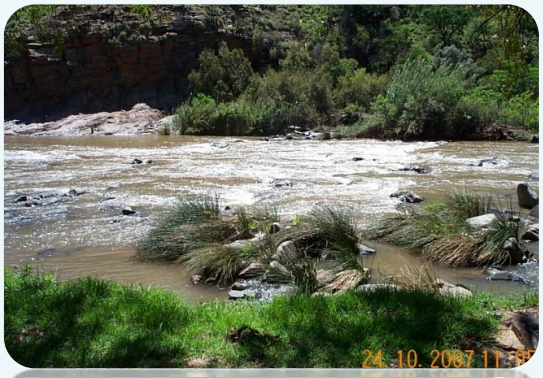

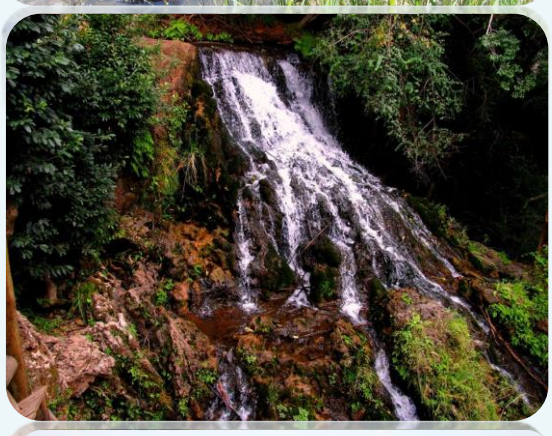

DETERMINATION OF RESOURCE QUALITY OBJECTIVES IN THE MOKOLO, MATLABAS, CROCODILE (WEST) AND MARICO CATCHMENTS IN THE LIMPOPO NORTH WEST WATER MANAGEMENT AREA (WMA 01)

WP10992

INCEPTION REPORT

REPORT NO.: RDM/WMA01/00/CON/RQO/0116

FINAL

Chief Directorate: Water Ecosystems

MAY 2016

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Published by

Department of Water and Sanitation
Private Bag X313
Pretoria, 0001
Republic of South Africa

Tel: (012) 336 7500/ +27 12 336 7500
Fax: (012) 336 6731/ +27 12 336 6731

This report is to be cited as:

Department of Water and Sanitation, South Africa. May 2016. Determination of Resource Quality Objectives in the Mokolo, Matlabas, Crocodile West and Marico Catchments in the Limpopo North West Water Management Area (WMA01): Inception Report. Report No: RDM/WMA01/00/CON/RQO/0116

Prepared by:

Golder Associates Africa in association with Wetland Consulting Services, Hydrosol, JMM Stassen and Zitholele Consulting

Title:	*Inception Report*
Authors:	*P Moodley, L Boyd, E van Wyk, R Stassen*
Project Name:	*Determination of Resource Quality Objectives in the Mokolo, Matlabas, Crocodile (West) and Marico Catchments in the Limpopo North West Water Management Area: WP 10992*
DWS Report No:	*RDM/WMA01/00/CON/RQO/0116*
Status of Report:	*Final*
First Issue:	*March 2016*
Final Issue:	*May 2016*

Professional Service Providers: Golder Associates Africa/ Zitholele Consulting/ Wetland Consulting Services/ JMM Stassen and Hydrosol

Approved for the PSP by:

…… ……..

Trevor Coleman *Date*

Project Leader

DEPARTMENT OF WATER AND SANITATION

Chief Directorate: Water Ecosystems

Approved for DWS by:

……

Ndileka Mohapi

Chief Director: Water Ecosystems

DOCUMENT INDEX

Reports as part of this project:

Bold type indicates this report.

REPORT INDEX	REPORT NUMBER	REPORT TITLE
1.0	RDM/WMA01/00/CON/RQO/0116	**Inception Report**

LIST OF ABBREVIATIONS

BID	Background Information Document
CD: WE	Chief Directorate: Water Ecosystems
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
EC	Ecological Category
EIS	Ecological importance and sensitivity
EWR	Ecological Water Requirements
IUA	Integrated Unit of Analysis
IWRM	Integrated Water Resource Management
IWRMP	Integrated Water Resources Management Plan
MCWAP	Mokolo and Crocodile River (West): Water Augmentation Project
NWA	National Water Act
NWRS	National Water Resource Strategy
PES	Present Ecological Sate
PMC	Project Management Committee
RQOs	Resource Quality Objectives
RDM	Resource Directed Measures
RUs	Resource Units
TOR	Terms of Reference
WMA	Water Management Area
WfWetlands	Working for Wetlands
WRCS	Water Resource Classification System

EXECUTIVE SUMMARY

The Chief Directorate: Water Ecosystems (CD: WE) of the Department of Water and Sanitation (DWS) is tasked with the responsibility to protect water resources by setting objectives for the desired condition of the water resources. The CD: WE has identified the need to undertake the determination of Resource Quality Objectives (RQOs) in Mokolo, Matlabas, Crocodile (West) and Marico catchments in the Limpopo North West Water Management Area (WMA). Golder Associates (Africa) in association with Zitholele Consulting, Hydrosol, Wetland Consulting Services and JMM Stassen have been appointed to undertake the study.

The Water Resource Classification process and the Reserve determination have been completed in these catchment areas. The determination of the RQOs will follow on from this and will define the clear goals relating to the quality of the relevant water resources based on the water resources classes that have been established. A key objective of this study is thus to undertake the implementation of the RQO determination procedure (7 step process) in the Mokolo, Matlabas and Crocodile (West) and Marico Catchments. The spatial extent of the area includes tertiary drainage regions A10, A21 to A24, A31, A32, A41, A42 and quaternary drainage region D41A.

This study is primarily of a technical nature being supported by stakeholder engagement and consultation and the necessary legal processes. The study includes the following tasks:

- Project Inception
- RQO Determination Process
- Gazetting Process
- Stakeholder engagement and consultation processes
- Reporting and Study Management and Co-ordination
- Capacity Building (Skills Transfer)

The inception phase has been completed and captured in this report. The inception report has been produced to better define the scope of work for the study, document any changes to the scope of work from the proposal, highlight related considerations that could influence the study and confirm the study programme.

Determination of Resource Quality Objectives in the Mokolo, Matlabas, Crocodile (West) and Marico catchments

Inception Report

TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 BACKGROUND 1

1.2 PURPOSE OF THE STUDY 2

1.3 PURPOSE OF THE REPORT 2

1.4 STUDY AREA 3

1.4.1 Surface Water 6

1.4.2 Groundwater 8

1.4.3 Ecological Important Areas 8

1.4.4 Shared Watercourse 11

2 STUDY PARAMETERS 11

2.1 WATER RESOURCE COMPONENTS 11

2.2 RESOURCE UNITS 12

2.3 VISION 12

2.4 STAKEHOLDER ENGAGEMENT 12

2.5 METHODOLOGY 12

3 SCOPE OF WORK 12

3.1 TASK 1: STUDY INCEPTION 14

3.1.1 Review of existing information 14

3.1.2 Stakeholder Engagement 16

3.1.3 Capacity Building 17

3.1.4 Preliminary Resource Unit Delineation 19

3.1.5 Compilation of the Inception Report 32

3.2 TASK 2: WATER RESOURCES INFORMATION AND DATA GATHERING 32

3.3 TASK 3: DETERMINATION OF RESOURCE QUALITY OBJECTIVES 32

3.4 TASK 4: COMMUNICATION AND LIAISON 35

3.4.1 Identification and Arrangement of Committees/Task Teams 35

3.4.2 Preparation for meetings/workshops 35

3.4.3 Workshops and meetings – co-ordination and liaison 35

3.4.4 Dissemination of meeting documentation 36

3.5 TASK 5: STAKEHOLDER ENGAGEMENT 36

3.5.1 Stakeholder identification and database 36
3.5.2 Announce the project 37
3.5.3 Obtaining agreement on Resource Units; RQOs and Numerical Limits with stakeholders – step 6 of the RQO determination procedure 38
3.5.4 Project Steering Committee 38
3.5.5 Technical Task Groups 38
3.5.6 Issues and Response Register 38
3.5.7 Support to Gazetting Process. 39
3.6 TASK 5: CAPACITY BUILDING 39
3.7 TASK 6: STUDY MANAGEMENT AND REPORTING 39
3.7.1 Client liaison 40
3.7.2 Coordination of Study Team 40
3.7.3 Study administration 40
3.7.4 Reporting and Reviewing System 40
3.8 SUMMARY OF DELIVERABLES 41
4 STUDY PROGRAMME 42
5 STUDY TEAM 42
5.1 GENERAL 42
5.2 TEAM MEMBERS 42
..... 44
6 STUDY COSTS 45
6.1 SUMMARY COSTS 45
6.2 SUMMARY COST BREAKDOWN PER STUDY DELIVERABLE 45
6.3 DISBURSEMENTS 46
6.4 CASH FLOW PROJECTIONS 46
7 ASSUMPTIONS AND LIMITATIONS 46
8 REFERENCES 48

LIST OF FIGURES

Figure 1: The Study Area - Mokolo, Matlabas, Crocodile (West) and Marico catchments 4
Figure 2: Scope of work 13
Figure 3: IUAs delineated within Crocodile (West), Marico, Mokolo and Matlabas catchments 22
Figure 4: Preliminary delineation of Resource Units 31
Figure 5: The 7 Step RQO Determination Procedure 33

Figure 6: Summary of stakeholder engagement/communication 37

Figure 7: Team Organogram 44

LIST OF TABLES

Table 1:Sub-catchments and related quaternary drainage regions comprising the Mokolo, Matlabas and Crocodile (West) and Marico Catchment areas 3

Table 2: Proposed Study Tasks 13

Table 3: Proposed capacity building programme 17

Table 4: IUAs delineated for the Crocodile (West), Marico, Mokolo and Matlabas catchments 20

Table 5: Preliminary Resources Unit delineation in the Crocodile (West) catchment, Marico catchment and Mokolo and Matlabas catchments 24

Table 6: Summary of study deliverables 41

Table 7: Team members involved in the study 42

Table 8: Summary of Study Costs 45

Table 9: Summary of Cost breakdown per deliverable 45

LIST OF APPENDICES

APPENDIX A Study programme

APPENDIX B Projected Study Cash Flow

1 INTRODUCTION

1.1 BACKGROUND

The Chief Directorate: Water Ecosystems has initiated the development of Resource Quality Objectives (RQOs) for the Mokolo, Matlabas, Crocodile (West) and Marico catchments. The purpose of this study is to implement the RQO determination procedures in the catchment area and in so doing determine the RQOs of the significant water resources.

The Water Resource Classification System (WRCS), Reserve and Resource Quality Objectives (RQOs) are protection-based measures that together comprise Resource Directed Measures (RDM), the protection principles which are contained in Chapter 3 of the National Water Act (Act No. 36 of 1998). The classification system and the Reserve are intended to ensure comprehensive protection of all water resources. An important consideration in the determination of RDM is that they should be technically sound, scientifically credible, practical and affordable. Once the water resources class and the Reserve have been established, RQOs are established to give effect to these.

A resource quality objective has to be determined for a significant water resource as the means to ensure a desired level of protection. The purpose of the RQOs is to provide limits or boundaries (biological, physical and chemical attributes, etc) which should be met in the receiving water resource in order to ensure protection. In this way it can be deduced whether the resource is being stressed by existing management practices or not.

RQOs are a mechanism through which a balance between sustainable and optimal water use and protection of the water resource can be achieved and are defined by the National Water Act (Act No. 36 of 1998) as “clear goals relating to the quality of the relevant water resources”. RQOs are descriptive or quantitative, spatial or temporal, and are thus aimed at ensuring that local priorities are appropriately balanced with broader spatial and temporal perspectives (WMA and national level) and at meeting the objectives of the resource directed measures.

In determining the RQOs, it is important to recognise that different water resources will require different levels of protection. In addition to achieving the water resource class, the process will allow due consideration of the social and economic needs of competing interests by all who rely on the water resources.

In terms of the National Water Act (NWA) (Act 36 of 1998), the RQO’s are based on the water resources class and may relate to the following:

- Reserve;
- in-stream flow;
- in-stream and riparian habitat quality;
- water level;
- presence and concentration of substances in the water;
- characteristics and quality of water resource;
- characteristics and distribution of aquatic biota; and
- regulation of in-stream or land-based activities affecting water quality.

The setting of the RQOs is best carried out through establishing a vision for the WMA. The RQOs for the different water resources within the WMA are then established as management tools towards achieving the overall vision.

The RQOs encompass four sub-components of the resource quality:

- Water quantity;
- Water quality;
- Habitat integrity; and
- Biotic characteristics.

In this respect the Chief Directorate: Water Ecosystems (CD: WE) of the Department of Water and Sanitation (DWS) is tasked with the responsibility to protect water resources by setting objectives for the desired condition of resources and putting measures in place to control water use to limit impacts to acceptable levels. The CD: WE has identified the need to undertake the determination of RQOs in Mokolo, Matlabas, Crocodile (West) and Marico catchments. Golder Associates (Africa) in association with Zitholele Consulting, Hydrosol, Wetland Consulting Services and JMM Stassen have been appointed to undertake the study.

The Water Resource Classification process and the Reserve determination have been completed in the catchment areas. The determination of the RQOs will follow on from this and will define the clear goals relating to the quality of the relevant water resources based on the water resources classes that have been established.

1.2 PURPOSE OF THE STUDY

The main objective of the study is to determine Resource Quality Objectives (RQOs) for all significant water resources in the Mokolo, Matlabas and Crocodile (West) and Marico Catchments that must give effect to the water resources classes that have been determined.

A key aim of this study is thus to undertake the implementation of the RQO determination procedure (7 step process) (DWA, 2011) in the Mokolo, Matlabas and Crocodile (West) and Marico Catchments. It is understood that this study is strongly linked to the classification study, previous Reserve determination and Reconciliation Strategy studies. Where identified and required these linkages will be established and common aspects aligned and integrated.

It is recognised that the successful determination of RQOs will depend on the integration of a number of scientific disciplines in respect of water resources with the water uses and the needs of the water users present in the catchment area in giving effect to the water resources classes. In addition key stakeholders that are able to contribute to different elements of the RQO determination will also be involved in the process.

1.3 PURPOSE OF THE REPORT

The inception report has been produced to better define the scope of work for the study, document any changes to the scope of work from the proposal, and highlight related considerations that could influence the study, confirm the study programme and indicate any revised cost estimates resulting from the initial assessments and reviews undertaken during the inception phase of the project.

1.4 STUDY AREA

The study area for the RQO Determination study is the Mokolo, Matlabas and Crocodile (West) and Marico Catchments (Figure 1) in the Limpopo North West Water Management Area (WMA). The spatial extent of the area includes tertiary drainage regions A10, A21 to A24, A31, A32, A41, A42 and quaternary drainage region D41A (Table 1).

Table 1:Sub-catchments and related quaternary drainage regions comprising the Mokolo, Matlabas and Crocodile (West) and Marico Catchment areas

Sub-catchment	Catchment Area (km^2)	Quaternary catchments
Upper Crocodile (A21)	6 336	A21 A – L
Elands (A22)	6 221	A22 A – J
Apies/Pienaars (A23)	7 588	A23 A – L
Lower Crocodile (A24)	9 204	A24 A – J;
Marico (A31 and A 32)	12 030	A32 A – E; A31 A – J
Ngotwane (A10)	1 842	A10 A – C
Upper Molopo (D41))	4 300	D41 A
Matlabas (A41)	6 014	A41A – E
Mokolo (A42)	8 387	A42 A – J

The Mokolo and Matlabas catchments

The Mokolo catchment stretches from the Waterberg Mountains through the upper reaches of the Sand River, and includes the Mokolo Dam and a number of small tributaries that join the main Mokolo River up to its confluence with the Limpopo River, including the Tambotie, Poer-se- Loop, Sterk and Rietspruit rivers. The catchment covers an area of 8 387 km^2 and is largely undeveloped, apart from irrigation in parts of the upper catchments with limited water resources and limited water use. The climate in the Lephalale area is mild winters (4-20 °C) and moderate summers (17-28°C). Rainfall in the Matlabas and Mokolo catchment areas ranges from 600 mm in the east to 400 mm in the west towards the Botswana border.

Exxaro's Grootegeluk Colliery the largest open cast coal mine of its kind in the world, with a current annual production of 15.3 Mt/a, is currently the only commercial coal mining operation in the Waterberg Basin and is being expanded to supply the new Medupi Power Station with coal. However, the Lephalale area has been selected by Sasol to access the vast coal reserves in the Waterberg coal fields for its Maphuta coal to liquid fuel projects (Mafutha).

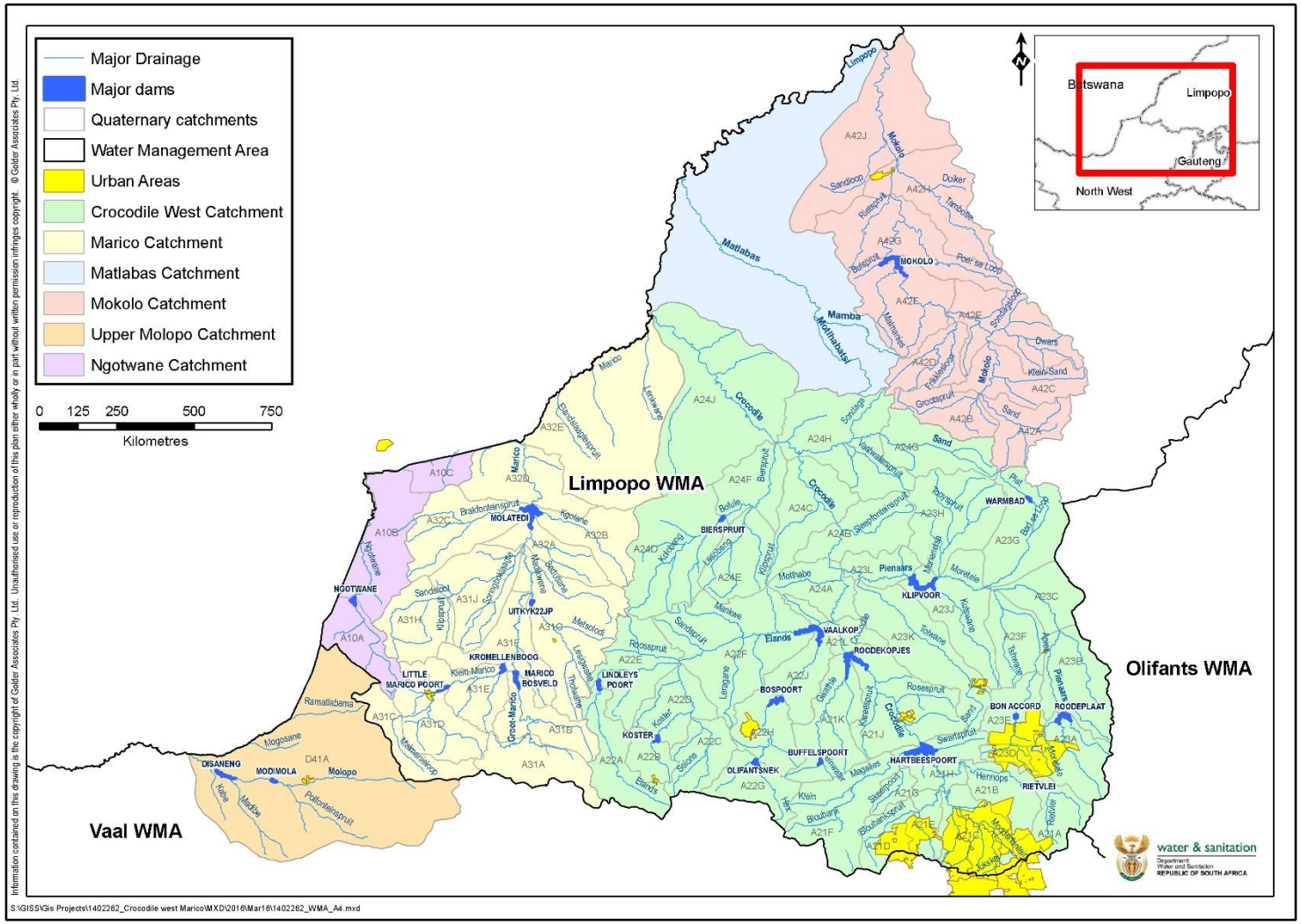

Figure 1: The Study Area - Mokolo, Matlabas, Crocodile (West) and Marico catchments

A transfer of water from the Crocodile West catchment into the Mokolo catchment is being planned to support the expected growth in mining and power generation in the Lephalale area (Mokolo and Crocodile River (West): Water Augmentation Project (MCWAP). The land-use is agriculture, with private and provincial nature reserves as well as coal mining and platinum mining. The area is largely rural in nature.

The Steenbokpan area, quaternary catchment A41E in the Matlabas catchment, is part of the Lephalale coalfield and numerous mining developments are foreseen for this region. Current and future developments around the available coal reserves in the Steenbokpan area will require adequate planning for future water needs.

Crocodile (West) and Marico Catchments

The Crocodile (West) and Marico catchments borders on Botswana in the north-west and includes the two major river systems: Crocodile West and Marico, which give rise to the Limpopo River at their confluence.

The catchment also includes the headwaters of the Molopo River, a tributary of the Orange River which drains westwards to the Atlantic Ocean. The catchments cover a total catchment area of 47 565 km^2. The Pienaars, Apies, Moretele, Hennops, Jukskei, Magalies and Elands rivers are the major tributaries of theCrocodile River. There are significant volumes of return flow from wastewater treatment works discharged into the Apies, Pienaars and Jukskei Rivers. These flows play an important role in the water quality status of the rivers and dams. The volumes are also an important factor in the in the reconciliation of water availability and requirements in the WMA and the adjacent Mokolo Catchment. The Crocodile River contributes to the flow of the Limpopo River, which has an international river basin shared with Botswana, Zimbabwe and Mozambique.

The Crocodile (West) and Marico catchments stretch across three provinces: Gauteng, Northwest and Limpopo. Economic activity across the catchment area is diverse with the Upper Crocodile sub-catchment (A21) and the urban areas of the Pienaars sub-catchment (A23) comprising a well-developed manufacturing and general commercial urban economy. Rustenburg in the Elands River sub-catchment (A22) is well known for its extensive platinum mining activities. The rural parts of the Pienaars River sub-catchment (A23); the Lower Crocodile River (A24); and the Groot Marico (A3) economies are dominated by agriculture and eco-tourism activities.

Mining operations in the Crocodile (West) and Marico catchment area is dominated by platinum and the platinum group metals, gold, chrome, manganese, iron ore, diamonds, dimension stone and mineral sands, as well as smaller quantities of vanadium, limestone and and alusite (an aluminium nesosilicate mineral). The entire western section of the mineral-rich Bushveld Igneous Complex is situated here, resulting in intense mining activity in the region.

Irrigation occurs mostly in the Crocodile catchment, immediately downstream of the Hartbeespoort Dam and also further downstream towards the south of Thabazimbi. Irrigation is done at Mmbatho with water sourced from the Grootfontein dolomitic compartments. Dry land crops, mostly maize, are grown in the higher rainfall south and south-eastern parts of the Crocodile (West) Marico catchment area. Stock and game farming dominate land-use in the drier northern and western regions.

Several heavy industries occur in the catchment area including Pelindaba and Valindaba (direct

abstractions from the Crocodile River upstream of Hartbeespoort Dam), and the Dwaalboom cement factory at Thabazimbi (supplied by Magalies Water from the Vaalkop Dam). Three relatively small power stations: Rooiwal, Pretoria West and Kelvin, are present in the catchment.

The Marico catchment borders Botswana to the northwest and the Vaal WMA to the south. The catchment is a large, relatively flat basin with low rainfall. Surface water is limited. Groundwater is important with springs and eyes providing river base flows and dolomitic aquifers providing water supply to the neighbouring Mafikeng area. The catchment is predominantly rural, with the main economic activity and water use being irrigated agriculture. Major towns include Zeerust and Marico. Some mining activity is present in the catchment but this is limited. Water supply is limited in the Marico, and sources are over exploited, with resources fully developed. The system is under stress.

Although the Crocodile (West) and Marico catchment area is not as renowned for its tourism activities as other provinces (e.g. Mpumalanga, KwaZulu-Natal, Eastern Cape and Western Cape), tourism nevertheless plays an important role in stimulating accommodation, transport and retail sectors. Of special interest is the Hartbeespoort Dam, a significant hub for various forms of recreation and tourism. The Crocodile River contributes to the flow of the Limpopo River, which has an international river basin shared with Botswana, Zimbabwe and Mozambique.

1.4.1 Surface Water

Mokolo and Matlabas catchments

The surface water resources of the Mokolo catchment are substantially used while groundwater is also used. The Mokolo Dam, together with numerous dams in the upper reaches of the catchment, as well as run-of-river, all contribute to the surface water resource estimated at 77 million m^3/a, after allowing for the Ecological Reserve. The Mokolo Key Area is approximately in balance.

The Matlabas catchment is dry with non-perennial flow, accept in the upper catchment in the Marakele National Park and hence no sustainable yield from surface water. The limited water use in this catchment is mostly from groundwater, which is under-exploited. Despite the significant mean annual runoff of the catchment (49 million m^3/a), the surface water flow is very erratic, the river flow is ephemeral, and the 1:50 year run of river yield is effectively zero.

There are several small irrigation dams in the Mokolo catchment, upstream of the Mokolo Dam, the main storage dam in the catchment used for domestic supply.The Mokolo Dam has full supply capacity of about 146 million m^3 and the natural MAR at the dam site estimated at 240 million m^3/a (Midgely, et al). The dam was constructed in the late 1970s primarily to supply water to the Matimba power station but the dam also supplies water to the town of Lephalale as well as for irrigation downstream of the dam.

There are no significant dams in the Matlabas catchment and a significant portion of the water use is from groundwater due to the low assurance of the run-of-river yields.

Crocodile (West) Marico

The Marico and Crocodile Rivers form the headwaters of the Limpopo at their confluence. The flow in the Marico River is highly variable and intermittent in the lower reaches (upper reaches constant baseflow from various dolomitic eyes).

Marico River

There are two major storage reservoirs that regulate the flow in the Marico River: the Marico Bosveld Dam in the middle reaches of the catchment and the Molatedi Dam in the lower part of the catchment. There are several other dams including the Klein Maricopoort, Kromellenboog, from which water is mainly used for irrigation along the Klein Marico and Marico Rivers. Sehujwane Dam is used for mainly domestic water supply to the rural villages.

The Marico River flows through a variety of geomorphological features from source to the confluence with the Limpopo River. The topography of the area is generally very flat with undulating hills in the lower reaches of the Marico River. The gradient of the upper Marico River is fairly steep below the dolomitic eyes, flowing through mountainous areas. The river has a total length of 250 km and an altitudinal variation of 700 m descending at an average slope of 1: 357 (Grobler *et al*., 2007). The upper tributaries flow in deeply incised gorges that are relatively unimpacted and sheltered from anthropogenic disturbances such as intensive agricultural activities (Grobler *et al*., 2007). The lower catchment area, downstream from Marico Bosveld Dam, is characterised by limited flow contribution to the Marico River (Ashton *et al*., 2001).

The surface water runoff is highly variable and the available surface water resources of the area has been fully developed with very limited potential for further surface water resources development.

Ngotwane River

The Ngotwane River is a tributary of the Limpopo River. It flows into Botswana before turning and joining the Limpopo River. Only one dam (Ngotwane Dam) is situated in the upper reaches of the river and is mainly used for water supply to rural villages.

Molopo River

The Molopo River is a tributary of the Orange River which ceases as surface flow and discharges into pans in Botswana before turning south and emerging as surface flow just before it reaches the Orange River. The upper reaches of the Molopo River is fed by a dolomitic eye that is diverted for domestic water supply.

The Marico, Upper Molopo and Upper Ngotwane area is currently under stress and therefore, no new water uses can be considered from surface water resources with the exception of abstraction of groundwater outside of the dolomites. The area should rely on groundwater for its future water requirements.

Crocodile (West) River

The naturalised mean annual runoff in the Crocodile (West) catchment area is about 646 million m^3 per annum, with an exploitable groundwater resource of about 125 million m^3 per annum.

The Crocodile (West) Marico WMA receives water from the Upper Vaal and Olifants WMAs, of which the most significant transfer is by Rand Water from the Upper Vaal WMA to supply the urban and industrial demands of Johannesburg, Midrand, Tshwane and Rustenburg, as well as the larger mines in the WMA. Water is transferred from the Crocodile (West) Marico WMA to Botswana (Gaborone) and the Limpopo WMA (Modimolle).

Several large dams have been constructed on the rivers and their tributaries, and the surface water

resources are already highly developed. The main storage dams on the Crocodile River system are:

- Rietvlei, Hartbeespoort and Roodekopjes in the Upper Crocodile catchment;
- Roodeplaat and Klipvoor dams in the Apies/Pienaars catchment, and
- Olifantshoek, Bospoort, Lindleyspoort and Vaalkop in the Elands River catchment.
- No major dams occur in the Lower Crocodile catchment area.

A key factor in terms of water supply in the Crocodile West and Marico catchment is that about 90% of all municipal and bulk industrial use and 50% of mining use is supplied from the Upper Vaal catchment area. The catchment is therefore heavily reliant on the Upper Vaal for its water. This water produces about 87% of the urban, industrial and mining return flow in the Crocodile (West) catchment area (which may be used as a proxy for the water quality impact on the catchment). While the return flows offer considerable potential for re-use, effluent is causing major pollution of the rivers in the Crocodile (West) catchment.

1.4.2 Groundwater

Mokolo and Matlabas catchments

The current groundwater resource of the Mokolo catchment is estimated at 11 million m^3/a and is used to supply irrigation and domestic rural use. A significant portion of the water use in the Matlabas catchment is from groundwater due to the non-perennial flow of the Matlabas River.

Crocodile (West) and Marico

Groundwater in the Marico area is an abundant source of water because of the geology. Groundwater is important at two levels, *viz*. as high yielding dolomitic aquifers and as local groundwater sources. The local groundwater sources are available for rural water supplies.

The western portion of Upper Molopo catchment is underlain by Basement granite. This is covered with an increasing thickness of Kalahari sand to the west. A mostly intrusive volcanic rock assemblage (Allanridge lava) lies to the east of Mafikeng. Significant aquifers are present locally north of Slurry. The aquifers tend to be relatively shallow. Groundwater is the only source of water supply for the rural population. There is also direct abstraction from the Molopo eye for water supply to Mahikeng.

In the Upper catchment of the Groot Marico as well as the Upper Ngotwane catchment, the landscape is generally flat to gently rolling due to the Malmani dolomites. The dolomite is intruded by numerous dolerite dykes that have effectively sub-divided the dolomite into a series of compartments, which may or may not be hydraulically linked. Groundwater is widespread, especially in chert rich horizons and karst zones where borehole yields greater than 5l/s are common, and yields of 20l/s are feasible.

1.4.3 Ecological Important Areas

Mokolo catchment

Between Bela-Bela and Lephalale in the north eastern section of the study area, is the Waterberg.

This comprises the watershed and upper catchment of the Mokolo catchment area. This area is characterized by steep mountain slopes with sandy nutrient poor soils, rocky plateaus and mixed broad leaved savanna bushveld. The wetland systems typically found in the Waterberg include hillslope seeps, sheetrock wetlands and channeled and unchanneled valley-bottom systems. Water quality is typically good, and the streams are flanked by narrow riparian zones with the larger dominant tree typically being the Waterberry (*Syzygium cordatum*) and water pear (*Syzygium guineense)*. The main ecosystem services supplied by these systems include flood attenuation, water quality enhancement, streamflow augmentation and biodiversity maintenance.

Extensive wetland systems occur in the Sand River catchment (southern-most watershed of the Mokolo River). They form important habitat for Blue cranes and are thus of high importance from a conservation and biodiversity perspective. Land use in the area is mostly agricultural and as a result many of the wetland systems have been degraded. Working for Wetlands targeted the area for wetland rehabilitation and to date a number of projects have been implemented. In addition to these wetlands, the riparian and instream habitats of the Sterkstroom, Taaibosspruit and Rietspruit are also considered important ecologically. These are also some of the remaining rivers in the catchment that still support flow dependent fish species (River Health Programme, 2006).

Downstream of the Mokolo Dam the Mokolo River enters the Limpopo plain. Here colluvial processes dominate and the river and associated riparian and wetland habitats are controlled by the deposition, transport and erosion of sediment. Here the alluvial (river process driven) aquifer supports an extensive riparian forest fringe and instream biota. In the vicinity of Lephalale, the river is extensively used for sand mining. This together with the regulated flows from the Mokolo Dam upstream has affected the structure of the river along this reach with resulting alterations to the flow regime and pattern. There is also evidence suggesting that the resulting changes have not only affected the distribution and abundance of reedbeds in the system, but also the alluvial aquifer which in turn is impacting on the instream and riparian ecosystem.

The Tambotie River which flows through D'Nyala Nature Reserve and joins the Mokolo River near to Lephalale, is also regarded as an important system. The floodplain of the Tambotie River supports an extensive population of Tamboti (*Spirostachys Africana*) and Leadwood trees (*Combretum imberbe*). Water abstraction and the droughts experienced in the 1980's and early 1990's impacted on the system and with the drying out of the alluvial aquifer during this time, many of the Leadwood trees died. This floodplain system is nevertheless considered to have high ecological importance and sensitivity and is a key wetland in the region.

Matlabas catchment

The Matlabas River flows through the Marakele Nature Reserve. The park is characterized by the Waterberg Moist Bushveld vegetation type (veld type 12), mixed Bushveld (veld type 18) and the Sweet Bushveld (veld type 17). The Sweet Bushveld is mostly found along the banks of the Matlabas River and forms an important winter refuge area for game particularly during limiting periods at the end of the dry season. The planned western expansion of the park will include more of this vegetation type, which is crucial to sustain adequate numbers of prey species for large predators such as lion and spotted hyena. One of the rare and threatened plant species of Marakele is the Waterberg cycad

(Waterbergbroodboom) *Encephalartos eugene-maraisii*. This cycad is endemic to the Waterberg region and grows to 5 m tall among low shrubs at an altitude of 1 450 m.

Crocodile (West) Marico catchment

Dolomite forms the main watershed of the Molopo, Marico and Malmani Rivers to the southwest of the study area as well the upper reaches of the Apies, Pienaars and tributaries of the Crocodile River to the southeast of the study area. The actual source of the Molopo Ngotwane, Marico and Malmani rivers are known as dolomitic eyes, which are wetlands fed by groundwater originating from fractures in the underlying dolomite. The water from these dolomitic eyes is typically alkaline (pH range from 7.5 to 9.3) having picked up magnesium and calcium carbonates through solution from the parent dolomite. Associated with this is the active tufa waterfall in Bokkraal se loop (fed by dolomitic eye, a tributary of Marico River) and the associated active- seasonal tufa cascade on Kuilfontein; a tributary of Marico River. Being perennial, all the wetland systems associated with, and downstream of, the eyes form peat wetlands or peatlands.

Three Peat Wetland Eco-regions are represented in the study area, being the Highveld, Central Highlands and Bushveld Basin (Marneweck, Grundling and Muller, 2001). Peatlands in general, and more specifically those associated with the dolomitic eyes, are rare in South Africa and southern Africa in general. Those associated with the dolomites in the Molopo, Malmani and Marico Rivers in particular comprise unique ecosystems characterised by a high degree of endemicity (species which are found only there). Dolomitic eyes and their associated peatlands are regarded as sensitive systems. Most of these systems are also important water supply sources and thus the associated ecosystems have been impacted by water abstraction. They are also threatened by groundwater contamination from agriculture, industry and mining, habitat transformation and invasions by alien species (particularly exotic plants e.g. poplars and fish species e.g. black bass) and some have been mined for peat. Working for Wetlands (WfWetlands) started doing rehabilitation work in the Molopo catchment in 2001 including in the headwaters. It has long been recognized that an integrated management strategy is required for conserving or maintaining these unique wetland systems.

The wetlands within the Borakalalo National Park are also considered of high conservation value, despite being heavily degraded. They have also been the focus of WfWetlands work over the past few years. Borakalalo forms the western end of the Moretele floodplain. This is the second largest floodplain in the Bushveld Ecoregion and represents the southern-most natural distribution of Wild Rice (*Oryza longistaminata*) in Africa. The floodplain is used extensively by the surrounding communities for fishing and grazing and is also regarded as an important birding area, with the floodplain and surrounding area supporting 362 of the 461 species recorded in the North West Province. The wetland also includes traditionally sacred sites which have high cultural significance.

The Mareetsane wetland near Mafeking also provides important ecosystem services for people, livestock and wildlife, including water supply and livelihoods support. It is on the Mareetsane River, which flows into the Molopo River. WfWetalnds has been undertaking wetland rehabilitation work on this system. Other rehabilitation projects within the study area targeted by WfWetlands include a wetland system within the Rustenburg Nature Reserve and on the Hex River. These projects were undertaken in partnership with the Local Municipality and Tribal Authority.

A wetland type not well represented in the study area is pans. Pan complexes (groups of pans) occur

in three main areas in the study area, namely: south and northwest of Koster (a complex of approximately 24 pans); northeast of Derby (7 pans); and in Johannesburg (approximately 24 pans between Midrand and Kempton Park). Despite impacts from agriculture, an extensive complex of hillslope seepage and valley-bottom wetlands remains associated with the pans near Koster and Derby. Pans are recognized as being important for biodiversity support and more recently their links to other wetland systems in relation to landscape hydrology have also been highlighted. Pans are also unique in terms of their individual biogeochemical attributes. This combination of an extensive network of pans, hillslope seepages and valley-bottom systems, and also that they are unaffected by urbanization and not found elsewhere in the catchments under consideration, renders this an important water resource in the study area. The pans in the Midrand and Kempton Park area are also considered important, but mainly from a biodiversity perspective as they support related bird and amphibian populations. Those that still have some of their catchments intact or that still have associated hillslope seepage wetlands also support some of the last remaining populations of the endangered Giant bullfrog (*Pyxicephalus adspersus*) on the Highveld. The remaining pans and wetlands are thus regarded as critical habitat for these populations. The wetlands including the pans in this area are all threatened by impacts from urbanization. Wetland habitat loss continues as urbanization expands and the hydrology of the related systems and catchments change due largely to storm water management or lack thereof. It is likely that populations of the Giant bullfrog may occur or be found in the pans in the Koster and Derby areas.

1.4.4 Shared Watercourse

The Crocodile (West), Marico, Mokolo and Matlabas catchments fall within the Limpopo River Basin, shared by South Africa, Botswana, Zimbabwe and Mozambique. As the Ngotwane, Marico, Crocodile and Mokolo rivers flow directly from South Africa into Botswana, joining the Limpopo River, developments in South Africa can directly impact upon its' neighbours. Issues related to the management of these aforementioned catchments therefore can have bearing on all the basin states of the Limpopo River.

The Molopo River is a tributary of the Orange River. It ceases as a surface flow and discharges into pans in Botswana before turning south and emerging as surface flow just before it reaches the Orange River.

International co-operation with respect to the use and management of the watercourses in the Limpopo River Basin was overseen by the Limpopo Basin Permanent Technical Committee (LBPTC) with membership by South Africa, Botswana, Zimbabwe and Mozambique. The commitment of the riparian states managing their water resources together dates back to 1986, when the "Limpopo Basin Permanent Technical Committee" was jointly established. In 2003 this cooperation was fostered through the multilateral agreement to establish the Limpopo Water Course Commission (LIMCOM).

2 STUDY PARAMETERS

2.1 WATER RESOURCE COMPONENTS

This study is an extension of the recently completed Water Resource Classification (WRC) Study

and is dependent on the outputs and results of that study. In terms of the RQO study, steps 1 and 2 of the process will use outputs as defined and will thus be limited to the extent of the WRC process. The water resources classified and the river nodes defined will be applied in the RQO study. RQOs will be determined for surface water resource components (rivers and wetlands identified) and where applicable and available, groundwater RQOs will be set.

2.2 RESOURCE UNITS

The resource units (RUs) will be defined based on the IUAs, the river nodes defined and the water resources classified including groundwater, wetlands and dams. This study will not define any additional IUAs. RUs will be delineated within the IUAs and based on the river node and Reserve information (ecological) from the WRC study.

2.3 VISION

The vision for the Crocodile (West), Marico, Mokolo and Matlabas catchments will be limited to the water resources classes set for the water resources as part of the WRC process. A visioning process will not be undertaken as part of the RQO process for this study. However the aspirations and desired direction of change required by stakeholders will be considered and incorporated within the context of the water resources classes set.

2.4 STAKEHOLDER ENGAGEMENT

A robust and focused stakeholder engagement process will be undertaken that is aligned to the technical steps of the study. Stakeholders will be brought along with the process to ensure that engagement undertaken will support the RQOs set. A wide stakeholder database will be set up that will periodically be updated. The idea is not to consult with everybody, but rather with representatives of specific sectors of society.

The capturing of information from stakeholders is considered important to the RQO Process. The determination of RQOs for Crocodile (West), Marico, Mokolo and Matlabas catchments will thus require the selection of appropriate points in the technical process that allow for optimisation of stakeholder involvement with the resources. The level of stakeholder engagement will range between consultation and involvement.

2.5 METHODOLOGY

The DWS Manual: 'Procedures to Develop and Implement RQOs' (DWA, 2011) will be followed in the execution of this study. The implementation of the process and the methodology will be followed using the 7-step process as closely as possible. Any suggested changes to this process will be made under guidance from the client. As this is a detailed approach, efforts will be made to streamline the process where possible after discussions with the client.

3 SCOPE OF WORK

This study is primarily of a technical nature being supported by stakeholder engagement and consultation and the necessary legal processes. The sections to follow reflect the scope of work.

The proposed study has been structured into the tasks as listed in Table 2.

Table 2: Proposed Study Tasks

Task	Component
1 and 2	Project Inception
3 and 4	RQO Determination Process
	Gazetting Process
5	Stakeholder engagement and consultation processes
6	Reporting and Study Management and Co-ordination
7	Capacity Building (Skills Transfer)

Figure 2 indicates the study tasks, each of which are described in the sections below. The Study Management component which encompasses the reporting task will continue throughout the study period.

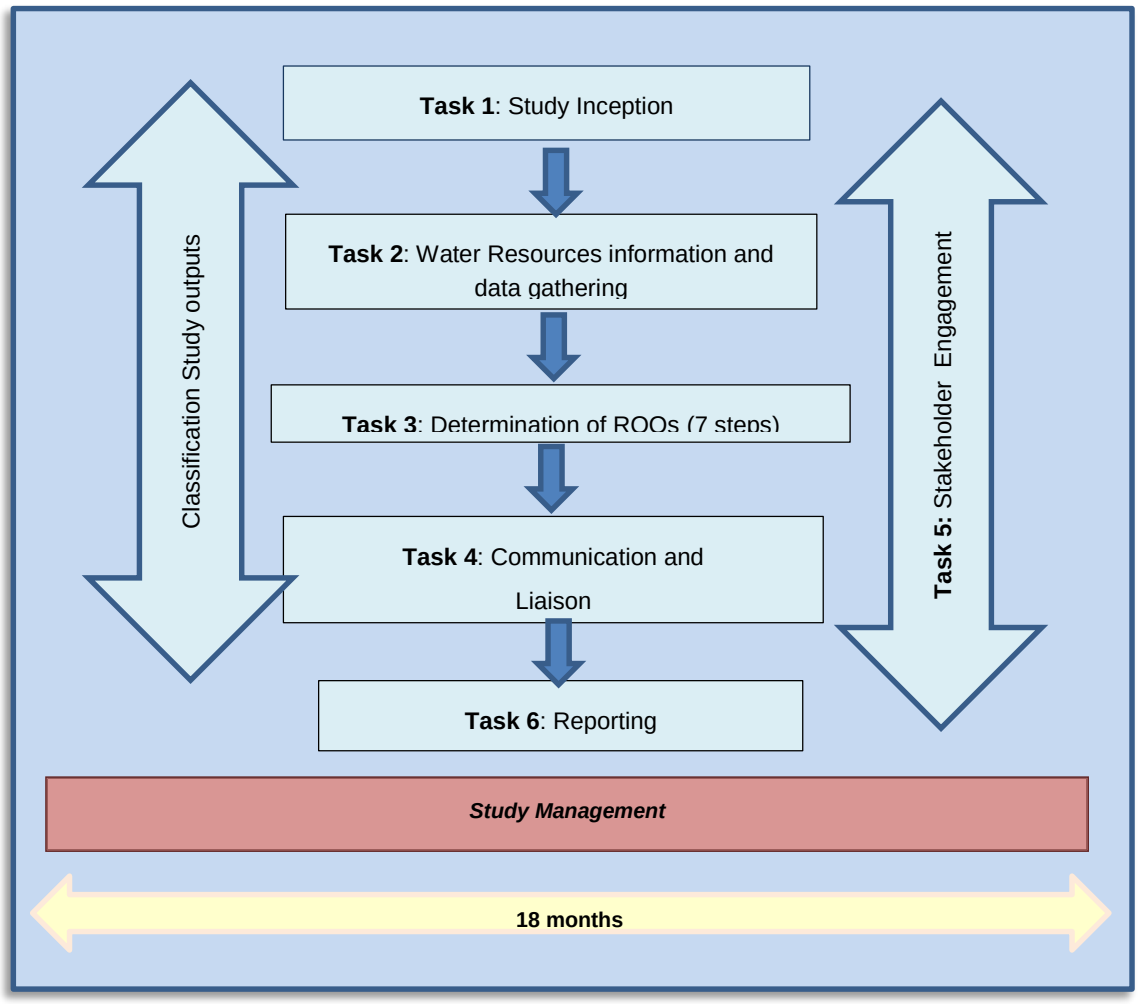

Figure 2: Scope of work

3.1 TASK 1: STUDY INCEPTION

Task 1 entails the inception phase of the study. The inception phase is important as it provides a platform for assessing and understanding the nature of the scope of the project to ensure alignment between DWS's expectations for the study and the actual product to be delivered by the study team. The Inception Phase will include a review of existing information, outputs of the classification study and an understanding of the DWS's requirements with the aim of formulating a final study plan that covers all important matters. The purpose of the task is also to clearly indicate what will not be done.

All relevant information that is currently available on the study area will be sourced and reviewed. The specific linkages and alignment with the classification study activities will be confirmed and made during this phase. The shared activities will be identified and a plan developed to detail what, when and how the activities will be aligned and integrated. Gap analysis will be performed and results and recommendations thereof documented. The necessary study committees will also be determined and confirmed during the inception phase. A capacity building programme will be included in the inception report as required. It is also important that the stakeholder engagement, communication and implementation actions are defined during the inception phase

An important task to be undertaken during this phase is to delineate the Integrated Unit of Analysis (IUA) in the catchment area and define the Resource Units (RUs). The IUAs have been delineated as part of the classification study, however the preliminary RUs will be delineated through the inception phase. Once the RUs have been presented and discussed with the study committees and through stakeholder engagement, they will be refined and prioritised through Task 3 of the study process.

Inception Phase Preliminary Outcomes:

The findings and outcomes based on the preliminary review and assessment undertaken during the initial phase of project inception in terms of the activities listed above are captured below:

3.1.1 Review of existing information

The following previous and parallel studies have been identified and relate to the Crocodile (West), Marico, Mokolo and Matlabas catchments. Some of these reports and information sources have been preliminary reviewed for this inception phase. The information will be further consulted and reviewed and used to support the information needs of this study. The information analysis task will address the information review in detail and highlight potential gaps. Should further studies be identified then these will be included.

- Classification of significant water resources in the Mokolo and Matlabas catchments: Limpopo Water Management Area (WMA) and Crocodile (West) and Marico WMA (DWA, 2014)
- Maintenance of the Reconciliation Strategy of the Crocodile West Water Supply System (DWA: National Water Resource Planning, 2015).
- PES and EIS and of South African Rivers (DWA Chief Directorate: RDM);

- Crocodile West and Marico Intermediate Reserve Determination study (DWA Chief Directorate: RDM); and
- Reconciliation Strategy for the Crocodile West water supply system (DWAF, Directorate National Water Resource Planning. July 2008);
- North West Province, Report on the State of the Environment. (2008);
- Adopt-A- River Programme Phase II: Development of an Implementation Plan Water Resource Quality Situation Assessment (DWA RQS, 2009);
- Framework and Manual for the evaluation of aquatic ecosystems services. Water Research Commission, 2010)
- A Systematic Conservation Plan for the Freshwater Biodiversity of the Crocodile West Marico WMA;
- Freshwater Ecosystems Priority Areas (NFEPA) Project (CSIR, DWA, Department of Environment Affairs, south African National Biodiversity Institute, World Wildlife Fund, 2011);
- Mokolo and Crocodile River (West) Water Augmentation Project (MCWAP) Phase 1: Augment Supply from Mokolo Dam Environmental Impact Assessment - MCWAP Phase 1 DWA, Directorate: Integrated Water Resources Planning
- Hydrology and Yield Analysis for the Mokolo River Basin
- Determination of the Groundwater component of the Reserve: Limpopo Water Management Area , RDM/WMA1/02/CON/COMP/0111
- River Health Programme. State-of-Rivers Report: The Mokolo River System (Department of Environmental Affairs and Tourism, Pretoria, 2006);
- Internal Strategic Perspective: Limpopo Water Management Area (Department of Water Affairs: Directorate: National Water Resource Planning, 2004);
- Intermediate Reserve Determination Study for the Surface and Groundwater Resources in the Mokolo Catchment, Limpopo Province: Main Report. (Department of Water Affairs, South Africa, 2010)
- Mokolo and Crocodile River (West) Water Augmentation Project (MCWAP) - Phase 1: Augment Supply from Mokolo Dam -Amended Plan of Study for Environmental Impact Assessment – MCWAP Phase 1 (Department of Water Affairs, Directorate: Integrated Water Resources Planning. 2010);
- MCWAP PHASE 1: Wetlands & Watercourse Survey (Compiled by Matthew and Tahla Ross Henning of Nemai Consulting. 2010);
- River Health Programme studies.

Data sources

Data sources to be used will include amongst others the following:

- Updated hydrology for Mokolo catchment and Crocodile (West) and Marico catchments (DWS, Directorate National Water Resource Planning);
- Updated PES/EIS data (DWS: Directorate RQOs);
- The Water Resource Planning Model (WRPM) and the Water Resources Yield Model (WRYM) for the catchment areas (DWS, Directorate National Water Resource Planning);
- Water demand and requirement projections from Reconciliation strategy Maintenance Studies, Directorate National Water Resource Planning);
- Updated water quality data and information from the Water Management System of the Department. (DWA, Directorate Resource Quality Services);
- Ecological Water Requirements (Information, data, models, indices) (DWS, Directorate: Reserve Requirements);

3.1.2 Stakeholder Engagement

The determination of RQOs for the Mokolo, Matlabas, Crocodile (West) and Marico catchments requires the selection of appropriate points in the technical process that allow for optimisation of stakeholder involvement with required outcomes. The level of stakeholder engagement will range between technical involvement and consultation. The following is proposed in terms of stakeholder engagement:

- ***Technical specialist workshops (involvement)***: The specialist workshops are convened at the appropriate steps in the study (Steps 3 and 4 of the RQO procedure). This will include the study team members and additional specialists identified by virtue of the expert knowledge of the catchment and scientific/technical discipline. Three separate technical workshops are proposed for each of the two prioritisation steps (6 in total), based on the three primary catchment areas: the Crocodile (West) catchment, Marico catchment and Mokolo and Matlabas catchment. The workshops are (1) the resource unit prioritisation and (2) the sub-component prioritisation and indicator selection.
- ***Project Steering Committee:*** Stakeholders representing specific sectors within the study area (e.g. agriculture, mines, municipalities, conservation) will be identified and asked to serve on a Project Steering Committee (PSC) for the duration of this project. The PSC should be a relatively small group of people of key representative bodies that will provide strategic advice and guidance on the RQO development process. It is the intention that these representatives communicate the key outcomes of the study back to their organisations.

  The PSC members will act individually and collectively as vocal and visible project champions in their representative organisations. They can also act as liaisons between the project management team and the broader body of stakeholders in the project area and beyond.
- ***Technical task Groups:*** Technical Task Group meetings will be held with identified stakeholders (a core group from each of the Crocodile (West) catchment, Marico catchment and Mokolo and Matlabas catchments) to discuss specific issues should there be a need to further interrogate a specific topic during the RQOs development process. Stakeholders will be identified (per relevant sector of society, impact on water use, technical input/clarification required, information needs, etc.) and invited to attend these meetings. They will however be

the 'technical' representatives of their constituencies, so that they are able to sufficiently direct and engage with the study team. It is anticipated that these meeting will be held on an ad-hoc basis when the need arises.

- ***Broader Stakeholder (Public-type) Meetings (consultation)***: At step 6 of the process, broader stakeholder meetings will be held in the three primary catchments as a part of the consultation process (the Crocodile (West) catchment, Marico catchment and Mokolo and Matlabas catchments). This activity will form an information sharing and dissemination process. However inputs obtained will be captured and addressed as required. This consultation could form the basis for the gazetting process that will follow.
- ***Project Management Committee (involvement):*** For the purpose of project management, technical review and input and administrative and institutional assistance a Project Management Committee (PMC) is to be established. The PMC would comprise of representatives of the National and Regional Department of Water and Sanitation Offices and other organisations if deemed necessary. The PMC will meet to ensure the goals of the project are achieved and will guide the development of the project deliverables. In addition, the PMC will address issues and challenges presented to the project process and progress and ensure matters are discussed, decisions taken and approval is obtained as required. The PMC will meet every 8 to 10 weeks over the course of the study.

3.1.3 Capacity Building

Ms Adaora Okonkwo, will be directly included and involved in the Crocodile (West), Marico, Mokolo and Matlabas catchments RQO determination study as part of the capacity building as per the request of the Directorate: WRC at the project inception meeting. It is proposed that Ms Okonkwo implement the RQO process in one of the IUAs under the guidance, mentorship and supervision of the project team. She will also be involved in the specialist workshops and included in the development of the RQOs and numerical limits. A proposed programme is outlined in Table 3. The programme will be reviewed and expanded during the inception phase should it be required.

Table 3: Proposed capacity building programme

Capacity building activity	Level of training	Timeframe	Key performance area	Knowledge area gap	Learning area addressed
Resource Unit delineation	Discussion, demonstration, and application	1 day	Implementation of the RQO determination procedure	Delineating RUs.	Understanding the delineation process.
Resource Unit prioritization	Discussion, demonstration, and application	3 days	Implementation of the RQO determination procedure	Application of the tool.	Understanding and application of the tool. The prioritisation of

Capacity building activity	**Level of training**	**Timeframe**	**Key performance area**	**Knowledge area gap**	**Learning area addressed**
					the resources units including the results and details of the application of the tool
Sub-component prioritisation	Discussion, demonstration and application	3 days	Implementation of the RQO determination procedure	Selection and prioritisation of the sub-components and indicators. Understanding and application of the tool.	Evaluation results of the components of the water resource per resource unit. Prioritised sub-components for development of RQOs Key indicators for monitoring the sub-components selected for each RU
RQOs and Numerical Limits Development	Discussion, demonstration and application	6 days	Implementation of the RQO determination process	Application of the relevant information and details with the catchment context to set RQOs. Consideration of stakeholder needs. Formulation numerical limits.	RQOs developed for the sub-components selected per RU based on scientific and technical information. Derivation of numerical limits
Gazette Templates	Demonstration and	3 days	Gazetting Process	Understanding process and	Knowledge on population of the

Capacity building activity	Level of training	Timeframe	Key performance area	Knowledge area gap	Learning area addressed
	application			requirements in terms of populating the Gazette template	RQO gazette templates
Stakeholder Engagement	Application	1 day	Presentations and engagement	Presentation of the process and discussion of the proposals to the stakeholders	Interaction with the stakeholders and obtaining input at key milestones. Presentation skills

In addition workshops relating to the topics set listed below will be presented in a participatory manner to Department of Water and Sanitation Officials and stakeholders.

- Resource Quality Objectives and Determination Process ;
- Resource Unit delineation and prioritisation;
- Selection of sub-components and indicators; and
- Developing RQOs and deriving numerical limits.

3.1.4 Preliminary Resource Unit Delineation

The definition of Resource Units (RUs) forms part of Task 1 of the RQO determination process, “Delineate Integrated Units of analysis and Define Resource Units”, specifically sub-tasks 1.5 to 1.7. It is required to facilitate effective management and necessitates the breakdown of a river into discrete manageable units, primarily from an ecological perspective. The resource units are generally ecologically homogenous in nature. The delineation of IUAs and prioritisation of RUs are undertaken as the initial steps of the RQO process. RQOs are then developed per priority RU within the context of the IUA catchment perspective.

In this study RQOs for rivers, groundwater, dams and wetland resources will be determined. To generate RQOs for these resources the existing seven step procedure methodology available from DWA (2011) has been expanded on to include dam and wetland methodologies.

The outcomes of this study will include RQOs for rivers, groundwater, wetlands and dam resources on five different scales as follows:

- rivers on a river RU scale (river RUs),
- priority groundwater resources on a system specific scale (priority groundwater RUs),

- general groundwater resources on a groundwater RU scale which is comparable with river RUs (general groundwater RUs),
- priority wetland resources on a system specific scale, and
- dam units.

As part of the inception phase preliminary resource units have been delineated. These are the proposed units, and will be refined after the consultation with the PMC and stakeholders, combined with the prioritisation process.

The Water Resource Classification (WRC) and the Reserve Determination studies for the Crocodile (West) catchment, Marico catchment and Mokolo and Matlabas catchments have been completed in 2014. Through the classification study the IUAs for the catchment were delineated and the EWR sites and river nodes were specified. These outputs from the classification study form the basis for the RQO determination process, and primarily for the RU definition.

In terms of the classification study, 20 IUAs were delineated (DWA, 2012). These are listed in Table 4 and shown in Figure 3. The IUAs form the boundaries for RU delineation.

Table 4: IUAs delineated for the Crocodile (West), Marico, Mokolo and Matlabas catchments

IUA No.	Main river system/ IUA name	Quaternary catchments
1	Upper Crocodile/Hennops/Hartebeespoort	A21A, A21B, A21C, A21D, A21E, A21H, A23A, A23B,A23D, A23E
2	Magalies	A21F, A21G
3	Crocodile/Roodekopjes	A21J
4	Hex/Waterkloofspruit/Vaalkop	A21K, A22G, A22H, A22J
5	Elands/Vaalkop	A22A, A22B, A22C, A22D, A22E, A22F
6a	Klein Marico	A31D, A31E
6b	Groot Marico	A31B
7	Kaaloog-se-Loop	A31A
8	Malmaniesloop	A31C
9	Molopo	D41A
10	Dinokana Eye/Ngotwane Dam	A10A
11a	Groot Marico/Molatedi Dam	A31F, A31G, A31H, A31J, A32A, A32B, A32C, A10B

IUA No.	Main river system/ IUA name	Quaternary catchments
11b	Groot Marico/seasonal tributaries	A10C, A32D, A32E
12	Bierspruit	A24D, A24E, A24F
13	Lower Crocodile	A21L, A24A, A24B, A24C, A24G, A24H, A24J
14	Tolwane/Kulwane/Moretele/Klipvoor	A23C, A23F, A23G, A23H, A23J, A23K, A23L
15	Upper Mokolo	A42A, A42B, A42C, A42D, A42E, A42F
16	Lower Mokolo	A42G, A42H, A42J
17a	Mothlabatsi/Mamba	A41A, A41B
17b	Matlabas	A41C, A41D, A41E

From an ecological perspective, rivers should be viewed as continuous longitudinal systems. Impacts that occur in upstream reaches are likely to affect downstream biological processes of the aquatic life. As it would not be appropriate to set the same RQOs for the headwaters of a river as for the lowland reaches due to the impacting activities along the river and differences in geomorphic, ecological and biological characteristics in the water resource environment, RUs are required to take account of this variances. The RUs are river reaches that are each significantly ecological different to warrant their own specification of the RQOs and as such the geographic boundaries of each must be clearly delineated (DWAF, 1999, Volume 3).

A resource unit is a section of a river that frequently has different natural flow patterns, reacts differently to stress according to their sensitivity, and requires individual specifications of the ecological requirements and RQOs appropriate for that reach, as compared to the rest of the river. The delineation of a catchment into RUs is done primarily on a biophysical basis, and where the hydrology, geomorphic characteristics (*i.e.* geomorphic zone), water quality attributes and river size remains relatively similar, a RU can be defined.

In addition management requirements also play a role in the delineation of a RU (DWAF, 1999, Volume 3). The purpose of distinguishing a RU of management requirements is to identify a management unit within which the EWR can be implemented and managed based on one set of identified flow requirements. These management units are based on the principle of homogeneity of impacts in the demarcated RU. This may include the modification of flows in the system due to abstraction, regulation by impoundments and development along the RU and upstream from the RU which may influence the geomorphology and water quality conditions.

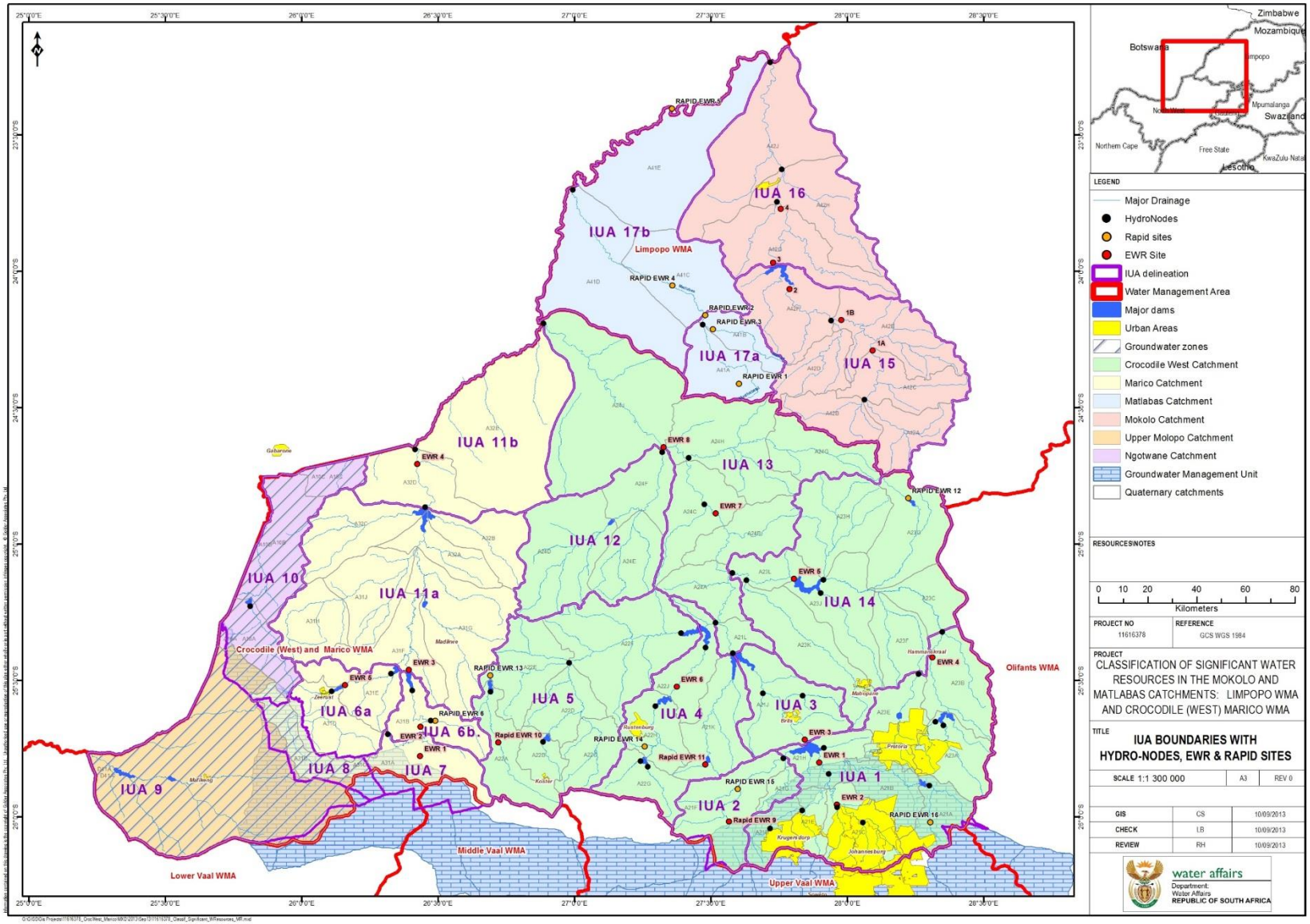

Figure 3: IUAs delineated within Crocodile (West), Marico, Mokolo and Matlabas catchments

The RU delineation process considers the above aspects. Overlaying all the data does not necessarily result in a logical and clear delineation and expert judgement, a consultative process and local knowledge are required for the final delineation of the RUs. The practicalities of dealing with numerous reaches within one study must also be considered to determine a logical and practical suite of RUs.

The preliminary resource unit delineation was done based on the following considerations:

- IUA boundaries and sub-quaternary boundaries
- EWR sites and location of biophysical nodes (in terms of the Classification study outputs)
- PES/EIS sub-quinary reaches
- Ecological condition (based on the EWR and node information)
- Operation of the system
- Water quality impacts
- Land use and anthropogenic activities
- Groundwater units,
- Wetlands, and
- Expert knowledge of the catchment area and system.

Based on the consideration of the above by the study team, seventy nine RUs in the Crocodile (West) catchment, Marico catchment and Mokolo and Matlabas catchments have been preliminarily delineated. The RUs are listed below in Table 5 and shown in Figure 4 below.

Table 5: Preliminary Resources Unit delineation in the Crocodile (West) catchment, Marico catchment and Mokolo and Matlabas catchments

IUA1	**Upper Crocodile/Hennops/Hartebeespoort**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
1_1	Upper Hennops and Rietvlei Rivers to inflow to Rietvlei Dam	A21A		Groundwater resources are important – to be prioritised for RQOs development
1_2	Rietvlei Dam	A21A	dam only	
1_3	Hennops River from outflow Rietvlei Dam to the A21B catchment	A21B		Groundwater resources are important – to be prioritised for RQOs development
1_4	Upper Pienaars River, Edendalespruit and Moretlele Rivers to Roodeplaat Dam	A23A		
1_5	Roodeplaat Dam	A23A	dam only	
1_6	Upper and middle reaches of Apies River, Skinnerspruit, Pienaars River from outflow Roodeplaat Dam to Boekenhoutpruit confluence, Roodeplaatspruit, Boekenhoutspruit	A23B, A23D, A23E		
1_7	Jukskei, Klein Jukskei, Modderfonteinspruit	A21C		
1_8	Upper reaches of Crocodile River and Bloubank Spruit	A21D, A21E		
1_9	Crocodile River from Jukskei confluence to inflow Hartebeespoort Dam, Swartspruit	A21H		
1_10	Hartebeespoort Dam	A21H	dam only	
IUA2	**Magalies**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
2_1	Maloneys Eye	south eastern portion of A21F	Groundwater unit	Groundwater resources are important – to be prioritised for RQOs development
2_2	Magalies River, Klein Magalies, Bloubank, Skeerpoort Rivers	A21F, A21G		Magalies River downstream of Maloneys Eye dependant on dolomitic outflows (constant high baseflows) and not similar to other tributaries

IUA3	**Crocodile/Roodekopjes**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
3_1	Crocodile River from outflow Hartebeespoort Dam to inflow Roodekopjes Dam, Rosespruit, Ramogatla and Kareespruit	A21J		
3_2	Roodekopjes Dam	A21J	dam only	
IUA4	**Hex/Waterkloofspruit/Vaalkop**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
4_1	Sterkstroom from outflow Buffelspoort Dam to inflow Roodekopjes Dam, Maretwane, Tshukutswe	A21K middle and lower catchment below dam		
4_2	Buffelspoort Dam	A21K	Dam only	
4_3	Upper reaches of Sterkstroom to inflow Bueffelspoort Dam , Kleimwater	A21K upper catchment to dam		
4_4	Upper Hex River to Olifantsnek Dam, Rooikloofspruit	A22G		
4_5	Olifantsnek Dam	A22G	Dam only	
4_6	Hex River outflow Olifantsnek Dam to inflow Bospoort Dam, Sandspruit	A22H		
4_7	Bospoort Dam	A22H	Dam only	
4_8	Water Kloofspruit tributary catchment	A22H	wetland unit	Wetlands are important – to be prioritised for RQOs development
4_9	Hex River outflow Bospoort Dam to inflow Vaalkop Dam	A22J		
4_10	Vaalkop Dam	A22J	Dam only	
IUA5	**Elands/Vaalkop**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
5_1	Upper reaches of Eland	A22A south eastern portion	wetland unit	Wetlands are important – to be prioritised for RQOs development
5_2	Elands river to Lindleyspoort Dam	A22A		
5_3	Lindleyspoort Dam	A22A	Dam only	

IUA5	**Elands/Vaalkop**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
5_4	Upper Koster River to Koster Dam	A22B		
5_5	Koster Dam	A22B	Dam only	
5_6	Selons River, Kodoespruit, Dwarsspruit, lower Koster River	A22C, A22D		
5_7	Elands River outflow Lindleyspoort Dam to inflow Vaalkop Dam, Brakkloofspruit, Roosspruit, Sandspruit Mankwe. Leragane, Molapongwamongana	A22E, A22F		
IUA6a	**Klein Marico**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
6_1	Upper Klein Marico to inflow Klein Maricopoort dam, Rhenosterfonteinspruit, Malmanieloop, Kareespruit	A31D		
6_2	Klein Maricopoort dam	A31D		
6_3	Klein Marico downstream Klein Maricopoort Dam to Kromellenboog Dam, Wilgeboomspruit	A31E		
6_4	Kromellenboog Dam	A31E	Dam only	
IUA6b	**Groot Marico**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
6_5	Marico Bosveld Dam	A31B	Dam only	
6_6	Groot Marico, Polkadraaispruit	A31B		
IUA7	**Kaaloog-se-loop**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
7_1	Marioco Eye	A31A	Wetland unit, groundwater unit (Grootpan)	Wetlands and Groundwater resources are important – to be prioritised for RQOs development

IUA8	**Malmaniesloop**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
8_1	Malmanie Eye, Dolomites	A31C	Wetland unit, groundwater unit	Wetlands and Groundwater resources are important – to be prioritised for RQOs development
IUA9	**Molopo**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
9_1	Bodibe Eye	D41A (Polfonteinspruit and Lotlhakane tributary catchment area)	Wetland unit, groundwater unit	Wetlands and Groundwater resources are important – priority for RQOs development
9_2	Molopo Eye, Grootfontein Eye, Molopo headwaters to inflow Modimola dam	D41A	Wetland unit, groundwater unit	Wetlands and Groundwater resources are important – priority for RQOs development
9_3	Molopo River mainstem only from Modimola Dam to Disaneng Dam	D41A (mainstem)	Wetland unit	Wetlands are important – to be prioritised for RQOs development
9_4	Modimola Dam	D41A	Dam only	
9_5	Disaneng Dam	D41A	Dam only	
9_6	All remaining tributaries - Madibe, Kabe, Mogosane	D41A		
IUA10	**Dinokana Eye/Ngotwane Dam**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
10_1	Upper Ngotwane, Dinokane Eye	A10A	Groundwater unit	Groundwater resources are important –priority for RQOs development
10_2	Ngotwane Dam	A10A	Dam only	
10_3	Ngotwane River outflow Ngotwane Dam to drainage boundary	A10A		

IUA11a	**Groot Marico/Molatedi Dam**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
11a_1	Rasweu, Maselaje rivers	A32D		
11a_2	Elandslaagtespruit, Lengope la Kgamanyane, Lenkwane	A32E		
IUA11b	**Groot Marico/Molatedi Dam**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
11b_1	Groot Marico from outflow Marico Bosveld Dam to Molatedi Dam, all tributaries	A31G, A31H, A31F, A31J, A32A, A32B, A32C		
11b_2	Molatedi Dam	A32A, A32B, A32C	Dam only	
IUA12	**Bierspruit**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
12_1	Upper Bierspruit, Wilgespruit, Bofule, Kolobeng, Magoditshane	A24D		
12_2	Bierspruit oultfloe Bierspruit Dam to confluence with the Crocodile River, Brakspruit, Phufane, Sefatlhane, Lesobeng	A24E, A24F		
12_3	Bierspruit Dam	A24D	Dam only	
IUA13	**Lower Crocodile**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
13_1	Crocodile River outflow Roodekopjes Dam to upstream Sand River confuence, Motlhabe, Sleepfonteinspruit, Klipspruit tributaries	A21L, A24A, A24B, A24C		
13_2	Sand River to confluence with the Crocodile River to Bierspruit confluence, Sondags, Vaalwaterspruit and Monyagole tributaries	A24G, A24H		
13_3	Lower Crocodile from Bierspruit confluence to the Botswana border (Limpopo River)	A24J		

IUA14	**Tolwane/Kulwane/Moretele/Klipvoor**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
14_1	Apies River, Tshwane tributary	A23F	wetland unit	Wetlands are important – to be prioritised for RQOs development
14_2	Pienaars River from Boekenshout confluence to Apies River confluence	A23C	wetland unit	Wetlands are important – to be prioritised for RQOs development
14_3	Plat River	A23G		
14_4	Moretele (Pienaars) River from Plat River confluence to Klipvoor Dam, Kutswane to Klipvoor Dam	A23J		
IUA14	**Tolwane/Kulwane/Moretele/Klipvoor**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
14_5	Rietspruit and all tributaries	A23H		
14_6	Klipvoor Dam	A23J	Dam only	
14_7	Pienaars River from Klipvoor Dam to Crocodile Riverconfluence, Tolwane tributary	A23K, A23L		
IUA15	**Upper Mokolo**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
15_1	Moloko River in A42C, Sand River and Klein Sand	A42A, A42C		
15_2	Mokolo River in A42E, Sterkstroom, Frikkiesloon, Brakspruit, Sondagsloop, Heuningspruit, Dwars, Jim se loop tributaries	A42D, A42E		
15_3	Mokolo River in A42F to inflow Mokolo Dam, Taaibosspruit, Malmanies and Bulspruit tributaries	A42F		
15_4	Mokolo Dam	A42F	Dam only	
15_5	Grootspruit and Sandspruit tributaries (Mokolo headwater catchment)	A42B	Wetland unit	Wetlands are important – to be prioritised for RQOs development

IUA16	**Lower Mokolo**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
16_1	Tambotie river catchment	A42H (major portion - east)		
16_2	Poer se Loop catchment	A42G		
16_3	Rietspruit catchment	A42G (SW portion)		
16_4	Sandloop	A42J & remaining portion of A42H		
16_5	Mokolo mainstem	A42 G, A42H, A42J (along main stem river)		
IUA17a	**Mothlabatsi/Mamba**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
17a_1	Mothlabatsi, Mamba Rivers	A41A, A41B		
17a_2	Headwaters Mothlabatsi (peatlands)	A41A (south eastern)	wetland unit	Wetlands are important – to be prioritised for RQOs development
IUA17b	**Matlabas**			
RU	**Delineation**	**Catchment**	**Unit**	**Note**
17b_1	Matlabas	A41D, A41C		
17b_2	Catchment area	A41E		

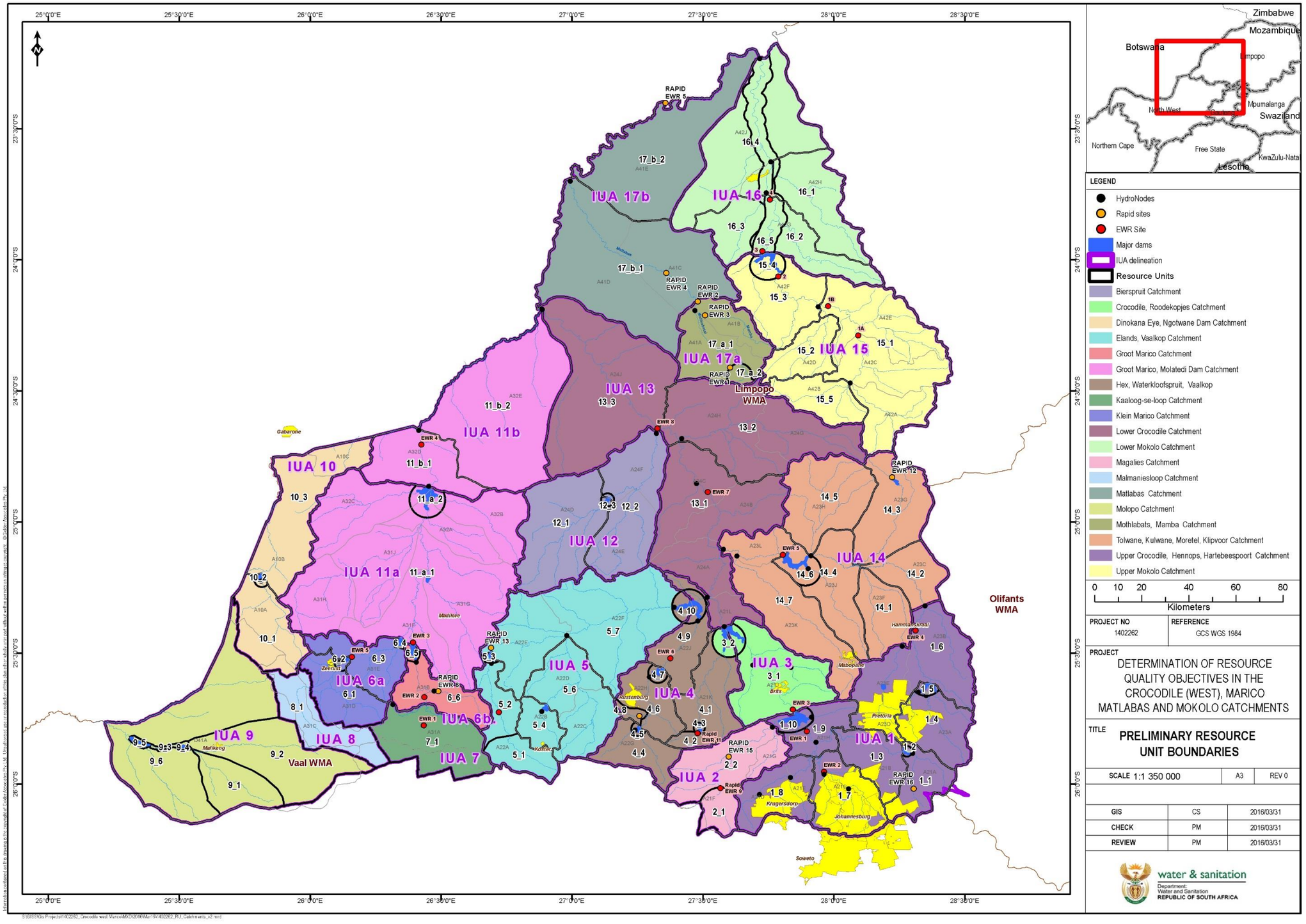

Figure 4: Preliminary delineation of Resource Units

3.1.5 Compilation of the Inception Report

This Inception Report forms the deliverable of the Inception Phase and includes the proposed scope of work, cost estimates, work programme and incorporates the preliminary findings and outcomes of the above tasks.

3.2 TASK 2: WATER RESOURCES INFORMATION AND DATA GATHERING

The purpose of this task will be to review existing literature, reports, maps and any other relevant information on the study area that is supportive and required for the determination of RQOs in the Mokolo, Matlabas, Crocodile (West) and Marico catchments. The review will specifically put emphasis on the recent Classification Study that was completed at the end of 2013, the Crocodile (West) River System Reconciliation Strategy and MACWAP planning to augment the Mokolo River catchment's water resources. Information from River Health Programme studies and other related studies will also be assessed in performing a gap analysis to determine if there is any other additional work required. Water quality and ecological information will also be assessed. A key component of the information gathering will be the understanding and incorporation of the outputs of the classification process.

This task will also include the sourcing of the Water Resources Planning Model (WRPM), Water Resources Yield Model (WRYM) and Water Quality Total Dissolved Solids (WQT) model that have been used for water quantity and quality modelling in the study area. These models will be used to understand the achievability of the quantity and salinity RQOs that maybe set.

All the above will be used to identify any data and information shortfalls. Specific recommendations will be made as to the collection of additional data and/or the extension of existing data. This will be discussed with the client before finalization. A preliminary assessment will be done in the inception phase in order that additional work needed is incorporated into the project plan and final study budget.

Task 2 Deliverables:

- **Report on water resources information analysis and recommendations.**

3.3 TASK 3: DETERMINATION OF RESOURCE QUALITY OBJECTIVES

It is understood that the purpose of setting RQOs is to establish clear goals relating to the resource quality of the relevant water resources. In determining RQOs, the objective will be to achieve a balance between protecting the water resource for the downstream users and allowing use and development of the water resource upstream. The focus is on protecting the water resource in order to ensure a healthy functional aquatic ecosystem, while also meeting the requirements of the other water user groups (e.g. domestic, agricultural, industrial, recreation and aquatic ecosystems) downstream of the RQO point.

The determination of the RQOs of significant water resources in the Mokolo, Matlabas, Crocodile (West) and Marico catchments will have to take cognisance of land based activities and anticipate the impacts that these activities may have on the water resources in the catchment. The setting of

RQOs will require the assessment and evaluation of these impacts on current and future use on the water resource components, which will require a balancing of upstream “impactors” with downstream user requirements.

In addition due to the economic demands and level of development within the Mokolo, Matlabas, Crocodile (West) and Marico catchments, the evaluation of the water resources, its condition, use, socio-economic implications and ecosystem characteristics will have to be considered, much of which will have formed part of the Classification Study and will be used in this study.

The 7 step process of RQO determination will be implemented for all significant water resources in the Mokolo, Matlabas, Crocodile (West) and Marico catchments (Figure 5). Activities common to the Water Resource Classification process will be synchronized, and outcomes aligned to the RQO determination procedure. This study is extensively reliant on existing results and information from the Water Resources Classification Study. All socio-economic and ecological outputs from the WRC study will be used in this study to ensure the RQOs proposed are adequately and sufficiently supported for approval by the delegated authority.

The implementation of the RQO procedure in the Mokolo, Matlabas, Crocodile (West) and Marico catchments will be undertaken using the following study approach:

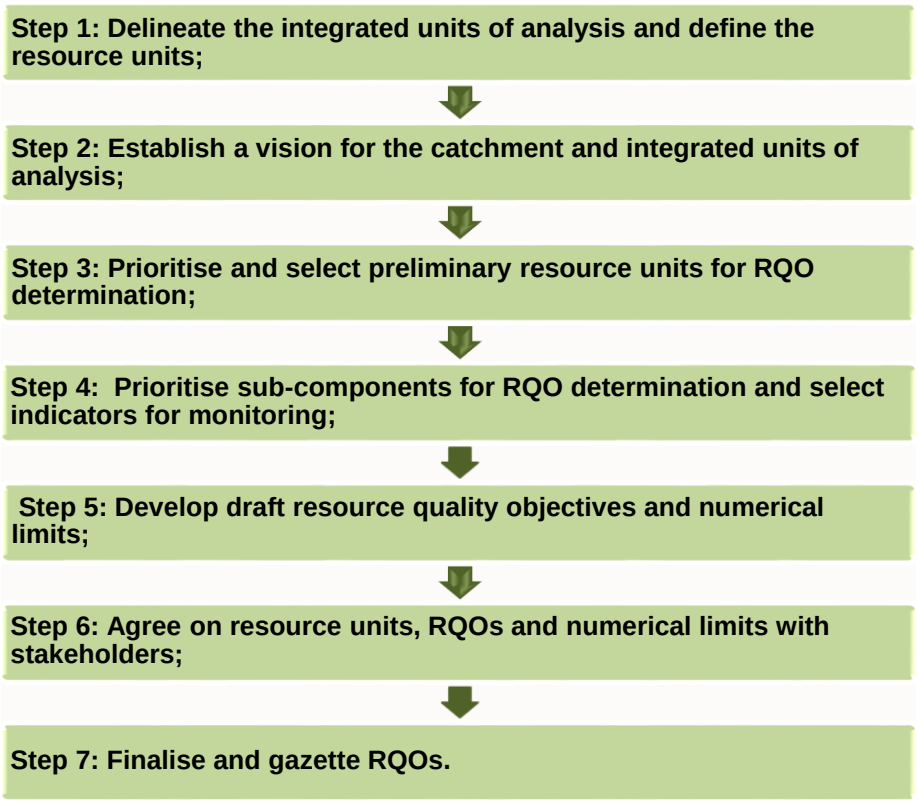

Figure 5: The 7 Step RQO Determination Procedure

- An assessment of the study area to understand the status quo with regard to water resources (river, wetlands, groundwater, dams) in the catchment, the assessment of the necessary information and data to support RQO determination and the incorporation of the outputs of the WRCS. In terms of the RQO study, steps 1 and 2 of the process will use outputs of the

Classification study as defined and will thus be limited to the extent of the WRC process. The water resources classified and the river nodes defined will be applied in the RQO study. RQOs will be defined for surface water resource components (rivers, dams and wetlands identified) and where applicable, groundwater RQOs will be set. It is envisaged that Steps1 and 2 of the RQO process have to a large extent been addressed by the WRCS.

- The Resource Units (RUs) will be defined based on the Integrated Units of Analysis (IUAs), the hydrological nodes defined and the water resources classified in terms of the WRCS. This study will not define any additional IUAs. RUs will be delineated within the IUAs and based on the node information and ecological information from the WRC study. Catchment activities, water users, water use and system operation will be considered.
- The vision for the Mokolo, Matlabas, Crocodile (West) and Marico catchments will be limited to the visioning exercise undertaken and the water resources classes set as part of the WRC process. A visioning process will not be undertaken as part of the RQO process for this study. However the aspirations and desired direction of change required by stakeholders will be considered and incorporated within the context of the water resources classes set, and the RQOs to be developed.
- The remaining steps of the RQO procedure, Steps 3 to 7 will then be applied i.e. determining the RQOs by giving effect to the water resources classes and ecological requirements through measurable management goals. The process to be followed will be as that outlined in Figure 5 and described in the RQO determination procedure (DWA, 2011).
- It is proposed that the RU prioritisation (Step 3) and the sub-component prioritisation workshops (Step 4) be restructured in order that the focus is not on population of the spreadsheets, but on confirming the prioritisation based on the experience of the study team specialists. This will ensure the time spent at the specialists workshops are utilised to the maximum benefit to draw expert knowledge and experience available from the specialists. However, the RU prioritisation and Evaluation Prioritisation spreadsheet resulting from the application of the tool will be completed as required and submitted as deliverables and available for comment from stakeholders. The workshop format will however be discussed with the client prior to the process being initiated.
- The stakeholder consultation will form a key component of the process and stakeholders will be brought along with the process to ensure that engagement undertaken will support the RQOs set and the envisaged gazetting process that is to follow. A focused stakeholder engagement process will be undertaken that is aligned to the technical steps of the study. Every effort will be made to link and align to existing structures and forums in the Mokolo, Matlabas, Crocodile (West) and Marico catchments. The Classification Study stakeholder database will be used and built upon. This will be periodically be updated. The idea is not to consult with everybody, but rather with representatives of specific sectors of society. The exact extent of the consultation will be confirmed with the client during the inception phase. A stakeholder engagement plan will be developed early on in the study to confirm the process to be followed.

  The structures for engagement are proposed in Section 3.1.2 above and the communication and stakeholder engagement processes are discussed in Sections 3.4 and 3.5 that follow.
- A proposed plan for RQO implementation will be drafted as part of the study process as a means

to facilitate its application in the catchment area. This will be developed once the RQOs have been determined. An implementation plan will be developed however this will need to be taken forward through the DWS.

- The RQO gazette templates will be populated.

The RQO determination procedure will be followed as best suited to circumstances and conditions in the study area. This will be an iterative process and may have to be adapted according to the prevailing circumstances. The team will also strive to ensure that as much of the existing information will be used and the steps kept as simple as possible without comprising the validity of the process.

Task 3 Deliverables –

- **Preliminary Resource Units Report (with prioritisation)**
- **Sub-component prioritisation and Indicator selection**
- **Draft RQOs and Numerical limits;**
- **Populated RQOs gazette template; and**
- **Proposed plan for RQO implementation.**

The Study Team will be responsible for the function and arrangement of the meetings for the specialist task groups, workshops, Project Steering Committee (PSC) and *ad-hoc* liaison. It proposed that these meetings are scheduled in accordance with the study execution and deliverable schedule. Meeting members will be kept informed and updated as and when required. The following sub-tasks will be undertaken.

3.4.1 Identification and Arrangement of Committees/Task Teams

- At the conclusion of the inception step of the study the required committee (PSC) and or task groups will be formed (separate to the technical specialists).
- The stakeholders will be identified and invited to participate on the PSC/task group. The group will form the representatives of identified organisations, users, constituencies and other government departments. A database will be maintained and updated.

3.4.2 Preparation for meetings/workshops

- Invitation letter, reply sheet and agendas will be prepared and circulated; and
- The meeting venues, catering, document and registers will be organised.

3.4.3 Workshops and meetings – co-ordination and liaison

The process requires that a number of different meetings be arranged including specialist workshops, group meetings with specialist task teams, institutional workshops and Technical Task Team meetings. The proposed methodology for arranging any type of meeting is as follows:

- clear objectives for the meeting / workshop and what needs to be achieved by the meeting/workshop will be defined and communicated ;
- stakeholders/specialists will receive notification of the meeting date and its objectives at least three weeks in advance;
- a formal advance registration process will be followed if necessary; and

- stakeholders will received documentation for the meeting at least five working days before the meeting, with a formal information letter of their attendance (an agenda and a background document helps stakeholders to understand the purpose of the meeting).

3.4.4 Dissemination of meeting documentation

- Meeting minutes will be prepared and distributed, as well any reports/technical information as required.

Task 4 Deliverables:

- **Meeting agendas**
- **Meeting minutes, invitation letters and, attendance registers**
- **Meeting presentations, documentation**

3.5 TASK 5: STAKEHOLDER ENGAGEMENT

Stakeholders will specifically be involved in obtaining agreement on the Resource Units, draft RQOs and numerical limits. Communication and liaison for the RQO determination process will be aligned to the initiatives of the Mokolo, Matlabas, Crocodile (West) and Marico Classification Study as much of the visioning for the catchments will have been undertaken as part of the classification study. A visioning exercise will not be undertaken with stakeholders however their aspirations will be incorporated into a vision for the catchment areas within the context of the water resources classes defined as part of the classification process.

Participation in in the process is not only a statutory requirement, but a process that should lead to a joint effort by stakeholders. Stakeholders should represent all relevant interests and sectors of society, technical specialists and the various relevant organs of state who work together to produce better decisions than if they had acted independently, and better implementation of decisions through stakeholders “owning” the process.

The stakeholder process for the project is summarised in Figure 6. The structures for engagement are proposed in Section 3.1.2 above.

3.5.1 Stakeholder identification and database

Stakeholders from the following sectors have been identified in the study area and will be targeted to become involved in the study (in obtaining agreement on the draft RQOs and numerical limits):

- Relevant government departments on national, provincial/regional level from amongst other the DWA, Department of Environmental Affairs, Cooperative Governance and Traditional Affairs and others;
- District and Local Municipalities and Metros;
- Agriculture (Irrigation Boards, Unions);
- Mines and industries;
- Relevant parastatals (e.g. Eskom); and

- Community representatives' organisations such as rate payers organisations and civil society (NGOs, CBOs).

The stakeholder database of the Classification Study is being used as a departure point. This will be extended to include other stakeholders as identified for the different IUAs. Details of the representative stakeholders will be captured electronically for record keeping purposes. The draft database will be compiled early on in the study; however will be constantly updated as more information becomes available and as stakeholders change.

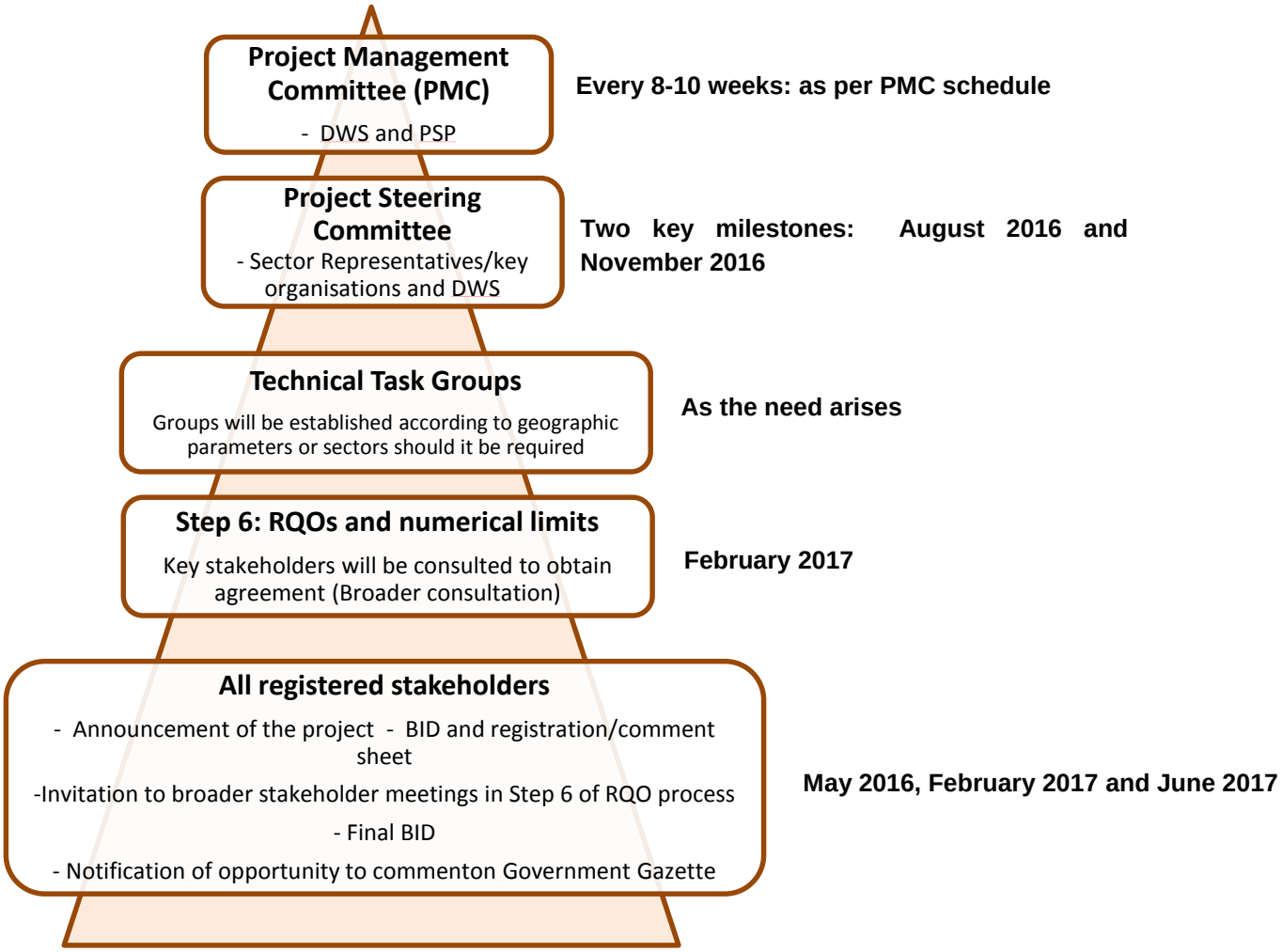

Figure 6: Summary of stakeholder engagement/communication

3.5.2 Announce the project

After the Inception Report has been approved an announcement/ background information document (BID) will be compiled for distribution to all identified stakeholders. The purpose of this document will be to announce that the DWS is undertaking the determination of RQOs for significant water resources in the study area, the process to be followed, anticipated activities, proposed time lines as well as how stakeholders will be involved in the project. This document will also aim to explain the necessity of the project and the context of the study. At this early stage in the project stakeholders will be requested to provide their comments and inputs and also to note if they are aware of any stakeholders who should become involved. Responses will be captured electronically at the

beginning of the process to register stakeholder comments and responses.

3.5.3 Obtaining agreement on Resource Units; RQOs and Numerical Limits with stakeholders – step 6 of the RQO determination procedure

Stakeholders have to review the prioritised Resource Units; the RQOs and Numerical Limits presented by the DWS and its study team. The following steps are anticipated:

- Identification of stakeholders to be invited to a discussion meeting / workshop where the RUs and RQO information are to be presented;
- Distribution of invitation letters, draft RQOs and proposed agenda to the identified stakeholders providing them sufficient information about the status of the project, the purpose of the workshop/s and what will be expected of them (e.g. read through documents prior to the meeting/s and provide inputs and comments);
- Compilation of a simplified document explaining the various results (outputs) on the Resource Units, RQOs and Numerical Limits and distributed to all stakeholders;
- Hosting of workshop/s with proper presentations of the draft RQOs where thorough minutes can be taken which will act as a record of stakeholder comments and inputs; and
- Distribution of minutes of the workshop/s.

Should the draft RQOs which were presented have changed significantly with the consideration of stakeholder comments, the process to invite stakeholder inputs on the revised RQOs will have to be repeated to reach an acceptable level of agreement with stakeholders. Once the RQOs have been agreed upon, stakeholders need to be informed of the RQOs which will be submitted for final sign-off.

3.5.4 Project Steering Committee

A PSC representing specific sectors of society in the study area will be established to guide the project. The PSC will be invited to a meeting when the study team has new information to discuss with the stakeholders. It is anticipated that the PSC will not meet more than two over the 18 month study period. Invitation letters and a proposed agenda will be distributed to the PSC members providing them with sufficient information about the status of the project, the purpose of the meeting and what will be expected of them (e.g. read through documents prior to the meeting and provide inputs and comments).

3.5.5 Technical Task Groups

A technical task group, which will be a sub-group of the PSC, for the project will be set up if required. The nature and composition of these meetings will vary. It is anticipated that these meetings will be held on an ad-hoc basis when the need arises. Prior to these meetings the necessary documentation will be compiled and distributed. The nature and composition of these meetings will vary. This will be determined by the study team.

3.5.6 Issues and Response Register

The capturing of information from stakeholders is considered important to the RQO Process. An Issues and Responses Report will be compiled and updated throughout the study period of the project. This report will list all the comments from stakeholders (to be received from at meetings,

workshops, emails etc.) and the responses from the project team. This could be carried through to the gazetting process.

3.5.7 Support to Gazetting Process.

The study team will support the DWS through gazetting process. This will relate to the addressing of matters related to the RQOs determined.

Task 5 Deliverables –

- **Stakeholder database;**
- **BIDs as developed;**
- **Notes and minutes of the meetings; and**
- **Register of stakeholders and their comments and responses.**

3.6 TASK 5: CAPACITY BUILDING

In terms of building capacity and ensuring skills transfer in DWS personnel, individuals who could be used in the execution of specific tasks on the project will be identified through the DWS study manager. This will ensure the broadening of the RDM skills base. There is also the opportunity for members from the Department to be seconded to the study team to assist in the study. These opportunities will be explored in the inception phase.

Ms Adaora Okonkwo is the project manager from the Department and in order to build her capacity will be used in the execution of specific tasks on the project and in the general running of the study. Ms Okonkwo will work with the project team on various tasks. In addition Ms Okonkwo will participate in workshops and stakeholder participation processes. A proposed programme is outlined in Section 3.1.3 above.

The Team will also hold capacity building workshops at certain points in the study (*i.e* at tasks 3, 4 and 5 of the process). DWS personnel will be included in the development of RQOs definition and gazette template population. The DWS study manager will need to supply names and contact details of all the relevant DWS officials who will attend such sessions.

Another component of the skills transfer and capacity may be required is that of the stakeholders. As the RQOs determination will be new to most stakeholders, building their capacity on the process, decision-making and outcomes maybe required. The study team through the process implementation will ensure that stakeholders are informed and understand their participation in the process.

Task 5 Deliverables –

- **Capacity building programme; and**
- **Capacity building report at study closure.**

3.7 TASK 6: STUDY MANAGEMENT AND REPORTING

Mr Trevor Coleman will be responsible for overall project direction, while Ms Priya Moodley and Ms Lee Boyd will be responsible for the project management and coordination of the study. The PMC

will be constituted during the inception phase of the project. Ten (10) Project Committee meetings held bi-monthly over the project duration have been allowed for.

In order to ensure effective management of this study with the appropriate guidance from various levels of DWS the following management structures will be used for both guidance and review:

3.7.1 Client liaison

Liaison with the DWS Study Manager will include the following activities:

- Arrange Project Management Committee (PMC) over the course of the Study as required;
- Establishing interim communication (between meetings) to advise the Study Manager of, inter alia, important events or problem situations, possible changes to the scope of work etc;

3.7.2 Coordination of Study Team

The PSP Project Manager will be responsible for overall coordination of the Study Team and activities will include:

- Serving as link between DWA Study Manager and Study Team;
- Ensuring that the task leaders and specialists are properly briefed prior to commencing with work.
- Monitoring and control of performance, programming and cost of study, including revision of the Study Programme, if and when necessary.

3.7.3 Study administration

Study administration duties to be performed will include:

- Compiling, certifying and submitting monthly invoices to the Client. The Client will be presented with a monthly invoice from the Study Team. The Study Manager will arrange payment to the other members of the Study Team after receiving the same from the Client.
- The Study Manager will provide a secretariat to perform the required duties for the Project Management Committee.

3.7.4 Reporting and Reviewing System

The Project Management Committee will give overall guidance to the Study Team and progress meetings will take place in accordance with the project plan and as set up by the Client.

Progress reports will be submitted to the Client to advise on progress and status. Interim milestone reports will also be drafted according to the milestone programme.

The RQOs will be written up in the gazette template in accordance with appropriate guidelines.

Task 6 Deliverables

- **Progress reports documenting work progress against programme and actual expenditure against cash flow estimates;**
- **Technical reports after completion of each defined milestone;**
- **Minutes of the meetings; and**
- **Study Closure Report**

3.8 SUMMARY OF DELIVERABLES

The summary of deliverables for the study as outlined per task will include the following:

Table 6: Summary of study deliverables

DELIVERABLES
Task 1: Study Inception
• Study Inception Report with work Programme
Task 2: Water Resource Information and Data gathering
• Report on Water Resources Information Analysis and Models
Task 3: Determination of Resource Quality Objectives
• Preliminary Resource Units Report (Selection and Prioritisation)
• Resource Units Prioritization, Sub-component prioritisation and indicator selection Report
• Draft RQOs and Numerical limits
• Proposed plan for RQOs implementation/ operation
Task 4: RQO Gazette Templates and support with gazetting process
• Gazette Templates
• Support with gazetting process
Task 5: Communication and Liaison
• Meeting agendas, Meeting minutes, Invitation letters and, attendance registers
• Meeting presentations, documentation
Task 6: Stakeholder Engagement
• Background Information Documents as required (X 2 for database and as required for meetings)
• Stakeholder database
• Registers of stakeholders of all meetings
• Issues and response report
Task 7: Reporting
• Technical interim milestone reports
• Progress reports

DELIVERABLES
Task 8: Capacity Building
• Capacity building report
Task 9: Study Management
• Study Administration, Financial Management, Team co-ordination
• Electronic information and data
• Project close out report

4 STUDY PROGRAMME

The study programme of the study tasks is provided as a bar chart programme of the tasks in Appendix A. The study will be completed within the 18 month time frame as specified in the Terms of Reference. In terms of the programme the study is expected to terminate in July 2017.

5 STUDY TEAM

5.1 GENERAL

The study team consists of Golder Associates Africa supported by Zitholele Consulting, Wetlands Consulting, JMM Stassen and Hydrosol Consulting.

The Study Leader for the study will be Trevor Coleman who has worked extensively on water resource projects over the years. Ms Priya Moodley will be the study manager supported by Ms Lee Boyd in terms of project management and coordination of the study. Task leaders include Trevor Coleman, Gary Marneweck, Eddie van Wyk, Retha Stassen and Nicolene Venter; all experienced in working on large integrated projects will provide an experienced support base to the study leadership.

The Study Manager will be responsible for the liaison with the Client and the general supervision of the study.

5.2 TEAM MEMBERS

The study team and indicated in Table 7 with organogram indicating the proposed project organisational structure indicated in Figure 7.

Table 7: Team members involved in the study

Team Member	Company	Role/Study Position
Trevor Coleman	Golder Associates	Technical Lead and advisor, Water Resources Integration, Systems Assessment, Review
Lee Boyd	Golder Associates	Project Management, Water Quality and Reporting
Priya Moodley	Golder Associates	Project co-ordination, Water Quality, Integration, Reporting
Zinhle Sithole	Golder Associates	Support water quality, hydrology, data analysis

Warren Aken	Golder Associates	Aquatic Biology - Fish
Kylie Farrell	Golder Associates	Aquatic Biology - Macro-invertebrates
Andrew Zinn	Golder Associates	Riparian Vegetation
Eddie van Wyk	Golder Associates	Groundwater Lead
Tracy Skinner	Golder Associates	GIS
Bennie Haasbroek	Hydrosol Consulting	Hydrology/Systems Analysis
Nicolene Venter	Zitholele Consulting	Communication/ Stakeholder Engagement Lead
Tricia Njapha	Zitholele Consulting	Communication/ Stakeholder Engagement Support
Dr Gary Marneweck	Wetland Consulting Services	Wetlands Task Leader
Dieter Kassier	Wetland Consulting Services	Wetlands
JMM Stassen	Specialist	Reserve, Ecological Water Requirements, Systems Analysis
Collen Todd	Specialist	Macro-invertebrates/ Aquatic Biology

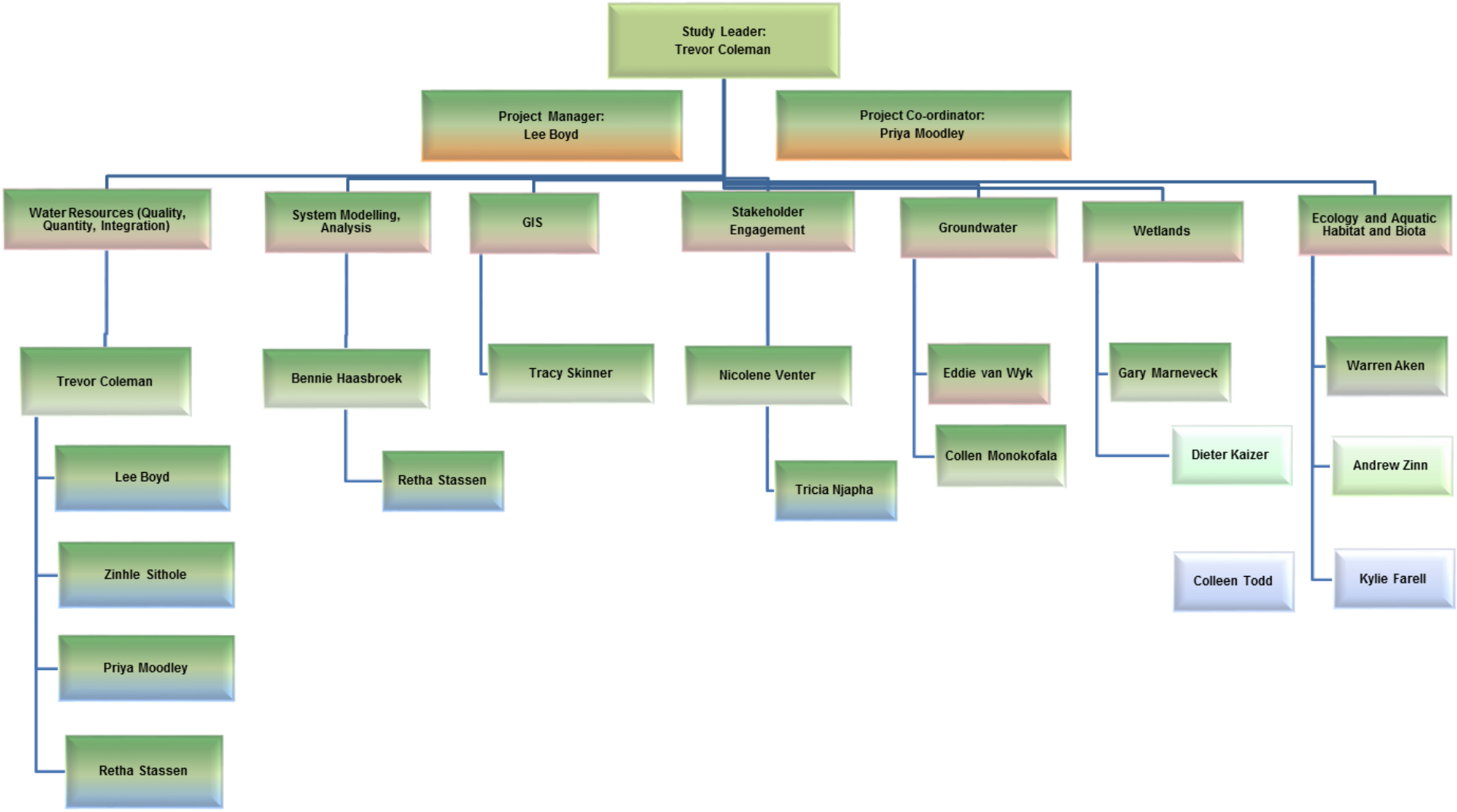

Figure 7: Team Organogram

6 STUDY COSTS

6.1 SUMMARY COSTS

The cost estimates presented in this section are based on the proposed tasks and are applicable to the study period, which has been programmed for 18 months, ending July 2017. Table 8 represents the summary of the total study costs.

Table 8: Summary of Study Costs

Cost item	Costs (R)			% of Total
	Excl VAT	VAT	Incl VAT	
Professional fees	R 2 231 507.00	R 312 410.98	R 2 543 917.98	88.1
Disbursements	R 300 000.00	R 42 000.00	R 342 000.00	11.9
Total	**R 2 531 507.00**	**R 354 410.98**	**R 2 885 917.98**	100

6.2 SUMMARY COST BREAKDOWN PER STUDY DELIVERABLE

A summary of the breakdown of the costs for the study deliverables for the study phases is provided is provided in Table 9

Table 9: Summary of Cost breakdown per deliverable

Phase/Deliverable	Cost		
	Excl VAT	VAT	Incl VAT
Study Inception Report	R 174 400	R 24 416	R 198 816.00
Report on Water Resources information and data gathering and analysis	R 103 800	R 14 532	R 118 332.00
Preliminary Resources Units Report (Selection and Prioritisation)	R 210 000	R 29 400	R 239 400.00
Resource Units Prioritisation, Sub-component prioritisation and indicator selection Report	R 370 000	R 51 800	R 421 800.00
Draft RQOs and Numerical Limits Report	R 520 000	R 72 800	R 592 800.00
Proposed Implementation/Operation Plan Report	R 127 000	R 17 780	R 144 780.00
Gazette Templates	R 108 000	R 15 120	R 123 120.00
Support with gazetting process	R 44 998	R 6 300	R 51 297.72

Phase/Deliverable	Cost		
	Excl VAT	VAT	Incl VAT
Communication and liaison	R 126 534	R 17 715	R 144 248.76
Stakeholder engagement/Issues and Response Report	R 293 915	R 41 148	R 335 063.10
Reporting	R 61 676	R 8 635	R 70 310.64
Capacity Building report	R 170 312	R 23 844	R 194 155.68
Study Management	R 220 872	R 30 922	R 251 794.08
SUB TOTAL PROFESSIONAL FEES	**R 2 231 507.00**	**R 312 410.98**	**R 2 543 917.98**
TOTAL DISBURSEMENTS	**R 300 000.00**	**R 42 000.00**	**R 342 000.00**
TOTAL STUDY COST	**R 2 531 507.00**	**R 354 410.98**	**R 2 885 917.98**

6.3 DISBURSEMENTS

The proposed disbursement costs for the Study are R 300 000 (excl. VAT) and are allowed for in this study per deliverable. Disbursements will be charged to the Client without mark-up and economy air travel will be used in all cases. The standard government rates for car travel will be used and any other similar items will be agreed with the Client.

6.4 CASH FLOW PROJECTIONS

A cash flow projection is provided in Appendix B.

7 ASSUMPTIONS AND LIMITATIONS

The following assumptions are made with regard to the determination of the RQOs in the Mokolo, Matlabas, Crocodile (West) and Marico catchments:

- the vision for catchment and IUAs determined through the Classification study are adequate and will be applied in the RQO process;
- the Ecological Water requirements for rivers, identified wetlands, groundwater and lakes have been completed at the appropriate level of resolution, with associated ecological specifications;
- The DWS will ensure that all relevant information, including relevant reports and data from previous and parallel studies, are made available to the team.
- All historical data and information received from the Client is assumed to be correct, Golder will not review such data.

In addition,

- Determination of groundwater RQOs is constrained by the current understanding of groundwater processes in the catchments, and how these have been considered in the WRC process. Additionally, since the groundwater RQO process was developed separately to the

more generic surface water RQO process, not all steps are directly compatible. Where possible comparable steps will be applied however no allowance has been made to collect new data and no data processing will be undertaken in this project, beyond what has already been produced as part of the WRC process. In this respect where additional data collection is required in respect of specific indicators, this will be discussed with DWS and may have budget and time implications.

- Due to the extent of the catchment areas and the diversity and complexity within each of the catchments, the RQO development will be better achieved with stakeholder engagement processes being undertaken within each area. Alignment and integration will however take place among the systems.

8 REFERENCES

Department of Water Affairs and Forestry (1999). *Resource Directed Measures for Protection of Water Resources*. Volume 4. Wetland Ecosystems Version 1.0, Pretoria.

Department of Water Affairs and Forestry (1999). *Resource Directed Measures for Protection of Water Resources*. Volume 3. River Ecosystems. Version 1.0, Pretoria.

Department of Water Affairs and Forestry (2004). *Internal Strategic Perspective: Crocodile River (West) Catchment.* Directorate National Water Resources Planning

Department of Water Affairs and Forestry (2004). *Internal Strategic Perspective: Marico, Upper Molopo and Upper Ngotwane Catchments*. Directorate National Water Resources Planning

Department of Water Affairs and Forestry, South Africa. 2004. Internal Strategic Perspective: Limpopo Water Management Area: National Water Resource Planning. Report No. P WMA 01/000/00/0304.

Department of Water Affairs and Forestry (2007). Development of the Water Resource Classification System (WRCS), Vol. I. Chief Directorate: Resource Directed Measures, Department of Water Affairs and Forestry, Pretoria, South Africa;

Department of Water Affairs (2011). Procedures to develop and implement Resource Quality Objectives. Department of Water Affairs, Pretoria, South Africa.

Marneweck, G.C., Grundling, P.L. and Muller, J.L. 2001. *Defining and classification of peat wetland eco-regions in South Africa*. Wetland Consulting Services (Pty) Ltd. Report to the Institute for Soil, Climate and Water (ISCW), Agricultural Research Council for the Directorate for Land and Resources Management (DLRM), Department of Agriculture, Pretoria, South Africa.

Midgley, D.C, Pitman W.V, Middleton B.J. (1994), *Surface Water Resources of South Africa.*

APPENDIX A:

Study Programme

STUDY PROGAMME: DETERMINATION OF RESOURCE QUALITY OBJECTIVES IN THE MOKOLO, MATLABAS AND CROCODILE (WEST) AND MARICO CATCHMENTS (WP10992)

	STUDY TASKS	YEAR																	
		Financial Year 1 (2015/2016)		Financial Year 2 (2016/2017)									Financial Year 3 (2017/2018)						
		2016											2017						
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Task 1	**Project Inception**																		
	Collation of all relevant information on studies conducted																		
	Synchronization/alignment with Classification Study																		
	Development of a capacity building programme																		
	Draft Inception Report																		
	Final Inception Report																		
Task 2	**Water resources information and data gathering**																		
	Assessment of water resource information																		
	Gap analysis and recommendations																		
	Report																		
Task 3	**Determination of RQOs (Application of 7 step process)**																		
Step 1	Delineate the Integrated Units of Analysis and define the Resource Units																		
Step 2	Establish a vision for catchment and key elements for the IUAs																		
Step 3	Prioritise and select preliminary resource units for RQO determination																		
Step 4	Prioritise sub-components for RQO determination, select indicators for monitoring and propose the direction of change																		
Step 5	Develop draft RQOs and numerical limits																		
Step 6	Agree on Resource Units, RQOs and numerical limits with stakeholders																		
Step 7	Develop plan of implementation																		
	Finalise RQO template and support RQO gazetting process																		
Task 4	**Communication and liaison**																		
	Co-ordinaton and liaison																		
	Dissemination of documentation																		
	Stakeholder engagement plan																		
Task 5	**Stakeholder Engagement**																		
	Stakeholder identification and database development																		
	Background Information Documents																		
	Technical Group meetings (PSC)																		
	Public Meetings/Broader Engagement																		
	Issues and Response register																		
Task 7	**Capacity Building/Skills Transfer**																		
Task 6	**Reporting and Study Management**																		
	Progress reports/technical milestine reports																		
	Project Closure																		
	Project Close out report																		
	Final RQOs																		
	Study Management																		
	Project management team meetings and meeting minutes																		

APPENDIX B:

Cashflow Projection

RQO DETERMINATION STUDY FOR CROCODILE (WEST) AND MARICO WMA, MOKOLO AND MATLABAS CATCHMENTS

CASHFLOW PROJECTION 31 MARCH 2016

	CASHFLOW PROJECTIONS								ACTUAL EXPENDITURE (incl. VAT)		Per Quarter	
Study Task	**Invoice**	**Month**		**Finanical Year**	**Proposed Projected Expenditure**	**Cumulative Projected Expenditure**	**Proposed Projected Expenditure (incl VAT)**	**Cumulative Projected Expenditure (incl VAT)**	**Invoiced (incl. VAT)**	**Culumulative invoiced**	**Total Actual Expenditure per Quarter (excl. VAT)**	**Total Actual Expenditure per Quarter (incl. VAT)**
Study Inception	1	Apr-16	Q1	2106/2017	R 182 109.50	R 182 109.50	R 207 604.83	R 207 604.83	R 0.00	R 0.00	R 0.00	R 0.00
Water Resources information and data gathering	2	May-16			R 111 509.50	R 293 619.00	R 127 120.83	R 334 725.66	R 0.00	R 0.00		
Preliminary Resources Units: Selection and Prioritisation	3	Jun-16			R 217 709.50	R 511 328.50	R 248 188.83	R 582 914.49	R 0.00	R 0.00		
Resource Units Prioritisation, Sub-component prioritisation and indicator selection		Jul-16	Q2		R 0.00	R 511 328.50	R 0.00	R 582 914.49	R 0.00	R 0.00	R 0.00	R 0.00
		Aug-16			R 0.00	R 511 328.50	R 0.00	R 582 914.49	R 0.00	R 0.00		
	4	Sep-16			R 377 709.50	R 889 038.00	R 430 588.83	R 1 013 503.32	R 0.00	R 0.00		
Draft RQOs and Numerical Limits		Oct-16	Q3		R 0.00	R 889 038.00	R 0.00	R 1 013 503.32	R 0.00	R 0.00	R 0.00	R 0.00
		Nov-16			R 0.00	R 889 038.00	R 0.00	R 1 013 503.32	R 0.00	R 0.00		
	5	Dec-16			R 527 709.50	R 1 416 747.50	R 601 588.83	R 1 615 092.15	R 0.00	R 0.00		
Gazette Templates and Implementation Plan		Jan-17	Q4		R 0.00	R 1 416 747.50	0.00	R 1 615 092.15	R 0.00	R 0.00	R 0.00	R 0.00
		Feb-17			R 0.00	R 1 416 747.50	0.00	R 1 615 092.15	R 0.00	R 0.00		
		Mar-17			R 0.00	R 1 416 747.50	0.00	R 1 615 092.15	R 0.00	R 0.00		
		Apr-17	Q1	2017/2018	R 0.00	R 1 416 747.50	0.00	R 1 615 092.15	R 0.00	R 0.00	R 0.00	R 0.00
	6	May-17			R 242 709.50	R 1 659 457.00	276688.83	R 1 891 780.98		R 0.00		
Issues and Response register	7	Jun-17			R 428 158.50	R 2 087 615.50	488100.69	R 2 379 881.67	R 0.00	R 0.00		
Study Management and Close out/Capacity Building Report	8	Jul-17	Q2		R 398 893.50	R 2 486 509.00	454738.59	R 2 834 620.26	R 0.00	R 0.00	R 0.00	R 0.00
		Aug-17			R 0.00	R 2 486 509.00	0.00	R 2 834 620.26	R 0.00	R 0.00		
Support with Gazetting Process	9	Sep-17			R 44 998.00	R 2 531 507.00	51297.72	R 2 885 917.98	R 0.00	R 0.00		
	TOTAL				**R 2 531 507.00**	**R 2 531 507.00**	**R 2 885 917.98**	**R 2 885 917.98**	**R 0.00**	**R 0.00**	**R 0.000**	**R 0.00**