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RESERVE DETERMINATION STUDIES FOR SELECTED SURFACE WATER, GROUNDWATER, ESTUARIES AND WETLANDS IN THE USUTU/MHLATUZE WATER MANAGEMENT AREA
WP 10544

INCEPTION REPORT
FINAL

DECEMBER 2013

Report No. RDM/WMA6/CON/COMP/0113

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Water Affairs
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF WATER AFFAIRS
CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

CONTRACT NO. WP 10544

RESERVE DETERMINATION STUDIES FOR SELECTED SURFACE WATER (RIVERS, ESTUARIES AND WETLANDS) AND GROUNDWATER IN THE USUTU/MHLATUZE WATER MANAGEMENT AREA

INCEPTION REPORT
FINAL

DECEMBER 2013

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TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 Purpose and structure of the inception report 1

1.2 Background 2

1.3 Study Objectives 2

2 OVERVIEW OF THE USUTU/MHLATUZE WMA 4

2.1 Drainage 4

2.1.1 Mhlatuze Basin (W10) 4

2.1.2 Mfolozi Basin (W2) 5

2.1.3 Mkuze Basin (W3) 7

2.1.4 Pongola Basin (W4) 7

2.1.5 Usutu Basin (W5) 8

2.1.6 Lake Sibaya and Kosi Basin (W70A) 9

2.2 Protected areas and natural heritage sites 10

3 OVERVIEW OF THE RESERVE STUDIES CONDUCTED IN THE WMA 12

3.1 Mhlatuze River catchment 12

3.2 Usutu River catchment 13

3.3 Mfolozi River catchment 13

4 SCOPE OF WORK 15

4.1 Overview 15

4.2 Methodology 16

4.2.1 Hydrology 16

4.2.1.1 Mfolozi hydrology 16

4.2.2 The DRIFT DSS 16

4.2.3 Rivers 17

4.2.3.1 Determination levels and sites 18

4.2.3.2 EF Methodology - Intermediate determinations 19

4.2.3.3 EF Methodology - Rapid determinations 19

4.2.3.4 EF Methodology – Pongola Floodplain 19

4.2.4 Wetlands and groundwater 20

4.2.5 Estuaries 20

4.2.5.1 St Lucia/Mfolozi Estuarine System - Intermediate determination 20

4.2.5.2 Mlalazi Estuary - Rapid determination 21

4.2.5.3 Amatikulu and Kosi Estuary - Rapid determination 21

4.2.6 Lake Sibaya 22

4.2.7 Socio-economics 23

4.2.8 Basic Human Needs Reserve 23
4.2.9 Capacity building and skills transfer 23
4.2.9.1 Project management 25
4.2.9.2 Rivers 25
4.2.9.3 Estuaries 25
4.2.9.4 Groundwater and wetlands 26

5 APPROACH TO ACHIEVE OBJECTIVES 27

5.1 Activity 1: Project management 27
5.1.1 Task 1.1: Overall project co-ordination and management 27
5.1.2 Task 1.2: Project Management Committee (PMC) meetings 28
5.1.3 Task 1.3: Project Steering Committee (PSC) meetings 28
5.1.4 Task 1.4: Focussed discussion sessions 28
5.1.5 Task 1.5: Scenario selection 29
5.1.6 Task 1.6: Technical monitoring and control 29
5.1.7 Task 1.7 Financial control 30
5.1.8 Task 1.8 Progress reporting 30
5.2 Activity 2: Project Inception 30
5.2.1 Task 2.1: Catchment overview 31
5.2.2 Task 2.2: Workplan 31
5.2.3 Task 2.3: Inception Report 31
5.2.4 Task 2.4: ToRs for team members 31
5.2.5 Task 2.5: Team appointments and mobilisation 31
5.2.6 Task 2.6: Water resources prioritisation and delineation 31
5.2.6.1 Rivers 31
5.2.6.2 Estuaries 32
5.2.6.3 Wetlands & Groundwater 33
5.2.7 Task 2.7: Project Management Information System Implementation 33
5.3 Activity 3: Hydrology 33
5.3.1 Task 3.1: Overview of hydrological data 34
5.3.2 Task 3.2: Daily data for seven river Intermediate EWR sites 34
5.3.3 Task 3.3: Monthly data for WRCS nodes 34
5.3.4 Task 3.4: ACRU modelling for Mfolozi basin 34
5.3.5 Task 3.5: DRIFT analyses 34
5.3.6 Task 3.6: Flow scenarios for rivers and estuaries 35
5.3.7 Task 3.7: Internal review and reporting 35
5.4 Activity 4: Intermediate River EWRs 35
5.4.1 Task 4.1: Literature review 35
5.4.2 Task 4.2: Site selection 35
5.4.3 Task 4.3 Data collection 36
5.4.4 Task 4.4 Data analysis and modelling 38
5.4.5 Task 4.5: Ecoclassification 38

5.4.6 Task 4.6: Determine EWRs *38*
5.4.7 Task 4.7: Scenario analysis *38*
5.4.8 Task 4.8: Resource Quality Objectives and monitoring *39*
5.4.9 Task 4.9: Internal review and reporting *39*
5.5 Activity 5: Rapid EWR for Rivers **39**
5.5.1 Task 5.1: Ecoclassification *39*
5.5.2 Task 5.2: DRIFT/Desktop extrapolation and adjustments for key sites *40*
5.5.3 Task 5.3: Extrapolation of EWR data for remaining WRCS nodes *40*
5.5.4 Task 5.4: Internal review and reporting *40*
5.6 Activity 6: Pongola Floodplain **40**
5.6.1 Task 6.1: Literature review *40*
5.6.2 Task 6.2: Data for Gauge W4H013 and water level gauges along the floodplain *41*
5.6.3 Task 6.3: Survey water level gauges relative to MSL *41*
5.6.4 Task 6.4: Landsat 5 and 7 scenes *41*
5.6.5 Task 6.5: Inundation computations *42*
5.6.6 Task 6.6: Wetland typing and ecoclassification *42*
5.6.7 Task 6.7: Application of DRIFT *42*
5.6.8 Task 6.8: Resource Quality Objectives and monitoring *43*
5.6.9 Task 6.9: Operating rules *43*
5.6.10 Task 6.10: Internal review and reporting *43*
5.7 Activity 7: Wetlands and Groundwater **43**
5.7.1 Task 7.1: Literature review and acquisition of data *43*
5.7.2 Task 7.2: Delineation and wetland typing *45*
5.7.3 Task 7.3: Geohydrological characterisation and aquifer boundaries *45*
5.7.4 Task 7.4: Ecoclassification *46*
5.7.5 Task 7.5: Identification of links between abstraction and wetland condition *46*
5.7.6 Task 7.6: Ground truthing *47*
5.7.7 Task 7.7: Integration workshops *47*
5.7.8 Task 7.8: Coarse-level water balance *47*
5.7.9 Task 7.9: Internal review and reporting *47*
5.8 Activity 8: St Lucia/Mfolozi Estuarine System Intermediate EWR **47**
5.8.1 Task 8.1: Prepare hydrodynamic simulation data *48*
5.8.2 Task 8.2: Ecoclassification *48*
5.8.3 Task 8.3: Setting EWRs *48*
5.8.4 Task 8.4: Ecological specifications and monitoring programme *49*
5.8.5 Task 8.5: Internal review and reporting *49*
5.9 Activity 9: Mlalazi Estuary Rapid EWR **49**
5.9.1 Task 9.1: Data collection *49*
5.9.2 Task 9.2: Data analysis and specialist reporting *50*
5.9.3 Task 9.3: Ecoclassification and setting of EWR *50*

5.9.4 Task 9.4: Ecological specifications 50
5.9.5 Task 9.5: Internal review and reporting 50
5.10 Activity 10: Amatikulu Estuary Rapid EWR 51
5.10.1 Task 10.1: Data collection 51
5.10.2 Task 10.2: Data analysis and specialist reporting 51
5.10.3 Task 10.3: Ecoclassification and setting of EWR 51
5.10.4 Task 10.4: Ecological specifications 52
5.10.5 Task 10.5: Internal review and reporting 52
5.11 Activity 11: Kosi Estuary Rapid EWR 52
5.11.1 Task 11.1: Data collection 52
5.11.2 Task 11.2: Data analysis and specialist reporting 52
5.11.3 Task 11.3: Ecoclassification and setting of EWR 53
5.11.4 Task 11.4: Ecological specifications and monitoring programme 53
5.11.5 Task 11.5: Internal review and reporting 53
5.12 Activity 12: Mhlatuze, Nhlabane and other existing lakes 53
5.12.1 Task 12.1: Review existing studies 53
5.12.2 Task 12.2: Reformat and incorporate into results 54
5.12.3 Task 12.3: Internal review and reporting 54
5.13 Activity 13: Lake Sibaya Intermediate EWR 54
5.13.1 Task 13.1: Literature and available data/models review 54
5.13.2 Task 13.2: Delineation of the extent of aquifer 54
5.13.3 Task 13.3: Identification of biophysical indicators 54
5.13.4 Task 13.4: Summary of Geohydrological modelling results 55
5.13.5 Task 13.5: Data collection and analysis 55
5.13.5.1 Abiotic components (hydrodynamics and water quality): 55
5.13.5.2 Microalgae 55
5.13.5.3 Macrophytes 56
5.13.5.4 Invertebrates 56
5.13.5.5 Fish 56
5.13.5.6 Birds 56
5.13.6 Task 13.6: Ecoclassification 56
5.13.7 Task 13.7: Setting of EWR and scenarios analysis 56
5.13.8 Task 13.8: Ecological specifications and monitoring 57
5.13.9 Task 13.9: Internal Review and Reporting 57
5.14 Activity 14: Socio-economic profile of study area 57
5.14.1 Task 14.1 Delineate socio-economic zones 57
5.14.2 Task 14.2 Identification of water use sectors 57
5.14.3 Task 14.3 Ecosystem Function and Services Identification and Assessment 58
5.14.3.1 Step 14.3.1 Identification of functions and services 58
5.14.3.2 Step 14.3.2 Screen the list for potential double counting of services 59

5.14.3.3 Step 14.3.3 Identification of stakeholders using the services 60
5.14.3.4 Step 14.3.4 Selection of indicators for ecosystem services 60
5.14.3.5 Step 14.3.5 Quantitative analysis of ecosystem services 60
5.14.4 Task 14.4 Summarise value of aquatic ecosystems 61
5.14.4.1 Task 14.4.1 Types of economic valuation 61
5.14.4.2 Task 14.4.2: Determination of economic value of services generated from the available water. 62
5.14.4.3 Task 14.5 Internal review and reporting 63
5.15 Activity 15: Basic Human Needs Reserve 63
5.15.1 Task 15.1 Estimate population directly dependent on resource 64
5.15.2 Task 15.2 Scenarios of water use 64
5.15.3 Task 15.3 Mapping 64
5.15.4 Task 15.4 Internal review and reporting 64
5.16 Activity 16: Study Closure 64
5.16.1 Task 16.1: Prepare Reserve templates 64
5.16.2 Task 16.2: Prepare letter to the region 65
5.16.3 Task 16.2: Prepare Final Summary Report 65
5.16.4 Task 16.3: Prepare Project Audit and Closure Report 65
6 STUDY TEAM 66
6.1 Changes since proposal 66
6.2 Members of the study team 66
7 WORK PROGRAMME 68
7.1 Implementation programme 68
7.2 Sub-tasks on the critical path 72
7.2.1 TASKS ON THE CRITICAL PATH 72
8 DELIVERABLES AND LINEAR RESPONSIBILITIES 73
8.1 Milestone list 73
8.2 Linear responsibility and staffing 75
8.2.1 Overall project leadership 75
8.2.2 Activity leadership 75
8.2.3 Specialist activities 75
9 PROJECT BUDGET AND CASHFLOW 77
9.1 Professional fees estimate by task 77
9.2 Total estimated study budget 77
9.3 Equity Participation 78
9.4 Cashflow 80

10 PROJECT MANAGEMENT INFORMATION MANAGEMENT CONTROL SYSTEM 81

11 ASSUMPTIONS AND LIMITATIONS 82

11.1 Reserve team meetings 83

11.1.1 River – Intermediate Reserves 83
11.1.2 Pongola Floodplain 84
11.1.3 Estuary – Intermediate Reserves 84
11.1.4 Estuary – Rapid Reserves 84
11.1.5 Wetlands & Groundwater 84

12 REFERENCES 85

Appendix A. PROGRESS REPORT TEMPLATE 87

Appendix B. BUDGET TEMPLATES 88

Appendix C. GANTT CHART 89

LIST OF FIGURES

Figure 2-1 Map of WMA, with basin boundaries indicated 6
Figure 2-2 Protected Areas in Usutu to Mhlatuze WMA 10
Figure 4-1 DWA eight-step process to determine the Ecological Reserve (DWAF 1999) 18
Figure 4-2 Procedures for intermediate or comprehensive determination of the Reserve for estuaries. Former step numbers corresponding to the generic 8-step process are shown in parentheses. Source: Turpie et al. (2013) 21
Figure 4-3 Procedures for a rapid ecological Reserve determination for estuaries, in context of the broader RDM process (components not addressed as part of the ecological reserve determination process are indicated by hatched line boxes) (DWAF 2004) 22
Figure 5-1 Summary of the procedure of river node establishment 32
Figure 8-1 Linear responsibility organogram 76
Figure 9-1 Monthly cash flow projection 80
Figure 9-2 Cumulative cash flow projection 80

LIST OF TABLES

Table 3-1 Sites selected in the Mhlatuze River Catchment and neighbouring Mlalazi River catchment 12
Table 3-2 EWR sites as per Joint Maputo Basin Study 13
Table 3-3 Derived EWRs as per Joint Maputo Basin study 14
Table 4-1. Overview of water resources addressed in study 15
Table 4-2. Capacity Building Plan for DWA 23
Table 5-1. EWR sites selected for Intermediate level Reserve assessment 36
Table 5-2 The expected sorts of data, and frequency of collection 37
Table 5-4 Framework of the valuations 62
Table 5-5 Valuation for different types of services 63
Table 6-1 Members of the team and their positions on the team 66
Table 7-1 Project Workplan 68
Table 8-1 Milestone list 73
Table 9-1 Summary of professional fees and disbursements per task (excl VAT) 77
Table 9-2 Summary of the study budget 78
Table 9-3 Charge-out rates, Professional fees and Equity Participation 79

ABBREVIATIONS AND ACRONYMS

CRUZ	Coastal Research Unit Zululand
BHNR	Basic Human Needs Reserve
DWA	Department of Water Affairs
DRIFT	Downstream Response to Imposed Flow Transformations
DSS	Decision Support System
EC	Ecological category
EF	Environmental Flow
EI	Ecological Importance
ES	Ecological Sensitivity
ERQOs	Estuarine Resource Quality Objectives
EWR	Ecological Water Requirements
IFR	Instream Flow Requirement
IHI	Index of Habitat Integrity
MC	Management Category
PES	Present Ecological State
PMC	Project Management Committee
PSC	Project Steering Committee
PSP	Professional Service Provider
REC	Recommended Ecological category
RHAM	Rapid Habitat Assessment Method
RHP	River Health Programme
RQOs	Resource Quality Objectives
TPCs	Thresholds of Potential Concern
WRCS	Water Resource Classification System
WMA	Water Management Area

GLOSSARY OF TERMS

- ***Ecological Water Requirements*** (EWR) should be used instead of the term Instream Flow Requirements (IFR) for various reasons, including international acceptance of the former term.
- ***Ecological Categories.*** A distinction is made between Management Classes, which form part of the National Classification System, and Ecological Categories, which forms part of the preliminary Ecological Water Requirement assessment.
- The **Reserve**" means the quantity and quality of water required (a) to satisfy basic human needs by securing a basic water supply, as prescribed under the Water Services Act, 1997 (Act No. 108 of 1997), for people who are now or who will, in the reasonably near future, be (i): relying upon; (ii): taking water from; or (iii): being supplied from, the relevant water resource; and (b) to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource. The ***Reserve*** refers to the modified EWR where operational limitations and stakeholder consultation are taken into account, also include both ecological and Basic Human Needs (BHN) requirements.
- ***Preliminary Reserve*** refers to Reserve signed off by the Minister or her representative in the absence of the Classification Process having been undertaken in the basin.
- ***Ecological Water Requirement Scenarios*** (EWRS) replaces the term Reserve Scenarios. EWRS is the term to use at all stages through the preliminary ecological Reserve process until such time a decision has been made about the Reserve (at which time one of the EWRs including the requirements of the BHNR, will be selected as the Preliminary Reserve).
- ***Operational Scenarios*** refers to scenarios devised on the basis of issues other than ecological, i.e. availability of water, operational constraints in the system, other demands and proposed impacts.
- ***Recommended Ecological Category*** (REC) replaces former terms used, namely: Ecological Reserve Category (ERC), Desired Future State (DFS) and Ecological Management Class (EMC).

1 INTRODUCTION

1.1 Purpose and structure of the inception report

This inception report serves to record additions, variations or clarifications to the scope of work and the approach and methodology of the tasks and activities presented in the revised Technical and Financial Proposal on the "**Reserve Determination Studies in selected surface water, groundwater, estuaries and wetlands in the Usutu/Mhlatuze WMA**" submitted by Tlou Consulting (Pty) Ltd.

This inception report provides the updated approach and work plan to be used in the Reserve Determination studies of selected priority water resources in the Usutu/Mhlatuze WMA. Following on the meetings with the Department of Water Affairs (DWA) – Chief Directorate: Resource Directed Measures in May and October 2012 and August 2013, the scope of work as contained in the Terms of Reference was expanded to include all priority water resources in the WMA.

This report provides the following:

- A review of the scope of work designed to meet the client's expectations from the project and the deliverables to achieve the objectives of the assignment, including deviations and/or variations from the revised proposal, submitted in October 2012.
- An update of the approach and methodology for the Reserve determination studies in the Usutu/Mhlatuze WMA.
- The prioritisation and selection of water resources that will be sampled and assessed during this project.
- A reassessment of the human resources and required skills necessary to achieve the objectives of the assignment. Changes to the original project team and the reasons for the changes have been highlighted.
- A detailed work programme for water resources for which Reserve determinations must be undertaken, fieldwork, workshop sessions, integration and reporting.
- An assessment of the risks associated with changing the scope of work, and the mitigation measures required if the objectives of the assignment are to be met.
- A revised apportionment of costs between tasks and the projected cash flow.

This Inception Report is not a stand-alone document but should be read in conjunction with the following documents:

- Terms of Reference for the "WP 10544: Reserve determination studies for selected surface water, groundwater, estuaries and wetlands in the Usutu/Mhlatuze WMA".
- Tlou Consulting (Pty) Ltd – Volume I: Revised Technical Proposal, October 2012.
- Tlou Consulting (Pty) Ltd – Volume II: Revised Financial Proposal, October 2012.

1.2 Background

The Chief Directorate: Resource Directed Measures issued an open tender invitation for the "Appointment of a Professional Service Provider to undertake Reserve Determinations for selected Surface water, Groundwater, Estuaries and Wetlands in the Usutu to Mhlatuze Basins". The focus on this area was a result of the high conservation status and importance of various water resources in the basin and the significant development pressures in the area, which are likely to impact on the availability of water. Reserve determinations are required to assist the DWA in making informed decisions regarding the protection of water resources and provide information required for the assessment of water use licence applications. Further to this the preliminary high confidence Reserves provide an opportunity to evaluate various scenarios related to future development, current impacts and protection measures with the associate risk to the water resources. The selected basins listed in the invitation were Mfolozi, and the St Lucia to Kosi Bay systems.

Tlou Consulting submitted a tender in response to the invitation and in February 2012, was notified that they were being considered for the appointment. An inception meeting between Tlou Consulting and DWA was held on the 4th May 2012, at which DWA indicated that the whole Water Management Area was to be addressed and not just the areas highlighted in brackets on the tender. Subsequently the Client sought legal opinion on this matter and on the 3rd October 2012, requested that Tlou Consulting revise their proposal to address all priority systems in the Usutu to Mhlatuze WMA at their originally quoted budget.

On 17th October 2012, Tlou Consulting submitted a revised tender that provided for Reserve determinations, at various levels of detail, for all priority water resources in the Usutu/Mhlatuze WMA. On 19th November 2012, DWA informed Tlou Consulting that the revised scope of work had been accepted and indicated that work could proceed on the project.

1.3 Study Objectives

The objectives of the study are to:

- determine the Ecological Reserve (DWAF 1998), at various levels of detail, for the Nyoni, Matigulu, Mlalazi, Mhlatuze, Mfolozi, Nyalazi, Hluhluwe, Mzinene, Mkuze, Assegaai and Pongola Rivers;
- determine the Ecological Reserve, at an Intermediate level for the Pongola floodplain;
- determine the Ecological Reserve, at an Intermediate level for the St Lucia/Mfolozi, Estuary System;
- determine the Ecological Reserve, at a Intermediate level for the Mlalazi Estuary;
- determine the Ecological Reserve, at a Rapid level for the Amatikulu Estuary;
- determine the Ecological Reserve, at an Intermediate level for Lake Sibaya;

- determine the Ecological Reserve, at a Rapid level for Kozi Lake and Estuary;
- classify the causal links between water supply and condition of key wetlands
- incorporate existing EWR assessments on the Mhlatuze (river and estuary) and Nhlabane (lake and estuary) into study outputs;
- determine the groundwater contribution to the Ecological Reserve, with particular reference to the wetlands;
- determine the Basic Human Needs Reserve for the Usutu/Mhlatuze WMA;
- outline the socio-economic water use in the Usutu/Mhlatuze WMA;
- build the capacity of team members, DWA Officials and stakeholders with respect to EWR determinations and the ecological Reserve.

At the meeting of the 5th November 2013, the Client requested that the proposed Intermediate level Ecological Reserve determination for the **Mlalazi Estuary be conducted at a rapid level**, as the development pressures and water stresses are similar to that experienced on the Amatikulu system. The scope of work for this system has been accordingly adjusted in this report.

2 OVERVIEW OF THE USUTU/MHLATUZE WMA

The Usutu/Mhlatuze WMA is situated in the northern portion of KwaZulu-Natal Province. The WMA borders Swaziland and Mozambique, with the Usutu and Pongola Rivers shared with these countries. The WMA is bordered by the Indian Ocean in the east and the Drakensberg range in the north west. It comprises a number of surface-water basins: Matikulu, Mhlatuze, Mfolozi, Mkuze, Pongola, Upper Usutu and Lake Sibaya and Kosi basin (see **Figure 2-1**).

2.1 Drainage

2.1.1 Mhlatuze Basin (W10)

The Mhlatuze Drainage Area includes all the W10 quaternary catchments but can be considered as two distinct regions.

The catchments W11A, B and C and W13A and B make up two small to medium sized coastal catchments, namely the Matikulu (489km^2) and Mlalazi (954km^2) respectively. Economic activity related to water resources in these areas consists mainly of afforestation and some irrigation (DWA, 2004). Other than a few large farm dams, there are no major water-resource developments or water quality problems in these basins, the further development of which is limited by the lack of storage. There are a few significant towns in these areas, notably Mtunzini, which harnesses local resources for its water supply, and the larger town of Eshowe, which imports water from the Goedetrouw dam on the neighbouring Mhlathuze River. (DWA, 2002).

The Mhlathuze catchment itself (W12A to J), stands in stark contrast to the W11 and W13 catchments by being arguably the most developed catchment in the Usutu-Mhlathuze WMA.

The Mhlatuze Catchment (4210 km^2) is the economic hub of the Usutu/Mhlatuze WMA and, as such, the water abstractions in this basin are substantial. The basin contains a large number of industries and the world's largest coal export terminal, as well as large areas of afforestation, dryland sugarcane farming and irrigated agriculture (DWA, 2004).

There are also a number of natural lakes in the Mhlathuze catchment, which contribute considerably to the yield of the system. Current estimates put the combined yields of the lakes at about 54 million m^3/annum (DWAF, 2001).
The Goedertrouw Dam (Built in 1981 with a capacity of 304 Mm^3) is situated in the upper reaches of the Mhlatuze catchment. It was built to meet the expanding industrial and mining requirements of the Richards Bay area, but provision was also made for large- scale irrigation. In 1996, the Middledrift emergency scheme was implemented to transfer water from the Thukela River into Goedertrouw Dam, with transfer taking place when the water

level in the dam is below 90%, although this level is frequently reviewed. In addition, water is abstracted from the lower Mfolozi and pumped into the Mhlatuze catchment for use in their coastal mining operations (DWA, 2002).

Richards Bay and Empangeni are the main towns in the basin, and obtain their water from Lakes Nsezi and Mzingazi and the Goedertrouw Dam. Lake Nhlabane is used to supply industry north of Richards Bay.

In response to the development pressure in this basin, the DWA has initiated a Reconciliation Study of the Richards Bay area, to determine whether the water demands in the area can be met from the available sources.

Despite the development in the basin, water quality is generally good, mainly because urban and industrial effluent is discharged to the sea (ISP 2004).

2.1.2 Mfolozi Basin (W2)

The Mfolozi River consist of two main tributaries, the Black and White Mfolozi, both of which rise on the eastern escarpment of the Drakensberg Mountain range and flow eastward across the Zululand coastal plain before discharging into the Indian Ocean.

The Mfolozi catchment (10 007km^2) consists mostly of tribal land, with the main activity being cattle farming. There is a limited amount of afforestation in the catchment. This is situated in the upper reaches of the catchment near Vryheid, in the vicinity of Nongoma and near the coast. Dryland sugarcane is also grown in the coastal area where the rainfall is high (DWA, 2004). The Mfolozi Game Reserve lies in the central part of the catchment.

Significant towns in the catchment are Vryheid, Ulundi, Babanango, Nongoma and Mtubatuba.

The water resources of the Mfolozi catchment are mostly undeveloped. The most significant development is the Klipfontein Dam (with a capacity of 19 Mm^3), which is situated in the upper reaches of the White Mfolozi River.

In general the rivers are in good condition in their upper reaches and poor condition in their lower reaches, and the reconnection of the Mfolozi /Msunduzi River floodplain link (the floodplain was drained for sugar cane plantation) to the St Lucia ecosystem has been identified as a critical intervention to protect the World Heritage National Park.

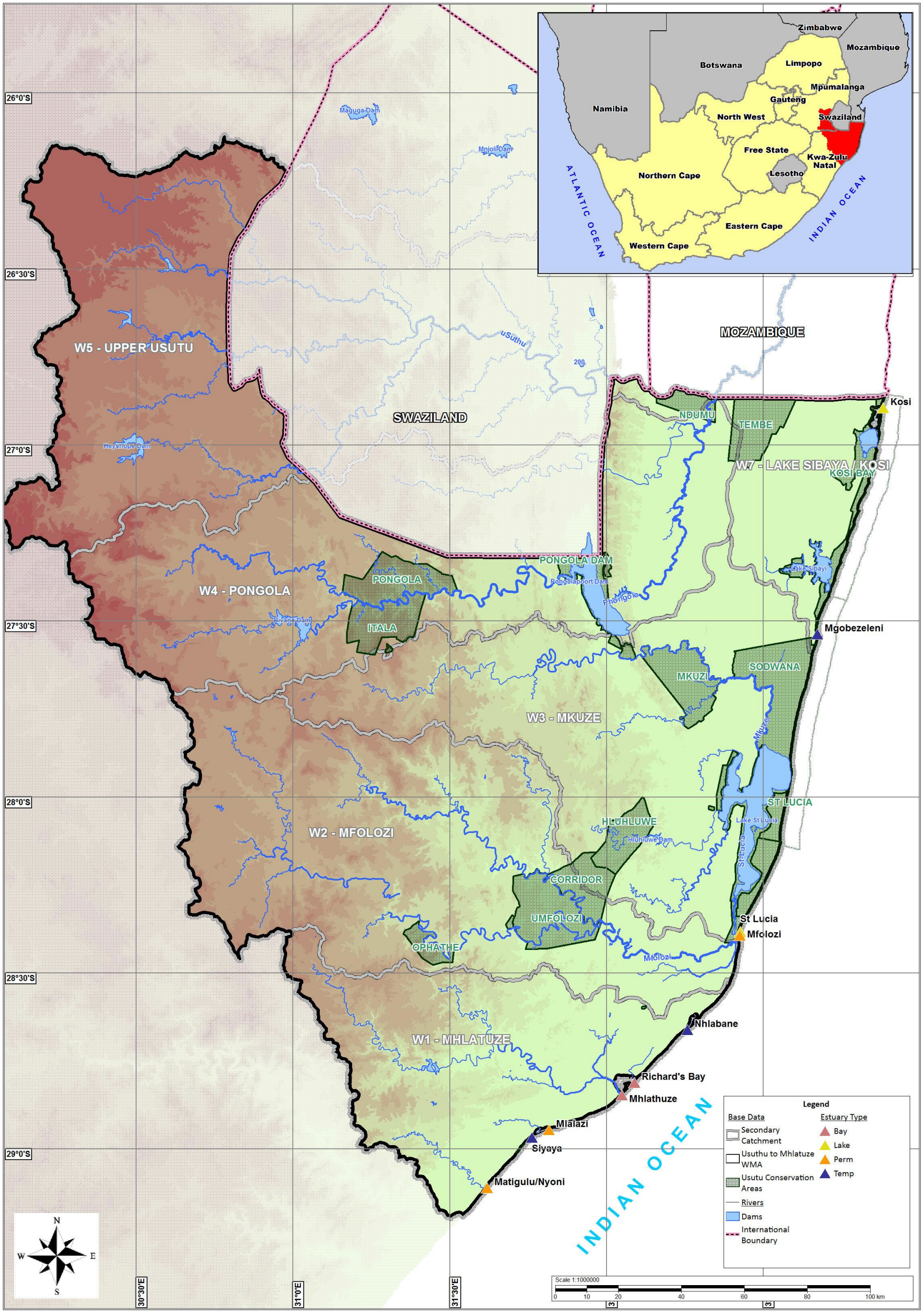

Figure 2-1 Map of WMA, with basin boundaries indicated

2.1.3 Mkuze Basin (W3)

The Mkuze Basin comprises the drainage areas of both the Mkuze (W31) and Hluhluwe (W32) rivers, feeding into Lake St Lucia, a World heritage Site. The land area of this catchment is 9 545 km^2 (DWA, 2004). The catchment is characterised by large-scale irrigation and afforestation, with significant domestic, mostly rural, requirements. The only large dam in the basin is Hluhluwe Dam (built in the 1960 with a capacity of 60 Mm^3), the yield of which is fully utilised. Hluhluwe Dam does not make any releases for the environment. The Senekal Trust pipeline, which transfers c. 32.6 million m^3/annum from Pongolapoort Dam in the Pongola Basin (W4), discharges into the middle reaches of the Mkuze River for urban, industrial and irrigation purposes.

Significant towns in the area are Hluhluwe, St Lucia and Mkuze.

Water quality in the Mkuze River is poor due to coal mining activities and irrigation return flows. The water quality of the Hluhluwe catchment (W32) is generally good, however sedimentation rates in the Mkuze/Hluhluwe system are naturally high but increased by people and grazing.

The coastal aquifer is vulnerable to contamination due to its high permeability.

2.1.4 Pongola Basin (W4)

The Pongola Basin (11 712 km^2) is characterised by large areas of afforestation and planned mining activities in the upper reaches, irrigated agriculture in the middle reaches. The lower reaches, which are mainly floodplain, are largely undeveloped with some irrigation taking place with water supplied from the Dam.

There are two major dams in the basin. The Pongolapoort Dam (built in the 1960s with a capacity of 2 445 Mm^3) situated in the middle reaches of the Pongola River is one of the largest in South Africa. The allocations from the dam have not been finalised as there are uncertainties relating to the social and ecological requirements of the floodplains downstream of the dam and requirements in Mozambique. The Bivane Dam (built in the 1999 with a capacity of 113 Mm^3) is situated on the Bivane River upstream of the Pongolapoort Dam, and was constructed to improve the levels of assurance to existing irrigators (DWA, 2004).

The towns of Jozini, Pongola and Paulpietersburg are located in this basin, supplied from the run-of-river abstraction and the Bivane Dam, through the Impala WUA canals.

The water quality of the Pongola catchment is naturally good, however the areas upstream of the Pongolapoort Dam are significantly affected through saline and nutrient enriched return flows from large irrigation areas. The quality of groundwater from the Makhathini Flats

(floodplain below the Pongalapoort Dam) is poor (the Flats are an old sea bed and thus the water is saline) (DWA, 2004).

Large volumes of water are released from Pongolapoort Dam for the maintenance of the Makhathini floodplains. These releases currently utilise nearly half the yield available from the Pongolapoort Dam. The environmental and social requirements of this system will need to be investigated in order to optimise the releases to sustain the floodplain.

Water is also released from the Pongolapoort Dam to meet Mozambique's requirements in terms of the IncoMaputo Water Use Agreement. This is normally achieved through the releases to maintain the floodplain (DWA, 2004).

2.1.5 Usutu Basin (W5)

The Usutu catchment (1 700km^2) is of strategic importance because water for the cooling of coal-fired power generation plants, situated in the Vaal and Olifants systems, is sourced from this catchment, with the Heyshope, Morgenstond, Westoe and Jericho dams providing the transferable yield for these power stations. These dams are all situated upstream of Swaziland and the catchment forms part of the Maputo River Basin which is an international river basin. This has a major influence on how the catchment is managed.

The largest water user in the Usutu catchment is the transfer of water out of the catchment to the Vaal system and to power stations in the Olifants WMA. Water for domestic purposes as well as for irrigation is abstracted from run-of-river flows or from small farm dams. These users are not supplied by the major dams in the catchment, which are only used for transferring water to the Upper Vaal and Olifants WMAs (DWA, 2004).

Due to very limited opportunities for building dams in Swaziland, they make almost exclusive use of run-of-river abstractions which are supplied at low assurance. The surplus that occurs downstream of the dams in the Usutu catchment is therefore not allocable at present.

The water quality in the upper Usutu catchment is excellent, which is why Eskom source their water for the cooling of coal-powered power stations from this catchment. However, there is a huge risk of coal mining activities polluting the resource.
The only current water quality problem that was identified in the Usutu catchment is due to industrial effluent from the tannery in Piet Retief. This has resulted in pollution of the Assegaai River. The effluent from the tannery is currently irrigated onto fields as a disposal measure but a longer-term solution must be found (DWA, 2004).

The towns of Piet Retief and Amsterdam are found in this catchment with several less formal settlements near the Swaziland border in the Eerstehoek region.

The Heyshope Dam (built in 1984 with a capacity of 453 Mm^3) on the Assegaai River, a tributary to the Usutu River, transfers water to the Upper Vaal under the Usutu-Vaal River

Government Water Scheme, where it contributes to the yield of the Grootdraai Dam. Eskom has an allocation from the Grootdraai Dam to meet the cooling requirements of its power stations in the upper Vaal catchment. Jericho Dam (built in 1996 with a capacity of 60 Mm3) on the Mpama River, a tributary to Usutu River, was commissioned in 1996 and provides water for irrigation as well as being part of the multi-dam system that transfers water to the Vaal River system. According to the DWA (2004), the proposed strategy for the basin is not to make any changes to the existing operating rules until a comprehensive Reserve assessment is conducted in close consultation with Eskom. Implementation of the Reserve should be done as part of an integrated operating rule for the whole Maputo Basin, which should be forthcoming out of the Maputo Basin Study. The implications of this on the Vaal system will also have to be taken into account and mitigating strategies formulated.

2.1.6 Lake Sibaya and Kosi Basin (W70A)

The surface water resources of Lake Sibaya catchment (77km^2) are limited but there is huge groundwater potential. The only significant water users in the catchment are rural water use (domestic and stock watering) from groundwater supplies and afforestation. There is abstraction from Lake Sibaya for domestic use, however this is negligible in comparison with the inflow into the Lake.

The area is ecologically sensitive and the exploitation of the groundwater would require careful consideration. There is no immediate or anticipated future pressure to develop the water resources of this catchment, with the possible exception of forestry. Of importance in this catchment is the groundwater Reserve, that is, how much water can be safely abstracted from groundwater without reducing the health of the ecology to below an acceptable limit.

There are no known water quality problems in the Lake Sibaya catchment, but the coastal aquifer which underlies much of this catchment is very susceptible to contamination.

Mbazwane and Mseleni obtain domestic water supply from Lake Sibaya.

The Kosi system is incorporated into the Isimangaliso Wetland Park. The system is composed of four interconnected, roughly circular lakes (Makhawulani, Mpungwini, Nhlange and aManzimnyama), a broad channel leading to an estuary and three extensive areas of swamp. The lakes are separated from the ocean by a strip of forested sand dunes, 600-2000m in width.

The Kosi drainage area comprises approximately 500km^2. However, due to the high infiltration rate of water on the sandy coastal plain over which such rivers move, it is believed that only 5% of the total annual precipitation is borne by rivers/streams in the Kosi area. The most sensitive area is apparently Lake Nhlange, which can be isolated with the slightest change in drainage pattern. There is a fairly strong seasonal inflow of fresh water into the head of the estuary.

There are two main rivers that flow into the system, namely the Sihadhla River (approx 30km), which rises in the Mtombeni pans and enters the Kosi system at Lake Amanzimnyama. The other is the Nswamanzi River (approx. 15km), which enters Lake Nhlange on its western shore.

The nearest towns to the Kosi system is the rural area of KwaNgwanase on the northeastern shores of Lake Nhlange and Ingwavuma (105km away).

2.2 Protected areas and natural heritage sites

The Usutu to Mhlatuze WMA is important for conservation and contains a number of protected areas, natural heritage sites, including a number of cultural and historical sites, and other conservation areas (Figure 2-2). St. Lucia Lake is a World Heritage Site, while there are six RAMSAR sites within the WMA.

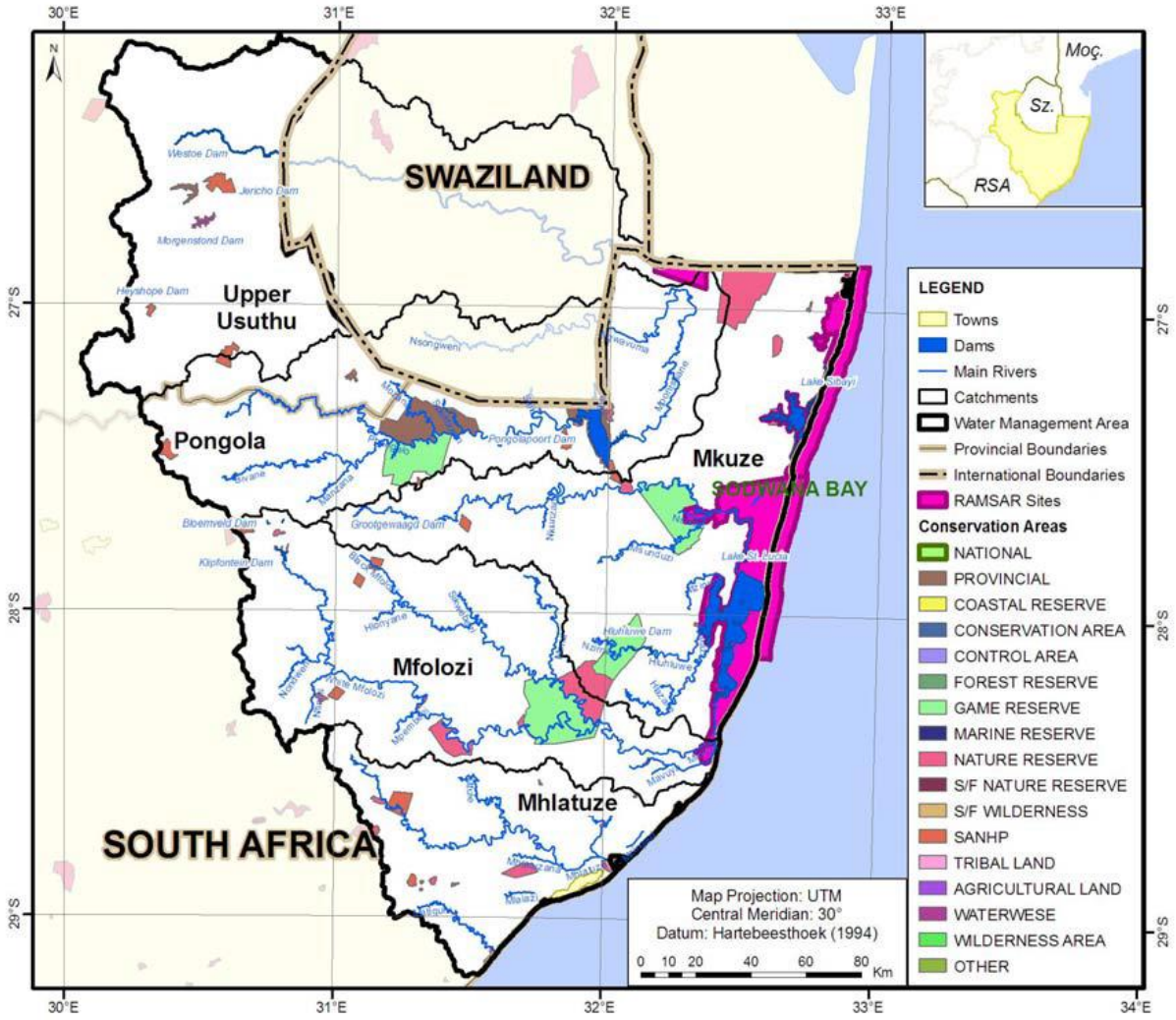

Figure 2-2 Protected Areas in Usutu to Mhlatuze WMA

The main areas associated with the aquatic systems in the WMA are briefly summarised below (DWAF 2003c). The Pongola River flows through Ithala Game Reserve upstream of the Pongolopoort Dam while the Pongola Nature Reserve is located on the shores of the dam. Downstream of the dam lies a unique flood plain, which contains many notable wetlands, including Ndumo Game Reserve, a RAMSAR site. The pans of this flood plain depend on the Pongola River. The north-eastern part of the WMA comprises the Makhatini Flats, bounded by the Pongola River and the Lebombo mountains to the west and the coast. The area is endoreic, in part draining into Lake Sibaya and the Kosi Estuary and Lake System. There are large swamps where the Mkuze River enters Lake St. Lucia, which is a World Heritage Site. The eastern shores of Lake St. Lucia are a game reserve. Water from the Mkuze River is essential to maintain the salinity levels in Lake St. Lucia. The Mkuze Game Reserve lies upstream with the Mkuze River forming the western border of the reserve. Both the Black and White Mfolozi Rivers flow through the Hluhluwe and Imfolozi Game Reserves, with their confluence within the reserve complex. The Opathe Game Reserve is situated on the southern banks of the White Mfolozi River –this reserve is part of the Emakhosini Opathe Heritage Park near Ulundi.

3 OVERVIEW OF THE RESERVE STUDIES CONDUCTED IN THE WMA

There have been a number of Reserve studies conducted on the water resources of the Usutu to Mhlatuze WMA. These include the very first studies on Reserve determinations conducted in 1998 on the Mhlatuze River and lakes in the Mhlatuze catchment.

3.1 Mhlatuze River catchment

- In 1998, the IFR was considered as part of the Mhlatuze Operating Rules and Future Phasing study. Four sites were selected downstream of the Goedertrouw Dam on the Mhlatuze River;
- In 2002 a Rapid level III Reserve determination was undertaken at IFR 5 in the Mhlatuze River.
- In 2003, the Rapid Level III Ecological Reserve Methodology was applied at IFR 6 and 7 in the Nseleni River and at IFR 8 and 9 in the Mfule River.
- In 2004-2005 an aerial assessment, site clarification, hydraulic and fish survey was conducted of the Mhlatuze, Nseleni, Mfuli and Mlalazi Rivers. During this field visit 2 additional sites were selected on the Mlalazi River - Site 10 on the upper Mlalazi and Site 11 on the lower Mlalazi River.
- A monitoring programme was designed, but unfortunately not implemented.

Table 3-1 provides a summary of the Reserves that have been conducted on this system. Unfortunately, the Reserve for this system has not been implemented and the system is experiencing high flows due to transfer of water to downstream users. A review of the previous studies, augmentation with additional data to ensure the data is compatible with the results of this study will take place. The existing data will be reformatted as necessary and if necessary adjusted for updated hydrology.

Table 3-1 Sites selected in the Mhlatuze River Catchment and neighbouring Mlalazi River catchment

Site	River	Longitude	Latitude	Usefulness of site
EWR 1	Mhlathuze River	S 28°44.583	E 31°36.347	Operated at high flow. Usable
EWR 2	Mhlathuze River	S 28°44.817	E 31°44.847	Usable
EWR 3	Mhlathuze River	S 28°50.741	E 31°52.083	Poor condition due to extensive sand mining. Use EWR 2 instead as within same resource unit.
EWR 4	Mhlathuze River	S 28°48.512	E 31°57.360	Not usable as it is within the estuarine zone
EWR 5	Mhlathuze River	S 28°5.01	E 31°15.046	Usable although change in profile due to recent floods
EWR 6	Lower Nseleni River	S 28°38.089	E 31°55.86	Usable
EWR 7	Upper Nseleni River	S 28°34.82	E 31°45.804	Usable

Site	River	Longitude	Latitude	Usefulness of site
EWR 8	Mfule River	S 28°39.98	E 31°37.082	Usable
EWR 9	Mfule River	S 28°36.567	E 31°31.870	Usable
EWR 10	Upper Mlalazi			Usable
EWR 11	Lower Mlalazi			Usable

3.2 Usutu River catchment

The Joint Maputo River Basin Reserve Study was completed recently. Four sites were selected in the Usutu River catchment (see Table 3-2) and EWR requirements set. The results at these sites are at a comprehensive level of assessment.

Table 3-2 EWR sites as per Joint Maputo Basin Study

EFR site no	Site name	South	East	Quat[1]	EcoRegion II	Geomorphic zone	Altitude (m)
EFR JMB1	Lower Ngwempisi	26°41.832	31°22.26	W53G	4.06	Lower Foothills	361
EFR JMB2	Assegaai	27°03.737	30°59.323	W51D	4.06	Lower Foothills	1012
EFR JMB3	Lower Mkondvo	26°42.438	31°24.833	W51H	4.06	Lower Foothills	327
EFR JMB4	Maputo	26°48.0	32°26.797	W70CX	Not available	Lowland River	19

1 Quaternary catchment

During the study, Ecological Flow Requirements were set at all outlets to water management sub-catchments. See Table 3-3.

3.3 Mfolozi River catchment

A rapid Reserve study was undertaken on the Mofolozi River at site **S 28°22.183' & E 32°00.739** in quaternary catchment W23A. Field verification has shown that this site is no longer accessible due to mining activities in the area.

Table 3-3 Derived EWRs as per Joint Maputo Basin study

Water Management Sub-Catchment	PES to be Maintained	EFR Derived in this Study		IIMA ** Mean Flows Mm^3/a At Key Points in WMSC
		Average Flow (Mm3/a)	% Natural MAR (Mm^3/a)	
Mpuluzi	B	73	28	65 (Dumbarton) excluding the Mtula
Upper Usuthu	B	24	27	20 (GS 23)
Middle Usuthu	C/D	122	25	
Lusushwana	D	87	21	35 (GS 33) V. high in WM SC
Upper Ngwempisi	B	70	26	30 (GS 21) 35 Hlelo (GS 22)
Lower Ngwempisi	C	116	26	
Upper Mkhondvo	C	72	22	35 (GS 25) at outlet
Lower Mkhondvo	D	90	16	
Lower Usuthu	B	713	29	520 (GS 16) close to outlet
Ngwavuma	D*	29	20	50 (at Border) within WMSC
Upper Pongola	B	261	25	
Middle Pongola	C	298	24	
Lower Pongola	C	272	21	300 (Nduma)
Maputo	C	801	21	
Maputo	B	1167	31	840 (E4) near estuary

* PES is E which is not sustainable.

** IIMA key points are not exactly the same as the outlets to the WMSCs and may not include all tributaries in the WMSC.

4 SCOPE OF WORK

4.1 Overview

The original scope of work was reviewed based on discussions with the Client in October 2012 and again in August 2013. The revised scope of work is structured to reflect the approach and methodology required for each task, while capturing the generic processes to be followed for the Reserve determination studies in the WMA. Table 4-1 provides an overview of the water resources in the WMA and the approach taken to address them during this study.

Table 4-1. Overview of water resources addressed in study

Resource Type	WA	Name of water resource	Reserve determination to be done in this study. Yes or no	If no, why not?	If yes, describe approach
Rivers	W1	Matigulu	Yes		Intermediate
	W1	Nyoni	Yes		Extrapolation using DRIFT DSS
	W1	Mlalazi	Yes		Extrapolation using DRIFT DSS
	W1	Mhlatuze	Yes		Extrapolation using DRIFT DSS
	W1	Nseleni	Yes		Intermediate
	W2	White Mfolozi	Yes		Intermediate
	W2	Black Mfolozi	Yes		Intermediate
	W2	Mfolozi	Yes		Extrapolation using DRIFT DSS
	W2	Msunduzi	Yes		Extrapolation using DRIFT DSS
	W3	Nyalazi	Yes		Extrapolation using DRIFT DSS
	W3	Hluhluwe	Yes		Extrapolation using DRIFT DSS
	W3	Mzinene	Yes		Extrapolation using DRIFT DSS
	W3	Mkuze	Yes		Intermediate
	W4	Pongola	Yes		Intermediate
	W5	Assegaai	Yes		Intermediate
	W5	Ngwempisi	Yes		Extrapolation using DRIFT DSS
	W5	uSutu	Yes		Extrapolation using DRIFT DSS
Lakes/Estuary	W7	Kosi (Kosimeer (KuHlange)	Yes		Rapid
	W7	Lake Sibayi (Lake Sibayi)	Yes		Intermediate
	W1	Nhlabane, Mhlatuze, Cubhu, Nsezi, Mzingazi			Desktop review and update
Estuaries	W3	St Lucia/Mfolozi estuary	Yes		Intermediate
	W1	Mlalazi	Yes		Rapid
	W1	Amatikulu	Yes		Rapid
	W7	Mgobezeleni	No	despite its uniqueness as an Estuarine Coastal Lake System, it is a very small system whose small catchment would not really be able to provide much potable water	
Wetlands			Yes		Desktop with ground truthing. Integrated groundwater-wetland study to address changes/pressures and impacts that can be allowed
Groundwater			Yes		

4.2 Methodology

4.2.1 Hydrology

The hydrology require for the EWR studies includes from daily and monthly records of naturalised, present day and scenario-induced flow regimes for all of the locations for which EWRs are to be determined. These will be compiled using a combination of gauging weirs in the WMA. Where there are no measured flows available, such as the Amatikulu River, WR2005 data will be used.

4.2.1.1 Mfolozi hydrology

The hydrological simulations for the St Lucia GEF study (see Section 4.2.5.1) included all the influent catchments for the St Lucia estuarine system and were prepared using the ACRU model (Smithers and Schulze 2004). It is assumed that simulation for any future water resources development scenarios to be evaluated as part of this project will be generated by the client. These scenarios will need to be generated using the ACRU model configured for the GEF study, otherwise they not be comparable with the calibrated response curves in the GEF DRIFT DSS.

4.2.2 The DRIFT DSS

The Downstream Response to Imposed Flow Transformations (DRIFT; Brown et al. 2013) DSS will be used for at least four of the intermediate assessments in this study (rivers, the St Lucia/Mfolozi Estuarine System, Lake Sibaya and the Pongola Floodplain) and may be used for the wetlands.

The process will be used in the Intermediate determinations. DRIFT is one of the methods recognised by the DWA as suitable for river Reserve determinations, and has recently been used to evaluate resource change associated with freshwater inflows to the St Lucia/Mfolozi Estuary System (Anchor in prep).

DRIFT is a process that was developed in South Africa to aid management and future planning of water-resource developments, rehabilitation of rivers or any other management activity that could affect the flow or inundation patterns of an inland water ecosystem. Development has taken place through extensive application of the process within South Africa, in southern and eastern Africa, and in other continents - mostly Asia and South America. The DRIFT Decision Support System (DSS) has recently been updated and upgraded as part of a Water Research Commission project (Brown et al 2013).

DRIFT is adaptable and suited to the task at hand:

- Its custom-designed DSS, once populated with the results of the data-collection phase, allows investigation of any number of scenarios of interest to managers and decision makers, without reconvening specialist workshops.
- It is a time-series based approach that is equally applicable to daily or hourly fluctuations in flow.
- It addresses both low flow and flood flow aspects of the flow regime in a structured single approach.
- It is adaptable and so in a project it is adapted to suit the river under investigation rather than the river having to 'fit' the method
- It has been the focus of 18 years of applied development, and is published in international scientific journals (e.g., King *et al*. 2004; Brown and Joubert 2004).
- It is compatible with the requirements of the approach used for determining the Reserve, and has been used in numerous Reserve assessments in South Africa (e.g., Olifants-Doring, Breede, Berg, Groot Brak, Sandveld, Kaaimans, Gwaing, Maalgate Basins).
- It has been widely applied internationally (e.g., Cunene River, Angola and Namibia; Huaura River, Peru; Mekong River, Thailand, Lao PDR, Cambodia and Viet Nam; Nile River, Sudan; Neelum River, Kashmir/Pakistan, Odzi and Pungwe Rivers, Zimbabwe; Okavango River, Angola, Namibia and Botswana; Pangani River, Tanzania; Zambezi River, Mozambique).
- It produces easily understood predictions that detail how the river could change, and how this could impact people, in way that stakeholders can relate to.

The overall process contains three main steps:

1. Set up
2. Knowledge capture, comprising:
    a. hydrological modelling of present day, naturalised and possible future daily flow regimes (scenarios);
    b. predictions of the response of relevant physical, chemical, biological and socio-economic variables to described changes in the future scenario flow regimes;
3. Analysis.

The DRIFT DSS holds the input data for Steps 1 and 2b, and receives data from outside on Step 2a (the hydrological modelling). It then brings all the information together for the summary reports (Step 3).

4.2.3 Rivers

The process for the determination of the Ecological Water Requirements for rivers is based on the DWA eight-step process (DWAF 1999; Figure 4-1), with cognisance of subsequent

refinements; e.g., ecoclassification (DWAF 2008) and the Water Resource Classification System (WRCS) (DWA, 2007).

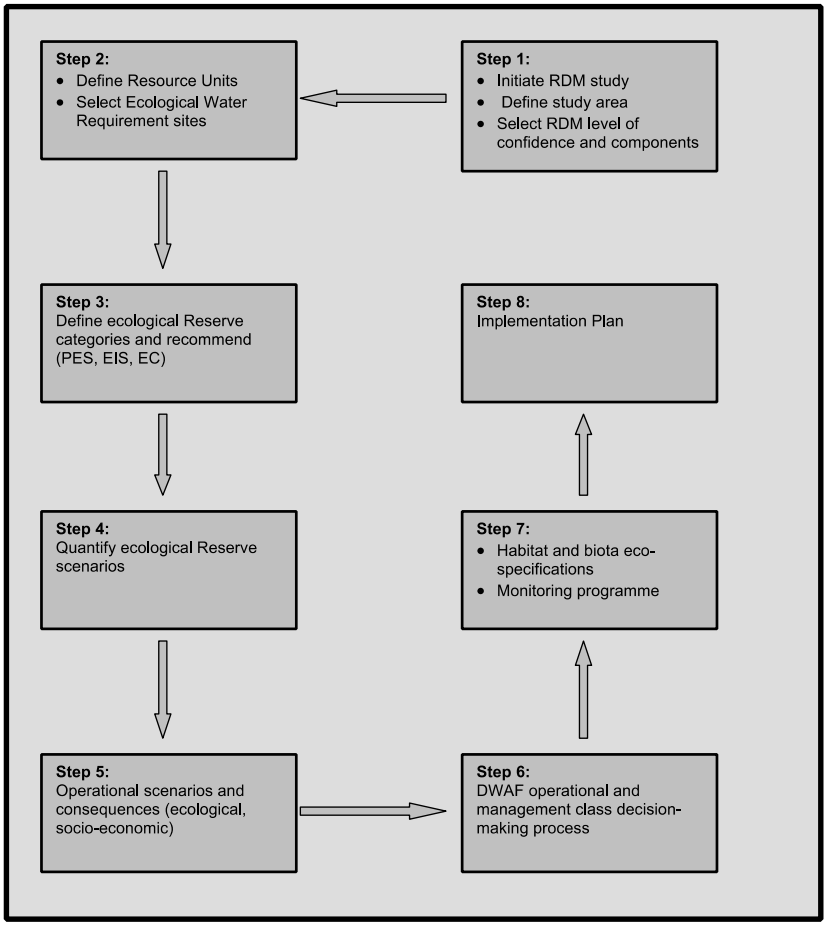

Figure 4-1 DWA eight-step process to determine the Ecological Reserve (DWAF 1999)

4.2.3.1 Determination levels and sites

The revised scope of work made provision for five new Intermediate EWR sites in the Water Management Area. Preliminary delineation, however, suggests that, if use is made of the existing Mhlatuze and Usuthu EWR sites and data and maximum value is taken from those basins with good hydrological data, it will be possible to do Intermediate EWR determinations for seven sites, thereby ensuring that there are updated and compatible data for more sites for use in informing the rapid determinations and/or extrapolations to other parts of the basin. Thus, this Inception Report makes provision for seven EWR sites, located as follows:

- one in the Mhlatuze Basin;
- two in the Mfolozi Basin;
- one in the Matigulu Basin

- one in the Mkuze Basin;
- one in the Pongola Basin, and;
- one in the Usuthu Basin.

The exact location of these sites are provided in Table 5-1. Once the Intermediate EWR determinations have been completed, the intention is undertake rapid determinations for an additional 20-30 locations to be determined using the procedures outlined in the WRCS (DWA 2008) and summarised in Section 4.2.3.3.

4.2.3.2 EF Methodology - Intermediate determinations

DRIFT will be used for the Intermediate determinations. The multidisciplinary team appointed to populate the DRIFT DSS includes (see Section 6.2):

- DRIFT process management team
- Basin hydrologist
- Hydraulic modeller
- Fluvial geomorphologist
- Aquatic chemist
- Botanist(s) (riparian, marginal and aquatic)
- Macroinvertebrate specialist
- Fish specialist
- GIS specialist.

4.2.3.3 EF Methodology - Rapid determinations

For nodes that are suitable for extrapolation of data from sites with intermediate-confidence Reserve data, the EWR quantifications will be done:

- using DRIFT if and where there are reliable daily hydrological data available;
- using the IFR Edit feature of the Desktop Model where there are only monthly hydrological data available.

For nodes that are not suitable for extrapolation (i.e. low EISC and low calibration confidence) of data from sites with intermediate-confidence Reserve data, the EWR quantifications will be done using the standard Desktop Model, i.e., without any adjustment or IFR Edit input. It is important to note that in some cases the Desktop Model provides markedly different estimates of the Reserve requirements from determinations done using more comprehensive methods. One reason for this is that the Desktop Model is based on the results of past Reserve studies, and may not include any studies from a particular WMA.

4.2.3.4 EF Methodology – Pongola Floodplain

The DRIFT DSS will be used for the assessment of flood releases on the Pongola Floodplain. DRIFT has been used in a similar setting before, when it was used to facilitate

an analysis of the implications of different releases from Cahorra Bassa on the Zambezi Delta (Beilfuss and Brown 2010).

4.2.4 Wetlands and groundwater

Considering the large number of wetlands in the WMA, it is not practical to undertake Reserve determinations for each system. Also considering the type of wetlands in the area, there are no Reserve methods developed for many of the systems.
The approach will be to undertake a delineation of the wetlands in the area and a wetland typing exercise. The focus will be on understanding the relation between the wetlands and the surface and groundwater resources in the area, with the aim of providing the DWA with guidelines on managing the wetlands from an abstraction/consumptive water use perspective.

4.2.5 Estuaries

The procedures for determination of the Reserve for estuaries are provided in Figure 4-2, with step numbers corresponding to the generic 8-step process (Figure 4-1) are shown in parentheses.

4.2.5.1 St Lucia/Mfolozi Estuarine System - Intermediate determination

Pending agreement of the iSimangaliso Wetland Park Authority (iSimangaliso WPA), the results of their GEF-funded project to investigate a range of options for improving the ecological functioning of the St Lucia/ Mfolozi Estuary System will be extended to provide a Reserve determination for the system.

DWA has agreed to seek permission for this on behalf of the study.

If permission is not obtained, the St Lucia/Mfolozi Estuarine System cannot be undertaken within the budget of this project.

If permission is obtained it is expected that the resultant Reserve assessment will be at an Intermediate level.

The Isimangaliso study used the DRIFT DSS (Section 4.2.3.2) for the assessment of flow scenarios for the St Lucia/Mfolozi Estuarine System (Anchor 2013).

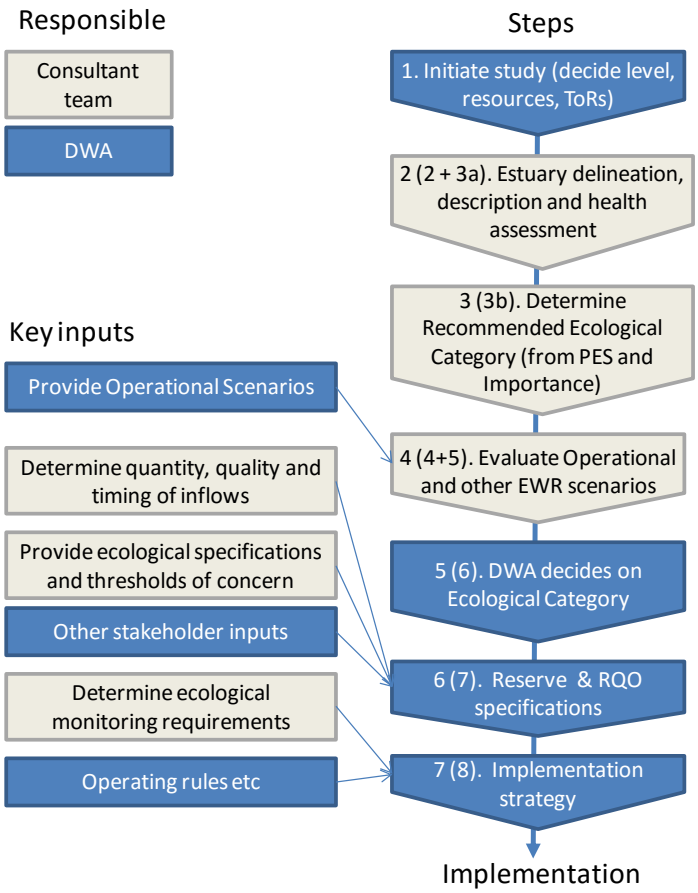

Figure 4-2 Procedures for intermediate or comprehensive determination of the Reserve for estuaries. Former step numbers corresponding to the generic 8-step process are shown in parentheses. Source: Turpie et al. (2013)

4.2.5.2 Mlalazi Estuary - Rapid determination

The process for the Rapid Reserve determination for estuaries is based on that prescribed by DWA (DWAF 2004, Figure 4-3).

4.2.5.3 Amatikulu and Kosi Estuary - Rapid determination

The process for the rapid Reserve determination for estuaries is based on that prescribed by DWA (DWAF 2004; Figure 4-3).

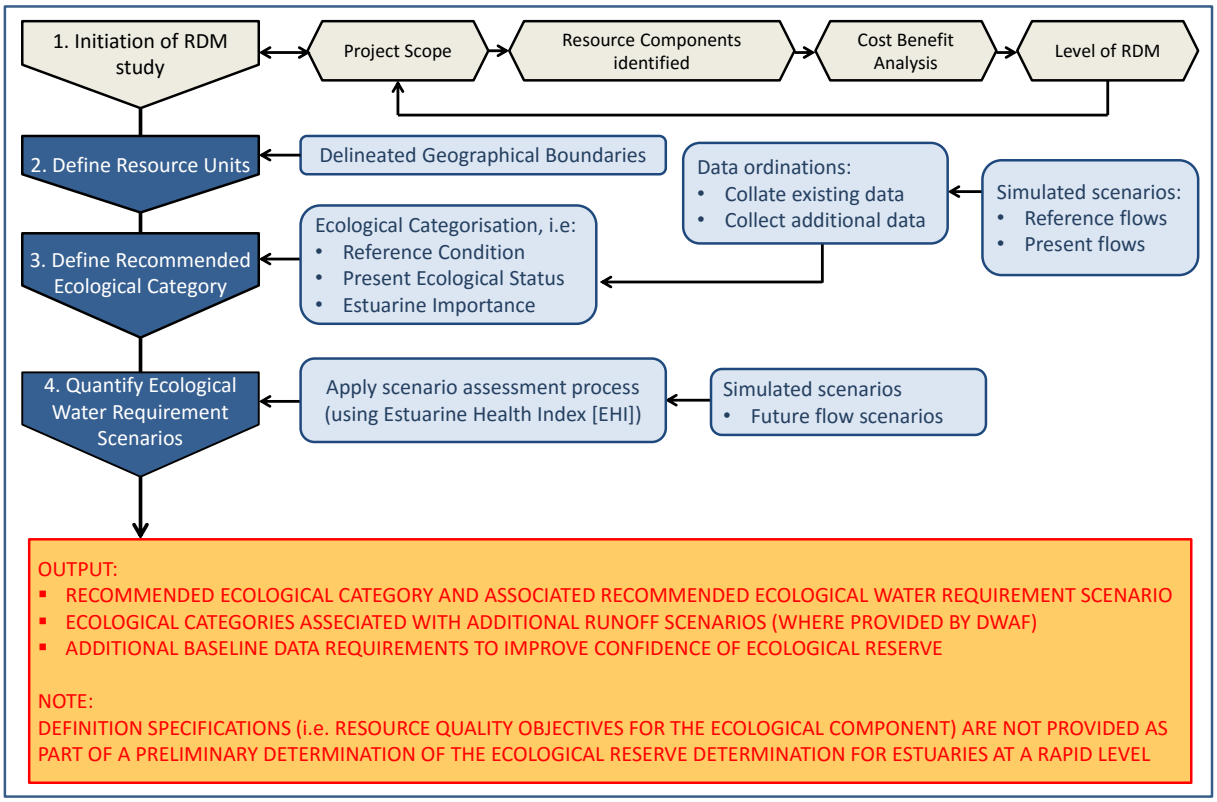

Figure 4-3 Procedures for a rapid ecological Reserve determination for estuaries, in context of the broader RDM process (components not addressed as part of the ecological reserve determination process are indicated by hatched line boxes) (DWAF 2004)

The reason for a rapid assessment for Kosi Estuary is that there is strong agreement among estuarine ecologists that know the system well that, given the importance, current pressures and declining condition of Kosi, the Reserve requirements will approximate, or exceed, present day inflows with a reasonably high level of confidence, regardless of the level of the Reserve determination exercise. Given this, it makes sense to reduce the focus on the requirements of the biological aspects of the system and rather to focus on establishing the vulnerability of the water supply to outside interference and use this to establish controls to protect the water needed for the Reserve, and ensure the on-going viability of the Kosi System.

4.2.6 Lake Sibaya

For Lake Sibaya, the emphasis will be on the physical drivers of the ecosystems, chiefly groundwater inflow, and the possible implications of abstraction on these sources.

An intermediate Reserve determination using a DRIFT approach will be adopted (see Section 4.2.5.1), using time-series of water levels as input.

4.2.7 Socio-economics

The socio-economic investigation will focus on valuing the ecosystem services in terms of its contribution to human welfare. The services that will be looked into include provisioning services, regulation services and cultural services. The Ecosystem Valuation will be undertaken within the framework of Total Economic Value, which includes direct, indirect and non-use values.

Available information, such as the study undertaken by Anchor Environmental Consultants in 2010, on the Aquatic Ecosystem Services of the Olifants, Inkomati and Usutu to Mhlatuze Water Management Areas will be referred to during this investigation.

The socio-economic findings will be used as input into DRIFT and in the evaluation of flow scenarios.

4.2.8 Basic Human Needs Reserve

The revised approach for determining the Basic Human Needs Reserve in large or complex catchments as proposed at the October 2008 DWA workshop and documented in King & Pienaar (2011) will be implemented.

4.2.9 Capacity building and skills transfer

Capacity building forms an integral part of the project design, and opportunities for building capacity have been incorporated at all levels of seniority. On a broad level, capacity building will be realised through the following mechanisms:

- The Client will second seven (7) DWA staff members to the appointed project team, while two (2) senior members will be capacitated on DRIFT. See Table 4-2.

Table 4-2. Capacity Building Plan for DWA

DWA personnel	Specialist field	Mentor	Area of capacity building
Mazibuko Molefi Jacob	Fish	Bruce Paxton	• Field work • Participation at EWR workshop • Review specialist report
Boniwe Nobubele	SASS & Wetlands	Gary Marneweck – Wetlands (Pongola floodplain) Colleen Todd – River (SASS)	• Field work on Pongola floodplain and Rivers • Participation at EWR workshop for rivers • Review the Pongola floodplain wetland report • Review the macro invertebrate specialist report
Mazibuko Simphiwe	Project Management & Socio-economics	Toriso Tlou (Socio-Economics) Adhishri Singh (Project Management)	• Participation on defining socio-economic zones • Review socio-economic report

			• Review progress reports (Which provides achievement, planned activities and financial control of project) • Interaction with PSP throughout the project
Mpete Tinyiko	Hydraulics	Martin Kleynhans	• Field work - rivers • Review specialist report
Qoko Mathabo	VEGRAI and Water Quality	James MacKenzie – vegetation Heather Malan – water quality	• Participation at EWR workshop (Veg & Water Quality) • Review specialist reports
Ntwampe Leshego	Groundwater quality (GRDM 2012)	Phil Hobbs	• Participation at Groundwater/Wetland discussions • Review groundwater/wetland report
Nzama Stanley	Groundwater quality (GRDM 2012)	Phil Hobbs	• Participation at Groundwater/Wetland discussions • Review groundwater/wetland report
Motebe Nancy	DRIFT	Cate Brown	2 hr DRIFT discussion and demonstrations: • Methodological understanding • Information requirements and output of DRIFT DSS.
Weston Barbara	DRIFT	Cate Brown	2 hr DRIFT discussion and demonstrations: • Methodological understanding Information requirements and output of DRIFT DSS.

- Participation of DWA officials (CD: RDM, Regional Offices) will ensure active sharing of ideas and contribute to the broadening of the RDM skills base. In addition, discussion groups between the PSP and DWA will take place once a year before a PMC meeting. Topics for discussion will be identified ahead of time, and the PSP will prepare material to aid the discussion as appropriate.
- Local specialists and stakeholders (e.g. DWA Regional Office, iSimangaliso WPA, KwaZulu-Natal Wildlife Service, Catchment Management Agency, Local Authority, Environmental Groups, etc.) will be involved in the PSC. Through their participation, these groups will develop an understanding of water resource protection through the Reserve determination methodologies and its relevance. This will also assist in the enhancement of their understanding of the concepts of integrated water resource management and sustainable development;

Specific intra-team arrangements for capacity building are outlined below.

4.2.9.1 Project management

Project Leader: Ms Adhishri Singh will work in close liaison with Dr Cate Brown.

4.2.9.2 Rivers

River Activity Leader: Ms Adhishri Singh will work in close liaison with Dr Cate Brown and, in so doing, will gain experience in Overall Project Coordination and River Reserve Determinations. Southern Waters has used this process successfully in the past to train three River Quantity Reserve Determination facilitators, who now operate independently of the company.

Site selection: Mr Tobias Sibande will accompany Ms Adhishri Singh and Dr Cate Brown on the site selection visits. This will give him an opportunity to see the study area, and discuss issues pertaining to both the aquatic ecosystems and the study, which will enhance his understanding of the issues pertaining to RDM investigations. It will also provide him with useful perspective for the reconciliation studies in this area that he is currently involved in.

DRIFT: The river specialists will be instructed, and gain experience, in the use of DRIFT in Reserve determinations. The PSP has already conducted a one-day DRIFT overview workshop, which involved all the specialists with the exception of the estuarine team.

4.2.9.3 Estuaries

Mlalazi, Amatikulu and Kosi Activity Leader: Prof Digby Cyrus will work in close liaison with Ms Lara van Niekerk and, in so doing, will gain experience in process coordination for Estuary Reserve Determinations.

Water quality specialist: Mr M. Mzimela will work in close liaison with Ms Susan Taljaard and, in so doing, will gain experience in provision of water quality data for Estuary Reserve Determinations.

Students: Capacity building will also focus on the development of estuarine fieldwork skills among University of Zululand students and junior professionals such as:

- site selection,
- scientific sampling techniques,
- boating skills,
- species identification in the field, and
- observational skills needed to identify the relationship between river inflows and abundance/species composition.

After completion of the field exercises, students/assistants will also be involved in the data analysis and will be encouraged to develop their report writing skills.
As CRUZ, who is leading the estuarine component is a tertiary institution, they involve the post graduate students to assist with data collection. Should any of the DWA officials with under-graduate qualifications in estuarine or aquatic biology be interested in assisting with this work, please supply us with the names of these individuals so we can include them in the data collection schedules.

4.2.9.4 Groundwater and wetlands

The groundwater and wetlands tasks have been combined in an effort to improve inter-disciplinary communications and allow specialists to develop a greater appreciation of the other discipline, and to develop synergies between the outputs from these two areas.

In addition, junior team members will be drawn into the project so that they gain insight into the processes and techniques used to evaluate Reserve related issues pertaining to groundwater and wetlands.

5 APPROACH TO ACHIEVE OBJECTIVES

The study has been divided into 16 Activities, as follows:

1. Project Management
2. Project Inception
3. Hydrology
4. Intermediate river EWRs
5. Rapid river EWRs
6. Pongola floodplain Intermediate EWR
7. Wetlands and groundwater
8. St Lucia/Mfolozi Estuarine System Intermediate EWR
9. Mlalazi Estuary Intermediate EWR
10. Amatikulu Estuary Rapid EWR
11. Kosi Estuary Rapid EWR
12. Mhlatuze, Nhlabane and other existing estuary review EWRs
13. Lake Sibaya Intermediate EWR
14. Socio-economic profile of the WMA
15. Basic Human Needs Reserve
16. Study Closure.

The tasks associated with these activities are described in Sections 5.1 to 5.16.

5.1 Activity 1: Project management

Activity 1 comprises eight tasks, and will generate three main kinds of regular deliverables, plus one stand-alone deliverable (Deliverable 1.4). These are:

Deliverable 1.1 Six-monthly progress reports.
Deliverable 1.2 Milestone invoices accompanied by interim progress reports
Deliverable 1.3 Minutes of project steering committee meetings.
Deliverable 1.4 Scenarios selected for evaluation.

5.1.1 Task 1.1: Overall project co-ordination and management

This task will involve the collation of data on the study progress, cost schedule, the capacity utilisation of the human resources particularly with the participation rate of HDIs. Targets set in the inception phase for the participation rate of the HDIs and the capacity building will be monitored for compliance.

In order to achieve a seamless programme, an integrated project programme will be used as the baseline for integrating the activities of the project.

The approach will be the use of exception reporting where progress varies from the schedule programme and plan expenditures. In the event that the target is not being met, the project manager will, through exception reporting, inform the client of the issues and constraints causing the targets not to be met. The exception report will also highlight mitigation measures to address the problem.

5.1.2 Task 1.2: Project Management Committee (PMC) meetings

Project Management Committee meetings between the Client and PSP will be held at quarterly intervals throughout the project duration. The constitution of the PMC is the DWA RDM Chief Directorate and the PSP Project Manager and key Task Leaders (as required). According to the ToR the preparation of the minutes of the PMC meetings will be the responsibility of the Client and as such no cost was allocated to this sub-task.

The focus of the PMC meetings is to monitor progress on the project, discuss any issues or challenges that might arise during the project and on planning for the annual PSC meeting.

PMC meetings have been planned to take place in Pretoria, except for those linked to the planning of the PSC. The intention is to have the PSC planning sessions in the catchment the day prior to the PSC meeting, in order to cut down on travel costs.

5.1.3 Task 1.3: Project Steering Committee (PSC) meetings

Project Steering Committee members will comprise key stakeholders involved in ecological water resource protection and conservation, such as iSimangaliso Wetland Park Authority, Ezemvelo KZN Wildlife Agency, the DWA KZN Regional Office, the Inkomati Catchment Management Agency and representatives of Catchment Forums already established in the WMA. Meetings will take place annually at critical points in the study programme. It is planned that the first meeting take place after submission of the Inception report to the Client; the second meeting to provide the findings of the Rivers EWR assessment and the third meeting to provide the outcomes of the estuary and wetlands/lakes/groundwater investigations.

Input of the PSC in the development of scenarios will be achieved through a dedicated workshop.

In order to accommodate the key stakeholders and to provide benefits to the catchment being studied, PSC meetings are planned to take place in the Usutu to Mhlatuze WMA.

The PSP will provide the secretarial services for the PSC meetings.

5.1.4 Task 1.4: Focussed discussion sessions

Focussed discussion sessions aimed at building capacity within the RDM Chief Directorate will take place once a year. These sessions will be linked to a PMC meeting in order to

reduce travel costs. Topics for discussion will be agreed to with the Client prior to the meeting in order for the PSP to prepare accordingly. Sessions are planned to take place in Pretoria.

5.1.5 Task 1.5: Scenario selection

Scenarios are a means of exploring possible pathways into the future. In Intermediate and Comprehensive EWR determinations, scenarios are used to 'test' the responsiveness of the aquatic ecosystems to possible future changes in the volume and/or timing of their water supply, and to ensure that a range of EWR possibilities is available for Classification.

Scenarios should cover as wide a range as possible of planned or possible options, whether they be of development or rehabilitation. The scenarios should reflect the issues of concern to stakeholders, and so identification of a suitable range of scenarios, through consultation with stakeholders (PSC), is a crucial step in EWR assessments.

Options for scenarios that explore the major water-related issues, trends and known development options linked to Intermediate EWRs will be presented and discussed at one or more PMC and PSC meeting.

The number of scenarios chosen will depend partly on time and cost limitations (c. 4), but also on data limitations. Where data are few, and understanding of the social and ecological structures linked to the river is poor, then fewer rather than more scenarios will be chosen. These should be as dissimilar as possible, so that broad basin-level trends can be described.

Considerations when selecting scenarios will include:

- the available hydrological modelling capacity, which will dictate the variables that can be changed per scenario;
- the possible spatial resolution (i.e. number of sites), which will be partially driven by the hydrological delineation of the basin;
- the base year and time of interpretation for the scenarios – often taken as 20-30 years into the future from the base year.

5.1.6 Task 1.6: Technical monitoring and control

Various levels of technical monitoring and control have been built into the project. Task Leaders are responsible to ensure technical quality of the investigations and reporting from their team members.
Internal review of technical quality is built into all activities, with Dr Brown reviewing the rivers and wetlands/groundwater process and deliverables and Ms van Niekerk reviewing the estuarine process and deliverables.

All Technical Reports will be reviewed by the Management Team before submission to the Client. Any correction required post-Client reviews will be done by the relevant technical specialist, overseen by the Management Team.

Technical and other reports will be forwarded to the Client against milestone dates identified In Section 8.1. Reports will be reviewed by the Client and then amended accordingly. The budget allows for one revision post the Client review.

5.1.7 Task 1.7 Financial control

Invoices will be submitted together with Milestone submissions. Invoices will outline expenditure per sub-consultant and per task and by disbursement per task (see Appendix C for *pro-forma* invoice). A six-monthly report of the budget will be submitted with the progress report, and will include a summary of the budget used for personnel. This will be represented in graphic format. Cashflow projections will be allied to the budget management process and will be set against expenditure, expected expenditure and the budget. Any variations between budget and actual expenditure will be noted and will be analysed in terms of impact on overall budget.

5.1.8 Task 1.8 Progress reporting

Six-monthly progress reports (See Appendix A for Table of Contents) will be sent to the Client. These will comprise:

- A Gantt chart detailing progress per task against programme
- Expenditure against budget (See Appendix B for examples)
- Progress against expenditure (See Appendix B for examples)
- Summary of progress, potential problems and possible changes to the scope of work
- A summary of the training/capacity building programme.

Expenditure against budget and progress against expenditure will be presented in a spreadsheet format and in a simplified bar graph (Appendix B). Allowance has been made in the budget for all of these activities.

Possible changes to scope of work will be identified as early as possible. These will be brought to the Client's attention through one or more of the following:

- progress reports;
- normal communication channels (telephone, *ad hoc*- meetings, fax, e-mail);
- PMC meetings;
- PSC meetings.

5.2 Activity 2: Project Inception

Activity 2 comprises seven tasks, and will generate two deliverables. The deliverables are:

Deliverable 2.1 Inception Report
Deliverable 2.2 Prioritisation and delineation of water resources.

5.2.1 Task 2.1: Catchment overview

The overview of the WMA was based on existing studies and is contained in section 2.

5.2.2 Task 2.2: Workplan

The workplan has been refined and is contained in Section 7.1

5.2.3 Task 2.3: Inception Report

This report.

5.2.4 Task 2.4: ToRs for team members

Once the Inception Report has been finalised and accepted by the Client, the management team will devise a series of specific ToRs for sub-consultants. These ToRs will detail budget, scope of work, deadlines and expected deliverables. Payment of invoices from sub-consultants will be subject to satisfactory progress on required tasks.

5.2.5 Task 2.5: Team appointments and mobilisation

Team appointments will take place once an approved Inception Report is in place. Appointments will take place via Sub-consultants agreements between Tlou Consulting and the sub-consultant.

5.2.6 Task 2.6: Water resources prioritisation and delineation

The geographical boundaries for the study are those of the Usuthu Mhlatuze WMA. More specific within-project boundaries will be set on the basis of ecoregional classification of the wetlands, estuaries, rivers and aquifers within the study area, proposed sites for water resource developments and areas of particular ecological or social significance.

The objective of this task is to delineate morphologically uniform zones (from the longitudinal profile, Google Earth imagery, available maps and other available data). Identification of morphologically uniform zones enables sites to be selected to cover the diversity of morphologies and associated habitat conditions, for the assessment of flows for the different zones, and can be used to inform the sensitivity or resilience of different reaches of the rivers, estuaries and wetlands to flow related impacts.

5.2.6.1 Rivers

For the rivers, the delineation will provide the WRCS nodes at which Rapid I assessments will be done (Section 5.5), or to which data will be extrapolated (Section 5.5.3). The WRCS

multi-tiered approach for establishing the location and number of nodes within a basin (Figure 5-1) will be used.

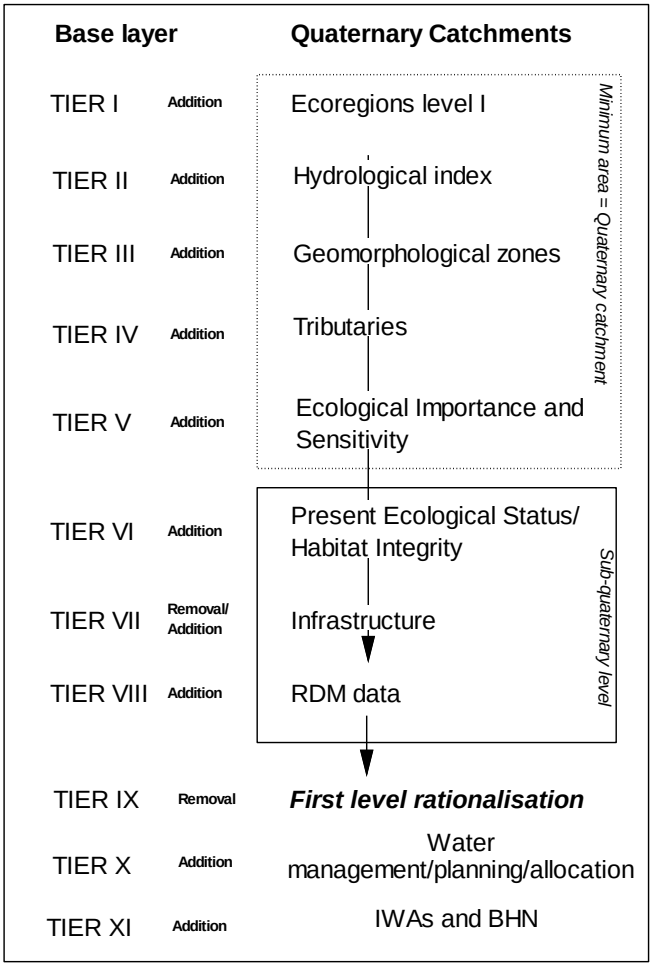

Figure 5-1 Summary of the procedure of river node establishment

5.2.6.2 Estuaries

The National Water Act (Act No. 36 of 1998) defines an estuary as "a partially or fully enclosed body of water—

(a) which is open to the sea permanently or periodically; and

(b) within which the sea water can be diluted, to an extent that is measurable, with freshwater derived from land;

In the RDM methods for estuaries it is recommended that the definition of an estuary be extended to include the estuarine functional zone as defined in the National Biodiversity Assessment: Estuary Component (van Niekerk and Turpie 2012):

"…a partially enclosed permanent water body, either continuously or periodically open to the sea on decadal time scales, extending as far as the upper limit of tidal action or salinity penetration. During floods an estuary can become a river mouth with no seawater entering the formerly estuarine area or when there is little or no fluvial input an estuary

can be isolated from the sea by a sandbar and become a lagoon or lake which may become fresh or hypersaline".

In term of this definition, the estuary mouth is taken as the downstream boundary or, where the mouth is closed, the middle of the sand berm between the open water and the sea. The upstream boundary is determined as the limits of tidal variation or salinity penetration. Lateral boundaries of each estuary are defined to include all associated wetlands, intertidal mud and sand flats, beaches and foreshore environments that are affected by riverine or tidal flood events whichever penetrates furthest, and were mostly plotted as the 5 m topographical contour surrounding each estuary.

For all practical purposes, the Reserve and the response of estuaries to fluctuations in water quality and quantity is reported for the estuary as a whole. Thus, estuary nodes will be placed at the upstream and downstream end of each estuary, i.e. at the interface with the sea.

5.2.6.3 Wetlands & Groundwater

Available GIS datasets including the national wetland inventory and NFEPA wetland layer will be used as the base layer for the study. Information gathered from the above reports and associated spatial databases will then be added to improve the coverage and inform the prioritisation of the wetlands.

Areas where the wetland coverage is poor will be identified and indicated on the base map. Where appropriate and depending on the delineation and prioritisation of Resource Units (RU's), gaps will be filled using a desktop delineation. Every attempt will be made to at least capture all the priority wetland systems within the study area in the GIS layer. Use will also be made of 1:50 000 topographical maps, Google Earth Imagery and available aerial photography to support the production of the digital base map of the wetlands.

Groundwater delineation will be based on the 1:1 000 000 scale geological data provided by the Council for Geoscience. Groundwater will be delineated into areas that are hydrogeologically similar (for monitoring and reporting purposes) and where there is a boundary between an aquifer and an aquitards or aquiclude.

5.2.7 Task 2.7: Project Management Information System Implementation

See Section 10 for details of PMIS.

5.3 Activity 3: Hydrology

Activity 3 comprises seven tasks, and will generate three deliverables. The deliverables are:

Deliverable 3.1	River Baseline Hydrology Report
Deliverable 3.2	Scenario Hydrology Report
Deliverable 3.3	Hydrological datasets as required for river and estuary EWR assessments.

5.3.1 Task 3.1: Overview of hydrological data

An overview of the availability and continuity of hydrology data for sites on the study rivers will be incorporated into the Delineation Report (see Section 5.2.6), and used in the deliberations around site selection and selection of the appropriate level of EWR determinations.

5.3.2 Task 3.2: Daily data for seven river Intermediate EWR sites

Long-term daily data naturalised and present-day flow records will be provided for the seven river sites selected for intermediate EWR level determinations. These will be used to populate the DRIFFT model so that scenarios of flow change can be evaluated.

5.3.3 Task 3.3: Monthly data for WRCS nodes

Long-term naturalised monthly flow records will be provided for the 51 WRCS nodes in the WMA.

5.3.4 Task 3.4: ACRU modelling for Mfolozi basin

The hydrological simulations for the St Lucia GEF study (see Section 4.2.5.1) included all the influent catchments for the St Lucia estuarine system and were prepared using the ACRU model (Smithers and Schulze 2004). It is assumed that simulation for any future water resources development scenarios to be evaluated as part of this project will be generated in consultation with the client. These scenarios will need to be generated using the ACRU model configured for the GEF study, otherwise they will not be comparable with the calibrated response curves in the GEF DRIFT DSS.

5.3.5 Task 3.5: DRIFT analyses

The first of the main assumptions underlying the DRIFT process is that it is possible to identify and isolate ecologically relevant elements of the flow regime from the historical hydrological record. Thus, this task will use the DRIFT software to identify the ecologically most important flow categories for each river site. In South Africa, for the majority of rivers for which environmental flow assessments have been undertaken, the following ecologically relevant flow categories have been used:

The low flows: the daily flows between high-flow peaks are divided into data sets for different seasons, usually:

- wet-season low flows;
- dry-season low flows.

The floods (or high flows): the peak events of higher flow are allocated to one of the following:

- four size classes of intra-annual floods;

- floods with a return period of up to 2, 5, 10 and 20 years.

Summary data of these ten flow categories, based on a long-term data set of daily flows that covers wet and dry years describe:

- the *ranges* of low flows within each chosen season;
- the *average number per annum* of each class of flood (high-flow) event; and
- the timing of seasonal and flood event onsets and durations.

5.3.6 Task 3.6: Flow scenarios for rivers and estuaries

The flow regimes expected under each of the scenarios defined in Section 5.1.5 will be modelled and provided for each of the Intermediate river EWR sites and the estuary EWR locations for the same dates of record as those used in Tasks 3.3 and 3.4, so that the ecological implications can be evaluated.

5.3.7 Task 3.7: Internal review and reporting

See deliverables.

5.4 Activity 4: Intermediate River EWRs

Activity 4 comprises nine tasks, and will generate eight deliverables. The deliverables are:

Deliverable 4.1	Site selection (as part of Prioritisation and delineation of water resources Deliverable Activity 2)
Deliverable 4.2	Data Collection Trip Report 1
Deliverable 4.3	Data Collection Trip Report 2
Deliverable 4.4	River Ecoclassification Report
Deliverable 4.5	River Intermediate Reserve Determinations – Specialist Reports
Deliverable 4.6	River Intermediate Reserve Determinations – EWR Report
Deliverable 4.7	River Intermediate Reserve Determinations – Ecospecs
Deliverable 4.8	DRIFT-DSS populated for eight sites.

5.4.1 Task 4.1: Literature review

The duration of the project is such that relationships between the riverine ecosystem and flow that will provide the basis for the EWR assessment will for the most part be obtained from the scientific literature. These data will be augmented by existing distributional and habitat data from the study rivers.

5.4.2 Task 4.2: Site selection

The prioritisation and delineation of water resources (Section 5.2.6) will be used to identify possible river reaches for the Intermediate determinations. The main criteria for the location of the EWR sites will be:

- to maximize on information required for the different river types/reaches in the study area so that the EWR information, once generated, can be extrapolated across most of the study area;
- to cater for the specific requirements in terms of proposed water resource developments in the study area.

Ms Singh and Dr Brown will visit these reaches to locate suitable sites. Site suitability will be dependent on:

- proximity to a DWAF gauging station with an accurate daily flow record;
- accessibility;
- degree of disturbance. Sites should be as undisturbed as possible, so that clues on required flow regimes can still be gleaned from the natural distribution patterns of aquatic plants and animals;
- suitability for accurate hydraulic modelling of the full range of flows, but particularly of low flows;
- presence of critical habitats (those necessary for completion of life cycles) for riverine biotas, or flow-sensitive habitats such as riffles.

5.4.3 Task 4.3 Data collection

Field surveys will be undertaken during the low flow and high flow periods to address gaps in the data record and to provide a baseline data set against which any future changes in the rivers can be benchmarked. Data will be collected at the seven sites selected in Table 5-1.

Table 5-1. EWR sites selected for Intermediate level Reserve assessment

EWR Site	Resource	Latitude	Longitude
BM	Black Mfolozi	S27 56.337	E31 12.617
Mk	Mkuze	S27 35.525	E32 13.080
Ns	Nseleni	S28 38.045	E31 55.852
Ma	Matigulu	S29 01.205	E31 28.226
As	Assegaai (Usutu)	S27 03.737	E30 59.328
Po	Pongola	S27 21.848	E30 58.177
WM	White Mfolozi	S28 13.826	E31 11.285

The frequency of sampling used here is based on generally acceptable discipline-specific sampling frequencies for EF monitoring. It will be essential that the specialists are given at least a full day at each site. Specialists who finish early will assist others with finishing their data collection.

- **Eco-hydraulic analysis and modeling:** The ecohydraulics data collection comprises surveys of cross-sectional profile/s at the EWR sites during a low-flow condition (including the survey of geomorphological and ecologically-relevant points of interest), (possibly) installation of automatic water level recorders where needed; surveys of the stages and water surface slopes, and discharge measurements, on at least one other separate occasion with markedly different discharge.

- **Geomorphology:** The focus of the field assessments will be on the identification and surveying of alluvial (depositional) morphological cues at the sites and within the reach that may be associated with regular flooding return frequencies. The river is an extremely high energy system, but depositional morphological features such as terraces and alluvial bars that are associated with geomorphologically significant flow classes may develop in more alluvial segments of the river. These alluvial features, usually paired (mirrored) on both banks, can be used to indicate the stage of important flow events. Bed sediments will be sampled at the sites to determine the sediment-size distributions. These will be used in conjunction with the available hydrology (present day and for scenarios) and site hydraulics to evaluate the impact of alterations in hydrology on sediment discharge. The focus of the study will be on the changes in potential sediment transport capacity.
- **Water quality:** A literature search will be carried out for information on water quality (WQ) issues relating to the catchments under consideration. WQ subunits will be delineated – where these are lengths of each river system that are considered to exhibit largely homogenous WQ. The delineation will be carried out by considering topography, ecoregional boundaries, and land use (including the location of major towns) which are all likely to affect WQ within the drainage system. The location of DWA WQ monitoring stations within each catchment will be examined, and the usefulness of the dataset for each station in terms of the number and frequency of sampling occasions and the parameters measured will be examined. The data for the key sampling stations will then be statistically analysed to derive the Reference Condition and the Present Ecological State for each WQ subunit.
- **Other disciplines:** The expected sorts of data and frequency of collection are outlined in Table 5-2.

Table 5-2 The expected sorts of data, and frequency of collection

Activity No.	Activity	Data sources	Frequency
G1	Sediment composition	Field data collection, existing data	Once
G2	Channel characteristics and habitat distribution	Field data collection, maps, Google Earth, etc.	Once
B1	Riparian vegetation community structure (zonation)	Field data collection, scientific literature	Once
B2	Riparian vegetation recruitment	Field data collection, scientific literature	Once
M1	Macroinvertebrate community structure	Field data collection, scientific literature	Once
M2	Assessment of macroinvertebrate habitat	Field data collection	Once
F1	Fish community structure	Field data collection, scientific literature	Once
F2	Assessment of fish habitat	Field data collection	Once

Specialists will be expected to take responsibility for the adequacy of the data collected and provided by them for their components. They will also indicate the level of confidence in the data used.

5.4.4 Task 4.4 Data analysis and modelling

Individual specialists will collate and analyse the data that they collect. The focus of the analyses will be on:

- Hydraulic relationships at the EWR sites
- Flow/abundance relationships
- Identification of suitable indicators for use in the DRIFT DSS
- Identification of linked indicators for use in the DRIFT DSS
- Developing relationships between indicators and linked indicators.

5.4.5 Task 4.5: Ecoclassification

The River Team will use existing data, in addition to newly collected information to finalise the resource quality reference conditions for the rivers in the study area. They will also assess the present day condition of the study rivers using the recommended Ecoclassification procedures (DWAF 2008). The Team will also assess the ecological importance and sensitivity based on the relevant levels and the methods provided in the RDM Manuals.

Finalisation of the Ecoclassification models will take place in a workshop setting in Pretoria.

5.4.6 Task 4.6: Determine EWRs

The River Team will undertake an Intermediate determination of the ecological water requirements (EWR) at seven sites on the WMA for maintaining four different ecological categories, *viz*.: A/B, B, C and D. Although the Reserve studies usually require considering three conditions (the PES, one ecological category up and one ecological category down), in order to prepare for Classification at least four extrapolations will be conducted. Depending on the Client's preferences it will be possible to report on only the three categories in the Reserve reports, however the extrapolations will be available for Classification.

Team deliberations will take place in a workshop setting in Pretoria using the DRIFT DSS (Brown et al. 2013) to organise the data.

The focus of the workshops will be the population and calibration of the DRIFT DSS (Section 4.2.3.2). The team of specialists will populate the response curves in the DSS. The inputs from the various specialists will be checked to ensure that they are complete, logical and supported by references from the scientific literature. The DRIFT DSS will be set up according to the parameters relevant for the Usuthu-Mhlatuze WMA.

5.4.7 Task 4.7: Scenario analysis

DRIFT is a scenario based method, and once the DRIFT-DSS has been populated any number of water-resource scenarios can be assessed. In this project, the scenario analysis

phase will be used to check the EWRs for the four different ecological categories, *viz*.: A/B, B, C and D, and to identify flow scenarios for consideration by the estuarine team.

5.4.8 Task 4.8: Resource Quality Objectives and monitoring

The Reserve specialists are responsible for recommending an Ecological Category (EC) for the Ecological Reserve. This will be known as the Recommended Ecological category (REC).

The Reserve specialists are also responsible for providing Ecospecs (and other relevant information) for the recommended EC[1] (REC) for the Intermediate EWR determinations. These Ecospecs will become the Resource Quality Objectives (RQOs) for the overall Management Class (MC) if the REC forms part of that MC. If not, some manipulation of the Ecospecs will be required. It will be optimum if the MC is the first to be determined. In this way the associated EC will then be known and the RQOs can be defined, during this study.
If not, the Ecospecs will be defined for the REC and there may be a mismatch when the MC is determined.
The RQOs are defined objectives for flow, quality, biota and habitat in order to achieve a specific river state defined as the EC.

Similarly, as the design of the monitoring programme also requires knowledge of the condition in which the systems is to be maintained, the relevant Monitoring Protocols in this study will be provided for the recommended EC.

5.4.9 Task 4.9: Internal review and reporting

See list of deliverables.

5.5 Activity 5: Rapid EWR for Rivers

Activity 5 comprises four tasks, and will generate one deliverable. The deliverable is:
Deliverable 5.1 River Rapid Reserve Determinations – EWR Report.

5.5.1 Task 5.1: Ecoclassification

The results of the recent DWA PES update project will form the basis for the PES assessments for the Rapid EWR determinations. These will be augmented by site-based habitat integrity assessments (Kleynhans 1998) of the reaches where the confidence in the updated PES assessments is very low.

[1] This is because the study will reach completion before the MC has been determined.

5.5.2 Task 5.2: DRIFT/Desktop extrapolation and adjustments for key sites

The procedure for testing river nodes to determine whether existing Reserve data can be extrapolated to them follows the draft Extrapolation Decision-Support System (DSS) proposed by Louw *et al*. (2006). For nodes that are suitable for extrapolation of data from sites with intermediate-confidence Reserve data, the EWR quantifications will be done:

- using DRIFT if there are daily hydrological data available;
- using the IFR Edit feature of the Desktop Model where there are only monthly hydrological data available.

5.5.3 Task 5.3: Extrapolation of EWR data for remaining WRCS nodes

For nodes that are not suitable for extrapolation of data from sites with intermediate-confidence Reserve data, the EWR quantifications will be done using the standard Desktop[2] Model (Section 4.2.3.3).

5.5.4 Task 5.4: Internal review and reporting

See list of deliverables.

5.6 Activity 6: Pongola Floodplain

Activity 6 comprises ten tasks, and will generate four deliverables. The deliverables are:

Deliverable 6.1	Inundation Modelling Report
Deliverable 6.2	Wetland Typing and Ecoclassification Report
Deliverable 6.3	Key social concerns with respect to the timing and magnitude of flooding (to be included in the EWR report)
Deliverable 6.4	Pongola Floodplain – EWR Report including recommended rules for releases from Pongolapoort Dam
Deliverable 6.5	DRIFT-DSS populated for Pongola Floodplain.

5.6.1 Task 6.1: Literature review

A literature review will be done to ensure that relevant information and insights from past studies are incorporated into the Pongola Floodplain study. In this regard, key literature includes:

- Begg, G. (1989). The Wetlands of Natal (Part 3). The location status and function of the priority wetlands of Natal. Natal Town and Regional Planning Report Volume 73, Pietermaritzburg, South Africa.
- Heeg, J. And Breen, C.M. (1979). The Pongolo River flood plain, It's functioning and role in the development of the Makatini Flats. University of Natal, Pietermaritzburg, South Africa.

2 There may be cases where the EWR for the same category 'jumps' between one node and the next.

- Kotze, D.C. (1995). Background information on Mbongolwane Wetland to be used for developing a management system. Department of Grassland Science and Institute of Natural Resources, Scottsville, South Africa.
- Pitman, W.V. and Weiss, H.W. (1979). A numerical hydraulic model of the Pongola flood plain, Report No. 2/79. Hydrological Research Unit, Johannesburg, South Africa.

In addition, information on the past operating rules for Pongolapoort Dam will be sought as will information on international agreements between South African and Mozambique as they related to water delivery across the border downstream of the floodplain, so that the study team is fully aware of the flow regime(s) that have been released onto the floodplain recent times, and what the issues are with respect to South Africa's downstream international obligation. For this discussions will be held with the DWA: National Water Resources Planning and the KZN Regional DWA Office.
A report by Breen and Grobler will be obtained from DWA: CD-RDM.

5.6.2 Task 6.2: Data for Gauge W4H013 and water level gauges along the floodplain

The available discharge records for Gauge W4H013 (immediately downstream of Pongolapoort Dam) and water level gauges along the floodplain will be obtained and collected. The water level gauges along the floodplain will be surveyed relative to mean sea level.

5.6.3 Task 6.3: Survey water level gauges relative to MSL

If the DWA gauge plates have not been surveyed to the same elevation datum (i.e. meters above MSL) this will need to be done as otherwise it presents a significant limitation in tying in recorded hydrological records with the models being developed as part of this study. The PSP will liaise with the KZN Regional Office to enable the latter if it is absent.

5.6.4 Task 6.4: Landsat 5 and 7 scenes

The available Landsat 5 and 7 scenes will be accessed from a data-base. Every attempt will be made to avoid images with cloud cover and Landsat 7 Scan Line Corrector (SLC)-off scenes (after May 2003). Scenes with excessive cloud cover are not usable. Thereafter a range of scenes (approximately five to seven) will be selected that are associated with floods pre- and post- flow-regulation by Pongolapoort Dam, and for each scene:

- GIS software will be used to perform unsupervised cluster analyses to map inundated surface areas,
- the inundated areas will be converted to vector shape files (which demarcate water edges) and the areas of inundation will be computed.

5.6.5 Task 6.5: Inundation computations

The inundated areas will be correlated with hydrological release parameters, including: peak discharge, duration and volume, taking cognisance of:

- the backwater effect of the Usutu River on inundation along the (downstream) Pongola River Floodplain[3], and
- antecedent ponding conditions[4].

Based on the existing gauging network in the Phongolo River Floodplain, it is unlikely that it will be necessary to install any additional (automatic) water level recorders in the pans.

5.6.6 Task 6.6: Wetland typing and ecoclassification

The wetlands on the Pongola Floodplain will be classified in accordance with the HydroGeoMorphic (HGM) classification system first described by Brinson (1993), with modifications based on insights gained from the inundation computations, and using surrogate datasets such as land use. The present ecological status for key wetlands and the expected change in condition of the wetland resources (grouped wetlands) in each of the delineated RU's (and within sub-basins where appropriate) will be determined based on known threats or pressures for development within the RU's, the relationship between the threats/pressures. Expert judgement will be used to derive how the key systems are likely to change with the pressures they are currently experiencing and with increases or changes in these or the addition of additional threats or pressures going forward.

The likely trajectory of change from current state will be considered in the context of a decision-support matrix aimed at:

- protecting good condition and important or priority wetlands;
- protecting and improving degraded but important or priority wetlands; and
- being less protective of degraded and/or less important wetlands.

5.6.7 Task 6.7: Application of DRIFT

The wetland typing will be used to define indicators types of the population and calibration of the DRIFT DSS (Brown et al. 2013), which will then be used to assess the implications of different flood releases for the aquatic resources on the Pongola Floodplain. These deliberations on the will take place in a workshop setting in Pretoria. The scenarios of flood releases will be compiled to ensure that they represent a range of options that cover Operating rules at Pongolapoort Dam, the concerns of people living on the floodplain with respect to flooding and the needs for the aquatic environment,

[3] within the Ndume Reserve
[4] *i.e.,* ponded water prior to the release or flood event

5.6.8 Task 6.8: Resource Quality Objectives and monitoring

Ecospecs will be provided for key wetlands for the recommended EC. These Ecospecs will become the Resource Quality Objectives (RQOs) for the overall Management Class (MC) if the recommended EC forms part of that MC. If not, some manipulation of the Ecospecs will be required.

Similarly, as the design of the monitoring programme also requires knowledge of the condition in which the systems is to be maintained, the relevant Monitoring Protocols in this study will be provided for the recommended EC.

5.6.9 Task 6.9: Operating rules

Operating rules for flood releases from Pongolapoort Dam to meet the recommended EWR at the Pongola floodplain will be developed in collaboration between the ecologists, hydrologists and the water resource engineers of DWA (NWRP, OA, KZN Regional Office).

5.6.10 Task 6.10: Internal review and reporting

See list of deliverables.

5.7 Activity 7: Wetlands and Groundwater

Activity 7 comprises nine tasks, and will generate four deliverables. The deliverables are:

Deliverable 7.1	Wetland Typing and Ecoclassification Report, including delineation and literature review
Deliverable 7.2	Integrated groundwater and wetland water-resource units based on key drivers
Deliverable 7.3	Wetlands –EWR Report
Deliverable 7.4	Groundwater EWR Report.

5.7.1 Task 7.1: Literature review and acquisition of data

A literature review will be done to ensure that relevant information is incorporated into the wetlands components of the study. For the wetlands, key literature includes:

- Begg, G. (1986). The Wetlands of Natal (Part 1). An overview of their extent, role and present status. Natal Town and Regional Planning Report Volume 68, Pietermaritzburg, South Africa.
- Begg, G. (1988). The Wetlands of Natal (Part 2). The distribution, extent and status of wetlands in the Mfolozi basin. Natal Town and Regional Planning Report Volume 71, Pietermaritzburg, South Africa.
- Begg, G. (1989). The Wetlands of Natal (Part 3). The location status and function of the priority wetlands of Natal. Natal Town and Regional Planning Report Volume 73, Pietermaritzburg, South Africa.

- Botha, G.A. (1997). Maputaland Focus on the Quaternary evolution of the south-east African coastal plain, Field Guide and Abstracts. International Union for Quaternary Research INQUA), Pretoria, South Africa.
- Grundling, P and Blackmore, A. (1998). Peat fire in the Vasi Pan Peatland, Manzengwenya Plantation. Council for Geoscience Geological Survey, Pretoria, South Africa.
- Grundling, P.L.; Mazus, H. And Baartman, L. (1998). Peat resources in northern Kwazulu-Natal wetlands: Maputaland. Department of Environmental Affairs and Tourism, Pretoria, South Africa.
- Kotze, D.C. (1995). Background information on Mbongolwane Wetland to b e used for developing a management system. Department of Grassland Science and Institute of Natural Resources, Scottsville, 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.

For groundwater, the key literature includes:

- DWAF 1995a. Hydrogeological characterisation and mapping of the KwaZulu-Natal Province: Mapping unit 3. Groundwater Development Services. 58 pp. (excl. Annexures).
- DWAF 1995b. Hydrogeological characterisation and mapping of the KwaZulu-Natal Province: Mapping unit 5. E Martinelli and Associates123 pp. (excl. Annexures).
- DWAF 1995c. Hydrogeological characterisation and mapping of the KwaZulu-Natal Province: Mapping unit 7. Council for Scientific and Industrial Research. 38 pp. (excl. Annexures).
- DWAF 1998. 1:500 000 Hydrogeological map series of the Republic of South Africa. Vryheid 2730. 1st edition. Department of Water Affairs and Forestry.
- DWAF 1999. 1:500 000 Hydrogeological map series of the Republic of South Africa. Nelspruit 2530. 1st edition. Department of Water Affairs and Forestry.
- DWAF/DFID 2002a. Hydrology and economics in the Usutu-Mhlatuze Water Management Area. Report no. DSA/0424/0671/075/A. Water Management Area Company. 121 pp. (excl. Annexures).
- DWAF/DFID 2002b. Overview of the water resources of the Usutu-Mhlatuze Water Management Area. Tlou Water Management cc. 32 pp.
- Godfrey, L. and Todd, C. 2002. Ecological reserve determination for Lake Sibaya, Quaternary catchment W70A, KwaZulu Natal coastal plain. Integrated report. 12 pp.
- IGS/WGC (in press). Groundwater resource directed measures manual. 2nd edition. Water Research Commission. 90 pp.
- Kelbe, B. and Germishuyse, T. 2010. Groundwater/surface water relationships with specific reference to Maputaland. Report no. 1168/1/10. Water Research Commission. 225 pp.

- Meyer, R. and Godfrey, L. 2003. Report on the geohydrology around Lake Sibayi, northern Zululand coastal plain, KwaZulu-Natal. Report no. ENV-P-C 2003-003. CSIR. 16 pp.
- Parsons, R. and Wentzel, J. 2007. Groundwater resource directed measures manual. Report no. TT 299/07. Water Research Commission. 109 pp.
- Xu, Y., Colvin, C., Van Tonder, G.J., Hughes, S., Le Maitre, D., Zhang, J., Mafanya, T. and Braune, E. 2003. Towards the resource directed measures: groundwater component. Report no. 1090-2/1/03. Water Research Commission. 125 pp.

In addition, the following information is required from DWA:

- Status of General Authorisation levels;
- National Groundwater Database data;
- Data and information from DWA research drilling and pump testing programmes; and
- Water Use License information applicable to Usuthu-Mhlatuze WMA.

5.7.2 Task 7.2: Delineation and wetland typing

Available GIS datasets including the national wetland inventory and NFEPA wetland layer will be used as the base layer for the study. Information gathered from the above reports and associated spatial databases will then be added to improve the coverage and inform the prioritisation of the wetlands.

Areas where the wetland coverage is poor will be identified and indicated on the base map. Where appropriate and depending on the delineation and prioritisation of Resource Units (RU's), gaps will be filled using a desktop delineation. Every attempt will be made to capture all the priority wetland systems within the study area in the GIS layer. Use will also be made of 1:50 000 topographical maps, Google Earth Imagery and available aerial photography to support the production of the digital base map of the wetlands.

The hydrogeological characterisation and mapping exercise of the KwaZulu-Natal Province commissioned by the DWA in the mid-1990s produced 1:250 000 scale hydrogeological maps for mapping units 3, 5 and 7 in this province. Each of these maps is accompanied by a brochure (DWAF 1995a; 1995b; 1995c) carrying descriptive text of the groundwater resources in each mapping unit. These maps were subsequently aggregated to develop the 1:500 000 scale hydrogeological map sheets Vryheid (DWAF 1998) and Nelspruit (DWAF 1999). These maps and brochures collectively provide an excellent baseline and reference material for the GRDM study. The study by Dennis in 2013, together with comments provided by iSimangaliso WPA will also be referred to during the study.

5.7.3 Task 7.3: Geohydrological characterisation and aquifer boundaries

Wherever the datasets allow, the wetlands will be classified in accordance with the HydroGeoMorphic (HGM) classification system first described by Brinson (1993) and modified for application in South Africa by Marneweck and Batchelor (2002), Kotze et al.

(2009) and SANBI (2009). Where no classification exists on a dataset, the one provided will be used unless it is deemed necessary for the purpose of the study to convert it to the HGM system or a modification of this depending on the accuracy or coverage of the dataset and/or imagery available.

5.7.4 Task 7.4: Ecoclassification

Given the extent of the study area, and based on experience of the wetland databases available, it is expected that Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) information will not be available for most systems. As such, surrogate databases and information sources will be used to derive general state and ecological importance indicators. It is envisaged that regional and national land cover databases as well as river health and NFEPA information will be used as the baseline data for this purpose. Other databases will be sought from conservation and other government authorities to assist with the eco-classification. Field visits to representative and/or priority wetlands in selected identified RU's (WRU's and GW-WRU's) will be undertaken to verify the derived eco-classification. Where possible, grouped PES and EIS categories will be derived for the wetland complexes at a sub-basin level within each of the RU's. The A to F PES categories described by DWA (2013) and the low/marginal to very high EIS categories described in DWA (2013) will be used where appropriate or possible. Where this is not available, it will be generated on a desktop basis. The idea is to at least have some idea of the current state and ecological importance of the key wetlands in each RU.

5.7.5 Task 7.5: Identification of links between abstraction and wetland condition

This study offers the opportunity to explore the hydrophysical linkages between groundwater and wetlands, particularly considering the direct link between these along the coastal plain. Initial perceptions are that land type (and the associated soil forms) that are largely informed by the underlying geology (rock type) might provide this linkage. Although the hydrogeologic characteristics of the environment are informed by the geology below the water table, the nature of the regolith, and in particular the unsaturated zone of the near-surface weathered/decomposed rock strata, is most likely to provide the link between groundwater and wetlands. In this regard, land cover and vegetation type are also important as these also link closely with geology.

Based on discussions with between the wetland and groundwater team, linkages between groundwater and wetlands, particularly in terms of the key drivers of the latter, will be identified to the extent possible within the constraints of the available data. Outside of the coastal plain, wetlands, and particularly hillslope seepage wetlands, are most often associated with the unsaturated groundwater zone. It is envisaged that a surrogate indictor of this relationship, land type and associated soil form (ISCW-ARC), will be used for this purpose. Using this approach, the idea is, wherever possible, to come up with groundwater-wetland resource units that integrate these two components of RDM.

The aim is for the end product to represent integrated Wetland Resource Units (WRU's) and GroundWater-Wetland Resource Units (GW-WRU's).

Also of relevance in this regard is impact of mining activity on the groundwater and wetland environments. This is a particular concern in the upper reaches of the WMA where coal mining on the Mpumalanga Highveld poses a significant risk to groundwater quantity in the short-term (active phase of mining) and in the long-term (post-closure phase of mining).
The impact of SFRA on groundwater, wetlands and runoff will also be considered. Relevant studies, such as that by Dennis (2013) will be referred to.

5.7.6 Task 7.6: Ground truthing

It is impossible to compile a report that carries authority without exposure to the physical landscape of the study area. The groundwater and the wetland specialists will undertake a joint 5-day field trip, which will serve to assess the groundwater (with geology as proxy) and the wetland (with geomorphology as proxy) components in their field settings. The field visit will take place after the collection, assimilation, assessment and evaluation of all relevant and available geological and hydrogeological information and data.

5.7.7 Task 7.7: Integration workshops

At least two workshops will be held between the groundwater and wetland specialist teams. The aim of the workshops will be to reach consensus on the integration of the groundwater and wetland components insofar as this is plausible, reasonable and convincing within the constraints of data and time.

5.7.8 Task 7.8: Coarse-level water balance

Conceptual model and water balance for the lakes, wetlands and groundwater.
Give an idea on land use and degree of change/impact and pressures that can be allowed.

5.7.9 Task 7.9: Internal review and reporting

See deliverables.

5.8 Activity 8: St Lucia/Mfolozi Estuarine System Intermediate EWR

As discussed in Section 4.2.5.1 – The proposal is that St Lucia determination will use the outputs of an iSimangaliso (GEF-funded) study to generate an intermediate level EWR determination for the St Lucia/Mfolozi Estuarine System. The ongoing iSimangaliso project on the St Lucia and Mfolozi Estuarine is doing many of the tasks required for a Reserve

assessment, and as such it makes sense to use their models to do the Reserve assessment, rather than repeating the work.

Activity 8 is thus based on the assumption that the outputs of the iSimangaliso (GEF-funded) study can be made available to do the Reserve assessment.

DWA has agreed to seek permission for this on behalf of the study.

If permission is not obtained, the St Lucia/Mfolozi Estuarine System cannot be undertaken within the budget of this project.

The monies allocated to the Mfolozi estuary, has been redistributed to address the St Lucia/Mfolozi system. No budget was allocated to the St Lucia in the revised proposal to the Client.

Activity 8 comprises five tasks, and will generate three deliverables. The deliverables are:

Deliverable 8.1 St Lucia: Estuarine EWR Report
Deliverable 8.2 St Lucia: Ecospecification Report
Deliverable 8.3 St Lucia: Resource Monitoring Programme Report.

5.8.1 Task 8.1: Prepare hydrodynamic simulation data

A hydrodynamic model of the St Lucia has been prepared under the GEF St Lucia project, but this will need to be rerun for any additional inflow scenarios that require evaluation under the EWR study.

5.8.2 Task 8.2: Ecoclassification

Assigning an Importance Score and a Recommended Ecological Category will be completed as part of this study, based on a standard formula specified in the RDM methods for estuaries (DWA 2008, Turpie *et al*. 2013).

5.8.3 Task 8.3: Setting EWRs

The estuary team will assess the implications for the health of the estuary of seven freshwater inflow scenarios provided by the hydrological team. These will include Operational Scenarios and EWR scenarios which are devised in order to ensure a full range of health impacts is assessed for calibration purposes. The impacts of alternative flow scenarios on hydrodynamic functioning of the estuary will be assessed using a two dimensional fully hydrodynamic numerical model of the St Lucia/Mfolozi Estuarine System that is being set up and calibrated as part of the GEF St Lucia project. Impacts of changes in runoff and the hydrodynamic functioning on ecological health will in turn be evaluated using the model developed for the GEF study, based on the DRIFT model and adapted for use in estuaries as part of the GEF St Lucia project. Outputs from the model will be

assessed in ecological sequence by a team of estuary specialists and then discussed in a workshop setting, before being written up as a draft report.

Note: The hydrological simulations for the St Lucia GEF study included all the influent catchments for the St Lucia estuarine system and were prepared using the ACRU model (Smithers and Schulze 2004). It is assumed that simulation for any future water resources development scenarios to be evaluated as part of this project will be generated in consultation with the client. These scenarios will need to be generated using the ACRU model configured for the GEF study, otherwise they will not be comparable with the calibrated response curves in the GEF DRIFT DSS.

5.8.4 Task 8.4: Ecological specifications and monitoring programme

The Resource Quality Objectives (water quantity, quality, habitat and biota) will be defined for the estuary in accordance with the Recommended Ecological Category and alternate categories by each of the specialist in sequence, and will be discussed and finalised at the workshop.

Specific recommendations for future monitoring of the St Lucia estuarine system are being prepared as part of the GEF St Lucia project. These recommendations will take account of best practice and other criteria such as efficiency and affordability and will be discussed (and if necessary) amended and finalised at the estuary EWR workshop.

5.8.5 Task 8.5: Internal review and reporting

See deliverables.

5.9 Activity 9: Mlalazi Estuary Rapid EWR

Activity 9 comprises five tasks, and will generate three deliverables. The deliverables are:

Deliverable 9.1 Mlalazi: Estuarine EWR Report

Deliverable 9.2 Mlalazi: Ecospecification Report

5.9.1 Task 9.1: Data collection

As per the methodologies for EWRs for estuaries (DWA, 2004), the following abiotic and biotic components need to be addressed as part of a Rapid level study:

- Hydrodynamics;
- Water Quality;
- Microalgae;
- Macrophytes;
- Invertebrates;
- Fish; and

- Birds.

Field data collection is not a formal part of a rapid assessment (DWAF, 2004), and these studies will be based primarily on available information. However, as the request to lower the confidence of the study from an Intermediate to a Rapid was received after the initial data collection trip was held, this data will be utilised in the study. This also allowed the specialists to familiarise themselves with the study area and contextualise the existing data.

5.9.2 Task 9.2: Data analysis and specialist reporting

Specialist reports are not normally required for rapid level determinations (DWA, 2004). However, the specialists will prepare summary reports describing the present, naturalized and futures states of the system based on flow scenarios provided by the hydrologist and other team members, defining resource quality objectives and defining resource quality objectives for their respective components. Specialist reports will be included into the main Estuarine Ecological Water Requirement Report.

5.9.3 Task 9.3: Ecoclassification and setting of EWR

Team deliberations will take place in a workshop setting at the University of Zululand.

At the 2-day workshop the following will be determined for the Mlalazi Estuary:

- Present Status Category (using the Estuarine Health Index)
- Ecological Importance of the Estuary (based on Turpie *et al*. 2004)
- ECs associated with each of the run-off scenarios provided to the estuarine component
- Recommended EC (using the Present Status Category and Ecological Importance).
- Recommended Ecological Flow Scenario

Specialists will be required to assess data on their components and to prepare the ecological Reserve templates as required in terms of the methods (DWA, 2004).

5.9.4 Task 9.4: Ecological specifications

An additional workshop day will be allocated to derivation of discipline specific Estuarine Resource Quality Objectives (ERQOs) for the recommended EC to the extent possible within the limitations of a rapid assessment. ;

Rapid EWR assessments do not include delivery of a monitoring programme.

5.9.5 Task 9.5: Internal review and reporting

See list of deliverables.

5.10 Activity 10: Amatikulu Estuary Rapid EWR

Activity 10 comprises five tasks, and will generate two deliverables. The deliverables are:
Deliverable 10.1 Kosi: Estuarine EWR Report
Deliverable 10.2 Kosi: Ecospecification Report.
Due to the poor hydrology in the area, there will be no benefit in increasing the biological data collection as prescribed for an Intermediate Reserve study. Confidence in the findings will remain low and hence at a Rapid level.

5.10.1 Task 10.1: Data collection

As per the methods for the determination of EWRs for estuaries (DWAF 2004), the following abiotic and biotic components will be addressed as part of the rapid level study:

- Hydrodynamics
- Water Quality
- Microalgae
- Macrophytes
- Invertebrates
- Fish
- Birds.

Field data collection is not a formal part of a rapid assessment (DWAF 2004), and these studies will be based primarily on available information. However, limited data collection has been included in the budget for the rapid assessment to allow the specialists to (re)familiarise themselves with the study area and to contextualise the existing data.

5.10.2 Task 10.2: Data analysis and specialist reporting

Specialist reports are not normally required for rapid level determinations (DWAF 2004). However, summary reports will be prepared based on literature reviews and limited field sampling. The specialists will prepare summary reports describing the present, naturalized and futures states of the system based on flow scenarios provided by the hydrologist and other team members, defining resource quality objectives for their respective components. Specialist reports will incorporated into the main deliverables.

5.10.3 Task 10.3: Ecoclassification and setting of EWR

Following the methods for the determination of EWRs for estuaries (DWAF 2004) a two-day workshop will be convened. The following will be provided:

- Present Status Category (using the Estuarine Health Index).
- Ecological Importance of the Estuary (based on Turpie *et al*. 2004).
- ECs associated with each of the run-off scenarios provided to the estuarine component.
- Recommended EC (using Present Ecological Status Category and Ecological Importance).

- Recommended Ecological Flow Scenario.

Specialists will be required to assess data on their components and to prepare the ecological Reserve templates as required in terms of the methods (DWAF 2004).

5.10.4 Task 10.4: Ecological specifications

An additional workshop day will be allocated to derivation of Estuarine Resource Quality Objectives (ERQOs) for the recommended EC, to the extent possible within the limitations of a rapid assessment.

Rapid EWR assessments do not include delivery of a monitoring programme.

5.10.5 Task 10.5: Internal review and reporting

See list of deliverables.

5.11 Activity 11: Kosi Estuary Rapid EWR

Activity 11 comprises five tasks, and will generate two deliverables. The deliverables are:

Deliverable 11.1 Kosi: Estuarine RDM Report

Deliverable 11.2 Kosi: Ecospecification Report

5.11.1 Task 11.1: Data collection

As per the methods for the determination of EWRs for estuaries (DWAF 2004), the following abiotic and biotic components will be addressed as part of the rapid level study:

- Hydrodynamics
- Water Quality
- Microalgae
- Macrophytes
- Invertebrates
- Fish
- Birds.

Field data collection is not a formal part of a rapid assessment (DWAF 2004), and these studies will be based primarily on available information. However, limited data collection has been included in the budget for the rapid assessment to allow the specialists to (re)familiarise themselves with the study area and to contextualise the existing data.

5.11.2 Task 11.2: Data analysis and specialist reporting

Specialist reports are not normally required for rapid level determinations (DWAF 2004), however, summary reports will be prepare based on literature reviews and limited field

sampling. The specialists will prepare summary reports describing the present, naturalized and futures states of the system based on flow scenarios provided by the hydrologist and other team members, defining resource quality objectives for their respective components. Specialist reports will incorporated into the main deliverables.

5.11.3 Task 11.3: Ecoclassification and setting of EWR

Following the methods for the determination of EWRs for estuaries (DWAF 2004) a two-day workshop will be convened. The following will be provided:

- Present Status Category (using the Estuarine Health Index).
- Ecological Importance of the Estuary (based on Turpie *et al*. 2004).
- ECs associated with each of the run-off scenarios provided to the estuarine component.
- Recommended EC (using Present Ecological Status Category and Ecological Importance).
- Recommended Ecological Flow Scenario.

Specialists will be required to assess data on their components and to prepare the ecological Reserve templates as required in terms of the methods (DWAF 2004).

5.11.4 Task 11.4: Ecological specifications and monitoring programme

An additional workshop day will be allocated to derivation of Estuarine Resource Quality Objectives (ERQOs) for the recommended EC, to the extent possible within the limitations of a rapid assessment.

Rapid EWR assessments do not include delivery of a monitoring programme.

5.11.5 Task 11.5: Internal review and reporting

See list of deliverables.

5.12 Activity 12: Mhlatuze, Nhlabane and other existing lakes

Activity 12 comprises three tasks, and will generate one deliverable. The deliverable is:

Deliverable 12.1 Summary of relevant EWR information for Mhlatuze and Nhlabane Estuaries.

5.12.1 Task 12.1: Review existing studies

Existing EWR assessments will be sourced and reviewed to obtain their EWR assessments. Where necessary, these will be augmented with additional data to ensure the data are as compatible as possible with the results of this study.

5.12.2 Task 12.2: Reformat and incorporate into results

The existing data will be reformatted as appropriate, and if necessary adjusted for updated hydrology, so that they are comparable with the outcomes of this study.

5.12.3 Task 12.3: Internal review and reporting

See deliverables.

5.13 Activity 13: Lake Sibaya Intermediate EWR

Activity 13 comprises nine tasks, and will generate four deliverables. The deliverables are:

Deliverable 13.1 Lake Sibaya: Lake Ecological Water Requirement Report
Deliverable 13.2 Lake Sibaya: Ecospecification Report
Deliverable 13.3 Lake Sibaya: Resource Monitoring Programme Report.
Deliverable 13.4 DRIFT DSS populated for Lake Sibaya.

There is no EWR method developed for systems such as Lake Sibaya and we do not have a method as yet. For this component of the study we will look at previous Lake, river and estuary methods and take relevant sections from each. DRIFT will be used to organise the data, as it is best suited to this kind of dispirit data set

5.13.1 Task 13.1: Literature and available data/models review

A great deal of data has been collected on Lake Sibaya over the years, and numerous papers, reports and books have been written. The literature review will aim to synthesis information of relevant to the ecological water requirements, trajectories of change in the condition of Lake Sibaya. Where possible and available, data and models will be evaluated in terms of their appropriateness to the study.

5.13.2 Task 13.2: Delineation of the extent of aquifer

The boundaries of the aquifer supplying Lake Sibaya will be delineated using existing information. This will provide an indication of the scale and location of potential impacts on the systems. Chief among these is expected to be landuse changes in the catchment area of the aquifer.

This task will integrate with the tasks in Activity 8: Wetlands and Groundwater.

5.13.3 Task 13.3: Identification of biophysical indicators

The specialists will each choose a set of indicators that represents ecosystem attributes that are likely to be flow sensitive. The indicators must be objects (e.g. fish species) rather than processes (e.g. nutrient cycling) and will be described through changes in their abundance,

concentrations (for e.g. water quality) or extent/area (for e.g. vegetation). In total 20-30 biophysical indicators will be used.

5.13.4 Task 13.4: Summary of Geohydrological modelling results

Our investigations thus far have revealed several models that have been set up to investigate the impacts on water levels in the Lake Sibaya and adjacent wetlands associated with water use and threats from water use applications. For instance, a Mike SHE model has been established and calibrated by the North-West University for the catchment of Lake Sibaya, and the University of KwaZulu-Natal has set up a Mod-Flow model for the catchment. Task 12.1 will identify the models that have been used in the area, and permission will be sought to use them where applicable and desirable. The information in these models will be assessed to provide the basis for the EWR assessments of the lake, and to general water-levels for Lake Sibaya under different water use scenarios.

5.13.5 Task 13.5: Data collection and analysis

The following abiotic and biotic components will be addressed:

- Bathymetry
- Water Quality
- Microalgae
- Macrophytes
- Invertebrates
- Fish
- Birds.

A summary of the field studies to be undertaken for different components is provided below:

5.13.5.1 Abiotic components (hydrodynamics and water quality):

The bathymetric survey of the Lake Sibaya was assessed in 1999, and will be used to support the hydrodynamic modelling.

Existing water quality data for the Lake Sibaya, where available, will be collated and used to aid in the interpretation of biotic data to be collated/collected as part of this study. Additional water quality data will be collected at key points in the lake in the wet and dry season as part of the field data collection programme:

5.13.5.2 Microalgae

There will be two sampling sessions coinciding with a typical wet and dry season conditions. Simultaneous measurements of flow, light, salinity, temperature, nutrients and substrate type (for benthic microalgae) will be taken at the sampling stations during both the phytoplankton and benthic microalgal surveys.

5.13.5.3 Macrophytes

The macrophytes will be mapped using aerial photography, and ground-truthed during the field visit.

5.13.5.4 Invertebrates

Two field surveys, one in spring/summer and one in winter/autumn, will be conducted to collect data on invertebrates.

5.13.5.5 Fish

One survey in summer/spring and one survey in winter/autumn will be undertaken to sample the spectrum of species in the system.

5.13.5.6 Birds

Two field surveys, one in spring/summer and one in winter/autumn, will be conducted to count birds. Birds will be counted, noting their use of habitats.

5.13.6 Task 13.6: Ecoclassification

The Resource Quality Objectives (water quantity, quality, habitat and biota) will be defined for the lake by each specialist in accordance with the Recommended Ecological Category and will be discussed and finalised at the workshop.

Specific recommendations for future monitoring of the Lake Sibaya will also be prepared. These recommendations will take account of best practice and other criteria such as efficiency and affordability.

5.13.7 Task 13.7: Setting of EWR and scenarios analysis

The Lake Team will undertake an Intermediate determination of the ecological water requirements (EWR) of Lake Sibaya for maintaining three different ecological categories, *viz*.: A/B, B and C.

Team deliberations will take place in a workshop setting using the DRIFT DSS (Brown et al. 2013) to organise the data.

DRIFT is a scenario based method, and one the DRIFT-DSS has been populated any number of water-resource scenarios can be assessed. In this project, the scenario analysis phase will be used to check the EWRs for different ecological categories, and any other scenarios deemed appropriate to assess the impact of water use on the system.

5.13.8 Task 13.8: Ecological specifications and monitoring

The Lake Team will set ecological RQOs for Lake Sibaya for selected categories for flow, habitat, biota and water quality. The Lake Team will provide a summary programme to monitor the efficacy of the lake Ecological Reserve once it has been implemented.

5.13.9 Task 13.9: Internal Review and Reporting

See list of deliverables.

5.14 Activity 14: Socio-economic profile of study area

Activity 14 comprises five tasks, and will generate one deliverable. The deliverable is:
Deliverable 14.1 Socio-economic profile of the Usuthu-Mhlatuze WMA

5.14.1 Task 14.1 Delineate socio-economic zones

There are four main river systems in the Usutu to Mhlathuze WMA which exhibit different habitat from the water resources, wetlands and groundwater in each river. The direct and indirect use value of the ecosystem functions and services in each of these systems are likely to be different.

Therefore the first task is to delineate the socio-economic zones based on the ecosystem functions and services in each of the Mhlathuze, Mfolozi, Mkuze, Usutu and Pongola River system. This will include undertaking the following:

- Define the physical boundaries of the different river systems and identify the individuals, species and populations in a spatially defined area, the interactions among them, and those between the organisms and the abiotic environment. The ecological zones will be used as the point of departure while the economic activities will provide the scale of the socio-economic zones.
- Establish the hydrologic, economic and ecological linkages of the different river systems based on the community activities in the different river systems. This will be done by distinguishing a range of spatially defined ecological scales in each river system, types of wetlands, lakes, etc.
- Prepare a delineation map indicating the hydrology, the water resources systems and the economic activities taking place in each socio-economic including the land use activities of the zones.

5.14.2 Task 14.2 Identification of water use sectors

Based on the delineation of the socio-economic zones of the WMA, the following activities will then be conducted with a view to establish the socio-economic baseline of each zone:

- Describe the socio-economic activities taking place in each socio-economic zone. This will entail identifying and assessing the economic activities benefitting from the available water resources.
- Determine the available water or water used by each economic activity. In the case of the ecosystem functions and services, the available water necessary to generate these services will be estimated.
- Determine the economic value added (EVA) based on the employment per m^3, contribution to the GDP per m^3 of water where this is available and the impact on household income.

5.14.3 Task 14.3 Ecosystem Function and Services Identification and Assessment

Before determining the value of the ecosystem functions and services, the identification and assessment of the functions and services provided by the resource will be undertaken. The framework of the Millennium Ecosystem Assessment (MEA) will be used in the identification of the ecosystem functions and services.

5.14.3.1 Step 14.3.1 Identification of functions and services

With the delineation of the units of analysis for the socio-economic evaluation of the goods and services provided by the resource (surface water (rivers, wetlands and estuaries) and groundwater), the next task is to identify the ecosystem functions and services in each socio-economic zone. The MEA framework will be used to carry out the identification of the ecosystem functions and services in each zone. Table 5-3 below provides a list of the ecosystem functions and services that will be used to review the work conducted by Anchor Environmental and determine any gaps in the ecosystem services in each of the socio-economic zones in the Usutu to Mhlathuze water management.

Table 5-3. Ecosystem functions and services

Category	Description	Ecosystem services
Provisioning Services	Provisioning services reflect goods and services extracted from the ecosystem	• Food (Flood irrigation; fish, etc.) • Fodder (including grass from pastures • Fuel (including wood and dung) • Timber, fibres and other raw materials • Biochemical and medicinal resources • Genetic resources • Ornamentals
Regulation Services	Regulation services result from the capacity of ecosystems to regulate climate, hydrological and biochemical cycles, earth surface processes, and a variety of biological processes	• Carbon sequestration • Climate regulation through control of albedo, temperature and rainfall patterns • Hydrological service: regulation of the timing and volume of flows • Protection against floods by coastal or riparian systems • Control of erosion and sedimentation • Nursery service: regulation of species reproduction • Breakdown of excess nutrients and pollution • Pollination • Regulation of pests and pathogens • Protection against storms • Protection against noise and dust • Biological nitrogen fixation (BNF)
Cultural services	Cultural services relate to the benefits people obtain from ecosystems through recreation, cognitive development, relaxation, and spiritual reflection	• Provision of cultural, historical and religious heritage (e.g. a historical landscape or a sacred forest) • Scientific and educational information • Opportunities for recreation and tourism • Amenity service: provision of attractive housing and living conditions • Habitat service: provision of habitat for wild plant and animal species

5.14.3.2 Step 14.3.2 Screen the list for potential double counting of services

Once the list of the ecosystem functions and services is completed for each socio-economic zone, the list of the services will be screen for potential double counting. Specifically, there is

a risk of double counting in relation to the regulation services that support the supply of other services from an ecosystem.

In general, regulation services will only be included in the valuation if :

- they have an impact outside the ecosystem to be valued; and/or
- if they provide a direct benefit to people living in the area (i.e. not through sustaining or improving another service).

5.14.3.3 Step 14.3.3 Identification of stakeholders using the services

Stakeholders have four main attributes with respect to their interests in ecosystem services: (i) the type of resource use practiced by the stakeholders, (ii) level of influence (power) they hold, (iii) their degree of dependency on the ecosystem services (availability of alternatives), and (iv) the group/coalition to which they belong.

These attributes can be identified through various data collection methods, including interviews with catchment experts knowledgeable about stakeholders or with the actual stakeholders directly. It is clear that the stakeholders deriving benefits from an ecosystem may be just as diverse as the ecosystem services themselves.

Nevertheless, it is crucial to consider the differences in stakeholders when analyzing ecosystem services, as stakeholder interests and access rights will determine the interests and motivations of stakeholders in managing the resource, and management plans need to be fine-tuned with these interests in order to obtain stakeholder collaboration at different levels.

5.14.3.4 Step 14.3.4 Selection of indicators for ecosystem services

A number of indicators to quantify the ecosystem services will be develop to guide the quantification of the availability and use of the functions and services. The quantify for the provisioning services such as food, fuel (i.e. wood) and fodder can be determined by the amount of product harvested per year; Inputs required for harvesting (time, equipment, etc.); Total inputs and outputs in case the goods is used as input in a production process.

5.14.3.5 Step 14.3.5 Quantitative analysis of ecosystem services

The next step in the economic assessment is the quantification, in biophysical units, of the relevant ecosystem services identified in the previous step. This quantification is a prerequisite for the economic valuation to be undertaken in the next step of the assessment.

In order to quantify the ecosystem functions and services in each unit of analysis, questionnaires surveys will be conducted. This and key informant interviews will be carried out to obtain information on the quantities of the different ecosystem functions and services being used by the identified stakeholders or communities in each socio-economic zone.

Quantification of Provisioning Services

For provisioning services, surveys can reveal the flows of products harvested from the ecosystem, for instance expressed as kilograms of fruits or tons of timber harvested per time unit. It should also be examined if this flow can be extracted every year, of if this is a one-time harvest in order to establish the future supply of ecosystem services.

Quantification of regulation services

For the regulation services, the impact of vegetation on water flow, as a function of the topography, peak flows, vegetation cover, absorbing capacity of the soil, infiltration rates, etc. (see e.g. Bosch and Hewitt, 1982; in Case study 2, below). Storm protective capacity depends on vegetation structure, topography, and length and width of the vegetation belt.

In particular wetland ecosystems have the capacity to filter water and recycle plant nutrients and, to some extent, absorb inorganic pollutants. This function depends on the retention time of water in the ecosystem, the temperatures affecting plant growth rates, vegetation structure, etc. The difference in pollutant concentrations between water flowing in, and water flowing out of the system will be used as a measure of filtration capacity. Any changes in the water flow into and out of the wetland system will then be used to determine the value lost as a result of changes in wetland water flow.

5.14.4 Task 14.4 Summarise value of aquatic ecosystems

5.14.4.1 Task 14.4.1 Types of economic valuation

The economic value of a resource can be determined via individual preferences as expressed by willingness to pay (WTP) or willingness to accept (WTA) a change in the supply of that resource.The approach used in Anchor Environmental report will form the basis for determining the total economic value (TEV) of the identified and assessed ecosystem goods and services. The framework of the type of valuations that will be used is indicated in Table 5-4.

Table 5-4 Framework of the valuations

Value Type	Description
Direct use value	This value arises from the direct utilization of ecosystems, for example through the sale or consumption of a piece of fruit. All provisioning services and some cultural services (such as recreation) have direct use value.
Indirect use value	This value stems from the indirect contribution of ecosystems to human welfare. Indirect use value reflects, in particular, the type of benefits that regulation services provide to society.
Option value	Because people are unsure about their future demand for a service, they are normally willing to pay to keep the option of using a resource in the future – insofar as they are, to some extent, risk averse. Option values may be attributed to all services supplied by an ecosystem
None-use value	Non-use value is derived from knowing that an ecosystem or species is preserved without having the intention of using it in any way. Kolstad (2000) distinguishes three types of non-use value: existence value (based on utility derived from knowing that something exists), altruistic value (based on utility derived from knowing that somebody else benefits) and bequest value (based on utility gained from future improvements in the well-being of one's descendants).

It is important to note that these different values may or may not be reflected in a market value. In most cases, a significant part of the direct use value will be reflected in market transactions, but most of the other value types will not. They may not be reflected in market transactions because, for instance, they have a public goods character or because a market has not (yet) been established for the service. Because of the economic benefits they provide, the non-market economic values also need to be included in economic Cost-benefit assessment. These will be determined based on the Willingness to Pay (WTP) approach that will be used.

5.14.4.2 Task 14.4.2: Determination of economic value of services generated from the available water.

The economic valuation methods for ecosystem services that will be used differ for private and public goods as follows.

(i). Valuation of private goods.

In the case of private goods or services traded in the market, price is the measure of marginal willingness to pay and will be used to derive an estimate of the economic value of an ecosystem service in each socio-economic zone. These market prices for food such as fish or firewood, etc will be sourced from the Usutu to Mhlathuze catchment and used to determine the income generated per unit from the sale of these services. Where market prices are not available in the area, the prices at provincial or national level will be used as proxies.

Based on the estimated water available the income per unit of water available to generate the service will then be determined. This will form the basis of evaluating the impact or value changes with any changes in the water available and/or changes in the quantity of the service.

In addition the number of people benefiting from the availability of the service will also be determined.

(ii). Valuation of public goods

Different valuation types will be used for different types of services as illustrated in Table 5-5.

Table 5-5 Valuation for different types of services

Valuation method	Suitable for	Value category			
		direct use value	indirect use value	option value	non-use value
Indirect methods:					
1) Averting behavior method	Applicable to services that relate to the purification services of some ecosystems.	x	x		
2) Travel cost method	Can be used to value the recreation service.	x			
3) Production factor approach	Applicable where ecosystem services are an input into a production process.	x	x		
4) Hedonic pricing	Applicable where environmental amenities are reflected in the prices of specific goods, in particular property.	x	x		
Direct methods:					
5) CVM	The use of CVM is limited to goods and services that are easily to comprehend for respondents. This means that the method is usually not appropriate for valuation of regulation services.	x		x	x
6) Market valuation	Ecosystem goods and services traded on the market.	x	x	x	

5.14.4.3 Task 14.5 Internal review and reporting

See list of deliverables

5.15 Activity 15: Basic Human Needs Reserve

Activity 15 comprises four tasks, and will generate one deliverable. The deliverable is:
Deliverable 15.1 Basic Human Needs Reserves for the Usuthu-Mhlatuze WMA

5.15.1 Task 15.1 Estimate population directly dependent on resource

Communities likely to be reliant on run-of-river flow or groundwater are identified within the catchment using GIS-based or 1:50 000 topographical maps. Population numbers will be calculated using the latest available Census data at a sub-place level or the latest IDP/WSDP for the municipality.

Verification of dependency on the run-of-river flow against the reconciliation strategy for the area will be undertaken.

Once the current qualifying population dependent on run-of-river or direct groundwater use has been determined, the population will be projected to a sensible target, such as 10 or 20 years hence, using a generic growth rate applicable to the area within the Municipality.

5.15.2 Task 15.2 Scenarios of water use

Using the projected population numbers the BHNR is calculated per quaternary catchment (or at EWR nodes) at an allocation of 25 litres per person per day. Two other allocation scenarios will be considered, depending on the climatic conditions, lifestyles, culture and conditions of access to the water resource.

5.15.3 Task 15.3 Mapping

This task is closely linked with Task 15.1, where the communities are mapped over the quaternary catchments and water resources.

5.15.4 Task 15.4 Internal review and reporting

See deliverable list

5.16 Activity 16: Study Closure

Activity 16 comprises three tasks, and will generate four deliverables. The deliverables are:

Deliverable 16.1 Reserve templates for Usuthu-Mhlatuze WMA
Deliverable 16.2 Letter to the region for Reserves
Deliverable 16.3 Final Summary Report
Deliverable 16.4 Project Audit and Closure Report.

5.16.1 Task 16.1: Prepare Reserve templates

An integrated Reserve template incorporating the rivers, estuaries, wetlands, lakes and groundwater resources investigated in the WMA will be compiled.

5.16.2 Task 16.2: Prepare letter to the region

The letter to the Regional Office of DWA outlining the Reserves and management objectives to achieve or maintain the ecological health of the water resources in the WMA will also be prepared. The latest format/template for the Reserve and letter will be provided by the Client.

5.16.3 Task 16.2: Prepare Final Summary Report

This report will provide a summary of the project, in terms of the objectives, approach and methodology employed to achieve the objectives and the findings of the various investigations. The report will draw on all investigations undertaken and provide a holistic picture of the WMA and its EWR, including the RQOs that should be managed for. This document will serve as input to the Classification System and the stakeholder process.

5.16.4 Task 16.3: Prepare Project Audit and Closure Report

At the end of the project, a project audit and closure report will be prepared in order to:

- Review and validate the success of the project
- Confirm outstanding issues, risks and recommendations;
- Outline tasks and activities required to close the project
- Obtain approval from the Client to close the project.

6 STUDY TEAM

6.1 Changes since proposal

There have been some changes to the proposed consultant team since submission of the proposal:

- Rivers
  - Mark Rountree replaces Lindo Hlongwane as the geomorphologist. Lindo has changed career path.
  - Bruce Paxton replaces Johan Engelbrecht as the fish specialist. Johan passed away.
  - James McKenzie replaces Anton Linstrom as the riparian vegetation specialist.
  - Heather Malan replaces Peter Wade, as the water quality specialist. Peter is experiencing health problems.

- Estuaries
  - Susan Taljaard has been included on the team to provide guidance and support to M Mzimela on the water quality.
  - Jane Turpie, Barry Clark, Janine Adams, Nicky Forbes and Gerrit Basson will be included onto the team to undertake the Reserve determination for the St Lucia/Mfolozi system, provided iSimangaliso WPA and DWA reach agreement to use of the results of the GEF funded study in the determination.

6.2 Members of the study team

The members of the team and their positions on the team are provided in Table 6-1.

Table 6-1 Members of the team and their positions on the team

Person	Organisation	Reserve Component	Position on Team
MANAGEMENT			
Ms A Singh	Tlou Consulting	All	Project Manager/Rivers Team Leader
Mrs M Taylor	Tlou Consulting	All	Project Administration
Mr T Sibande	Tlou Consulting	Rivers	Project Co-ordinator
Ms C Engelbrecht	TGIS	All	GIS
Prof. C Brown	Southern Waters	All	DRIFT practitioner / Training / Internal Reviewer / Team Leader (Lake Sibaya & Pongola floodplain)
Dr A. Joubert	Southern Waters	Rivers	DSS Manager/Training
Mr K. Reinecke	Southern Waters	Rivers	Training
Mr A Greyling	Southern Waters	All	DSS programmer

Person	Organisation	Reserve Component	Position on Team
RIVERS			
Mr W Nyabeze	WRNA	River hydrology	Hydrologist / Modeller
Mr M Kleynhans	Aurecon	River hydraulics	Hydraulician
Mrs H Malan	Independent	Freshwater water quality	Water Quality
Mr M Rountree	Fluvius Environmental Consultants	River geomorphology	Geomorphologist
Mr J McKenzie	MacKenzie Ecological & Development Services CC	Rivers – Riparian vegetation	Vegetation specialist
Ms C Todd	Independent	Rivers - Macroinvertebrates	Macroinvertebrate specialist
Mr B Paxton	Independent	Rivers - Fish	Fish specialist
ESTUARIES / COASTAL LAKES			
Prof D Cyrus	CRUZ, University of Zululand	Estuaries and Coastal Lakes	Team leader / Reserve process management / Fish / Birds
Mr R Taylor	Private	Estuaries and Coastal Lakes	Macrophytes
Prof G Bate	Private	Estuaries and Coastal Lakes	Microalgae and Phytoplankton
Mr L Vivier	CRUZ	Estuaries and Coastal Lakes	Zoobenthos and Macrocrustacea / Vegetation mapping
Mr H Jerling			Zooplankton
Mr M Mzimela			Estuarine water quality
Ms L van Niekerk	CSIR	Estuaries and Coastal Lakes	Training – Estuarine Reserve process / hydrodynamics
Dr S Taljaard	CSIR	Estuaries and Coastal Lakes	Training - Estuarine water quality specialist
ST LUCIA / MFOLOZI			
Dr B Clark	Anchor	St Lucia / Mfolozi	To be decided
Dr J Turpie		St Lucia / Mfolozi	
Dr G Basson	ASP Technology	St Lucia / Mfolozi	
Prof J Adams	NMMU	St Lucia / Mfolozi	
Mrs N Forbes	iSimangaliso WPA	St Lucia / Mfolozi	
Prof D Cyrus	CRUZ	St Lucia / Mfolozi	
WETLANDS			
G Marneweck	Wetland Consulting Services	Wetlands	Task Leader - Wetlands
A Birkhead	Independent	Pongola Floodplain	Inundation modelling
GROUNDWATER			
P Hobbs	CSIR	Groundwater	Team Leader - Groundwater
E Kapangaziwiri	CSIR	Groundwater	Hydrogeologist
SOCIO-ECONOMICS			
Mr T Tlou	Tlou Consulting	Socio-Economics - Rivers/Wetlands/Lakes/Estuaries	Socio-economist / Scenario development
Mr W Mullins	Mosaka Economists	Socio-Economics	Economist

7 WORK PROGRAMME

A detailed implementation programme is provided in Section 7.1. The commencement date of the project is August **2013** and the completion date is July **2016**. The implementation programme will be used to schedule the resources to achieve the milestones of the project and to track progress.

7.1 Implementation programme

Table 7-1 provides the envisaged schedule of activities and tasks on the project. The gantt chart is attached as Appendix C.

Table 7-1 Project Workplan

Task	End	Total Cost
1) Project Management & DSS	2016/07/21	R1 547 480,00
1.1) Overall project coordination and management	2016/06/27	R204 000,00
1.2) PMC meeting	2016/03/09	R295 320,00
1.2.1) PMC meeting 1 - Initiation meeting	2013/08/23	R32 814,00
1.2.2) PMC meeting 2 - Inception	2013/11/06	R32 814,00
1.2.3) PMC meeting 3	2014/04/09	R32 814,00
1.2.4) PMC meeting 4	2014/08/05	R32 813,00
1.2.5) PMC meeting 5	2014/12/05	R32 813,00
1.2.6) PMC meeting 6	2015/03/09	R32 813,00
1.2.7) PMC meeting 7	2015/06/17	R32 813,00
1.2.8) PMC meeting 8	2015/11/26	R32 813,00
1.2.9) PMC Meeting 9	2016/03/09	R32 813,00
1.3) PSC Meetings (Stakeholder liaison)	2016/03/22	R222 760,00
1.3.1) Meeting 1	2014/04/22	R60 580,00
1.3.2) Meeting 2	2015/02/04	R51 620,00
1.3.3) Meeting 3	2016/03/22	R50 280,00
1.3.4) Scenario development	2014/08/18	R60 280,00
1.4) Focus discussion sessions	2016/03/08	R84 960,00
1.4.1) Session 1	2014/12/04	R28 320,00
1.4.2) Session 2	2015/11/25	R28 320,00
1.4.3) Session 3	2016/03/08	R28 320,00
1.5) Scenario selection	2014/07/18	R72 400,00
1.6) Technical monitoring & control (PMIS)	2016/07/21	R124 960,00
1.7) Financial control	2016/07/21	R318 400,00
1.8) Progress reporting	2016/07/19	R224 680,00
1.8.1) Progress report 1	2013/12/05	R28 380,00
1.8.2) progress report 2	2014/04/07	R24 800,00
1.8.3) progress report 3	2014/08/06	R24 500,00
1.8.4) progress report 4	2014/12/10	R24 500,00
1.8.5) progress report 5	2015/04/08	R24 500,00
1.8.6) progress report 6	2015/08/06	R24 500,00
1.8.7) Progress report 7	2015/12/16	R24 500,00
1.8.8) Progress report 8	2016/04/18	R24 500,00
1.8.9) Progress report 9	2016/07/19	R24 500,00
2) Project Inception	2014/03/20	R440 560,00

Task	End	Total Cost
2.1) Catchment Overview	2013/09/05	R7 080,00
2.2) Workplan refinement	2013/10/04	R196 080,00
2.3) Inception report	2013/10/04	R68 680,00
2.4) ToRs for team members	2013/10/22	R49 280,00
2.5) Team appointments and mobilisation	2013/11/12	R27 200,00
2.6) water resources prioritisation and delineation	2014/03/20	R78 640,00
2.7) PMIS implementation	2013/12/20	R13 600,00
3) Hydrology	2014/09/08	R426 000,00
3.1) Overview of hydrological data	2013/11/27	R15 680,00
3.2) daily data for seven sites	2014/04/01	R84 400,00
3.3) Monthly data for 51 nodes	2014/04/25	R84 400,00
3.4) ACRU modelling for Mfolozi basin	2014/07/28	R15 680,00
3.5) DRIFT analysis	2014/09/08	R41 040,00
3.6) Flow scenarios for rivers and estuaries	2014/07/09	R137 760,00
3.7) Internal review and reporting	2014/07/28	R47 040,00
4) Intermediate EWR for Rivers	2015/01/23	R2 092 560,00
4.1) Literature Review	2014/02/21	R119 200,00
4.2) Site selection	2014/03/20	R187 600,00
4.2.1) Site selection survey	2013/11/25	R120 000,00
4.2.2) Site selection report	2014/03/20	R67 600,00
4.3) Data collection	2014/09/12	R459 200,00
4.3.1) Data collection 1	2013/12/19	R161 400,00
4.3.2) Data collection 2	2014/09/12	R297 800,00
4.4) Data analysis and modelling	2014/10/24	R194 000,00
4.5) Ecoclassification	2014/08/29	R254 906,00
4.5.1) Ecoclassification	2014/08/29	R164 000,00
4.5.2) Ecoclassification report	2014/08/29	R90 906,00
4.6) Determine EWRs	2015/01/23	R596 160,00
4.7) Scenario Analysis	2014/10/27	R59 520,00
4.8) Resource Quality Objectives & Monitoring	2014/11/03	R40 160,00
4.9) Internal reviewing and reporting	2014/11/28	R181 814,00
4.9.1) EWR report	2014/09/30	R90 906,00
4.9.2) Specialist reports	2014/10/30	R25 000,00
4.9.3) Ecospecs report	2014/11/28	R65 908,00
5) Rapid EWR for Rivers	2015/03/30	R331 840,00
5.1) Ecoclassification	2014/10/03	R39 520,00
5.2) DRIFT/Desktop Extrapolation & Adjustments for key sites	2014/10/31	R162 400,00
5.3) Extrapolation to all 51 WRCS nodes	2014/11/17	R82 000,00
5.4) Internal review and reporting - River rapid Reserve EWR report	2015/03/30	R47 920,00
6) Pongola floodplain	2015/06/30	R787 920,00
6.1) Literature review	2013/10/25	R61 520,00
6.2) Data for gauge W4H013 and water level gauges along the floodplain	2013/11/01	R13 600,00
6.3) Survey water level gauges relative to MSL	2013/10/21	R34 000,00
6.4) Landsat 5 and 7 scenes	2013/11/15	R54 800,00
6.5) Inundation computations	2014/01/27	R81 600,00
6.6) Wetland typing and ecoclassification	2014/07/01	R20 800,00
6.7) Application of DRIFT (Prep & workshop)	2014/12/01	R333 760,00
6.8) RQOs and monitoring	2015/02/13	R24 560,00
6.9) Operating rules	2015/02/16	R20 960,00
6.10) Internal review and reporting	2015/06/30	R142 320,00
6.10.1) Inundation modelling report	2014/03/31	R35 580,00
6.10.2) Wetland typing and ecoclassification report	2014/09/29	R35 580,00

Task	End	Total Cost
6.10.3) EWR report (incl social concerns, recon for release)	2015/05/29	R35 580,00
6.10.4) DRIFT DSS pop for floodplain	2015/06/30	R35 580,00
7) Wetlands & Groundwater	2015/04/30	R1 057 680,00
7.1) Literature Review and acquisition of data	2013/11/28	R151 520,00
7.2) Delineation and Wetland Typing	2014/01/24	R52 000,00
7.3) Geohydrological characterisation and aquifer boundaries	2014/02/14	R96 000,00
7.4) Ecoclassification	2014/02/03	R78 000,00
7.5) Identification of links between abstraction and wetland condition	2013/12/13	R198 400,00
7.6) Ground truthing	2014/08/04	R93 040,00
7.7) Integration workshops	2014/09/04	R195 960,00
7.8) Coarse level water balance	2014/10/03	R89 520,00
7.9) Internal reporting and review	2015/04/30	R103 240,00
7.9.1) Groundwater EWR report	2015/04/30	R25 810,00
7.9.2) Wetlands EWR Report	2015/03/30	R25 810,00
7.9.3) Wetland typing and ecoclassification report	2014/10/30	R25 810,00
7.9.4) Groundwater and wetland resource units report	2014/12/22	R25 810,00
8) St Lucia/Mfolozi Intermediate EWR	2014/12/01	R546 800,00
8.1) Prepare hydrodynamic simulation model	2014/03/11	R197 120,00
8.2) Ecoclassification	2014/04/22	R47 360,00
8.3) Setting of EWRs	2014/05/14	R155 040,00
8.4) Ecological specifications and monitoring programme	2014/08/22	R60 160,00
8.5) Internal review and reporting	2014/12/01	R87 120,00
8.5.1) Resource Monitoring Programme report	2014/12/01	R12 120,00
8.5.2) Ecospecifications report	2014/10/30	R25 000,00
8.5.3) Estuarine EWR report	2014/09/30	R50 000,00
9) Mlalazi Estuary Intermediate EWR	2015/04/30	R555 560,00
9.1) Data collection	2013/11/26	R50 200,00
9.2) Data analysis and specialist report writing	2014/10/24	R218 480,00
9.3) Ecoclassification and setting of EWR	2014/12/12	R136 080,00
9.4) Ecological specifications and monitoring programme	2014/12/12	R58 320,00
9.5) Internal review and reporting	2015/04/30	R92 480,00
9.5.1) Estuarine EWR report	2015/03/30	R62 480,00
9.5.2) Ecospecifications report	2015/04/30	R30 000,00
10) Amatikulu Estuary Rapid EWR	2015/06/30	R433 840,00
10.1) Data collection	2014/04/21	R40 400,00
10.2) Data analysis and specialist report writing	2014/09/12	R154 720,00
10.3) Ecoclassification and setting of EWR	2015/04/03	R106 720,00
10.4) Ecological specifications	2015/04/15	R55 120,00
10.5) Internal review and reporting	2015/06/30	R76 880,00
10.5.1) Ecospecifications report	2015/06/30	R26 000,00
10.5.2) Estuarine EWR report	2015/05/28	R50 880,00
11) Kosi Estuary rapid EWR	2015/10/30	R589 360,00
11.1) Data collection	2014/04/25	R99 120,00
11.1.1) Delineation	2014/03/07	R21 520,00
11.1.2) Fieldwork	2014/04/25	R77 600,00
11.2) Data analysis and specialist report writing	2014/10/20	R216 480,00
11.3) Ecoclassification and setting of EWR	2014/12/02	R154 720,00
11.4) Ecological specifications	2014/11/25	R38 960,00
11.5) Internal review and reporting	2015/10/30	R80 080,00
11.5.1) Estuarine EWR report	2015/09/30	R55 080,00
11.5.2) Ecospecifications report	2015/10/30	R25 000,00

Task	End	Total Cost
12) Mhlatuze, Nhlabane and other existing estuary review EWRs	2015/07/30	R60 800,00
12.1) Review existing studies	2015/05/22	R32 480,00
12.2) Reformat and incorporate into results	2015/06/04	R14 160,00
12.3) Internal review and reporting	2015/07/30	R14 160,00
12.3.1) Summary report	2015/07/30	R14 160,00
13) Sibaya Lake Intermediate EWR	2016/02/29	R1 157 040,00
13.1) Literature and available data/models review	2014/01/16	R239 280,00
13.2) delineation of the aquifer	2014/03/14	R14 720,00
13.3) Identification of biophysical indicators	2014/04/29	R46 320,00
13.4) Summarise geohydrological modelling results	2014/04/29	R43 040,00
13.5) Data collection and analysis	2014/07/11	R397 920,00
13.6) Ecoclassification	2014/10/29	R45 760,00
13.7) Setting of EWR and scenario analysis	2015/06/10	R198 800,00
13.8) Ecological specifications and monitoring programme	2015/06/29	R45 760,00
13.9) Internal review and reporting	2016/02/29	R125 440,00
13.9.1) Lake EWR Report	2015/10/30	R125 440,00
13.9.2) Ecospecifications report	2015/11/30	
13.9.3) Resource Monitoring Programme report	2015/11/30	
13.9.4) DRIFT-DSS populated	2016/02/29	
14) Socioeconomic profile	2014/03/31	R384 800,00
14.1) Delineate socio-economic zones	2013/11/13	R36 800,00
14.2) Identify water use sectors	2013/11/20	R87 200,00
14.3) Ecosystem function and services identification and assessment	2013/12/13	R16 400,00
14.4) Summarise value of aquatic ecosystems	2014/01/27	R120 000,00
14.5) Internal review and reporting	2014/03/31	R124 400,00
14.5.1) Socio-economic profile of the WMA	2014/03/31	R124 400,00
15) Basic Human Needs Reserve	2014/11/20	R73 600,00
15.1) Estimate population directly dependent on resource	2014/11/11	R28 400,00
15.2) Scenarios of water use	2014/11/20	R27 200,00
15.3) Mapping	2014/02/04	R11 200,00
15.4) Internal review and reporting: BHNR report	2014/03/31	R6 800,00
16) Study Closure	2016/06/20	R188 560,00
16.1) Prepare Reserve templates	2016/03/08	R70 160,00
16.2) Prepare letters to Region	2016/03/09	R27 760,00
16.3) Final summary report	2016/04/22	R63 440,00
16.4) Preparation of Project audit and closure report	2016/06/20	R27 200,00

7.2 Sub-tasks on the critical path

7.2.1 TASKS ON THE CRITICAL PATH

The tasks on the critical path for this project are shown in chronological order below. Also shown are key inputs/decisions required from the Client. Delay in one or more of the deliverables from these sub-tasks, or in decisions and data provision, will result in an overall delay in the project.

Task 2.4: Inception report
ACCEPTANCE OF INCEPTION REPORT AND AGREEMENT WITH ISIMANGALISO
Task 4.2: Team appointments and mobilisation.
Task 4.2: River: site selection
Task 4.3: River: Data collection
Task 9.1: Mlalazi: Data collection
Task 10.1: Amatikulu: Data collection
Task 11.3: Kosi: Data collection
Task 13.5: Lake Sibaya: Data collection
Task 14.4: Socio-economics: Valuation of the aquatic goods and services

Note: The approval of the Inception Report, which necessitates discussion and agreement with iSimangaliso, is an immediate item on the critical path. Given the delays that have already ensued in the commencement of this project[5], it is essential that the project plan is approved timeously, failing which the project will be delayed by six-months, and the budget will require readjustment.

[5] 10 months between acceptance of the proposal and a final contract.

8 DELIVERABLES AND LINEAR RESPONSIBILITIES

8.1 Milestone list

The milestone list and anticipated dates of delivery are provided in Table 8-1

Table 8-1 Milestone list

Milestone		Due Date
Activity 1: Project management		
Deliverable 1.1	Quarterly progress reports.	Every three months
Deliverable 1.2	Milestone invoices.	On delivery
Deliverable 1.3	Minutes of client meetings.	2 weeks after meetings
Activity 2: Inception		
Deliverable 2.1	Inception Report	30 September 2013
Deliverable 2.2	Prioritisation and delineation of water resources	March 2014
Activity 3: Hydrology		
Deliverable 3.1	River Baseline Hydrology report	October 2014
Deliverable 3.2	Scenario hydrology report	November 2014
Deliverable 3.3	Hydrology datasets required for river and estuary EWR assessments	August 2014
Activity 4: Intermediate EWR for Rivers		
Deliverable 4.1	River delineation and site selection (included in deliverable 2.2)	March 2014
Deliverable 4.2	Data Collection Trip Report 1	January 2014
Deliverable 4.3	Data Collection Trip Report 2	July 2014
Deliverable 4.4	River Ecoclassification Report	August 2014
Deliverable 4.5	River IRD – Specialist Reports	October 2014
Deliverable 4.6	River IRD – EWR Report	September 2014
Deliverable 4.7	River IRD – Ecospecs	November 2014
Deliverable 4.8	DRIFT-DSS populated for eight sites	December 2014
Activity 5: Rapid EWR for Rivers		
Deliverable 5.1	River RRD – EWR Report	March 2015
Activity 6: Pongola Floodplain		
Deliverable 6.1	Inundation Modelling Report	March 2014
Deliverable 6.2	Wetland Typing and Ecoclassification Report	September 2014
Deliverable 6.3	Pongola Floodplain – EWR Report (including the social concerns & recommended rules for Dam releases)	May 2015
Deliverable 6.4	DRIFT_DSS populated for Pongola floodplain	June 2015

Milestone		Due Date
Activity 7: Wetlands and Groundwater		
Deliverable 7.1	Wetland typing and ecoclassification report (incl delineation and literature review)	Oct 2014
Deliverable 7.2	Integrated groundwater and wetland water resource units based on key drivers	December 2014
Deliverable 7.3	Wetlands EWR report	March 2015
Deliverable 7.4	Groundwater EWR report	April 2015
Activity 8: St Lucia/Mfolozi		
Deliverable 8.1	Estuarine EWR report	September 2014
Deliverable 8.2	Ecospecifications report	October 2014
Deliverable 8.3	Resource Monitoring Programme report	November 2014
Activity 9: Mlalazi Estuary Intermediate EWR		
Deliverable 9.1	Estuarine EWR report	March 2015
Deliverable 9.2	Ecospecifications report	April 2015
Activity 10: Amatikulu Estuary Rapid EWR		
Deliverable 10.1	Estuarine EWR report	May 2015
Deliverable 10.2	Ecospecifications report	June 2015
Activity 11: Kosi Estuary Rapid EWR		
Deliverable 11.1	Estuarine EWR Report	September 2015
Deliverable 11.2	Ecospecifications report	October 2015
Activity 12: Mhlatuze, Nhlabane and other existing EWRs		
Deliverable 12.1	Summary of relevant EWR information for Mhlatuze & Nhlabane estuaries	July 2015
Activity 13: Lake Sibaya Intermediate EWR		
Deliverable 13.1	Lake EWR Report	October 2015
Deliverable 13.2	Ecospecifications report	November 2015
Deliverable 13.3	Resource Monitoring Programme Report	November 2015
Deliverable 13.4	DRIFT-DSS populated	February 2016
Activity 14: Socio-economic profile of study area		
Deliverable 14.1	Socio-economic report	March 2014
Activity 15: Basic Human Needs Reserve		
Deliverable 15.1	Basic Human Needs Reserve report	March 2014
Activity 16: Study Closure		
Deliverable 16.1	Reserve templates	March 2016
Deliverable 16.2	Letter to the Region	March 2016
Deliverable 16.3	Final Summary report	April 2016
Deliverable 16.4	Project audit and Closure report	June 2016

8.2 Linear responsibility and staffing

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

8.2.1 Overall project leadership

Ms Adhishri Singh is the Project Leader and will take responsibility for overall project leadership. She will be assisted by:

Technical and quality control:	Dr Cate Brown
DSS management:	Dr Alison Joubert
Administrative:	Mrs Magda Taylor & Mr Tobias Sibande
Financial:	Mrs Magda Taylor

8.2.2 Activity leadership

Activity leaders will each take responsibility for administrative and technical control for each of the following study components:

Rivers	Ms Adhishri Singh.
Estuaries	Dr Digby Cyrus.
Lake Sibaya	Dr Cate Brown.
Water Quality	Dr Heather Malan.
Groundwater	Mr Phil Hobbs.
Wetlands	Mr Gary Marneweck
Socio-economics	Mr Toriso Tlou.

8.2.3 Specialist activities

Individual specialist will take responsibility for execution of their tasks according to the TORs issued to them. The specialists involved in each of the study components are listed in Table 6-1.

The linear responsibility organogram is provided in Figure 8-1.

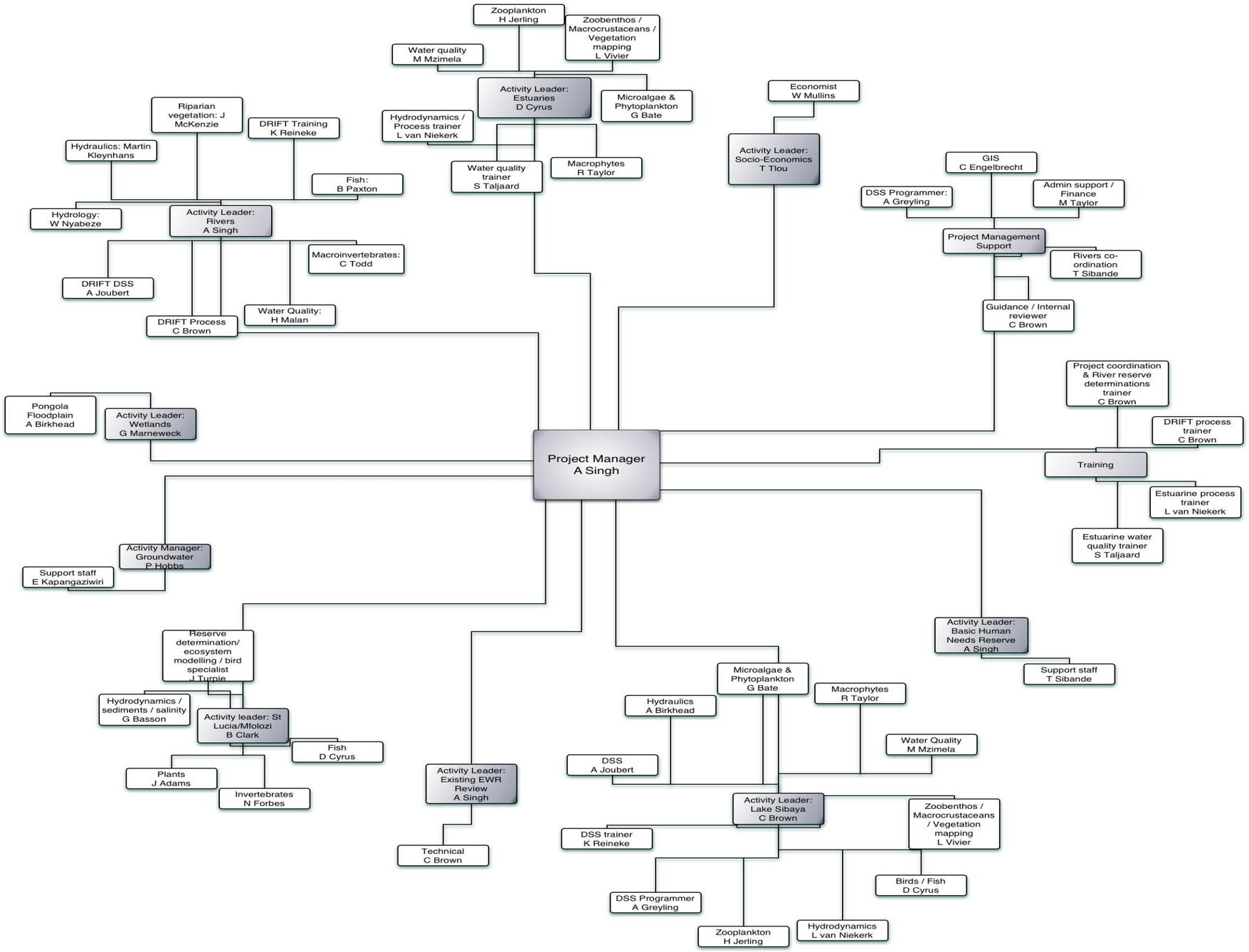

Figure 8-1 Linear responsibility organogram

9 PROJECT BUDGET AND CASHFLOW

This section includes the following items:

- Summary of cost estimate per task
- Summary of the total estimated study budget
- Cash flow diagram.

9.1 Professional fees estimate by task

There have been slight adjustments of the budget to facilitate the change in focus and effort required to achieve the objectives of the assignment, and the professional fees have been revised to reflect the update tasks and approach. The total study cost estimate is, however, unchanged.

Table 9-1 provides detailed professional fees and disbursements per task excluding VAT.

Table 9-1 Summary of professional fees and disbursements per task (excl VAT)

	PROFESSIONAL FEES				
TASK DESCRIPTION	TOTAL HOURS	TOTAL DAYS	COST	DISBURSEMENTS	TOTAL COST
Task 1: Project management	1944	243	R 1 547 480,00	R 212 260,00	R 1 759 740,00
Task 2: Project inception	532	67	R 440 560,00	R 23 960,00	R 464 520,00
Task 3: Hydrology	448	56	R 426 000,00	R 40 000,00	R 466 000,00
Task 4: Intermediate river EWRs	2 920	365	R 2 092 560,00	R 297 200,00	R 2 389 760,00
Task 5: Rapid River EWRs	448	56	R 331 840,00	R -	R 331 840,00
Task 6: Pongola Floodplain	952	119	R 787 920,00	R 78 600,00	R 866 520,00
Task 7: Wetlands and Groundwater	1 392	174	R 1 057 680,00	R 120 120,00	R 1 177 800,00
Task 8: St Lucia/Mfolozi Intermediate EWR	488	61	R 546 800,00	R 27 440,00	R 574 240,00
Task 9: Mlalazi Estuary Intermediate EWR	916	115	R 555 560,00	R 13 730,00	R 569 290,00
Task 10: Amatikulu Estuary Rapid EWR	712	89	R 433 840,00	R 142 070,00	R 575 910,00
Task 11: Kosi Estuary Rapid EWR	976	122	R 589 360,00	R 167 070,00	R 756 430,00
Task 12: Mhlatuze, Nhlabane and other existing estuary review EWRs	72	9	R 60 800,00	R -	R 60 800,00
Task 13: Sibaya Lake Intermediate EWR	1 880	235	R 1 157 040,00	R 198 000,00	R 1 355 040,00
Task 14: Socioeconomic profile	400	50	R 384 800,00	R 26 100,00	R 410 900,00
Task 15: Basic Human Needs Reserve	112	14	R 73 600,00	R -	R 73 600,00
Task 16: Study closure	248	31	R 188 560,00	R -	R 188 560,00
Contingency			R 314 057,70	R 28 931,00	R 342 988,70
Total	**14 440**	**1 805**	**R 10 988 457,70**	**R 1 475 481,00**	**R 12 463 938,70**

9.2 Total estimated study budget

Table 9-2 summarises the total budget as reflected in the contract agreement. It is important to note that the study budget in the contract does not include escalation in professional fee rates. The Client has indicated that an application to increase the rates after a year of the project is possible, however the total increase in project cost should be within a certain percentage of the budget, which has not been made known to the PSP. Also, the Client has indicated that, if necessary and within reason, monies may be moved between tasks and

between professional fees and disbursements provided the agreed project cost is not affected. Changes will be communicated to the Client.

Table 9-2 Summary of the study budget

Item	Description	Budget Estimate
1	Professional Fees	R10 988 457,71
2	Disbursements and expenses	R1 475 481,00
	Sub-total	R12 463 938,71
	VAT at 14%	R1 744 951,42
Total study cost		**R14 208 890,13**

9.3 Equity Participation

Table 9-3 provides the equity participation in terms of time and cost on the project. This is the minimum participation rate that will be maintained on the project.

Also contained in this table are the revised charge-out rates of the team members. Professional charge-out rates have been increased from those provided in the proposal, as a year has passed since submission of these rates. The increase was based on CPI. However, no impact on the overall budget of the project was incurred.

Table 9-3 Charge-out rates, Professional fees and Equity Participation

Personnel	Position in team	Gender	Race	Rate (R/hr)	No of hours	Cost (R)	HDI Participation		% HDI Participation	
							Time	Cost	Time	Cost
A Singh	Project Manager / Rivers Activity Leader	F	I	850	2444	R 2 077 400,00	2444	R 2 077 400,00	17	19
M Taylor	Admin support	F	W	350	288	R 100 800,00	288	R 100 800,00	2	1
C Engelbrecht	GIS	F	W	700	104	R 72 800,00	104	R 72 800,00	1	1
T Sibande	Field Assistant / Rivers Co-ordinator	M	B	450	344	R 154 800,00				
C Brown	Process Manager	F	W	920	1316	R 1 210 720,00	1316	R 1 210 720,00	9	11
A Joubert	DSS Manager	F	W	750	528	R 396 000,00	528	R 396 000,00	4	4
Andre Greyling	DSS programmer	M	W	750	88	R 66 000,00				
K Reinecke	DSS Trainer	M	W	650	120	R 78 000,00				
W Nyabeze	Hydrologist	M	B	980	464	R 454 720,00	464	R 454 720,00	3	4
M Kleynhans	River hydraulician	M	W	800	296	R 236 800,00				
H Malan	River Water Quality	F	W	650	328	R 213 200,00	328	R 213 200,00	2	2
M Rountree	Geomorphology	M	W	650	344	R 223 600,00				
J Mackenzie	Riparian vegetation	M	W	650	328	R 213 200,00				
C. Todd	Macroinvertebrates	F	W	650	336	R 218 400,00	336	R 218 400,00	2	2
B. Paxton	Fish	M	W	650	344	R 223 600,00				
G Marneweck	Wetlands	M	W	650	880	R 572 000,00				
A Birkhead	River/floodplain hydraulican	M	W	850	460	R 391 000,00				
P Hobbs	Groundwater Activity Leader	M	W	855	424	R 362 520,00				
E Kapangaziwiri	Groundwater Support	M	B	690	128	R 88 320,00				
D Cyrus	Estuarine Activity Leader / Birds / Fish specialist	M	W	700	804	R 562 800,00				
D Cyrus	Estuarine Activity Leader / Birds / Fish specialist	M	W	350	172	R 60 200,00				
R. Taylor	Macrophytes	M	W	500	264	R 132 000,00				
R. Taylor	Macrophytes	M	W	350	112	R 39 200,00				
G. Bate	Microalgae and Phytoplankton	M	W	500	260	R 130 000,00				
G. Bate	Microalgae and Phytoplankton	M	W	350	112	R 39 200,00				
L Vivier	Zoobenthos / Macrocrustaceans / Veg mapping	M	W	500	572	R 286 000,00				
L Vivier	Zoobenthos / Macrocrustaceans / Veg mapping	M	W	350	200	R 70 000,00				
H Jerling	Zooplankton	M	W	500	260	R 130 000,00				
H Jerling	Zooplankton	M	W	350	104	R 36 400,00				
M Mzimela	Water quality	M	B	500	344	R 172 000,00	344	R 172 000,00	2	2
L v Niekerk	Hydrodynamics / Estuarine process trainer	F	W	820	560	R 459 200,00	560	R 459 200,00	4	4
S Taljaard	Estuarine water quality trainer	F	W	910	64	R 58 240,00	64	R 58 240,00	0	1
B Clark	St Lucia Activity Leader	M	W	800	96	R 76 800,00				
J Turpie	Reserve practitioner / modelling / bird specialist	F	W	800	120	R 96 000,00	120	R 96 000,00	1	1
J Adams	Plants	F	W	800	40	R 32 000,00	40	R 32 000,00	0	0
D Cyrus	Fish	M	W	800	48	R 38 400,00				
N Forbes	Invertebrates	F	W	800	40	R 32 000,00	40	R 32 000,00	0	0
G Basson	Hydrodynamics / sediments / salinity	M	W	1920	144	R 276 480,00				
T Tlou	Socio-Economics / Scenario development	M	B	1200	336	R 403 200,00	336	R 403 200,00	2	4
W Mullins	Economist	M	W	850	224	R 190 400,00				
TOTAL					**14440**	**R10 674 400,00**	**7312**	**R 5 996 680,00**	**51**	**56**

9.4 Cashflow

Figure 9-1 presents the predicted monthly cash flow requirements for professional fees and disbursements excluding VAT. The cumulative cash flow programme is reflected in **Figure 9-2.**

There are a few periods when no invoicing will take place. This is because it is between sampling, analysis and the workshops. The expenditure will be quite small during these periods and will run over to the next month.

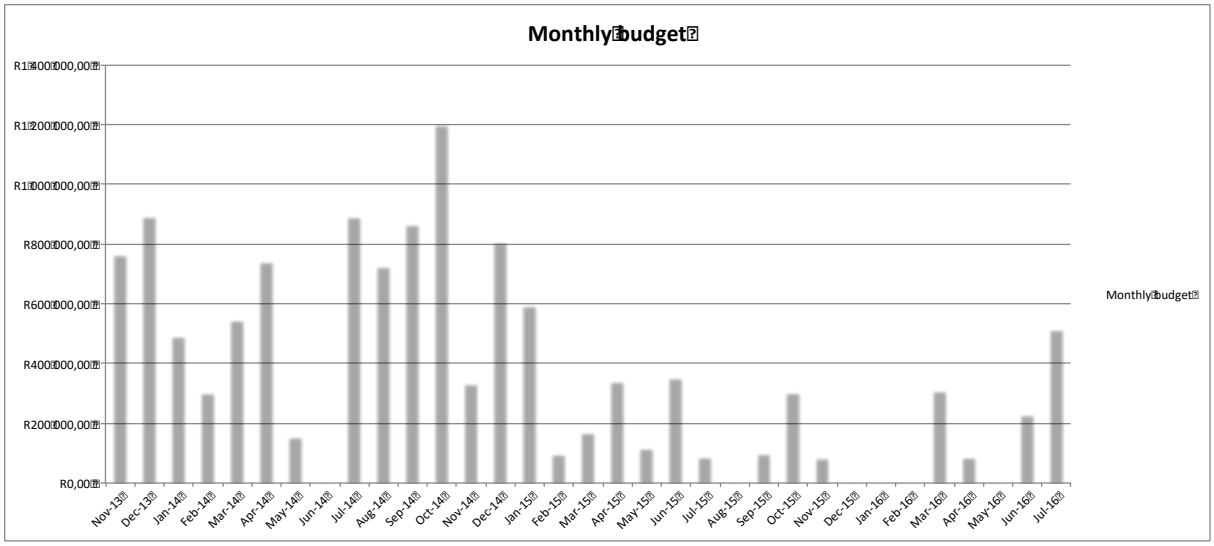

Figure 9-1 Monthly cash flow projection

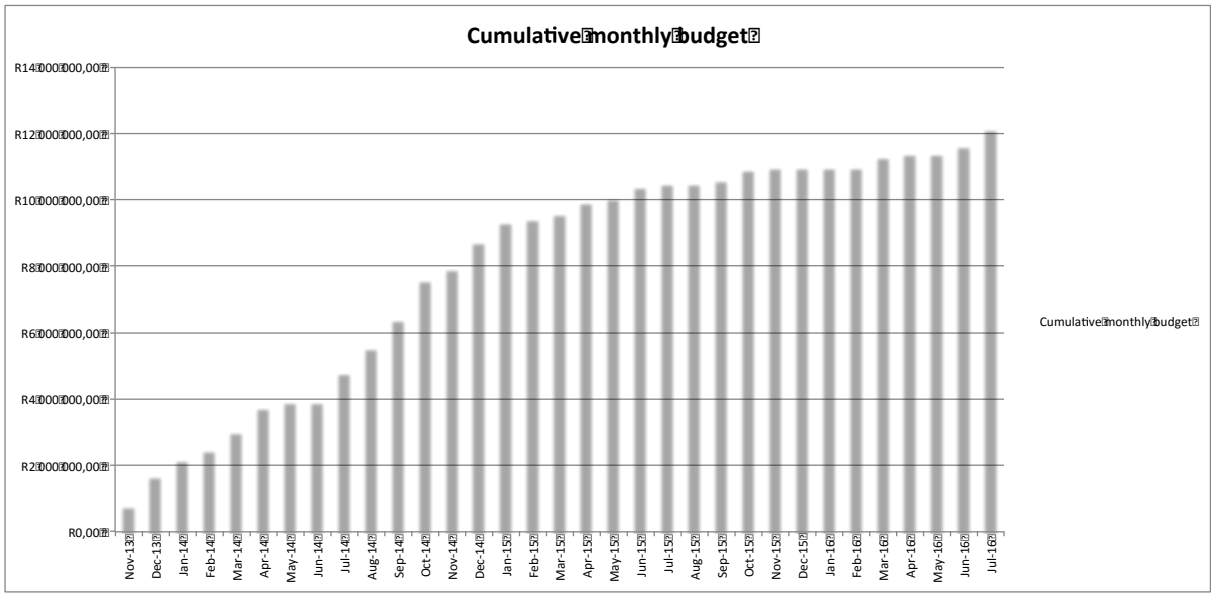

Figure 9-2 Cumulative cash flow projection

10 PROJECT MANAGEMENT INFORMATION MANAGEMENT CONTROL SYSTEM

The Gantt chart detailing progress per Task against programme (Section 7.1 and Appendix C), the Cash Flow Projections (Section 9.4), and the Deliverables (Section 8.1) against budget (Section 9.1) together provide the basis for financial monitoring and control. These will be submitted to the Client for review as part of the six-monthly progress reporting (Appendix A). In addition, a short performance report will accompany each invoice.

These monitoring measures will be augmented by the following control measures:

1. Clear and concise briefs to each Activity Leader, detailing their programme of work, budget and schedule of deliverables. These are to be sent to specialists once the Inception Report has been accepted, they will require team members to sign an agreement to complete the work in the time and budget allocated.
2. Sub-consultant performance management.
    a. Team members not adhering to the agreed schedules will be queried as to the reasons for performance failure and assisted where possible to meet their agreed terms.
    b. Payment will only be made on evidence of the relevant tasks having been undertaken.
    c. At least 10% of each team member's budget for each Task will be withheld until that task has been completed to the satisfaction of the Activity Leaders and Project Leader.
    d. 5% of each team member's budget will be permanently withheld for report contributions that are not formatted according to that required for this project (style sheet to be provided with ToRs). This money will be used to pay someone else to format their contribution.
    e. Team members will be replaced if necessary.

11 ASSUMPTIONS AND LIMITATIONS

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

Availability of team members: We have assumed that all Team members will be available at the times indicated in the schedule, but it is inevitable that the proposed schedule will need to be modified to accommodate clashes with other activities.

Biological sampling: The budget makes provision for limited biological sampling in accordance with DWA Reserve determination protocols. It is acknowledged that additional biological sampling would add confidence to the results, however, it is not possible at this stage to determine how much additional sampling would result in a significant benefit to the study – this is only possible once the planned sampling has been undertaken.

Contingency: The budgets for the specialists will be slightly reworked to provide some in-house contingencies but there are no formal contingencies included in the budget.

Lump sum: We have assumed that monies can be moved between tasks and between personnel and disbursements as required to affect successful completion of the project as laid out in the inception report, provided the total budget is not exceeded.

Escalation: Escalation is excluded from the budget, i.e., no escalation in 2013. However, as indicated by the Client, escalation can be applied for in 2014/15 and 2015/16. Escalation amounts have not been included in the budget

External review: The budget does not make provision for external review. Limited internal review is however included in the budget.

Habitat integrity: The budget excludes an aerial survey. Habitat integrity will be assessed on the basis of existing information and information that can be readily collected from road surveys. This will be augmented by existing information.

River Hydraulics: We have budgeted for two field visits to measure river hydraulics and take fixed-point photographs. There is no budget to replace reference pegs should these be vandalised or swept away by floods and the budget excludes the costs of geo-referencing EWR profiles.

Hydrology: The St Lucia budget assumes that we can use the ACRU hydrological data modelled for the St Lucia catchments.

Observers: The budget excludes the costs for observers or associates of the Client or other Interested and Affected Parties who may attend site visits or meetings. These will be billed separately.

Client meetings: The budget makes provision for 12 Client meetings, all in Pretoria. Our budget has assumed that these meetings carry no cost to the project other than time and reimbursements to the team.

Schedule: Delays in various project activities may result in problems with the timing of later activities, and this may require re-scheduling that could affect the budget. We have assumed that the Client will respond with comments and feedback on all reports within one (1) month of submission, and that reports will be finalised following one (1) iteration of editing.

Social assessment: It will not be practically possible for all ecosystem functions and services to be identified and when identified, quantified in all cases. Assumptions will therefore be made more on the changes in quantity or impact with changes in the drivers of the services namely changes in the available water to generate the ecosystem functions and services. Where values cannot be determined, the benefit transfer approach will be used to value the functions and services.

In addition, the valuation of the functions and services will not all be quantified as there are some of those services that have values that cannot be quantified. Therefore some of the services will be qualified and the extent and significance of these services will be described

Reporting: We have budgeted for the printing, binding and distribution costs of two (2) draft and two (2) final copies, as well as one (1) CD containing a .doc and .pdf file of all reports (page estimates). Copies and binding of reports will be charged according to DWA rates.

11.1 Reserve team meetings

The budget makes provision for the following team meetings only:

11.1.1 River – Intermediate Reserves

Planning meeting:	3-hour meeting in Pretoria.
DRIFT Introduction:	3-hour meeting in Pretoria
Site selection:	9-day site selection trip
First data collection:	1-day site visit to each EWR site
Second data collection:	1-day site visit to each EWR site
Ecoclassification meeting	2-day ecoclassification meeting in Pretoria.

EWR Workshop: Two 5-day workshops.

11.1.2 Pongola Floodplain

Site visit & data collection: 5 day data collection trip

11.1.3 Estuary – Intermediate Reserves

Planning meeting: 3-hour meeting in Pretoria.
DRIFT Introduction: 3-hour meeting in Pretoria
Site selection & data collection 5-day site selection and data collection trip

11.1.4 Estuary – Rapid Reserves

Site selection and Data collection 5-day site selection & data collection trip

11.1.5 Wetlands & Groundwater

Inception meeting: 3-hour meeting in Pretoria
Planning meeting: 3-hour meeting in Pretoria.
DRIFT Introduction: 3-hour meeting in Pretoria
First data collection: 1-day site visit to each EWR site
Second data collection: 1-day site visit to each EWR site
Wetlands/groundwater: Two 1-day integration workshops in Pretoria.

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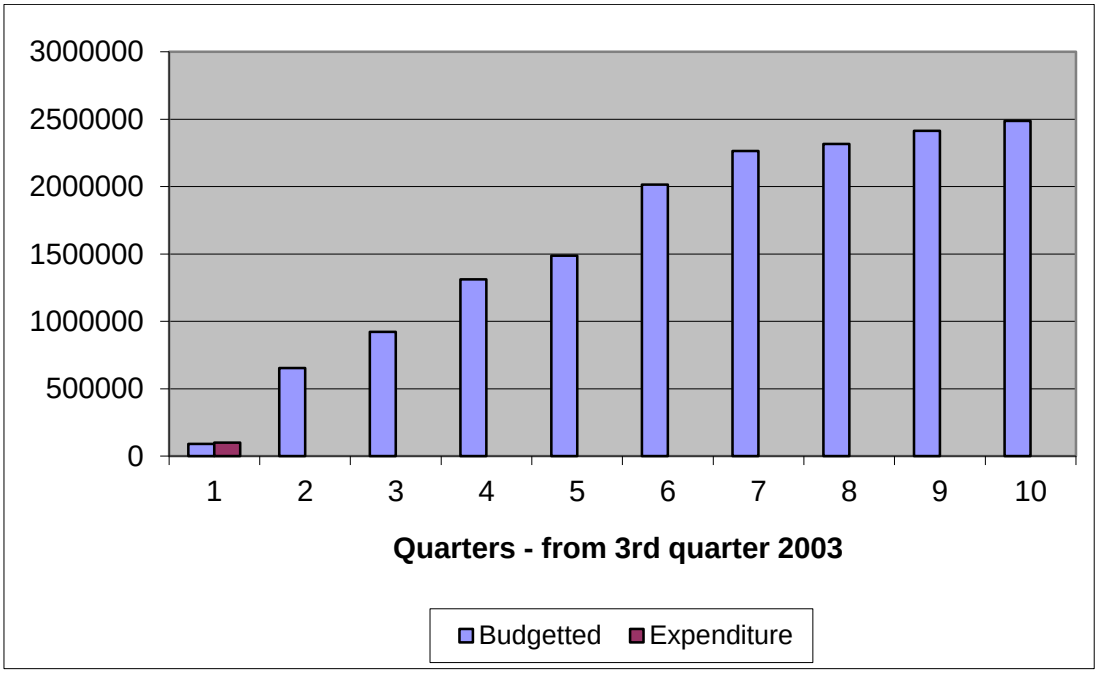
Appendix A. PROGRESS REPORT TEMPLATE

1. PROGRESS SUMMARY
    - 1.1 PROJECT REPORTING ON TASKS
    - 1.2 SUMMARY OF PROJECT TASK VS BUDGET
2. PROJECT PLAN AND DEVIATIONS
3. BUDGET AND CASH FLOW
    - 3.1 BUDGETED AMOUNTS
        - 3.1.1 Budget spent to date
        - 3.1.2 Budget remaining to date
    - 3.2 PROJECT BUDGET
    - 3.3 PROJECTED BILLING
4. KEY ISSUES AND CONSTRAINTS
    - 4.1 ISSUES AND CONSTRAINTS FROM PREVIOUS PROGRESS REPORTS
    - 4.2 ADDITIONAL ISSUES AND CONSTRAINTS
5. CAPACITY BUILDING AND HDI UTILIZATION
    - 5.1 CAPACITY BUILDING
    - 5.2 HDI UTILISATION
6. CONCLUSIONS
7. SIGNATURES.

Appendix B. BUDGET TEMPLATES

TEMPLATE: EXPENDITURE AGAINST BUDGET

Example:



TEMPLATE: PROGRESS AGAINST EXPENDITURE

To be developed.

Appendix C. GANTT CHART