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REPUBLIC OF SOUTH AFRICA

DWAF Water Resource Study in Support of the ASGISA EC Mzimvubu Development Project

SUMMARY REPORT

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DWA WATER RESOURCE STUDY IN SUPPORT OF THE ASGISA-EC MZIMVUBU DEVELOPMENT PROJECT

LIST OF STUDY REPORTS

REPORT	DWA report number
Summary Report	**P WMA 12/000/00/3609**
Existing water supply infrastructure assessment	P WMA 12/000/00/3609 Volume 1 of 5
Agricultural assessment and irrigation water use	P WMA 12/000/00/3609 Volume 2 of 5
Groundwater assessment	P WMA 12/000/00/3609 Volume 3 of 5
Water resources assessment	P WMA 12/000/00/3609 Volume 4 of 5
Assessment of potential for pumped storage and hydropower schemes	P WMA 12/000/00/3609 Volume 5 of 5
Rainwater Harvesting	P WMA 12/000/00/3609
An assessment of rain-fed crop production potential in South Africa's neighboring countries	P RSA 000/00/12510

Title	***Summary Report***
Authors	*Study Team*
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DWA WATER RESOURCE STUDY IN SUPPORT OF THE ASGISA-EC MZIMVUBU DEVELOPMENT PROJECT

SUMMARY REPORT

EXECUTIVE SUMMARY

Introduction

In 2006 the DWA Directorate: National Water Resource Planning appointed BKS to assist in the provision of water-related support to the Eastern Cape Provincial Government (later AsgiSA-EC after its establishment). The main component of the task was to direct water resource planning inputs to specific development projects, for example an irrigation project, that AsgiSA-EC may identify and want to pursue as a poverty alleviation project. As a secondary component the DWA undertook to provide some general water resource information which could facilitate the identification of other potentially viable projects by AsgiSA-EC.

Water Resources Assessment

Rainfall ranges from above 1 000 mm at the coast and against the mountainous Drakensberg, to between 700 and 800 mm in the upper plateau region. Annual evaporation ranges from 1 150 mm at the coast to 1 400 mm inland. The total streamflow for the Mzimvubu River catchment as given in the WR2005 report is 2 613 million m^3*/a.*

Maps that were produced as part of the groundwater task are not a quantitive reflection of actual groundwater potential or availability, but are intended to give an indication of the change in groundwater potential across the catchment. A generalised conclusion can be made that groundwater potential, based on allocatable volumes and preliminary Reserve estimates, increases towards the east of the Mzimvubu River catchment.

Preliminary indications are that none of the quaternary catchments are currently stressed and allocatable groundwater volumes are significant, resulting in groundwater being a feasible water source in most of the quaternary catchments in the study area. Based on the preliminary assessment of available groundwater and the indication that sufficient potential exists, water supply to thousands of people in the numerous villages and towns occurring throughout the catchment, will have to consider groundwater development as a sole or supplementary water supply solution.

Sediment yields in the Mzimvubu River have been estimated according to catchment size and sediment yield potential based on the latest sediment yield maps. The reduction in storage in the dams was taken into account when the water availability (yield) from the dams were calculated.

Water Resource Development Potential

A number of possible dam sites have been identified on the Mzimvubu River and its tributaries in previous studies. Together with a few new sites identified from topographical maps, a total of 19 potential dam sites were assessed in this study. Historic firm yields ranged on average between 25% of the MAR for a 0.5 MAR sized dam, 38% for a 1 MAR sized dam, and 47% for a 1.5 MAR sized dam. Capital costs of the assessed dams vary between R290 million and R2 070 million for dams between 0.5 and 1.5 MAR.

Unit reference values (URV) of the water have been calculated from the capital costs of the dams and their corresponding historic firm yields. The URVs provide an indication of the cost of the water. URVs have been calculated for a 45 year period, a discount rate of 8%, and with the construction of dams assumed to start in 2011 and finish in three years.

The URVs of water at some of the dam sites are relatively low (varies between 40 cents and R3.90/m^3. These URVs, however, do <u>not</u> include the cost of distributing the water to the points of use. Due to the predominantly hilly topography in the catchment, the cost of distribution is likely to be high, particularly for water users remote from dam sites.

Review of Potential Water Transfer

Water transfers from the Mzimvubu River have been identified as a water resource development option that could utilise the water to supply surrounding regions. Regions that have been previously identified as possibly benefiting from water transfers from the Mzimvubu River are north to the Vaal River, east towards Durban and west towards the western parts of the Eastern Cape. With the construction of a dam at a potential site at Ntabelanga, 180 million m^3/a could be yielded from a reservoir of capacity of about 600 million m^3. Assuming most of the water is made available for transfer and a small portion is reserved for local supply, a total of 150 million m^3/a could be allocated for transfer.

The capital costs of the infrastructure are estimated to be R2 800 million for the pipelines, pump stations and the reservoir at Ntabelanga. The water needs to be pumped over the divide through a static height of 1 500 m. The total energy requirements to pump the water would be 130 MW resulting in an annual energy cost of approximately R280 million. Conveyance losses of 1.2 m^3/s of water from the point of discharge in the Kraai River near Rhodes to the Orange River have been provided for. A net of 110 million m^3/a could be made available in the Orange River at a unit reference value of about R7/m^3, which would be far too expensive for irrigation. The unit cost does <u>not</u> include distribution infrastructure to the farms.

Conventional Hydropower Potential Assessment

The modelling of water yield from potential dams in the catchment provided the opportunity to assess the hydropower potential at these dam sites. For simplicity, the potential for a single purpose hydropower development only, were assessed. Possible multipurpose developments could be investigated as more information on other development options becomes available.

The generation of hydropower was simulated with the Water Resources Yield Model (WRYM). The firm hydropower available at a 99.5% assurance of supply for each potential dam site was determined. The results are average monthly hydropower available and are presented as mega-watt continuous (MW_C), which is analogous to base load-power. This can be converted for load factor. A load factor of say 10% was assumed to be indicative of peaking power.

Base load power generation is not viable at current electricity tariffs as a single-purpose development. Peaking power is only marginal as a single-purpose development. Power generation at a potential dam site may be considered if part of a multipurpose development, and for local power supply.

Pumped Storage Schemes Assessment

Although both pumped storage and conventional hydropower schemes use water-driven turbines for the generation of power, there is a fundamental difference between the schemes with respect to the primary source of energy used. For conventional hydropower, power is generated from harnessing the energy in the streamflow, which is a source of renewable energy. Pumped storage schemes in contrast use the excess energy generated by other sources to pump water to a higher elevation during off-peak periods, from where the water is released for the generation of power during peak demand periods, much like a huge battery. Once the initial filling (priming) of the reservoirs of a pumped storage scheme has been complete, pumped storage schemes are essentially closed systems, apart from replacing evaporative and seepage losses, and are independent of river flows.

Assessment of the Ecological Water Requirements

The ecological water requirements (EWR) were determined for the Mzimvubu River catchment to investigate various development options, including several large dams. This was mainly done on a desktop level and where available with results from previous rapid Reserve studies using the Desktop Reserve Model and the updated hydrology supplied by the study team. EWR has a big impact on the available yield from the dams that were assessed. The EWR as a percentage of the MAR ranges between 13% and 44%, while the percentage reduction in yield by the EWR ranges between 18% and up to 63% (average 32%) for a 0.5 MAR sized dam, between 19% and 47% (average 30%) for a 1 MAR sized dam, and between 17% and 40% (average 26%) for a 1.5 MAR sized dam.

Assessment of Future Irrigation Potential

The climate of all the agro-ecological zones in the catchment is not suitable for large, capital intensive irrigation schemes. Generally temperatures are too low (frost is common in winter) and rainfall is too high to justify such developments. Large irrigation schemes are usually found in frost-free regions with a temperature regime that is suitable for high value perennial crops or out-of-season winter production of high value annual crops such as vegetables grown on a commercial scale. Excessive rainfall on an irrigation scheme can be disruptive to production practices and can adversely affect crop quality, particularly during harvesting time.

The likely returns from relatively low-value irrigated crops will in most cases be inadequate to cover the cost of expensive irrigation water and not be able to provide the growers with a reasonable "take-home" income.

The topography is characterized by steep incised river valleys where irrigable soils are restricted mainly to "pockets" of alluvial soils along the main rivers where flooding is an ever-present threat. These "pockets" of alluvial soils have a high irrigation potential from a climatic and soils perspective, but significant irrigation development will be limited without the river-flow regulating effect of expensive large dams upstream of these areas. Furthermore most of the irrigable areas are largely inaccessible and in general infrastructure is limited

Most land in the study area falls under the communal land tenure system in terms of which the Tribal Authority allocates the right to use or occupy land. A "permission to occupy (PTO)" certificate is the official "deed of occupation". Despite this system being widely accepted by local communities, it is recognised as one of the most significant constraints to agricultural development in the region. Without freehold title (or at least a long-lease form of land tenure) it is very difficult for any commercial enterprise, especially with expensive irrigation equipment, to be established and developed in a sustainable way.

The communal land tenure system poses special challenges to irrigation development. The issue of who owns the irrigation infrastructure of a scheme and who is responsible for it's maintenance and repair and the inability to offer land as a security for "on-farm" irrigation infrastructure and operating loans will always be a constraint to irrigation development. This land-tenure limitation has been shown to be a major contributor to the failure of many small-holder irrigation schemes and other agricultural development initiatives in South Africa in the past. Every effort should be made to address this important issue on new development projects.

Assessment of Potential Future Forestry Development

Forestry has great potential as a development driver in the Eastern Cape, and is potentially one of the most effective users of water in the Mzimvubu River catchment. The DWA is responsible for forestry regulation, but at the same time is expected to facilitate an increase in plantation area by 100 000 hectares in support of the Forestry Sector Transformation Charter. The "afforestation" task in this study was therefore aimed at assessing the impact that forestry currently has on the water balance, and at determining what further development potential should be considered for water use licensing.

The licensing of forestry water use is a complex cooperative governance affair, requiring that development should not negatively impact on water, biodiversity, or agricultural potential, and that it should have positive social outcomes. A key issue in the Mzimvubu River catchment was to reconcile forestry development with its potential impact on the ecological Reserve, with licence applications for 20 000 ha of plantation requiring decisions.

Biodiversity value was reassessed and found to be of less concern than previously thought, this in part because so much of the land has already been cultivated at some stage. A close examination of suitable and available land revealed that the biggest constraint is probably the *potential for conflict with agricultural planning. Forestry targets can be met from a water resource perspective, but this will require a negotiated land use plan with a mix of cropland and forestry development.*

Rainwater Harvesting

Rainwater harvesting presents an attractive option for households in remote villages or areas with limited access to water supply infrastructure. The cost of operation and maintenance of a household rainwater tank is minimal indeed, therefore a once-off capital investment by the state to install a tank can provide a poor family with a high degree of water security and independent responsibility. In this context, rainwater harvesting also enables year round production of fruit and vegetable crops high in micro-nutrients and therefore key in poor households' fight against child malnutrition, which is rife in the study area.

The high and evenly distributed rainfall in the Mzimvubu River produces good rainwater yields, but the area has some of the lowest water tariffs in the country. The net present value (NPV) of cost savings on conjunctive rooftop rainwater harvesting for an urban household in Lusikisiki turns positive at a water tariff of R3.20/kℓ, while the current tariff is R2.49/kℓ and experiencing strong upward pressure.

The potential for rainwater harvesting as a water resource was assessed through a desktop study to provide a preliminary indication of the rainwater techniques that can be used to augment conventional supplies. The potential for improved rainfed agriculture through increased infiltration of rainwater into the soil profile is currently central to many agricultural initiatives across the continent. Many of these techniques apply to the topographical, climate and social characteristics found in the Mzimvubu area.

The characteristics of collection surfaces greatly impact rainwater harvesting potential. Good quality roofing is beneficial for collection of drinking quality water, while thatch and uneven and rusted roof sheeting presents a limitation. In the landscape, grass cover is often maintained year round in parts of the catchment, thanks to the relatively even distribution of rainfall across seasons, which reduces the surface runoff potential but is an important erosion barrier.

It is recommended that rainwater harvesting for the built environment, cultivated areas and uncultivated areas in the study area should be analysed as a standard component of water supply options for all economic development options and municipal water supply requirements.

The area is characterised by widespread poverty and a paucity of infrastructure which complicates the provision of services and economic opportunities. Therefore the potential demand is high for independent and low maintenance household solutions to improve water, food and energy security, which can include suitable rainwater harvesting and renewable energy solutions.

Rainwater harvesting is currently economically viable for specific situations. Viability of a greater range of applications, techniques and locations is likely to improve over time as tariffs for alternative supplies are set to increase, and the cost of construction is expected to decrease as technology thereof improves.

In the light of evolving climate change mitigation mechanisms it is worthwhile to seek ways in which Payment for Ecosystem Services could help pay for implementation, thereby improving the prospects for more affordable and sustainable job creation programmes in environmental restoration.

Conclusions

- *There may be considerable potential for water resource development in the catchment. Such dams could yield considerable quantities of water in the Mzimvubu River catchment.*
- *The Eastern Cape region has favourable topography and water availability for potential pumped storage schemes. The findings of this pumped storage scheme assessment have been discussed with Eskom, who could take it forward for more detailed analyses.*
- *The preparatory work conducted has not been focused on water supply to specific locations. This is likely to be a significant factor in the planning of future projects due to the topography of the catchment and population distribution.*
- *The hydropower availability is in the order of between 0.5 and 25 MW continuous power, or between 5 and 250 MW peaking power at an indicative load factor of 10%. The unit costs for peaking power scenarios ranged between R15 million and R300 million per MW installed.*
- *The intention of potential transfer would be to supply water to irrigators in the western parts of the Eastern Cape through the Orange-Fish Tunnel from Gariep Dam. At around R7/m^3 this water, however, would most likely be far too expensive for irrigation. This cost does not include distribution infrastructure to the farms. Adding on the distribution infrastructure will further increase the cost of the water.*
- *Substantial potential exists in the study area for the development of new agricultural enterprises under rain-fed conditions and for the improvement of existing agricultural practices and productivity. The paucity of infrastructure in the area, in particular roads and power, is a major obstacle to any kind of development.*
- *There is no single major forestry area to be found in the Study Area. Areas of suitable land tend to be relatively small and scattered. Commercial forestry interests today seek a minimum of 5 000 to 10 000 ha to make up what would be considered to be a 'viable management unit'. A core forestry area attracting large-scale international investment would want in the order of 30 000 to 50 000 ha.*

Recommendations

- *Potential dam sites that have shown to be more favourable in this study may be considered if suitable development scenarios in the region are identified that can make sustainable use of the water.*
- *An initial focus on the upgrading of rain-fed cultivation and livestock farming can bring*

great gains at moderate investment. Land tenure and some institutional and social systems will, however, have to be addressed.

- *If forestry is to happen seriously, it will need to be an integrated development, requiring a negotiated settlement with agriculture and with communities. The move might best be towards mixed cropping, with forestry part of the agricultural mix.*
- *It is recommended that rainwater harvesting for the built environment, as well as cultivated and uncultivated areas in the Mzimvubu Development Zone, should be analysed as a standard component of water supply options for all economic development options and municipal water supply requirements.*

DWA WATER RESOURCE STUDY IN SUPPORT OF THE ASGISA-EC MZIMVUBU DEVELOPMENT PROJECT

SUMMARY REPORT

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1 INTRODUCTION

1.1 BACKGROUND

The Mzimvubu River area in the Eastern Cape Province is one of the poorest and least developed parts of South Africa. Development of the area, with the express purpose of accelerating the social and economic upliftment of the people in the region, was therefore identified as one of the priority initiatives of the Eastern Cape Provincial Government. The Mzimvubu Development Project was consequently identified as a Presidential Icon Project and has been accepted as such by the National Government.

Harnessing the water resources of the Mzimvubu River, the only major river in the country which is still largely unutilised, was considered by the Eastern Cape Government as offering one of the best opportunities in the province to achieve such development. In 2007, they therefore established a special-purpose vehicle (SPV) in terms of the Companies Act, the so-called AsgiSA-Eastern Cape (Pty) Ltd (AsgiSA-EC), to initiate planning and to facilitate and drive the development.

The five pillars on which the EC Provincial Government and AsgiSA-EC proposed to build the Mzimvubu Development Project are:

- Afforestation;
- Irrigation;
- Hydropower;
- Water transfer; and
- Tourism.

In 2006 the DWAF Directorate: National Water Resource Planning appointed BKS to assist in the provision of water-related support to the Eastern Cape Provincial Government (later AsgiSA-EC after its establishment). The main component of the task was supposed to be direct water resource planning inputs to specific development projects, for example an irrigation project, that AsgiSA-EC may identify and want to pursue as a poverty alleviation project. As a secondary component the DWAF undertook to provide some general water resource information which could facilitate the identification of other potentially viable projects by AsgiSA-EC. Work in this regard commenced in December 2006.

1.2 STUDY AREA

AsgiSA-EC is focused on upliftment in a larger area, the “Mzimvubu Development Zone”, which covers not only the Mzimvubu River catchment, but also neighbouring areas such as the Pondoland area to the north-east and parts of the Mthatha River catchment to the south-west.

Some tasks, such as the irrigation assessment and ecological water requirements, were conducted for the Mzimvubu Development Zone and included the Pondoland and parts of the Mthatha River catchment

The Mzimvubu River catchment study area and the Mzimvubu Development Zone are presented graphically in **Figure 1.1**, and fall under the OR Tambo, Alfred Nzo, Sisonke and Ukhahlamba District Municipalities.

1.3 PURPOSE OF THIS REPORT

The purpose of this document is to summarise the work executed for this project. The main tasks executed include:

- Updating and refining the broad assessment of the surface water resources of the Mzimvubu River;
- Groundwater assessment;
- Assessment of environmental water requirements;
- Broad assessment of the irrigation potential in the Mzimvubu River catchment;
- Documentation of existing forestry developments and assistance with the assessment of further potential, which impact on the catchment hydrology;
- A first level assessment of possible dams;
- Indicative assessment of conventional hydropower potential;
- Identification of sites for possible pumped storage hydropower developments;
- Review of the previously identified potential for possible bulk transfer of water out of the catchment;
- Rainwater harvesting; and
- Marginal cost of water.

The following stand-alone reports were prepared:

- Existing water supply infrastructure assessment;
- Agricultural assessment and irrigation water use;
- Groundwater assessment;
- Water resources assessment;
- Assessment of potential for pumped storage and hydropower schemes; and
- Rainwater harvesting.

An afforestation task was added at a later stage. The full description is give in Chapter 6, as no stand-alone report was compiled. The support for this task was mainly coordination of specialists' inputs with support to the DWA Regional Office in Cradock.

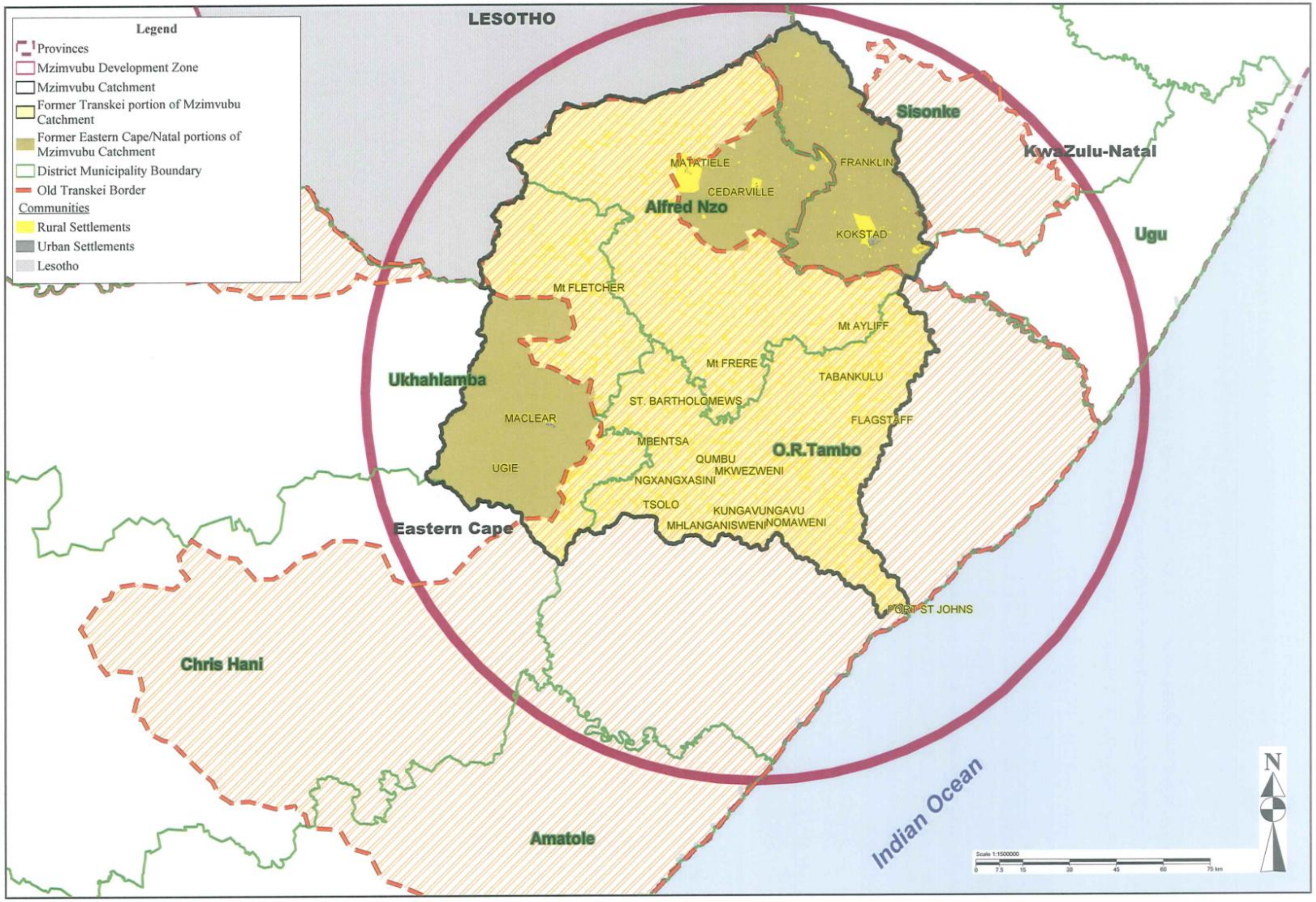

Figure 1.1 Mzimvubu River study area

2 WATER RESOURCES ASSESSMENT

This task is addressed in a stand-alone report (P WMA 12/000/00/3609 Volume 4 of 5) entitled ***Water resources assessment***, where the full details can be found. A summary of this is included in the rest of this section.

2.1 SURFACE WATER

2.1.1 Hydrology

The hydrology for the Mzimvubu River system was updated as part of the Water Resources 2005 Study (WR2005).

2.1.2 Rainfall and evaporation

Rainfall in the catchment is significantly higher than the South African average. Rainfall ranges from above 1 000 mm at the coast and against the mountainous Drakensberg, to between 700 and 800 mm in the upper plateau region.

Annual evaporation ranges from 1 150 mm at the coast to 1 400 mm inland.

2.1.3 Streamflow

The natural (virgin) streamflows for the Mzimvubu River and all its tributaries were updated as part of the hydrology assessment of the WR2005 study. These naturalised streamflows were assumed to be the best available streamflow data to be used for the water balance and yield modelling for the Mzimvubu catchment.

The total streamflow for the Mzimvubu River catchment as given in the WR2005 report is 2 613 million m^3/a. This is a decrease of the total naturalised mean annual runoff (MAR) from the Water Resources 1990 (WR90) study of 219 million m^3/a (from 2 832 million m^3/a). This decrease is likely due to the extended record period of the WR2005 study. The rainfall, evaporation and streamflow are presented in **Table 2.1**.

Table 2.1 Rainfall, evaporation and streamflow: Mzimvubu River catchment

Quaternary catchment	MAP (mm)	MAE (mm)	MAR (million m^3/a)
T31A	907	1 350	32.7
T31B	833	1 350	31.3
T31C	830	1 350	31.9
T31D	736	1 350	25.0
T31E	756	1 350	39.9
T31F	713	1 350	37.0
T31G	801	1 300	20.2
T31H	808	1 300	64.8
T31J	807	1 300	52.8
T32A	804	1 300	30.5

Quaternary catchment	MAP (mm)	MAE (mm)	MAR (million m^3/a)
T32B	814	1 250	30.8
T32C	781	1 200	35.5
T32D	789	1 250	32.9
T32E	844	1 200	47.6
T32F	924	1 200	48.4
T32G	862	1 200	57.2
T32H	892	1 200	66.0
T33A	757	1 350	97.4
T33B	801	1 400	94.3
T33C	768	1 400	51.5
T33D	736	1 350	61.0
T33E	748	1 350	20.5
T33F	829	1 350	51.9
T33G	835	1 300	60.9
T33H	780	1 250	46.1
T33J	730	1 200	35.6
T33K	856	1 200	22.4
T34A	905	1 400	41.1
T34B	860	1 400	35.9
T34C	807	1 400	33.9
T34D	850	1 350	52.2
T34E	901	1 400	45.2
T34F	875	1 350	39.5
T34G	894	1 350	57.7
T34H	863	1 300	91.3
T34J	771	1 250	27.3
T34K	715	1 200	25.9
T35A	912	1 400	92.4
T35B	915	1 400	78.1
T35C	1 008	1 400	86.8
T35D	818	1 350	52.9
T35E	918	1 350	102.9
T35F	860	1 400	58.2
T35G	759	1 400	64.0
T35H	845	1 350	84.6
T35J	924	1 300	40.3
T35K	783	1 300	86.1
T35L	764	1 250	29.0
T35M	861	1 200	42.3
T36A	930	1 200	65.2
T36B	1 029	1 150	55.2

2.2 GROUNDWATER

Africa Geo-Environmental Services (Pty) Ltd (AGES) was appointed as part of the project team for geohydrological inputs during the execution of the study. It was stated at the onset of the project that the investigation of water resources will be restricted to the Mzimvubu River catchment.

This task is addressed in a stand-alone report (P WMA 12/000/00/3609 Volume 3 of 5) entitled ***Groundwater assessment***, in Chapter 5, where the full details can be found. A summary of this is included in the rest of this section.

The following tasks were included in the preliminary groundwater assessment:

- Information sourcing;
- Data sourcing;
- Data processing;
- Inception Phase; and
- Preliminary groundwater potential assessment:
    - Groundwater assessment based on available data; and
    - Groundwater assessment based on GRDM outputs.

Outputs generated for the purpose of the preliminary groundwater assessment approach of the study focussed mainly on the following to get a regional comparative indication of broad groundwater potential between quaternary catchments in the study area:

- Allocatable groundwater per quaternary catchment;
- Reserve as a percentage of recharge; and
- Stress Index as defined by the GRDM.

Groundwater potential assessments and aquifer types occurring in the study area must be viewed in the light of the type of dolerite intrusion, as well as the geological formation present. This needs to be combined with a future regional water balance and groundwater Reserve figures before groundwater availability and potential can be accurately defined.

The following groundwater occurrences can be described for the study area:

- Aquifers associated with dolerite intrusion;
- Aquifers associated with fracturing unrelated to dolerite intrusion; and
- Intergranular aquifers.

Groundwater quality data is insufficient to delineate potential based on expected water classes. It was stated that the water resources of the Mzimvubu River catchment need to be considered during the investigation of the various proposed development options and depending on the impact of the development and the present state of the water resource. Two borehole information data sets were used to obtain additional desktop information on the project area and to confirm the findings of the investigation. These data-sets are known as the National Groundwater Data Base (NGDB) and the DWAF initiated, Groundwater Resource Information Project (GRIP) data set.

It is crucial to note that the brief was to indicate, on a preliminary assessment basis, the differences in groundwater potential between the quaternary catchments within the Mzimvubu River catchment. Maps produced are therefore not a quantitive reflection of actual groundwater potential or availability, but are intended to give the reader an indication of the change in groundwater potential across the catchment. A generalised conclusion can be made from the applicable maps that groundwater potential, based on allocatable volumes and preliminary Reserve estimates, increases towards the east of the Mzimvubu River catchment. Taking current abstraction volumes and distribution into account, it is noted, that some of the catchments have a higher groundwater dependency which will influence allocatable volumes.

The term “Stress Index” must not be misinterpreted as implicating that any of the quaternary catchments within the Mzimvubu catchment are currently stressed. It merely indicates differences between different catchments.

Preliminary indications are that none of the quaternary catchments are currently stressed and allocatable groundwater volumes are significant, resulting in groundwater being a feasible water source in most of the quaternary catchments in the study area.

Based on the preliminarily assessment of available groundwater volumes and the indication that sufficient potential exists, water supply to thousands of people in the numerous villages and towns occurring throughout the catchment will have to consider groundwater development as a sole or supplementary water supply solution. Provisional estimates of the allocatable groundwater per quaternary catchment are shown on **Figure 2.1**.

A map was produced indicating the preliminary groundwater potential at each of the towns located within the Mzimvubu River catchment. This is a preliminary holistic approach towards expressing groundwater potential at each town, taking note of hydrogeological setting, existing groundwater use, borehole yield potential, water quality and groundwater prominence. The potential, however, does not take into account what the stress index and allocatable groundwater component in the applicable quaternary catchments are. It is recommended that this be carried out as part of the detailed groundwater model that is listed as the most important recommendation for the next phase of the project. Groundwater potential was preliminarily defined as Very High at the town of Cedarville and as High at the towns of Matatiele, Qumbu and Tsolo. Of the remaining 14 towns within the catchment, a total of 8 were defined as having medium or moderate groundwater potential, while the remaining 6 towns were defined as having low potential to rely on groundwater as a sustainable water source for municipal water supply. This preliminary estimate will however have to be verified through more detailed assessments in the next phase of the project and in the light of regional water balance calculations. A summary of the provisional assessments of the groundwater potential for the main towns is given in **Table 2.1**.

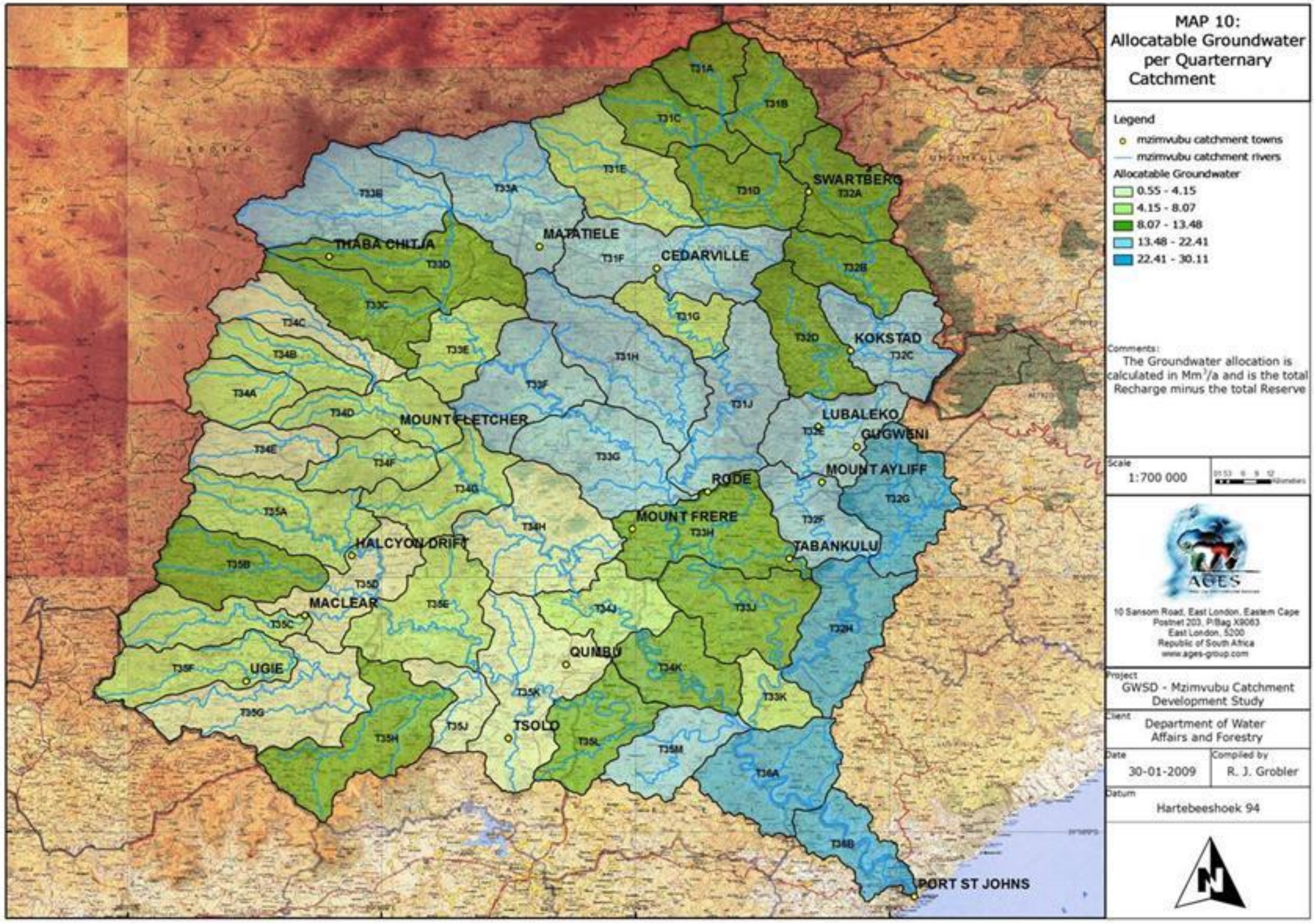

Figure 2.1 Allocatable groundwater per quaternary catchment (figures in million m^3/a)

Table 2.1 Preliminary groundwater potential assessment per town located within the Mzimvubu River catchment

Town survey: Groundwater potential estimates and preliminary Groundwater Reserve in applicable quaternary catchments

							Associated quaternary catchment status		
Province	**District Municipality**	**Local Municipality**	**Town**	**Aquifer type median yield class**	**Town groundwater potential estimate**	**Existing groundwater use**	**Reserve %**	**Stress index %**	**Allocatable groundwater (million m^3/a)**
EASTERN CAPE	Alfred Nzo	Matatiele	Matatiele	Intergranular & fractured 0.5 - 2.0 l/s	High	Yes	44 - 53	1.5 - 3.0	4 - 8
	Alfred Nzo	Umzimvubu	Mt Frere	Intergranular & fractured 0.5 - 2.0 l/s	Medium	Yes	53 - 75	0.5 - 1.5	4 - 8
	Alfred Nzo	Matatiele	Cedarville	intergranular & fractured 2.0 - 5.0 l/s	Very high	Yes	29 - 36	1.5 - 3.0	13 - 22
	Alfred Nzo	Umzimvubu	Mt Ayliff	Intergranular & fractured 0.5 - 2.0 l/s	Low	Yes	53 - 75	3.0 - 4.4	4 - 8
	OR Tambo	Mhlantlo	Tsolo	Intergranular & fractured 0.5 - 2.0 l/s	High	Yes	75 - 98	0.5 - 1.5	0.6 - 4
	OR Tambo	Mhlantlo	Qumbu	Intergranular & fractured 0.5 - 2.0 l/s	High	Yes	75 - 98	0.5 - 1.5	0.6 - 4
	OR Tambo	Ntabamkulu	Tabankulu	Intergranular & fractured 0.5 - 2.0 l/s	Low	Yes	53 - 75	0.5 - 1.5	4 - 8
	OR Tambo	Port St Johns	Port St Johns	Fractured 0.5 - 2.0 l/s	Low	No	29 - 36	0.5 - 1.5	22 - 30
	Ukhahlamba	Elundini	Ugie	Intergranular & fractured 0.5 - 2.0 l/s	Medium	No	53 - 75	0.5 - 1.5	4 - 8
	Ukhahlamba	Elundini	Maclear	Intergranular & fractured 0.5 - 2.0 l/s	Medium	No	53 - 75	0.5 - 1.5	4 - 8
	Ukhahlamba	Elundini	Mt Fletcher	Intergranular & fractured 0.5 - 2.0 l/s	Medium	Yes	36 - 44	0.5 - 1.5	13 - 22
	Ukhahlamba	Senqu	Rode	Intergranular & fractured 0.5 - 2.0 l/s	Medium	Yes	53 - 75	0.5 - 1.5	4 - 8
	Alfred Nzo	Matatiele	Thaba Chitja	Intergranular & fractured 0.5 - 2.0 l/s	Low	No	29 - 36	3.0 - 4.4	8 - 13
	Alfred Nzo	Umzimvubu	Gugweni	Intergranular & fractured 0.5 - 2.0 l/s	Low	Yes	36 - 44	3.0 - 4.4	13 - 22
	Alfred Nzo	Umzimvubu	Lubaleko	Intergranular & fractured 0.5 - 2.0 l/s	Low	Yes	36 - 44	3.0 - 4.4	13 - 22
	Ukhahlamba	Elundini	Halcyon Drift	Intergranular & fractured 0.5 - 2.0 l/s	Medium	Not Known	75 - 98	0.5 - 1.5	0.6 - 4
KZN	KZN	Greater Kokstad	Swartberg	Intergranular & fractured 0.5 - 2.0 l/s	Medium	Not Known	29 - 36	1.5 - 3.0	13 - 22
	KZN	Greater Kokstad	Kokstad	Intergranular & fractured 0.5 - 2.0 l/s	Medium	YES	29 - 36	3.0 - 4.4	8 - 13

A groundwater potential determination without accurate regional water balance and Reserve determination information is incomplete and cannot be used for final regional water resource management application and planning. It is therefore crucial for the reader to realise that this report aims to report only on available information in terms of existing borehole data, with reference to work carried out in other studies in similar geohydrological conditions.

It is the main recommendation from this preliminary assessment study that a numerical groundwater balance and flow model be applied for the Mzimvubu Catchment Development Area in the next phase of the project. Groundwater potential assessments and aquifer types occurring in the study area must be viewed in the light of the type of dolerite intrusion that occurs in different parts of the study area as well as the geological formation present. This needs to be combined with future regional water balance and groundwater Reserve figures before groundwater availability and potential can be accurately determined.

Available GRIP EC data must be incorporated into the Mzimvubu River catchment study dataset once captured. It is recommended that DWA complete the GRIP hydro-census in the Mzimvubu River catchment to ensure a complete and comprehensive dataset for application in the regional groundwater flow balance. Focus must be placed to obtain groundwater information in commercial farming areas in KZN where little or no information is currently available, especially in the high groundwater potential areas near Cedarville and Matatiele.

It is crucial to note that the brief from the client was to indicate, on a preliminary assessment basis, the differences in groundwater potential between the quaternary catchments within the Mzimvubu River catchment. Maps shown are therefore not a quantitative reflection of actual groundwater potential or availability, but aim to give the reader an indication of the differences in groundwater character across the catchment. The groundwater Reserve is indicated by the percentage of the recharge that is required to satisfy the Reserve requirement. The stress index is calculated by dividing the current abstraction with recharge. The groundwater allocation is calculated in million m^3/a and is the total recharge minus the total Reserve.

2.3 WATER REQUIREMENTS

2.3.1 Domestic water requirements

The population figures for each quaternary catchment were multiplied with the urban and rural unit consumption rates, respectively 25 and 87 ℓ/c/d, as obtained from the *National Water Resource Strategy*. No provision was made for return flows from urban and rural abstractions as there are only a few waste water treatment works within the catchment, and where these exist little or no information is available. The total effect of return flows on the hydrology is also assumed to be negligible. The total urban and rural domestic water requirements per quaternary catchment for the year 2005 are presented in **Table 2.2**.

Table 2.2 Urban and rural domestic water requirements (2005)

Catchment	Urban		Rural		Total domestic (urban + rural) (million m^3/a)
	Urban population	Water use (million m^3/a)	Rural population	Water use (million m^3/a)	
T31	1 925	0.06	91 762	0.84	0.90
T32	27 524	0.88	159 713	1.46	2.34
T33	17 763	0.56	340 291	3.11	3.67
T34	14 121	0.45	172 264	1.57	2.02
T35	36 955	1.17	213 363	1.95	3.12
T36	723	0.02	56 201	0.51	0.53
Total	**99 011**	**3.14**	**1 033 594**	**9.44**	**12.58**

2.3.2 Industrial, mining and livestock and wildlife water requirements

There are no industries within the study area that are not supplied with water through the existing municipal water supply systems. There are no significant mining activities in the Mzimvubu River catchment. The annual livestock and wildlife water requirement figure was also obtained from the *National Water Resources Strategy* and is estimated at only 0.9 million m^3.

2.3.3 Irrigation water requirements

Irrigation water requirements are strongly linked to land tenure systems present in the catchment. On the basis of land tenure, the catchment can be roughly divided into two sectors. Sector one is the old Natal and Eastern Cape regions of the catchment outside of the former Transkei borders. Sector two is the former Transkei region of the catchment.

Sector one is characterised by commercial agricultural and irrigation operations, and freehold land tenure. Sector two is characterised by state owned land mostly administered through the tribal land tenure system, and subsistence agriculture.

For the purposes of this study the original agro-ecological units system was modified to produce seven agro-ecological zones. These zones have been based mainly on the physiographic characteristics and rainfall patterns of the catchment. Irrigation was chosen to be presented by agro-ecological zones, as it is the best description of the regions with similar cropping patterns. A summary of the present irrigation water requirements by sectors and by agro-ecological zone are presented in **Table 2.3**.

Table 2.3 Summary of present irrigation water requirements in the Mzimvubu River catchment

Irrigation area and water use						Water use (million m^3/a)
Sector	**Zone***	**Production centres**	**Tertiary catchment**	**Area**	**Crops**	
				(ha)	**(% total irrigated area)**	
1 (Old Natal and Eastern Cape regions)	2a	Cedarville Kokstad Franklin Swartberg	T31 & T32	6 553	Pastures (75%) Maize (20%) Vegetables (5%)	**35.0**
	3	Ugie Maclear	T32 & T35	3 418	Pastures (75%) Potatoes (25%) Maize (20%)	**17.8**
2 (Old Transkei region)	2a, 3, 4	Mount Frere Matatiele Thabankulu Qumbu	T33 & T34	788	Vegetables (50%) Maize (50%)	**2.2**
	5	Port St Johns	T36	100	Fruit trees (60%) Vegetables (40%)	**0.4**
Total irrigation				**10 859**		**55.4**

* *Zones* refers to agro-ecological zones which are regions in which common cropping patterns and climate occur

2.3.4 Afforestation water requirements

Commercial forestry has been declared a streamflow reduction activity and reduces baseflow in rivers. Existing forestry water use needs to be considered before additional yields from water resources are determined for potential developments, so as not to over utilise water resources and impinge on the ecological water requirements (EWR).

Forestry has been identified as a development and poverty alleviation activity in the region. Water use by potential new forestry therefore needs to be determined so that new forestry developments themselves do not over utilise the available water resources and in particular impinge on the EWR.

Commercial forestry covers approximately 485 km^2 in the Mzimvubu River catchment and uses about 43 million m^3/a (average of 891 m^3/ha/a by commercial forestry). The majority of the afforestation occurs in the south-western part of the catchment around the towns of Ugie and Maclear. A summary of the present afforestation per quaternary catchment and the associated water requirements are presented in **Table 2.4**.

Table 2.4 Existing afforestation and associated water requirements (2007)

Catchment	Area	Water use	
	(km²)	(million m³/a)	(m³/ha/a)
T31	10.6	1.31	1 236
T32	25.0	2.66	1 064
T33	10.4	0.86	827
T34	76.1	5.58	733
T35	361	32.65	904
T36	0.9	0.05	556
TOTAL	**484.0**	**43.11**	**891**

Potential future forestry development in the Mzimvubu River catchment is discussed in more detail in Chapter 6 of this report.

2.3.5 Invasive alien water requirements

Extensive areas of invasive alien vegetation, particularly in the riparian zones, also cause a reduction of baseflow in rivers. The areas of invasive alien vegetation in the Mzimvubu River catchment were obtained from the WR2005 study report.

The areas and associated water use of invasive alien vegetation per quaternary catchment are included in **Table 2.5**. Clearing of alien vegetation could provide substantial quantities of water for other uses such as forestry in more water stressed areas of the catchment. This could also be a job creation action.

Table 2.5 Invasive alien vegetation and its associated water use (2005)

Catchment	Area (km²)	Water requirement	
		(million m³/a)	(m³/ha/a)
T31	65.5	5.4	821
T32	74.4	7.3	983
T33	50.9	6.4	1 265
T34	27.3	3.5	1 282
T35	6.0	0.8	1 300
T36	1.5	0.3	2 067
Total	**225.6**	**23.7**	**Average 1 051**

2.3.6 Ecological water requirements

Ecological water requirements (EWR) refer to the estimated streamflow that needs to be maintained in a river to support ecological ecosystems in the river, as well as basic human needs. The EWR for input into the Water Resources Yield Model (WRYM) have been determined at a desktop level for the Mzimvubu River catchment. The EWR should also be updated at a high level of confidence as part of a separate environmental Reserve study on the Mzimvubu River.

The EWR takes the current ecological status (category) of the river and the present water uses into account to determine the flow requirements for a river. The total EWR requirements for the Mzimvubu River have been estimated at 881 million m^3/a, which is approximately 34% of the total MAR, of which about 530 million m^3/a is required as low flows.

2.3.7 Summary of water requirements

A summary of the total water requirements of the study area is presented in **Table 2.6**. The total water abstraction which in the case of the Mzimvubu River catchment is almost all consumptive water use, is approximately only 5% of the average annual streamflow of 2 613 million m^3/a. The ecological water requirements are provisionally estimated to require approximately 34% of the total streamflow to remain in the rivers.

Table 2.6 Summary of study area water requirements

User group	Volume (year 2005) (million m^3/a)
Urban	3
Rural	9
Industrial	0
Mining	0
Irrigation	55
Afforestation	43
Alien vegetation	24
Consumptive total	**134**
Ecological water requirements	881
Total (including EWR)	**1 015**

3 WATER RESOURCE DEVELOPMENT POTENTIAL

3.1 POTENTIAL DAMS ASSESSMENT

This task is addressed in a stand-alone report (P WMA 12/000/00/3609 Volume 4 of 5) entitled ***Water resources assessment***, in Chapter 5, where the full details can be found. A summary of this is included in the rest of this section.

3.1.1 Potential dam sites

A number of possible dam sites have been identified on the Mzimvubu River in previous studies. Together with a few new sites identified from topographical maps, a total of 19 potential dam sites were assessed in this study. The reservoirs that would be created by the possible dams will be referred to by the name of the dam site, derived from the name of the local area or village closest to the site.

Sediment yields in the Mzimvubu River catchment have been estimated according to catchment size and sediment yield potential based on the latest sediment yield maps. In the absence of comprehensive measured data, sediment yield maps form the basis for catchment sediment yield estimation in the Mzimvubu River catchment.

The dam sites that have been considered and included in the water resources yield assessment are listed in **Table 3.1**. The location of these dams is presented in **Figure 3.1**.

It must be noted that these are not all the potential dam sites in the Mzimvubu catchment, but have been included to be indicative of the more favourable sites in the catchment. Other potential sites may exist closer to future identified water users, and a more complete assessment will need to be made to determine the optimal dam site choice for each potential development. The best site will depend largely on the volume of the water required by the future potential developments. Smaller localised water requirements will most likely be better suited to be supplied from small off-channel dams, or dams on smaller tributaries.

3.1.2 Yield assessment

The historic firm yields available from the potential dam sites were assessed with the Water Resources Yield Model (WRYM) to provide an indication of the volume of water that can be reliably abstracted from the dams. The historic firm yield is defined as the maximum annual water volume that can be abstracted from a dam without the dam failing once over the total historical hydrological record. The total hydrological record period for the Mzimvubu River catchment was from 1920 to 2004. For the purpose of this study the annual abstraction was distributed evenly over the 12 months.

The historic firm yields of the potential large dams in the Mzimvubu River catchment were calculated for each dam on its own, representing a single large dam development scenario. No combinations of potential dams were considered at this stage.

Table 3.1 Potential dam sites with estimated 50-year sedimentation in the Mzimvubu River catchment

Catchment	River	Dam name	Mean annual runoff (million m^3)	Wall height for 1 x MAR capacity (m)	Sedimen-tation 50 yrs (million m^3)	Dead storage level from bottom (m)
T31	Upper Mzimvubu	Dam 2	240	49	47	18
		Siqingeni	709	80	113	37
T32	Mzintlava	Bokpoort	130	60	24	30
		Luzi	198	63	33	26
		Dam B	282	93	43	36
T33	Kinira	Thabeng	307	53	31	26
		Somabadi	324	59	37	27
		Ntlabeni	396	65	47	28
T34	Tina	Pitseng	55	34	7	10
		Hlabakazi	248	57	28	18
		Mpindweni	337	56	38	23
		Mangwaneni	414	55	48	19
		Ku-Mdyobe	424	80 (*)	50	37
T35	Itsitsa	Nomhala	206	43	25	14
		Ntabelanga	403	53	35	12
		Malepelepe	696	42	68	18
		Laleni	755	62 (*)	75	26
		Gongo	800	100 (*)	81	58
T36	Mzimvubu	Mbokazi	2 520	100 (*)	328	65

(*) Wall heights stated for dams of storage capacity less than 1 MAR due to geographical limitations

The results of the historic firm yield analyses are summarised in **Table 3.2**. The historic firm yields are presented after making water releases to satisfy the ecological water requirements (EWRs).

Figure 3.1 **Location of dam sites that have been considered and included in the water resources yield assessment**

Table 3.2 Historic firm yields from potential dams in the Mzimvubu River catchment (after supplying EWRs)

Catchment	River	Dam name	Mean annual runoff (MAR)	Historic firm yield * (million m³/a)		
				Dam capacity		
				0.5 x MAR	1 x MAR	1.5 x MAR
T31	Upper Mzimvubu	Dam 2	240	26	56	73
		Siqingeni	709	184	289	
T32	Mzintlava	Bokpoort	130	24	37	53
		Luzi	198	46	72	93
		Dam B	282	82	125	135
T33	Kinira	Thabeng	307	102	144	174
		Somabadi	324	104	150	183
		Ntlabeni	396	138	187	227
T34	Tina	Pitseng	55	13	20	24
		Hlabakazi	248	62	93	108
		Mpindweni	337	84	125	149
		Mangwaneni	414	91	140	149
		Ku-Mdyobe	424	93	140	
T35	Itsitsa	Nomhala	206	43	76	90
		Ntabelanga	403	115	155	183
		Malepelepe	696	248	277	316
		Laleni	755	205	254	
		Gongo	800	148		
T36	Mzimvubu	Mbokazi	2 520	563		

* Historic firm yields are presented after releases for provisional EWRs were made

The reduction in firm yield available as a result of making releases to satisfy the EWRs are summarised in **Table 3.3**. Again, the EWRs have been provisionally calculated at a desktop level and will need to be revised for more specific development options.

Table 3.3 Impact of ecological water requirements on historic firm yields

Catch-ment	River	Dam name	Mean annual runoff (million m^3)	Total EWR (million m^3)	EWR as % of MAR	Percentage reduction in yield by EWR		
						Dam capacity (x MAR)		
						0.5	1.0	1.5
T31	Upper Mzimvubu	Dam 2	240	106	44	63	47	40
		Siqingeni	709	154	22	24	25	
T32	Mzintlava	Bokpoort	130	28	22	38	30	23
		Luzi	198	42	21	28	27	23
		Dam B	282	59	21	19	20	20
T33	Kinira	Thabeng	307	41	13	18	19	17
		Somabadi	324	68	21	20	22	19
		Ntlabeni	396	85	21	20	21	19
T34	Tina	Pitseng	55		0	34	32	29
		Hlabakazi	248	60	24	36	31	29
		Mpindweni	337	85	25	41	34	30
		Mangwaneni	414	133	32	45	38	37
		Ku-Mdyobe	424	138	33	45	38	
T35	Itsitsa	Nomhala	206	54	26	32	32	28
		Ntabelanga	403	104	26	28	31	28
		Malepelepe	696	177	25	29	30	28
		Laleni	755	192	25	26	28	
		Gongo	800	204	26	34		
T36	Mzimvubu	Mbokazi	2 520	860	34	36		

3.1.3 Cost estimates of water

Capital costs were determined for the potential dams and unit reference values (URVs) of water were calculated. The URVs give an indication of the likely cost of water yielded from the potential dams in the Mzimvubu River catchment, and allows comparison between the different dam sites.

The capital cost estimates were conducted at a desktop level of detail and based on 1:50 000 maps with 20 m contours. The geological information available at potential dam sites is not at an equal level of detail and is very limited at many sites. Only general information gathered using geological maps is available at most dam sites. To compare all dam sites on an equal basis, earthfill dams were provisionally assumed to be the most suitable in the Mzimvubu River catchment.

Where the topography at particular dam sites limits spillway chute construction, roller compacted concrete (RCC) gravity dams were considered and costed. Further geological investigations will be needed to determine the most feasible dam types for specific sites. The capital cost estimates of the dams are presented in **Table 3.4** and are based on March 2008 prices.

Table 3.4 Cost estimates of potential dam sites in the Mzimvubu River catchment

River	Dam name	Dam cost estimate (R million)		
		Dam capacity		
		0.5 x MAR	1 x MAR	1.5 x MAR
Upper Mzimvubu	Dam 2	640	800	980
	Siqingeni	1 120	1 470	
Mzintlava	Bokpoort	630	910	1 110
	Luzi	660	880	1 100
	Dam B	1 140	1 980	2 310
Kinira	Thabeng	490	710	790
	Somabadi	520	760	850
	Ntlabeni	590	770	1 010
Tina	Pitseng	290	380	450
	Hlabakazi	380	640	870
	Mpindweni	520	640	810
	Mangwaneni	1 100	1 490	1 670
	Ku-Mdyobe	1 220	1 940	
Itsitsa	Nomhala	490	620	720
	Ntabelanga	350	420	470
	Malepelepe	840	1 000	1 120
	Laleni	940	1 170	
	Gongo	2 010		
Lower Mzimvubu	Mbokazi	2 070		

Unit reference values (URV) of the water have been calculated from the capital costs of the dams and their corresponding historic firm yields. The URVs provide an indication of the cost of the water. URVs have been calculated for a 45 year period, a discount rate of 8%, and with the construction of dams assumed to start in 2011 and finish in three years. The URVs are presented in **Table 3.5**.

The unit reference values of water at some of the dam sites are relatively low. These URVs, however, do not include the cost of distributing the water to the points of use. Due to the predominantly hilly topography in the catchment, the cost of distribution is likely to be high, particularly for water users remote from dam sites.

The cost of distributing water to potential users must be included if specific developments are identified, as it is likely to affect the feasibility of the development.

Table 3.5 Unit reference values of cost of water at potential dam sites in the Mzimvubu River catchment

Catchment	River	Dam name	Mean annual runoff (MAR)	Unit reference values (R/m³)		
				Dam capacity		
				0.5 x MAR	1 x MAR	1.5 x MAR
T31	Upper Mzimvubu	Dam 2	240	3.70	2.10	2.00
		Siqingeni	709	0.90	0.80	-
T32	Mzintlava	Bokpoort	130	3.90	3.70	3.20
		Luzi	198	2.20	1.80	1.80
		Dam B	282	2.10	2.40	2.60
T33	Kinira	Thabeng	307	0.70	0.70	0.70
		Somabadi	324	0.80	0.80	0.70
		Ntlabeni	396	0.60	0.60	0.70
T34	Tina	Pitseng	55	3.40	2.90	2.80
		Hlabakazi	248	0.90	1.00	1.20
		Mpindweni	337	0.90	0.80	0.80
		Mangwaneni	414	1.80	1.60	1.70
		Ku-Mdyobe	424	2.00	2.10	-
T35	Itsitsa	Nomhala	206	1.70	1.20	1.20
		Ntabelanga	403	0.50	0.40	0.40
		Malepelepe	696	0.50	0.50	0.50
		Laleni	755	0.70	0.70	-
		Gongo	800	2.00	-	-
T36	Lower Mzimvubu	Mbokazi	2520	0.60	-	-

3.2 REVIEW OF POTENTIAL WATER TRANSFER

This task is addressed in a stand-alone report (P WMA 12/000/00/3609 Volume 4 of 5) entitled ***Water resources assessment***, in Chapter 5.5, where the full details can be found. A summary of this is included in the rest of this section.

Water transfers from the Mzimvubu River have been identified as a water resource development option that could utilise the water to supply surrounding regions. Regions that have been previously identified as possibly benefiting from water transfers from the Mzimvubu River are north to the Vaal River, east towards Durban and west towards the western parts of the Eastern Cape.

Water transfers to the Vaal River to augment the growing future requirements can still be made from catchments closer to the Vaal River such as the Senqu River and the Tugela River. The high cost of getting water from the Mzimvubu River to the Vaal River system makes this a less favourable option.

The catchments to the east of the Mzimvubu River, including the Mzimkhulu River, which are closer to Durban, still have capacity to service the growing water requirements of Durban and the local areas. Transfers to the east of the Mzimvubu River are therefore not deemed necessary in the foreseeable future.

Water requirements west of the Mzimvubu River, such as for East London, can also be met by the local river catchments. Irrigation in the western parts of the Eastern Cape could be expanded if water was made available at a feasible cost.

For the purpose of this study an option of transferring water from a potential dam in the western part of the catchment to the headwaters of the Kraai River (tributary of the Orange River) was assessed. This is possibly the most favourable potential single dam development transfer scenario, similar to the previous Northern Transfer option. The chosen dam site at Ntabelanga has the potential to provide some of the cheapest water available in the Mzimvubu River. The dam site is also located high up in the catchment near to the western divide. A 90 km long, 2 m diameter steel pipeline would be required to transfer the water from the dam to the headwaters of the Kraai River. All other transfer options are likely to be more expensive and less viable.

With the construction of a dam at the potential site at Ntabelanga, 180 million m^3/a could be yielded from a reservoir of capacity of about 600 million m^3. Assuming most of the water is made available for transfer and a small portion is reserved for local supply, a total of 150 million m^3/a could be allocated for transfer.

The capital costs of the infrastructure are estimated to be R2 800 million for the pipelines, pump stations and the reservoir at Ntabelanga. The water needs to be pumped over the divide through a static height of 1 500 m. Including friction losses and the assumption of pumping 20 out of 24 hours, the total energy requirements to pump the water would be 130 MW. At an assumed total energy tariff of 30 cents per kWh, the annual energy cost would be approximately R280 million.

Conveyance losses of 1.2 m^3/s of water from the point of discharge in the Kraai River near Rhodes to the Orange River have been provided for. Of the 150 million m^3/a transferred over the divide, a net of 110 million m^3/a could be made available in the Orange River at a unit reference value of about R7/m^3.

The intention of the transfer would be to supply water to water users in the western parts of the Eastern Cape through the Orange-Fish Tunnel from Gariep Dam. At around R 7/m^3 this water, however, would most likely be far too expensive for irrigation. The unit cost does not include distribution infrastructure to the farms. Adding on the distribution infrastructure will further increase the cost of the water.

In summary, water transfers from the Mzimvubu River would be too expensive for agriculture in this region. Water transfers from the Mzimvubu River are also not foreseeable in the near future as augmentation to Gauteng industrial developments to the north that could be supplied by far less expensive alternatives for at least the next 50 years.

3.3 CONVENTIONAL HYDROPOWER POTENTIAL ASSESSMENT

This task is addressed in a stand-alone report (P WMA 12/000/00/3609 Volume 5 of 5) entitled ***Assessment of potential for pumped storage and hydropower schemes***, in Chapter 3, where the full details can be found. A summary of this is included in the rest of this section.

The modelling of water yield from potential dams in the catchment provided the opportunity to assess the hydropower potential at these dam sites. For simplicity, the potential for a single purpose hydropower development only, were assessed. Possible multipurpose developments could be investigated as more information on other development options becomes available.

The generation of hydropower was simulated with the WRYM. The firm hydropower available at a 99.5% assurance of supply for each potential dam site is presented in **Figure 3.3**.

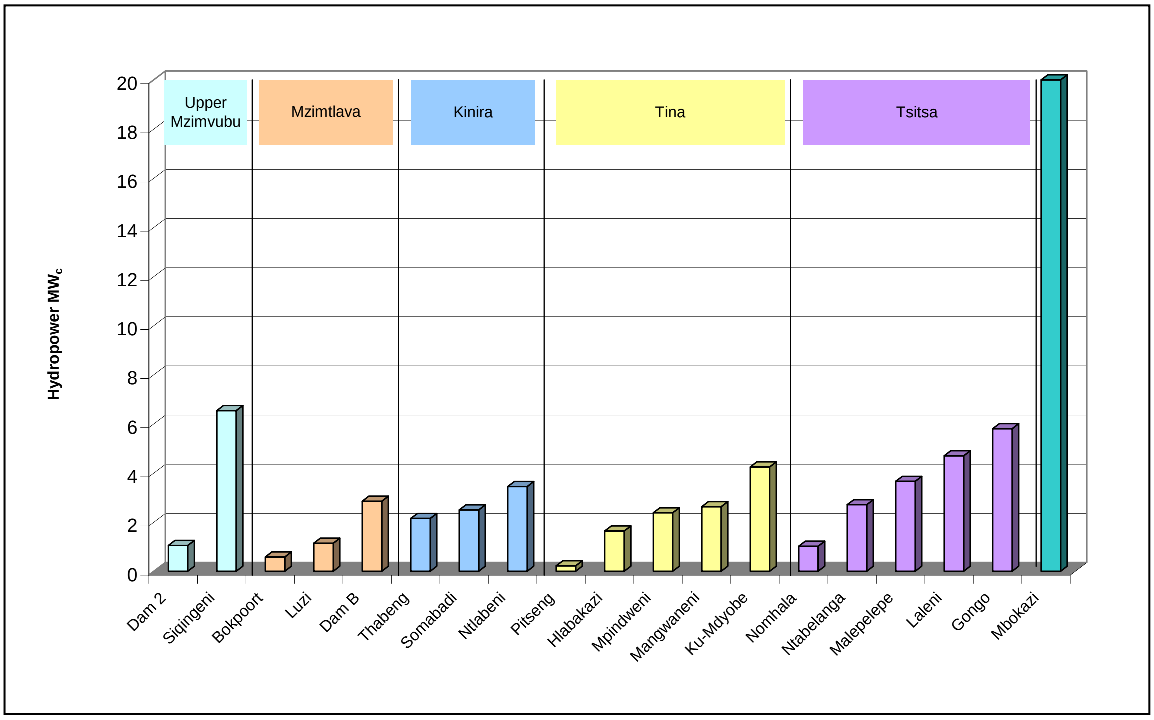

Figure 3.3 Firm hydropower available at potential dam sites

The results are average monthly hydropower available and are presented as mega-watt continuous (MW$_C$), which is analogous to base load-power. This can be converted for load factor. A load factor of say 10% was assumed to be indicative of peaking power.

The costs of the power plants were estimated based on generating capacity and head, and were added to the cost estimates of the dams to determine the total hydropower scheme costs. The total base load and peaking hydropower scheme costs are presented in **Figure 3.4**.

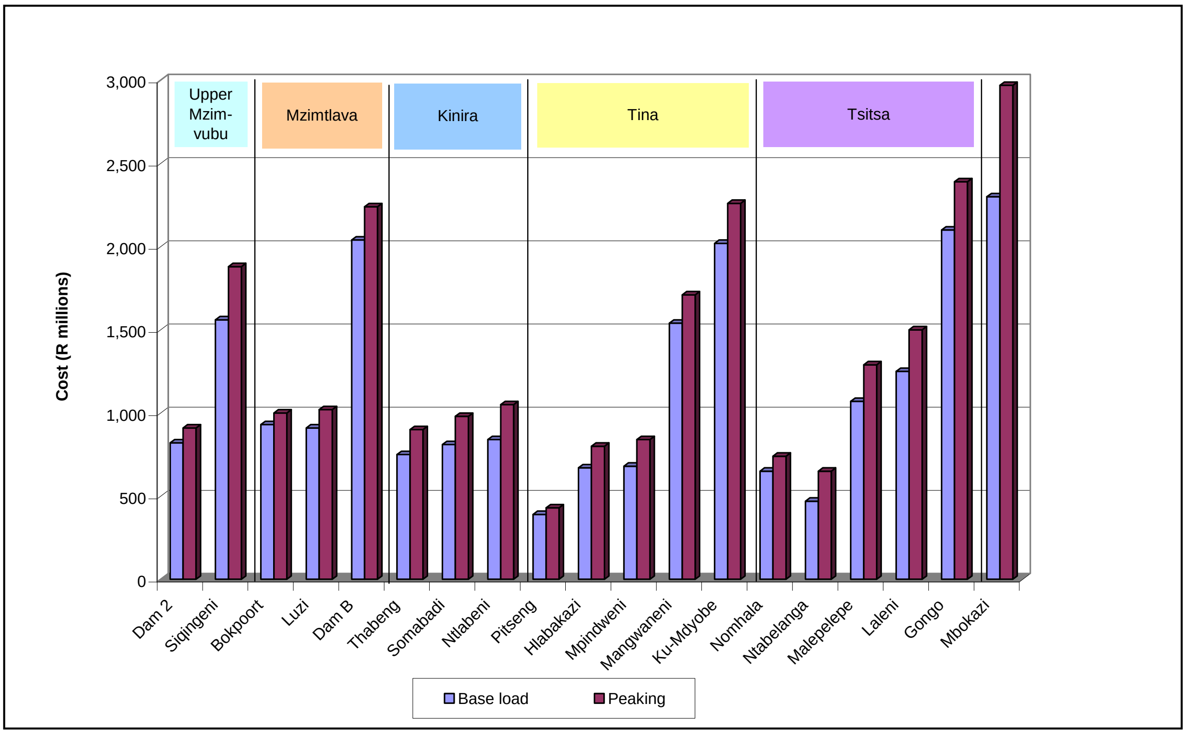

Figure 3.4 Total scheme costs for base-load and peaking hydropower generation at potential dam sites

The total scheme costs were converted to unit costs per installed generating capacity for comparative purposes. To compare the hydropower available at the potential dam sites, a scheme at the Tsitsa Falls, a site previously identified as showing the most potential in the catchment, was assessed. The Tsitsa Falls scheme incorporates a dam upstream of the falls and utilises the additional head at the falls to generate power.

The Tsitsa Falls scheme could produce an estimated 25 MW_C base load power at a unit cost of R100 million per MW_C, or 250 MW at a 10% load factor indicative of peaking power, at R16 million per MW.

A basic financial analysis was conducted to determine whether the capital cost of the Tsitsa Falls scheme could be off-set by the sales of hydropower. The preliminary results based on provisionally assumed prices for electricity of R0.30/kWh and R1/kWh for base-load and peaking power respectively, suggest that the Tsitsa Falls scheme is approximately double the cost that could be financed by the sales of electricity for base load. The scheme can only be financed by the sales of electricity at low discount rates for peaking power. The unit costs of the Tsitsa Falls scheme have been overlaid on the unit costs of hydropower at potential dam sites for base load in **Figure 3.5** and for peaking power in **Figure 3.6** for comparison.

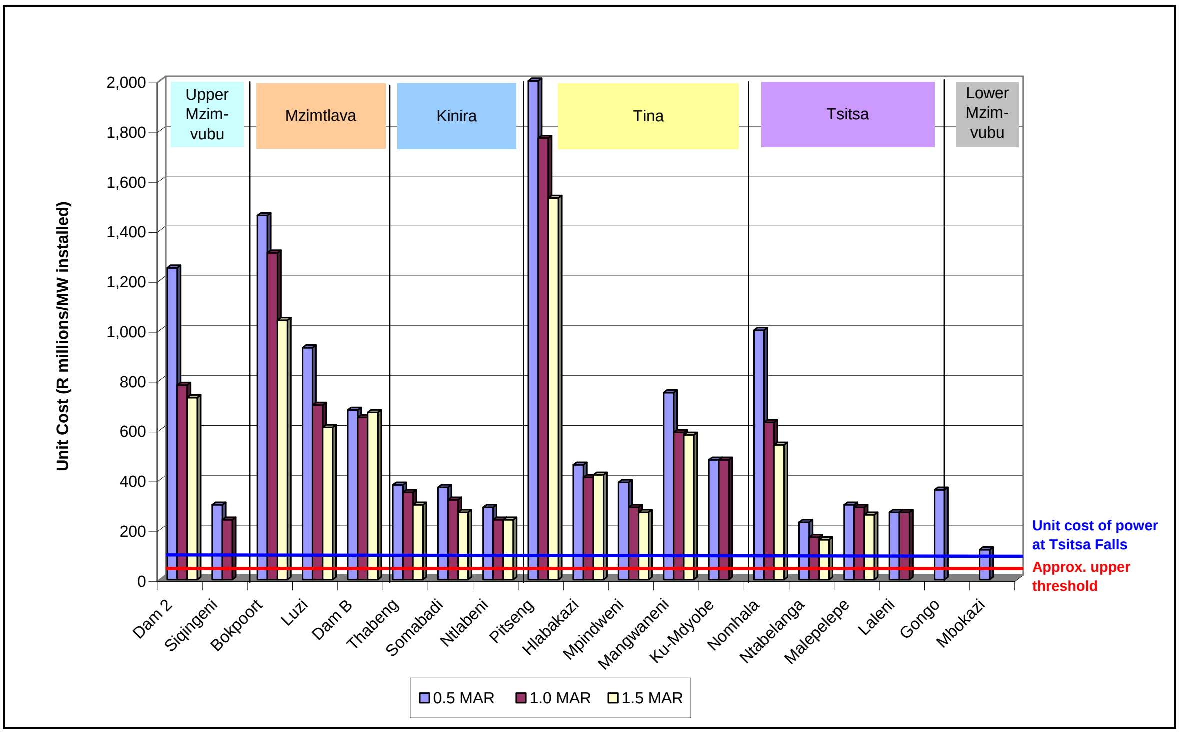

Figure 3.5 Unit costs of base load hydropower at potential dam sites compared with Tsitsa Falls and approximate upper threshold of feasible base-load cost

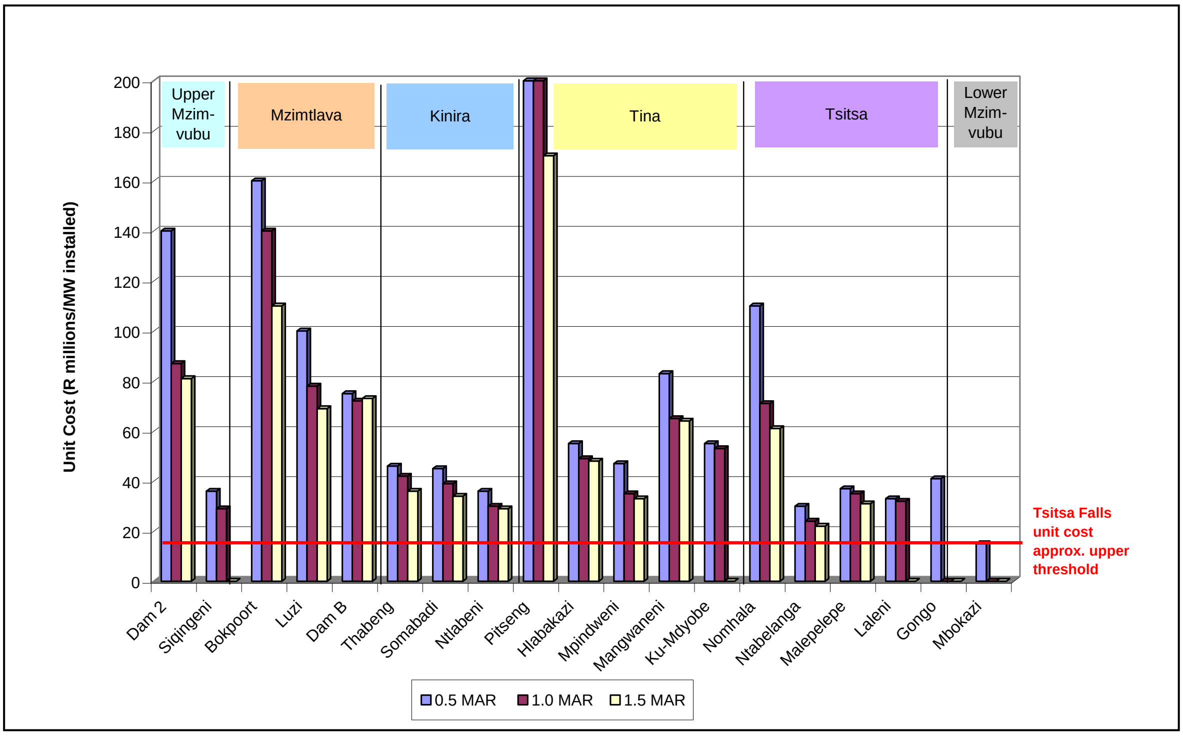

Figure 3.6 Unit costs of peaking hydropower at potential dam sites compared with Tsitsa Falls approximate upper threshold of feasible base-load cost

Figure 3.5 and **Figure 3.6** suggest that the sales of base-load hydropower cannot finance any of the hydropower schemes, both at the Tsitsa Falls and the potential dam sites. Only a few potential dams in the catchment had similar unit costs of peaking hydropower to the Tsitsa Falls scheme, and could be marginally feasible.

Base load power generation is not viable at current electricity tariffs as a single-purpose development. Peaking power is only marginal as a single-purpose development. Power generation at a potential dam site may be considered if part of a multipurpose development, and for local power supply.

Development of peaking power should be focused on Tsitsa Falls and a few potential dam sites. If the purpose of the development is primarily for peaking power generation, Tsitsa Falls and the site near Mbokazi could be considered. If the hydropower generation is to be part of a multipurpose development then a few potential dam sites, such as Ntabelanga and Somabadi, could be considered.

If further investigations are conducted, some additional detail should be included:

- The confidence in the value of power at different load factors should be improved.
- The specific conditions at each site should be accounted for in the cost of the hydropower plants.
- The costs of the transmission lines.
- The effects of releases of water for the generation of hydropower on the ecological functioning of the river and the estuary need to be considered. This is particularly important at the Tsitsa Falls.

3.4 PUMPED STORAGE SCHEMES ASSESSMENT

This task is addressed in a stand-alone report (P WMA 12/000/00/3609 Volume 5 of 5) entitled ***Assessment of potential for pumped storage and hydropower schemes***, in Chapter 2, where the full details can be found. A summary of this is included in the rest of this section.

Although both pumped storage and conventional hydropower schemes use water-driven turbines for the generation of power, there is a fundamental difference between the schemes with respect to the primary source of energy used. For conventional hydropower, power is generated from harnessing the energy in the streamflow, which is a source of renewable energy. Pumped storage schemes in contrast use the excess energy generated by other sources to pump water to a higher elevation during off-peak periods, from where the water is released for the generation of power during peak demand periods, much like a huge battery. Once the initial filling (priming) of the reservoirs of a pumped storage scheme has been complete, pumped storage schemes are essentially closed systems, apart from replacing evaporative and seepage losses, and are independent of river flows.

Due to the topography of the catchment and available water resources, pumped storage schemes are potential developments in the Mzimvubu Development Zone.

Pumped storage schemes have been included in the assessment of water resource development due to the possibility that a pumped storage scheme could be linked to a dam with other purposes such as water supply, as a multi-purpose scheme.

A desktop study was conducted to assess the potential pumped storage schemes in the Eastern Cape. This included potential sites in the Mzimvubu River and surrounding catchments that were identified by Eskom, listed in previous studies of the Mzimvubu River, and identified by the study team close to potential dams.

Using very basic parameters of available head and tunnel length, some of the sites were eliminated before cost estimates were conducted. The pumped storage sites were ranked according to a number of factors and the results were discussed with Eskom. No further work, other than the assessment of pumped storage schemes, was carried out as part of this study.

It may be to Eskom's benefit to do another round of site identification, focussed at off-channel lower reservoirs, to confirm that the sites identified in this study are the most favourable.

4 ASSESSMENT OF THE ECOLOGICAL WATER REQUIREMENTS

4.1 INTRODUCTION

The ecological water requirements (EWR) were determined for the Mzimvubu River catchment to investigate various development options, including several large dams. This was mainly done on a desktop level and where available, used results from previous rapid Reserve studies using the Desktop Reserve Model (SPATSIM 2.10) and the updated hydrology supplied by BKS.

4.2 APPROACH

The approach followed for the desktop EWR determination was:

- Sourcing of existing rapid Reserve results;
- Desktop eco-classification to determine the present ecological state (PES) and ecological importance and sensitivity (EIS) per quaternary catchment;
- Determination of an integrated importance value per quaternary catchment;
- Determination of the level of Reserve determination required per quaternary catchment for future studies using the importance scores and the existing as well as future land use information; and
- Determination of desktop EWRs for use during the yield modelling to investigate the various water resource development options.

4.3 RESULTS

The present state of the main stem rivers in most of the upper areas of the Mzimvubu catchment (T31 and T32) are in a A/B or B category (larely natural to natural) with the remainder of the quaternary catchments a C category (moderately modified) with the EIS as moderate to high.

The EWR per quaternary catchment were determined and requires on average 21% – 26% of the natural mean annual runoff (MAR) for a C category. The lower part of the Mzimvubu River close to the estuary is still in a largely natural state (B category) and requires as much as 42% of the natural virgin MAR.

The required level of ecological Reserve determination per quaternary catchment has been determined and a summary per tertiary catchment is as follows:

- T31 (main stem Mzimvubu to confluence with Mzintlava River) – mainly rapids with intermediate in the lower reaches (T31H and T31J);
- T32 (Mzintlava River and tributaries) – Intermediate for the upper part above Franklin Vlei (including the wetland) and rapids in the lower reaches;

- T33 (Kinira River and tributaries to confluence with Mzimvubu River) – rapid and desktop level Reserve determinations are required;
- T34 (Tina River and tributaries to confluence with Tsitsa River) – intermediate determination for the middle reaches of the river (T24D - T34H) with rapids for the remainder;
- T35 (Tsitsa River and tributaries) – rapids for the upper quaternary catchments with intermediate in the middle reaches to the confluence with the Tina River; and
- T36 (main stem Mzimvubu to estuary) – an intermediate study is required for this part, including the estuary.

5 ASSESSMENT OF FUTURE IRRIGATION POTENTIAL

This task is addressed in a stand-alone report (P WMA 12/000/00/3609 Volume 2 of 5) entitled ***Agricultural assessment and irrigation water use**,* where the full details can be found. A summary of this is included in the rest of this section.

There are many socio-political, cultural, technical, managerial and financial constraints that can mitigate against sustainable irrigation development in the study area. This does not imply that opportunities do not exist. If approached in the correct way with the full involvement of beneficiaries and supporting communities and with careful participatory planning and implementation, significant irrigation development could take place in the area.

5.1 CONSTRAINTS AND CHALLENGES TO IRRIGATION DEVELOPMENT

5.1.1 Climate

The climate of all the agro-ecological zones in the catchment is not suitable for large, capital intensive irrigation schemes. Generally temperatures are too low (frost is common in winter) and rainfall is too high to justify such developments. Large irrigation schemes are usually found in frost-free regions with a temperature regime that is suitable for high value perennial crops or out-of-season winter production of high value annual crops such as vegetables grown on a commercial scale. Excessive rainfall on an irrigation scheme can be disruptive to production practices and can adversely affect crop quality, particularly during harvesting time.

The likely returns from relatively low-value irrigated crops will in most cases be inadequate to cover the cost of expensive irrigation water and not be able to provide the growers with a reasonable “take-home” income.

5.1.2 Topography

The topography is characterized by steep incised river valleys where irrigable soils are restricted mainly to “pockets” of alluvial soils along the main rivers where flooding is an ever-present threat. These “pockets” of alluvial soils have a high irrigation potential from a climatic and soils perspective, but significant irrigation development will be limited without the river-flow regulating effect of expensive large dams upstream of these areas. Furthermore most of the irrigable areas are largely inaccessible and in general infrastructure is limited.

5.1.3 Present land use

Most irrigable soils in the catchment are already in use for rain-fed subsistence agriculture with individually “owned” plots seldom exceeding 1 ha. Any irrigation scheme would therefore have to accommodate all existing land users in some way. However, small irrigated plots on capital intensive irrigation schemes have proved to be mostly unviable, particularly with the limited enterprise selection available as determined by the climatic conditions.

With the reality of relatively high population density spread throughout Sector 2 (former Transkei area) of the study area, allocation of farms large enough to be commercially viable and sustainable units is a real challenge.

The only way this can be achieved is if the present land “owners” on the consolidated agricultural areas (who, in practice struggle to obtain meaningful production from their lands) are assisted to produce their household food needs by alternative means thus creating the opportunity for the leasing of these lands for consolidation into viable commercial units under irrigation (or rain-fed) production.

5.1.4 Land tenure

Most land in the study area falls under the communal land tenure system in terms of which the Tribal Authority allocates the right to use or occupy land. A “permission to occupy (PTO)” certificate is the official “deed of occupation”. Despite this system being widely accepted by local communities, it is recognised as one of the most significant constraints to agricultural development in the region. Without freehold title (or at least a long-lease form of land tenure) it is very difficult for any commercial enterprise, especially with expensive irrigation equipment, to be established and developed in a sustainable way.

The communal land tenure system poses special challenges to irrigation development. The issue of who owns the irrigation infrastructure of a scheme and who is responsible for it’s maintenance and repair and the inability to offer land as a security for “on-farm” irrigation infrastructure and operating loans will always be a constraint to irrigation development.

This land-tenure limitation has been shown to be a major contributor to the failure of many small-holder irrigation schemes and other agricultural development initiatives in South Africa in the past. Every effort should be made to address this important issue on new development projects.

5.1.5 Commercial farming experience

The lack of skilled and experienced (commercially orientated) farmers in this sector of the catchment is also a major constraint to irrigation development.

Crop production in the area is based on the principle of low cost, low risk, low return, “subsistence-type” agriculture. The subsistence culture remains a significant constraint to the commercialization of agriculture.

Crop production under irrigation is a practice which farmers usually only contemplate after gaining experience with, and having confidence in, rain-fed agriculture on a commercial scale.

5.1.6 Scheme ownership

There is high risk in developing an irrigation scheme without considering the long-term ownership arrangements for the project. Government-owned agricultural projects (anywhere in the world) are doomed to failure. This is mainly due to the reality that governments are not structured appropriately for commercial management and without some equity stake in an irrigation project, the farmers will not have adequate incentive or responsibility for sustained commercial production. It is therefore essential that appropriate farmer-led institutional structures are developed that will allow for farmer "ownership" and appropriate management structures to operate. Such structures will need strong government intervention to ensure capacity building, training and mentorship for the structures and their personnel.

5.1.7 Scheme management

Any large-scale irrigation scheme will require on-going management support for:

- Maintenance and repair of bulk infrastructure such as dams, pumps, canals, pipelines, power supply, roads and buildings;
- Ensuring that markets are found for the crops to be cultivated;
- Equitable distribution of irrigation water to participating farmers; and
- Facilitation of co-ordinated support services to farmers.

Whether management is provided by an external agent, by a joint-venture partner or by local community members appointed by the farmers, there will be a considerable responsibility and cost to the farmers for that management to be effective.

5.1.8 Support services

For commercialisation of agriculture to take root in the area, and particularly on irrigation schemes, it is imperative that more effective support services be put in place to facilitate the change from subsistence agriculture. The main components of support required for agriculture are:

- Efficient extension services and related relevant skills and technology transfer;
- Input supplies. Access to commercial supplies of agricultural requisites such as seed, fertilizer, chemicals and equipment;
- Mechanisation services. Cultivation of crop lands is difficult without tractors and agricultural machinery. Some form of reliable contractor service needs to be put in place to fill this gap;
- Credit facilities for input purchases. All commercial agricultural activities make use of production loans in some form or another. This is still largely unavailable to communities in tribal areas and ways need to eb found to assist upcoming farmers with financing;

- Management skills and technical “know-how”. A major training and capacity building initiative is required to bridge the skills gap that exists between commercial farmers and subsistence farmers;
- Joint-venture initiatives in terms of which commercial farmers and agribusiness entities form joint-venture partnerships with local farmers / land users, for the development of commercial agricultural projects; and
- Effective application of existing legislation relating to natural resource degradation, particularly with regard to soil erosion and removal of vegetation from wetland areas and riverine regions.

5.2 IRRIGATION DEVELOPMENT OPPORTUNITIES

The development opportunities outlined below have been divided into two categories. Firstly the opportunities in the communal areas of the former Transkei area and secondly the Port St Johns farms where an exercise is presently underway to secure freehold title for the farms.

5.2.1 Communal areas - small irrigation schemes

As outlined above the catchment is unsuitable for large irrigation schemes, particularly if designed to accommodate smallholder farmers.

One form of irrigation scheme which may be viable, are small (< 500 ha), low-cost, community-based projects which are initiated and driven by existing land users.

To minimise capital investment and operating costs of such schemes, they should be established on irrigable areas close to the villages where the participants live, and preferably downstream of the water source. This implies that, in most cases, existing consolidated, rain-fed agricultural lands would have to be converted to irrigation.

The irrigation water should be sourced from multi-purpose small/farm dams which, if established up-stream of the irrigation area, will allow for low-cost, gravity-fed reticulation and on-scheme storage.

For such schemes to be viable and sustainable they should operate on a commercial basis. This implies that farm sizes should be large enough for commercial production (25 to 50 ha). This, in turn, implies that there will need to be consolidation of existing rain-fed “permission to occupy” land holdings which, on average, are about 1 ha in size. Leasing of “permission to occupy” land holdings is feasible provided an alternative source of food security for the present land users is found. The irrigated homestead plot concept may provide a solution in this regard.

5.2.2 Communal areas - Homestead plot irrigation

It is evident that the standard and intensity of rain-fed crop production on a fenced arable plot adjacent to most homesteads is much higher than production on the consolidated cropping areas situated some way from each village. The main crop grown on the homestead plots is maize with sorghum occasionally planted. The reason for the more successful production on these plots is their proximity to the homestead. Ease of access makes the crop production practices, in terms of planting, weeding, fertilizing with kraal manure, harvesting and providing security for the crop, much more manageable and less time-consuming than in the communal cropping areas.

The main limitation to production however is variable and often inadequate rainfall.

The concept of providing untreated irrigation water to homestead gardens is not a new one, but it is felt that the concept needs to be thoroughly researched and tested as a significant contributor to increased food security in the rural areas of the catchment.

The concept is to provide raw water to a tap/hydrant at the edge of a homestead plot for supplementary irrigation of grain crops and other food crops such as sweet potato, potato and vegetables.

The size of irrigated area within the homestead plot could be in the order of 0.1 ha which is sufficient to make a significant contribution to the household food needs and could also generate a modest cash income especially in the warmer parts of the catchment where, with irrigation, it is possible to produce two crops per year.

It is recognised that the issue of reticulating water to villages in the former Transkei area, which are often situated on relatively high ground, is a considerable challenge. Nevertheless there are a number of options for the sourcing of irrigation water, including:

(a) the construction of weirs on rivers high enough upstream to allow gravity reticulation in pipes or modest canals to reservoirs situated at a high point in the village;

(b) the combination of a micro hydro-power scheme with a small dam which could generate surplus power to cover the cost of pumping water to village reservoirs;

(c) the use of low-cost “ram” pumps for elevation of water from a weir or small dam to lower lying villages;

(d) rainwater harvesting; and

(e) groundwater.

5.2.3 Communal areas - Homestead rainwater harvesting schemes

This topic is the subject of a parallel initiative in the catchment. However, it is important in this report to endorse the value and sustainability of this form of water use. It is recommended that the concept of assisting interested and committed households to establish appropriate rainwater harvesting and storage facilities at their homesteads, with associated vegetable production, be adopted and implemented in terms of a well-researched, tested and phased programme throughout the former Transkei area of the catchment. Refer to Chapter 7 for more detail.

5.2.4 Port St Johns farms

The unique sub-tropical climatic conditions prevailing in coastal region of the catchment coupled with the availability of the existing 73 Port St Johns farms which are presently being converted from state-ownership to free-hold tenure, provide an excellent opportunity for the commercial production of sub-tropical fruit and nut crops, particularly banana and macadamia. The 73 farms cover a total area of 3 650 ha of which about 5% (185 ha) is irrigable on alluvial flood plains of the Mzimvubu River.

On their own these farms would not constitute a viable entity to justify a banana ripening plant and a macadamia shelling and packaging plant. However, if linked to the adjacent Mngazana/Mngazi potential production area, a viable industry could be established with processing facilities in Mthatha.

5.3 ESTIMATED FUTURE IRRIGATION AREA AND WATER USE

Clearly, from the above discussion on irrigation development opportunities and recommended approaches, it would be pure speculation to predict the actual irrigation development in the Mzimvubu catchment over the next 10 to 20 years.

Nevertheless, **Table 5.1** summarises an attempt to project a possible irrigation development scenario which may assist in the medium- to long-term planning of the water resources of the catchment.

Table 5.1 Estimated future irrigation development and water use in the Mzimvubu catchment

Sector	**Present irrigation**		**Future new irrigation**		**Total irrigation**	
	Area (ha)	Water use (million m^3/a)	Area (ha)	Water use (million m^3/a)	Area (ha)	Water use (million m^3/a)
1	9 971	52.8	-	-	9 971	52.8
2	888	2.6	-	-	962	2.6
	20 x 250 ha schemes		5 000	25.6	5 000	25.5
	150 villages x 250 plots x 0.1 ha		3 750	19.1	3 750	19.1
	Port St Johns farms (80%)		150	0.8	150	0.8
Total	**10 859**	**55.4**	**8 900**	**45.5**	**19 833**	**100.8**

For a catchment with substantial water resources, this projected irrigation water use may seem inappropriate. However, in view of the many constraints to irrigation development as outlined in this report, it is considered a reasonable and sustainable projection for medium- to long-term water resource planning.

In this scenario it is assumed that:

- there will be no large irrigation schemes developed in the catchment;
- a limited number (say 20) of small community-based schemes with an average size of 250 ha will be developed;
- the irrigated homestead plot concept will be applied in say 150 villages with 250 plots per village and 0,1 ha per plot; and
- the development of 80% of the 73 Port St Johns farms which are presently being converted to freehold title.

5.4 KEY SUCCESS FACTORS REQUIRED FOR SUSTAINABLE IRRIGATION DEVELOPMENT

5.4.1 Focus on small community-based schemes

The focus of any irrigation development in the study area should be on small, community based projects which could take the form of:

(a) small (<500 ha) schemes where existing, consolidated, rain-fed production areas are upgraded to irrigation and where irrigation water can be affordably and sustainably sourced and applied at low operating cost; and

(b) irrigation water supplied under gravity to traditional household plots in those villages where water can be affordably and sustainably sourced.

5.4.2 Voluntary participation only

Irrigation development should only be considered where communities and individual land holders have shown interest in and have requested assistance for such development.

5.4.3 Involvement of participants in all aspects of planning and development

The decision to go ahead with irrigation development should be followed with participatory planning and development. From the outset the scheme should “belong” to the beneficiaries and not to government or some other institution.

5.4.4 Securing of land tenure

To ensure successful irrigation development, adequate security of tenure is essential to allow investment by individuals in appropriate irrigation infrastructure and equipment.

5.4.5 Commercialisation of production

Commercialisation of production under irrigation is essential in order to ensure adequate income generation to cover the operating costs of irrigated farming and provide a worthwhile contribution to household income.

5.4.6 Establishment of community-owned institutional structures (ownership and management of schemes)

The complexity and sensitivity of sharing infrastructure and water on an irrigation scheme, no matter how small, requires control and management. It is essential that appropriate, community-owned, institutional structures are in place to take responsibility for the control and management of the scheme.

5.4.7 Support services in place

Fundamental to the sustainability of an irrigation scheme is the regular and reliable supply of the range of agricultural support services essential on an irrigation scheme, including financing, mechanisation, input supplies, technical support, and marketing structures.

5.4.8 Low cost of water

The viability of any irrigation scheme is a function of the cost of water and/or the cost of operating and maintaining the water supply. Any scheme should therefore be designed to minimise tariffs, and operating and maintenance costs.

A major contributing factor to the cost of pumped water is the pumping head (the height above the water source to which the water has to be elevated). A head of above 50 m is unlikely to be viable unless the irrigation water is used for intensive production of high-value crops.

5.4.9 Integrated water use from storage facility

The cost of building even a small dam or weir on a river in the catchment could not be justified for irrigation alone. It is recommended that any water storage infrastructure should be developed with a multi-purpose objective such as domestic, irrigation, livestock and possibly hydro-power generation.

5.4.10 Undertake viability assessment

Before embarking on any irrigation scheme development a detailed technical, social, and financial viability assessment should be undertaken which involves all stakeholders (particularly the participating farmers), in all aspects of the study.

6 ASSESSMENT OF POTENTIAL FUTURE FORESTRY DEVELOPMENT

The Department of Water Affairs is responsible for Water Use Licences for Forestry and has managed this function since 1998 through the Sub-directorate Streamflow Reduction (SD: SFR).

Water use licences (for forestry) are dependent on a number of factors including:

- the availability of water;
- the impact on biodiversity;
- the perceived social and economic impacts;
- equity and targets to reallocate water;
- the agricultural value of the land to be used; and
- the threat posed by alien plant invasions.

Whilst a forestry water use licence is signed off by DWA, the decision to issue the licence is an inter-departmental cooperative governance decision. Records of decision required to meet own legislative requirements are also required of both the Department of Agriculture and the Department of Environment Affairs. Other Departments, at national or provincial level, that have a part in decision-making, include Land Affairs, Local Government and Housing, and Cultural Affairs. Environmental NGOs and the Forestry Sector are also given a chance to voice opinions and position. The approach has always been to try and reach consensus amongst all parties in regional Licence Assessment Advisory Committees (LAACs), in this case the Eastern Cape LAAC.

The DWA is under constant criticism for its failure to issue licences – when the reality is that it can be very difficult to muster both a sound application and inputs from all the roleplayers. Water is only one of the decision-making factors and is not by any means always the most difficult. In order to try and ease the process of integrated decision-making in forestry licensing the SD: SFR commenced with a series of Strategic Environmental Assessments for the Mhlathuze River catchment in 2000, the Usutu-Mhlathuze WMA in 2002, and in 2005 for the Eastern Cape Zone of Potential Afforestation. The Eastern Cape SEA found that at least 350 000 ha of land was biophysically suitable for the planting of trees, but that a target of 100 000 ha was more realistic. Most of this land is in the Mzimvubu River catchment. This target of 100 000 ha later become “enshrined” in the Forestry Sector Transformation Charter, and is a goal sought after by the Forestry Sector, the Forestry Branch (now in the Department of Agriculture, Forestry and Fisheries, DAFF), and the Department of Water Affairs itself. The DWA has, by virtue of its licensing responsibility, therefore almost inadvertently become the organisation seeking to support afforestation development. This is not totally counter to the aims and tasks of the regulator – as the NWA also requires that water be used to optimal benefit. DWA has therefore adopted the approach of supporting and even encouraging forestry where this appears to be the best possible use of available water – using a balance of environmental, economic and social criteria.

The SD: SFR played this role with the support of Professional Service Providers. The conclusion of PSP contracts in 2007, and the resignation of core staff in the sub-directorate in whom the necessary capacity had been built, left the task unsupported.

Forestry has long been viewed as one of the development drivers in the Eastern Cape, and potentially one of the most effective users of water in the Mzimvubu catchment. Licensing forestry is a way of allocating water to rural communities living in remote areas and out of the reach of irrigation infrastructure. The Study Team was therefore tasked by DWA Directorate: National Water Resource Planning with both assessing forestry’s role in the water balance of the Mzimvubu, and continuing the role of “forestry facilitation” in an attempt to make good the gap in capacity within SD: SFR. It was recognised that any facilitation and promotional work should really be undertaken by the Forestry Branch of the then Department of Water Affairs and Forestry (now within DAFF) and that the involvement of National Water Resource Planning was at best a temporary measure.

AsgiSA-EC has now taken a lead role in forestry facilitation at strategic level, with significant support offered by DWA through the Study Team, as will be seen below.

6.1 SCOPE OF THE TASK

The task is a sub-set of the overall project *DWA Water Resource Study in Support of the AsgiSA-EC Mzimvubu Development Project*. Fundamentally the task was to support the process of determining areas suitable for afforestation within quaternary catchments, given the prospect of certain licensing constraints that could amount to fatal flaws to forestry ambitions. Typically such constraints would be:

- The availability of water;
- High biodiversity value; and
- Concerns for food security, and the prioritisation of competing agricultural ambitions.

The study was required to focus on the Mzimvubu River catchment, but necessarily extended beyond the strict boundaries of the catchment in that forestry is a regional activity and all forestry development is economically linked. Catchments in the Kei and the Keiskamma, as well as the Pondoland coastal (T60) catchments, were therefore also given attention as part of this bigger picture.

6.1.1 Assess existing afforestation and calculate water use

The primary constraint was always taken to be water, and the first task was to assess exactly how much forestry was already practised within each quaternary, so that an accurate water use value could be ascribed to the activity, this being an essential part of the water balance equation in determining how much water was remaining for extending the activity. These values were derived from existing land cover maps, satellite images, and from the databases of forestry companies operating in the region.

The only forestry company to be really forthcoming in this regard was PG Bison, which produced excellent and accurate data.

6.1.2 Improve afforestation suitability maps

The key activity was then to improve the detail in the maps produced by the SEA for areas where forestry could commercially and viably be practised, and which would also stand a reasonably good chance of being granted a forestry licence. The key considerations were:

- biophysical suitability (as indicated in the SEA);
- water availability;
- biodiversity value and whether transformation of the land would be acceptable from a conservation perspective;
- agricultural value - high potential agriculture, or even whether previously farmed; and
- markets and access.

The actions were to explore each and all of these issues and improve on current understanding of where forestry could be practised.

Most of the work revolved around water availability and prioritising the determination of ecological Reserves within quaternaries. This required facilitation of a setting of the standards, and acceptability of Reserve determinations.

The other major constraint has been that of biodiversity. The biodiversity coverages provided as part of the SEA process rendered almost all land within the target area as unavailable to forestry. This was clearly both incorrect and unacceptable and came from the setting of too-strict criteria. The task was therefore to advise and work with AsgiSA-EC in negotiating with the Department of Environment Affairs in the Eastern Cape, and SANBI, on acceptable criteria and appointing and managing specialists to re-evaluate the biodiversity of prioritised catchments within the target area.

An additional task, undertaken at the specific request of AsgiSA-EC, was to develop a conceptual proposal aimed at catchment restoration where soil erosion is a threat to river ecology and most particularly results in the siltation of dams. The central concern was the loss of storage capacity in existing dams, and in any potential new dams that might be constructed as part of the development of the Mzimvubu River catchment.

6.2 OUTCOMES

6.2.1 Hydrology

The Mzimvubu River catchment has always been perceived as a catchment with a very large volume of water that could be put to use. Opportunities for development exist primarily because they have never been taken up before; this because the distance, remoteness and ruggedness of the terrain make development very difficult. This project has explored the construction of dams for transfer of water, for irrigation and for hydropower; opportunities for agriculture and large-scale irrigation schemes and opportunities for afforestation. Studies have indicated that there are some opportunities for dam construction, but nothing on a massive scale, that land is simply not available for large scale irrigation schemes, but that there are opportunities for smaller developments and that forestry is a very real opportunity. Development of forestry is significantly constrained by the terrain, biodiversity and potential conflicts with other plans to use both land and water (agriculture, including biofuels production, but especially food security).

With regard to water the major constraint proved to be the way in which the concept of 'ecological Reserve' was being applied, in that catchments that were categorised as "pristine" were then also classed as required to stay pristine, which meant that no reduction in low-flows could be contemplated in many quaternary catchments. Given that forestry is a water user that cannot switch the tap off, or make compensatory releases in the low flow (dry) season without mitigation dams, this effectively made it an "unacceptable" activity. The task became to raise an awareness of this problem and its implications, to indicate its unreasonableness, and to offer a satisfactory alternative. Calculations were undertaken in certain critical catchments and it was demonstrated that a likely failure of low flow ecological Reserve requirements could only be expected in 1:960 months of flow if a catchment was planted to a full 20% extent. Such extensive forestry is very unlikely in most catchments given the nature of the terrain. The directorate: RDM agreed that impacts on low flows were such that a maximum density of 10% to 20% afforestation could be considered in all catchments targeted for afforestation development for planning purposes.

The Reserve requirements and the water use by potential areas of afforestation were then determined through various different agencies, the East London Regional Office of DWA, and finally also the Cradock Regional Office of DWA. The Cradock Office provided a set of hydro-calculations for each quaternary, applying a range of criteria, based on an intimate knowledge of the terrain and of competing uses in assessing water availability.

This process was based on the first assumption that, before forestry could be considered, water should first be found to be available in a quaternary catchment. It was proposed through this project that the thinking should be reversed, or at least that water availability should not be applied as the first and primary constraint or sieve through which forestry suitability would have to pass. Rather than force forestry to come along as a secondary claimant for available water (thus always playing second fiddle to agriculture, the Reserve, and other users), the approach proposed was to say "*This is the land suitable and available for good commercial forestry and this is the water requirement. How can we accommodate this forestry into the ecological and hydrological landscape?*"

This has proved to be a very useful approach as forestry has been able to take its rightful place as an equal potential competing user of water.

6.2.2 Reserves

As discussed above, the issue of Reserve determinations proved to be the major challenge facing the afforestation task. The Directorate: RDM had made a commitment in 2008 to undertake a comprehensive Reserve study on the Mzimvubu River. This would cover the main stem, but did not resolve the immediate need to undertake Reserves to support licence applications at tertiary catchment level.

Two workshops were held with RDM and other DWA staff and consultants in East London in July and September 2009. The first workshop defined the problem and set the scene, whilst the second actively reviewed the situation with regard to specific Reserve determinations. The big breakthrough in this second workshop was the acceptance by the Directorate: RDM that even if Reserves had not necessarily been signed off they could still be accepted as reliable enough to meet planning objectives. These Reserves were designated “Planning Reserves”. The fundamental necessity is to know whether there is any water available and approximately how much, in order to plan afforestation development. This can be an iterative process but it is necessary to start off with the certainty that one is not going to unnecessarily arouse undue expectations that forestry will be licensed. These “Planning Reserves” have been incorporated into the Forestry Planning Spreadsheet – which has been maintained throughout the project as the baseline tool expressing the *status quo* of afforestation assessment (see **Table 6.1**).

The link to the point raised under hydrology (Section 6.2.1), which was determining first how much land could be available for forestry before knowing the water availability, is that planners can now fit water and land availability together. In many instances quaternaries are clustered into a cascade of catchments and if the water is not, or cannot be, taken up in one of the upper catchments, then it becomes available in a lower catchment. It can therefore be counter-productive to assign all available water in an upper catchment to forestry when there is little or no available land for that forestry. Far better is to have a reasonable idea of what is possible and then to allow that water to cascade downstream. The DWA Regional Office staff in Cradock used their Hydrocalc methodology to do this in a very crude way, in the absence of other limitations, by assigning a maximum of 30% area to forestry in any one quaternary and then cascading additional water downstream.

The Reserve workshop of 9 September 2009 showed that this 30% was often a major over-estimate of how much forestry would be practically possible and that significant volumes of water could be moved downstream. It is necessary to continue with these analyses and estimates in an iterative way. The workshop also reviewed all those Reserves that had already been determined at different levels in the Mzimvubu River catchment and affirmed that almost all of these Reserves could be adopted for the purposes of forestry licence applications already on the table. This should allow for licence approvals for ±20 000 ha of afforestation, provided other constraints, such as biodiversity, do not come into play. The situation in terms of water assessments for forestry suitability is summarised in **Table 6.1**.

Table 6.1 Forestry Planning Spreadsheet: Eastern Cape Zone of potential afforestation: Water resource and Reserve

Catchment	Quat	Approved or revised Reserve Determi-nation	Proposed Reserve Determi-nation	No. of Current licence applic.	EC new licence applic. area	Genus Exchange Applic Area	Desktop review or new by Stassen (May 2009)	Mallory Water availability 2008 (ha)	Gibson Water Availability 2008 (ha)	Quat	Catchment area (ha)	Cradock hydrocalcs - 30 Sept 09 (30% rule)	Teba priority Nov08	Focus Clusters Nov08	Comments (Teba classification)	CDK comment and notes of 9 Sept
Mbashe	T11A			1	1 187			0		T11A	33 000	0	2		/	WARMS water use looks too high
Mbashe	T11B			2	755			0		T11B	41 500	0	2			
Mbashe	T11C							0		T11C	38 600	10 960	1	4	Great opportunity	Cumulative
Mbashe	T11D							0		T11D	34 300	8 499	1	4	Great opportunity	
Mbashe	T11E			1	100			0		T11E	23 300	5 073	1	4	Great opportunity	
Mbashe	T11F							0		T11F	27 500	7 701	2	4	Great opportunity	Cumulative
Mbashe	T11G							0		T11G	29 100	5 633	2		Much lower potential	Cumulative
Mbashe	T11H							0		T11H					Nil	
Mbashe	T12A			2	2 578			0		T12A	27 900	5 470	2	4	Good opportunity	
Mbashe	T12B							0		T12B	23 000	6 880		4	Potential at Ngcobo end	Cumulative
Mbashe	T12C							0		T12C		6 537	1		Nomadama plantation	
Mbashe	T12D							0		T12D		9 352	4		Add-on potential (high but limited)	Cumulative
Mbashe	T12E							0		T12E		12 298	4		Add-on potential (high but limited)	
Mbashe	T12F			1	1 107			0		T12F		10 380	1		Add-on potential (high but limited)	Cumulative
Mbashe	T12G							0		T12G						
Lower Mbashe	T13A							0		T13A					Subsistence woodlot only	
Lower Mbashe	T13B							0		T13B					Subsistence woodlot only	
Lower Mbashe	T13C							0		T13C					Subsistence woodlot only	
Lower Mbashe	T13D							0		T13D					Subsistence woodlot only	
Lower Mbashe	T13E							0		T13E					Subsistence woodlot only	
?	T20A							0		T20A		0	4		Includes Langeni - small additions?	Water supply, hydro-power demand
?	T20B							0		T20B		0	2		Hih potential in upper reaches	
?	T20C							6 070		T20C					Very low potential	
?	T20D							7 340		T20D					Very low potential	
?	T20E							5 510		T20E					Very low potential	
?	T20F							0		T20F					Very low potential	
?	T20G							4 160		T20G					Very low potential	
Upper Mzimvubu	T31A	DT, 2000	Rapid					2 200		T31A	22 130				/ KZN. No applications	PES A
Upper Mzimvubu	T31B	DT, 2001	Rapid					2 800		T31B	28 395				/ KZN.	
Upper Mzimvubu	T31C	DT, 2006	Rapid	1	2076 + 148.9		2 076	0		T31C	29 058	0			Difficult. High altitude	PES B - Has new DT. Workshop agreed no water
Upper Mzimvubu	T31D	DT May 09	Rapid		0		Irrigation	0		T31D	35 251				/ KZN	
Upper Mzimvubu	T31E	DT, 2004	Rapid		0		Irrigation			T31E	50 900	0	2		Potential down towards Matatiele	Stressed! Use value 3. Workshop agreed no water
Upper Mzimvubu	T31F	DT, 2004	Intermed		0		Irrigation	0		T31F	60 466	0			Patchy. Competition with irrigation	
Upper Mzimvubu	T31G	R3, 2006	R3		0		Irrigation	0		T31G	20 900	0	2	1	Good potential. Competition with irrigation	Cumulative; PES C
Upper Mzimvubu	T31H	DT, 2003	Rapid	6	?		1 928	0		T31H	61 700	0	1	1	Myvenyani - the heart of potential	Water in catchmnet but downstream catchment is in deficit
Upper Mzimvubu	T31J	R3, 2003	Intermed		0		Irrigation	7 699	7 500	T31J	50 700	0	2	2	Potential on top of the mountain	Cumulative; problem is upstream water use
Mzintlava	T32A	R3, 2007	Intermed					3 440		T32A	34 707	0			KZN Franklin Vlei	Workshop agreed no water
Mzintlava	T32B	Rapid	Intermed					469		T32B	30 648				KZN	
Mzintlava	T32C	R3, 2003	Rapid					7 440		T32C	37 292				KZN - recent licence to Singisi for sawmill	
Mzintlava	T32D	R3, 2004	Rapid					0		T32D	35 018				KZN	
Mzintlava	T32E	DT, 2006	DT					0		T32E	38 300	0	1	2	Small areas. Desktop good enough for now	Cumulative
Mzintlava	T32F	DT, 2008	Rapid	1	part T32G			3 424	3 345	T32F	29 700	0	1	2	Small areas	Cumulative
Mzintlava	T32G	DT, 2007	Rapid	3	1 410			0		T32G	43 800	0	1	2	Small areas	Water in caqtcchmnet but downstream catchmnet in deficit
Mzintlava	T32H	R3, 2005	Rapid					0		T32H	45 300	0	2	2	Upper reaches - adjoining Gomo	Cumulative; problem of upstream use
Mt Fletcher / Matat	T33A	DT, 2005	Rapid	1	115		115	6 757		T33A	67 200	0	1		Good - but avoid high altitude	Cumulative
Mt Fletcher / Matat	T33B	DT, 2007	Rapid	4	1 548		948	10 569	10 000	T33B	60 200	5 753	1		Good - but avoid high altitude	Cumulative
Mt Fletcher / Matat	T33C	R3, 2007	Rapid	3	342		169	0		T33C	36 700	10 466	1		Good - but avoid high altitude	Cumulative
Mt Fletcher / Matat	T33D	R3, 2007	Rapid	11	414		414	0		T33D	46 100	12 941	1		Good - but avoid high altitude	
Mt Fletcher / Matat	T33E	DT, 2007	Rapid	6+1	236		236	5 057	5 057	T33E	26 700	7 831	1		Good	Cumulative
Mt Fletcher / Matat	T33F	DT May 09	Rapid	4	2 821		2 821	5 486	5 196	T33F	43 700	9 804	1	1	Good potential	Cumulative
Mt Fletcher / Matat	T33G	DT May 09	DT	?? 1	?? 281		??	7 675	7 700	T33G	50 300	14 662	1	1	Good potential	Cumulative
Mt Fletcher / Matat	T33H	DT May 09	DT	2	1 224		1 224	8 585	8 585	T33H	51 700	8 920	1	1	Good potential in upper reaches	Cumulative
Mt Fletcher / Matat	T33J		DT					8 928		T33J					Low potential and access	
Mt Fletcher / Matat	T33K	DT, 2003	DT					3 178		T33K					Low potential and access	
Tina	T34A		DT					3 620		T34A					None	
Tina	T34B		DT					2 970	2 970	T34B	24 600	6 169	2		Very limited opportunity	Cumulative
Tina	T34C	DT, 2003	DT					0		T34C	28 200	8 426	1			Before confluence with T34B
Tina	T34D	DT, 2004	Intermed	2	3 341		1 536	0		T34D	34 200	7 649	1	1	Core area	Cumulative before T34F
Tina	T34E		Intermed					3 780	3 780	T34E	26 800	8 029	2	1	Core area	
Tina	T34F		Intermed					3 610	3 580	T34F	23 800	7 012	2	1	Core area	Cumulative
Tina	T34G		Intermed	4	2 484		2 484	4 912	4 912	T34G	35 800	8 256	1	1	Core area	Cumulative
Tina	T34H	DT, 2007	Intermed	6	3 778		3 778	4 726	4 726	T34H	59 100	13 554	1	1	Core area	Cumulative
Tina	T34J	R3, 2003	R3					4 908	4 908	T34J	29 700	8 438	2		Limited	Cumulative
Tina	T34K	DT, 2002	DT					6 110		T34K					Very limited potential	
Tsitsa	T35A	DT, 2007	Rapid		0	395	do the Rapid	6 194	7 160	T35A	47 500	9 983	1			
Tsitsa	T35B	DT, 2007	Rapid	3	138	1 426	do the Rapid	4 343	5 214	T35B	39 600	5 312	1			Cumulative; new irrigation must still be accounted for. Probably nearly full.
Tsitsa	T35C	DT, 2007	Rapid	1	86	3 266	do the Rapid	0		T35C	30 600	3 714	1			Cumulative
Tsitsa	T35D	DT, 2005	Rapid					8 410		T35D	33 800	7 451			Some limited opportunity	Cumulative; new irrigation must be accounted for
Tsitsa	T35E	DT, 2003	Intermed	7+1	1 796		1796 - Int '11	10 800	6 195	T35E	49 200	12 165	1		Impacted by T35 F&G. Mitigation dam at Ugie?	Cumulative
Tsitsa	T35F	DT, 2007	Intermed	12	446	6 077	Nil - Int '11	2 272		T35F	35 900	0			Fully afforested (genus exchange?)	Workshop (not Cdk) set water at 0
Tsitsa	T35G	R3, 2003	Intermed	11	2 298	646	Nil - Int '12	5 500		T35G	57 500	0			Fully afforested (genus exchange?)	Workshop (not Cdk) set water at 0
Tsitsa	T35H	DT May 09	Intermediate	1	45		45	0		T35H	52 000	14 900	1			Cumulative
Tsitsa	T35J	DT May 09	Intermed	2	284		284	0		T35J	18 800	5 157	1			Cumulative
Tsitsa	T35K	R3, 2003	Intermed	1	595		595	5 660		T35K	62 500	16 832	1		Tsolo - heavily invaded with wattle	Cumulative
Tsitsa	T35L	DT, 2008	Intermed	?	436			0		T35L	34 000	9 764	1		Dry - tops of hills only	Cumulative
Col A: Catchment	**Col B: Quaternary**	Col C: Approved or revised Reserve Determination. Retha reviewed the existing T3 Reserves and used this in most cases. In some instances Desktops were recalculated. These are given the date MAY '09 and have been submitted for approval.	Col D: Proposed Reserve Determination: The Reserves proposed as culmination of the Comprehensive Reserve for T3.	Col E: No. of licence applications: Number of licence applications known to be on the table in May '09	Col F: EC New Licence application area: The area given by the EC Region for which there are licence applications (this does not always agree with the area tabulated and "agreed to" by Retha Stassen). Area updated by Naomi Fourie (29 June). Does not include Genus Exchange applications.	Col G: Areas under Genus Exchange application	Col H: Desktops either reviewed, repeated, or newly undertaken by Stassen, May 2009. This indicates which quaternaries were considered by Stassen. Only T3 quats were addressed and not all of those. Some were directed at irrigation applications. Only in some cases were new desktops calculated (marked as "May 09" in col C). Areas given indicate the extent to which current applications are considered acceptable for approval but this does not indicate maximum possible area.	Col I: Mallory Hydrocalcs: Water availability in terms of ha forestry as determined by Stephen Mallory (2008)	Col J: Gumede Hydrocalcs: Water availability in terms of ha forestry as determined by the EC RDM Office (2008)			Col M: Cradock hydrocalcs. The area of afforestable land in terms of available water - based on flow and licences already issued. To this the "30%" rule has been applied, by which no more than 30% of any quaternary may be afforested (existing + new forestry) - with any consequential additional available water distributed further downstream.	Col N: Teba priority - Nov 2008. Priorities for assessment of constraints (hydro and biodiversity) based on applications and recognised potential. (1-4 are all high priority).	Col O: Focus Clusters - Nov 2008. A higher level of prioritisation based on a clustering exercise (some quaternaries drop out)	Col P: Comments (Teba). These give an expert understanding of suitability for forestry - without suggesting actual areas.	Col Q. Some abbreviated Cradock comment (see Cradock / Asgisa spreadsheets for full comment. Occasional input from the RDM / hydrocalcs meeting in EL on 9 September 2009

Table 6.1 Forestry Planning Spreadsheet: Eastern Cape Zone of potential afforestation: Water resource and Reserve (continued)

Catchment	Quat	Approved or revised Reserve Determi-nation	Proposed Reserve Determi-nation	No. of Current licence applic.	EC new licence applic. area	Genus Exchange Applic Area	Desktop review or new by Stassen (May 2009)	Mallory Water availability 2008 (ha)	Gibson Water Availability 2008 (ha)	Quat	Catchment area (ha)	Cradock hydrocalcs - 30 Sept 09 (30% rule)	Teba priority Nov08	Focus Clusters Nov08	Comments (Teba classification)	CDK comment and notes of 9 Sept
Tsitsa	T35M	DT, 2002	DT					5 152	5 152	T35M	30 500	8 891	1	3	Dry - tops of hills only	Cumulative
Lower Mzimvubu -	T36A	DT, 2002	Intermed					7 330		T36A					Lower Mzimvubu - difficult for forestry	
Lower Mzimvubu -	T36B	DT, 2005	Intermed					4 230		T36B					Lower Mzimvubu - difficult for forestry	
Mtamvuna	T40A				3 466					T40A	20 800	0	1	2	Good potential	
Mtamvuna	T40B									T40B					KZN	
Mtamvuna	T40C									T40C	23 700	7 110	2	2	Good potential	Cumulative
Mtamvuna	T40D									T40D	37 200	11 150	1	2	Good potential	Cumulative
Mtamvuna	T40E									T40E						
North Pondoland	T60A							0		T60A	54 700	3 350	2	2	Very good potential esp upstream half	
North Pondoland	T60B				350			2 010	2 010	T60B	52 800	0	1	2	Whole qc med to high potential	
North Pondoland	T60C							7 100		T60C	36 300	1 860	3	2	Ridges and edges of qc only	Cumulative
North Pondoland	T60D							6 340		T60D1	7 600	1 000	3	2	Mtentu - Suitable in upper reaches of QC	Cumulative
										T60D2	33 900	3 400			Mnyameni	Incremental
North Pondoland	T60E							0		T60E	19 800	3 050	2	2	Wide area of potential	
North Pondoland	T60F			5	376			8 430	8 430	T60F1	15 600	1 000	1	2	(Msikaba) Wide area of potential	Cumulative
										T60F2	30 800	4 720			(Xura) Wide area of potential	Incremental
North Pondoland	T60G			3	14			6 170	6 170	T60G	36 000	5 040	1	2	Very high and high potential	Cumulative
North Pondoland	T60H			4				0		T60H	32 200	4 640	4	2	Ntsubane - highest areas only	
North Pondoland	T60J							5 370	5 370	T60J	29 400	8 790	1	2	Considerable potential	
North Pondoland	T60K							4 770	4 770	T60K	24 200	7 260	1	2	Considerable potential	
Libode	T70A			1	243			0		T70A		6 065	1	3	On high ground - good	
Libode	T70B							0		T70B					Avoid	
Libode	T70C							0		T70C	19 800	5 940	3	3 ??	Upper reaches - could avoid	
Libode	T70D							0		T70D					Difficult terrain	
Libode	T70E				550			0		T70E		1 865	1	3	On High ground - good	
Libode	T70F							0		T70F				3 ??	Upper reaches only - not recommended	
Libode	T70G							0		T70G				3 ??	Upper reaches only - not recommended	
Coastal	T80A							0		T80A	21 300	909	3		Med potential - estuary Reserve concerns	
Coastal	T80B							0		T80B	23 400	6 973	3		Med potential - estuary Reserve concerns	
Coastal	T80C							0		T80C					Med potential - estuary Reserve concerns	
Coastal	T80D							0		T80D					Med potential - estuary Reserve concerns	
Willowvale / Centa	T90A							0		T90A					Nil	
Willowvale / Centa	T90B							0		T90B					Not commercial	
Willowvale / Centa	T90C			4				0		T90C			4		Very limited opportunity	
Willowvale / Centa	T90D			1	90			0		T90D					?	
Willowvale / Centa	T90E			4				0		T90E			4		Some potential	
Willowvale / Centa	T90F							0		T90F		4 375	2		Lots of potential - Centani cluster (2nd phase)	
Willowvale / Centa	T90G							0	4 160	T90G	46 000	10 303	2		Lots of potential - Centani cluster (2nd phase)	
Katberg	Q94A									Q94A					Katberg - all potential taken up	
Katberg	Q94B									Q94B						
Keiskammahoek	R10A							0		R10A	13 800	3 815	2		Potential associated with Amatole	
Keiskammahoek	R10B			2	85			0		R10B			1		Nil	
Keiskammahoek	R10C							0		R10C					Questionable potential - little opportunity	
Keiskammahoek	R10D							479		R10D					Questionable potential - little opportunity	
Keiskammahoek	R10E							0		R10E						
Keiskammahoek	R10F			1	10			0		R10F	7 100	1 731	4		Planted up - little space left	
Keiskammahoek	R10G							0		R10G						
Keiskammahoek	R20A			1	2					R20A						
Keiskammahoek	R30A									R30A					Potential for the future	
Keiskammahoek	R30B									R30B	52 700	0	2		Potential for the future	
Kei (Doring River)	S20A									S20A	29 800	1 350			Not considered	Doring Dam at outlet
Kei (Indwe River)	S20B									S20B	44 700	8 580			Not considered	S20C has Lubisi Dam at outlet
Kei	S32D			1	25			0		S32D					Occupied by Hogsback.	
Kei	S32E			4				0		S32E		0	4		Limited opportunity (Seymour). Dams and QT demand	Water for Queenstown
Kei	S40A							0		S40A	44 600	0			Not considered by Teba. Sam Meyer Dam	
Kei	S40B							0		S40B		0	2		Possibe expansion N of Amatole. Granta Dam	Granta Dam in catchment
Kei	S50A							0		S50A					No	
Kei	S50B							0		S50B					No	
Kei	S50C							0		S50C					Nil	
Kei	S50D							0		S50D					Limited around edges	
Kei	S50E							0		S50E		13 440	1		Nomadamba plantation. Good opportunity	
Kei	S50F							0		S50F					Nil	
Kei	S50G							0		S50G					Minimal	
Kei	S50H							0		S50H					Minimal	
Kei	S50J							0		S50J					Minimal - and doubtful at that	
Kei	S60A			1	857			0		S60A		0	4		Amatole - limited space for expansion	Part of Amatole System - stressed!
Kei	S60B							0		S60B					Nil	Amatole Water Supply System
Kei	S60C			1	467			0		S60C					Already planted up	Amatole Water Supply System
Kei	S60D							3 600		S60D					Already planted up	
Kei	S60E							4 200		S60E		0	2			System stressed
Kei	S70A							0		S70A					No	
Kei	S70B							0		S70B					No	
Kei	S70D							0		S70D					Wattle jungle	
Kei	S70E							0		S70E					Wattle jungle	
Kei	S70F							0		S70F					Possible potential	
					23 837											
Col A: Catchment	**Col B: Quaternary**	Col C: Approved or revised Reserve Determination. Retha reviewed the existing T3 Reserves and used this in most cases. In some instances Desktops were recalculated. These are given the date MAY '09 and have been submitted for approval.	Col D: Proposed Reserve Determination: The Reserves proposed as culmination of the Comprehensive Reserve for T3.	Col E: No. of licence applications: Number of licence applications known to be on the table in May '09	Col F: EC New Licence application area: The area given by the EC Region for which there are licence applications (this does not always agree with the area tabulated and "agreed to" by Retha Stassen). Area updated by Naomi Fourie (29 June). Does not include Genus Exchange applications.	Col G: Areas under Genus Exchange application	Col H: Desktops either reviewed, repeated, or newly undertaken by Stassen, May 2009. This indicates which quaternaries were considered by Stassen. Only T3 quats were addressed and not all of those. Some were directed at irrigation applications. Only in some cases were new desktops calculated (marked as "May 09" in col C). Areas given indicate the extent to which current applications are considered acceptable for approval but this does not indicate maximum possible area.	Col I: Mallory Hydrocalcs: Water availability in terms of ha forestry as determined by Stephen Mallory (2008)	Col J: Gumede Hydrocalcs: Water availability in terms of ha forestry as determined by the EC RDM Office (2008)			Col M: Cradock hydrocalcs. The area of afforestable land in terms of available water - based on flow and licences already issued. To this the "30%" rule has been applied, by which no more than 30% of any quaternary may be afforested (existing + new forestry) - with any consequential additional available water distributed further downstream.	Col N: Teba priority - Nov 2008. Priorities for assessment of constraints (hydro and biodiversity) based on applications and recognised potential. (1-4 are all high priority).	Col O: Focus Clusters - Nov 2008. A higher level of prioritisation based on a clustering exercise (some quaternaries drop out)	Col P: Comments (Teba). These give an expert understanding of suitability for forestry - without suggesting actual areas.	Col Q. Some abbreviated Cradock comment (see Cradock / Asgisa spreadsheets for full comment. Occasional input from the RDM / hydrocalcs meeting in EL on 9 September 2009

6.2.3 Agriculture

Land availability for afforestation is influenced not only by biophysical capability, but also by ownership, and particularly community desire to engage in forestry. It is further influenced by competing land uses and the most important of these is agricultural development. It is a feature of most of the former Transkei, including almost all of the Mzimvubu River catchment, that very large areas have at some stage been cultivated, and as such are classified not only as arable land, but as cultivated lands. The Department of Agriculture notes that South Africa has three million hectares of unused high potential agricultural land, much of this in the Eastern Cape. This raises the question of whether all “previously cultivated land” should remain set aside for agriculture, or whether the addition of forestry plantations to the agricultural mix would not lead to higher overall productivity and that some “agricultural” land could be devoted to this purpose.

6.2.4 Biodiversity

The conservation of biodiversity is a necessary consideration in all development planning, and particularly so in forestry, where large swathes of land are transformed through conversion to plantation. It is also so that with so much of the South African landscape, notably the grasslands, already transformed to different land uses, with agriculture by far the most important of these, the little natural grassland that remains is often singled out for the fact that it holds the last remaining biodiversity. The less natural landscape that survives, the more valuable this becomes and the greater the need for its preservation.

This proved to be a very serious limitation towards further afforestation in the Eastern Cape and it became necessary to review the situation of biodiversity through a finer lens. In the first instance land that has already been ploughed up or cultivated has effectively lost its biodiversity value and there is little purpose in setting it aside for “biodiversity conservation”. This applies, too, to lands that have been seriously degraded. A re-assessment of the areas that really should be set aside for biodiversity conservation has indicated that in fact there are large areas of land that could be used for afforestation without compromising the biodiversity integrity of the landscape. In part this is because the vast swathes of biodiversity “pristine” landscapes originally set aside for protection are not in fact pristine, but also because the scale of re-assessment has been very much finer and the areas that definitely should be protected have now been picked out and marked specifically, with areas of lesser value also identified.

This additional work was undertaken by a team approved by SANBI (South African National Botanical Institute) under the auspices of AsgiSA-EC. The Mzimvubu Development Support Project was able to assist in the development of the Terms of Reference, the briefing of the biodiversity team, the coordination of tasks and the review of results.

6.2.5 Planning and mapping

As noted above the emphasis has been shifting towards the development of a forestry land use plan. This is based on the hydrology as influenced by the Reserve, biodiversity, agriculture and, most importantly, the willingness of communities to utilise that land for commercial forestry.

The Mzimvubu Project has not produced a map of potential for all afforestation in the Region. There are, however, now a series of coverages that have identified where the DWA and AsgiSA-EC personnel involved in this project have identified land that meets all the criteria for possible development. In this exercise, which to date has covered 19 of the 56 potential forestry catchments, some 16 000 ha of forestry land has been mapped out in polygons. These detailed coverages are held by Louis de Kock of Rance Timbers, who provided voluntary support to AsgiSA-EC in the mapping process.

6.2.6 Forestry water use licensing

Achievement in the facilitation of forestry water use licensing can be monitored in a number of ways:

- How much land has been licensed to forestry over the period in question?
- How much sustainable forestry has been approved / licensed?
- Forestry licence applications received (success being a factor of number and area)?
- Have blockages been removed and are licences now easier to obtain within designated areas?
- Is licensing on target with the Forestry Sector Development Charter?

None of these is an easy measure due to the time lags involved. There has been a very significant increase in applications for the number of licences and area to be licensed, with reported applications for 30 000 ha of forestry in the Eastern Cape – much in the Mzimvubu River catchment. Of these the water resource issues (Reserve and total water availability) have been cleared on at least 20 000 ha. Clarification on both water and biodiversity constraints has allowed for definite planning within a large number of quaternaries.

There are, however still a number of steps to be taken to complete these initiatives:

- Biodiversity assessments must be undertaken within all those catchments omitted on the first prioritisation. AsgiSA-EC (Stephen Keet) has indicated that it will take this forward.
- “Planning” Reserves should be calculated for all non-priority catchments. This work is to be continued to completion by the Cradock HydroCalc Team. A further meeting between the Directorate: RDM, Sub-Directorate: SFR and the Cradock Team will be required to review results. Facilitation of this review workshop should come from AsgiSA-EC and the Sub-Directorate: SFR.

- Rapid, Intermediate and Comprehensive Reserves must be completed as promised by the Directorate: RDM. The Sub-Directorate: SFR should monitor this process.
- It was a target of the project to gain greater clarity from the Department of Agriculture with regards to the reservation of so-called agricultural land, and especially lands that had previously been under the plough. This has not yet been achieved – but with mapping results in hand indicating the extent and impact of these exclusions, there is now a suitable discussion platform. Discussions need to take place at both national and provincial level.
- Register of afforestation and water use for continuous licensing assessments.

6.2.7 Catchment restoration

AsgiSA-EC has suggested the establishment of a catchment restoration programme, with implementation commencing in the Tsitsa River but aimed at the expansion and implementation of principles and techniques to all of Water Management Area 12 (Mzimvubu to Keiskamma), and over time to the rest of the province. The proposal is for an integrated development and public works programme aimed at restoring and protecting catchment stability.

AsgiSA-EC therefore requested, in February 2010, that the Support Team prepare a concept document towards the design and implementation of a large-scale public-works programme aimed at catchment restoration and rehabilitation. This request was made in the light of the very high levels of sedimentation experienced in most of the Eastern Cape rivers and possible further investigations of a multi-purpose storage dam at Ntabelanga on the Tsitsa River.

This concept document was prepared, and placed a strong emphasis on:

(i) ensuring research on both historical and current ‘LandCare’ type initiatives and communication with any current activities; and

(ii) the sustainability of the programme so that there should be a strong emphasis placed on the hand-over of knowledge and expertise, with incentives to make this a people-based initiative not entirely dependent on public works input.

AsgiSA-EC has used this material in national and provincial presentations. Some seed funding has been set aside to take the concept forward. The DBSA is in discussions with AsgiSA-EC regarding the provision of grant funding to pilot this process.

6.3 FINDINGS AND RECOMMENDED ACTIONS FOR AFFORESTATION DEVELOPMENT

The following is extracted from conclusions derived from the afforestation planning workshop of 9-10 December 2009, supported by AsgiSA-EC and Teba. The workshop used inputs generated through the DWA Mzimvubu Development Study.

6.3.1 Findings

1. 16 of 59 quaternaries were assessed at this workshop. These catchments yield only 16 080 ha of clearly demarcated potential forestry land, with some additional opportunity for wattle jungle conversion - at this stage a total of <20 000 ha of forestry land. Some of the quaternaries assessed were considered to be 'prime forestry land'. Whilst an arrangement may be struck with Agriculture to use old and unproductive agricultural lands, it is clearly not going to be easy to develop the expected 100 000 ha of new afforestation sought by both the forestry sector and the Forestry Branch of the Department of Agriculture, Forestry and Fisheries. By simple linear extrapolation at best 60 000 ha can be found at the moment. It is an imperative that this exercise be completed and that outputs be discussed with the Department of Agriculture.

2. Land, and not water, is the defining constraint in many quaternaries, especially in the T3 (Mzimvubu) catchments. From the Cradock HydroCalcs more than enough water is available in many Mzimvubu quaternaries (see spreadsheet - Table 6.1).

3. There is no single MAJOR forestry area to be found. Areas of suitable land tend to be relatively small and scattered. Commercial forestry interests today seek a minimum of 5 000 to 10 000 ha to make up what would be considered to be a 'viable management unit'. A core forestry area attracting large-scale international investment would want in the order of 30 000 - 50 000 ha.

   Mike Howard (Fractal Forests) argues that nowhere have we yet seen enough forestry potential to serve as a "catalytic" intervention. There are no 5 000 ha blocks anywhere – and hence nothing truly "commercial". The best area identified so far is in the vicinity of Ntsubane (T60H).

4. If forestry is to happen seriously, it will need to be an integrated development, requiring negotiated settlement with agriculture and with communities. The move might best be towards mixed cropping, with forestry part of the agricultural mix.

5. It would never be possible for the forestry companies to manage all the fragmentary bits of possible forestry that are emerging in the different quaternaries. The pieces are just not big enough. Companies would have to focus on helping communities, and not trying to control and administer. Companies like to have full control over their plantation feedstock, and will have to get used to a new way of working (some have already taken this step).

   <u>Proposed new model</u>: The 'command and control' model for community forestry long assumed by the controlling companies does not work. The model proposed is for individual groups doing forestry by themselves with some company support, without the land being leased or managed by the companies. Ownership must, at all levels, stay as far as possible within communities. SAPPI has recently indicated a willingness to move towards this kind of operational model (i.e. far less controlling than previously contemplated).

6. It may be possible to find more forestry land on the ground. The Ngele Ridge, Fort Donald and Gun Drift area that Fractal Forest identified during a ground survey 15 years ago should be re-investigated as a prospect.
7. With land, rather than water, the key constraint, forestry applications on both privately held and communal land will have to be favourably considered if afforestation targets (and promises to the forestry sector) are to be met. It can be noted that the allocation of forestry water use licences to private (often white) landholders will not impact on the water resource opportunities of previously disadvantaged community landholders.

6.3.2 Answers still required

1. Land tenure: Is agricultural land under community control, or is there land that may have been handed to individuals, families, or groups of families to farm on?
2. Has the impact of jungle wattle been factored at all into the water balance? Can one assume that this impact has been accounted for and that available water is based on the existence of jungle wattle?
3. Areas of 'high' but not 'very high' biodiversity (orange on the biodiversity maps) tend to be "intact grasslands" and it remains a question whether all must be conserved, or whether forestry requirements are so low overall that the loss of a few of these areas will not be serious, given that so little other land is being transformed.
4. What is the optimal mix of cropland and timber? To get the balance right quite a bit of cropland should perhaps go under timber in the long-term, just as KZN midlands farmers have brought forestry into the agricultural mix.
5. 30 000 ha of forestry licence applications have apparently been submitted to the Eastern Cape LAAC. This is difficult to reconcile with the apparent scarcity of forestry land – although such licences may, for example, not exclude agricultural lands. A review of existing licence applications should be undertaken to assess whether these are based on fact or fiction.

6.3.3 Next steps

1. Complete the mapping exercise for all quaternaries that show some forestry potential. This will require that the biodiversity assessment be extended to cover all quaternaries (AsgiSA-EC). The DWA Cradock Team should now calculate desktop Reserves and do hydrocalcs to those few catchments still outstanding (see Table 6.1).
2. Hold discussions with the Eastern Cape Department of Agriculture to determine whether there is scope for a forest/ farm economic mix. It may be necessary to repeat the forestry polygon mapping exercise together with Agricultural officials, for Agriculture to point out areas where there is no vision for commercial agriculture.

3. Take the expected area of prospective afforestation and apply this to the water availability model – so that water can be more accurately cascaded down through the quaternaries. This may result in water becoming available in quaternaries currently considered closed (this is a desktop exercise).
4. Advise DWA of the likely extent of forestry, and thus water use, according to this planning tool.
5. Inform DTI of the status quo.
6. Advise the Forestry Branch, and the institution now responsible for the implementation of the Forestry Sector Transformation Charter, of the revised expectation for potential forestry development in the Eastern Cape.

6.4 HANDING OVER RESPONSIBILITIES

The Directorate: National Water Resource Planning has been very clear that its involvement in afforestation planning and support in the water use licensing process is not its responsibility. Neither should this be the responsibility of the Sub-Directorate: SFR, but should be taken over by the Forestry Branch of what is now the Department of Agriculture, Forestry and Fisheries.

The Forestry Branch in 2009 did start to take a proactive role in determinations of forestry potential nationally, commissioning studies in Limpopo, KZN and Mpumalanga, and the Central Regions (Gauteng, North West, and Free State). This work was not extended to the Eastern Cape given the recent SEA, mapping inputs by Sub-Directorate: SFR and this work by the Mzimvubu Support Project.

It is, however, imperative that the Forestry Branch now takes an active hand in continually improving the identification and promotion of forestry in areas where there are no apparent constraints. This requires three things:

(i) Completion of the quaternary catchment land suitability and mapping process;

(ii) Continued high level involvement in all of the processes discussed in this report: ecological Reserve determinations, biodiversity assessments, discussions with agricultural authorities, equity, and licensing; and

(iii) A presence on the ground of well-trained forestry extension officers who can take the suitability maps and work with communities to turn these into a sustainable reality. Particular attention must be given to technology transfer and, in the event of company: community arrangements, to ensuring that equity is indeed the outcome.

The Department of Trade and Industry proposed in its Industrial Policy Action Plan (18 February 2010) that a national Forestry Task Team should be created, with the express aim of promoting and establishing forestry. It is important that the understanding of DWA and AsgiSA-EC with regard to opportunities and constraints to afforestation be brought to this table.

7 RAINWATER HARVESTING

This task is addressed in a stand-alone report (P WMA 12/000/00/3609) entitled ***Rainwater harvesting***, where the full details can be found. A summary of this is included in the rest of this section.

7.1 INTRODUCTION

The Mzimvubu River is the catchment which simultaneously has both the most available water and the greatest poverty in South Africa. Through the ages its abundant water has cut deep, steep valleys into the landscape, creating inaccessibility and remoteness, with major challenges for travel, service provision and most land-based economic activities. Even water, as abundant as it is, is essentially inaccessible. In such a landscape, rainwater harvesting techniques are valuable for users to capture water before it slips beyond economic reach into the deeply incised valleys.

The potential for rainwater harvesting as a water resource in the Mzimvubu Development Zone was assessed through a desktop study to provide a preliminary indication of the possibilities to harvest and use rainwater to augment conventional supplies. The study covers possibilities for four different areas of application, namely for household use, urban contexts, improved agricultural production and environmental restoration. The detailed results are given in the ***Rainwater harvesting*** stand-alone report.

The main focus of the study was on the potential for rainwater use for drinking and household food production at rural and urban homes. Rainfall quantity and seasonal distribution in the study area is highly favourable for household use of rainwater, while to date the combination of high capital cost and low water tariffs has inhibited implementation. However, current trends predict changes in favour of rainwater harvesting. Firstly new technology recently introduced into South Africa from large-scale rainwater harvesting implementation in other countries could significantly reduce the cost of construction. Secondly it would seem inevitable that water tariffs will increase more quickly over time.

In contrast with rapid progress in other parts of the world, South Africa is lagging behind with the application of rainwater harvesting in urban contexts, both for public access buildings and for landscaping and drainage associated with roads, parking areas and urban beautification. As national implementation experience grows, improved assessments will become possible. In this report, some possibilities are discussed for urban contexts like those of Kokstad and Lusikisiki.

The potential for improved rainfed agriculture through increased infiltration of rainwater into the soil profile is currently central to many agricultural initiatives across the continent. In the study area, progress has been made with field experimentation with a specific technique developed by the Free State University called infield rainwater harvesting. A preliminary indication is given for the potential in the study area for rainwater harvesting for dryland crop production and improved grazing. An assessment tool, the Rainfall Harvesting Calculator, has been developed and enables more detailed planning of rainwater harvesting projects at specific locations in future. Required sizes of rainwater tanks can be determined for a specific location, based on fifty years of daily rainfall data for the relevant quaternary catchment, available rainfall collection area, water requirements and the required reliability of supply.

7.2 NATURAL RESOURCES FOR RAINWATER HARVESTING

Rainfall, topography and collection surfaces are important in the assessment of rainwater harvesting potential. The Mzimvubu development Zone lies in a summer rainfall area, and average annual rainfall varies from 600 mm to 1 500 mm across the study area. To its advantage, rainfall in the winter months is more frequent than in many other parts of the country, meaning that rainwater tanks are replenished more often, and dry periods are shorter.

The hilly terrain in large parts of the Mzimvubu Development Zone increases runoff potential compared to very flat areas. While on flatter slopes it is easier to achieve *in situ* infiltration to increase dryland crop yields, the steeper slopes produce more water, e.g. to channel surface water to underground storage tanks. Through thoughtful layout, success has been achieved with both applications in the mountains inland of Port St Johns. Steep drops in topography create opportunities for bio-filtering above the intakes of rainwater storage tanks, thus improving the quality of stored water and reducing the required frequency of tank cleaning.

The characteristics of collection surfaces greatly impact rainwater harvesting potential. Good quality roofing is beneficial for collection of drinking quality water, while thatch and uneven and rusted roof sheeting presents a limitation. In the landscape, grass cover is often maintained year round in parts of the Mzimvubu Development Zone, thanks to the relatively even distribution of rainfall across seasons, which reduces the surface runoff potential but is an important erosion barrier.

Through judicious application of rainwater harvesting, the landscape can be improved to help fight erosion and achieve other gains in the context of potential payments for ecosystem services, which may include water and carbon credits, e.g. for avoided pumping. Climate change benefits of rangeland improvement are considered highly significant across the continent (FAO, 2010).

The report covers examples of various different situations in the Mzimvubu Development Zone and their implications for rainwater harvesting potential and techniques.

7.3 APPLICABILITY OF RAINWATER HARVESTING IN DIFFERENT SOCIO-ECONOMIC CONTEXTS

Rainwater harvesting presents an attractive option for households in remote villages or areas with limited access to water supply infrastructure. The cost of operation and maintenance of a household rainwater tank is minimal, therefore a once-off capital investment by the state to install a tank can provide a poor family with a high degree of water security and independent responsibility. In this context, rainwater harvesting also enables year round production of fruit and vegetable crops high in micro-nutrients and therefore key in poor households' fight against child malnutrition which is rife in the study area.

Counter-intuitively, the report also shows that rainwater harvesting becomes even more affordable and beneficial, for both poor and non-poor households and urban buildings, in situations where a reliable municipal supply is available and can be used in conjunction with rainwater harvesting. Smaller, cheaper tanks are needed for conjunctive use and enable households to save on municipal water bills. This results in reduced demand on mains supply, which can reduce pressure on over-stretched municipal systems.

Rainwater harvesting for domestic use is a longstanding practice of many generations on commercial farms in the Mzimvubu Development Zone, and holds potential for expansion.

7.4 ECONOMIC VIABILITY OF RAINWATER HARVESTING

The economic viability of a specific rainwater harvesting investment depends on:

(i) how much rainwater can be harvested (which depends on rainfall amounts and frequency);

(ii) how much it costs to construct rainwater storage capacity; and

(iii) the cost of alternative water supplies, namely cost of supply from the municipality point of view, and water tariff from the household perspective.

The stand-alone report on Rainwater Harvesting shows unit reference values, payback periods and the net present values of cost savings over the lifespan of the rainwater system for a few examples in the Mzimvubu Development Zone.

7.5 PRESENT IMPLEMENTATION OF RAINWATER HARVESTING

The report also presents a brief overview of implementation of rainwater harvesting in the Mzimvubu Development Zone to date. It includes the construction of household rainwater tanks at Gogela, Qumbu, Port St Johns and Lubala by the Department of Water Affairs, the implementation of infield rainwater harvesting by the Eastern Cape Department of Agriculture and some NGO initiatives. Reference is also made to current planning by OR Tambo District Municipality and rainwater harvesting initiatives of neighbouring District Municipalities, like Amathole.

7.6 DEVELOPMENT POTENTIAL FOR RAINWATER HARVESTING

An indication of potential for rainwater harvesting in the Coastal Zone, Great River Valleys, and other localities within the study area, for agriculture, for household water uses, and for urban applications is also presented in the report.

Rainwater harvesting for improved agriculture is much less constrained by conventional factors than irrigation development. Many of the difficulties identified in the *Agricultural assessment and irrigation water use* report would not present problems for rainwater harvesting implementation. For instance, rainwater harvesting can be practiced under current tenure systems. Freehold or other long-term tenure arrangements are not a prerequisite. In places pockets of good soils where irrigation development would be too expensive to construct, operate and maintain, may present specific opportunities for rainwater harvesting to reduce irrigation requirements, thus contributing to a reduction or even elimination of irrigation investment requirements.

Key success factors for rainwater harvesting development include respect for people's preferences and dedicated popular education to establish a broad awareness of the possibilities for rainwater harvesting as a neglected but valuable tradition. Today, many leading local, national and international politicians embrace workable 'green solutions' like rainwater harvesting which can contribute to the 'triple bottom line': planet, people and profit, where 'profit' includes both money made and money saved.

7.7 CONCLUSIONS

The natural resource base in the Mzimvubu Development Zone is favourable for the implementation of a range of rainwater harvesting applications. The area is characterised by widespread poverty and a paucity of infrastructure which complicates the provision of services and economic opportunities. Therefore the potential demand is high for independent and low maintenance household solutions to improve water, food and energy security, which can include suitable rainwater harvesting and renewable energy solutions.

Rainwater harvesting is currently economically viable for specific situations. Viability of a greater range of applications, techniques and locations is likely to improve over time as tariffs for alternative supplies are set to increase, and the cost of construction is expected to decrease as technology thereof improves.

In the light of evolving climate change mitigation mechanisms it is worthwhile to seek ways in which Payment for Ecosystem Services could help pay for implementation, thereby improving the prospects for more affordable and sustainable job creation programmes in environmental restoration.

8 CROP PRODUCTION POTENTIAL IN SA NEIGHBORING COUNTRIES

This task is addressed in a stand-alone report (P RSA 000/00/12510) entitled ***An assessment of rain-fed crop production potential in South Africa's neighboring countries**,* where the full details can be found. A summary of this is included in the rest of this section.

South Africa uses 60% of its scarce water resources on irrigation, a substantial portion of which is used to irrigate crops which are regarded internationally as rain-fed crops. The question is therefore being asked about the extent of alternative production areas in southern Africa (particularly in selected neighboring countries) for the range of crops which are presently produced sub-optimally under irrigation in South Africa.

The objective of this study is therefore to provide an answer to this question with adequate confidence to allow the rational pursuit of this concept which could have far-reaching mutual benefit for southern African countries.

The countries that were considered are Mozambique, Zimbabwe, Malawi and Zambia.

The assessment was based on a broad ("desk-top") regional evaluation of soils, topography and climate, which were, in turn, used to define and demarcate agro-ecological zones in which a range of crops can be grown commercially under rain-fed conditions.

The study used two main characterization systems to define the agro-ecological zones, namely the climate-based Koppen-Geiger Climate System (KGCS), and the US Department of Agriculture's, Natural Resources Conservation Service - Land Classification System (LCS). The estimation of crop production areas within the agro-ecological zones was then refined by the exclusion of reserve land, areas of high population (urban and peri-urban environments) and areas of unsuitable topography for crop production. These exclusions are referred to as the "principal exclusions".

A provision was then made for secondary exclusions which include areas committed to alternative land-use such as rangeland and afforestation and scattered areas of unsuitable soils such as wetlands, riverine areas and eroded areas.

This broad assessment revealed that the four target countries possess a net area of about 26,6 million ha of high-potential rain-fed cropping land (referred to as "Premium" land use potential) with the following breakdown per country:

• Zambia	11,1 million ha
• Mozambique	8,8 million ha
• Zimbabwe	6,3 million ha
• Malawi	0,4 million ha

The rain-fed crop production potential includes a wide range of summer field crops such as maize, soybean, dry bean, groundnuts and sorghum which are adapted to parts of all four of the target countries and winter rain-fed field crops such as wheat, barley and dry pea which can be grown extensively in all the countries except Mozambique.

The selected neighbouring countries therefore display a rich potential for rain-fed crop production and, in the context of the SADC countries as a whole, provide a highly significant opportunity for agricultural development in the region and an opportunity to substitute high-potential rain-fed crop production for expensive and water-inefficient irrigation of annual field crops in South Africa.

The four countries experience a number of major socio-economic constraints to the exploitation of this excellent potential. The constraints include land tenure issues (the majority of the high potential rain-fed cropping area is occupied by subsistence farmers on communally owned land), population (the high rural population spread presents a challenge to commercialisation of agriculture), present land use (widespread subsistence farming), poor or lacking infrastructure and poor agricultural support services. However, the constraints are not considered insurmountable. With the appropriate vision, investment and support from the governments of the respective countries there are significant opportunities for extensive commercial agricultural development which could involve and benefit local farmers and their communities. The recent examples of South African farmers operating successfully in Mozambique and Zambia, with full government backing, have shown that these constraints can be overcome.

Whilst the principal objective of this study is to identify areas that are suited to rain-fed crop production, the existence of a considerable network of largely ‘un-tapped’ surface water resources, especially in Zambia and Mozambique, is highlighted. There is therefore an opportunity for expanded utilisation of the water resources in these countries for irrigation where there is a higher irrigation potential, in terms of both soils and climate, than exists for many of the irrigation areas of South Africa.

9 CONCLUSIONS

- There may be considerable potential for water resource development in the catchment through the implementation of dams, subject to the feasibility of such developments. Such dams could yield considerable quantities of water in the Mzimvubu River catchment.
- The Eastern Cape region has favourable topography and water availability for potential pumped storage schemes. A desktop study was conducted to identify and compare such schemes in the region, and to assess whether any potential exists to couple a pumped storage scheme with a dam development. The findings of this pumped storage scheme assessment have been discussed with Eskom, who could take it forward for more detailed analyses.
- The preparatory work conducted has not been focused on water supply to specific locations, and attention has not been given to the distribution of the

water from the potential dam sites. This is likely to be a significant factor in the planning of future projects due to the topography of the catchment and population distribution, and could influence the feasibility of potential developments.

- The hydropower availability is in the order of between 0.5 and 25 MW continuous power, or between 5 and 250 MW peaking power at an indicative load factor of 10%. Base load hydropower was found to be generally expensive per unit installed capacity. The unit costs for peaking power scenarios ranged between R15 million and R300 million per MW installed.
- The intention of the transfer would be to supply water to irrigators in the western parts of the Eastern Cape through the Orange-Fish Tunnel from Gariep Dam. At around R7/m^3 this water, however, would most likely be far too expensive for irrigation. The unit cost does not include distribution infrastructure to the farms. Adding on the distribution infrastructure will further increase the cost of the water.
- Substantial potential exists in the study area for the development of new agricultural enterprises under rain-fed conditions and for the improvement of existing agricultural practices and productivity. Whilst opportunity exists for small irrigation scheme developments, there are several limiting factors with respect to large irrigation schemes.
- The paucity of infrastructure in the area, in particular roads and power, is a major obstacle to any kind of development.
- There is no single major forestry area to be found in the Study Area. Areas of suitable land tend to be relatively small and scattered. Commercial forestry interests today seek a minimum of 5 000 to 10 000 ha to make up what would be considered to be a ‘viable management unit’. A core forestry area attracting large-scale international investment would want in the order of 30 000 to 50 000 ha.

10 RECOMMENDATIONS

- Potential dam sites that have shown to be more favourable in this study may be considered if suitable development scenarios in the region are identified that can make sustainable use of the water.
- An initial focus on the upgrading of rain-fed cultivation and livestock farming can bring great gains at moderate investment. Land tenure and some institutional and social systems will, however, have to be addressed.
- If forestry is to happen seriously, it will need to be an integrated development, requiring a negotiated settlement with agriculture and with communities. The move might best be towards mixed cropping, with forestry part of the agricultural mix.

- It is recommended that rainwater harvesting for the built environment, as well as cultivated and uncultivated areas in the Mzimvubu Development Zone should be analysed as a standard component of water supply options for all economic development options and municipal water supply requirements.

11 REFERENCES

[1] Department of Water Affairs and Forestry (South Africa). 1998. ***Yield Analysis: Terms and procedures*.**
DWAF Report Number P0000/001/98. Report by BKS (Pty) Ltd.

[2] Department of Water Affairs and Forestry (South Africa). 2007. ***Crocodile (West) River Catchment: Hydrological Assessment***.
DWAF Report Number P WMA 03/000/00/2307. Report by BKS and Arcus Gibb.

[3] Department of Water Affairs and Forestry (South Africa). 2007. ***Mzimvubu River Basin: Water Utilization Opportunities***.
DWAF Report Number P WMA 12/000/00/0505. Report by ECH Sellick.

[4] Department of Water Affairs and Forestry (South Africa). 2007. ***National Water Resource Strategy***. First Edition. September 2004.

[5] Hawkins Associates, (1980). **The physical and spacial basis for Transkei's first five year development plan**. Salisbury, Rhodesia