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LETABA CATCHMENT
RESERVE DETERMINATION STUDY –
BRIEFING DOCUMENT
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Inception report
Heath, R G
DWAF Report No. RDM/B800/00/CON/COMP/0404

Main Report
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Briefing Document
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Groundwater Scoping Report
Haupt C J and Sami, K
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Wetland Scoping Report
Marneweck, G C
DWAF Report No. RDM/B800/03/CON/COMP/0604

Resource Units Report
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Fouche, P and Moolman
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ABBREVIATIONS

BBM	Building Block Methodology
BHNR	Basic Human Needs Reserve
D: RDM	Directorate: Resource Directed Measures
DRIFT	Downstream Response to Imposed Flow Transformations
DWAF	Department of Water Affairs and Forestry
EC	Ecological Category
EIS	Ecological Importance and Sensitivity
EWR	Ecological Water Requirement
HDIs	Historically Disadvantaged Individuals
MAR	Mean Annual Runoff
MIRAI	Macro Invertebrates Response Assessment Index
nMAR	Naturalised Mean Annual Runoff
NWA	National Water Act
RDM	Resource Directed Measures
PES	Present Ecological State
REC	Recommended Ecological Category
RU	Resource Unit
SAM	Social Accounting Matrix
SI	Social-Cultural Importance
WRYM	Water Resources Yield Model

GLOSSARY

DROUGHT FLOW	The minimum flow required facilitating the survival of the riverine ecosystem in a particular condition and over short, infrequent periods, when users are subject to water restrictions. In the Letaba River System, Drought flows were defined as low-flows that occur less than 10% of the time under natural conditions for each month.
ECOLOGICAL CATEGORY	A category indicating the potential management target for a river. Values range from Category A (unmodified, natural) to Category D (largely modified). This term replaces former terms used, namely: Ecological Reserve Category (ERC), Desired Future State (DFS) and Ecological Management Class (EMC). The reasons for these changes are explained in the proceedings of a workshop to clarify the terminology used in Reserve determinations (DWAF 2003). It should be noted that a distinction is made between Management Classes, which form part of the National Classification System, and Ecological Categories, which forms part of the Ecological Water Requirement assessment.
ECOSPECS	Clear and measurable specifications of ecological attributes (e.g. water quality, flow, biological integrity) that defines the Ecological Category. The purpose of ecospecs is to establish clear goals relating to resource quality (Kleynhans 2003).
ECOSTATUS	An overall assessment of the Ecological Category (A-F), based on rule-based integration of specialist indices (water quality, fish, etc). Ecostatus refers to the totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services" (Iversen *et al.* 2000, *In* IWR Environmental 2003).
ECOLOGICAL WATER REQUIREMENTS (EWR)	The flow patterns (magnitude, timing and duration) and water quality needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to both the quantity and quality components.

INSTREAM FLOW REQUIREMENTS (IFR)	The flow patterns (magnitude, timing and duration) needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to the quantity component only of Ecological Water Requirements.
MAINTENANCE FLOW	The flow required to meet the requirements of the riverine ecosystem at a particular site and maintain the resource base in a particular condition during "normal" climatic years. The distinction between "normal" and "drought" was based on an examination of monthly flow duration curves. For the Letaba River System, “normal” low-flows were defined as those that occur at or more than 30% of the time under natural conditions for each month.
PRESENT ECOLOGICAL STATE (PES)	The degree to which ecological conditions of an area have been modified from natural (reference) conditions. The measure is based on water quality variables, biotic indicators and habitat information collected 1 to 3 years prior to the assessment. Results are classified on a 6-poin scale, from Category A (*Largely Natural*) to Category F (*Critically Modified*).
REFERENCE CONDITION	Natural ecological conditions, prior to human development.
RESERVE	The quantity and quality of water required (a) to satisfy basic human needs by securing a basic water supply, as prescribed under the Water Services Act, 1997 (Act No. 108 of 1997), for people who are now or who will, in the reasonably near future, be (i) relying upon; (ii) taking water from; or (iii) being supplied from, the relevant water resource; and (b) to protect aquatic ecosystems under the National Water Act, 1998 (Act No. 36 of 1998) in order to secure ecologically sustainable development and use of the relevant water resource. The Reserve refers to the modified Ecological Water Requirement, where operational limitations, and stakeholder consultation are taken into account.
RESOURCE QUALITY OBJECTIVE	Quantitative and auditable statements about water quantity, water quality, habitat integrity and biotic integrity that specify the requirements (goals) needed to ensure a particular level of resource protection. This term takes into account the management *classes* and the requirements of other users. These components are not addressed in this project

RESOURCE UNIT	Stretches of river that are sufficiently ecologically distinct to warrant their own specification of Ecological Water Requirements, and that can be practically managed as a single unit.

1 THE LETABA COMPREHENSIVE RESERVE STUDY: INTRODUCTION AND BACKGROUND

1.1 BACKGROUND

The water shortages experienced in the Letaba Catchment area have led to intense competition for the available water resources between different sectors. A substantial portion of the population does not have access to the basic level of service and planned extensions to irrigation have consequently been put on hold. The Kruger National Park (KNP) is located at the lower end of the catchment, is internationally renowned as a conservation resource, and is responsible for significant tourism and contribution to South Africa's GDP. In order to sustain the flow of the Letaba River in the KNP and ultimately aquatic biota, riparian vegetation and terrestrial animal life, water has to be released from the series of dams and weirs starting at the headwaters of the catchment. Furthermore, there is an international obligation to release water to Mozambique at the eastern boundary of the KNP.

It is these conflicting water uses that have led to this study due to the need for compulsory licences in order to achieve resource protection and equity needs. In order to achieve the required resource protection in the Letaba catchment a comprehensive Reserve study was commissioned.

These studies were supported by a dedicated project management component (Consultants: Tlou and Mallory).

1.2 PURPOSE OF THIS DOCUMENT

This document provides information about the Letaba Comprehensive Ecological Reserve Study and its findings to support the DWAF Executive Management in decision-making. Recommendations are made regarding future resource management, with emphasis on maintenance of stream flow. Only the results and implications of the key components of this study are provided in a summarised format, however the level of detail provided should enable the DWAF to make informed decision on the level of protection required. A number of specialist technical reports, as well as a main report, support this document.

1.3 STUDY AREA

The study area, the Letaba Catchment, is shown in Figure 1.1. It is located in Limpopo Province and covers an area of approximately 13 400 km^2. The catchment is drained by the Groot Letaba River and its major tributaries the Klein Letaba, Middle Letaba, Letsitele and Molototsi rivers. From the confluence of the Klein and Groot Letaba rivers, the Letaba River flows through the Kruger National Park until it joins with the Olifants River near the border with Mozambique.

More than 20 major instream dams and weirs have been constructed in the Groot Letaba catchment, which has resulted in this catchment being highly regulated. The existing limited water resources in the Letaba Catchment have been severely overexploited at the expense of the environment in order to meet the commercial (irrigation, afforestation and industry) and rapidly increasing domestic water demands. The dense afforestation that takes place in the upper catchment and the intensive irrigated agriculture, of mainly sub tropical fruits, on the banks of the Groot Letaba outside the KNP, are the major water users in the study area. The instream dams are used for the supply of irrigation water for this intensive irrigated agriculture.

Specialist work was undertaken at study sites called EWR sites. Each EWR site is situated in a Resource Unit (RU), which is a section of river that is sufficiently different from other sections to warrant its own Reserve or management class. A total of 7 EWR sites were selected for the Letaba Comprehensive Reserve (Figure 1.1).

1.4 LEVEL OF THIS STUDY

The study was designed to follow, as far as practically possible, a comprehensive Ecological Reserve Determination approach to provide the highest confidence possible. The individual major components were addressed at different levels, depending on data availability and the importance of the component in the study area (see Table 1.1). For each, the present project status, the level of detail, and the specialist fields in which capacity building took place, are indicated.

Additional components that were incorporated into the study were:

- An economic study that included an examination of the **Ecological Goods and Services** of the Letaba catchment. The Goods and Services component was considered critical in generating an understanding of the linkage between the largely rural marginal communities, the intensive irrigated agriculture, KNP biodiversity requirements and human dependence on the resource base (sustained by the health of the river). (Consultants: Tlou and Mallory).

Table 1.1: Components/Tasks addressed within the study

Study components	Level	Status (1 Sep 05)	Capacity Building
Project Management	Comprehensive	Ongoing	
Inception Report	Comprehensive	Final	Yes
Resource Units	Comprehensive	Final	Yes
Wetland Scoping Report	Scoping	Final	Yes
Groundwater assessment	Scoping	Final	Yes
Socio-cultural importance	Scoping	Final	Yes
Ecological Water Requirement scenarios (River quantity and quality)	Comprehensive	Final	Hydrology, water quality, aquatic invertebrates, riparian vegetation
Economic evaluation	Intermediate	Final	Yes
Ecospecs and monitoring	Comprehensive	Pending	Hydrology, water quality, aquatic invertebrates, macro-invertebrates, vegetation
Capacity building	Comprehensive	90% complete	Regional office training, project team members

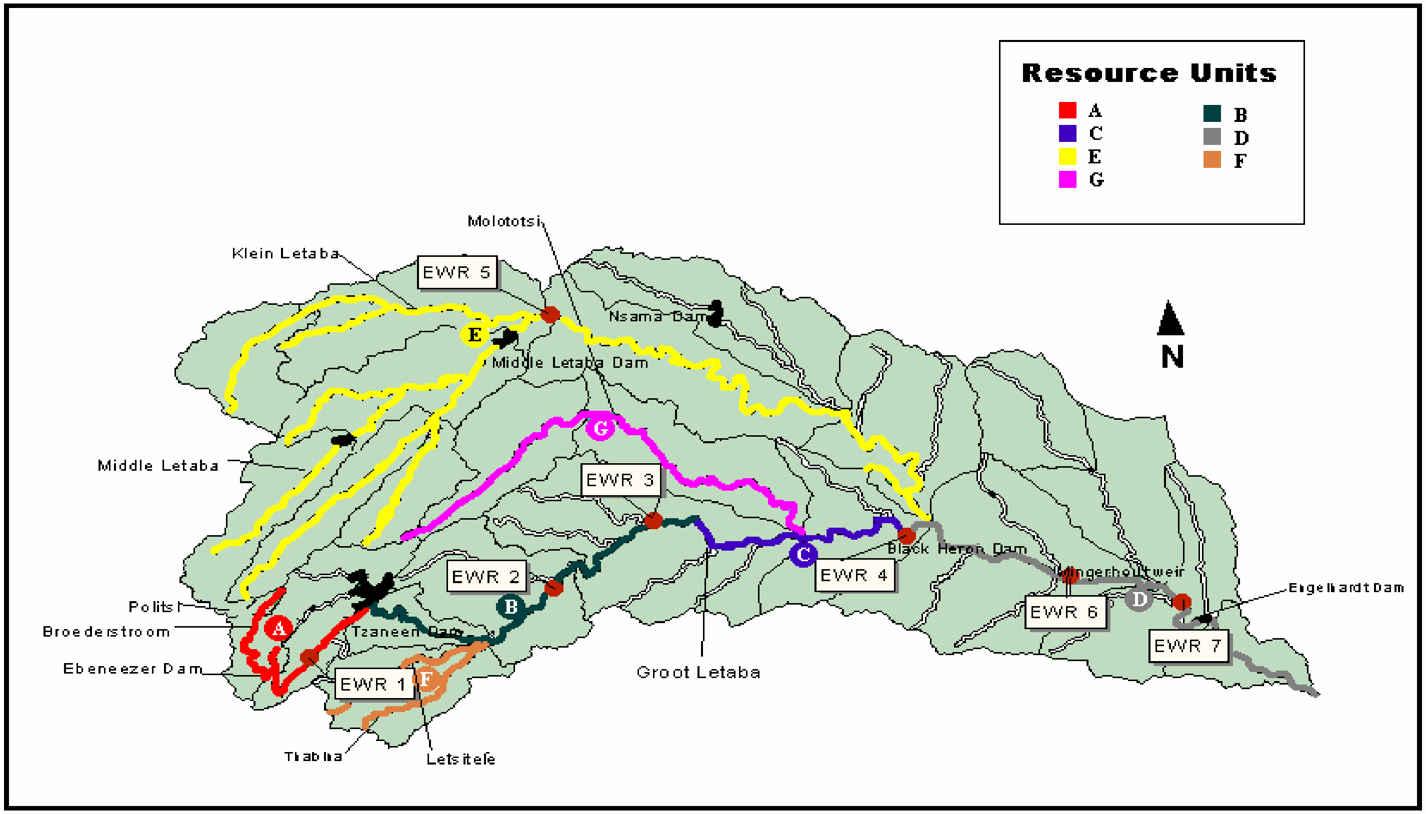

Figure 1.1: Main Resource Units and chosen EWR sites in the Letaba Catchment.

1.5 STUDY OBJECTIVES

The study objective was to determine an Ecological Reserve for the system which best meets the level of resource protection taking into account the legal, socio economic and sustainability goals/needs. A wetland and groundwater scoping assessment was also undertaken with the final product being a recommendation for what level of further study should be undertaken (if any).

An additional requirement of the study was the application of specialist and technical capacity building throughout the project with an emphasis on Historically Disadvantaged Individuals (HDIs) (see Table 1.1 and section 9 for further information).

1.6 PROCESS

The following process (Figure 1.2 modify DWAF 2002, Kleynhans *et al*., 2005) was followed in order to address the objectives:

- A set of Ecological Water Requirement (EWR) scenarios was generated to test through the application of a yield model. Each scenario represents a possible flow regime, intended to have specific outcomes linked to the Reserve. Scenarios specify how much water is required, where and when, and take cognisance of the likely water quality consequences.
- Based on the impacts of the EWR scenarios a set of flow scenarios, called Operational Scenarios, was generated and tested. These scenarios are realistic scenarios as impacts on users and constraints such as outlet sizes of dams are considered. Decision makers will select one of these scenarios as the Reserve.
- The likely impact of the Operational Scenarios on the available yield was determined.
- The likely impact of the Operational Scenarios on the aquatic ecology was determined.
- The likely economic impact of selected Operational Scenarios was determined.
- The likely impact of selected Operational Scenarios on the Goods and Services provided by the riverine system was determined.

1.7 ASSUMPTIONS AND LIMITATIONS

- The Classification System procedures (as referred to in the National Water Act, Act 36 of 1998) are still being devised.
- The Letaba comprehensive Reserve determination will not investigate the Basic Human Needs Reserve (BHNR).
- No transboundary (international) participation was undertaken in this project.
- International obligations to supply Mozambique with water from the Letaba and Olifants River are still under negotiation and were not used in this study.
- EWR sites could not be selected in all Resource Units because of funding constraints.
- No formal public participation was undertaken in this Project, which could make the process of stakeholder dialogue difficult in future (especially with the Groot Letaba Water User Association).
- Limited interactions undertaken with the KNP (major stakeholder).
- The Letaba hydrology used was last updated in 1995 and this did not include the 2000 floods. An assessment, using the most up to date hydrology was undertaken on two quaternaries (dry and wet). This assessment indicated that the low hydrology was not adversely affected and consequently the readily available hydrology was used in this study.

1.8 WORK STILL REQUIRED

The following actions are required to complete the fulfilment of the study objectives:

- To brief the DWAF Executive Management on the recommended Reserve and to facilitate further decision-making.
- To determine Ecospecs (the ecological component of Resource Quality Objectives). To develop a monitoring programme to measure whether the Ecospecs are being achieved.
- Finalise Capacity building report.

This process is consistent with the Resource Directed Measures (RDM) protocols, and is illustrated in Figure 1.2. Best practice was followed (Kleynhans *et al*., 2005), based on the most recent RDM developments. Dr's Kleynhans and Jooste as well as Ms Thirion (all from DWAF-RQS, where consulted with throughout the project to ensure consistency in methods applicability as well as to make sure that the most recent methods were applied). All changes in RDM protocols, during the course of the study, were incorporated within the existing budget and the study programme was amended to take cognisance of new requirements.

1.9 PROGRAMME

The study was initiated during May 2003 and will be finalised by March 2006.

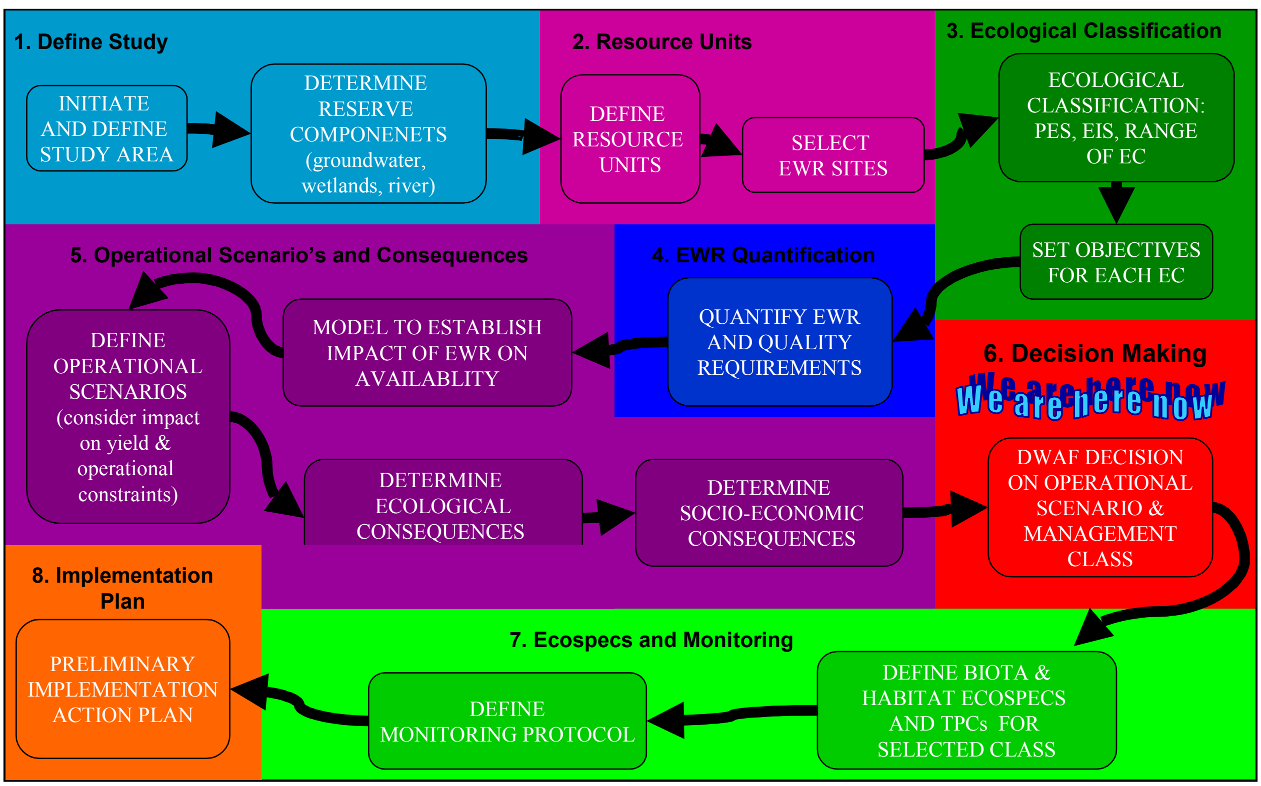

Figure 1.2: Diagram illustrating the sequential nature of the 8 step process followed for the Letaba Comprehensive Reserve Study.

2 ECOLOGICAL CLASSIFICATION

2.1 OVERVIEW AND OBJECTIVES

EcoClassification (the term used for Ecological Classification) refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers compared to the natural/close to natural, reference condition (Kleynhans *et al*., 2005). The purpose of EcoClassification is to gain insights into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable but attainable future ecological objectives for the river. The EcoClassification process also supports a scenario-based approach where a range of ecological endpoints (Ecological Categories) has to be considered. For each of these, a flow (EWR) scenario must be described (Chapter 4).

EcoClassification must not be confused with the Classification System as indicated in the National Water Act. The Classification System considers a range of different issues in Integrated Water Resources Management in the process of determining the class of a river, one of which is ecological.

2.2 LEVEL OF DETAIL

This study was designed to follow a comprehensive EWR determination for riverine components, and included a scoping level assessment for groundwater and wetlands. The comprehensive level study aimed to provide a reasonable confidence assessment of EWR for Letaba River and main tributaries.

2.3 METHOD

The following process was applied to each Resource Unit:

- ***Reference Conditions:*** Reference conditions were described for the main ecological drivers (hydrology, geomorphology and water quality) and ecological responses (riparian vegetation, aquatic invertebrate and fish).
- ***Present Ecological State***: The Present Ecological States (PES) for each of the drivers and the responses were assessed, and the results integrated into an overall assessment of PES, referred to as the EcoStatus.
- ***Changes in PES****:* An assessment was made as to whether the PES is stable under current development conditions, or whether it is changing.
- ***Causes and Origins*****.** The causes and origins for the PES were identified, and specified as flow or non-flow related.
- ***Ecological Importance and Sensitivity:*** The Ecological Importance and Sensitivity (EIS) of the biota and habitats were assessed.
- ***Socio-cultural Importance***: The dependence of communities on a health river system for various purposes such as subsistence fishing, collecting firewood, thatching grass, religious activities etc, was assessed, and referred to as the Socio-cultural Importance (SI).
- ***Recommended Ecological Category (REC):*** A realistic Ecological Category was recommended for each component as well as for the overall EcoStatus, based on a consideration of the PES, EIS and SI,
- ***Alternative Categories:*** Alternative categories, “up” and “down”, were identified, where appropriate.

The results of the EcoClassification process were expressed in terms of Ecological Categories (ECs) ranging from Category A (*Natural*) to Category F (*Critically Modified*) (Figure 2.2). The categories represent a range along a continuum, so boundary categories (i.e. Category B/C) represent a condition at the border between Categories B and C. The six-point classification system (A to F) will be converted into a descriptive terminology when applied to Management Classes, which are the output of the Classification System procedures, as referred to in the National Water Act (Act 36 of 1998). The flow diagram (Figure 2.1, adapted from DWAF, 2001) illustrates the process.

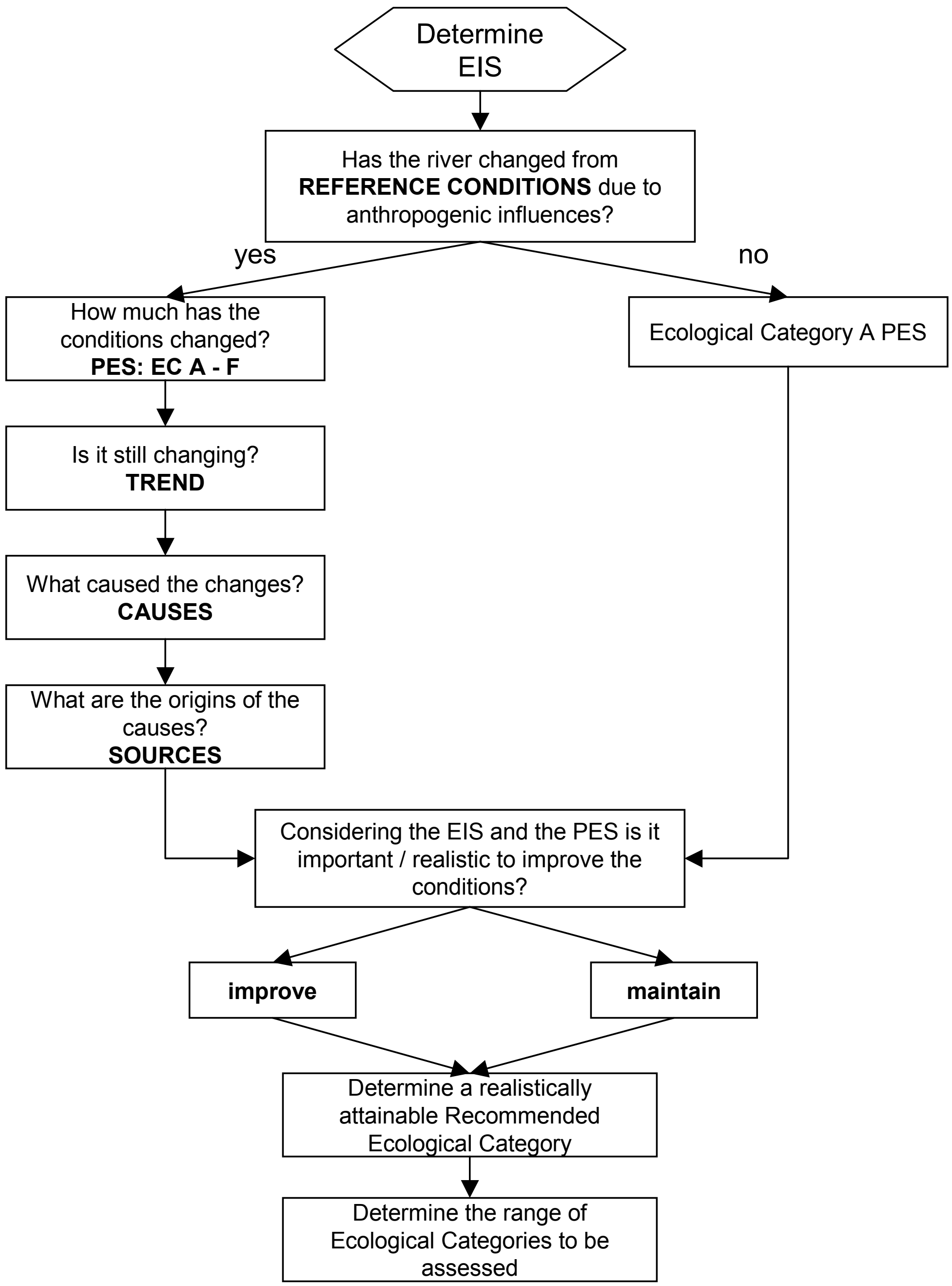

Figure 2.1: Flow diagram illustrating the information generated to determine the range of ECs for which EWRs will be determined.

The results of the process, i.e. the PES and EC are provided as different river categories ranging from A (near natural) to F (critically modified). These will be converted to a descriptive terminology (still to be determined, but illustrated as Good, Fair, Poor etc.) when applied to Management Classes that are the output of the Classification System procedures (as referred to in the National Water Act, Act 36 of 1998, which is currently being developed).

The interface between ECs and management Classes are provided in Figure 2.2.

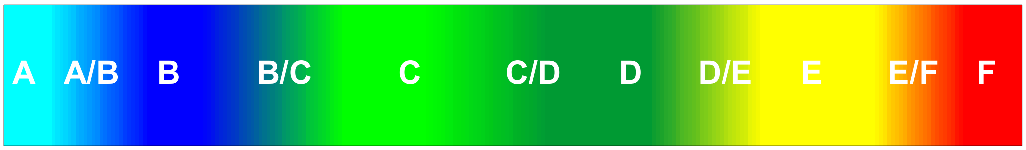

Figure 2.2: Illustration of the distribution of Ecological Categories (A to F) on a continuum and the relationship with Management Classes.

The range of Ecological Categories (ECs) for which flow scenarios were provided are guided by the rules as shown in Table 2.1. This must be seen as guidelines to determine a *realistic* range of ECs, which can be addressed within the scenario-approach.

Table 2.1: Guidelines for the range of Ecological Categories (ECs) to be addressed.

PES	Alternative EC	
	Increase (Up)	Decrease (Down)
A	N/A	N/A
A/B	N/A	B/C
B	N/A	C
B/C	B	C/D
C	B	D
C/D	B/C	D
D	C	N/A
D/E	D	N/A
E	D	N/A
E/F	D	N/A
F	D	N/A

2.4 RESULTS OF THE ECOLOGICAL CLASSIFICATION PROCESS

The Recommended ECs (from an ecological perspective) are provided spatially on maps (Figures 2.3 – 2.5) and tabulated (Table 2.2). A descriptive summary for the Letaba catchment follows.

Table 2.2: Summary of the Present Ecological Status (PES), Ecological Importance and Sensitivity (EIS) and Socio-cultural Importance (SI) of each Site in the Letaba River Catchment, the Recommended Ecological Category (REC) suggested by the specialists and used to determine the EWR, and the most likely alternative ECs, where applicable.

Site	PES	Importance		Ecological Category		
		EIS	SI	REC	Alternatives	
1	*C*	Mod	Low	C	N/A	D
2	*D*	Mod	Low	D	N/A	N/A
3	*C/D*	High	Mod	C/D	C	D
4	*C/D*	High	High	C/D	N/A	D
5	*C*	Mod	Mod	C	D	N/A
6	*C*	High	Low	C	D	B
7	*C*	High	Low	C	D	B

2.4.1 Groot Letaba River

Ecologically, the upper catchment (above Ebeneezer Dam) of the Groot Letaba River is considered closest to natural and has a very high ecological importance. The relatively natural condition is due to limited disturbance (some areas of indigenous forests, especially in inaccessible gorges).

The most ecologically modified sections in the Groot Letaba River are those between Tzaneen Dam and the border with the KNP. This is due to the reduction in flow due to upstream impoundments (Tzaneen and Ebeneezer Dams), large weirs (Junction, Yamorna, Prieska and Jasi) as well as direct abstraction for irrigation. The water quality problems are associated with intensive irrigated agriculture (fertilizer, salts and pesticide runoff).

The downstream section of the Groot Letaba River within the KNP has a PES and REC of a C (Figure 2.3).

Although the EIS was high in the KNP, the REC was not recommended to improve the PES (Figures 2.3 and 2.4). Cognisance was taken on the attainability of increasing the PES. Due to the existing high use and demand in the system, it would be unlikely that sufficient water would be available to allow improvement. Some of the problems are also catchment related (see section 5.2) and not flow and improvement using only flow is not practical.

The KNP has indicated that, due to its mandate being the improvement of biodiversity, they would like to improve the REC within the KNP to a B. Currently this would be difficult due to the upstream water usage for agriculture. In order to achieve a B the water quality would have to improve and this could only be attained by more regular, and greater, flow releases into the KNP.

A social survey concluded that rural communities, living adjacent to the main rivers in the middle reaches of the Letaba Catchment, particularly in the vicinity of Letaba Ranch (Site EWR 4) are highly depend on the rivers for drinking water, washing, harvesting of natural resources (particularly firewood, thatching and medicinal plants), ceremonial and cultural purposes (See Figure 2.5).

2.4.2 Klein Letaba River

The Klein Letaba (EWR 5) is in a moderately modified to modified state mostly due to dense settlements and agriculture above the Middle Letaba Dam and upper Klein Letaba River. The EIS is moderate and no improvements in categories are required (Figure 2.4).

2.4.3 Letsitele River

The Letsitele River (EWR 2) is highly modified to a PES of D (Figure 2.3). The Letsitele River, a tributary of the Letaba River is unregulated, although there is a small dam on the Thabina tributary. The river channel at this site is largely degraded due to erosion and local sources of water quality pollution (see section 5.2). The main impacts on water quantity and water quality at this site are upstream stream flow reduction (forestry) and a township, with no formal sanitation system, immediately upstream.

The EIS is moderate and the SI is low and hence no improvements in PES categories are required (Figures 2.4 and 2.5).

2.5 CONCLUSION

The REC was set to maintain the PES for all Resource Units.

However KNP officials have indicated that they have a mandate to improve biodiversity and have requested an improved PES within the KNP (PES of C to REC of B). With the currently upstream water usage, mainly for agriculture, and the difficulties in improving catchment (sediment) issues it would be problematic to improve the PES.

The reasons for no improvement in the PES was due to the following realities in the catchment, such as:

- **Dams:** the strategic demands and requirements of the Ebeneezer and Tzaneen dams in the upper catchment, to supply domestic water to both Tzaneen and Polokwane, provide limited scope for improved flows;
- **Flow changes**: the ecological conditions downstream of large dams have changed irreversibly from historical reference conditions and it was considered untenable to recommend an improvement in current conditions;
- **Weirs:** the ecology of the lower middle Groot Letaba River has been severely impacted by a large number of weirs and associated irrigation development. These have had major impacts on habitat availability, low flow conditions, riparian vegetation and channel morphology.

Non-flow related impacts: many of the reasons for ecological degradation in the Letaba River catchment are not flow related. For example, the subsistence agricultural land use practises and riparian vegetation removal in the river reach between Hans Marensky and Letaba Ranch Wilderness Areas is a continued source of sediment to the river.

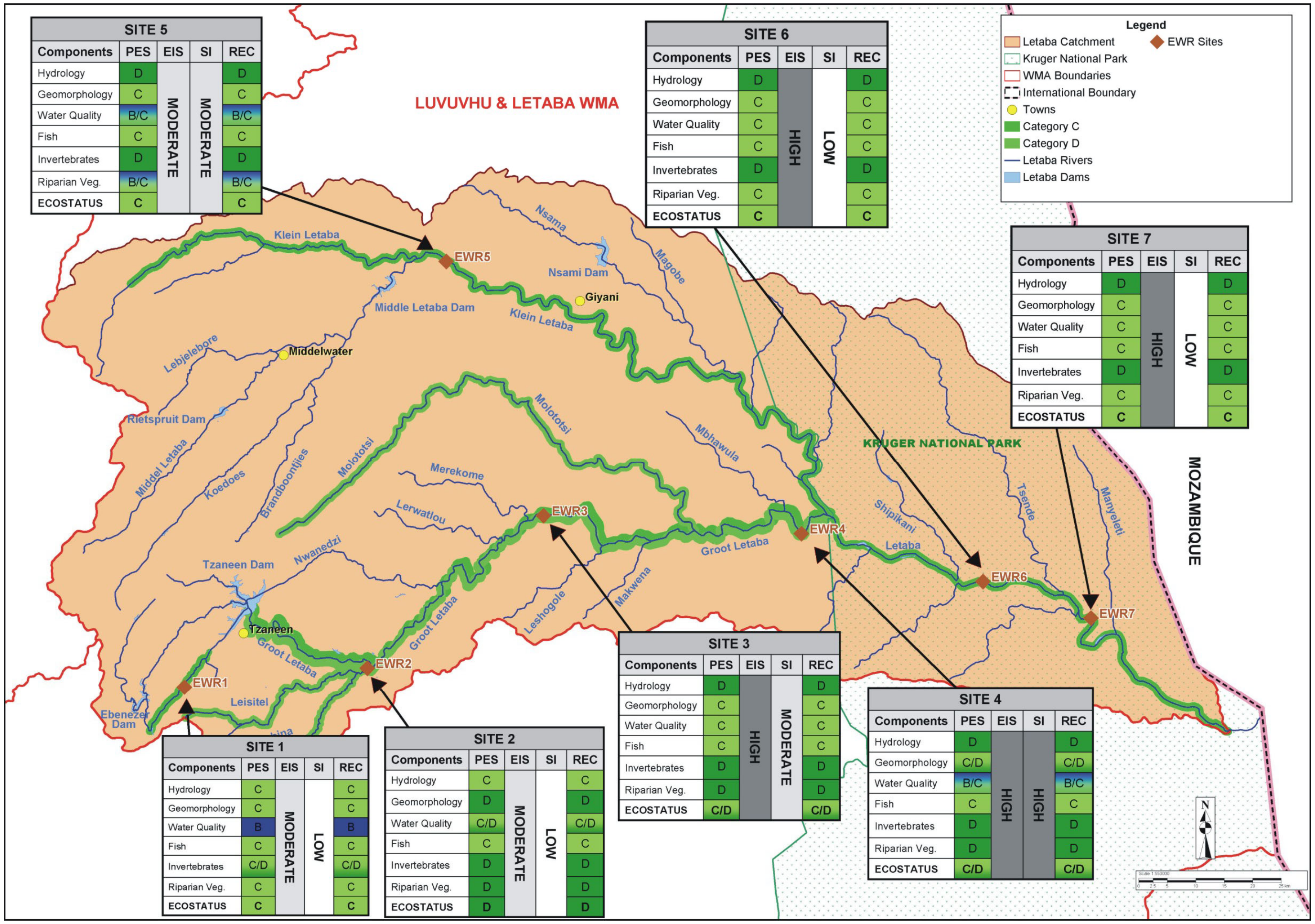

Figure 2.3: Present Ecological Status (PES), Ecological importance and sensitivity (EIS), Social importance (SI) and Recommended ecological category (REC) for the Letaba River catchment.

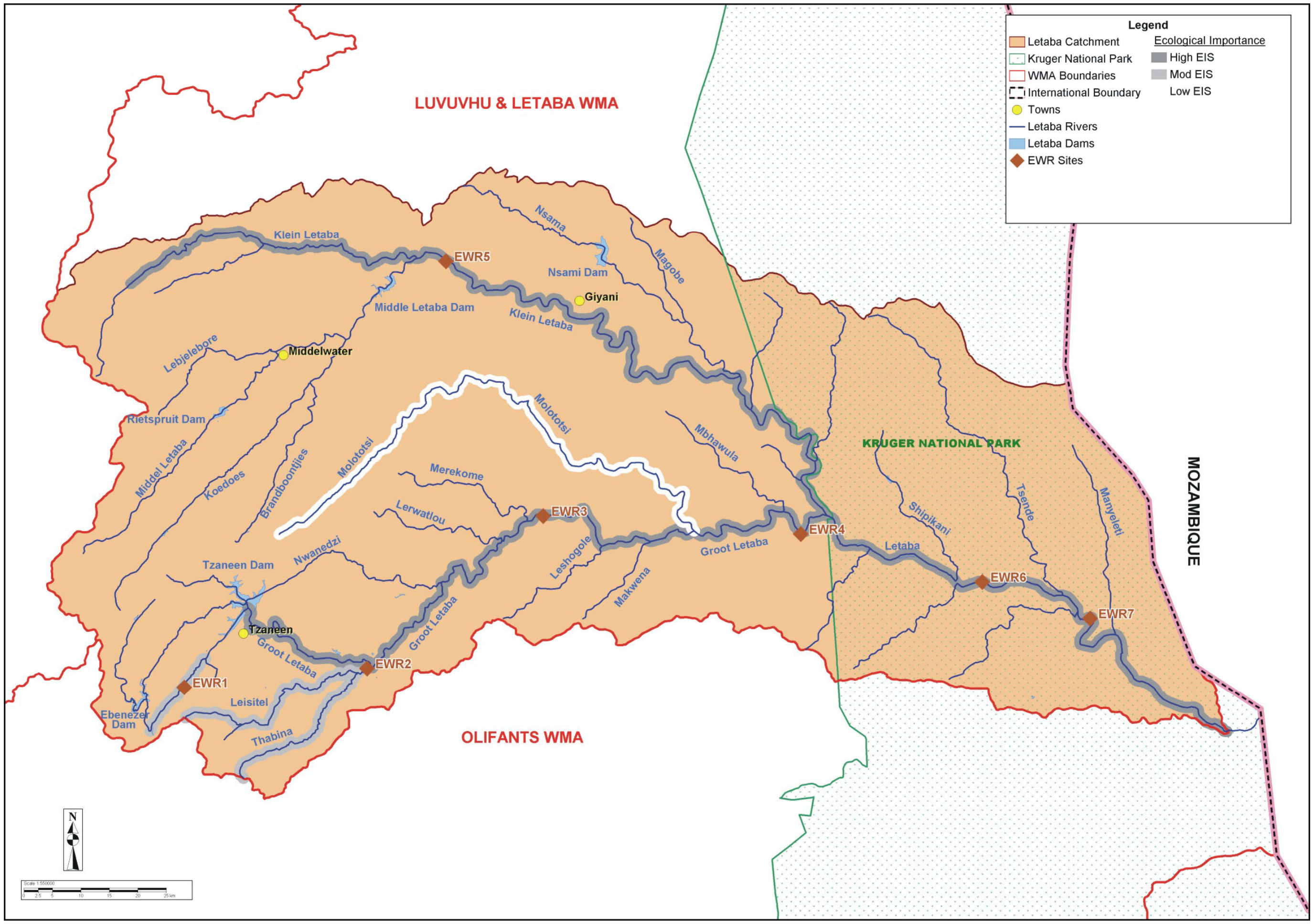

Figure 2.4: Ecological importance and sensitivity (EIS) for the different EWR sites for the Letaba River catchment.

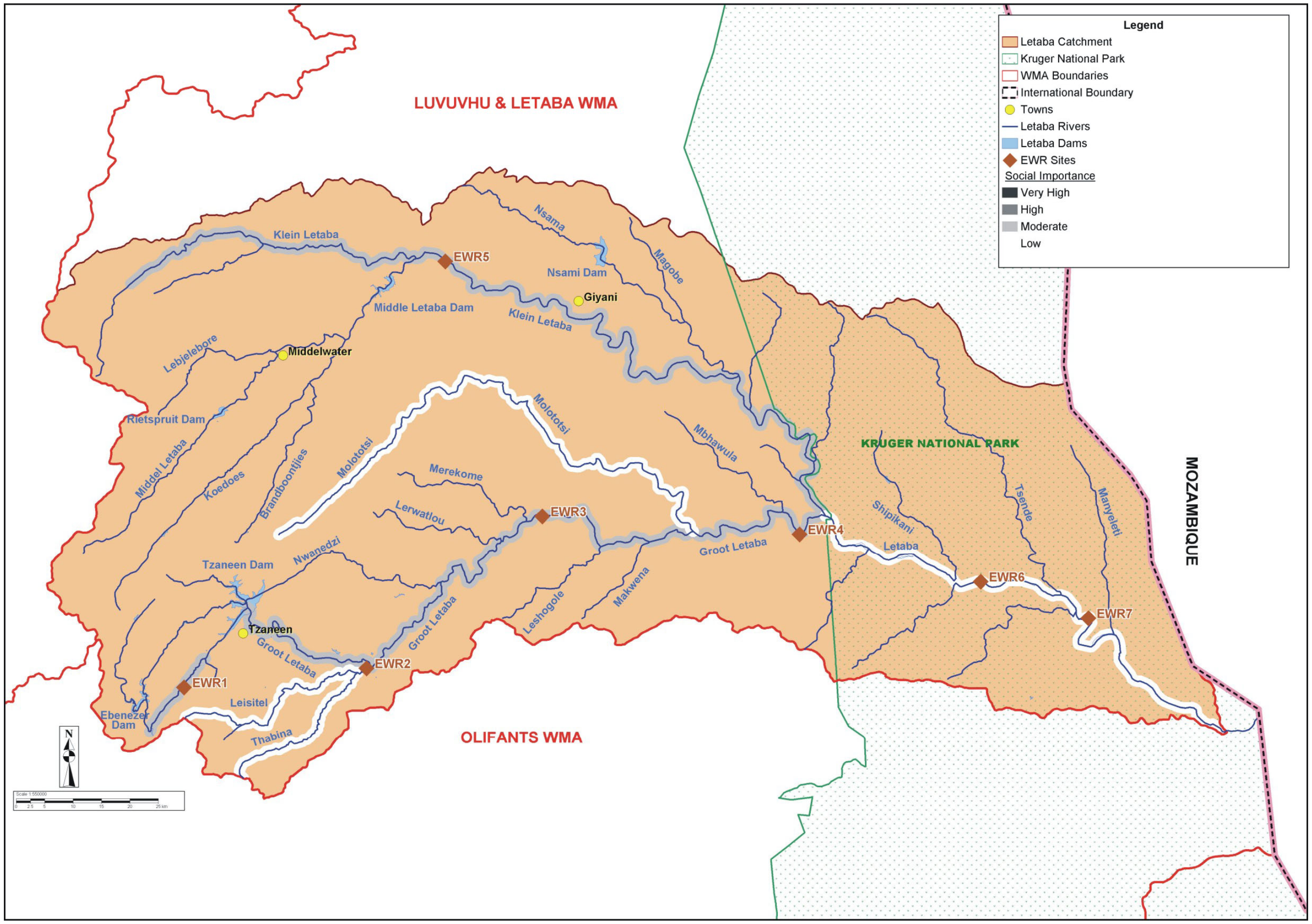

Figure 2.5: Social importance (SI) for the different EWR sites for the Letaba River catchment.

3 ECOLOGICAL WATER REQUIREMENTS (QUANTITY COMPONENT) SCENARIOS

3.1 OVERVIEW AND OBJECTIVES

The objectives of this task were to recommend the magnitude, duration and timing of specific flows and flow patterns that are considered to be the most important for maintaining the abiotic (e.g. geomorphology) and biotic components (plants and animals) of each Resource Unit in a particular condition, or Ecological Category (EC, see section 2).

Data analysis focussed on the relationships between discharge and habitat availability and key ecosystem processes. This process did not consider whether these flows could be supplied or managed, and impacts on users were not considered.

3.2 METHODS

The approach followed to provide the results was a combination of published South-African environmental flow requirement methods. The overall approach of this study was based on the Building Block Method (BBM) (King and Louw 1998). The Habitat-Flow-Stress-Response Method (HFS-R) was used to provide low flow requirements, while a modified Downstream Response to Imposed Flow Transformation (DRIFT) method was followed to set high flow requirements. The methods focus on identifying the size, duration and timing of specific flows and flow patterns that are considered to be the most important for maintaining the key ecological drivers (hydrology, geomorphology and water quality) and the key biological response indicators (riparian vegetation, aquatic invertebrates and fish), within a defined length of river, referred to as a Resource Unit, in a particular condition, or Ecological Category (EC).

The processes and the motivations for the results are provided in detail in the technical reports. These flow results were used as input to the Water Resource Yield Model (WRYM). Consequences of providing flow scenarios can then be tested based on the outputs of the WRYM (see chapter 5 to 8).

3.2.1 Low Flows

Recommendations for low flows were determined for each EWR site using the Habitat-Flow-Stressor-Response (HFSR) method described by Hughes and O'Keeffe (2004). Motivated recommendations regarding the duration of specified stress were provided for the recommended EC and alternative categories.

3.2.2 High Flows

Recommendations for high flows were determined for each EWR site using the Downstream Response to Imposed Flow Transformation (DRIFT) method (Brown and King, 2000). The method involved the classification of floods, followed by an assessment of their ecological roles. Motivated recommendations regarding timing and frequencies were provided for the recommended EC and alternative categories.

3.3 RESULTS

The results for the river linked to each EWR site are provided in Figures 3.1. Results are provided as the long-term mean percentages of the natural MAR (nMAR). The EWR flows constituted between 5.9 and 42.8 % of the nMAR.

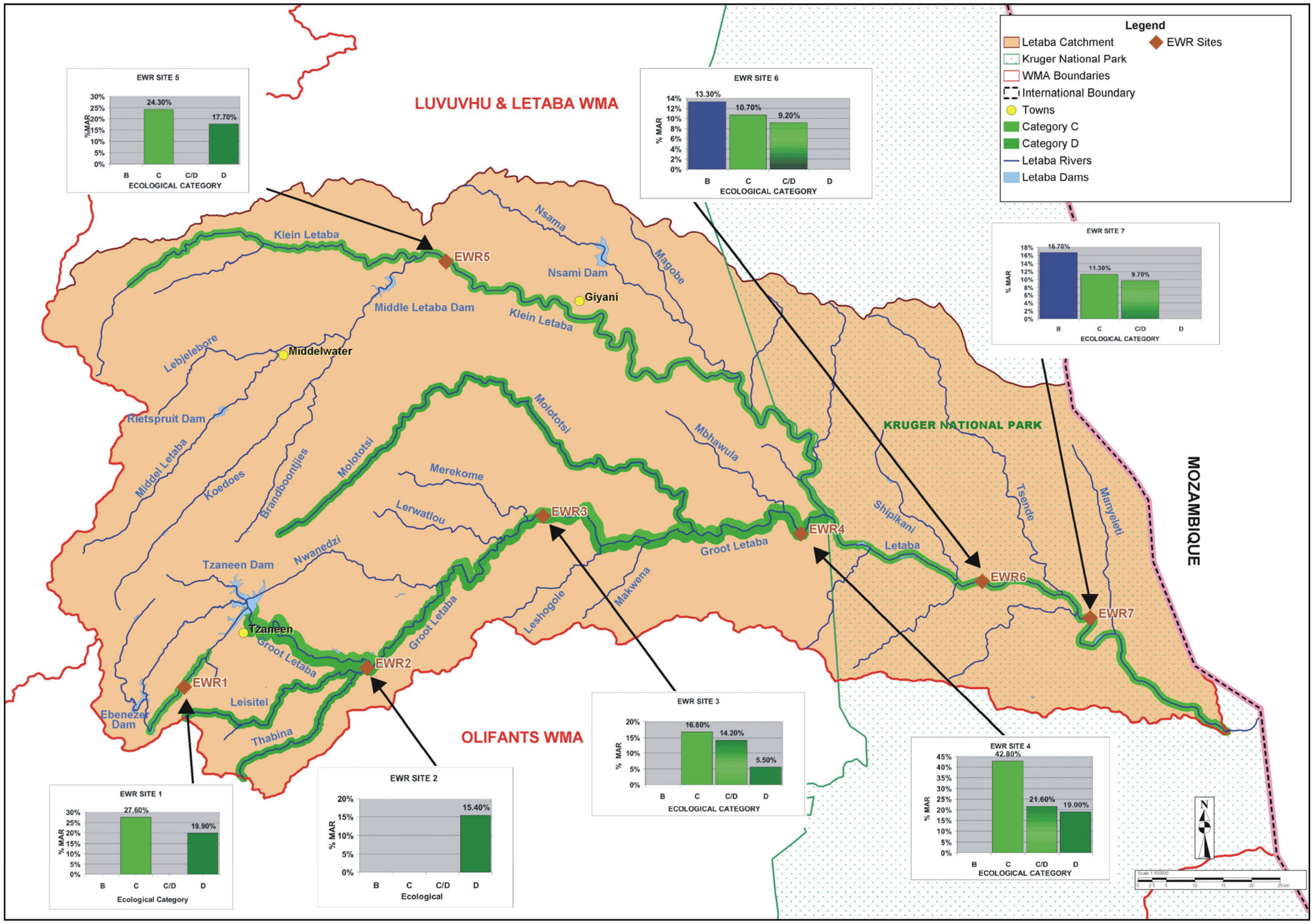

Figure 3.1: Ecological Water Requirements (EWR) for the Letaba Catchment, expressed as a long-term average percentage of the natural Mean Annual Runoff (nMAR).

4 DEVELOPMENT OF OPERATIONAL SCENARIOS

4.1 OVERVIEW AND OBJECTIVE

Ecological Water Requirement (quantity) scenarios had now been developed by ecologists as sets of possible flows to achieve different river states (or Ecological Categories) for each EWR site (see Chapter 3). This process did not consider whether these flows could be supplied or managed. The impact on users was also not considered. To provide decision makers with more comprehensive information, it was considered necessary to examine each of the scenarios and their full range of implications. Thereafter, a process was followed to devise an optimised scenario (if necessary) that would have the least overall impact on the users and the ecology. All these Operational Scenarios were tested to determine the resulting state of the river, and the water quality consequences of each flow scenario were supplied.

The objectives of this task were to develop a range of operational scenarios that result in different impacts on different users. The impacts of incorporating the EWR on the ecology, system yield, goods and services and overall economic activities could then be assessed.

4.2 METHOD

The Water Resources Yield Model (WRYM) was initially set up for the feasibility study of water resource management of the Groot Letaba by Consultburo in 1996. The basic operating policies were retained. The model was updated to take into account more recent data and understanding of the catchment operations. Furthermore the model was modified to include EWR channels at the appropriate places and additional channels to facilitate analysis of supply to users. Analyses were done using the historic inflow time series from 1922 to 1995 to determine supply to users for each scenario

A series of meetings with regional water managers from Tzaneen were held to develop appropriate operational scenarios. The WRYM was set up in such a way that the first mechanism of curtailment was a rule curve based on the level of the dams, and EWRs were treated as a priority demand. The EWRs were first met by incremental tributary accruals and releases were made from the dams only when these accruals could not supply the EWR. In regulated Resource Units, the high flow component of EWRs was modified to account for the limited outlet capacities of upstream dams. High flow EWR requirements that could not be met because of outlet constraints were removed completely as a demand, and not capped at the maximum outlet capacity.

The decision-making process to determine a range of scenarios is as follows:

- The Water Resources Yield Model (WRYM) was run using three different EWR scenarios: one that would achieve an EC higher than recommended (Scenario 1), one that would achieve the recommended EC (Scenario 2), and one that would result in an EC lower than recommended (Scenario 3, see Table 4.1).
- The results of the modelling process indicated that all three scenarios would result in a range of impacts on the yield and therefore on the users.

Note:
- That apart from these key scenarios, various additional interactions for preliminary evaluations to achieve an optimised scenario was required.
- The yield model is set up to deal with the EWRs as the highest (first priority) demand unless otherwise specified.

The key scenarios are described in Table 4.1.

Table 4.1: Scenario descriptions

Scenario Number	Description
1	EWR for PES.
2	EWR for the alternative categories below the PES were modelled
3	EWR for the alternative categories above the PES were modelled
4	**Main river downstream of Tzaneen Dam:** The model provides the REC flow requirements to EWRs 6 and 7 with the following modifications: • High flows are moved to more appropriate months **EWR 1**: The model provides the REC flow requirements but with floods > 8 m^3/s removed. **EWR 2**: (Letsitele) All high flows are removed. Low flows decreased to be equal to the present flows in the dry season. Wet season flows are provided for the REC. **EWR 5** (Klein Letaba): The model provides for the REC flow requirements but with high flows removed to appropriate months. Low flows decreased to be equal to present day in June and July.
5	**Same as Scenario 4 with the following changes**: **EWR 3:** If EWR 3 is not met with Scenario 4, supply EWR 3 at PES category. **EWR 4**: Decrease August, September and October low flows to present. Move the Nov. floods to Dec. or any other high flow month so that there is no conflict.
6	**Same as Scenario 4,** but where relevant, the alternative category below the PES are supplied rather than the PES or REC.
7	**Same as for Scenario 6 with the following changes:** • Delete all floods at EWR 4, 6 and 7 • Delete all floods at EWR 5 >than 5 m^3/s • Delete all floods at EWR 3 > than 18 m^3/s • Supply demand at EWR 3 and 4, according to the changes in requirements set up by the fish specialist, from Tzaneen Dam. • Supply the deficit at EWR 6 and 7 from Middle Letaba Dam (not from Tzaneen Dam)

5 ECOLOGICAL CONSEQUENCES OF THE OPERATIONAL SCENARIOS

5.1 OVERVIEW AND OBJECTIVES

In order for each of the operation scenarios to be assessed, it was necessary to consider their ecological consequences to account for system constraints. The next step in the process was to assess the ecological and water quality consequences of the various operational scenarios.

The aim of this section is to describe water quality and ecological consequences of various operational scenarios. The ecological evaluation is based on an assessment of the impact on the states or ECs recommended for each component. Information on the water quality assessment as a key driver is provided below, followed by the overall assessment.

5.2 WATER QUALITY CONSEQUENCES

Each of the flow scenarios where checked through simple concentration modelling (if appropriate data was available), as well as Physico-Chemical Driver Assessment Index (PAI) driver tables, to determine whether the water quality objectives would be met under these flow conditions. The pollution sources and types of pollution were determined per EWR site. The different flow scenarios were then used to determine if the scenario would improve or decrease the water quality status per EWR site.

Typically the water quality issues in the Letaba study area are driven by diffuse pollution, such as (Figure 5.1):

- Agricultural runoff from intensive fruit orchards (fertilizers, salts, nutrients, pesticides)
- Villages close to rivers (microbiological, litter, turbidity)
- Animal grazing and watering (microbiological, turbidity)
- Afforestation (turbidity, fertilizers)

The point sources of pollution in the Letaba River are limited to effluents from wastewater treatment works from Tzaneen and Giyane and are consequently not a major contributor to the water quality in the Letaba catchment.

The flow scenarios that result in an improved water quality are those scenarios that would enable the middle reaches of the Groot Letaba (below the confluence of the Letsitele to the confluence with the Klein Letaba) to be flushed in the winter low flow periods. The large number of weirs in this reach of the river has resulted in a deterioration of the water quality to such an extent that it has become enriched with nutrients and dissolved oxygen levels become limiting to the ecology. The scenarios that would improve the water quality are Sc 1,2 and 7.

None of the flow scenarios would result in an improved water quality at EWR sites 2 due to there being no regulatory mechanisms in the Letsitele River.

The flow scenarios that would result in an improved water quality in the lower Letaba River (within the KNP) are those that will result in a more assured flow in the river during spring (August to October) when the flows become historically low and water temperatures and dissolved oxygen levels become critical for the survival of the aquatic ecology.

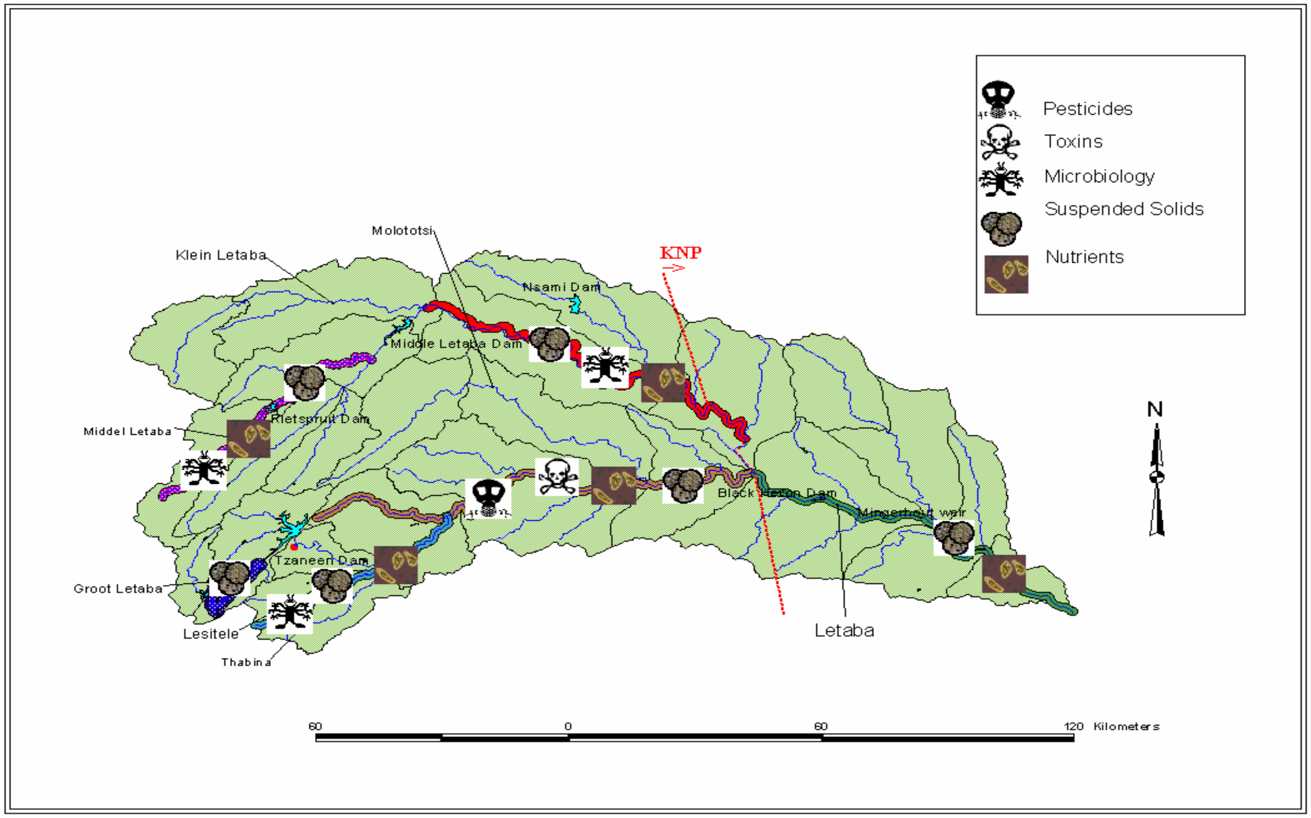

Figure 5.1: Water quality issues per major tributary in the Letaba catchment.

Note that:

- Table 5.1 refers to the PES and EC as determined by the revised methods of DWAF (2002) for assessing the Ecological Reserve: Water Quality. To maintain continuity with previous reports based on DWAF (1999) water quality methods, a "y" or "yes" to the EC means that the present day state will be maintained.
- **EWR 1:** Water quality conditions will remain stable (PD) under all flows scenarios evaluated. This site's flow and water quality is mainly controlled by flow releases from Ebeneezer Dam for irrigation and Tzaneen potable water supply. Elevated nutrients (agricultural practices) as well as low flow releases (dissolved oxygen and water temperature) to be managed and improved.
- **EWR 2:** No upstream regulation. Elevated nutrients, periphyton and higher turbidity will not be improved with different flow scenarios.
- **EWR 3**: Increased phosphates with greater flows, increased periphyton and toxicity with low flows. Water quality not expected to change significantly under any of the flow scenarios.
- **EWR 4**: The PD flows were 60% lower than the other scenarios in high flows but in low flows the various scenarios were comparable. Large variations in dissolved oxygen and temperatures are noted during low flows. Nutrient status increased with greater flows and toxicity with low flows. Water quality conditions improved under Sc1, 2 4 and 6 when compared to PD.
- **EWR 5**: Increased periphyton with low flows. No spillage from Middle Letaba Dam is provided for. No water quality changes due to the different scenarios.
- **EWR 6**: Large variations in dissolved oxygen and higher temperatures are noted during low flows. Nutrient status increased with greater flows and toxicity with low flows. Water quality conditions will improve under all flow scenarios.
- **EWR 7**: Large variations in dissolved oxygen and higher temperatures are noted during low flows. Nutrient status increased with greater flows and toxicity with low flows. Water quality conditions will improve under all flow scenarios

5.3 ECOLOGICAL CONSEQUENCES

The results as depicted on the Figures 5.2 are summarised in Table 5.1. A Traffic Light diagram comparing the ecological effects of the different scenarios is shown in Figure 5.2. The results per IFR site are summarised in Figure 5.2.

Table 5.1: Summary of ecological results

Site	REC	Sc 1	Sc 2	Sc 4	Sc 6	Sc 7	PD
EWR 2	D	☺	☺	☺	☺	☺	☺
EWR 3	C/D	Y+	Y+	X	X	☺	X
EWR 4	C/D	Y+	Y+	X	X	☺	X (-)
EWR 5	C	☺	☺	☺	☺	☺	☺ (1)
EWR 6	C	☺	☺	☺	☺	☺	X
EWR 7	C	☺	☺	☺	☺	☺	X
No. EWR sites where ecological objectives are NOT achieved		0	0	2	2	0	4

Where: Face = meet REC, X = did not meet REC, 1= Riparian vegetation a problem, Y+ = exceeds REC.

It is clear from Table 5.1 that Scenarios 1, 2 and 7 would meet the recommended Ecological Category at all sites. Scenarios 4 and 6 would be problematic at IFR Sites 3 (Prieska) and 4 (Letaba Ranch). The present day situation, even with supposed 0.6 m^3/s releases from the Tzaneen dam for the KNP, does not meet the recommended EC at EWR sites 3, 4, 6 and 7.

The Traffic Light diagram in Figure 5.2 summarises Table 5.1 and shows the approximate difference between scenarios, from an ecological point of view, along a continuum of the scenarios.

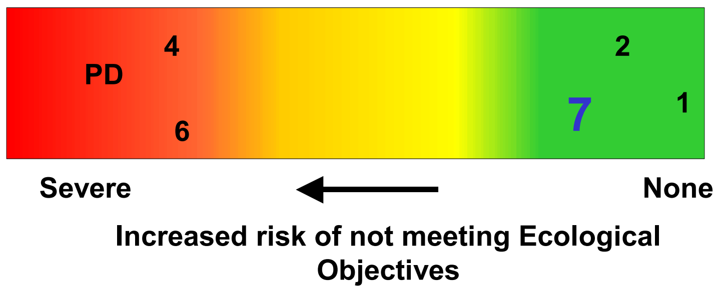

Figure 5.2: Ecological comparison of scenarios. Note that red illustrates an unacceptable situation for ecology and green an acceptable condition. The numbers in the traffic diagram in the white blocks refer to scenarios. The scale refers to the number of EWR sites.

The continuum illustrates how successfully the scenarios meet the EWR objectives at the 7 EWR sites. Scenarios PD, 4 and 6 fail to meet the ecological objectives at EWR sites 4 and 6. EWR sites 3 and 4 are sites where improvement is required (both flow and water quality) due to the current regulated flow upstream. If no water flows past these EWR sites the KNP requirements will not be met (EWR sites 6 and 7). During the scenario optimisation process Scenarios 1, 2 and 7 where used to improve the assurance of water to EWR sites 3 and 4 and ultimately to the KNP. These scenarios will therefore not degrade the river at these EWR sites.

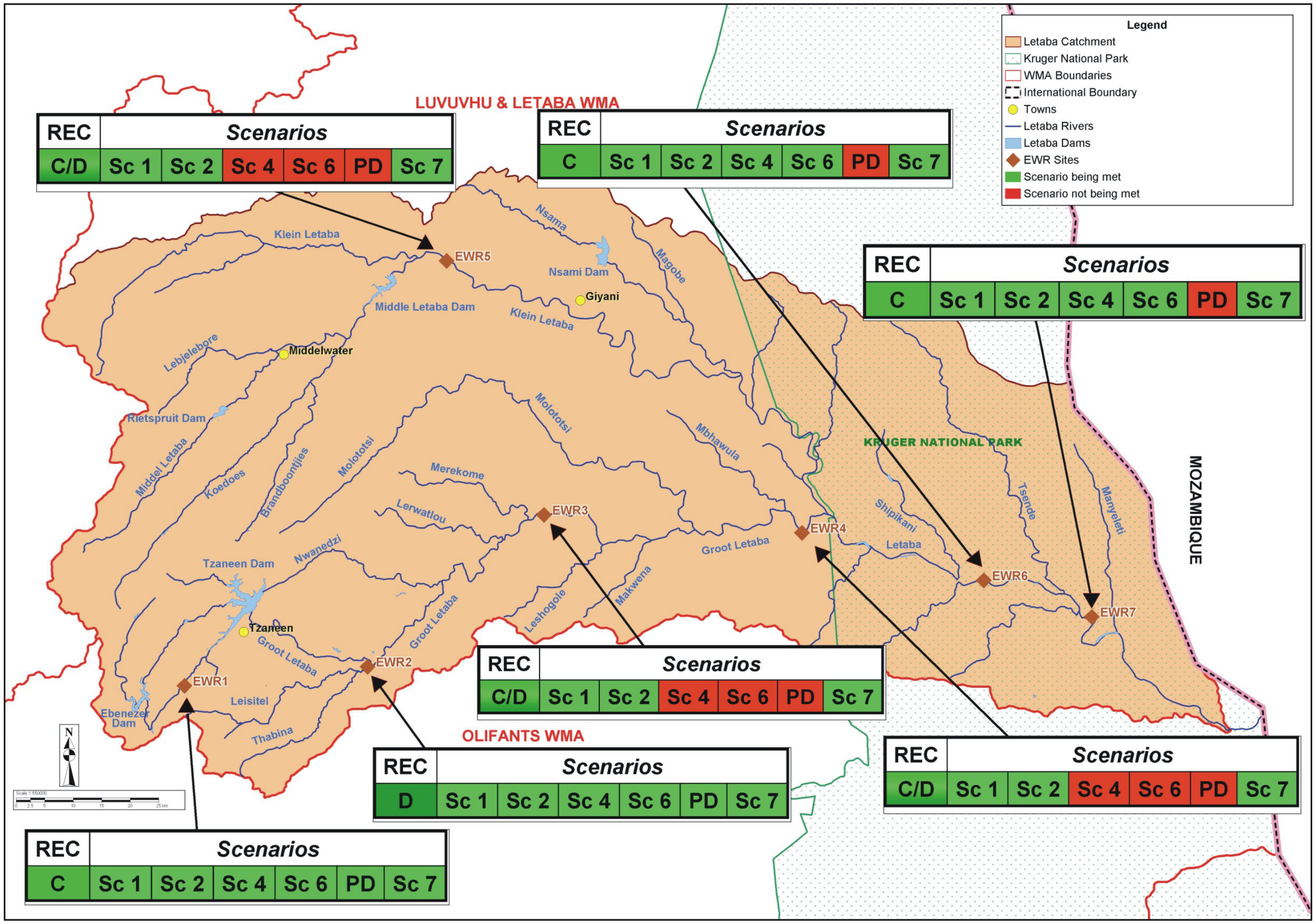

Figure 5.3: Scenarios that meet and do not meet the Recommended EC per EWR site.

6 IMPACT OF EWR FLOW SCENARIO ON WATER AVAILABILITY TO OTHER USERS

6.1 OVERVIEW

In order to determine the available water to economic water user sectors in the Letaba catchment, a yield assessment study was conducted for each EWR scenario.

6.2 OBJECTIVES

The aim of this component of the study was to quantify the consequences of various operational scenarios on the water availability to the economic user sectors with the EWR for each scenario being supplied as a priority.

6.3 METHODS

The original hydrology of the Groot Letaba Water Resources Development Study: Feasibility Study (DWAF, 1996) was used as the basis for the modelling of the water resource availability. The Water Resources Yield Model (2000) was used to assess the impacts that the EWR Scenarios will have on the available water to user sectors in each of the sub-catchments.

User requirements were based on best available data and interviews with the Tzaneen irrigation board. It should however be noted that the water use figures are not based on a validation and verification of existing water use. Curtailment structures were developed where the available water did not meet the requirements of the existing water users. This was based on the current operating rules that are used by DWAF to provide water to the water users in the Letaba River Catchment. The water use in the upper catchments of the Middle Letaba Dam were based on assumption as there was no data on water use.

The operating rules assumption together with the fact that IFRs were channelled separately in the WRYM (i.e. no conjunctive river flow or " piggy-backing" of IFRs with water releases in the river for other users) provides slightly more conservative water availability results (i.e. slightly less water in the system than may occur in practice). These operating assumptions are justifiable at this level of investigation. Specific operating rules per river reach can be developed when a Reserve is implemented in the future.

The scenarios that were investigated were scenario 1, 4, 6 and the optimised scenario 7. The first run of the WRYM was on the present day use. This confirmed the fact that the allocation of 0.6 m^3/s of water to the Kruger National Park does not reach the park.

6.4 RESULTS

The results of all flow scenarios indicated that there will be a negative impact on the available water to other users, particularly irrigation agriculture. The WRYM results of maintaining the present ecological state (i.e. Scenario 1) of the Letaba River and its main tributary from its present ecological state had the most severe negative impact on the availability of water in the river system for other users, particularly in the Letsitele River and the sub-catchment downstream of Tzaneen Dam. Most of the yield from Tzaneen Dam was required to meet the EWR for the flow scenario 1. This was because the IFR sites that were driving the system are IFR sites 6 and 7 situated in the Kruger National Park.

6.4.1 Letaba River

Scenario 1 will reduced the volume of water available to water users in the Groot Letaba by 195 million m^3/a by the year 2010. This impact is most severe to the irrigators downstream of Tzaneen Dam. However by dropping the ecological category by one category and with optimisation made to the Ecological Water Requirements, scenario 7 showed that volume of water available to other users was only reduced by 55.6 million m^3/a in the Groot Letaba River catchment.

Although the impact is still significant the optimised flow scenario 7 provides the best compromise between ecological water requirements for resource protection and the water available to water users to ensure the level of productivity is maintained. This can be further improved by improving the agronomic and economic efficiency of water use by the irrigation sector.

6.4.2 Middle Letaba River

Implementation of the ecological water requirements for Scenario 1 will significantly reduce the water requirements to users in the Middle Letaba catchment by 18 million m^3/a at the current level of assurance of supply or reduce the assurance of supply by 80%.
However implementation of the ecological water requirements for the optimised Scenario 7 will reduce the water requirements by only 3.5 million m^3/a at the current assurance of supply.

6.4.3 Klein Letaba River

Implementation of the ecological water requirements for Scenario 1 will significantly reduce the water requirements to users in the Klein Letaba catchment by 9 million m^3/a at the current level of assurance of supply or reduce the assurance of supply by 60%.
However implementation of the ecological water requirements for the optimised Scenario 7 will reduce the water requirements by only 3.1 million m^3/a at the current assurance of supply.

6.4.4 Letsitele River

Water allocations in this area already exceed the water resources available, since there is no storage on the Letsitele River. Irrigators are depended on run-of-river supply. The deficit at the accepted level of assurance of supply for the current water requirement is estimated to be approximately 8 million m^3/a out of a requirement of 14 million m^3/a.

Implementation of the ecological water requirements for the optimised scenario 7 will therefore further exacerbate the already negative situation and further reduce the assurance of supply to the farmers. Compulsory licensing may be required here in order to reduce existing water allocations, and to affect a balance between water use and the protection of the ecological integrity of this system. However this can only be done once verification of existing water use is conducted. There is an urgent need to undertake a validation and verification of existing water use particularly in the Letsitele River catchment.

6.4.5 Lower Groot Letaba River

The impact of providing for the ecological water requirements for any of the scenarios investigated on the water users in the Lower Groot Letaba catchment will be minimal.

6.5 CONCLUSION

The current water requirements for water users, particularly irrigators, are not being met. This includes the current 0.6 m^3/s that should be supplied to the KNP which is not being met most of the time The WRYM results have indicated that water users in the Lower Groot Letaba River catchments are the only ones that will not be impacted on under all the Ecological Reserve Scenarios from 1 to 7.

The best comprise scenario is the ecological water requirements for Scenario 7. The overall impact of this scenario is not as significant as for scenario 1. This is shown graphically in Figure 6.1.

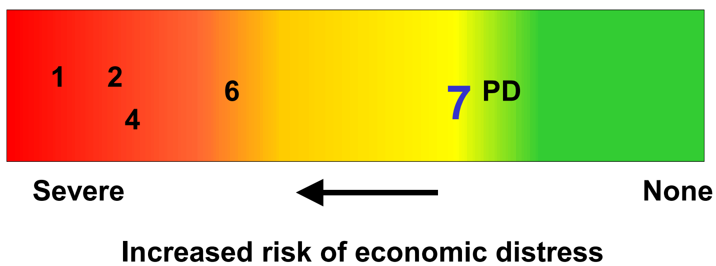

Figure 6.1: Economic and yield consequences of the different flow scenarios in the Letaba Catchment.

7 CONSEQUENCES FOR THE GOODS AND SERVICES AND ECONOMY

7.1 OVERVIEW

Water resources provide important benefits to society, both as input capital for production and ecological goods and services. However because of the increasing scarcity of water for both production and environmental benefits and scarcity of resources to develop water infrastructure, socio economic valuation plays an increasingly important role in decision making between socioeconomic development and protection of the resource for long term sustainability. Therefore development and management of water resources cannot be interpreted without some idea of the value of water to the socioeconomic activities taking place in a catchment, and the value of ecological goods and services provided by the catchment.

7.2 OBJECTIVES

The purpose of valuing the water for production and socioeconomic activities and ecological goods and services is to assess the preference for or against environmental change.

7.3 METHODS

7.3.1 Economic value of water for commodity use

The Letaba River Catchment was divided into seven economic zones or subsystems (Figure 7.1). For each zone, a customised Water Impact Model was developed to calculate the economic value of water. The model was based on a Social Accounting Matrix (SAM) that was developed separately for the Letaba catchment. Therefore the sectoral multipliers used are specific to the economic activity in the Letaba River catchment. The underlying principal of the model was that water is scarce, and so its allocation among competing users needs to be structured to ensure that positive socioeconomic impacts are maximised. The model distinguished four water user sectors as follows:

- Irrigated Agriculture
- Domestic including commercial and industrial
- Commercial Forestry
- Transfers to Tzaneen from Ebenezer Dam

Not all scenarios were investigated. The range of scenarios investigated was such that the worst case and base case for socio economy could be determined. The scenarios that were investigated therefore were Scenarios 1, 2, 4, 6 and 7. These were compared with the present day (using year 2000 level of economic activity), which was the socioeconomic value of the present water available to the above water user sectors. The model was structured to provide a detailed description of the water availability in sub-catchments for various scenarios. Given the water availability for a new scenario, the model determined the economic and socioeconomic impacts emanating from the change in water availability.

The Water Impact Model determined the different impacts that the various scenarios will have on the economy. The marginal differences in economic and socioeconomic impacts were calculated by subtracting the impact of these situations from each other. This made it possible to quantify the impact that the various scenarios will have on the community, as well as the broader economy.

The factors that were used to determine the implication of the EWR scenarios were the following:

- The incremental change in the economic surplus or profit to the users in each sub-catchment and per water user sector
- The incremental change in the Gross Domestic Product for each EWR scenario
- The number of jobs that would be generated or lost for EWR scenario.

7.3.2 Economic value of goods and service

A specialist workshop was held were the ecological goods and services in each sub-catchment were identified. In the Letaba catchment, the following ecological goods and services were identified:

- Fishing by community - Benefit
- Fish farming - Benefit
- Thatch grass
- Reed harvesting
- Wood gathering
- Recreational fishing
- Recreational boating
- Cultivated floodplains
- Sand mining
- Recreational swimming
- Medicinal plants

It should be noted that the above goods and services are from direct and indirect use of the river. The specialist workshop also identified the indirect use of the in stream water namely the following:

- Waste assimilation
- Waste dilution
- Black flies
- Livestock diseases
- Malaria
- Bilharzia
- Cultural activities
- Grinding stones

Various techniques were used to measure the economic value of direct and indirect goods and services provided by the Letaba River because of the different volume of ecological water left in the river to protect the resource. These ranged from use of surrogate markets to contingency valuation methods.

7.3.3 Economic contribution of the Kruger National Park

The economic contribution of the Letaba river catchment in the Kruger national Park which is subsystem 7 (see Figure 7.1) was conducted separately because of the significant tourism.

The travel cost method was used to determine the economic contribution of tourism because of changes in flow in the portion of the Letaba River catchment situated in the Kruger National Park. This was based on deriving a demand curve from data supplied by the South African National Parks (SANAP) of the number of visitors going through the Palaborwa gate.

There are limitations to the methods because of the number of camps in the Kruger National Park because of the multiple destinations tourists will visit in the park.

7.4 RESULTS

7.4.1 Ecological Goods and Services

A comparison of all scenarios indicates that there is an improvement in the direct and indirect use value of the water from providing EWR to meet the level of resource protection set for each scenario. (see Table 7.1). The total number of households who will benefit directly from the instream water use ranges from 1 435 households for scenario 1 to 484 households for scenario 7. Indirect benefits were not determined.

The increase in economic contribution for each scenario due to ecological water is due to the increase in subsistence fishing and recreational swimming.

Table 7.1: Incremental Change in the value of goods and services.

Ecological Goods & services	Economic Surplus	Impact on GDP	Impact on Low Income distribution	Households impacted
Scenario 1	6.99	11.12	0.45	1,437
Scenario 2	4.61	5.47	0.30	1,001
Scenario 4	4.23	4.88	0.26	841
Scenario 6	3.53	4.20	0.23	685
Scenario 7	2.24	2.66	0.14	484

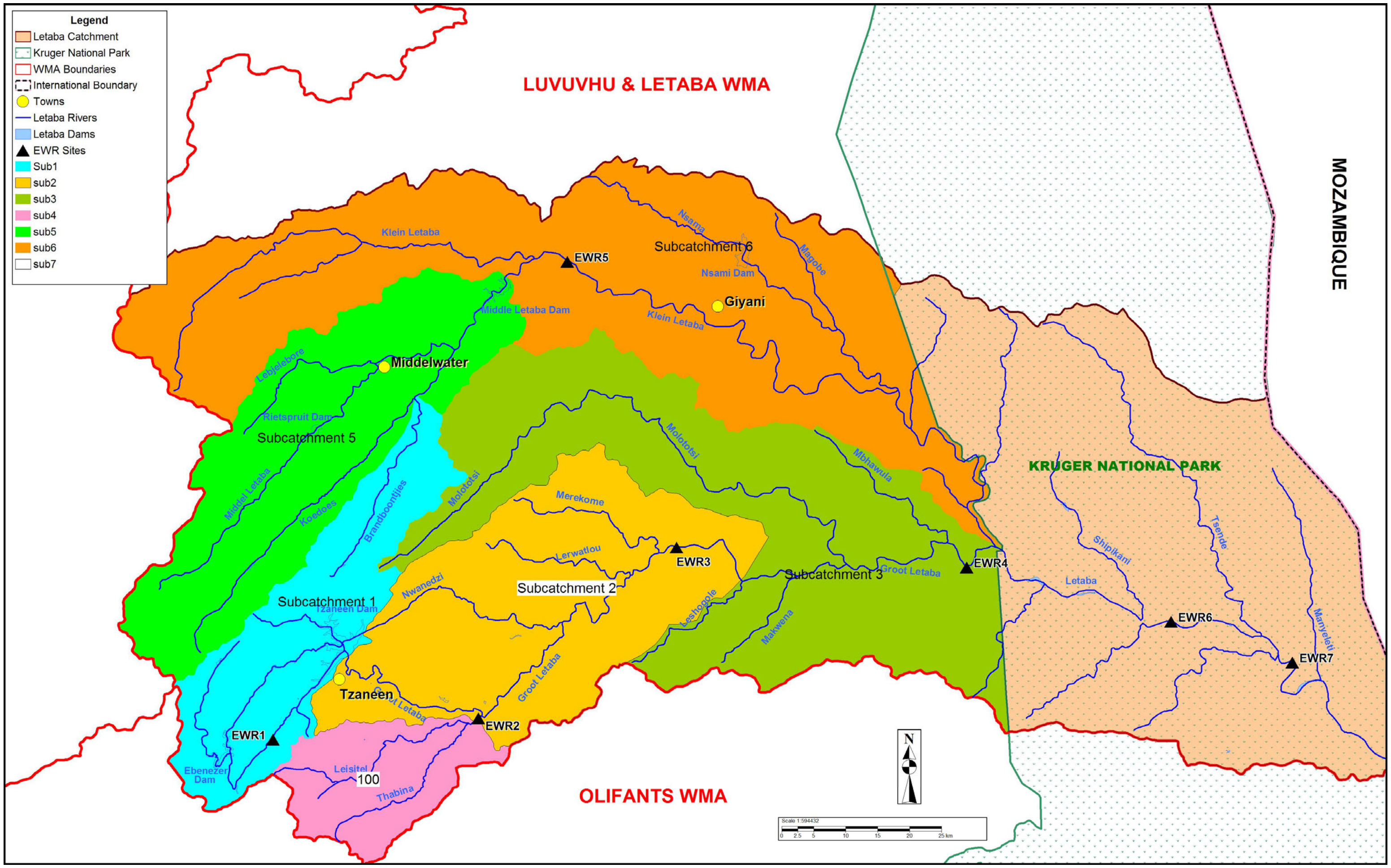

Figure 7.1: Map of the River Catchment, showing the delineation of the catchment into seven economic sub-systems.

7.4.2 Consequences of flow scenarios on the economics of the Kruger National Park

The incremental change in the economic activity for each scenario investigated for the Kruger National Park (sub catchment 7) is presented in Table 7.2. The flow requirements for scenario 1 will have the most positive impact on the contribution to the GDP and employment. The impact increases negatively with reduction in the EWR flows for the scenarios investigated. However all of the above scenarios have a positive impact from the present day where the required flows are not being met.

Table 7.2: Incremental change in the flow of benefits from Kruger National Park.

	Impact on surplus value (profits)-R mil.	*Impact on GDP R mil.*	*Impact on labour Number*	*Impact on low-income households (R mil.)*
Scenario 1	23.70	49.98	360	18.22
Scenario 2	10.21	21.54	155	7.85
Scenario 4	8.04	16.96	122	6.18
Scenario 6	6.18	13.03	94	4.75
Scenario7	4.23	8.92	64	3.25

7.4.3 Consequences of flow scenarios on the socio-Economy

The incremental change in economic activity in each subcatchment for each scenario investigated is presented in Table 1.3. The impact of Scenario 1 will have the most negative impact on the economic surplus and the contribution to the GDP. This is because more water is requirement to meet the ecological objectives of scenario 1. The best case for the economic contribution of the Letaba catchment is Scenario 7.

As can be seen in Table 1.4, irrigated agriculture will be the most severely negatively impacted in scenario 1 with the number of hectares that will have to be withdrawn estimated to be approximately 18 000 hectares under current irrigation practices. The impact is severe in subcatchment 2 downstream of Tzaneen dam where the GDP contribution for Scenario 1 will reduce by approximately R611 million. However by increasing irrigation efficiency there may be potential for reducing the number of hectares that will be required to be withdrawn in order to meet the EWR for Scenario 1.

Under scenario 7, whereas for Scenario 7 although irrigation agriculture is still negatively impacted, with the GDP contribution reducing by about R52 million, the impact is not as severe as all other scenario investigated. The situation improve

Table 7.3: Incremental change in value added for each scenario.

	Total Surplus	GDP	Capital Requirements	Low Income Households	All Households
	Rand mil.	Rand mil.	Rand mil.	Rand mil.	Rand mil.
Scenario 1	(161.50)	(1,186.93)	(2,657.82)	(298.36)	(1,174.63)
Scenario 2	(95.68)	(877.00)	(1,808.64)	(216.41)	(852.09)
Scenario 4	(94.36)	(550.03)	(1,326.17)	(143.98)	(564.02)
Scenario 6	(63.87)	(371.98)	(942.99)	(101.67)	(398.26)
Scenario 7	(11.11)	(109.82)	(187.83)	(27.85)	(109.85)

Table 7.4: Impact on employment and irrigated agriculture.

	Employment	Number of Hectares Withdrawn	Percentage Irrigation Withdrawn
	Numbers		Hectares
Scenario 1	(92,244)	(18,056)	95.1%
Scenario 2	(71,635)	(13,797)	72.6%
Scenario 4	(38,974)	(7,752)	40.8%
Scenario 6	(24,485)	(4,750)	25.0%
Scenario 7	(9,859)	(2,093)	11.0%

7.5 CONCLUSIONS

The overall impact of the various scenarios on the goods and services is not highly significant, with the worst case scenario being scenario 7 and the best case being Scenario 1 as shown in the traffic diagram below.

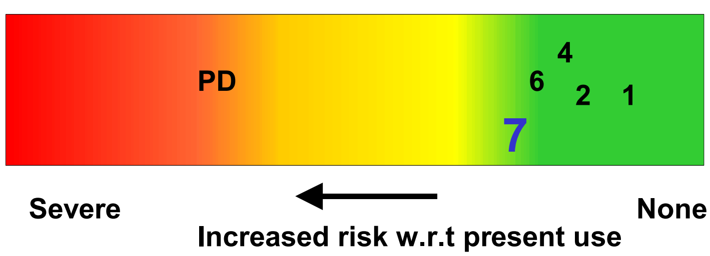

Figure 7.2: Consequences for various operational scenarios on Goods and Services in the Letaba River.

The overall impact of the various scenarios on the economy is highly variable for the scenarios investigated. The worst case EWR scenario is Scenario 1 and the best case EWR scenario being scenario 7. This is as shown in the traffic diagram below.

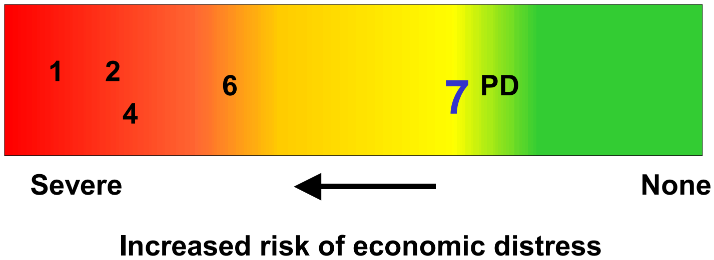

Figure 7.3: Economic consequences for various operational scenarios in the Letaba River.

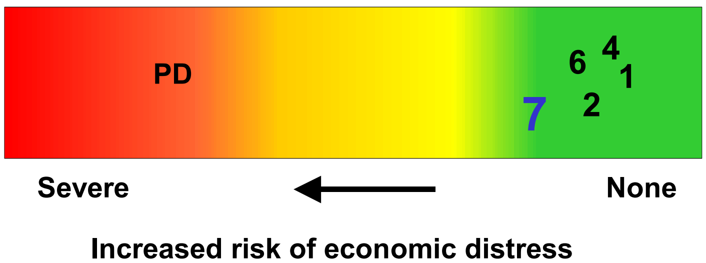

Figure 7.4: Economic consequences to the Kruger National Park of the various operational scenarios in the Letaba River.

8 CAPACITY BUILDING

8.1 OVERVIEW AND OBJECTIVES

A capacity building programme formed part of this study with a dedicated budget. The objective of the capacity building was to increase the technical expertise available for Reserve related studies in the country.

8.2 METHOD

To initiate the training, a number of trainees were identified and mentors appointed. Trainees were selected largely from HDIs as persons who had relevant skills and who were interested in the Reserve Determination process. Table 8.1 indicates the trainees and mentors for the areas to be developed.

Table 8.1: Capacity building team member, mentors and areas of development. * = team members that left for other employment.

HDI TEAM MEMBER	MENTOR	DEVELOPMENT AREA	NEWS SKILLS DEVELOPED
Kevin Pillay	Ralph Heath	Reserve determination project management	The comprehensive Reserve methodology Facilitate Reserve scenario workshops SPATSIM model training WRYM training Hands on modelling
Paul Chipwanya* Yosief Fsehazion	Ken Haumann Kevin Pillay	Hydrology Water Resource Yield Modelling	Site selection methods SPATSIM model training WRYM training Hands on modelling Manipulation of flow scenarios
Deborah Vromans	Patsy Scherman	Water quality data analysis, graphic, statistics, trend analysis	Water quality data collation Water quality data interpretation and manipulation
Patterson Khavhagali *	Gary Marneweck	Riparian vegetation and wetland surveys	Field assessment techniques Key indicator species identification Vegetation transects Vegetation and wetlands role in the Reserve methodology
Thomas Mufanadzo *	Robert Skorozewski	Rapid biological assessment of invertebrates in field	Field assessment techniques (SASS5) Key indicator species

HDI TEAM MEMBER	MENTOR	DEVELOPMENT AREA	NEWS SKILLS DEVELOPED
			identification Fill in and understand how assessment forms work for SASS5 and Habitat assessment.
Shaka Sebola Calvin Mawelela	Indaran Govender	Socio – cultural importance survey of water in the catchment.	Methodology required for Reserve determination with regards to field surveys
Duncan Munyai	Carel Haupt Karim Sami	Groundwater assessment and terms of reference for groundwater Reserve	Literature review of current available groundwater data Data collation into a situation assessment report Report writing skills

Each HDI was given a mentor whose responsibility was to make sure that the trainee is undertook the following:

- Understands the process of how the Reserve is to be determined
- Undertakes at least 1 field visit (if appropriate) to the Letaba River to observe the chosen EWR sites
- Assists in the determination of his/her specific aspect of the Reserve (hands on trainee and undertaking specific tasks)
- Attend all specialist workshops

The following additional capacity building exercises will be undertaken:

- Regional representatives of DWAF-Polokwani and Limpopo Province were included in the first Ecospecs workshop (Mpho Daswe and Washington Tuhna)
- DWAF Limpopo Regional office staff undertook training over two days in conjunction with the Komati workshop (26/27 October, Silo Kheva, Mpho Daswe, Minky Chauke, Happy Mushwana, Benson Mpefe, Sharon Mashaba, Caroline Shai).

The following additional capacity building exercises will be undertaken:

A series of lectures to the biological sciences students at the University of Venda (Dr R Heath, P Fouche and M Angliss) on integrated water resource management and how the Reserve process is an important part of sustainable water allocations.

One of the outputs of the Letaba comprehensive Reserve study will be a capacity building report. This report will give an overview of the training programme and will include evaluations by the mentors of their trainees as well as an evaluation by the trainees of the mentoring programme.

8.3 PROBLEMS ENCOUNTERED WITH CAPACITY BUILDING

- High mobility of trained HDI staff. This made it difficult to follow through with the full capacity building programme as many of the trainees successfully gained employment in other fields.

- There is an urgent need for some for of pre-training of the trainees as it was difficult to balance the project plan and deadlines with appropriate training. A two-day workshop on the Reserve process needs to take place before any of the trainees venture out into the field.
- Lack of assurances of continued work for trainees after the study (no guarantee that further comprehensive or intermediate Reserve studies will be requested).
- A Master's degree is being planned.
- The specialists workshops are too focussed and a waste of time for the regional office staff.
- It was suggested that a cradle to grave approach should be implemented so that the regional staff, who will ultimately implement the Reserve, prior to the establishment of a WUA, be able to grow with the process.

Regional staff responsible for the implementation of the Reserve should be part of the Reserve process from the onset. That is regional DWAF staff should be involved in the project from the choice of EWR sites, scenario development and the development of the monitoring programme.

DWAF should put emphasis on building expertise within regional offices as well as head office to be able to guide both consultants and DWAF personnel in order to undertake both intermediate as well as comprehensive Reserve determinations.

9. CONCLUSION AND RECOMMENDATIONS

9.1 CONCLUSIONS

After consideration of the original scenarios it became apparent that it was possible to develop a scenario that optimised flow requirements and had the least potential impact on all sectors. As such, Scenario 7 was developed. The specific impacts of Scenario 7, as compared to the other relevant scenarios, are specified in Chapters 5 to 8.

The Letaba River catchment is highly regulated particularly in the upper catchments where most of the runoff is generated. Implementation of ecological flows in the Letaba River catchment can therefore be realised through active management of the water resource infrastructure such a the dams and weirs in the catchment as well as through reducing abstractions for water users in the catchment based on their curtailment structures. This however has a negative impact on the available water to users. The restrictive flow management will therefore involve changing the existing allocations to water users in the catchment to ensure that enough water is left in the river. Both types of interventions require a change in the water use practices of the stakeholders and the need for stakeholder commitment and buy-in with the level of resource protection that can be effected without significantly impacting on the socio-economy of the catchment.

The ecological consequences of the flow scenarios are present in Figure 9.1. It is noted that in most cases the ecological objectives are being met for most scenarios with the exception of Scenarios 4, 6 and the present day for EWR sites 3, 4 and 5. The ecological objectives for the present day are not being met in the Kruger National Park given the fact that there is an existing allocation of 0.6 m^3/s from Tzaneen Dam.

The impact of the ecological water requirements on the socio economy of the Letaba catchment was premised on the water use that was not verified and validated. Therefore depending on the verification of water use in the Letaba River catchment, particularly in the Middle Letaba river catchment upstream of the Middle Letaba Dam and the Letsitele River catchment, the extent of the impact may not be as severe. The impact of the EWR flow scenarios on the ecological goods and services as well as the socio-economy is provided in Figure 9.1.

After consideration of the flow scenario that were investigated, it is apparent that the EWR flows for **Scenario 7** provide the best trade off between the need for protection of the ecological ecosystems in the Letaba catchment with the need to ensure the socio-economic growth is not severely negatively impacted.

9.2 RECOMMENDATIONS

Because of the limitations in the development of the comprehensive Reserve study for the Letaba River catchment, a number of issues need to be addressed. These are discussed below:

No stakeholder participation was conducted for the determination of the EWR. Stakeholder involvement should be an integral part of the process determining the comprehensive reserve because it would:

- Assure alternative serving a broad range of interests are considered. This may not be case with the scenarios generated as stakeholders were not involved.
- Provide transparency and accountability regarding both decisions taken and the process by which those decisions on the level of resource protection are taken.

- Accustom stakeholder to the fact that some difficult choices may have to be made in order to manage water resources effectively and in a sustainable manner. This will mean change in the allocation mechanism and the need for water allocation reform.
- Build a board base of commitment to options by creating an environment that takes into account the benefits, risks and costs of the options and that provides a meaningful basis for informed consent to DWAF decisions on the Reserve.
- Increase the probability of implementation of the Reserve through restrictive management of the water users as may be necessary.

From the study it is recommended that the EWR flows for scenario 7 be considered for the preliminary ecological Reserve. Consideration should also be taken to delay implementation of the EWR flow of scenario 7 in the Letsitele River catchment because of the significant impact it will have on the irrigators until the verification and validation has been undertaken.

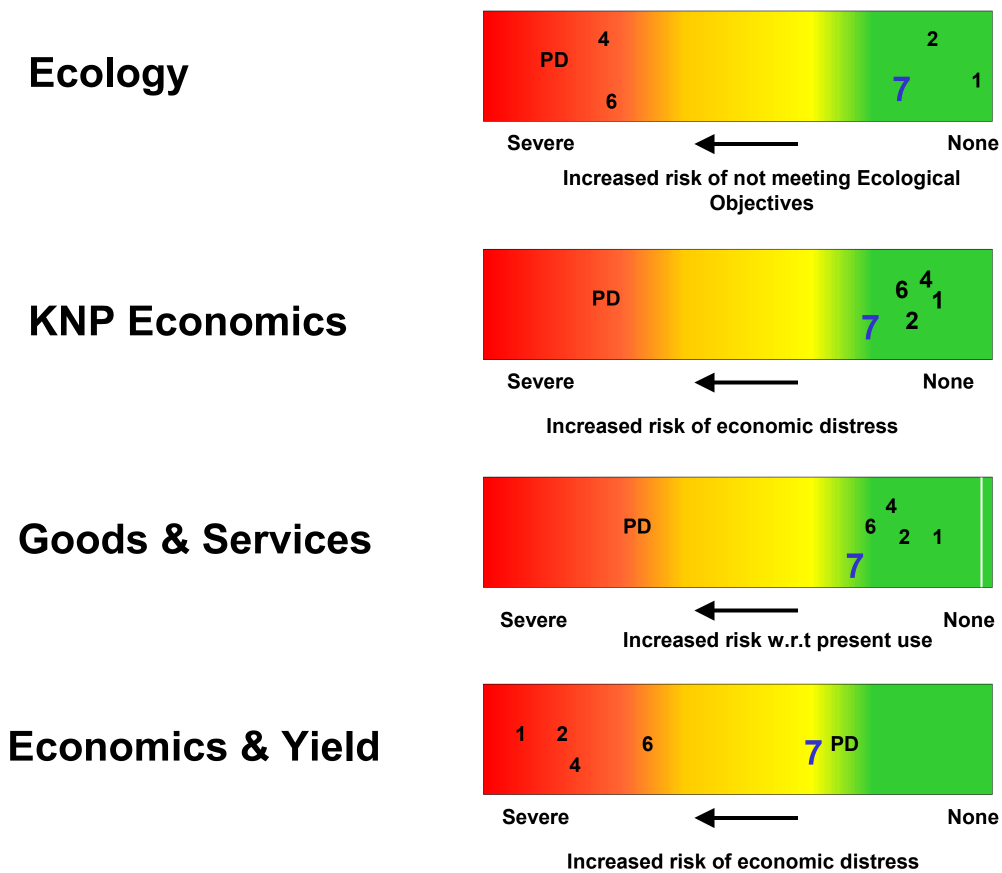

Figure 9.1: Comparison of scenario impacts across major study components.

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