DEPARTMENT: WATER AFFAIRS
CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES
DIRECTORATE: WATER RESOURCE CLASSIFICATION

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

FINAL INCEPTION REPORT

MAY 2011

This report may not be copied or used unless full reference is made as follows:

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ACRONYMS

ADE	Aquifer Dependent Ecosystems
BHN	Basic Human Needs
C.A.P.E.	Cape Action Plan for People and the Environment
CD: RDM	Chief Directorate: Resource Directed Measures
CMS	Catchment Management Strategy
CSIR	Council for Scientific and Industrial Research
DEAT	Department of Environment Affairs and Tourism
D: RQS	Directorate: Resource Quality Services
DRIFT	Downstream Response to Imposed Flow Transformations
DSLF	Dry Season Low Flow
DSS	Decision Support System
DWA	Department of Water Affairs (previously DWAF)
EC	Ecological Category
EGSA	Ecosystem Goods, Services and Attributes
EIS	Ecological Importance and Sensitivity
EISC	Ecological Importance and Sensitivity Category
ELU	Existing Lawful Use
ESBC	Ecological Sustainability Base Configuration
EWR	Ecological/Environmental Water Requirements
GIS	Geographic Information System
GRU	Groundwater Response Unit
GW	Groundwater
I&AP	Interested and Affected Parties
IFR	Instream Flow Requirement
ISP	Internal Strategic Perspective
IUA	Integrated Units of Analysis
IWRM	Integrated Water Resource Management
LORWUA	Lower Olifants River Water User Association
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
Masl	metres above sea level
mbgl	metres below ground level
MC	Management Class
MSL	Mean Sea Level
MTIFR	Maintenance Total Instream Flow Requirement
NDSD	National Department of Social Development
NDA	National Department of Agriculture
NGDB	National Groundwater Database

nMAR	Naturalised Mean Annual Runoff
NMMP	National Microbial Monitoring Programme
NWA	National Water Act
PES	Present Ecological Status
PESC	Present Ecological Status Category
RDM	Resource Directed Measures
REC	Recommended Ecological Category
RHP	River Health Programme
RQOs	Resource Quality Objectives
RU	Resource Unit
RWQO	Resource Water Quality Objective
SAM	Social Accounting Matrix
SANBI	South African National Biodiversity Institute
SAWQG	South African Water Quality Guidelines
SW	Surface Water
TDGE	Terrestrial Dependent Groundwater Ecosystems
TDS	Total Dissolved Solids
TWQR	Target Water Quality Range
WMA	Water Management Area
WMS	Water Management System
WRCS	Water Resource Classification System
WSAM	Water Resource Situation Assessment Model
WTW	Water Treatment Works
WWTW	Waste Water Treatment Works

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 of physico-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 for Ecostatus (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.

Nodes: These are modelling points representative of an upstream reach or area of an aquatic ecosystem (rivers, wetlands, estuaries and groundwater) for which a suite of relationships apply.

Nodal reaches: the upstream reach or area of an aquatic ecosystem as represented by nodes.

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

The National Water Act (Act No. 36 of 1998) (NWA) is founded on the principle that National Government has overall responsibility and authority over water resource management for the benefit of the public, without seriously affecting the functioning of the natural environment. In order to achieve this objective, Chapter 3 of the NWA provides for the protection of water resources through a number of measures including the classification of all significant water resources. The Chief Directorate: Resource Directed Measures (CD:RDM) is tasked with the responsibility of ensuring that this chapter of the NWA is properly implemented.

The Water Resource Classification System (WRCS) is a legal requirement in terms of the National Water Act (NWA, No. 36 of 1998, Chapter 3, Part 1, Section 2(a)). The system provides a set of guidelines and procedures for determining the different classes of water resources, and will be used in a consultative (not consensus seeking) classification process to classify water resources in a phased and progressive manner over a period of time throughout South Africa. The classification process entails a seven-step classification process during which the social, economic and environmental implications of different class scenarios and 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 for approval.

The classification process requires the consideration of all aspects related to the water resources and freshwater biodiversity considerations must be integrated into the resource class scenario planning. It therefore requires consultation with a wide range of stakeholders (not restricted to the classic water users and associated industries). The outcome of the classification process provides a Management Class, Resource Quality Objectives and a Reserve requirement for rivers, estuaries, wetlands and aquifers according to predetermined resource units (Units of Analysis).

A Water Resource Classification System (WRCS) was developed for South Africa and has culminated into Regulations for the Establishment of the Water Resource Classification System, published as Regulation 810 in Government Gazette 33541 dated 17 September 2010. The Department of Water Affairs now wishes to embark on a detailed classification process for some of its priority catchments, of which the Olifants-Doorn WMA was identified as one.

In the development of the WRCS, the Olifants-Doring Catchment was used as a pilot catchment. This resulted in much of the information required for such a classification process being generated for the catchment; however the classification process or consultative process was not conducted. In addition, the Environmental Water Requirements for rivers and groundwater in the Sandveld has also been determined.

This project was awarded to BlueScience Consulting. The study is being conducted under the auspices of the Water Resource Classification Directorate of the Department of Water Affairs (DWA).

This report outlines the approach, methods, tasks, schedule and budget for undertaking the Classification of Significant Water Resources (rivers, wetlands, estuaries and groundwater) in the Olifants-Doorn Water Management Area (WMA 17).

1.2 OBJECTIVES

The Terms of Reference for this study are detailed in the Scope of Work presented in the Classification of Significant Water Resources in the Olifants-Doorn Water Management Area (WMA 17). The main objective of the project is to facilitate or co-ordinate the implementation of the WRCS, according to the 7-step process, within the Olifants-Doorn WMA. This is undertaken in order to classify all the significant water resources (rivers, wetlands, lakes, estuaries and groundwater) and to determine suitable management classes for these water resources.

Key objectives within the implementation of the classification process are:

1. It should be a consultative process (not necessarily a consensus-seeking process) to classify water resources;
2. It should help facilitate a balance between protection and use of the water resources in the Olifants-Doorn WMA, i.e. to recommend management classes (MC)s;
3. The economic, social and ecological implications of choosing a MC should be established and clearly communicated to all Interested and Affected Parties (I&AP), stakeholders and water users during the Classification Process; and
4. It should democratize the decision-making process and create stability in terms of decision making with regard to water resources management.
5. Ongoing capacity building of key stakeholders throughout the project period

1.3 OVERVIEW OF THE WRCS

Regulations for the Establishment of the Water Resource Classification System have recently been gazetted for South Africa (Regulation 810, Government Gazette No. 33541, 17 September 2010). The WRCS is required in terms of the National Water Act (NWA, No. 36 of 1998, Chapter 3, Part 1, Section 2(a)) and provides a set of guidelines and procedures for determining the different classes of water resources.

The WRCS is based on the principle of sustainable development and utilisation of water resources which is explicit to the South African Constitution. In line with this, fundamental principles to the NWA are that water-resource management must:

- Meet the water needs for current and future generations;
- Promote the efficient, sustainable and beneficial use of water in the public interest; and
- Protect aquatic and associated ecosystems and their biological integrity.

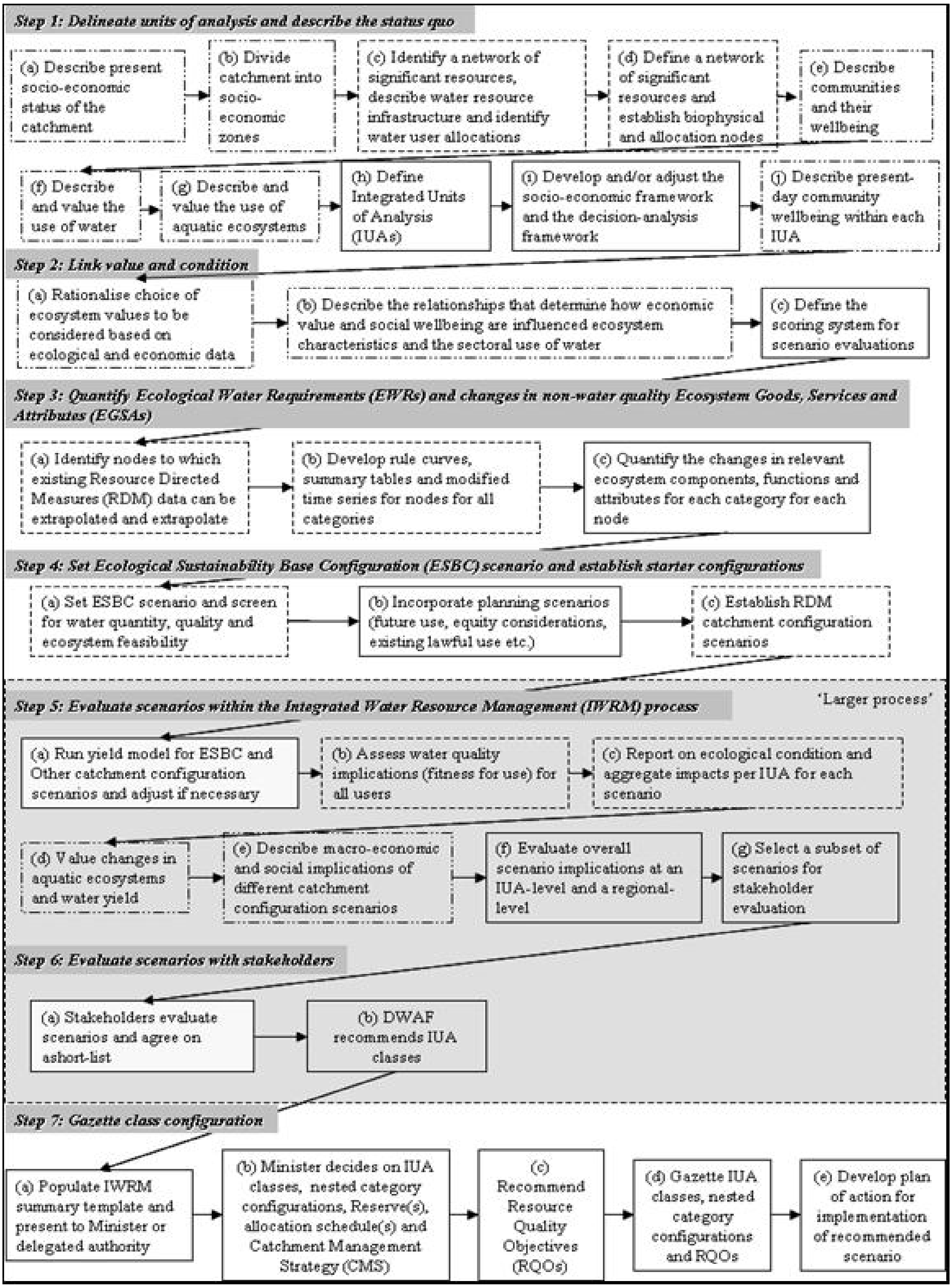

Figure 1: The 7-step water resource classification process

These fundamental principles are also central to the guiding principles of the WRCS: to balance resource protection and use; ensure sustainability of use; be in national interest and be consistent; be transparent; be implementable; address the interdependency of all resources within the hydrological cycle; be legally defensible and scientifically sound; be at an applicable scale for the management for the resource; be enforceable and auditable; allow for the lowest level of contestation and have the highest level of legitimacy amongst stakeholders; and must make use of existing tools, data and information.

A seven-step procedure (Figure 1) was developed for the determination of the Management Class (MC) that is to be recommended for a resource. To classify South Africa's water resources with the aim of achieving a balance between the protection and use of these resources, the WRCS must be used in a consultative manner. The outcome of the classification process is a MC, the Reserve and the Resource Quality Objectives (RQOs) for all identified significant water resources (rivers, estuary, wetlands and aquifers).

MCs will be:

- Defined for each sub-catchment within the WMA (referred to as the Integrated Units of Analysis [IUAs]);
- Defined in terms of the use that will be made of water resources in an IUA (Table 1); and
- Comprised of a configuration of aquatic ecosystem conditions, resulting in an 'overall condition'.

Table 1: Water resource management classes (MC)

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.

The WRCS is an integral component of the Integrated Water Resources Management (IWRM) environment and needs to be linked to other processes such as water resource planning and development and the management of its use. There is additional information requirement in the Classification Process that relate to socio-economic issues in the catchment that may not be highlighted in classification system documents.

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 estuaries. This outcome may influence the water yield that can be utilised from the resources, and indirectly activities within the catchment, such as land use.

1.4 SUMMARY OF SCOPE OF WORK

The following Scope of work and services was described in the Terms of Reference for the Project:

- ***Project Inception:*** This task is intended to provide the opportunity for the identification, assessment and interpretation of the nature and scope of the project and to document all the relevant information available in the WMA. The potential Integrated Units of Analysis are to be identified in this task and the budget adjusted if required.

- ***Water Resource Information and Data Gathering***: In this task the existing literature, reports, maps, aerial photographs and any other information for the WMA will be reviewed, specifically relating to the project.

- ***Determination of Management Class(es):*** The 7-steps of the WRCS will be followed in this task. Included in the task is the preparation of the WRCS templates for the WMA, documenting of the socio-economic and ecological findings, facilitating an independent review of the project reports, report on the capacity building initiatives within the project and submitting of the project reports for the technical and specialist work.

- ***Communication and Liaison:*** This task should include undertaking stakeholder, institutional and sectorial workshops, reference group meetings and task team meetings.

- ***Reporting***: The following project management outputs are required as part of this task: Progress reports, technical material, records of proceedings of stakeholder engagement, interim technical reports, project progress reports.

- ***Capacity building***: The establishment of capacity according to the capacity building programme.

1.5 DELIVERABLES

The following set of deliverables will be provided:

- *Draft and Final Inception reports which will include:*
  - *Gap analysis and recommendations to deal with the gaps;*
  - *Updating of available information;*
  - *A list of water resource models and applicability to the project;*
  - *A proposed schedule of meetings;*
  - *A proposed capacity building programme;*

- *A register of all stakeholders involved in the process as well as a database of all comments received and minutes of all meetings held;*
- *Capacity building programme;*
- *Progress reports at the end of Phase 2, 3a and 3b (refer to section 3);*
- *Economic, Social and Ecological Scenario reports;*
- *Scenario Integration report;*
- *External Review report;*
- *Water Resource Classification Templates; and*
- *A draft and final project technical report.*

2. OVERVIEW OF THE OLIFANTS-DOORN WMA AND INITIAL LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this section is to provide a general overview of the components that will be addressed in this classification project. For each of these components the following aspects were addressed:

- Identification and evaluation of relevant studies and reports in terms of their relevance to this project;
- Assessment of the information and data requirements for the various components of the project; and
- Identification of any additional data and information requirements and recommendations on how the gaps could be filled and the necessary information obtained.

2.2 SUMMARY OF PREVIOUS RIVER STUDIES AND MODELS

The Olifants/Doring River Systems have been the focus of several studies and initiatives over the past decade that has focussed mainly on assessing the potential of the rivers and groundwater for water resource developments. Most of these studies have to a greater or lesser extent also considered the impacts on the freshwater environment of proposed developments and in recent years the studies and projects have provided information that has contributed to the knowledge and understanding particularly of the resource protection aspects within the WMA, and will support the classification process to a large degree.

The focus of previous hydrological studies in the Olifants-Doorn WMA has been the Olifants-Doring system, which has been the subject of numerous studies at the quaternary level. The coastal rivers in tertiary drainage basin F60 as well as the Sandveld catchment in tertiary drainage basin G30 have not been studied in great detail, although they have been modelled as part of the WR90 and WR2005 studies. A brief summary of these studies is given below:

- Due to the growth of irrigation upstream of the Clanwilliam Dam, this area was declared a Government Water Control Area (GWCA) in the mid 1980s. The current and permissible irrigated areas as given in the **Government Gazette (1987)** were divided into three zones. Zone A consists of the area above the farm Keerom 511 and has an allocated irrigation quota of 940 mm/year. Zone B and Zone C make up the area between Keerom 511 and the Clanwilliam Dam. They both have an allocated irrigation quota of 1 220 mm/year.

- The **Olifants River System Analysis (ORSA) (BKS, 1990)** consisted of an assessment of the existing hydrology of the area upstream of Clanwilliam Dam and the extension of the hydrology to include the area down to Bulshoek Weir. This resulted in calibrated hydrology for the period 1920 to 1988 and a system configuration for the Upper Olifants River and calibrated hydrology for the period 1920 to 1990 for the Doring River.

- The **Olifants/Doring River Basin Study (ORBS) (DWAF, 1998)** consisted of an investigation into the yields and cost of developing potential dam sites in the Olifants and Doring River basins. Part of this study included a review of irrigated areas and associated water requirements. The sub-catchments defined for this study are referred to as hydro-catchments so as to distinguish them from the standard WR90 quaternary catchments used during later assessments. These hydrological sub-catchments have been further subdivided in more recent studies to accommodate the inclusion of instream flow requirement (IFR) sites for inclusion in the yield model. The major sub-division is in the Citrusdal catchment, which has been divided into two to accommodate an Instream Flow Requirement (IFR) site on the Olifants River. This subdivision occurs just downstream of Citrusdal and roughly coincides with the division between quaternary catchments E10E and E10F. This study resulted in the extension of hydrology from the ORSA (BKS, 1990) for the period 1920 to 1990 in the upper Olifants River and the extension of hydrology using WR90 (1920 to 1990) in the lower Olifants River.

- **Western Cape Olifants/Doring River Irrigation Study (WORDRIS) (PGWC, 2001)** used the same sub catchments as the Olifants/Doring Basin Study to estimate the total irrigation demand. The irrigated area given in this report is the same as that of the Olifants/Doring Basin Study, but the water requirements have been recalculated and show a slight increase.

- **Olifants-Doorn Water Management Area: Water Resources Situation Assessment (DWAF, 2002)** gives only an estimate of the total irrigated area for the upper Olifants River (i.e. above Bulshoek weir) of 107 km^2 and associated demand of 80 millionm^3/a. No hydrological analysis was undertaken.

- The **Olifants/Doring River Basin Study (Phase II) (DWAF, 2003)** investigated the potential raising of the Clanwilliam Dam. While the hydrology records were extended by ten years from 1989 to 1999, no changes were made to the irrigation requirements upstream of Bulshoek Weir. Hence the irrigation areas and water requirements used were the same as for Phase I of the ORBS (DWAF, 1998). The water requirements downstream of Bulshoek were revised based on a survey conducted in 1998.

- The **Olifants/Doring River Comprehensive Reserve** determination study in 2006 for DWA where a Comprehensive Reserve determination for six sites on the Olifants and Doring rivers was done, and this resulted in Environmental Water Requirements (EWRs) for a range of possible future conditions for the six sites and the Olifants estuary site;

- The use of the **Olifants/Doring Catchment for pilot testing the development of the Water Resource Classification System** in 2006. The Comprehensive Reserve data was used to extrapolate EWRs to 46 nodes throughout the catchment as part of the proof of concept activities for the development of the Water Resource Classification System (WRCS). Cumulative EWRs for B, C and D ecological conditions were determined for each of these nodes. In addition, incremental EWRs for B, C and D conditions were determined for the river reaches represented by each node. A Comprehensive Reserve Determination for the estuary was included in the development of the WRCS. Approval of the preliminary Reserves and resource classes for the preferred configuration for the Olifants and Doring rivers as part of the pilot testing of the WRCS by the Director General of DWA (the classification delegated authority of the Minister) was granted in July 2008 for 51 nodes which included the estuary. The following figures are of the hydrology balance sheet that was compiled during the classification system development and was used for the scaling of the ecological Reserve to the entire catchment.

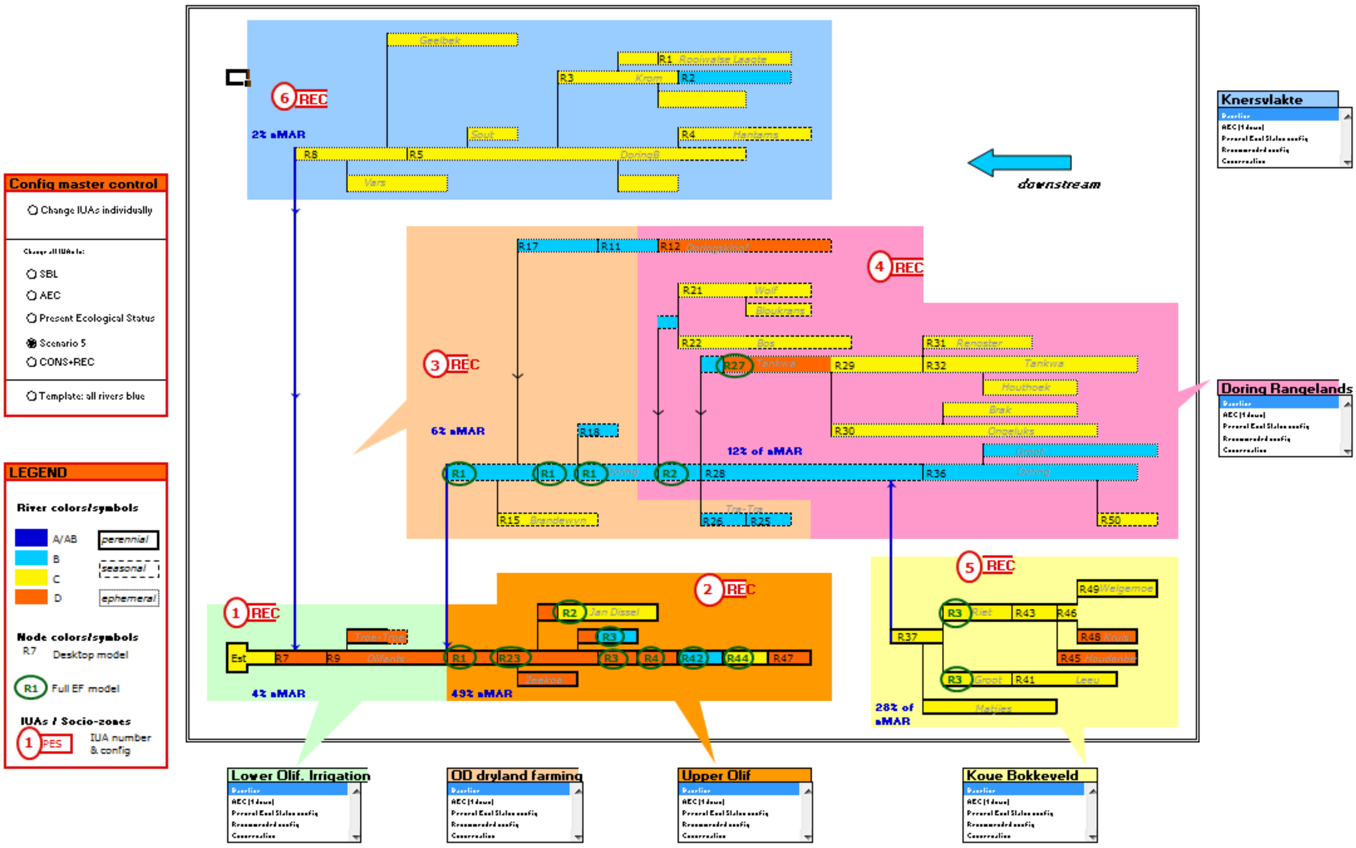

Figure 2: Catchment configuration for Scenario 5 which was selected as the optimal configuration

Node	Quaternary Single	Multiple			Ecol Category (Node) D C B A/B	PES ntribution of incremental ### ### ### ###	Increm input	Chann el evap	Cumul flow	EWR at node	Balance	Linked to Ecol Categ controls		
49	E21B		0			E/F	10.760		10.760	5.100	5.660	2		C
48	E21A		0			E/F	6.980		6.980	4.906	2.074	1		D
46	E21C		2	49,48		E/F	10.000	0.18	27.560	16.403	11.157	2	2	C
45	E21D		0			E/F	9.080		9.080	6.376	2.704	1		D
43	E21E		2	46,45		B	11.760	0.40	48.000	29.016	18.984	2	3	C
39	E21F		1	43		B	9.900	0.71	57.190	35.738	21.452	2	3	C
41	E21G		0			B	12.240		12.240	6.277	5.963	2		C
38	E21H	E21J	1	41		B	45.504	0.15	57.594	31.450	26.144	3	4	C
37	E21K	E21L	2	38,39		B	18.240	0.60	132.424	55.167	77.257	2	4	C
50	E22C	E22D	0			C	6.920		6.920	1.752	5.168	2		C
36	E22A	E22B E22E E22F	1	50		B	8.960	1.77	14.110	5.787	8.323	3	2	B
28	E22G		2	37,36		B	0.880	1.26	146.154	145.595	0.559	3	4	B
32	E23A	E23B E23C E23D	0			C	8.040		8.040	2.041	5.999	2		C
31	E23E		0			C	2.640		2.640	0.667	1.973	2		C
29	E23F		2	32,31		C	0.100	0.56	10.220	2.760	7.460	2	1	C
30	E23G	E23H E23J	1	29		C	3.200		13.420	3.566	9.854	2		C
27	E23K		2	28,30		C	0.100	0.84	158.834	28.793	130.041	1	1	D
25	E24A		0			B	10.380		10.380	2.642	7.738	3		B
26	E24B		1	25		B	6.180	0.49	16.070	4.163	11.907	3	3	B
21	E24C	E24D	0			C	6.360		6.360	1.675	4.685	2		C
22	E24E	E24F E24G	0			C	5.520		5.520	1.480	4.040	2		C
20	E24H		4	27,26,21,22		B	1.600	2.00	186.384	173.797	12.587	3	2	B
19	E24J		1	20		B	8.120	1.61	192.894	183.071	9.823	3	2	B
16	E24K		1	19		C	6.120		199.014	187.714	11.300	3		B
12	E40A	E40B	0			C	2.680		2.680	0.519	2.161	1		D
11	E40C		1	12		B	2.720	1.38	4.020	3.080	0.940	3	2	B
17	E40D		1	11		C	2.800	1.33	5.490	4.160	1.330	3	2	B
15	E24L		2	16,17		C	9.360	2.01	211.854	90.428	121.426	2		C
14	E24M		1	15		C	5.880	1.77	215.964	215.190	0.774	3	3	B
47	E10A		0			C	12.280		12.280	11.548	0.732	1		D
44	E10B		1	47		C	41.880	0.11	54.050	28.771	25.279	2	3	C
42	E10C		1	44		B	29.880	0.21	83.720	71.430	12.290	3	3	B
40	E10D		1	42		C	9.800	0.28	93.240	57.364	35.876	1	1	D
33	E10E	E10F	1	40		D	21.000	0.77	113.470	88.000	25.470	1	1	D
24	E10H		0			D	27.640		27.640	7.170	20.470	2		C
23	E10G	E10J	2	33,24		D	12.700	2.16	151.650	88.796	62.854	1	1	D
13	E10K		1	23		D	1.880	0.73	43.890	43.890	0.000	1	2	E/F
4	E32A	E32B E32C	0			C	3.440		3.440	0.104	3.336	2		C
2	E31B	E31C E31D E31E	0			C	1.860		1.860	0.436	1.424	3		B
1	E31G		0			C	0.160		0.160	0.066	0.094	2		C
3	E31F	E31H E32E	3	4,2,1		C	0.880	0.20	6.140	2.308	3.832	2	1	C
5	E33A	E33B	1	3		C	0.260	0.05	6.350	1.989	4.361	2	1	C
8	E33C	E33D E33E	1	5		C	0.600	0.10	6.850	1.301	5.549	2	1	C
9	E33F	E33G	2	14,13		D	1.160	1.30	259.714	91.430	168.284	1	1	D
7	E33H		2	8,9		D	0.120	0.34	266.344	178.511	87.833	1	1	D
Est	E33H		1	7		C	0.120		266.464	297.500	-31.036	2	1	C

Figure 3: Water balance sheet for Scenario 5 which was selected as the optimal configuration for the Olifants Doring catchments

- **Groundwater Reserve determination studies** - Parsons and Associates (2000) completed a rapid Reserve determination for groundwater in the Olifants-Doring Catchment. GEOSS (2003) then developed the Terms of Reference for more comprehensive Groundwater Reserve determinations for the Olifants-Doring Catchment. This study was undertaken by SRK in 2006. The level of determinations undertaken were based on the importance, sensitivity and the demand for groundwater, where higher confidence Reserves were undertaken for catchments E21A – K; E22C, D; E24M; E3E – H and E40A and B; and low confidence determinations were done for most of the remaining catchments. The G30 catchments in the Sandveld were later addressed at the high confidence level in a separate study (Conrad, 2006). Parsons and Associates also determined the Reserve for the E10 catchments in a project funded by the Water Research Commission (Flanagan *et al*., 2006);

- Ongoing **River Health surveys** have been undertaken and based on these results the State of the River Report for the Olifants/Doring WMA was compiled in 2006;
- **Biodiversity conservation planning for the Olifants-Doorn WMA** include a 2006 freshwater biodiversity plan for the entire Olifants-Doorn WMA which was undertaken at a coarse scale and the C.A.P.E. fine-scale plan, which was a 2008 integrated terrestrial and freshwater fine-scale biodiversity plan for parts of the Olifants-Doorn WMA;
- **Implementation of Integrated Water Resource Management in the Olifants/Doring Catchment** as part of the DANIDA initiative in 2008;
- The **establishment of Water User Associations** (WUAs), in particular the Lower Olifants River WUA, LORWUA;
- The **establishment of the Catchment Management Reference Group** in preparation of the establishment of the Olifants-Doorn Catchment Management Agency (CMA) in 2003;
- The development of a **proposal for the establishment of the Olifants-Doorn CMA** in 2005; and
- The Olifants-Doorn WMA: **Olifants-Doorn Internal Strategic Perspective** (ISP) in 2005;
- **Environmental Impact Assessment and Feasibility Study for the Raising of Clanwilliam Dam in the Western Cape (DWAF, 2007)** – System Analysis verified the behaviour of existing yield model configuration and determined the optimum size of the proposed Clanwilliam Dam. The system model includes the river catchments in primary drainage region E and excludes the coastal rivers in tertiary drainage basin F60 and the Sandveld rivers in tertiary drainage basin G30. The hydrology from 1920-1990 was based on stream flow sequences from earlier studies: the Olifants River System Analysis and the Olifants/Doring River Basin Study. Historical stream flow sequences from 1991 -2005 were determined to check the severity of the 2003 to 2005 drought during this study, but they were not naturalised.

  The system model from the Feasibility Study for the Raising of the Clanwilliam Dam used the hydrology from the Olifants/Doring River Basin Study (DWAF, 2003) which was also used in the Comprehensive Reserve Determination Study for the Olifants/Doring (DWAF, 2008).

- **Compulsory Licensing in the Jan Dissels River Catchment (2007)** – established the existing lawful water use from Oct 1996 to Sept 1998 through a process of validation and verification. Natural stream flows for the period: 1901-2006 were calibrated at flow gauge E1H006, and extrapolated to a daily model in Excel. The EWR are based on Rapid II Reserve for the Jan

Dissels River. The proposed allocation schedule for Jan Dissels has been drafted and it is anticipated that gazetting thereof will be concluded in June 2011.

- Cape Action Plan for People and the Environment (C.A.P.E.) initiatives in the WMA consisted of the following:
    - Proclamation of the Greater Cederberg Biodiversity Corridor as part of C.A.P.E.;
    - C.A.P.E. fine-scale planning of the south western portions of the Olifants-Doorn WMA in 2008;
    - The C.A.P.E Ecological Reserve Implementation Project that focused on capacity building of resource protection aspects in the Olifants-Doring in 2008;
    - C.A.P.E. Olifants-Doring Catchment Management Agency project, Catchment Management Strategy, Water-Resource Protection Sub-strategy 2008/9; and
    - Development of an Estuary Management Plan for the Olifants-Doring Estuary and Verlorenvlei in 2008/2009.
- Integrated Water Resources Management Plan for the Sandveld, Olifants-Doorn Water Management Area, Western Cape, prepared for DWA Western Cape in 2008.
- During 2010 the DWA has appointed a team of scientists to reconsider the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the Olifants-Doorn WMA. The integration between the classification of the water resources of the Olifants-Doorn WMA and this project is essential to ensure that all available information is utilised and that scientific consensus is sought in terms of the present ecological state (PES) of the water resources and in particular to address the small tributaries in the upper parts of the catchments.

2.3 DESCRIPTION OF THE OLIFANTS-DOORN WATER MANAGEMENT AREA

The Olifants-Doorn Water Management Area (WMA) comprises of the Olifants, Doring, Kouebokkeveld, Knersvlakte and Sandveld areas (Figure 4). The Olifants River is the main river within the WMA. It flows to the north-west, through a deep, narrow valley that widens and flattens into a wide floodplain below Clanwilliam. The Doring and Sout rivers are major tributaries. The Sandveld comprises the seasonal Verlorenvlei, Langvlei and Jakkals rivers which flow westwards of the Olifants River towards the Atlantic Ocean.

Water abstractions from surface and groundwater throughout the Water Management Area (WMA) have further modified flow, particularly reducing low flows in summer. Major impacted rivers are the Doring tributaries, Sandveld rivers and the lower Olifants River. Modified flows have reduced habitat integrity and consequently the goods and services provided by the rivers (breakdown of pollutants). Land-use in the area consists largely of livestock farming (sheep and goats), with small areas being used for dryland farming. Citrus, grapes, deciduous fruit and potato farming is intensive in the south-west. Urban and rural areas are small, with the main towns being Citrusdal, Clanwilliam, Vredendal, Vanrhynsdorp, Niewoudtville, Calvinia and Lamberts Bay.

2.3.1 Hydrology

A significant portion of the Northern Olifants-Doorn Water WMA falls within the drier Northern Cape Province, with the remainder of the catchment falling within the wetter Western Cape Province. The major rivers in the WMA are the Olifants, Doring, Krom, Sand and Sout rivers which are located in primary drainage basin E and tertiary drainage areas G30 and F60, which together comprise of 88 quaternary catchments. The WMA has a total catchment area of some 53 893 km^2 and an estimated mean annual runoff (MAR) of 1065 million m^3/a. The WMA lies within the winter rainfall region of South Africa and mean annual precipitation (MAP) varies from 900 mm/a in the south-west to less than 100 mm/a in the north-west.

The Olifants/Doring River system consists of two distinctly different rivers. The perennial Olifants River which is heavily impacted due to the catchment's suitability to agriculture and is therefore more developed and more populated, while the Doring River valley is sparsely populated and relatively unimpacted. The flow requirements for the lower Olifants River and the estuary are supported primarily by the contributions from the Doring River.

The seasonal Langvlei, Jakkals and Velorenvlei river systems are the most significant in the Sandveld area. The predominant drainage direction is from the southeast to the northwest. The systems are in an arid environment and are highly seasonal, with only streams within the upper Verlorenvlei catchment that flow throughout the year. The remaining catchments mainly to the north east, experience no flow for more than 33% of the year.

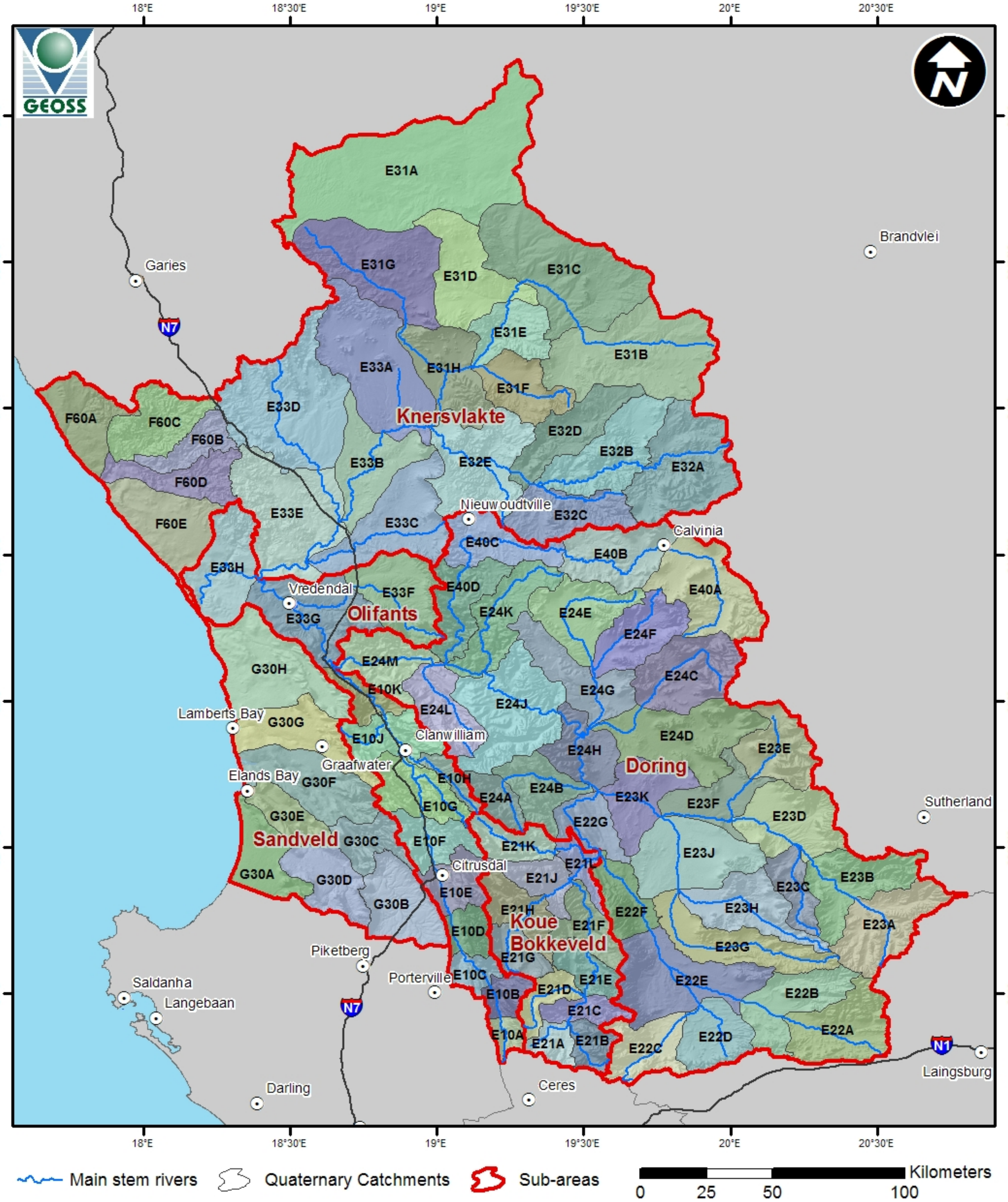

Figure 4: Major catchment and quaternary catchments of the Olifants-Doorn WMA

2.3.2 Water Quality

The surface water quality of the Olifants-Doorn WMA is quite variable, ranging from pristine and "ideal" for all uses in the headwaters and mountain catchments, to naturally saline flowing from the tributaries originating in the north eastern parts of the catchment and "unacceptable" for most uses in the Knersvlakte, to very saline upstream of the Olifants River estuary as a result of irrigation return flows in the lower Olifants River.

Upper Olifants sub-catchment

Water quality in the upper Olifants River catchment, upstream Clanwilliam Dam, is classified (DWAF, 2006) as 'ideal' and suitable for all uses. There is a slight increase in the concentrations of total dissolved solids (TDS) in a downstream direction. Previous studies (DWAF, 1998) found that there was a difference between unimpacted catchments and the main stem of the Olifants River, which was impacted by agricultural activities. Physical and chemical characteristics of the Olifants River gorge and the mountain river reaches largely resemble natural conditions in unimpacted streams of the Western Cape. Water quality is very good until the valley widens at Citrusdal. Unimpacted catchments, like the Jan Dissels River, showed evidence of a seasonal trend in the TDS data. The seasonal trend indicated elevated TDS concentrations at the end of summer (March/April) due to an evaporative concentration effect, and decreased concentrations at the end of winter (July – October) due to dilution with winter rainfall run off. It was found that TDS concentrations in the main stem of the Olifants River were higher but still suitable for agricultural and domestic purposes (DWAF, 1998). No long-term temporal trend was evident but there were strong seasonal variations with higher concentrations early in winter probably originating from the wash-off of accumulated salts from the catchment, and reduced concentrations at the end of the winter rainfall season due to dilution. The middle reaches of the river (Citrusdal to Bulshoek Dam) are impacted by agricultural activities which lead to elevated levels of dissolved and suspended solids, and nutrients, in particular nitrates. The effect of poorer water quality is exacerbated during the summer months.

There are some concerns about moderately elevated phosphate concentrations in the Olifants River downstream of Citrusdal, probably the result of treated domestic wastewater discharges to the river. However, both Clanwilliam and Bulshoek dams were classified as meso-trophic dams meaning they were regarded as moderately enriched with nutrients. Concerns have been expressed about bacteriological pollution upstream of Citrusdal and in response to these concerns, the National Microbial Monitoring Programme (NMMP) has established monitoring points on the Olifants and Boontjies rivers (NMMP, 2008). No concerns have been raised in the upper Olifants River about unnatural pH values nor have there been concerns about trace metals. The presence of pesticide and herbicide residues in irrigation return flows can be a concern but no surveys have been undertaken in the upper Olifants River to determine if this concern was valid. In the Olifants River downstream of Clanwilliam Dam and upstream of the Doring River confluence the water quality remained suitable for agriculture and domestic water supplies even though irrigation return flows are already impacting the mainstream Olifants River between Bulshoek Dam and the Doring River confluence.

Doring River sub-catchment

The quality of water in the upper Doring River (E22), when flowing, is suitable for agriculture and domestic water supplies. Water quality in the middle Doring River (E24) is marginal and TDS concentrations increase in a downstream direction. In the lower reaches, the water quality varies between good at the end of winter and marginal at the end of summer, largely as a result of the predominantly winter rainfall in the catchment. The water quality is still suitable for all uses but it does indicate a slow deterioration over time. It has been reported (Dr Cate Brown, Southern Waters pers. com. 2004) that farmers stop irrigating when the water begins tasting salty. Highly saline flows from the Tankwa Karoo tributaries have a sporadic influence on water quality in the mainstream Doring River.

Lower Olifants sub-catchment

In the lower Olifants River, downstream of the Doring River confluence, salinity increases in a downstream direction due to irrigation return flows entering the river. In the lower reaches near Lutzville, salinity is classified as 'unacceptable' for irrigation purposes (DWAF, 1998, DWAF, 2002). No nutrient data was available for the lower Olifants River although one can expect the irrigation return flows to contain elevated nitrogen concentrations. Concerns have been expressed about bacteriological pollution in the lower Olifants River and in the irrigation canals. The National Microbiological Monitoring Programme (NMMP) has established monitoring points on the main stem river and the irrigation canals, because some households abstract water for domestic use directly from the canals (NMMP, 2008). No concerns have been raised about trace metals or pH values in the lower Olifants River. The presence of pesticide and herbicide residues in irrigation return flows is a potential concern, especially if the findings of a pesticide study in the Western Cape (Hex River, lower Berg River and Grabouw area) (London *et a*l., 2000) are extrapolated to the lower Olifants River.

The water quality status in the Oudekraal (E23), Oorlogskloof (E40), Kromme (E31), Hantams (E32), and Namaqualand (F60) areas is not adequately known due to very limited monitoring. It should be noted that water availability in these rivers is limited.

Sandveld sub-area

In the Sandveld sub-area water quality is classified as "tolerable" to completely "unacceptable" in the Kruis River catchment (upper reaches of the Verlorenvlei River) due to elevated salinities. It improves slightly in a downstream direction but the lack of data precludes any meaningful conclusions to be drawn about water quality in the Verlorenvlei River and in Verlorenvlei itself. The cause of the poor water quality is the result of agricultural activities on the Malmesbury shales, which are naturally high in salts and cover a large part of the Kruis River catchment (Sinclair *et al*., 1986).

Summary of water quality issues and concerns in the Olifants-Doorn WMA

Microbiological water quality in the Upper Olifants River - The Olifants River supports a very important fruit export industry in the middle and lower Olifants River valley. Poor quality treated effluents from the towns of Citrusdal and Clanwilliam can put this industry at risk. The impacts of effluent return flows should be monitored and reviewed on a regular basis in light of the European Common Agricultural Policy standards (EUROCAP) to ensure that the export market is not jeopardised. Water quality management in the upper Olifants River should ensure that export standards for the agricultural industry are met. Many households use water from the irrigation canals for domestic purposes. Preventing microbial pollution would also protect these users.

Nutrient enrichment in the upper Olifants River - The Citrusdal valley experiences nutrient enrichment problems which are largely attributed to agricultural return-flows, especially in the summer months when the flow is relatively low in the river. Poorly treated domestic wastewater, poor municipal solid waste management and run off from informal settlements contribute towards this problem.

Impacts of irrigation return flows - Agricultural activities in this WMA include a wide variety of crop types, many of which are high value produce. The cultivation of wine and table grapes, rooibos tea, citrus, deciduous fruit, wheat, potatoes, flower cultivation and wildflower harvesting, livestock and fisheries contribute to the sector. Wine and dried fruit are important value-added products. Irrigation water use is the largest water user and only a small percentage of crops are dry-land crops due to the low rainfall over most of the WMA. Irrigation is with good quality water from the irrigation canals but farmers tend to over-irrigate in order to leach out salts that accumulate in their irrigated soils. The leach water is returned to the middle and lower Olifants River resulting in a progressive deterioration in water quality. The irrigation farming industry should investigate alternative disposal and/or re-use practices to reduce their impact on the lower Olifants River.

Concerns have also been raised about the impacts of effluents from fruit and wine industries which cause seasonal water quality problems and it was recommended that the wine industry effluents from Klawer, Vredendal and Lutzville required on-going monitoring and management. Effluent from fruit and wine industries also needs to be monitored in the Citrusdal area.

Impacts of agro-chemicals - Concerns have been raised about the impacts of residues from agricultural chemicals such as pesticides and herbicides on surface and sub-surface waters in intensive irrigation areas. Such impacts have not been studied in the middle and lower Olifants River but research in similar irrigation developments have shown that residues should at least be monitored to validate concerns.

Protection of the upper Olifants River catchment - The high winter rainfall and the natural geology in the upper reaches of the Olifants River ensure that the water quality is good. Catchment management should focus on protecting the upper Olifants River in order to protect the water quality in Clanwilliam Dam, the main source of water to the Olifants River government water scheme.

2.3.3 Ecological Status

The ecological characteristics of the rivers, estuaries and wetlands of the Olifants-Doorn WMA are described below for the Olifants/Doring and Sandveld catchments:

Olifants/Doring River System

The Olifants River rises in the Skurweberg and Witzenberg Mountains surrounding the Agter Witzenberg and flows northwards. It is a perennial river with relatively high flow variability. In winter the flow is very strong, whereas in summer irrigation abstractions reduce the river to very low flow between large pools. The Olifants River mainly drains sandstones and quartzites of the Table Mountain Group, Bokkeveld Group shales in its upper reaches and Tertiary to Quaternary sands, together with some Nama Group outcrops (SACS 1980).

The extensive agriculture in the Clanwilliam and Agter Witzenberg Valleys and numerous farm dams, as well as the large instream Clanwilliam and Bulshoek dams have had a considerable negative impact on the ecological health of the lower Olifants River.

The Doring River drains the eastern slopes of the Cedarberg, the Swartruggens and the western Roggeveld Mountains. The Doring River is a seasonally flowing river, also with high flow variability, where in winter the river is strongly flowing and in summer the river consists of pools. The Doring River in the western and extreme southern portion of its catchment area drains sandstones and quartzites of the Table Mountain Group, Bokkeveld Group shales and Witteberg Group quartzites and shales. The eastern parts of the catchment consist of Karoo Super Group rocks: the easily-eroded Dwyka Formation tillites and the Ecca Group shales and sandstones (SACS 1980). This river contributes a very large proportion of the silt carried down to the Olifants River (Morant 1984). The Doring River confluence with the Olifants River is approximately twenty kilometres downstream of the Bulshoek Dam.

The Olifants and Doring rivers support ten endemic fish species, eight of which are endemic to these systems. There are three cyprinid redfin minnow (*Barbus* and *Pseudobarbus* spp.), two rock catfish (Austroglanididae), and three large cyprinid species (*Barbus* and *Labeo* spp.). The three redfin minnow and two catfish species are restricted to the headwaters of tributaries, whereas the three larger cyprinids occur throughout the mainstem and tributaries of both systems. In addition to the endemic species, there are two other indigenous species with wider South African distributions, a small cyprinid *Barbus anoplus*, which occurs in the northern tributaries of the Doring River, and the Cape Kurper *Sandelia capensis,* which is endemic to the Western Cape, but may have been introduced into the Olifants River. Bass (*Micropterus* spp.) and bluegill sunfish *Lepomis macrochirus* that have been introduced into the system pose a significant threat to the indigenous species.

Abstraction, particularly in the Olifants River, is believed to have contributed to the decline in numbers and range of the three large cyprinids, i.e. Clanwilliam yellowfish *Labeobarbus capensis*, the sawfin *Barbus serra* and Clanwilliam sandfish *Labeo seeberi*.

Olifants Estuary

The Olifants Estuary is one of the two major estuaries on the west coast of South Africa. The estuary is still largely in a pristine state, however the MAR from the catchment into the estuary has been reduced by 34 per cent, from 1 042 x 10^6 m^3/a under natural conditions to 691 10^6 m^3/a at present. Run-off from the catchment area is seasonal with high flows and major floods during the winter months and low flows during the summer months. The baseflow during the summer months is strongly influenced by return flow from irrigation water along the river that results from agricultural developments along the Olifants River. Saltworks are found near the mouth of the estuary.

The mouth of the Olifants Estuary is permanently open and because of the length of the estuary and the still relatively high run-off of the system, it is considered highly unlikely that the mouth will close under present day conditions. The estuary has a strong tidal influence with a tidal difference of 1 m being recorded at the Lutzville causeway 36 km upstream. Saline water has been recorded at the Lutzville causeway but the tidal prism seldom extends further than Ebenhaeser situated 15 km upstream (Morant 1984). Water depths in the upper estuary range from 1-3 m whereas in the lower 2 km it varies from 0.5-7 m along the southern and northern bank respectively.

In a botanical importance rating of 33 Cape estuaries (Coetzee *et al.* 1997) the Olifants Estuary achieved the highest score. The Olifants estuary also had the highest score in the estuarine health index (EHI) survey of the west coast (Harrison *et al*. 1994) and has been ranked amongst the top 10 estuaries important for waterbird conservation in South Africa. The Olifants Estuary is important botanically as it has large areas of intertidal and supratidal salt marsh in the lower reaches that are in good condition. Other macrophytes in the estuary include the submerged macrophytes *Zostera capensis* and *Potamogeton pectinatus* and emergent macrophytes *Phragmites australis* and *Scirpus littoralis*.

The Olifants Estuary fauna is similar but richer than that of the adjacent Berg Estuary. Some 45 species of aquatic invertebrates have been recorded from the Olifants Estuary. A total of 30 fish species from 21 families have been recorded from the Olifants Estuary (Lamberth, unpublished; Day 1981, Morant 1984; Harrison *et al*. 1994). Six of these are entirely dependent on estuaries to complete their life cycle. These are *Gilchristella aestuaria* and *Psammogobius knysnaensis*, which breed only in estuaries and *Lichia amia*, *Mugil cephalus*, *Myxus capensis* and *Lithognathus lithognathus*, which are dependent on estuaries as nursery areas. A further 12 species, e.g. *Pomatomus saltatrix* and *Syngnathus acus,* are at least partially dependent on estuaries.

Sixty percent of the fish species recorded in the Olifants River can be regarded as either partially or completely dependent on estuaries for their survival. Eight of the remaining species were marine species, e.g., *Sardinops sagax* and *Argyrosomus inodorus,* which occur in, but are not dependent on, estuaries. Four are euryhaline freshwater species whose penetration into estuaries is determined by salinity tolerance, e.g., *Barbus serra* and *Oreochromis mossambicus*.

Sandveld Rivers

All three river systems in the Sandveld consist largely of a series of wetlands, connected by poorly defined river channels. The upper Jakkals River in particular consists of a series of temporary vleis and meadows, with a poorly defined central channel. Short sections of distinct river channels exist on the

Upper Verlorenvlei System (Kruis, Bergvallei, and Krom Antonies rivers) and the headwaters of the Langvlei tributaries (the Alexandershoek and Lambertshoek).

All of the systems assessed here were found to be largely groundwater driven or groundwater dependent ecosystems. Multiple freshwater springs or ‘eyes’, occur along the length of all three systems. Lateral intrusions of brackish to saline water also occur. Distinct variations in water quality and plant species occur throughout each of the three systems as a result.

Verlorenvlei

Verlorenvlei is one of the most important estuarine systems in the Western Cape and one of the largest natural wetlands along southern Africa’s west coast. The open water lake (13 km long, 1.5 km wide and 4.6 m deep) is linked to the sea by a narrow, hydraulically inactive estuary channel. Occasionally, winter flooding or high spring tides have known to breach the sandbar which overlies the rock-barrier obstruction at the mouth, resulting in interchange between the sea and the lake. Large evaporative losses occur from the lake during summer; however evaporation losses are compensated for by the significant contribution of groundwater to the lake, flowing in from the north-eastern side of the lake. The Velorenvlei River only feeds the lake during the rainfall months in winter and early summer.

This freshwater coastal lake is classified as a Ramsar site, an important feeding ground for several rare and threatened bird species. It is regarded as one of the ten most important wetlands for wading birds in the south-western Cape and is a particularly important feeding area for the white pelican. Indigenous freshwater fish species occurring in the wetland are the Cape galaxia and the rare Verlorenvlei redfin. Rare and threatened mammals such as the Cape clawless otter, *Aonyx capensis*, have also been recorded.

Several causeways disrupt hydrological fluctuations, cause siltation and prevent fish migration. Land surrounding the wetland is privately owned and intensive farming practices pose several threats to the surrounding vegetation (grazing, invasive alien vegetation and drawdown of groundwater). The vlei is also dominated by alien fish (carp and Mozambique tilapia).

Wadrif Saltpan/Langvlei Estuary

Wadrif wetland previously was a lush palmiet wetland but extensive groundwater abstraction in the late 1970’s for water supply to Lambert’s Bay resulted in the long-term drying out of the peat layers. As a result, during the 1990’s much of the vegetation in the wetland was destroyed by a fire, with little hope of regeneration.

Jakkals River Estuary

Jakkalsvlei is a small (~0.5 x 1.4 km) narrow seasonal vlei (coastal lake) that used to discharge via a small estuarine linkage to the sea. The linkage to the sea has been closed by the construction of a berm across the outlet.

Wetlands

A large number of wetlands occur in the Olifants-Doorn WMA and have been identified through the fine-scale planning project of C.A.P.E., these are discussed below according to their types. Groundwater abstraction, farming activities, sand mining, road/rail crossings and invasive alien trees such as *Prosopis* sp. are threats to these systems.

Arid floodplain wetlands: The arid floodplains (e.g. the lower Sout/Hol River system) tend to only flow only after good rains between June and August. They typically occupy broad river valleys, with alluvial sandy soils with some clayey depressions. Sandstone, granite or shale bedrock is observed within the riverbeds and a salt crust may develop in the riverbed over dry periods. The dominant vegetation type (Namaqualand Rivers) is characterised by a mixture of succulent shrubs and patches of grasses on the riverbeds and banks and a narrow band of trees (*Acacia karoo* or *Tamarix usneoides)*.

Alluvial floodplain wetlands: Alluvial floodplains occur in the Olifants River floodplain, Jan Dissels River, and the Verlorenvlei and its major tributaries – Kruismans, Krom Antonies, and Hol rivers. The rivers flowing through alluvial floodplain wetlands are both permanent and non-permanent systems. These floodplains are characterised by wide river valleys, where periodic inundation of the floodplain sustains wetland habitat. They tend to occur on acid sands, which can be deep in places. Sandstone and shale bedrock outcroppings are observed within river channels. The river channel itself is often braided, with secondary and tertiary channels meandering across the wide floodplain. Vegetation is diverse, including a band of perennial trees (often alien) and tall shrubs that occur on the wet river bank, with swathes of varying width of reeds, sedges and palmiet (e.g. in the Olifants River) extending on either side of the riparian trees. Other plant groups include restios, seasonal aquatics, annuals and bulbs (after floodwaters subside).

Sandveld floodplain wetlands: Sandveld floodplain wetlands occur along the Langvlei, Verlorenvlei and Jakkals River systems. All of the Sandveld rivers (with the exception of the Verlorenvlei) are seasonal in nature. The wetlands occur on alkaline to neutral silts and sands, which can be deep in places, and can lie over calcretes and clays. They tend to be saline, and have a high dependence on groundwater. Sandveld floodplains are often wide, sandy systems with braided channels within the wider floodplain. This vegetation type is dominated by small succulent shrubs, such as *Sarcocornia* spp., and rushes, *Juncus kraussii*. Trees, annuals, bulbs and grasses (with the exception of *Cynodon dactylon*) are rare. The botanical diversity is low.

Arid valley bottom wetlands: These wetlands are associated with rivers located to the north of the Sandveld (Klein/Troe-Troe river system, a section of the middle Olifants River, the lower Doring River and a number of small streams in the middle Olifants). These systems tend to have a well-defined channel, and are found associated with lower foothill or lowland rivers. Arid valley bottoms are vegetated, usually with reeds and sedges along the water's edge, but often invaded by reeds, *Phragmites australis*, where water is now more permanent as a result of disturbance. The river channels tend to be sandy/silty and unvegetated. Trees (usually alien) occur in the riparian zone. *Acacia karoo* could be expected to naturally occur in valley bottom wetlands.

Sandstone fynbos valley bottom wetlands are located in the lowlands and higher lying areas, where sandstone fynbos vegetation types occur. These systems are fed by hillslope seeps and comprise of a generally well-defined channel with riparian wetland of varying width. These valley bottom wetlands are typically associated with upper and lower foothill river systems, which can be permanent or seasonal, depending on location and aspect. Floating aquatics can occur in more permanent pools. The underlying soils are derived from sandstones, and are acid. The dominant vegetation is a mix of low to medium height herbaceous species – reeds, restios, grasses, sedges – and scrub shrub-type vegetation – small trees and proteomic and ericoid fynbos species.

Arid seeps are located along the lower Olifants River and its smaller tributaries and are defined by the climate (semi-arid) rather than the underlying geology or soils. The hillslope are mostly short systems, on the slopes of the hills to the west of the Olifants River. A single arid basin seep is situated on the Olifants River, near Ebenhezer. In the Doringrivier the seeps are dominated by sedges and grasses, and lie on a mix of acid to alkaline shale- and sandstone-derived soils. Seeps further north tend to be more arid with reeds where there is more permanent water, and riparian trees (*Acacia karoo* and *Prosopis)*. Arid seeps are fed primarily by precipitation and upstream surface flow, and are not considered to be particularly important for groundwater recharge.

Sandstone fynbos seeps are located in the mountain ranges on either side of the Olifants River (Western Cederberg and Kouebokkeveld mountains). These seeps are important areas for water supply, located near the source of rivers and streams, and for groundwater recharge. The seeps are both permanent and non-permanent, depending on location and slope, with those to the north being more arid. The seeps are also associated with the upper reaches of the Peddies River (tributary of the Jakkals River) and the Lambertshoek River (tributary of the Langvlei system). The seeps are fairly densely vegetated, and tend to be dominated by restioid (where sands are deeper) and proteoid fynbos and indigenous grasses, but can be invaded by reeds *Phragmites australis* and bulrush *Typha capensis*.

Sand fynbos basin seeps occur in the upper Sandlaagte River catchment, the Jakkals River and Verlorenvlei and in the middle to upper Langvlei catchment. The seeps occur on the coastal sand flats at low altitude (less than 150 m) on acid sands that are deep. The vegetation consists of patches of medium to tall shrubs, separated by dense restiolands. The seeps are generally vegetated, dominated by restios and the rush, *Juncus kraussii*, but can be invaded by the reeds *Phragmites australis* and the bulrush *Typha capensis*, where disturbed. *Sarcocornia natalensis*, which requires seasonal freshwater flooding, can occur in the seeps

Renosterveld hillslope seeps occur within the Renosterveld vegetation types on alkaline shale-derived clays in the upper reaches of tributaries of the Verlorenvlei. They tend to occur on gentle slopes at low altitudes and are dominated by sedges and grasses, but are often impacted and invaded by kikuyu grass, *Typha capensis* and *Phragmites australis*.

Strandveld basin seeps are all coastal systems, occurring on neutral to alkaline deep sands. A basin seep lying occurs near the Olifants River mouth, several others occur around the upper reaches of the Jakkals River and its tributaries, and one isolated hillslope seep occurs north of the Sandlaagte. They are isolated systems, fed seasonally by precipitation. They tend to occur on neutral to alkaline sands. None of the seeps appear to be important for groundwater recharge. The vegetation type is Cape Inland Salt Pan/Marsh with strandveld surrounding the seep.

Sandstone fynbos depression wetlands (isolated and non-isolated) occur in the upper Jakkals River catchment. These systems occur inland on gently sloped terrain. The seasonal, shallow (littoral) systems occur in depressions on acid sandstone-derived soils. They are fed by precipitation and are situated in groundwater recharge areas. The depressions are sparsely vegetated and tend to be dominated by restioid and proteoid fynbos and indigenous grasses and sedges, but can be invaded by the reeds *Phragmites australis* and the bulrush, *Typha capensis*.

Sand fynbos depression wetlands occur mostly in the west Sandlaagte, Jakkals, Langvlei and Verlorenvlei river catchments. These wetlands are found on acid deep sands, and tend to be fed by groundwater. The majority are isolated, shallow and seasonally inundated. They are mostly muddy or silty depressions which are unvegetated. Where vegetation does occur it is dominated by restios and the rush *Juncus kraussi*.

Strandveld depression wetlands are situated around the lower Langvlei system, in the Sandlaagte catchment, and a few are scattered around the lower and middle Olifants River. Strandveld depressions tend to be saline and can be vegetated or unvegetated. Those that are vegetated are dominated by grasses (such as *Cynodon dactylon*), *Sarcocornia* spp., and various restios, rushes and sedges.

Arid depression wetlands are located close to the Sout River in the Knersvlakte, alongside the Moedverloor River (a tributary of the Hol/Sout) and close to the middle Olifants River at its confluence with the Doring River. All of the arid depressions are fairly saline, ephemeral systems, which are only inundated after good rains in winter. They are silt or mud depressions that are unvegetated, with underlying geology and soils varying from acid to alkaline sands, sandstone- or shale-derived soils.

2.3.4 Groundwater

Groundwater is an important component of the hydrological resources of the Olifants-Doorn WMA and geological and hydrogeological conditions vary considerably. The main implication of this variability across the WMA is that groundwater quantity and quality varies significantly. Consequently the role groundwater plays in the socio-economic and ecological sectors also varies.

This chapter on the groundwater component of the WMA includes a brief overview of the hydrogeological setting briefly discussing geology, aquifer types, recharge, groundwater quality, groundwater/surface water interaction, groundwater dependent ecosystems and groundwater importance. Thereafter the classification work completed to date is discussed and the classification work still required is reviewed. The following section proposes methodologies to complete the groundwater classification for the catchments not yet addressed. A short discussion is held on capacity building within the project team for the geohydrological component.

There is no shortage of literature on the Olifants-Doorn WMA. Good information regarding groundwater is contained within the Internal Strategic Perspective (ISP) for the Olifants-Doorn WMA (DWAF, 2005). It discusses the geohydrological setting in some detail, even at the tertiary catchment sub-area level. Although a Catchment Management Strategy has not been finalised for the Olifants-Doorn WMA the draft version provides useful information. In addition the development of the Water Resources Classification System (WRCS) was developed and tested in the Olifants-Doorn WMA. A list of literature with specific reference to groundwater resource classification includes: Parsons and Associates (2000); GEOSS (2003); SRK (2006); GEOSS (2006); Southern Waters (2006); DWAF (2007) and C.A.P.E. (2009).

Geology

Table 2 summarises the geology of the Olifants-Doorn WMA. The geological description is taken from SRK (2006). The nature and composition (lithology) of each of the different stratigraphic units is considered. Hydrogeological characteristics, with regard to the permeability of the unit and its classification as an aquifer, aquitard or aquiclude, are also included. The geology of the Olifants-Doorn WMA is dominated by metamorphic rocks of the Nama Group in the north and sedimentary rocks of the Cape Supergroup in the southern and southwestern parts. In the northern and north-eastern parts, the rocks of the pre-Cape Van Rhynsdorp Group, the sedimentary rocks of the lower Karoo Supergroup as well as intrusive Karoo dolerites are dominant.

Various metamorphic rocks (i.e. quartzites, granulite and schists), augen gneisses as well as mafic gneisses of the Garies and Bitterfontein Subgroups (Okiep Group) are overlain by sediments of the Nama Group in the north-western portion of the WMA near Nuwerus. Tertiary to recent sediments occurs along the major river courses and extensively along the coast (including north-west of the town of Graafwater). The main characteristics of each of the main aquifers as well as the *status quo* of groundwater abstraction and exploitation potential in the Olifants-Doring WMA, are summarised in Table 2.

Table 2: Stratigraphy of the Olifants-Doorn WMA (SRK, 2006)

Lithostratigraphic Unit			Era	Characteristics	Hydrogeological Significance
Sandveld Group			Cenzoic		
Karoo Dolerite (north-east)			Mesozoic		Fractured contact zones and metamorphic aureoles serve as aquifers. Also barriers to flow.
Karoo Group	Beaufort Group		Mesozoic	6000 m alternating arenaceous and argillaceous sediments	Localised significance as aquifer systems.
	Ecca Group		Paleozoic	Dark grey shale and inter-bedded sandstone	Middle to upper thin sandstone strata may have greater hydrogeological significance
	Dwyka Group			Tillite	Aquiclude
Cape Supergroup	Wittenberg Group		Paleozoic	Alternating sand-stone and shale	Marginal hydrogeological significance
	Bokkeveld Group			Alternating sand-stone and shale	Little significance, else regolith aquifer
	Table Mountain Group	Nardouw Subgroup		1100 m to 810 m alternating sand-stone and shale with lenses of quartzite	Top aquifer of TMG-2. Confined above by lowermost shale unit of Bokkeveld Group
		Cederberg Shale Formation		50m to 120m shale	Top confining layer for lower aquifer system (TMG-1)
		Pakhuis Formation		40m	Major fractured rock/secondary aquifer system. Middle aquifer (TMG-1)
		Peninsula Formation		1800 m to 2150 m sandstone	
		Graafwater Formation		Sandstone	
		Piekenierskloof Formation		Conglomeratic base, followed by 800 m coarse sandstone	Basal aquifer unit (TMG-1)
Klipheuvel Group			Paleozoic	Lower conglomeratic formation and an upper mudstone formation of approx 2000 m	Aquitard of limited hydrogeological significance
Van Rhynsdorp Group (north-west)			Paleozoic	A sucession of shallow sediments deposited on a tidal plain	Impermeable aquiclude
Malmesbury Group (south)			Namibian		Impermeable aquiclude

Geohydrology

With regard to the geohydrological setting, the description that follows is based on the 1:500 000 Hydrogeological Map Series of Department of Water Affairs (DWA). The four aquifer types and associated extent (expressed as a percentage) within the Olifants-Doorn WMA are:

- Fractured (78%)
- Intergranular (1%)
- Intergranular and fractured (20%)
- Karst (1%)

The percentage of the total WMA for each aquifer type and associated sub-divisions are given in Table 3. The total area of the WMA is approximately 56 742 km^2.

Table 3: Aquifer types and percentage of the Olifants-Doorn WMA

Aquifer type and yield	Total Area (km^2)	% of Area of WMA
Fractured 0.0 - 0.1 ℓ/s	947.6	1.7
Fractured 0.1 - 0.5 ℓ/s	18584.0	32.8
Fractured 0.5 - 2.0 ℓ/s	18414.5	32.5
Fractured 2.0 - 5.0 ℓ/s	5975.9	10.5
Fractured > 5.0 ℓ/s	188.9	0.3
Intergranular 0.1 - 0.5 ℓ/s	267.1	0.5
Intergranular 2.0 - 5.0 ℓ/s	198.5	0.4
Intergranular > 5.0 ℓ/s	157.7	0.3
Intergranular and fractured 0.0 - 0.1 ℓ/s	1227.1	2.2
Intergranular and fractured 0.1 - 0.5 ℓ/s	9685.2	17.1
Intergranular and fractured 0.5 - 2.0 ℓ/s	335.8	0.6
Karst 0.5 - 2.0 ℓ/s	482.9	0.9
Karst > 5.0 ℓ/s	276.8	0.5

This table reflects that fractured aquifers are widely distributed across the WMA with the most typical borehole yield being between 0.1 ℓ/s and 2.0 ℓ/s.

Recharge

Groundwater recharge is an important component of hydrogeological characterisation as it has a major influence on groundwater quantity (especially if aquifer transmissivity and storage is favourable) and groundwater quality. Across the Olifants-Doorn WMA groundwater recharge ranges from 0 mm/a to 245 mm/a. The highest groundwater recharge occurs in the Upper Olifants sub-area, especially in the Winterhoek mountain area. Significant recharge also occurs in the Koue Bokkeveld, eastern Doring, and western Sandveld sub-areas. For the remaining areas groundwater recharge is quite limited.

Groundwater / Surface water interaction

Regarding groundwater/surface water interaction the range in contribution of groundwater supplying river base flow is from 0.0 to 20.4 millionm^3/a (per quaternary catchment). The highest base flow contribution areas are the same as areas of highest groundwater recharge. It must be noted, however, that in the other areas groundwater still plays a significant role in maintaining river base flow, although on a much smaller scale, i.e. smaller volumes and more limited in extent.

Groundwater quality (EC)

Groundwater quality varies greatly across the WMA and this is a function of many factors but mainly geology and recharge. The groundwater quality is good in the Koue Bokkeveld, Olifants, Sandveld and western Doring sub-areas. Groundwater quality (as indicated by Electrical Conductivity (EC)) is very poor in the western part of the Knersvlakte sub-area.

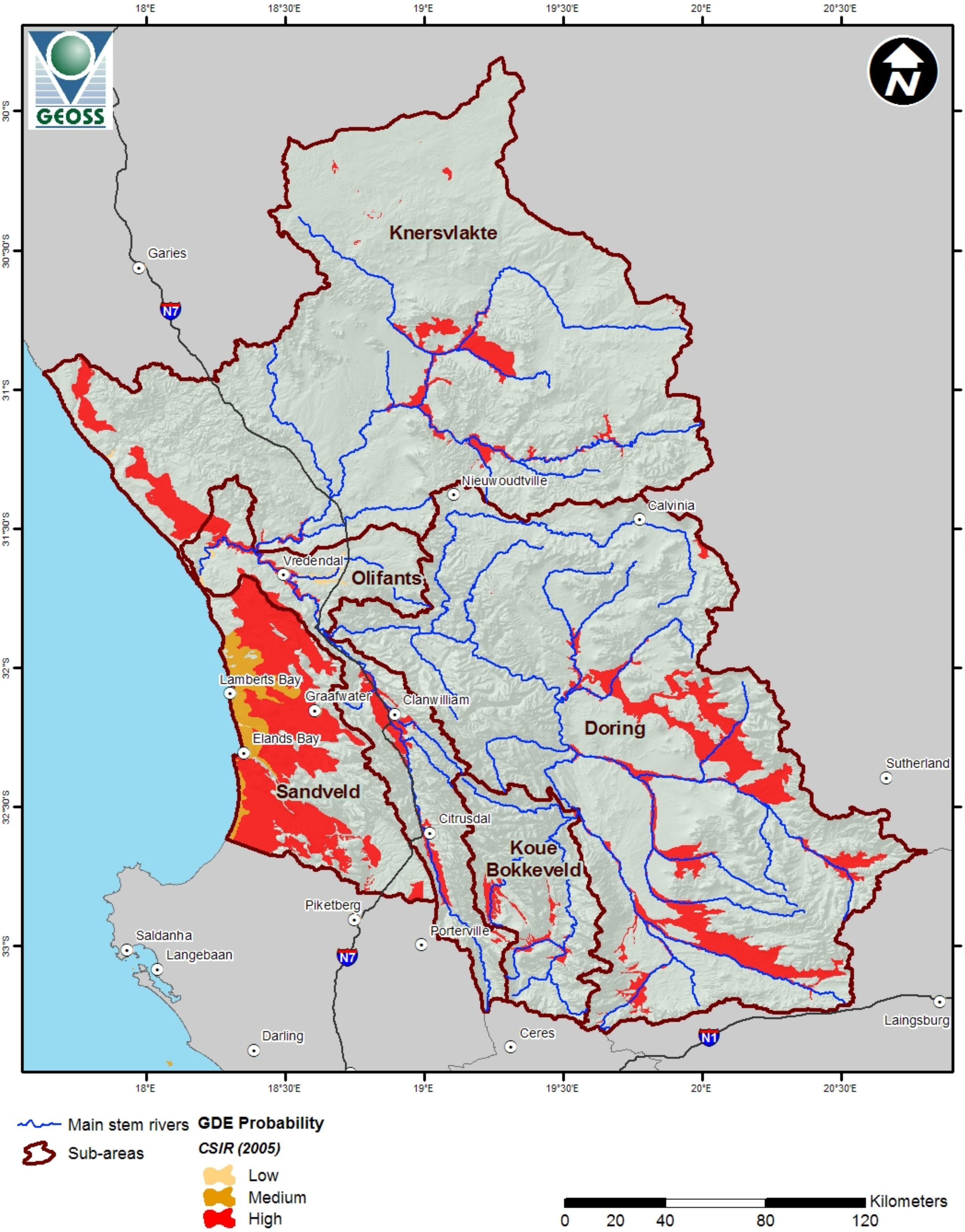

Figure 5: Groundwater dependent ecosystems (CSIR, 2005)

Groundwater dependent ecosystems

Based on the national scale mapping of Groundwater Dependent Ecosystems (GDEs) (Figure 5) in the Sandveld sub-area groundwater plays a significant role in sustaining ecosystems, whilst there are many river riparian zones throughout the WMA where the probability of GDEs occurring is high.

Groundwater importance (ecological and socio-economic)

Groundwater importance varies across the WMA. If groundwater importance is categorised according to (a) socio-economic importance and (b) ecological importance, then all groundwater components mentioned above need to be taken into account as well as groundwater use by the private, commercial and municipal sectors. Groundwater importance is relevant to this project as, when defining target management classes, it is important to know whether groundwater needs to be considered and to what degree or whether it does not need to be taken into account at all. During this project the socio-economic importance of groundwater will be addressed.

Groundwater classification completed to date

The classification of water resources will include consideration of all components of the hydrological system (surface water, wetlands, estuaries and groundwater) as well as the outcome of the catchment visioning process. The class of a resource is to be set by water resource managers, technical specialists and stakeholders in a catchment. In addition to water-related technical issues, consideration is also given to social and economic factors during the catchment visioning and public participation processes.

To determine the class of a water resource, reference conditions must be identified and present status assessed (referred to as the present ecological status (PES). Assigned to each unit is a single PES which comprises the classification according to sustainable use, the level(s) of stress and the level of usage or contamination. The level of stress is based on the volume of groundwater abstracted compared to the volume recharged. Once the single PES has been assigned to each resource unit, then the groundwater resource category can be determined (see Table 4).

Table 4: Terminology and classes used during the classification process

Category	Present Status Category (PES)	Desired Status Category*	Water Resource Category	Management Class*
A	Unmodified natural	Highly sensitive systems, negligible risk allowed	Natural	Excellent
B	Largely natural	Sensitive systems, small risk allowed	Good	Good
C	Moderately modified	Moderately sensitive systems, moderate risk allowed	Fair	Fair
D	Largely modified	Resilient systems, large risk allowed	Poor	
E	Seriously modified			
F	Critically modified			

* *only considered during public participation and catchment visioning processes*

For this project it is proposed that the following groundwater classification categories be assigned per quaternary catchment.

- Class 1 (excellent) where the water resource is minimally used and the overall ecological condition is minimally altered from its pre-development condition;
- Class 2 (good) where the water resource is used moderately and the overall ecological condition is moderately altered from its pre-development condition;
- Class 3 (fair) where the water resource is heavily used and the overall ecological condition is significantly altered from its pre-development condition.

Table 5: Management Classes and descriptions

Class	**Where the water resource is:**	**Where the pre-development ecological condition is:**
1	Minimally used	Minimally altered
2	Moderately used	Moderately altered
3	Significantly used	Significantly altered

As part of the WRCS seven-step process, the Geohydrological Response Units (GRUs) are defined and then classified. However, for the scale of the project and for the practical implementation of the target management classes, it is proposed quaternary catchments are used for the GRUs. Once this classification per quaternary catchment is completed, discussion with the project team will be held on the linkage between groundwater and surface water. The methodology for identifying these nodes is well described in the report by DWAF (2007).

SRK (2006) completed a Reserve determination study for the Olifants-Doring WMA, excluding catchments G30, E10 and F60. Regarding the Sandveld Table 6 lists the classes defined for the G30 catchments.

Table 6: Groundwater usage and classification of six of the Sandveld catchments (G30A and G30H were not included in the study)

Catchment	Recharge (millionm^3/a)	Groundwater Usage (millionm^3/a)	Ratio of usage/Area (millionm^3/ha/a)	Stress Index (%)	Present Status Category	Water Resource Category
G30B	15.62	0.49	8	3.1	A	Natural
G30C	8.48	2.78	79	32.8	C	Good
G30D	12.38	4.00	75	32.3	C	Good
G30E	4.45	2.90	82	65.2	D	Fair
G30F	13.80	14.03	180	101.7	F	Poor
G30G	11.06	6.74	104	60.9	D	Fair

The E10 quaternary catchments have been classified and at the time of writing this input into the Inception Report the E10 report had not arrived from the Water Research Commission.

2.3.5 Social and Economic Characteristics

Demographics

The estimated population of this Water Management Area based on quaternary catchment estimates, is approximately 83 200 people. The majority of the population in the WMA are Afrikaans speaking (more than 90%) and Coloured (77%). About two thirds of the population is concentrated in the south-western part, in the Koue Bokkeveld, the Olifants River Valley and the Sandveld (outside of the Olifants/Doring catchment). Only 30% of the population live in the arid areas of the Doring River catchment, the catchments of the northern tributaries of the Olifants River, and the Namaqualand coastal catchments (80% of the WMA). Thus the majority of the area is very sparsely populated.

Relatively few people (3.9%) have been educated beyond grade 12, posing a challenge when human resources are required for the management of both institutions and water resources. Most people live in either formal or traditional households and have access to a treated water supply water supply (98.7%). Nine percent of the population are without sanitation. Approximately 41% of households do not have a municipal waste removal services.

Economic overview and land use

The largest towns in the Olifants-Doorn WMA are Vredendal, Klawer, Vanrhynsdorp and Lutzville in the Matzikama municipal area, followed by Calvinia in the Hantam municipal area. Other major towns in this area are Citrusdal and Clanwilliam in the Cederberg municipal area..

The regional economy is supported largely by agriculture (45%) and ecotourism. Other economic sectors are mainly those serving the agricultural sector. In excess of 90% of the water use is for irrigation in the summer months. Land along the Olifants River is intensely cultivated with deciduous fruit and vegetable crops in the Witzenberg Valley; citrus along the upper Olifants River; and wine and table grapes along the lower Olifants River. Citrus farming in the area is important nationally, as it is the biggest citrus-growing area in South Africa and contributes to the Western Cape’s international exports. Significant irrigation also takes place in the Koue Bokkeveld of deciduous fruit and in the Sandveld sub-areas for vineyards and potato farming. Wine and dried fruit are value-added products of the area. Most of the land (90%) in the WMA is used for livestock, predominantly sheep and goats.

The area has high poverty levels and extreme dependence on agriculture and subsistence activities. Resource-poor farmers have limited access to good quality agricultural land and have been historically sidelined in terms of access to water. The communities at Ebenhaeser and Papendorp are particularly vulnerable to poverty, with approximately 3 500 people almost solely dependent on the river for their subsistence activities of fishing and irrigated agriculture. The estuary is also a nursery for various line-fish that underpin the West Coast fisheries.

Water for irrigation is either obtained directly out of the river, from groundwater, pumped into off-channel dams, or diverted into irrigation canals. Numerous farm dams occur throughout the upper Olifants/Doring River catchments. The Olifants River Government Water Scheme consists of the

Clanwilliam Dam (122 million m^3), Bulshoek Weir (5.7 million m^3), and a canal system of 186 km in length which distributes water along the Olifants River. The total irrigated area dependent on the Clanwilliam Dam is more than 14 000 ha. Various small towns and other users also receive water from the dam.

2.3.6 Stakeholders and Institutional Arrangements

The following are seen as key stakeholders in the project:

National Government

Department of Water Affairs

The CD: RDM is the lead agent in the project as it is their key responsibility to see that the classification of water resources takes place. Classification of these resources cannot take place in isolation and needs to take place within integrated water resources management. In addition, implementation of the water resource management classes and the resource quality objectives will need to be undertaken within other sections and functions of the Department, therefore it is essential that there is engagement with other directorates throughout the project. The directorates include:

- *Hydrological Services Water Resources Planning Systems: Water Quality Planning and IHP*
- *National Water Resources Planning*
- *Options Analysis*
- *Resource Directed Measures: Western Cape*
- *Catchment Management: Olifants-Doorn*
- *Hydrological Services: Western Cape*

Other National Departments

Table 7 provides a summary of other Government departments that should participate and/or will be mandated to give effect to the class of the water resources.

Table 7: Other government departments that are stakeholders in the Classification of Water Resources

Department	***Directorate/Section***
Department of Environmental Affairs & Tourism	*Marine and Coastal Management*
	Biodiversity and Heritage
	Environmental Quality and Protection
South African National Biodiversity Institute	*Biodiversity Policy*
South African National Parks	*Western Cape Region*
Department of Agriculture	Western Cape
Department of Mining	

Provincial Government

The Olifants-Doorn WMA is located within two provinces, the Western and Northern Cape. Both sets of provincial government departments need to be included as stakeholders for the WMA.

Table 8: Provincial departments that will need to participate and/or will be mandates to implement the outcome of the class

Provincial Government	***Department***
Western Cape	Cape Nature
	Department of Economic Development and Tourism Department of Local Government Department of Social Development
	Department of Environmental Affairs and Development Planning
	Department of Agriculture
Northern Cape	Department of Environment and Nature Conservation Department of Finance, Economic Affairs and Tourism
	Department of Agriculture, Land Reform and Rural Development
NGOs and Others	Conservancies, Action Groups, Wilderness and Conservation Areas, Nature Reserves, Greater Cederberg Biodiversity Corridor

Local Government

The district municipalities and local municipalities within the WMA area is provided in table 9.

Table 9: District and local municipalities in the Olifants-Doorn WMA

District Municipalities	***Local Municipalities***	***Main towns in the Olifants Doorn WMA***
West Coast	*Berg River*	*Aurora, De Hoek, Dwarskersbos, Eendekuil, Het Kruis, Redelinghuys*
	Cederberg	*Citrusdal, Clanwilliam, Doringbos, Elands Bay, Graafwater,Lamberts Bay, Leipoldtville, Paleisheuwel, Ratelfontein, Sandberg, Wolfhuis, Wuppertal*
	Matzikama	*Doringbaai, Grootdrif, Klawer, Koekenaap, Landplaas, Lutzville, Papendorp, Spruitdrif, Strandfontein, Trawal, Vanrhynsdorp, Vredendal*
Cape Winelands	*Witzenberg*	*Bokfontein, Ceres, Enduli, La Plaisante, Op-die-Ber*
Central Karoo	*Laingsburg*	*Area draining the western portion of the Laingsburg municipality*
Namakwa	*Kamiesberg*	*Kamieskroon*
	Hantam	*Brandvlei, Calvinia, Loeriesfontein, Nieuwoudtville*
	Karoo Hoogland	*Sutherland*

The Catchment Management Agency (CMA), Water User Associations (WUA) and Catchment Forums

A Catchment Management Agency (CMA) has not been established for the WMA. The process for establishment was however initiated in 2000 and a Reference Group has been established, supported by Catchment Forums established for the eleven sub-catchment (quaternary drainage) areas within the Olifants-Doorn WMA. A proposal for the CMA establishment has also been drawn up and submitted for approval. DWA is currently carrying out the functions that would be allocated to the CMA. Eleven forums have been established in the WMA. They are:

- *Koue Bokkeveld Forum*
- *Upper Olifants Forum*
- *Middle Olifants Forum*
- *Lower Olifants Forum*
- *Sandveld Catchment Forum*
- *South Namaqualand Forum*
- *Hantam Forum*
- *Nama-Karoo Forum*
- *Ceres Karoo Forum*
- *Cederberg / Doorn Forum*
- *Witzenberg Forum*

Water User Associations (WUA)

Currently, DWA is in the process of converting existing Irrigation Boards into becoming Water User Associations. There are already nine water user associations established in the Olifants-Doorn WMA. These include:

- *Lower Olifants River WUA (LORWUA)*
- *Clanwilliam WUA*
- *Citrusdal WUA*
- *Vanrhynsdorp WUA*
- *Langvlei WUA*
- *Krom Antonies WUA*
- *Noord-Sandveld WUA*
- *Verlorenvlei WUA*
- *Koue Bokkeveld WUA*

The status and stage of implementation of each of the WUA will be determined during the classification process.

NGOs and other organisations

These stakeholders include representatives from conservancies, action groups, wilderness and conservation areas, nature reserves, Greater Cederberg Biodiversity Corridor.

2.3.7 Gaps in currently available information

Hydrology: The previous hydrological studies in the WMA cover all parts of the catchment at the quaternary level, although the Olifants-Doring system has been studied in more detail. There are no gaps with regard to the available hydrology for the study area. The most current system model however excludes the coastal rivers in tertiary drainage basin F60 as well as the Sandveld river catchment in tertiary drainage basin G30.

Water Quality: Characterising the water quality at the outflows of different Integrated Units of Analysis (IUAs) is constrained by the lack of good water quality data records. This is especially true for the Knersvlakte, Doring Rangeland, and to a lesser degree, the lower Olifants River. Not much has changed in terms of available water quality data since the completion of the WRCS documents which was based on data collected up to 2005. The water quality database has been updated to 2010 but the data records for the ephemeral rivers are still very sparse. The team would have to rely on making informed assumptions about the quality in those IUAs based on the limited data that is available, extrapolation from adjacent catchments, and knowledge of the geology of those IUAs.

Predictability of water quality, especially in ephemeral systems: Estimating the water quality impacts of different catchment configurations relies on a catchment-scale water quality model that is based on the configuration of the hydrological model. Such a water quality model has not been set up or calibrated for the Olifants-Doorn WMA. The solution that was developed for the WRCS proof of concept (DWAF, 2007) will be applied in this study. The approach was to develop, where possible, a relationship between flow and water quality concentrations. This relationship is then used to estimate the water quality time series from the hydrological time series for a specific catchment configuration. The water quality duration diagram is then examined to determine how much of the time the outflow from an IUA is in a specific water quality category. Different catchment configurations can then be evaluated by comparing the water quality duration diagrams and assessing whether a specific configuration results in an overall change in water quality category. This works well with constituents that exhibit some relationship with flow (such as salts) but it was found that nutrients are often insensitive to changes in flow. The quantitative assessment is complemented with qualitative knowledge of how the water quality would behave in a specific catchment configuration.

Economic impacts of poor water quality: The WRCS and other studies (e.g. DWAF, 2006) developed methods for water quality classification but the determination of the economic and social implications of deteriorating water quality is often not well understood and studied and data is often insufficient. Since the completion of the WRCS documents, a number of Water Research Commission studies have been initiated to investigate the economic and social impacts of poor water quality. These include a WRC study, “Development of a model to assess the cost associated with eutrophication” which investigated the costs of nutrient enrichment, and a study “A Comparison of the Costs Associated with Pollution Prevention Measures to that Required to Treat Polluted Water Resources” which, *inter alia*, investigated the costs to irrigation farmers of poor water quality in the Loskop Dam irrigation scheme, as well as the direct costs associated with diarrhoea as a result of microbial water pollution. These projects are in various stages of completion and the water quality specialist and economist on this project will consult with the relevant project teams, the WRC study leaders and other investigations to find an appropriate method for estimating the social and economic impacts of poor water quality.

Aquatic Ecology: The rivers and estuaries of the Olifants Doring river catchment and Sandveld have been well covered in the literature, with only a little information available on the rivers and estuaries of the F60 catchment. These systems are however not very utilised or impacted on, therefore the existing information should suffice. The major gap in information on aquatic ecology for the WMA is for wetlands. The identification of wetlands have been undertaken as part of the fine-scale planning project for C.A.P.E., however very little is available on the condition or importance of these wetlands. No EWR determinations have been undertaken for these systems due to the lack of methodologies for determining the Reserve for wetlands at the time of the higher level studies in the WMA. As a result the wetlands of the Olifants-Doring Catchment were not included in the proof of concept catchment determinations done for the pilot study to develop the Water Resources Classification System.

Economics: The spatial / administrative units in terms of which economic data are available for the study area are mostly much larger (e.g. statistical region) than the socio-economic zones (Integrated Units of Analysis). This implies that the same economic multiplier will be applied for all the socio-economic zones in the study area. The cost of generating economic data area specific for each socio-economic zone will be too costly. The challenge therefore exists to find more accurate data per socio-economic zone where available and to collect / generate it in a cost-efficient way.

Due to insufficient data available, the accuracy and applicability of cause-effect relationships between water use and e.g. socio-economic wellbeing parameters cannot be validated. Knowledge of the form of these relationships is necessary to estimate the impact of changes in water supply on socio-economic variables (various scenarios). In the case of the impact of changed water availability and assurance of water availability of agricultural production, turnover and profitability, a limited use of typical farm modelling should provide more clarity of this relationship.

Due to the low frequency of censuses in South Africa and the slow release of census data, the socio-economic data provided by the Central Statistical Services will typically be between 5 and 10 years old. Where possible, estimates by (local) experts will be included to indicate more probable current numbers of such parameters.

2.4. ASSUMPTIONS, LIMITATIONS AND RISKS

The following section details the assumptions and limitations of this study in alphabetical order. Unless otherwise agreed by the Client and the PSP, the methods described in this report will be adhered to for the duration of the project. Should any requested changes to the procedures affect the study plan significantly, a revision of the budget may be needed.

2.4.1 AVAILABILITY OF TEAM MEMBERS

It is assumed that all team members and DWA staff members will be available at the times indicated in the schedule (see Schedule).

2.4.2 CAPACITY BUILDING

The budget includes a limited budget for capacity building, for example for the costs for observers or members of the Client, Project Management Consultants, or other Interested and Affected Parties who may attend site visits or meetings. It is assumed that all participants in the capacity building programme are fully funded by their respective Organizations. The team members of the PSP are funded via the project budget as per the project proposal and project budget.

2.4.3 CONTINGENCY

There are no formal contingencies included in the budget. All disbursements are included in the contracted amount of the budget and should be sufficient to cover the associate costs to undertake the project and stakeholder engagement meetings.

2.4.4 ESCALATION

Escalation is not included in the budget due to the fact that the project is of a short duration. If substantial delays occur in the project it can therefore be expected to influence the budget.

2.4.5 EXTERNAL REVIEW

The budget makes provision for two external reviewers. Limited internal review is also included in the budget.

2.4.6 PROJECT MANAGEMENT MEETINGS

The budget makes provision for the required PMC meetings, all in Cape Town. The budget has assumed that these meetings have no cost to the project other than time and reimbursable costs to the team as per the project budget.

2.4.7 SCHEDULE

The project schedule is largely according to the project proposal and it is estimated that the project will be complete within the DWA financial year (2011/2012) before end March 2012.

2.4.8 SPECIALIST WORK

Specialist work will be based on available information only and no additional data will be collected.

2.4.9 STAKEHOLDER ATTENDANCE OF WORKSHOPS

2.4.10 REPORTING

The budget makes provision for the printing, binding and distribution costs of two (2) draft and two (2) final copies, as well as one (1) CD containing a .doc and .pdf file of the following reports:

- Inception Report
- Report
- Progress Reports, and
- Minutes.

Copies and binding of reports will be charged according to DWA rates and according to the contract.

2.4.11 TEAM MEETINGS

The budget makes provision for the required technical team meetings of the project team members.

2.4.12 RISKS

Various risks exists in a project of this magnitude and potential complexity. Table 10 provides a summary of the risks identified and the mitigation measures that will be used to manage these risks within an acceptable range.

Table 10: Summary of the identified risks and the proposed mitigation measures to be used

Risk category	Risk description	Cause	Mitigation Action
Water quality data	The availability of water quality covering the entire catchment.	The nature of rainfall and resulting flow within the catchment and the geographical extend is such that water quality monitoring programme is designed to adequately collect data.	The available water quality will used and then brought into relation with flow and presented with the flow data
Economic and social data	The availability of economic and social data is not at the same level as the data for other technical aspects related to the water resources.	Economic data and social response data is not collect at the same scale as the water resource data. The catchment boundaries are not the same as the economic units, local and district municipality and provincial boundaries.	The IUA will be selected in such a way as to represent the prevailing homogenous economic and social activities in the catchment. The assumptions and scaling of the data to smaller units within the catchment will be carefully documented.
Stakeholder participation	A lack of participation could delay the finalisation of technical work and the class recommendations to the DWA, requiring additional public sessions.	The classification process is conducted at a time in the catchment after various public participation processes has been used for the preparation of the CMA and the delay in the formalisation of the CMA establishment might discourage people to participate.	The DWA procedures for public participation will be followed and comments recorded will be documented, to allow appropriate response from the DWA and the project team.

3 METHODOLOGY

3.1 PHASE 1: INCEPTION

The inception phase is a critical phase of the project that will allow for the scope of the project to be clearly defined from the onset. This will include:

- *An inception team meeting to align team members with the scope and approach for the project;*
- *An inception meeting with the client to gain a common understanding and agreement on the specific approach;*

- *Collecting background and historical information for the project and updating background information;*
- *List available water resource models and evaluating their applicability to this project;*
- *Identification and confirmation of IUA's;*
- *Undertaking gap analysis and compile recommendation on how to deal with information and data gaps; The gap analysis will specifically need to address the following technical aspects which are most likely underrepresented in past studies:*
  - *Groundwater classification in areas where aquifers are extensively utilised but are not necessarily make a direct contribution to annual flows of rivers (e.g. Sandveld);*
  - *Water quality classification for which methods exist but the determination of the economic and social implications of deteriorating water quality is often not well understood and studied and data is not sufficient;*
  - *Wetland inventories which have not been compiled and the condition and importance of wetlands which are in general unclear;*
  - *The F60 tertiary catchment area that has not been addressed in any of the previous studies*
- *Compile a proposed schedule of meetings;*
- *Compile a proposed capacity building programme and implementation schedule;*
- *Compile draft inception report for comment; and*
- *Revise and finalise the inception report.*

The inception phase of the project is expected to take three to six weeks as it contains a number of the initial information collection aspects for the project.

3.2 PHASE 2: PUBLIC CONSULTATION – PLANNING AND INITIALISATION

- The stakeholder participation is vital to the successful classification of the Olifants Doorn WMA and will help to ensure the acceptance of the outcome of the classification process. The fact that the stakeholder engagement process will be consultative and not necessarily consensus seeking will require that the process comply with the guiding principles for the classification of water resources. The guiding principles include the following:
- Principle 1: Balance and trade-off for optimal use
- Principle 2: Sustainability
- Principle 3: National interest and consistency
- Principle 4: Transparency

- Principle 5: Implementability
- Principle 6: Interdependency of the hydrological cycle
- Principle 7: Legally defensible and scientifically robust
- Principle 8: Management scales
- Principle 9: Auditable and enforceable
- Principle 10: Lowest level of contestation and the highest level of legitimacy
- Principle 11: Utilisation of existing tools, data and information.

Adherence to these principles will assist to make the process of classification open, transparent and reasonably predictable, and will also reduce the level of potential contestation.

In addition to adhering to the principles for classifying the water resources it will also be important to provide water users and stakeholders with a summary of all the benefits that can be gained by classifying water resources. A complete list of the direct and indirect benefits of classifying water resources must be compiled and communicated to all stakeholders to ensure that the benefits of the classification of the water resources in the Olifants-Doorn WMA is clear from the onset of the project. This could include the following:

Water use licensing

The consideration of water use licenses should be facilitated with the class determination in the catchment as it will provide an indication of the limitations and availability of water within a particular part of the WMA.

Freshwater biodiversity priorities

The classification of water resources will provide an opportunity for the integration of biodiversity priorities into the water resource management and allocation decision-making within the WMA.

This list should be expanded and completed to be distributed with the first communication and stakeholder meetings in 2011.

The stakeholder and public consultation process will occur throughout the duration of the project and the focus would be to consult with the Reference Group and water use forums and Water User Associations (where and when applicable). A total of 3 public engagements events are proposed.

In the process of preparing for the setting up of the Catchment Management Agency (CMA) for the Olifants-Doorn WMA, a Reference Group as well as eleven Catchment Forums has been established in the area. These stakeholder bodies have been recipients of a number of capacity building initiatives relating to IWRM and resource protection as mentioned above and should thus relatively well informed on the topic of Water Resource Classification.

Inter-relation and inter-dependency between regulatory mechanisms and stakeholder consultations

The Western Cape Region of the DWA initiated the consultations required to establish Catchment Management Agencies (CMA's). The reconsideration of the number of CMA to be established in South Africa has unfortunately delayed the process for the establishment of the Olifants-Doorn CMA.

The relationship between the classification process and the following regulatory processes will require clarification in preparation for the stakeholder engagement process:

- Compulsory licensing;
- Water use verification and validation;
- Water use licensing;
- General authorisations applicable in the WMA and particularly to groundwater and riparian zones (section 21 c and i);
- The establishment status of the CMA; and
- The establishment and status of Water User Association (WUAs).

Clarification is require to limit the potential confusion among stakeholders as to the purpose of the classification process and also to ensure a good understanding as to the relationships that exist between these various regulatory processes and decision making that will influence the use of the water recourse in the Olifants Doorn WMA.

Preferred language of the Olifants Doorn stakeholders

The stakeholders in the Olifants Doorn WMA are primarily Afrikaans speaking and it wil be a requirement for all key documents to be translated and made available in Afrikaans. The English version of the classification brochure was already translated into Afrikaans and isiXhosa during the inception phase.

Development of a stakeholder database

During this phase, a register will be compiled of all the stakeholders in the WMA that need to be consulted in the project. A database will also be set up to capture all the comments received during the Classification Process and store minutes taken at the various meeting. The Department of Water Affairs office in Clanwilliam will be contacted to obtain their database. The database will then be augmented with current information (contact details). The consulting team will ensure that the database is comprehensive in covering all of the stakeholders and during the process the database will be updated and maintained.

Public Awareness
An advert will be posted in various local community news papers to notify the general public of the intended study/project. The general public, interested and affected parties will be invited to register on the database for future communication.

STAKEHOLDER ENGAGEMENT AND MEETINGS

- **Pre - Stakeholder Consultation**

During February 2011 the project team will visit stakeholders which include: Water User Associations, Municipalities, Commercial and Emerging Farmer Organisations, Nature Conservation Agencies, Industry and Commerce to inform them about the process and to list their comments and concerns. To manage the costs the consulting team will as far as possible attend the stakeholders scheduled meetings.

- **Stakeholder Meetings**

It is envisaged that two reference stakeholder meetings will be held over the duration of the classification process. All stakeholders will be invited to attend the meetings at a central location/ venue in the Water Management Area. An initial meeting will be held with the Reference Group for the Olifants-Doorn WMA to familiarise them with the project and allow for the tabling of key issues that would need to be addressed in the process. The level of involvement of the team and the stakeholders (at a reference group level or forum level) would be established at this meeting to facilitate further discussions on the social, economic and environmental factors in the WMA.

The first stakeholder meeting is scheduled to be held in May 2011 and the second meeting towards the end of September 2011. At the first meeting the stakeholders will have an opportunity to meet the project team and the various task team leaders. Various options will be put forward for comments. The purpose of the second meeting will be to consolidate the options and the stakeholders will then have an opportunity again to raise their concerns and indicate their preferences. The project team will then be in the position to make their final recommendations to the Department of Water Affairs. Records will be kept of all discussions during the meetings and the stakeholders will also be provided with the minutes of such meetings.

A large number of studies and projects have been undertaken in the Olifants-Doorn Water Management Area. The WMA was also utilised as a pilot or 'proof of concept' catchment for the development of the Classification Methodology, therefore much of the necessary information for the classification process already exists. This information will need to be re-evaluated in terms of the final Gazetted requirements for the Classification Process. Key to the success of the consultative process is the manner in which the information is packages to be presented to the water users and other stakeholders.

Key aspects within the catchment such as the possible over-utilisation of the lower Olifants River and the need to protect the Doring River, as well as the socio-economic implications of a reduction of the low flow in these rivers will be presented to the stakeholder group at this first meeting to facilitate their understanding of the key concepts involved in the process.

The importance of recognising the language primarily utilised in this area is thus stated in Afrikaans: "*Die meerderheid van die inwoners in die opvangsgebied is Afrikaans sprekend. Die publieke deelname proses sal daarom in Afrikaas plaasvind. Me Doreen Februarie en Dana Grobler is ten volle tweetalig en sal die leiding neem met die publieke deelname proses.*"

A progress report will be compiled at the end of this phase outlining the outcomes from the stakeholder group meeting.

- **Communication with the Stakeholders**

The consulting team will make available various mediums for the stakeholders to lodge their comments and concerns.

Stakeholders will be able to lodge formal written comments/concerns on a template that will be developed for this purpose. This template will be made available electronically and by fax. At the meeting a comment box will be available. Stakeholders will be invited to lodge their comments /concerns via e-mail, fax, post or telephonically. An example of the issues and concern form is provided in Table 11.

Table 11: Example of the formal response form that wil be supplied to stakeholders

Item number Catchment and analysis unit number	**Issues, questions, comments Concerns related to the class and/or class configuration**	**Date**	**Commentator**	**Response**

The completed table of identified issues, questions, comments and concerns will be attached to the recommendations to the delegated authority in DWA who will need to consider the approval of the class and class configuration within the catchment. This is of particular importance in resource units where disagreements between stakeholders may arise in terms of the most preferred and/or beneficial class for the part of the resource. By providing all the information collected during the stakeholder engagement process and providing recommendations from a technical point of view, the delegated authority is in a position to assess the full social, economic and ecological implications of the decisions to accept a class and its consequences.

Stakeholders will also have an opportunity to visit a website (www.ewisa.co.za) specially set up for the project to track the progress of the project and also to lodge their comments and concerns.

- **Stakeholder Travel Cost**

The travel cost for the stakeholders to attend the 2 planned meetings in Clanwilliam will have to be paid by the client as the furthest travel distance is in the region of 750 kilometers. The Water Management Area is very vast and mostly rural. The budget required for this was only partially budgeted for and the costs are anticipated to be in the order of R11 000 to R15 000 per stakeholder engagement meeting. This could partially be obtained from the planned disbursement budget. As far as reasonably possible, stakeholder travel costs will be minimised by ensuring that meetings are held at suitable and cost-effective locations. Reimbursement of travel costs will be under controlled conditions in order to avoid situations leading to unexpected expenses and unrealistic expectations.

3.3 PHASE 3: CLASSIFICATION PHASE

Phase 3a – Scenario Determination

7-step classification procedure

The seven-step procedure to recommending the class of a resource (the outcome of the Classification Process) is as follows:

Step 1: Delineate units of analysis and describe the status quo including:

a. Describe present socio-economic status of the catchment.

b. Divide catchment into socio-economic zones.

c. Identify a network of significant resources, describe water resource infrastructure and identify water user allocations.

d. Define a network of significant resources and establish biophysical nodes.

e. Describe communities and their wellbeing.

f. Describe and value the use of water.

g. Describe and value the use of aquatic ecosystems.

h. Define Integrated Units of Analysis (IUAs).

i. Develop and/or adjust the socio-economic framework and the decision-analysis framework.

j. Describe present-day community wellbeing within each IUA.

Step 2: Link value and condition, including:

a. Rationalise the choice of ecosystem values to be considered based on ecological and economic data.

b. Describe the relationships that determine how economic value and social wellbeing are influenced by ecosystem characteristics and the sectoral use of water.
c. Define the scoring system for scenario evaluations.

Step 3: Quantify Ecological Water Requirements (EWRs) and changes in non-water quality ecosystem goods, services and attributes (EGSAs), including:

a. Identify nodes to which Resource Directed Measures (RDM) data can be extrapolated and extrapolate.
b. Develop rule curves, summary tables and modified time series for nodes for all categories.
c. Quantify the changes in relevant ecosystem components, functions and attributes for each category for each node.

Step 4: Set Ecological Sustainability Base Configuration (ESBC) scenario and establish starter configurations, including:

a. Set ESBC scenario and screen for water quantity, quality and ecological feasibility.
b. Incorporate planning scenarios (future use, equity considerations, existing lawful use, RDM etc.).
c. Establish RDM catchment configurations for each scenarios.

Independent reviewers will be identified and provided with a brief of the review to be conducted.

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

Steps 5 and 6 form part of the 'larger process' where the economic, social and ecological trade-offs will be made. Trade-offs will also need to be made between existing lawful use (ELU) and equity considerations. Emerging from this 'larger process' will be the recommended MC, RQOs and Reserve, Catchment Management Strategy (CMS), allocation schedule, modelling system and the monitoring, auditing and compliance strategy. A number of key questions will need to be addressed in this 'larger process'. These include:

- at what level will the trade-offs be negotiated?
- in what institutional setting will they be negotiated?
- what types of scenarios will inform the process of negotiation?, and
- the recommended MC, Reserve, RQOs, CMS and allocation schedule will impact on specific groups of people, so the key question will be who benefits and who pays the social and economic cost?

These key questions should be framed (and assessed) in the context of equity, efficiency and sustainability as required by the NWA, and by the core objectives of the present government which are, amongst others, to '…halve poverty and unemployment by 2014', reduce the regulatory burden on small and medium businesses and eliminate the second economy. Step 5 should therefore contribute to meeting government's objective of '…reduce(ing) inequality and virtually eliminating poverty'. Step 5 should therefore include:

a. Run yield model for ESBC and other catchment configuration scenarios and adjust it if necessary.
b. Assess water quality implications (fitness for use) for all users.
c. Report on the ecological condition and aggregate impacts per IUA for each scenario.
d. Value changes in aquatic ecosystems and water yield.
e. Describe macro-economic and social implications of different catchment configuration scenarios.
f. Evaluate overall implications at an IUA level and a regional level. Report on the ecological condition and aggregate impacts per IUA for each scenario.
g. Select a subset of scenarios for stakeholder evaluation.

Step 6: Evaluate scenarios with stakeholders, including:

a. Stakeholders evaluate scenarios and agree on short-list.
b. DWA to recommend IUA classes.

Step 7: Gazette class configuration; including:

a. Populate IWRM summary template and present to Minister or delegated authority.
b. Minister decides on IUA classes, and nested category configurations, Reserve(s), allocation schedule(s) which will inform the Catchment Management Strategy (CMS).
c. Recommend Resource Quality Objectives, Incorporate Reserves and (RQOs).
d. Gazette IUA classes, nested category configurations and RQOs.
e. Develop plan of action for implementation of recommended scenario.

According to the 7-step classification process, the first 5 steps involve the setting up of the catchment configuration scenarios. While much of this work was undertaken as part of the pilot testing of the WRCS development in the Olifants/Doring Catchment, this work will still need to be undertaken for the remainder of the WMA and any gaps in the existing work must also filled, particularly in terms of the feedback from the Reference Group and stakeholders.

Each of the specialist areas will in this phase of the project compile their contributions towards the catchment configuration scenarios. Where necessary the specialists will consult with stakeholders in the WMAs to refine their scenarios. A project team meeting will then be held to integrate the specialist work.

The draft integrated catchment configuration scenarios will then be compiled and packaged into visual presentations that clearly illustrate the implications of the scenarios. These presentations will then be given and worked through with the Reference Group and water users forums where applicable. Comments received will be captured in the progress report at the end of Phase 3a.

Phase 3b – Scenario Refinement

In Phase 3b, a team meeting will be held between the specialists to review the comments received from the public consultation process in the previous phase and to discuss how to refine and change the scenarios. The scenarios will then be refined and the Social, Economic and Environmental implications of these changes provided. These refined scenarios will then be presented to the reference group for final comment and input. These comments will be captured on the database and the proceedings of the meeting minuted. A progress report for this phase will be compiled.

Independent reviewers will continue with the review process during this phase to ensure that they can still comment and contribute in terms of guiding the Classification Process if necessary. The Terms of Reference for the external reviews will be compiled in conjunction with the client.

Phase 3c – Scenario Finalisation

A final scenario configuration will be determined and the social, economic and ecological implications thereof documented. This will be reviewed by the external review before preparing the water resources classification templates for approval by the delegated authority in DWA.

3.4 PHASE 4: PROJECT CLOSURE

The purpose of the project closure phase is to:

- *Reproduce and distribute final copies of the project reports, and*
- *To conclude all financial and contractual agreements.*

4 DELIVERABLES AND LINEAR RESPONSIBILITIES

4.1 MILESTONE LIST

Phases and project deliverables	Estimated date of completion
Phase 1. Inception	
Inception team meeting Inception client meeting Collection of material and preparation inception report Revision of inception report	November 2010
Phase 2. Public consultation initialisation	
Prepare and present at project team meeting	February 2011
Progress report and technical meeting	March 2011
Phase 3. Classification phase / Phase 3a.	
Prepare technical scenarios and report	
Project team meeting	
Reference group and public consultation Meeting 1	May 2011
Progress report (socio –economic and ecological scenario report)	June 2011
Phase 3b. Refine scenarios	
Project team meeting	
Revision of scenarios	
Reference group and public consultation Meeting 2	August / September 2011
Progress report	September 2011
Proposed management classes for IUA's	September 2011
Phase 3c. Finalise scenarios	
Revision of scenarios	October 2011
Compile templates	November 2011
Project closure	
Final draft report (management classes)	December 2011
Project meeting	
Revision of final report	February 2012

4.2 THE PROJECT TEAM

The proposed project team consists of individuals from various companies and institutions working in a consortium. The team consists of individuals that are highly qualified and experienced in the water resource management, protection and RDM. The companies include:

- *Blue Science® Consulting cc,*
- *Nosipho Consultancy, and*
- *Aurecon (Pty) Ltd,*
- *GEOSS (Pty) Ltd,*
- *University of Cape Town, and University of Stellenbosch, and*
- *WAMTechnology cc.*

The individuals who form part of the proposed consortium team that will undertake the project are provided in Table 12.

4.3 LINEAR RESPONSIBILITY AND STAFFING

Project administration will occur at three levels, as detailed below*:*

5.3.1. OVERALL PROJECT LEADERSHIP, INCLUDING ADMINISTRATIVE, OVERALL TECHNICAL AND FINANCIAL CONTROL

Mr Dana Grobler is the Project Leader and will take responsibility for overall project leadership. He will be assisted by Ms Sheeba Thomas.

5.3.2. TASK TEAM LEADERSHIP

Task leaders will each take responsibility for administrative and technical control for each of the following study components (table 12):

Table 12: Task team leaders

Surface water ecology:	Ms T Belcher
Hydrology:	Dr V Jonker
Water Quality:	Mr N Rossouw
Groundwater:	Mr J Conrad
Economics:	Prof T Kleynhans
Social:	Mr T Barbour
GIS:	Ms M Carstens
Stakeholder Involvement:	Ms D Februarie

4.4 STUDY TEAM CHANGES SINCE PROPOSAL

There have been some changes to the proposed consultant team:

The economic task team leader Prof Theo Kleynhans has indentified two students that will be working on the economic component of the project. They are:

Ms Kandas Cloete who has a BCom (Hons) degree in Business Management with a focus on agricultural economics. Ms Cloete will be undertaking post graduate studies.

Mr Manana Rancho who has a BSc degree in Agricultural economics. Mr Rancho will be undertaking post graduate studies.

Table 13: Proposed team members, roles and affiliations

Name	Surname	Role	Qualifications	Affiliation
Mr Dana	Grobler	Project coordination and integration	BSC (Hons) HED *Pr Sci Nat*	BlueScience ® Consulting cc
Ms Toni	Belcher	Bio assessments (rivers, wetlands and document integration)	MSc Environmental Management *Pr Sci Nat*	BlueScience ® Consulting cc
Ms Doreen	Februarie	Public participation	Diploma in Social Work	Nosipho (Pty) Ltd
Ms Alycia	Hartel	Public participation support	Diploma Business Admin	Nosipho (Pty) Ltd
Ms Yolanda	Ngubo	Public participation support	Registered assessor	Nosipho (Pty) Ltd
Dr Verno	Jonker	Hydrology task leader	PhD (Eng)	Aurecon (Pty) Ltd
Ms Louise	Dobinson	Hydrology support	MSc	Aurecon (Pty) Ltd
Mr Nico	Rossouw	Water quality	MSc (Limnology) - MPhill Information & Knowledge Management	Aurecon (Pty) Ltd
Mr Julian	Conrad	Groundwater	M.Sc. (Hydrogeology and GIS)	GEOSS (Pty) Ltd
Ms Candice	Lasher	Groundwater	MSc – Environmental and Water Science	GEOSS (Pty) Ltd
Ms Sheeba	Thomas	Data management / project management	MBA and BCom	WAMTechnology cc
Mr Tony	Barbour	Social studies leader	MSc (Environmental Science)	UCT
Mr Vuyisile	Zenani	Social studies support	MSc (Masters in Social sciences)	UCT
Prof Theo	Kleynhans	Economics studies leader	PhD	US
Mr Manana	Racho	Economics support	BSc (Agricultural economics)	US
Ms Kandas	Cloete	Economics support	BCom (Hons)	US
Ms Marelie	Carstens	GIS and mapping	MSc	GEOSS Pty(Ltd)

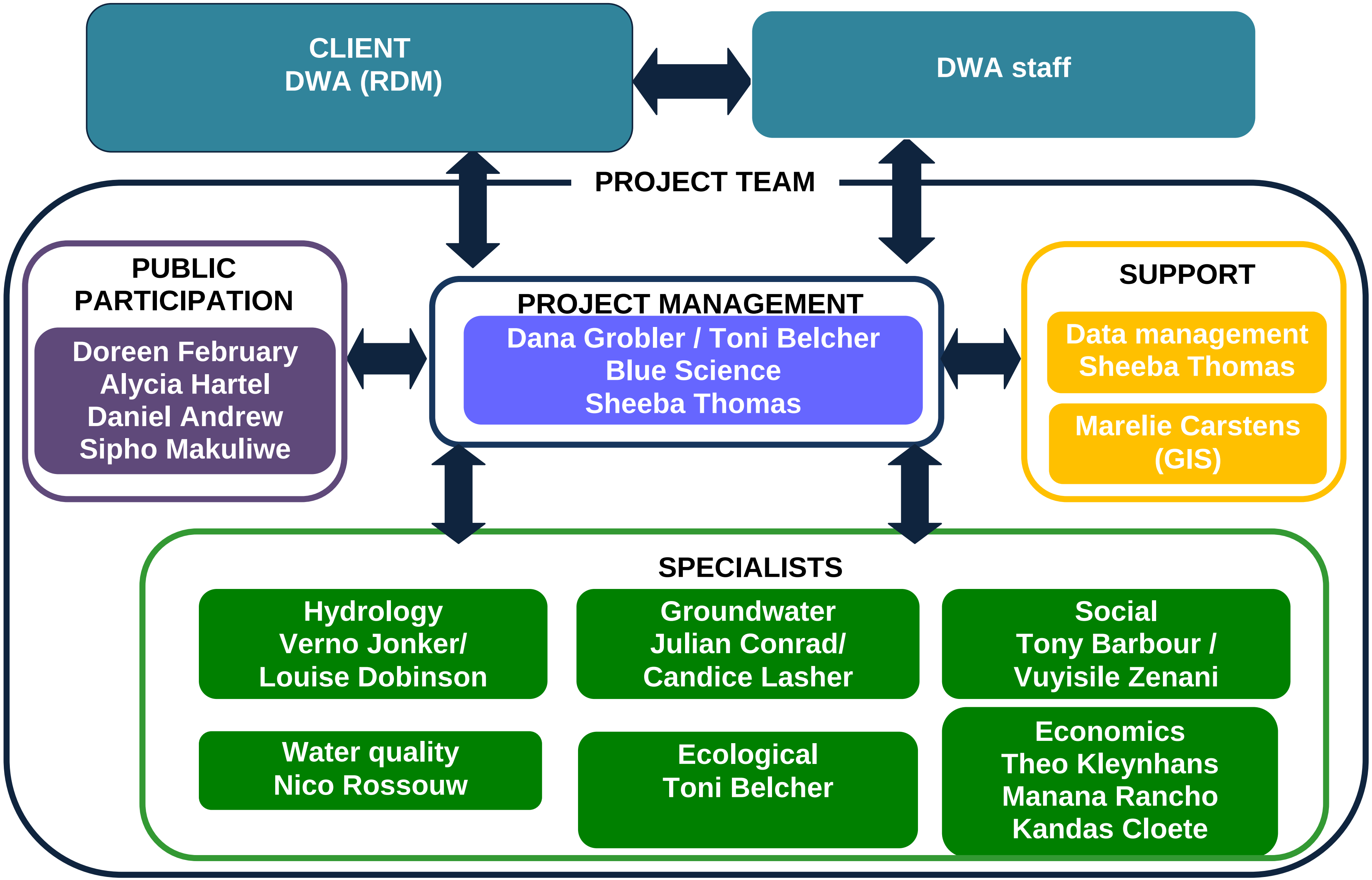

Figure 6: Organogram of proposed team structure and reporting lines

5 PROJECT MONITORING, MANAGEMENT AND COMMUNICATION

5.1 PROJECT MANAGEMENT

The initiation of the classification of the Olifants-Doorn, Olifants and Vaal River WMA represents a milestone in the implementation of provisions of chapter 3 of the NWA. The simultaneous classification of the three WMA does however pose a challenge to ensure consistent interpretation and application of the classification guidelines to determine the class of the water resources.

The successful classification of the water resources in each of the WMA with distinct differences between the ecological condition, current use and future needs and threats will add to the knowledge necessary to improve the methods to classify and ultimately to improve the guidelines for the classification of water resources.

In order to manage the above-mentioned challenges a National Classification Project Steering Committee (NPSC) is to be established. This committee should ensure that classification of the water resources in the three selected WMA's is compliant with the guidelines and is responsive to the unique water resources circumstances in each of the WMAs. The Olifants-Doorn WMA classification project will be guided by the Olifants Doorn WMA Classification PSC (see list of proposed members in Appendix A) and the management of the project will be overseen by the Olifants-Doorn WMA Classification Project Management Committee - PMC (Table 14).

Mr Dana Grobler is the project manager and will oversee the managerial, financial and administrative aspects of the project. The project manager will report to the Project Manager in the Chief Directorate: Resource Directed Measures of DWA as the client.

Table 14: List of the proposed Olifants-Doorn PMC members

Name	Component	Designation	Email Address	Contact Number
Harrison Pienaar	RDM	CD	qin@dwa.gov.za	012 336 7197
Shane Naidoo	RDM:WRC	Director	tbe@dwa.gov.za	012 336 6707
Ndileka Mohapi	RDM:C	Director	qme@dwa.gov.za	012 336 8234
Yakeen Atwaru	RDM:RR	Director	atwaruy@dwa.gov.za	012 336 7816
Nadene Slabbert	RQS	Director	Slabbertn@dwa.gov.za	012 392 1439
Tovhowani Nyamande	RDM: Class	Deputy Director	NyamandeT@dwaf.gov.za	012 336 7521
Wilna Kloppers	DWA: WC	Deputy Director	kloppew@dwa.gov.za	021 950 7141/ 082 807 6191
Pumza Lubelwana	DWA: WC	Director	lubelwp@dwa.gov.za	021 950 7107
Francois Van Heerden	DWA: WC			
Isa Thompson	DWA: NWRP	Chief Engineer	ijg@dwaf.gov.za	012 336 8647
Mohlapa Sekoele	DWA:RDM-WRC	Scientist	sekoelem@dwa.gov.za	012 336 8329

6 DATA STORAGE AND PRESENTATION

6.1 DATA STORAGE

Ensuring that the data collected and analyses generated during the study are properly collated, audited and stored is a central focus of this proposal. Drawings and maps will be produced according to Client specifications.

6.2 GIS and mapping

All information that can be portrayed effectively and efficiently on GIS will be done so. The data will be prepared in accordance with DWA latest specifications for electronic spatial data.

7 CAPACITY BUILDING PROGRAMME

7.1 APPROACH

A key requirement of the Terms of References for the implementation of the classification projects is capacity building of relevant departmental officials. Capacity building therefore forms an integral part of the project and the building of capacity has been incorporated at all levels.

7.2 Strategic objectives of the capacity building programme

The DWA has indentified the following strategic objectives that need to be achieved by the capacity building programme:

- The application of policies, strategies, systems, methodologies and guidelines for the classification of water resources,
- Determining and updating the class of all significant water resources,
- Scientific and Water Resources Classification (WRC) related support for the implementation of strategic imperatives (i.e. WfGD, Climate Change and NWRS),
- Development and maintenance of strategic relationships within the department and with other organs of state, NGO’s and stakeholders, and
- Financial planning and project management to comply with the requirements of the Public Finance Management Act.

7.3 Capacity building programme for the Olifants Doorn Classification project

The DWA identified possible gaps in the knowledge and skills of officials who are involved in the RDM functions and the implementation of the WRCS. These gaps exist in different fields of expertise and on different levels of authority. To address possible gaps and to ensure a comprehensive knowledge and skills base to implement the WRCS, a capacity building framework has been developed by DWA. This framework will be complemented by a measurable capacity building programme which will be developed and included in the Inception Report. Table 14 provides a list of the capacity needs indentified by the RDM Chief Directorate as well as the key performance areas in which capacity is required.

Broad capacity building can be realised through the following mechanisms, namely:

- **Stakeholder involvement** in the project, through their participation. Stakeholder groups will develop an understanding of water resource protection through the Classification Process and its relevance. This will also assist in the enhancement of their understanding of the concepts of integrated water resource management and sustainable development.
- **Participation of relevant DWA officials** will ensure active sharing of knowledge and ideas and contribute to the broadening of the RDM skills base by officials being intensively involved in the day to day running of the project.
- The project team has included **HDIs in the project** to be trained and within whom capacity can be built by maximising their involvement in the project. The aforementioned has particular reference to the following specialist fields namely:
  - Hydrology;
  - Resource quality (Aquatic ecology) ;
  - Geomorphology;
  - Socio-economics;
  - Resources economics;
  - Water quality;
  - GIS;
  - Geohydrology; and
  - Hydraulics.
- The client has also seconded DWA Western Cape Regional Office staff members to the appointed project team when required.

Table 16 provides a summary of all the individuals that will be included in the capacity programme of the Olifants Doorn Classification project.

Table 15: DWA Identified Capacity Building Needs

Key Performance Area	Knowledge & skills required	Current knowledge & skills	Gaps	Learning Area	Learning outcomes
1. IWRM	Understanding of Classification within the larger IWRM process and aligning with initiatives in the respective study areas	IWRM theory; some formal training	Moving from managing silos to managing as a whole (integration); Managing towards a vision with stakeholder participation	IWRM (policy & legislation)	Creating an enabling environment, both in terms of enabling legislation and the institutional environment, to ensure integration with associated systems and processes in IWRM
2. Water Resource information & data sourcing	Data interpretation: • Hydrological; • Socio-economic, and • Ecological	Formal NQF in hydrology and related fields;	Understanding river basin systems (spatial dimension) and variability (temporal dimension); Water resource yield & planning models	Understanding biophysical processes: • water quantity & quality; • geomorphology • hydrology • ecology • hydraulics	Baseline information required to inform the classification process is systematically updated
3. Water resources modelling	Hydrological assessment and modelling (quality & quantity)	Very basic understanding of WRY and planning models	Limited experience in modelling and use thereof in decision support	Water resource modelling & decision support	Modelling of key components of the water resource is undertaken to support decision making
4. Implementation of the WRCS process (7-step process)	4.1 Delineating Integrated Units of Analysis (IUAs)	Catchment & WMA boundaries	Using GIS for delineation	Use of GIS and mapping of IUA's	Ability to delineate IUA's and link to Resource Management Units (RMUs) from Reserve Determinations
	4.2 Extrapolation of data from EWR sites to nodes	Desktop Reserve determination; Limited exposure to Rapid Reserve determinations	Understanding EWR sites in relation to IUA's and nodes	Understanding biophysical processes: • water quantity & quality; • geomorphology • hydrology • ecology • hydraulics	Understanding EWR sites in relation to IUAs and nodes
	4.3 Evaluating ecosystem	Limited involvement	Selecting ecosystem	Resource economics	Mapping of ecosystem services

Key Performance Area	Knowledge & skills required	Current knowledge & skills	Gaps	Learning Area	Learning outcomes
	services	in determining ecosystem values	values; Describing relationships between economic value and social well-being; Understanding ecosystem services & relation to RDM		Ability to define a scoring system to value ecological goods, services & attributes & implications thereof in setting a management class
	4.4 Determining scenarios to achieve vision of catchment through stakeholder engagement	Limited understanding of scenario determination	Understanding the relationship between economic, social and ecological trade-offs within the larger IWRM process	Socio-economic issues	Understanding balance and trade-off between water users
5. Stakeholder consultation	Public participation process (PPP)	Very limited exposure	Conducting appropriate participation; Creating an enabling environment for stakeholder engagement	Stakeholder consultation	Communication, awareness creation and identifying key messages to enable adequate stakeholder engagement
6. Project management	Project management & financial controls Administration tools for use in project management	Some formal project management training	Limited experience in project management	Identification of key project activities and task scheduling; Administration of projects; Preparing cash flows; Financial reporting	Effective management of projects

Table 16: Summary of the individuals who will be included in the Capacity building programme of the Olifants Doorn Classification project

Name of official	F	M	A	C	I	W	Designation	Job Description	Mentor	Applicable key performance area (see table ZZ)
DWA RDM Chief Directorate staff										
Ms Tovhowani Nyamande	x		x				Deputy Director	Project Manager for classification of water resources in the Olifants, Vaal, Olifants-Doorn WMA	Ms Toni Belcher	4, 5 and 6
Ms Mohlapa Sekoele	x		x				Scientist (Production)	Assist with the co-ordination and implementation of the WRCS; Contribute to the development of ecological, socio-economic tools and methodologies to support the WRCS; Liaison with stakeholders on classification of water resources in the Olifants-Doorn WMA	Ms Toni Belcher	1, 2, 4 and 5
DWA Western Cape Regional staff										
Mr Bentley Engelbrecht		X		X			Scientist (Production)	River Health Programme; Reserve Determination; Olifants/Doorn WMA	Mr Dana Grobler / Ms Toni Belcher	1, 4 and 5
Ms Thembela Bushula	x		x				Control Environmental Officer (Grade A)	Assist with the co-ordination and implementation of the WRCS from the Regional Office perspective; Contribute to the development of ecological, socio-economic tools and methodologies to support the WRCS; Liaison with stakeholders on classification of water resources in the Olifants-Doorn	Ms Toni Belcher / Mr Dana Grobler	1, 4 and 5

Table 16 (continue): Summary of the individuals who will be included in the Capacity building programme of the Olifants Doorn Classification project

Project team members to be included in the capacity building activities										
Ms Louise Dobinson							Hydrology	Hydrology modelling	Dr. Verno Jonker	2, 3 and 4
Ms Candice Lasher							Geo-hydrology	Groundwater Reserve determinations and groundwater within the public participation	Mr. Julian Conrad	4 and 5
Mr Manana Rancho							Resource economics		Prof Theo Kleynhans	4.3 and 4.4
Ms Kandas Cloete							Resource economics		Prof Theo Kleynhans	4.3 and 4.4
Mr Vuyisile Zenani							Social Science		Mr Tony Barbour	4.3 and 4.4
Ms Marilie Carstens							GIS	GIS mapping and modelling	Mr Julian Conrad	4
Ms Sheeba Thomas							Data management	Data management	Mr Dana Grobler	6

7.4 CAPACITY BUILDING WITHIN STUDY TEAM

Groundwater: Ms Candice Lasher graduated from the University of the Western Cape (UWC) in 2007 with a BSc (Hon) in geohydrology and will soon be submitting her MSc thesis. She is involved in the GRDM work and particularly the resource classification. This is a new component of geohydrology to her. She will also play an active role in the public participation meetings if specialist input is required on groundwater occurrence. Her knowledge of the Olifants-Doorn WMA is increasing along with her experience.

Regular reports will be compiled in terms of the progress and successes within the proposed capacity building initiatives. These progress reports will be incorporated into the main progress reports of the project.

7.5 INVOLVEMENT AND CAPACITY BUILDING OF DWA STAFF

See table 16.

8 PROJECT SCHEDULING

The project schedule is provided in Figure 7. indicating that the project could be finished in the DWA financial year 2011/2012. See Figure 7.

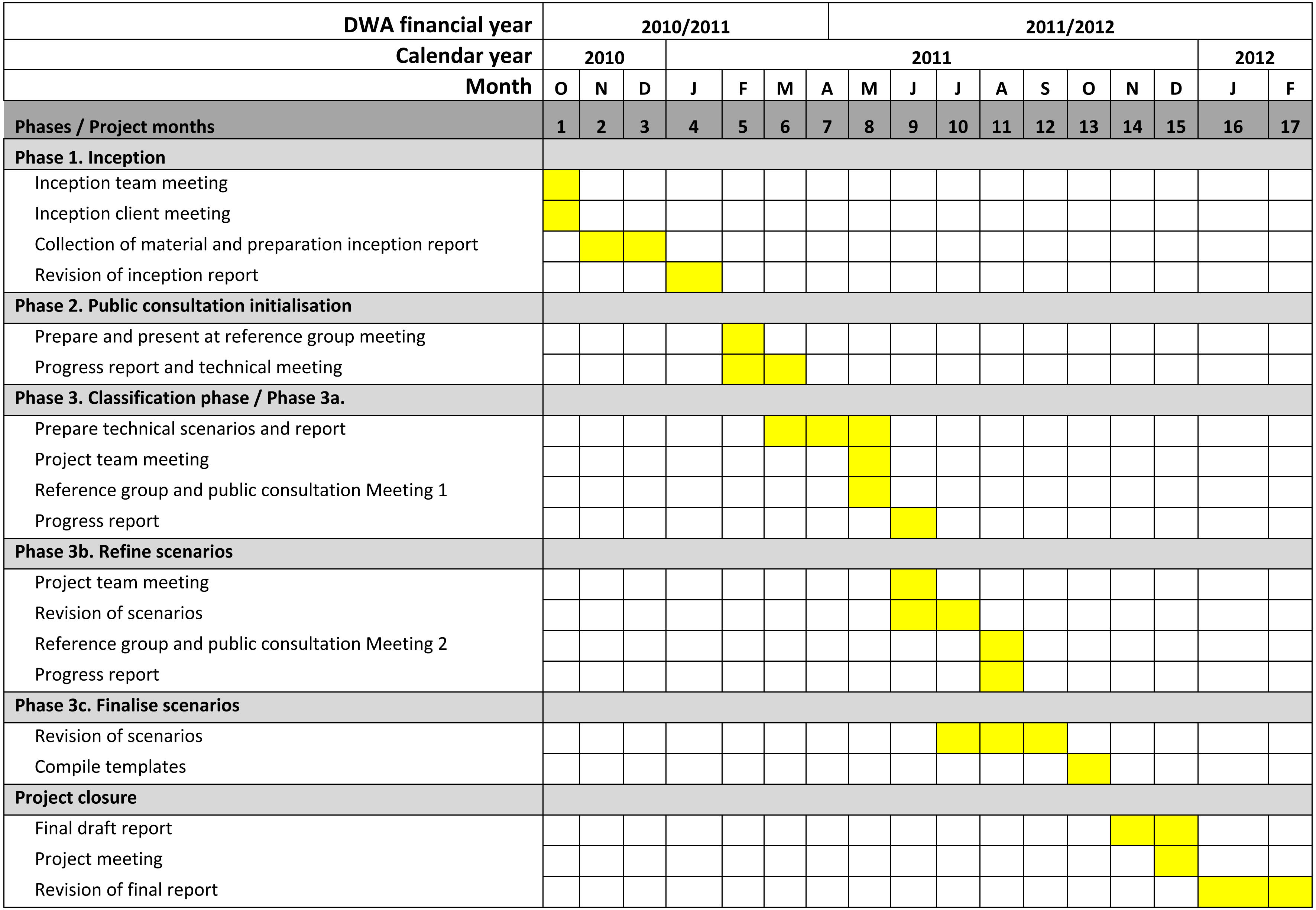

Figure 7: Gantt chart of proposed tasks indicating the task scheduling and its relation to the DWA financial and calendar years.

9 REFERENCES

ADAMS, J.B. AND BATE, G.C. (1997). Preliminary assessment of altered freshwater flow on the flora of the Olifants Estuary. Report submitted to Ninham Shand as part of the Olifants/Doring basin study for the DWAF in 1997.

BOUCHER, C. (1997b). A synoptic assessment of the riparian vegetation in the Riet and Doring Rivers (Western Cape) as determined during a helicopter survey on 14 October 1997. Unpublished report prepared for DWAF.

BICKERTON, I.B. AND WOOLDRIDGE, T.H. (1997). The effect of future changes in runoff on the Olifants Estuary: Benthic Invertebrates. Report submitted to Ninham Shand as part of the Olifants/Doring basin study for the DWAF in 1997.

BROWN, C.A. AND DAY, E.G. (1997). Olifants / Doring Basin 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. 52 pp.

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

COETZEE, J.C., ADAMS, J.B. AND BATE, G.C. (1997). A botanical importance rating of selected Cape estuaries. Water SA Vol. 23 No. 1

COETZER, A. (1982). Hydrobiological report on the Olifants River, Western Cape Province. Cape Department of Nature Conservation. Unpublished report.

CSIR. (1990a). Preliminary assessment of the potential for fresh water extraction from the Olifants Estuary. *CSIR Report* EMA-C 9049. Stellenbosch.

DALLAS, H.F. (1997). Olifants / Doring Basin Study. Impacts of the Water Resource Developments on the Riverine Ecosystem. Volume 2: Olifants River Situation Assessment. Unpublished report to the Department of Water Affairs and Forestry. 52 pp.

DAY, E., THARME., R.E., FOWLER, J. and BROWN, C.A. (1998). River Health Programme. Biomonitoring of the Olifants/Doring River systems, Western Cape. Volume 1: Initial Assessment: October 1998. Commissioned by Project Planning, Department of Water Affairs and Forestry, Pretoria.

DAY, E., THARME, R.E., FOWLER, J. and BROWN, C.A. (1998). River Health Programme. Biomonitoring of the Olifants/Doring River systems, Western Cape. Initial Assessment: October 1998. Volume 2: Appendices. Commissioned by Project Planning, Department of Water Affairs and Forestry, Pretoria.

DENNIS MOSS PARTNERSHIP. (2001). Cederberg Environs Spatial Development Framework. Unpublished report prepared for West Coast District Council.

DEPARTMENT OF AGRICULTURE. (2003). Botanical Report. Prepared by C. Boucher for ARCUS GIBB (Pty) Ltd as part of Contract No. 259 – 2000/2002: Western Cape Olifants/Doring River Irrigation Study.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (1996). South African Water Quality Guidelines for Fresh Water. Edition 2. Volumes 1-7. Department of Water Affairs and Forestry, Pretoria, Republic of South Africa.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (1997). Olifants/Doring River basin study. Background information document. First draft (June). Directorate of Planning, Pretoria.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (1998). Water Resources Evaluation: Hydrology. Prepared by G Howard of Ninham Shand (Pty) ltd as part of the Olifants/Doring River Basin Study. DWAF report No. P E000/00/0398.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (1998). *Olifants-Doorn River Basin Study. Water Quality Assessment.* Prepared by BKS Engineering and Management in association with Ninham Shand (Pty) Ltd. DWAF Report No PE 000/00/0798.

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 (2004). Calibration of the Water Quality Model. Olifants/Doring River Basin Study – Phase II. Report no: E100/00/0203. Department of Water Affairs and Forestry, Pretoria, Republic of South Africa.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (2005). *Olifants-Doorn Water Management Area: Internal Strategic Perspective.* Prepared by Ninham Shand (Pty) Ltd in association with Jakoet and Associates, Umvoto

Africa, FST and Tlou and 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). Water Resource Planning Systems Series, Sub-Series No. WQP 1.7.2.1, Resource Directed Management of Water Quality: Guideline for determining Resource Water Quality Objectives (RWQOs), Allocatable Water Quality and the Stress of the Water Resource. Pretoria.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (2007). Department: Water Affairs and Forestry: Development of the Water Resource Classification System (WRCS). By Chief Directorate: Resource Directed Measures.

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. (2009). Adopt-a-River Programme Phase II: Development of an Implementation Plan. Water Resource Quality Situation Assessment. Prepared by Aurecon for the Department of Water Affairs, Pretoria, South Africa.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, PRETORIA, GEOSS, (2006). Groundwater Reserve Determination required for the Sandveld, Olifants-Doorn Water Management Area. Prepared by GEOSS for the Department of Water Affairs and Forestry.

DOLLAR, E.S.J., BROWN, C.A., TURPIE, J.K., JOUBERT, A.R., NICOLSON, C.R. AND MANYAKA, S. (2006): *The development of the Water Resource Classification System (WRCS).Volume 1. Overview and 7-step classification procedure*. CSIR Report.

FLANAGAN, L.E., PARSONS, R.P., MUNCH, Z., BASSON, F.C., CONRAD, J.E. AND WENTZEL, J. (2006) *Groundwater resource directed measures pilot study - groundwater atlas of the E10 catchment*; WRC Project K5/1427, March 2006 prepared in association with the Department of Water Affairs and Forestry and GEOSS for the Water Research Commission.

GEOSS, (2003). Groundwater Reserve Determination Required for the Olifants/Doring Catchment, Western Cape – Terms of Reference (Draft 1.0). Prepared for Southern Waters ER & C as Report 3 of the Olifants/Doring Catchment Water Requirements Study, by J Conrad of GEOSS.

GORE, J.A.; KING, J.M. AND HAMMAN, K.C.D. (1991). Application of the instream flow incremental methodology to Southern African rivers: protecting endemic fish of the Olifants River. *Water SA*. 17 (3): 225-236.

HAMMAN, K.C.D.; THORNE, S.C. AND SKELTON, P.H. (1984). The discovery of the Caper Kurper *Sandelia capensis* (Curvier in C. and V., 1831) in the Olifants River System (Western Cape Province). *The Naturalist*. 28: 24-26.

HARRISON, T.D., COOPER, J.A.G., RAMM, A.E.L. AND SINGH, R.A. (1994). Health of South African estuaries, Orange River - Buffels (Oos). Executive report. Project No WE005. Prepared by CSIR, Durban for the Department of Environment Affairs, Pretoria.

HUIZINGA, P. and VAN NIEKERK, L. (1997). The effect of future changes in runoff on the Olifants Estuary - physical dynamic conditions. *CSIR Report* ENV/S-C 97128. Stellenbosch. Report submitted to Ninham Shand as part of the Olifants/Doring basin study for the DWAF in 1997.

HEROLD, C.E. & LE ROUX, P.J. (2004). WQ2000: Development of an Interactive Surface Water Quality Information and Evaluation System for South Africa. WRC Report No. 950/1/04. Water Research Commission, Pretoria.

JOUBERT, A., TURPIE, J., BROWN, C., MANYAKA, S. AND DOLLAR, E. (2006): *The development of the Water Resource Classification System (WRCS). Volume 4. Decision-analysis (including the stakeholder engagement process) guidelines for the 7-step classification procedure*. CSIR Report No., Department of Water Affairs and Forestry, Pretoria,

MORANT, P.D. (1984). Estuaries of the Cape Part II: Synopsis of available information on individual systems (A E F Heydorn and J R Grindley eds.). Report No. 26: Olifants. *CSIR Research Report* 425. Stellenbosch.

NEL, J.L., BELCHER, A., IMPSON, N.D. KOTZE, I.M., PAXTON, B., SCHONEGEVEL, L.Y. AND SMITH-ADAO, L.B. (2006). Conservation assessment of freshwater biodiversity in the Olifants-Doorn Water Management Area: Final report. *CSIR Report Number CSIR/NRE/ECO/ER/2006/0182/C*, CSIR, Stellenbosch.

PROVINCIAL GOVERNMENT WESTERN CAPE: Department of Agriculture. (2001). Riverine Ecosystems Report Prepared by Southern Waters Ecological Research and Consulting cc as part of Contract No. 259 – 2000/2001: Western Cape Olifants/Doring River Irrigation Study.

ROWNTREE, K.M. AND WADESON, R.A. (1999). A hierarchical geomorphological model for the classification of selected South African rivers. Water Research Commission Report No. 497/1/99. Pretoria, South Africa.

TALJAARD, S. (1997). The effect of future changes in runoff on the Olifants Estuary. Phase 1: Water quality and related issues. CSIR Report ENV/S-C 97127. Report submitted to Ninham Shand as part of the Olifants/Doring basin study for the DWAF in 1997.

LONDON, L., DALVIE, M.A., CAIRNCROSS, E., AND SOLOMANS, A. (2000). The quality of surface and groundwater in the rural Western Cape with regard to pesticides. WRC Report No. 795/1/00. Water Research Commission, Pretoria.

PARSONS AND ASSOCIATES, (2000). Rapid Reserve Determination of the Olifants and Doring Rivers: Assessment of the Groundwater Component. Prepared for BKS (Pty) Ltd, by R Parsons, Report No. 065/BKS-D1, June 2000.

PROVINCIAL GOVERNMENT WESTERN CAPE:. DEPARTMENT OF AGRICULTURE (2003). Soils and Irrigation Potential. Prepared by JJN Lambrechts, F Ellis and BHA Schloms in association with ARCUS GIBB (Pty) Ltd as part of Contract No. 259 – 2001/2002: Western Cape Olifants/Doring River Irrigation Study. PGWC Report Number 259/2004/10.

PROVINCIAL GOVERNMENT WESTERN CAPE: DEPARTMENT OF AGRICULTURE. (2004b). Water Quality Aspects. Prepared by ARCUS GIBB (Pty) Ltd in association with BKS (Pty) Ltd as part of the Contract No 259-200/2001: Western Cape Olifants/Doing River Irrigation Study. PGWC Report Number 259/2004/14.

SINCLAIR, S.A., LANE, S.B AND GRINDLEY, J.R. (1986). Estuaries of the Cape: Part II: Synopsis of available information on individual systems. Report No. 32 – Verlorevlei (CW13). Heydorn, A.E.F. and Morant, P.D. (Eds). Stellenbosch, CSIR Research Report. 431

SOUTHERN WATERS, (2006). Olifants/Doring Catchment EWR Study ???

SRK, (2006). Groundwater Reserve Determination Study for the Olifants-Doorn Catchment. Prepared for Directorate: Resource Directed Measures, Department of Water Affairs & Forestry by M Fortuin and A.C. Woodford. SRK Project Number 348965.

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.

VAN RENSBURG, K.J. (1966). Die vis van die Olifantsrivier (Weskus) met spesiale verwysing na die geelvis (*Barbus capensis*) en saagvin (*Barbus serra*). *Investigational Report Cape Department of Nature Conversation*. 10: 1-14

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

WATER RESEARCH COMMISSION (1998). Quality of Domestic Water Supplies, Volume 1: Assessment Guide. No. TT 101/98, Second Edition.

10 APPENDICES

Appendix A: List of the proposed Olifants-Doorn Project Steering Committee

Name	Affiliation	Designation	Email address	Contact details
Pienaar Harrison	DWA:RDM	Chief Director	qin@dwa.gov.za	012 336 7197
Shane Naidoo	DWA: RDM-WRC	Director	tbe@dwa.gov.za	012 336 6707
Ndileka Mohapi	DWA:RDM-RDMC	Director	qme@dwa.gov.za	012 336 8234
Yakeen Atwaru	DWA:RDM-RR	Director	atwaruy@dwa.gov.za	012 336 7816
Tovhowani Nyamande	DWA:RDM-WRC	Deputy Director	nyamandet@dwa.gov.za	012 336 7521
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Rashid Khan	DWA: WC RO	Chief Director	khanr@dwa.gov.za	
Pumza Lubelwana	DWA: WC RO	Director	lubelwp@dwa.gov.za	021 950 7107
Zacharia Maswuma	DWA: HS	Director	maswumaz@dwaf.gov.za	012 336 8784
Wilna Kloppers	DWA: WC RO	Deputy Director	kloppew@dwa.gov.za	021 950 7141 082 807 6191
Beason Mwaka	DWA: IWRP	Director	tda@dwaf.gov.za	012 336 7514
Isa Thompson	DWA: NWRP	Chief Engineer	ijg@dwaf.gov.za	012 336 8647
Sipho Skosana	DWA: Water Allocation	Director	bbl@dwaf.gov.za	012 336 7677
John Dini	SANBI		dini@sanbi.org	012 843 5192 083 420 7988
Joanne Yawitch	DEA:National		jyawitch@deat.gov.za	012 310 3565
Gary de Kock	SANParks		GaryDK@sanparks.org.za	021 799 8873
MJM Gabriel	Dept. of Agriculture	Director	DWUID@nda.agric.za	012 846 8567/9
Bonani Madikizela	WRC		bonanim@wrc.org.za	
Jan Briers	DME		janbriers@dmr.gov.za	021 427 1000/1051
Anthony Barnes	Western Cape Department of Environmental, Cultural Affairs and Sport	Director	anbarnes@pgwc.gov.za	021 483 4094

Appendix B: Technical task team leaders for the Olifants-Doorn Classification project

The **project manager** is **Mr Dana Grobler**. Dana is the managing member of Blue Science Consulting cc. Dana has more than 20 years of experience in the water resources management field with specific experience related to various aspects of water resources management and the implementation of water resource protection measures. Dana has provided management and technical support to the DWAF RDM directorate and Chief directorate during the period 2000 – 2007. During this period Dana was the DWA representative on the team who developed the classification system. Dan was the C.A.P.E coordinator for the various studies that was undertaken in the Cape Floristic Region, including the Reserve implementation study and the compilation of a proto protection sub strategy for the Olifants Doring Catchment Management Area.
Ms Toni Belcher has more than 20 years experience in the water sector. During her employment in the DWA she has been involved in many water quality and water resource management projects providing training and has compiled various outstanding reports containing the results from water resource quality monitoring programmes. Toni was the author, designer and layout artist of the five State of Rivers reports in the Western Cape, including the Olifants Doring State of River report (2006). Toni was the DWAF project manager for the comprehensive determination of the Ecological Reserve for the Olifants Doring catchment. Toni was a technical team member for the compilation of the legal templates for the Olifants Doring catchment. Toni was the senior author of the Sandveld Integrated Water Resources Management Plan. Toni has extensive experience with the determination of ecological status of rivers.
Ms Doreen Februarie is a professional Social Worker with 23 years experience in the community development field. She has been involved since 1999 with the management and facilitation of Public Participation Processes for the Department of Water Affairs and Forestry in the various Water Management areas in the Western Cape which include: Breede, Olifants Doorn and the Berg Water Management Areas. She subsequently got involved with other processes and projects with the Department of Water Affairs and Forestry. Such projects include the following: Management and implementation of a training programme for the National Working for Water Programme, Management of the Public Participation Process for the Raising of Clanwilliam Dam, Western Cape Masibambane Water Sector Strategy, Western Cape Reconciliation Study, Western Cape Table Mountain Aquifer Study.
Dr Verno Jonker has more than fifteen years experience as a water resources engineer in catchment hydrology, water supply feasibility and water resource planning studies, flood hydrology, flood risk assessments and mapping, eco-hydraulics, hydraulic modelling and design. He has been the hydraulics/hydrology task leader for a number of ecological Reserve determination studies in various river systems such as: Diep & Spoornetkloof Rapid Reserve; Berg River Intermediate

Reserve; and Krom/Seekoei Rivers Comprehensive Reserve Determinations, C.A.P.E. EWR studies in the Palmiet and Koekedouw Rives. He also has extensive project management experience and experience of software applications.

Mr Nico Rossouw has over 28 years of experience working as a water quality specialist on river and reservoir systems in Southern Africa. He specialises in water quality assessment, water quality modelling, water quality management and water quality decision support systems. He has been involved in many water quality related resource protection projects such as: Water quality assessment and management guideline for determining Resource Water Quality Objectives (RWQOs), Allocatable Water Quality, and the stress of the Water Resource for the Joint Maputo River Basin Water Resources Study; Ecological Water Quality Reserve determinations in the Olifants, Apies/Pienaars, Berg, Breede, Hex, Swartkops, Amatole, Mhlathuze, Black & White Kei River Systems; Development of a strategy for the implementation of Resource Directed Measures, Development and refinement of water quality protocols and procedures for the assessment of the water quality reserve in river ecosystems. He also has extensive water quality experience in the Olifants-Doorn WMA.

Mr Julian Conrad has worked extensively in the Olifants-Doorn Water Management Area (WMA), both across the entire WMA and intensively in specific portions of the WMA such as: Development of the RDM Classification System and its pilot testing for the groundwater component; Groundwater resource classification as part of the National Scale Groundwater Resource Assessment Project, Phase II; training for the DANIDA-funded Integrated Water Resources Management (IWRM) project in the Olifants-Doorn Water Management Area; Comprehensive Groundwater Reserve Determination Measures for the Sandveld (2005) which included Reserve calculations, resource Classification and defining Resource Quality Objectives. His technical skills, experience and expertise are in the use of ArcGIS, the management of geodatabases and the use of other groundwater-related specialist software products, including the calculation of groundwater contribution to river system base flows.

Mr Tony Barbour is an independent environmental consultant and researcher with a focus on social impact assessment, strategic environmental assessment and planning, resource economics, training, capacity building and review work. He has worked for ten years as an environmental consultant in the private sector and spent more than four years at the University of Cape Town's Environmental Evaluation Unit, where he has gained experience in environmental, strategic and social impact assessment. He also serves on the Board of Trustees for the Environmental Monitoring Group, an Environmental Non Government Organisation. He is currently a director on the Richtersveld Environmental and Rehabilitation Company, a company that was set up as part of the successful land claim by the Richtersveld community who live in the north-western part of South Africa.

Prof Theo Kleynhans is an agricultural economist who obtained his PhD at the University of

Stellenbosch, where he has been teaching since 1984. He is affiliated with both the Department of Agricultural Economics and Department of Economics of the Faculty of Economic and Management Sciences at the University of Stellenbosch As a practicing farmer, his research focus has been on aspects of environmental economics, especially as it affects the Western Cape exporting industries. He has also led a research initiative whose aim is to assess the resource potential of the SADC region using GIS techniques, and has travelled widely in the region. In .2007 he wrote the article "Towards more inclusive long-term bulk water resource management," for the agricultural sector in South Africa.