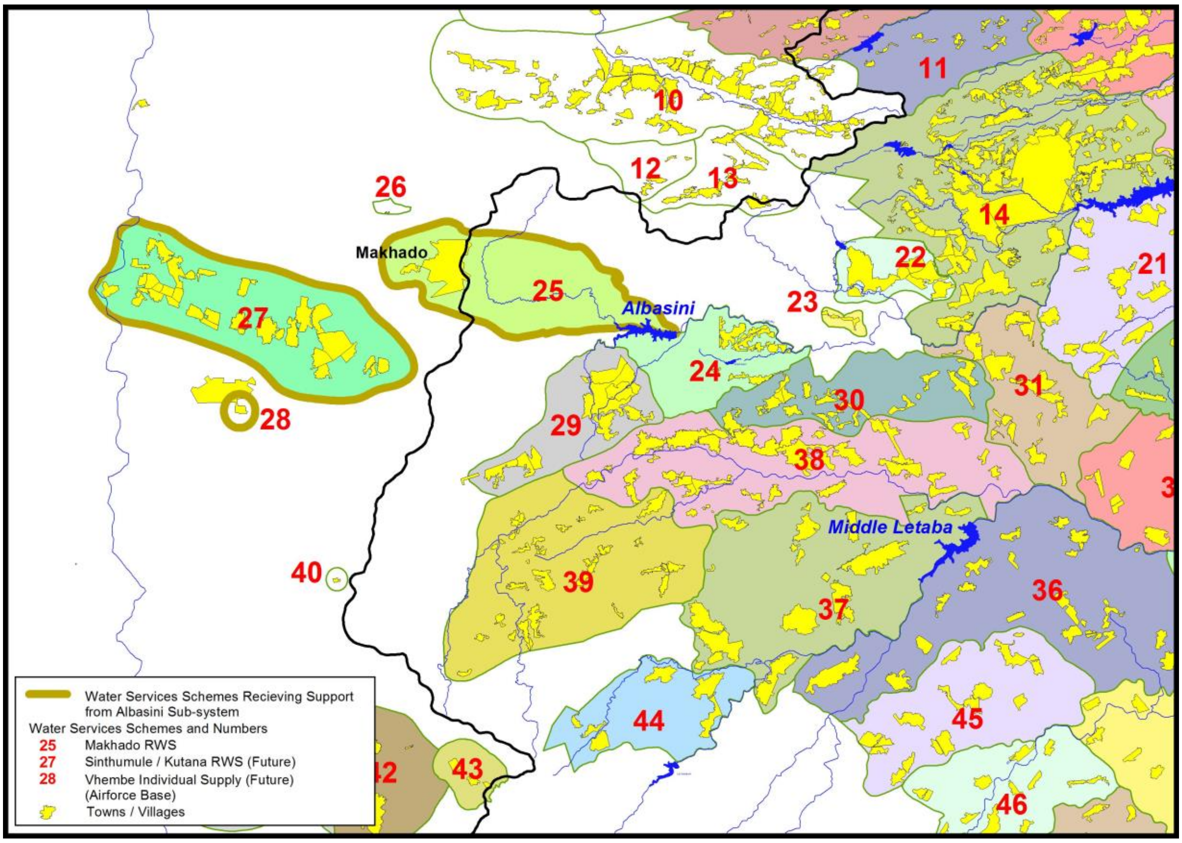


Figure 11.9 Location of Urban and rural domestic water services schemes supplied from the Albasini sub system.

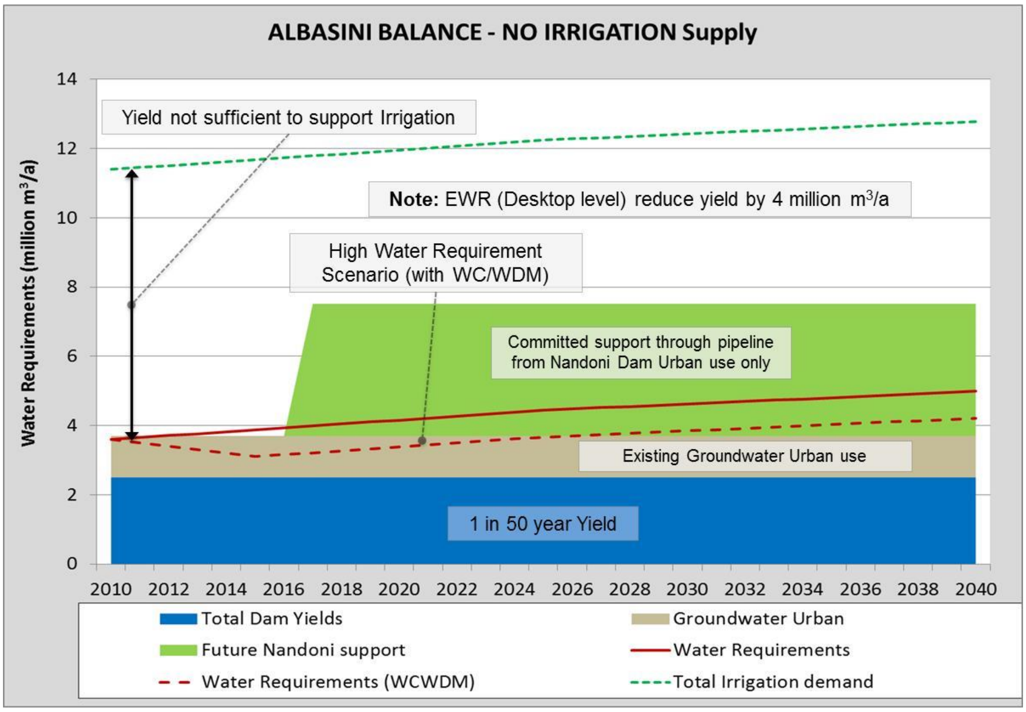


Figure 11.10 Albasini sub-system water balance

The volume allocated from Nandoni Dam for this scenario is more than sufficient to supply the high water requirement until 2040.

It is however important to also take into account the overall balance which includes Sinthumule Kutana RWS and the Air Force Base as shown in **Figure 11.11** for the Greater Albasini sub-system. In this water balance the existing groundwater use from the other two water services schemes is added to the available yield component of this system, as well as the volume already allocated from Nandoni Dam to Sinthumule Kutana RWS and the Air Force Base. From this balance it is evident that the total allocation from Nandoni Dam is more in line with the 2040 expected deficit. In the initial period until the pipeline and related supply from Nandoni Dam start to take place, significant deficits will still occur in the Sinthumule Kutana RWS and the Air Force Base supply areas, although supply to Louis Trichardt (Makhado) should be sufficient when WC/WDM is successfully implemented.

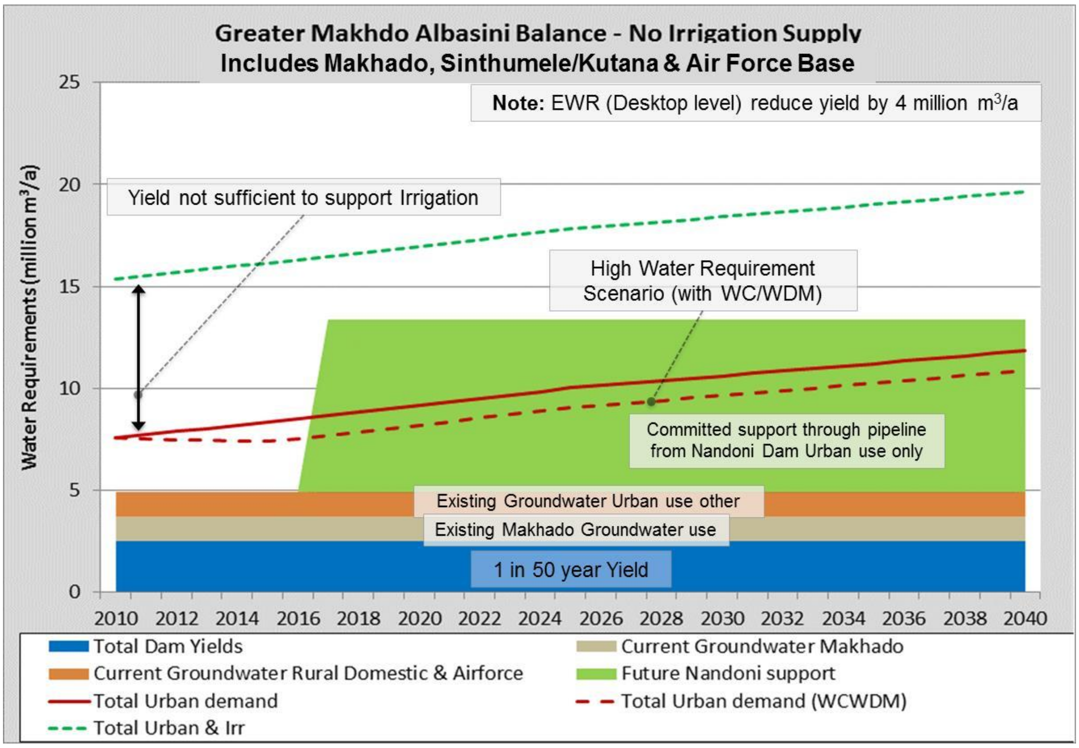


Figure 11.11 Greater Albasini sub-system water balance

The support from Nandoni Dam is not available to augment irrigation requirements in this sub-system, and it is thus easier to view the balance regarding the irrigation requirements from Albasini separately (see **Figure 11.12**). The 1 in 20 year yield from Albasini Dam given in this balance represent the incremental 1 in 20 year yield that is available after the 1 in 50 year yield as used in **Figures 11.10** and **11.12,** have already been supplied in full. Due to the severe shortages experienced from Albasini Dam, the irrigators started to move towards the use of groundwater resources. The best estimate of the available current groundwater resources within the irrigation area was given as 2.4 million m^3/a.

This means there is still an expected deficit in excess of 4 million m^3/a regarding the irrigation supply. The impact of current irrigation development abstractions upstream of Albasini Dam from both surface and groundwater combined is in the order of 8 million m^3/a. Some of this irrigation might be unlawful and should be removed once the current validation and verification process has been completed.

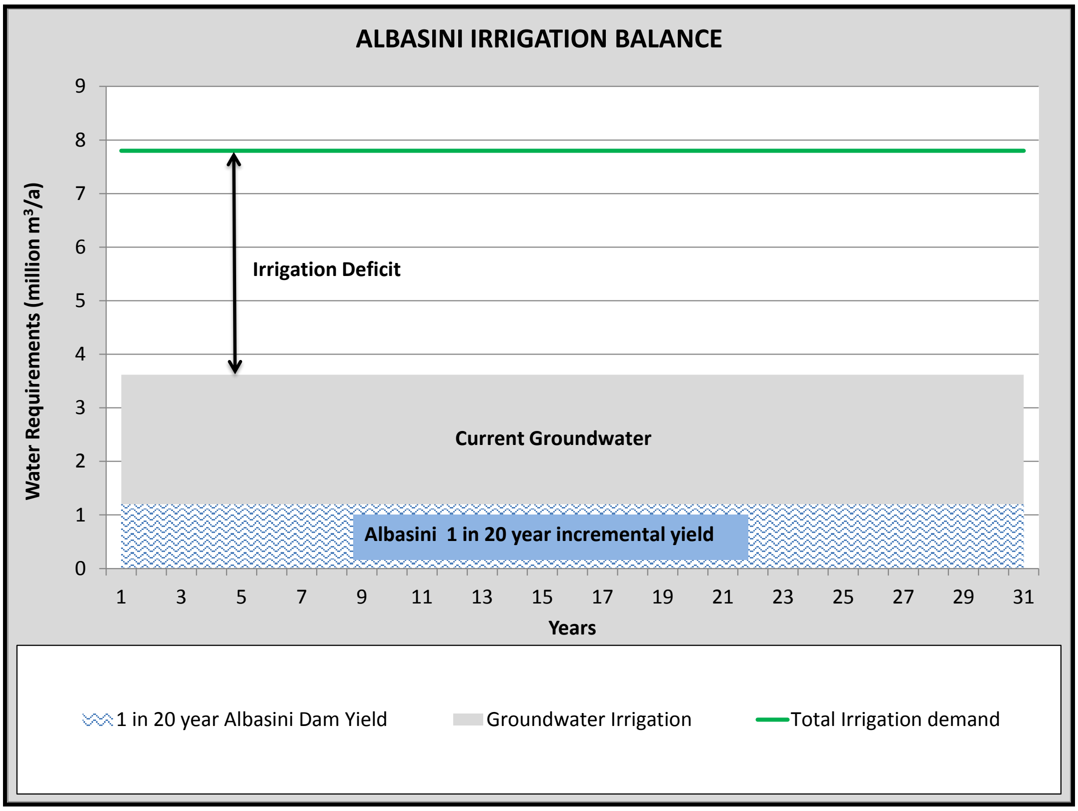


Figure 11.12 Albasini sub-system irrigation water balance

Table 11.7: Greater Albasini sub-system intervention options

Intervention	Contribution (million m^3/a)	(1)Date	Remark
Water Conservation and Water Demand Management in Urban Sector	0.97	2015	Saving
Pipeline from Nandoni	8.5	2016	Support
(2) Reduce upstream irrigation (Ground and surface water abstractions based on V&V)	4.00 (when 50% reduced)	2023	Increase yield

Notes: (1) Estimated date when the development option is operational
(2) Enable Albasini Dam to support current irrigation allocation

All the urban/industrial as well as rural domestic use up to the year 2040 can be supplied when the intervention options given in **Table 11.7** are implemented. To be able to fully supply the irrigation allocation will depend on the findings from the Validation Verification study, currently in progress.

11.4.2 Damani Dam sub-system

Damani Dam is located in the Luvuvhu River catchment and support irrigation as well as rural domestic requirements in the Damani RWS, which is partly located in the Luvuvhu catchment and partly in the Mutale River catchment (**Figure 11.13**). The irrigation allocation amounts to 4 million m^3/a, and is not yet utilised. For the purpose of the balance it was assumed that the irrigation allocation will be taken up from 2016 and be fully utilised by 2020.

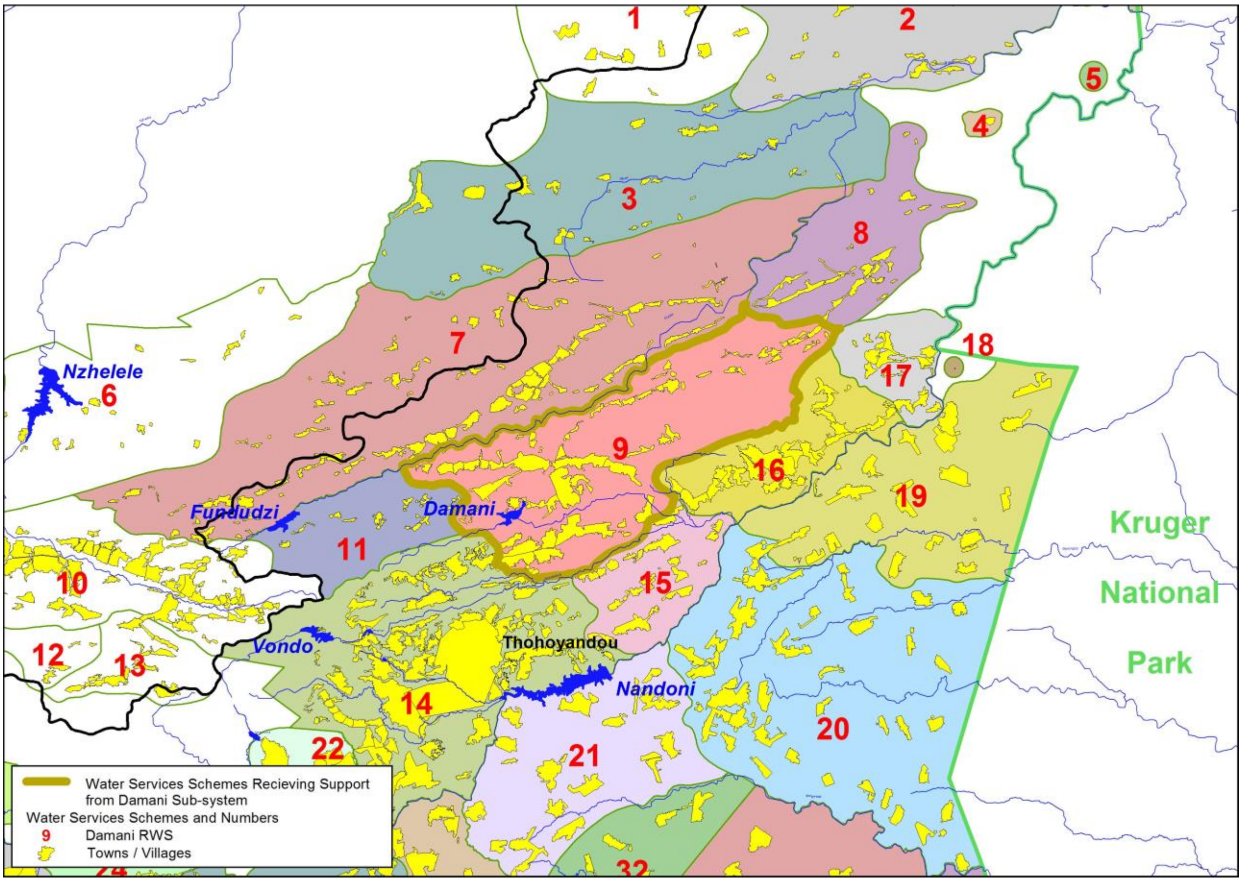


Figure 11.13 Location of Urban and rural domestic water services schemes supplied from the Damani sub system.

Although the sub-system is currently in balance (see **Figure 11.14**), significant deficits are expected in the near future, which will largely depend on the development rate of the irrigation allocated to this resource. With no initial irrigation developments and only considering rural domestic requirements, sufficient water will be available from this sub-system until 2019.

From Nandoni Dam a commitment of 0.9 million m^3/a was made in support of this sub-system, and there is potential for the development of additional groundwater resources of approximately 1.9 million m^3/a in future. With these interventions and WC/WDM in place, the rural domestic demand can be supplied until 2030 if no irrigation developments are in place.

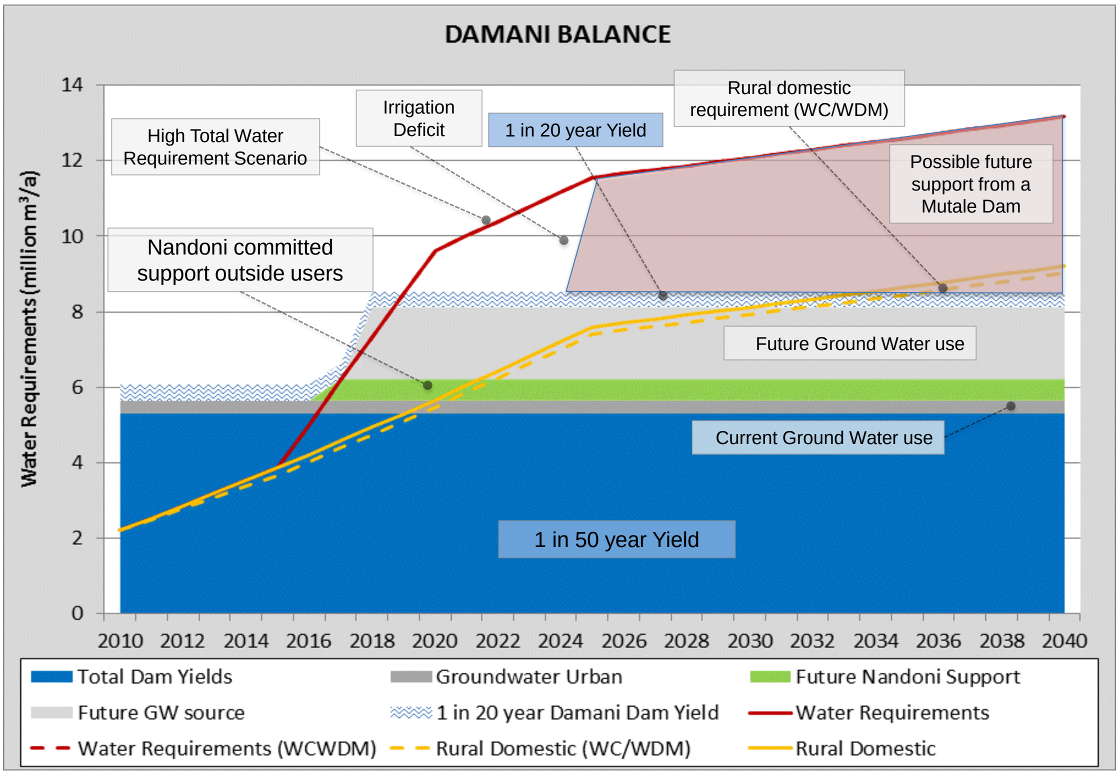


Figure 11.14 Damani sub-system water balance

Table 11.8: Damani sub-system intervention options

Intervention	Contribution (million m³/a)	(1)Date	Remark
Water Conservation and Water Demand Management in Urban Sector	0.2	2015	Saving
Support from Nandoni	0.6	2017	Increase yield
Utilise remaining groundwater potential (only 60% of potable exploitation potential used)	1.9	2018	Increase resource yield
(2)Support from a dam in Mutale	5.1	2024	Increase yield Increase yield

Notes: (1) Estimated date when the development option is operational.
(2) Only fully develop irrigation once a Mutale dam is in place

With the irrigation allocation fully utilised, a significant deficit will be experienced in this sub-system. The most feasible option to overcome this deficit will be to support this system from a possible new dam in the Mutale River.

It therefore recommended to only fully develop the irrigation allocated to this scheme, when a new dam in the Mutale River is in place to support part of the demand imposed on this sub-system.

11.4.3 Greater Thohoyandou sub-system (Vondo, Phiphidi & Tshakuma dams)

Before the completion of Nandoni Dam in 2004, the Greater Thohoyandou area as depicted in **Figure 11.15** was supplied only from Vondo, Phiphidi and Tshakuma dams, with support from two run off river abstractions and related package plants at Dzindi and Dzingae, as well as from some groundwater abstractions.

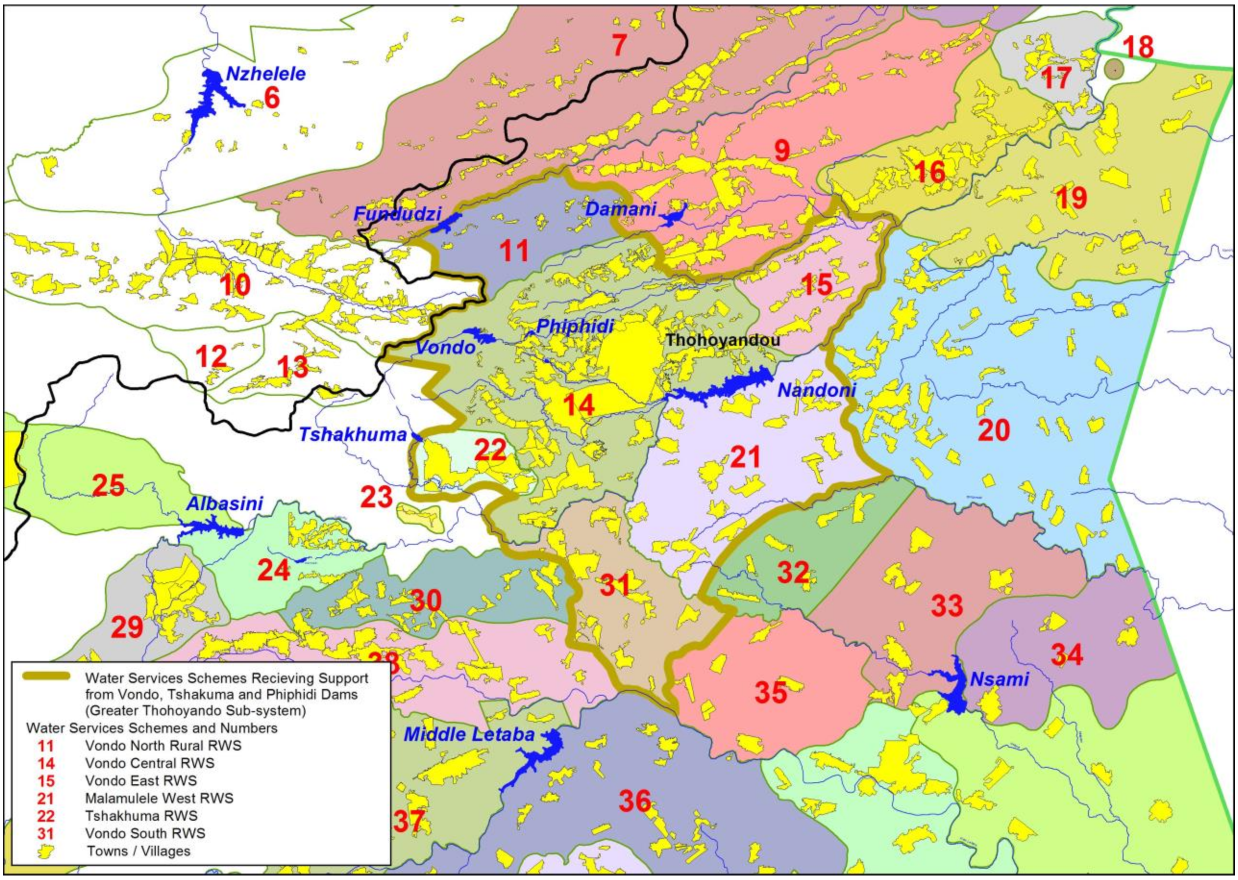


Figure 11.15 Location of Urban and rural domestic water services schemes supplied from the Vondo, Tshakuma and Phiphidi dams (Greater Thohoyandou sub system).

From **Section 9.1.3** as shown on **Figure 9.12** is was clear that this sub-system could only support the growing water requirements until 2018 with a significant deficit of 20 million m^3/a expected by 2040. Support from Nandoni Dam is the intervention option that will provide the largest support volume in future. A volume of 16 million m^3/a from Nandoni Dam was already committed for support to the Greater Thohoyandou sub-system. This intervention option in combination with WC/WDM will be sufficient to support the growing water requirements until 2040, as shown in the water balance (**Figure 11.16**).

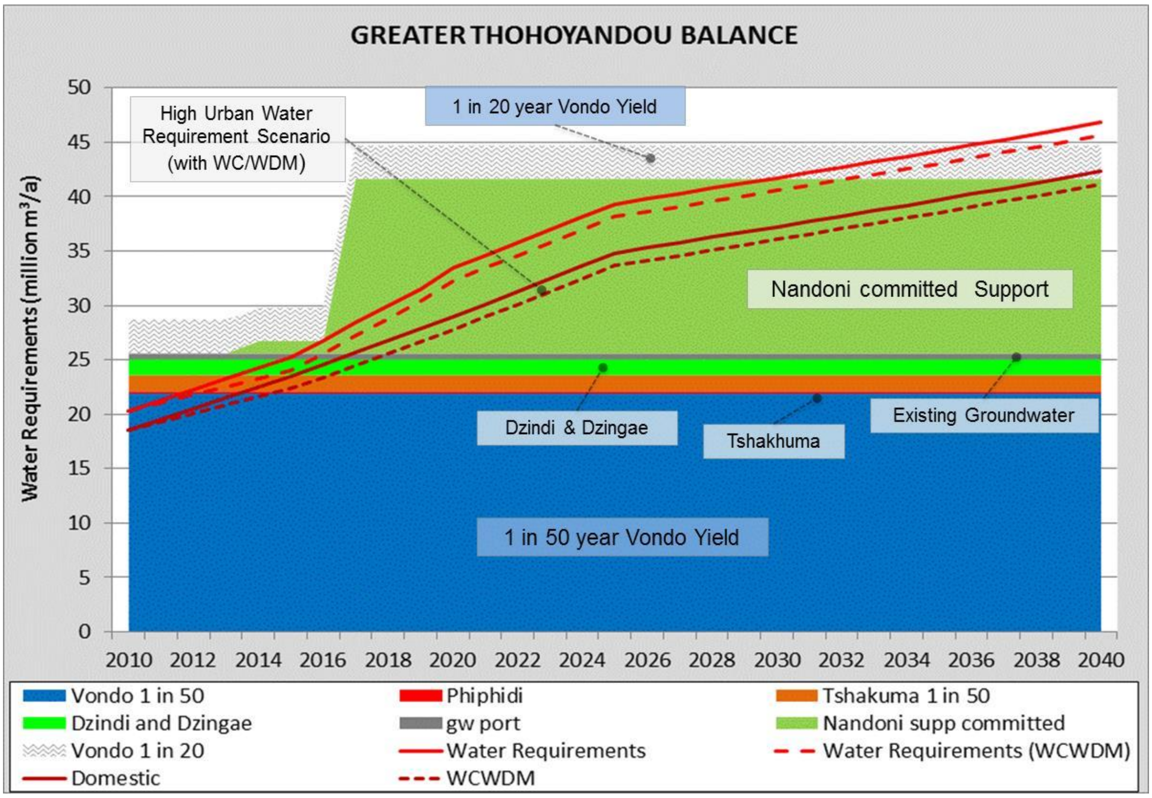


Figure 11.16 Greater Thohoyandou sub-system water balance

Table 11.9: Greater Thohoyandou sub-system intervention options

Intervention	Contribution (million m^3/a)	[1]Date	Remark
Water Conservation and Water Demand Management in Urban Sector	1.18	2015	Saving
Support from Nandoni	16.05	2017	Support
Utilise remaining groundwater potential (only 60% of potable exploitation potential used)	5.14	2040	Increase resource yield

Notes: (1) Estimated date when the development option is operational.

There is still a fair amount of potential for the development (in excess of 5 million m^3/a) from groundwater resources within this area, which can be utilised from 2040 onwards or earlier if required.

The intervention options given in **Table 11.9** will enable the sub-system to supply the expected growth in demands to beyond 2040.

11.4.4 The combined Nandoni and Greater Thohoyandou sub-system (Integrated Nandoni system)

Two water balances were prepared to illustrate the extensive demand growth imposed on this sub-system. These demands include the demands and related growth projections from the immediate water services schemes around and downstream of Nandoni Dam, as well as for those located relatively far from the dam, with some located even outside the Luvuvhu catchment. The first water balance focus on the water supply to the Nandoni immediate and downstream water supply areas in combination with the Greater Thohoyandou sub-system as discussed in **Section 11.4.3.** This supply area is shown in **Figure 11.17** and mainly combines the Water Services Schemes located downstream of Nandoni Dam with the existing Greater Thohoyandou sub-system.

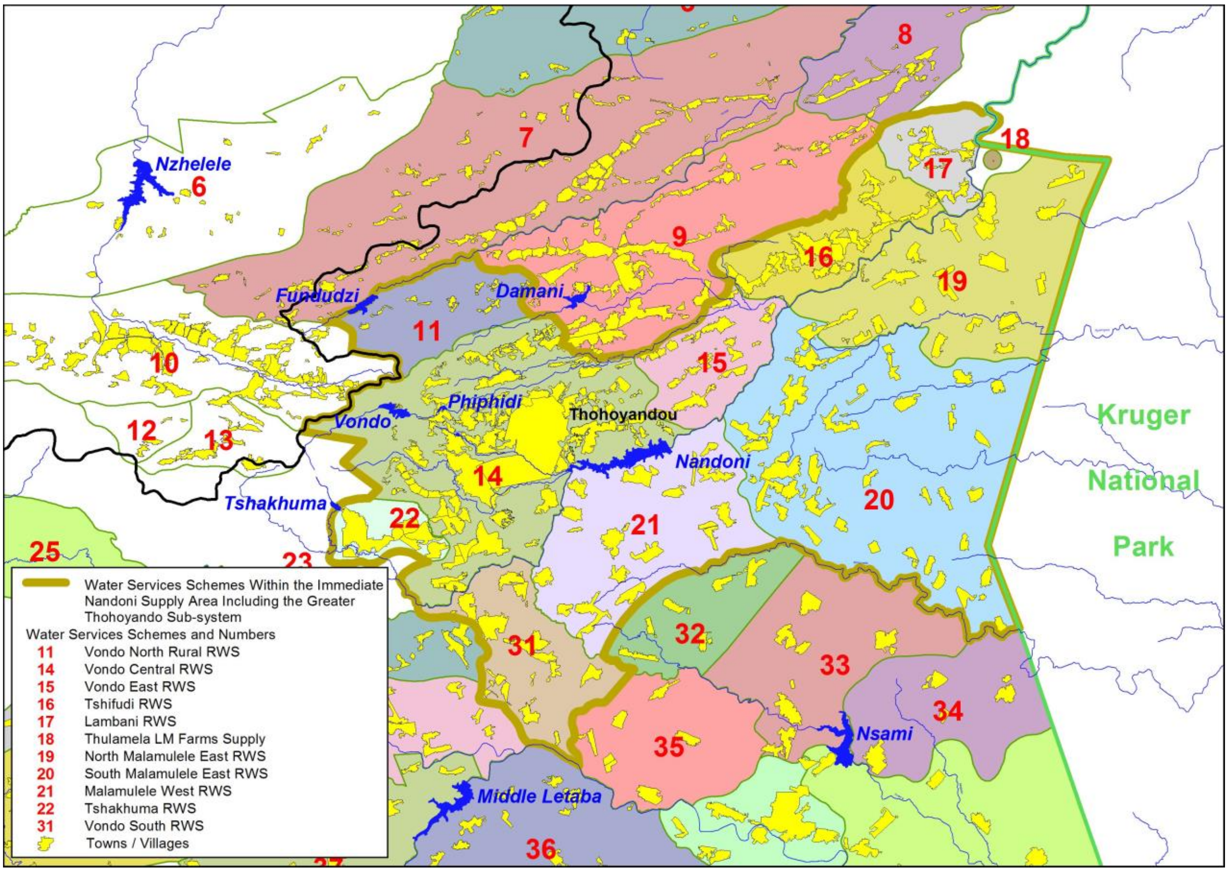


Figure 11.17 Location of Urban and rural domestic water services schemes within the immediate Nandoni supply area including the Greater Thohoyandou sub system.

This first water balance focus only on the urban/industrial and rural domestic requirements and thus excludes the irrigation requirements and the lower assurance yield available from the sub-system able to support irrigation water requirements. Only the 98% assurance yield or also referred to as the 1 in 50 year yield was applied in this balance as given in **Figure 11.18.**

From this balance it is clear that the 1 in 50 yield from Nandoni Dam is more than sufficient in combination with the existing dams in the Greater Thohoyandou sub-system to supply the expected 2040 demand, with a fair amount of the 98% assured yield not utilised.

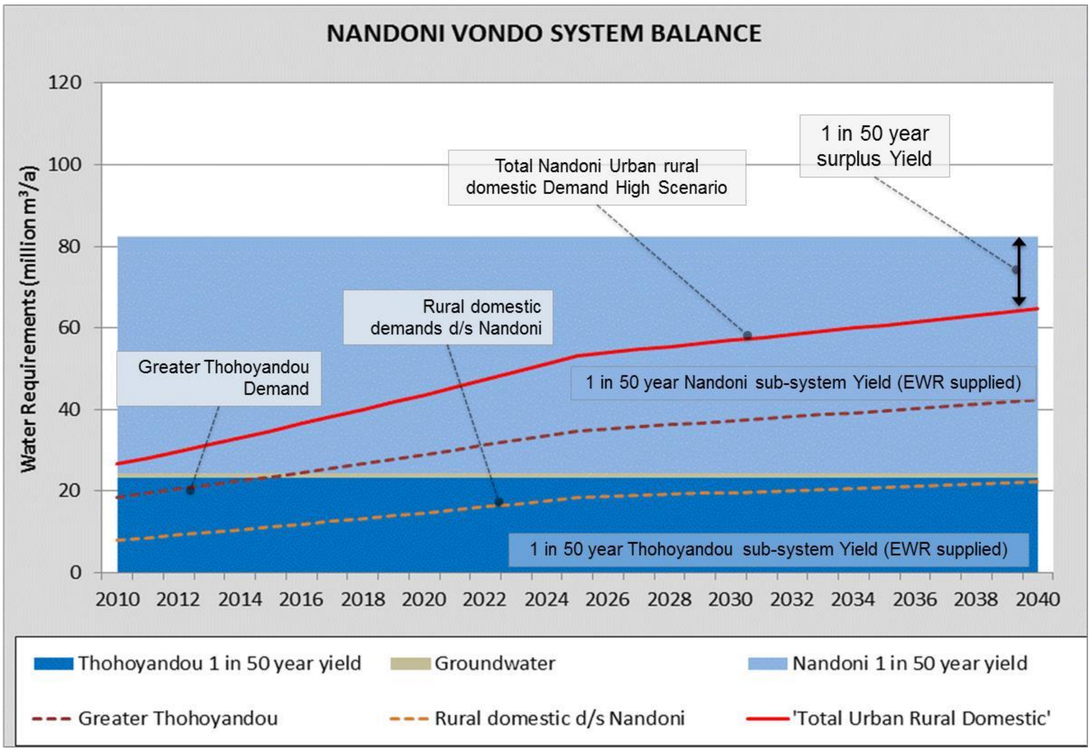


Figure 11.18 Greater Thohoyandou Nandoni sub-system water balance

A substantial volume of approximately 28 million m^3/a from the Nandoni yield was already committed to several other water services schemes located outside the supply area as shown in **Figure 11.17**. A summary of these supply commitments are given in **Figure 11.19.**

These committed support volumes were included as one of the intervention options in the sub-systems already discussed in **Section 11**, such as the Greater Albasini sub-system, the Damani sub-system and the Middle Letaba Nsami system. The location of the water services schemes utilising these committed volumes, as well as the immediate Nandoni supply area and the Greater Thohoyandou sub system supply area, are shown in **Figure 11.20**.

All these water services schemes are, or will in future be connected to the Nandoni supply system, referred to as the Integrated Nandoni system. The timing of phasing in of the support to the different demand centres is uncertain at this stage, and depends largely on the construction time and available funds to put the required infrastructure in place.

Most of these support systems need to be in place as soon as possible, and the bulk of them were thus included in the balances to be available by around 2016. The water balance for the Integrated Nandoni System without intervention options is given in **Figure 11.21**. This balance clearly illustrates the different main demand and yield components forming part of the Integrated Nandoni System.

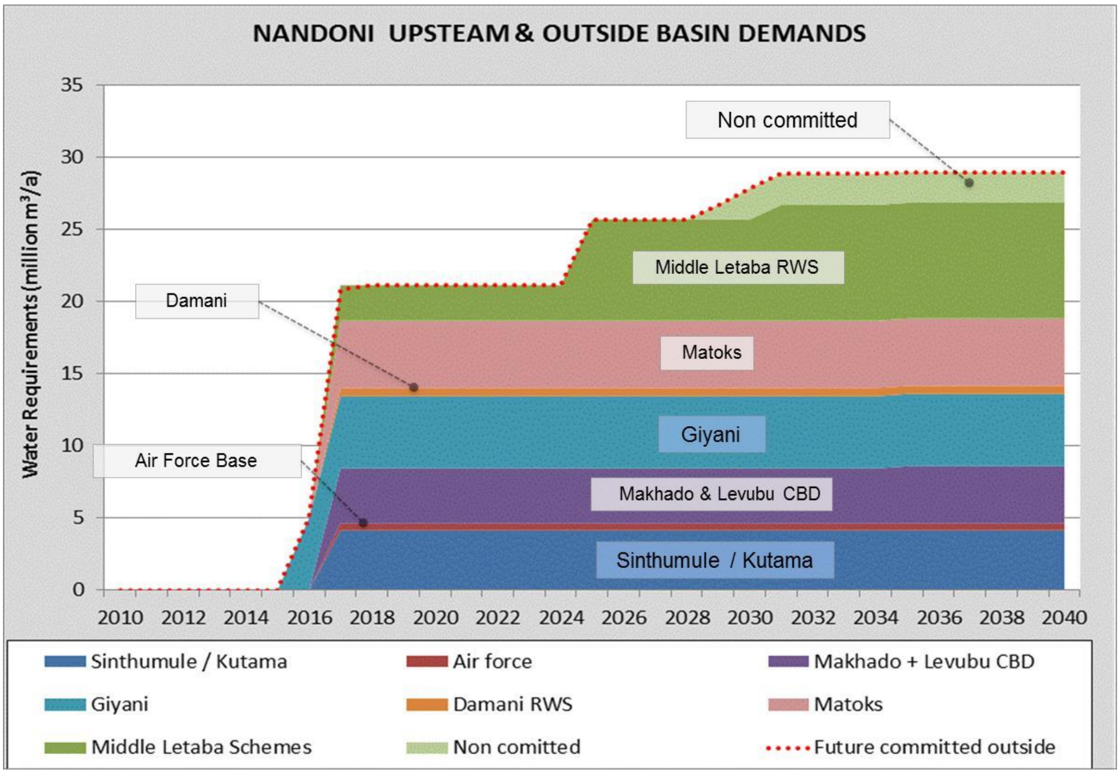


Figure 11.19 Support committed from Nandoni Dam in support other water services schemes

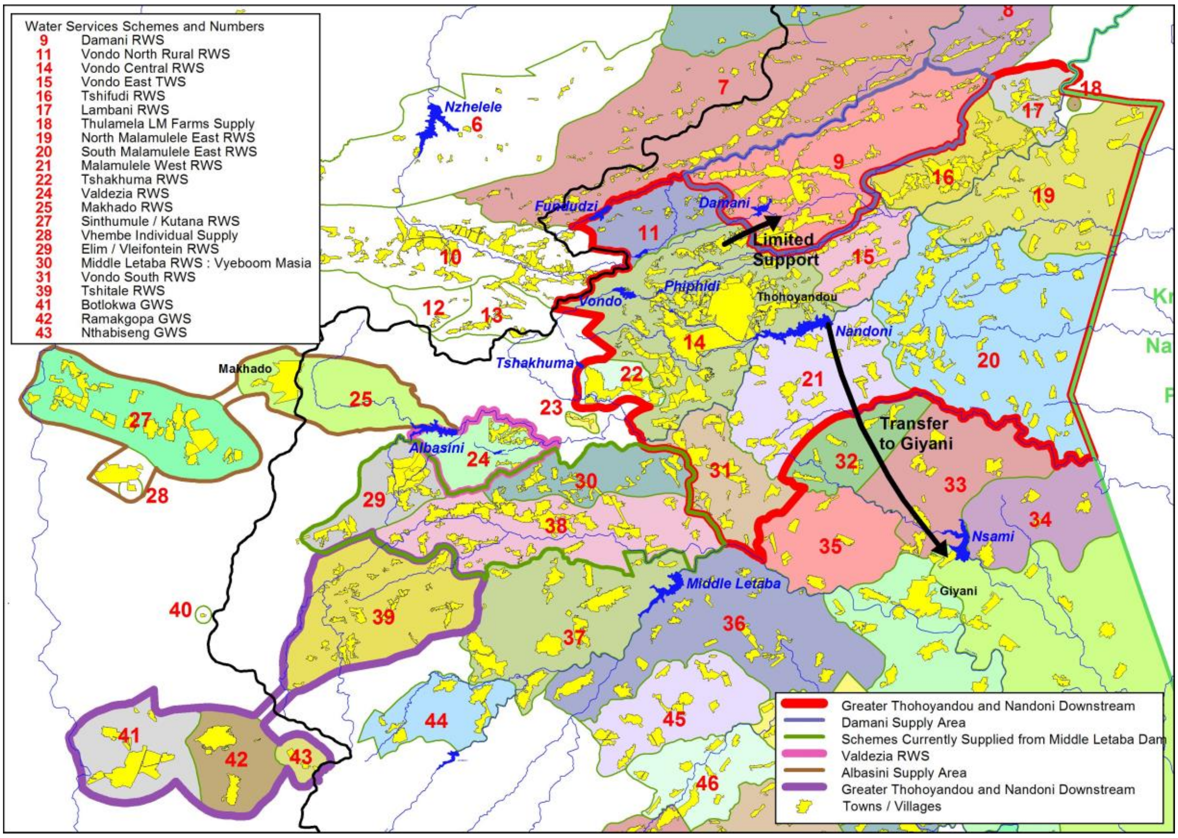


Figure 11.20: Location of Urban and rural domestic water services schemes within the Integrated Nandoni system.

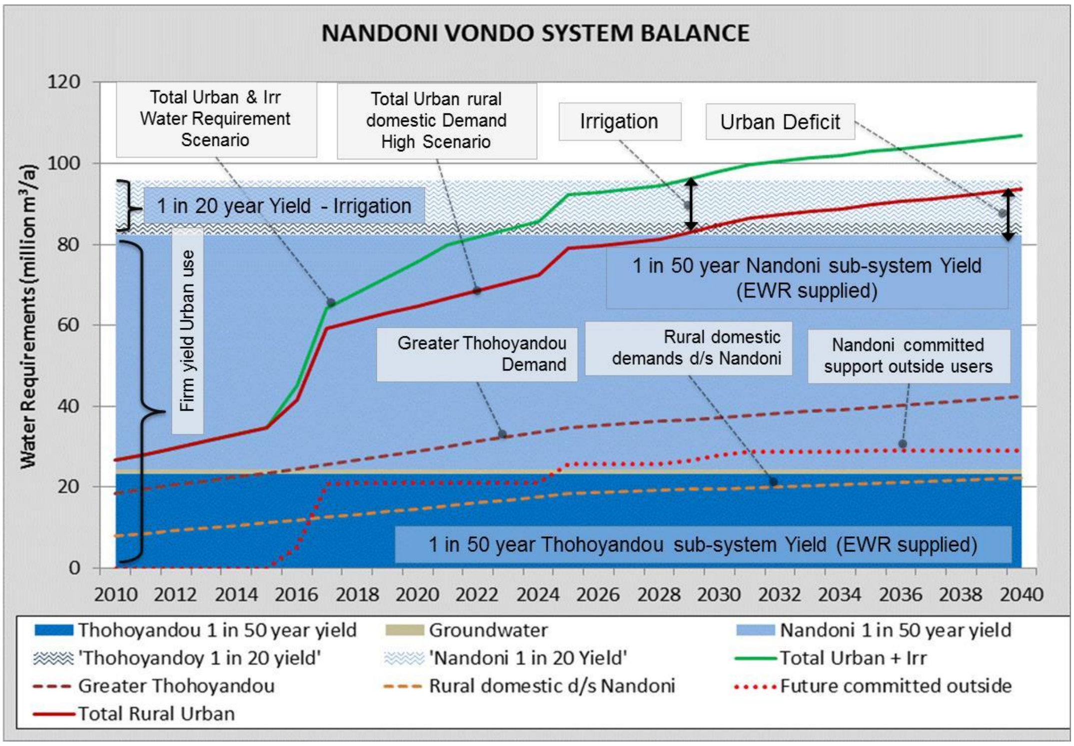


Figure 11.21 Integrated Nandoni System water balance without intervention options

Deficits is expected to occur in this system from 2031 onwards, for both water use sectors, urban/domestic rural and irrigation. This system is thus already (2012) slightly over allocated; although a relative small portion of the allocated demand centres are currently receiving water from Nandoni Dam.

The first two intervention options to implement are WC/WDM activities followed by further exploitation of groundwater resources (See **Table 11.10**). The impact of these two intervention options is illustrated in **Figure 11.22**. These two intervention options are only able to keep the system in balance until 2035 and a third intervention option will be required. From a yield and economic point of view the possible Paswane and Xikundu dams are intervention options that can be used to provide additional yield to be utilised by the Integrated Nandoni system. However, due to important fish migration that needs to take place between the Luvuvhu and the Mutshindudi rivers these two dams were excluded for further considerations (see **Section 10.2.2**).

The next intervention option that can be utilised to support the Integrated Nandoni system is a possible dam in the Mutale River.

The water balances prepared for the Mutale system showed that even a relative small dam in the Mutale River can provide more than sufficient yield for the existing and projected future Mutale system demands to 2040 development level (See **Section 11.5**).

The Integrated Nandoni system currently supplies water to water services schemes located in the Mutale River basin such as the Vondo North Rural RWS (11) and the Damani RWS(9). This already opens the option where these two RWS can be supplied from the possible future dam in the Mutale, instead of receiving water from the Integrated Nandoni system.

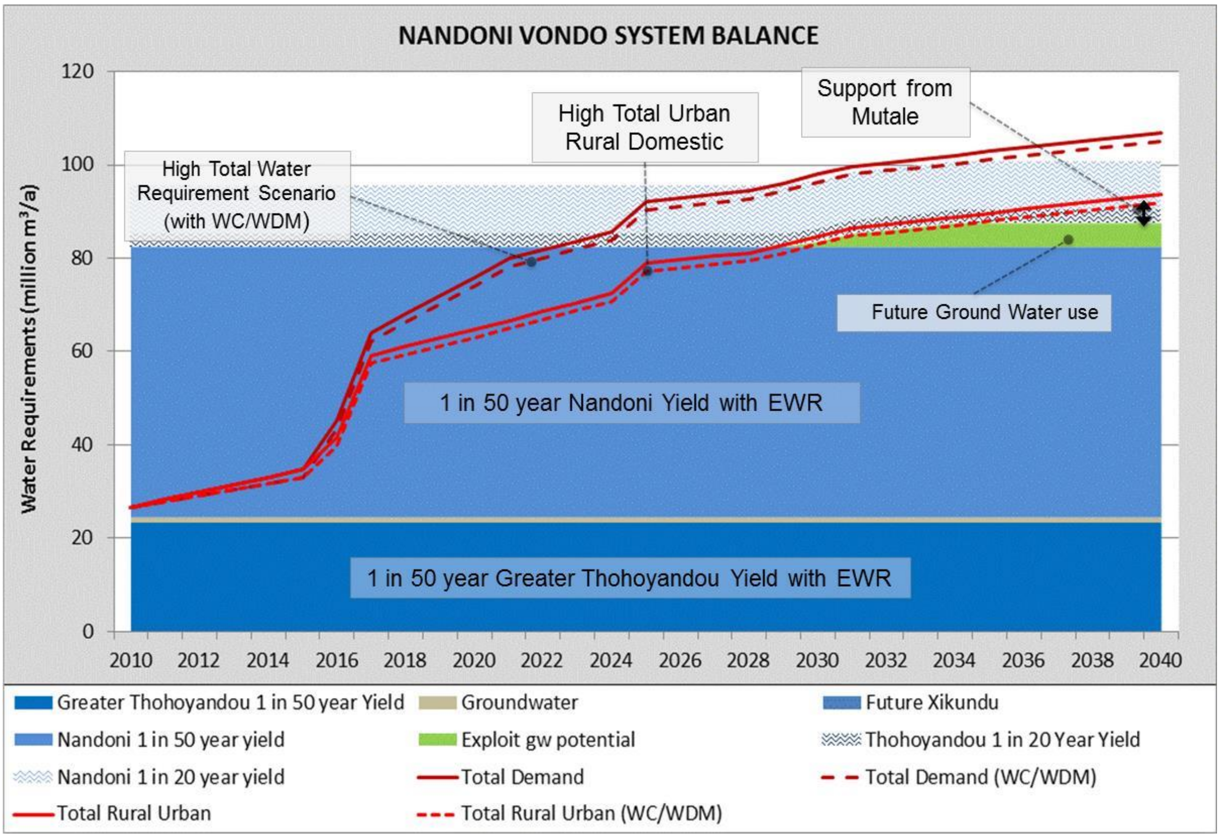


Figure 11.22 Integrated Nandoni System water balance with intervention options

Table 11.10: Integrated Nandoni system intervention options

Intervention	Contribution (million m^3/a)	(1)Date	Remark
Water Conservation and Water Demand Management in Urban Sector	1.7	2015	Saving
Utilise remaining groundwater potential (only 60% of potable exploitation potential used)	5.1	2031	Increase resource potential
Support from future dam in Mutale	4.8	2035	Support

Notes: (1) Estimated date when the development option is operational

The support required from a dam in the Mutale River to maintain the Integrated Nandoni water balance until 2040 is relative small, and can easily be achieved.

11.5 MUTALE SYSTEM

The water services schemes in the Mutale basin are supplied with both ground and surface water resources. The surface water resources comprise in almost all cases river runoff abstractions, representing a non-firm yield. The existing groundwater resources support approximately 50% of the 2010 rural domestic demand. The assurance of supply from the groundwater resources is in general expected to be higher than the surface water currently obtained from river runoff abstractions.

At 2010 development level a significant portion of the rural domestic requirement is supplied from sources with a non-firm yield with an unacceptable low level of assurance (see **Figure 9.17** in **Section 9.1.4**). Intervention options that can be implemented fairly quickly are WC/WDM and further exploitation of groundwater resources as indicated in **Figure 11.23**.

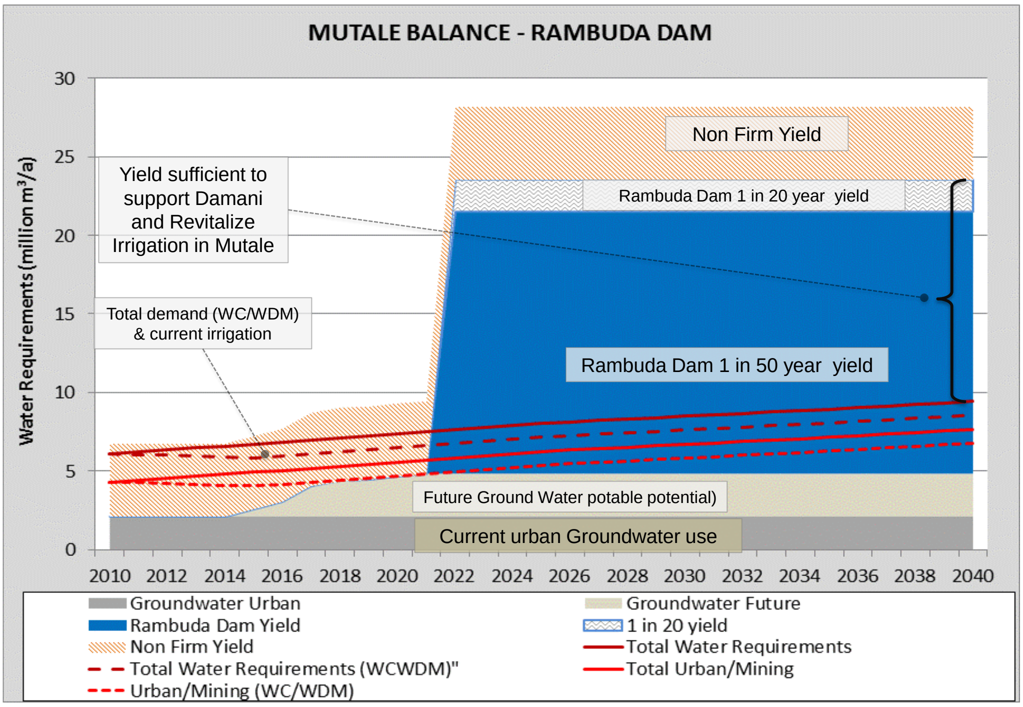


Figure 11.23 Mutale System water balance with intervention options – Rambuda Dam

From the “Mutale River Water Resources Investigation” study (DWAF, 1999) the possible Rambuda downstream Dam and the Tswere Dam were identified as the most promising dam sites. The Rambuda Dam size is limited due to foundation problems at the site, while Tswera Dam can be constructed to quite a large capacity. For the purpose of the water balance a medium size Twera Dam was considered. Both these two possible future dams yield significantly more than the projected 2040 urban rural domestic requirement including the current irrigation in the Mutale basin. This however excludes the urban rural domestic requirements located in the Mutale catchment, but currently supplied from Vondo and Damani dams in the Luvuvhu catchment.

The WC/WDM and additional groundwater resources can only maintain a positive water balance for the water supply to the urban and rural domestic requirements from 2018 to 2021. The earliest possible date to have a new storage dam in place was taken as 2022.

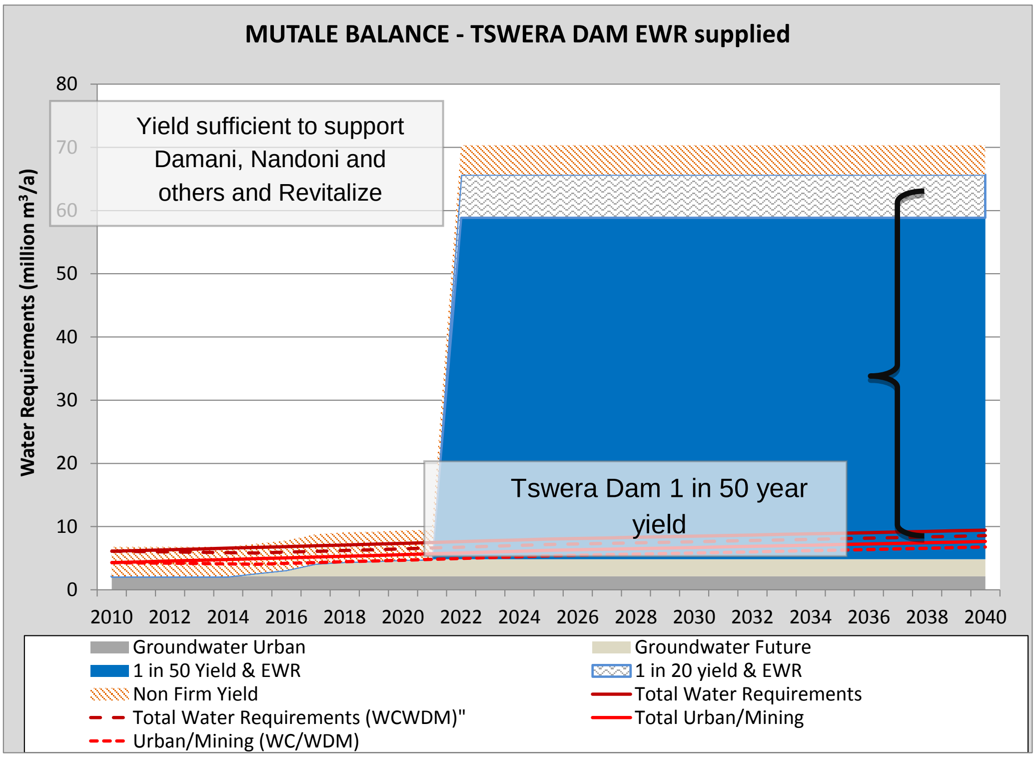


Figure 11.24 Mutale System water balance with intervention options – Tswera Dam

Table 11.11: Mutale system intervention options

Intervention	Contribution (million m^3/a)	(1)Date	Remark
Water Conservation and Water Demand Management in Urban Sector	0.74	2015	Saving
Utilise remaining groundwater potential (less than 60% of potable exploitation potential used)	2.7	2015	Increase yield
(2)Rambuda or Tswera Dam (recommend to undertake a Pre-feasibility study)	(2)16.7 ((3)62.1)	2022	Increase resource potential

Notes:(1) Estimated date when the development option is operational.

(2) Rambuda Dam yield- can revitalise ±400ha after supporting Integrated Nandoni system

(3) Tswera Dam yield – can revitalise all areas (1800ha) identified and much more after supporting the Integrated Nandoni system

The Rambuda Dam site location relative to the demand centres is expected to be the preferred option as it will result in the least pumping costs. The dam size is unfortunately limited due to foundation problems.

The possible Rambuda Dam can however provide more than sufficient yield to supply the existing irrigation requirements and the projected Mutale rural domestic requirements until 2040. The remaining yield available after supporting the Mutale system requirements will be sufficient to cover the deficits in the Integrated Nandoni system and to revitalise some of the irrigation in the Mutale basin.

Tswera Dam can provide a significantly higher yield as shown in **Figure 11.23** and **Table 11.11**. The 62.1 million m^3/a reflects the yield for a medium size Twera Dam and can be increased if required, by increasing the size of the possible future Tswera Dam.

By implementing the given intervention options all the water requirements can be supplied to beyond the year 2040.

11.6 RISKS THAT MAY INFLUENCE THE RECONCILIATION SCENARIOS

11.6.1 Groundwater developments

As part of the Reconciliation Strategy study, high level catchment wide groundwater assessments were carried out (desktop balances). These assessments indicated that in some areas additional groundwater abstractions are possible, and this was included in the water balances as possible intervention options. Although these results will provide reasonable indications of the groundwater availability, more detailed groundwater investigations are required to ensure that final planned groundwater developments will be feasible and sustaining.

Before any of these groundwater developments can take place, it is very important to commission feasibility studies focussed on the relevant areas. Sub-systems where future groundwater developments play a significant role, include the Middle Letaba Nsami sub-system, the Albasini sub-system, Damani sub-system, Mutale sub-system, the Greater Thohoyandou sub-system and to a lesser extend also the Groot Letaba system.

11.6.2 Validation Verification Study Results

Only the validation component of the current Validation Verification of Water use process was completed. The validation component identified the actual water use, while the focus of the verification component of the study is to verify the lawfulness of these abstractions.

It is expected that unlawful water use in the Letaba catchment will be relative small and should therefore not impact significantly on the water balances prepared for the Letaba sub-systems. Unlawful water use is expected to be present in the Luvuvhu catchment particularly in the Albasini sub-system and surrounding areas. This however, still need to be determined and proved, and might result in an improved water balance for the Albasini sub-system, if such unlawful water use is eradicated.

11.6.3 Development rate of irrigation

The development of irrigation in most areas is limited to areas which were previously irrigated. These irrigation areas have reduced over time due to land claims and the low assurance of water supply. Areas on the Lower Groot Letaba that were historically allocated for the development of small scale farmers, did not yet realise and is still expected to be developed in future.

The Limpopo and Mpumalanga Provincial Departments of Agriculture are attempting to revitalise many of these schemes, in order to stimulate the rural economy of the provinces. Whether these will take place in future and if so from when and at what rate it will happen, is at this stage not clear. In some of the sub-systems this can have a significant impact on the water balances. This typically includes the Damani sub-system, the Integrated Nandoni system, the Magoebaskloof Vergelegen sub-system and the Mutale system.

11.6.4 Timing related to the phasing and completion of water supply networks from the integrated Nandoni system

Nandoni Dam was completed in 2004, while only a small portion of the infrastructure required to distribute the water to the various users forming part of the Integrated system, is currently in place and operational. The water balances related to the Integrated Nandoni system will all be affected when the delivery time of the bulk water distribution infrastructure are not meeting the target dates that were applied in the respective water balances. No official information was available at the time, providing a schedule of completion dates for the different infrastructure components. The implementation dates applied in the water balances is purely based on best estimates, also bearing in mind the expected time when deficits will start to occur in a specific demand centre.

Most of the sub-sub-systems within the Integrated Nandoni system are already experiencing deficits, and it is therefore very important that the construction of the related bulk water supply infrastructure receive high priority and be completed as soon as possible. Deviating from the required time off receiving support from Nandoni Dam will change the sub-system water balances, and can have significant impacts in some cases.

11.6.5 Results from the Classification study for Luvuvhu and Mutale catchments

For the purpose of the reconciliation strategy study only desktop level EWRs were available for the Luvuvhu and Mutale catchments. Some of these EWRs impacted significantly on the system yield and in the case of Albasini and Tshakuma dams, will result in a zero yield available from these two dams. It is also possible that the final agreed reserve volumes for the Mutale and Luvuvhu sub-systems can result in reduced yields available from current and possible future dams. These EWRs can thus result in substantial changes to water balances, and it is proposed to commission a Classification study on the Luvuvhu and Mutale rivers to address this uncertainty.

11.6.6 Improved observed flow and other hydrology related data

Improved observed flow that was available for the Mutale catchment calibrations as part of this study, resulted in a new set of hydrology flow records that provided fairly higher yield estimates from possible dams in the Mutale, in comparison with previous study results. Reliable observed flow in the Mutale is however still very limited, and improved observed flow records covering a longer record period will be of high value to confirm the higher yield results obtained for this system.

Yield results obtained for Thabina, Thapane and Modjadji dams were regarded as low confidence yield results, due to lack of observed data for those sub-systems. Obtaining good quality observed data for these sub-systems will result in more reliable results, which most probably will change the water balances that were prepared as part of this study.

The area capacity data available for Dap Naudé Dam is suspicious, and different resources provide significantly different characteristics. The storage capacity of any dam directly impacts on the yield available from the dam, and it is therefore recommended that a survey be done to determine the correct actual capacity of Dap Naudé Dam.

11.6.7 International Obligations

The international agreement between South Africa and Mozambique does not specify a minimum flow quantity or quality. South Africa however, is party to international policies and protocol and the flow across the border must be reasonable (both in terms of quantity and quality). As part of these international policies and protocol there are specific provisions in terms of which State Parties shall exchange information and consult each other and, if necessary, negotiate the possible effects of planned measures on the condition of a shared watercourse.

Depending on the outcome of such possible negotiations, there might be some limitations on development in the RSA, or the minimum flows that need to enter Mozambique. These limitations are currently not known and can impact on the water balances, specifically those relating to the Mutale catchment.

11.7 ACTIONS THAT NEED TO BE STARTED AS A MATTER OF URGENCY

For the purpose of confirming and implementing the preferred reconciliation (intervention) scenario, a number of associated actions will be required soon. A summary of the required actions and related time line and responsibilities are given in **Table11.12**. These actions are described in the next paragraphs and include the following:

A. Verification of water entitlements

The verification component of the Validation Verification study is currently still in process. Once the extent of unlawful irrigation water use has been determined, the Department of Water Affairs need to prepare a compliance monitoring and enforcement plan. This plan must clearly determine whether unlawful water use should be eliminated through prosecution or whether licences for the unlawful water users will be considered.

Areas where the removal of unlawful water use will impact significantly on the water resources need to be re-evaluated and water balances adjusted accordingly.

B. Monitor water use to confirm water requirement projections before implementing options

The monitoring of water use is essential for the operation and future planning of any water supply system. This is the only way how it will be possible to detect whether measures such as WC/WDM, operating rules etc. are successful and if the selected intervention options given in the strategy will be sufficient to support the growing water requirements in the system. Interactions with Municipalities and irrigation schemes are important to ensure that reliable water use data can be obtained at key points in the system.

C. Water Conservation and Water Demand Management

Interactions with the Municipalities are necessary on WC/WDM. A WC/WDM plan needs to be developed for each of the LMs where saving through WC/WDM can be obtained. These plans should address the related Water Services Schemes within the study area, as well as for those located outside the study area, but are receiving water from the Luvuvhu Letaba systems. Implementation of these plans needs to start in 2015.

D. Monitor observed flows and storage levels at strategic points

The monitoring of observed flows and storage levels in dams and maintaining the related gauging stations to ensure accurate measurement, is essential. Quite a number of existing gauging points require attention to be able to provide reliable and very essential data required to be able to manage this system properly, and to be able to do sensible and realistic future planning of water resources and related assured water supply to users. Details of these are given in the Hydrology and System Analysis reports, and need to be followed up. Observed flow data is in particular of importance for the planning of a possible future dam in the Mutale River.

E. Clarify future irrigation developments and revitalisation of previous irrigation schemes

There is very little or no information available on what will happen in future with irrigation that was affected by land claims and poor water supply as well as the related time frames for the revitalisation of several irrigation schemes within the study area.

This information is vital an in some of the sub-systems it may have a significant impact on the water balances. Over and above the smallholder schemes in the former homelands which are included in the list of schemes to revitalise, there is also the Albasini Dam sub-system that is currently not able to support the irrigators, due to upstream developments and related reduction in yield. These irrigators have an allocation from the dam, but can't use it purely due to the current insufficient yield available from the dam. These irrigators started to utilise groundwater resources to provide some relief to the severe water shortages. DWA need to consult with Department of Agriculture regarding the above mentioned matters, to firm up on the future irrigation requirements and to be able to adjust the related water balances accordingly.

F. Set clear targets for the construction of bulk water distribution systems

Significant delays in the construction of the bulk water supply systems from Nandoni Dam were experienced in the past. This resulted in ongoing deficits in water supply to several areas. Clear timeframes for construction and commissioning of these bulk water distribution systems are not available. These need to be confirmed and adhered to, so that deficits in water supply can be addressed in time and in many cases as soon as possible. Interactions with the Municipalities and DWA Water Services are crucial to ensure effective and sufficient water supply within the Integrated Nandoni system.

G. Continuous integration between Water Balances and water supply planning to water services schemes

Continuous integration and interaction between the Reconciliation Strategy and related water balances with the water supply planning and construction of water supply related infrastructure need to take place. This is required to ensure that these developments are aligned with the strategy and also to adjust or refine the strategy to address changing circumstances as and when required.

11.8 MEDIUM AND LONG TERM ACTIONS REQUIRED

A number of actions are required over time. They are:

A. Commission a Bridging study on the possible development and revitalisation of irrigation in the Mutale River. This study should focus on the use of a possible future dam on the Mutale River as the resource to be used to supply water to the irrigation schemes. This dam will also be used to supply water for urban and rural domestic purposes. It is however expected that a dam in the Mutale will provide more yield than can be utilised by the urban and rural domestic sector, and thus providing an opportunity for the development and revitalising of irrigation in this area.

B. Pipeline to replace the canal between Middel Letaba and Nsami dams

Initiate an investigation to determine the most viable and cost effective pipeline route and size for the pipeline replacing the canal between Middel Letaba and Nsami dams. This needs to be followed by the design of this pipeline and the preparation of tenders, tender procedure, construction and commissioning of the construction.

C. Commission a Classification study on the Luvuvhu and Mutale rivers.

A classification study was already completed for the entire Letaba River catchment. The agreed EWRs and related classes were included in the final WRYM and WRPM analyses carried out in support of the Reconciliation Strategy study. However, only Desk top level EWRs were available for the Luvuvhu and Mutale river catchments. Impacts of EWRs on the yield from a system or a dam can be substantial. The Mutale and Luvuvhu eventually flow through the Kruger National Park before entering into Mozambique and this emphasise the importance and the need of properly determined high confidence EWRs, before pre-feasibility or feasibility studies are carried out for a dam in the Mutale River. The commissioning of a Classification study should thus be high on the priority list regarding the medium term related actions.

D. <u>Investigate the possibility of increasing Nandoni su-system yield by improved use of incremental flows downstream of Nandoni Dam</u>

Investigate the possibility of increasing the yield of the Nandoni sub-system by improving the utilising of incremental flows downstream of Nandoni Dam. This can be done by increasing the abstractions at the existing downstream weirs, by increasing the storage capacity of these weirs and by using real time monitoring.

E. <u>Commission Feasibility studies on groundwater development in relevant areas</u>

The availability of groundwater resources as an intervention option for the reconciliation strategy was determined by means of high level groundwater assessments (desktop catchment based water balances). Sub-systems where the exploitation of groundwater plays an important role as a future intervention option require more detailed groundwater investigations well before the implementation of the option. It is thus important to commission groundwater focussed feasibility studies on selected areas as indicated in the strategy. This is required to provide or confirm the correct development potential of the identified groundwater resources, and to determine the best locations for the related groundwater abstractions, forming part of the envisaged groundwater scheme.

F. <u>Commission Feasibility studies on the construction of storage dam in the Mutale River</u>

After the completion of the Bridging Study (see Item A above) and preferably also the Classification study, a feasibility study on the construction of a dam on the Mutale River needs to be commissioned. This study should investigate the development of a dam at any of the given three sites that was considered in the Reconciliation Strategy study. Depending on where the demand centres are located, in particular the irrigation developments, might also require the option to consider a combination of two dams on the river. It is however expected that the two upstream dams Rambuda and Tswera possible dams will be the most viable options, mainly due to their proximity to the demand centres.

Table 11.12: Summary of short term and medium to long term actions

Action	Responsibility	Timeline
Verification of Water Entitlements	DWA Regional Office, Polokwane/Tzaneen	Process started already. Complete within 3 years, i.e. 2017.
Monitor water use to confirm water requirement projections before implementing options	Municipalities and WUAs, with support from Directorate Water Use Efficiency in DWA Head Office	Start as soon as possible
Develop WC/WDM plans for municipalities, WUAs and IBs not	Municipalities and WUAs, with support from Directorate Water	Start immediately. Plans must be in place and ready

Action	Responsibility	Timeline
yet transformed into WUAs.	Use Efficiency in DWA Head Office	for implementation in 2015
Monitor observed flows and storage levels at strategic points.	DWA Regional Office, Polokwane/Tzaneen with support from Hydrology in DWA Head Office	Start as soon as possible
Clarify future irrigation developments and revitalisation of previous irrigation schemes in key areas	DWA Regional Office, Polokwane/Tzaneen with support from Limpopo Provincial Department of Agriculture	RESIS programme ongoing process.
Setting of clear targets for the construction of bulk water distribution systems related to the integrated Nandoni system	DWA Regional Office, Polokwane/Tzaneen with support from Municipalities and DWA Water Services Head office Pta	Start as soon as possible
Continuous integration between Water Balances and water supply planning	DWA Regional Office, Polokwane/Tzaneen with support from Municipalities and DWA Water Services Head office Pta and DWA National Water Resource Planning	Ongoing process
Commission a Bridging study on the possible development and revitalisation of irrigation in the Mutale River.	DWA; Options Analyses in Head Office with support from Department of Agriculture	Start at the latest in 2016
Initiate an investigation to determine the most viable and cost effective pipeline route and size for the pipeline replacing the canal between Middel Letaba and Nsami dams	DWA; Options Analyses in Head Office with support from DWA National Water Resource Planning and Municipalities	Start as soon as possible
The design of the pipeline between Middle Letaba and Nsami dams, the preparation of tenders, tender procedure, and construction.	DWA; Options Analyses in Head Office with support from DWA Water Services Head office Pta and Municipality	Start at the latest in 2015
Commission Feasibility studies on groundwater development in relevant areas	DWA National Hydrological Services Groundwater with support from National Water Resource Planning and Municipalities	Start at the latest in 2015
Commission Classification study on the Luvuvhu and Mutale rivers	DWA Head Office, RDM.	Start at the latest in 2016
Investigate the possible increase of the Nandoni sub-system yield by improved utilising of downstream incremental flows	DWA; Options Analyses in Head Office with support from DWA National Water Resource Planning	Start at the latest in 2017
Commission Feasibility studies on the construction of storage dam in the Mutale River	DWA; Options Analyses in Head Office.	Start at the latest in 2017

12 THE RECONCILIATION STRATEGY IN A NUTSHELL

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(xi) Nandoni Dam to be used to support the already committed areas located outside as well as inside the Luvuvhu catchment.

(xii) Remove unlawful use upstream of Albasini Dam, based on findings from the validation and verification process.

(xiii) Use a possible dam in the Mutale River (Rambuda or Tswera dam) to create additional yield in the system to augment future requirements in the Mutale and Luvuvhu.

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

(xv) Investigate the possibility of increasing the yield of the Nandoni sub-system by improving the utilising of incremental flows downstream of Nandoni Dam. This can be done by increasing the abstractions at the existing downstream weirs, by increasing the storage capacity of these weirs and by using real time monitoring.

13 RISKS AND UNCERTAINTIES CONSERNING THE RECONCILIATION PERSPECTIVE

The following risks and uncertainties have been identified in accordance with the NWA:

- The extent of unlawful water use and lawful growth in water use is unknown. Until the verification component of the V&V processes is completed, the water reconciliation strategy will be based on the assumption that all validated water use is lawful.
- The cooperation of District and Local Municipalities is of utmost importance for achieving the WC/WDM targets in the urban water use sector.
- The timing related to the phasing and completion of water supply networks from Nandoni Dam to the different water services schemes already committed to receive water from the dam.
- Uncertainties concerning the development of new irrigation schemes, the revitalizing of existing inactive irrigation schemes, to what extent existing irrigation allocations that forms part of land claims will be taken up again in future. The timing when these developments will commence and the rate at which the irrigation developments will be phased in, is currently not known.

- Only high level groundwater assessments were undertaken as part of the Reconciliation Strategy study. More detailed groundwater investigations are required to provide the correct development potential of the groundwater resources and to identify the best location for specific future developments. It is important to commission groundwater feasibility studies focussed on the areas identified for possible future development.
- The yield estimates determined for the existing and possible future water supply schemes in the Luvuvhu and Mutale catchment included the requirements for the environment, based on desk top EWR estimates. Far more extensive work needs to be carried out to determine high confidence EWRs and to take into consideration the impacts not only on the ecology, but also on the related socio economic impacts on the associated areas.
- Uncertainties regarding the International Obligations, as the current agreement between the RSA and Mozambique does not specify a minimum flow quantity or quality, but do require that the flow across the border must be reasonable, both in terms of quantity and quality.
- The prevailing storage in the dams within the sub-system under consideration at the time when future implementation decisions are taken will influence the short-term risk of supply and the related urgency to implement the required interventions. Drought restriction operational decisions are therefore a key management mechanism where-by the acceptance of short duration restrictions could postpone eminent capital expenditure, by a number of years.

  Given this characteristic, the operational and intervention planning must be closely integrated to ensure prudent decisions are taken at any point in time. These decisions should be supported by risk assessments that are based on system analysis (simulations) with the Water Resources Planning Model.

14 IMPLEMENTATION ARRANGEMENTS

It is DWA's intention to form a Strategy Steering Committee that will oversee the implementation of the strategy, as well as recommend adaptive measures to accommodate any changes that may affect the reconciliation scenarios.

The strategy actions will be the responsibility of the respective institutions listed in **Table 11.12.** Detail project plans need to be compiled in which the actions will have to be broken down further with time lines and budgetary requirements for each organisation.

The SSC members will convene twice a year, where each organisation will be requested to present progress on the implementation of their respective activities.

Particular attention needs to be given to strategy recommendations requiring negotiations with the Mozambique. DWA International Liaisons will have to take the lead, most likely through the structures provided by LIMCOM.

15 RECOMMENDATIONS FOR FURTHER WORK

15.1 WORK RELATED TO THE FINAL RECONCILIATION STARTEGY

All issues identified for investigation towards the Final Reconciliation Strategy were already investigated.

Other issues go beyond the scope of this study as discussed in **Section 15.2.**

15.2 FUTURE WORK OUTSIDE THE SCOPE OF THIS STUDY

A number of issues go beyond the scope of this study and separate studies are recommended for these issues.

- The extent of unlawful water use within the study area is not yet known, as the verification component of the Validation Verification study is currently still in process. The water balances for affected areas should be redone as part of the continuation study, once the validated water uses have been verified.

- The time frames in which irrigation developments will take place, as well as the expected rate of the developments are currently not known. This includes the development of new irrigation schemes, the revitalizing of existing inactive irrigation schemes as well as to what extent existing irrigation allocations that forms part of land claims will be taken up again in future. DWA need to consult with Department of Agriculture regarding this matter to firm up on the future irrigation requirements. These changes need to be included in updated water balances to be prepared as part of the continuation study.

- Engage with processes undertaken by LIMCOM and obtain clarity on the international obligations.

- Ensure that continuous integration between Water Balances and related Water Supply Planning of water services schemes takes place. As part of this process it is important to obtain details on the timeframes of the different infrastructure developments, to ensure that these can take place within the available yield from the resources and the growing demands in the system. The correct timing of most of these infrastructure developments is essential, to maintain a positive water balance over the planning period.

- Licencing Issues: Ensure that water licence related issues are resolved within the given framework of the reconciliation strategy.

- The hydrology for the entire study area was completely redone and improved with water requirements updated for the entire study area based on results obtained from the current Validation and Verification study, with only the Validation of water use component currently completed. This information in combination with the updated WRYM and WRPM provides a wealth of information and should be utilised for Operating Analyses which are carried out on an annual basis under the supervision of DWA. In some cases it will be required to update and or improve on existing operating rules.

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Appendix A

MAPS

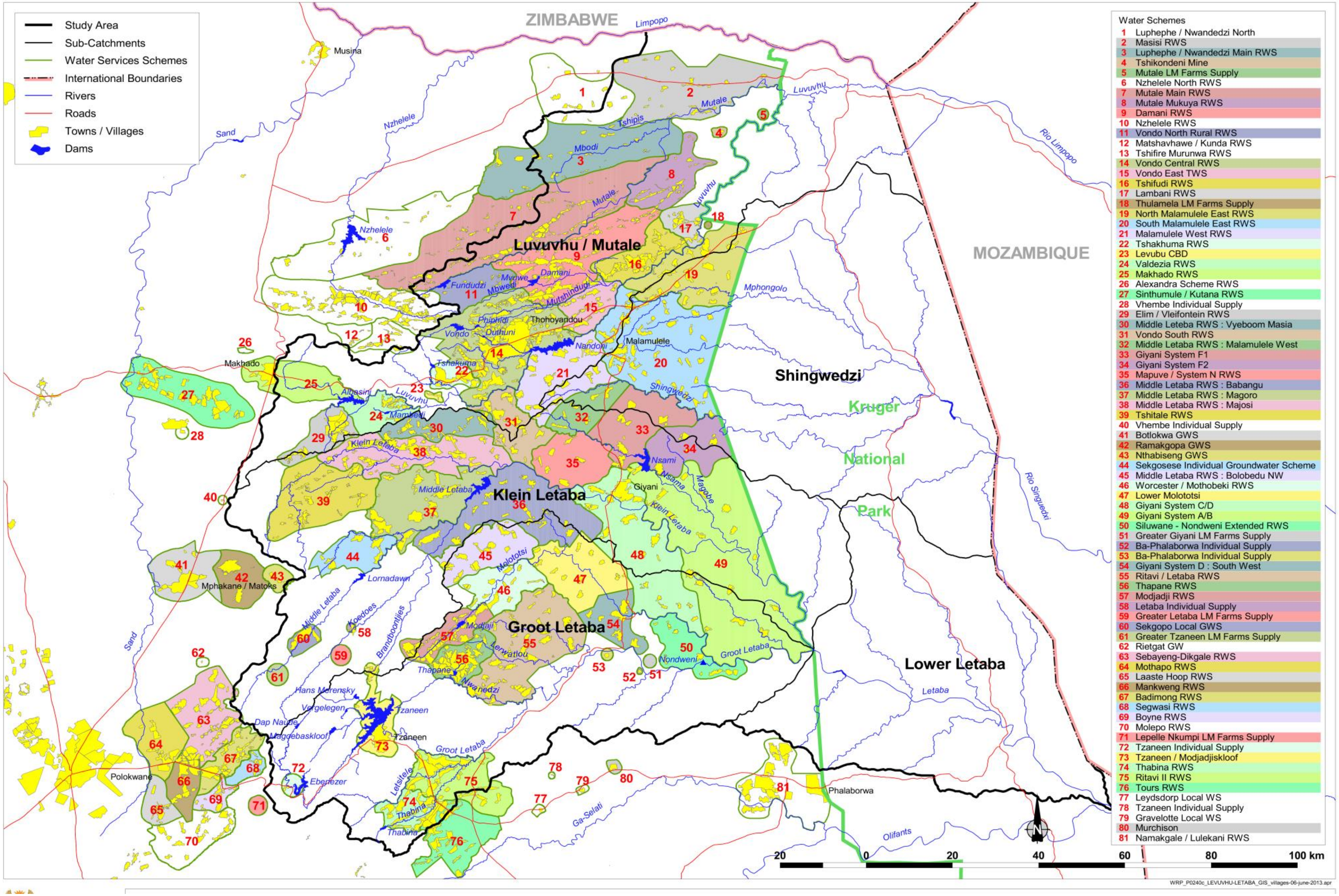

Figure A-1 Water Services Schemes

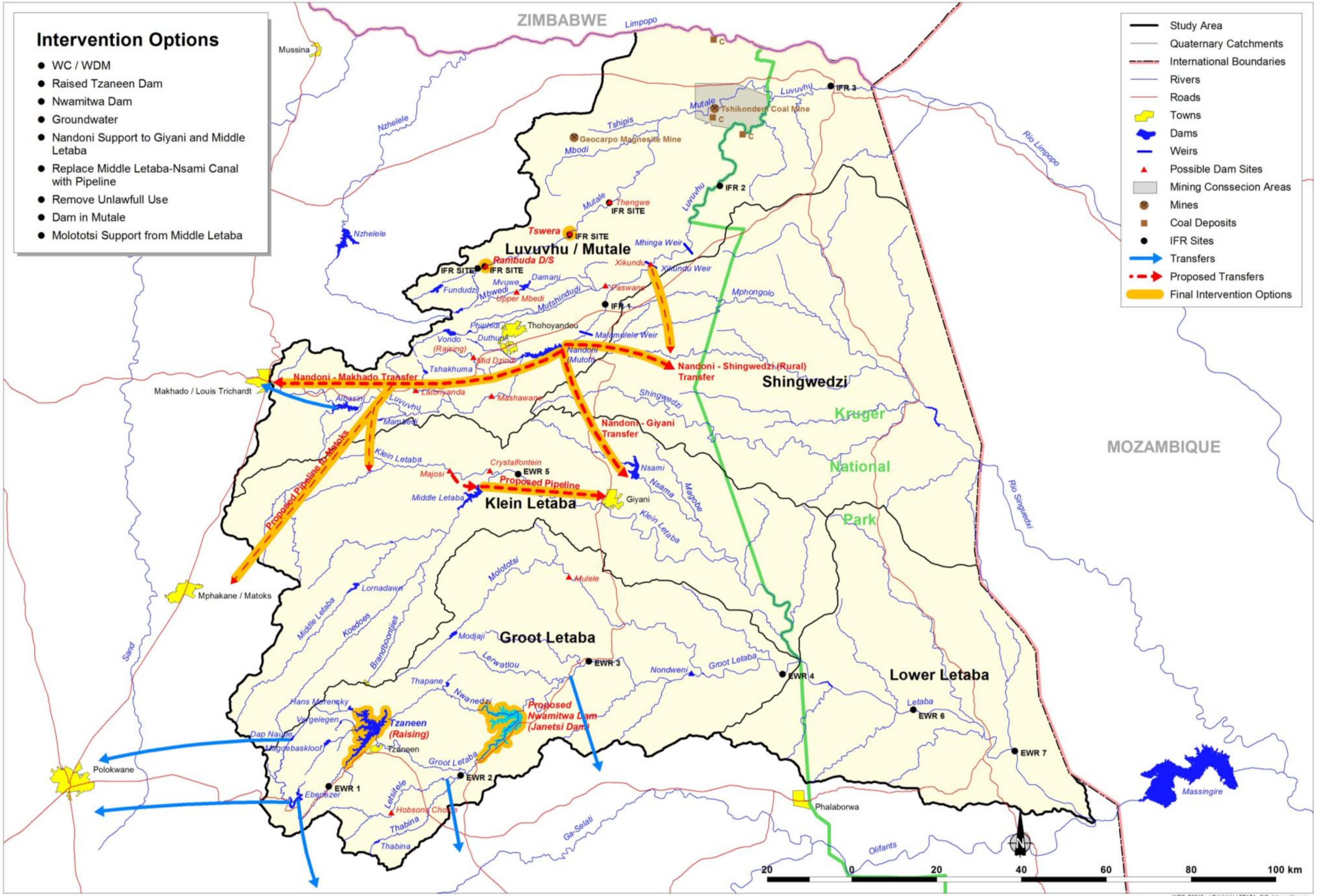

Figure A-2 Location of Key Intervention Options