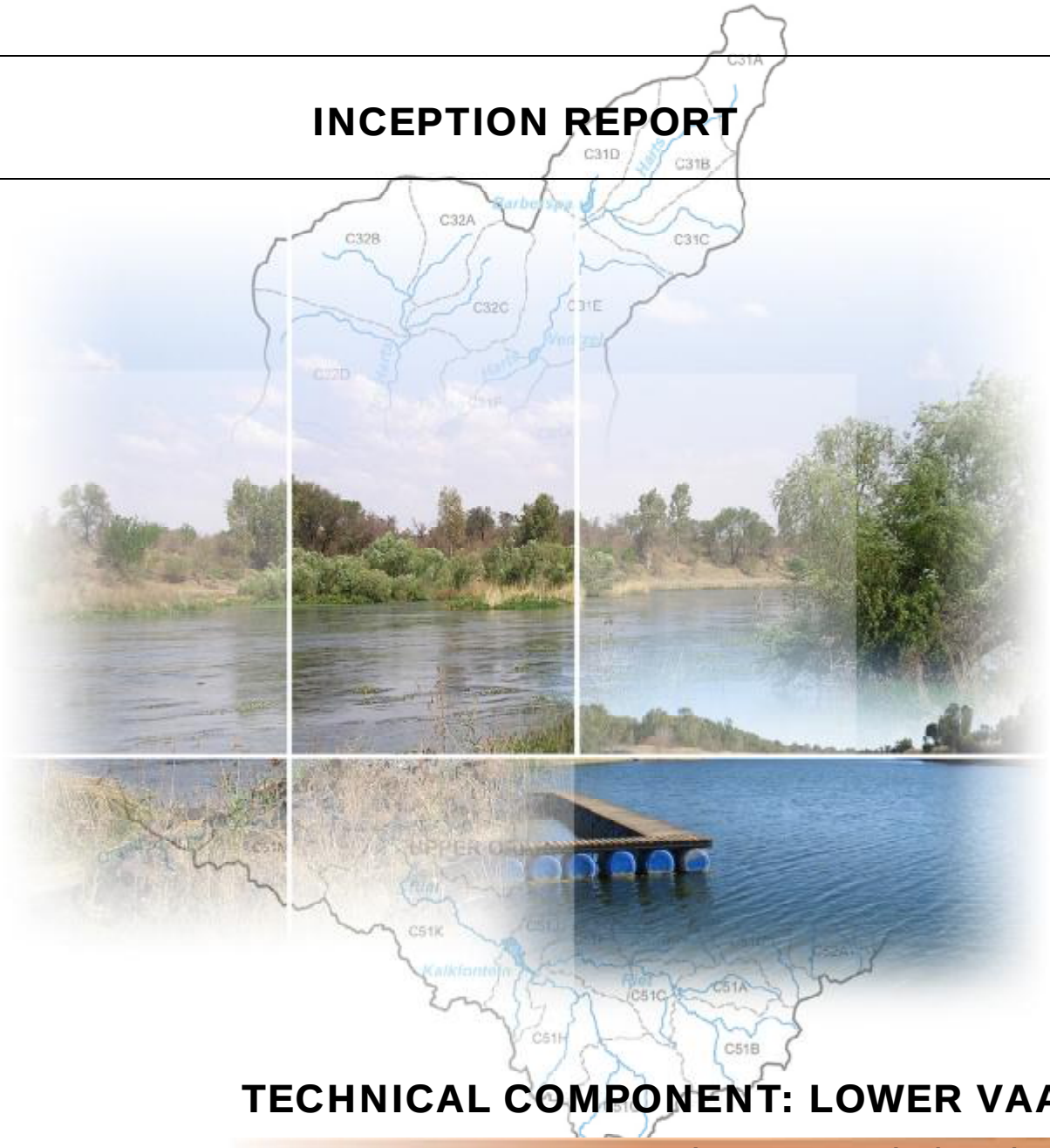
COMPREHENSIVE RESERVE DETERMINATION

INTEGRATED VAAL RIVER SYSTEM

SURFACE WATER

INCEPTION REPORT



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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
RDM	Resource Directed Measures
REC	Recommended Ecological Category
PES	Present Ecological State
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
WRYM	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: Lower 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: Lower Vaal Water Management Area (WMA) surface water quantity (technical component). The purpose of the Comprehensive Reserve Determination Study for the water resources of the Lower Vaal 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. In addition an assessment of the pans in the Lower Vaal 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 ongoing project management and capacity building phases.

This inception report is the first phase of the Ecological Reserve: Water Quantity for the rivers of the Lower Vaal 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 reaches of the Vaal River and its main tributaries within the Lower 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);
- **Capacity Building and Training:** to include identified persons from DWAF, identified team members 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 Lower 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 Lower 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. The wetland Reserve methods are being tested as part of a separate study and hence will not be tested on the priority wetland/pan systems as part of this study.

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 Vaal WMA 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 Lower 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 Lower 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. An extrapolation method is currently being developed by Dr Kleynhans of DWAF and if approved for use this method could be applied to this study.

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):

- Vaal main stem downstream of Bloemhof Dam, before Vaal-Harts abstraction weir

It is important to note that the flow in the north western catchments (Harts River) is very seasonal and that this could make site selection difficult. An alternative Reserve data collection approach might be required for these sites. A recently completed Water Research Commission (WRC) study on ephemeral rivers could be investigated as a possible approach to assessing these rivers in the Lower Vaal WMA.

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. Subsequent 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 Lower 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 (Lower 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.
- Diatoms will be collected per EWR site visit but the analysis will be undertaken by Dr Bill Harding as part of a separate contract. It is assumed that the results of the analysis will be made available to the project team.

- The surveying of each EWR site has not been budgeted for as it was planned to use DWAF's surveyors. The DWAF team will be accompanied by the team hydraulics specialist on the surveys.

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 extrapolations are required then the method to be used will be decided upon at that stage.

5 THE STUDY AREA

5.1 Overview and Background to the Lower Vaal WMA

The Lower Vaal WMA covers a catchment area of 133 354 km^2, and includes parts of the Northern Cape and North-West Provinces, and a small part of the Free State Province. It is situated in the north-western part of the country and forms part of the Orange River watercourse. The Vaal River is the only major river in the WMA, as it flows in a westerly direction from Bloemhof Dam to the confluence with the Orange River. The largest part of the WMA falls within the catchment of the Molopo River, a tributary of the Orange River. The Molopo, Nossob and Kuruman rivers drain the remainder of the WMA but due to the very low rainfall in the WMA, these rivers are episodic. The WMA consists of the D41 (excluding D41A), parts of D42C and D42D, parts of D73A and D73C, C31, C32, C33, C91, and C92 tertiary catchments. For the purpose of this study only the C drainage region is of relevance as it forms part of the Vaal River System, which includes the Harts River catchment and the Vaal River catchment. These two catchments as part of the Vaal River System cover a catchment area of 53 500km^2 within the Lower Vaal WMA. The C drainage region of the Lower WMA comprises four sub-catchments as listed in **Table 1**. The location and general layout of the WMA is depicted in **Appendix A.**

Table 1: Sub-catchments and related quaternary drainage regions of the C drainage primary catchment within the Lower Vaal WMA

PRIMARY CATCHMENT	SUB-CATCHMENT	QUARTENARY CATCHMENTS	AVERAGE GROSS AREA (Km^2)
C	Dry Harts	C32A-D	10 205
	Harts	C31A-F	11 023
	Vaalharts	C33A-C	9843
	Vaal downstream Bloemhof	C91A-E, C92A-C	22 427

The average temperature for the WMA is 16˚C. The rainfall is strongly seasonal occurring mainly in the summer months. Mean annual precipitation ranges between 100mm in the west and 500mm to the east of the WMA. Mean annual evaporation can reach as high as 2800 mm per year which is in excess of rainfall. The WMA has no climatic barriers and thus climate varies gradually according to the larger regional patterns, and is fairly uniform from east to west.

The WMA has relatively flat terrain with no distinct topographic features. As a result of the arid climate, vegetation over the WMA is sparse, consisting mainly of grassland and some thorn trees (notably the majestic camel thorns). The WMA is dominated by tropical bush and savannah with small areas of pure grassveld to the east.

Virtually all the surface flow of the Vaal River, the main source of water in the Lower Vaal WMA, originates from the Upper and Middle Vaal WMAs. Very little surface run-off originates within the WMA itself due to the low rainfall, flat topography and sandy soils. The groundwater resource is more substantial, supplying an estimated 128 million m^3/annum. The Vaal River is fed by the only tributary, the Harts River which drains a catchment area of 31 000km^2, with the Dry Harts being the major tributary of the Harts River, joining it just downstream of Taung. The only lake and wetlands of note are at Barberspan in the Upper Harts River catchment which has been given Ramsar status as a wildlife conservation area.

Large quantities of water are transferred from the Vaalharts weir on the Vaal River to supply the Vaalharts irrigation scheme in the Harts River catchment. The Vaalharts Irrigation scheme generates irrigation return flows which enter the Harts River upstream of Spitskop Dam. The return flows contribute salinity and nutrients to the Harts River.

The development of the surface water resources occurring in the WMA has reached its potential, however all water is not being fully utilised. The water in Taung Dam is currently not utilised. Studies are however currently underway to investigate the utilisation of these two dams, and if this happens this may impact on the ecosystems in these catchments and in downstream catchments which in some cases include ephemeral systems. There are several large dams that have been developed in the WMA. The main dams are listed in **Table 2.**

Table 2: Major Dams in the Lower Vaal WMA

Dam name	Quaternary catchment	River
Douglas Weir	C92B	Vaal
Spitskop	C33B	Harts
Taung Dam	C31F	Harts
Vaalharts Weir	C91B	Vaal
Wentzel	C31E	Harts

The Lower Vaal WMA is dependant on the Upper Vaal and Middle Vaal WMAs for supply of utilisable surface water resources, with over 90% of the water required being sourced through releases

from the Upper Vaal WMA and from Bloemhof Dam. More than 50% of the yield from natural water resources in the tributary catchments within the WMA is supplied from groundwater.

Most of the water is used for urban, agricultural and mining purposes within the WMA. Water is also transferred into the WMA from the Lower Orange WMA into Douglas Weir.

The water quality of the rivers in the WMA has high seasonal turbidity levels and the Lower Vaal River has also high nutrient levels. The high TDS and nutrient levels are cumulative impacts of upstream agriculture and mining.

Current land use in the WMA, due to the arid climate is characterised by extensive livestock farming as the main activity and large scale dry land cultivation in the north eastern part of the WMA. Intensive irrigation (about 80% of water use) is practised at Vaalharts, as well as at locations along the Vaal River. The most significant urban area in the WMA is Kimberley to the South. Several towns as well as scattered rural settlements are found mainly in the central and eastern part of the WMA. Iron ore, diamonds and manganese are mined in the WMA. Small scale diamond mining is a common occurrence in and on the banks of the Lower Vaal River. Previous studies on the Lower Vaal (Heath, Moffet and Bannister 2004) have indicated tat the only impacts associated with the diamond mining is as follows:

- Habitat degradation (instream and riparian)
- Water quality (turbidity)
- Aesthetics (no rehabilitation)

These impacts and land use issues will be taken into account when the sites are selected.

The economy of the Lower Vaal WMA is relatively small, with the WMA generating about 2% of the Gross Domestic Product of South Africa (DWAF, 2003). The economy is still dominated by mining, however much of the beneficiation is done in other areas. Most of the economic activity is concentrated in Kimberley and at other major mining areas. Manufacturing activities in the WMA include cement and cheese factories and relate to the agriculture sectors as well as items for local consumption. The trade sector is concentrated in wholesale of primary products and related services to the community. No significant changes to the economy of the WMA are foreseen over the medium term. The agricultural and mining sectors in the region are strong and will continue to make an important contribution to the regional economy.

The Lower Vaal WMA also shows minimal potential for strong economic growth, and thus a low population growth is projected. Consequently, limited growth in water requirements is expected.

6 RESERVE COMPONENTS

This study focuses on the technical part of the Comprehensive Reserve determination for the water resources of the Lower Vaal 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 Lower Vaal WMA Reserve study where necessary.

The determination of the ecological Reserve for the identified aquatic ecosystems in the Lower 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 component 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, organizational 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 Error! Reference source not found. 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 Lower Vaal WMA

Tertiary	PES	EIS
Lower Vaal WMA		
C31	C	Moderate
C32	C	Moderate
C33	C to D	Moderate
C91	D	Moderate
C92	C	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							
Vaal main stem	Lower Vaal	C91E	Quantity and Quality	Rapid III	C	Moderate	C
Vaal main stem	Lower Vaal	C92A	Quantity and Quality	Rapid III	C	Moderate	C

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 Error! Not a valid bookmark self-reference.. 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 Lower Vaal WMA

Monitoring Point	Latitude	Longitude	Drn	Begin	End
C3H003Q01 AT TAUNG ON HARTSRIVIER	-27.573056	24.746389	C31	23/02/1960	10/05/2001
C3H007Q01 AT ESPAGSDRIF ON HARTSRIVIER	-27.902778	24.615556	C33	11/12/1967	22/10/2004
C3H016Q01 AT DELPORTSHOOP LLOYDS WEIR ON HARTSRIVIER	-28.376944	24.303056	C33	05/11/1992	22/10/2004
C3R001Q01 SCHWEIZER RENEKE DAM ON HARTS RIVER: NEAR DAM WAL	-27.174444	25.336667	C31	23/10/1975	30/11/1998
C3R002Q01 SPITSKOP DAM ON HARTS RIVER: NEAR DAM WALL	-28.123889	24.501389	C33	24/10/1975	16/09/2004
C3R003Q01 BARBERS PAN AT ZANDVLEI (AT GAUGE PLATE)	-26.5675	25.598889	C31	14/03/1972	01/07/2004
C3R006Q01 TAUNG DAM ON HARTS RIVER: NEAR DAM WALL	-27.536944	24.85	C31	15/11/1995	16/09/2004
C9H008Q01 VAALHARTS BARRAGE ON VAAL RIVER: DOWN STREAM WEIR	-28.114167	24.915278	C91	23/11/1957	16/09/2004
C9H009Q01 VAAL RIVER AT DE HOOP	-28.515833	24.601111	C91	09/12/1971	28/10/2004
C9H013Q01 BOPLAAS EYE AT BOPLAAS	-28.160833	23.558611	C92	03/07/1995	05/08/2004
C9H017Q01 DOUGLAS BARRAGE ON VAAL RIVER: BUCKLANDS CANAL (L	-29.043333	23.836944	C92	10/12/1992	13/10/2004
C9H018Q01 VAALHARTS BARRAGE ON VAAL RIVER: RIGHT CANAL	-28.115278	24.925833	C91	07/10/1971	29/10/2004
C9H019Q01 DOUGLAS BARRAGE ON VAAL RIVER: ARTHERTON CANAL (R	-29.043333	23.836944	C92	09/12/1992	13/10/2004
C9H021Q01 BLOEMHOF DAM ON VAAL RIVER: DOWN STREAM WEIR	-27.669167	25.618056	C91	23/11/1972	15/09/2004
C9H024Q01 AT SCHMIDTSDRIFT (WEIR) ON VAAL RIVER	-28.711111	24.073333	C92	01/06/1995	28/10/2004
C9H025Q01 ORANGE-VAAL CANAL AT ST CLAIR/DOUGLAS BARRAGE	-29.045833	23.841389	C92	13/12/1995	29/09/2004
C9R001Q01 VAALHARTS BARRAGE ON VAAL RIVER: NEAR BARRAGE WAL	-28.115278	24.925833	C91	27/10/1975	16/09/2004
C9R002Q01 BLOEMHOF DAM ON VAAL RIVER: NEAR DAM WALL	-27.669167	25.618056	C91	03/03/1971	13/10/2004
C9R003Q01 DOUGLAS BARRAGE ON VAAL RIVER: NEAR BARRAGE WALL	-29.043333	23.836944	C92	03/10/1977	13/10/2004

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. Directorate National Water Resource Planning. *Water Resources Situation Assessment Study. Lower Vaal Water Management Area.* Report No: P 10000/00/0101. November 2002.
- DWAF, 2003. Directorate National Water Resource Planning. *Lower Vaal Water Management Area: Overview of Water Resources Availability and Utilisation.* Final Report. Report No: P WMA 10/000/00/0203. September 2003
- DWAF, 2004. Directorate National Water Resource Planning. *Internal Strategic Perspective – Lower Vaal Water Management Area*. Report No: P WMA 10/000/00/0304. October 2004.
- DWAF (2004) Vaal River System: Overarching: Internal Strategy Perspective. Report No. P RSA 2000/00/01/0103, March 2004
- 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.
- Feasibility Study for utilisation of Taung Dam. DWAF. Directorate Options Analysis. *Study currently underway*.Kwezi V3 Engineers.

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 are 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 Northern Cape Regional Office.

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

1	Vaal main stem downstream of Bloemhof Dam, before Vaal-Harts abstraction weir*
2	Harts River upstream of Barberspan
3	Harts River between Barberspand and Wentzel Dam
4	Harts River between Wentzel Dam and Taung Dam
5	Harts River below Taung Dam, before confluence with Droe Harts
6	Harts River upstream of Spitskop Dam, after confluence with Droe Harts
7	Downstream of Spitskop Dam on the Harts River, before the Vaal River confluence

8	Vaal main stem between Vaalharts and Schmidtdrift Weirs
9	Vaal main stem between Schmidtdrift and Douglas Weirs

Where: *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, 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 Lower 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.

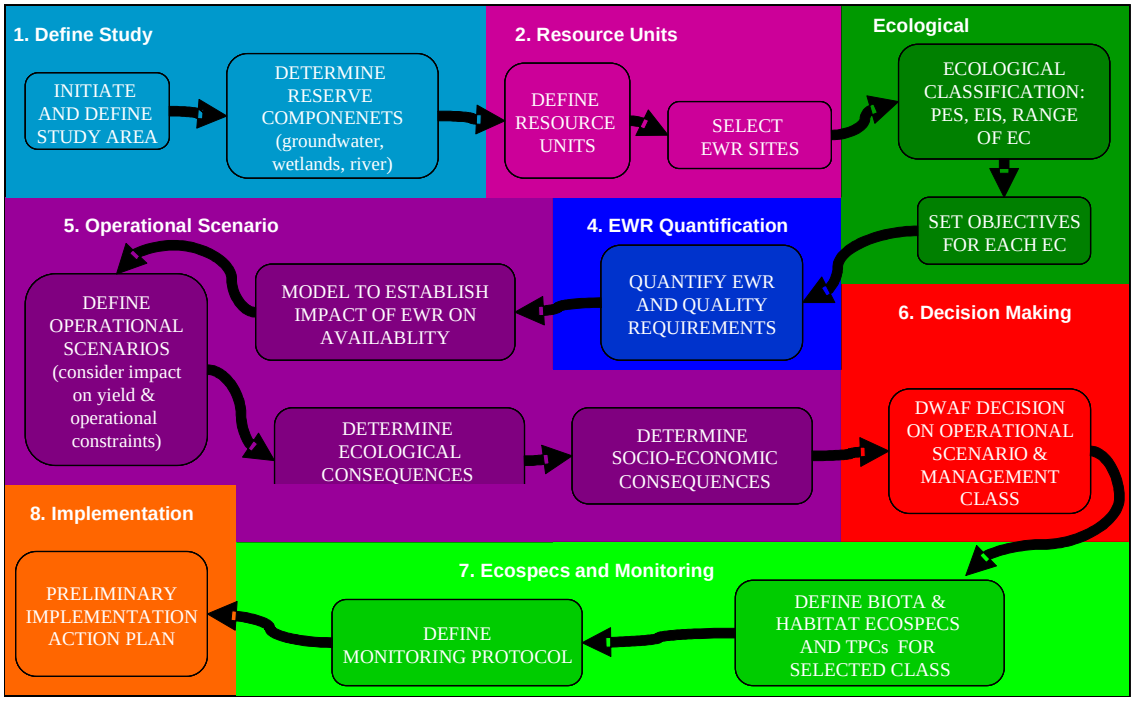

Figure 1: The generic 8-step Ecological Reserve Procedure (from DWAF 2003).

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/pans typing and classification are not well developed. Rapid Reserve methods for wetlands are currently under development. The method and approach indicated (Error! Reference source not found.**)** has been developed by Mark Rountree and a similar approach 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 pans within the study area (mapped at the 1:50 000 or (preferentially) 1:10 000 scale).
- classify the identified pans according to the HydroGeomorphic wetland classification system, which has been proposed as the wetland classification system for South Africa.

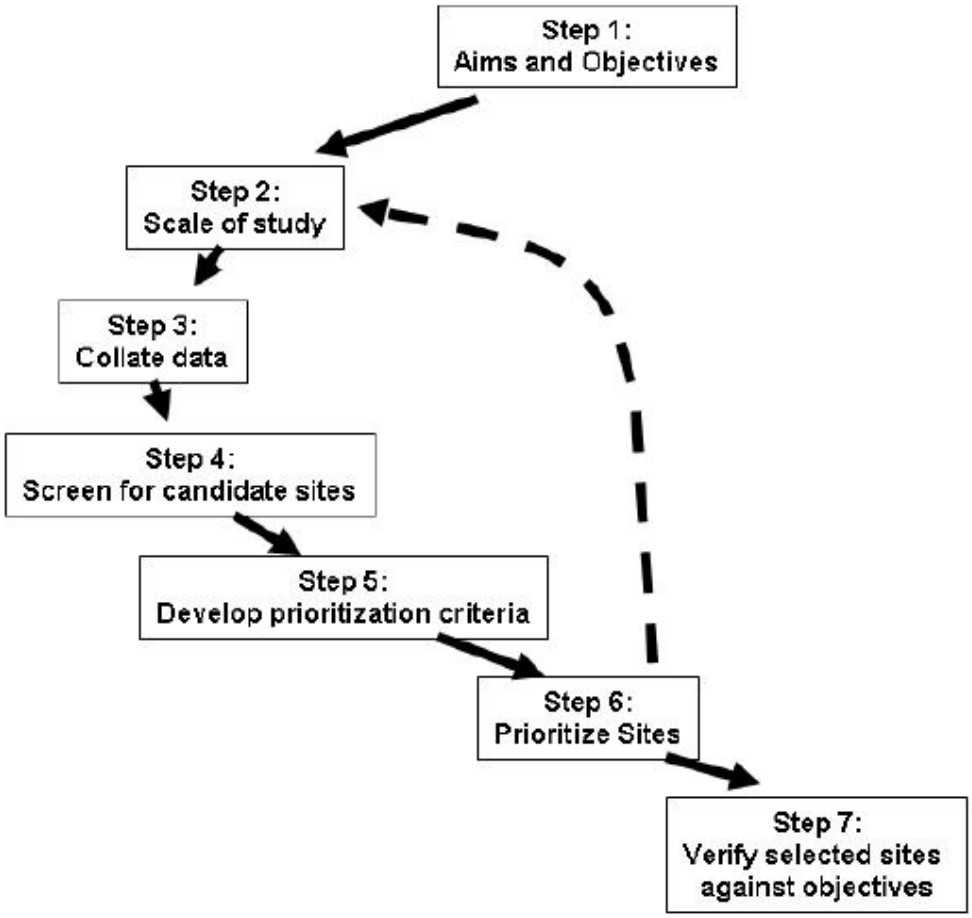

Figure 2: The steps to be undertaken as part of the wetland/pan prioritization procedures.

- determine the general reference conditions of the pans in the catchment.
- determine the general current ecological condition of the pans identified.
- identify priority 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), or a similar process for pans, assessment of a maximum of two of the high priority pans
- compile a report detailing the outcomes and results from the above tasks.

Prior to commencement of the pans assessments liaison with the Regional Office will be undertaken to identify those pans that are important from a water use perspective.

As the first step in pans typing process in the Lower 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.

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 is 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 Lower 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 "freshets", 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 flow 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 ecological category or considerations and proposals relating to the water supply schemes in the catchment.

Data to be provided :

- cumulative variance of total runoff about 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 Lower 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 further be analysed 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. It is not planned that any ground truthing or catchment visits will take place as part of this study. 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 still 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 the client for a possible variation order.

9.12 Stakeholder Awareness

The Stakeholder Awareness Programme will be limited to the production of two information newsletters. The first will be a stakeholder awareness newsletter informing the stakeholders of the study at the beginning of the study. The second newsletter announces the preliminary results. The newsletter will be posted to all water users currently registered on the Catchment Forums/CMC structures databases of the Northern Cape 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 PSP teams on the Vaal Reserve 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 and approach are 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 Lower 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 H du Toit of DWAF (Northern Cape 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 who will then adopt the chosen approach..

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 are 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 will be 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 9 EWR sites should be considered (**Table 7**). 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: Proposed EWR sites (As per terms of reference)

1	Vaal main stem downstream of Bloemhof Dam, before Vaal-Harts abstraction weir*
2	Harts River upstream of Barberspan
3	Harts River between Barberspand and Wentzel Dam
4	Harts River between Wentzel Dam and Taung Dam
5	Harts River below Taung Dam, before confluence with Droe Harts
6	Harts River upstream of Spitskop Dam, after confluence with Droe Harts
7	Downstream of Spitskop Dam on the Harts River, before the Vaal River confluence
8	Vaal main stem between Vaalharts and Schmidtdrift Weirs
9	Vaal main stem between Schmidtdrift and Douglas Weirs

It is important to note that the sites in the upper reaches of the Harts River have a very seasonal flow regime and consequently unless a different approach is used the prescribed Reserve determination process could prove difficult. . A Water Research Commission (WRC) study on ephemeral rivers could be investigated as a possible approach to assessing these rivers in the Lower Vaal WMA.

The budget is based on 5 EWR sites to be addressed at comprehensive level. Extrapolation of some of the results might be possible and this will be determined once an appropriate method has been approved.

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 photo point 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 the 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 final site verification and selection. At the same time the dry season surveys, hydraulic calibration

and flow measurements will be undertaken. Prior to this process the possible sites would have been pre-selected from aerial photographs. Google Earth, local RO knowledge. This process will be complete by the end of August 2007.

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 reconnaissance site 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/pans typing and Eco-classification

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

Task responsibility

- **Otto**, Hattingh

Information required

- SANBI Wetlands/Pans 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 Assessment report detailing the outcomes and results of the tasks to be undertaken (as described in section 9.5).
- Desktop mapping of the pans within the study area (A GIS shapefile/layer of the pans in the Lower 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 Lower Vaal WMA.
- The project team will work in close collaboration with Mark Rountree
- Only a very limited number of priority pans will be field assessed

- 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 Lower 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

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. However input to the design of a monitoring programme will be provided.

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, 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 PROGRAMME

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**							

Task	Phase	2007 Feb - Jun	2007 Jul - Dec	2008 Jan - Jun	2008 Jul - Dec	2009 Jan - Jun	2009 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 Lower 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 Middle Vaal and it makes sense that the system is studied as a whole. The same trainee as used for the Middle 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 A ssociates
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.

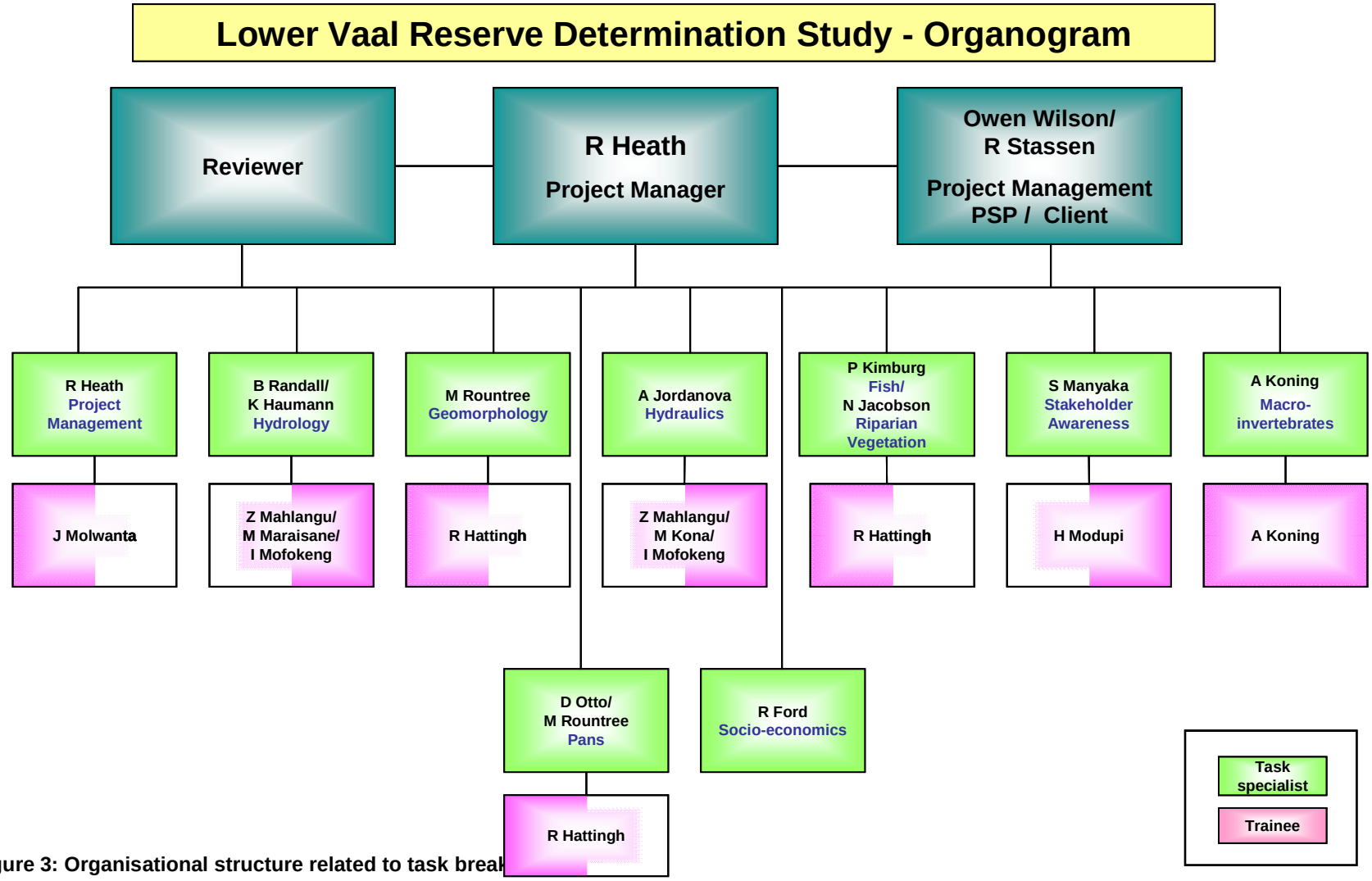

Figure 3: Organisational structure related to task breal

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

Capacity building in the Lower Vaal WMA will be realised through the following mechanisms, namely:

- Local specialists and stakeholder involvement (e.g. the existing catchment management forums in the Lower Vaal WMA).
- The Bloemhof Dam and Northern Cape Regional Office of DWAF have existing catchment initiatives with 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.

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
Michael Maraisane	Bruce Randell Angelina Jordanova Ken Haumann Prof Dennis Hughes	Hydrology SPATSIM Modelling Desk top modelling Hydraulics
Mbulelo Kona	Angelina Jordanova Ken Haumann	Hydraulics

HDI candidate	Mentor	Skills to be trained
Isaac Mofokeng	Bruce Randell Angelina Jordanova Ken Haumann Prof Dennis Hughes	Hydrology SPATSIM Modelling Desk top modelling Hydraulics

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 Lower 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 variation 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 Lower Vaal WMA is R1 754 386.00 excluding VAT.

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 Lower Vaal.

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.

Task	Title	Total
1	Phase 1: Study Initiation	33,480.00
2	Phase 2: Study Implementation	1,367,440.00
3	Phase 3: Study Termination	116,630.00
4	Phase 4: Project Management	151,020.00
	Disbursements	85,816.00
	Total (Excluding VAT)	1,754,386.00
	VAT	245,614.04
	Total for Project	**2,000,000.04**

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

Company	Total hours	%	Fees	%
Golder	2113	52%	R 988,740	59.26%
Zitholele	244	6%	R 63,800	3.82%
Ecosun	948	23%	R 344,630	20.65%
Private Consultant	258	6%	R 103,200	6.18%
PDNA	526	13%	R 168,200	10.08%
	4089	**100%**	**R 1,668,570.00**	**100.00%**

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

***HDI Involvement**		
Total HDI %: Fees Earned	**39.3%**	**R 656,380.0**
Total HDI %: Time Allocated	**50.5%**	**1919**

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

GOLDER ASSOCIATES AFRICA (PTY) LTD

R Heath **SAP Brown**

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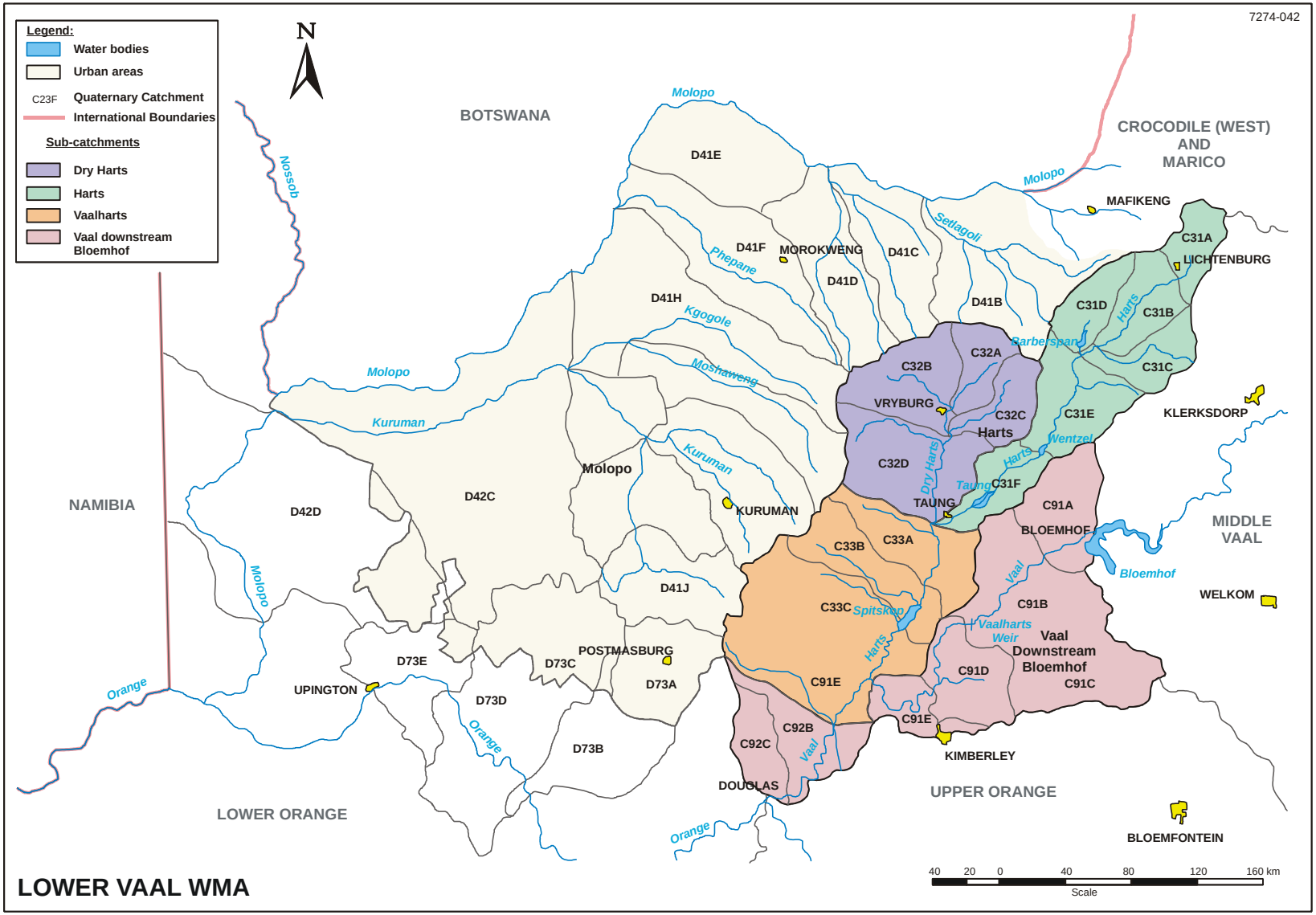
APPENDIX A

STUDY AREA


7274-042
Legend:
Water bodies
Urban areas
C23F Quaternary Catchment
International Boundaries
Sub-catchments
Dry Harts
Harts
Vaalharts
Vaal downstream Bloemhof
N
BOTSWANA
NAMIBIA
LOWER ORANGE
UPPER ORANGE
CROCODILE (WEST) AND MARICO
MIDDLE VAAL
Molopo
Nossob
Kuruman
Moshaweng
Kgogole
Phepane
Setlagoli
Harts
Barberspan
Wentzel
Dry Harts
Taung
Vaal
Bloemhof
Spitskop
Vaalharts Weir
Orange
D41E
D41F
D41H
D41C
D41D
D41B
D41J
D42C
D42D
D73E
D73C
D73A
D73D
D73B
C31A
C31B
C31C
C31D
C31E
C31F
C32A
C32B
C32C
C32D
C33A
C33B
C33C
C91A
C91B
C91C
C91D
C91E
C92B
C92C
MAFIKENG
LICHTENBURG
MOROKWENG
VRYBURG
Harts
KLERKSDORP
TAUNG
KURUMAN
Molopo
BLOEMHOF
WELKOM
POSTMASBURG
UPINGTON
Vaal Downstream Bloemhof
KIMBERLEY
DOUGLAS
BLOEMFONTEIN
40 20 0 40 80 120 160 km
Scale
LOWER VAAL WMA

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	296,360	17.8%	478	11.7%
Trevor Coleman	62,000	3.7%	100	2.4%
Bruce Randell	44,100	2.6%	98	2.4%
Jennifer Molwantwa*	62,400	3.7%	208	5.1%
Herbert Modupi*	38,000	2.3%	95	2.3%
Danie Otto	44,100	2.6%	98	2.4%
Zwele Mhalangu*	83,500	5.0%	334	8.2%
Raina Hattingh*	34,300	2.1%	98	2.4%
Angelina Jordanova*	262,600	15.7%	505	12.4%
Rene Ford	61,380	3.7%	99	2.4%
Isaac Mofokeng	16,800	1.0%	112	2.7%
Michael Maraisane	16,800	1.0%	112	2.7%
Mbulele Kona	16,800	1.0%	112	2.7%
Ken Haumann	117,800	7.1%	190	4.6%
Alwa Koning	122,450	7.3%	395	9.7%
Peter Kimberg	139,680	8.4%	388	9.5%
Niels Jacobson	82,500	4.9%	165	4.0%
Mark Rountree	103,200	6.2%	258	6.3%
Solly Manyaka*	4,800	0.3%	8	0.2%
Admin Assistant*	59,000	3.5%	236	5.8%
TOTAL	1,668,570	100.0%	4089	

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	Zitholele	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*	Zitholele	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*	Zitholele	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	Associate	R 620.00	Negotiated Rate	HDI
Isaac Mofokeng	PDNA	C	Hydrology Trainee	Civil Engineering Junior Technician	R 150.00	DWAF rate	HDI
Michael Maraisane	PDNA	C	Hydrology Trainee	Civil Engineering Technician	R 150.00	DWAF rate	HDI
Mbulele Kona	PDNA	C	Surveyor Trainee	Junior Civil Technician	R 150.00	DWAF rate	HDI
Ken Haumann	PDNA	E	Spatsim and hydrology	Director	R 620.00	Negotiated Rate	
Peter Kimberg	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	D	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

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

*** As per the Preferential Procurement Regulations, 2002