DEPARTMENT: WATER AFFAIRS

CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

THE CLASSIFICATION OF SIGNIFICANT WATER RESOURCES IN THE OLIFANTS-DOORN WATER MANAGEMENT AREA (WMA 17)

FINAL PROJECT REPORT

APRIL 2012

Prepared for:
Department of Water Affairs
Chief Directorate: Resource Directed Measures
Private Bag X313
Pretoria
1200

Contact person:
Ms. Shane Naidoo
Tel: 012-336 6707
Fax: 012-336 6712
Email: NaidooShane@dwa.gov.za

Prepared by:
BlueScience Consulting cc
PO Box 195
Stellenbosch
7599

Contact person:
Mr. Dana Grobler
Tel: 021 887 7161
Fax: 021 887 7162
Email: dana@bluescience.co.za

TITLE	Final Project Report
PROJECT NUMBER	WP 10387
AUTHORS	Belcher A. and Grobler D.
PROJECT NAME	The Classification of Significant Water Resources in the Olifants-Doorn Water Management Area (WMA 17)
REPORT STATUS	Final Draft (April 2012)
DWA REPORT No.	

Specialist reports reference in this final project report:

- *Department of Water Affairs 2012: The Socio economic impact of proposed class configurations on irrigation farming in the Olifants-Doorn WMA, Department of Water Affairs, South Africa. Kleynhans, TE and Hoffmann WH, April 2012.*
- *Department of Water Affairs 2012: Socio economic overview of the Olifants-Doorn WMA and the social impact of the proposed class configurations, Department of Water Affairs, South Africa. Barbour, Tony April 2012.*
- *Department of Water Affairs 2012: Public participation report for the Classification of significant water resources in the Olifants-Doorn WMA, Department of Water Affairs, South Africa. Februarie D., & Grobler D. April 2012.*
- *Department of Water Affairs 2012: Olifants / Doorn Water Management Area (WMA17) Classification Phase (3a) Technical Report – Groundwater. Conrad, J., Carstens, M., and Lasher, C. April 2012.*

APPROVED BY BLUESCIENCE CONSULTING cc

……………………………………..

MR D.F. GROBLER

PROJECT LEADER

APPROVED BY DEPARTMENT OF WATER AFFAIRS

……………………………………..

MS. S. NAIDOO

DIRECTOR: WATER RESOURCES CLASSIFICATION

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

CMS	Catchment Management Strategy
DM	District Municipality
DWA	Department of Water Affairs (previously DWAF)
EC	Ecological Category
EGSA	Ecological Goods, Service and Attributes
EIS	Ecological Importance and Sensitivity
EISC	Ecological Importance and Sensitivity Category
ESBC	Ecological Sustainability Base Configuration
EWR	Ecological/Environmental Water Requirements
FEPA	Freshwater Ecosystem Priority Area
GRAII	Groundwater Resources Assessment Phase II project
GDPR	Gross Regional Domestic Product
IFR	Instream Flow Requirement
IRR	Internal Rate of Return
IUA	Integrated Units of Analysis
IWRM	Integrated Water Resource Management
LM	Local Municipality
MAR	Mean Annual Runoff
MC	Management Class
MCM	Million Cubic Metres
nMAR	Naturalised Mean Annual Runoff
NPV	Net present value
NWA	National Water Act
PES	Present Ecological Status
PESC	Present Ecological Status Category
RDM	Resource Directed Measures
REC	Recommended Ecological Category
RQOs	Resource Quality Objectives
RWQO	Resource Water Quality Objective
SANBI	South African National Biodiversity Institute
TEV	Total Economic Value
WARMS	Water Allocation and Registration Management System
WMA	Water Management Area
WRCS	Water Resource Classification System

GLOSSARY

Catchment configuration: A set of ecological categories (ECs) within a catchment for each nodal reach representing a significant water resource.

Ecostatus: 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 it capacity to provide a variety of goods and services (Kleynhans *et al.* 2005).

Environmental Water Requirements: An allocation of water with a prescribed distribution in space and time, and of a specific quality, that is deliberately left in a river or released into it, to manage river health and the integrity of ecosystems and communities sustained by river flows.

Habitat Integrity: A measure of the extent or degree to which the integrated composition ofphysico-chemical and habitat characteristics is maintained on scale that is comparable with the characteristics under natural conditions. Habitat integrity can be used as a surrogate forEcostatus (Kleynhans *et al.* 2005).

Integrated Unit of Analysis (IUA) class: The desired condition or characteristics of a resource and concomitantly, the degree to which it can be utilised. It may range from minimally to heavily used, depending on societal requirements. The IUA Class is a summary condition recommended for a configuration of water resources within an IUA and between IUAs in a catchment.

Present Ecological State: the current state or condition of a resource in terms of its various biophysical components, i.e. drivers (physico-chemical, geomorphology, and hydrology and biological responses (i.e. fish, riparian vegetation and aquatic invertebrates).

Reserve: The quantity and quality of water required (a) to satisfy basic human needs by securing a basic water of 25 litres per person per day and (b) to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource as indicated in the National Water Act (Act No. 36 of 1998).

Significant Water Resources: Water resources that are deemed to be significant from a water resource use perspective, and/or for which sufficient data exist to enable an evaluation of changes in their ecological condition in response to changes in their quality and quantity of water.

1. INTRODUCTION

1.1. Background

This report is part of a project to classify the Water Resources of the Olifants Doorn Water Management Area (WMA) (Figure 1.1). The Olifants Doorn WMA is located on the west coast of South Africa, extending from about 100 km to 450 km north of Cape Town. The south-western portion mainly falls within the Western Cape Province, and the north-eastern portion falls within the Northern Cape Province. The WMA incorporates the E primary drainage region and components of the F and G drainage regions along the coastal plain, respectively north and south of the Olifants River estuary, covering a total area of 56 446 km^2. The major river in the WMA is the Olifants River, of which the Doring River (draining the Koue Bokkeveld and Doring area) and the Sout River (draining the Knersvlakte) are the main tributaries. The Olifants and Doring Rivers flow strongly during the winter months whilst flows only occur very occasionally in the Sout River. There are also a number of smaller coastal rivers and water courses which flow infrequently.

The Water Resource Classification System (WRCS) is used (via a described Classification Process) to define a set of ecological categories that describe the condition of aquatic ecosystems. The classification process entails a seven step classification process (Figure 1.2) during which the social, economic and environmental implications of different class scenarios and a configuration in the catchment are investigated and the consequences communicated to the users and stakeholders in the catchment. The users and stakeholders are then consulted in terms of each of these scenarios in order to recommend a class configuration and scenario to the DWA delegated authority responsible for classification for approval.

The Management Class (MC) of an aquatic ecosystem will reflect the future desired condition or health of the system, and will be used to guide the amount and quality of water to be reserved for that ecosystem. Deciding on the MC of a system will involve consideration of a broad range of issues and a set of related processes that will include water resource planning, catchment management planning as well as the Classification Process itself. It is important to understand that the product of a Classification Process is the assignment of a management class to water resources within a catchment, i.e. rivers, wetlands, groundwater and estuary. This outcome may influence the water yield that can be utilised from the resources, and indirectly activities within the catchment, such as land use.

Table 1.1: Water resource management classes

Class I: Minimally used
The configuration of water resources within a catchment results in an overall water resource condition that is minimally altered from its pre-development condition.
Class II: Moderately used
The configuration of water resources within a catchment results in an overall water resource condition that is moderately altered from its pre-development condition.
Class III: Heavily used
The configuration of water resources within a catchment results in an overall water resource condition that is significantly altered from its pre-development condition.

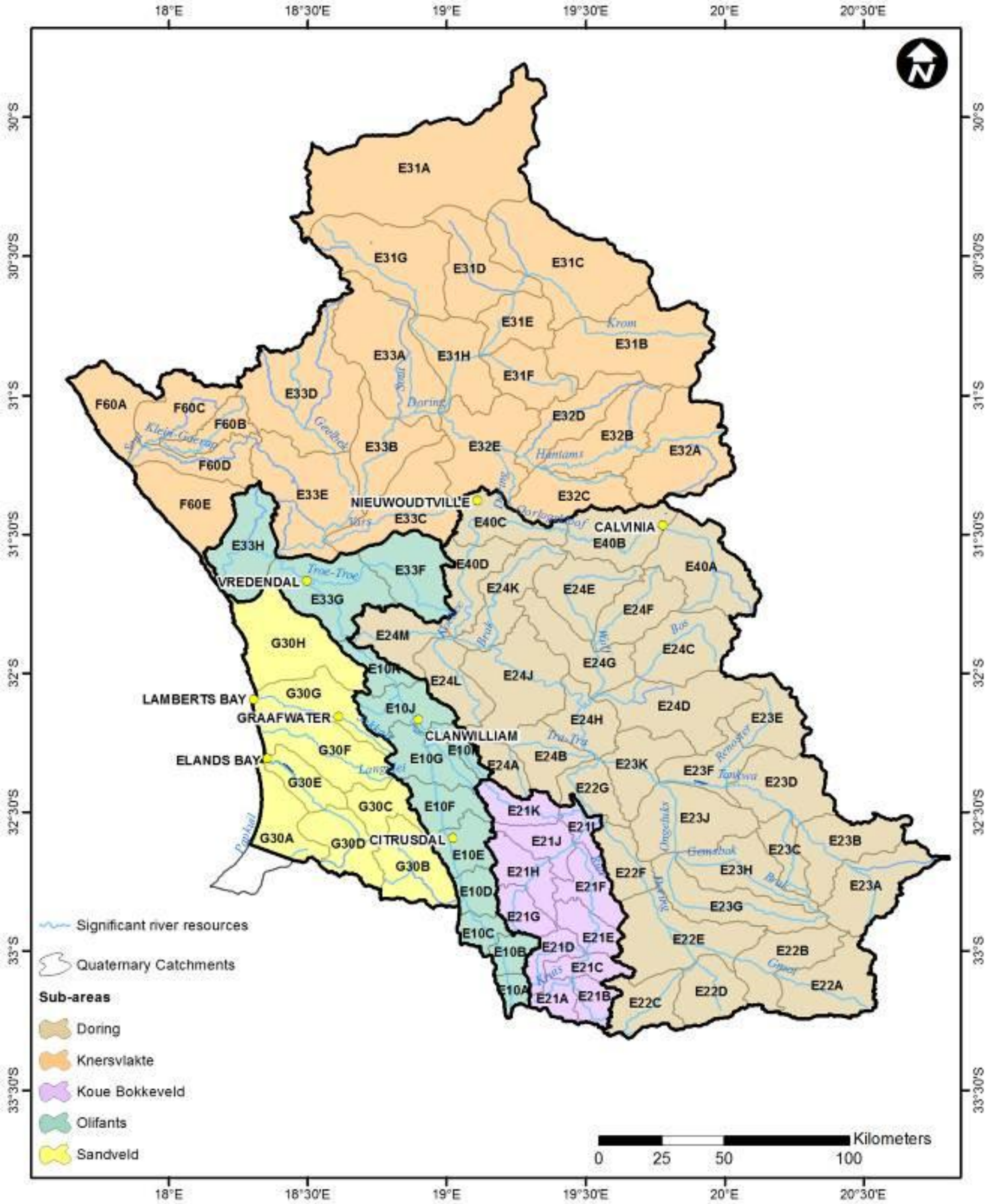

Figure 1.1: The Olifants/Doorn Water Management Area and Sub-areas

1.2. Objective of this report

The report focuses on Steps 5 and 6 of the Classification Process.These steps form part of the 'Larger Process', where the economic, social and ecological trade-offs are made. Emerging from this 'Larger Process' are the recommended MC which prescribes the need for the RQOs and Reserve, Catchment Management Strategy, allocation schedule, modelling system and the monitoring, auditing and compliance strategy to give effect to the class. A key question in this 'Larger Process' is how the recommended MC, Reserve, Resource Quality Objectives (RQOs), Catchment Management Strategy (CMS) and allocation schedule will impact on specific groups of people.

1.3. Process followed for the finalisation of the IUA classes

The steps followed to achieve the final outcomes for the project were guided by the seven-step classification procedure for recommending a Class of a resource. The steps included the following tasks:

Step 5: Evaluate scenarios within the Integrated Water Resource Management (IWRM) process

- Run yield model for Ecological Sustainability Base Configuration (ESBC) and other catchment configuration scenarios and adjust if necessary. (Unfortunately this was not available to this project at a level at which could effectively inform the project outcomes);
- Assess water quality implications (fitness for use) for all users;
- Report on ecological condition and aggregate impacts per IUA for each scenario;
- Value changes in aquatic ecosystems and water yield;
- Describe macro-economic and social implications of different catchment configuration scenarios;
- Evaluate overall implications at an IUA-level and a regional-level; and
- Select a subset of scenarios for stakeholder evaluation.

Step 6: Evaluate scenarios with stakeholders; including:

- Stakeholders evaluate scenarios and agree on short-list; and
- DWA recommends IUA classes.

These steps precede the final Gazetting of the recommended water resource classes. Detail on the outcomes from each of these tasks is provided in the following chapters of this report.

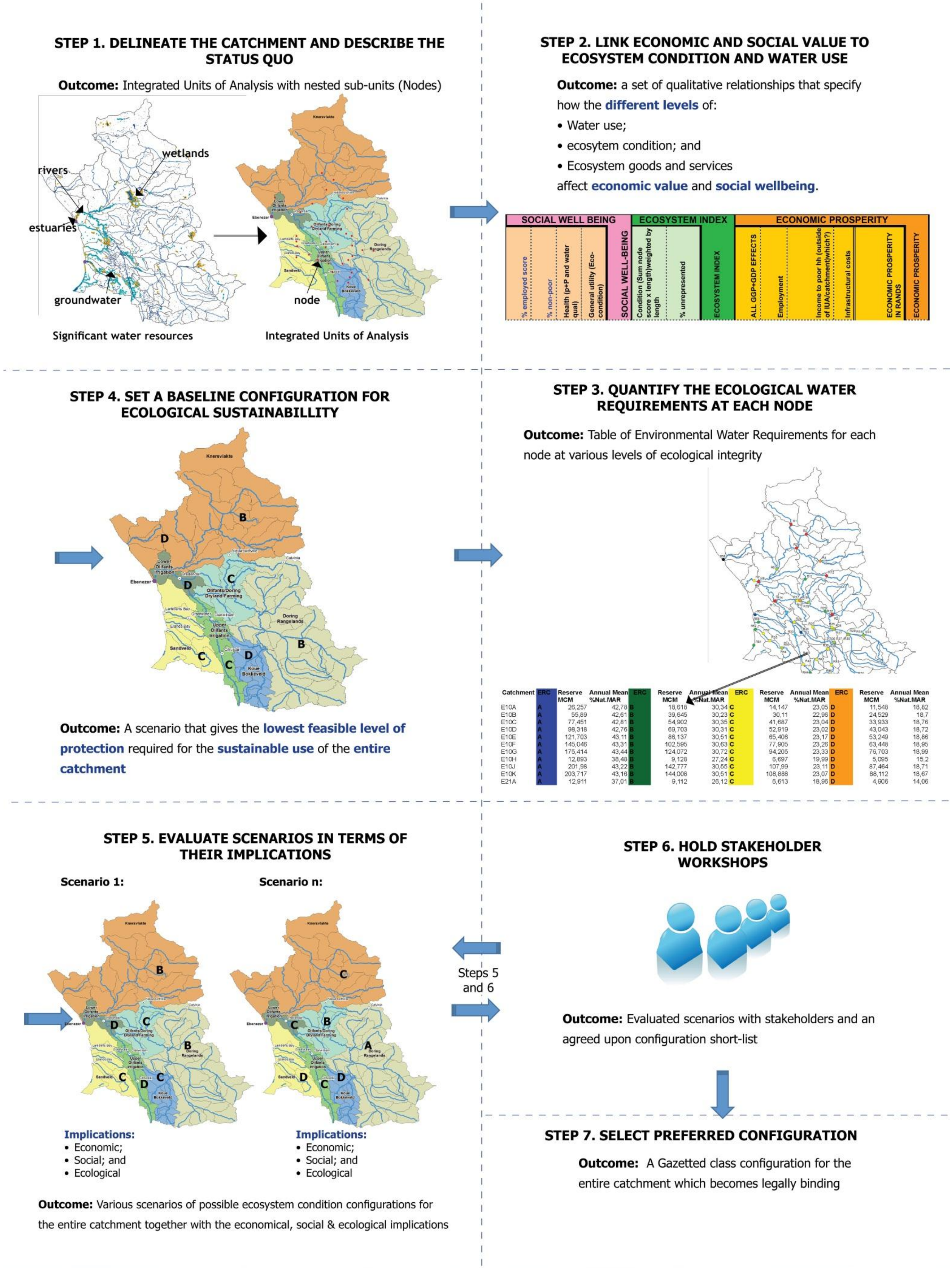

Figure 1.2: A simplified diagram of the seven-step procedure for recommending the Class of a water resource

2. RECOMMENDED CATCHMENT CONFIGURATION SCENARIO

2.1. Recommended Catchment Configuration Scenario per Quaternary Catchment

The Recommended Starter Catchment Configuration Scenario consisted largely of a combination of maintaining the Present Ecological Status and meeting the conservation requirements as indicated by Freshwater Ecosystem Priority Areas (FEPAs). Table 2.1 provides a summary of the recommended catchment configuration scenario as determined per quaternary catchment that was taken forward to assess the ecological, social and economic implications.

Table 2.1: Recommended Catchment Configuration Scenario: Ecological categories for surface water per quaternary catchment

Quat. Drainage Region	River name	Mainstem Ecological Category	Tributary Ecological Category* (% of Incremental quaternary area)
E10A	Olifants	C	C
E10B	Olifants	C	C (80%); AB (20%)
E10C	Olifants	C	AB (100%)
E10D	Olifants	C	C (70%); AB (30%)
E10E	Olifants	C	C (60%); AB (40%)
E10F	Olifants	D	C (40%); AB (60%)
E10G	Olifants/ Rondegat	D	C (70%); AB (30%)
E10H	Jan Dissels	D	D (95%); AB (5%)
E10J	Olifants	D	D (80%); AB (20%)
E10K	Olifants	D	D (95%); AB (5%)
E21A	Kruis	D	C
E21B	Welgemoed	D	D
E21C	Winkelhaak	C	B
E21D	Houdenbeks	D	D (95%); AB (5%)
E21E	Riet	C	C (30%); AB (70%)
E21F	Riet	C	C
E21G	Groot/Leeu	D	D (95%); AB (5%)
E21H	Groot/Leeu	AB	B (40%); AB (60%)
E21J	Groot	AB	AB (100%)
E21K	Maatjies	B	AB (100%)
E21L	Groot	AB	AB (100%)
E22A	Doring	B	AB
E22B	Doring	AB	AB (16%)
E22C	Tankwa	AB	AB (5%)
E22D	Tankwa	B	AB (95%)
E22E	Doring	B	AB (30%)
E22F	Doring	B	AB (100%)
E22G	Doring	C	AB (100%)
E23A	Tankwa	AB	AB
E23B	Tankwa	AB	AB (20%)
E23C	Tankwa	AB	AB
E23D	Tankwa	AB	AB
E23E	Tankwa	B	AB (20%)
E23F	Tankwa	B	B
E23G	Ongeluks	B	B (95%), AB (5%)
E23H	Ongeluks	AB	AB (5%)
E23J	Ongeluks	B	AB (40%)
E23K	Tankwa	B	AB (30%)
E24A	Tra-tra	B	AB (100%)
E24B	Tra-tra	B	B (50%); AB (50%)
E24C	Bos	C	B
E24D	Bos	C	B
E24E	Wolf	AB	AB (5%)
E24F	Wolf	B	AB
E24G	Wolf	B	AB (40%)
E24H	Doring	C	AB

Table 2.1 (*cont.*): Recommended Catchment Configuration Scenario: Ecological categories for surface water per quaternary catchment

Quat. Drainage Region	River name	Mainstem Ecological Category	Tributary Ecological Category* (% of Incremental quaternary area)
E40A	Oorlogskloof	C	C (90%); AB (10%)
E40B	Oorlogskloof	C	C (70%); AB (30%)
E31A	Kromme	B	B (85%); AB (15%)
E31B	Kromme	B	B (10%); AB (90%)
E31C	Kromme	B	B (65%); AB (35%)
E31D	Kromme	B	B
E31E	Kromme	B	B
E31F	Kromme	B	B
E31G	Kromme	B	B (90%); AB (10%)
E31H	Hantams	B	B (80%); AB (20%)
E32A	Hantams	B	B (85%); AB (15%)
E32B	Hantams	B	B
E32C	Hantams	B	B (70%); AB (30%)
E32D	Hantams	B	B (85%); AB (15%)
E32E	Hantams	B	B (30%); AB (70%)
E33A	Sout	B	B (60%); AB (40%)
E33B	Sout	B	B (95%); AB (5%)
E33C	Sout	D	D (95%); AB (5%)
E33D	Sout	B	B (65%); AB (35%)
E33E	Sout	C	B (75%); AB (25%)
E33F	Hol	D	D
F60A	Brak	B	B
F60B	Klein Goerap	B	B
F60C	Sout	B	B
F60D	Groot Goerap	B	B
F60E	Groot Goerap	B	B
E33G	Hol	D	C
E33H	Olifants	D	B (95%); AB (5%)
E24J	Doring	C	AB (70%)
E24K	Doring	C	AB (20%)
E24L	Brandewyn	B	C (90%); AB (10%)
E24M	Doring	C	C (40%); AB (60%)
E40C	Oorlogskloof/Koebee	D	B (25%); AB (75%)
E40D	Oorlogskloof/Koebee	B	B (30%); AB (70%)
G30A	Papkuils	C	C (95%); AB (5%)
G30B	Kruismans	C	C (50%); AB (50%)
G30C	Bergvallei	C	C (95%); AB (5%)
G30D	Verlorevlei	C	C (80%); AB (20%)
G30E	Verlorenvlei	C	C (90%); AB (10%)
G30F	Langvlei	C	C
G30G	Jakkalsvlei	C	C
G30H	Sandlaagte	C	C

* Percentage of catchment area in an AB condition relates to Freshwater Ecosystem Priority Areas mapped

The Olifants Estuary (E33H) as well as the Verlorenvlei Estuary (G30E) should be maintained in a C Ecological Category.

As the determination of the ecological categories were determined largely from a surface water flow and ecological condition perspective, the impact on water quality and on groundwater was also assessed. The social, economic and water quality information that is available is at an Integrated Unit of Analysis (IUA) level, therefore the recommended catchment configuration was determined and assessed at this broader scale.

2.2. Recommended Catchment Configuration Scenario per Integrated Unit of Analysis (IUAs)

The IUAs are a combination of the socio-economic zones and watershed boundaries, within which ecological information will be provided at a finer (node) scale Figure 2.1. The Olifants Doorn WMA has long been divided, from a water resources management point of view, into sub-areas that are based on considerations of land as well as water use. These sub-areas are also relatively homogenous socio-economic zones and represent similar aquatic ecological characteristics.

As the areas have been delimited to quaternary catchment boundaries and are at a sufficiently fine scale to approximate socio-economic zonal boundaries, they have the potential to facilitate the integration of ecological and socio-economic aspects that is required in the classification procedure. These areas have thus formed the basis in the delineation of IUAs for the Olifants Doorn WMA classification procedure, where some of the original sub-areas (that is the Koue Bokkeveld, Doring Rangelands, Knersvlakte, Olifants and Sandveld), were further divided to further facilitate the classification procedure for the WMA.

The IUAs that have been identified through the classification procedure for the WMA consist of the following areas:

- The Koue Bokkeveld area consists of 11 quaternary catchments (E21A-L),
- The Doring Rangelands consists of 27 quaternary catchments (E22A-G, E23A-K, E24A-H, E40A-B),
- The Knersvlakte consists of 24 quaternary catchments (E31A-H, E32A-E, E33A-F, F60A-E),
- The Upper Olifants Irrigation area consists of ten quaternary catchments (E10A-K),
- The Olifants/Doring Dryland Farming area consists of seven quaternary catchments (E24J-M, E40C-D, E33F),
- The Lower Olifants Irrigation area consists of two quaternary catchments (E33G-H),
- The Olifants/Doring Estuary, and
- The Sandveld sub-area consists of 8 quaternary catchments (G30A-H).

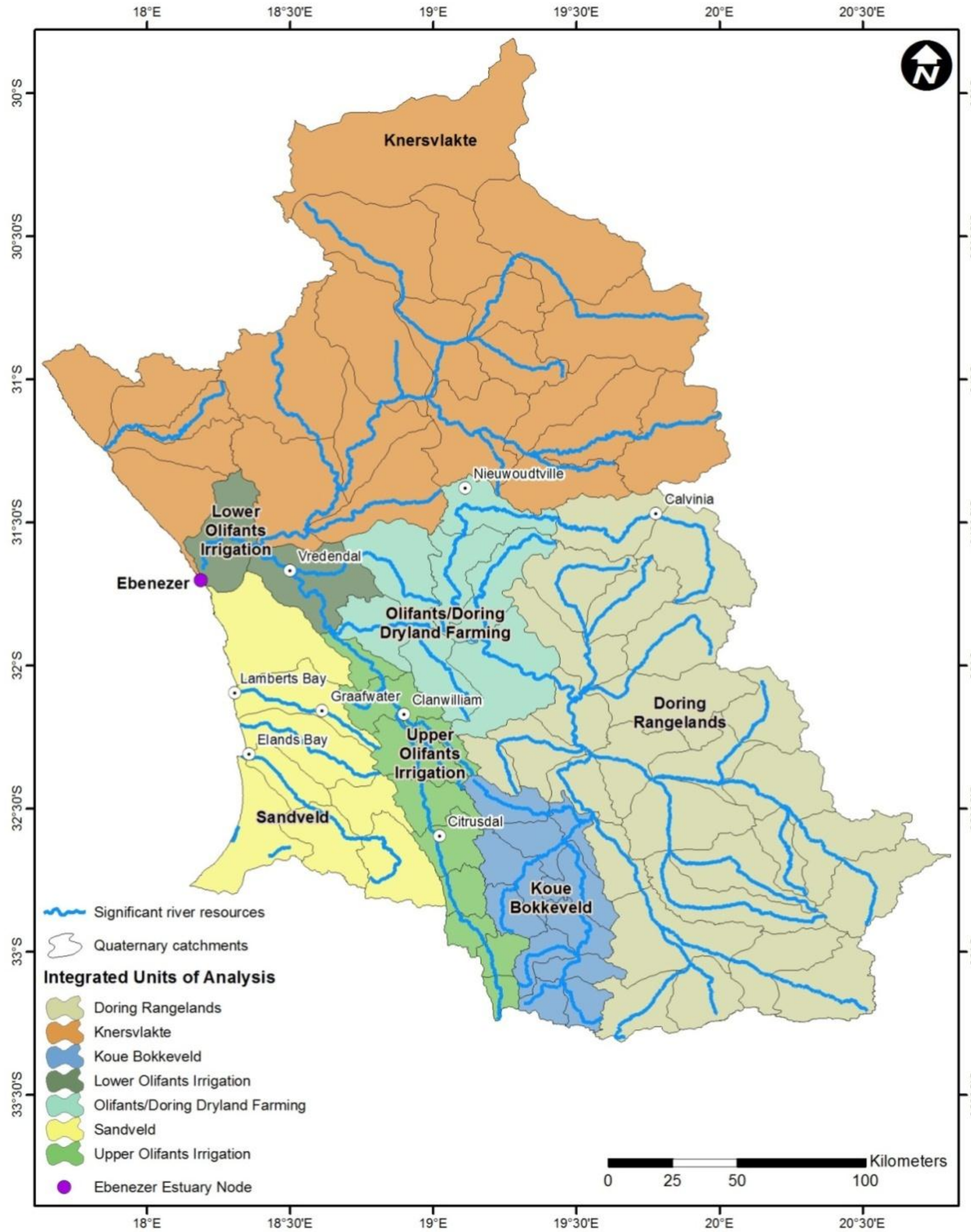

Figure 2.3. Integrated Units of Analysis for the Olifants Doorn WMA

The recommended catchment configuration is summarised in Table 2.2 according to the overall aggregated Class per IUA. The guidelines (as provided in the classification guideline documents) for the calculation of the IUA Class are provided in Table 2.3.

Table 2.2: IUA Class assignations for starter catchment configuration

Integrated Units of Analysis	Recommended Scenario		
	Incremental	Cumulative	Combined
Knersvlakte	Class I	Class I	Class I
Koue Bokkeveld	Class II	Class II	Class II
Doring Rangelands	Class I	Class I	Class I
Olifants Doring Drylands	Class II	Class II	Class III
Lower Olifants Irrigation Area	Class III	Class III	Class III
Upper Olifants Irrigation Area	Class II	Class III	Class III
Sandveld	Class III	Class III	Class III

Table 2.3: Guidelines for the calculation of the IUA Class for the recommended starter configuration scenario

IUA Class		Percentage category representation at units represented by biophysical nodes in an IUA				
		≥A/B	≥B	≥C	≥D	<D
Class 1		≥40	≥60	≥80	≥99	-
Class 2		-	≥40	≥70	≥95	-
Class 3	Either	-	-	≥30	≥80	-
	Or		-	-	100	-

3. ASSESSMENT OF YIELD AND WATER USE

In order to determine the implications of the recommended catchment configuration on the social and economic environments, one needs to ascertain how the recommended water resource classes will impact on water availability and water use activities.

3.1. Assessment of the yield available in the WMA for the recommended catchment configuration

The yield of a given catchment is the volume of water that is available constantly throughout the year. It is estimated from a monthly time series and establishes the surplus water available in each month of the year after the ecological Reserve for the recommended ecological category has been met. The Reserve requirement that was used in the determination of the yield available at a quaternary catchment level included high flow requirement.

For nearly all the rivers of the Olifants Doorn Water Management Area, the present day yield is negligible or zero during summer months but is nearly always in surplus in winter months. The run-of-river yield calculation however determines the volume of water that is available throughout the year i.e. the lowest volume that can be abstracted with a pre-selected assurance in all months of the year. Therefore all of the catchments within the WMA show an almost zero run-of-river yields.

While the mean annual runoff of many of the catchments might be high, one has to bear in mind the seasonality of the flows. A lot of the water is only available during the winter months and could be used in the summer if storage was provided. The yield calculations do not take into account available storage. In order to improve the yield storage facilities will need to be constructed to capture winter run-off which can be utilised in summer.

3.2. Assessment of Current Water Use

Two sources of information were used to determine the current water use (abstraction and/or storage of water), that is, the water use registered with the DWA on the Water Allocation and Registration Management System (WARMS) and the modelled water use from Water Resources 2005 (WR2005). Table 3.1 gives the WARMS data per IUA, while Table 3.2 gives the modelled water use from WR2005.

Table 3.1: Water use registered on WARMS for the Olifants Doorn WMA, separated per IUA and for surface verse groundwater use

Integrated Unit of Analysis	TOTAL Surface water use (Million m3/a)	Percentage	TOTAL Ground water use (Million m3/a)	Percentage	Grand Total (Million m3/a)	Percentage
1. Lower Olifants Irrigation	129	41%	4	3%	133	31%
2 Upper Olifants	82	26%	28	23%	110	25%
3 Olifants Doring Dryland Farming	14	4%	5	4%	18	4%
4 Doring Rangelands	11	3%	4	4%	15	4%
5 Koue Bokkeveld	66	21%	14	12%	80	18%
6. Knersvlakte	2	1%	10	8%	11	3%
7. Sandveld	12	4%	54	46%	66	15%
Total	**314**	100%	**119**	100%	**434**	100%
Percentage use	72.50%		27.50%			

Table 3.2: Modelled water demand and use for the Olifants Doorn WMA, separated per IUA

Integrated Unit of Analysis	TOTAL incremental present day water demand (Million m3/a)	TOTAL incremental present day water use (Million m3/a)
1. Lower Olifants Irrigation	1*	1*
2 Upper Olifants	87	60
3 Olifants Doring Dryland farming	16	6
4 Doring Rangelands	48	24
5 Koue Bokkeveld	86	64
6. Knersvlakte	5	5
7. Sandveld	28	28
Total	**269**	**187**

** The water modelled for this IUA is obtained from IUA 2 (Upper Olifants) thus not reflected within IUA*

According to the water use figures given above, the modelled present day water use is only 43% of the registered water use, while the registered water use is approximately 60% higher than the modelled water demand for the WMA. The registered water use for the Olifants River and the Sandveld are significantly higher than that modelled, while the Doring Rangelands registered water use is about half the modelled amount.

In the absence of reliable water use data the following assumptions were made to allow the process to calculate the economic and social implications of an increase or decrease on the agricultural sector and the classification to proceed:

- Deciduos fruit in the Koue Bokkeveld: An increase of approximately 15% is possible in selected areas in the Koue Bokkeveld. This is based on detailed hydrological work conducted by Mr Gerald Howard (Evaluation of the hydrology of the Koue Bokkeveld, February 2010),

- Citrus fruit in the Upper Olifants: An increase in the assurance of supply in the Upper Olifants River IUA based on increased storage of winter water in the Citrusdal area in combination with a recduction of summer abstractions,
- Table and wine grape production in the Lower Olifants: A staged increase analysis of water use based on the proposed raising of Clanwilliam dam, including the following steps:
    - Increase of assurance of supply,
    - Increase up to the maximum design distribution capacity of the LORWUA irrigation canal
    - Increase in water use from the Clanwilliam canal
- Potato production in the Sanveld IUA
    - Decrease of approximately 15% in a particular area the Sandveld
    - Increase of 10% in selected areas only

4. WATER QUALITY IMPLICATIONS

To evaluate the water quality implications of the recommended catchment configuration, a comparison was undertaken of the current fitness for use of the water with that for the recommended water resource classes. This was undertaken at an IUA level as the existing water quality was only available at that level. The fitness for use assessment was also only undertaken for the two key users sectors, irrigation and domestic water users as well as for the aquatic ecosystems.

Table 4.1: Monitoring points selected to characterise the water quality at the outflows from the IUAs

Sub-areas	Quaternary No(s)	Monitoring point	Comment
Doring Rangeland (1)	E40B	E4R001	Only one sampling point in this IUA, E4R001 – Karee Dam on Karee River. Fair observed data record but no flow data to develop concentration/flow relationship.
Doring Rangeland (2)	E24H	E4R001	No monitoring points, assumed to be same as E4R001 - Karee Dam on Karee River, low confidence assessment.
Knersvlakte	E33E	E3H002	There is only one monitoring point in the Knersvlakte with 7 observations, E3H002 - Hantams River At Brake Rivier/Tweefontein. Low confidence assessment., No
Koue Bokkeveld	E21L	E2H002	E2H002 – Doring River at Elands Drift/Aspoort. Good data point, sufficient data to develop concentration/flow relationship.
Lower Olifants	E33H	E2H016	Only one monitoring point, E2H016 - Olifants River at Lutzville. May be marine influence on TDS but estuarine specialist felt it was unlikely and high salinity was due to irrigation return flows upstream of monitoring point.
Lower OD Dryland farming	E24M	E2H003	Good data record at E2H003 & flow data to develop concentration/flow relationship.
Upper OD Dryland farming	E24B	E2H002	Water quality in the Tra-Tra was assumed to be the same as those observed at E2H002 close by.
Upper Olifants	E10J	E1H011	Assumed same as outflow from Clanwilliam Dam. No flow data at Bulshoek Dam to develop a concentration/flow relationship used total outflow from Clanwilliam Dam.
Sandveld		VV4	Water quality monitoring in the Sandveld very poor. Monitoring point in Verlorevlei, Ptn Grootdrif VV4 was assumed to represent water quality in the Sandveld

For each of the monitoring points located at the outflow of an IUA, the median, 75th percentile and 95th percentile was calculated for the chemical constituents, for the period 2000-2010. These were then classified using the generic water quality guidelines.

4.1. Generic Water Quality Requirements

The generic water quality requirements and fitness for use categories of the two key users sectors, irrigation and domestic water users as well as for the aquatic ecosystems are summarized (Department of Water Affairs and Forestry, 2006) in the following tables:

Table 4.2: Generic water quality guidelines for Agricultural Use: Irrigation

WATER QUALITY GUIDELINES FOR AGRICULTURAL USE:, IRRIGATION					
Variable	Units	Ideal	Acceptable	Tolerable	Unacceptable
PHYSICAL AND CHEMICAL REQUIREMENTS					
Total Suspended Solids	mg/l	50	75	100	>100
Chloride	mg/l	100	137.5	175	>175
Electrical Conductivity	mS/m	40	90	270	>270
Fluoride	mg/l	2.0	8.5	15.0	>15.0
pH (upper)		8.4	8.4	8.4	>8.4
pH (lower)		6.5	6.5	6.5	<6.5
Sodium Absorption Ratio	mmol/l	2.0	8.5	15.0	>15.0
Sodium	mg/l	70.0	92.5	115.0	>115.0
Aluminium	mg/l	5.0	12.5	20.0	>20.0
Arsenic	mg/l	0.1	1.05	2.0	>2.0
Beryllium	mg/l	0.1	0.3	0.5	>0.5
Boron	mg/l	0.5	0.75	1.0	>1.0
Cadmium	mg/l	0.01	0.03	0.05	>0.05
Chromium VI	mg/l	0.1	0.56	1.0	>1.0
Cobalt	mg/l	0.05	2.75	5.0	>5.0
Copper	mg/l	0.2	2.6	5.0	>5.0
Iron	mg/l	5.0	12.5	20.0	>20.0
Lead	mg/l	0.2	1.1	2.0	>2.0
Lithium	mg/l	2.5	2.5	2.5	>2.5
Manganese	mg/l	0.02	5.1	10.0	>10.0
Molybdenum	mg/l	0.01	0.03	0.05	>0.05
Nickel	mg/l	0.2	1.1	2.0	>2.0
Selenium	mg/l	0.02	0.04	0.05	>0.05
Uranium	mg/l	0.01	0.06	0.1	>0.1
Vanadium	mg/l	0.1	0.56	1.0	>1.0
Zinc	mg/l	1.0	3.0	5.0	>5.0
BIOLOGICAL REQUIREMENTS					
Faecal coliforms	per 100ml	1	500	1000	>1000

Reference: South African Water Quality Guidelines, Volume 4, Agricultural Water Use - Irrigation, (DWAF, 1996)

* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.

** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.

*** The limits presented above do not take into account site-specific conditions.

In the WODRIS report the Provincial Department of Agriculture used a site-specific classification for salinity that is more stringent than the SA Water Quality Guidelines for Irrigation Agriculture to specify the water quality requirements for the Olifants irrigation area and to assess the fitness for use of the water (Provincial Government Western Cape, 2004).

Table 4.3: Salinity ratings for irrigation in the Olifants River (Provincial Government Western Cape, 2004). The values in brackets represent the generic SAWQG values for irrigation.

Salinity hazard	EC (mS/m)	TDS (mg/l)	Applicability
Low (Ideal*)	10 – 25 (<40)	64 – 160 (<260)	Can be used on most soils with little likelihood that soil salinity will develop. Some leaching is required but this occurs under normal irrigation practices except in soil of extremely low permeability.
Medium (Acceptable*)	25 – 75 (40-90)	160 – 480 (260-585)	Can be used for irrigation if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control.
High (Tolerable*)	75 – 225 (90-270)	480 – 1 440 (585-1755)	Not to be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.
Very high (Unacceptable*)	≥ 225 (>270)	≥ 1 440 (>1755)	Not suitable for irrigation water under most conditions.

* - The equivalent water use categories (Ideal, Acceptable, Tolerable, and Unacceptable) were added to the original table.

Table 4.4: Generic water quality guidelines for Domestic Use

WATER QUALITY GUIDELINES FOR DOMESTIC USE					
Variable	Units	Ideal	Acceptable	Tolerable	Unacceptable
PHYSICAL AND CHEMICAL REQUIREMENTS					
Hardness	mg $CaCO_3$	200	300	600	>600
Turbidity	NTU	0.1	1	20	>20
Calcium	mg/l	80	150	300	>300
Chloride	mg/l	100	200	600	>600
Chlorine (upper)	mg/l	0.6	0.8	1.0	>1.0
Chlorine (lower)	mg/l	0.3	0.2	0.1	<0.1
Electrical Conductivity	mS/m	70	150	370	>370
Fluoride	mg/l	0.7	1.0	1.5	>1.5
Magnesium	mg/l	70	100	200	>200
Nitrate + Nitrite	mg N/l	6.0	10.0	20.0	>20.0
pH (upper)		9.5	10.0	10.5	>10.5
pH (lower)		5.0	4.5	4.0	<4.0
Potassium	mg/l	25	50	100	>100
Sodium	mg/l	100	200	400	>400
Sulphate	mg/l	200	400	600	>600
Total Dissolved Solids (TDS)	mg/l	450	1000	2400	>2400
Arsenic	mg/l	0.01	0.05	0.2	>0.2
Cadmium	mg/l	0	0.01	0.02	>0.02
Copper	mg/l	1.0	1.3	2.0	>2.0
Iron	mg/l	0.5	1.0	5.0	>5.0
Manganese	mg/l	0.1	0.4	4	>4
Zinc	mg/l	20	20	20	>20
BIOLOGICAL REQUIREMENTS					
Total coliforms	per 100ml	0	10	100	>100
Faecal coliforms	per 100ml	0	1	10	>10

Reference: Quality of Domestic Water Supplies, Volume 1: Assessment Guide. (Water Research Commission, 1998).

* The 'Ideal' water quality is equated to the Target Water Quality Range (TWQR) provided in the Water Quality Guidelines.

** The above generic water quality guidelines are recommended for use in determining the present and desired water user category at a low confidence desktop and rapid approach.

*** The limits presented above do not take into account site-specific conditions.

Table 4.5: Generic water quality guidelines for Aquatic Ecosystems

WATER QUALITY GUIDELINES FOR AQUATIC ECOSYTEMS					
Variable	Units	Natural (Ideal)	Good (Acceptable)	Fair (Tolerable)	Poor (Unacceptable)
PHYSICAL REQUIREMENTS					
Temperature*#	°C	Depends on background (Upper boundary = 90th percentile; Lower boundary = 10th percentile); Good +2°C; Fair +4°C; Poor +>4°C			
Total Suspended Solids#*	mg/l	Depends on background (Not more than 10% of background)			
Dissolved Oxygen*	mg/l	>8	8-6	6-4	<4
Electrical Conductivity (EC)#*	mS/m	Depends on background (not more than 15% from normal cycles)			
pH *	units	8-6.5	9-8 or 6.5-5.75	10-9 or 5.75--5	>10; <5
Soluble Reactive Phosphates*	mg/l	<0.005	0.005 - 0.025	0.025 - 0.125	>0.125
Total Inorganic Nitrogen*	mg/l	<0.25	0.25-1	1-4	>4
Ammonia (NH3-N)*	mg/l	<0.015	0.015-0.058	0.058-0.1	>0.1
Fluoride	mg/l	<1.5	1.5-2	2-2.5	>2.5

Reference:

South African Water Quality Guidelines (DWAF, 2004)

* Ecological Reserve water quality benchmarks (2005)

4.2. Present day water quality and fitness for use

Doring Rangeland IUA

Water quality in Karee Dam was ideally suited for domestic water supply and it was, on average, ideal for irrigation water supply although the slightly elevated dissolved salts resulted in the water being categorised as acceptable for irrigation. Elevated nutrients place the water quality in tolerable for aquatic ecosystems.

Table 4.6: Summary water quality statistics and fitness for use the Doring Rangeland IUA

Doring Rangeland IUA (E4R001Q01)

Variables		Water quality statistics			Fitness for Use		
	Units	Median	75% tile	95% tile	Domestic	Irrigation	Aquatic Ecosystems
Ca	mg/l	16.30	22.35	33.25			
Cl	mg/l	12.28	15.24	22.44			
DMS	mg/l	148.94	205.76	297.09			
EC	mg/l	21.50	27.60	38.40			
F	mg/l	0.16	0.19	0.28			
K	mg/l	1.33	1.70	2.42			
NO3+NO2	mg/l	0.06	0.20	1.08			
Na	mg/l	10.37	12.96	18.75			
PO4-P	mg/l	0.03	0.04	0.10			
SO4	mg/l	8.70	13.02	24.09			
pH	mg/l	7.88	8.09	8.44			

Key		Ideal
		Acceptable
		Tolerable
		Unacceptable

Knersvlakte IUA

There was only one sampling point in the Knersvlakte (E3H002 – Hantams River at Brakke River) and only 7 samples were collected from 1990 – 1991. This is insufficient to draw any conclusions about water quality in the Knersvlakte. A once-off survey of quality along the Swart-Doring River in 2009 indicated high salinities along the length of the river surveyed.

Koue Bokkeveld IUA

Water quality in the Koue Bokkeveld is ideally suited for domestic and irrigation water use.The quality is however largely acceptable for aquatic ecosystems.

Table 4.7: Summary water quality statistics and fitness for use the Koue Bokkeveld IUA

Koue Bokkeveld IUA (E2H002)

Variables		Water quality statistics			Fitness for Use		
	Units	Median	75% tile	95% tile	Domestic	Irrigation	Aquatic Ecosystems
Ca	mg/l	3.28	4.48	7.89			
Cl	mg/l	17.17	22.55	32.76			
DMS	mg/l	46.12	57.23	89.90			
EC	mg/l	8.94	116400.00	16.60			
F	mg/l	0.10	0.13	0.17			
K	mg/l	0.83	1.21	2.06			
NO3+NO2	mg/l	0.05	0.10	0.28			
Na	mg/l	7.43	9.70	15.11			
PO4-P	mg/l	0.02	0.03	0.08			
SO4	mg/l	7.17	9.09	14.19			
pH	mg/l	7.11	7.43	7.86			
Key		Ideal					
		Acceptable					
		Tolerable					
		Unacceptable					

Lower Olifants IUA

Water quality in the Lower Olifants River is very poor as a result of natural high salinity run-off but is exsabated of irrigation return flows (Table 4.8). Almost all the constituents are elevated making the water largely unsuitable for domestic water supply and for irrigation water supply. The microbial water quality for *E. coli* indicates that the water is unacceptable for domestic water supply but acceptable for irrigation water supply. High nutrient concentrations also as a result of run off from cultivated lands have rendered the water pooly suited for aquatic ecosystems.

Table 4.8: Summary water quality statistics and fitness for use the Lower Olifants IUA

Lower Olifants IUA (E2H016)

Variables		Water quality statistics			Fitness for Use		
	Units	Median	75% tile	95% tile	Domestic	Irrigation	Aquatic Ecosystems
Ca	mg/l	94.37	116.48	136.80			
Cl	mg/l	777.33	1085.65	1430.13			
DMS	mg/l	2213.75	2973.60	3443.99			
EC	mg/l	337.00	427.00	581.00			
F	mg/l	0.79	0.99	1.06			
K	mg/l	9.67	12.77	17.94			
NO3+NO2	mg/l	0.09	0.27	0.56			
Na	mg/l	539.34	708.64	909.01			
PO4-P	mg/l	0.06	0.08	0.19			
SO4	mg/l	329.77	446.49	609.96			
pH	mg/l	8.20	8.31	8.47			
E. coli	Count/100ml	38.00	84.00	272.00			
Key		Ideal					
		Acceptable					
		Tolerable					
		Unacceptable					

Olifants Doring Dry land farming IUA

Two water quality monitoring sites were utilised within the IUA as the water quality in the upper reaches of Doring River is significantly different to that in the lower reaches. The water quality in the upper Doring River is ideal for domestic water use and for irrigation water use (Table 4.9). In the lower Doring River, the water quality is on average ideal but there are occasions when high elevated salt concentrations occur, such as during the dry summer months, which changes the fitness for use to acceptable or even tolerable classes (Table 4.10). During those times the water can also become unsuitable for irrigation purposes. The water quality in the upper and lower Doring River is largely acceptable for aquatic ecosystems.

Table 4.9: Summary water quality statistics and fitness for use the upper portion of the Olifants Doring Dry land Farming IUA

Upper Olifants Doring Dryland farming IUA (E2H002)

Variables		Water quality statistics			Fitness for Use		
	Units	Median	75% tile	95% tile	Domestic	Irrigation	Aquatic Ecosystems
Ca	mg/l	3.28	4.48	7.89			
Cl	mg/l	17.17	22.06	32.76			
DMS	mg/l	46.12	57.23	89.90			
EC	mg/l	8.94	11.64	16.60			
F	mg/l	0.10	0.13	0.17			
K	mg/l	0.83	1.21	2.06			
NO3+NO2	mg/l	0.05	0.10	0.28			
Na	mg/l	7.43	9.70	15.11			
PO4-P	mg/l	0.02	0.03	0.08			
SO4	mg/l	7.17	9.09	14.19			
pH	mg/l	7.11	7.43	7.86			
Key		Ideal					
		Acceptable					
		Tolerable					
		Unacceptable					

Table 4.10: Summary water quality statistics and fitness for use the lower portion of the Olifants Doring Dry land Farming IUA

Lower Olifants Doring Dryland farming IUA (E2H003)

Variables		Water quality statistics			Fitness for Use		
	Units	Median	75% tile	95% tile	Domestic	Irrigation	Aquatic Ecosystems
Ca	mg/l	9.10	12.76	38.32			
Cl	mg/l	52.57	82.73	272.07			
DMS	mg/l	143.06	207.72	807.39			
EC	mg/l	27.80	40.10	126.60			
F	mg/l	0.12	0.15	0.32			
K	mg/l	1.94	2.53	7.89			
NO3+NO2	mg/l	0.04	0.13	0.51			
Na	mg/l	27.26	42.45	191.43			
PO4-P	mg/l	0.02	0.03	0.10			
SO4	mg/l	17.00	23.44	96.48			
pH	mg/l	7.58	7.75	8.18			
Key		Ideal					
		Acceptable					
		Tolerable					
		Unacceptable					

Upper Olifants IUA

Water quality in the upper Olifants River is ideal for domestic and irrigation water use as well as for aquatic ecosystems (Table 4.11). However, the microbial water quality indicates that the water is unsuitable for domestic water supply unless it is disinfected (treated) but it is acceptable for irrigation water supply without treatment.

Table 4.11: Summary water quality statistics and fitness for use the Upper Olifants IUA

Upper Olifants IUA (E1H011)

Variables		Water quality statistics			Fitness for Use		
	Units	Median	75% tile	95% tile	Domestic	Irrigation	Aquatic Ecosystems
Ca	mg/l	2.49	3.09	4.64			
Cl	mg/l	19.80	24.91	30.82			
DMS	mg/l	48.91	61.22	77.20			
EC	mg/l	10.31	13.10	15.60			
F	mg/l	0.10	0.11	0.15			
K	mg/l	0.94	1.10	1.79			
NO3+NO2	mg/l	0.06	0.13	0.25			
Na	mg/l	9.62	12.24	15.25			
PO4-P	mg/l	0.02	0.02	0.05			
SO4	mg/l	4.76	6.55	8.62			
pH	mg/l	7.00	7.29	7.72			
E. coli	Count/100ml	5.00	19.00	172.00			
Key		Ideal					
		Acceptable					
		Tolerable					
		Unacceptable					

Sandveld IUA

The water quality data record in the Sandveld is poor and only a few samples have been collected in Verlorenvlei (Table 4.12). The few samples that have been collected indicated that the quality is mostly unacceptable for domestic water supply and for irrigation due to high salt concentrations. The water quality is also acceptable to tolerable for aquatic ecosystems as a result of elevated nutrients.

Table 4.12: Summary water quality statistics and fitness for use the Sandveld IUA

Sandveld IUA (VV4)

Variables		Water quality statistics			Fitness for Use		
	Units	Median	75% tile	95% tile	Domestic	Irrigation	Aquatic Ecosystems
Ca	mg/l	42.87	49.95	127.09			
Cl	mg/l	534.72	490.63	2358.90			
DMS	mg/l	1331.48	3105.68	4658.12			
EC	mg/l	244.00	289.00	1163.00			
F	mg/l	0.23	0.43	0.60			
K	mg/l	7.42	13.08	32.93			
NO3+NO2	mg/l	0.04	0.06	0.17			
Na	mg/l	303.75	417.06	1273.13			
PO4-P	mg/l	0.03	0.05	0.18			
SO4	mg/l	64.47	93.46	261.90			
pH	mg/l	7.56	8.07	8.32			
Key		Ideal					
		Acceptable					
		Tolerable					
		Unacceptable					

4.3. Implications of the Recommended Catchment Configuration

In the table below an evaluation was undertaken of any changes that may occur as a result of the recommended catchment configuration.

Table 4.13: Comparison of current fitness for use of the water quality in IUAs to the fitness of use for the recommended catchment configuration

Integrated Unit of Analysis	Overall Fitness for use (Present Status)			Recommended Resource Class
	Domestic	Irrigation	Aquatic Ecosystems	
1. Lower Olifants Irrigation				Class III
2 Upper Olifants				Class III
3 Olifants Doring Dryland farming				Class III
4 Doring Rangelands				Class I
5 Koue Bokkeveld				Class II
6. Knersvlakte	Unknown			Class I
7. Sandveld				Class III
Key		Ideal		
		Acceptable		
		Tolerable		
		Unacceptable		

From the table above it can be seen that the recommended catchment configuration is unlikely to impact on the current fitness for use of the water quality.

5. ECOLOGICAL IMPLICATIONS

5.1. The Recommended Ecological Categories

The Recommended Starter Catchment Configuration Scenario consisted largely of a combination of maintaining the Present Ecological Status and meeting the conservation requirements as indicated by FEPA. It was decided to proceed with configuration as the basis, however to increase the ecological category only for the incremental catchments where FEPA river and wetland areas had been identified. Table 5.1 indicates the percentage of the incremental catchment areas (or catchment areas for the tributaries within each quaternary catchment) that was identified as a river or wetland FEPA.

Table 5.1: Recommended Ecological Categories per Quaternary Catchment incorporating FEPA percentage of catchment areas

Quaternary	PES (2011)		FEPA (2011) % of Inc Quat Catch Area			Recommended Ecological Category	
	Main stem	Tributaries	% of catchment area = FEPA river	% of catchment area =Fish support	% of catchment area =FEPA wetland	Cumulative flow	INC (% of catchment area assigned to the category; Reserve verses FEPA)
E10A	C	C	0	98	0	C	C
E10B	B	C	21	77	0	C	C (80%); AB (20%)
E10C	B	B	97	2	1	C	AB (100%)
E10D	C	C	24	50	5	C	C (70%); AB (30%)
E10E	C	C	32	46	6	C	C (60%); AB (40%)
E10F	D	C	58	40	0	D	C (40%); AB (60%)
E10G	D	C	28	32	0	D	C (70%); AB (30%)
E10H	D	D	3	0	3	D	D (95%); AB (5%)
E10J	D	D	16	0	1	D	D (80%); AB (20%)
E10K	D	D	1	0	2	D	D (95%); AB (5%)
E21A	E	C	0	0	0	D	C
E21B	D	D	0	0	0	D	D
E21C	C	B	0	0	1	C	B
E21D	D	D	3	0	0	D	D (95%); AB (5%)
E21E	B	C	72	0	0	C	C (30%); AB (70%)
E21F	AB	C	2	0	0	C	C
E21G	D	D	1	1	0	D	D (95%); AB (5%)
E21H	AB	B	61	0	0	AB	B (40%); AB (60%)
E21J	AB	AB	98	0	0	AB	AB (100%)
E21K	B	B	100	0	2	B	AB (100%)
E21L	AB	AB	100	0	0	AB	AB (100%)
E22A	B	AB	0	0	0	B	AB
E22B	AB	AB	16	0	0	AB	AB (16%)
E22C	AB	B	1	0	0	AB	AB (5%)
E22D	B	AB	93	0	0	B	AB (95%)
E22E	B	AB	28	0	0	B	AB (30%)
E22F	B	B	99	0	0	B	AB (100%)
E22G	B	AB	98	1	0	C	AB (100%)
E23A	AB	AB	0	0	0	AB	AB
E23B	AB	AB	22	0	0	AB	AB (20%)

Table 5.1 *cont.*: Recommended Ecological Categories per Quaternary Catchment

Quaternary	PES (2011)		FEPA (2011) % of Inc Quat Catch Area			Recommended Ecological Category	
	Main stem	Tributaries	% of catchment area = FEPA river	% of catchment area =Fish support	% of catchment area =FEPA wetland	Cumulative flow	INC (% of catchment area assigned to the category; Reserve verses FEPA)
E23C	AB	AB	0	0	0	AB	AB
E23D	AB	AB	0	0	1	AB	AB
E23E	B	AB	22	0	0	B	AB (20%)
E23F	B	B	0	0	0	B	B
E23G	B	B	3	0	0	B	B (95%), AB (5%)
E23H	AB	AB	6	0	0	AB	AB (5%)
E23J	B	AB	39	0	0	B	AB (40%)
E23K	B	AB	16	12	0	B	AB (30%)
E24A	B	B	99	0	0	B	AB (100%)
E24B	B	B	45	15	0	B	B (50%); AB (50%)
E24C	C	B	0	0	1	C	B
E24D	C	B	0	0	0	C	B
E24E	AB	AB	1	0	0	AB	AB (5%)
E24F	B	AB	0	0	0	B	AB
E24G	B	AB	40	0	0	B	AB (40%)
E24H	B	AB	0	62	0	C	AB
E24J	B	AB	40	32	0	C	AB (70%)
E24K	AB	AB	2	16	0	C	AB (20%)
E24L	B	C	1	7	0	B	C (90%); AB (10%)
E24M	B	C	48	28	0	C	C (40%); AB (60%)
E31A	B	B	14	0	0	B	B (85%); AB (15%)
E31B	B	B	12	0	0	B	B (10%); AB (90%)
E31C	B	B	34	0	0	B	B (65%); AB (35%)
E31D	B	B	0	0	0	B	B
E31E	B	B	0	0	0	B	B
E31F	B	B	0	0	0	B	B
E31G	B	B	9	0	0	B	B (90%); AB (10%)
E31H	B	B	22	0	0	B	B (80%); AB (20%)
E32A	B	B	15	0	0	B	B (85%); AB (15%)
E32B	B	B	0	0	0	B	B
E32C	B	B	29	0	0	B	B (70%); AB (30%)
E32D	B	B	16	0	0	B	B (85%); AB (15%)
E32E	B	B	67	0	2	B	B (30%); AB (70%)
E33A	B	B	37	0	0	B	B (60%); AB (40%)
E33B	B	B	4	0	0	B	B (95%); AB (5%)
E33C	D	D	1	1	1	D	D (95%); AB (5%)
E33D	B	B	34	0	0	B	B (65%); AB (35%)
E33E	C	B	23	0	1	C	B (75%); AB (25%)
E33F	D	D	0	39	0	D	D
E33G	D	C	0	0	2	D	C
E33H	D	B	0	0	4	D	B (95%); AB (5%)
E40A	C	C	8	0	0	C	C (90%); AB (10%)

Table 5.1 *cont.*: Recommended Ecological Categories per Quaternary Catchment

Quaternary	PES (2011)		FEPA (2011) % of Inc Quat Catch Area			Recommended Ecological Category	
	Main stem	Tributaries	% of catchment area = FEPA river	% of catchment area =Fish support	% of catchment area =FEPA wetland	Cumulative flow	INC (% of catchment area assigned to the category; Reserve verses FEPA)
E40B	C	C	27	0	0	C	C (70%); AB (30%)
E40C	D	B	73	0	2	D	B (25%); AB (75%)
E40D	B	B	69	0	0	B	B (30%); AB (70%)
F60A	B	B	0	0	0	B	B
F60B	B	B	1	0	0	B	B
F60C	B	B	0	0	0	B	B
F60D	B	B	0	0	0	B	B
F60E	B	B	0	0	0	B	B
G30A	C	C	1	1	4	C	C (95%); AB (5%)
G30B	C	C	52	1	1	C	C (50%); AB (50%)
G30C	C	C	1	5	2	C	C (95%); AB (5%)
G30D	C	C	21	43	1	C	C (80%); AB (20%)
G30E	C	C	0	100	8	C	C (90%); AB (10%)
G30F	C	C	0	48	1	C	C
G30G	C	C	0	0	1	C	C
G30H	C	C	0	0	1	C	C

5.2. Ecological Goods, Services and Attributes identified within the WMA

The aquatic ecosystems of the Olifants Doorn WMA provide a number of Ecosystem Goods, Services and Attributes (EGSAs) that need to be identified and valued to determine the implications of the recommended ecological categories on the value that the freshwater systems provide to the WMA. Healthy ecosystems carry out a diverse array of processes that provide goods, services and attributes to humanity. Here, goods refer to items given monetary value in the marketplace, whereas services and attributes of ecosystems are valued, but are rarely bought or sold.

- Ecosystem "goods" include: Food; Construction materials; Medicinal plants; and to provision of water within the freshwater systems for basic human needs as well as for larger scale and commercial use.
- Ecosystem "services" include: Maintaining hydrological cycles; Regulating climate and flow; and Cleansing water.
- Ecosystem “attributes” include: Providing beauty, inspiration, and recreation

Table 5.3 provides a brief description of the main types of EGSA identified within the WMA.

Table 5.3: Description of EGSA types identified in the WMA

EGSA type	Description
Water yield	Provision of water for commercial use through bulk water supply systems such as large instream dams
Water use	Provision of water for basic human needs – raw water supply from the aquatic ecosystem to communities
Water adsorption/regulation	Absorption of wet season flows and provision of dry season flows for agricultural, industrial and household use (spatially and temporally)
Waste disposal	Breaking downs of waste. Dilution and transport of pollutants

Protected areas	Areas recognised for biodiversity conservation purposes
Recreation and tourism	Areas recognised for fishing, river rafting, hiking, swimming, aesthetic value, property value
Cultural, educational, spiritual	Specific use a water features for religious purposes such as baptisms
Geomorphic features	Areas of specific aesthetic value due to geomorphic structure such as gorges or waterfalls
Fish sanctuary	Areas recognised for the conservation of endemic fish species
FEPA wetlands	Wetland areas protected from a biodiversity conservation point of view
Food	Subsistence or commercial level use of fish and plants
Carbon sequestration	Net storage or loss of carbon that takes place as a result of long term increase/decrease in biomass
Erosion control	Prevention of sedimentation and erosion due to healthy wetland and riparian areas
Raw materials	Use of reeds and wood for crafts, construction, fodder, etc.
Mining	Use of river sand and stones for construction purposes
Estuarine EGSA	Nursery for marine fish, breeding area for marine fish, estuarine fisheries

The following EGSAs have been identified within the WMA:

Table 5.2: Ecological Goods, Services and Attributes provided by the aquatic ecosystems in each quaternary catchment

Quaternary	Ecological Goods, Services and Attributes
E10A	Water yield - Witzenburg, protected areas (terrestrial) - Gr Winterhoek, Visgat Natural Heritage Site, Fish sanctuary (Clanwilliam sawfin, C. yellowfish, Spotted rock catfish, Cape galaxias)
E10B	Protected areas (terrestrial) - Gr Winterhoek, Fish sanctuary (Clanwilliam sawfin, C. yellowfish, Spotted rock catfish, Cape galaxias), water yield
E10C	Protected areas (terrestrial) - Gr Winterhoek, Tourism & recreation (geomorphic feature) - Olifants Gorge & Ratel River, Fish sanctuary (Clanwilliam sawfin, C. yellowfish, Spotted rock catfish, Fiery redfin, Clanwilliam redfin), FEPA wetlands, water use
E10D	Water yield, Fish sanctuary (Clanwilliam sawfin, C. yellowfish, C. sandfish, C. rock catfish, Spotted rock catfish, Fiery redfin, Clanwilliam redfin, Cape galaxias), FEPA wetlands
E10E	Water yield - Citrusdal, waste adsorption, protected areas (terrestrial), Fish migration route, FEPA wetlands
E10F	Protected areas (terrestrial), Fish sanctuary (Clanwilliam sandfish, C. rock catfish, Spotted rock catfish), FEPA wetlands, water use
E10G	Protected areas (terrestrial) - Rondegat, Fish sanctuary (Clanwilliam sawfin, C. yellowfish, Spotted rock catfish, Fiery redfin, Clanwilliam redfin, Cape galaxias), Water Yield - Clanwilliam Dam, FEPA wetlands
E10H	Protected areas (terrestrial), Fish sanctuary (Clanwilliam sawfin, C. yellowfish, Spotted rock catfish, Fiery redfin, Clanwilliam redfin, Cape galaxias), water yield - Jan Dissels, FEPA wetlands
E10J	Protected areas (terrestrial) - Clanwilliam, Fish migration, Waste adsorption, FEPA wetlands, water yield
E10K	Water yield - Bulshoek Dam, FEPA wetlands, Recreation and Tourism - Cascades
E21A	Protected areas (terrestrial) - Koue Bokkeveld Mnt Catchment, Water yield (Koue Bokkeveld)
E21B	Protected areas (terrestrial)- Koue Bokkeveld Mnt Catchment, Water yield (Koue Bokkeveld)
E21C	Protected areas (terrestrial)- Koue Bokkeveld Mnt Catchment, water yield (Koue Bokkeveld), FEPA wetlands
E21D	Protected areas (terrestrial)- Koue Bokkeveld Mnt Catchment, Water yield (Koue Bokkeveld)
E21E	Protected areas (terrestrial)- Koue Bokkeveld Mnt Catchment, Water yield (Koue Bokkeveld)
E21F	Protected areas (terrestrial), water use
E21G	Water yield (Koue Bokkeveld), Fish sanctuary (Twee River redfin), Protected areas (terrestrial) - Koue Bokkeveld Mnt Catchment
E21H	Protected areas (terrestrial), Fish sanctuary (Twee River redfin), Water yield, Tourism & recreation (geomorphic feature) - Waterfalls Twee and Middeldeur rivers
E21J	Tourism & recreation (geomorphic feature) - Groot River Gorge, water yield
E21K	Tourism & recreation, Protected areas (terrestrial) - Matjiesriver Reserve and wetland area, Cederberg, water yield
E21L	Water yield
E22A - E22D	Water use
E22E & E22F	Water use
E22G	Water use, fish migration
E23A - E23D	FEPA wetlands
E23E	Water use
E23F	Protected areas (terrestrial) - Tankwa, Water yield - Oudebaaskraal Dam

Table 5.2 *(cont.)*: Ecological Goods, Services and Attributes provided by the aquatic ecosystems in each quaternary catchment

Quaternary	Ecological Goods, Services and Attributes
E23G - E23J	Water use
E23K	Protected areas (terrestrial) - Tankwa, water yield - Elands Karoo
E24A	Protected areas (terrestrial) - Cederberg, FEPA wetlands
E24B	Water use - Wuppertal, Tourism and recreation, waste adsorption
E24C	water use, FEPA wetlands
E24D	Protected areas (terrestrial) - Tankwa, water use
E24E - E24G	Water use
E24H	Water yield - Elands Karoo, Tourism and recreation - Doring Gorge
E24J	Protected areas (terrestrial) - Cederberg, Tourism and recreation - Doring Gorge and Biedouw Gorge, waterfall & Valley, water use, Fish sanctuary (Clanwilliam sawfin, C. yellowfish, C. redfin, Spotted rock catfish, C. rock catfish, Cape galaxias)
E24K	Tourism & recreation (river rafting) - Doring Gorge, water use
E24L	Protected areas (terrestrial) - Brandewyn, tourism and recreation (Doring River), water yield
E24M	Tourism & recreation (Doring river rafting), water use, fish migration
E31A - E31C	FEPA wetlands, water use
E31D - E31H	Water use
E32A	FEPA wetlands, water use
E32B	FEPA wetlands, water use
E32C - E32D	FEPA wetlands, water use
E32E	Tourism & recreation (geomorphic feature) - Niewoudtsville waterfall, water use
E33A - E33B	Water use, FEPA wetlands
E33C - E33D	Water use, FEPA wetlands
E33E	Water use, FEPA wetlands, sand mining - Sout and Hol rivers
E33F	Tourism and recreation - waterfall Troe-Troe River, Vanrhynsdorp, waste adsorption, water yield
E33G	Vredendal and Klawer - water adsorption, water yield, FEPA wetlands
E33H	Estuarine EGSA (fish consumption, nursery area), FEPA wetlands, Lutzville, waste adsorption, water yield, sand mining
E40A - E40B	Calvinia, water yield and waste adsorption
E40C	Tourism & recreation (geomorphic feature), Protected area (terrestrial), FEPA wetlands, Niewoudtsville - water yield and waste adsorption, Fish sanctuary (Clanwilliam sawfin, C. yellowfish, Spotted rock catfish, Chubby head barb)
E40D	Tourism & recreation (geomorphic feature) - Oorlogskloof Nature Reserve (waterfall) and Kobee River Gorge, water use, Fish sanctuary (Clanwilliam sawfin, C. yellowfish, Spotted rock catfish)
F60A - F60D	water use, mining, Bitterfontein & Nuwerus
G30A	Protected area - Rocherpan, FEPA wetlands, water use
G30B	Water yield, FEPA wetlands
G30C	Water yield, FEPA wetlands
G30D	Water yield, FEPA wetlands, Fish sanctuary (Verlorenvlei redfin, Cape kurper)
G30E	Verlorenvlei estuary/wetland - FEPA wetlands, Fish sanctuary (Verlorenvlei redfin, Cape kurper)
G30F	FEPA wetlands, water use, Fish sanctuary (Verlorenvlei redfin, Cape kurper)
G30G - G30H	FEPA wetlands, water use

5.3. Significance of EGSAs

This section consists of an assessment of the significance of each of the EGSA identified in the previous section in order to inform the consideration of the ecological, economic and social implications of the recommended ecological categories. The table below lists each of the different EGSA identified in Table 5.2 above and provides an analysis of the significance of each of these EGSA types.

Table 5.3: Significance of EGSA types identified in the WMA

EGSA type	Significance	Score
Water yield	The dominant water user in the WMA (95%) is agriculture. This aspect is thus dealt with in detail through the economic assessment (Section 7 of this report).	High
Water use	Very few people in the Olifants/Doring catchment depend on collecting water from rivers or boreholes for their domestic water supplies, with the vast majority having piped water to their dwellings. This is reflected in the socio-economic assessment (Section 8 of this report).	Low
Water adsorption/ regulation	There are important wetland areas throughout the WMA that provide an important function to the downstream catchment of adsorbing winter run off and slowly releasing the water during the low flow period.	Medium to high
Waste disposal	There are very few wastewater discharges to the aquatic ecosystems in the WMA – these occur in the built-up urbanised areas such as Citrusdal and Vredendal. The 'benefit' of utilising aquatic ecosystems for the treatment of waste should not be a key driver in the classification of water resources but should rather the treatment and disposal of wastewater should be dealt with through point source control measures. The lower Olifants River however is known for its poorer water quality during the low flow period as a result of irrigation return flows. It is important that the catchment management strategy and RQOs for the lower Olifants River address this issue.	Medium
Protected areas	The Olifants Doorn WMA and its freshwater features are well known for their conservation value. This EGSA was considered significant in the selection of the recommended ecological categories and has been incorporated into the recommended catchment configuration.	High
Recreation and tourism	The Olifants Doorn WMA and its freshwater features are also well known for their tourism value. This relates mostly to terrestrial aspects such as the flowing of indigenous plants but also relates to amenities associated with freshwater such as Clanwilliam and Bulshoek dams. The Doring River is also known for white water rafting and kayaking.	High
Cultural, educational, spiritual	There is not known to be any significance use of the freshwater ecosystems in the WMA for religious ceremonies.	Low
Geomorphic features	There are a number of geomorphic features within the WMA such as Niewoudtsville Waterfall, Oorlogskloof and the Olifants River Gorge.	Medium to high
Fish sanctuary	The number of endemic fish species that occur within the WMA is significant.	High
FEPA wetlands	The presence of FEPA wetland areas throughout the WMA is also considered to be significantly important.	High
Food	The only significant use of food obtained from the aquatic ecosystems is in the estuary at Ebenhaeser.	Medium
Raw materials	Only small scale use of raw materials associated with aquatic ecosystems takes place.	Low
Mining	Sand, stone and diamond mining along river channels is only known to occur in the drier areas such as in the Knersvlakte and near the Olifants River estuary. The significance of this activity is however considered to be relatively small.	Low
Estuarine EGSA	The estuary as one of only four permanently open estuaries that occur along the west coast of South Africa. The estuary thus has a particularly important role to play as a nursery and refuge area of estuarine and marine fish species. The estuary is also an important area in terms of its recreational, commercial and subsistence level fishing	High

5.4. Implications of Recommended Ecological Categories for identified EGSAs

The implications of the Recommended Ecological Categories for the identified EGSA are indicated in the table below. Particular attention is given to those areas/aspects where the EGSAs have been scored as high.

Table 5.4: Description of the possible implications of the Recommended Ecological Categories on the EGSAs

EGSA type	Score	Implication of Recommended Ecological Categories
Water yield	High	Implications are considered further in terms of water use change and the socio-economic implications
Water use	Low	Subsistence level water use is small to negligible. Proposed ecological categories are unlikely to have any impact on this EGSA.
Water adsorption/ regulation	Medium to high	All key wetland areas are included in the FEPA wetland areas that have been identified and are thus addressed in the recommended ecological categories through the FEPA wetlands.
Waste disposal	Medium	Wastewater discharges should be managed as point sources in the catchment management strategy. Maintenance of the low flow in the Olifants River, as well as the wetland areas upstream of the estuary forms part of the recommended ecological categories and should be included in the catchment management strategy and RQOs for the lower Olifants River address this issue.
Protected areas	High	These areas have been included as part of the FEPA input into the recommended ecological categories.
Recreation and tourism	High	Property values, recreational activities and fishing associated with the large instream dams in not likely to be altered by the recommended ecological categories. River rafting and kayaking in the Doring River should not be impacted by the recommended ecological categories as the recommendation is that thereis no further abstraction of low flows from the Doring River systems not large instream dams built within the lower Doring River.
Cultural, educational, spiritual	Low	Religious use of the aquatic ecosystems is small to negligible. Proposed ecological categories are unlikely to have any impact on this EGSA.
Geomorphic features	Medium to high	These features have been included in the mapping of FEPA rivers and were taken into consideration in the selection of the recommended ecological categories.
Fish sanctuary	High	The fish sanctuaries as identified in the FEPA mapping have been included in the selection of the recommended ecological categories.
FEPA wetlands	High	This aspect has been included in the selection of the recommended ecological categories.
Food	Medium	This aspect is addressed in the Estuarine EGSAs.
Raw materials	Low	The use of raw materials from aquatic ecosystems in the WMA is small to negligible. Proposed ecological categories are unlikely to have any impact on this EGSA.
Mining	Low	The mining activities are unlikely to be influenced by the proposed ecological categories.
Estuarine EGSA	High	The proposed ecological category for the Olifants and Verlorenvlei Estuaries are C categories as have been recommended by the ecological Reserve determination that have been undertaken for the estuaries. The determination of the Olifants Estuary was undertaken at an intermediate level and socio-economic considerations were taken into account during the study. The outcomes are discussed further in Section 7. It is however clear that achieving the EWR for the Olifants Estuary cannot be achieved through meeting the EWRs for the entire river systems alone. It is also essential that the recommendation that formed part of the estuarine Reserve recommendations also form part of the special conditions that must be adhered to within this WMA, that is, that no large instream dams or weirs should be built in the lower Doring River. It is also essential for all the rivers in the WMA, that there be no further (or new) run of river abstraction during the low flow period.

6. GROUNDWATER IMPLICATIONS

This section of the report addresses the classification of groundwater resources and the consideration of the implications of the recommended catchment configuration on groundwater availability. A lot of spatial variability exists with regard to groundwater especially as for 78% of the WMA the groundwater occurs within a fractured rock aquifer setting. However this variability is lost to a degree as the groundwater classification is per Quaternary Catchment. It is acknowledged that the groundwater flow is controlled to a large extent by the geological and hydrogeological conditions and not by the surface topography. Quaternary Catchments are defined according to topographical variation and features. Nonetheless the analysis has been completed on a Quaternary Catchment basis as this facilitates and simplifies the integration of the classification process with the other disciplines.

6.1. Methodology

The basis used for the groundwater classification was to calculate the groundwater stress index. The groundwater stress index takes into account groundwater abstraction and groundwater recharge (i.e. abstraction/recharge). Table 6.1 lists the groundwater stress index classes and then also the linkage to Present Status Category).

Table 6.1: Groundwater stress index classes

Stress Index (abstraction / recharge)	Description	Present Status Category (PES)
< 0.05	Unstressed or low levels of stress	A
0.05 – 0.20		B
0.20 – 0.40	Moderate levels of stress	C
0.40 – 0.65		D
0.65 – 0.95	Stressed	E
> 0.95	Critically stressed	F

The groundwater recharge values were obtained from the Groundwater Resources Assessment Phase II project (GRAII) per Quaternary Catchment. The groundwater abstraction values were also obtained from the GRAII project work. Once a surface water resource PES has been assigned to each resource unit, then the groundwater resource category was determined.

In addition to the groundwater resource categories, the following data/information was generated per Quaternary catchment: Desired Water Resource Category; management class; total amount of groundwater recharge occurring annually; volume of groundwater abstracted annually per sector; groundwater balance ; groundwater stress index; surface water Ecological Water Requirements (EWR) low flow requirement; volume of groundwater remaining for allocation; if a Groundwater Reserve has been calculated; aquifer type and yield for the catchment; groundwater quality for the catchment; geological setting of the catchment; risk to groundwater; assumptions and constraints; levels of confidence associated with the classification; implications of using more/less water; groundwater “hot spots”; and relevant previous work.

6.2. Results

The summary of the data and information associated with the groundwater categories is included in Tables 6.3 and 6.4 for each quaternary catchment. It is acknowledged that the approach with regard to groundwater classification is somewhat subjective however the GRDM process has been followed. Due to the fact that the "Groundwater Stress Index" does not take into account environmental requirements, the surface water EWR low flow requirements for the recommended catchment configuration were taken into account in the groundwater balance. Thus for each quaternary catchment the additional groundwater available for use (i.e. for allocation) was calculated by using the following equation (all units in Mm^3/a):

Groundwater available for use = Recharge – (Total Use + surface EWR water low flow requirement)

Those quaternary catchments where groundwater availability is already in a deficit (after taking surface water EWR low flow into account) are listed in Table 6.2 in ascending order:

Table 6.2: Groundwater deficits after taking surface water EWR low flow into account) in ascending order

Quaternary Catchment	Gwater available for use (-ve = a deficit (Mm^3/a))
E21H	-7.37
E21G	-4.53
E32E	-2.7
E32B	-2.56
G30F	-1.28
E23F	-1.15
E24G	-1.04
E23K	-0.59
E24E	-0.37
E22G	-0.29
E24H	-0.27
E23J	-0.25
E24K	-0.08
E31C	-0.08
E31G	-0.07
E33A	-0.06
E31D	-0.05
E31H	-0.04
E31E	-0.03
E31F	-0.03

Of the 88 quaternary catchments in the Olifants Doorn WMA there are 20 catchments that are considered to have insufficient groundwater to be available to meet the surface water EWR low flow requirements. This should be taken into account when considering groundwater use license applications. However it is very important that temporal variability with regard to climatic conditions and spatial variability with regard to geohydrological settings are carefully considered as part of the groundwater use license applications.

Table 6.3: Groundwater categories and availability for use summary per quaternary catchment

Quaternary Catchment	Present Category	Desired Status category	Management Class	Area (km2)	Recharge (Mm3/a)	Total Usage (Mm3/a)	Water Balance (Mm3/a)	SW EWR Low Flow (Mm3/a)	GW Available for use (Mm3/a)	GW Avail For Use
E10A	B	B	Good	134	17.5895	3.452	14.138	5.44	8.70	Adequate
E10B	B	B	Good	202	20.6085	3.729	16.880	6.78	10.10	Adequate
E10C	A	A	Excellent	192	14.3015	0.343	13.959	5.66	8.30	Adequate
E10D	C	B	Fair	235	13.6855	3.576	10.110	5.74	4.37	Adequate
E10E	A	A	Excellent	366	14.6810	0.270	14.411	7.35	7.06	Adequate
E10F	C	B	Good	386	14.6025	4.896	9.707	5.13	4.58	Adequate
E10G	A	A	Excellent	508	19.3352	0.104	19.231	4.21	15.02	Adequate
E10H	B	A	Excellent	162	9.0796	1.037	8.043	1.51	6.53	Minimal
E10J	C	C	Fair	468	8.7380	1.946	6.792	1.63	5.16	Adequate
E10K	A	A	Excellent	235	2.1529	0.095	2.058	0.36	1.70	Minimal
E21A	D	C	Fair	190	10.7001	5.359	5.341	1.48	3.86	Adequate
E21B	B	B	Good	223	7.7935	1.348	6.446	0.012	6.43	Minimal
E21C	B	B	Good	233	7.1742	1.256	5.918	0.07	5.85	Minimal
E21D	D	C	Fair	242	13.7246	7.387	6.338	1.884	4.45	Adequate
E21E	D	C	Fair	293	6.1869	2.690	3.497	0.09	3.41	Adequate
E21F	B	B	Good	379	5.0851	0.544	4.542	0.15	4.39	Minimal
E21G	F	D	Fair	266	9.6261	12.088	-2.462	2.07	-4.53	None
E21H	F	D	Fair	404	11.8491	2.561	9.288	16.656	-7.37	None
E21J	A	A	Excellent	317	5.5000	0.006	5.494	0.321	5.17	Adequate
E21K	B	A	Excellent	330	6.3447	0.400	5.944	0.184	5.76	Adequate
E21L	A	A	Excellent	195	0.5102	0.004	0.507	0.14	0.37	Minimal
E22A	A	A	Excellent	750	3.5276	0.030	3.498	0.39	3.11	Minimal
E22B	A	A	Excellent	638	2.6987	0.022	2.677	0.432	2.24	Minimal
E22C	A	A	Excellent	490	3.8245	0.209	3.615	0.332	3.28	Minimal
E22D	A	A	Excellent	496	1.0380	0.017	1.021	0.26	0.76	Minimal
E22E	A	A	Excellent	1013	2.2736	0.120	2.154	1.78	0.37	Minimal
E22F	A	A	Excellent	400	0.4846	0.012	0.473	0.21	0.26	Adequate
E22G	F	D	Fair	367	0.1410	0.004	0.137	0.43	-0.29	None
E23A	A	A	Excellent	762	6.0995	0.059	6.041	1.048	4.99	Adequate
E23B	A	A	Excellent	705	4.2650	0.000	4.265	0.97	3.30	Adequate
E23C	A	A	Excellent	318	1.8446	0.000	1.844	0.437	1.41	Minimal
E23D	A	A	Excellent	750	3.2592	0.052	3.208	1.031	2.18	Minimal
E23E	B	A	Excellent	564	4.5617	0.339	4.223	0.604	3.62	Minimal
E23F	F	D	Fair	473	0.4311	1.071	-0.640	0.506	-1.15	None
E23G	A	A	Excellent	747	1.7226	0.027	1.696	0.8	0.90	Minimal
E23H	A	A	Excellent	660	2.9601	0.023	2.937	0.907	2.03	Minimal
E23J	F	D	Fair	895	0.7403	0.031	0.709	0.958	-0.25	None
E23K	B	D	Fair	572	0.0199	0.003	0.017	0.612	-0.59	None
E24A	A	A	Excellent	255	4.8767	0.046	4.831	0.468	4.36	Adequate
E24B	A	A	Excellent	468	2.6930	0.061	2.632	0.857	1.77	Minimal
E24C	B	A	Excellent	784	2.5331	0.243	2.290	0.75	1.54	Adequate
E24D	A	A	Excellent	997	1.6650	0.000	1.665	0.96	0.71	Adequate
E24E	A	A	Excellent	671	1.2469	0.039	1.208	1.576	-0.37	None
E24F	A	A	Excellent	582	1.7163	0.004	1.712	1.07	0.64	Adequate
E24G	A	A	Excellent	633	0.1209	0.000	0.121	1.16	-1.04	None
E24H	A	A	Excellent	483	0.3017	0.008	0.294	0.56	-0.27	None
E24J	C	B	Good	1078	5.7537	1.456	4.298	1.24	3.06	Adequate
E24K	A	A	Excellent	652	0.6656	0.000	0.666	0.75	-0.08	None
E24L	C	B	Good	516	6.6738	2.430	4.244	1.014	3.23	Adequate
E24M	A	A	Excellent	529	2.7315	0.004	2.728	0.71	2.02	Minimal
E31A	A	A	Excellent	2865	0.0233	0.000	0.023	0.021	0.00	None
E31B	A	A	Excellent	1476	0.6397	0.000	0.640	0.088	0.55	Minimal
E31C	A	A	Excellent	1572	0.0117	0.000	0.012	0.093	-0.08	None
E31D	A	A	Excellent	839	0.0001	0.000	0.000	0.049	-0.05	None
E31E	A	A	Excellent	478	0.0001	0.000	0.000	0.029	-0.03	None
E31F	A	A	Excellent	525	0.0006	0.000	0.001	0.029	-0.03	None

Table 6.3 (*cont.*): Groundwater categories and availability for use summary per quaternary catchment

Quaternary Catchment	Present Category	Desired Status category	Management Class	Area (km2)	Recharge (Mm3/a)	Total Usage (Mm3/a)	Water Balance (Mm3/a)	SW EWR Low Flow (Mm3/a)	GW Available for use (Mm3/a)	GW Avail For Use
E31G	A	A	Excellent	1238	0.0039	0.003	0.001	0.073	-0.07	None
E31H	F	D	Fair	726	0.0046	0.001	0.003	0.043	-0.04	None
E32A	A	A	Excellent	1118	4.2423	2.159	2.083	0.401	1.68	Adequate
E32B	F	D	Fair	828	1.1174	3.377	-2.260	0.297	-2.56	None
E32C	A	A	Excellent	638	1.9643	0.000	1.964	0.228	1.74	Minimal
E32D	A	A	Excellent	616	0.3491	0.000	0.349	0.22	0.13	Minimal
E32E	F	D	Fair	1001	1.2983	3.636	-2.338	0.358	-2.70	None
E33A	A	A	Excellent	1355	0.0580	0.033	0.025	0.083	-0.06	None
E33B	A	A	Excellent	702	0.0844	0.021	0.064	0.062	0.00	None
E33C	A	A	Excellent	980	1.5792	0.027	1.552	0	1.55	Adequate
E33D	C	B	Good	1559	0.2322	0.049	0.184	0.138	0.05	Minimal
E33E	C	B	Good	1282	0.5992	0.169	0.430	0.06	0.37	Adequate
E33F	A	A	Excellent	725	3.5663	0.073	3.493	0.05	3.44	None
E33G	D	C	Fair	894	2.2859	1.302	0.984	0	0.98	Adequate
E33H	B	A	Excellent	719	0.7588	0.044	0.715	0.01	0.71	Minimal
E40A	C	B	Good	941	4.6549	1.722	2.933	0.9	2.03	Adequate
E40B	C	B	Good	707	3.4478	0.933	2.515	0.68	1.84	Adequate
E40C	A	A	Excellent	530	2.8450	0.094	2.751	0.11	2.64	Adequate
E40D	A	A	Excellent	544	2.4849	0.002	2.483	0.996	1.49	Minimal
F60A	A	A	Excellent	572	0.4399	0.009	0.431	0.02	0.41	None
F60B	B	A	Excellent	320	0.4776	0.045	0.433	0.018	0.42	Minimal
F60C	A	A	Excellent	622	0.9391	0.023	0.916	0.039	0.88	Minimal
F60D	A	A	Excellent	481	0.4966	0.016	0.480	0.032	0.45	Minimal
F60E	A	A	Excellent	795	0.7100	0.027	0.683	0.005	0.68	Minimal
G30A	C	B	Good	761	10.7313	2.769	7.962	0.82	7.14	Adequate
G30B	A	A	Excellent	658	15.6200	0.490	15.130	1.49	13.64	Adequate
G30C	C	C	Good	351	8.4800	2.780	5.700	1.98	3.72	Adequate
G30D	C	B	Good	534	12.3800	4.000	8.380	1.27	7.11	Adequate
G30E	D	C	Fair	352	4.4500	2.900	1.550	0.6	0.95	Minimal
G30F	F	D	Fair	780	13.8000	14.030	-0.230	1.049	-1.28	None
G30G	D	C	Fair	647	11.0600	6.740	4.320	0.413	3.91	Adequate
G30H	A	A	Excellent	1077	4.5224	0.035	4.487	0.589	3.90	Minimal

Table 6.4: Summary table of groundwater risk, assumptions, implications and 'hot spots'

QUAT	GW Risk	Assumptions	Confi-dence	Implications	HotSpot Discussion
E10A	In central southern portion of catchment intensive agriculture - poss. non-point source contamination risk. Gwater plays an important role is providing baseflow. CSIR studied the area intensively using isotopes.	Most of the agricultural activity is irrigated from groundwater.	low	Groundwater monitoring network necessary	In summer groundwater levels are drawn down significantly, however these recover each winter.
E10B	In the north-eastern portion of the catchment there is intensive agriculture, mainly fruit.	Most of the agricultural activity is irrigated from groundwater.	low	Groundwater monitoring network necessary	The boreholes in this area are typically very high yielding and the groundwater quality is excellent. Monitoring data in the area does not show any signs of significant impact on groundwater resources.
E10C	A pristine catchment - no agricultural activity.	Groundwater is a completely natural unimpacted state	low	No monitoring required - unless for regional purposes	No hot spots
E10D	Also a mountainous catchment, however intense agriculture in the western portion (along the north/south valley). Thus non-point source contamination risk.	Most of the agricultural activity is irrigated from groundwater.	low		Further work will be required to assess the status of groundwater monitoring in the area. However the groundwater contribution to base flow is very important and agricultural activities must not impact this contribution.
E10E	Citrusdal is within this catchment. Groundwater is used in summer however the bulk of the irrigation water is from the Olifants R. Groundwater is at risk from non-point source contamination sources.	Most of the agricultural activity is irrigated from the Olifants River.	low	The catchment becomes quite water stressed in summer. A groundwater monitoring network is necessary.	No known hot spots of over-abstraction.
E10F	Mainly a mountainous catchment - however intense agriculture along the Olifants River. Surface water and groundwater is used intensively.	There is significant groundwater abstraction.	low	The catchment has a PES of C and this needs to be managed to a B, as groundwater plays a crucial role in supplying base flow to the Olifants River. This contribution is crucial in summer.	No known hot spots of over-abstraction, however this catchment needs to be carefully monitored, as it is important. If a monitoring network is not in place - one needs to be installed. Groundwater allocations need to be adhered to or even revised.
E10G	The risk is minimal of groundwater being impacted. The Clanwilliam Dam is within this catchment. This is a rugged and mountainous catchment.	Very little groundwater use. Water is obtained from the Clanwilliam Dam.	low	No major concerns regarding groundwater in this catchment.	No hot spots
E10H	Very rugged catchment - very little groundwater use The use given here may be an over-estimation.	Very little groundwater used and this catchment needs to be kept as natural as possible.	low	The class of the catchment needs to be improved to an A.	No known hot spots.
E10J	Groundwater is used extensively in this catchment. It is at risk from over-abstraction and non-point source contamination. Clanwilliam is within this catchment.	The groundwater use needs to be carefully monitored within this catchment.	low	This catchment needs to be carefully monitored.	No known hot spots of over-abstraction, however this catchment needs to be carefully monitored, as it is important. If a monitoring network is not in place - one needs to be installed. Groundwater allocations need to be adhered to or even revised.
E10K	There is more agriculture in this catchment than the groundwater abstraction data suggests.	The Olifants River is within the catchment and the assumption is that the bulk of the irrigation water is from the river.	low	Groundwater most likley has a significant role to play in the summer months.	No known hot spots of over-abstraction are known.
E21A	There is a lot of agriculture in this catchment (above the Gydo Pass). Groundwater levels are shallow and at risk from non-point based contamination.	Groundwater abstraction is high in the summer months	medium	The TMG aquifers in this catchments are high yielding and of excellent quality	From monitoring work in the area, the groundwater resources are not being impacted by agricultural activity. However the classification of the catchment needs to be improved. A few dedicated monitoring sites are necessary as the PES is a D. The volumes of groundwater being abstracted also need to be verified and if necessary allocations adjusted.

Table 6.4 *(cont.)*: Summary table of groundwater risk, assumptions, implications and 'hot spots'

QUAT	GW Risk	Assumptions	Confi-dence	Implications	HotSpot Discussion
E21B	Agricultural activtity is limited in this rugged catchment. Best practices must be followed in the agricultural sector - as groundwater levels are shallow / artesian in places and can easily be impacted.	Groundwater use is limited	medium	Groundwater is limited in this large catchment however land owner monitoring should be encouraged.	Monitoring records indicate no over-abstraction areas - aquifers are high yielding and very good quality.
E21C	Agricultural activtity is limited in this rugged catchment. Best practices must be followed in the agricultural sector - as groundwater levels are shallow in places and can easily be impacted.	Groundwater use is limited	medium	Groundwater is limited in this large catchment however land owner monitoring should be encouraged.	Monitoring records indicate no over-abstraction areas - aquifers are high yielding and very good quality.
E21D	There is a lot of agricultural activity within this catchment (>50%). There are also a lot of shallow surface water dams however groundwater is used extensively in summer. The groundwater is generally shallow and the risk with be from non-point source contamination.	Extensive groundwater use in summer	medium	Generally the TMG aquifers are high yielding and good quality. However there should be monitoring by the land owners to ensure sustainable groundwater use. Some DWA monitoring within the catchment will be good to have.	There are no known hot spots as the groundwater levels recover each year and the water quality remains good.
E21E	Agricultural activity is limited to the river valley - with the large dams within the catchment, the groundwater use figure may be an over-estimate otherwise there is extensive use of groundwater in summer. Groundwater will be at risk to non-point source contamination.	Extensive groundwater use in summer	medium	As the class of this catchment is to be improved land owners and DWA need to monitor.	There are no known hot spots as the groundwater levels recover each year and the water quality remains good.
E21F	There is very little agricultural activity in this catchment. It should probably be an A class catchment. No risk to groundwater.	Groundwater contributes significantly to river base flow.	medium	Some further consultation is required but this is probably an A class aquifer.	No hot spots.
E21G	There is extensive agriculture in this catchment. Indications are the groundwater is not being used sustainably. Water levels are likley to be dropping and groundwater quality deteriorating. Groundwater supply at risk.	Groundwater use exceeds recharge and levels are dropping.	medium	Groundwater use needs to be assessed with a hydrocensus and a monitoring network established. It will be necessary to introduce compulsory licensing if the groundwater use is not sustainable after the land owners are informed of the situation.	Likely to be several hot spots - where groundwater levels are dropping and possibly water quality deteriorating.
E21H	Agriculture is limited - groundwater contribution to baseflow important. Groundwater quality could be impacted through agricultural activities.	Groundwater is shallow and contributes to baseflow.	medium	This class of the catchment can be imporved a level.	Unlikely.
E21J	None	Essentially no groundwater use in the catchment.	medium	Groundwater will provide baseflow.	None
E21K	Groundwater use is very low and this is very close to Class A	Essentially no groundwater use in the catchment.	medium	Groundwater will provide baseflow.	None
E21L	None	Essentially no groundwater use in the catchment.	low	Groundwater will provide baseflow.	None
E22A	None	Essentially no groundwater use in the catchment.	low	Groundwater will provide some baseflow.	None
E22B	None	Essentially no groundwater use in the catchment.	low	Groundwater will provide some baseflow.	None
E22C	None	Essentially no groundwater use in the catchment.	medium	Groundwater will provide baseflow.	None

Table 6.4 *(cont.)*: Summary table of groundwater risk, assumptions, implications and 'hot spots'

QUAT	GW Risk	Assumptions	Confi-dence	Implications	HotSpot Discussion
E22D	None	Essentially no groundwater use in the catchment.	medium	Groundwater will provide baseflow.	None
E22E	None - a very large catchment	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E22F	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E22G	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E23A	None - the most eastern catchment of the WMA	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E23B	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E23C	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E23D	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E23E	The agricultural use of groundwater is over-estimated - this is a Class A catchment.	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E23F	The groundwater use is likely to be completely wrong - the Tankwa Karoo National park is in this catchment - likley to be no groundwater use.	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E23G	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E23H	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E23J	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E23K	The agricultural use of groundwater is over-estimated - this is a Class A catchment. Limited use in the western part of the catchment on the river.	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E24A	None	Essentially no groundwater use in the catchment.	low	TMG aquifers contribute to river baseflow	None

Table 6.4 *(cont.)*: Summary table of groundwater risk, assumptions, implications and 'hot spots'

QUAT	GW Risk	Assumptions	Confi-dence	Implications	HotSpot Discussion
E24B	None	Essentially no groundwater use in the catchment.	low	TMG aquifers contribute to river baseflow	None
E24C	The agricultural use of groundwater is over-estimated - this is a Class A catchment.	Limited groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E24D	None - a large catchment	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E24E	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E24F	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E24G	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E24H	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E24J	The agricultural use of groundwater is probably over-estimated - this is more a Class B catchment.	The agriculture in the west is probably more dryland farming, some centre pivots adjacent to the river - groundwater probably used mainly in summer.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E24K	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E24L	Very limited	A few centre pivots in the catchment - groundwater probably used extensively in summer	low		None
E24M	None	Essentially no groundwater use in the catchment.	medium	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E31A	None (the most northern catchment of the study area)	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E31B	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E31C	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None

Table 6.4 *(cont.)*: Summary table of groundwater risk, assumptions, implications and 'hot spots'

QUAT	GW Risk	Assumptions	Confi-dence	Implications	HotSpot Discussion
E31D	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E31E	None	Essentially no groundwater use in the catchment.	medium	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E31F	None	Essentially no groundwater use in the catchment.	medium	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E31G	The agricultural use of groundwater is over-estimated - this is a Class A catchment.	Limited groundwater use in the catchment.	medium	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E31H	Very low	Limited groundwater use in the catchment.	medium	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E32A	The agricultural use of groundwater is over-estimated - this is a Class A catchment.	Limited groundwater use in the catchment.	medium	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E32B	The agricultural use of groundwater is over-estimated - this appears a Class A catchment. This must be assessed in more detail. Why is the groundwater stress index so high?	Limited groundwater use in the catchment.	medium	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E32C	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E32D	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E32E	There is a lot of agricultural activity in the west - including centre pivots. Groundwater abstraction is >recharge, so groundwater levels are likely to be dropping and groundwater quality worsening.	Significant groundwater use in the west of the catchment	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	There are possibly hot spots.
E33A	The groundwater use is probably over-estimated. The calculated stress index is too high. This needs to be checked.	Groundwater use is very little.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E33B	The groundwater use is probably over-estimated. The calculated stress index is too high. This needs to be checked.	Groundwater use is very little.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E33C	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E33D	Very low	Groundwater use is very little.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None

Table 6.4 *(cont.)*: Summary table of groundwater risk, assumptions, implications and 'hot spots'

QUAT	GW Risk	Assumptions	Confi-dence	Implications	HotSpot Discussion
E33E	Lutzville is in the south of this catchment. There is groundwater use in the south. Groundwater could be over-abstracted.	Groundwater use in the south of the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E33F	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E33G	Vredendal is in this catchment. Groundwater levels could be dropping. DWA are doing excellent monitoring in this area.	Groundwater is used throughout the year.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E33H	None	Limited groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E40A	The groundwater use is probably over-estimated. The calculated stress index is too high.	Limited groundwater use in the catchment.	medium	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E40B	Calvinia lies in the eastern portion of this catchment. Possibility of groundwater levels being over-abstracted and groundwater levels dropping	Limited groundwater use in the catchment.	medium	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E40C	None	Limited groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
E40D	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
F60A	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
F60B	None	Limited groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
F60C	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
F60D	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
F60E	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None

Table 6.4 *(cont.)*: Summary table of groundwater risk, assumptions, implications and 'hot spots'

QUAT	GW Risk	Assumptions	Confi-dence	Implications	HotSpot Discussion
G30A	Groundwater stable currently however can easily be impacted in times of low rainfall	None - really - the area is being studied in some detail.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None
G30B	None	Essentially no groundwater use in the catchment.	high	TMG aquifers contribute to river baseflow	None
G30C	Groundwater over-abstraction can occur. Monitoring is important.	Good rainfall / recharge in this area, but with low rainfall the water balance can change quite rapidly.	high	Over-abstraction must be avoided - an important recharge area.	None
G30D	Groundwater is used extensively; however the aquifers are high yielding. The risk is quite high that over-abstraction can occur. Groundwater quality can also deteriorate.	None - really - the area is being studied in detail.	high	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None - but needs to be monitored carefully
G30E	Groundwater is used extensively; however the aquifers are high yielding. The risk is quite high that over-abstraction can occur. Groundwater quality can also deteriorate.	None - really - the area is being studied in detail.	high	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	Yes - in the proximity of Velorenvlei
G30F	Groundwater is being over-abstracted. Ecosystems impacted. Groundwater quality worsening in places.	None - really - the area is being studied in detail.	high	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	Yes
G30G	Groundwater levsl are dropping and water quality worsening in places	None - really - the area is being studied in detail.	high	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	Yes
G30H	None	Essentially no groundwater use in the catchment.	low	Unfavourable conditions (low rainfall/deep groundwater levels/limited presence of groundwater) for gwater contribution to baseflow.	None

7. ECONOMIC IMPLICATIONS

7.1. Agricultural Use

Water use in the Olifants Doorn Water Management Area (WMA) is dominated by agricultural use. Approximately 95% of the water used is applied in the agricultural sector. The diversity of agricutural activities in the WMA can be subdivided into four predominant crop production areas. This includes the following production areas:

- Deciduous fruit in the Koue Bokkeveld,
- Citrus fruit in the Upper Olifants,
- Wine grapes in the Lower Olifants, and
- Potatoes in the Sandveld area.

The agricultural-economic component of the Olifants Doorn WMA Classification process describes the financial-economic and employment impacts of a possible reduction or increase in water allocated to farming after taking into account the requirements of the ecological reserve, current use and the particular scenario proposed to support a particular class configuration. The impact is determined by means of representative, typical farm models developed for each of the water management areas covered by the study.

7.1.2. Methodology: Typical Farm Modeling

A change in the quantity and/or assurance of supply of water available for irrigation affects the area under irrigation and/or the crop choice and causes changes in land, labour and capital use, which in turn determines production and the farm profit. Both income and costs change with either an increase or reduction in water availability. In order to capture the interrelationships among the various components of a complex farming system to calculate the net financial-economic and employment effects, a typical farm model is used. A typical farm model simulates a farm which is typical of farms in a water management area in terms of physical extent, size and nature of the farming operation of farms. The use of average industry cost and income values is avoided as it distorts those relationships.

The typical farm model provides the net financial-economic and employment outcome of a typical farm in a particular area. It allows a before-and-after comparison of the input-output situation when it changes due to a change in water availability. It takes the form of a multiperiod budget that captures the costs and income involved in the establishment and production of an orchard or vineyard or potato-grain rotation system. When dealing with a perennial crop or even annual crops integrated in a crop rotation system, profitability cannot be expressed simply in terms of an annual gross margin as the time value of money has to be incorporated. A multiperiod budget captures the time value of money and therefore measures the financial result of the farming operation in terms of the net present value (NPV)of a discounted income-cost stream over 25 years. The internal rate of return (IRR) measures the return on the funds invested in the farming operation in the form of fixed and operational costs. The annuity is the net income stream over 25 years, expressed as equal annual amounts, taking the effect of interest into account. The change in permanent and seasonal labour required by the existing and the expanded or smaller farming operation is also given by the typical farm model.

The financial and employment impacts are given as totals for the typical farm, as well as per irrigated hectare, per 1000m^3 irrigation water applied and the totals per area. The before-and-after comparisons in terms of these parameters show thefinancial and employment impact of a change in water allocated to irrigation on farm level and on regional level. The expression of the financial and employment impacts per hectare and per 1000m^3 irrigation water allows interregional comparison. It also shows the opportunity cost or profit and employment opportunities forgone in a particular area if water is re-allocated to another area or to an alternative, non-agricultural use, like the ecological Reserve.

An increase in available irrigation water allowing an increase in irrigated area causes a disproportional increase in profit as expressed in the increase in NPV or the annuity of the typical farm provided that suitable land is availble for expansion . This relatively higher profit is due to the increase in scale of production. The total variable cost increases more or less in the same ratio as the increase in income, while the total fixed cost increases to a far lesser extent. The fixed cost per unit product drops, implying that the existing physical infrastructure and managerial capacity of the farm are utilised more economically. Likewise, a decrease in the amount of available irrigation water causes a relatively greater drop in profit and employment capacity.

7.1.3. Impact of a Change in Water Allocation on Agriculture

KOUE BOKKEVELD IUA

The Koue Bokkeveld area is well known for its deciduous fruit production (apples and pears), mainly for the export market. Deciduous fruit production is complemented by vegetable production. This combination allows an assured availability of irrigation water for the perennial crops and surplus water with less certainty of availability for annual crops. The total area currently irrigated is 8 600 ha.

The current water use per hectare per annum is 8 000 m^3 and the typical farm in this IUA has some 200 hectares of irrigated land. Total farm size is around 1 500 hectares with ample suitable land to expand irrigated crop production if more water can be allocated for irrigation. Water for irrigation is abtracted from rivers like the Leeu River which feeds the Doorn River. Winter water is currently stored in dams on the farms in the area to be used during the summer growing season. Water is often gravity fed from the dams located at higher altitudes to orchards, saving on pumping cost.

An increase of 15% in water availability was projected. This increase can be attained if producers will be allowed to store more winter water in dams that will have to be constructed on their farms at their own cost. The additional water will allow a producer on a typical Koue Bokkeveld farm to expand the irrigated land from 200 hectares to 230 hectares. The amount of water irrigated per hectare will remain at 8 000 m^3. The irrigated area for the Koue Bokkeveld as a whole is 8 600 but cannot be increase with 15% in all areas. The Houdenbeks is fully developed and some smaller areas in the Leeu River can be expanded.

The impacts of a projected increase of 15% in water available for irrigation was determined by means of a typical deciduous fruit farm model for the Koue Bokkeveld area. Additional water can only be obtained by storing winter water. The dam and mother pipeline construction costs to allow storage of additional water was spread over the lifespan of such infrastructure and were included in the farm model. The dam construction cost is R33 000/ha and the pump station and mother pipeline cost is R23 000/ha of the new land brought under irrigation.

The 15% projected increase in water will cause the NPV and the annuity to increase by 36%, despite the fact that the typical farm will have to carry the water storage and distribution cost. The annuity for the Koue Bokkeveld production area will increase from R98 763 502 to R134 656 250, if a 15% increase could be applied in the entire area. The increase will proportionally benefit the individual farming unit on which an increase in use can be allowed given the class scenarios. The increase in seasonal and permanent employment is 13.4 % and 13 % respectively, more or less in correspondence with the 15% increase in water availability. The total seasonal labour requirement for the Koue Bokkeveld IUA will increase from 810 009 to 918 209 man days (8 200 additional), while the total number of permanent labourers will increase from 4 286 to 4 877 (591 permanent jobs created).

UPPER OLIFANTS IUA

The Upper Olifants area is well known for its citrus production, traditional as well as soft citrus varieties, mainly for the export market. The climate and well drained soils allow high yields, making this area one of the most productive agricultural areas in South Africa. The total area currently irrigated is 7 000 ha. Water for irrigation is abtracted from the Olifants River. Winter water is stored in dams on farms. The current restriction is 6 000 cubic meter of water can be stored for each hectare under irrigation. The water stored is primarily the result of winter water abstraction but supplemented during the low flow season.

Producers are currently registered for 12 200 m^3/ha for 75 hectares on a typical farm, but they get and use only 10 800 m^3 /ha. If producers are allowed to store additional winter water (and reduce the summer low flow season abstraction) in order to abtract their full quota of 12 200 m^3 per hectare, a producer on a typical farm will get 12 200m^3/ha for 75 ha, but will only apply 10 800m^3/ha and will expand the area under irrigation to 85ha, an increase of 13.3%. The irrigated area for the Upper Olifants area as a whole could theoretically be increased from 7 000 hectares to 7 933 hectares.

Additional water can only be obtained by storing the additional winter water. The existing dams will have to be increased and new dam(s) will have to be constructed on farms at the producers' own cost. The dam and mother pipeline construction costs was spread over the lifespan of such infrastructure. The dam construction cost is R40 000/ha and the pump station and mother pipeline cost is R23 000/ha. The dams will also have to be constructed outside the river, implying that winter water will have to be pumped from the river to the dam and from there to the orchards. More water and greater assurance of water availability will allow an expansion of the irrigated area, and the planting of more profitable citrus cultivars.

The impacts of a projected increase of 13.3% in water available for irrigation was determined by means of a typical deciduous fruit farm model for the Upper Olifants IUA. The projected increase in water will cause the NPV and the annuity to increase by 36%. The annuity for the Upper Olifants production area could increase from R209 224 297 to R264 738 250, if a 13.3% increase could be applied in the entire area. The increase will proportionally benefit the individual farming units on which an increase in use can be allowed given the class scenarios. A major increase in welfare creation for the area.

The increase in seasonal and permanent employment is 10 and 12.3 % respectively, slightly lower than the 13.3% increase in water availability. The total seasonal labour requirement for the Upper Olifants IUA will increase from 379 102 to 418 284 man days (39 182 increase). The total number of permanent labourers will increase from 5 289 to 5 973 (684 permanenet jobs created).

OLIFANTS RIVER BASIN BETWEEN CLANWILLIAM DAM AND KLAWER

The area is well known for its table grape production. The total area currently irrigated is 3 000 ha. The Clanwillian canal supplies water to 1 673 hectares, while the rest of the area (1 327 ha) requires pumping from the Olifants River. The analysis focuses only on the area supplied by the Clanwillian canal, which should not be confused with the LORWUA distribution canal.A producer on a typical farm of 50 ha currently receives 7 600 m^3/ha for 43 hectares.

The projected increase of 9.3% in water allocation will allow a producer on a typical farm to expand the area under irrigation from 43 to 47 hectares at the same intensity of 7 600 m^3/ha. The irrigated area in the Olifants River Basin between Clanwilliam Dam and Klawer area served by the Clanwillian canal will increase from 1 673 hectares to 1 829 hectares.

The impacts of a projected increase of 9.3% in water available for irrigation was determined by means of a typical table grape farm model for the Olifants River Basin between Clanwilliam dam and Klawer. The 9.3% projected increase in water will cause the NPV and the annuity to increase by 47%. The annuity for the Olifants River basin between Clanwilliam Dam and Klawer area will increase from R17 511 244 to R25 694 986, a major increase in welfare creation for the area.

The increase in seasonal and permanent employment is 9.3 and 9.4 % respectively, the same magnitude as the 9.3% increase in water availability. The total seasonal labour requirement for the Olifants River Basin between Clanwilliam Dam and Klawer area will increase from 768 744 to 840 426 man days (71 682 increase), reflecting the labour intensive harvesting of table grapes, while the total number of permanent labourers will increase from 937 to 1 051 (114 permanenet jobs created).

LOWER OLIFANTS IUA

TheLower Olifants River area is well known for wine grape production. The total area currently irrigated is 10 000 ha. Due to the uncertainty of sufficient water during the summer assurance of supply, producers do not plant their whole irrigable areas with wine grapes, but use some 14% of the area for vegetable production. During a very dry winterthe water stored in the Clanwilliam Dam is inadequate for irrigation during the summer for the whole irrigable area. Producers can then decide not to plant vegetables as annual crops in order to use the available water for the wine grapes as a perennial crop.

Producers are registered for 12 200m^3/ha, but the canal from the Clanwilliam Dam allows a maximum of only 325m^3/ha per week (or 8 400 cubic meter oper hectare). Given the limitation provided by the distribution canal and the uncertainty of delivery of water from the dam due to limited storage capacity to bridge dry years, producers receive on average only 6 400m^3/ha per annum.An increase in the height of the wall of the Clanwilliam Dam will improve the assurance of delivery by bridging dry winters and will bring about a fuller utilisation of the exiting capacity of the Clanwilliam canal. A typical farm will then receive and use 8 200m^3/ha.

The increased amount of water per hectare will be combined with a limited expansion of the irrigated area from 47 to 50 hectares. Due to the increased assurance of delivery, 94% of the total irrigated area will be used for wine grape production and 6% for vegetable production. This scenario has not taken the possible increase in the distribution canal into consideration.The irrigated area in the Lower Olifants IUA will increase marginally from 10 000 hectares to 10 638 hectares.

The impacts of a projected increase of 6.4% in the area under irrigation, the increase in the quantity of water per hectare of 28%, as well as the assurance of delivery was determined by means of a typicalwine grape and vegetables farm model for the Lower Olifants IUA. These changes will cause the NPV and the annuity to increase by 93%. The annuity for the Lower Olifants IUA will increase from R42 708 644 to R82 215 016, a major increase in welfare creation for the area.

The seasonal employment will drop by 60% due to the termination of vegetable production which relies heavily on seasonal labour. Permanent employment will remain the same. The total seasonal labour requirement for the Upper Olifants IUA will decrease from 274 226 to 110 635 man days (decrease of 163 591), while the total number of permanent labourers will stay constant at 1 702.The drop in seasonal employment capacity must be seen as a sacrifice to allow a financially more viable farming pattern. A typical farm currently shows an IRR of only 4.3% which is lower than the real bank interest rate. This implies that a producer can do better by selling his/her farm and invest the money in the bank. Stated differently, a farmer will not be able to service his/her loan if he/she borrows money from a bank to buy land and farming equipment.

SANDVELD IUA

Potato production on circular fields with sandy soils under centre pivot irrigation systems fed by groundwater is the common intensive farming practice in the Sandveld. A rotation system of one season potatoes on an irrigated circle, followed by five years winter grain on the same circle to combat soil pathogens that would have spoiled a potato crop directly following a previous potato crop. The total area under circles will thus consist of one sixth of the number of circles under irrigation and five sixths of the number of circles without irrigation. The Sandveldtypical farm model incorporates the contributions from the winter grain.Three sub-areas are distinguished.

- **Area 1**: Total irrigated area is 1 750 ha and an increase of 15% water abtraction is projected.
- **Area 2**: Total irrigated area is 1 750 ha and a decrease of 10% water abtraction is projected.
- **Area 3**: Total irrigated area is 3 500 ha and no change in water abtraction is projected.

Groundwater is abstracted to provide 6 200m^3/ha on an irrigated circle in all three areas.

Projected change in water allocation:

- **Area 1**: An increase of 15% water abstraction is projected. This will increase the irrigated area on a typical farm from 60 to 69 ha and the total area under circles (irrigated and non-irrigated) from 360 to 414 ha.
- **Area 2**: A decrease of 10% water abstraction is projected, reducing the irrigated area from 60 to 54 ha and the total area under circles (irrigated and non-irrigated) from 360 to 324 ha.
- **Area 3**: Total irrigated area is 3 500 ha and no change in water abstraction is projected.

The impacts of a projected increase or decrease in the area under irrigation was determined by means of a typical potato farm model for the SandveldIUA. The total IRR, NPV and annuity of the typical farm include the contribution of the winter grain as it forms an integral part of the total farming system. The NPV per irrigated hectare and per 1 000m^3 focus on the profitability of the whole farm per irrigation unit to allow comparison with the other IUA.

Financial-economic impacts of projected changed water allocation:

- **Area 1**: The 15 % increase in water availability and likewise in irrigated area causes the NPV and the annuity to increase by 114%. The annuity for Area 1 of the Sandveld will increase from R11 771 123 to R25 190 411, a major increase in welfare creation for the area. The reason for the relatively great increase of the annuity in the Sandveld compared to that of the other IUA is the limited increase in capital expenditure needed to expand the area under pivot irrigation, as the Sandveld producer does not have to store (construct storage facilities) water and does not have a high crop establishment cost and interest on capital while waiting for the crop to reach its breakeven year, as in the case of perennial crops. Variable cost contributes the dominant part of the total cost structure of potato farming.
- **Area 2**: The 10 % reduction in water availability and likewise in irrigated area causes the NPV and the annuity to decrease by 307%. The profitability of potato farming is clearly very sensitive for a reduction in scale of production. The annuity for Area 2 of the Sandveld will decrease from R11 771 123 to R2 829 103, a major setback in welfare creation for the area.
- **Area 3**: No change in profitability will take place. The annuity for the whole area will be R23 542 247.

Employment impacts of projected changed water allocation:

- **Area 1**: The 15 % increase in water availability and likewise in irrigated area causes the seasonal and permanent employment to increase by 19% and 17 % respectively. The total seasonal labour requirement for Area 1 of the Sandveld IUA will increase from 70 000 to 83 146 man days, while the total number of permanent labourers will increase from 175 to 204 (29 permanenet jobs created).

- **Area 2**: The 10 % reduction in water availability and likewise in irrigated area causes the seasonal employment to decrease by 8% and permanent employment to remain constant. The total seasonal labour requirement for Area 2 of the Sandveld IUA will drop from 2 400 to 2 205 man days (195 increase), while the total number of permanent labourers will remain constant at 175.
- **Area 3**: No change in employment will take place. The total seasonal labour requirement for Area 3 of the Sandveld IUA will stay at 2 400 man days, while the total number of permanent labourers will remain constant at 350.

7.1.4 Conclusions

The projections show that all the IUAs, on farm level, will experience a significant increase in profit generation if water availability can be increased according to the projected levels. In the case of the Lower Olifants IUA, such a change is desparately required by farms with a size similar to that of the typical farm model.

On regional level the increased availability of water will result in significantly greater welfare creation. This will in turn generate more upstream (input side of the farm) and downstream (marketing of the farm produce) benefits.

The financial impact of the increased water availability in the case of the Koue Bokkeveld and Upper Olifants IUAs as expressed in terms of an annuity per 1 000m^3 irrigation water used per annum (R/1 000m^3) exceed that of all the other IUAs. If one takes into account that the values of this parameter for these two areas are negatively influenced by the dam storage and water distribution cost incorporated in theirfarm cost structures, while the storage cost in the case of the Lower Olifants IUA should be lower due to scale benefits of large irrigation schemes, and none of the other IUA farms have water storage costs, the former areas (Koue Bokkeveld) do actually even better.

The reduction in water availability as in the case of Area 2 of the Sandveld has a similar magnitude, but negative financial impact. The low IRR of 3.2% warns that such a reduction in water availability will mean the termination of most farms in the particular area. In order to minimise the economic impact of a reduction in the use it would be recommneded that the reduction in use that is required should not be applied proportionally to all existing lawful users in a particular area but the unlawful use be identified and used as a starting point to reduce current use.

All the areas show an increase in employment numbers in response to an increase in water availability, except for seasonal labour in the Lower Olifants IUA, due to the termination of labour intensive vegetable production. More water and greater assurance of delivery are essential for the longer term viability of the typical farm and the protection of the employment capacity of wine grape production.

7.2. Estuarine use

As part of the Olifants Doring pilot classification project as part of the development of the Water Resource Classification System, the economic value Olifants Estuary's EGSAs was quantified (DWAF, 2007b). Below is a summary of that quantification.

7.2.1. The Olifants estuary recreational fishery

The Olifants estuary line-fishery comprises recreational shore-angling and limited recreational boat fishing, where an estimated 1 to 2 tonnes are caught. Recreational anglers catch a further 0.1 tonnes of harders using cast-nets. The economic value of the recreational fishery was considered in terms of the expenditure on fishing by recreational fishers (= income to subsidiary industries such as accommodation and fuel). Based on regional estimates of recreational value, the fishery is estimated to be worth between R561 600 and R1 259 200 (estimated in 2006).

7.2.2. Estuarine fisheries

Use of fish resources within the estuary is mostly by the Ebenhaeser Community. There are 45 gill-net permit holders in the Olifants estuary, and an estimated additional 10 to 30 people operating without permits. Annual effort is about 15 300 net days/year. Fishing is seasonal, being confined mostly to summer (October to April) during low flows. Sixty percent of the fisher households rely on fishing for 25 to 50% of their summer income, whereas for the remaining 40%, fishing comprises 75% of household income. A large part of the catch is consumed with more than 50% of households eating fish every day.

The economic value of the fishery was considered in terms of the value of landed catches by small-scale fishers (this includes the value of fish consumed as well as sold), and turnover generated by commercial fishers.Based on estimated catches of the gill-net fishery and the national average value per kg, the fishery in the Olifants estuary is estimated to be worth about R491 400 to R629 600 per annum (2005 rands).

7.2.3. Nursery value

The nursery function of the Olifants estuary is thus considered to be significant as the Olifants estuary accounts for 23% of the estuarine area on the West Coast and many marine species caught in the surrounding marine fisheries are dependent on estuaries as nursery areas. Beach seine and gill net fisheries on the West Coast are deemed to be most likely to be the fisheries that are most affected by any changes in the Olifants estuary. The commercial line fishery, recreational shore angling and recreational boat angling fisheries are also likely to be affected to a lesser extent. A conservative estimate of the nursery value of the Olifants estuary is some R3.45 million per year (2005 rands). The table below shows the estimated value per different inshore fishery type.

Table 7.1: Annual values of fisheries that benefit from the Olifants estuary, and the total value attributed to the estuary (DWAF, 2007b)

Fishery	Fishers	Total value (millions)	Value from Olifants estuary (millions)
West Coast gill and seine	321 gill + 84 seine (+ crew)	R18.1	R1.07
West Coast commercial boat	9 000	R286.87	R0.18
West Coast recreational shore and boat	210	R341.71	R2.28
		Total nursery value of Olifants estuary fish	R3.45

8. SOCIAL IMPLICATIONS

8.1. Background to the Social Assessment

In terms of its administrative setting, the Olifants Doorn WMA falls within two District Municipalities (DM), namely the West Coast District Municipality (WCDM) and Cape Winelands District Municipality (CWDM) in the Western Cape Province and the Namakwa District Municipality (NDM) in the Northern Cape Province. The most relevant local municipalities (LM) within these district municipalities are the Matzikama, Cederbergand Berg River LM in the WCDM, the Witzenberg Local Municipality, in the CWDM and the Hantam and Kamiesberg LM in the NDM. These DM and LM provide the basis for the socio-economic overview of the Olifants/Doorn WMA.

In terms of the methodology used, the approach to and methods used for measuring well-being in Volume 3 of the Socio-Economic Guidelines for the 7-Step Classification Procedure(DWA, 2007b) were found to be problematic in that they assume that the factors that inform and are used to measure well-being are closely linked to water and ecosystem health. However, as indicated above, there are a number of other factors that are likely to have a more important bearing of overall well-being. In addition, for many of the indicators/measures it is not possible to establish a clear link between well-being and water. Changes in the MC are likely to have little or no bearing on these indicators. Their applicability and use when considering scenarios for assessing MC and comparing scenarios is therefore likely to be limited.

As a result Step 1E (Describe communities and their well-being) and Step 1J (Describe the present-day community well-being within each IUA) of the 7-step procedure are likely to be challenging. This has direct implications for Step 1L (Develop and or adjust the socio-economic framework and the decision-analysis framework). Due the potential concerns regarding the type of information used to measure societal well-being and challenges associated with establishing Total Economic Value (TEV), is it recommended that consideration be given to simplifying the socio-economic assessment process for the WRCS and the associated determination of MC.

The steps that can use existing baseline data are:

- Description of the present day socio-economic status of the catchment area (Step 1A);
- Division of the catchment into socio-economic zones (Step 1B);
- Description of the value and use of the water(Step 1F);
- Description of the value and use of aquatic ecosystems (Step 1G). The valuation of aquatic ecosystems can be a complicated and costly exercise and requires detailed data. However, establishing a monetary value may not be necessary if one provides a detailed description of the use of aquatic ecosystems and how they contribute to the overall well-being of the catchment area. For example, in the case of the OD catchment, the high altitude catchment areas play a critical role in the functioning of the system. One does not necessarily have to attach a monetary value to this function to highlight the importance of maintaining these areas in their current, undisturbed status. A detailed ecological description of the role

that the aquatic ecosystem plays is therefore likely to be more valuable than attempting to attach a monetary value.

However, it is important to ensure that the links between the data and water are made.

8.2. Key Socio-Economic Informants

Key factors influencing the socio-economic environment in the WMA are listed below as follows:

- The local economy is dominated by agricultural sector (~ 43 % GDPR), followed by Manufacturing (~ 25% GDPR). The manufacturing sector is largely linked to the processing of agricultural products;
- Agriculture and Manufacturing account for ~ 50% of employment;
- Agriculture accounts for 95% of the water use in the WMA;
- The available water resources in the WMA are already fully utilised and shortages occur in Olifants sub-region which has the highest concentration of the population (75%) and accounts for 65% of the water used;
- The majority of the population (~70%) live in urban settlements, while the remaining 30% live in the rural areas;
- All of the main towns, with the exception of Calvinia are located on Olifants River;
- Population growth in the ODWMA is low, and negative in some areas;
- In-migration to the area is low;
- Agriculture will remain the dominant economic sector. Growth in the agriculture sector has, however, been slow and employment is seasonal;
- The needs of emerging farmers, both in terms of land and water, need to be addressed;
- Education, income and skills levels in the region are low. This is exacerbated by the dominance of the agricultural sector;
- Tourism represents a key growth sector;
- The mining sector may grow in the future and place additional pressure on water resources.
- The West Coast District Municipality (WCDM) has been identified as the region in South Africa that is likely to be the most affected by global climate change.

8.3. Summary of Water Users

The water users are summarised below according to IUA and economic sectors:

Table 8.1: Distribution of water use and population Per IUA

Integrated Units of Analysis/Sub area	% of water use in IUA	% of population in IUA
Upper and Lower Olifants IUAs/Sub area	66	~ 75
Koue Bokkeveld IUA	18	~ 2
Sandveld IUA	10	~ 8
Doring IUAs/Sub area	4	~ 15
Knersvlakte IUA	2	~ 1

Distribution of water use per economic sector

- Agriculture: ~ 95%
- Urban and industrial (including manufacturing): ~2%
- Rural use, including livestock: ~ 2%
- Mining: ~ 1%

8.4. Summary of Amenity and Environmental Values

The amenity and environmental values of water resources within the WMA can be summarised as follows:

- The Olifants River estuary is one of only three permanently open estuaries on the west coast of South Africa. Ranked as the third most important estuary in South Africa in terms of conservation;
- The Olifants Estuary an important resource for the local community at Papendorp
- Verlorevlei wetland in the Sandveld has Ramsar status and is considered as important habitat for birdlife;
- The Cederberg Wilderness Area and the northern section of the Groot Winterhoek Wilderness Area are recognised as important conservation areas. These areas also represent the key catchment areas for the Olifants River;
- The Olifants River and Doring River are important from a conservation perspective as they contain a number of indigenous and endangered endemic fish species;
- Clanwilliam Dam and Bulshoek Barrage are important for their amenity and recreational values that are linked to water;
- White water rafting is an importance activity on the Doring River;
- Tankwa-Karoo National Park is a South African National Park.

8.5. Recommended Catchment Configuration: Social Implications

The key findings of the socio-economic study indicate that the agricultural sector followed by manufacturing represent the key economic sectors in the WMA both in terms of contribution to GDPR and employment. Together they account or ~ 68% of the GDPR and 50% of the employment. The agricultural sector is also the single largest consumer of water (95%). Urban and industrial (including manufacturing) (2%), rural use, including livestock (2%) and mining (1%) make up the remaining 5%. In terms of population, the majority of the population (~70) lives in urban settlements, while the remaining 30% lives in the rural areas.

The water supply of the majority of the population is therefore linked to and dependent upon the local authorities in the WMA. The Olifants sub-area (Upper and Lower Olifants IUAs), which has 75% of the total population of the WMA, accounts for 66% of the water usage. Koue Bokkeveld IUA, which has 2 % of the population accounts for 18% of the water usage. The Sandveld IUA, which accounts for 8% of the population, accounts for 10% of water usage. The study also found that population growth in the WMA is low and negative in some areas. Future growth in demand for water is therefore likely to be linked to increased demand from agricultural sector and not due to increased demand linked to population growth.

The findings of the agricultural-economic study indicate that all of the WMA's, on farm level, will experience a significant increase in profit generation if water availability can be increased according to the projected levels. In the case of the Lower Olifants River basin, such a change is desperately required by farms with a size similar to that of the typical farm model. A regional level the increased availability of water will result in significantly greater welfare creation. This will in turn generate more upstream (input side of the farm) and downstream (marketing of the farm produce) benefits.

In terms of employment, all the IUAs show an increase in employment numbers in response to an increase in water availability, except for seasonal labour in the Lower Olifants IUA, due to the termination of labour intensive vegetable production.

Based on the above information the proposed scenario of a 15% increase in water availability for agricultural use will result in socio-economic benefits for the affected farmers and the WMA as a whole. This is due to the dominant role played by the agricultural and the associated manufacturing sector in the areas local economy. However, it should be noted that such an improvement will not necessarily translate into an improvement of the over well-being of all communities in the WMA. Such an improvement is also dependent upon a range of other factors that are not necessarily directly linked to determination of a management class (MC). These include improved education and access to basic services, such as housing, sanitation and electricity etc.

The provision of and improved access to these services is linked to the performance of the relevant national, provincial and local authorities. Likewise the 15% increase in water availability will not necessarily translate into benefits for emerging farmers. The success of emerging farmers in the WMA is linked to a range of other factors which fall outside the scope of a water resource classification exercise, including the cost of land and capital equipment, support from government, market fluctuations, interest rates and the fuel price etc.

9. STAKEHOLDER PARTICIPATION

It is a legal requirement to ensure that public and stakeholder participation takes place during the process of water resource classification. The section of the report provides a summary of the process that was followed for the classification of the Olifants Doorn WMA water resources, as well as lists the key issues raised and discussed during the process. See "*Department of Water Affairs, South Africa, May 2011. Classification of significant water resources in the Olifants-Doorn WMA. Inception report. Report number: RDM/WMA17/00/CON/CLA/0111*" for further details

9.1. The Public and Stakeholder Participation Process

9.1.1 Mobilisation of stakeholders

The following measures were taken to mobilise the stakeholders:

- The Department of Water Affairs has placed advertisements in the Sunday Times and Mail and Guardian Nation newspapers to inform members of the public and water stakeholders of the start of the classification of water resources in South Africa.
- Notices in Afrikaans, English and isiXhosa were published in local newspapers (Olifants Gazette, Ons Kontrei, and Noordwester) announcing the first public meeting, the purpose thereof and the stakeholders was requested to indicate their interest by registering on the database
- Various existing databases was consulted in the in the area to ensure inclusivity of all sectors, stakeholders and affected parties. The database that was used consisted of more than 350 stakeholder members and was used to record participation during the process. The database was updated continuously during the study period and after each of the public meetings. The final database consist of various sectors which include the following: Local Government, National and Provincial Government Departments, Water User Associations, Nature Conservation and Environment, Water Catchment Forums, Community organisations, Emerging Farmer (individuals and forums), Commercial Farmers (individual and farmer unions), Labour Unions, Private Consultants and individuals, Universities, Olifants River Estuary, Management Forum, Verlorenvlei Estuary Management Forum, Tourism and Recreation and Department of Water Affairs (National and Provincial).

9.1.2 Public Participation Meetings

With the inception of the study a classification background document and brochures were developed for the stakeholders and made available in the three official languages of the Western Cape Province: English, Afrikaans and Xhosa. Various mediums was utilised to communicate with the stakeholders: e-mails, fax, telephone in preparation of each Public Participation meeting and also during the study period. Stakeholders could also access documents from the website: www.ewisa.co.za. The classification guideline documents, according to which classification is to be conducted, was also made available to stakeholders.

Three public meetings were held in Clanwilliam at the Rolbal Klub. The first and second public meetings were done in a workshop format to allow maximum participation by the stakeholders. Presentations were also done in two languages (Afrikaans and English) simultaneously for the benefit of the stakeholders. The agenda of each meeting was also set in such manner to allow maximum time for questions, clarity and to raise any other concerns. Stakeholders were invited to speak in their mother tongue during the meetings, as there were translation services available.At each of the meetings comment sheets were made available for the stakeholders that wanted to provide their comments and concerns in written form.

Table 9.1: Summary of the focus of each of the public meetings

Dates of meetings	Purpose
14 June 2011	Introduce the study to the stakeholders, process, study team and DWA Project team. Background to the water resource classification system and process. Legal and regulatory mandate and technical overview. Process for the classification of water resources in the Olifants/Doorn WMA: Groundwater, Surface water and ecology, economic and social considerations.
6 October 2011	Provide feedback as to the status of the study with the focus on groundwater, surface water and ecology, and Presentation of possible scenarios
14 February 2012	Presentation of the refined classification scenarios, and Way forward in terms of the process to gazette the class configuration and opportunity of public to make comment during the gazetting period.

Minutes were kept of each of the public meeting. A comments and responses register was also compiled and updated after each public meeting which resulted in a consolidated comment and responses register which was distributed at the second and third public participation meetings to allow stakeholders to scrutinize.

Table 3 provides a summary of the comments received and the attendance of the public meetings. More than 150 comments and questions to which responses were supplied and are captured in the comments a responses register.

Table 9.2: Summary of the number of participants in the public meetings and the number of comments and responses provided during the classification process

Meeting	Date	Number of comments received and responses provided	Number of attendees
Public meeting 1	14-Jun-11	51	69
Public meeting 2	06-Oct-11	21	60
Public meeting 3	14-Feb-12	21	52

9.1.3 Technical meetings with Water User Associations (WUA)

In addition to the three formal public and stakeholder consultation meetings the study team members also engaged during four meetings with representatives of the following:

- Koue Bokkeveld,
- Citrusdal,
- LORWUA, and
- Sandveld

The purpose of these meetings was to obtain input into the agricultural economic modeling in order to determine the impact of either an increase or decrease in the availability of water on agricultural activities.

9.1.4 Project Stakeholder Committee meetings

A Project Steering Committee (PSC)was established, consisting of representatives of sectors important to the study such as from national, provincial and local government. The PSC wasestablished as a voluntary body and was intended to operate at a strategic level in order to ensure that all technical aspects of the projectwere transparent, open and consultative and that cooperative governance was embraced.

Table 9.3: Summary of the number of participants in the PSC meetings and the number of comments and responses provided during the classification process

Meeting	Date	Number of comments received and responses provided	Number of attendees
PSC 1	17-May-11	10	29
PSC 2	06-Sep-11	16	23
PSC 3	24-Jan-12	24	19

9.2. Issues raised during the stakeholder

The table below provides a summary of the types of issues raised during the public and stakeholder process and the numbers of comments received on each topic. The bulk of the issues raised pertained to water use and how the classification process in the WMA will impact on current use of surface and groundwater.

Table 9.4: Summary of issue topics and number of comments received for each topic

Topic of comments and issues raised	Number of comments received
Climate change	1
Borehole water use	2
Stakeholders	2
Alien Vegetation	3
Economic	3
Farming practises	3
Scale of the study	3
Emerging farmers (resource poor farmers)	4
Estuaries	4
Other	4
Water pricing	4
Water law and regulations	4
Monitoring	5
Clanwilliam dam	6
Ecology	6
FEPA and biodiversity	6
Hydrology	6
Institutions (CMA and management)	6
Water quality	7

Data (availability)	9
Groundwater (recharge and use)	9
Classification and its implications	14
Water use (allocation, re-use, re-dress, additional use, licensing and charges)	37

9.3. Challenges experience during the stakeholder participation process

The following challenges were experienced during the public and stakeholder participation process:

- The Olifants Doorn WMA is very vast and stakeholders have to travel a radius of 400 kilometers to attend the public participation meetings in Clanwilliam. A budget was used to cover he travel costs of stakeholders groups that needed to travel long distances to attend the public meetings.

- Stakeholder fatigue, anger and frustrations: it was very evident during the stakeholder processes that there are many unresolved issues in the Olifants Doorn Water Management Area, and stakeholders then use this opportunity to express their concerns related to the unresolved issues such as the raising of the Clanwilliam Dam, non-existence of Catchment Management Agency and lack of support to Emerging Farmers.

10. SUMMARY OF OUTCOMES AND CONCLUDING REMARKS

10.1. Summary of Outcomes and Recommendations

The recommended catchment configuration consists of a combination of the present ecological state of the water resources in the WMA and the freshwater biodiversity targets as provided by the FEPA maps. The FEPA maps were generated by identifying those freshwater ecosystems that were important from a biodiversity or habitat importance and that were as far as possible still in a near natural condition. This recommended scenario could thus be expected to have minimal implication on the ecological, economic and social environments of the WMA.

Below is a summary of the key findings from the assessment of the recommended scenario on water use, water quality, aquatic ecosystem condition and EGSAs, groundwater, as well as the economic and social situation in the WMA. The main outcomes from the public participation process are also included in the table.

Table 10.1: Summary of key project outcomes

Characteristic	Key Outcome
Water use	There are large differences in the available water use data between that which has been registered and that determined based on land use coverage (WR2005). This made the task of assessing the implications of the recommended catchment configuration on the existing water use a difficult task. There are however areas where it is clear that water use needs to be reduced and others where water is still available. The proposed scenario is assumed to result in a 15%, 13.3% and 10% increase in water availability for agricultural use in selected areas of the Koue Bokkeveld, Lower Olifants River and LORWUA distribution area respectively. The scenario will also require a reduction in water availability in portions of the Sandveld.
Water quality	Water quality in the WMA is in general good, with most of the poor suitability for use resulting from naturally high salinities in the water. In the lower Olifants River system as well as the Sandveld however this situation is exacerbated by the intensive agriculture that occurs within the surrounding catchments. Elevated nutrient concentrations also occur within these areas. The recommended catchment configuration is unlikely to impact significantly on the water quality in the catchment. Areas where water quality impacts have been identified need to be addressed through the CMS and RQOs.
Aquatic ecosystems	Due to the fact that the recommended catchment configuration is based on the present ecological state together with the freshwater ecosystem priority areas, there is unlikely to be any significant impact on the aquatic ecosystem condition or the EGSAs associated with the water resources. In terms of maintaining the Olifants and Verlorenvlei estuaries in the desired moderately modified state it is important that there is no new water abstraction authorised from the low flow period for the Olifants, Doring, Groot, Riet, Verlorenvlei, Langvlei, Jakkals and Papkuils rivers. No new licenses for water abstraction in summer (low flow) period of the year in the mainstream of the
Groundwater	
Economics	The key conclusions of the agricultural-economic study indicate that all of the WMA's, on farm level, will experience a significant increase in profit generation if water availability can be increased according to the projected levels. In the case of the Lower Olifants River basin, such a change is desperately required by farms with a size similar to that of the typical farm model. At a regional level the increased availability of water will result in significantly greater welfare creation. This will in turn generate more upstream (input side of the farm) and downstream (marketing of the farm produce) benefits. A reduction in water availability as in the case forportions of the Sandveld has a similar magnitude, but negative financial impact. The low internal rate of return of 3.2% warns that such a reduction in water availability will mean the termination of most farms in the particular area if the reduction is applied to all farming activities.In terms of employment, all the WMA areas show an increase in employment numbers in response to an increase in water availability, except for seasonal labour in the Lower Olifants River basin, due to the potential termination of labour intensive vegetable production. More water and greater assurance of delivery are essential for the longer term viability of the typical farm and the protection of the employment capacity of wine grape production.
Social	The agricultural sector represents the key economic sectors in the WMA both in terms of contribution to regional gross domestic product (~ 68%) and employment (50%) and is the single largest user of water (95%). Tthe majority of the population (~70) lives in urban settlements, where the water supply is provided by local authorities. The

	Olifants sub-area, which has 75% of the total population of the WMA, accounts for 66% of the water usage. Koue Bokkeveld sub-area, which has 2 % of the population accounts for 18% of the water usage. The Sandveld sub-area which accounts for 8% of the population, accounts for 10% of water usage. Population growth in the WMA is low and negative in some areas. Future growth in demand for water is therefore likely to be linked to increased demand from agricultural sector and not due to increased demand linked to population growth. At a farm level, all of the IUAswill experience a significant increase in profit generation if water availability can be increased according to the projected levels based on the assumptions made. In the case of the Lower Olifants River basin, such a change is desperately required by farms with a size similar to that of the typical farm model. At a regional level the increased availability of water will result in significantly greater welfare creation. This will in turn generate more upstream (input side of the farm) and downstream (marketing of the farm produce) benefits.In terms of employment, all the IUAsareas show an increase in employment numbers in response to an increase in water availability, except for seasonal labour in the Lower Olifants River basin, due to the termination of labour intensive vegetable production. The proposed scenario will result in socio-economic benefits for the affected farmers and the WMA as a whole.Such an improvement will however not necessarily translate into an improvement of the over well-being of all communities in the WMA but is dependent upon a range of other factors that are not necessarily directly linked to determination of a water resource class such as improved education and access to basic services, such as housing, sanitation and electricity etc. The provision of and improved access to these services is linked to the performance of the relevant national, provincial and local authorities. Likewise the 15% increase in water availability will not necessarily translate into benefits for emerging farmers. The success of emerging farmers in the WMA is linked to a range of other factors which fall outside the scope of a water resource classification exercise, including the cost of land and capital equipment, support from government, market fluctuations, interest rates and the fuel price etc.
Public participation	The public participation process followed to facilitate information sharing with stakeholder and the public on the project progress included 3 public meetings, 3 steering committee meetings, technical meetings with specific stakeholder groups and a number of information documents. During the process more than 150 comments were received. Most of these comments related to the use of water and the impact that the proposed scenario would have on existing and future water use.

10.2. Recommended water resource classes for the Olifants Doorn WMA

The following recommendations are made for the water resource class (Table 10.2) and ecological categories for the rivers, wetlands and groundwater in the WMA (Table 10.4):

Table 10.2: IUA Class assignations for catchment configurations

Integrated Units of Analysis	Recommended Water Resource Class		
	Incremental	Cumulative	Combined
Knersvlakte	Class I	Class I	Class I
Koue Bokkeveld	Class II	Class II	Class II
Doring Rangelands	Class I	Class I	Class I
Olifants Doring Drylands	Class II	Class II	Class III
Lower Olifants Irrigation Area	Class III	Class III	Class III
Upper Olifants Irrigation Area	Class II	Class III	Class III
Sandveld	Class III	Class III	Class III

Table 10.3: Summary of Quaternary Catchments per Integrated Unit of Analysis (IUA)

IUA	Quaternary catchments
Doring Rangelands	E40B, E40A, E24E, E24F E24G, E24C, E24D, E23E, E24H, E23F, E23K, E23D, E22G, E23J, E23C, E23B, E22F, E23H, E23A, E23G, E22E, E22B, E22A, E22D, E22C, E24B, E24A
Knersvlakte	E31A, E31C, E31D, E31G, E33A, E31B, E31E, E33D, E31H, E31F, E32D, E33B, E32B, E32A, E32E, E33E, E33C, E32C, F60A, F60B, F60C, F60D, F60E
Koue Bokkeveld	E21K, E21L, E21J, E21H, E21F, E21G, E21E, E21D, E21C, E21B, E21A
Lower Olifants Irrigation	E33H, E33G
Olifants/Doring Dryland Farming	E40C, E33F, E40D, E24K, E24M, E24J, E24L
Upper Olifants Irrigation	E10K, E10J, E10G, E10H, E10F, E10E, E10D, E10C, E10B, E10A
Sandveld	G3

Table 10.4: Summary of Water Resource Classes and Ecological Categories per Quaternary Catchment

IUA	Water Resource Class for IUA	Quat. Drainage Region	Water Resource Class for Quaternary	River name	Mainstem Ecological Category	Tributary Ecological Category* (% of Incremental quaternary area)	Wetland area and Ecological Category*	Groundwater Category
Upper Olifants Irrigation	III	E10A	I	Olifants	C	C	-	B
		E10B	I	Olifants	C	C (80%); AB (20%)	-	B
		E10C	I	Olifants	C	AB (100%)	wetland area 1.2% of quaternary, 85% in a AB condition	A
		E10D	I	Olifants	C	C (70%); AB (30%)	wetland area 5.4% of quaternary, 16% in a AB condition	B
		E10E	I	Olifants	C	C (60%); AB (40%)	wetland area 5.8% of quaternary, 10% in a AB condition	A
		E10F	II	Olifants	D	C (40%); AB (60%)	-	B
		E10G	III	Olifants/ Rondegat	D	C (70%); AB (30%)	-	A
		E10H	III	Jan Dissels	D	D (95%); AB (5%)	wetland area 3.3% of quaternary, 10% in a AB condition	A
		E10J	III	Olifants	D	D (80%); AB (20%)	wetland area 1.1% of quaternary, 5.5% in a AB condition	C
		E10K	III	Olifants	D	D (95%); AB (5%)	wetland area 1.9% of quaternary, 50% in a AB condition	A
Koue Bokkeveld	II	E21A	III	Kruis	D	C	-	C
		E21B	III	Welgemoed	D	D	-	B
		E21C	II	Winkelhaak	C	B	wetland area 0.5% of quaternary, 98% in a AB condition	B
		E21D	III	Houdenbeks	D	D (95%); AB (5%)	-	C
		E21E	II	Riet	C	C (30%); AB (70%)	-	C
		E21F	II	Riet	C	C	wetland area 0.001% of quaternary, 91% in a AB condition	B
		E21G	III	Groot/Leeu	D	D (95%); AB (5%)	-	D
		E21H	I	Groot/Leeu	AB	B (40%); AB (60%)	-	B
		E21J	I	Groot	AB	AB (100%)	-	A

Table 10.4(*cont.*): Summary of Water Resource Classes and Ecological Categories per Quaternary Catchment

IUA	Water Resource Class for IUA	Quat. Drainage Region	Water Resource Class for Quaternary	River name	Mainstem Ecological Category	Tributary Ecological Category* (% of Incremental quaternary area)	Wetland area and Ecological Category*	Groundwater Category
Koue Bokkeveld	II	E21K	I	Maatjies	B	AB (100%)	wetland area 1.7% of quaternary, 99% in a AB condition	A
		E21L	I	Groot	AB	AB (100%)	-	A
Doring Rangelands	I	E22A	I	Doring	B	AB	-	A
		E22B	I	Doring	AB	AB (16%)	-	A
		E22C	I	Tankwa	AB	AB (5%)	-	A
		E22D	I	Tankwa	B	AB (95%)	-	A
		E22E	I	Doring	B	AB (30%)	-	A
		E22F	I	Doring	B	AB (100%)	-	A
		E22G	I	Doring	C	AB (100%)	wetland area 0.3% of quaternary, 100% in a AB condition	A
		E23A	I	Tankwa	AB	AB	wetland area 0.1% of quaternary, 100% in a AB condition	A
		E23B	I	Tankwa	AB	AB (20%)	wetland area 0.1% of quaternary, 100% in a AB condition	A
		E23C	I	Tankwa	AB	AB	wetland area 0.001% of quaternary, 100% in a AB condition	A
		E23D	I	Tankwa	AB	AB	wetland area 0.7% of quaternary, 100% in a AB condition	A
		E23E	I	Tankwa	B	AB (20%)	-	A
		E23F	I	Tankwa	B	B	wetland area 0.001% of quaternary, 100% in a AB condition	A
		E23G	I	Ongeluks	B	B (95%), AB (5%)	-	A
		E23H	I	Ongeluks	AB	AB (5%)	-	A
		E23J	I	Ongeluks	B	AB (40%)	-	A
		E23K	I	Tankwa	B	AB (30%)	-	A
		E24A	I	Tra-tra	B	AB (100%)	wetland area 0.1% of quaternary, 100% in a AB condition	A
		E24B	I	Tra-tra	B	B (50%); AB (50%)	wetland area 0.001% of quaternary, 95% in a AB condition	A
		E24C	I	Bos	C	B	wetland area 0.8% of quaternary, 100% in a AB condition	A

Table 10.4(*cont.*): Summary of Water Resource Classes and Ecological Categories per Quaternary Catchment

IUA	Water Resource Class for IUA	Quat. Drainage Region	Water Resource Class for Quaternary	River name	Mainstem Ecological Category	Tributary Ecological Category* (% of Incremental quaternary area)	Wetland area and Ecological Category*	Groundwater Category
Doring Rangelands	I	E24D	I	Bos	C	B	wetland area 0.1% of quaternary, 100% in a AB condition	A
		E24E	I	Wolf	AB	AB (5%)	-	A
		E24F	I	Wolf	B	AB	wetland area 0.001% of quaternary, 79% in a AB condition	A
		E24G	I	Wolf	B	AB (40%)	wetland area 0.001% of quaternary, 100% in a AB condition	A
		E24H	I	Doring	C	AB	-	A
		E40A	II	Oorlogskloo f	C	C (90%); AB (10%)	-	B
		E40B	II	Oorlogskloo f	C	C (70%); AB (30%)	wetland area 0.001% of quaternary, 100% in a AB condition	B
Knersvlakte	I	E31A	II	Kromme	B	B (85%); AB (15%)	wetland area 0.3% of quaternary, 100% in a AB condition	A
		E31B	I	Kromme	B	B (10%); AB (90%)	wetland area 0.1% of quaternary, 99% in a AB condition	A
		E31C	I	Kromme	B	B (65%); AB (35%)	wetland area 0.001% of quaternary, 100% in a AB condition	A
		E31D	I	Kromme	B	B	-	A
		E31E	I	Kromme	B	B	-	A
		E31F	I	Kromme	B	B	-	A
		E31G	I	Kromme	B	B (90%); AB (10%)	-	A
		E31H	I	Hantams	B	B (80%); AB (20%)	-	B
		E32A	I	Hantams	B	B (85%); AB (15%)	wetland area 0.1% of quaternary, 95% in a AB condition	A
		E32B	I	Hantams	B	B	wetland area 0.001% of quaternary, 100% in a AB condition	A
		E32C	I	Hantams	B	B (70%); AB (30%)	wetland area 0.1% of quaternary, 24% in a AB condition	A
		E32D	I	Hantams	B	B (85%); AB (15%)	-	A
		E32E	I	Hantams	B	B (30%); AB (70%)	wetland area 2.2% of quaternary, 48% in a AB condition	D

Table 10.4(*cont.*): Summary of Water Resource Classes and Ecological Categories per Quaternary Catchment

IUA	Water Resource Class for IUA	Quat. Drainage Region	Water Resource Class for Quaternary	River name	Mainstem Ecological Category	Tributary Ecological Category* (% of Incremental quaternary area)	Wetland area and Ecological Category*	Groundwater Category
Knersvlakte	I	E33A	I	Sout	B	B (60%); AB (40%)	wetland area 0.001% of quaternary, 100% in a AB condition	A
		E33B	I	Sout	B	B (95%); AB (5%)	wetland area 0.2% of quaternary, 100% in a AB condition	A
		E33C	III	Sout	D	D (95%); AB (5%)	wetland area 1.1% of quaternary, 92% in a AB condition	A
		E33D	I	Sout	B	B (65%); AB (35%)	-	B
		E33E	II	Sout	C	B (75%); AB (25%)	wetland area 1% of quaternary, 99% in a AB condition	B
		E33F	III	Hol	D	D	-	A
		F60A	I	Brak	B	B	wetland area 0.001% of quaternary, 1% in a AB condition	A
		F60B	I	Klein Goerap	B	B	-	A
		F60C	I	Sout	B	B	wetland area 0.001% of quaternary, 1% in a AB condition	A
		F60D	I	Groot Goerap	B	B	wetland area 0.001% of quaternary, 3.5% in a AB condition	A
		F60E	I	Groot Goerap	B	B	wetland area 0.001% of quaternary, 19% in a AB condition	A
Lower Olifants Irrigation	III	E33G	III	Hol	D	C	wetland area 1.9% of quaternary, 13% in a AB condition	C
		E33H	II	Olifants	D	B (95%); AB (5%)	wetland area 3.8% of quaternary, 5% in a AB condition	A
Olifants/ Doring Dryland Farming	III	E24J	II	Doring	C	AB (70%)	wetland area 0.001% of quaternary, 99% in a AB condition	B
		E24K	II	Doring	C	AB (20%)	-	A
		E24L	II	Brandewyn	B	C (90%); AB (10%)	wetland area 0.001% of quaternary, 100% in a AB condition	B
		E24M	II	Doring	C	C (40%); AB (60%)	wetland area 0.001% of quaternary, 100% in a AB condition	A
		E40C	III	Oorlogskloof/Koebee	D	B (25%); AB (75%)	-	A
		E40D	I	Oorlogskloof/Koebee	B	B (30%); AB (70%)	-	A

Table 10.4(*cont.*): Summary of Water Resource Classes and Ecological Categories per Quaternary Catchment

IUA	Water Resource Class for IUA	Quat. Drainage Region	Water Resource Class for Quaternary	River name	Mainstem Ecological Category	Tributary Ecological Category* (% of Incremental quaternary area)	Wetland area and Ecological Category*	Groundwater Category
Sandveld	III	G30A	III	Papkuils	C	C (95%); AB (5%)	wetland area 4.1% of quaternary, 35% in a AB condition	B
		G30B	II	Kruismans	C	C (50%); AB (50%)	wetland area 0.9% of quaternary, 10% in a AB condition	A
		G30C	III	Bergvallei	C	C (95%); AB (5%)	wetland area 1.5% of quaternary, 7% in a AB condition	C
		G30D	II	Verlorevlei	C	C (80%); AB (20%)	wetland area 0.8% of quaternary, 3% in a AB condition	B
		G30E	III	Verlorenvlei	C	C (90%); AB (10%)	wetland area 7.9% of quaternary, 3% in a AB condition	C
		G30F	III	Langvlei	C	C	wetland area 1.5% of quaternary, 5% in a AB condition	D
		G30G	III	Jakkalsvlei	C	C	wetland area 0.9% of quaternary, 11% in a AB condition	C
		G30H	II	Sandlaagte	C	C	wetland area 1.4% of quaternary, 25% in a AB condition	A

* Percentage of catchment area in an AB condition relates to Freshwater Ecosystem Priority Areas mapped

The Olifants Estuary (E33H) as well as the Verlorenvlei Estuary (G30E) should be maintained in a C Ecological Category.

Special conditions that should be included as part of the water resource classification for the WMA:

- No large dam or large weir development on the mainstream of the Doring, Groot, Riet, Verlorenvlei, Langvlei, Jakkals and Papkuils rivers.
- No new licenses for water abstraction in summer (low flow) period of the year in the mainstream of the Olifants upstream of Clanwilliam Dam, Doring, Groot, Riet, Verlorenvlei, Langvlei, Jakkals and Papkuils rivers.
- Reduction of low flow abstractions in mainstream of the Olifants upstream of the Clanwilliam Dam and increased off channel storage allowance from 6 000 to 8 000 cubic meter per hectare allocated water use.

11. REFERENCES

ANCHOR ENVIRONMENTAL CONSULTING. (2008). Olifants Estuary Situation Assessment. Report prepared for the C.A.P.E. Estuaries Programme.

BROWN, C.A. AND DAY, E.G. (1997).Olifants / DoringBasin Study.Impacts of the Water Resource Developments on the Riverine Ecosystem. Volume 3: Doring River Situation Assessment. Unpublished report to the Department of Water Affairs and Forestry.

C.A.P.E. (2009).C.A.P.E. Olifants-Doorn Catchment Management Agency Project.Prepared by Southern Waters, NinhamShand, GEOSS, CSIR (March, 2009)

CSIR (2009) Development of the Verlorenvlei estuarine management plan: Situation assessment. Report prepared for the C.A.P.E. Estuaries Programme. CSIR Report No.CSIR/NRE/CO/ER/2009/0153/B Stellenbosch.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, South Africa.(1990). Yield analysis of the area upstream of Bulshoek Dam. Prepared by R S Mackenzie, N W Shafer and W A G Venter of BKS as part of the Olifants River System Analysis. Internal Report No. 9278/01.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, South Africa.(1994). Hydrology of the Doring River.Prepared by S L Murray and A Görgens of NinhamShand (Pty) Ltd as part of the Olifants River System Analysis.DWAF Report No.P E200/00/0194.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, South Africa. (1998). Water Resources Evaluation: Hydrology. Prepared by G Howard of NinhamShand (Pty) Ltd as part of the Olifants/Doring River Basin Study.DWAF Report No.P E000/00/0398.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (1999). Resource Directed Measures for the Protection of Water Resources. Version 1.0.Pretoria, South Africa.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (2002).*Olifants-Doorn Water Management Area: Water Resources Situation Assessment.* Prepared by Ninham Shand (Pty) Ltd in association with Jakoet and Associates. DWAF Report No P 17/000/00/0101.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, South Africa. (2003). Olifants/Doorn Water Management Area: Overview of Water Resources Availability and Utilisation.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, South Africa.(2005a). Scenario Report. Prepared by A Sparks and C A Brown as part of the Olifants Doring Catchment Ecological Water Requirements Study.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, South Africa. (2005b). Olifants/Doorn Water Management Area: Internal Strategic Perspective. Prepared by NinhamShand (Pty) Ltd in association with Jakoet& Associates, Umvoto Africa, FST and Tlou&Matji on behalf of the Directorate: National Water Resource Planning. DWAF Report No P WMA 17/000/00/0305.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY. (2006). Resource Directed Management of Water Quality: Guideline for determining Resource Water Quality Objectives (RWQOs), Allocatable Water Quality and Stress of the Water Resource. Water Resource Planning Systems Series, Sub-Series No. WQP 1.7.2.1, Pretoria, South Africa.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY. (2007). Approved Reserve for the Olifants Doring catchment area.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY. (2007a). *Development of the Water Resource Classification System (WRCS). Volume 2.* Pretoria, South Africa: Department of Water Affairs & Forestry.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY. (2007b) Development of the Water Resource Classification System (WRCS): Socio-Economic Guidelines for the 7 Step Classification Procedure, Volume 3 (February, 2007);

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (2008).Integrated water resources management plan for the Sandveld, Olifants Doorn Water Management Area, Western Cape.Background Information to Management Plan.Consulting report for the Department of Water Affairs and Forestry.Compiled by A Belcher, J Conrad and D Grobler.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, South Africa (2009). System Analysis.Prepared by A Sparks and J Cullis of NinhamShand (Pty) Ltd and A Brown and Z Sulieman of DWAF as part of the Feasibility Study for the Raising of Clanwilliam Dam.DWAF Report No.P WMA 17/E10/00/0609.

DEPARTMENT OF WATER AFFAIRS. (2011a). Inception report for the Classification of significant water resources in the Olifants-Doorn WMA, Department of Water Affairs, South Africa. Belcher A., *et al* 2011.

DEPARTMENT OF WATER AFFAIRS. (2011b). Integrated specialist and scenario report for the Classification of significant water resources in the Olifants-Doorn WMA, Department of Water Affairs, South Africa (Draft). Department of Water Affairs, South Africa.Belcher A., *et al* 2011.

DEPARTMENT OF WATER AFFAIRS. 2012: Recommended Scenario Report for the Classification of significant water resources in the Olifants-Doorn WMA, Department of Water Affairs, South Africa.Belcher A., *et al* 2011.

DRIVER, A., NEL, J., SNADDON, K. MURRAY, K., ROUX, D., and HILL, L.(2011).Implementation Manual for Freshwater Ecosystem Priority Areas Report to the Water Research Commission Draft for NFEPA Steering Committee.

TURPIE, J.K., ADAMS, J.B., JOUBERT, A., HARRISON, T.D., KOLLOTY, B.M., MAREE, R.C., WHITFIELD, A.K., WOOLDRIDGE, T.H., LAMBERTH, S.J., TALJAARD, S. AND VAN NIEKERK, L.(2002). Assessment of conservation priority status of South African estuaries for use in the management and water allocation. Water SA 28: 191-206.

WATER RESEARCH COMMISSION (2005). Water Resources of South Africa, 2005 Study (WR2005): Inception report. Compiled by SRK Consulting, Stewart Scott International, Knight Piesold, NinhamShand, Arcus Gibb, PD Naidoo and UmfulaWempilo.