COMPREHENSIVE RESERVE DETERMINATION

INTEGRATED VAAL RIVER SYSTEM

SURFACE WATER

INCEPTION REPORT

TECHNICAL COMPONENT: MIDDLE VAAL

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ACRONYMS

BBM	Building Block Methodology
BHNR	Basic Human Needs Reserve
CD: RDM	Chief Directorate: Resource Directed Measures
CMA	Catchment Management Agency
D:NWRP	Directorate: National Water Resource Planning
DWAF	Department of Water Affairs and Forestry
D:RQS	Directorate: Resource Quality Services
DTM	Digital Terrain Model
EC	Ecological Category
EcoSpecs	Ecological Specifications
EQR	Ecological Quality Requirements
EMC	Ecological Management Class
EWR	Ecological Water Requirements
EIS	Ecological Importance and Sensitivity
FAII	Fish Assemblage Integrity Index.
FD	Fast-Deep
FMP	Flow Management Plan
FRAI	Fish Response Assessment Index
FS	Fast-Shallow
GAI	Geomorphology Assessment Index
HAI	Habitat Assessment Index

HFSR	Habitat Flow Stressor Response
HG	Hydro-Geomorphic
IHI	Index of Habitat Integrity
MIRAI	Macro Invertebrates Response Assessment Index
nMAR	Naturalised Mean Annual Runoff
NWA	National Water Act
NWRS	National Water Resource Strategy
KNP	Kruger National Park
PAI	Physico-chemical Driver Assessment Index
PD	Present Day
PES	Present Ecological State
REC	Recommended Ecological Category
RDM	Resource Directed Measures
RHP	River Health Programme
RQO	Resource Quality Objective
PSP	Professional Service Provider
RU	Resource Unit
SANBI	South African National Biodiversity Institute
SASS	South African Scoring System
Sc	Scenario
SCI	Socio Cultural Importance
SD	Slow-Deep

SPATSIM	Spatial and Time Series Information Modelling
ToR	Terms of Reference
TPC	Threshold of Potential Contamination
VEGRAI	Riparian Vegetation Response Assessment Index
WHI	Wetland Health Index
WMA	Water Management Area
WR2000	Water Resources 2000
FWRYM	Water Resources Yield Model

GLOSSARY

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

ECOLOGICAL WATER REQUIREMENTS (EWR)	The flow patterns (magnitude, timing and duration) and water quality needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to both the quantity and quality components.
INSTREAM FLOW REQUIREMENTS (IFR)	The flow patterns (magnitude, timing and duration) needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to the quantity component only of Ecological Water Requirements.
MAINTENANCE FLOW	The flow required to meet the requirements of the riverine ecosystem at a particular site and maintain the resource base in a particular condition during "normal" climatic years. The distinction between "normal" and "drought" was based on an examination of monthly flow duration curves
PRESENT ECOLOGICAL STATE (PES)	The degree to which ecological conditions of an area have been modified from natural (reference) conditions. The measure is based on water quality variables, biotic indicators and habitat information collected 1 to 3 years prior to the assessment. Results are classified on a 6-poin scale, from Category A (*Largely Natural*) to Category F (*Critically Modified*).
REFERENCE CONDITION	Natural ecological conditions, prior to human development.
RESERVE	The quantity and quality of water required (a) to satisfy basic human needs by securing a basic water supply, as prescribed under the Water Services Act, 1997 (Act No. 108 of 1997), for people who are now or who will, in the reasonably near future, be (i) relying upon; (ii) taking water from; or (iii) being supplied from, the relevant water resource; and (b) to protect

	aquatic ecosystems under the National Water Act, 1998 (Act No. 36 of 1998) in order to secure ecologically sustainable development and use of the relevant water resource. The Reserve refers to the modified Ecological Water Requirement, where operational limitations, and stakeholder consultation are taken into account.
RESOURCE QUALITY OBJECTIVE	Quantitative and auditable statements about water quantity, water quality, habitat integrity and biotic integrity that specify the requirements (goals) needed to ensure a particular level of resource protection. This term takes into account the management *classes* and the requirements of other users. These components are not addressed in this project
RESOURCE UNIT	Stretches of river that are sufficiently ecologically distinct to warrant their own specification of Ecological Water Requirements, and that can be practically managed as a single unit.

Comprehensive Reserve Determination Study for the Integrated Vaal River System: Middle Vaal Water Management Area

INCEPTION REPORT

1 INTRODUCTION

The National Water Act (Act No. 36 of 1998) (NWA) is founded on the principle that National Government has overall responsibility for and authority over water resource management for the benefit of the public without seriously affecting the functioning of the water resource systems. In order to achieve this objective, Chapter 3 of the NWA provides for the protection of water resources through the implementation of resource directed measures (RDM). As part of the RDM, a Reserve has to be determined for a significant water resource, as means to ensure a desired level of protection.

The Chief Directorate: Resource Directed Measures (CD:RDM) is tasked with the responsibility of ensuring that the Reserve requirements, which have priority over other uses in terms of the Act, are determined before any new water uses are authorised.

Golder Associates Africa in association with PD Naidoo and Associates have been appointed to undertake the Comprehensive Reserve Determination Study for the Integrated Vaal River System: Middle Vaal Water Management Area (WMA) and part of the Upper Orange WMA surface water quantity (technical component). The purpose of the Comprehensive Reserve Determination Study for the water resources of the Middle Vaal WMA and part of Upper Orange WMA is to determine the ecological and basic human needs water quantity Reserve for the rivers in the WMA at the highest possible level of confidence given data, budget and time constraints. The wetlands/pans in the WMA with regard to their type, distribution, health, function, importance, sensitivity and present state will be undertaken at a desktop level in order to determine those priority pans for which a Reserve will be have to be determined.

The study area to be covered as part of this study is included in **Appendix A**. The study will be carried out in three phases. The phases are the study initiation and design phase (Inception Phase), study implementation phase and the study termination phase. The study will also include an ongoing project management phase.

This inception report is the first phase of the Ecological Reserve: Water Quantity for the rivers of the Middle Vaal WMA and part of the Upper Orange WMA. The inception report has been produced to better define the scope of work for the study, document any changes to the scope of work from proposal, highlight related considerations that could influence the study and indicate any revised cost estimates resulting from the initial assessments and reviews undertaken during the inception phase of the project.

The inception report thus details the final technical and financial implications of the intended study.

2 TERMS OF REFERENCE

The Terms of Reference for this study is as indicated in the accepted proposal.

3 AIMS

The aims of the study are as follows:

- **Ecological Reserve**: to recommend a comprehensive Ecological Reserve for quantity for various reaches of the Vaal River and its main tributaries (including Modder Riet catchment) within the Middle Vaal WMA.
- **Pans:** to review the importance of pans in the WMA and recommend an appropriate level of study based on available information (actual Reserve studies on the pans are outside the scope of this study);
- to review the importance of pans in the WMA and recommend an appropriate level of study based on available information;
- **Capacity Building and Training:** to include identified persons from DWAF and those identified by the client and to train them to undertake Ecological Reserve determinations.

4 ASSUMPTIONS AND PROVISIONS

The following section is an important assessment of the assumptions and potential limitations of the studies as seen by the study team. This section needs to be discussed by the management PSP and the project team and the potential ramifications understood at the onset of the project.

The Middle Vaal Comprehensive Reserve will use the **best available methods** at all stages of the project, provided budget and time constraints are met. The methods to be followed is according to the revised methods for rivers as outlined in Louw and Hughes (2002), HFSR manual (IWR Source-to-Sea, 2004) and the EcoClassification manual version 2 (if available or version 1, Kleynhans *et al.*, 2005)

Whilst the methods for the determination of Reserves for riverine systems are well developed, those for wetlands systems are not current readily available. **Wetland/pans methods** to be used are currently in development for DWAF. For this study the pans/wetlands in the Middle Vaal WMA will be assessed at a desktop level in terms of their type, distribution, health, function, importance, sensitivity and present state in order to determine a priority list of pans requiring Reserve determinations. Detailed pan Reserve assessments are not part of these studies terms of reference.

To provide the final results of the study, it is assumed that the **Management Class** will be provided to the PSP during the final stages of the study. If this is not the case the preliminary Reserve will be provided based on the current information at the time and the most applicable scenario.

The Comprehensive Reserve Determination Study for the Vaal River System is divided into Upper, Middle and Lower sub-studies. These sections cannot be addressed independently as any of the flow scenarios designed and evaluation affects the adjacent areas. **Integration** and similarity of approaches and combined design of scenarios are essential. This will require **strong coordination and guidance** from the management PSP.

The provision of the **system hydrology** in the required format and continuous close liaison is also essential.

It is assumed that physico chemical input into the EcoClassification process is provided based on Kleynhans *et al.*, 2005 presently being updated for version 2. The most updated and applicable version of TEACHA will be used. The **water quality component** of the Middle Vaal study is being undertaken by a separate PSP and it assumed that the results of that study are made available to this study at the required times so that we can meet our proposed schedule.

A separate PSP has also been appointed for the **water quantity requirements** of the rivers and wetlands/pans of the Upper, Middle and Lower Vaal WMAs. This PSP will provide an overall hydrological model of the integrated Vaal River system (including all transfers) as well as an understanding the operation of the system. An overview of system management is required to ensure an understanding of the system operation and to interpret biological responses. **System operation** infrastructure is also often the logical endpoint of a RU. A description on the present operation which includes present uses, abstractions, curtailments etc., and operational structures if any, within the system must be available to the specialist team. An understandable summarised description will be expected from WRP Consulting Engineers (WRP).

Integration of these sub-studies, to ensure that the end product reflects the **Ecological and Basic Human Needs Reserve**, is crucial.

The proposal is based on the study being initiated 1 February 2007. The **site selection and first survey must take place during the 2007 dry season** (July to October 2007). To allow for a full spectrum of flows to be experienced for hydraulic calibration purposes, the collection of data will be undertaken until at least May 2008.

The number of river reaches recommended for the **EWR sites in the ToR cannot practically be accommodated within the budget made available for this study**. Once the potential site selection survey and available data on existing Reserve studies has been assessed further discussions with the client will be undertaken on the number of EWR sites that will be used for the comprehensive Reserve for the Middle Vaal. A preliminary assessment of the sites and a thorough assessment of the budget has indicated that 5 EWR sites can be accommodated at a comprehensive level. However

extrapolation of results and rapid assessments maybe undertaken at other identified EWR sites that cannot be addressed at a comprehensive level of detail.

The results of the following **previous Reserve determination** studies will be considered during this study. It is assumed that the **results from these sites are available** (or that the client will get the results from the consultants who undertook these studies) and that the results will be in such a format that they can be used directly in this current study. In other words there would be **no need to collect further primary information for these sites** (no further fish, invertebrate, vegetation, water quality and hydraulics surveys required):

- Schoon Spruit before the confluence with the Vaal River
- Schoon Spruit before the confluence with the Rietspruit
- Downstream of Allemanskraal Dam on the Sand River
- Upper Orange WMA: Riet River (upper site)
- Upper Orange WMA: Modder River (upper site)
- Upper Orange WMA: Modder River downstream of the confluence with the Riet River

Two of the above site could be selected based on discussions with the Regional Offices, at which a high flow survey could be done to improve the confidence.

Strong emphasis is made on capacity building in the ToR. Previous capacity building exercises within Comprehensive Reserve studies have had limited success. It is important that **capacity building is integrated over all the Vaal Reserve studies** especially for aspects of specialist training. For example SPATSIM and the Desktop model training should be undertaken with trainees from all the studies participating at the same session.

The ToR recommends that for the highly modified Vaal River, a **Flow Management Plan** (FMP) be applied. Susequent to the development of the FMP, the Building Block Method has been modified into the **Habitat Flow Stressor Response** (HFSR) to accommodate the scenario approach and in effect therefore, the FMP is no longer required.

The scope of work follows where budget allows the requirements for a comprehensive Reserve assessment in terms of number of surveys, number of hydraulic calibrations and the level of EcoClassification. The **following requirements cannot be accommodated** due to budget constraints with the Middle Vaal Comprehensive Reserve study:

- Habitat Modelling will not be undertaken
- Sediment transport modeling will only be undertaken at one suitable site in the Vaal River (Middle Vaal).

- The Riparian vegetation specialist and geomorphologist will not be present at site selection survey
- Fish and aquatic invertebrate surveys will only be undertaken at the chosen EWR site.
- The surveying (GPS fixing) of each EWR site has not been budgeted for as it was planned to use DWAF's surveyors.

The **Level of socio-cultural/economic assessment** will be determined by the project management PSP and the client. Once a decision is made on a unified approach this will be communicated to this project team. The level of effort budgeted for in the proposal will then be compared to the proposed method and negotiations undertaken with the client for a possible variation order if more detailed assessments are required.

It has been agreed that the **method of extrapolation** from site to site has not been completed and hence will not be used in this study. However if some extrapolation is required the method to be used will be decided upon at that stage.

5 THE STUDY AREA

5.1 Overview and Background to the Middle Vaal WMA

The Middle Vaal WMA forms part of the Vaal River watercourse. It covers a catchment area of 52 563 km^2, and includes parts of the Free State and North-West Provinces. The Vaal River flows in a westerly direction to the Lower Vaal WMA. It is the middle WMA within the Vaal River System, with water being transferred *via* the Vaal River through this WMA to Bloemhof Dam, from the Upper Vaal WMA to the Lower Vaal WMA. The Middle Vaal WMA comprises eight sub-catchments as listed in **Table 1**. The WMA consists of the C24, C25, C41, C42, C43, C60 and C70 tertiary catchments. The location and general layout of the WMA is depicted in **Appendix A.**

Table 1: Sub-catchments and related quaternary drainage regions within the Middle Vaal WMA

PRIMARY CATCHMENT	SUB-CATCHMENT AREAS	QUARTENARY CATCHMENTS	AVERAGE GROSS AREA (Km^2)
C	Renoster	C70A-K	6656
	Vals	C60A-J	7871
	Schoon Spruit	C24C-G	5644
	Middle Vaal	C24A-B, C24H-J, C25A-C	8281
	Bloemhof	C25D-F	4959
	Allemanskraal	C42A-E	3628
	Erfenis	C41A-E	4724
	Sand	C42F-L	3927
	Vet	C41F-J, C43A-D	6873

The climate in the Middle Vaal WMA can vary considerably from west to east. The average temperature for the WMA is 16˚C, with the mean annual temperatures ranging between 18˚C in the west to 14˚C in the east. Mean annual precipitation per year ranges between 500mm in the west and

700mm in the east of the WMA. Mean annual evaporation ranges from 1800mm in the east to a high of 2600mm per year in the dry western parts of the WMA, and is well in excess of rainfall.

The western parts of the WMA are characterised by pans. The WMA is dominated by the "pure grassveld" veld type with sparse bushveld in patches. The northern areas have some regions of "false grassveld", while the area upstream of Bloemhof Dam includes some "tropical bush and savanna". Maize, wheat and fodder crops are the main crops in the WMA.

Current land use in the WMA is characterised by extensive dry land cultivation in the central parts of the WMA. The largest urban areas are Klerksdorp (North West Goldfields) Welkom and Kroonstad (Free State Goldfields). Irrigation is practiced downstream of dams and along the main tributaries and at locations along the Vaal River. The WMA is characterised by a large number of goldmines.

The surface flow of the Vaal River, most of which originates in the Upper Vaal WMA, represents the bulk of the surface water in the Middle Vaal WMA. The Vaal River is fed by a number of tributaries of which the most significant are the Renoster, Schoonspruit, Vals and Vet Rivers. Vlei areas occur along the lower Vet River and in the upper Schoon Spruit catchment. The surface water flows that originate within the WMA are highly seasonal and intermittent.

The surface water occurring in the WMA has been developed to its potential and all water is being fully utilised. There are several large dams that have been developed (**Table 2**) in the WMA.

Table 2: Major Dams in the Middle Vaal WMA

Dam name	Quaternary catchment	River
Bloemhof	C91A	Vaal
Allemanskraal	C42E	Sand
Bloemhof	C60D	Jordaan Spruit
Erfenis	C41E	Vet
Johan Neser	C24G	Schoonspruit
Klipplaatdrift	C25A	Vaal
Koppies	C70C	Renoster
Marquard	C41A	Laai Spruit
Rietspruit	C24D	Schoonspruit
Three Sisters	C42F	Sand
Uniefees	C70C	Eland Spruit

The Middle Vaal WMA's water quality and flow is mainly controlled by activities that take place in the Upper Vaal WMA. The Middle Vaal WMA is dependant on the Upper Vaal WMA for meeting the bulk water requirements of its mining, industrial and urban sectors. Large quantities of water are transferred into the WMA to augment local water resources. These upstream activities include releases from the Vaal Dam and Vaal River Barrage, waste water treatment works discharges, urban runoff and gold mining activities on the Witwatersrand. In the Middle Vaal WMA discharges and decants from gold mining activities in the Mooi and Koekemoer Spruits have an impact on the continued salinity build up in the Vaal River. These impacts are subject to many catchment studies that have been undertaken by DWAF as well as a current Integrated Water Quality Management Plan

for the Vaal River system. Management of water quality and quantity in the Middle Vaal WMA is therefore integrally linked to both the Upper and Lower Vaal WMAs.

The Middle Vaal WMA is rural in nature with the land use typically characterised by extensive livestock farming, dry land agriculture and some irrigation farming. The economy of the Middle Vaal WMA contributes about 4% of the GDP of South Africa with the most dominant economic activity being the mining sector, contributing more than 45% of the GDP in the WMA, trade (12,3%), and agriculture (8,9%) (DWAF, 2003). Due to a decline in gold mining activity, a decline in population is also projected for the WMA, with a concomitant effect on the regional economy. Manufacturing activities in the WMA relate to the mining and agriculture sectors as well as items for local consumption. No dramatic changes to the economy of the WMA are foreseen for the medium term. The agricultural sector in the region is relatively stable and will continue to make an important contribution to the regional economy. A minimal change in water requirements is therefore projected.

It is imperative that integration takes place with the Upper Vaal Reserve Study as the Middle Vaal's water quality, quantity and ultimately ecological status is dependant on this upper water management area.

5.2 Overview and Background to the Modder Riet catchment of the Upper Orange WMA

The Modder Riet catchment of the Upper Orange WMA is part of the C drainage region and thus forms part of the Vaal River System. The catchment is situated in the Free State and Northern Cape Provinces has a catchment area of 35 000 km^2. The Modder and Riet Rivers are the only major rivers in the catchment, which drain into the Vaal River which subsequently flows into the Orange River. The catchment includes Kalkfontein, Rustfontein, Tierpoort, Groothoek and Krugersdrift Dams. The general layout of the catchment is depicted in Error! Reference source not found..

Land use in the catchment is related agricultural activities, urbanisation and mining and industrial activities. Agricultural use comprises primarily the irrigation of crops and activities are concentrated around the dams in the catchment. Livestock watering also occurs, but to a lesser extent. The major urban centres in the catchment are Bloemfontein, Botshabelo and Thabu Nchu whose collective population is 1.2 million people. The Modder River is a major source of water to these urban areas. Most industries in the Modder and Riet catchments are centred around Bloemfontein and use treated water from the municipal supply system.

The Riet River generally flows in a north-westerly, to the confluence with the Vaal River. The Tierpoort dam and Kalkfontein dam are situated on the tributaries of the Riet River. The Modder River is the main tributary of the Riet River and joins the Riet River just upstream of Ritchie. The Krugersdrift Dam is located on the Modder River. Most of the natural runoff into the Modder River is from above the confluence of the Modder and Klein Modder Rivers. The rest of the Modder River catchment is very flat and very little runoff occurs. There is a transfer of water from the Caledon River to the Modder River for the supply of drinking water to Bloemfontein.

6 RESERVE COMPONENTS

This study focuses on the technical part of the Comprehensive Reserve determination for the water resources of the Middle Vaal WMA and Modder Riet Catchment of the Upper Orange WMA and includes the quantity component of the rivers and pans in the WMA. The water quality component, yield modelling and groundwater studies will be undertaken separately, but will be initiated simultaneously. The results of these studies will be integrated with the results of the Middle Vaal WMA Reserve study where necessary.

The determination of the ecological Reserve for the identified aquatic ecosystems in the Middle Vaal WMA shall consist of the determination of the **water quantity** requirements for the:

- **Rivers** at a comprehensive level of detail at various Ecological Water Requirement (EWR) sites and will include a habitat flow stressor response (HFSR); and
- **Pans** in the study area will be assessed in terms of their abundance, health, function, importance, sensitivity and present state. A priority list of the most important pans will be compiled for final selection of the pans for which rapid or higher level of detail Reserve determinations will be determined. However the actual Reserve determinations of these pans do not form part of the scope for this study.

The updated hydrology from the studies undertaken by the Directorate National Water Resources Planning will be utilised during the Reserve determination studies. Major changes to the hydrology could have specific ecological impacts/consequences. This will be highlighted and addressed during the study.

7 DELIVERABLES

The anticipated deliverables of the study are as follows:

- **Inception Report**, containing the detailed Project Plan (this report);
- **Desktop Ecoclassification report;**
- **Resource Units Report,** describing delineation of the study area into Resource Units, and the process of site selection;
- **Pans assessment Report**
- **Ecological Water Requirements (EWR) Report**, describing the proceedings of the EWR Specialist Meetings, including methods used, motivations and Ecological Resource Quality Objectives. The EWR report will include the following specialist reports:
    - Fish
    - Invertebrates
    - Riparian vegetation

- Socio-economics/cultural
- Quantification of the Basic Human Needs Reserve
- Geomorphology
- Hydraulics
- EWR quality (cross referenced to the Vaal Water quality study).

- **Ecological consequences of flow scenarios**
- **EcoStatus and monitoring.**
- **Stakeholder awareness report,** describing the process undertaken and the communication and engagement that was done as part of the study.
- **Main Integration Report,** summarising the information contained in the supporting reports and including the s**tudy performance audit** and **Capacity Building assessment.** This report will include the Technical Component documenting the history, objectives, achievements, administrative performance, organisational structure, techniques used and the successfulness of the various technical techniques. The report will also include recommendations on how to improve future Reserve determination studies.

The following information will be handed to the client in electronic format:

- **Colour Photographs** of chosen EWR sites at different flows;
- **Hydraulic data** of calibrated EWR profiles;
- **Hydrological data and model outputs**.
- **All models** used with **populated information; and**
- All **raw data** (scoring sheets, etc – that is **not included** in the models).

8 STATUS QUO

8.1 Previous Reserve Determination Studies

The Reserve requirements for most of the water resources of the Vaal River System and the main stem of the Vaal River still need to be determined, thus the need for thus study. In the interim, an Environmental Flow Management Plan for the main stem of the Vaal River was developed as part the Vaal River System Analysis Update Study, and at present the system is being managed based on this plan. In addition the Department has determined low confidence desktop estimates of the ecological water requirements and in some instances the water quality Reserves in catchments where the need has arisen. However this has been based primarily on responses to water use licence applications.

The present ecological state (PES) and the Ecological Importance and sensitivity (EIS) of the catchments in the study area as classified by DWAF in 2001 are listed below in **Table 3**. Within the study area the following preliminary Reserve determinations of surface water resources, as indicated in **Table 4** have been done. The determinations have in some cases been conducted at a desktop low confidence level and in others on a higher confidence level.

Table 3: Summarised PES and EIS per tertiary catchment for the Middle Vaal WMA and Upper Orange WMA

Tertiary	PES	EIS
Middle Vaal WMA		
C24	C to D	Moderate to high
C25	C	Moderate
C41	C	Moderate
C42	C to D	Moderate
C43	C	Moderate
C60	C	Moderate
C70	B to C	Moderate
Modder Riet Catchment (Upper Orange) WMA		
C51	D	Low to moderate
C52	D	Low to moderate

Table 4: Preliminary reserve determinations of surface water resources that have been undertaken within the study area

River	Water Management Area	Quaternary catchment	Preliminary Reserve Determined	Determination Level	Present Ecological State	Ecological Importance and Sensitivity	Ecological Category
HIGHER CONFIDENCE RESERVE DETERMINATIONS							
Sand River	Middle Vaal	C42H	Quantity	Rapid III	C/D	Moderate	B/C
Sand River	Middle Vaal	C42L	Quantity	Rapid III	C	Moderate	B/C
Modder River	Upper Orange	C52F	Quantity and Quality	Intermediate/ Rapid III (final)	D	Moderate	D
Modder River	Upper Orange	C52H	Quantity and Quality	Intermediate/ Rapid III (final)	D	Low	D
Riet River	Upper Orange	C51K	Quantity and Quality	Intermediate/ Rapid III (final)	D	Low	D
Riet River	Upper Orange	C51L	Quantity and Quality	Intermediate/Rapid III (final)	D	Moderate	D
Schoon Spruit	Middle Vaal	C24E	Quantity and Quality	Intermediate	C/D	Moderate	C/D
Rietspruit	Middle Vaal	C24E		Intermediate	??	??	??
Schoon Spruit	Middle Vaal	C24H	Quantity and Quality	Intermediate	C/D	Moderate	C/D
Schoon Spruit	Middle Vaal	C24G	Quantity and Quality	Intermediate	D	Moderate	D
SchoonSpruit	Middle Vaal	C24H	Quantity and Quality	Intermediate	D	Moderate	D

8.2 Summary of current Monitoring Points

The Department of Water Affairs and Forestry (DWAF) conducts an ongoing monitoring programme on the water resources of Vaal River System WMAs. Historical and current monitoring sites are shown in **Table 5**. The available water quality and flow data at these sites will be assessed by the water quality and WRYM PSP's. This information will be used to assist with the selection of the EWR sites.

Table 5: Summary of current monitoring points on the rivers in the Middle Vaal WMA and Modder Riet Catchment

Monitoring Point	Latitude	Longitude	Drn	Begin	End
C2H007Q01 AT PILGRIMS ESTATE ORKNEY ON VAAL RIVER	-27.011111	26.698333	C24	29/05/1979	02/11/2004
C2H061Q01 VAAL RIVER AT KLIPPLAATDRIFT	-27.3875	26.4625	C25	14/05/1972	09/11/2004
C2H064Q01 SKOON SPRUIT AT EYE OF SCHOONSPRUIT	-26.283889	26.860833	C24	11/06/1981	24/04/2002
C2H065Q01 LEEUDORING SPRUIT AT KLIPSPRUIT	-27.369444	26.351111	C25	23/02/1972	07/09/2004
C2H066Q01 MAKWASSIE SPRUIT AT VLIEGEKRAAL	-27.495556	26.074722	C25	02/08/1972	10/05/2004
C2H067Q01 AT LEEGTE ON SANDSPRUIT	-27.560278	26.233333	C25	21/01/1974	01/07/2002
C2H073Q01 SKOON SPRUIT AT GOEDGENOEG/ORKNEY BRIDGE	-26.956667	26.651111	C24	31/03/1980	02/11/2004
C2H084Q01 SKOON SPRUIT AT KLERKSDORP WEIR	-26.873889	26.658611	C24	20/08/1979	04/08/2004
C2R006Q01 ELANDSKUIL DAM ON SWARTLEEGTE RIVER: NEAR DAM WAL	-26.349167	26.777778	C24	11/06/1981	10/02/2004
C2R007Q01 RIETSPRUIT DAM ON RIET SPRUIT: NEAR DAM WALL	-26.413611	26.7975	C24	11/06/1981	10/02/2004
C4H005Q01 VET RIVER AT FLOORSDRIFT/HOOPSTAD	-27.841667	25.9	C43	29/01/1980	15/12/1998
C4H007Q01 ALLEMANSKRAAL DAM ON SAND RIVER: LEFT CANAL	-28.287778	27.145833	C42	26/10/1972	29/05/2003
C4H009Q01 ERFENIS DAM ON GREAT VET RIVER: LEFT CANAL	-28.5075	26.778333	C41	16/06/1986	13/09/2002
C4H016Q01 SAND RIVER AT BLOUDRIF	-28.1175	26.719444	C42	03/11/1995	26/08/2004
C4H017Q01 SAND RIVER AT DORINGRIVIER/BLOUDRIF	-28.116667	26.725278	C42	03/11/1995	26/08/2004
C4H018Q01 MOSTERD CANAL AT VERMEULENSKRAAL NOORD/VIRGINIA	-28.091944	26.805556	C42	03/11/1995	26/08/2004
C4R001Q01 ALLEMANSKRAAL DAM ON SAND RIVER: NEAR DAM WALL	-28.287778	27.145833	C42	01/04/1968	29/05/2003
C4R002Q01 ERFENIS DAM ON GREAT VET RIVER: NEAR DAM WALL	-28.5075	26.778333	C41	01/04/1968	24/10/2002
C5H003Q01 MODDER RIVER AT LIKATLONG/SANNASPOS	-29.160278	26.573333	C52	26/08/1987	16/08/2004
C5H007Q01 RENOSTER SPRUIT AT SHANNON VALLEY	-29.144444	26.318056	C52	13/06/1972	16/08/2004
C5H012Q01 RIET RIVER AT KROMDRAAI/RIETWATER	-29.658056	25.973333	C51	21/12/1975	08/05/2003
C5H014Q01 RIET RIVER AT KLIPDRIFT/RITCHIE	-29.042222	24.6	C51	02/11/1992	06/09/2004
C5H016Q01 RIET RIV AT ESTATE BIESIESBULT/AUCAMPSHOOP	-28.96	24.2425	C51	08/06/1970	21/04/2003
C5H018Q01 MODDER RIVER AT TWEERIVIER	-29.043333	24.640833	C52	03/05/1971	18/03/2002
C5H022Q01 KGABANYANE RIVER AT BEDFORD UP STREAM GROOTHOEK D	-29.285556	26.921944	C52	10/06/1986	12/07/2004
C5H023Q01 KGABANYANE RIVER AT DANKBAAR D/STREAM GROOTHOEK D	-29.286111	26.764167	C52	27/07/1983	19/08/2002
C5H030Q01 @ RIETRIVIER SETT. JACOBSDAL ON ORANGE-RIET CANAL	-29.140556	24.756667	C51	19/04/1994	04/10/2004
C5H035Q01 @ TWEE RIVIER D/S TWEE RIVIER ON MODDER RIVER	-29.028333	24.639167	C52	02/11/1992	11/10/2004
C5H039Q01 KRUGERSDRIFT DAM ON MODDER RIVER: DOWN STREAM WEI	-28.883333	25.950278	C52	21/08/1979	12/08/2004
C5H040Q01 KALKFONTEIN DAM ON RIET RIVER: LEFT CANAL	-29.496944	25.221389	C51	02/12/1981	07/10/2004
C5H048Q01 RIET RIVER AT ZOUTPANSDRIFT	-29.033333	23.983333	C51	10/08/1990	27/10/2004
C5H053Q01 MODDER RIVER AT GLEN	-28.948889	26.321667	C52	18/09/1995	03/12/2003
C5H054Q01 RENOSTER SPRUIT AT BISHOP'S GLEN	-28.966667	26.333056	C52	25/09/1995	13/11/2003
C5R001Q01 TIERPOORT DAM ON KAFFER RIVER: NEAR DAM WALL	-29.421667	26.136389	C51	27/10/1972	18/08/2004
C5R002Q01 KALKFONTEIN DAM ON RIET RIVER: NEAR DAM WALL	-29.496944	25.221389	C51	02/04/1968	14/10/2004
C5R003Q01 RUSTFONTEIN DAM ON MODDER RIVER: NEAR DAM WALL	-29.270833	26.616667	C52	19/05/1968	16/08/2004
C5R004Q01 KRUGERSDRIFT DAM ON MODDER RIVER: NEAR DAM WALL	-28.883333	25.956111	C52	10/03/1975	03/08/2004
C5R005Q01 GROOTHOEK DAM ON KGABANYANE RIVER: NEAR DAM WALL	-29.302778	26.848889	C52	03/03/1981	16/08/2004
C5R006Q01 MASELSPOORT DAM ON MODDER RIVER: NEAR DAM WALL	-29.029167	26.408333	C52	18/03/1987	08/01/2004
C5R007Q01 MOCKES DAM ON MODDER RIVER: NEAR DAM WALL	-29.050556	26.461667	C52	22/05/1987	08/01/2004
C6H001Q01 VALS RIVER AT ROODEWAL	-27.441389	26.986389	C60	07/01/1980	01/11/2004
C6H002Q01 VALS RIVER AT GROOTDRAAI/BOTHAVILLE	-27.398611	26.614722	C60	01/08/1972	02/11/2004
C6H003Q01 VALS RIVER AT MOOIFONTEIN/BOTHAVILLE	-27.4	26.624722	C60	21/01/1974	20/07/2004
C6H007Q01 VALS RIVER AT KROONSTAD BRIDGE (OLD BAREND WESSEL	-27.671111	27.236944	C60	04/04/1995	01/11/2004
C6R002Q01 SERFONTEIN DAM ON VALS RIVER: NEAR DAM WALL	-27.701667	27.3025	C60	08/12/1987	20/04/2004
C7H003Q01 AT DANKBAAR MISPAH ON HEUNINGSPRUIT	-27.356667	27.286389	C70	19/03/1972	27/04/2004
C7H006Q01 RENOSTER RIVER AT ARRIESRUST	-27.044444	27.005	C70	19/12/1974	29/09/2004
C7H007Q01 KOPPIES DAM ON RENOSTER RIVER: RIGHT CANAL	-27.258056	27.674167	C70	12/06/1972	15/02/2004
C7R001Q01 KOPPIES DAM ON RENOSTER RIVER: NEAR DAM WALL	-27.258056	27.674167	C70	12/06/1972	15/02/2004
C6R001Q01 BAREND WESSELSDAM (SEE C6H007)	-27.670833	27.233333	C60	1899-12-30	1899-12-30

8.3 Relevant Studies/Reports related to the Study Area

The following is a list of the relevant studies that have been investigated as part of the status quo report assessment:

- DWAF (2002) A Catchment Management Plan for the Schoon Spruit And Koekemoer Spruit Catchments - A Situation Analysis. DWAF report.
- DWAF (2004) Middle Vaal Water Management Area: Internal Strategic Perspective. Report No. P WMA 09/000/00/0304, July 2004
- DWAF (2004) Vaal River System: Overarching: International Strategy Perspective. Report No. P RSA 2000/00/01/0103, March 2004
- DWAF (2006 a) Development of a Catchment Management Strategy for the Schoon Spruit and Koekemoer Spruit catchments in the middle Vaal management area phase II. 16/2/7/Report volume 1/Skoon Spruit Koekemoer Spruit Catchment Management Strategy/ Catchment Management Strategy
- DWAF (2006 a) Development of a Catchment Management Strategy for the Schoon Spruit and Koekemoer Spruit catchments in the middle Vaal management area phase II. 16/2/7/Report volume 1/Skoon Spruit Koekemoer Spruit Catchment Management Strategy/ Catchment Management Strategy
- DWAF (2006 b) Development of a Catchment Management Strategy for the Schoon Spruit and Koekemoer Spruit catchments in the middle Vaal management area phase II. 16/2/7/Report volume 2/Surface water quality and quantity status / Catchment Management Strategy
- DWAF (2006 c) Development of a Catchment Management Strategy for the Schoon Spruit and Koekemoer Spruit catchments in the middle Vaal management area phase II. 16/2/7/Report volume 1/Groundwater assessment / Catchment Management Strategy
- DWAF (2006 d) Development of a Catchment Management Strategy for the Schoon Spruit and Koekemoer Spruit catchments in the middle Vaal management area phase II. 16/2/7/Report volume 1/Water and salt balance / Catchment Management Strategy
- DWAF (2006 e) Development of a Catchment Management Strategy for the Schoon Spruit and Koekemoer Spruit catchments in the middle Vaal management area phase II. 16/2/7/Report volume 1/Monitoring programme / Catchment Management Strategy
- DWAF (2006 f) Development of a Catchment Management Strategy for the Schoon Spruit and Koekemoer Spruit catchments in the middle Vaal management area phase II. 16/2/7/Report volume 1/Institutional arrangements / Catchment Management Strategy
- DWAF (2006 g) Development of a Catchment Management Strategy for the Schoon Spruit and Koekemoer Spruit catchments in the middle Vaal management area phase II. 16/2/7/Report volume 1/Intermediate Reserve / Catchment Management Strategy.
- DWAF, Catchment Management Strategy for the Modder and Riet Rivers (Water quality Assessment) Draft Report. BKS. May 2002.

- DWAF. Middle Vaal WMA: Overview of Water Resources Availability and Utilisation. P WMA 09/000/00/0203. BKS. September 2003.
- DWAF. Internal Strategic Perspective for the Middle Vaal WMA. P WMA 09/000/00/0304. PDNA, WRP, WMB, and Kwezi-V3. July 2004
- DWAF. Sand Vet Study Report. Draft Report.
- DWAF. Modder Riet Catchment Management Strategy. Draft
- DWAF (Ongoing). Development of an Integrated Water Quality Management Plan for the Vaal River system – Zitholele and Golder and Associates.
- DWAF (Ongoing), Development of a large bulk water supply reconciliation strategy for the Vaal River system – WRP Consulting.

These reports, as well as others that are identified have been or will be assessed during the Inception phase of this project.

8.4 Proposed EWR Sites

Table 6 provides a list of proposed EWR sites that specified in the Terms of Reference document for the study and were identified during discussions with representatives from the RDM Chief Directorate, National Water Resources Planning Directorate and the Free State Regional Office.

Table 6: Proposed EWR sites (As per terms of reference)

1	Downstream of Allemanskraal Dam on the Sand River*
2	Downstream of Erfenis Dam on the Groot Vet River
3	Downstream of the confluence of the Sand and Vet Rivers
4	Makwassie River
5	Vals River downstream of Kroonstad
6	Koekemoerspruit/ Jagspruit
7	Vierfonteinspruit
8	Downstream of Koppies Dam on the Rhenoster River
9	Schoon Spruit before the confluence with the Vaal River*
10	Schoon Spruit before the confluence with the Rietspruit*
11	Vaal main stem upstream of Bloemhof Dam
12	Upper Orange WMA: Riet River (upper site)*
13	Upper Orange WMA: Modder River (upper site)*
14	Upper Orange WMA: Modder River downstream of the confluence with the Riet River*

*The results of previous Reserve determination studies will be considered during this study.

The EWR sites to be used in this study will be determined depending on the availability of data from the studies in Table 6 and the findings of the site selection visit and based on discussions with the Regional Office, DWAF and the project management PSP.

9 TECHNICAL APPROACH

9.1 Methods and Approach

The Ecological Water Requirements (EWR) of the rivers will be determined on a comprehensive level of detail. The pans in the Middle Vaal WMA will be assessed during the inception phase as to their distribution, health, function, importance, sensitivity and present state to determine those priority pans for which the Reserve will be determined at a rapid or higher level of detail. The Resource Directed Measures for Protection of Water Resources (DWAF 1999) and approved updated methods will be used. This study followed the generic 8-step process to Reserve determination, shown in **Figure 1.**

This study will follow comprehensive methods for EcoClassification, as well as for Ecological Water Requirement determination and BHN. The level of detail for the pans component will be at a scoping level only.

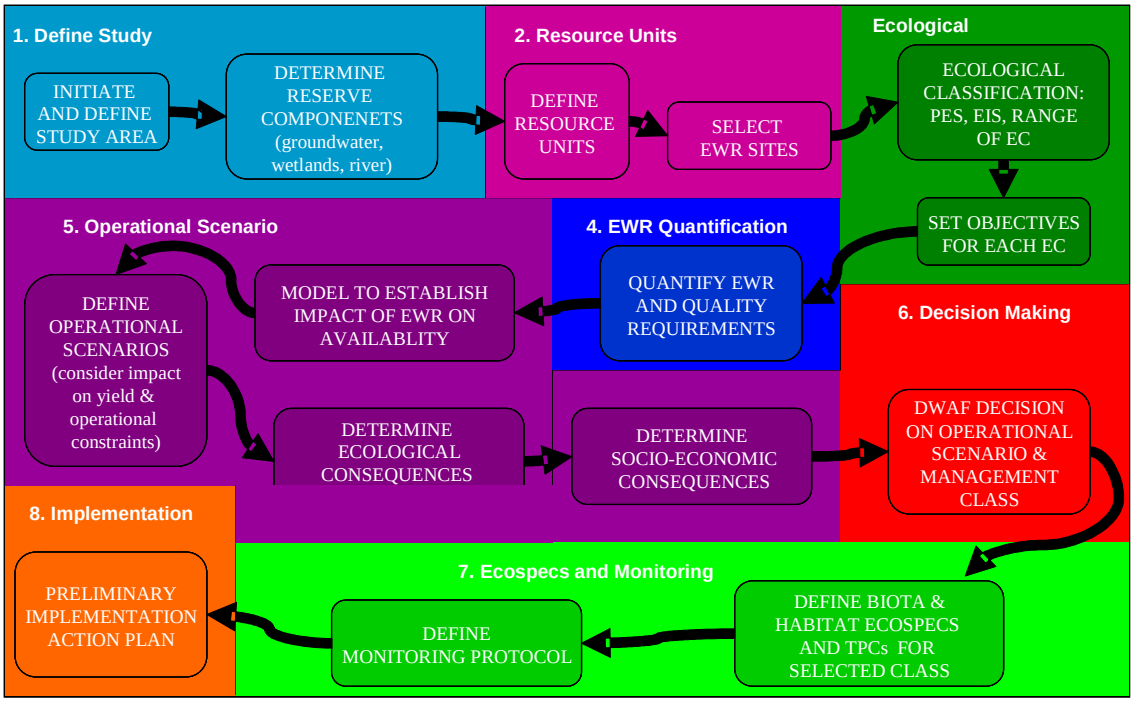

Figure 1: The generic 8-step Ecological Reserve Procedure (from DWAF 2003).

The following is a list of methods that will be used during this study:

- DWAF 1999a. Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems Version 1.0, Pretoria.

- DWAF 1999. *Resource Directed Measures for Protection of Water Resources. Volume 3: River Ecosystems Version* 1, September 1999. Pretoria. Report Number N/29/99.
- Hughes, A. and O'Keeffe, J. H. 2004. Flow-stressor response approach to Ecological Water Requirement Assessment. Extract from WRC Project No K5/1160/0/1 presented In: Institute for Water Research Source-to-Sea, Department of Water Affairs and Forestry: Resource Quality Services, Institute for Water Research Rhodes University 2004. EcoClassification and Habitat-Flow-Stressor-Response Manual. Draft 1 June 2004.
- Institute for Water Research. 2003. SPATSIM – Spatial and Time Series Information Modelling Software, Denis Hughes and David Forsyth
- IWR Source to Sea (2004). Editors. A comprehensive Eco Classification and Habitat Flow Stressor Response manual. Prepare for IWQS DWAF, Project No. 2002-148.
- Jooste S and Rossouw J N, (2002). Hazard-Based Water Quality EcoSpecs For The Ecological Reserve In Fresh Surface Water Resources. Report No. N/0000/REQ0000. Institute for Water Quality Studies, Department of Water Affairs and Forestry, Pretoria, South Africa.
- King J. M. and Louw, D. 1998. Instream flow assessments for regulated rivers in South Africa using the Building Block Methodology. Aquatic Ecosystem Health and Management 1: 109-124.
- Kleynhans, C.J and Louw, M.D. 2006. Ecological Reserve Monitoring: Preliminary Generic guidelines. With contributions from C Thirion, P Scherman, N Muller, D Hughes, L du Preez and K Rowntree. Draft report DWAF RQS.
- Kleynhans, C.J, Louw, M.D, Thirion, C, Rossouw, N.J, and Rowntree, K. 2005. River EcoClassification: Manual for EcoStatus determination (Version 1). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. KV 168/05.
- Kotze, D.C, Marneweck, G.C., Batchelor, A.L., Lindley, D. and Collins, N. 2004. Wetland Assess: A rapid assessment procedure for describing wetland benefits. Mondi Wetland Project, Unpublished report.
- Palmer, C G, Muller, W J and Hughes, D A (2004). Chapter 6: Water quality in the ecological Reserve. IN: SPATSIM, an integrating framework for ecological Reserve and implementation: incorporating water quality and quantity components for rivers. Hughes DA (Ed.) WRC Report No. 1160/1/04, Water Research Commission, Pretoria
- Rountree, W. M, Thompson, M. Batchelor, A.L. Kotze, D and Marneweck, W (2007) Wet-Management Series Wet-Prioritise: Tools And Guidelines For Prioritising Wetlands At National, Regional And Local Scales. Unpublished Draft 5.

It is important to note the following with regards to methods, levels of detail and corresponding studies:

- The **Groundwater** studies (separate contracts) will include water quantity and quality.

- An overarching **Water Quality** study will cover the entire Upper, Middle and Lower Vaal system as well as the contributing rivers in the linked WMA.
- The **Water Resource Yield Model** study will also look at the whole area. The model is already set up for the Vaal catchment. The data generated by the surface water teams will be plugged into the model for the various scenarios.

9.2 Desktop Ecoclassification (quaternary scale)

This task serves as a scoping phase to investigate the WMA at a desktop level and at the scale of quaternary catchments and serves as the basis for most of the other tasks. A comprehensive assessment at Level 4 (Kleynhans *et al.,* 2005) is followed for each of the RUs with study sites (EWR sites). This scoping assessment provides an overview of the WMA and a better understanding when focussing on the EWR sites and the sections of rivers where comprehensive assessments will be undertaken. The output of the information also identifies areas of potential concern based on an integrated importance (combination of EIS, SCI and PES).

The methods followed are those detailed in Kleynhans *et al.,* 2007 (in press, , as supplied to this project team by Delana Louw) and will consist of a compilation of all available data, a reconnaissance survey and populating existing models developed by the Directorate: Resource Quality Services (D:RQS) for the main rivers in each quaternary catchment. The reconnaissance survey also aids in a preliminary identification of potential Ecological Water Requirement (EWR) sites.

EcoClassification (Kleynhans *et al.,* 2007) - the term used for Ecological Classification - refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers compared to the natural or close to natural reference condition. The purpose of EcoClassification is to gain insights into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river. The state of the river is measured in terms of Ecological Categories (A to F).

The EcoClassification process also includes an assessment of Ecological Importance and Sensitivity (EIS) and Socio-Cultural Importance (SCI). These are measured in terms of Low to Very High (EIS) and Minimal to Very High (SCI). All assessments include a confidence assessment using a rating of 1 (low confidence) to 5 (high confidence).

9.3 Hydraulics Assessment

The product of the hydraulics work comprises series of relationships between flow rate, and flow depth, flow velocity, wetted perimeter and flow area (Tharme, R.E. & King J.M, 1998). These relationships have to be determined for EWRs cross-sections at each selected site. In order to satisfactorily characterise the hydraulic relationships for Reserve determination study, field data, including discharge, water stage, and slope have to be collected for a range of flows over the hydrological season. Through the hydraulic modelling, using measured cross-sectional and flow data relationships (discharge and flow depth), biologically useful parameters (wetted perimeter, flow area

and flow velocity) will be developed. These relationships will be presented graphically and in a tabulated format. The methodology of generating hydraulic information for determining the water quantity component of the Comprehensive Ecological Reserve is based on the RDM for Protection of Water Resources: River Ecosystems, Appendix R 17 (Birkhead, A.L. 2001).

9.4 Geomorphology Assessment

The GAI level IV (Kleynhans et al, 2005) is a specialist rule-based model used to derive the Geomorphological Present Ecological Category (PES) of the river reach within which a study site is situated.

Information will be collated during the site visits to undertake the specialist Level 4 GAI assessment. Reference conditions and GAI model (PES) results will be generated, and an assessment of reasons for change from reference conditions will be provided. A low confidence assessment of the EWR for the geomorphological components will be undertaken. These components of the geomorphological studies will be undertaken according to the following sections.

Resource Unit Report

No budget for the development of a Resource Unit Report has been allocated. Instead, it is recommended that the team use desktop information available from DWAF: RQS to determine the Resource Units of the study area.

Site Selection

The budget limitations preclude the geomorphologist from attending and participating in the Site Selection trip. Therefore only one site visit will be undertaken by the Geomorphologist; namely the site visit to assess PES and Reference State conditions.

Reference State Assessment

An assessment of the EWR sites will be undertaken to determine the Reference State of the sites. The consultant will source the aerial photographic record and undertake the Reference State assessment for the EWR sites using the aerial photographic record as well as other sources of available information.

GAI Level IV Assessment

The GAI level IV (Kleynhans et al, 2005) is a specialist rule-based model used to derive the Geomorphological Present Ecological Category (PES) of the river reach within which a study site is situated. A site visit (half a day per site) will be undertaken to collect field data from the EWR sites. These field data will be used together with remote (desktop) information to determine the PES scores for the sites.

Sediment transport modelling for important sites

For a maximum of two sites (to be decided after discussions with client), sediment transport modelling may be undertaken, using the method developed for Intermediate and Comprehensive Reserve methods by Dollar and Rowntree (2003). This exercise (the assessment of present state versus virgin flow condition potential bed material transport modelling) allows higher confidence assessments of the flood requirements of river systems through the identification of the significant flows which are responsible for the majority of sediment transport in the system. In many South African rivers, these flows have been removed or reduced as a result of flow regulation. In such cases, sediment transport potential has reduced and the pools and deep channels have become infilled with sediment, with consequences for the biota associated with such habitats. The objective of the sediment transport modelling is to identify these significant flows in order to ensure that they are provided in the requested environmental flows for the sites, and thus ensure that the potential for sediment transport is maintained.

EWR's for geomorphology will thus be low confidence specialist assessments at sites were sediment modelling does not take place, determined through the identification of significant morphological features at the EWR sites and determined from available information and previous studies.

9.5 Pans/wetland assessment

The methods for wetland typing and classification are not well developed. Rapid Reserve methods for wetlands are currently under development. The method and approach indicated **Figure 2** has been developed by Mark Rountree and will be used for the Upper, Middle and Lower Vaal Reserve studies. This is due to the lack of any rigorous methods, the following procedure (after consultation with DWAF, Mark Rountree and Alan Cochrane and adapted from M. W. Rountree, M. Thompson, A. L. Batchelor, D. Kotze and G. Marneweck (2007) Wet-Management Series Wet-Prioritise: Tools and Guidelines for Prioritising Wetlands at National, Regional and Local Scales. Unpublished Draft 5) is suggested to:

- develop an inventory of wetlands/pans within the study area (mapped at the 1:50 000 or (preferentially) 1:10 000 scale).
- classify the identified wetlands/pans according to the HydroGeomorphic wetland classification system, which has been proposed as the wetland classification system for South Africa.
- determine the general reference conditions of the wetlands/pans in the catchment.
- determine the general current ecological condition of the wetland/pan types identified.
- identify priority wetlands/pans in the study area (based on size and/or ecological; social and/or economic criteria).
- determine Ecological Integrity and Sensitivity (EIS) Categories for these priority systems.
- undertake a Wetland Habitat Integrity (PES) assessment of a maximum of two of the high priority floodplain or channelled valley bottom wetlands, and

- compile a report detailing the outcomes and results from the above tasks.

Prior to commencement of the pans/wetlands assessments liaison with the Regional Office will be undertaken to identify those pans that are important/priority.

As the first step in pans typing process in the Middle Vaal WMA, is to know where the pans are located. Although the South African National Biodiversity Institute (SANBI) has recently produced a wetlands/ map of South Africa, a preliminary assessment of that data seems to indicate that the dataset for the Lower Vaal is not complete. Due to the lack of available methods and the limitations of the available budget, a desktop approach is proposed to generate information on the location, types and conditions of wetlands/pans within the study area. This desktop approach will include a desktop delineation of pans using existing maps. Regional DWAF and DEAT discussions to verify strategic pans and once a couple of pans have been identified a field verification will take place.

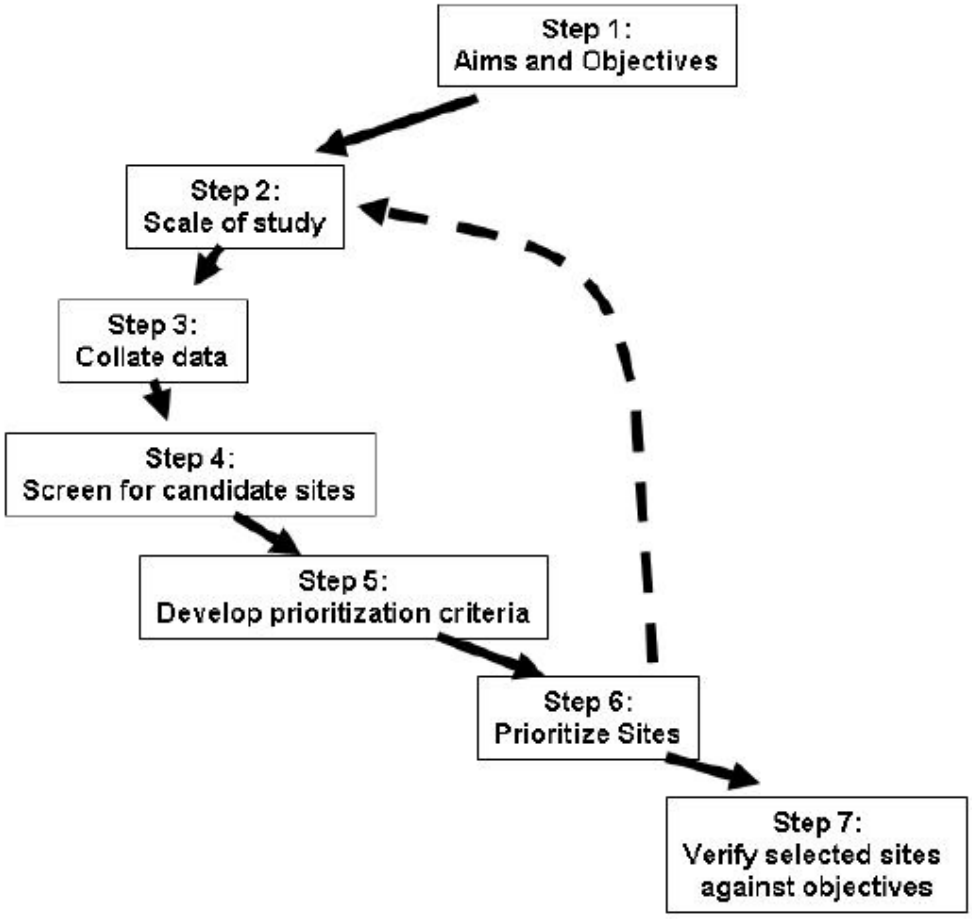

Figure 2: The steps to be undertaken as part of the wetland prioritization procedures.

9.6 Fish

Summary of the Approach for the Fish Response Assessment Index (FRAI):

- Determine reference conditions for fish assemblages based on an assessment of least-impacted sites, historical data or expert knowledge.
- Determine the Present Ecological State (PES) of the fish assemblage based on the species collected during the field survey.
- Determine the trends in fish assemblage. A trend can be either absent (close to natural or changed but stable), negative (away from reference) or positive (moving back to reference). The purpose is to determine whether biota have adapted to the current habitat template or are still in a state of flux.
- Determine reasons for PES and whether these are flow or non-flow related.
- Determine the Ecological Importance and Sensitivity (EIS) of the fish assemblage and habitat
- Based on the PES and EIS, suggest a realistic Recommended Ecological Category (REC) for the fish assemblage as well as for the EcoStatus.
- Determine alternative Ecological Categories (ECs) for the fish assemblage as well as for the EcoStatus.

9.7 Macroinvertebrates

The methodology to be used is based on the Resource Directed Measures for the Protection of Water Resources Manual, Version 1 (DWAF, 1999). Any amendments published after this date will be adhered to if they are received prior to the commencement of field sampling. Summary of the Approach for the Macroinvertebrate Response Assessment Index (MIRAI):

- Establish reference conditions for the macroinvertebrate assemblage can be based on an assessment of minimally impacted sites within the same Level II Ecoregion, similar sites in different rivers or historical information.
- Select site with suitable habitat for macroinvertebrates. The site should be either representative of the river delineation or should represent a critical section of the river.
- Before the site is visited and sampling conducted all available macroinvertebrate data for the river is collected. This includes a literature survey, a search of the Rivers Database and contacting other specialists that have previously worked in the area.
- The main aim of the habitat assessment is to evaluate the template on which the invertebrates exist. One of the routine habitat assessments has been the Invertebrate Habitat Assessment System (IHAS) developed by McMillan (1998). While the IHAS is validated and tested, a modified version of the IHAS is utilized.
- Although the MIRAI can be calculated using data collected during a standard SASS survey, it is usually determined using a more detailed assessment. The aim of the MIRAI is to provide a habitat-based cause and effect foundation to interpret the deviation of the aquatic macroinvertebrate assemblage from the reference condition.
- Rank and weight each of the metrics: The metrics used in the calculation of the MIRAI are 1) Flow modification; 2) Habitat modification; 3) Water quality modification and 4) System connectivity and seasonality

- Compare the observed taxa with the expected taxa.
- Rate the metrics accordingly.
- Rank and weight the metric groups.
- The four metric groups are combined to derive the invertebrate Ecological Category (EC).
- By interpretation of flow and non-flow related impacts the reasons for a specific EC can be determined. This allows recommendations to be made with regards to the maintenance or improvement of the invertebrate assemblage

9.7.1 Objectives

The objectives of the sampling programme are:

- To identify the number of species/taxa and their abundance at each EWR site in the available habitats as prescribed by the SASS5 manual.
- To identify key species that are the most sensitive to changes in flow regime.
- To determine the habitat preferences of key species in terms of substrate type, velocity and depth.

9.7.2 Field Sampling

SASS5 sampling (which is an updated method of SASS version 4) will be used to record the number of species/taxa present and their abundance at each EWR site in the available habitats (as specified in the SASS5 manual).

A standard RBA hand-net of 1000 μm will be used to sample available habitats. These habitats include stones in current, stones out of current, fringing or marginal vegetation and sandy/muddy substrate and are sampled and scored separately. The stones in current habitat will be sampled by holding the net immediately downstream of the stones being sampled. The stones are agitated using the foot to dislodge any benthic invertebrates, which are then swept into the net. The agitation is continued for two minutes if all of the stones were moveable otherwise for a maximum period of five minutes. Any fringing or marginal vegetation was sampled by sweeping the net forwards and backwards through the vegetation for one minute. Sand or mud bottom substrate is sampled by agitating for 30 seconds and sweeping the net through the water.

After the sampling of each substrate, the contents of the net are tipped into a sorting tray and the taxa recorded on standard SASS5 scoring sheets for the lesser of fifteen minutes or five minutes since the last taxon was found. These sheets are used to calculate the number of taxa, the SASS5 score as well as the ASPT (average score per taxon). The SASS5 score is calculated by summing the scores of the taxa recorded. The ASPT score is calculated by dividing the SASS5 score by the number of taxa.

The SASS samples will be preserved using formalin and taken back to the laboratory for further analysis.

Semi-Quantitative Sampling

Benthic invertebrate samples will be collected using a 30 cm diameter hand net with a 300 µm pore size. Areas of uniform substrate, depth and current velocity will be sampled. Stones in current will be sampled by holding the net downstream of the sampling area and lifting the stones out of the water into a large bucket. Any dislodged animals would be collected in the hand net. The stones are carefully washed in the bucket and the contents of this bucket are then poured into the hand net. The substrate, depth and current speed (at 60% depth) are measured at the same place as the sample was collected. Fringing or marginal vegetation will be sampled by sweeping the net through the vegetation several times. Sand or mud will be sampled by disturbing the area to be sampled with the foot and then sweeping the net through the disturbed material. This will be repeated as many times as possible during the field trips.

After collection, the contents of the net will be transferred into a plastic collecting jar or into a 500 ml plastic Whirl-Pak bag. Approximately 5 ml of formalin will be added to each sample as well as a label detailing the site (code and description) and date of collection. The same details will also be recorded using a marker pen on the outside of the plastic bag. The samples will then be transferred to the laboratory for sorting and identification to species or tax level. In the laboratory the samples will be sorted by first picking out large animals and then washing the remainder with tap water using either a 300 µm pore size hand net. The specimens which have been sorted will be preserved in 80% ethanol. Specimens will be identified using a microscope and taxonomic keys.

The data obtained will be used to produce Substrate/Velocity/Depth (SVD) histograms. These will be useful to indicate the physical habitat preferences of individual taxa. SVD histograms plot the number of individuals against selected substrate, velocity and depth classes which will be defined after the data has been collated.

9.7.3 Key Species

The invertebrate data will be interrogated and key species identified in terms of relative importance in the invertebrate community, their sensitivity to current velocity as well as their sensitivity to physical and chemical water quality. Whether identifications will be made to species or taxon level will depend on the ease of identification in terms of size and availability of taxonomic literature.

9.8 Riparian Vegetation

The flow requirements of the riparian vegetation will be determined using the standard procedure of examining the distribution of indicator tree and shrub species along hydraulic profiles at the EWR sites selected during planning and following the site visit in August. This will be based on the broad assumption that individual surveyed trees at or near the surveyed transects correlate to the distribution of riparian plant species within the macro-channel. This together with a general understanding of the determinants of riparian vegetation distribution patterns will be used as the basis for determining the flow requirements of the riparian vegetation. Consideration will also be given to the influence of different channel types and associated geomorphological features (see van Coller, Rogers and

Heritage, 1996) at each of the survey sites in order to facilitate a better understanding of hydrological and fluvial influence. Assistance will also be provided with respect to the riparian component of the habitat integrity determination. This will include consideration of whether the sites are representative of the habitat diversity, channel types and riparian species occurring in the Vaal River. Reference conditions based on the modified geomorphological template will be determined for the riparian vegetation as will those aspects relevant to the determination of the PES and EIS.

An initial report will be produced describing each survey site in terms of the riparian vegetation, including plots of the cross-sectional profiles showing the position of individually marked and surveyed trees. This will need to be done with the assistance of the surveyor who will be involved in surveying the hydraulic profiles. Indicator species will be used to demarcate estimated flow types along each of the profiles. This information will be presented as large plans for use in an integration workshop where further evaluation of the links between hydrology, hydraulics and the riparian plant species distribution will be made. The report will also include those aspects relating to the riparian vegetation relevant to the determination of the reference conditions and PES and EIS. It will also form the supporting document for the riparian component of the integration workshop. It will thus not only include issues relating to the flow requirements of the riparian vegetation such as flows to meet transpirational needs, terrestrialisation, regeneration requirements and site diversity, but also i) a broader description of the spatial distribution patterns of the riparian vegetation in relation to the general morphology of the river (van Coller and Rogers, 1996); and ii) a discussion on the determinants of the riparian distribution patterns including aspects such as site availability, species occurrence and abundance, species performance.

Input will also be provided from a riparian vegetation perspective with respect to the scenario development and risk assessment aspects of the study and a separate monitoring section will be included for the riparian vegetation component. Information will be collated during the site visits to undertake the Level 4 VEGRAI assessment. The modelled results and an assessment of reasons for change from reference conditions will be provided.

9.9 Hydrology

During the data collection phase of the project, any existing hydrology for the catchment will be collected, with particular emphasis on hydrological data that has been used in previous yield modelling on the catchment.

The data will be evaluated by the PSP and recommendations made to the client should any further hydrology be required to be developed for the project.

Both simulated naturalised and present day hydrological data will be presented at the level of monthly flows. Daily flow conditions will be represented by observed data where recorded. Observed daily flow data (using DWAF rating curves) from selected flow gauging stations will be used where available. Where necessary simulated 'naturalised" daily flow data, using observed daily flow records from reliable gauging stations will be used.

Disaggregation of the catchment at the proposed EWR sites will be carried out and hydrological modelling for the various EWR sites and the catchment as a whole will be performed using the models specified in the DWAF "Guidelines for Decision Support Models for Water Use Evaluation". If an adequate amount of reliable daily streamflow data is available, a daily rainfall-runoff model will be calibrated and used. If unavailable, then monthly modelling will be applied.

The spatial and time-series distribution of flows will be studied and will take into account flow volumes, timing, flow patterns, flow levels, seasonal and inter-annual flow variability together with flood and drought cycles. Current flow regimes as well as naturalised flows, to represent the virgin hydrology of the catchment, will be studied. The hydrologist will prepare monthly base flows as well as the frequency and size of "freshes", average annual floods, drought and other high flow events, together with their frequency, in as much detail as possible, to represent what has been naturally experienced in the flow reach.

During the specialist workshops the hydrologist will present the time series of flow regimes to assist the other specialists in making decisions about the ecological water requirements and ensuring that they do not set flows that are unrealistic from the point of view of what would be expected to occur in the river under natural conditions.

The outcome of the specialist workshops will be the required flows for various scenarios and will include:

- Maintenance low flows expressed in m^3 s-1
- Maintenance high flow events defined as peak flows in m^3 s-1 and durations in days
- Drought low flows expressed in m^3 s-1
- Drought high flow events defined as peak flows in m^3 s-1 and durations in days
- Flood events defined as peak flows in m^3 s-1 and durations in days

The monthly hydrology from the systems model (to by supplied by the Hydrological PSP.) for each EWR site (present and naturalised flows) will be used and will be set up in SPATSIM. No additional systems modelling will be undertaken by this study.

This information will be relayed to the water resources analysts (systems modellers), who will determine what the impacts that these requirements have on the yield of the catchment.

The Scenario Planning phase is designed to resolve any disparities between the EWR and the required yield and could involve reassessment of the workshop results, redefinition of the EWR assurance rules, a change in management class or considerations and proposals relating to the water supply schemes in the catchment.

<u>Data to be provided :</u>

- cumulative variance of total runoff MAR for each site

- seasonal distribution of simulated monthly naturalised and present day flows at each EWR Site
- whisker-box plots of "virgin" daily averages at each EWR Site
- monthly flow duration curves for “virgin" daily averages at each EWR Site
- flood frequency curves based on annual maxima for each EWR Site
- simulated naturalised monthly flows at selected gauging stations
- simulated present day flows at selected gauging stations

From the above, for the selected critical periods and in conjunction with the specialists requirements, flow-duration curves, exceedance diagrams and flow-stress data will be generated at each of the sites.

9.10 Basic Human Needs Reserve

The Basic Human Needs Reserve (BHNR), for the Middle Vaal Reserve Determination Study, will be generated following a number of steps. The first of these steps will be to use demographic data supplied by the Directorate Water Services: DWAF (or other appropriate sources) as a basis for analysis. Data would be acquired by the PSP from an appropriate source agreed upon with the PMT. The ward or sub-place name data available for the Census 2001 will be compared to the DWAF data and the most recent/accurate set will be used.

The data for the purposes of this study will then be further broken down to reflect the likely direct users of the surface water resources of the catchments. This will involve demarcating a 5km buffer zone on either side of the rivers and major tributaries. This buffer zone will then be used to estimate the numbers of people who would be likely to be reliant on the flow in the relevant river reach. It will be assumed that people outside of this area, although they might be making use of water from the rivers via a formal urban supply or a community water supply scheme, would in the main be using springs, minor streams or groundwater.

The data will be analysed further to estimate the population above and below the EWR sites identified for the study. This gives an indication of the volume of water that would need to pass certain EWR sites in order to meet the needs downstream. This would be fed into the yield modelling. A report that gives the quantity of water required for the Basic Human Needs Reserve will be produced. The report will be produced according to the required standards.

9.11 Social Economic Assessment

The level of study and approach is till under discussion between the management PSP and the client. Once a decision is made on a unified approach this will be communicated to this project team. The level of effort budgeted for in the proposal will then be compared to the proposed method and negotiations undertaken with client for a possible variance order.

9.12 Stakeholder Awareness

The Stakeholder Awareness Programme will be limited to the production of two information newsletters. The first will be a public awareness newsletter informing the stakeholders of the study at the beginning of the study. The second newsletters announce the preliminary results. The newsletter will be posted to all water users currently registered on the River Forums (such as the Schoon Koekemoer Spruits) in the Middle Vaal and the Free State Regional Office. The project will also be presented at any required forum meetings, or related meetings in the catchment, or as required by the client.

Phases of the stakeholder awareness are as follows:

- Development of a database of contact details using existing catchment forums.
- Determine what we need to communicate to them and this will determine (in many cases) how best to communicate to them.
- Once we know what should be communicated, we decide on methods of communication (this could include a letter, discussion document, workshop, advertisement, newsletter, posters, open house event, etc).
- We will announce the project to stakeholders by means of a background information letter or document, depending on what should be communicated and what we want from them.
- We will send out a non-technical update of the project to the stakeholders.
- We will not hold any workshops but will use existing catchment forums to communicate with the stakeholders

The stakeholder awareness process in this project is limited to key stakeholders and will be more of an education process to sensitise these stakeholders as to what the Reserve process is about and prepare them for a future full participatory process. No formal public participation will be undertaken without the clearance of the Project Management PSP.

10 DETAILED PROJECT PLAN

10.1 PHASE 1: STUDY INITIATION

10.1.1 Objectives of Phase 1:

The objective of Phase 1 is to ensure that the project team and the Client have a common understanding of the efforts and level of technical co-ordination and integration that will be required to achieve the objectives of the study.

The aim of this task is for the project team to initiate the project, mobilise the project team and produce an Inception Report that will spell out all the technical tasks and deliverables with associated

cash flows and timeframes. Of particular importance at this stage is the development of consensus between the project team and the Client regarding the particular requirements of the assignment, including the finalisation of the level of detail, scope of work, work processes and programmes and how they will be monitored and evaluated?

It is important that the project team will work closely with the project teams responsible for conducting the water quality, yield modelling and groundwater studies. Close liaison should also be maintained with the studies currently being undertaken by the NWRP directorate of the DWAF. The programme of these studies will be followed closely to ensure timely availability of the Reserve determination results to the NWRP directorate for incorporation into the various models when needed.

10.1.2 Tasks and Activities of Phase 1:

The primary purpose of this phase is to give the project team (technical PSP) the opportunity to identify, assess, and understand the nature and scope of the project and to document all the relevant information currently available on the study area. This will be done by reviewing existing literature, reports, maps, aerial photos, videos and any other relevant information on the study area. Tasks 1.1 to 1.11 are indicated in the project schedule (Table 8).

Task responsibility

Heath

Information required

Finalisation of the methods to undertake the pans and the socio-economic assessments.

Actions

Liaison with the project management PSP, DWAF as well as the other consultants in the Vaal studies so as to have a common understanding as to how the projects will link, common methods and deliverable dates.

10.1.3 Deliverables of Phase 1

- Inception report which will include
    - Revised budget
    - Revised schedule
    - Revised project team

The draft inception report to be submitted at the beginning of June 2007 for review.

Responsibility of the Consultant

Liaison with the project management PSP, DWAF as well as the other consultants in the Vaal studies so as to have a common understanding as to how the projects will link, common methods and deliverable dates.

Linkages/reliance with other studies

Linked deliverables such as reliance on water quality information, common approach needs to be finalized before the Inception Report is finalized.

10.2 PHASE 2: STUDY IMPLEMENTATION

10.2.1 Objectives of Phase 2

This phase will only proceed once the Client has approved the Inception Report and the project team are formally instructed to proceed with the execution of the study. This phase of the study is expected to dominate all the other phases in effort and duration. The purpose of the Implementation Phase of the study is for the appointed PSP to implement the project plan developed during the initiation and design phase. The critical aspect in this phase is to ensure the flow of information between the Client and all other relevant stakeholders.

In this phase the water quantity characteristics of the various Ecological Water Requirement sites and identified priority pans in the study area will be determined. This phase of the study has been divided into Tasks 2.1 to 2.10 as indicated in the project schedule (Table 8). More details of each task will be indicated below.

10.2.2 Tasks and Activities of Phase 2:

Task 2.1: Desktop Ecoclassification (quaternary scale) – as supplied by Delana Louw

This task serves as a scoping phase to investigate the WMA at a desktop level and at the scale of quaternary catchments and serves as the basis for most of the other tasks. The methods followed are those detailed in **section 9.2**.

All information required for the application of this task will be obtained. This includes amongst others land cover, photos, video material, Google Earth data, hydrology, system operation and fish reference conditions at the National River Health sites.

Task responsibility

- **Heath,** Molwantwa

Information required

- Land cover from D:RQS, DWAF
- Helicopter flight videos (from D:RQS and Free State Regional Office, DWAF)
- Readily available background information on the operation of the Middle Vaal.
- Information on important wetlands/pans in the catchment

Assumptions

- Data will be made available by DWAF
- No helicopter surveys have been included in the budget and available videos will be used for habitat assessment and site selection.

Deliverables and milestones

- Have desktop Ecoclassification data ready for use before site selection trip at the end of July 2007.
- Reconnaissance site visit to be undertaken 30 July to 3 August 2007 (Heath, Jordanova, Kimberg).

Task 2.2: Stakeholder Awareness

As indicated the stakeholder awareness process to be undertaken will only include limited public awareness through information newsletters. The process to be followed is described in **section 9.12**.

Task responsibility

Modupi, Heath

Information required

- General information from project leader describing the project and its objectives as well as preliminary results
- Database of relevant stakeholders from project leader and W Grobler of DWAF (Free State regional Office)

Actions

Two newsletters will be produced that explain the project, its objectives and preliminary results in a manner that is understandable to the stakeholders. These will then be distributed via post and e-mail.

Deliverables and milestones

- Production and distribution of two newsletters. First newsletter/BID will produced by end August 2007.

Assumptions

The budget does not include any other form of public participation activities.

Task 2.3: Basic human needs reserve (BHNR)

The BHNR, for the Vaal Reserve Determination Study, will be generated as described in **section 9.10**.

Task responsibility

Molwantwa, Heath

Information required

- Demography of the area
- Location of EWR sites

Actions

Analysis of demographic data to generate BHNR model and dis-aggregation of model to reflect location of EWR sites.

Deliverables and milestones

A report that gives the quantity of water required for the Basic Human Needs Reserve will be produced. (October 2007)

Assumptions

The budget does not allow for site visits for data verification

Task 2.4: Socio economic Present state

The Level of socio-cultural/economic assessment will be determined by the project management PSP and the client. Once a decision is made on a unified approach this will be communicated to this project team. The level of effort budgeted for in the proposal will then be compared to the proposed method and negotiations undertaken with client for a possible variance order.

Task 2.5: Resource Units

The purpose of this task is to define the study area for the comprehensive assessment and to delineate key rivers of the study area into Resource Units (RU). Each RU represents a homogenous area which requires its own specification of the Reserve. The process followed will be that described in the updated Reserve manuals (Louw and Hughes, 2002). The National River Health Programme sites as well as any relevant previous EWR studies will be assessed during this task.

Task 2.5.1 Geomorphological zones

Geomorphology provides a basis of classification for the purpose of describing the physical habitat of riparian and aquatic ecosystems, as it encompasses the physical processes which have shaped the river channel. The hierarchical classification approach of Rowntree and Wadeson (1999) will be followed. The information is available from D:RQS for South Africa.

Task 2.5.2 EcoRegions

EcoRegional classification allows for the grouping of rivers according to similarities. The method is based on a top-down approach as developed by DWAF (Kleynhans ***et al.***, 2004). The existing delineation into Level II EcoRegions is required and the results are available. The information is available from D:RQS.

Task 2.5.3: System operation

An overview of system management is required to ensure an understanding of the system operation and to interpret biological responses. System operation infrastructure is also often the logical endpoint of a RU. A description on the present operation which includes present uses, abstractions, curtailments etc., and operational structures if any, within the system must be available to the specialist team. A summarised description will be supplied by WRP Consulting Engineers (WRP) who is the lead consultants for the Vaal River Water Resource Yield Model update.

Task 2.5.4: Water quality sub-units

The objective of this task is to identify river reaches homogenous in terms of water quality, and to select the water quality variables to be evaluated. The water quality PSP (Golder Associates Africa (Golder)) will need to provide this information in the form of maps and supporting background information.

Task 2.5.5: Groundwater sub-units

This information is to be supplied by the Groundwater PSP but it is doubtful that they will be able to supply this information in time for inputs into this task.

Task 2.5.6: Identification of Resource Units

Using information generated during Task 2.5.1 to 2.5.5 and local expert knowledge the suggested RUs presented and illustrated using GIS mapping. If any of the pans information is available it will also be included during RU identification.

Task 2.5.7 EWR site selection

Ecological Water Requirements (EWR - quantity) sites are set at specific points on the river. These points are critical sites within a reach of river. The EWR sites must provide sufficient indicators for the specialists to assess environmental flows. The criteria for site selection as detailed in the BBM manual and DWAF (1999b) will be followed.

In the terms of reference it was suggested that 14 EWR sites should be considered (Table 9). It is not possible with the available budget to address this number of sites at a comprehensive level.

The results from previous Reserve determination studies, proposed systems modelling nodes and any additional information (e.g. operational constraints of the system) will be obtained and considered. Where previous rapid or higher confidence Reserve determination studies have been undertaken, the results of these studies will be utilised during this study. Where results of previous studies are used, they will also be reviewed in terms of the applicability of the methodologies used. This will be evaluated to indicate the usefulness of the data and previous studies.

Table 7 provides a list of proposed EWR sites that specified in the Terms of Reference document for the study and were identified during discussions with representatives from the RDM Chief Directorate, National Water Resources Planning Directorate and the Free State Regional Office.

Table 7: Proposed EWR sites (As per terms of reference)

1	Downstream of Allemanskraal Dam on the Sand River*
2	Downstream of Erfenis Dam on the Groot Vet River
3	Downstream of the confluence of the Sand and Vet Rivers
4	Makwassie River
5	Vals River downstream of Kroonstad
6	Koekemoerspruit/ Jagspruit
7	Vierfonteinspruit
8	Downstream of Koppies Dam on the Rhenoster River
9	Schoon Spruit before the confluence with the Vaal River*
10	Schoon Spruit before the confluence with the Rietspruit*
11	Vaal main stem upstream of Bloemhof Dam
12	Upper Orange WMA: Riet River (upper site)*
13	Upper Orange WMA: Modder River (upper site)*
14	Upper Orange WMA: Modder River downstream of the confluence with the Riet River*

* The results of previous Reserve determination studies will be considered during this study

The budget is based on 5 EWR sites to be addressed at comprehensive level. Extrapolation of some of the results is a possibility. This will be done where required after discussion with the client and if a suitable method is available at that time. Final EWR sites will be discussed with the client, Free State Regional Office and the project management PSP.

Ecological Reserve determination is the estimation of flow requirements of different components of a river. It focuses on the amount of water required to maintain the system in a particular ecological condition. Hydraulics tend to quantify the water needs of the various biotic components in terms of parameters such as water depth, flow velocity, wetted perimeter and water surface width. The results of hydraulic analyses and modelling therefore form the essential link between the way in which the hydrologists, engineers and water managers express the flow of water in the river in terms of flow rate, and the way in which river ecologists express the water requirements of the river ecosystem itself in terms of variables like the flow depth and velocity (Jordanova *et al*, 2002; Jordanova *et al*, 2004; Rowlston *et al*, 2000).

Cross-sectional surveys to the required hydraulic standards (updated Reserve methods, Louw and Hughes, 2002 as well as DWAF, 1999 and the BBM manual, King and Louw, 1998) will also be undertaken as well as the required photopoint monitoring. Sites where two-dimensional hydraulic modelling will be undertaken will require a Digital Terrain Model (DTM). This will be undertaken at a maximum of 3 sites, depending on site characteristics. For these sites, the two-dimensional hydraulic/habitat modelling must be cost effective, i.e. the additional information and increase in confidence must warrant the additional resources required (DTM survey, hydraulic and habitat related data collection, two-dimensional hydraulic modelling).

For Comprehensive determination (RDM for Protection of Water Resources: River Ecosystems, Appendix R 17) 4 to 5 observations of discharge and stage are required. According to the budget for the hydraulic modelling the number of site visits could be limited to three (exc. Site selection trip).

The key EWR specialists (R Heath, P Kimberg, A Jordanova, A Koning, hydraulics trainee) will do the site verification select sites. At the same time the dry season surveys, hydraulic calibration and flow measurements will be undertaken.

Task responsibility

- **R Heath**, P Kimberg, A Jordanova, A Koning, M Rountree, T Coleman

Information required

- Operation procedures to be supplied by WRP Consulting Engineers
- Water quality sub units to be supplied to Golder
- Relevant shape files for GIS presentation

- Landcover maps from D:RQS
- 1:50 000 topographical maps and aerial photography

Actions

- DWAF surveyors to agree to assist with cross sectional surveys (letter of request required from RDM)
- One site reconnaissance visit of 5 days (August 2007)

Deliverables and milestones

- The Resource Units report, which includes all the information, generated during the sub-tasks, as well as the final Resource Units (November 2007)

Assumptions and exclusions:

The following aspects are not included for in this study:

- The Geomorphological zonation will only be down to a level of zones
- The selection of more than 5 comprehensive EWR sites.
- There will not be an EWR site in each RU
- Additional site visits if adverse weather conditions occur
- Resurveying sites if benchmarks are removed.
- Making arrangements, booking or paying for any non-team members that are participating in site surveys.

Task 2.5.8 Resource Units report

The final Resource Units report will be produced (November 2007).

Task 2.6: Wetland typing and Ecoclassification

The process and tasks identified for the pans assessments is described in **section 9.5**.

Task responsibility

- **Otto**, Hattingh

Information required

- SANBI Wetlands Map (available)
- SANBI Wetlands Probability Layer (DWAF to source)
- 1:50 000 topographic maps (available)
- 1:10 000 orthomaps from CD:RDM

Deliverables and milestones

- A Pans/wetlands assessment report detailing the outcomes and results of the tasks to be undertaken (as described in **section 9.5**).
- Desktop mapping of the pans/wetlands within the study area (A GIS shapefile/layer of the pans/wetlands in the Middle Vaal Water Management Area)

Assumptions and limitations

- The budget does not include the describing the reference condition of every wetland/pan identified of identified in the Middle Vaal WMA.
- The project team will work in close collaboration with Mark Rountree of the Upper Vaal WMA study
- Only a very limited number of priority wetlands/pans will be field assessed (these will not be EWR determined)
- Higher confidence Reserve determination studies for the wetlands/pans falls outside the scope of this study.

Task 2.7: River Ecoclassification

The updated EcoClassification methods as described in Kleynhans *et al*., 2007 (in press) will be followed for a Level 4 assessment. This will be undertaken at the RUs where EWR sites are selected.

The EcoClassification approach includes determining the following:

- Ecological Importance and Sensitivity (EIS),
- Socio Cultural Importance (SCI),
- Present Ecological Status (PES), and
- Recommended Ecological Category (REC).

The EcoClassification process will also include predicting Ecological Categories (EC) linked to flow scenarios as well as for setting Ecological Specification (EcoSpecs) as part of Resource Quality Objectives (RQOs).

This PES phase of EcoClassification aims to obtain sufficient information to supply a PES for each component and EcoStatus for each RU represented by an EWR site. All relevant existing information will be sourced, and the required surveys will be undertaken. The surveys will take place at the EWR sites.

The frequency of surveys for geomorphology and riparian vegetation will be only once during the appropriate season. Fish and invertebrate surveys in some areas, depending on sensitivity and type of assemblage, might require two surveys, one during the dry season, and one post-wet season. The flows will be measured at least three times at some of the sites.

The analysis of all the data collated will consist of individual indices and the PES categories for each component. The information will be documented in the required format. The rule-based models (HAI, GAI, VEGRAI, FRAI, MIRAI), developed as part of the EcoClassification system by D:RQS (Kleynhans ***et al.***, 2005) will be used to determine the PES for each of the components.

Task 2.8: EWR scenario assessment

The EWR scenario assessment process is to supply a relationship between an index of stress and habitat availability during different flow conditions using the Habitat Flow-Stressor Response (HFSR) method. This information is required for the determination of required stresses for different ECs.

The information on habitat, collated during the previous tasks as well as the hydraulics will be used to determine the stress indices. These indices form the base information for the determination of low flows using the HFSR method, i.e. for setting the low flow requirements for the EWR scenarios.

The high flows will be assessed by indicating flood requirements based on the biophysical response of the floods. The floods are grouped into flood classes and the number of events required for different EWR scenarios are identified. The EWR scenario determination will be undertaken at two workshops.

Task responsibility

- **Heath**, Haumann, Jordanova, Rall, Kimberg, Rountree, trainees, Molwantwa, Koning, Mahlangu and Jacobson

Information required

- All collated information from previous tasks
- Hydraulic information

- Hydrology available before workshops

Deliverables and milestones

- EcoClassification results (August and September 2008)
- EWR scenarios (August and September 2008)

Assumptions and limitations

- The budget provides for only three flow scenarios per EWR site.

Task 2.9: Operational scenarios and consequences

The objective of this task is to provide the final EWR recommendation. The EWR scenarios developed during Task 2.8 will be evaluated and Operational Scenarios designed which will consider the availability and the present constraints (such as outlet sizes of existing dams).

During this task interactions between this study team (Ecological Reserve) and the Vaal WRYM PSP will be required. For the following process to be followed:

- Provision of the EWR scenarios to the system modellers.
- Inclusion of the EWR scenarios in the system model
- Design of operational scenarios considering constraints such as availability and operational aspects.
- Modelling of the additional scenarios.
- Provision of the results at each EWR site.
- This information will then be used to determine a range of consequences.

The derived scenarios will be assessed in terms of **ecological consequences** so as to determine the impact on the EC. This assessment forms part of the EcoClassification process where the rule-based models are used in a predictive manner. The first requirement will be the analysis of the scenarios in terms of impact on the physico-chemical EC using the PAI. This information must be provided by the Golder PSP. The other rule-based models (MARAI, FRAI, VEGRAI, GAI) are also assessed. The results will be used to generate the resulting EcoStatus. The process to determine the ecological consequences is as follows:

- The flows will be converted to stress for each scenario at each EWR site.
- The flow information will also be supplied in a format suitable for high flow evaluation to all the specialists.
- This information will be provided to the biological and geomorphological specialists as well as a template for completion.

- These specialists must complete their indices for the new flow/stress scenario to determine the resulting EC.
- The water quality consequences will be modelled for each scenario and will be supplied as an EC with a qualified explanation and motivation by Golder.
- All information must be supplied to the EWR co-ordinator who will use the information as input to the Ecostatus model.
- A meeting will be held with key persons present to confirm and refine the above results

At this stage, if the information has been collated the consequences on Socio-economics and ecosystem services (goods and services) would be determined. The purpose of this task is to evaluate and forecast for each EWR scenario, the social and economic values of changes in the water availability to the socio-economic sectors as well as the value of the ecosystem services by leaving different amounts of water in the river reaches of the Middle Vaal River WMA.

Task responsibility

- **Heath**, Haumann, Randall., Jordanova, Rall, Kimberg, Rountree, trainees, Molwantwa, Koning, Mahlangu and Jacobson

Information required

- EWR scenarios
- Interactions with WRYM (WRP)
- Results of yield modelling in usable format
- PAI results from Golder
- Interactions/integration with Upper Vaal EWRs

Deliverables and milestones

- Range of scenarios available for consequences assessment (February 2009)
- Ecological consequences in terms of predicted EC available for each EWR site and each operational scenario
- Suite of EcoStatus models run for each operational scenario

Assumptions and limitations

- Setting up or reconfiguring the Water Resource Yield Model (WRYM) not included in the budget.
- Only six scenarios will be assessed.

- Social and economic assessment not included to a high level of confidence in the budget

Task 2.10: Identification of Ecospecs

The objective of this task is to determine the EcoSpecs (the ecological component of RQOs) for the recommended EC and link the ECs to TPCs (Thresholds of Potential Concern). During the specialist meeting, EcoSpecs which form the ecological component of RQOs, will be set for flow, quality, habitat and biota. The quality and flow EcoSpecs are dependent on a decision regarding an acceptable operational scenario as the Ecological Reserve. The habitat and biota EcoSpecs must be linked to the relevant category and will be quantified as far as possible.

Draft documentation (Kleynhans & Louw, 2006) is available which describes the process of using the suite of EcoStatus models to generate the EcoSpecs and TPCs. These EcoSpecs and TPCs can then used for design of a monitoring programme which is not requested in this study.

Task responsibility

- **Heath,** Rall, Kimberg, Rountree, trainees, Koning, Rowntree

Information required

- All collated information from previous tasks
- Hydraulic information
- Hydrology available before workshops

Deliverables and milestones

- Workshop (March 2009)
- EcoSpecs and TPCs at each EWR site.

Assumptions and limitations

- The assessments for more than one EC;
- The design of a monitoring programme.

10.3 PHASE 3: STUDY TERMINATION

10.3.1 Objectives of Phase 3:

The purpose of this phase is firstly to consolidate what the project team has learnt and to translate this knowledge into improvements in the management of future Reserve determination studies.

The project manager will ensure completion and termination of all the technical tasks and activities. Once all the objectives of the Reserve determination study, including the technical integration as required have been achieved, the Client will issue instructions to terminate the study.

10.3.2 Tasks and Activities of Phase 3:

The project manager will assist and support the Client with the following tasks:

Task 3.1: Documentation collation

Ensure that the technical findings are documented in the formal Reserve template format that can be used by the Department to submit the Reserve determination results for approval by the Director General.

Task 3.2: Handover to client

Ensure that all study documents, including specialist reports are received in the format and quantities described (hard and electronic copies) and that all the project files are completed and transferred to the Client.

Task 3.3: Technical performance audit

Prepare a technical performance audit report and provide comments on the capacity building done during the study.

10.3.3 Deliverables of Phase 3

The appointed project team will produce the following:

- Study performance audit report which shall include the following items:
  - Amount of actual project costs versus budgeted project costs; and
  - Technical and financial performance evaluation of the study.

We have planned that the study termination should begin in April 2009 and that it will take 4 months to complete.

Task responsibility

- **Heath,** Molwantwa

10.4 PHASE 4: PROJECT MANAGEMENT

This phase of the project will be the responsibility of the project team's project manager. The tasks associated with project management include the following:

- Liaison with the project team
- Liaison with the Project management PSP and the client
- Attendance of Project Management Committee meetings
- Attendance of Project Steering Committee meetings
- Development of progress reports
- Financial administration and invoicing
- Overseeing the capacity building programme
- Quality control of reports
- Integration with the concurrent Vaal River studies

Task responsibility

- **Heath,** Molwantwa

11 STUDY MANAGEMENT

The management of the proposed team and the study will consist of a Study Leader and Deputy Study Leader as well as Task Leaders. The role of the Study Leader is to provide technical vision and direction to the project while the Deputy Study Leader will be responsible for the administration of the project, financial control, progress reports and minutes of meetings. The project team has a number of members who have been involved in the management and execution of projects of this size and nature and are therefore ideally suited to execute the assignment.

11.1 Monitoring of Project

The monitoring of the project will be undertaken by means of a detailed work programme for each task. The Task Leader will be responsible for producing the Gantt chart for his task, showing the individual activities, time line and the key deliverables. The Gantt chart will be related to cash flow. The Gantt chart will be discussed at the internal project meetings and discussed at the meeting between the Project Management Committee (PMC) and the PSP. In this way the impacts on the critical path can be monitored and remedial action can be taken timeously.

11.2 Study Control

A series of internal project team meetings will be set up. The composition of the members of the project team attending the meetings will vary depending on the work programme and the tasks currently active. This will allow for the exchange of information, monitoring of progress, financial control and achievement of the work programme. The task Gantt charts will be discussed at these meetings to check on progress. The projected cash flow will be compared to invoicing to control the financial aspects of the project. These meetings will be held at least every two months and will coincide with the PSP meetings with the PMC.

11.3 Coordination

The co-ordination of the project will involve bi-monthly meetings between the PSP and the PMC. In addition there will be regular informal contact between the study manager and the PSP to discuss issues that may have arisen and to plan remedial action. If the matter is of a serious nature, the PMC will be convened to deal with the issue.

Internal review of the deliverables by a senior member of the team has been allowed for in the project. The deliverables when completed will be presented to the PMC with both the Task Leader and the reviewer present. No allowance has been made in the project cost estimate for external peer review, although this would be welcomed and recommended on key deliverables. Once a deliverable has been accepted by the PMC and PM PSP, the report will be completed and signed off. That deliverable is considered final and will not be re-visited.

Progress reports which include progress on the individual tasks, highlight any problems experienced and financial control will be produced for each of the meetings between the PMC and the PSP.

12 STUDY SCHEDULE

12.1 Phases of Programme

The generic tasks to be undertaken are discussed in the following phases:

- Phase 1: Study Initiation and Design (Inception)
- Phase 2: Study Implementation
- Phase 3: Study Termination
- Phase 4: Project management

It is expected that these phases will run sequentially, but will overlap for a least some period. A detailed project schedule is included in **Table 8**.

Table 8: Proposed project schedule

		2007		2008		2009		
Task	Phase	Feb - Jun	Jul - Dec	Jan - Jun	Jul - Dec	Jan - Jun	Jul - Dec	
1	**PHASE 1: STUDY INITIATION**							
1.1	Mobilise project team							
1.2	Liaise with DWAF (RDM Directorate and Region)							
1.3	Review all documentation							
1.4	Status Quo Report							
1.5	Client meeting to discuss proposed EWR sites							
1.6	Define methods to be used							
1.7	Capacity Building Plan							
1.8	Detailed project plan developed							
1.9	Draft Inception report							
1.1	Client Review							
1.11	Finalise Inception Report							**31 July 2007**
2	**PHASE 2: STUDY IMPLEMENTATION**							
2.1	**PES, EIS and SCI: Quaternary basis**							
	Data preparation							
	Application of EcoStatus models (PES, EIS and SCI							
	Report on Ecoclassificification							**31 August 2007**
2.2	**Stakeholder awaerness**							
	Data base							
	Awareness newsletters/BID							**BID 1: 31 August 2007**
2.3	**Basic human needs Reserve**							
	Assessment & report							**31 October 2007**
2.4	**Socio economic Present state**							

		2007		2008		2009		
Task	**Phase**	**Feb - Jun**	**Jul - Dec**	**Jan - Jun**	**Jul - Dec**	**Jan - Jun**	**Jul - Dec**	
2.5	**Resource units**							
	Geomorphological zones		■					
	EcoRegions		■					
	System operation		■					
	Water quality sub-units		■					
	Groundwater sub-units		■					
	Identification of Resource Units		■					
	EWR site selection		■					
	Dry season site survey		■	■				
	Wet season site survey		■					
	Resource units report		■	■	→	→	→	**31 November 2007**
2.6	**Wetland typing and ecoclassification**							
	Inventory, classificaton, assessment		■					
	Wetland classification report		■	■	→	→	→	**31 January 2008**
2.7	**River Ecoclassification**							
	Run suite of Ecostatus models			■	■			
	Index of Habitat Integrity			■	■			
	EcoClassification specialist meeting: Workshop			■	■			
	Ecoclassification report			■	■	→	→	**30 September 2008**
2.8	**EWR scenario assessment**							
	Hydraulics field surveys		■	■	■			
	Hydraulics calibration and assessment			■	■			
	Sediment Transport Modelling			■				
	EcoHydrology analysis		■	■	■			
	EWR scenario determination workshop 1				■			
	EWR scenario determination workshop 2				■			
	EWR scenarios report				■	→	→	**30 September 2008**
2.9	**Operational scenarios and consequences**							
	Liase with WRYM				■	■		
	Determining consequences on socio economics					■		
	Optimisation of the overall water re-allocation scenarios					■	→	**28 February 2009**
2.10	**Identification of Ecospecs (Ecological RQO's)**							
	Workshop					■		
	Ecospecs report					■	→	**31 March 2009**
3	**PHASE 3: STUDY TERMINATION**							
3.1	Documentation collation							
3.2	Handover to client						■	**31 August 2009**
3.3	Technical performance audit						■	**31 July 2009**
4	**PHASE 4: PROJECT MANAGEMENT**							
4.1	Team liaison	■	■	■	■	■	■	
4.2	Project management committee	■	■	■	■	■	■	
4.3	Project steering committee	■	■	■	■	■	■	
4.4	Progress reports	■	■	■	■	■	■	
4.5	Liaison with other Vaal studies	■	■	■	■	■	■	

The results of the comprehensive Reserve determination for the water resources of the Middle Vaal WMA will be integrated with the results of the other studies that will be initiated in the other WMAs. Further, the water quality requirements of these water resources, yield modelling tasks as well as the requirements of groundwater resources will be conducted as separate studies.

The success of this project and the ability to meet the required terms of reference and schedule is dependant on close liaison between all the other studies throughout the duration of the project.

13 STUDY TEAM CHANGES

Golder Associates Africa (Pty) Ltd will be the lead consultancy for this proposal. Golder Associates Africa (Pty) Ltd has merged with Ecosun as of 1 June 2007 and hence these team members will not need to be subcontracted. PD Niadoo and Associates (PDNA) and Zitholele consulting will also form part of the project team.

13.1 Study Team Changes

The capabilities of the Key Personnel included in the Golder Associates Africa (Pty) Ltd proposed team (with reference to the skills required for the study) are presented in Table 9. The following changes to the team have been made since the proposal was developed:

- John Howcroft has due to personal circumstances withdrawn from the team. His position has been replaced by Rene Ford (CV attached) who is an agricultural economist. Mrs Ford's participation increases the HDI component of the project team.

- Ms L du Preez has had to withdraw from the project team due to study commitments. Mr M Rountree has agreed to be part of the study team as the geomorphologist expert. Mr Rountree is undertaking the geomorphology aspects on the Upper Vaal and it makes sense that the system is study as a whole. The same trainee as used for the Upper Vaal will be included in this study.

- Dr Johan Rall will guide and do quality assurance on the fish. Peter Kimberg has been included to undertake the fish field assessments. Peter is an experienced fish biologist and is an accredited SASS practitioner.

- Veronika Rall has withdrawn from science to follow another career. We would like to use Alvar Koning for the macroinvertebrate field assessment. He is a qualified SASS practitioner. Dr Johan Rall will guide and do quality assurance on the macroinvertebrate assessments.

- Detailed CV's of the team change personnel is provided in **Appendix B**.

Table 9: Summarised Capabilities of Key Personnel

Name / Affiliation	Educational qualification	Applicable Capabilities	Company working for
Ralph Heath	PhD (Aquatic Toxicology)	Project management of comprehensive Reserve determinations (Letaba, Limpopo, Schoon Spruit), water quality assessments (Komati)	Golder Associates
Trevor Coleman	M.Sc.(Eng) Civil	Water quality assessments (Olifants, Ngagane, Mokolo and Vaal Rivers)	Golder Associates
Bruce Randell	PhD (Eng) Civil	Hydrologist and hydraulics	Golder Associates
Jennifer Molwantwa	MSc (Biotechnology), current PhD	Water quality assessment for Komati comprehensive Reserve	Golder Associates
Ken Haumann	B.Sc.(Eng) Civil	Hydrology and SPATSIM specialist	PD Naidoo and Associates
Solly Manyaka	BSc	Public participation – stakeholder engagement	Zitholele
Herbert Modupi	Current completing BA degree	Stakeholder engagement facilitator	Zitholele
Danie Otto	MSc	Wetland/pans geomorphology specialist	Golder Associates
Johan Rall	PhD (Fish ecology)	Aquatic Ecologist - fish	Ecosun
Peter Kimberg	BSc (Hons)	Aquatic Ecologist - fish	Golder Associates
Raina Hattingh	BSc (Hons)	Environmental scientist	Golder Associates
Alvar Koning	M Tech (Nature conservation)	Macroinvertebrates	Golder Associates
Niels Jacobson	PhD (Zoology)	Riparian vegetation	Golder Associates
Angelina Jordanova	M.Sc.(Eng) Hydraulics	Hydraulics (low flows) and River Morphology	Golder Associates
Mark Rowntree	BSc (Hons)	Fluvial Geomorphologist	Private consultant
Rene Ford	M.Sc Agric. Economics	Agricultural Economists	Zitholele
Zwelibanzi Mahlangu	S3	Trainee hydrologist	Golder Associates

13.2 Organisational Structure

The organisational structure related to task components is presented in **Figure 3** on the next page.

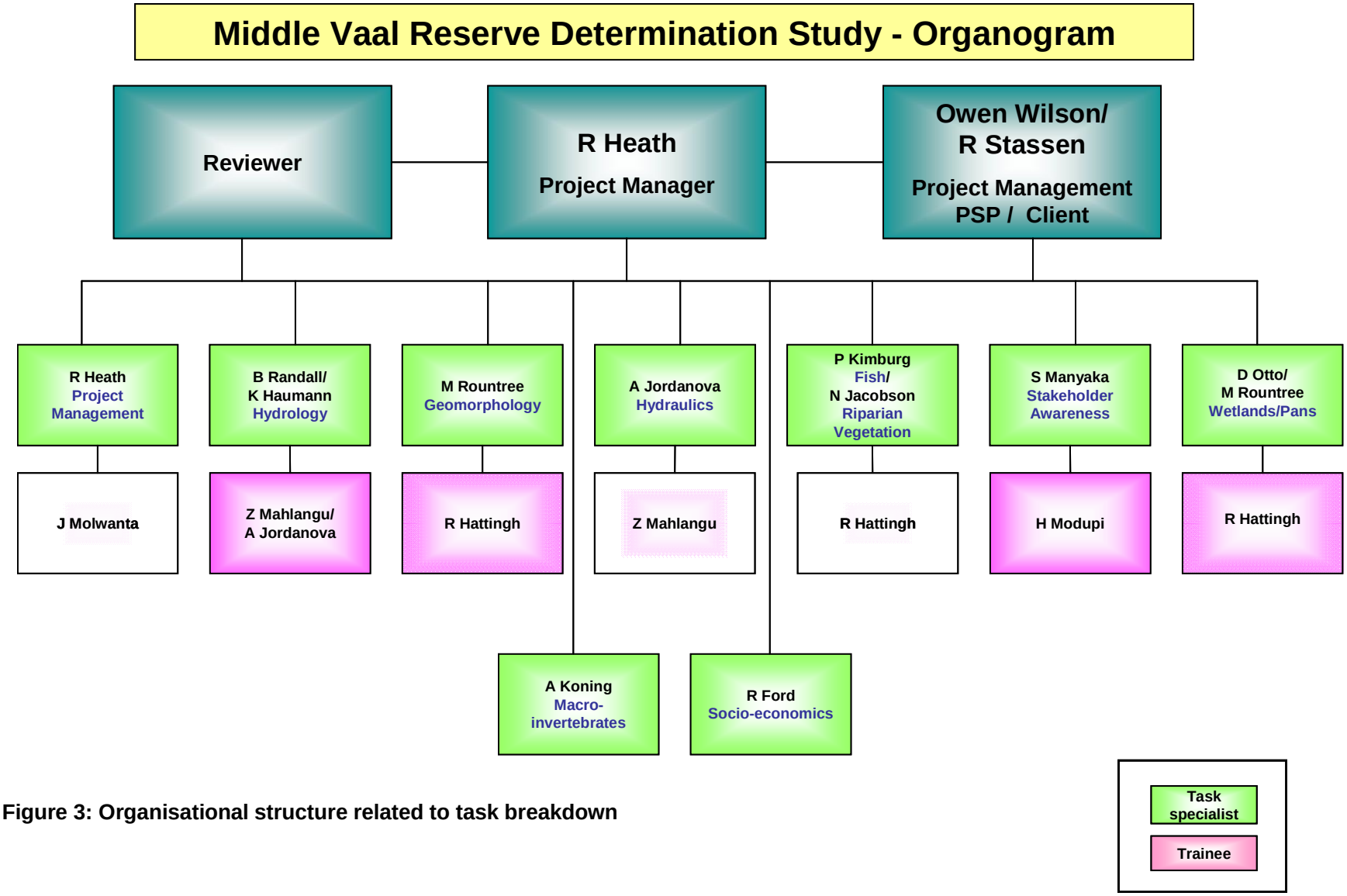

Figure 3: Organisational structure related to task breakdown

14 CAPACITY BUILDING AND PARTICIPATION OF HDI'S AND HDE'S IN THE MIDDLE VAAL

Capacity building in the Middle Vaal and Upper Orange River will be realised through the following mechanisms, namely:

- Local specialists and stakeholder involvement (e.g. the existing catchment management forums in the Middle Vaal WMA.
- The Sand Vet and Schoon Spruit and Koekermoer Spruits have existing catchment executive committee's who have Local Authority, NGO'S and Environmental Groups chosen to these committees. 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 concept of integrated water resource management and sustainable development;

Participation of DWAF officials (RQS, CD: RDM, CD: IWRP, Regional Offices) will ensure active sharing of ideas and contribute to the broadening of the RDM skills base;

- Our project team of specialists have identify and included HDIs, as well as junior personnel in our team, in order to train and build capacity by maximising their involvement in the project; and
- The Client has the right to consider to second DWAF staff members to the appointed project team.
- O Wilson from the project management PSP.

The following HDI resources will be included in the capacity building programme:

HDI candidate	Mentor	Skills to be trained
J Molwantwa	Ralph Heath	Project Management
Z Mahlangu	Bruce Randell Angelina Jordanova Ken Haumann Prof Dennis Hughes	Hydrology SPATSIM Modelling Desk top modelling Hydraulics
A Jordanova	Ken Haumann Prof Dennis Hughes	SPATSIM Modelling Desk top modelling
R Ford	Ralph Heath Trevor Coleman	Socio-economic assessment tools for Reserve processes
R Hattingh	Mark Rountree Danie Otto	GAI assessment tools Wetland/pans assessment
H Modupi	Solly Manyaka	Public awareness campaign for Reserve process WMA database development Background information newsletters

Secondees from DWAF-RDM will also be given capacity building during the project. These secondees capacity building will be funded out of a separate budget.

In order to structure the training and development and optimize the time available at specialist workshops it has been suggested that training workshops are held for the trainees. These workshops would be used to explain the Reserve process and then simulate the specialist workshops via data entering, manipulation etc. It has further been suggested that these workshops be held in collaboration with all three Reserve studies being undertaken on the Vaal. The training that was originally planned in the proposal submitted for the Middle Vaal did not include dedicated workshops but rather included hands on training (along side the dedicated specialists). It is suggested that if such workshops were to be held that alternate sources of funds be sought such as Fetwater or a variance order on this existing contract.

The following training courses have specifically been suggested as part of the capacity building programme:

- SPATSIM and Desk Top model – to be presented by Prof Dennis Hughes

Note: Integrated training is planned for the various Reserve studies. The PM PSP will co-ordinate the DWAF training (awareness, capacity building, etc.) and the specialist Reserve teams will be responsible for the training of identified trainees and DWAF secondments (if any)as specified in the inception reports.

15 STUDY BUDGET

The total budget for this project for the Reserve for the Middle Vaal is **R1 578 948.00** (excluding Vat).

Task	Title	Total
1	Phase 1: Study Initiation	45,320.00
2	Phase 2: Study Implementation	1,260,640.00
3	Phase 3: Study Termination	71,240.00
4	Phase 4: Project Management	140,880.00
	Disbursements	60,868.00
	Total (Excluding VAT)	1,578,948.00
	VAT	221,052.72
	Total for Project	**1,800,000.72**

The hours and percentage fees per consultancy company is indicated in the table below:

	Total hours	%	Fees	%
Golder	2891	84%	R 1,274,600	83.96%
Zitholele	103	3%	R 37,080	2.44%
Private Consultant	268	8%	R 107,200	7.06%
PDNA	160	5%	R 99,200	6.53%
	3422	**100%**	**R 1,518,080.00**	**100.00%**

The level of HDI involvement in this study is the following:

*HDI Involvement		
Total HDI %: Fees Earned	**35.4%**	**R 537 500.00**
Total HDI %: Time Allocated	**38.9%**	**1333**

More details on the budget are given in **Appendix C.**

The budget has limitations in the number of EWR sites that can be included at a comprehensive level. It is proposed that a total of 5 new EWR sites will be surveyed in the Middle Vaal and that the Desktop Ecoclassification (quaternary scale) approach as supplied by Delana Louw was not included in the original budget as this aspect of the method was not documented at the stage when the proposal was written.

GOLDER ASSOCIATES AFRICA (PTY) LTD

T Coleman **R G Heath**

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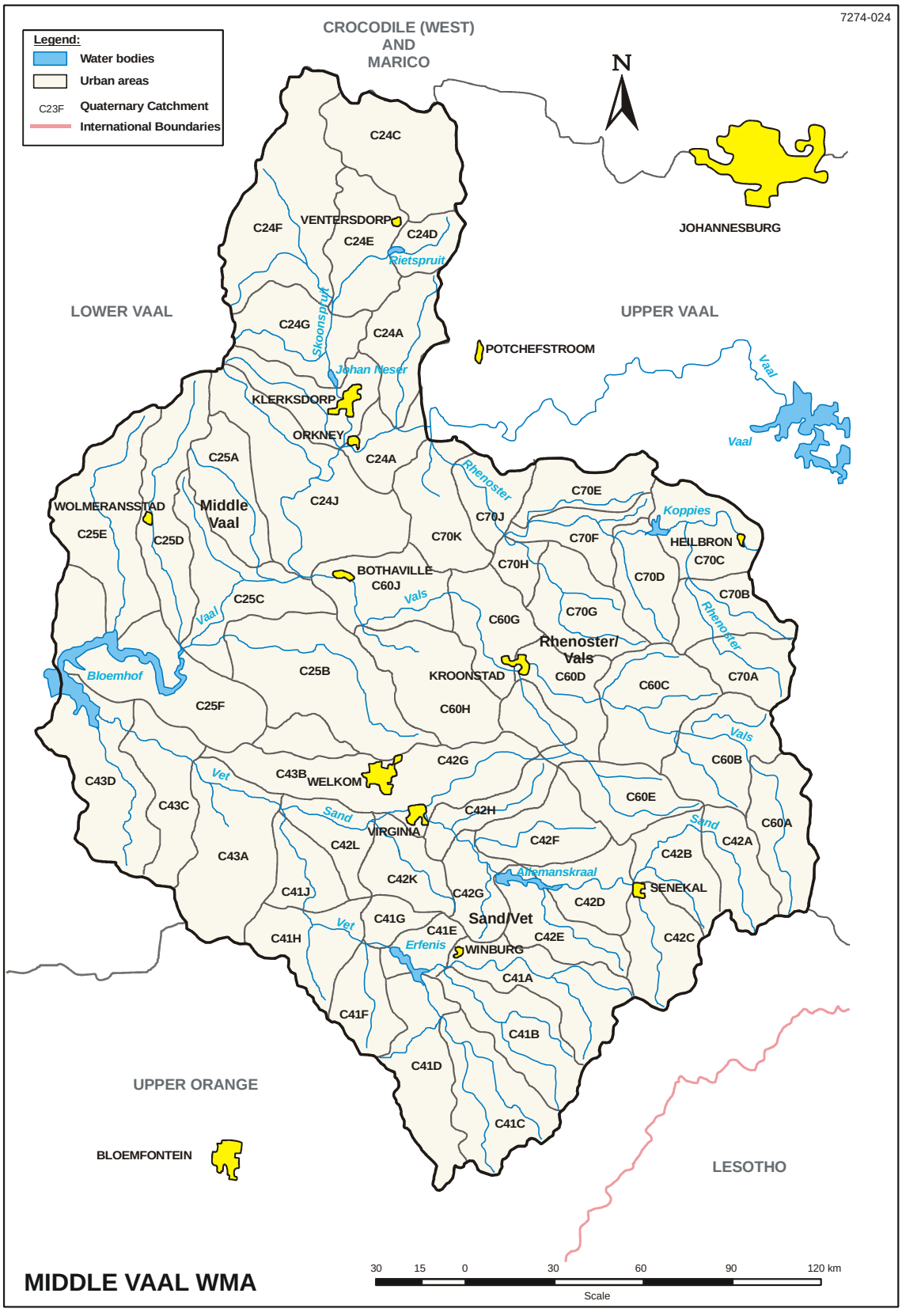
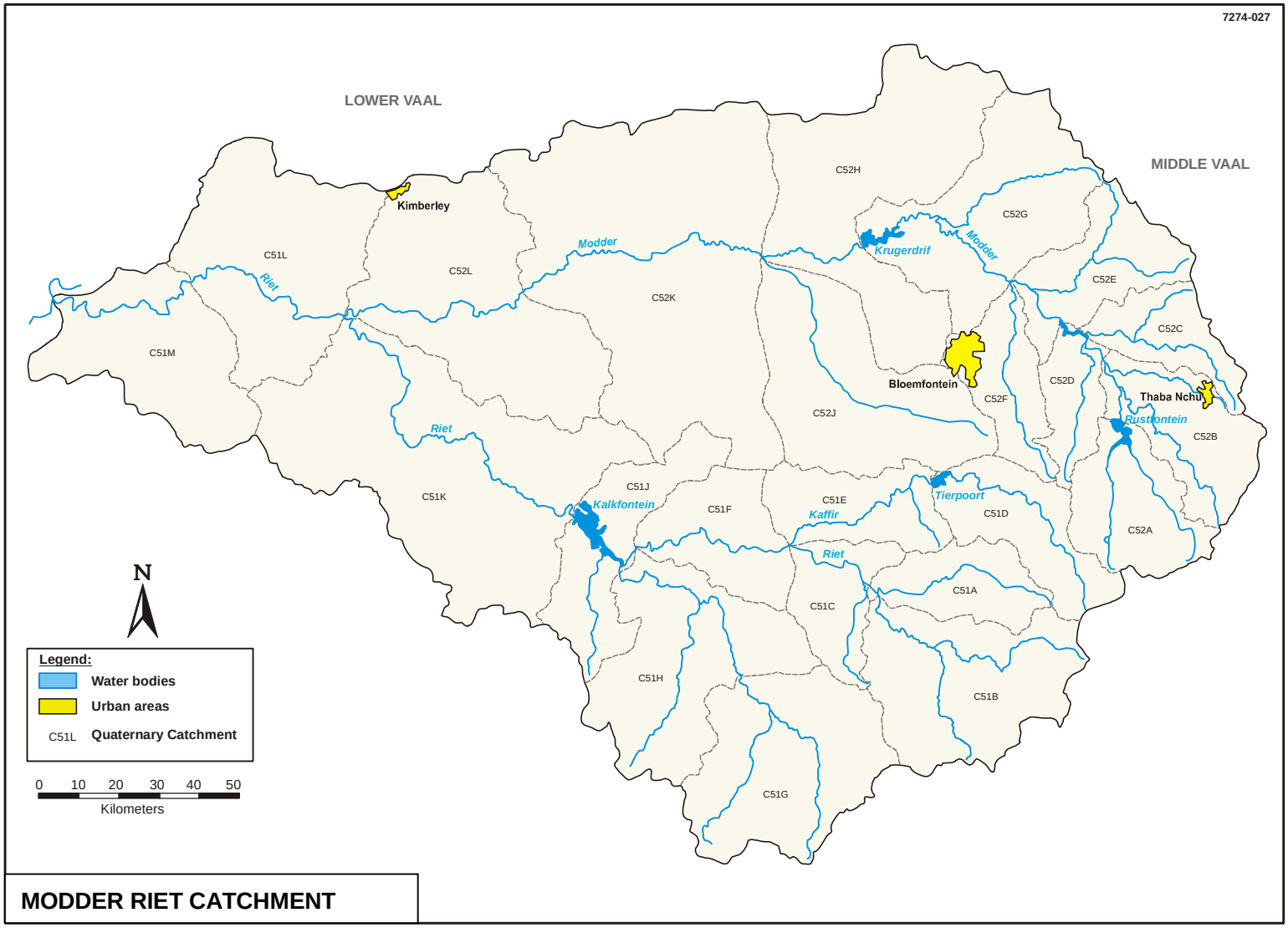
APPENDIX A

STUDY AREA


7274-024
Legend:
Water bodies
Urban areas
C23F Quaternary Catchment
International Boundaries
CROCODILE (WEST) AND MARICO
N
JOHANNESBURG
LOWER VAAL
UPPER VAAL
POTCHEFSTROOM
Vaal
Vaal
C24C
C24F
VENTERSDORP
C24D
C24E
Rietspruit
C24G
Skoonspruit
C24A
Johan Neser
KLERKSDORP
ORKNEY
C25A
C24A
Rhenoster
C70E
WOLMERANSSTAD
Middle Vaal
C24J
C70J
Koppies
C25E
C25D
C70K
C70F
HEILBRON
C70C
C70H
BOTHAVILLE
C60J
C70D
C25C
Vals
C70B
Vaal
C60G
C70G
Rhenoster
Rhenoster/ Vals
Bloemhof
C25B
KROONSTAD
C60D
C60C
C70A
C25F
C60H
Vals
C42G
C60B
C43D
Vet
C43B
WELKOM
C60E
C43C
Sand
C42H
Sand
C60A
VIRGINIA
C42L
C42F
C42A
C43A
C42B
Allemanskraal
C42K
SENEKAL
C41J
C42G
C42D
C41G
Sand/Vet
C41E
C42E
C42C
C41H
Vet
Erfenis
WINBURG
C41A
C41F
C41B
C41D
UPPER ORANGE
C41C
BLOEMFONTEIN
LESOTHO
30 15 0 30 60 90 120 km
Scale
MIDDLE VAAL WMA



MODDER RIET CATCHMENT

APPENDIX B

***CURRICULA VITAE* OF NEW TEAM MEMBERS**

APPENDIX C

STUDY BUDGET DETAILS

Team member	Professional fees	Fees: % Participation	Total Hours	Time: % Participation
Ralph Heath	317,440	20.9%	512	15.0%
Trevor Coleman	44,640	2.9%	72	2.1%
Bruce Randell	40,500	2.7%	90	2.6%
Jennifer Molwantwa*	49,200	3.2%	164	4.8%
Herbert Modupi*	36,000	2.4%	90	2.6%
Danie Otto	45,000	3.0%	100	2.9%
Zwele Mhalangu*	76,000	5.0%	304	8.9%
Raina Hattingh*	34,300	2.3%	98	2.9%
Angelina Jordanova*	255,320	16.8%	491	14.3%
Rene Ford	49,600	3.3%	80	2.3%
Ken Haumann	99,200	6.5%	160	4.7%
Pieter Kimburg	133,200	8.8%	370	10.8%
Alvar Koning	118,400	7.8%	370	10.8%
Niels Jacobson	75,000	4.9%	150	4.4%
Mark Rountree	107,200	7.1%	268	7.8%
Solly Manyaka*	0	0.0%	0	0.0%
Admin Assistant*	37,080	2.4%	103	3.0%
TOTAL	**1,518,080**	**100.0%**	**3422**	

Human resource Information and Charge-out Rates

Project team member	Firm	Responsibility Level*	Position in Team	Profession	Rate (R/h)	Rate Basis	HDI Status*
Ralph Heath	Golder	F	Project manager	Senior scientist	R 620.00	Negotiated Rate	
Trevor Coleman	Golder	E	Water quality specialist	Senior engineer	R 620.00	Negotiated Rate	
Bruce Randell	Golder	C	Hydrology specialist	Hydrological engineer	R 450.00	DWAF rate	
Jennifer Molwantwa*	Zitholele	C	Trainee water quality	Scientist	R 300.00	DWAF rate	HDI
Herbert Modupi*	Golder	C	Socio-cultural assessor	Social scientist	R 400.00	DWAF rate	HDI
Danie Otto	Golder	D	Pans specialist	Senior scientist	R 450.00	DWAF rate	
Zwele Mhalangu*	Golder	C	Trainee hydrologist	Junior Scientist	R 250.00	DWAF rate	HDI
Raina Hattingh*	Golder	C	Trainee aquatic ecologist	Scientist	R 350.00	DWAF rate	HDI
Angelina Jordanova*	Golder	D	Hydraulic Enginner	Hydraulics engineer	R 520.00	DWAF rate	HDI
Rene Ford	Golder	E	Economics expert	Agri Economist	R 620.00	Negotiated Rate	HDI
Ken Haumann	PDNA	E	Spatsim and hydrology	Director	R 620.00	Negotiated Rate	
Pieter Kimburg	Golder	E	Fish specialist	Managing Director	R 500.00	DWAF rate	
Alvar Koning*	Golder	D	Macroinvertebrate specialist	Director	R 500.00	DWAF rate	
Niels Jacobson	Golder	E	Riparian vegetation	Scientist	R 500.00	DWAF rate	
Mark Rountree	Private Consultant	E	Geomorphologist	Senior scientist	R 400.00	DWAF rate	
Solly Manyaka*	Zitholele	E	Stakeholder communication	Managing Director	R 600.00	DWAF rate	HDI
Admin Assistant*	Zitholele	B	Administrative support	Administrative support	R 250.00	DWAF rate	HDI
							At least 50% HDI Participation

* As per the DWAF Policy Guidelines on the Remuneration and Reimbursement of Professional Service Providers

** Hourly Rates are applicable to 31 October 2007 after which a 6% annual increase in rates will be applicable. CV's for all team members are included in Appendix I

*** As per the Preferential Procurement Regulations, 2002