DEPARTMENT OF
WATER AFFAIRS
AND FORESTRY

Feasibility Study for the Raising of Clanwilliam Dam

Inception

Final
July 2005

NINHAM SHAND
CONSULTING SERVICES

ASCH

JAKOET &
ASSOCIATES

DEPARTMENT OF WATER AFFAIRS AND FORESTRY
DIRECTORATE OPTIONS ANALYSIS

FEASIBILITY STUDY FOR THE RAISING OF THE CLANWILLIAM DAM

INCEPTION REPORT

Final

July 2007-07-31

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Department of Water Affairs and Forestry
Directorate Options Analysis

FEASIBILITY STUDY FOR THE RAISING OF THE CLANWILLIAM DAM

APPROVAL

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STUDY TEAM **Approved for the Clanwilliam Dam Raising Association by :**

…….. ……..
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GLOSSARY AND ABBREVIATIONS

CEO	Chief Executive Officer
CSIR	Centre for Scientific and Industrial Research
DME	Department of Minerals and Energy
DWAF	Department of Water Affairs and Forestry
ECA	Environmental Conservation Act
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMP	Environmental Management Plan
EMPR	Environmental Management Plan Report
FSL	full supply level
GIS	Geographical Information System
HDI	historically disadvantaged individuals
I&APs	Interested and affected parties
IFR	instream flow requirements
ISP	Internal Strategic Perspective
LORWUA	Lower Orange River Water User Association
OA	Options Analysis
%	percentage
PPP	Public participation process
RPF	Resource-poor farmers
SFR	streamflow reduction
TMG	Table Mountain Group
TR	trunk road
URV	Unit Reference Value
WAS	Water Administration System
WDM	Water Demand Management
WfW	Working for Water
WMA	Water Management Area
WODRIS	Western Cape Olifants Doring River Irrigation Study
WRC	Water Research Commission
WRYM	Water Resources Yield Model
WUA	Water User Association

1. INTRODUCTION

1.1 Background

The Clanwilliam Dam was originally built in 1935, and was later raised by pre-stressed cables and by adding gates. The current height of the dam wall is 43 m and the storage capacity of the dam is 122 million m^3. The total irrigated area dependent on the Clanwilliam Dam is more than 13 000 ha. Various small towns receive water from the dam, but the bulk of the water goes to the three irrigation areas below the dam, comprising the area served by the canal immediately below the dam, the area along the river between the Clanwilliam Dam and Bulshoek Weir and the area served by the canal below Bulshoek Weir.

1.2 Need for the study

The Clanwilliam Dam requires remedial work for dam safety reasons. There is concern that the pre-stressed cables have lost their shear resistance ability and there are also problems with alkali-aggregate reaction. Cavities in the foundation have been detected, indicating that the shear resistance is not adequate. As the downstream spillway apron is very thin it cannot be relied on to provide sheer resistance. The flanks of the dam are very jointed, which poses a major problem for the raising of the dam. The left flank has a leak (50 to 120 m downstream) when the dam is at full supply level. The dam therefore does not comply with dam safety requirements and must be strengthened. This presents an opportunity to raise the full supply level economically, if the marginal cost of raising over and above the cost of the strengthening is relatively small.

It has initially been proposed that concrete be added to the downstream side of the wall to increase stability. The gates would be removed, concrete would also be added to the overspill crest and the flanks and the apron would be tied down with rock anchors. The necessity of a multi-level outlet also needs to be assessed, in light of the pending recommendations from DWAF's Olifants/Doring Rivers Comprehensive Reserve determination Study, which is underway.

The required remedial work presents an opportunity to raise the dam by up to 15 m. The Reconnaissance Study (DWAF, 2003), which formed part of the Olifants/Doring River Basin Study Phase II, concluded that raising the dam could cost-effectively result in the provision of increased yield and recommended that it be investigated further.

Hence, the Department of Water Affairs and Forestry (DWAF) invited proposals to undertake a Feasibility Study for the Raising of the Clanwilliam Dam in June 2003.

1.3 Appointment of Consultant

Proposals for this study was submitted during August 2003, in response to the Department of Water Affairs and Forestry's request for a proposal in accordance with the DWAF Guidelines and Terms of Reference.

The Department's Directorate of Options Analysis (OA), appointed the Clanwilliam Dam Raising Association to undertake this study entitled Feasibility Study for the Raising of Clanwilliam Dam. The study commenced on 26 January 2004, according to contract, and must be complete by 31 January 2006.

1.4 Study Team

For the purposes of the study, an association, called the *Clanwilliam Dam Raising Association*, exists between:

- Ninham Shand (Pty) Ltd;
- ASCH Professional Services (Pty) Ltd; and
- Jakoet & Associates Consulting Engineers cc.

In addition to the firms in association, a number of sub-consultants and individual specialists are utilised on specific technical tasks.

1.5 Capacity Building

Building capacity of historically disadvantaged individuals (HDIs) in the fields of water resource planning and development, and environmental management, is viewed as an integral part of this study. Capacity building entails giving HDIs the requisite practical exposure and background training to be able to participate meaningfully in the study.

Within the team, Ntomboxolo Danti and Elroy Walters will receive training in the Yield Analysis and Irrigation tasks. Faldi Samaai will act as Assistant Project Manager, providing support to Mr Van der Berg. **Table 1.1** lists individuals that will undergo capacity building as part of the study.

Within the study area, Focus Groups will be held as part of the Public Participation task. The aim of the Focus Groups is to provide HDIs and local communities with the knowledge and ability to participate in the study in a meaningful and effective manner.

Table 1.1 Individuals undergoing capacity building

Name	Institution	Task/discipline
Danti, Ntomboxolo	ASCH	Engineering
January, Mariam	EEU	Social-environmental
Mlisa, Andiswa	Umvoto	Hydrogeological
Mohamed, Bulelwa	Umvoto	Hydrogeological
Nackerdien, Shaheen	ASCH	Engineering
Samaai, Faldi	ASCH	Deputy study leader
Tolobisa, Ntombomzi	Ninham Shand	Environmental
Walters, Elroy	ASCH	Engineering
West, Ashwin	Ninham Shand	Environmental
Zenani, Vuyisile	EEU	Social-environmental

2. OBJECTIVES OF THE STUDY

An additional objective of this study, identified at the Inception Workshop, is to address the need for a comprehensive options assessment process that would identify the preferred suite of development options within the Water Management Area (WMA) and would provide motivation for this study to proceed.

The aim of the study is to verify the technical, environmental, social, economic and financial viability of raising the Clanwilliam Dam, at feasibility level. The study will also determine the optimal height for such raising, if found to be viable. Other options for increasing supply volumes for irrigation, including clearing invasive exotic vegetation, reducing system losses and water demand management, will be evaluated to ensure that DWAF is aware of the full range of alternatives and implications and would thus be able to make an informed decision.

Social development needs in the region are very important and the opportunities presented by the dam raising for resource-poor farmers will therefore be considered and evaluated. This study and its associated public consultation and environmental impact assessment process will be informed by the extensive previous work undertaken in the Olifants-Doring River basins and, where applicable, lessons learnt elsewhere will be applied.

3. SCOPE OF WORK

3.1 General

The assignment will support the Chief Engineer Options Analysis: South, who is *inter alia* responsible for planning studies in the Western Cape and Olifants-Doorn WMA.

Raisings of the Clanwilliam Dam by 5 m, 10 m, and 15 m will be investigated. The raising of the dam by 5 m, 10 m and 15 m was also investigated in the Reconnaissance Study. It was agreed that a 12.5 m raising would only be investigated if later regarded as necessary.

The scope of work has been significantly increased by the inclusion of additional tasks, notably the Screening Process (**Task 3.2.2**), approved under Variation Order 1, the roads re-alignment process and concomitant environmental impact assessment (EIA) process (under **Task 3.2.5**) and the groundwater resources Task (**Task 3.2.7**). The need for refinement of several smaller tasks has also been addressed, as identified during the Inception Phase.

3.2 Study tasks

3.2.1 Inception Phase

a. Field trip and workshop

A field trip was arranged and DWAF staff, other stakeholders and the consultant study team visited the study area during the Inception Phase of the study. Thereafter, the study team, together with key stakeholders participated in a Strategic Planning Workshop. An overview of the study area and study objectives and scope of work was presented and debated. The approach to the engineering, economic, social, public process, environmental and management tasks were further debated with the objective to ensure that they are focussed and address the key questions.

b. Extended Inception Phase

From the Strategic Planning Workshop it became clear that further focusing and refinement of the study tasks, beyond the scope of what was initially envisaged, was necessary. The requirement for more focussed objectives with regard to e.g. the Resource-poor Farmer Task, were also identified. This need for the further focussing of tasks and redefining of the scope of work required additional meetings to be held with the Client. Some specialist input was also required to define possible new or focussed tasks. Additional meetings were needed with sub-consultants to focus several study tasks, especially the Resource-poor Farmers Task, Soils Task and Agricultural Economics Task.

The need to include the EIA investigations for the impact of the possible dam raising on the N7 road and secondary roads was identified. A meeting with the Provincial Roads Department staff as well as liaison with other affected organisations were necessary to clarify the scope of this new task.

The requirement by the Client for an extensive new Groundwater Resources Task, as well as a possible increased groundwater EIA input was addressed, and the scope of work of these envisaged tasks were quantified and costed.

Because some reports, such as the Western Cape Olifants Doring River Irrigation Study (WODRIS) reports and an investigation into the Olifants River canal by the Lower Olifants River Water User Association (LORWUA), were not available, meetings with the respective consultants, as well as the attendance of presentations of the results, were needed.

Upon request from the Client, a presentation of the study was made to the Catchment Reference Group in Clanwilliam, which targets all water users in the WMA.

c. Inception Report (Ninham Shand)

This Inception Report is based on the project proposal, which had been refined, where required, to provide a clear and concise description of how the project will be undertaken, what deliverables will be produced, and in which sequence. It provides detailed financial information and a summary study programme. This is therefore the document that aims to clarify outstanding aspects and uncertainties, address new issues or tasks identified during the Inception Phase, and lists the anticipated deliverables.

The following changes (from the original proposed scope of work) have been incorporated in the Inception Report:

- Proposed changes to the scope of work, approved according to Variation Order 1 were incorporated, which includes:
  - A Screening Process Task was included, which is an additional task;
  - Inclusion of time for two key team members from the WODRIS study, under the Project Management Task, to ensure continuation; and
  - An expanded Inception Phase;
- The provisionally approved Eutrophication Sub-Task has been added under the Water Quality Task;
- Under the EIA Task the following changes have been made:
  - The scope of work of the social assessment task has been refined;
  - The very limited original scope of work for the EIA of the N7 and secondary roads has been extended to a full EIA process, upon request by the Client. This also affects the botanical, archaeological and social investigations, as well as the macro-economic study under the Financial and Economic Analysis Task and the Public Participation Task;
- The *Impact of Raising on New Off Channel Storage Schemes Downstream of Bulshoek Weir* sub-task was moved from the Irrigation Task to the Yield analyses Task, where it more logically fits;
- The DWAF's undertaking to provide the farm dam volumes and irrigation areas in the Olifants River catchment above Clanwilliam Dam was added;
- The Groundwater Resources Task was included upon request by the Client;
- Under the Irrigation Task, the following refinement was made:
  - General agreement among stakeholders was reached that any requirement for the new identification of arable land and soil sampling for specific identified development should only be addressed in later studies;
- Financial and economic analyses Task: Prof Laubscher will now be responsible for uniformity in the task approach and a small budgetary adjustment has been made. The PAM analysis and the determination of economic plot sizes are not required in terms of

these study objectives. The budget of the on-farm financial viability analysis was increased to be able to accommodate the full range of scenarios;
- Resource-poor farmers: The budget for the *Models for Establishing and Sustaining Resource-poor Farmers* sub-task was increased to accommodate the full range of scenarios;
- Public participation: Adjustments were made to the Stakeholder Meetings sub-task budget;
- Due to the significantly increased study length from 14 to 24 months, adjustments to the budgets of the following were necessary:
  - Ongoing project management costs were increased;
  - Additional study management committee (SMC) meetings were allowed for;
  - Increased infrastructure costs (phones, faxes and computers);
- More attendees were allowed for at Study Management Committee Meetings, the Start-up Workshop, Screening Phase workshop and public meetings, for staff of ASCH, Jakoet & Associates and Nosipho, for training purposes, partly upon request by the DWAF;
- More specialists, namely Ms February and Brown and Messrs Loubscher and Le Grange, were allowed for to attend the Screening Process workshop and to provide further specialist inputs to the Screening Phase document;
- Some oversights were corrected, such as attendance of public meetings by the Study Leader and allowance of project management time for the Study Director.

3.2.2 Screening Process (mainly Ninham Shand, Umvoto Africa)

a. Objectives

To gain acceptance of a specific development option (in this case the raising of Clanwilliam Dam), a comprehensive options assessment should precede the selection of a possible development option for further study at feasibility level, as part of a widely accepted process. The need for a screening process was therefore identified, to be undertaken as part of the Inception Phase of this study. This would involve a, logical, documented multi-disciplinary screening of the reasonable options and would facilitate a robust and defendable basis for the Feasibility Study.

The objectives would be to:

- Clarify the policy of DWAF and its co-operative governance partners regarding the need for development in the Olifants-Doorn WMA;
- Clarify development needs, objectives and intended beneficiaries;
- Collate and summarise existing information on development options, and update information where required to facilitate comparison;
- From existing information, assess the feasibility of the various identified options in terms of technical, financial, economic, environmental and social criteria. Identify options for which adequate required information is not available. This could require searching for additional information or even writing of new text;
- Clearly motivate the most appropriate augmentation option or suite of options, for more detailed study;
- Document the options evaluation process;
- Gain acceptance through a focussed stakeholder engagement process.

The following sub-tasks will be undertaken:

b. Data collection and collation

The various reports that contain information about potential large-scale surface and groundwater development options in the Olifants Doorn WMA will be obtained and will be studied to be able

to abstract the relevant information. Where required, authors of such documents will be contacted or interviewed to clarify relevant aspects of the various options investigated. Available information will be collated, with a focus on the technical, financial, economic, environmental and social evaluations undertaken, where these are available. Missing or inadequate information will be highlighted, and will be briefly addressed, where possible, to facilitate comparison.

Information regarding development needs in the WMA will be obtained, as well as information regarding the various historical and current initiatives for large-scale development. It is envisaged that some targeted interviews will be held with DWAF staff and other stakeholders to augment the information if required.

c. Preparation of workshop material

A workshop starter document will be prepared, which will brief participants on the background and objectives of the workshop, and on known development needs. A preliminary comparison of the feasibility of potential development options will be provided, according to agreed criteria. Workshop presentations will be prepared.

d. Specialist Screening Workshop

A workshop will be arranged, with selected DWAF staff, study team members and other identified stakeholders, to agree on development needs, objectives and intended beneficiaries in the WMA. Following that, screening of the various identified development options would take place, according to a set of criteria to be agreed upon. The workshop participants would then recommend the most appropriate augmentation option or suite of options. Following the workshop, participants will provide comment on the Workshop Starter Document.

e. Options Screening Report

A *Screening of Options* report will be prepared. The report will contain information on potential development options and will document the screening process followed, including the specialist workshop minutes and the most appropriate recommended augmentation option or suite of options.

f. Public process

A Key Stakeholder Workshop will be held during February 2005 in Clanwilliam, targeting the Catchment Reference Group. An Executive Summary information document, in English and Afrikaans, will be prepared on the screening process and recommendations, and will be distributed prior to the workshop. Workshop arrangements, including presentations will be made at the workshop and the stakeholder process will be recorded. Following the workshop and after stakeholder comments have been collected and addressed, the documentation of the process will be incorporated in the Screening of Options report.

3.2.3 Reserve Requirements and their Implications

This task is being undertaken as part of a separate appointment and this study would merely utilise the Reserve outputs to inform various tasks, such as the yield, environmental impact and economic analysis. The availability of information from that study could however influence the study programme. It is not currently foreseen that this would pose a problem.

3.2.4 Water quality (Ninham Shand)

a. Water quality investigation

The raising of Clanwilliam Dam would have an impact on the temperature regime of the dam and concomitant impact on the temperature of water released from the dam. This can affect the downstream biota and impact on the water quality component of the Reserve downstream of the dam. The study would describe the following:

- The effect of shifting, in time, the occurrence of summer maximums and winter minimums as a result of raising the dam;
- The potential for summer thermal stratification, the stability and depth of thermal stratification and potential hypolimnion temperatures;
- The potential water temperature of the released water given the different outlet structures under consideration as well as the possible operating rules for the system;
- An assessment of the impact of released water temperatures when compared to the temperature requirements of the water quality Reserve;
- Assessment of the fitness for use (social impacts).

Furthermore, the following aspects will be considered for the assessment of the fitness for use of the in-lake and released water quality:

- The potential changes in in-lake water quality as a result of changing the volume, surface area, water residence time and dam operations, as well as a result of changes in the catchment of Clanwilliam Dam (namely as a result of the removal of alien vegetation, allocating more water upstream of the dam and meeting the requirements of the water quality Reserve in the water resource unit upstream of the dam;
- The potential changes in release water quality and an assessment of its fitness for use for the primary user groups (irrigation and domestic water supply) and compliance with the water quality component of the Reserve;
- An assessment of potential short to medium term construction impacts on water quality downstream of the dam;
- An assessment of potential impacts of irrigation water supply quality and main-stream quality of managing evaporation water losses from the canals of water demand management measures, of off-channel storage schemes under consideration downstream of Bulshoek Weir and of the effect of regional social upliftment initiatives on wastewater and receiving waters of waste discharges.

b. Eutrophication

At the inaugural meeting that was held on the 15th of March 2004, it was noted that in terms of eutrophication, only the temperature impact of the water released from Clanwilliam Dam was addressed in the study proposal. Concerns were further raised about eutrophication problems currently being experienced at Bulshoek Weir (but not yet at Clanwilliam Dam). The Department therefore requested the team to undertake additional work on eutrophication.

From discussions with Mr. Matthee, CEO of the Lower Olifants River Water Users Association, it appeared that problems were experienced with filamentous algae and free-floating algae. The filamentous algae cause problems in the weir and in the canal system. The LORWUA spends about R170 000 per year to control the algae in the canals. He noted that in 2003, taste and odour problems were encountered with water abstracted from Bulshoek Weir. He ascribed these to phytoplankton, low water levels and the low flushing rate of water in the weir.

These symptoms appear to indicate that the eutrophication potential needs to be investigated as part of the feasibility study, even though it has not previously been identified as a concern. The raising of Clanwilliam Dam is expected to increase the retention time in the system, which can potentially increase eutrophication related water quality problems. In general, there is a direct relationship between the nutrient concentration in the water and amount of phytoplankton algae. However, with filamentous algae the relationship is more complex and these algae can occur even at low nutrient concentrations.

A reconnaissance level assessment will be undertaken of the present nutrient and eutrophication status, using available monitoring data and published or anecdotal information. This task would entail the collection of some water samples from Clanwilliam Dam and Bulshoek Weir for chlorophyll *a* analysis. This component would include a synthesis of data and information that is available about the growth of filamentous algae in the Bulshoek Weir and in the canal system.

Assessment of the potential impacts of raising Clanwilliam Dam on the eutrophication status of Clanwilliam Dam and of Bulshoek Weir will be determined.

A site visit, survey of algal status and Chlorophyll *a* analysis of eight samples has been provided for.

c. Report

A report describing the in-lake and downstream water quality implications of the various options and the necessity to investigate multi-level outlet works to ameliorate any downstream impacts will be written. The present status and potential impacts of eutrophication will also be addressed.

3.2.5 Environmental authorisation

The raising of the Clanwilliam Dam would require environmental authorisation in terms of sections 21, 22 and 26 of the Environment Conservation Act (ECA) 73 of 1989, within the framework of the National Environmental Management Act 107 of 1998. In particular, the upgrading of structures causing disturbances to the flow of a river, dams, and schemes for the abstraction of surface water for bulk supply purposes are all listed as activities requiring authorisation. Furthermore, the development of quarries and borrow pits, and the potential realignment or re-construction of roads, resorts and associated infrastructure due to inundation, could require environmental authorisation, as could certain changes in land use initiated directly or indirectly as a result of the proposed dam raising.

Spatially, the EIA would focus on the area of potential inundation in terms of various dam-raising scenarios, and the associated direct impacts. However, consideration will be given to the broader, indirect and cumulative impacts that may arise as a result of the proposed scheme, particularly as it applies to the development of further irrigation areas.

Further to the above, DWAF has requested the Clanwilliam Dam Raising Association to undertake the EIA process for the road realignment to ensure that the relevant authorisations are obtained in time, so as not to compromise the programme for the dam raising. Consequently, the EIA process for the potential road realignment would be undertaken in parallel with the EIA for the dam raising, utilising the same specialists and public participation process. Adopting the proposed approach allows for cost and time savings, and more importantly, reduces the likelihood of stakeholder fatigue. The EIA process would evaluate the suite of road alignments developed during the conceptual planning process, which would be informed by the three levels of dam raising.

In addition to the ECA, the proposed activity would require approval from the Department of Mineral and Energy Affairs, via an Environmental Management Programme Report for proposed quarries and borrow pits, in terms of the Minerals Act 50 of 1991. This would be required for both the dam raising and the road realignment.

Heritage Western Cape would be notified and requested to comment on the implications of the proposed development in terms of the National Heritage Resources Act 25 of 1999.

The EIA process would be developed in consultation with the environmental authorities and the requisite public participation process would be integrated with the public participation process for the Feasibility Study as a whole. An Environmental Impact Report (EIR) and Environmental Management Plan (EMP) would be produced, and would serve as the basis for the environmental authority's decision on authorisation.

a. Scoping Phase (Ninham Shand)

The scoping task would be run as a distinct but integrated component of the overall public participation process. Two public meetings would be held in this phase, the first to inform interested and affected parties of the proposed project and to provide an opportunity to raise issues and concerns, and the second to present the draft Scoping Report. As mentioned previously, the EIA processes for both the dam raising and road realignment would be presented to the public through a joint public consultation process.

A background information document (Afrikaans and English), draft and final Scoping Reports (executive summaries in Afrikaans) and plan of study for Environmental Impact Assessment, will be produced.

b. Environmental impact assessment phase (Ninham Shand)

The Scoping Phase would inform the EIA. It would entail a public meeting and compilation of an EIA report for the dam raising and the road realignment projects. A number of specialist studies in the following disciplines have been allowed for: botany, icthyology, hydrogeology, archaeology and sociology/anthropology. The EIA would also incorporate information from the other tasks and would serve as the main communication tool with the public. The EIA would meet the legislated requirements.

A Scoping Report, Environmental Impact Report, Environmental Management Plans (for both the construction and implementation phases) and Environmental Management Programme Reports would be produced.

c. Specialist studies to be incorporated into the EIA

i. Vegetation impact assessment (Charlie Boucher)

This would entail the following:

- Obtain and collate information about rare and endangered plants;
- Collate and review all available existing vegetation documentation;
- Consult with relevant botanists and institutions to obtain information not in the public domain; and
- Undertaking of a survey and analysis of the vegetation during spring in the potential inundation area around the perimeter of the dam.

A vegetation map at 1:10 000 scale and specialist report describing and assessing the implications of raising the dam and the alternative road alignments on surrounding vegetation would be produced. This would include implications from the raising of the soil water table and from a reduction in the overall extent of plant cover due to the two developments, and a brief comment on the botanical implications of various further irrigation developments.

ii. Freshwater fish impact assessment (Dean Impson)

This would involve a detailed fish survey of the lower Olifants and Rondegat rivers, including snorkelling, seine and gill netting. Electrofishing is also recommended to allow rock catfishes to be caught. Angling clubs that fish Clanwilliam Dam will be contacted regarding catch statistics. A literature survey will be done to determine the habitat requirements of fishes historically and presently occurring in the study area. The impact of the raising of Clanwilliam Dam on the proposed Rondegat River rehabilitation project will be assessed, together with mitigation measures.

Based on the above, the negative and positive (if any) impacts of the raising of the dam on the fish community present will be ascertained. Mitigation measures will be proposed to minimise the potential impact of the enlarged dam on the indigenous fish community.

A specialist report on the potential impacts of dam raising options on indigenous fish populations and mitigation measures will be produced.

iii. Hydrogeological impact assessment (Umvoto Africa)

This would entail a desktop review of previous work and relevant data (e.g., CAGE structure database, existing hydrocensus information, current monitoring sites in area) and use of available data. A one-day trip to Clanwilliam is included, for mapping of springs. Development and population of a GIS-based digital model and geo-informatics system (database) covering a defined domain around the town and reservoir will be done.

A Hydrogeological Impact Assessment Report will be produced, detailing:

- The context and work outline;
- The hydrogeological context (topography, geology, hydrogeology, elevation of known springs, if possible (depending on data availability), fluctuations in groundwater table and spring flows with changes in dam levels and rainfall trends;
- A schematic cross section showing the relationship of dam elevations at 5 m, 10 m and 15 m to the water table in the Skurweburg and Peninsula aquifers (assuming that relevant data is available); and
- Data limits and recommendations.

iv. Social impact assessment (Environmental Evaluation Unit)

The key social issues that need to be addressed include:

- Identification and assessment of the social impacts associated with the loss of land and infrastructure due to the raising of the dam wall and realignment of the N7 National Road and secondary roads;
- Identification and assessment of social and developmental opportunities and constraints associated with changing land-uses in and around the dam as a result of the proposed raising of the dam wall and realignment of the N7 National Road and secondary roads.

- Identification and assessment of social impacts on other downstream users, including activities in the Olifants River estuary;
- Identification and assessment of the social impacts associated with the construction phase of the project, including the potential influx of job seekers and construction workers to the area;
- Identification and assessment of the social impacts on up-stream water users.

The study will engage with individuals, communities, organizations and institutions in the affected area in a sensitive and appropriate manner. The indirect and cumulative impacts will be described and recommendations made.

A Social Impact Assessment specialist report will be written.

v. Heritage investigation (Archaeology Contracts Office)

A heritage impact assessment will be undertaken in compliance with the requirements of the National Heritage Act 25 of 1999. This component will entail a review of available literature, field surveys and a report integrated into the Environmental Impact Assessment. Fieldwork will be conducted by two pairs of archaeologists working in separate teams, and entails:

- Walking the entire area that may be affected by inundation as well as the road alignment alternatives;
- Identifying rock art sites, completing site record forms for each and recording rock art images by means of digital photography;
- Identifying open scatters of artefacts, completing site record forms and recording each site photographically; and
- Identifying built structures such as ruins or graveyards and recording them as above (archival research may be necessary to identify the origin of such structures).

A detailed assessment of the heritage sites that may be affected by the various dam raising scenarios and road alignment alternatives will be provided.

vi. Impacts on the N7 and secondary roads (ASCH, Ninham Shand and specialists)

The raising of the dam wall will impact directly on Trunk Road 11 (TR11) in the vicinity of the dam wall. The higher the dam is raised, the greater will be the impact. An increase of 5 m in water level may necessitate the construction of a short viaduct section and some local relocations, while the raising by 15 m could require the complete relocation of TR11 for a distance of up to 10 km, including the current access to Clanwilliam from TR11. Secondary roads would also be affected.

In terms of the ECA (Act 73 of 1989) the upgrade of roads requires environmental authorisation. It has been decided by the DWAF that authorisation for the upgrade of the roads, affected by the possible raising of the dam, will be addressed in this study. Preliminary discussions have been held with Mr Steve Fanner of the Provincial Government of the Western Cape, who indicated that this would be acceptable, as long as design is according to their standards. The various alignment options and their impacts will therefore be considered during the EIA process.

For each increment of raising, the impacts on the current road alignment of TR11 and the secondary roads will need to be determined. The next step will be to review current planning for the future upgrading of TR11 and the secondary roads to assess the suitability thereof. Options for the treatment of TR11 required for each increment of raising will be identified and workshopped with the three relevant road authorities (SA National Roads Agency Ltd, Western Cape Provincial Administration and Cedarberg District Municipality). These options will be costed and this information will be fed into the impact assessment processes.

Potential material sources (quarries and borrow pits) will be identified and materials will be sampled and tested to confirm the quality thereof.

The road inputs will be undertaken at a conceptual planning level using 1:50 000 or 1:10 000 mapping (unless more detailed survey information and road planning is sourced). The cost for the conceptual planning would depend on the extent of the impacts of the raising.

vii. Environmental Management Plan (Ninham Shand)

The development of the framework EMP would entail the following:

- Identifying the activity, aspect and potential impact requiring management;
- Outlining the potential mitigation measures in terms of the objective and target;
- Identifying the performance indicators; and
- Highlighting the responsibilities for implementation, in terms of various criteria.

This framework EMP will highlight the key environmental aspects and identify the mechanism required to manage these concerns.

A framework EMP that clearly indicates all mitigation measures and responsibilities will be written.

viii. Environmental Management Programme Report (Ninham Shand)

In terms of the Minerals Act, Act 50 of 1991, all prospecting and mining activities require approval from the Department of Minerals and Energy (DME) via the compilation and submission of an Environmental Management Programme Report (EMPR) to DME. Preliminary discussions with Mr Jan Briers of the Western Cape office of DME indicate that they are unlikely to require authorisation of any borrow pits or quarries located within the full supply level of the dam. Material required for the road construction is unlikely to be located within the dam basin. Two quarry sites will therefore be identified and the requisite authorisations will be applied for.

Authorisation for borrow pits or quarries located outside of the full supply level of the dam would entail:

- Compilation of the requisite EMPR in terms of the Mineral and Petroleum Resources Development Act and it's Regulations; and
- Submission of the EMPR to DME for their review and decision.

An Environmental Management Programme Report will be written, as required in terms of the Minerals Act.

3.2.6 Yield analysis

a. Yield potential of various dam raisings (Ninham Shand and ASCH)

It is envisaged that the Water Resources Yield Model (WRYM) as further developed by Ninham Shand for use on the Kobwa and the Western Cape System would be utilised for this study. This model utilises the Water Resources Yield Model, but allows both historical and stochastic analysis to be undertaken and the yields for various assurances of supply to be easily determined and displayed in a form which is readily understood by stakeholders.

Ninham Shand is also undertaking the hydrological work for DWAF's D: RDM for the current study of the determination of the high confidence Reserve in the Olifants/Doring River. The modelling started in October 2003 and much of the relevant yield modelling could, with some adaptation, be used for this study.

i. Obtain and review available information

The following reports and information will be obtained:

- The Olifants Doring Basin Study Phase 2 study reports and associated information;
- Study on the Rapid Reserve determination for the Olifants/Doring River;
- The WODRIS Study available reports or associated information;
- Other relevant information on off-channel storage/farm dams;
- Information on the various raisings of Clanwilliam Dam;
- Silt survey reports;
- Existing dams from the Register of Farm Dams from the Dam Safety Office and previous studies;
- Dam Safety Reports;
- White Papers; and
- Any other relevant identified reports, drawings, maps and information.

Preliminary review of the available information will be done to confirm the adequacy of the level of information and to identify outstanding information. Additional identified information will be sourced.

ii. Sedimentation

The sedimentation rate into the dam will be confirmed by studying the silt surveys (which will be obtained from DWAF), taking into account the recommendations from previous studies. The assumption of 100 % silt retention by the dam will be made.

iii. Demands

The demands from the dam as used in the previous study on the raising of the dam will be obtained and reviewed. All existing information on historical, current and proposed water use in the study area will be reviewed and where necessary updated. The assurances of supply at which water must be supplied for high-value crops will be established through liaison with the irrigation boards/water user associations, major agricultural industries and the DWAF.

iv. Expert workshop

An expert workshop will be conducted to decide or confirm future combinations of the Reserve, dam raising options and other scenarios to be investigated. The attendees will be confirmed with the DWAF Study Manager.

v. Setting up the network model

Updating of hydrological records have been done in the recent dam raising study and will not be re-visited. Meteorological records will not be extended. The system network and base hydrology that will be obtained will be set up and tested.

Once the Reserve (the in-stream flow requirement and estuarine flow requirement), and any changes to the irrigation demands are known, the model will be updated for current demands. It is assumed that the essential Reserve information at an intermediate level will be available in February 2005. If this is not the case, an alternative option utilising the Rapid Reserve (actually an improved confidence desktop) information resulting from the Reconnaissance Study Report may be utilised. The operating rules of the existing dam will be checked.

Along with the specific future demands and diminishing dam storage due to siltation, interim-operating rules will also be determined for the raised dam, taking the requirements of environmental releases and possibly revised supply to irrigators into account.

vi. Yield analysis

The yield analyses will then be done, using the WRYM with stochastic inflow time series. The following scenarios are currently envisaged:

- The yield for the current system will be modelled, without a Reserve requirement;
- The yield for the raised dam will be modelled for three levels of raising, incorporating the Reserve requirement upstream and downstream and including various upstream and downstream scenarios for additional farm dams on tributaries and diversions to off-channel farm dams;
- The yield for the raised dam will be modelled, incorporating one class higher Reserve requirement upstream and downstream, for three levels of raising;
- Modelling of the recommended raising for the most likely scenario once it is defined;

The required yield and impoundment volume for the raised dam will be optimised to satisfy the irrigation and other requirements.

A report detailing the following will be produced:

- Total and incremental yields from the dam for various scenarios at different levels of raising;
- Assurance /draft envelope curves will be produced; and
- A storage/yield curve will be drawn, based on the assurances of supply to the various demand sectors.

vii. Meeting the estuarine requirements

Once the Reserve estuarine flow requirement, including the specific required contribution by the Olifants River are known, the model will be updated for such Reserve

requirements. It is assumed that the Reserve information at an intermediate level will be available in February 2005. If this is not the case and until the high confidence estuarine environmental flow requirements are available, we recommend that the estuarine requirements not be modelled, whilst recognising that the estuary will drive the environmental flow requirements downstream of the confluence of the Olifants and Doring Rivers. None of the scenarios previously modelled for the estuary are similar to the proposed range of Clanwilliam Dam raising scenarios contemplated. The estuarine results therefore cannot be applied. Furthermore, the results of the previous estuarine work are descriptive only and cannot be used to add value to the system modelling.

b. Effect of increased allocations upstream of the Clanwilliam Dam (Jakoet and Ninham Shand)

For this evaluation, the use of the current day scenario, including the requirements of the Reserve, is recommended. To meet the Reserve, allocations for summer abstractions upstream of Clanwilliam Dam may need to be reduced. If the raised dam creates additional yield, all of the envisaged reduced allocations or a portion thereof (or even nothing) could be reallocated for winter abstraction to off-channel storage to sustain the upstream irrigation.

A diversion function for the WRYM will be developed for all off-channel abstractions upstream of Clanwilliam Dam. It will be based on daily or hourly flow data from the nearest gauge in the region, taking the Reserve requirements into account. The required off-channel storages and diversion capacities to meet the monthly upstream irrigation requirements for the current allocations will be established by WRYM modelling of off-channel dummy dams.

Engineering assessments with cost estimates will be prepared, to decide whether the required off-channel volumes can best be provided by raising existing dams and providing summer releases or by constructing new dams (taking their Reserve release requirements into account). For this purpose, information on existing dams will be obtained from the register of farm dams from the Dam Safety Office and from Dam Safety Reports, and the impact can be established to determine if this option could be feasible.

Additional capacity of required off-channel dams will thus be established and the feasibility of allocating additional yield for upstream irrigation will be determined.

c. Impact of raising on new off-channel storage schemes downstream of Bulshoek Weir (Ninham Shand, Jakoet)

Additional relevant information from the WODRIS study scenarios regarding off-channel diversion schemes from the Doring River will be obtained. Information on the duration and frequency of pumping will be required. A table of available information regarding off-channel diversion schemes will be compiled.

A daily flow diversion function will be developed from daily or hourly records for use in the WRYM to investigate the impacts of the raising of Clanwilliam Dam on a typical off-channel storage dam downstream of Bulshoek Weir. The diversion at a representative diversion point will be checked for the revised flow regime vs. the original flow regime for the most likely raising level of the dam wall, as well as its impact on the sizing of such an off-channel dam. Because water quality becomes a factor further down in the catchment, recommendations on water quality aspects will also be made.

For off-channel dams below the confluence of the Olifants and Doring Rivers, it will be necessary to use a model for the entire Olifants/Doring catchment area, to develop the flow diversion

function. The model from the High Confidence Reserve study would be utilised to determine flows and abstraction patterns.

Recommendations will be made on the impacts that the decision to raise the dam could have on the possible downstream off-channel dams. Operational recommendations will also be made regarding required releases from Clanwilliam Dam and on abstraction patterns.

d. Alien Vegetation (Ninham Shand)

Information on the current situation with regard to the alien infestation will be obtained from Working for Water (WfW). This would include the extent and distribution of the infestation, the current as well as the proposed WfW projects in the area and the quantity of riparian vs. other infestation. This will be compared with the alien infestation information as used in the previous study.

The assessment of the impacts of stream flow reduction (SFR) of both afforestation and alien infestations on system yield will be based on existing monthly sequences of afforestation and/or alien "water use", which will be incorporated as "demand files" in the system model. The upland alien vegetation SFR sequences will be evaluated and revisited if necessary, based on the CSIR age-biomass-stream flow reduction model. In the case of riparian alien vegetation, it is recommended that the SFR sequences be re-assessed based on a new method which has been developed by Ninham Shand, assisted by the University of Stellenbosch and the CSIR, as part of a Water Research Commission (WRC) project entitled *The development of guidelines for the treatment of scale and resolution in assessing the stream flow reduction impacts of alien plant infestations and commercial afforestation in integrated water resource management*. In addition, some of the recommendations and guidelines of the above WRC project with regard to the impacts of SFR on system yield will be incorporated in the system analysis and might necessitate minor changes to the system model configuration.

Current costs for clearing will be obtained and the unit rate of clearing of aliens will be established, both above the dam and between Clanwilliam Dam and Bulshoek Weir, in the riparian zone. Conclusions will be drawn on the effect of clearing activities in specified areas, as well as its consequent effects on the social environment, taking factors such as job creation into account. Recommendations will be made on further clearing as an augmentation option, weighing up the need to make water available through clearing against the standard policy of first clearing lightly infested areas.

Expected yield resulting from specific clearing operations will be determined, and an outline of the social benefits will be provided.

e. Farm Dam Releases/Ban on Summer Abstraction (Jakoet, Ninham Shand)

To undertake this task adequately calls for a survey of the capacities of all existing farm storage dams to establish their actual capacities and their legality in terms of the current and previous Water Acts. This of course carries a large cost. If such a survey has not been undertaken, recommendations will be made on undertaking such a survey. Information on any available field surveys will be sourced. Effectively dealing with illegal dams could relieve much of the water stress. The DWAF has however undertaken to map the areas of farm dams.

We propose that the number of farm dams and capacities, as available from the register of farm dams from the Dam Safety Office, as well as from dam safety reports and previous studies and the updated information to be provided by DWAF be used to ascertain the status of farm dams. Typical dams for Class 1 and Class 2 dams will be selected and their outlet capacities will be assessed. Additional means of letting the IFR through the dams will be assessed, such as

pumping or siphoning, or raising and filling from their own catchments. Options for meeting the IFR will be assessed and recommendations will be made. These recommendations will be discussed with representatives of the irrigation boards.

The requirement to investigate off-channel storage has been covered under **Section 3.2.6b**.

Recommendations on meeting the required IFR releases from farm dams will be provided.

f. Reporting

Results will be evaluated and included in the System Analysis Report.'

3.2.7 Groundwater resources (Umvoto Africa)

a. Task objective

It was recognised during the Olifants Doring Basin Study (DWAF, 1999) that there is significant potential for groundwater use from the Nardouw and Peninsula Aquifers of the Table Mountain Group (TMG). The recent CAGE and Danida studies have confirmed this. The Provincial Government of the Western Cape undertook an integrated water resource study in the area below the Clanwilliam Dam, known as the Western Cape Olifants-Doring River Irrigation Study (WODRIS) project. Groundwater supply from the TMG was recommended as a viable and cost effective option for irrigation supply. If these fractured rock and primary aquifers upstream and downstream of the Clanwilliam Dam could be developed to supplement the existing supply, there would be more flexibility with regards to the allocation and use of the additional yield from Clanwilliam Dam. Such groundwater could be used in conjunction with off-channel farm dam storage, relatively close to the sites of the demands. Downstream of Clanwilliam Dam groundwater could be used locally, or reticulated in the canal, or discharged directly into the river, up to the confluence with the Doring River.

The study's original scope of work had a very limited groundwater component, which did not allow for the evaluation of conjunctive surface water/groundwater use options, neither did it allow for a comprehensive review and revision of aquifer specific groundwater potential for planning purposes in the study area.

b. Task inception

i. Synthesis and comparison of results and approaches developed in various studies

It is necessary to integrate the results and approaches of the numerous studies undertaken at different scales and for different purposes, in the context of different conjunctive use scenarios/options arising from the raising of the Clanwilliam Dam. Based on this synthesis critical data gaps will be identified for those aquifers which are considered to be suitable for planning of large-scale groundwater supply.

These numerous previous studies have approached resource assessment from different perspectives and for different reasons. It is necessary to integrate the results in a basin hydrogeology context and for the purpose of resource evaluation, development and management. It is important to extract the useful hard data contained therein. The different approaches used and the extent to which conclusions are based on hard data scientific theory or opinion will be reviewed, to optimise the input and improve confidence into the resource evaluation to be undertaken.

ii. Hydrocensus to update usage and drilling results and obtain datum-monitoring information

In 1998 a comprehensive hydrocensus was undertaken in the E10 as part of the CAGE study and follow-up monitoring was undertaken. More recently a WRC funded study has undertaken a hydrocensus in the area and monitoring has been relatively intense during the ongoing Sandveld studies funded by the D: RDM of DWAF. There is therefore a wealth of information, and even if somewhat restricted in time and place, a set of time series data that warrants evaluation. It is necessary to establish the relevance of the data set(s) to resource evaluation. This would be a function of where the boreholes that have been monitored are situated, with respect to the proposed "hydrotects", what pump regime records are available and from which boreholes, to what extent do these records tally with registered groundwater usage ? etc. Critical data gaps will be identified and field hydrocensus information will be obtained as needed.

iii. Retrieval of rainfall collectors, sampling, analysis and calibration of recharge estimates

Recharge, whether established over one year or more, is the limiting factor in sustainable resource evaluation. The various groundwater studies undertaken have provided different recharge estimates, all with differing results and using different methods over different study areas. To date there has been no critical review of any method used or any calibration of any study result. The results are sufficiently divergent to warrant examination. It is necessary to collect cumulative rainfall samples and analyse them for chloride content, oxygen and deuterium isotopes, in order to calibrate the recharge values obtained to date, and to select a subset that mostly closely cohere, and are supported by the hydrochemical based estimate of recharge.

c. Reconnaissance level investigation

i. Identification of preferred wellfields and cross section preparation

There is reasonable regional scale structural information available, arising from the CAGE and WODRIS studies. This data has not been evaluated with a view to selecting target zones in which wellfield development could be considered. There is also no site-specific information within any possible target zones. This is needed to establish storage potential, in a volume of the aquifer likely to be accessed in any particular wellfield, and optimal position of target sites and relationship to surface water features or discharge sites of the different aquifers. Detailed evaluation of available structural data, identification of target zones and field reconnaissance work to select target site areas within target zones is needed.

ii. Preliminary field and desktop evaluation of impacts of abstraction

A key concern and currently the most limiting factor on groundwater resource development is the perception that if the confined portions of the Peninsula and Skurweberg Aquifers are pumped that springs and seep zones will be significantly impacted upon. Whilst any development of a resource will result in changes in natural patterns it is necessary to place these changes in the context of the society, the economy, longer term changes such as climate change, local and regional natural resource development and planning. Through desktop evaluation and preliminary field reconnaissance, the most likely zones of impact will be recommended, as well as where monitoring should take place, together with the recommended frequency of monitoring. Monitoring and maintenance cost will be included in unit reference value (URV) calculations.

iii. Preliminary borehole design and costing

The costs for drilling boreholes can vary widely depending upon the depth to be drilled, the start diameter, the drilling method, access issues, servitude issues inter alia. Based on the results of preceding sub-tasks, preliminary boreholes will be designed and costed as input to establishing the URV cost.

iv. Development of scenarios for conjunctive use and cost

Based on the wellfield yields and the positions thereof, various conjunctive use scenarios will be determined, either using the Clanwilliam Dam, or for individual users, e.g. resource-poor farmer developments, should they be appropriately situated; or to recommend water trading to promote resource-poor farmers without limiting current use.

v. Refinement of groundwater resource values

From the Internal Strategic Perspective (ISP) study it became clear that there were differences between the values as stated for the groundwater resource in the NWRS, previous studies and the ISP study itself. In finalising any resource estimates these numbers must be reconciled, differences understood and final selection should be well motivated. These numbers will be refined on a wellfield-scale if possible, otherwise at quaternary level.

vi. Development of storage models for Nardouw and Peninsula Aquifers

Groundwater resource evaluation requires knowledge of recharge, discharge, how much groundwater can be stored and what the aquifer water table or piezometric level response is to abstraction. A preliminary model, based on physically measurable data of aquifer geometry and current water tables, is needed to establish the likely drawdown, given different aquifer geometry, to different volumes of abstraction. Appropriate models will be developed.

vii. Monitoring protocol design and recommendations for implementation

Recommendations will be made regarding monitoring requirements. Groundwater resource evaluations have in the past been asked for and undertaken as a once-off estimation. For historical reasons these evaluations have generally been based on sparse data sets without a statistically relevant data set. Any sustainable resource evaluation for which there is no historical data must be followed up with ground truthing and a well-defined programme to acquire that data in order to refine and improve these numbers is required. This is an essential component of groundwater resource evaluation without which the DWAF will not in due course realise credible values. The results of the ongoing monitoring could be used in subsequent phases as well as in regulatory decisions.

d. Data requirements

This task will rely on:

- The current comprehensive Reserve determination for surface water in the area to make any hydrograph analyses available for use to this study.
- Data or satellite digital imagery or data made available by DWAF from the SANDVELD, DANCED as well as any other studies funded by the RDM or other office since 1998 in the study area;
- Data made available by the WRC through DWAF arising from any WRC funded projects in the area; and

- DWAF monitoring data as well as monitoring data arising from other studies. e.g. Boschkloof wellfield monitoring and/or other monitoring.

Data, information and insights from the current DWAF and WRC funded studies in the area will be integrated into the groundwater resource evaluation. It is presumed that DWAF will obtain the relevant digital and hard copy data and reporting arising from these studies. It is presumed that all data and project reports as well as other results will be available timeously. Requests for data will be made in writing, and required formats will be specified. If data cannot be provided in these formats and if additional processing is required this will either be undertaken by DWAF or will be assessed as the need arises. In-house data and information will be used to the advantage of the study without charge.

e. Isotopic analyses of rainfall samples

It is assumed that the cost of isotopic analysis of rainfall samples (up to 10) will be carried by DWAF under existing contracts with the relevant laboratories. Similarly it is assumed that any hydrochemical analyses of macro or trace elements if required would be undertaken by the DWAF laboratory or at direct cost to DWAF. No such analysis has been planned since it is assumed that the results of the SANDVELD studies or currently funded WRC study would be available. It is at present not known whether these studies did analyse for full or selected trace elements.

f. Reporting and other deliverables

A Groundwater Resources Report will be produced. All raw data will be submitted in hard copy and in raw data files. Data will be provided to DWAF in the format or software used for data processing. All electronic data will be submitted in a format that can be imported or used in Excel. No GIS database development will be undertaken and there are no specific GIS deliverables for this study.

3.2.8 Irrigation

a. Current Irrigation and Irrigation Potential (ASCH, Soils Team, Laubscher)

Current scheduled areas and water allocations will be obtained from DWAF/WUAs/Irrigation Boards, including those areas supplied directly from Clanwilliam Dam. The DWAF has also undertaken to determine current irrigation areas from recent aerial photography, which would greatly increase the confidence of the modelled yields. Information will also be sourced from previous and ongoing studies. This information will be compared with the information used in the existing yield model.

Homogenous farming areas that will be affected by the dam raising development of the irrigation water source will be identified from mainly previous studies and mapped. In combination with the WODRIS soils data, data from other studies and expert knowledge, a soils map will be compiled for the Olifants River Basin from Keerom, south of Citrusdal, to the coast. The map will specifically focus on areas already identified for establishing resource-poor farmers, the inundation area of the dam, and the Olifants River south of the Clanwilliam Dam. Areas of unknown soils will however also be indicated. The lateral extent of the area covered will on average be about 60 m above the levels of the river or existing canals or an agreed horizontal distance away. An expert system approach will be used to evaluate the different soils in terms of likely physical and chemical limitations, amelioration measures and suitability for a variety of climatically adapted crops.

Soil suitability maps will be compiled. The average cost for chemical and physical amelioration measures will be determined on a soil type basis.

The effect of additional irrigation on communities in surrounding areas with irrigation potential would involve round table discussions with other experts as well as representatives from these communities.

b. Crop Types, Water Requirements and Level of Assurance (ASCH, Soils Team)

Extensive information is available from previous relevant studies. The Water User Associations and other groups will be consulted to provide additional information on irrigation practices in the study area. Information to refine the available data will be drawn from the Department of Agriculture, with regard to crop water requirements and irrigation system efficiencies. This information will be assimilated and used to inform the efficiency of existing use and make recommendations on future irrigation potential.

The required assurance of supply for both cash and permanent crops will be investigated for each crop type, and would entail the following:

- Collation of all the information dealing with suitable crops in previous reports on the Olifants River valley; information to be confirmed during workshops with producers/farmers and crop specialists.
- Gross irrigation water requirements will be determined by a combination of models including SAPWAT and the A-pan/crop factor approach. Round table discussions with climatologists would be undertaken to verify the raw climate data. The estimated requirements for a range of crops and localities will be confirmed during workshops in the study area involving producers/farmers and irrigation specialists.
- The necessity for average drainage (including system type and density) requirements per chosen evaluation area will be determined during a site visit in consultation with other experts.
- The agricultural development cost on a soil type/crop/locality basis will be estimated from soil classification information, chemical profile of the dominant soil types, and inputs from producers/farmers and other technical advisors during workshops, per chosen area and evaluation ranges. During these workshops the level of assurance of supply of irrigation water can also be determined.

Deliverables will include:

- Maps of homogenous farming areas and soil suitability;
- Allocated *vs*. actual water use details;
- A list of the crops suited for the particular irrigation areas along with their specific water requirements;
- The various types of irrigation systems in use and irrigation system efficiency;
- Agricultural development costs for various areas and agreed ranges.

c. Reticulation System – existing systems and upgrading implications (ASCH)

The Water User Associations will be contacted to provide information on the existing operation of the dam. From the information obtained, a number of options for improving the utilisation of the reticulation system and for distributing higher volumes will be identified and evaluated. These will include:

- Development of a new canal system,
- Increasing the number of hours of operation (including weekends);
- Reducing the losses in the system by improved operation.

- Lessons learnt in the Breede River Basin Study will be used, including remedial measures to reduce seepage losses;
- Provision of off-channel storage to be filled during the winter months by pumping from the canal or river;
- Raising the level of the canal;
- Providing balancing storage along the canal;
- Releasing from the Bulshoek weir and pumping into the canal further downstream. The impacts of water quality and the Reserve will have to be considered; and
- The possible application of the Water Administration System (WAS) Model that effectively manages releases for abstraction downstream will be evaluated.

All of these options, as well as any other options that will be identified will be considered both individually as well as in combination to make recommendations.

The relevant DWAF Directorates (Water Use Efficiency and Hydrology) will be advised on the means of gauging the evaporation and seepage losses and releases from Bulshoek Weir. Experience gained on the Kalkfontein and Orange-Riet systems for the Directorate of Water Use Efficiency will assist in identifying the most appropriate procedures for DWAF or the WUA to undertake seepage loss tests and assessments of the canals.

The problems of the resource-poor farmer community at the end of the canal will be evaluated and recommendations will be made to improve their situation.

Deliverables will include:

- The advantages and disadvantages of each option for upgrading the existing infrastructure;
- A recommendation will be made on the need to upgrade the existing canal system or whether other measures may be more appropriate;
- Recommendations on canal seepage tests and seepage losses from Bulshoek Weir;
- Recommendations on the adequacy of and improvements to the supply to the resource-poor farmer community at the end of the canal system.

d. Water Demand Management (Ninham Shand)

Conveyance losses, irrigation methods, scheduling, soil preparation, crop selection, crop yield targets, evaporation and preventative maintenance programmes all affect the efficient use of water. The consultant will familiarise himself with the operation of the canal and other related infrastructure and obtain relevant plans and information as needed. Water Management Plans (that should detail their WDM targets and plans) of WUAs will be sourced, if available. Site visits will be arranged in conjunction with meetings with Water User Association representatives. Current conservation and demand management practices will be compared with best management practices and guidelines as produced by DWAF as well as experience gained by the consultant on the Kalkfontein and Orange-Riet systems for the Directorate of Water Use Efficiency and from WRC studies on losses from rivers and canals. Options available for improved demand management will be identified for each type of current irrigation system in use and recommendations will be made to improve efficiency and save water. A current status interim report, including recommendations, will be prepared.

A report detailing the current demand management situation and recommendations for improved demand management practices will be written.

e. Operating rules (Ninham Shand, Jakoet)

The current operating rules of both the dam and the canal will be obtained and reviewed. Previous recommendations for curtailment during droughts (linked to required assurances of supply) will also be reviewed utilising the WRYM. Increased operational hours for the canal system will be evaluated and the current dry period will be reviewed against required irrigation and maintenance practices.

Once the Reserve and changes in assurances of supply are known, any requirements to change current release patterns will be identified and the rules will be modified as needed.

Updated operating rules for the dam and the canal system will thus be provided.

f. Telemetry (ASCH)

The operation and function of the current manually operated gates will be reviewed, in liaison with the operators thereof to inter alia establish the efficiency of the system. Safety aspects and the likelihood and implications of vandalism will be assessed and information provided on good working examples of automated gates. The requirement for technical backup systems and requirement for other instrumentation that registers water levels at critical operational locations will be assessed.

A recommendation on the feasibility and desirability of installing a centrally controlled telemetric system for automated gates and other required instrumentation would be provided.

Telemetry was also addressed in the recent study undertaken by LORWUA on the state of the canal. Because the report is not yet available, it is not clear how work undertaken in that study will affect this sub-task.

3.2.9 Preliminary design and cost estimate

a. Preparation (DWAF)

i. Pertinent information

A comprehensive list of previous reports and drawings relating to the dam will be compiled.

ii. Investigations

- *Geotechnical:* A geotechnical investigation will be conducted to establish the quality of the foundation material and availability of suitable construction material. Issues relating to rock permeability at the dam wall and surrounding area will also be investigated.
- *Flood Hydrology:* An updated flood hydrology report will be compiled for flood magnitudes with an exceedance probability between 50% (1:2 year) and 0.5% (1:200 year), as well as for extreme floods.
- *Sedimentation:* A new sediment survey will be conducted to establish the latest sediment levels in the dam. The additional cross-sections that are required for the backwater calculations will also be surveyed.

b. Conceptual Design and Drafting (DWAF)

Four designs will be considered: a "dam safety design" to address the stability of the structure and three levels of raising the full supply level (FSL), *viz*. 5 m, 10 m and 15 m.

i. Type of Spillway

During the reconnaissance study the design of the spillway was based on an ogee-type spillway with the same length as the existing spillway. The latest hydrological report will be used as basis for refinement of the design. Outflow hydrographs and water levels (upstream and downstream of the dam wall) will be calculated for the different options.

ii. Method of Raising

In the reconnaissance study a fixed raising with RCC was proposed as the preferred method of raising the dam. The results of the geotechnical investigation will confirm the feasibility of this option. In the event that the geotechnical results pan out differently the method of raising the dam would be revisited. The proposed structure will be designed in accordance with current DWAF practises. Attention would be given to the existing ARR problem and possible shear and seepage problems that may be arise from the raising.

iii. Type of Outlet Works

The conceptual design of the outlet works will be governed to a large extent by the quality and quantity of releases required for irrigation and environmental purposes. The Comprehensive Reserve Study that is currently underway will establish realistic environmental releases and to some extent the type of inlets and outlets that may be required. The study team will advise on water quality considerations as described under Section 3.2.4.

iv. Purchase Lines

A backwater analyses will be conducted to establish flood levels for the dam safety option and the different raising options. Sedimentation will be taken into consideration. The purchase lines will be established based on current DWAF policy. The results will be provided on 1:10 000 orthophotos with 5 m contour intervals.

v. Site Layout

A conceptual site layout will be done to indicate the position of access roads, quarries, crusher plant, stockpiles, batching plant, workshops, site offices and single quarters.

c. Costing and Scheduling (DWAF)

Full cost estimates, based on the conceptual design, will be prepared, and will include, as clearly identifiable entities, the initial capital costs and the budgetary operations and maintenance costs. Capital costs will be all-inclusive and will include all contractors' costs, engineering costs (including site surveys), foundation and materials investigations and construction supervision, contingencies, access roads and environmental mitigation costs. Capital cost will be broken down into the major cost components. DWAF construction unit rates will be used. Financing costs and provision for escalation will be excluded, as well as expropriation costs and the cost of relocating infrastructure.

d. Infrastructure Implications of raised FSL (Ninham Shand, ASCH)

The map provided by DWAF will be used to identify inundated infrastructure, lands, housing, etc. The affected land and infrastructure at the various levels of raising as previously identified will be verified and some ground-truthing will be undertaken. Cost implications as developed in the Reconnaissance Study Report will also be reviewed and updated. A description of the roads and other infrastructure and land affected by inundation and associated cost estimates thereof for the range of raising scenarios will be provided.

e. Report Compilation (DWAF)

A design report with the relevant drawings will be compiled in which the different options will be evaluated.

3.2.10 Financial and economic analysis

a. Impact analysis for various dam raising scenarios

i. Unit Reference Values (Jakoet, Ninham Shand)

Costs relating to the enlargement of canal infrastructure will be determined, if required, as well as estimates of typical off-channel diversion and dam infrastructure, both upstream and downstream of Clanwilliam Dam. Operation and maintenance costs will also be determined. Cost estimates relating to the raising of the dam and the accompanying safety remedial works will be obtained from DWAF, whereas estimates for the relocation of infrastructure will be obtained from this study (**Section 3.2.9c**). Updated costs are available from the Breede River Basin Study and will be updated for this study. Financial analyses for various dam raising scenarios for an appropriate range of discount rates will be calculated, yielding URVs.

The agreed range of scenarios for which cost-benefit analyses will be undertaken will be finalised in consultation with DWAF. Cost-benefit analyses for the identified range of scenarios will be undertaken, including the effect of reducing system losses on the URVs. The life expectancy of existing infrastructure will also be taken into account.

ii. Economic Implications (Urban Econ)

The purpose of this element will be to quantify the importance of agriculture in the regional economy. Agriculture generates the second largest contribution towards the regional economy, which implies that it is a very significant sector. Recent decreases in agricultural input into the regional economy have not been caused by a decrease in the production output of agriculture, but rather by an increase in the outputs by other sectors, most notably mining.

The study will involve a more detailed assessment and analysis on the internal structure of the regional and the local economies. This will include an assessment of the labour profile. The proportion of the agricultural production that can be directly attributed to the three irrigation areas in the study area will also be determined. The significance of this profile is that it provides a macro perspective on the economic significance of agriculture, with particular reference to the production outputs and its multiplier effect on the regional economy.

This perspective presents the basis to determine the possible impacts of various scenarios of raising the height of the Clanwilliam Dam wall and the way in which the water is allocated. The economic implications can be divided into two phases, namely the construction phase, and the post construction phase.

Construction Phase

The Construction Phase involves the impact on the economy during the construction of the dam wall. This impact involves a number of elements such as:

- Cost of the land and infrastructure to be affected by the raising of the dam. The current value of this capital infrastructure, as well as the cash flows will be

determined, projected for a specific period and then discounted to determine the current value. This will establish the quantum of the financial mitigation.

- Impact on the economy as a result of the construction of the dam and /or the development or rehabilitation of the canal. This is calculated, based on variables such as the capital value of the investment, and the number of employment opportunities. The Input / Output Model will be used and the findings can be expressed in terms of:

  - Total number of additional employment (direct and indirect);
  - New business sales (i.e. for the purchases of construction material, hiring of construction equipment, etc); and
  - Taxes (the total increase in taxes payable to government).

This "injection" into the local and regional economy will be driven by the construction sector, with indirect inputs from some of the other sectors such as transport, manufacturing and finance. It is important to note that this injection will be a once off and will not be sustainable on its own. However, the increased production rates in agriculture, due to an increase in the amount of water available, will be sustainable.

Post-construction Phase

The Post Construction Phase refers to the effect of the change in the amount of water available to both upstream and downstream farmers (commercial and resource-poor farmers).

The impact will largely be based on the cash flows of the individual farmers (as reflected by the micro economics). Factors that will impact on the annual cash flow include the possible increase in their water tariff to recoup the costs of the capital investment in the dam and/or canal. Of particular importance here is to distinguish between the existing commercial farmer and the emergent or resource-poor farmer. The Western Cape Government is planning to settle a large number of emergent farmers, and this scheme may offer the opportunity to implement this.

For the purposes of these calculations, it will be assumed that the crop profile of the upstream (mainly citrus) and downstream (mainly grapes) will largely remain the same. However, the scheme may also provide the opportunity to unlock the latent potential for new crops with higher values. Also, the possibility of further beneficiation of these agricultural produces will add value to the local and regional economies. These possible benefits will also be highlighted.

The micro economic agricultural information will be translated into different scenarios, which can then be modelled to determine the different impacts that each scenario could have on the economy.

This will involve a recommendation on the most preferred option regarding the height of the dam wall, and / or the rehabilitation of the canal.

Deliverables will include:

- URVs for a range of dam raising scenarios and an appropriate range of discount rates;
- Economic impact analyses for a range of agreed scenarios;
- Recommendations on an optimal raising height; and

- Recommendations on the implications of a zero raising and a zero raising plus a reduction in system losses.

iii. Upgrading of canal infrastructure versus dam raising (Ninham Shand, Jakoet)

The various options as identified in **Section 3.2.8c**, relating to the upgrading of the canal infrastructure, will be costed, taking into account information forthcoming from the seepage tests, to be conducted by DWAF. Envisaged costs purely related to betterments will also be established, following liaison with DWAF and the operator of the system, and on-site inspections if necessary. The required cost of upgrading will be compared to the envisaged cost of raising the dam (as provided by DWAF) and used in the cost/benefit and impact benefit analyses.

Pilot projects to reduce unaccounted-for water, as identified in the water demand management investigation, which is addressed in **Section 3.2.8d**, will be recommended.

Comparison between the cost of upgrading the canal infrastructure and the option of raising the dam will be provided, taking the required betterments into account.

iv. Upstream versus downstream development (Jakoet, Laubscher)

Typical costs of raising or constructing off-channel dams will be determined. The procedures, as put forward in the Yield Analysis Task, regarding off-channel diversion functions will be followed. From the results obtained, the balance between upstream and downstream use and the economics of development will be quantified and compared. Recommendations concerning the relative importance of upstream and downstream irrigation development, in terms of crop types and their economic significance will be provided. This information will be utilised as part of the inputs in measuring/modelling the impacts to the micro and macro economy.

v. Financial implications for individual farmers (Laubscher)

The appropriate farming models for each farming area will be determined, both above and below Clanwilliam Dam and downstream of Bulshoek Weir. All existing input and output costs will be taken into account, including the additional costs of water associated with the raising of Clanwilliam Dam, upgrading of canals and off-channel storage. This will be done with the aid of workshop sessions with leading farmers and other industry experts from the farming areas. As this can be seen as an investigation into the irrigation potential of the regions, an explorative approach (i.e. normative farming models) to the study is seen as appropriate.

The effects on the cash flows of farms will be determined for existing conditions, for increased assurance of supply, increased development and the development of new farms. Employment opportunities will also be assessed. This approach for commercial farmers will also be utilised to assess the financial requirements and viability of resource-poor farmers.

A financial viability analysis of each typical farming situation will be conducted. The following decision-making criteria will be employed:

- The expected internal rate of return on capital employed;
- The nett present value of the expected cash flow per m^3 of irrigation water consumed;

- The expected cash flows and break even years of the typical farms at different owner's equity ratios; and
- Financial sensitivity analysis for important factors as output value (i.e. product prices and output) and discounting rates.

The financial viability analysis will be dependent on relevant information regarding the expected costs of irrigation water.

vi. Socio-Economic benefit

The socio-economic benefits of employment opportunities and socio-economic upliftment of the region will be addressed under **Sections 3.2.5c(iv)** and **3.2.10a(v)** respectively as well as under **Section 3.2.11** on resource-poor farmers. This will provide an assessment of job opportunities and income upliftment for the historically disadvantaged residents of the region.

3.2.11 Resource-poor farmers

a. The Need for Regional Social Upliftment (Ninham Shand, Jakoet)

The Olifants River valley is characterised by significant income and social disparities and fluctuating seasonal unemployment. The October 2001 draft of the Joint Agricultural Water Use Policy commissioned by the Co-ordinating Committee on Small-scale Irrigation Support promotes a dual objective to combat poverty and set historically marginalised people on a growth path through agricultural water use initiatives. The dual objectives are:

- Improved food security through own production; and
- Mainstreaming historically disadvantaged farmers in the local, national and international economy through active support and market development.

Any serious effort to mainstream the marginalised through the use of agricultural water in the Olifants River valley will have to start with the envisioning of a shared desired future by local people who are serious about actively building a new future. The vision will have to be cognisant of:

- Opportunities and limitations relating to the inherent profitability and sustainability of agriculture in South Africa;
- Strata of needs and opportunities, representing a continuum from household food security to the interests of agri-business;
- "Start big, fall hard", or the principle of addressing development at a level that people can relate to, and incrementally realise within their growing means;
- Lack of knowledge of and experience with the development of successful small-scale farming; and
- Support needs, as reflected in the sustained government support that contributed to the success of latter-day commercial farming operations.

This task requires detailed understanding of the specific circumstances and social milieu of the Olifants River valley. Therefore, the generalities will be augmented by focus group meetings held as part of the social, economic, public participation and agricultural tasks.

Specific information on the regional social circumstances will be derived by observation and consultation and included in the social impact, economic and agricultural tasks in order to verify the need for regional social upliftment.

b. Opportunities provided by the Scheme (Ninham Shand)

There is a clear need for coordination between departments and institutions to plan and support new farmer development through the Irrigation Action Committee and other institutions.

The study will identify rural agricultural development opportunities that are offered by the state, and facilitate strategies to co-ordinate and implement these government-funded schemes. These will include, amongst others:

- DWAF – Subsidies of up to R10 000 per hectare to Water User Associations on schemes for previously disadvantaged farmers;
- National and provincial departments of agriculture – Grants of up to R10 000 per individual on-farm and off-farm infrastructure, and an Irrigation Improvement Scheme with subsidies of up to R7 500 per individual;
- Department of Land Affairs – Grants of between R20 000 and R100 000 per individual;
- Department of Public Works – Funding of infrastructure delivery projects and start-up grants of up to 10% of total project cost;
- Department of Health – Grants for community gardening to increase household food security; and
- Land Bank – Incremental low interest rate schemes for emerging farmers.

Furthermore, the study team will liaise with the African Business and Manufacturers Development Association with respect to their Emerging Farmers Development Project. Again, this task entails significant overlap with the social, economic and agricultural tasks.

A report that highlights the need for broader investments and identifies support programmes to ensure the sustainability of any resource-poor farmer initiatives will be provided.

c. Models for Establishing and Sustaining Resource-poor Farmers and the Implications for Government (Laubscher, Nosipho)

Any project to assess the financial viability of irrigation farming and achieve successful establishment of new entrants to irrigation farming must consider certain basic measures, i.e.,

- The provision of adequate training in managerial and farming skills;
- The provision of adequate and appropriate financial support;
- The development of appropriate farm ownership models;
- The development of suitable financial support systems to accommodate and encourage partnerships between new entrants and commercial farmers;
- The development of appropriate models for phased development of farming ventures for emergent farmers;
- The development of effective measures to prevent the establishment of informal residential townships on farmlands earmarked for emergent farmer developments;
- The provision of adequate state- and private sector-assisted after-care in the form of managerial and technical support on new projects; and
- The identification of suitable appropriately resourced land for emergent farmers.

The study will address the relevant factors and recommend workable solutions, informed by the community, key stakeholders, and biophysical and socio-economic factors. Again, much of this task will be achieved in an integrated manner by the social, public participation, agricultural and economic tasks, which will all work closely together.

A report detailing achievable opportunities and strategies for establishing emergent farmers on irrigation projects in the Olifants River Valley will be written.

3.2.12 Public participation

a. Process (Nosipho)

An integrated public participation process (PPP) is crucial to the success of the study and will take cognisance of the Guidelines for Public Participation (DWAF, 2001 and 2003). The proposed PPP will entail targeting specific groupings (e.g. agricultural producers or Water User Associations), with an overall emphasis on meeting the requirements of the Environment Conservation Act and ensuring that all interested and affected parties are empowered to engage with the study. In this regard, the PPP will communicate all relevant information in the language of preference at a level that is clearly understood by different language communities.

The PPP comprises sub-tasks on:

- Establishing baseline information and database;
- Preparation of information and publicity documents;
- Developing an awareness campaign;
- Convening public meetings;
- Convening stakeholder forum meetings;
- Reporting and minutes; and
- Focus group meetings for specific interested and affected parties (I&APs).

A special effort will be made to get the stakeholders from historically disadvantaged communities, especially potential beneficiaries of new irrigation opportunities, involved in the process by the distribution of information leaflets, posters at public places and at the public meetings.

The PPP is integrated into the EIA process (see **Section 3.2.5**) and in various other study tasks as described below.

b. Participatory Irrigation Planning (Nosipho)

Focus Group Meetings and "one-on-one" discussions will be held to address specific needs and expectations. Many of these would take place with resource-poor farmers as part of the agricultural, economic, social and hydrological tasks.

The public participation process in general, and the participatory irrigation planning process in particular will build on existing development and sectoral forums. One of the outcomes of the PPP will be to identify established development and sectoral forums (e.g. Water User Associations, Catchment Management Agencies, RDP forum, agricultural union branches and irrigation boards) that would provide direct access to affected constituencies.

Such forums would be invited to provide feedback into the various tasks-and sub-tasks, and the EIA scoping process. All meetings will be documented and minutes will be disseminated to stakeholders.

This will culminate in the involvement of all interested and affected parties in the study and the hosting of various focus group meetings.

3.2.13 Main Report (Ninham Shand)

This task involves the analyses, interpretation and integration of results from the various tasks, culminating in making recommendations in the Final (or Main) Report. Summaries of findings of all the study tasks, as contained in the Inception Report, will be included, as well as recommendations on future required developments or studies.

3.2.14 Deliverables

a. Study reports

It is envisaged that the following reports will be produced:

- Inception
- Screening of options
- Water quality
- System analysis
- Groundwater resources
- EIA Reports:
  - Environmental scoping
  - Environmental impact
  - Environmental management plans
  - Environmental programme report
  - Specialist reports
- Irrigation and economic analyses
- Dam design
- Resource-poor farmers
- Analysis of options
- Public participation
- Main Report, inclusive of an Executive Summary

Individual reports will be produced during the course of the study, as well as a Main Report, including an Executive Summary. It is however possible that additional reports, which are not indicated, may be required. It may also be that not all the abovementioned reports are eventually required as stand-alone reports. Proposed changes to the suite of reports will be discussed with the Client before proceeding. The reports will initially be produced in draft format and will be provided to the Client and specified members of the SMC for comment and input.

b. Progress reports

Progress reports will be produced in the format as prescribed by the Client. It is proposed that progress reports be combined with every second Project Management Meeting, which will be an effective way to obtain comment on progress and provide opportunities for questions. Cost management will be addressed in the progress reporting to ensure adequate tracking and reporting of technical versus financial progress. A list of major project issues will accompany the progress report. The Progress Reports will describe operational issues that arise and progress toward dealing with them. The reports will be submitted to DWAF's Western Cape Regional Office, Directorate: Options Analysis, Sub-directorate: Abstraction and Storage, other local stakeholders and (if required) to the Stakeholder Committee members.

c. Other deliverables

In addition to various reports described, other deliverables arising from this study which do not form part of the reports such as maps, plans, etc. on suitable scales, indicating all relevant detail and data and information collected during the study will be made available to the Client if required.

The proposed implementation programme and associated cash flow will also be produced and revised during the study as required. Tri-annual cash flows for the DWAF budgeting process will also be provided.

d. Reporting formats

The consultant will present all the relevant information in a bound report or suite of reports. The report will also be submitted in the required electronic format. The Consultant will design and create a format where the complete set of reports will be stored on disc so that all information can be easily accessed and reproduced by using a Portable Document Format (PDF). The electronic format of the Report (CD) will be handed over to the Client together with the final report. All data that have a spatial reference will be captured in Arc/Info GIS.

4. PROJECT ADMINISTRATION

The success of a project of this nature is dependent on sound technical input and proper project management and financial control. The study team will give advice and make recommendations but the Client will make major decisions. Approval for such decisions will be obtained through the Client's nominated representative.

Ad hoc technical meetings will address specific technical issues. The input from operating staff at these meetings is of primary importance. The project associates will also conduct scheduled internal meetings to discuss and review designs, proposals and programming.

In summary, the following tasks will be undertaken under project management:

- Co-ordination of technical aspects and preparation and issuing of progress reports in terms of the client's requirements;
- Budget preparation, monitoring and other administrative matters;
- Monthly management and other intermediate meetings, including making all arrangements and keeping minutes; and
- Ensuring review of specialist outputs.

4.1 Client

The Department of Water Affairs and Forestry (DWAF) is the Client for the proposed study. The Directorate of Options Analysis of DWAF will administer the Study and undertake technical supervision, with Mr. Alan Brown as the Client's Study Manager.

4.2 Study Management Committee

A Study Management Committee, chaired by the Study Manager of the Client, will undertake the day to day management of the study. Three-monthly progress meetings by the Study Management Committee, to monitor progress and expenditure against the programme and to discuss and clarify issues which might arise, has been provided for, to issue supplementary brief directives if necessary. The meeting venues will be chosen on the basis of what is most practical and cost effective and as agreed with the Client. Seven meetings have been provided for.

The Consultant team will arrange Project Management Committee meetings, record proceedings of such meetings, make presentations at such meetings, distribute all agendas and minutes, and for undertake other related administrative tasks. The Consultant shall keep an up-to-date record of all decisions taken in the process of the study. The record shall identify the issues raised, findings of investigations and decisions taken.

4.3 Team composition

The study team comprises the consultants Ninham Shand, ASCH Consulting Services and Jakoet & Associates Consulting Engineers, which are operating in association as the Clanwilliam Dam Raising Association. The team comprises a core of competent people with excellent local knowledge of the study area. In addition to the firms in association, a number of sub-consultants and individual specialists are utilised on specific technical tasks.

The organogram of the project team is as shown in **Figure 4.1**.

4.4 Key personnel

Dr Mike Shand, of Ninham Shand, is the *Study Director*: He is located at the company's Cape Town office.

Mr Erik van der Berg of Ninham Shand is the *Study Leader*. He will co-ordinate the various activities, and is responsible for the day-to-day management of the study.

Mr Faldi Samaai of ASCH Professional Services is the *Assistant Study Leader*.

Mr Mike Luger of Ninham Shand is the *Task Co-ordinator* for biophysical and socio-economic tasks.

4.5 Task Leaders

The Task Leaders will manage the various tasks. They are responsible for directing and co-ordinating the personnel working on each task, as well as ensuring technical correctness and applicability. They will ensure that each task is completed within budget and time, to acceptable standards. Their responsibility is also to provide timeous and adequate warning of any problems encountered, which can either delay the study or result in budget overruns. The Task Leaders are listed in **Table 4.1**.

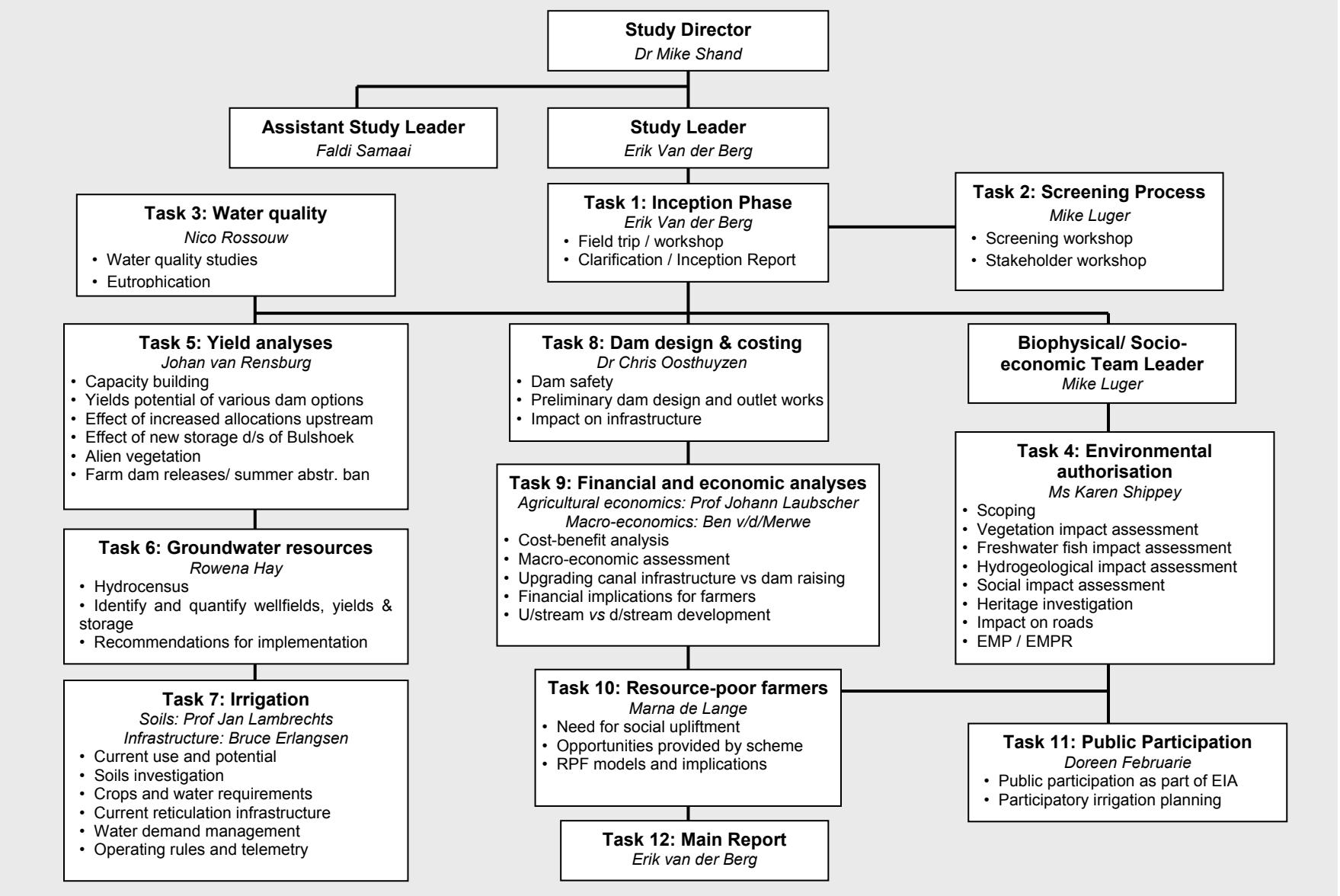

Figure 4.1 Study organogram

Table 4.1 Task Leaders

No	Task	Task Leader	Company
1	Inception	E van der Berg	Ninham Shand
2	Screening process	M Luger	Ninham Shand
3	Water quality	N Rossouw	Ninham Shand
4	Environmental authorisation	Ms K Shippey	Ninham Shand
5	Yield analysis	Prof A Görgens	Ninham Shand
6	Groundwater resources	Ms R Hay	Umvoto Africa
6	Irrigation: - Soils - Infrastructure	 J Lambrechts B Erlangsen	 Stellenbosch University ASCH Consulting
7	Dam design and costing	Dr C Oosthuyzen	DWAF
8	Financial and economic analyses: - Agricultural economics - Macro-economics	 Prof J Laubscher Mr B van der Merwe	 Stellenbosch University Urban-Econ
9	Resource-poor farmers	Ms M de Lange	IWMI
10	Public participation	Ms D Februarie	Nosipho Consulting
11	Main Report	E van der Berg	Ninham Shand

4.6 Study Team

Besides the Clanwilliam Dam Raising Consortium members, the following sub-consultants will be involved with the study tasks:

- Archeological Contracts Office
- Environmental Evaluation Unit, UCT
- Nosipho Consulting
- Umvoto Africa
- University of Stellenbosch
- Urban Econ

In addition, a number of individual specialists are utilised on specific technical tasks.

Individuals from Arcus GIBB and BKS have also been contracted to this study to ensure continuance from the WODRIS study, which is not yet complete.

5. PROGRAMME

The summary study programme for the main tasks is shown in **Figure 5.1.**

The two-year programme runs from February 2004 to January 2006. The extended Inception Phase has taken ten months to complete and the main study tasks will be undertaken over the following fourteen-month period. The draft Main Report will be made available within the programme. The programme would however require that the DWAF follows a short review process, especially for the Main Report.

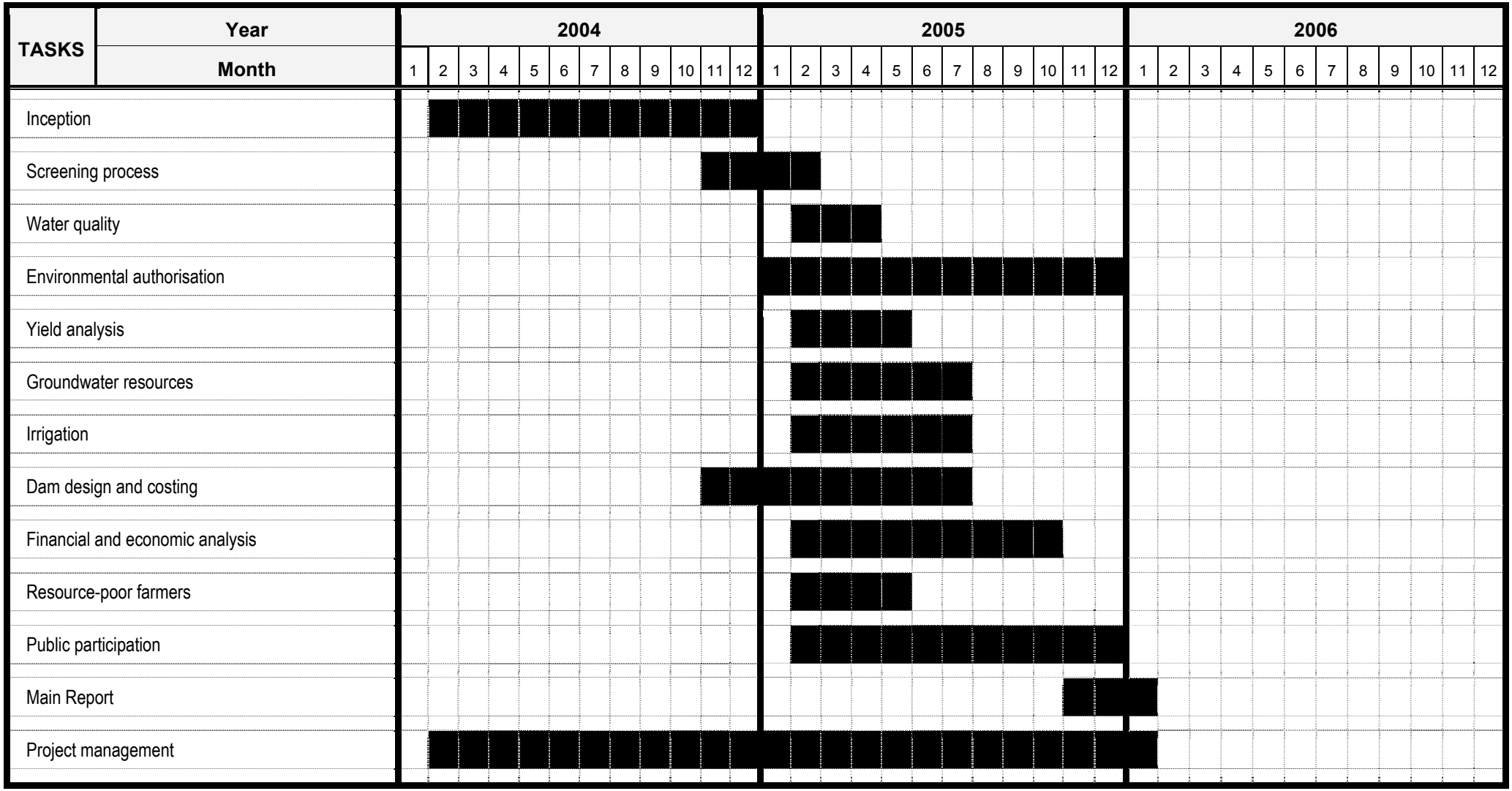

Figure 5.1 Summary study programme

6. COST ESTIMATE

6.1 General items

6.1.1 Form of agreement

The standard DWAF form of agreement is the legal binding document between the Client and Consultant.

6.1.2 Value added Tax (VAT)

All fee and cost items shown in this report exclude VAT, except where otherwise indicated.

6.1.3 Escalation of professional fees

Hourly rates in excess of R432/hour will be reviewed annually on 1 October each year and rates below R432/hour when salary increases take place, both subject to the clients' approval. A provisional allowance of R 143 000 has been made, in the cost estimate, for future escalation and increases in professional fees.

6.2 Professional Fees

Professional fees are determined according to the document *Policy Guidelines on the Remuneration and Reimbursement of Consultants* of DWAF and are contained in the Agreement. The cost estimate for professional fees for the study is shown in **Table 6.1** and is based on the programme presented in **Figure 5.1**.

A breakdown of the professional fees per study task is presented in **Table 6.1**.

Three tasks/sub-tasks, additional to the original scope of work, that have the most significant impact on the cost of professional fees are the following:

Task:	**Prof fees budget**
• Task 2 – Screening process (approved under Variation Order 1):	R 347 399
• Inclusion of the roads realignment and EIA process under Task 4 – Environmental Authorisation in terms of revised DWAF procedures:	R 459 139
• Task 6 – Groundwater resources Task, included upon request from DWAF:	R 590 510

These three additional tasks/sub-tasks therefore have a total professional fee budget of R1 397 048 (VAT excl.), comprising about a third of the proposed budget.

Table 6.1 Professional fees per study task

Task	Cost Estimate (Rand)
1. Inception	333 486
2. Screening process	347 399
3. Water quality	78 746
4. Environmental authorisation	1 014 003
5. Yield Analysis	216 379
6. Groundwater resources	590 510
7. Irrigation	357 977
8. Dam design and costing	32 666
9. Financial and economic analysis	254 810
10. Resource-poor farmers	89 982
11. Public participation	176 117
12. Main Report	47 268
13. Project Management	658 865
Total excluding VAT	**4 198 206**

The Human Resources, Time and Cost Schedule Table is included in **Appendix A**.

6.3 Disbursements

All external invoices will be recoverable at cost. Travel costs will be recovered at the rates advised by DWAF. The estimated disbursements are as listed in **Table 6.2**.

Table 6.2 Disbursements

Item	Cost Estimate (Rand)
Subsistence and accommodation	85 000
Air fares	18 000
Car hire	4 000
Meeting venues and sundries	25 000
Vehicle travel and parking	130 000
Photocopies	10 000
Documents and Reports	65 000
Miscellaneous	50 000
Total excluding VAT	**387 000**

6.4 Infrastructure Costs

An amount of R700 per month each is estimated for computer costs and for telephone and fax costs for the contract period (24 months) as shown in **Table 6.3**. It is accepted that the cost of digital projector usage is included in the cost of computer infrastructure.

Table 6.3 Infrastructure cost estimate

Item	Cost Estimate (Rand)
Computer (and digital projector)	16 800
Telephone and Fax	16 800
Total excluding VAT	**33 600**

6.5 Contingencies

No contingencies have been allowed for.

6.6 Summary of study cost estimate

The estimated total cost of the study, excluding escalation, is shown in **Table 6.4**.

Table 6.4 Total cost estimate

Item	Cost Estimate (Rand)
Professional Fees	4 198 206
Disbursements and Infrastructure	370 000
Infrastructure costs	33 600
Total excluding VAT	**4 618 806**
VAT	646 323
TOTAL INCLUDING VAT	**5 265 439**
Estimated escalation (@ 3% up to September 05 and 5% thereafter)	143 000
TOTAL INCLUDING VAT AND ESCALATION	**R 5 408 439**

6.7 Projected Cash Flow

The projected cash flow schedule for the study is shown in **Table 6.5**.

Table 6.5 Projected cash flow per financial year

DWAF Financial Year	Cash Flow (VAT incl.) (Rand)
2004/2005	1 650 000
2005/2006	3 615 439
Total including VAT	**5 265 439**

* For financial year 1 April to 31 March

* Excludes provisional allowance for escalation

6.8 Retention of Professional fees due

A retention amount of 10% is applicable. Half of the retention amount will be released upon receipt and acceptance of the suite of draft reports. The Client will then retain 5% of the study cost and this amount will be paid to the Consultant only after the completed final report(s) and information CD(s) have been delivered to and have been approved by DWAF. Retention monies may not be withheld unreasonably by DWAF.

6.9 Participation of historically disadvantaged individuals

6.9.1 HDI Ownership

The division of professional fees based on HDI Ownership and actual percentage of HDI Ownership are shown in **Table 6.6**.

Table 6.6 HDI Ownership : professional fees

Company	Professional Fees	% of Total	HDI Ownership
Ninham Shand	1 925 150	45.9	30
ASCH	473 270	11.3	100
Jakoet & Associates	150 356	3.6	70
Umvoto Africa	740 967	17.6	100
Nosipho Consultancy	135 268	3.2	100
ACO UCT	135 575	3.2	50
Urban Econ	139 319	3.3	0
EEU UCT	108 808	2.6	92
Soils Team	86 537	2.1	0
Agri-Economics Team	134 367	3.2	0
Botanical Team	107 520	2.6	0
M de Lange	16 160	0.4	100
D Impson WCNCB	8 484	0.2	0
Southern Waters	10 185	0.2	100
BKS	16 544	0.4	40
Arcus-GIBB	9 696	0.2	71
TOTAL	**R 4 198 206**	**100**	

6.9.2 HDI participation and fees earned

HDI participation per category of person is shown in **Table 6.7**. The original HDI participation was 30%.

Table 6.7 HDI participation and fees earned

Project Staff Category	Professional Fee Expenditure (R)	% of Total
Black male	840 913	20
Black female	243 988	6
White female	521 071	12
Disabled person	0	0
Sub-total	**1 605 972**	**38%**
White male	2 592 233	62
TOTAL	**4 198 206**	**100%**

APPENDIX A
Human Resources, Time and Cost Schedule

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
1. INCEPTION PHASE								
	M Shand	Study Director/ F	46	717.10	32987	W	M	N
	E van der Berg	Study Leader/ F	216	590.85	127624	W	M	N
	M Luger	Task Co-ordinator/ F	61	611.05	37274	W	M	N
	J van Rensburg	Key Support Staff/D	14	435.58	6098	W	M	N
	K Shippey	Task Leader/ E	34	399.70	13590	W	F	N
	N. Roussouw	Task Leader/ E	3	484.80	1454	W	M	N
	A. West	Support Staff/ C	108	223.05	24089	B	M	N
	N. Covary	Support Staff/ C	25	181.50	4538	W	F	N
	S. Swartz	Support Staff/ B	1	193.60	194	B	F	N
	C. Beuster	Support Staff/ A	9	129.60	1166	B	F	N
	N Tolobisa	Admin Support/ A	47	136.50	6416	B	F	N
	F Samaai	Assistant Study Leader/ E	28	575.70	16120	B	M	N
	D. Wilson	Infrastructure/ D	16	350.00	5600	B	M	N
	M. Jakoet	Study Director/ E	16	606.00	9696	B	M	N
	J Lambrechts	Task Leader/ D	20	318.15	6363	W	M	N
	J Laubscher	Task Leader/ D	20	371.18	7424	W	M	N
	R Hay	Groundwater Investigation/ E	20	636.30	12726	W	F	N
	N Mouton	Public Participation Co-fac./ B	12	159.08	1909	B	M	N
	T Hart	Heritage Impact Assessment/ D	20	226.95	4539	W	M	N
	A Kempthorne	Key Support Staff/ C	25	190.89	4772	W	M	N
	T Barbour	Social Impact Assessment/ D	20	445.41	8908	W	M	N
Subtotal			**761**		**R 333,486**			

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
2. SCREENING PROCESS								
	M Shand	Study Director/ F	29	717.10	20796	W	M	N
	E van der Berg	Study Leader/ F	82	590.85	48450	W	M	N
	M Luger	Task Co-ordinator/ F	56	611.05	34219	W	M	N
	K Shippey	Task Leader/ D	11	399.70	4397	W	F	N
	G. English	Key Support Staff/ D	104	484.80	50419	W	M	N
	A. West	Support Staff/ C	284	223.05	63346	B	M	N
	S. Swartz	Support Staff/ B	20	193.60	3872	B	F	N
	N Tolobisa	Admin Support/ A	10	136.50	1365	B	F	N
	F Samaai	Assistant Study Leader/ E	18	575.70	10363	B	M	N
	D. Wilson	Infrastructure/ D	18	350.00	6300	B	M	N
	E Jakoet	Hydrology/ B	18	200.00	3600	B	M	N
	J Loubscher	Task Leader/ D	8	371.18	2969	W	M	N
	R Hay	Groundwater investigation/ E	96	636.30	61085	W	F	N
	A Mlisa	Groundwater & GIS/ B	12	295.88	3551	B	F	N
	D Februarie	Task Leader/ D	38	318.15	12090	B	F	N
	N Wullshelger	Public participation support/ C	8	185.59	1485	W	M	N
	C Brown	Specialist/ E	20	509.25	10185	W	F	N
	A. Le Grange	Specialist/ E	14	636.30	8908	W	M	N
Subtotal			**846**		**R 347,399**			

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
3. WATER QUALITY IMPACTS								
	N Rossouw	Water quality/ D	68	484.80	32966	W	M	N
	W Kamish	Water quality/ C	120	381.50	45780	B	M	N
Subtotal			**188**		**R 78,746**			

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
4. ENVIRONMENTAL AUTHORISATION								
	B Alexander	Roads Task Leader/ E	20	717.10	14342	W	M	N
	D Nel	Task Leader/ E	20	717.10	14342	W	M	N
	D Rose	Roads Geotech Task Leader/ E	20	717.10	14342	W	M	N
	N Petersen	Key support roads/ C	20	358.75	7175	B	M	N
	D Marra	Support Roads/ B	30	112.50	3375	B	M	N
	D Castro	Task Leader/ E	30	656.25	19688	W	M	N
	A v Pletzen	Key support roads/ C	20	463.75	9275	W	M	N
	I Gordon	Key support roads/ C	30	315.00	9450	W	M	N
	E v/d Berg	Study Leader/ F	56	590.85	33088	W	M	N
	M Luger	Task co-ordinator/ F	84	611.05	51328	W	M	N
	K Shippey	Task Leader/ D	268	399.70	107120	W	F	N
	A Spinks	EMP, EMPR/ D	115	420.18	48321	W	M	N
	A. West	Support Staff/ C	400	223.05	89220	B	M	N
	N Zimmerman	Support staff/ B	18	217.50	3915	W	F	N
	S. Swartz	Support Staff/ B	40	193.60	7744	B	F	N
	N Tolobisa	Admin support T/A	48	136.50	6552	B	F	N
	F Samaai	Assistant Project Leader/ E	24	575.70	13817	B	M	N
	D. Wilson	Infrastructure/ D	24	350.00	8400	B	M	N
	O Jakoet	Roads Task Leader/ E	30	650.00	19500	B	M	N
	S Darries	Roads Task Leader/ E	60	550.00	33000	B	M	N
	I Britten	Roads key support staff/ C	80	358.00	28640	W	M	N
	C Bam	Roads CAD/ B	30	180.00	5400	B	F	N
	M. Jakoet	Study Director/ E	24	606.00	14544	B	M	N
	R Hay	Groundwater/ E	90	636.30	57267	W	F	N
	A Mlisa	Groundwater, GIS Support staff/ B	34	295.88	10060	B	F	N

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
4. ENVIRONMENTAL AUTHORISATION								
	B Mohamed	Groundwater, GIS Support staff/ B	34	169.68	5769	B	F	N
	D Impson	Fish Specialist/ D	32	265.13	8484	W	M	N
	C Boucher	Botanical Specialist/ D	220	424.20	93324	W	M	N
	US Student	Botanical Support staff	104	136.50	14196	?	?	?
	D Februarie	Task Leader/ D	40	318.15	12726	B	F	N
	T Hart	Heritage Impact Assessment/ D	256	226.95	58099	W	M	N
	D Halkett	Heritage Impact Assessment/ D	240	226.95	54468	W	M	N
	UCT Student1	HIA Support	180	52.55	9459	?	?	?
	UCT Student2	HIA Support	180	37.54	6757	?	?	?
	UCT Student3	HIA Support	60	37.54	2252	?	?	?
	B. van der Merwe	Task Leader/ D	40	371.18	14847	W	M	N
	A Kempthorne	Economics/ C	20	190.89	3818	W	F	N
	M Sowman	SIA Review/ D	48	466.62	22398	W	F	N
	T Barbour	Social Impact Assessment/ D	104	445.41	46323	W	M	N
	V Zenani	SIA Support/ B	80	190.89	15271	B	M	N
	M January	SIA Support/ A	100	159.08	15908	B	F	N
Subtotal			**3107**		**R 1,014,003**			

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
5. YIELD ANALYSIS								
	M Shand	Project Director/ F	4	717.10	2868	W	M	N
	A Gorgens	Task Leader/ F	28	717.10	20079	W	M	N
	E van der Berg	Project Leader/ F	13	590.85	7681	W	M	N
	J van Rensburg	Hydrology/ D	44	435.58	19166	W	M	N
	A Sparks	Yield Analysis/ D	216	420.53	90834	W	M	N
	G. English	Key Support Staff/ D	7	484.80	3394	W	M	N
	N Rossouw	Water quality/ D	16	484.80	7757	W	M	N
	E Walters	Engineering Support/ T/A	116	150.00	17400	B	M	N
	N Danti	Engineering Support/ T/A	60	120.00	7200	B	F	N
	E Jakoet	Hydrology Support staff/ B	184	200.00	36800	B	M	N
	H. Davids	Support staff/ B	16	200.00	3200	B	F	N
Subtotal			**704**		**R 216,379**			

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
6. GROUNDWATER RESOURCES								
	R Hay	Task Leader/ E	240	636.30	152712	W	F	N
	C Hartnady	Specialist/ E	80	630.00	50400	W	M	N
	C Riemann	Key support staff/ D	232	504.00	116928	W	M	N
	C Jackson	Key support staff/ D	96	344.40	33062	W	M	N
	L Groenewald	Support staff/ C	424	292.95	124211	W	M	N
	A Mlisa	Key support staff - GIS/ C	160	295.88	47341	B	F	N
	P Sibandze	Support staff/ A	392	168.00	65856	B	F	N
Subtotal			**1072**		**R 590,510**			

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
7. IRRIGATION								
	E van der Berg	Project Leader/ F	41	590.85	24225	W	M	N
	A Sparks	Yield Analysis/ D	16	420.53	6728	W	M	N
	G. English	Key Support Staff/ D	95	484.80	46056	W	M	N
	S.de Wet	Key Support Staff/ D	120	400.00	48000	W	M	N
	S. Swartz	Support Staff/ B	24	193.60	4646	B	F	N
	B Erlangsen	Infrastructure Task Leader/ D	114	400.00	45600	W	M	N
	S Nackerdien	Infrastructure/ D	60	400.00	24000	B	M	N
	D Wilson	Infrastructure/ D	80	350.00	28000	B	M	N
	E Walters	Engineering Support/ T/A	80	150.00	12000	B	M	N
	N Danti	Engineering Support/ T/A	160	120.00	19200	B	F	N
	C. Myburg	Support Staff/ T/A	50	90.00	4500	W	F	N
	J Lambrechts	Task Leader/ D	92	318.15	29270	W	M	N
	F Ellis	Soils key support staff/ D	80	318.15	25452	W	M	N
	B Schloms	Soils key support staff/ D	80	318.15	25452	W	M	N
	J Loubscher	Task Leader/ D	40	371.18	14847	W	M	N
Subtotal			**1132**		**R 357,977**			

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
8. PRELIMINARY DESIGN AND COST ESTIMATE								
	G. English	Key support staff/ D	6	484.80	2909	W	M	N
	N Rossouw	Water quality/ D	16	484.80	7757	W	M	N
	S Nackerdien	Infrastructure/ D	20	400.00	8000	B	M	N
	D Wilson	Infrastructure/ D	40	350.00	14000	B	M	N
Subtotal			**82**		**R 32,666**			

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
9. FINANCIAL AND ECONOMIC ANALYSIS								
	E van der Berg	Study Leader/ F	29	590.85	17135	W	M	N
	M Luger	Task co-ordinator/ F	16	611.05	9777	W	M	N
	N Tolobisa	Admin support T/A	16	136.50	2184	B	F	N
	E Jakoet	Hydrology/ B	152	200.00	30400	B	M	N
	J Loubscher	Task Leader/ D	214	371.18	79433	W	M	N
	B. van der Merwe	Task Leader/ D	215	371.18	79804	W	M	N
	A Kempthorne	Economics/ C	189	190.89	36078	W	F	N
Subtotal			**831**		**R 254,810**			

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
10. RESOURCE-POOR FARMERS								
	M Luger	Task Co-ordinator/ F	16	611.05	9777	W	M	N
	J Cullis	Key support staff/C	108	245.40	26503	W	M	N
	J Loubscher	Task Leader/ D	80	371.18	29694	W	M	N
	M de Lange	Task Leader/ E	32	505.00	16160	W	F	N
	D Februarie	Task Leader/ D	16	318.15	5090	B	F	N
	N Mouton	Public Participation Co-facilitation/ B	8	159.08	1273	B	M	N
	N Wullshelger	Public Participation Support/ B	8	185.59	1485	W	M	N
Subtotal			**268**		**R 89,982**			

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
11. PUBLIC PARTICIPATION								
	M Shand	Study Director/ F	16	717.10	11474	W	M	N
	E van der Berg	Study Leader/ F	20	590.85	11817	W	M	N
	M Luger	Task Co-ordinator/ F	20	611.05	12221	W	M	N
	K Shippey	Task Leader/ D	10	399.70	3997	W	F	N
	A. West	Support Staff/ C	48	223.05	10706	B	M	N
	N Tolobisa	Admin support T/A	16	136.50	2184	B	F	N
	F Samaai	Assistant Project Leader/ E	16	575.70	9211	B	M	N
	D Wilson	Infrastructure/ D	16	350.00	5600	B	M	N
	M. Jakoet	Study Director/ E	16	606.00	9696	B	M	N
	D Februarie	Task Leader/ D	189	318.15	60130	B	F	N
	N Mouton	Public Participation Co-fac./ B	129	159.08	20521	B	M	N
	N Wullshelger	Public Participation Support/ B	100	185.59	18559	W	M	N
Subtotal			**596**		**R 176,117**			

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
12. MAIN REPORT								
	E van der Berg	Project Leader/ F	80	590.85	47268	W	M	N
			80		**R 47,268**			

Task	Name	Study Responsibility/ Fee Category*	Time Schedule (Hours)	Hourly rate (R/h)	Cost (R)	HDI Status**		
						Race (B/W)	Gender (F/M)	Disability (Y/N)
13. PROJECT MANAGEMENT								
	M Shand	Study Director/ F	187	717.10	134098	W	M	N
	E van der Berg	Study Leader/ F	482	590.85	284790	W	M	N
	M Luger	Task Co-ordinator/ F	55	611.05	33608	W	M	N
	A. West	Support Staff/ C	60	223.05	13383	B	M	N
	N. Covary	Support Staff/ B	10	181.50	1815	W	F	N
	F Samaai	Assistant Project Leader/ E	207	575.70	119170	B	M	N
	D Wilson	Infrastructure/ D	35	350.00	12250	B	M	N
	M. Jakoet	Study Director/ E	70	606.00	42420	B	M	N
	A. Le Grange	Specialist/ F	12	636.30	7636	W	M	N
	J. du Plessis	Specialist/ D	24	404.00	9696	W	M	N
Subtotal			**1142**		**R 658,865**			
PROFESSIONAL FEES TOTAL			**10809**		**R 4,198,206**			